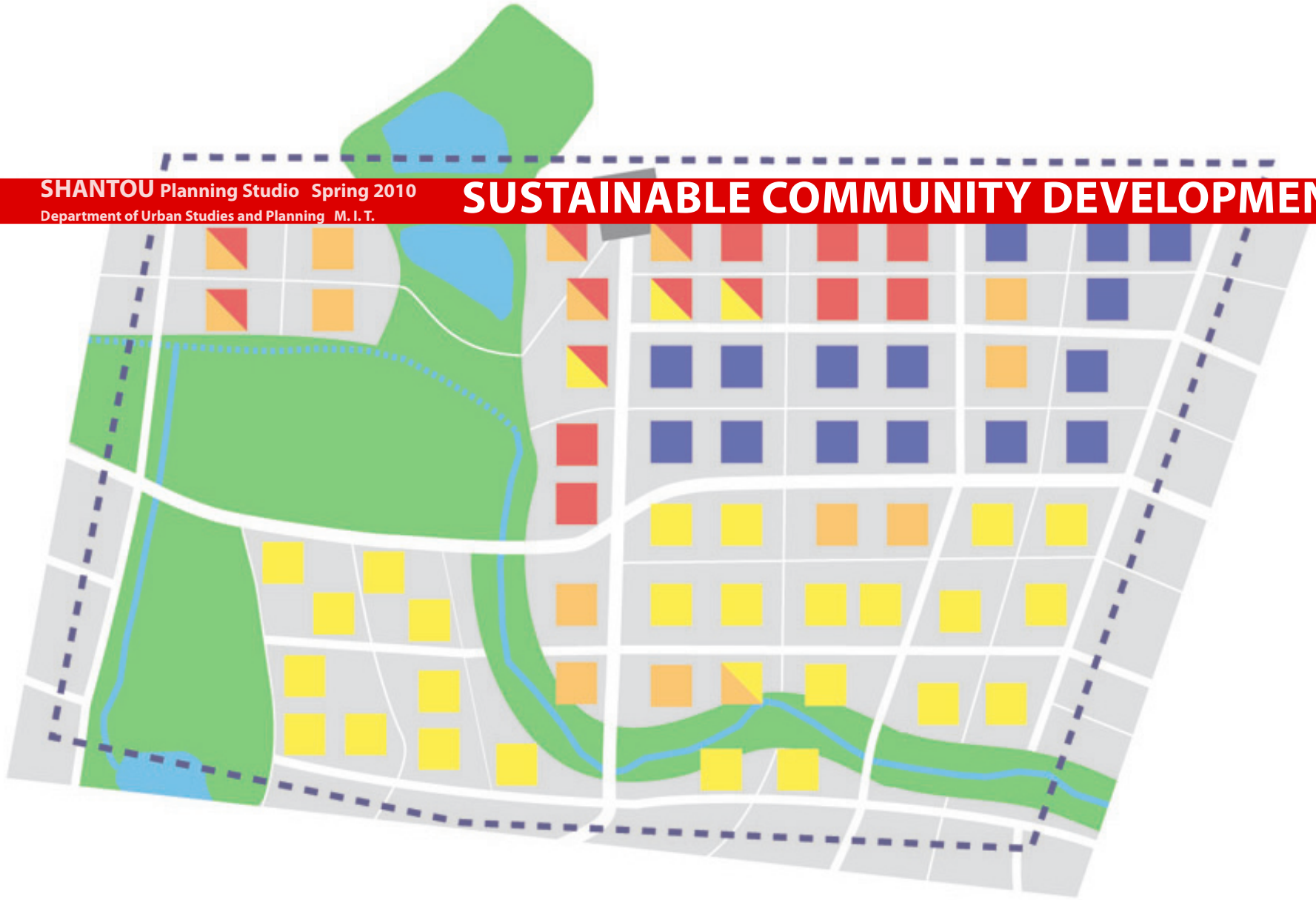
SHANTOU Planning Studio Spring 2010

Department of Urban Studies and Planning M. I. T.

SUSTAINABLE COMMUNITY DEVELOPMENT



Acknowledgements

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INTRODUCTION

Tunney Lee

Sustainable Residential Development in Shantou

This report contains the work of the Spring 2010 Planning Studio, in Shantou, Guangdong, China. The 2010 Studio is the latest in the series of studios and research seminars on sustainable residential development in China conducted by MIT's Department of Urban Studies and Planning since 2005. The studios' goal has been to plan and design sustainable neighborhoods in the context of the environmental, social, and economic issues expected to emerge over the next twenty years. The earlier studios (sponsored by Esquel and Vanke China) have served as valuable resources for this year's work.

Sustainability is defined by a balance of the "three E's": environment, economy, and equity. Sustainable residential development goes beyond environmental considerations and must be economical and provide access to public goods such as housing, transportation and public services. Our goals in planning are resource efficiency, demographic inclusiveness, accessible community facilities, and mobility.

This year, our sponsor is the Cheung Kong Design Research Centre with the cooperation of Shantou University. The City government of Shantou provided invaluable material on every aspect of the city's development and planning. The City organized a session with all relevant agencies to brief the class and to answer our questions.

Our task was to explore ways in which the University could promote sustainability and to enhance its role in supporting the city's growth. For this, they selected two sites adjacent and close by the University. One site is adjacent to the University and is a mostly hilly area which has been extensively quarried. The other is an underused site (controlled by the University) surrounded by villages and recent higher density development.

Context

In the next twenty years or so, Shantou, one of the original Special Economic Zones, is expected to develop rapidly as it becomes better connected to the Pearl River Delta and to other coastal cities. Shantou will be one of the cities on the high-speed rail line between Shenzhen and Shanghai. That rail line along with a new airport and increasing trade with Taiwan will serve as the catalyst for the economic growth. As China is entering a new era of urban development that is based on social equity, environmental protection and higher productivity, Shantou will learn from the problems of rapid growth.

To set the context for our work, we describe reasonable scenarios for the next ten to twenty years. We look at a series of meta-trends in urbanization and planning. The assumptions include the following:

Economy

> The economy will grow in a balanced pattern: manufacturing, services, logistics, etc. building on existing strengths and innovations.
> Household income will continue to grow steadily.
> Income and municipal benefits will be distributed more equally – housing, schools, health care, etc.
> Integration with the Pearl River Delta and other coastal cities will increase.

Energy and Resource Use

> More national and local regulations on energy efficiency, water conservation, materials, recycling and waste disposal. Restrictions will be placed on polluting sources.
> Higher energy costs will make alternative sources more economical.

Lifestyle

> Increased demand for mobility for commuting, recreation, entertainment, etc.
> Cell phone usage for multi-purposes.
> More widespread internet access.

Transportation

> Increased auto ownership along with increased truck and cargo volumes will create bigger problems of congestion and air quality.
> Public transit system continues development.
> The government will control motorcycle and automobile use through regulation, road pricing, auto-sharing, etc.
> Incentives for transit use through more convenient and comfortable transit options and easier access to stations.

Land Planning

> Integration of land use and transportation planning.
> District planning to accommodate mixed income groups with access to transit, open space networks.
> Land disposition procedures will be more regulated and based on district plans.
> Need for redevelopment of areas/structures reaching obsolescence.
> Cell phone usage for multi-purposes.
> More widespread internet access.

Organization of the Report:

I. The broad regional context and city policies on transportation, housing, water and solid waste management.

II & III. Planning of the two neighborhoods (Sites A and B) that would serve as examples of balanced growth of the city and to provide opportunities for the university's continued development.

IV. Parallel to teamwork, each student (from different academic and professional backgrounds) selected an individual topic or "tool" for this project.

SHANTOU RISING

Andrew Gulbrandson
Shan Jiang
Jiyang Zhang

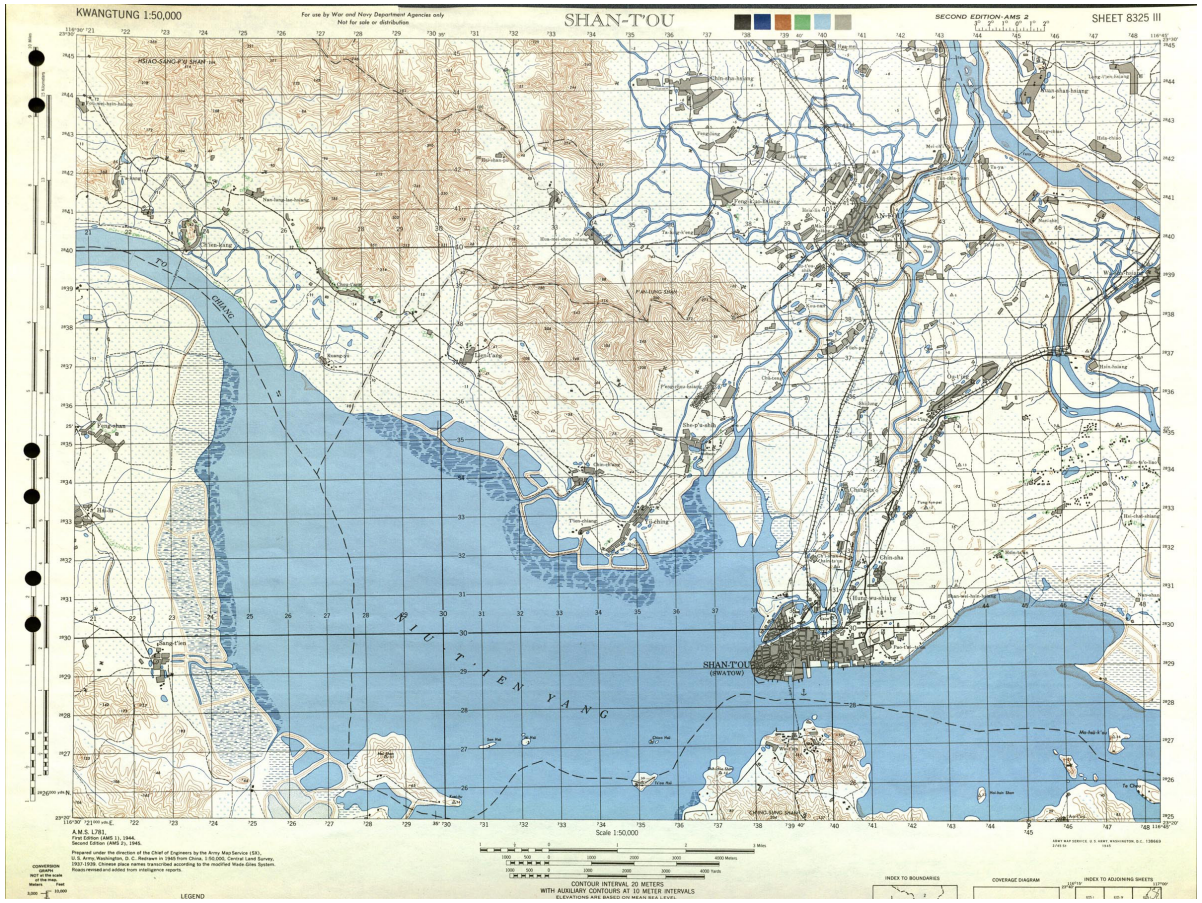
Mid-day near central Shantou

MISSION

The mission of our team, the "policy group" is as follows:

- Provide detailed contextual information on Shantou and the surrounding region to set the stage for site-specific programming and design discussion
- Forecast future trends in population, economic growth, and identify future macro-level policy issues
- Discuss infrastructure related policy concerns and identify solutions that will make Shantou a clean, healthy, desirable place to live, work, and play

Our discussion spans multiple scales, from local, site-specific issues to regional issues including the surrounding towns and villages that comprise the greater Chaoshan region.



Shantou and the greater Chaoshan Region, 1945. Source: US Army Survey Maps

Map 1 - Shantou's regional context, include Hong Kong and Xiamen. Source: http://robertlindsay.files.wordpress.com/2008/12/chinese-language-map1.jpg, modified by the authors

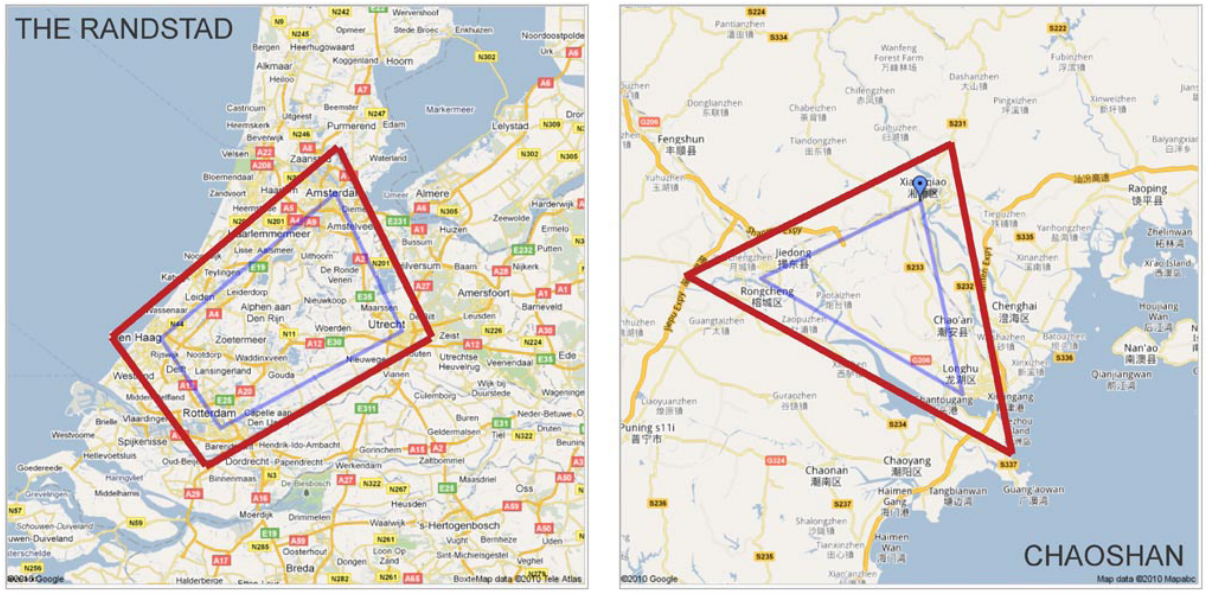
Shantou's Geographical Context

Shantou is a coastal city of just over five million people (2010) located in the far northeastern part of Guangdong Province of China along the South China Sea. The city is located roughly 250 km to the east of Shenzhen, Guangdong's provincial capital, putting it within reach of Hong Kong by car, bus, train, or plane. According to the Shantou city government's website, the city is "the gateway of east Nanling Mountains and the communication hub of Southeast China," because of its advantageous geographical location. Map 1 provides an illustration of the geographical context.

The Chaoshan Region

Shantou is one of three cities that comprise the greater Chaoshan region, the other two being Jieyang and Chaozhou. The greater Chaoshan region is just over 10,000 square kilometers in size, making it roughly the size of the Randstad in Holland (see Map 2 for a comparison). At present the region is connected via a series of highways and second-tier roadways. Many of the transport connections are excellent. For example, the G206 highway that transects both study areas discussed in this report and Shantou University while also connecting Shantou with Jieyang is nearly brand new, having been significantly upgraded in 2009.

According to Shantou's Director of Overseas Chi-



Map 2 - Comparing the Randstad and the greater Chaoshan region. Source: Google Maps, modified by the authors

nese and Foreign Affairs, the Chaoshan region has a population of 15 million. Migrants from the Chaoshan region have spread far and wide, with an estimated 15 million people residing in other parts of China with another 15 million living in other countries.

Regional Connections – China and International

For most of Shantou's history, despite having a central location, the city has been very difficult to access by any means of transport. At present, a small international airport, a railway station, and several major highways serve Shantou and the greater Chaoshan region.

Prior to the 2000s, it took 7-8 hours to reach by bus or car from Shenzhen and as many as 11 hours to reach from Guangzhou. The rail connection to those cities was and continues to be poor as it takes upwards of 11 hours to reach Shantou from either origin. Shantou's current airport has been operating since 1956 and handles roughly 2 million passengers per year. It was not until 2003 that the airport had regular international service (by China Southern airlines) to Hong Kong and Bangkok. In January 2010, Jetstar Airways became the first airline to offer a direct flight between Shantou and Singapore.

Since 2005 however, Shantou and the greater Chaoshan region are becoming increasingly well connected to the surrounding region as the national government makes significant investments in transport infrastructure.

Within the last five years, a national-level coastal expressway has been completed that links Shenzhen with Shantou while providing further connectivity along the coast to Xiamen in Fujian Province and points beyond. This expressway has reduced the travel time by car (and express bus) between Shenzhen and Shantou from 7-8 hours each way to just over four.

Shantou has a major railway station located in the eastern part of the city that provides westbound connections to Shenzhen and Guangzhou as well as a few eastbound connections like Xiamen. Traveling via Guangzhou provides access to several key interior cities, most notably Wuhan which is connected with a new high-speed rail link. Unfortunately, the rail link between Shenzhen and Shantou is quite circuitous and it takes 10-11 hours to travel between the two cities.

A new high-speed rail link is currently under construction and due to open in 2012. This link will connect Shenzhen and Xiamen via the Chaoshan region. While the exact station location is yet to be made public, there is speculation that it will be built on the outskirts of Chaozhou City. Despite the lack of a station in Shantou city proper, this innovation will be hugely beneficial for the city and the region as it will cut travel times to just 90 minutes between Shenzhen and Chaozhou while providing a similar level of service to Xiamen.

Once this line is complete, a traveler bound for Shanghai can leave Chaozhou in the morning, change trains in Xiamen to a different high-speed line, and arrive in Shanghai in the early afternoon. This is a major improvement over the current situation. Rail currently takes nearly an entire day while traveling by car would be at least a 12-hour trip.

Several airlines provide domestic service from Shantou to points across China, including Chengdu, Shanghai, Beijing, and Changsha and Guangzhou. As people from the Chaoshan region have dispersed throughout Asia, demand for international flights has increased. As mentioned previously, Shantou can be reached directly from Bangkok, Hong Kong, and Singapore. In addition to the introduction of international destinations, demand has warranted the construction of a new international airport to better serve the Chaoshan region as a whole. The new airport is located along the G206 highway about 20km northwest of Shantou.

Image 1 - High-speed Rail link between Shenzhen and Shantou under construction, January 2010.
Source: Andrew Gulbrandson

Shantou: A Background

From Qing Dynasty to People's Republic

Shantou (formerly named Swatow) existed primarily as a small fishing village from the mid 1500s until its designation as a treaty port in 1860 at the close of the "Arrow War," China's second major war with the Colonial Powers of Britain, France, and the USA. After the Treaty of Tien-tsin was signed in 1860, Shantou developed as a key import/export hub for China. At one point in the late 1800s, it was the third largest port (by cargo volume) in the country. Over time, at least eight foreign powers established consulates in Shantou, including the USA, Britain, France, and Japan (Liu 2009).

By the 1930s, Shantou's share of trading volume was on the decline but it was still an important center of commerce. Many large western corporations like Standard Oil and Royal Dutch had established key offices in the city. When Japanese forces invaded in 1939, Western companies and consulates were forced to close their doors and leave. The Japanese occupied Shantou until the end of World War II in 1945, using it as a strategic blockade point preventing foreign powers from providing the Chinese Nationalist forces with food, weapons, and other supplies.

When Mao and the Communist Party came to power in 1949, they invested in Shantou's industrial and manufacturing infrastructure. Subsequently, Shantou's importance as a major port facility waned and its industrial base grew.

Image 2 - The "Little Garden," Shantou's historical core and site of Japanese occupation headquarters during World War 2 , January 2010. Source: Shan Jiang

Life as a Special Economic Zone

Shantou's strategic position near Taiwan, its growing industrial base, and its strong commercial transport infrastructure (port and rail facilities) played a significant role in the city's designation as a Special Economic Zone (SEZ) in 1980. Shantou was designated as one of China's first five Special Economic Zones along with Hainan (the entire island), Shenzhen, Xiamen, and Zhuhai. Shantou's status as an SEZ has given it flexibility and special treatment from the government, allowing for increased foreign investment and export opportunities.

Shantou's economic growth since 1980 has been substantial though it pales in comparison to the growth experienced in Shenzhen and trails growth in nearby Xiamen. Between 1980 and 2007, Shantou's gross city product (GCP) increased from 1,079,000,000 RMB to 85,100,000,000, with an average annual growth rate of 17.8%, slightly faster than the national average of 16.8% over the same period. Shantou's nominal GCP per capita in 2007 was just over USD $2,200, about 15% less than the national average in 2007 as computed by the International Monetary Fund (IMF).

Today, the majority of Shantou's economic output comes from manufacturing and construction. According to the 2007 Shantou Economic and Social Development Report, 52.6% of GCP was created in the secondary sector. Within the secondary sector, Shantou is most famous for its toy manufacturing. According to Liu (2009), textiles, garments, chemicals, plastics, foodstuff, toys and handicrafts, medicine, and audio-visual products, have all become pillar industries in the city.

Most of the remaining output comes from the tertiary (services) sector with 41.8%. The primary sector, consisting of agriculture and fishing only accounts for 5.6% of GCP. The small contribution of the primary sector to Shantou's GCP largely owes to the fact that Shantou has very little arable land.

Teochew Culture

The people of Shantou and the Chaoshan region are renowned for their entrepreneurial business sense, excellent cuisine, and tea consumption.

Many well-known entrepreneurs in East and Southeast Asia have roots in Shantou or Chaoshan. Hong Kong billionaire (and Asia's richest man), Li Ka-shing hails from the area. Mr. Li has invested countless millions of dollars into the region. He is provided funding necessary for the creation of Shantou University, the main client of this report. He has funded hospitals, schools, and numerous social programs in Shantou, not to mention greater China. Dhanin Chearavanont is the 2nd richest person in Thailand (Nam 2009). Chearavanont is the CEO of Charoen Pokphand Group (CP Group), Thailand's largest business conglomerate with interests in telecommunications, retail, and agri-business, among others. CP was founded in 1921 when Chearavanot's father and uncle opened a small shop in Bangkok's Chinatown, having recently emigrated from the Chaoshan region.

This famous entrepreneurial spirit has led Shantou's private sector to be the largest contributor to the city's economy. According to Liu (2009), privately owned businesses in Shantou accounts for two-thirds of the city's GCP. Official government statistics

Image 3 - Li Ka-Shing, famous Hong Kong billionaire hailing from the Chaoshan region. Source: www.mint.com

suggest that 1,600 of the 2,100 firms with an output of more than 5 million RMB annually are privately owned. Privately owned firms are also growing rapidly, as in 2007, total industrial output by the private sector increased by 19.3% percent from the previous year to USD $16.8 billion (RMB 115.1 billion). In

addition to these large firms, there are numerous self-employed business owners that often provide goods and services to the local populace.

As Li Ka-shing invests in Shantou and its surroundings, so do other emigrants from Chaoshan. In Shantou, emigrants from Shantou are invested in more than 90% of all firms that have some foreign investors. This phenomenon is readily visible near the sties discussed in this report. Immediately adjacent to the south and east of Site B is an industrial park that houses ten firms. The study team visited three of these firms and found that two of the three had overseas investors originally from Shantou. Investors from Thailand are the primary backers of a factory that produces nets for commercial fishing while investors from Canada own a factory that produces pregnancy test kits.

According to several government officials and faculty members at Shantou University, the local entrepreneurial spirit can be a double-edged sword. The general claim is that because Shantou does not have an abundance of opportunities for intelligent, ambitious business people, many leave the city and do not return, let alone send remittances or reinvest in the community.

Regional cuisine and tea culture are another point of recognition for the area. Chaoshan is famous for its rich, well-prepared dishes that often use the best of ingredients. When dining in large Chinese cities like Beijing and Shanghai, restaurants featuring Chaoshan cuisine are the most expensive, reflecting the quality of the food and the care taken in preparation. Tea is ubiquitous and is served not only with all meals but at all times of day.

Image 4 - Place setting at a meal hosted by the Party Secretary and Vice Mayor of Shantou , January 2010.
Source: Andrew Gulbrandson

Cities of Shantou, Jieyang and Chaozhou

Central districts (Jinping, Longhu, Haojiang) and other districts in Shantou

The City

Owing to its classification as a prefecture level city, Shantou has jurisdictional authority over six districts and one county. These districts are Chenghai, Longhu, Jinping, Haojiang, Chaoyang, Chaonan while the county is named Nan'ao. Shantou is spread over 2,064 sq km, and as of 2007, it has a total population of just over five million, yielding a population density of roughly 2,500 people per square kilometer. The Central District of Shantou consists of Jinping, Longhu and Haojiang, covering 347 sq km (or 17% of the total) land area and housing 1.4 million (or 28% of the total) population, yielding a population density of 3,992 people per square kilometer which is lower than that in the City of Boston (4947 people per sq km).

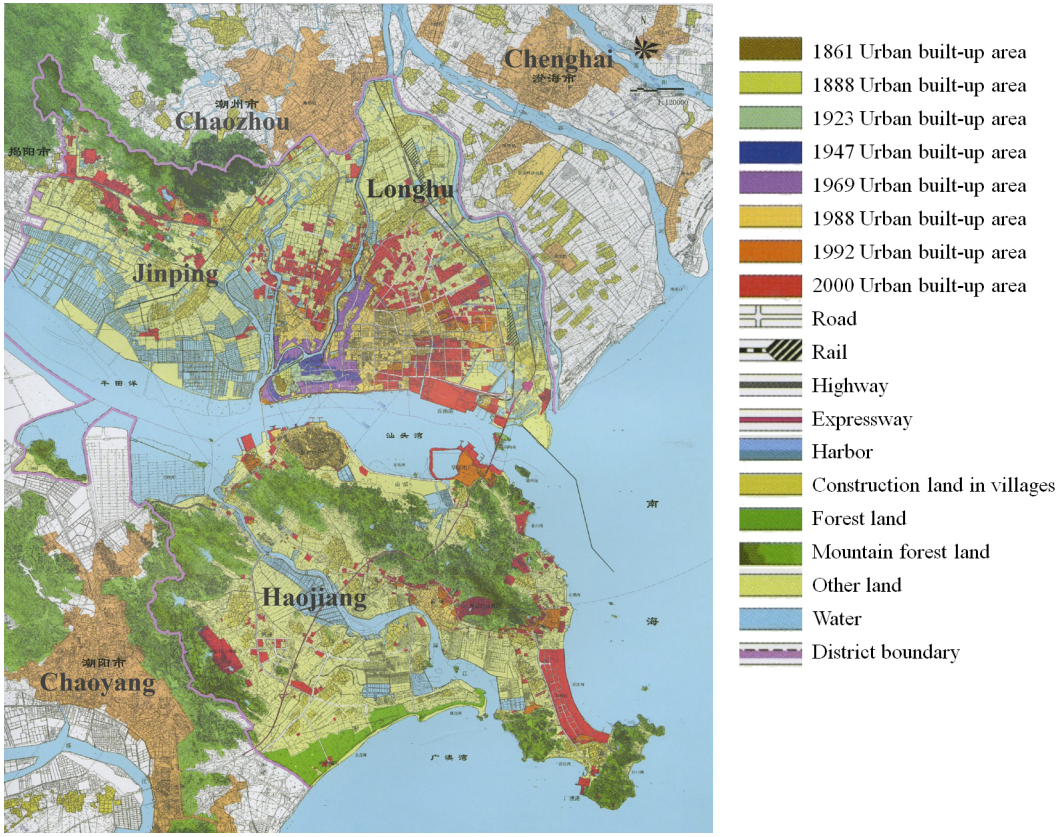
Historical Development Trajectory

Shantou's historical core is located in the southwestern corner of the city. Along the major rivers, some villages were established in the late nineteenth century. The map on the right shows the historical urban development trajectory in Shantou from 1861 to 2000. Physically, the northern riverside of the central city has grown to the north and to the east, largely as a function of geographical (water) features. More recently, the western part of the central city (Jinping District) has been developed, due to the investment in research and higher education (e.g., Shantou University).

Much of Shantou's newer residential and commercial development has taken place along to coastal or just a few kilometers inland. By contrast, manufacturing firms and other heavy industry have chosen to locate in more peripheral areas along major roadways, such as the G206 highway that leads to Shantou University and the city of Jieyang.

However, the major service functions are still heavily concentrated in the center of the city, including administrations, schools and institutions, hospitals, shopping, recreation and entertainment, etc.

Shantou Historical Urban Development, 1861- 2000



Source: Shantou Urban and Rural Areas Planning Bureau, 2003

Future Trajectory

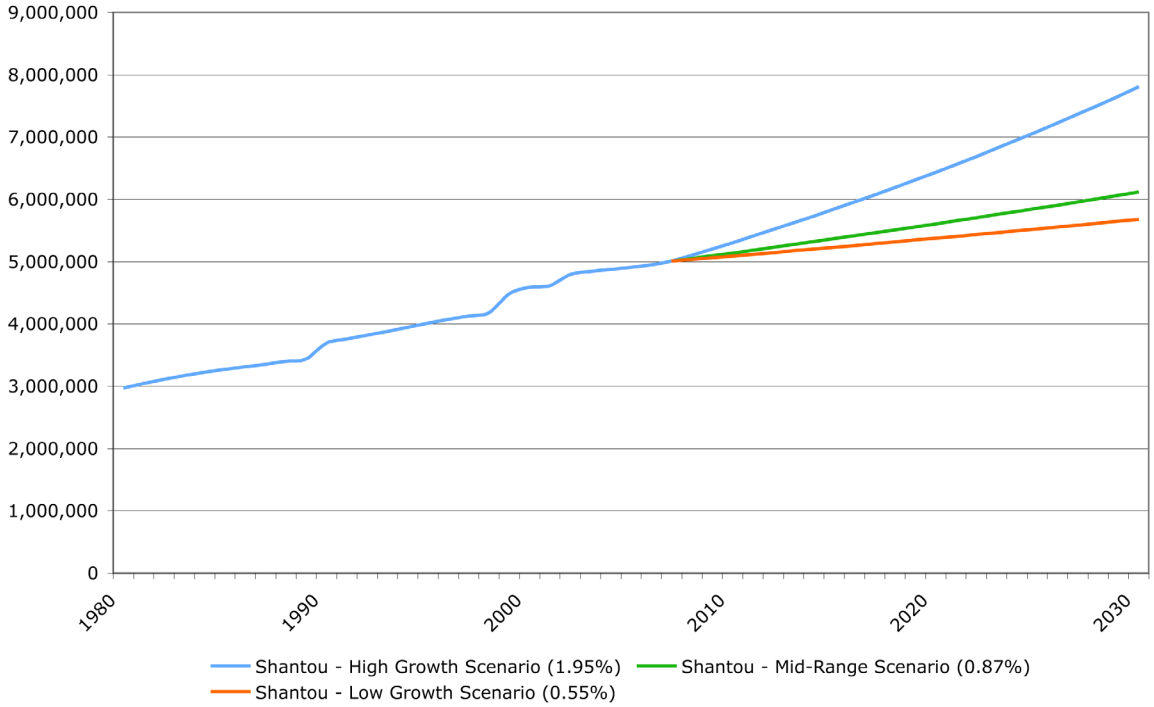
The overall purpose of this report is to provide basic design and programming suggestions for the study area through the year 2030 or thereabouts. These suggestions are based on the assumption that Shantou's population will continue to grow and its citizens will accrue more wealth. The following describes the most plausible growth scenario based on information that is currently available.

When Shantou was designated as a special economic zone in 1980, the city's population was just under three million. By 2007, the last year for which official statistics are available, the population had reached just over five million, growing by 1.95% per year on average. This group believes that most of this growth can be attributed to rural-urban migration as rural populations seek greater economic opportunities in urban areas. This hypothesis is supported by empirical evidence that suggests nearly all factory workers in the areas surrounding Shantou University and the study areas are migrants from other provinces. Unfortunately detailed data is not available from the city government to text this hypothesis.

In 2030, Shantou will likely have a population of just over six million. In reaching this conclusion, we examined three possible growth scenarios:

High Growth = 1.95% per annum, which represents the average annual growth rate in Shantou from 1980-2007. This is the most robust conclusion given the relatively large number of observations that encompass many changes in Shantou over time.

Figure 1 Shantou Population, 1980-2030



Mid-Range = 0.87% per annum, which represents the average annual growth rate in Shantou from 2002-2007. Using data from the last five years, this rate most accurately captures current trends.

Low Growth = 0.55% per annum, which represents the annual growth rate for the entire nation (China) from 2003-2008. Comparing Shantou to the national average, it becomes clear that the city is growing faster, but not by a large margin.

Figure 1 illustrates each scenario and projects population to 2030. We used the mid-range growth scenario. This selection is based on the assumption that natural birth rates will remain low and the rate of urbanization (rural to urban migration) will parallel

changes in the economy. We believe that the economy will grow much more slowly in the next 20 years versus the preceding 20 years. This presumption is based on the effects current global economic recession has had on China's economy and the widely quoted prediction that China will not be able to attain high levels of growth unless its large rural population can be turned into consumers of domestic goods on an extremely large scale.

Figure 2 illustrates three economic growth scenarios for Shantou through to the year 2030.

High Growth = 17.55% per annum, which represents the average annual growth of Gross City Product (GCP) in Shantou from 1980-2007. This is the most robust conclusion given the relatively large number of observations that encompass many changes in Shantou over time.

Mid-Range = ~13.12% which represents the average annual growth of Gross City Product (GCP) in Shantou from 2002- 2007. Using data from the last five years, this rate most accurately captures recent trends. Unfortunately the data is not recent enough to capture changes in the economy since 2008 caused by the global economic recession.

Low Growth =~7.26% per annum, which is based on the current (2010) projected GDP for China in 2010 of 9% followed by reducing the GDP progressively over time. The assumptions leading to reduced GCP are based on current (Q2 2010) speculation that China's economy may be overheating and that a growth bubble may burst, leading to substantial slower growth in the coming years (Oliver 2010). Thus we have calculated future GCP to grow at 9% per year from 2008-2014, 8% from 2015-2018, 7% from 2019-2022, 6% from 2023-2026, and 5% from 2027-2030.

We believe that the low growth scenario represents the most realistic path for the economy to follow in the next 20 years.

Figure 2 Shantou GDP (RMB), 1980-2030

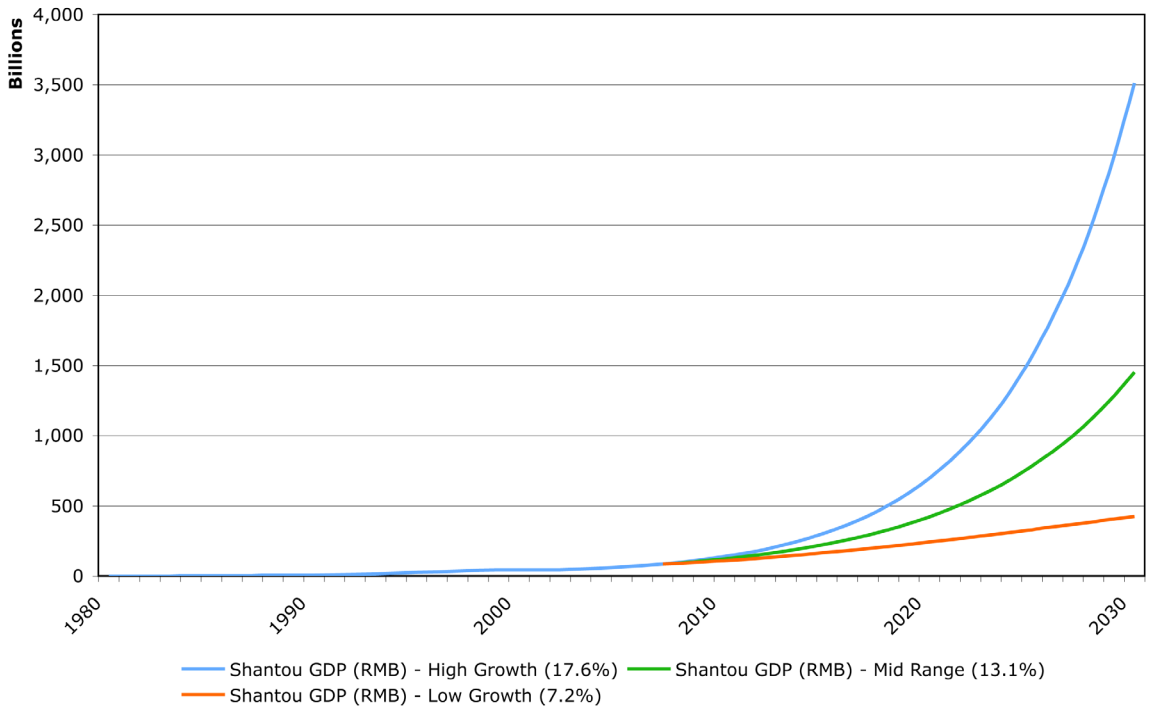
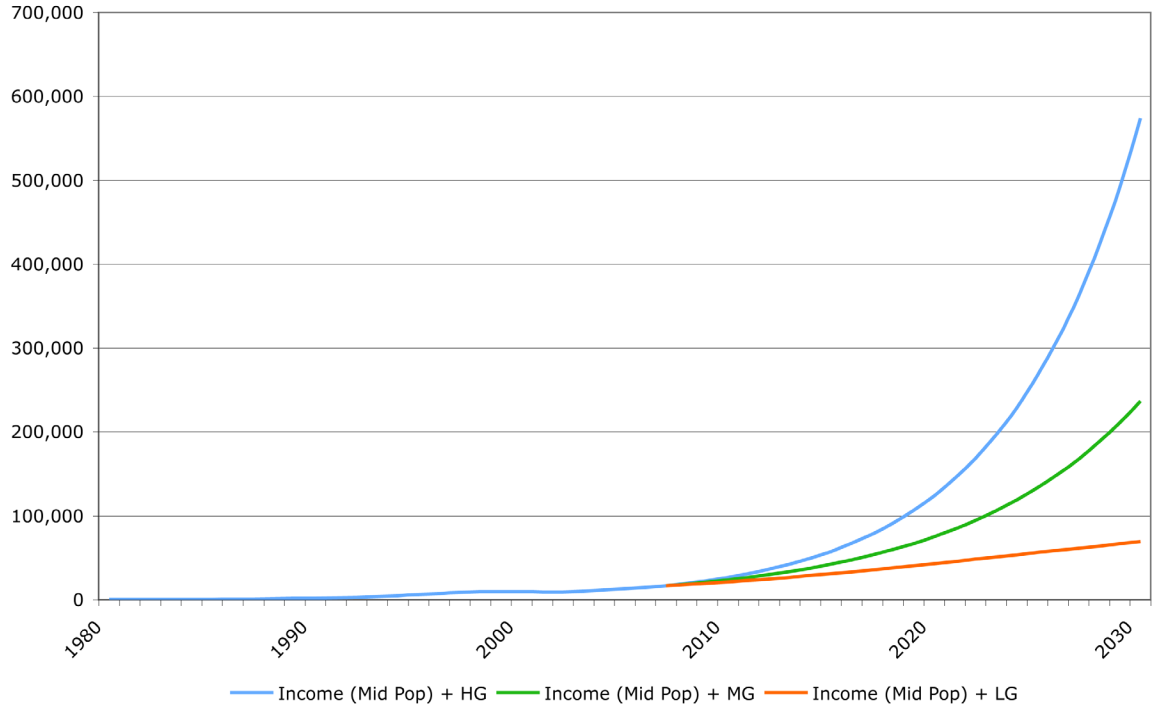


Figure 3 GDP per Capita, 1980-2030 (Middle Population Growth)



Understanding changes in per capita income (GCP per capita) is very important. Per capita income increases usually lead to increases in disposable income. In turn, more disposable income increases demand for better housing, better services, and luxury goods such as automobiles. In order to forecast approximate income for the people of Shantou in 2030, we have calculated GCP per capita using the mid-range population growth scenario coupled with each of the three economic growth scenarios. The outcomes are illustrated in Figure 3.

Combining the mid-range population growth scenario with the low economic growth scenario produces the most realistic forecast of GCP per capita, based on available data. Our data suggest that GCP per capita will grow by roughly 8% per year, not taking into account the effects of inflation, which will undoubtedly vary over time.

Figure 4: Trends in Shantou, 2002-2008

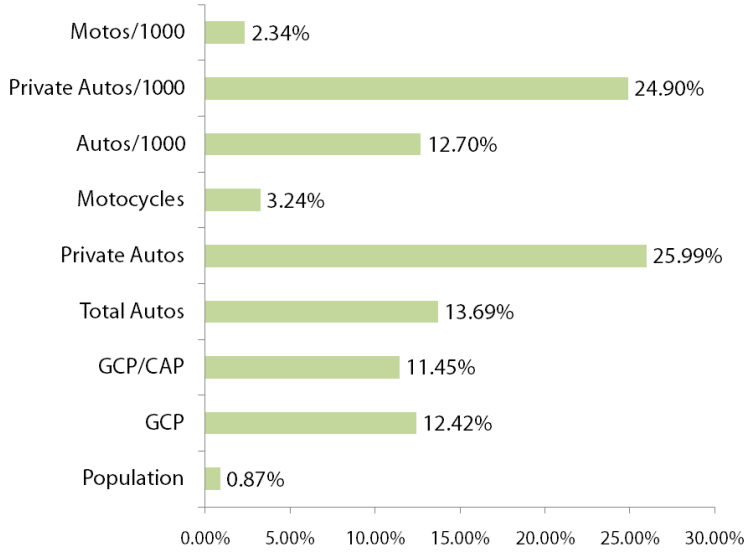


Table 1: Projected vehicle ownership in Shantou

Year	Population	Total Vehicles per 1000 People	Equivalent to
2010	5,140,635	180	Singapore (2008)
2015	5,369,230	275	Taiwan (2002)
2020	5,607,990	421	Greece (2002)
2025	5,857,368	644	Australia (2002)
2030	6,117,834	985	Bangkok (2006)

Figure 4 clearly illustrates that growth per capita income and growth in total vehicle ownership (the number of motor vehicles per 1000 people), go hand in hand. These findings support a large body of scholarly research, best embodied by Dargay et al (2007).

As of 2008, there are 152 total vehicles for every 1000 people in Shantou (including motorcycles, trucks, buses, private autos, taxis, etc). Over the last six years, total vehicle ownership has grown 10.93% faster than per capita income. Based on our projected 8% annual growth for per capita income, that means total vehicle ownership should increase by 8.87% per year. Assuming constant, sustained growth through 2030, Table 1 traces projected vehicle ownership and compares to other cities and countries around the world.

As Table 1 illustrates, if Shantou does not make an effort to restrain vehicle ownership, it will soon have very high levels of ownership and very likely, extreme congestion. As extreme congestion will undoubtedly produce negative economic, environmental, and social externalities, we highly recommend that the Shantou government start taking measures to restrict growth.

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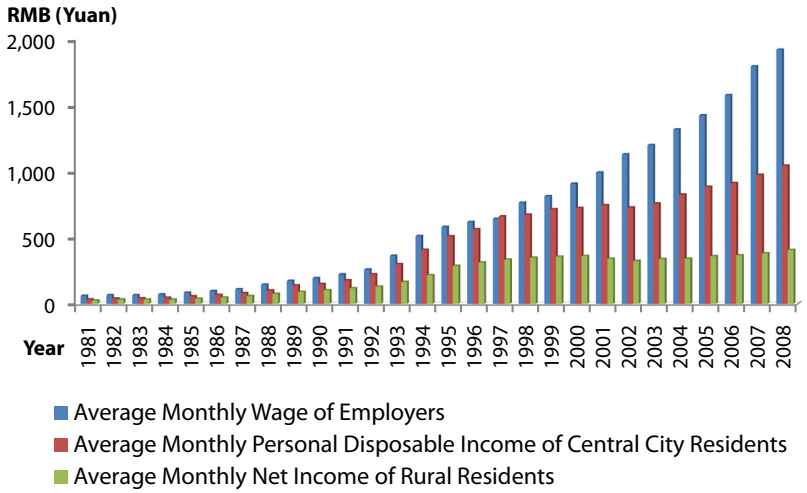
Housing Policy in Shantou

In this section, we first analyze the housing affordability in Shantou for the past decade. We find that since personal income has grown faster than that of market housing price, housing affordability for medium income people in Shantou, in general, has improved. However, we find a gap between the population who are eligible for applying for affordable housing and the average income level population in Shantou. In other words, there are still many people whose income level is below average but above the affordable housing requirement threshold. Those people have few options of improving their quality of housing.

In order to accommodate more people with affordable housing options, we suggest that the Shantou government keeps a higher share of affordable housing in the future housing plan. Affordable housing development should also be mixed with other types of housing development, so as to provide social inclusion and social harmony. It should also be developed around major public transportation corridors to provide low income people with diverse mobility choices. Further details about housing development integration with public transportation will be discussed later in the Transportation Policy section.

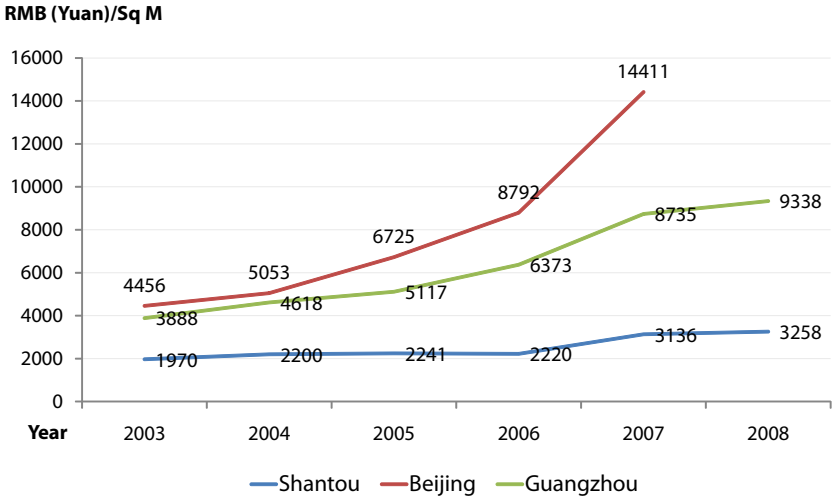
An affordable housing site in the Central District of Shantou.
Source: Shan Jiang, 2010

Average Monthly Personal Income in Shantou, 1981-2008



Data Source: Statistical Yearbook of Shantou, 2008, 2009

Housing Prices in Beijing, Guangzhou, and Shantou, 2003-2008



Data Source: 1-http://www.ydtz.com/news/shownews.asp?id=30977; 2-http://good.hostse.com/?p=27; 3-http://news.xinhuanet.com/house/2010-01/21/xin_332010721085525014545 5.jpg

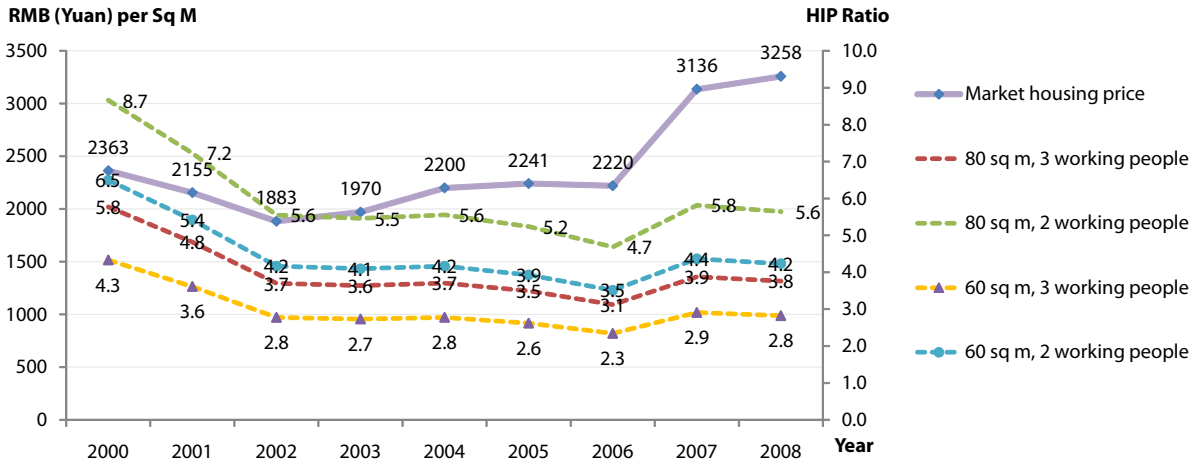
Housing Affordability

To discuss housing affordability, we cannot ignore personal income. The above figure shows the historical change of personal monthly income from 1981 to 2008 in Shantou (Statistical Yearbook of Shantou, 2009). As of 2008, the average monthly (1) wage of employers in Shantou is around 1,924 Yuan; (2) disposable income of urban residents, 1,045 Yuan; and (3) net income of rural residents, 407 Yuan.

We also obtained average market housing price from 2000 to 2008 in Shantou. Generally speaking, the average housing price in Shantou is much lower than that in other major Chinese cities.

By using the housing price and personal income, we are able to estimate the housing affordability index (measured by housing-price-to-income ratio). In the U.S., housing affordability is usually measured by the median market home value to the median household income ratio. Over the past three decades the national average home-price-to-income (HPI) ratio in the U.S. ranges from 3 to 5 (Iacono, 2009).

Housing Price and Housing Price-to-Income (HIP) Ratio in Shantou, 2000-2008



Data Source: 1-Statistical Yearbook of Shantou, 2008, 2009; 2-http://www.ydtz.com/news/shownews.asp?id=30977.

Due to data availability, we use average unit housing price and average personal income as substitutes for median home price and median household income to estimate the HPI ratio in Shantou. We estimate the housing-price-to-income ratio under 4 scenarios, assuming an average household may buy an 80 sq meter housing unit or a 60 sq meter unit, with 3 or 2 workers.

From our estimation results, we can see that since personal income grows faster than the market housing price increase, housing affordability in Shantou has improved in recently years. The potential housing price-to-income ratio under our four scenarios ranges from 2.8 to 5.6 in 2008, which is lower than that in 2000 (ranging from 4.3 to 8.7).

Affordable Housing Policy

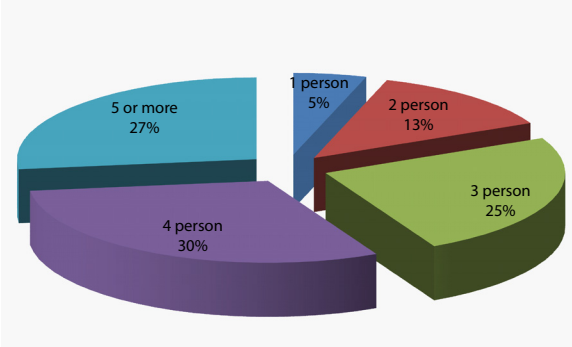
The housing-price-to-income ratio only measures housing affordability of median (or average) housing price to median (or average) income households, while this index does not reflect the housing affordability for low income households.

In order to ensure housing for low income people, Shantou government provides two options of affordable housing: (1) affordable rental housing; and (2) affordable ownership housing. Low income people meeting certain criteria may apply for the affordable housing provided by Shantou government.

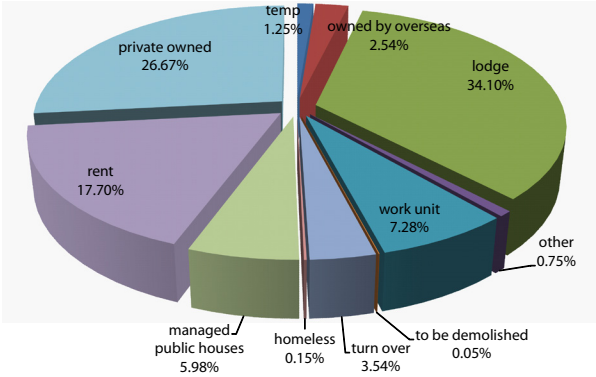
Criteria for affordable rental housing require that the monthly personal income of the applicants must be no more than 375 RMB (Yuan) while their living spaces should be no more than 10 sq meter per person. Criteria for affordable ownership housing relax the threshold for personal monthly income (750 RMB Yuan), while the living space requirement keep the same.

As of 2009, Shantou Housing Department approved 2008 affordable rental housing applications and 47 affordable ownership housing applications in the Central District of Shantou. Amongst these applicants, over 57% live in households with larger than 4 members, which is much higher than the average number of household member (3.29) in the central district of Shantou in that year (Statistical Yearbook

Number of Household Members of the Affordable Rental Housing Applicants in Shantou, 2008

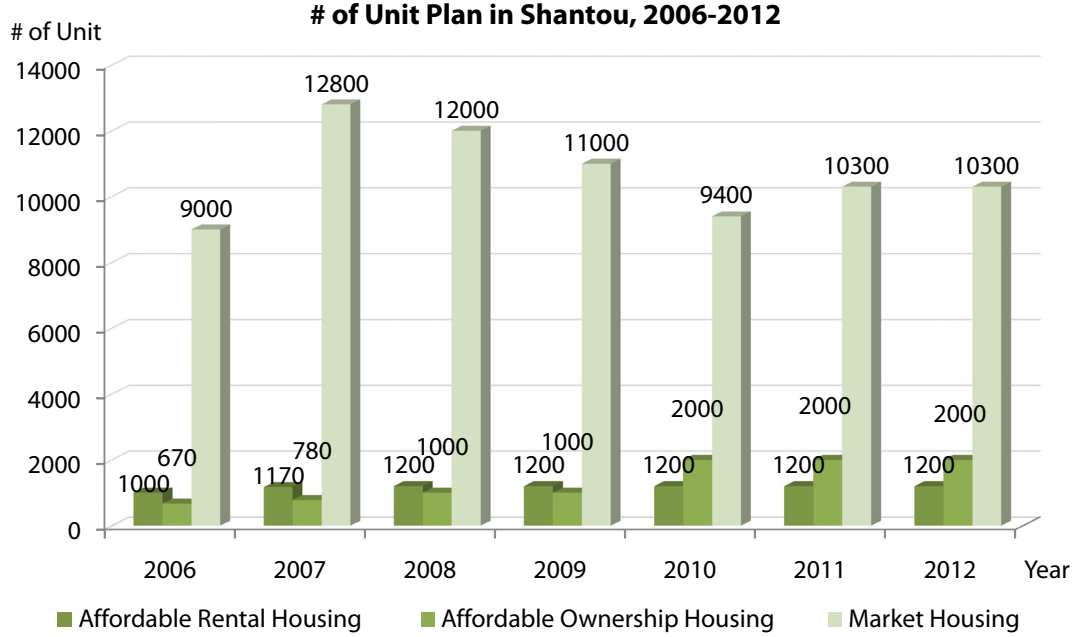


Current Housing Types of the Affordable Rental Housing Applicants in Shantou, 2008



Data Source: Shantou Housing Department, 2009 (http://www.stfcj.gov.cn/stweb/XXLR1.ASP?ID=1866)

Figure 1 Affordable Housing v.s. Market Housing # of Unit Plan in Shantou, 2006-2012



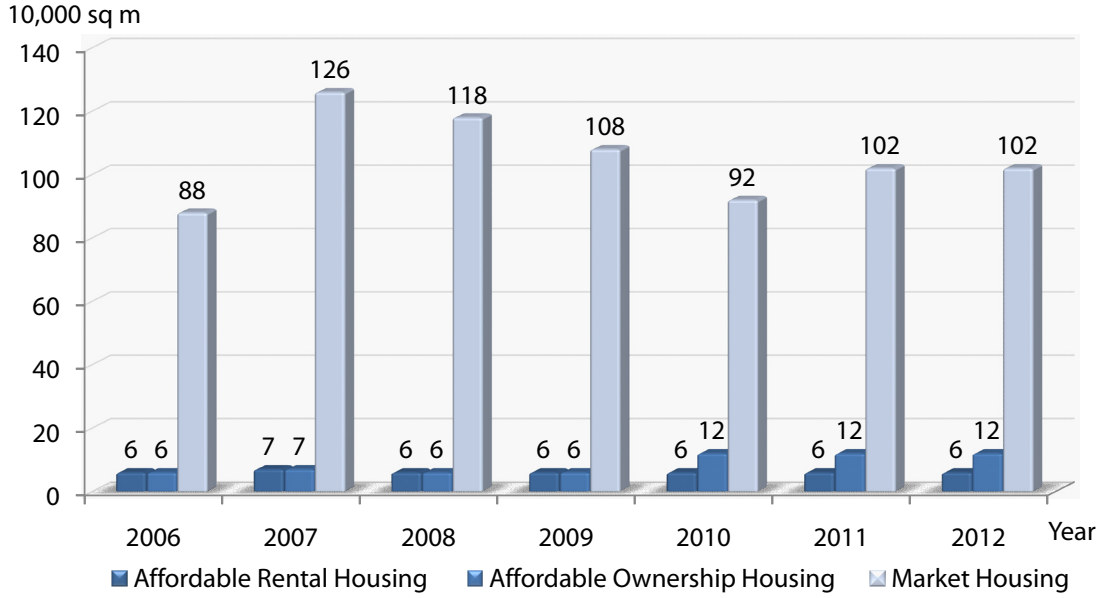
Data Source: Shantou Housing Department, 2009 (http://www.stfcj.gov.cn/stweb/XXLR1.ASP?ID=1866)

of Shantou, 2009). Their current housing places consist of various types, including private owned, work unit owned, rental, public housing, etc.

Shantou government, specifically, Shantou Housing Department (2006, 2008) has made plans for affordable housing construction. For example, in 2006, the government plans to build 60 thousand square meter floor area of affordable rental housing (or 6% of the total floor area of the all types of planned housing), and the same amount of floor area of affordable ownership housing. The total number of units for these two types of affordable housing is around 1,670, which consists of 15.65% of total planned housing units in 2006 in Shantou.

These numbers keep roughly the same until 2010 when the planned affordable ownership housing doubled both in terms of floor area (120 thousand sq m), and number of units (2,000 units). The total

Figure 2 Affordable Housing v.s. Market Housing Floor Area Plan in Shantou, 2006-2012

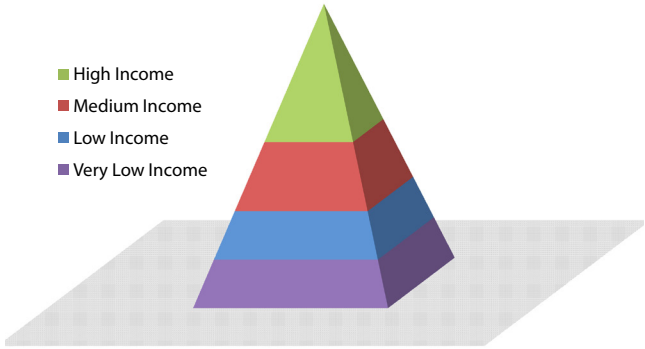


Data Source: Shantou Housing Department, 2009 (http://www.stfcj.gov.cn/stweb/XXLR1.ASP?ID=1866)

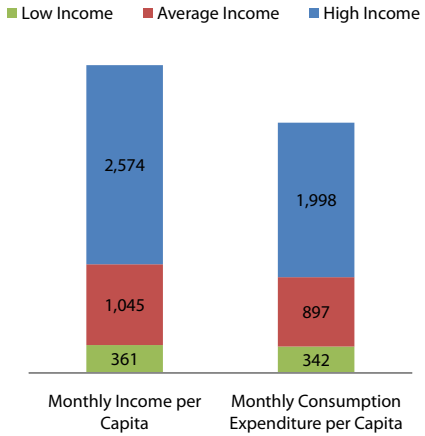
affordable housing units is planned to reach 25.4% of total housing units built in 2010, and 16.36% of the total housing construction floor area. Figures 1 and 2 demonstrate Shantou government's intention of providing more and more affordable housing in Shantou.

However, as there is still a big gap between the income criteria threshold and the average income level of the Shantou residents, there will still be a great continuing demand for more affordable housing. For example, in 2008, the average monthly personal disposable income (for central city residents) is 1,045 RMB (Yuan), while the survey data suggests that the lower end goes to around 350 Yuan, and the higher end goes up to around 2,600 Yuan. The population in the gap between the lower end and the medium income consists of the group of people who are not eligible for affordable housing yet not financially capable to buy market housing.

Monthly Personal Income Distribution In Shantou, 2008



Monthly Personal Income and Consumption Expenditure in Shantou, 2008 (Yuan)



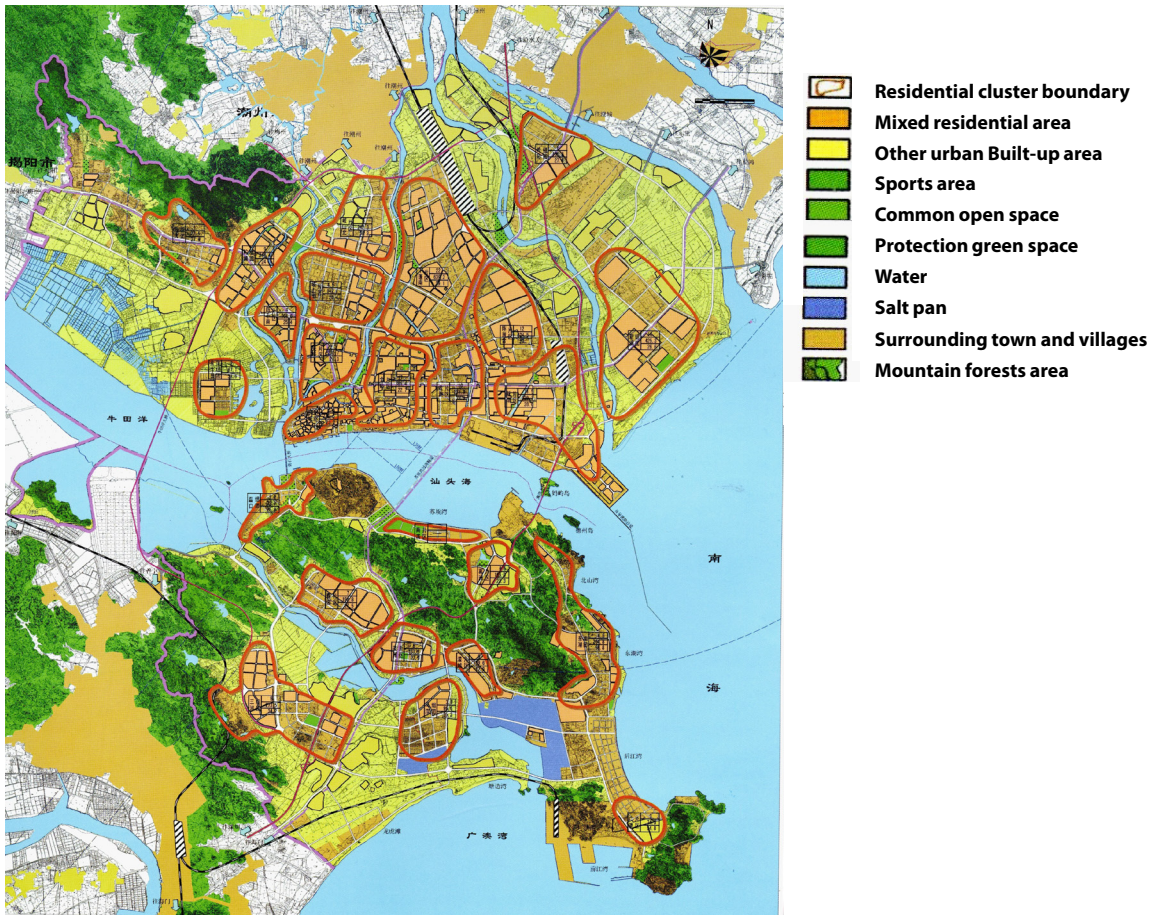
Data Source: Statistical Yearbook of Shantou, 2008, 2009

Future Outlook

In the next twenty years (2010-2030), inevitably, the personal income level of Shantou residents will continue to grow, while as the Chinese central government tries to implement more strict mortgage rate policies (for second and third homes) to control housing bubbles in the market and contain housing prices (New York Times, April 28, 2010), we estimate that housing affordability for medium income people in Shantou will keep stable. However, as aforementioned, there is still a big gap between low income people (who meet the criteria of affordable housing application) and the medium income people. In order to accommodate the needs of people in the gap, we suggest that the Shantou government gradually relax the threshold of affordable housing application so as to include more households in the affordable housing plan, and provide a higher share of affordable housing units (land area and floor area) in the future housing plan.

Affordable housing development should also be mixed with other types of housing (i.e., market housing) to ensure social inclusion of different income levels of residents and keep social harmony. Affordable housing should also be developed around major public transportation corridors to provide low income people with more diverse mobility and accessibility alternatives. Further details about housing integration with public transportation development will be discussed later in the Transportation Policy section.

Residential Clusters in Central Districts of Shantou



Source: Shantou Urban and Rural Areas Planning Bureau, 2003

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An intersection in Shantou, by Shan Jiang, 2010

Shantou Today…

BRT in Curitiba, Brazil. Source: http://bikeblogs.org/sf/files/2008/10/expresso-biarticulado-curitiba.jpg

Shantou Tomorrow?

Transportation Policy

In the first section, based on the growth rate of current economic development and motorization, we estimate that by 2020, the private car ownership per thousand people in Shantou will reach 421; and by 2030, the number will increase to 985. On the one hand, experiences in developed countries have informed us that car ownership increase is inevitable as personal income level rises. On the other hand, there are successful demonstrations on how to possibly keep low level of car usage even with high rate of car ownership.

For example, Curitiba, Brazil, is famous for its efforts in reducing car usage even with the second highest per capita car ownership rate in Brazil (one car every three people). With decades of efforts in building efficient bus rapid transit (BRT) systems, Curitiba's buses now carry 50 times more passengers than they did 20 years ago, and its gasoline use per capita is 30 percent below that of 8 comparable Brazilian cities (Dismantle, 2010). Curitiba sets a vanguard example for the rest of the world on a sustainable development model—by improving its public transit system and urban planning processes, it has greatly reduced traffic congestion, air pollution and energy missions. It's has become a famous city that is pleasant to live in.

Given the pressure of the rising car ownership in Shantou, in this section, we try to first analyze the existing problems and challenges of the current transportation system in Shantou and layout the future transportation plan made by the Shantou government. We then propose potential paths of sustainable development for Shantou.

In summary, we propose three main guidelines for Shantou transportation development in the future: (1) integrating land use and transportation development; (2) integrating multi-modal transportation systems; and (3) reclaiming space for non-motorized transportation modes.

Current Transportation System and Challenges

In the introduction section, we discussed the major drawbacks of the regional transportation network in Shantou, including inconvenient rail connections to other cities, relatively limited access to other cities through air transport, etc. In this section, we will focus more on the intra-city transport.

The major existing problems of the current intra-city transport network are as follows.

For automobiles
>Mixed right-of-way with cyclists/motorists
>No signals or stop signs at many intersections
>Parking regulations in public spaces are absent (thus often causes traffic congestion)
>Freight transport and passenger transport is not separated in space nor time
>Road connectivity city wide is limited to only a few major corridors.


Mixed right-of-way. Jiang, S.2010


No parking regulations in public space. Jiang, S. 2010


Mixed passenger and freight transport. Jiang, S. 2010


Bus Stop. Eugene Siong Aun Lee,2010.


Motorbikes occupy sidewalks. Jiang, S. 2010

For Pedestrians and Cyclists
>Mixed right-of-way with autos and motorbikes
>No specific signals for non-motorized modes (including pedestrians, and cyclists) at intersections
>Parking of motorcycles takes pedestrian path
>No system-wide cycling path or pedestrian sidewalk

Public Transit
>Low level-of-services
>>only regular bus services (no intra-city rail system, nor high quality level bus services)
>>long headways
>Duplicated routes vs. limited service coverage area
>>inconvenient transfers
>Low quality bus stop facilities
>Public information of transit services is limited
>Information technology is not updated
>>no automatic vehicle location (AVL) system
>>no automated fare collection (AFC) system
>>no real time information provision

Planning Institutions
>No integration between urban land use planning and transportation planning
>>no coordination of urban density or diversity along transit corridors

Transportation Network Planning in Shantou

The Shantou government has realized some of the problems listed above and the latest transportation plan for 2020 (Shantou Urban and Rural Areas Planning Bureau, 2003) has tried to address some of the issues mentioned.

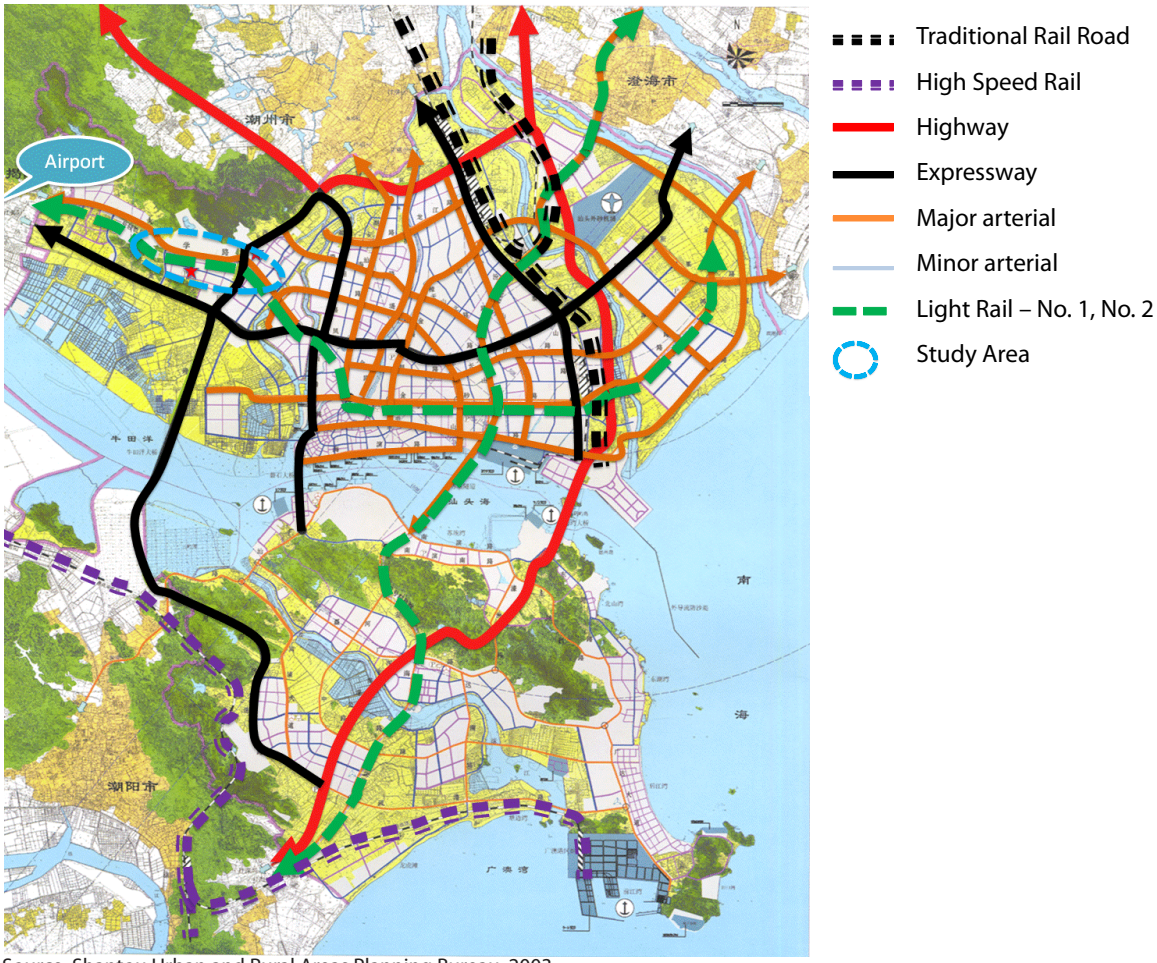
The major improvements in the 2020 plan include:

> Inter-city
>> A new airport in the North West part of the city is planned and under construction
>>Access to other cities will be improved though the connection to the Shenzhen-Xiamen High Speed Rail

>Intra-city
>>More roads planned will improve the connectivity and accessibility of different areas in the city
>>Two major light rail lines are planned to improve public transit services
>>Intermodal connections between road/railroad and public transit (light rail) have been considered

The map on the right demonstrates the 2020 transportation plan in Shantou. Even though the proposed change of the transport system in the plan are significant, there is still much room for improvements towards a sustainable future in Shantou.

Transportation Master Planning, 2002-2020, Shantou



Source: Shantou Urban and Rural Areas Planning Bureau, 2003

Transportation Policy Suggestions

Given the challenges in current transportation systems and the transportation master plan supported by the Shantou government, we emphasize on three major aspects of transportation planning for Shantou: (1) integration of land use and transportation development; (2) integration of intermodal transportation systems; and (3) reclaim space for non-motorized transportation modes.

Integration of land use and transportation development

As travel demand is derived from economic activities, integrating land use planning with transportation planning rationally will be effective in reducing traffic problems before creating any. For example, encouraging mixed land use development with easy access to public transit can help to reduce travel demand as travel needs can be fulfilled by non-motorized modes (either by walking or riding public transit). However, these integrations need both institutional efforts as well as physical design consideration.

>Institutional Integration
>> Transportation planning and land use/city planning department should work together to prepare urban development plans.
>>Studies focusing on the transportation and environmental impacts of new development should be required.

Transit Oriented Development in Jacksonville, FL

Source: : http://www.metrojacksonville.com/article/2009-nov-jacksonville-transportation-center-moves-forward

>>Urban planning law should be established to require the integration between the two aspects

>Physical Integration
Transit –oriented-development (TOD) is a type of development that encourages mixed-use of development to concentrate around major transit station or transit node/hub area.
>> encourage high density, mixed use, diversified economic activities around transit nodes
>>departing from the transit node, density usually decreases
>> Residential parking near transit station is often limited, yet parking for commuters to transfer from other modes to transit should be provided.
>>Walking friendly design and environment are often enhanced in the TOD areas.

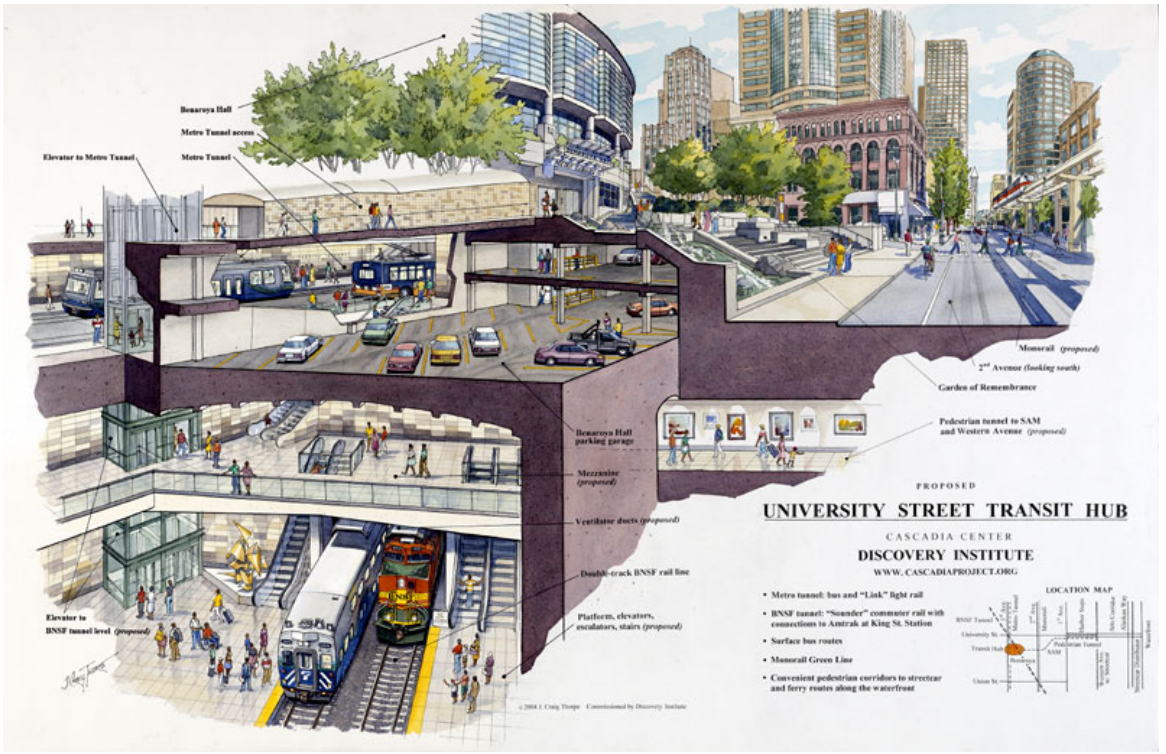
Integration of intermodal transport systems

An intermodal transport system specifically indicates the integration of different modes such as bus, light rail, taxi, private car, bike and walk into a convenient and coherent system. This integration requires institutional and operational planning and physical design efforts.

>Institutional Integration
>>Schedule integration among different bus operators and light rail operators.
>> Fare integration (e.g., include linked ticketing system between bus and light rail, and between different operators)
>>Accessible public information (e.g., information about schedules, stop locations, transfer information, and real time information on site or through other media)
>>Incorporating information technology into the management and planning of public transit systems

>Physical Integration
>>Transfer integration (e.g., transit hubs that can accommodate buses, light rail, taxi, bicycles and pedestrians to transfer from one mode to another easily and conveniently)
>>Parking integration (e.g., parking spaces for automobiles and bicycles adjacent to or in the transit hub or node area)
>> Accessible services to disabled people

Downtown Seattle Transportation facilities: University Street (Mid-Town) Transit Hub



Source: http://www.discovery.org/cascadia/centralPugetSound/midTownHub-JCT-Web.jpg

Reclaim space for non-motorized modes

Sustainable cities can operate very efficiently by using little energy and few resources, and balancing social equity and economic development. Non-motorized transportation modes have their special contribution in shaping cities in sustainable ways. With more residents walking and cycling, and more workers to commute by public transport instead of driving private cars, cities will become greener and healthier for people to live, work and play.

>Institutional change
>> support programs that encourage non-motorized travel, such as
>>>bicycle sharing program, or public bicycle systems
>>>walk-to-school program for students
>>>transit-pass program for employee benefit (i.e., employers share partial costs of transit pass to encourage more usage of public transit instead of driving cars)

> Physical improvement
>>system wide pedestrian/cyclist paths along major/minor arterials, and local streets, etc.
>>green spaces along major/minor arterials with pedestrian paths
>>dedicated right-of-way on major/minor arterials for bicycles (e.g., it can be painted path, or separated way, depending on traffic conditions)

Bike sharing program in Wuhan, Hubei, China, 2010

Source: http://life.fdc.com.cn/topic/sh/266321.htm

Bike path system

Source: http://life.fdc.com.cn/topic/sh/266321.htm

Bike and Pedestrian path and signage in Vancouver, Canada

Source: http://www.sobersecondthought.com/archives/003340.php

Transportation Planning in the Study District

Study District

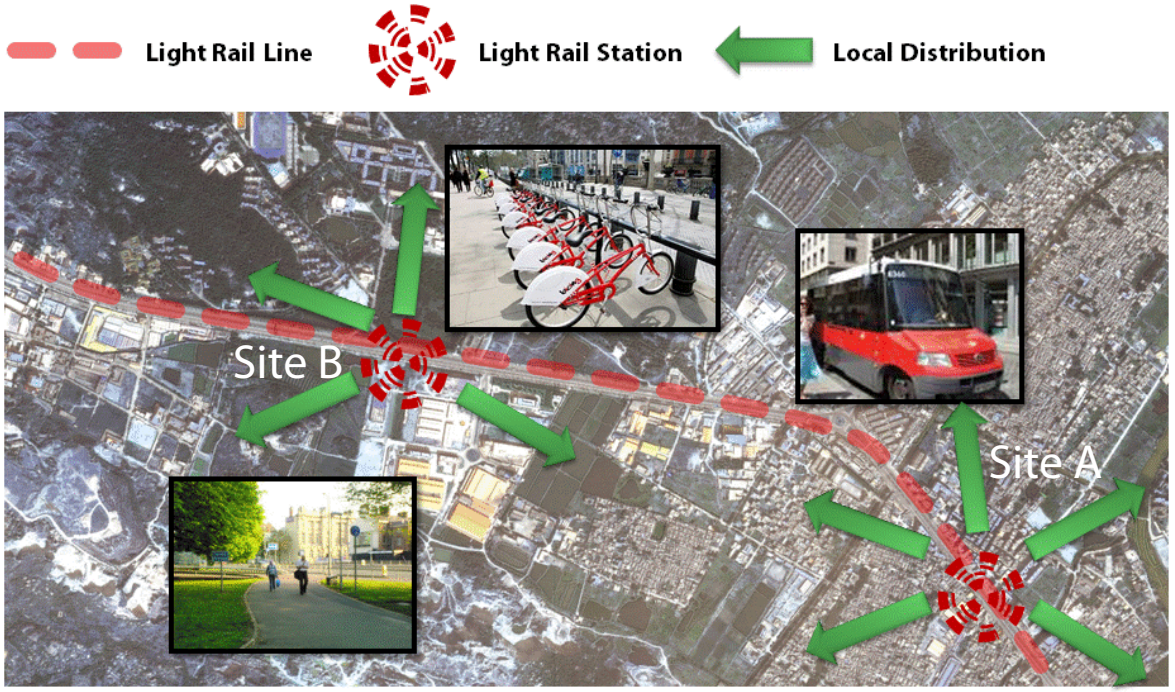
Our study area is located along the University Road in the northwestern part of the central city (Jinping District). Site A is located in the largest residential cluster in the northwest part of the central city, just on the urban edge; while Site B is located opposite to Shantou University.

Linkages between Site A and B

The planned No.1 light rail will be aligned along the University Road, passing through both Sites A and B, according to the 2020 Shantou Transportation Plan (Shantou Urban and Rural Areas Planning Bureau, 2003). Given the population distribution and activities located in these two areas (residential and commercial activities around Site A, and educational and industrial activities around Site B), we propose two light rail stations serving our study area as demonstrated in the map on the right.

The distance between our two proposed stations is around 1 mile. The light rail will be the major public transport mode that links Sites A and B. At both stations, we propose hub-and-spoke model (with shuttle buses and bike sharing program to distribute passengers from the stations to their destinations).

Site A, Site B, and Light Rail linking them, Shantou, 2010



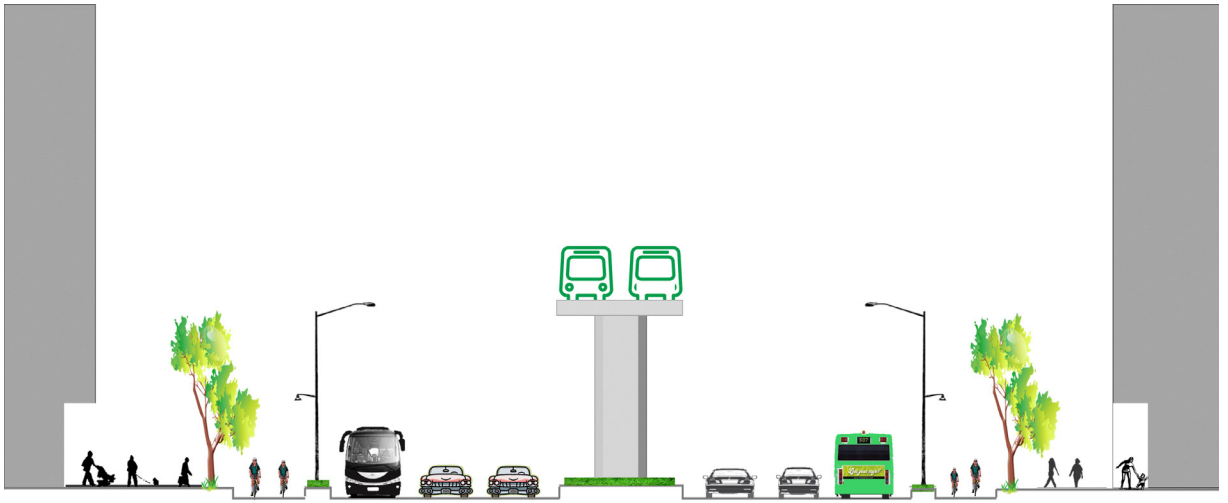
Source: Jiang, S. 2010

Multi-modal Stations

As discussed previously, one of our suggestions to improve the transport system in Shantou is to integrate different transportation modes into one efficient system. Here we use our study area to illustrate this concept.

The section image on the right demonstrates the right-of-way and space dedicated to different modes (including: elevated light rail, buses, automobiles, cyclists, and pedestrians). Adjacent to light rail stations, we propose bay areas for buses, taxies and cars to pull over for loading and waiting for passengers. We also propose parking areas for bike sharing programs around the rail stations.

Proposed Section of University Road, Shantou



Source: Jiang, S. 2010.

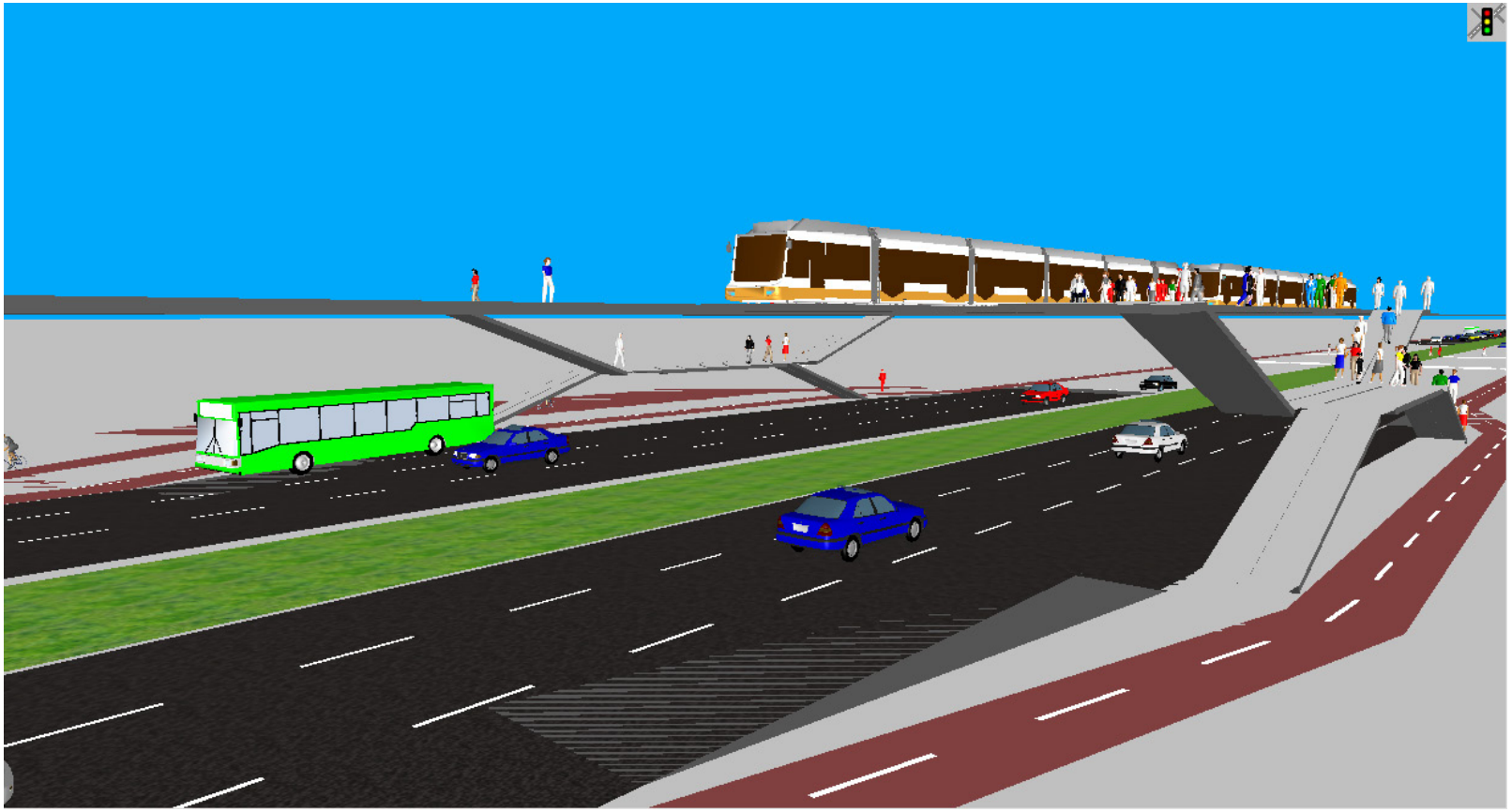
Problems and Two Scenarios

We employed a microscopic traffic simulation model, VISSIM, developed by PTV (2009), to plan and design the integrated transport system, and we encountered one big challenge. We use Site B to demonstrate the potential solutions that we propose, although Site A may also have the similar problems.

We need to clarify that we will design an integrated transport system for the study area in Shantou in 2030, when the amount of cars on the road will be much higher and denser than that of today. The elevated light rail line passes along the University Road, which lies between Shantou University and our Site B. As you will read later in this report that planners from the Site B team propose to develop more research and development (R&D), and commercial and recreational activities, the pedestrian flow between Shantou University and Site B will be very busy.

On the one hand, the 6-lane two direction University Road will be a major barrier for pedestrians to travel between the University and Site B; on the other hand, the pedestrian flow will also be a major interruption for the automobiles driving on the University Road. Pedestrian convenience and safety, and traffic queuing interrupted by the pedestrian flow are the major concerns in this situation. We propose two scenarios as alternatives to address the discussed issues. However, we have to admit that these two scenarios are not necessarily the final "solutions", but are demonstrations to illustrate how we should tackle the problems-- using the concepts discussed in this section.

A proposed plan: a light rail station with bus bays and bike parking integrated with it, around Shantou University.



Source: Shan Jiang, 2010

> Scenario 1: Traffic signal to control the pedestrian flow and car traffic

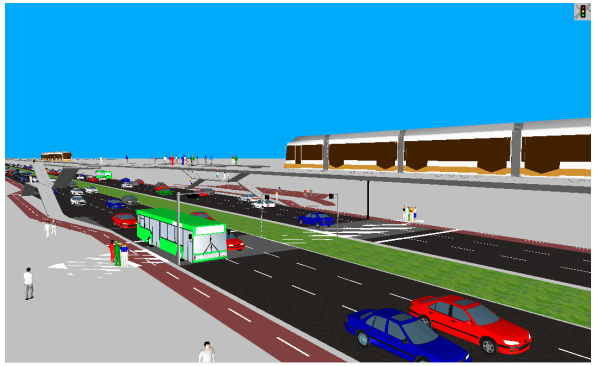
In this scenario, we use traffic signal for pedestrians and cars to control the conflicting flow between people and automobiles. The good side of this scenario is that the cost is relatively low, added by the installation of traffic signal and pedestrian pathway/ paintings. Yet the down side is that the fundamental problem of car traffic interrupting pedestrians (and vice versa) is not solved.

>Scenario 2: Underground bypass to create a pleasant, walkable and vibrant urban space

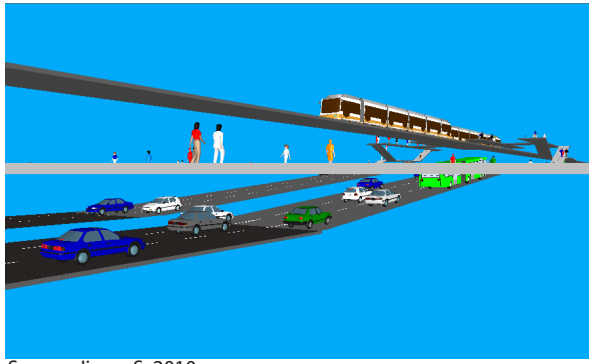
In this scenario, different from the first one, we propose to develop an underground bypass for automobiles, while the pedestrian activities still keep on the ground. This solves the problem of traffic interruption between cars and pedestrians, yet its cost compared to that in the first scenario is relatively high.

We realize that these two scenarios are not the only potential solutions. Our purpose of doing this exercise is to use the 3-D simulation visualizations to demonstrate the importance of the problem and our way of thinking on how to tackle the problem. The method can be used to replicate similar studies for Shantou in the future.

Scenario 1: Traffic signal to control the pedestrian and car traffic flow



Scenario 2: Underground bypass to create a pleasant, walkable and vibrant urban space



Source: Jiang, S. 2010

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Overview

The quantity of solid waste has been increasing rapidly in Shantou since the 1990s. The current municipal sanitation provides satisfactory service for the central city, but the service delivery is relatively poor in newly urbanized areas of the periphery. The solid waste recycling is informal and low-efficient, containing potential environmental hazards. Landfill is still the only destination of solid waste, and other approaches to enable the energy potential of solid waste are not yet implemented. "Waste treatment industry" is a promising outlook for the development of solid waste management system in Shantou for the next 10-20 years.

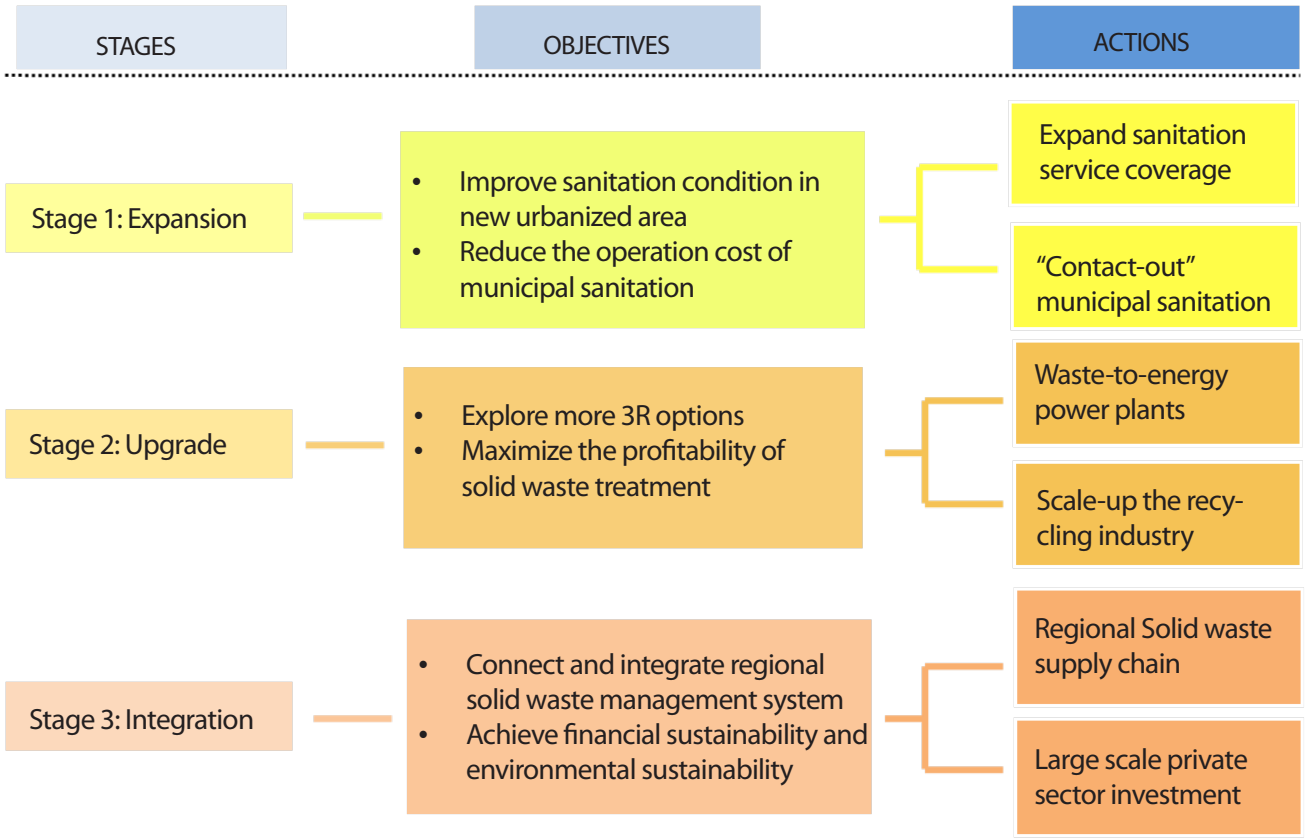

Diagram: Three-stage Policy Scheme for Solid Waste Management

The Solid Waste Management System

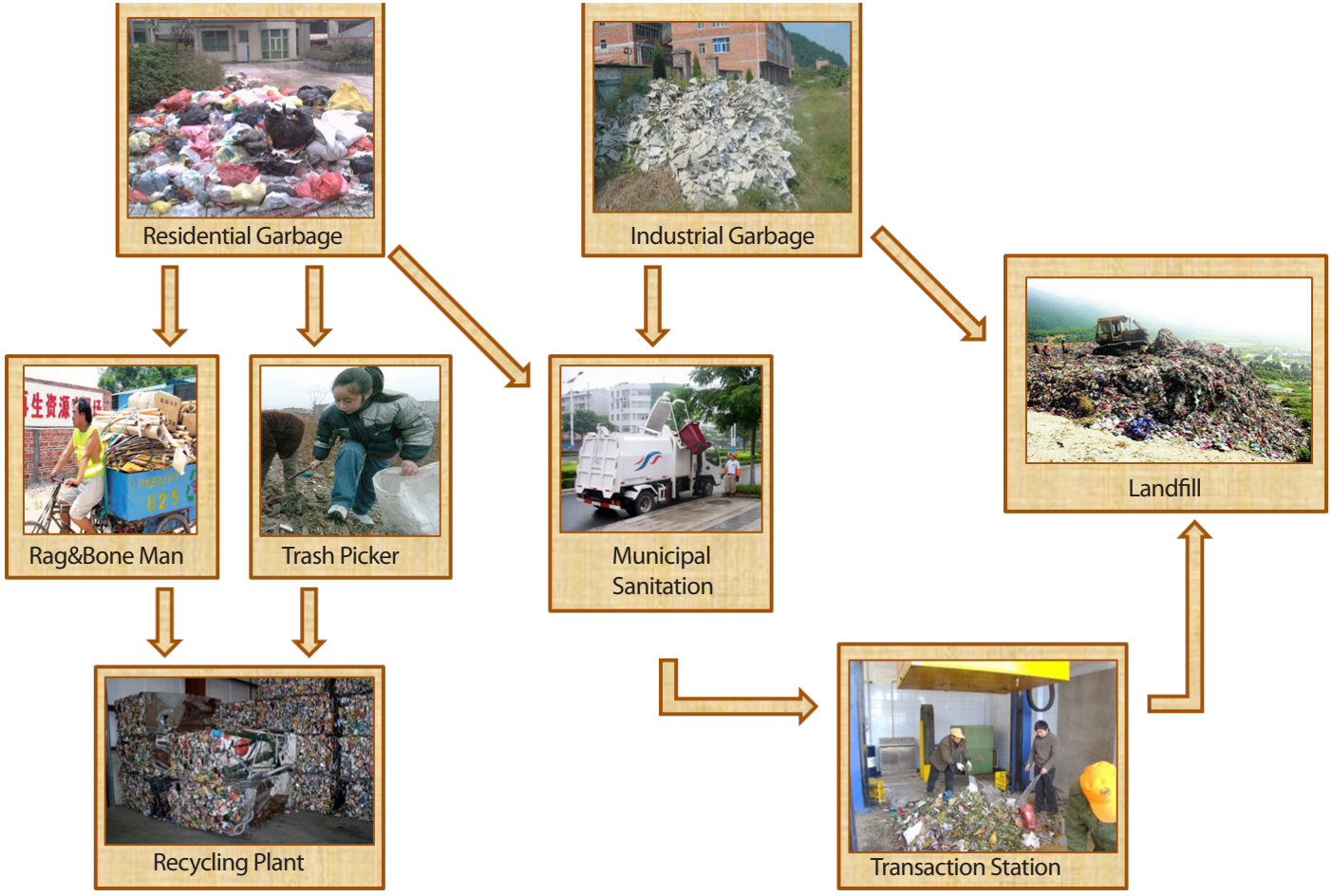

Diagram: Current Solid Waste Management System in Shantou

Current Situation

The current daily volume of residential solid waste in Shantou is 1,300 ton/day. The municipal sanitation employs about 2500 workers, and establishes 32 sanitation stations and 41 trash transfer stations, mainly serving the central city to the north of Rong River. There is one large landfill in operation, with daily capacity of 1,000 ton/day. One old landfill saturated and closed in 2002. No trash sorting to enable recycling is done by household or by municipal sanitation. The recycling activities are purely conducted by the private sector, such as the trash pickers and the rag-and-bone men. The trash recycling rate is estimated to be lower than 10%.

Future Outlook

At an annual growth rate of 3%, the daily volum of residential solid waste is expected to reach 2,50 ton/day in 2030. The recycling rate will increase a well, given that promoting efficient use of energ and resources has become a policy priority of Chi na. Upon a conservative estimation, the recyclin rate will reach 40% in 2030. The extended pro ducer responsibility will be enforced by law, an the solid waste recycling activities in private secto will be formalized. Under governmental suppor large-scale recycling clusters specializing in certai product categories will emerge.

The landfill will gradually be replaced by other solid waste reuse options, such as waste-to-energy power plants. Unrecyclable trash will be incinerated to produce electricity. The facilities will be built under BOT mechanism, managed and operated by professional investors.

Expanding the sanitation service to suburban areas is another policy priority for Shantou. New sanitation stations and trash transfer stations should follow up with the pace of urbanization to cover the previous rural villages. Sanitation service privatization is a widely applied approach to improve the efficiency of service delivery and meanwhile lower the cost.

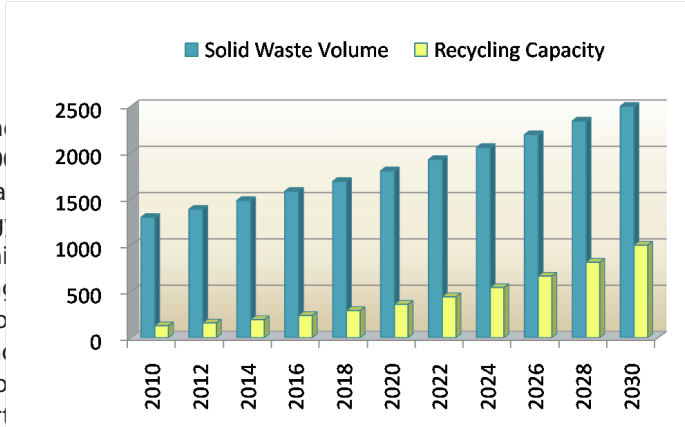

Figure : Waste Volume and Recycling Projection

Picture: Landscape design for a solid waste transfer station, Wuxi, Hangzhou
Source: Wuxi Daily
http://www.wxrb.com/szb/wxsb/html/2009-07/09/content_385868.htm#

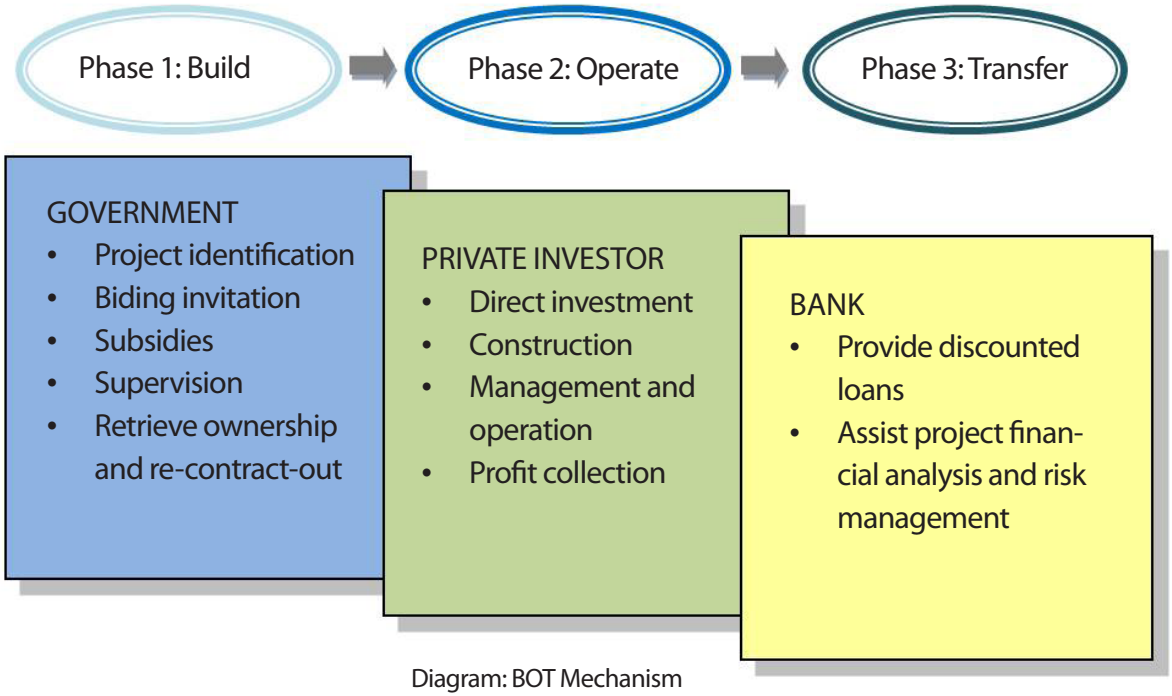

Diagram: BOT Mechanism

"The Waste Treatment Industry"

The Concept

Urban solid waste management has long been treated as a public service relying on the support of municipal finance. However in many industrialized countries, solid waste management has been "industrialized" and become partially sustainable from a financial perspective. The core rationale is to fully exploit the profitability potential of solid waste, and encourage private sector investment. The potential profitability includes the following components:

- Sanitation service charge
- Recyclables
- Energy production from solid waste
- Other by-products (such as fertilizer)

If these 3R options are fully utilized, the cost of solid waste management will be significantly reduced. Meanwhile, the development of the industry can bring about economic development opportunities and create a considerable amount of jobs for Shantou. What is more, the environmental benefit, which is difficult to quantify, will be enormous.

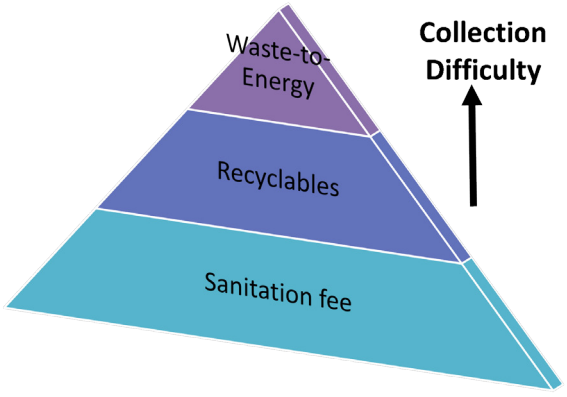

Diagram: Profitability Pyramid

The Scenarios for Shantou

To illustrate the potential benefits of waste treatment industry, three scenarios are established for Shantou in 2030. To avoid inconsistency, the scenario uses 2010 price level and does not adjust for inflation.

Scenario 1 Business-as-usual 10% recycling, 90% traditional landfill
Scenario 2 Enforced recycling 40% recycling, 60% traditional landfill
Scenario 3 Enforced recycling and waste-to-energy 40% recycling, 40% incineration, 20% landfill

Treatment	Recycling	Trash -Energy	Landfill
Net Cost (RMB/ton)	180-100 =80	100	150

Table 1: Net Cost per Ton of Solid Waste Treatment

	Recycling	Trash-Energy	Landfill	Total
Scenario 1	7.3	0	123.2	130.5
Scenario 2	29.2	0	82.1	111.3
Scenario 3	29.2	36.5	27.4	93.1

Table 2 : Total Cost of the Three Scenarios (million RMB)

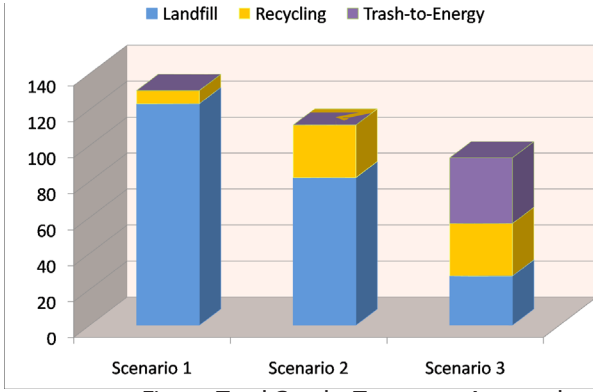

Figure: Total Cost by Treatment Approach

According to our result, when the potential of recycling and trash-to-energy is fully utilized, the solid waste treatment cost can be reduced by nearly 30%.

The economic development impact can be even more significant. Beyond the 36.5 million value directly created from recycling, other industries using the recycled materials as inputs will also get developed, bringing more economic development opportunities. The input-out analysis suggests that the multiplier can be as high as 3, indicating that the total economic scale of the industry can exceed 100 million, with 500-1000 new jobs created.

The productivity of trash-to-energy power plant is smaller. A ton of sorted trash can be converted into 2/3 KWH of electricity. At a market price of 0.8 yuan/KWH, the total annual revenue is less than 1 million. However, the biggest benefit of trash-to-energy is that it saves large amount of land which would otherwise be used for landfills. Also, if the solid waste treatment cluster is established around the waste-to-energy power plant, the electricity produced would be enough to support the operation of the whole cluster.

Diagram: System Benefits

Barriers and Solutions

1) Scale matters. The trash recycling and waste-to-energy facilities will not be efficient unless reaching certain scale threshold. The "economy of scale" is important.

2)Large initial investment. The initial investment of waste-to-energy power plant can be 30 times larger than a traditional landfill with similar capacity. Recycling also requires intensive equipment inputs.

3)Technical barrier. The current incineration and recycling techniques used in China are still far behind those in developed countries. The trash-to-value efficiency is still low.

4) Management capacity. The high-level recycle and reuse activities requires intensive waste management support, and the most critical limitation is trash sorting, the implementation of which faces large difficulty in China.

5) Environmental concern. If not properly handled, both recycling and waste-to-energy will cause environmental pollution. The notorious electronic recycling town, Guiyu in Shantou, is an example.

The solutions of these barriers include governmental subsidies and supervision, regulation enforcement, technological upgrades, regional scaling-up cooperation, and so forth. More details are provided in the Integrated Solid Waste Management Topic under the Individual Tool Section.

Picture: Electronic recycling, Guiyu Town in Shantou
Source: hc360.com
http://info.water.hc360.com/2009/03/120840129202.shtml

Picture: Unregulated disposal along the canal
Source: Jiyang Zhang

Area Zoom-in—the Planning Area

Current Situation

The planning area is at the urban periphery, and municipal sanitation has limited coverage. The sanitation condition is relatively better along the University Road since sanitation vehicles have easy access. In the traditional residential blocks however, sanitation is nearly blank. Trash is often disposed along the canal, directly causing water pollution. In the west part of the planning area, the solid waste disposal is even more unregulated. Both industrial waste and residential waste are disposed intensively along the University Road. Map… shows the "trash corridors" in the planning area.

The Liantang landfill is not far from the planning area, further down to the west. A waste-to-energy power plant is under construction. Several informal recycling points disperse in the area. Cans, bottles, paper, plastics, and electronic appliances are the major targets of recycling.

Picture: Informal recycling in TuoPu Town
Source: Jiyang Zhang

Future Outlook

To expand sanitation service coverage, new sanitation stations and trash transaction stations should be established in the area. To complement municipal sanitation, part of the service can be contracted out to private sanitation firms. Trash collection facilities such as trash bins and trash pits will be added to the neighborhood to avoid unregulated disposal. The industrial disposal will go through more stringent regulations with solid waste fee. The recycling activities will be led by several licensed private companies, supervised by the local government.

Future Policy Scheme

Period	Policies
5-year	* BOT experiment of waste-to-energy power plant
	* Expand municipal sanitation service to newly urbanized area
	* Formalize current private sector recycling activities
	* Eliminate unregulated trash disposal activities
10-year	* Large scale waste-to-energy power plant constructed serving broader region beyond Shantou
	* Partially contract-out the sanitation service to private sector
	* Promote private investment in large-scale recycling factories
	* Enforce extended producer responsibility for major products
15-year	* The solid waste treatment industry established in the form of industrial park
	* Trash-sorting and other advanced management activities implemented from household level

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Overview

Shantou has plenty of water resource thanks to the river streams and the monsoon rainfall. Water supply is not a problem for the city, and nearly 100% of urban area is covered by tap water service. The major challenge of the water system comes from the waste water and the storm water. The urban sewage system of Shantou is constructed decades ago and is not capable to meet current needs. Also, the water treatment facilities do not have enough capacity to handle the increasing amount of waste water as a result of urban expansion and living quality increase. Water pollution has been deteriorating for years, and its impact on environmental quality and water safety is severe. Undoubtedly, the upgrades of urban sewage system and water treatment facilities will be an important task for Shantou in the next 10-20 years.

Picture: Map of Shantou water system

Waste Water

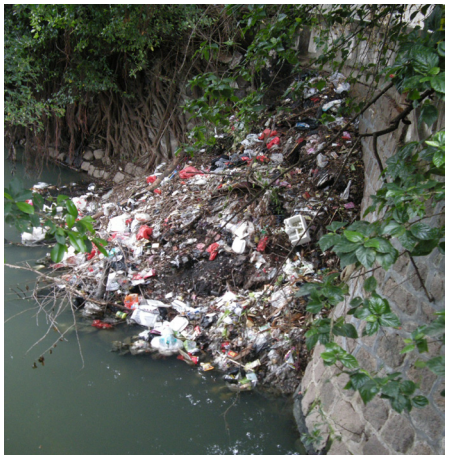
Current Situation

The current daily volume of waste water in Shantou is around 600,000 ton/day, consisting of 65% residential and 35% industrial. There are 3 waste water treatment plants operating, with capacity of 350,000 ton/day. The waste water treatment rate is still low (58%), and a large amount of waste water is directly discharged into the water body without any treatment.

Future Outlook

The daily waste water volume in Shantou is expected to increase significantly in the next 20 years. At a conservative growth rate of 4% per year, the waste water volume will reach 880,000 ton/day in 2020 and get more than doubled to 1,320,000 ton/day in 2030. To handle this trend, more waste water treatment facilities with be built using BOT mechanism. It is expected that the waste water treatment rate in Shantou will reach 70% in 2020 and 90% in 2030.

The major industries in Shantou are light industries and food processing, and their pollution impacts are much smaller compared to heavy industries. More stringent regulations will be implemented to enforce industrial on-site water treatment and pollution charge. Heavy-polluting industries will be either closed or moved to industrial parks where large-scale collective waste water treatment is applicable. It is expected that the water quality in Shantou will get improved continuously in the 20-year horizon.



Picture: Canal Pollution, Shantou
Source: Jiyang Zhang

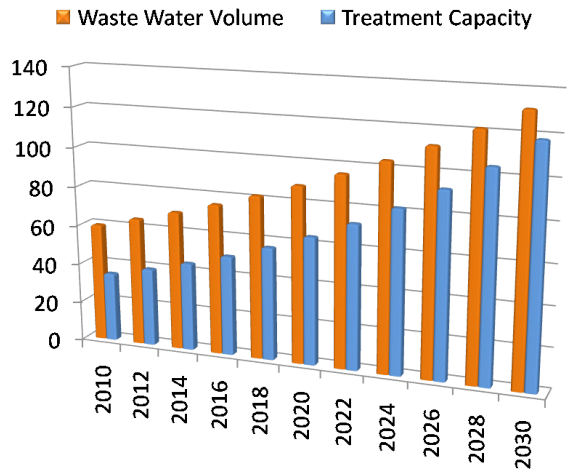


Figure: Waste Water Volume and Treatment Projection

Picture: Yuegang Waste Water Treatment Plant, Guangdong
Source: Yuegang leather Industrial Park Website

Storm Water

Current Situation

Shantou has plenty of rainfall during the monsoon season (April-August), and the annual precipitation is 1,300-1,800mm. Storm water either enters the combined sewer system, or directly enters the water body in the form of surface runoff. Currently there is barely any infrastructure to capture the storm water for reuse. In heavy-rain days, water logging is a prevalent problem across the city, given the low elevation of Shantou Delta. The sewage overflow also creates trouble for urban sanitation.

Future Outlook

The storm water management in Shantou will mainly rely on the upgrades of the sewer system. The separate sewer is the best approach to handle both waste water and storm water. In areas where combine sewer is in use, Surface open-channels can be constructed to reduce the burden of pipelines thus reduce the chances of waste water overflow. Since a number of river streams and canals flow through the urban area, these water bodies can be utilized for storm water absorption. Other important approaches include increasing urban green space coverage, promoting on-site storm water collection facilities, and building water stock landscapes such as wetland swales and detention basins.

Storm Water Capture and Treatment Methods				
METHOD	EXAMPLE	SCALE	PURPOSE	COST
Porous pavement		Street	Stormwater capture	$
Bio-retention		Neighborhood	Filtering and retention	$
Waterfront Vegetation		Along the canals	Filtering	$$
Wetland basin		Neighborhood and Regional	Filtering and retention	$$$
Reservoir		Regional	Capture and retention	$$$

Table: Stormwater Treatment Approaches
Source: Part from Shenzhen Studio 2009, 11.306
DUSP, MIT

The Sewer System

Current Situation

Like most other historical cities in China, Shantou mainly uses combined sewer system. The system collects sanitary sewage and storm water runoff in a single pipeline. In dry weather, all waste water is collected and piped to water treatment facilities. In rainy weather however, if the total amount of storm water and waste water exceeds the capacity of the pipeline, part of the water mix will be discharged into the adjacent water body, know as Combined Sewer Outflows (CSO). CSO can cause serious water pollution, not only from the waste water but also from surface pollutants flushed into the sewer system.

The sewer system of Shantou has not yet covered the whole urban area. In urban peripheries, residential and industrial waste water is often discharged directly into the water body.

Future Outlook

Sewage service expansion should follow up with urban development, especially in redeveloping the urban villages. By 2030, it is expected that the sewer system coverage will reach 95% in Shantou. Separate sewer system, which collects waste water and storm water through different pipelines, will be constructed in newly developed urban areas. The system will avoid sewer outflows and reduce water pollution. In old urban areas where combined sewer system is in use, mitigation facilities such as CSO storage tunnels and retention treatment basins will be installed.

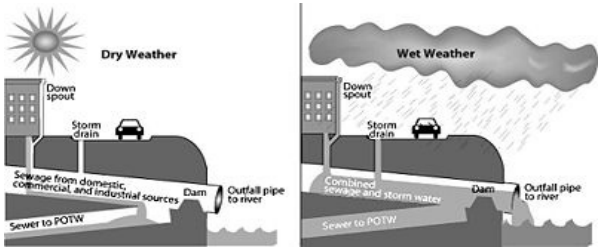


Diagram: Combined Sewer System
Source: Wikipedia

Picture: Current Sewer
Source: Jiyang Zhang

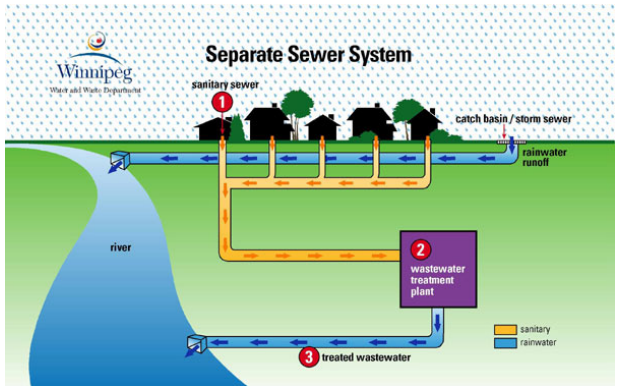


Diagram: Separate Sewer System
Source: City of Winnipeg
http://winnipeg.ca/interhom/

Cross-Border Water Issue

Current Situation

Shantou is at the downstream of Chao-Shan Delta. Two of the three river streams, Han River and Rong River, flow through Chaozhou urban area before entering Shantou. Cross-border water pollution is a critical issue for the city. Intensive residential and industrial activities in the Chaozhou upstream area produce large amount of waste. Similar to Shantou, the current sanitation and water treatment system in Chouzhou is not well developed. As a result, the river streams entering Shantou are already polluted. Till now, there is no agreement between the two cities about cross-border water management.

Future Outlook

Shantou and Chaozhou will enforce the joint efforts to clean up the river streams shared by the two cities. However, given the existence of administrative boundaries and municipal finance constraints, it is unlikely that the water treatment budget can be shared. The extent of upstream water quality improvement largely depends on the water treatment actions and regulations Chaozhou will take in the future. If the overall development pattern of Chao-Shan region applies similarly to the two cities, it is expected that Shantou will benefit from cleaner water inflow from the upstream, given that Chaoshou will improve its sewage system and waste water treatment facilities to match up with its development.

Area Zoom-in: Local Sewage and the Canal

Current Situation

The planning area is higher elevated in the northwest and lower elevated in the southeast. Several canals flow through the residential cluster, connecting to the river stream to further east. There is a major sewage pipeline along the University Road, serving surrounding area.

Besides the university campus, the west part of the planning area serves industrial land uses, and the construction density is low. Small canals penetrate through the industrial park on the south of the University road. The major pollution source is waste water from light industries.

The east part of the planning area is the Tuopu Town residential cluster. Besides high density residencies, there are also small-scale light industries dispersing along the canals. The pollution source is mainly residential waste, in the form of direct disposal or surface runoff. The combined sewer system has not yet covered the traditional courtyard blocks. Although the canals provide instant storm water absorption function, water logging is still a problem for the lanes squeezed between traditional buildings.

The water source of the canals comes from a tributary of Han River, and the upstream flows through high-density built up area of Chaozhou. As a result, the water is of bad quality even before it enters the canals.

Picture: Canal Pollution
Source: Jiyang Zhang

Picture : Area Water System and Storm Water Flow

Future Outlook

1) Regional sewage system will be upgrade upgrades. The separate sewer pipelines will be constructed when the redevelopment of traditional blocks takes place. The storm water pipelines can be easily connected to the canals to save construction cost.

2) On-site storm water collection and gray water treatment faculties will be a mandatory requirement for new neighborhood development. The low cost solutions with instant benefits will be the first priority. Landscaping to absorb storm water and improve canal water quality will also be promoted.

3) Polluting industries will be moved out of the residential cluster to the industrial park. In the short run, industrial waste water can be discharged into urban sewer system with a pollution fee. When the industrial park reaches certain scale, a on-site collective waste water treatment plant can be built.

4) Water treatment facilities will be built at the canal headstream. When the area gets developed, more municipal finance funding will be applicable to promote water clean-up activities. It is also expected that the upstream water quality will improve given increasing investment in environmental infrastructure from Chaozhou in the next 10-20 years.

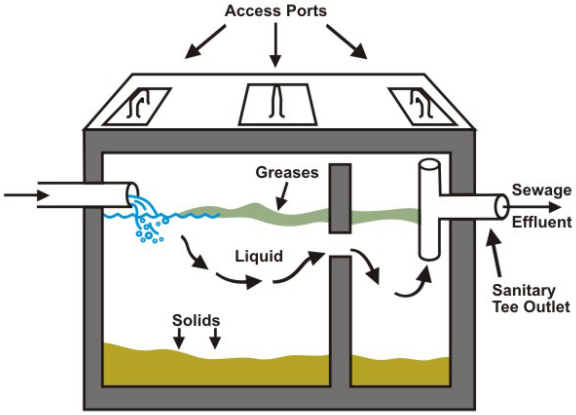


Diagram: Onsite waste water treatment
Source: National Center for Environmental Health
http://www.cdc.gov/NCEH/publications/books/housing/archive/cha10.htm

Picture: Onsite wastewater facility, Oregon
Source: Edgewater NW

Future Policy Scheme

Period	Policies
5-year	* BOT experiment of waste water treatment plants * Stringent regulations and pollution charge implemented to control industrial pollution * Combined sewer system upgrades with storm water mitigation facilities
10-year	* More waste water treatment plants built under BOT mechanism * Enforce zoning and relocate polluting industries to the industrial parks * Promote on-site water treatment facilities through regulations and subsidies
15-year	* Gradually replace combined sewer system with separate sewer system * Environmental Partnership with Chaozhou established to improve upstream water quality * Systemic water clean-up work implemented in local river streams and canals

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SITE A

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GEOGRAPHIC INFORMATION

Site A is a small a parcel of land, roughly 7 hectares, that once served as a former military barracks and is now owned by Shantou University. It is primarily undeveloped but embedded within a dense residential and retail neighborhood located slightly more than 1.5 km east of the University. The 100-hectare surrounding neighborhood serves as the greater study area for analysis and development. Site A is currently connected to Shantou University by a busy highway that runs through the larger study area. It is part of a system of waterways and canals that connects it to Site B.

Figure: Context Map

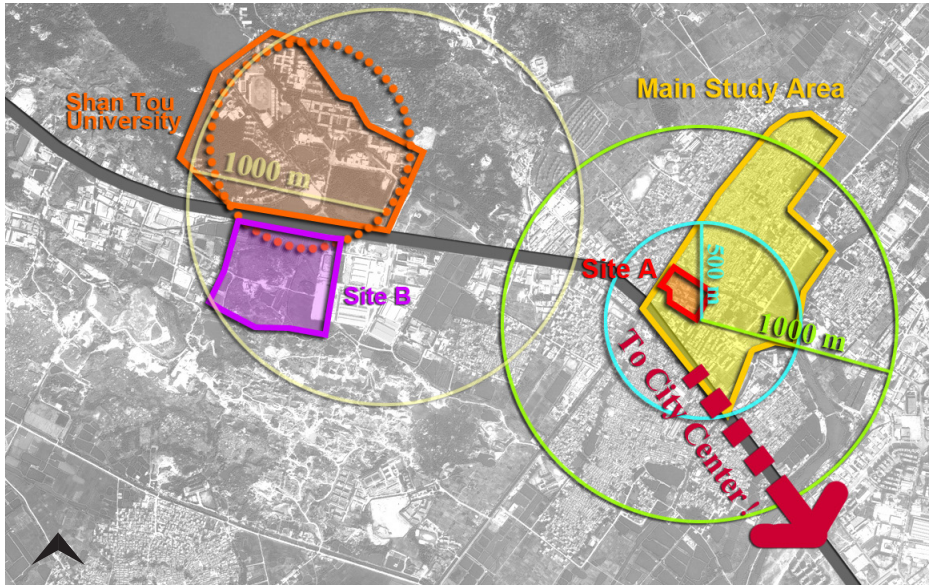
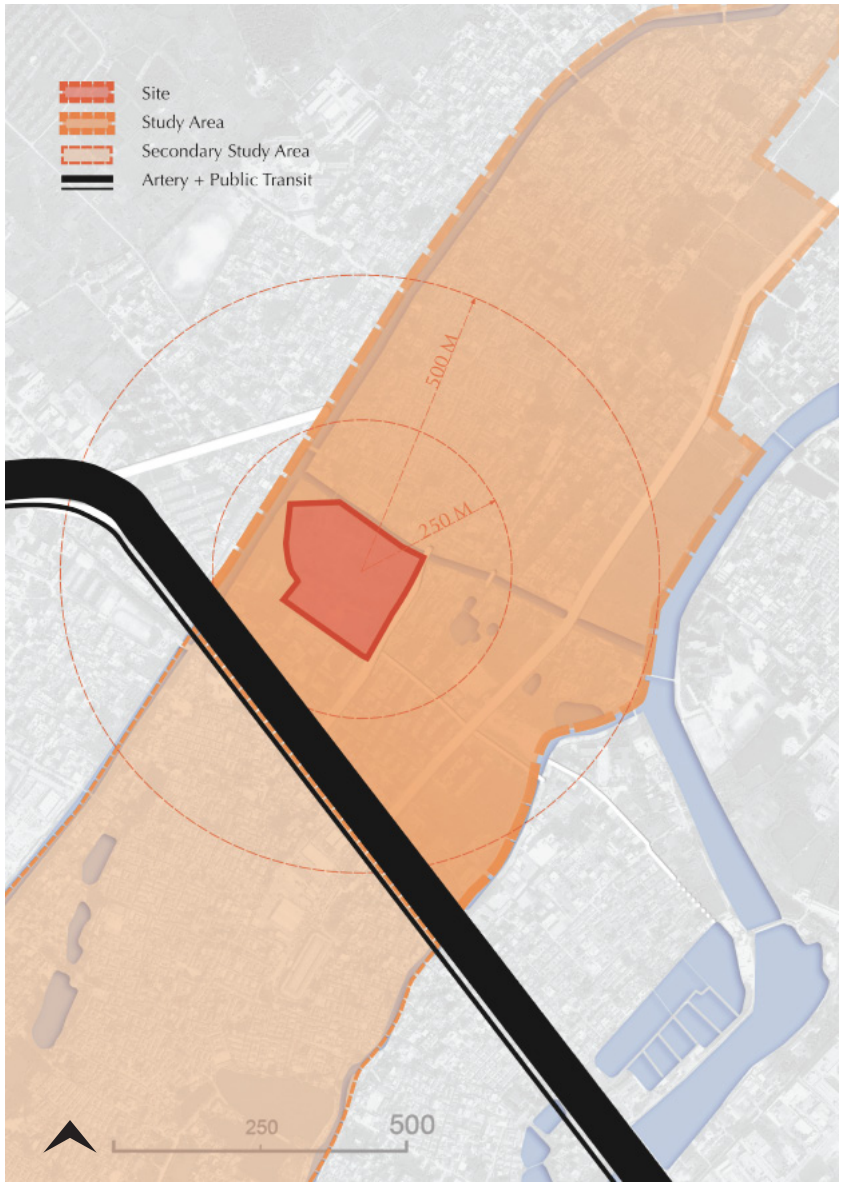


Figure: Study Area Map



NATURAL SYSTEMS

There are two natural systems in the area - the green system and the canal.

Green System

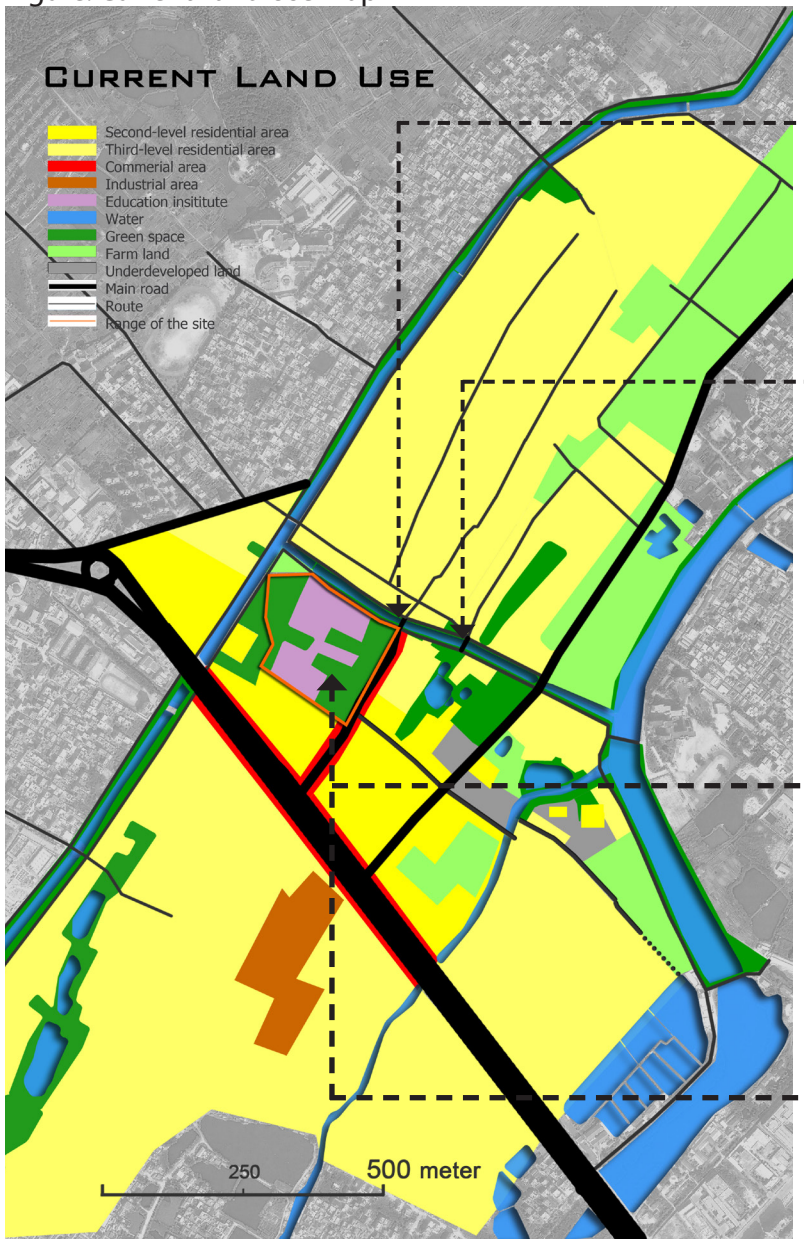
The green system consists of parks scattered through the site and larger plots of agricultural land towards the north east corner of our study area. The parks are not properly cultivated or maintained and are more swathes of open green space than parks with facilitates for visitors. Moreover, they are not connected with one another and their use is largely restricted to residents of the area.

Canal

The canal is currently used as a garbage dump and is of no aesthetic value to the residents. The canal runs along the eastern and western edges of the study area and traverses a west to east trajectory across the center of the area and along the northern edge of our site.

The water in the canal is contaminated and not fit for domestic use or ingestion. The garbage build up seems to have reduced the natural flow so that the water moves very slowly and is almost stagnant. However the wide banks indicate that the water levels might rise over the monsoon periods.

Figure: Current Land Use Map



Photos: Canal

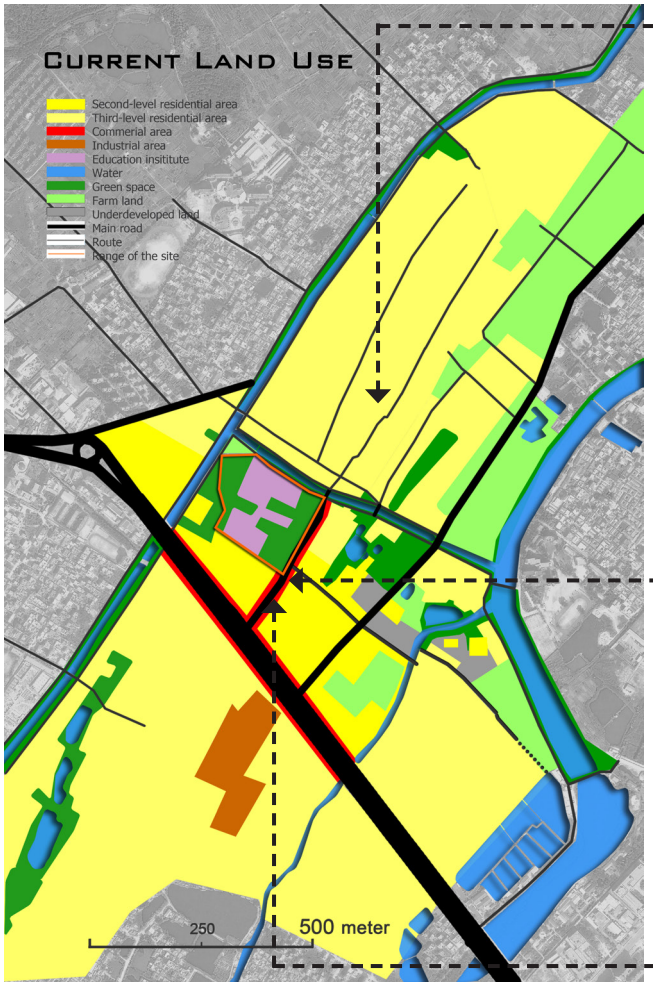
Photos: Site A, Source: Yun Zhan

HOUSING

There are two main types of housing found in the study area – the traditional low-density village housing and the higher-density new housing.

The traditional village housing follows the traditional Chauzhou architecture of the region and comprises single-story homes built around a courtyard. The homes themselves are arranged around a central courtyard which has a temple, and sometimes a fountain and small garden. Most of the homes we visited were not inhabited and though most of the structure remained intact they were not well-maintained and had fallen into disrepair. The traditional villages were clustered in the area just north of the canal and extending up to the northern end of our study area. The current inhabitants are largely migrant workers who have moved to Shantou in search of construction work and other odd jobs.
The original inhabitants of the urban villages now occupy two to three-story homes on the eastern edge of the site, having moved out as their families expanded and incomes increased. They rent their old homes to the migrant workers for a nominal price every month.

The other main housing type in this area consists of 7-9 story walkups. These were found in the entire area to the south of our site and below the main highway. There is also some higher density housing on the eastern edge of our site. These walkups are built on old village land and most likely by the village inhabitants themselves. To maximize space these buildings are built very close to one another; colloquially called "kissing buildings" as there is very little space between them for pedestrian or vehicular use and residents of adjacent homes can literally reach into each others houses.



EXISTING CONDITIONS > Community Facilities, Transportation/Access

COMMUNITY FACILITIES

In its existing state, there are no community facilities located within Site A. Around the site, however, there exists an array of community facilities, with services in every category. There are several kindergartens and primary schools, one major hospital, a small handful of green, open spaces, and a main street of retail perpendicular to another strip of smaller retail shops.

According to our observations and informal interviews, the kindergartens and primary schools in the area are well utilized. The one hospital to the southeast of the site is a major hospital comprising of 88 hospital beds and has the capacity to perform 520 surgeries per day. In speaking to residents in the area, the hospital is used for major medical needs while smaller clinics or traditional Chinese medical doctors are more frequented for minor medical needs. There are several small open spaces, some with green areas and others without, that are all underutilized and mostly sit idle. Despite these spaces, residents have stated that there is little space for senior citizens and children to frequent. Along the main road near Site A is a major commercial strip of retail that includes clothing, small appliance, and drug stores. The narrower street that lies perpendicular to this main road has a series of shops, most of which are smaller with more informal street fronts. Also along this road are small restaurants and food carts.

Overall, there is a variety of services but an underutilization of the existing open spaces for all residents, a lack in diversity of retail, a slightly unorganized appearance, and few attractions for entertainment.

TRANSPORTATION/ACCESS

The site area consists of a number of disorganized roads and pathways. Primary access into the site comes from the busy highway to the south, which leads into a dense commercial street. A bus line serves this area and stops not far from this intersection. The highway is wide and chaotic without any lights within the site area and is extremely difficult to cross, which poses a real danger. Otherwise, there are very few entry points into the site, so access is extremely limited.

Within the site itself, the roads are not well connected and there are a number of dead ends. The current road system is messy, inconvenient, and suffers from poor circulation. Movement within the site is dangerous due to the mixing of transportation modes, including pedestrians, automobiles, and motorbikes. This is particularly notable in the village areas north of the canal, which consist mainly of smaller one-lane pathways that try to accommodate two-

Figure: Current Community Facilities

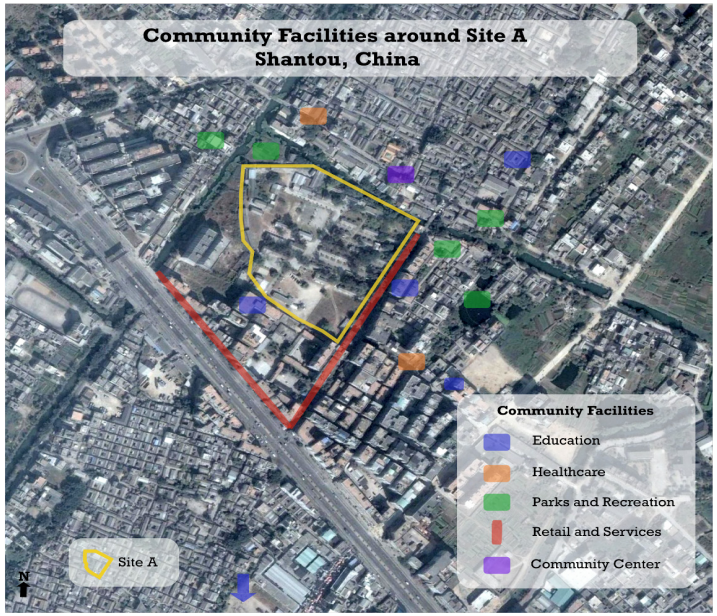


Photo: Current Transportation Conditions, Source: Yun Zhan

ASSUMPTIONS

ECONOMIC GROWTH

- China's economy has been growing at a rate of 10% or 11% over the past number of years and needs 6% - 8% growth just to sustain itself, and Shantou's economy will continue at a similar pace over the next couple of decades.
- Family income will grow proportionally to China's economic growth.

POPULATION

- Cities throughout China are rapidly urbanizing and seeing an influx of rural migrants. Shantou will see significant population growth and increased density.
- Shantou's demographics will include more families and less single workers. There is also a growing aging population and the elderly will become more independent despite the presence of extended family.
- City services will change to have more inclusion of migrants.

TRANSPORTATION

- As incomes grow, automobile users will increase.
- Public transport can offset the shift from motorbikes to automobiles and can keep auto ownership from going up.

LAND PLANNING

- Opportunity for coordinated approach to growth and modernization instead of piecemeal development, particularly vis a vis district and neighborhood planning.
- Land use and transportation integration. .

GOALS

PUBLIC DOMAIN

Open Space

- Incorporate more open space into the site that is accessible to the public.
- Take advantage of existing green system.

Culture

- Maintain the heritage and certain architectural features of the villages while still modernizing the area.

Community Facilities

- Provide quality and strategically located community facilities to meet the needs of the population in terms of both quality and quantity.

Mixed-use

- Develop community that residential, commercial, and institutional uses within the site.

LIVING

- Transform the current low-density villages into a higher density community that can fit into the future development needs of this area.
- Develop mixed-income community, create social equity, and provide housing opportunities for all residents.
- Generate equitable finance scheme that balances public and private funding sources.
- Incorporate villagers into the development process and finance scheme to share benefits among the residents.

ACCESS & CIRCULATION

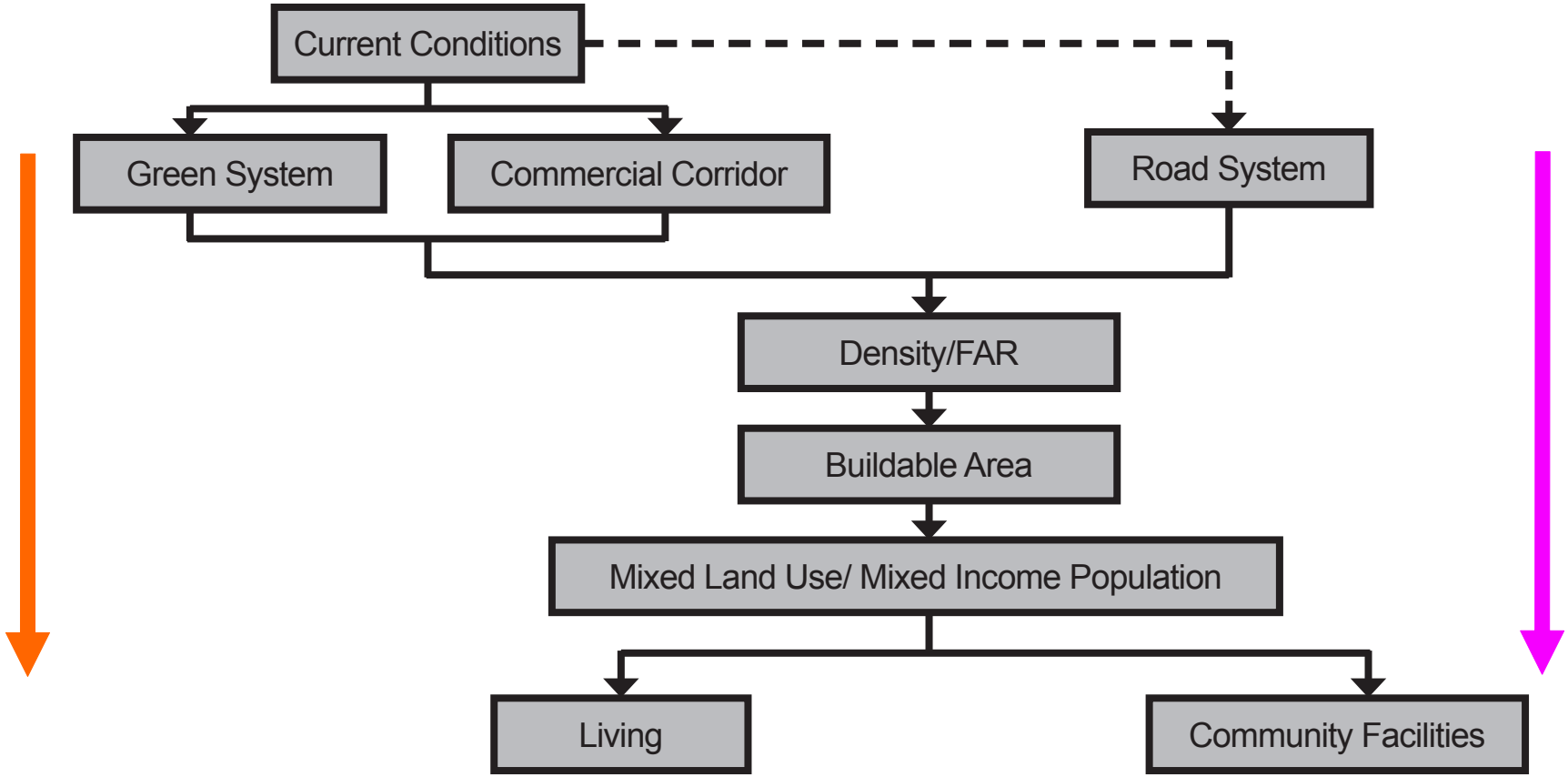
- Allow for greater access into the site.
- Improve circulation within the site.
- Promote a pedestrian friendly zone.
- Encourage use of public transportation by strengthening access to these services.
- Separate transportation modes (i.e. pedestrians, bicycles, public transportation, automobiles).

METHODOLOGY > Development Logic

The development plan takes advantage of the study area's strongest existing qualities and builds upon them. Utilizing and connecting the existing open space areas, a green space system is developed, which serves as one of the anchors for the site. The other is the commercial corridor built off an existing central pathway that runs through the site, creating a retail spine to centralize the site. A transportation network based off connectivity and access analysis is integrated with these elements to serve as a centerpiece for the community and a base around which we determine further site programming.

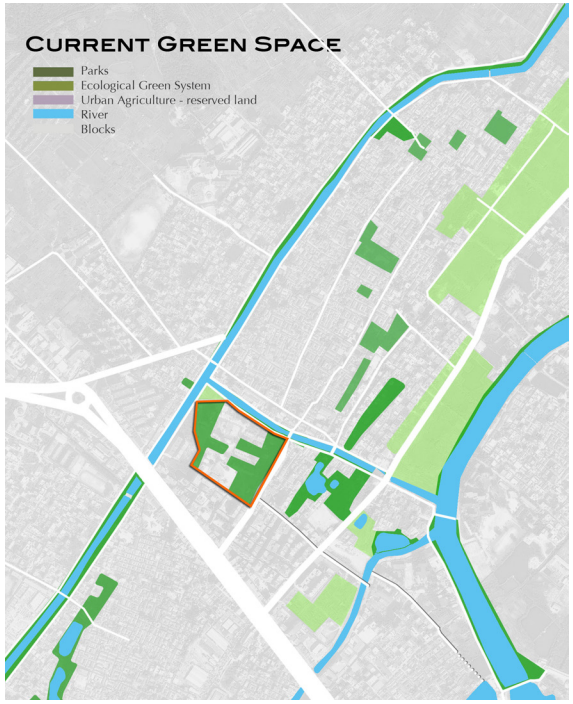
By prioritizing these core elements, we then determine the neighborhood density and FAR which tell us how much buildable area we anticipate in the site area. This information influences land use decisions which allows us to estimate the site population. This gives us the tools to design housing and community facilities plans that will best serve the residents of this area.

Figure: Our Development Logic for the Whole Study



The current green space in and around Site A exists in isolated pockets that are used only by those who live adjacent to them. Large sections of the area therefore are cut off from access to green systems. The canal traverses the length of the area on both sides, but is currently used as a trash dump and is of little aesthetic value. The water is unclean and largely stagnant making it a health hazard for those who live alongside the canal. Additional ecological features of the site include small areas of green space and vegetation along the length of the canal to the left of the site, and plots of agricultural land to the northeast and southeast.

Figure: Current Green Space

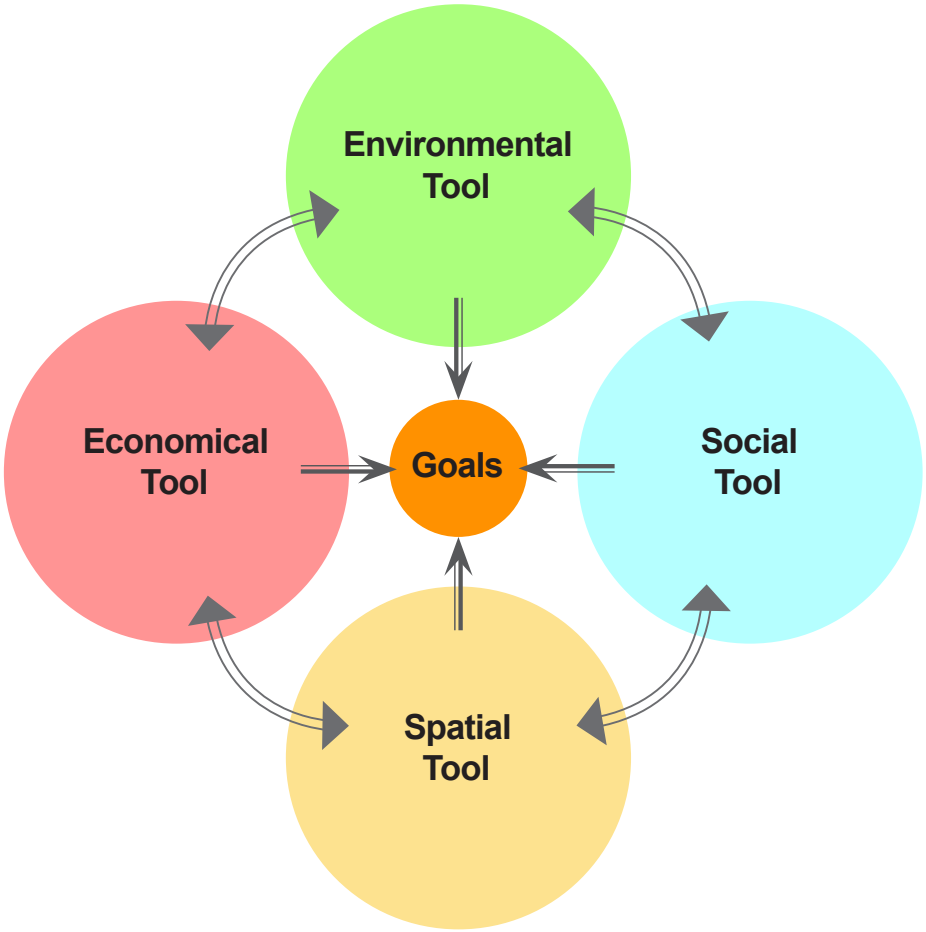


Our open space plan builds on these existing features. Given the density of housing in the area, we thought it would be best to work around existing systems to minimize relocation and disruption of patterns of social activity. Our open space plan utilizes Site A to create connections between these isolated pockets; in creating a fluid system that runs through the entire area we aim to facilitate greater integration and movement of residents.

Proposed Overall Green System

Proposed Eco-System

Proposed Park System



ENVIRONMENTALLY MOTIVATED TOOL

The environmental motivation for our design was to preserve green space despite the density we predict for the area. This reflects our awareness of the important role the natural environment has to play in purifying the air, attracting rain clouds, providing a natural drainage system, and enhancing the character of dense urban settings amongst others. We also hope that this will help youth growing up in urban areas develop an appreciation for nature.

ECONOMICALLY MOTIVATED TOOL

Our vision for the site and the area is to cater to a range of income levels by building both affordable and market rate housing. We plan to build lower-density market housing along the canal and green space system with the expectation that unobstructed views of both would raise the desirability and price of this housing. The premium from this housing will help cross-subsidize more affordable units elsewhere. Further, given the pressure for land as rapid urbanization continues, we expect those who enjoy its views will ensure that the park is preserved and not taken over for construction.

SOCIALLY MOTIVATED TOOL

By creating a means by which people entering the park can walk through almost the entire length of the area we hope to better integrate the separate housing blocks and foster a sense of community within the whole area. Previously, only those who lived close to a park tended to utilize it but by spreading the green system out we hope to make it accessible to a wider section of the resident population.

SPATIALLY MOTIVATED TOOL

Given that there is already one dense economic center, the park was a means to disperse activity through the area. We hope that a mix of uses will come up throughout the green space (playgrounds, cafes, exercise spaces etc.) making the area a multi-nodal space rather than one with a single defined core. This should also have a deflationary effect on real estate prices for units on the site as other parts of the area will enjoy similar access to some part of the green system.

PARK SPACE

Our inspiration for park space comes from some sources:

- Southwest Corridor Park

The Southwest Corridor Park is a linear urban park in Boston that lay as an unused strip of land for many years before communities alongside the park took it over for community gardening. Today the park is a vibrant center for youth camps and summer activities in addition to its use for urban small-scale agriculture. We hope that our green space system can attract the same set of uses, and more, as communities interact with it. Already pockets of urban agriculture dot the area, and we expect the park to meet this expressed demand.

- Back Bay Fens and Riverway Park

The Back Bay Fens and Riverway Park in Boston, Massachusetts are both part of the larger 1,100 acre Emerald Necklace park system in the city which consists of a chain of park, parkways and waterways running throughout the city. The Riverway park is a narrow strip of park that runs alongside the Muddy River and connects two larger parks to each other via a pedestrian route. The Fens is larger and sometimes described as the "urban wild"; the park houses a rose garden, statues and memorials, meeting spaces and other landscaped features that make it an enjoyable place to visit and observe nature.

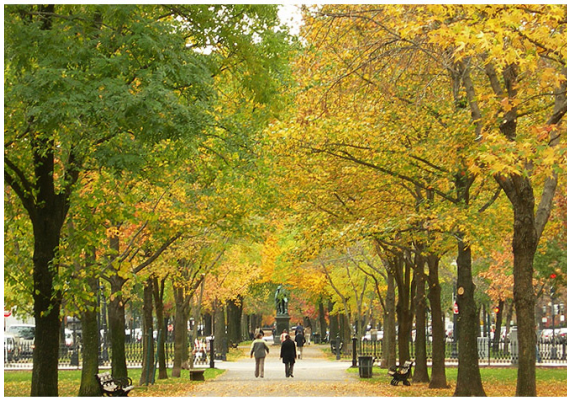


Photo: Commonwealth Ave
Source: http://www.nnnonline.org

Photo: Southwest Corridor Park
Source: http://ks-gaccman.harvard.edu

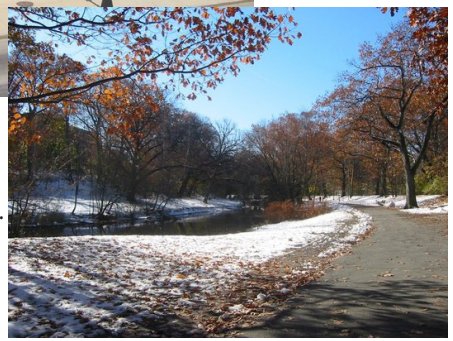


Photo: Riverway Park
Source: http://www.yelp.com

PEDESTRIAN PATHWAY

As a part of our green system we include two types of pedestrian pathways – pathways with wider green spaces on either side, along the lines of Commonwealth Avenue in Boston, and narrower pathways with trees lining the sides as seen in many international cities. The wider green spaces allow for additional facilities – for joggers, cyclists and pedestrians.

Photo (Right): Back Bay Fens
Source: http://www.fenwayvictorygardens.com

Photo: Agricultural Space in Shenyang Architectural University
Resource: http://g.tgnet.cn/jg/BBS/Detail/200706181314236443/

AGRICULTURAL SPACE

The inspiration for incorporating agricultural land into our green system and within the limits of a dense urban setting comes from the use of agricultural space in Shenyang Architectural University. In 2002, designers for this 80-hectare suburban university campus used agricultural land as part of the landscape of the campus using rice, native plants, and other crops to maintain the productivity of the land while also giving an aesthetic value as part of the campus grounds. Given rapid urbanization and concern about its encroachment on China's limited arable land, this design set a precedent for maintaining the function of agricultural land and addressing the twin issues of food production and sustainable land use while giving it an additional value as an attractive landscape. Just as students on the campus are involved in the harvest we hope that residents of the area will be involved in activities on this land.

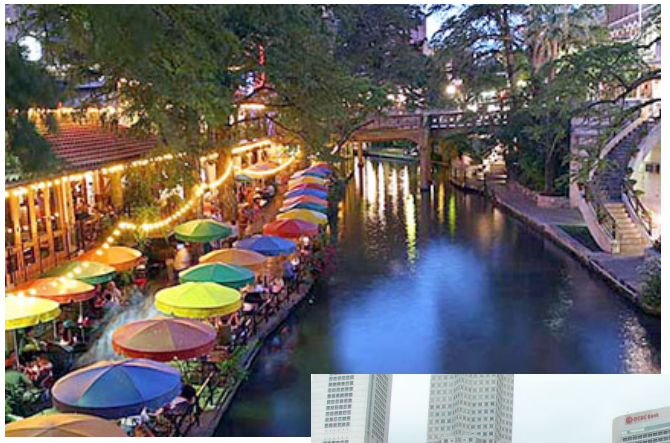


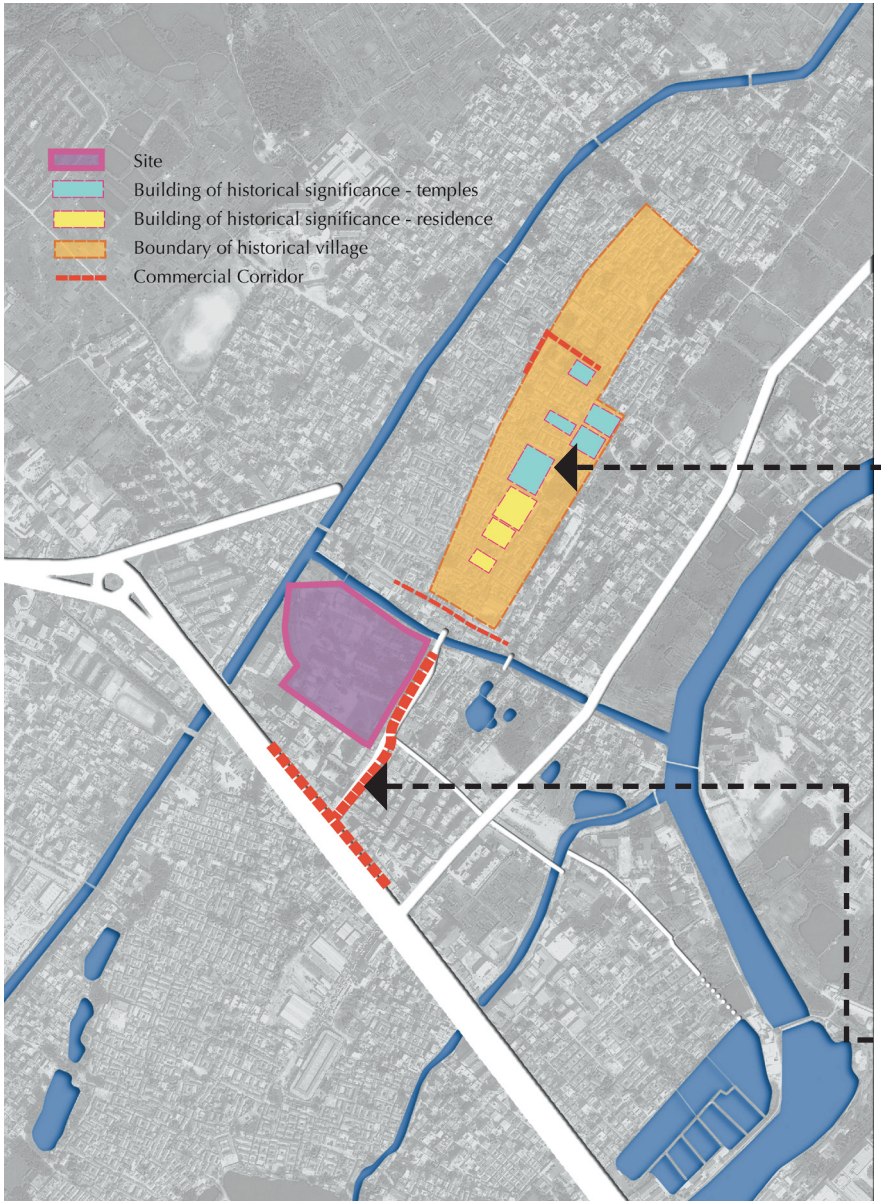
Photo (Left): San Antonio
Source: http://www.wttc.com

Photo (Bottom): Boat Quay
Source: http://stonemole.files.wordpress.com

CANAL REVITALIZATION

A central part of our open space plan is to revitalize the canal by transforming its use from functional to aesthetic and recreational. The San Antonio Riverwalk in San Antonio, Texas offers a good example of what we hope to accomplish for the canal in Shantou. The banks of the canal serve as a public park lined with cafes, restaurants, hotels, and stores. Pedestrians may also walk along the river walk to enjoy views of the canal. Boat Quay in Singapore is another source of inspiration for our projected use of the canal – in addition to the commercial and recreational activity along the canal, there is also housing built along a gradient that offers residents views of the canal. As with the green space system, we hope that orienting the residents' experience out onto the canal will aid in its preservation and upkeep.

Figure: The Current Condition of the Corridor



ORIGIN

Retail Passageway

The commercial corridor stems from the busy retail passageway that runs from the major highway in the south of the study area, past Site A, and up through the canal, at which point the area transitions into traditional village housing.

Traditional Villages and Temples

Above the canal, a smaller pathway continues northward through the villages with a number of family temples sitting along this road. These temples, which have greater significance to the community at large and serve as historical landmarks, are well-suited to play a role as part of the neighborhood spine. These temples, furthermore, are easily incorporated into the community facilities system.

Photo: Village Temples, Source: Daniel Tien Simon

Photo: Current Commercial and Retail Area, Source: Yun Zhan

CONCEPT > Commercial Corridor > Planning

Figure: Site A's Proposed Corridor

PLANNING IDEA

Taking advantage of the study area's strongest existing qualities, this corridor builds off crrent pathway that runs through the site and formalizes it, essentially creating a spine that anchors the area. The integration of this corridor with the open space system and public transportation network creates a foundation for the site to serve as a centerpiece for the neighborhood. This also establishes a core for the site area around which we base further analysis to determine site programming, including road networks, housing, retail, and community facilities.

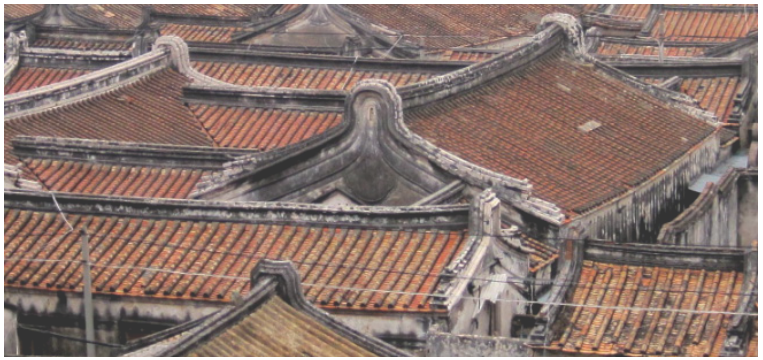
VILLAGE INTEGRATION

- The corridor creates a strong connection between the dense areas south of the canal and the village housing above it. This opens up the area and makes it a more desirable location to live.
- As the village areas become slowly developed to accommodate the city's increasing density, maintaining areas along the pathway is a way to incorporate the villages' traditional heritage and architecture.

CENTRALIZED FOCUS

- The corridor creates a central focus to the neighborhood and houses its retail activities and community facilities.
- By encouraging a pedestrian-friendly, walkable district, the corridor will foster neighborhood interaction.
- Through integration with the public transport system and neighborhood road networks, it provides a convenient and accessible commercial zone for local residents.
- It can stimulate the economic well-being of the area by generating local business opportunities.

Photo: Traditional Chaozhou Architecture, Source: Pritika Hingorani



CONCEPT > Access & Circulation

GOALS

Proper access and circulation is imperative for any sustainable community. We think a sustainable community should have a transportation system that

(1) Creates connected street system
(2) Provides a walkable, pedestrian and cycle-friendly environment
(3) Encourages the use of public transportation over private automobiles

The current transportation system has some positive attributes but is also problematic in many ways.

EXISTING CONDITIONS

Constraints:

- Limited connected routes inside the site
- Significant number of dead ends exist for both vehicles and pedestrians resulting in inefficient movement within the site
- Lack of bike paths discourages biking
- Uneven and lack of sidewalks make walking dangerous

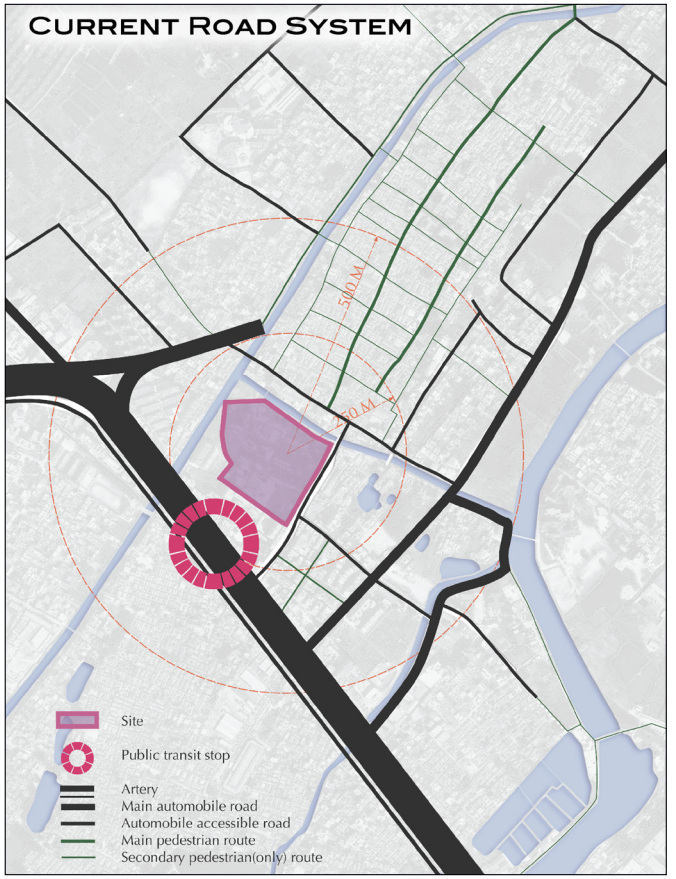
One positive attribute that currently exists on the site is the limited entry-ways for automobiles. Currently, automobiles are not able to enter the site. They must park on the outskirts and then enter by walking. This specific situation encourages pedestrian movements over automobile movements.

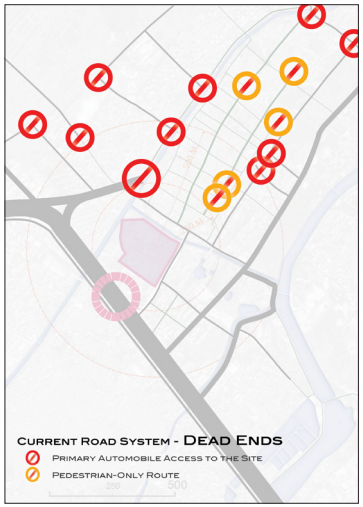
APPROACHES

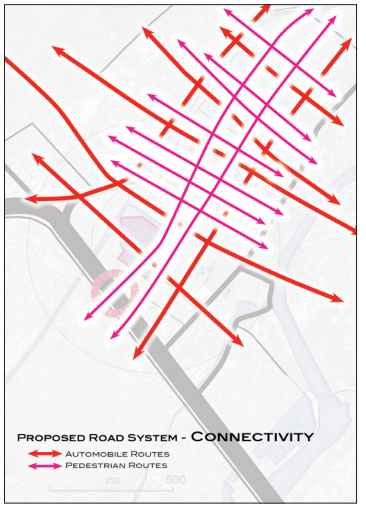
The ideal access and circulation in and around Site A is determined by tackling the following two issues:

1. **Access** - Different transportation modes and their access through the site: How the different types of transportation modes access and move throughout the site is important to consider. We reorganized the circulation of transportation modes in order to ensure efficiency and safety based on current conditions.

2. **Street Grid** - Appropriate street grid: size of blocks and width of streets
An appropriate street grid is based on (1) pedestrian-friendliness (2) integration of current streets

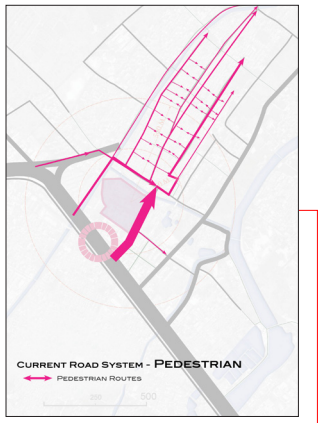


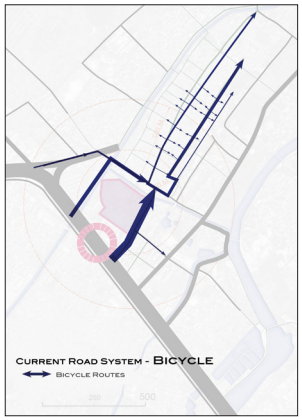


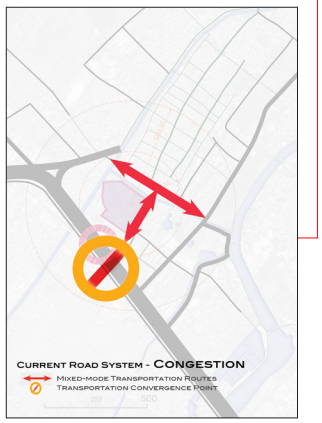


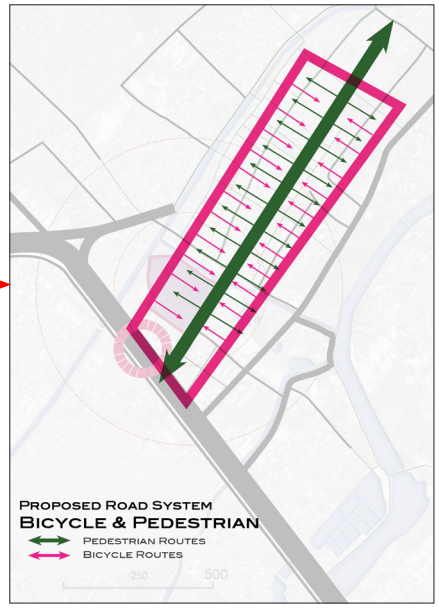
CONCEPT > Access & Circulation > Access

Bicycle and Pedestrian





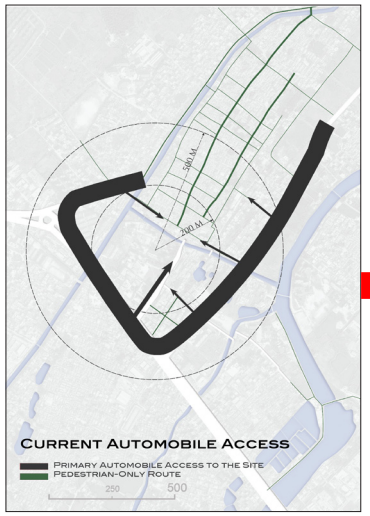




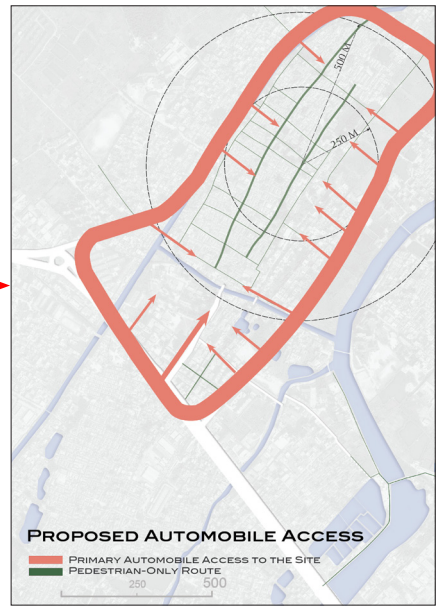
← Current ☹ Proposed ☺

Automobile

Current ☺



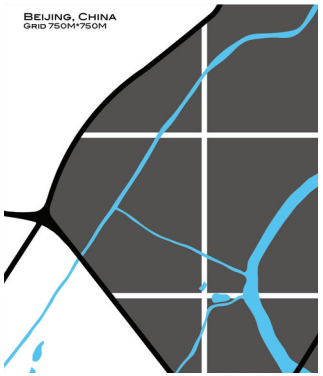
Proposed ☺

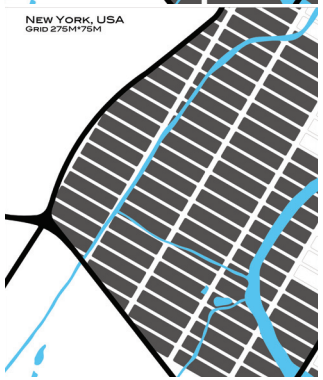


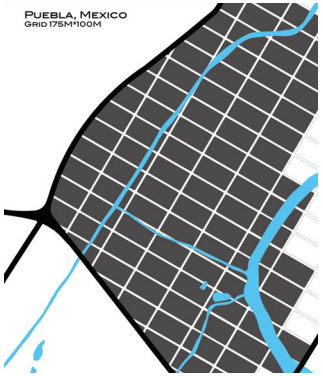
CONCEPT > Access & Circulation> Street Grid

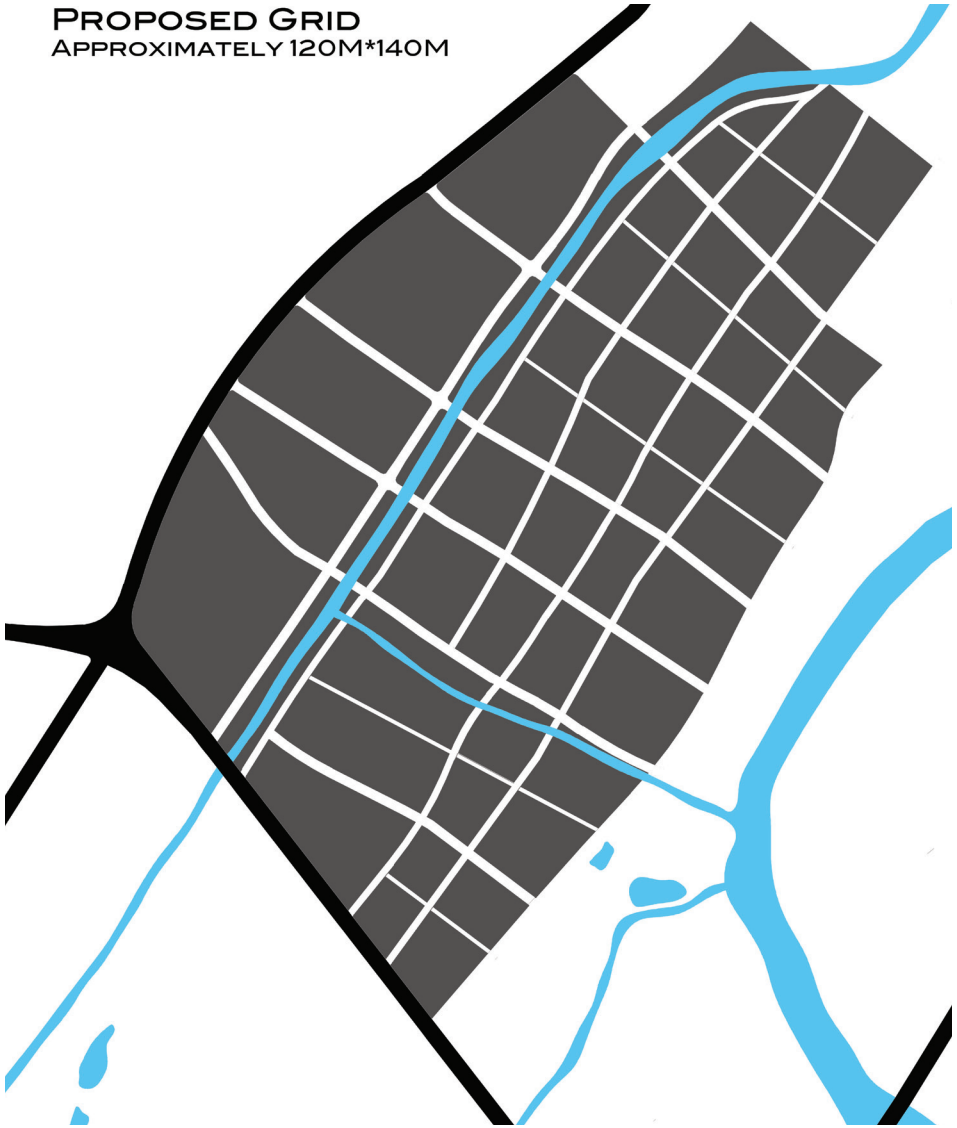
GRID SIZE STUDY

In the study below, we overlaid grid patterns of certain cities. The cities were chosen based upon different levels and feelings of "walkablity." Three cases are selected: Beijing, a typical Chinese setting; New York, a well known US city that is known to be relatively walkable; and Puebla, Mexico, chosen as an example of a walkable city. Puebla with a street grid of 100m by 175m, in comparison has the most narrow street grid as compared to Beijing and New York.









INTERNAL SHUTTLE SYSTEM

> Create a shuttle bus that moves people from the light rail to other destinations. The routes would differ during the peak hours (between 7-10am) and regular hours (all other hours). The peak hour route would circle around the site in a clock-wise manner. There would be one shuttle every 3 minutes (2 buses for the whole site, with one full one cycle taking 6-7 minutes, assuming a 25km/hour speed). The regular route would follow a linear route along the commercial corridor, sharing the same path as pedestrians and bikes.

BICYCLE SYSTEM

> Create dual bike paths in a circular route for daily commuting and recreational purposes. The path for the daily commute would be combined with a shuttle bus route, while the path for recreational purposes would exist along the green system.

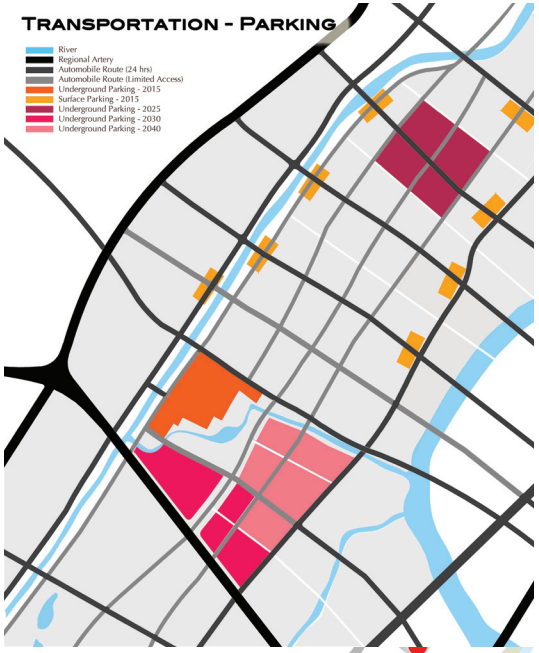
PEDESTRIAN SYSTEM

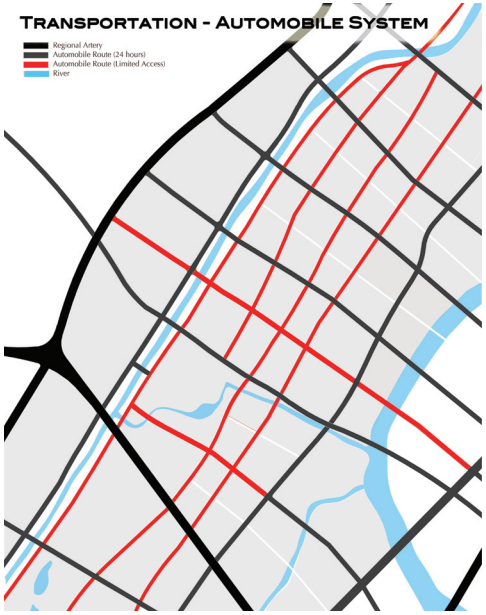
> Concentrate pedestrian movement in the center, so as to maximize flow of pedestrians in the commercial area. For people taking vehicles to access the site, they are able to bike, take the shuttle or automobile, and walk to their homes in the site within 2-3 minutes.

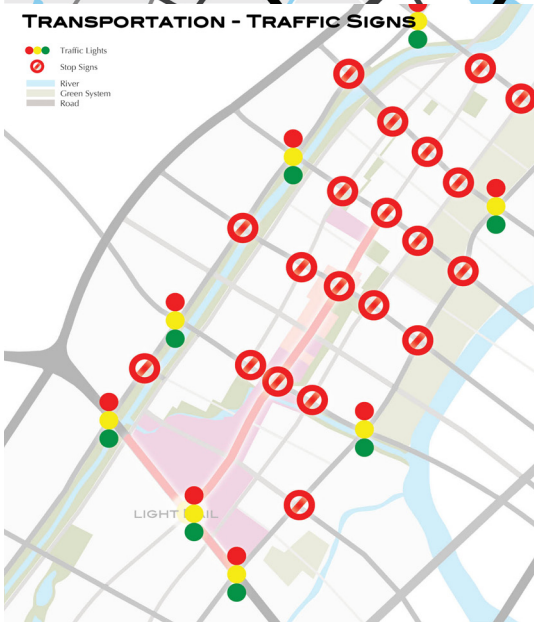
AUTOMOBILES AND PARKING

> Allow automobiles only around the outer route. For service purposes, many streets would be automobile accessible but restricted during most times of the day to maintain a pedestrian-friendly zone. All routes within the site would have a speed limit of 25 km/hr.

To discourage automobile use on a daily basis and encourage pedestrian, cycling and public transit, parking is centralized instead of scattered near homes. Centralized parking areas would exist mainly near the transit station, which can be shared between residents and employees in that area. On-street parking would also be available throughout the site, mainly for short-term parking needs and for the handicapped. These would be arranged on the outer-ring of the site where people can easily park.





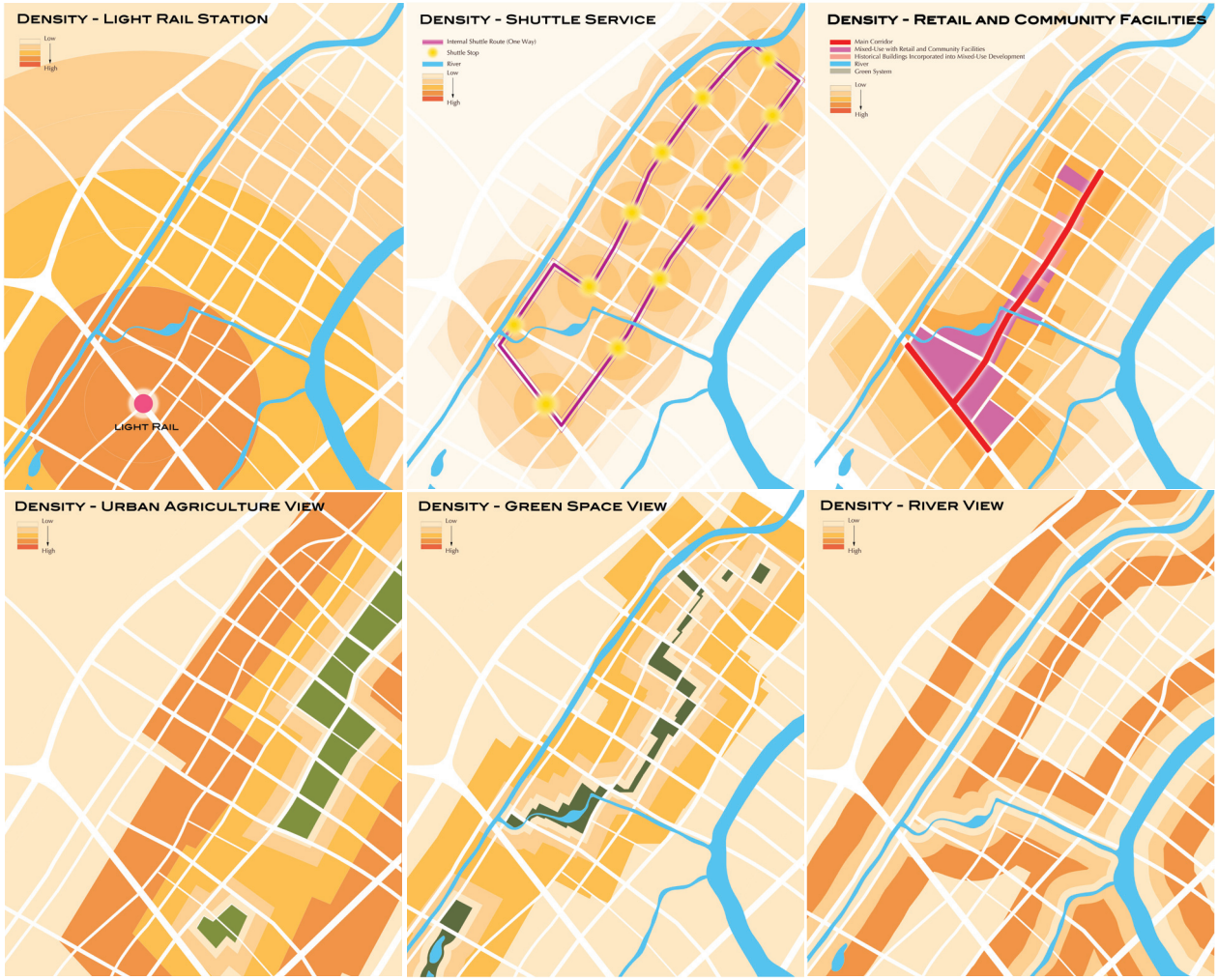


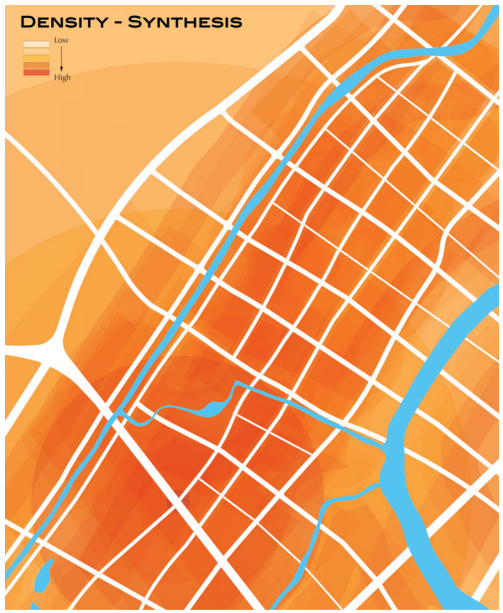
DENSITY

Densification of the site is an assumption for the future. In determining the optimal density for the site, we took a two-step approach:

1. We first analyzed the density relationship between blocks and as a result created a density gradient that optimizes the amenity of the land. This process was done by first considering what influences density, such as the proximity to the light rail station, shuttle and bus stops, and the views of the river and green spaces. After identifying these influential factors, density gradient maps were created for each factor. Those maps were then weighed according to their importance and overlaid together to reveal the optimal density.
2. We then analyzed neighborhoods of different densities to find the appropriate FAR for Site A's blocks. Several cases are referred to in order to illustrate what different FARs. From the different projects below, we can understand what these densities might mean and look like on the site.

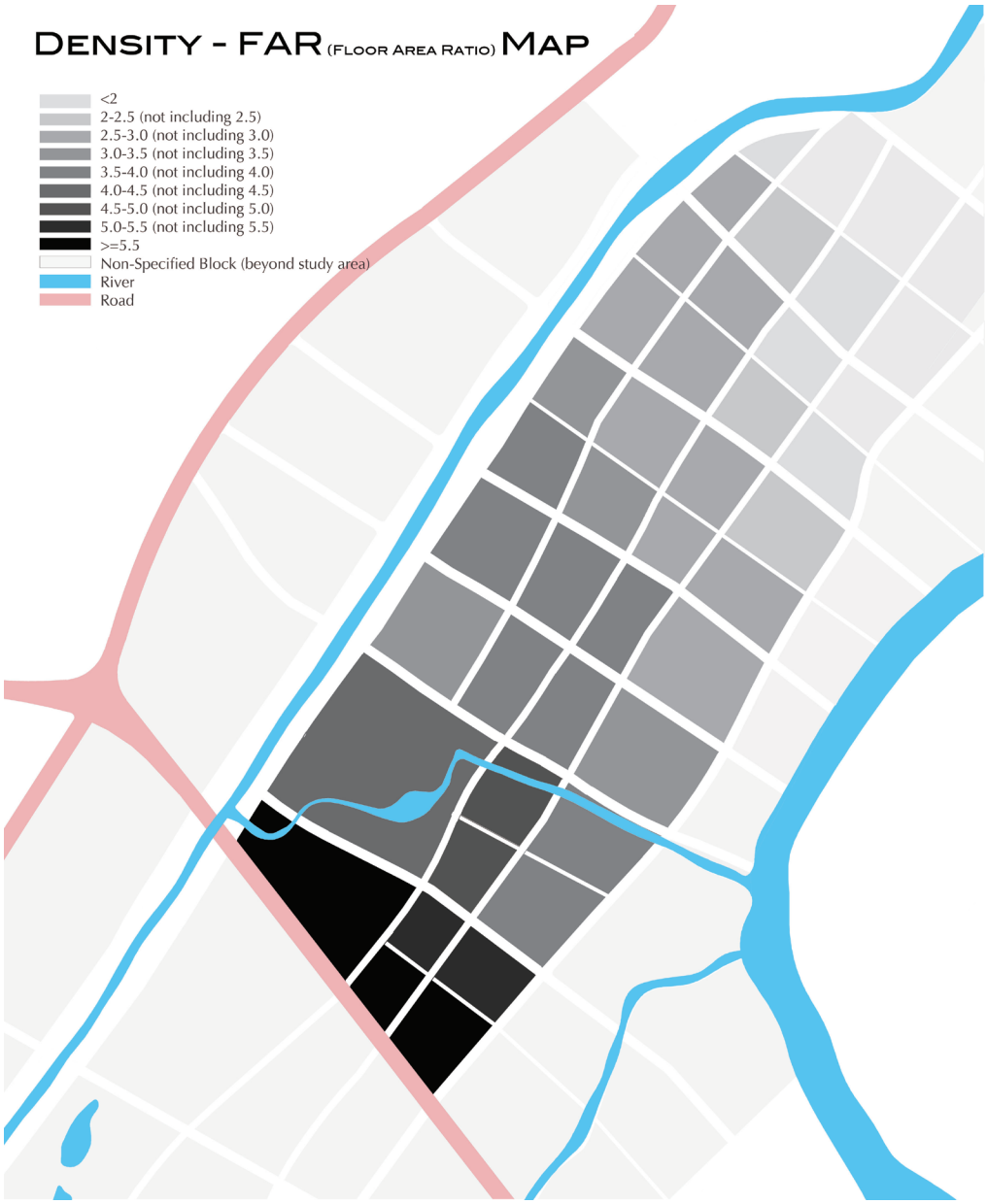
In the end, FARs were assigned to each block of the site based on the two analysis above.





1
2 4
3

1. FAR = 2.0, Boston, US
2. FAR = 4.5, Barcelona, Spain
3. FAR = 9.5, Hong Kong
4. FAR = 5.0, Shantou, China



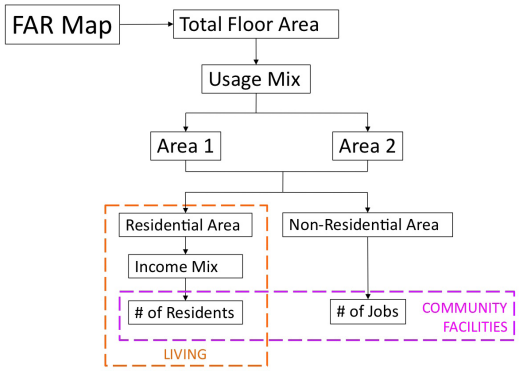
SOME BASIC CALCULATIONS FOR BOTH HOUSING AND COMMUNITY FACILITIES

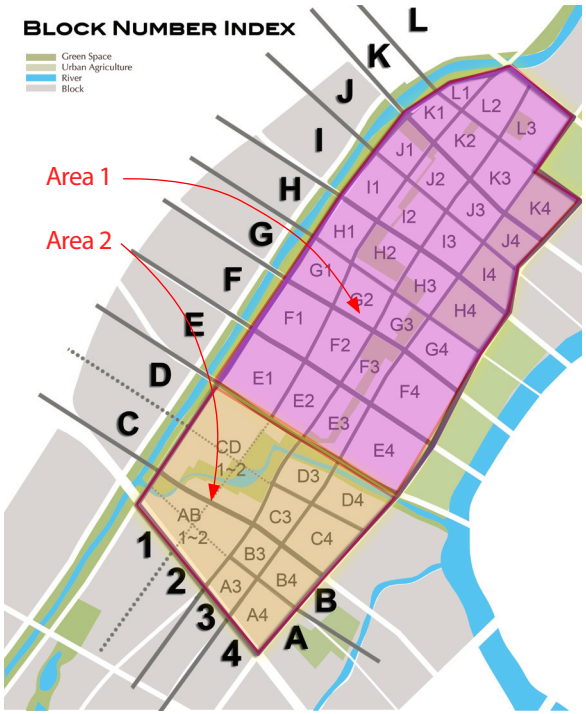
Based on density analysis and green system, we came up with buildable area and floor area. (The programming of the site is based on our best knowledge and assumptions, and might be adjusted in the future according to specific conditions.)

Buildable Area and FAR Calculation

	Block No.	Area	FAR	% of Green	Buildable Area	Floor Area
Area 1	AB-12	26,620	6.5	5%	25,289	164,379
	A-3	6,400	6.5	0%	6,400	41,600
	A-4	11,160	6.5	0%	11,160	72,540
	B-3	6,130	5.5	0%	6,130	33,715
	B-4	9,300	5.5	0%	9,300	51,150
	CD-12	51,130	4.5	30%	35,791	161,060
	C-3	8,390	5	0%	8,390	41,950
	C-4	14,360	4	0%	14,360	57,440
	D-3	10,935	5	30%	7,655	38,273
	D-4	14,375	4	22%	11,213	44,850
Total A1		158,800	4.452	N/A	135,687	706,956
Area 2	E-1	18,775	3.5	0%	18,775	65,713
	E-2	12,070	4	0%	12,070	48,280
	E-3	11,410	4	25%	8,558	34,230
	E-4	21,080	3.5	0%	21,080	73,780
	F-1	15,520	4	0%	15,520	62,080
	F-2	12,390	4	0%	12,390	49,560
	F-3	9,760	4	40%	5,856	23,424
	F-4	20,120	3	0%	20,120	60,360
	G-1	10,775	4	0%	10,775	43,100
	G-2	10,150	3.5	0%	10,150	35,525
	G-3	7,390	3	40%	4,434	13,302
	G-4	12,810	3	0%	12,810	38,430
	H-1	9,125	3.5	0%	9,125	31,938
	H-2	12,055	3	60%	4,822	14,466
	H-3	10,500	3	25%	7,875	23,625
	H-4	14,090	2.5	100%	0	0
	I-1	10,280	3	0%	10,280	30,840
	I-2	11,770	3	15%	10,005	30,014
	I-3	9,325	2.5	0%	9,325	23,313
	I-4	9,555	2	100%	0	0
	J-1	7,715	3	18%	6,326	18,979
	J-2	9,430	3	5%	8,959	26,876
	J-3	8,065	2	0%	8,065	16,130
	J-4	7,595	1.5	100%	0	0
	K-1	5,890	3	0%	5,890	17,670
	K-2	10,380	2.5	5%	9,861	24,653
	K-3	11,680	2	0%	11,680	23,360
	K-4	13,005	1.5	100%	0	0
	M-1	3,370	2	0%	3,370	6,740
	M-2	11,520	1.5	0%	11,520	17,280
	M-3	14,955	1	15%	12,712	12,712
Total A2		352,555	2.457	N/A	282,352	866,377
Grand Total		**511,355**	**3.077**	N/A	**418,039**	**1,573,332**

* Area 1 Zoned as Mixed-use, Area 2 Zoned as Residential
* "% of Green" Only include Park system and Urban Agriculture level green space, excluding piecemeal block level green space excluding
* All units are in Square Meter





As densification of Shantou and the site will occur, the demographics are also assumed to differ greatly in the next ten to twenty years. As such, our goal is to create a mixed-income community that caters to the needs of all income groups and family types. A specific vision for the future of the site is to incorporate current villagers and migrant workers. In the following analyses, we determine the percentage mix of people from different income groups and the potential locations of housing for these different groups. Finally, we illustrate how we can ensure the long-term sustainability of providing affordable housing units.

Income mix:

In the US, individuals are categorized into different income groups based on how much they earn as compared to the Area Medium Income. Individuals with yearly income below 30% AMI are considered to be extremely low-income group, 30% to 60% as low-income group, etc. For Site A, we created categories of different incomes based on a similar approach and divided our total residential floor area among these different groups.

Size of Living Space:

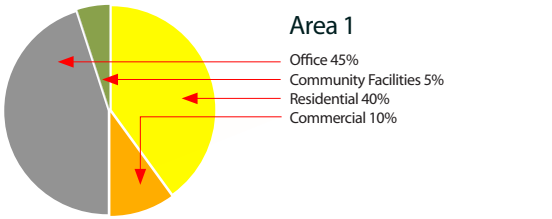
For market-rate units, the assigned living space is based on the market (the common size of a market-rate unit for different family sizes of different income groups in China) For subsidized units, the assigned living space is based on the housing sizes and needs of low-to-medium income groups.

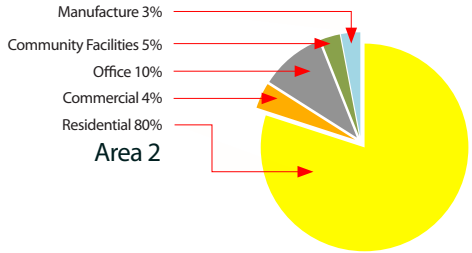
Residential Income Mix Calculation

	Definition AMI	Living Standards SQM/person	Percentage %	Area SQM	Population PP	% Populatoin
Very Low	<30%	20	5%	48,794	2,440	9%
Low	30%-60%	25	5%	48,794	1,952	7%
Medium	60%-80%	30	20%	195,177	6,506	24%
High	80%-120%	35	25%	243,971	6,971	26%
Wealthy	120%-300%	45	35%	341,559	7,590	28%
Wealthy	>300%	70	10%	97,588	1,394	5%
Total			**100%**	**975,884**	**26,852**	**100.0%**

Mixed-Use Calculation

	% of Area1	% of Area2	Floor area 1 (M^2)	Floor Area 2 (M^2)	Total (M^2)	sqm/job	Jobs
Residential	40%	80%	282,782	693,101	975,884	2,000	488
Commercial	10%	4%	70,696	34,655	105,351	50	2,107
Office	50%	10%	353,478	86,638	440,115	25	17,605
Manufacturing	0%	3%	0	25,991	25,991	15	1,733
Community Facilities	0%	3%	0	25,991	25,991	100	260
Total	**100%**	**100%**	**706,956**	**866,377**	**1,573,332**		**22,192**

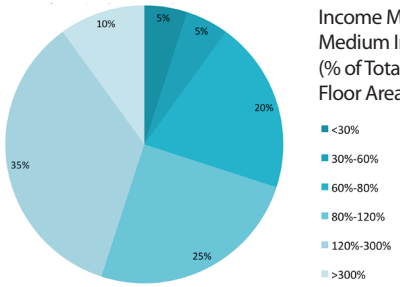


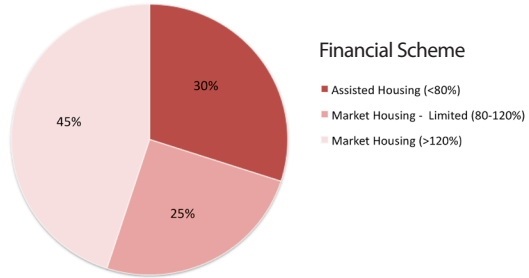


Spatial Distribution by Income Groups

Our goal is to integrate affordable units with market rate housing and three scenarios are created based on different levels of integration. The first level is the optimal situation, whereby affordable units are fully integrated with market rate housing by the unit. The second level integrates affordable housing by blocks rather than by individual units. The last level divides the site into two parts, one with affordable units, and the other with market-rate units.

For market-rate units, the assigned living space is based on the market (the common size of a market-rate unit for different family sizes of different income groups in China) For subsidized units, the assigned living space is based on the housing sizes and needs of low-to-medium income groups.

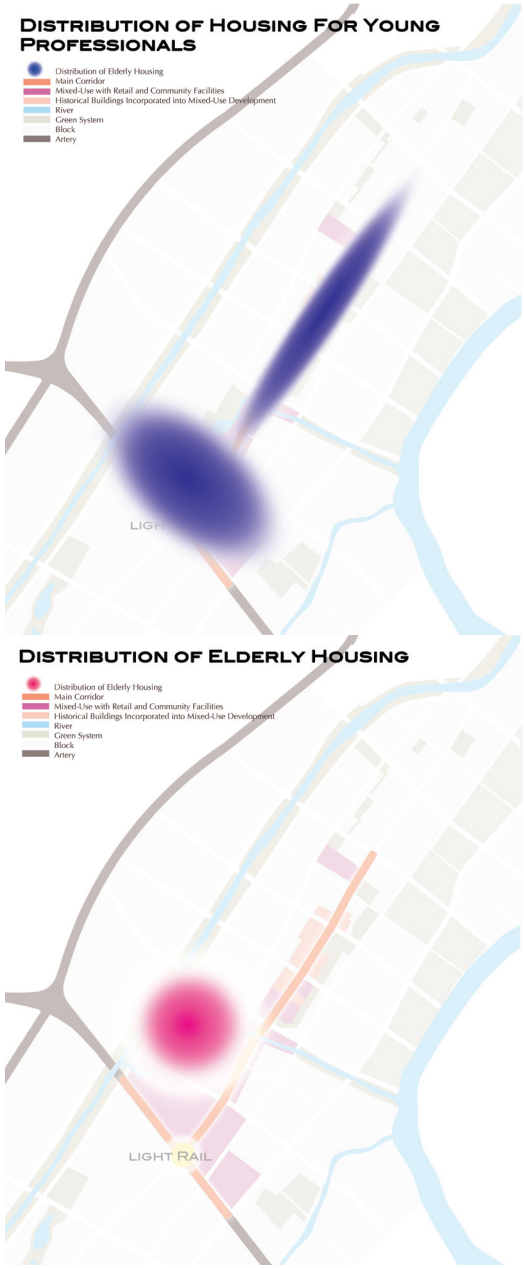




Spatial Distribution based on Family Types

We identified three major family types that will reside in the site and indicate where they may be located based on their preferences.

(A) Young professionals – This group may desire to live near public transit and active spaces such as alongside the commercial corridor
(B) Elderly - Based on the statistic that the elderly population in Shantou is projected to compose 15% of the total population, about 5000 elderly will reside in site A. This group may desire to be close to public transit, services, and green space such as actively utilized parks.
(C) Families (parents with children) – The majority of the residents may fall into this category. Their preferences may not be as strong as the ones above and as a result they may be distributed throughout the site.



Sustainable Model for Affordable Housing

Financial Support

In the US, community development financial institutions (CDFI) are a major financial source for developments. These institutions give out loans based on the project's "social returns" in addition to financial feasibility. The provision of affordable housing is considered an important social return. Although no such banks currently exist in China, providing affordable housing as a prerequisite for loan applications should be encouraged within the current system.

Regulations

In the US, affordable housing is required by law. In the short-run, Site A can be a pilot setting where the government can assign a certain percentage of affordable housing for the redevelopment of the site. In the long-run, a city-wide regulation should require a certain percentage of floor area assigned exclusively to affordable and subsidized housing.

Zoning Incentives

In the US, when more affordable units are included in addition to what is required, the developer is given an FAR bonus as a means of financial support. In China, this mode can be adopted as it can provide affordable units with no additional cost from the government.

Importance

Community facilities is an important aspect of any community.

- It creates a sustainable society by:
- Providing access to essential services
- Creating a healthy environment for residents to build community
- Complementing housing by creating an attractive place to live
- Fostering a sense of equality, openness, and stability

Long-Term Goals

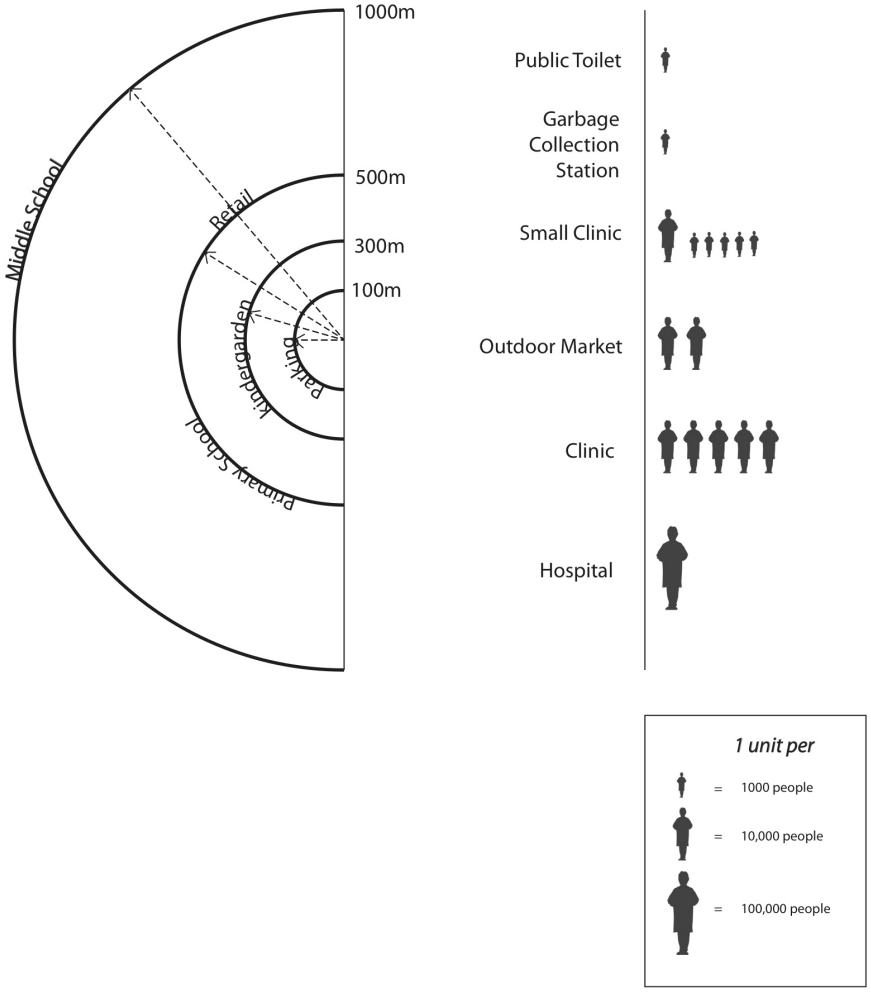
Specific to Site A, there are several long-term goals that should be considered for its future:

- Maintain and improve the equity, accessibility, sustainability of community facilities
- Strengthen city identity to attract and maintain a diverse population
- Preserve Chaozhou culture through art, music, food, cultural activities, museums/historic preservation

Short-Term Targets

In the short-term, additional facilities should be added. This report will outline the location of selected community facilities in and around the site. Based on national planning standards from the Chinese Planning Agency, we have distilled certain community facilities according to distance and population as the figure shown here.

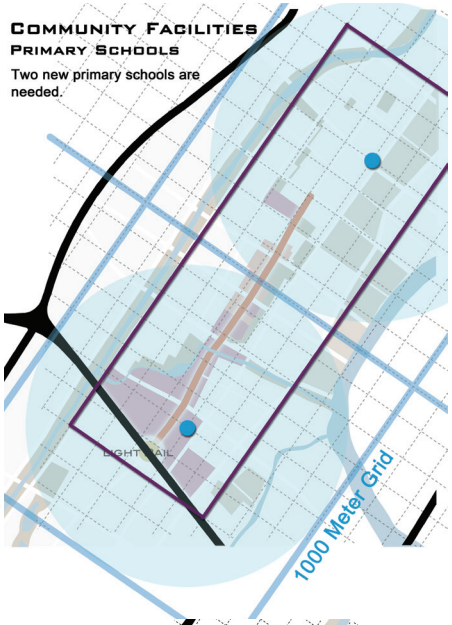
Community Facility Standards

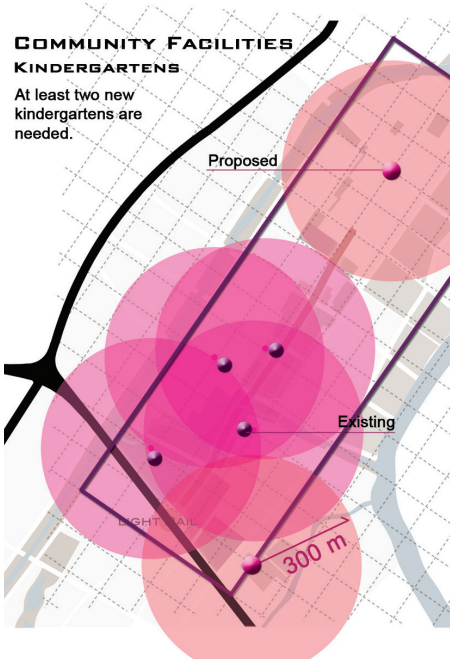


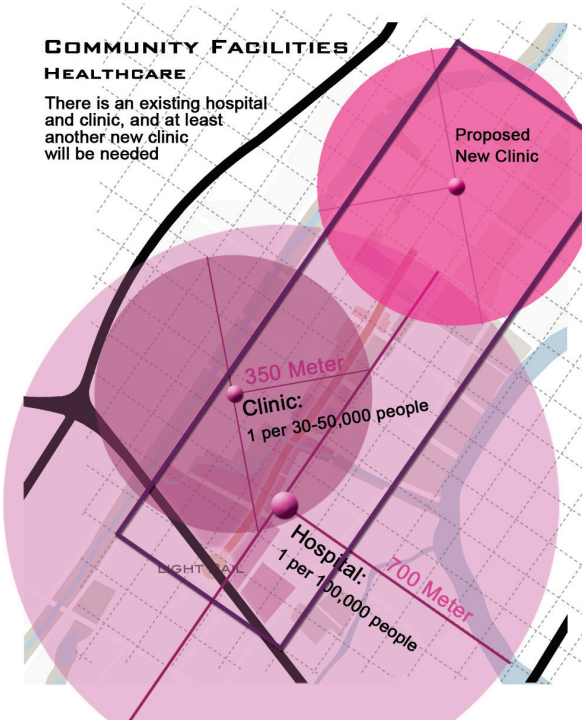
**Source: Based on China's Planning Standards*

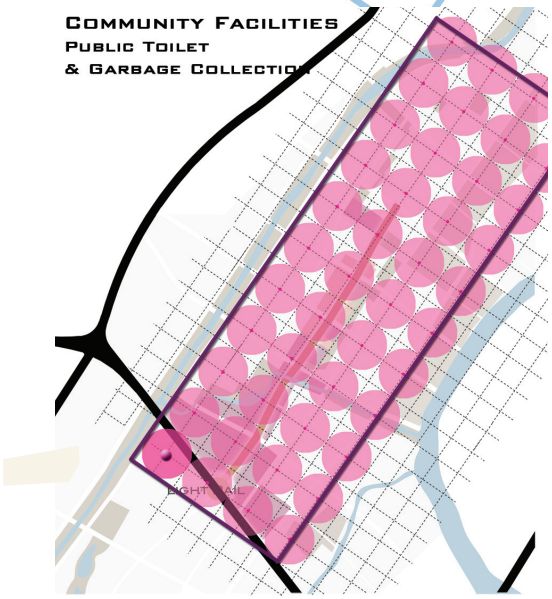
Analysis

Based on the aforementioned national Chinese standards, we gridded the area 100 meters by 100 meters and performed calculations on the number and potential locations (giving a uniform density) of specific community facilities in and around Site A, which are shown on this page.



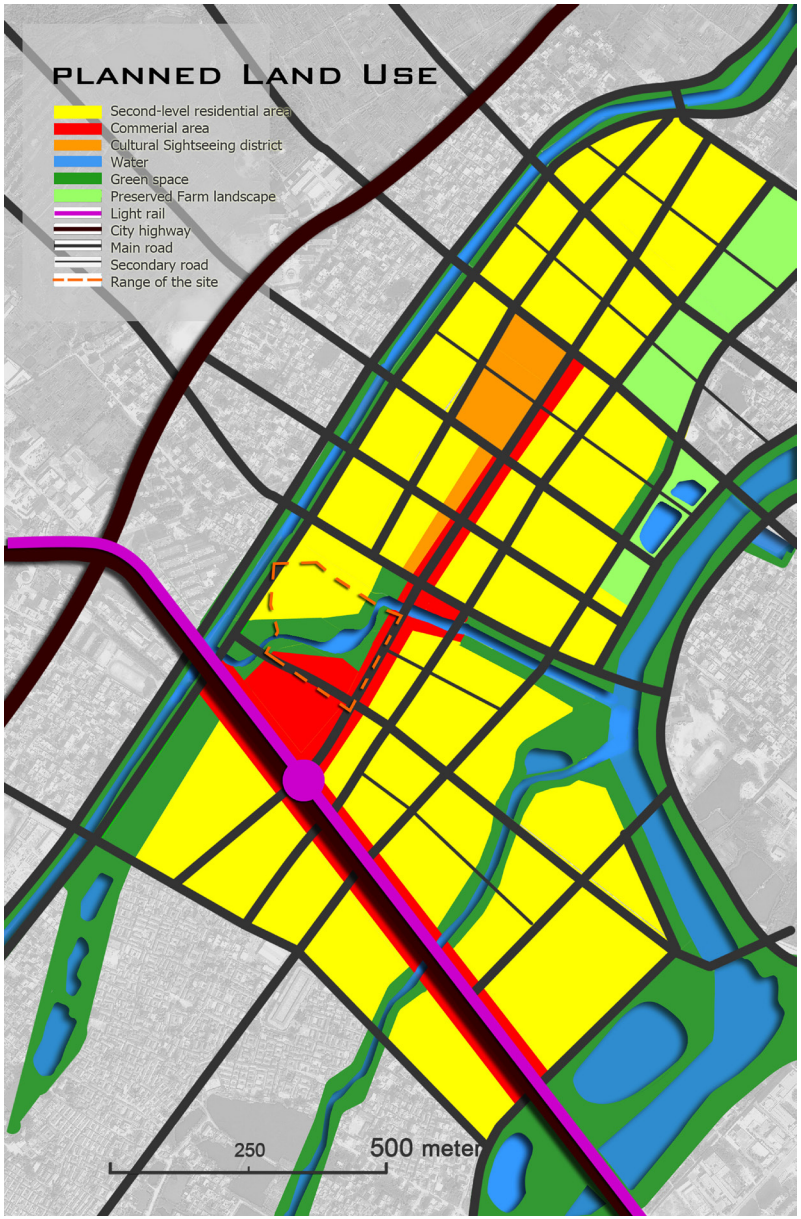






According our analysis, for future planning we propose:

- Education - There should be at least two additional kindergartens; two new primary schools are needed.
- Healthcare - There should be at least another clinic.
- Public Toilet and Garbage Collection Station - There should be around 50 in total of both amenities around the area. However, when the distribution is made, the difference between areas in density population should be considered.



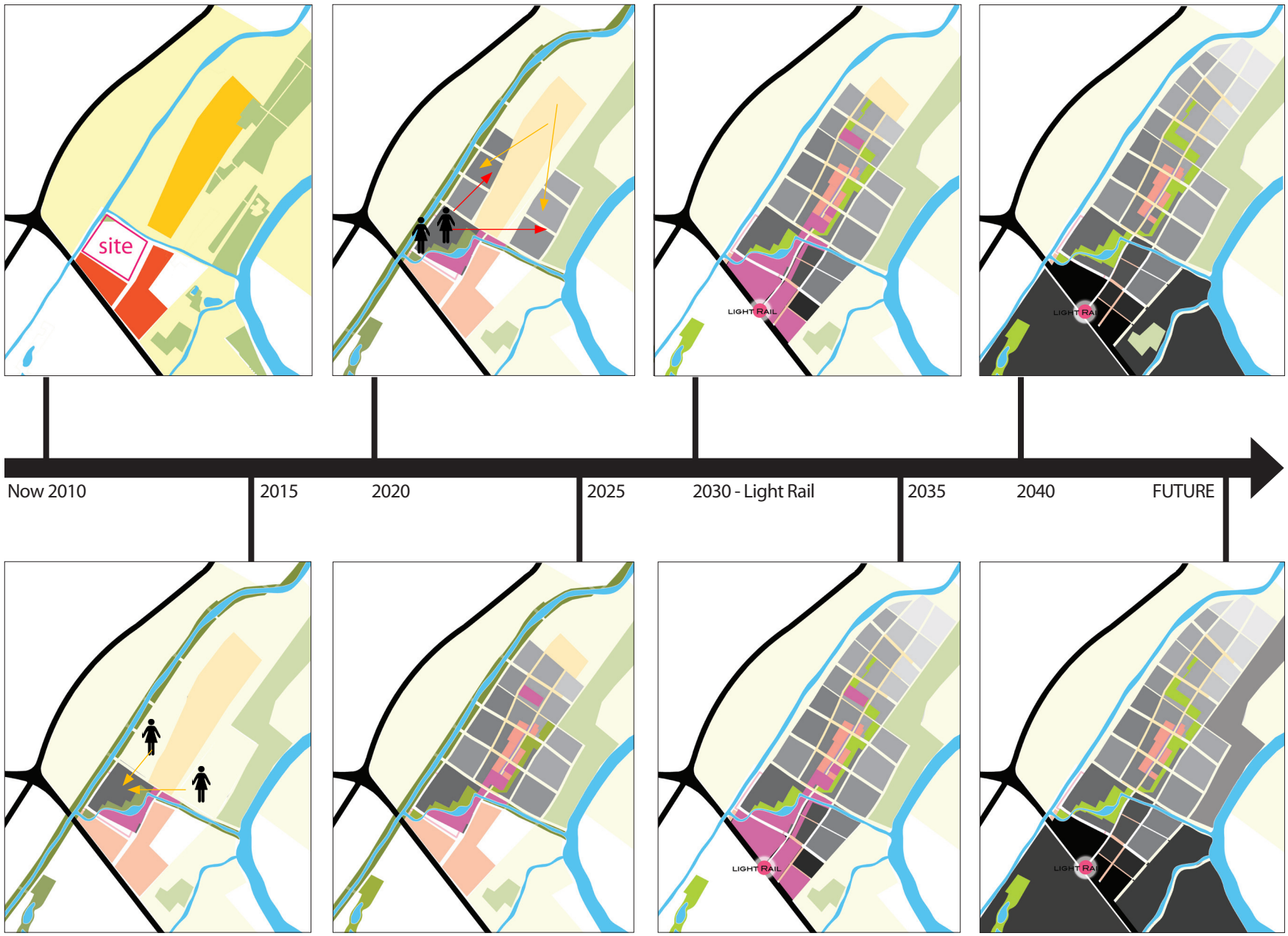
To the left is a diagrammatic image illustrating our green, river, and transit system, and commercial corridor.

Site A

Our site is bordered by the vibrant commercial corridor on its eastern edge, and by the canal on its northern and western boundaries. We take advantage of Site A's existing large open spaces to maintain green space in the midst of what will be a very high density area. The widest strip of our green space system cuts diagonally across the site, and opens onto the commercial corridor creating opportunities additional opportunities for social, recreational and retail activities.

The housing on the site occupies the space on either side of the green corridor and is a mix of low and high density structures that maximizes views of the canal and the green space system. Housing directly adjacent to the canal is of the lowest density and commands a high real estate value for its unobstructed views. As one moves eastwards away from the canal, the housing is more dense; designed on a gradient the buildings allow even those further away from the canal and green system to enjoy the view of the site's natural features.

CONCEPT > Phasing



PHASING

The transformation of the neighborhood will start from the land that the university owns. As the example of a sustainable neighborhood, the first phase will be mixed-use and mixed-income including both rental and homeownership housing. The revenue from the first phase will be reinvested into latter phases and therefore a sustainable financial model is created. Phase I will have a significant amount of rental housing, which, in the short term, serve as temporary homes for villagers when they relocate themselves for transforming the old village. The whole site will therefore be transformed step by step.

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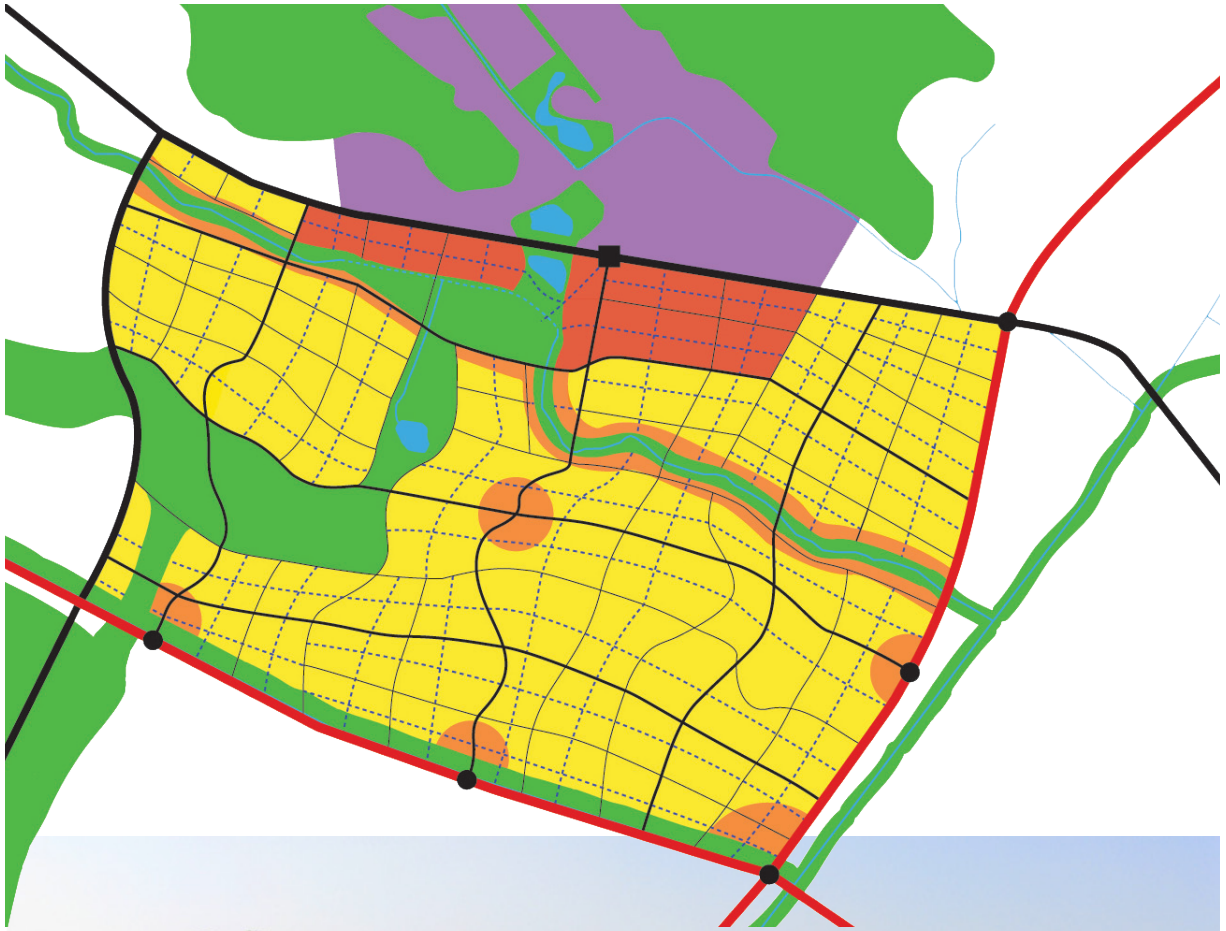


Source: Tyler Corson-Rikert

[SITE B]

Julie Chan
Tyler Corson-Rikert
Diana Jue
Eugene Siong Aun Lee

SITE B OVERVIEW

INTRODUCTION

Our studio's Site B is located directly opposite the entrance to Shantou University in the western portion of Shantou. The site is of great significance to Shantou University because it contains nearly all the undeveloped or underdeveloped land in close proximity to the university. As Shantou University continues to grow in the size and strength of its academic programs it will exert a significant influence on the larger development of Shantou and the Shantou-Chaozhou-Jieyang region. As we describe in our proposals, Site B presents Shantou University with an opportunity to shape the coming development of the western edge of Shantou to create a center for research, economic activity, and residential life that will link the university's strengths with the future economies and lifestyles of Shantou. In contrast to Site A where existing urban villages will shape the area's redevelopment, Site B is largely a greenfield with much more open possibilities. In this section we present a conceptual plan for Site B that fulfills our vision of a community that is environmentally responsive, built around the knowledge economy, diverse and integrated.

OUR VISION FOR SITE B

> Environmental Responsiveness

We envision a community that is responsive to the environment in terms of water resources, open space, topography, energy use, waste management and transportation. As a greenfield site, Site B's natural resources are among its greatest assets. Leveraging them can create an environment of unique value within the larger city of Shantou, a model for the reinvigoration of natural ecosystems and the advancement of residents' quality of life.

> Knowledge Economy

We envision a community that stands as a center of innovation within the larger city of Shantou, leveraging Shantou University's academic programs to build Shantou's knowledge economy. As many leading universities around the world have done, Shantou University can become a hub for research and development, business incubation, and information exchange. Connecting this vibrant activity with exciting, modern residential options can create a mixed-use community that encourages Shantou University graduates and other Shantou youth to stay and grow their families and careers in this dynamic environment.

> Diversity

We envision a community that a diverse spectrum of Shantou residents call home; that supports a diversity of housing types, retail, community facilities, and jobs; and that provides many distinctive, pleasant environments for life, work, and leisure. The design of this community must be politically, economically and culturally relevant in the context of Shantou, Guangdong Province and China.

> Integration

We envision a community that integrates physically with Shantou University, Shantou and the entire region through a comprehensive system of mobility including high speed rail, light rail, bus rapid transit, local buses, shuttle buses, automobiles, motorbikes, bicycles and walking. These connections in turn integrate the residences, businesses and research of the community with the larger economic and cultural life of the university and city.

SITE B OVERVIEW > BEFORE AND AFTER

BEFORE

The stream running through the site has development potential. Our design seeks to leverage this water source's economic and environmental value.

Source: Tyler Corson-Rikert and Eugene Lee

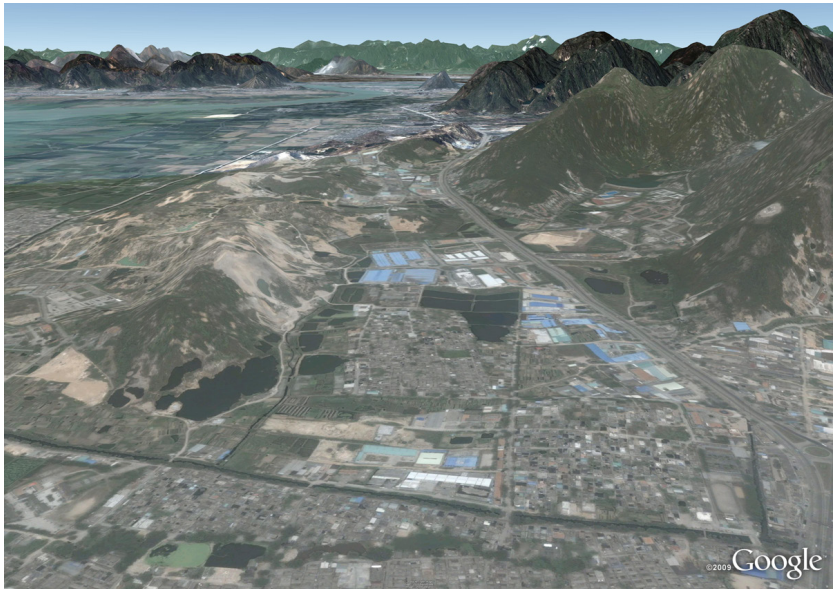
SITE B OVERVIEW > BEFORE AND AFTER

AFTER

Residential units and community facilities around the central stream create a pleasant outdoor, neighborhood experience.

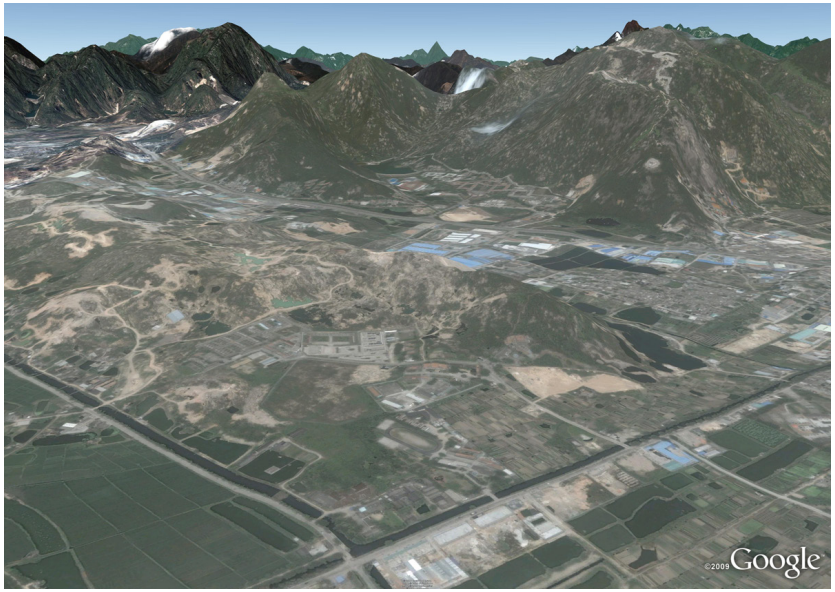
SITE B CONTEXT > EXISTING CONDITIONS > Physical Setting

Site B is located opposite Shantou University in an area framed by two existing east-west roads and two major north-south roads that the Shantou master plan indicates will be built to link different areas of the city. The site is 7 kilometers northwest of Shantou's city center and half a kilometer west of Site A along the road that runs past Shantou University toward the new airport under construction and Jieyang beyond. A stream valley occupies the northern portion of the site, and low ridge the souther portion. The site is 375 hectares in area, approximately 2 kilometers east-west by 1.5 kilometers north-south.



A 3D view of the site from the east with 3X vertical exaggeration (Source: Google Earth)

Master plan roads defining the boundaries of Site B



A 3D view of the site from the southeast with 3X vertical exaggeration (Source: Google Earth)

SITE B CONTEXT > EXISTING CONDITIONS > Sense of Size

The 375 hectares study area is compared against prominent places in China and USA to provide a sense of size.

In comparison with the 33 hectares People's Park (Renmin Gongyuan) and People's Square (Renmin Guangchang) in Shanghai, the study area in Shantou is approximately 11-12 times bigger.

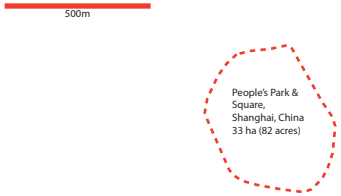
In comparison with the 68 hectares Back Bay in Boston, the study area is approximately 5-6 times bigger.

People's Park & People's Square
Shanghai, China

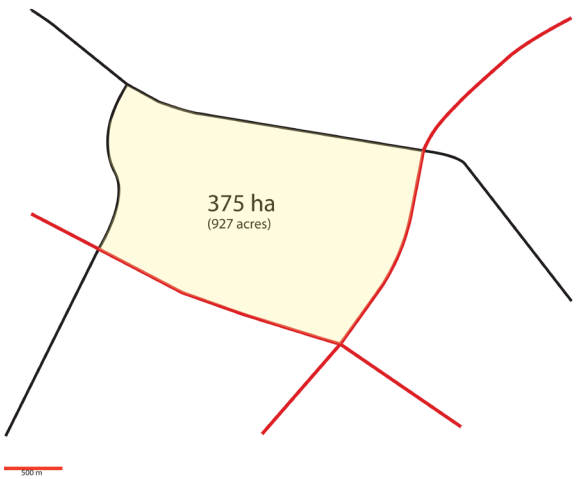
Source: Google Earth

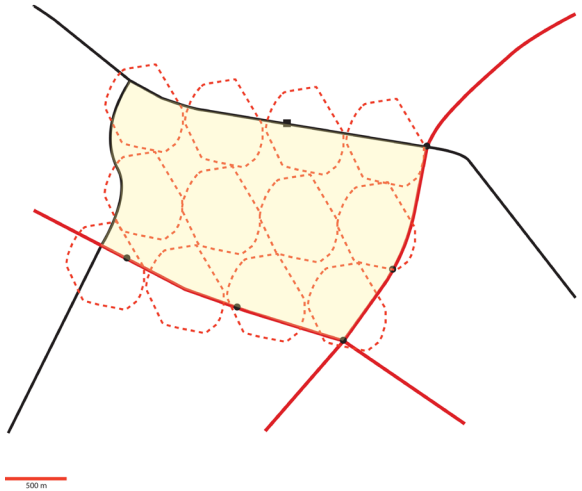
Back Bay
Boston, USA

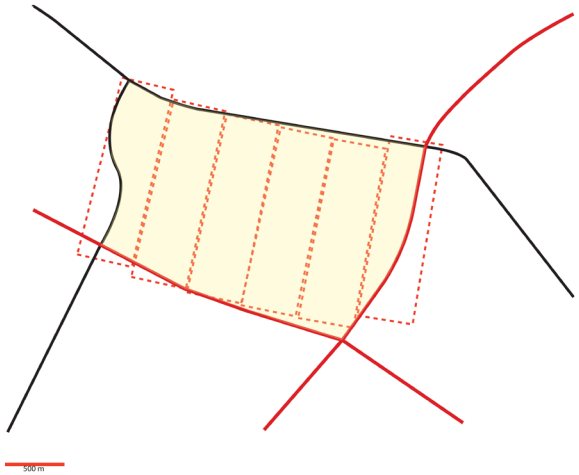
Source: Google Earth



SENSE OF SIZE COMPARISONS







Source: Tyler Corson-Rikert

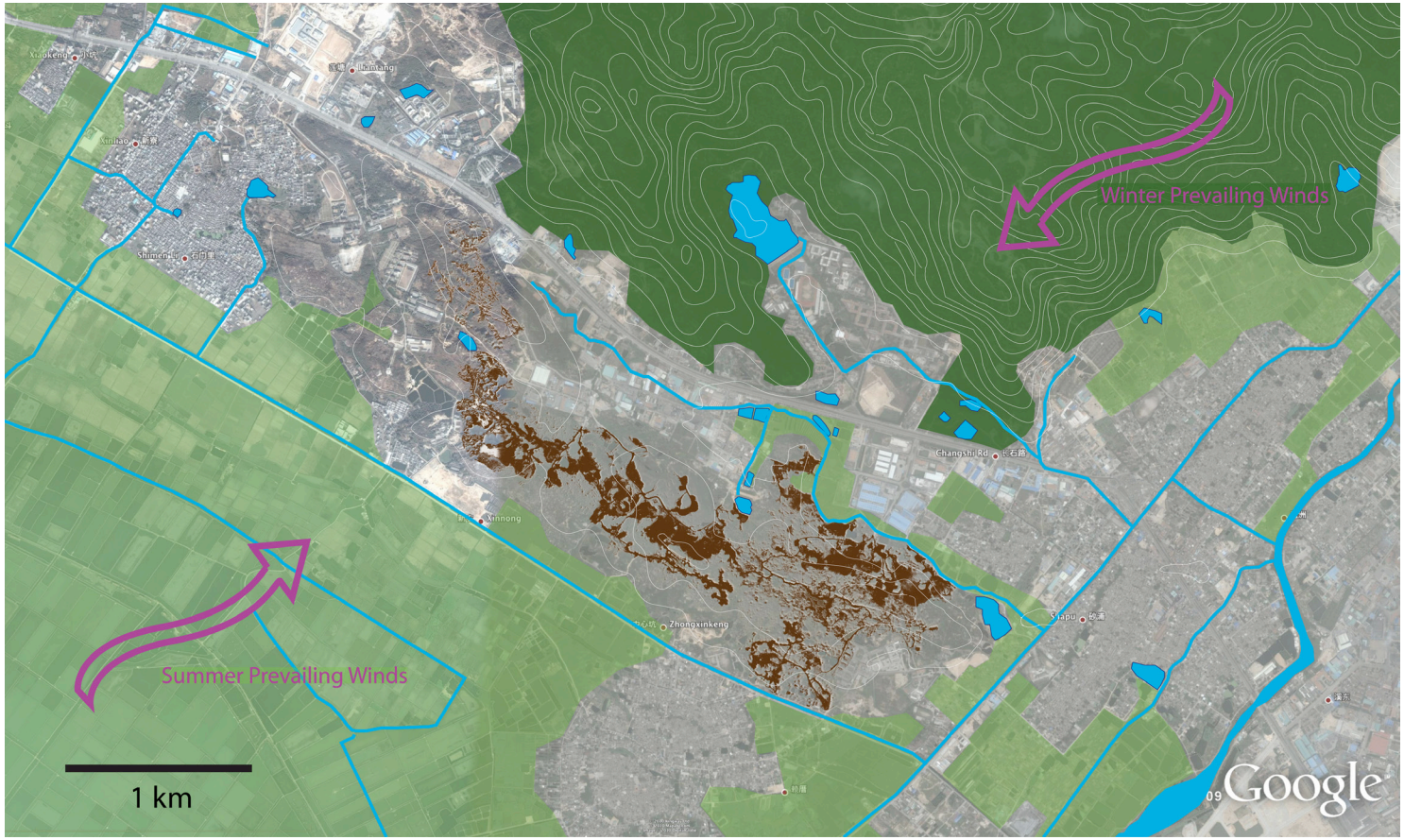
The stream running through an industrial area on the site
(Source: Tyler Corson-Rikert)

Site B spans a valley and low ridge between Shantou University and the coastal plain to the south. A stream runs through the site from west to east on the north side of the low ridge. Numerous fish ponds, remnants of terracing and open fields reflect the agricultural heritage of the area. Vegetation consists primarily of low trees and shrubs. Water quality is currently poor due to industries adjacent to the stream that do not property treat their waste water.

The low ridge is highly disturbed due to ongoing stone and gravel quarrying. High ridges rise behind Shantou University to the north with protected natural areas and Shantou University's campus contains substantial green space with tree-lined walkways and roadways and attractive landscaping. Extensive agricultural land remains on the coastal plain south of the low ridge.

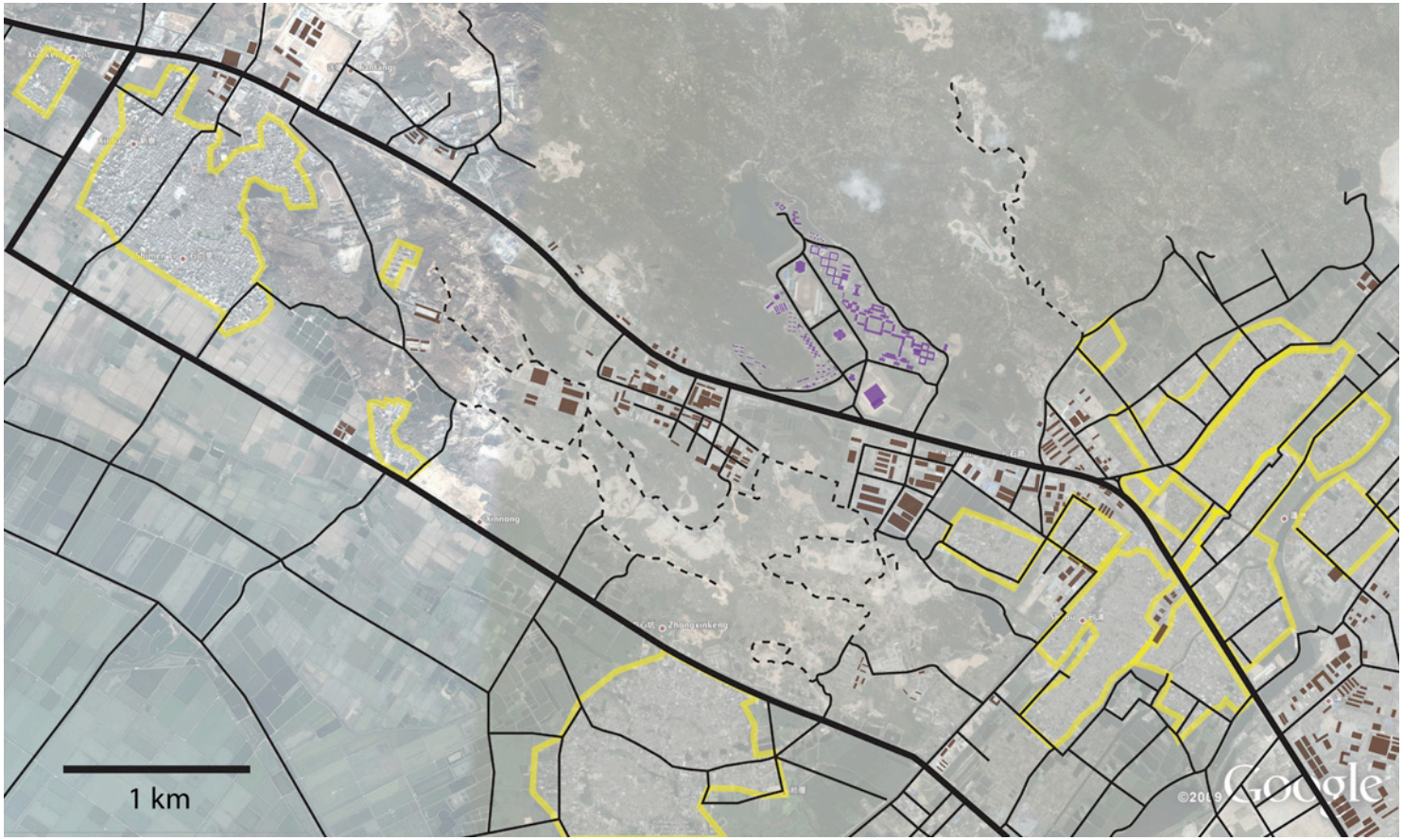
EXISTING NATURAL SYSTEMS

- Quarried areas
- Protected natural areas
- Agricultural land
- Streams
- Ponds



The arterial road by Shantou University's entrance (Source: Tyler Corson-Rikert)

The primary roads around Site B are the road by the university connecting the center of Shantou and the Site A area to the new airport being built west of Site B, and a parallel road on the south side of the low ridge. A grid of roads has been constructed along the south edge of the road by the university. There is a relatively tight grid in the northwest portion of the site where numerous small industries have developed, and a somewhat larger, more poorly connected grid in the northeastern portion of the site where newer and larger food processing plants are located. Narrower and less organized streets run through the urban village and surrounding low density development in the far northeast corner of the site. Dirt roads have been built over the low ridge to support the quarry operations, however no improved streets yet link the northern and southern sides



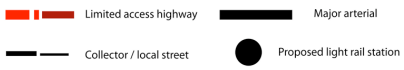
SITE B CONTEXT > EXISTING CONDITIONS > Land Uses

The most notable surrounding land use is Shantou University, whose long-term presence in the area and cultural and economic importance in the city lend great significance to the site. Industrial uses currently dominate the site itself with light industries arrayed parallel to the road by the university on the north side of the site, including firms making watches, clothing, and processed foods. Yet directly opposite the university's entrance approximately 30 hectares of land remains undeveloped between two separate industrial parks. Active quarrying takes place on both flanks of the low ridge, producing gravel and stonework for construction in the region. The northeastern portion of the site, closest to Site A, contains one urban village with closely-packed, one-story traditional housing. The southern flank of the low ridge is less developed except for one light industrial park and a substantial village that lies across the road to the south of Site B. The only residential development in Site B is the single village, scattered farm houses, home-based business along the road by the university, and dormitories for workers in the industrial parks. There is no retail on the site aside from scattered neighborhood shops selling snacks and staples. The nearest significant retail centers are a grocery store and restaurant cluster by the eastern edge of Shantou University, and the retail near Site A a kilometer to the east.

SITE B CONTEXT > MASTER PLAN

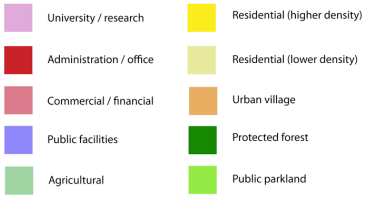
Circulation

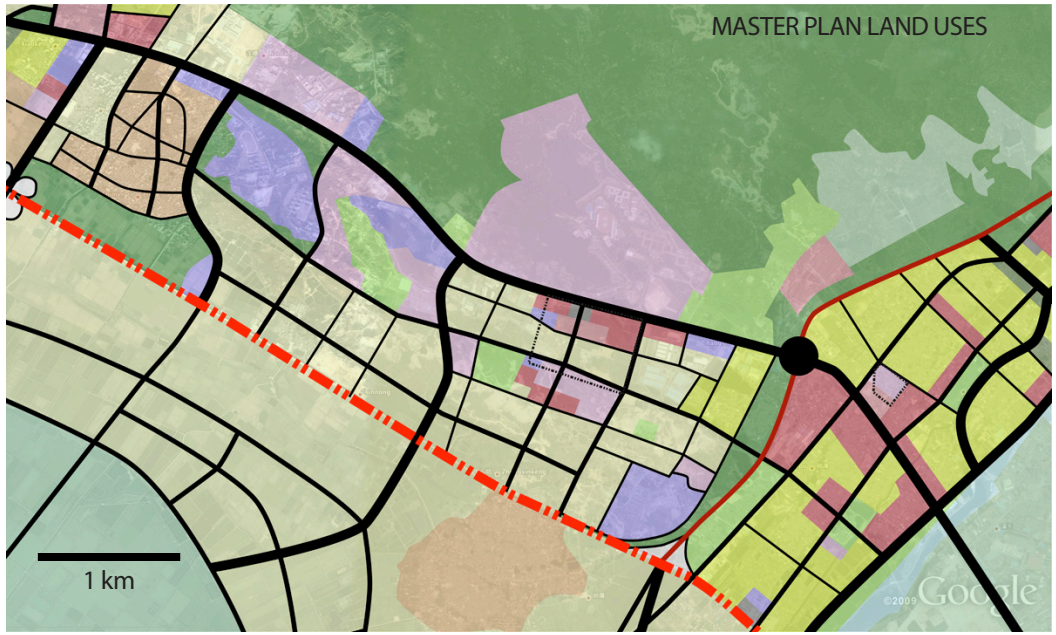
The Shantou 2002-2020 master plan indicates that the roads on the north and south sides of the low ridge will become an even more significant arterial and a limited access highway, respectively. A new limited access highway will run along the eastern boundary of the site connecting Shantou's western coastal plain with its northern areas. A series of roads will connect the road by the university to the highway south of the low ridge. Other roads will run the length of the low ridge creating a complete street grid and preparing the ridge for development.



Land Uses

The master plan envisions a diversity of land uses occupying our studio's Site B. Directly opposite the university's entrance the plan shows a mix of administration/office and commercial/financial uses as well as public facilities. Much of the rest of the site is slated for housing, with the exception of a ridge-top cluster of university/research and commercial/financial uses alongside public facilities and open space.





As we approached our design process for Site B we made certain assumptions about how the area will develop over the next couple decades:

Mobility

We assume that the airport currently under construction west of university will soon be completed, that a proposed light rail line will be built to connect the downtown Shantou to the Site A area and on past the university to the airport. Specifically, we assume that a light rail stop will be built directly adjacent to Shantou University. A bus rapid transit system will also likely extend along the highways defining the southern and eastern borders of the site.

Shantou University

We assume that Shantou University will continue to grow its academic programs and expand its facilities. We understand that the university is considering moving the main entrance to the east, building a sports arena near the current entrance, and also relocating the medical school from downtown to a location on or near the main campus. We assume that the university will increasingly emphasize biotechnology and other forms of research and development, as well as expand its strong program in the art and design.

Shantou's Economy

We assume that the Shantou economy will continue to change from light and medium industry to a knowledge- and service-based economy. New airport and high speed connections to the rest of China as well as increased integration within the three-cities region will propel rapid growth. Shantou University will continue to be an engine for growth within the city, generating both economically-valuable research and training a highly-educated workforce.

Housing and Residential Population

Incomes will rise as Shantou's knowledge economy grows, but real estate prices may increase more rapidly. New commercial and residential construction will increase land values and use up available land, inflating the cost of market rate housing. The current low density urban villages will be redeveloped, possibly lot by lot as has occurred in Shenzhen, but ideally through a coordinated program. A more expensive real estate market and a decreased stock of cheap village housing will create pressure for more affordable housing. The supply of low to moderate income housing will simply not be able to meet demand. Migrant workers will continue to move to Shantou from rural areas in Guangdong Province and elsewhere in China to find jobs and help drive the economic expansion. Jobs created in Shantou will attract young student and post-graduate populations who will want to find housing and start families. The elderly population will increase as Shantou offers improved universal healthcare and better hospital systems. Shantou's increasingly educated and globally-focused population will demand higher standards of living, including better housing and more extensive community facilities.

Sustainability

Shantou residents' rising standards of living will also lead to an increasing focus on conserving open space and natural systems. Residents will expect access to open space for recreation, relaxation and cultural interaction. They will also value a healthier environment for their children and for the many plant and animal species that inhabit the delta region. The city will build a complete sewer system with water treatment plants, and force businesses to fully comply with water quality regulations. A comprehensive waste management system will reduce waste and properly handle remaining flows to ensure environmental quality and public health. The city will also provide less polluting transportation options like light rail and bus rapid transit to improve air quality. Together the government, businesses and individuals will embrace the need for a sustainable economy, society and environment.

A new middle income housing development in Shantou
(Source: Tyler Corson-Rikert)

High income housing in Vanke Town, Shenzhen
(Source: Tyler Corson-Rikert)

University

Shantou University presents enormous opportunities for this site, defining the area's significance within the larger city and providing a core population of students, faculty and staff in need of retail, entertainment and to a lesser extent housing. Moreover, the university's research activities and well-educated graduates provide the impetus for developing a vibrant node within Shantou's knowledge economy.

Airport

A new airport under construction 20 km west of the site will serve the three cities of Shantou, Chaozhou and Jieyang, promoting easy movement of people and goods between this integrated regional economy and the rest of China. Site B lies between two of the main highway and arterial connections between the airport and downtown Shantou, so will be well positioned to capitalize on the movement of people to and fro and the quick connection to national and international destinations.

Light Rail Stop

The light rail stop that we are assuming will be built directly adjacent to Shantou University will better link Shantou University with other areas of the city and stimulate the development of our site. The land close to the stop will see substantially increased foot traffic supporting higher densities and diverse land uses such as retail and entertainment.

Road Dividing the University and Site

The current arterial in between Shantou University and the site forms a barrier limiting connections between the two. Crossing the road is dangerous with several lanes of traffic and no pedestrian crossings and there is nothing on the south to encourage people at the university to go there. However, creating connections across this road would open up new opportunities for development linked in function to the strengths of the university and the needs of its population. It could also enable links between currently isolated green space areas.

Two Limited Access Highways

The two limited access highways running along the southern and eastern edges of the site will provide rapid automobile access from distant areas of the city as well as, we assume, bus rapid transit. On the western edge of Shantou, the site will be at the center of regional movement between the three cities.

Stream

With its waters cleaned and flooding properly managed the stream running east to west across the northern portion of the site can become a great asset as an environmental amenity, a space for relaxation and recreation, and as a link to areas upstream and downstream of the site. The stream is narrow enough that it need not be a boundary, but rather an organizing focus for the physical development of the site.

Surrounding Industry

The industry in the northern portion of the site near the university initially poses questions for how to develop pleasant residential neighborhoods and finer-grained mixed use districts. However, much of the industry has been there for some years and even the new structures will not likely have long lifespans, so this land will be prime for redevelopment under a comprehensive scheme.

Distance from City Center

The site's distance from Shantou's city center means that it has some independence from the development patterns there. Certainly residents of the Shantou University area will travel to and from downtown Shantou for business, shopping and entertainment, but they will also demand services locally. As a greenfield on the city's edge, the site can be developed along a new vision to become a model sustainable community for the rest of the city.

Topography

Perhaps Site B's most unique attribute is its topography, with the low ridge rising above Shantou's coastal plain and the university and the small hill at the center of the vacant parcel directly opposite the university's entrance. The development of the site will have to take into account the topography, whether by flattening it or locating roads, open spaces and structures to accommodate the slopes. If preserved, the site's terrain can provide a varied natural environment for residents while maintaining natural ecosystems.

Quarrying

One of the most distinctive features of the low ridge is the extensive and ongoing quarrying that has defaced the land, creating an uneven moonscape where there once were smooth slopes. These areas will require restoration, but when restored will create opportunities for unique environments with stone, revegetation and diverse topography

SITE B PROPOSAL > OVERVIEW

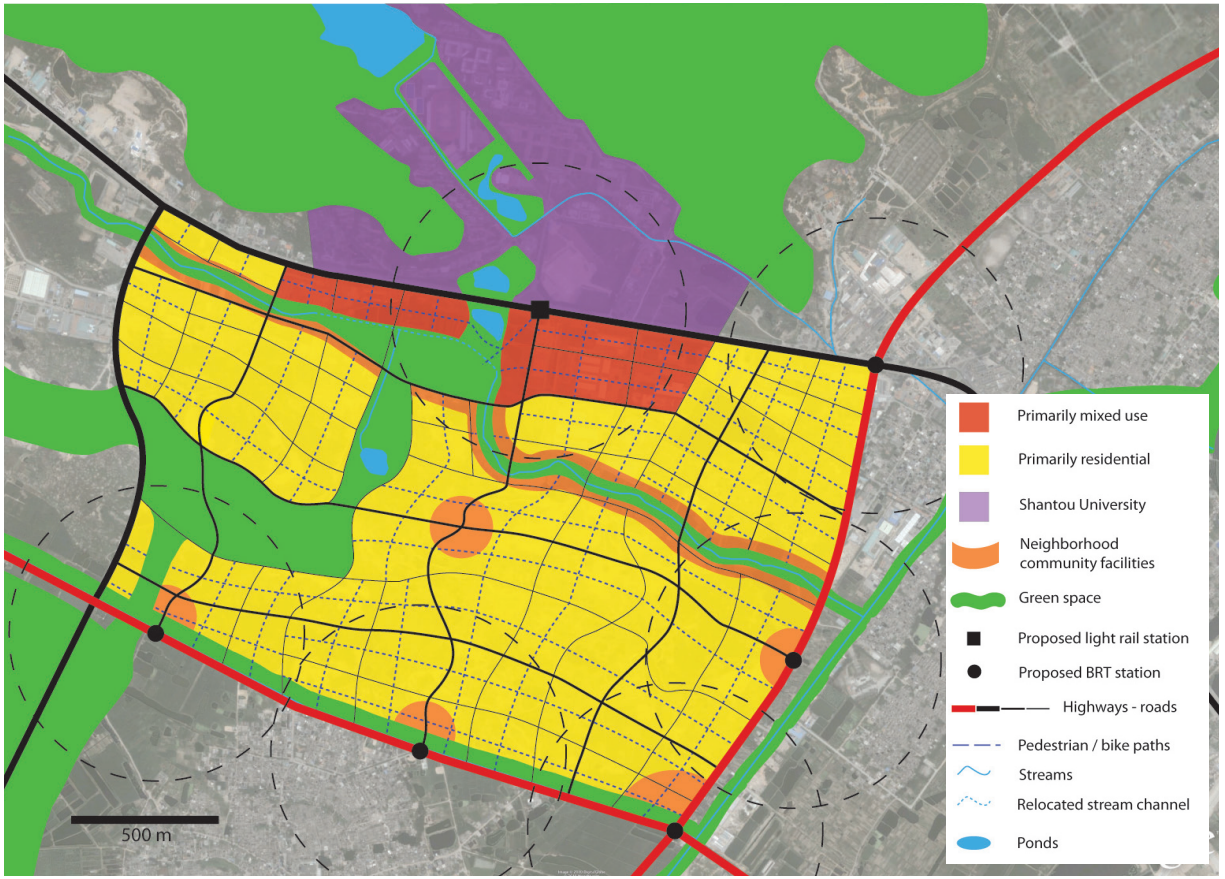
This plan is our vision for how Site B can be developed as a diverse, integrated, knowledge-based, environmentally responsive community. The plans lay out a network of green spaces, a circulation system, areas of predominant land use including mixed use development and housing, and concentrations of density, activity and community facilities. However, this presentation remains conceptual and does not describe the locations of particular structures nor provide an overly rigid framework for subsequent development. Our goal is to present a coherent framework to guide the development of the site, exciting interest in the site's potential and illustrating the value of planning sustainable communities.

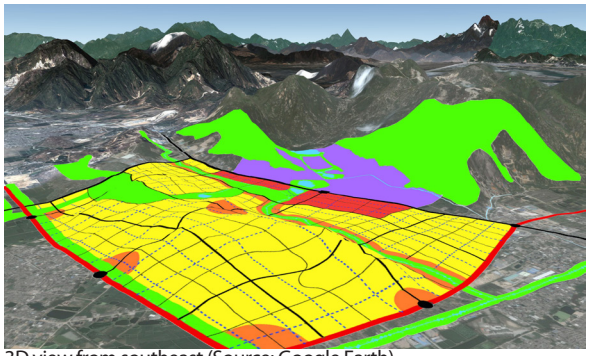
Vision

> Environmental Responsiveness
> Knowledge Economy
> Diversity
> Integration

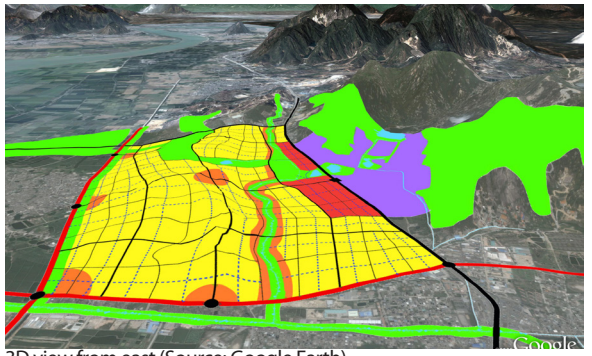
Core Elements

> Open Space
> Mixed Use
> Housing
> Community Facilities





3D view from southeast (Source: Google Earth)



3D view from east (Source: Google Earth)

First and foremost, we wanted the plan to be environmentally responsive and leverage the tremendous natural resources on the site. To achieve this we set out three objectives: maintaining ecological functions, creating connections and creating green public spaces.

Maintain ecological functions

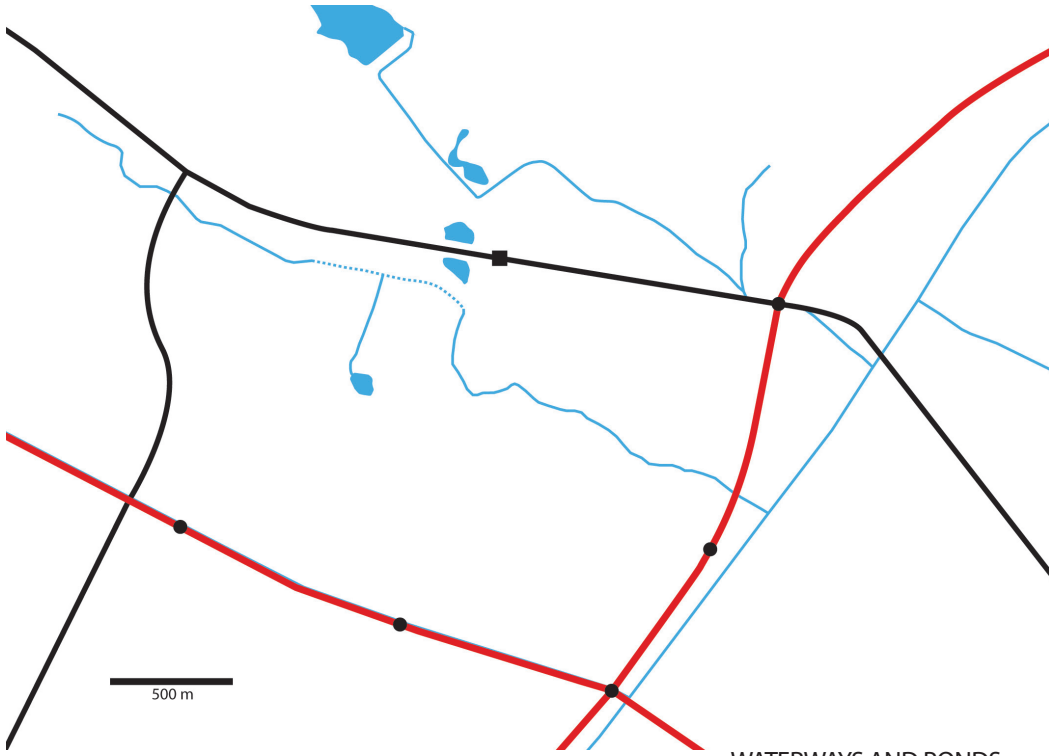
The purpose of maintaining the ecological functions of the site is to contribute to the larger natural environment of Shantou, model ecologically sustainable development patterns for the rest of the city, and create a healthier environment for the residents who will live in the area as it develops.

> Waterways

We propose preserving and enhancing the stream that runs through the northern portion of the site by maintaining a green corridor along its length and implementing methods for water purification and stormwater control, including wetlands and bioswales (see the individual tool "On-site water purification system") similar to the systems constructed in Chengdu and at the Shanghai 2010 World Expo. We also suggest maintaining a number of ponds that reflect the agricultural heritage of the area, with its tradition of fish farming. We suggest relocating the stretch of the stream immediately opposite the university's entrance to the far side of the flood plain to create more space for development adjacent to the main road.

> Existing topography

We propose that new roads opening the low ridge to development follow topography as much as possible to limit the need for road cuts and flattening of terrain, allowing natural vegetation and surface runoff to follow natural patterns. Likewise, we suggest building lower densities on the ridge that do not require substantial terrain modification, saving very high densities for flat areas such as near the light rail station.



WATERWAYS AND PONDS

> Restored quarries

We propose that slopes damaged by stone quarrying, which currently represent a blatant disregard for the value of natural ecosystems, be restored to in some areas create green space and in other areas create space for residential development.

A fish pond at Site B across from the Shantou University
(Source: Tyler Corson-Rikert)

Create connections

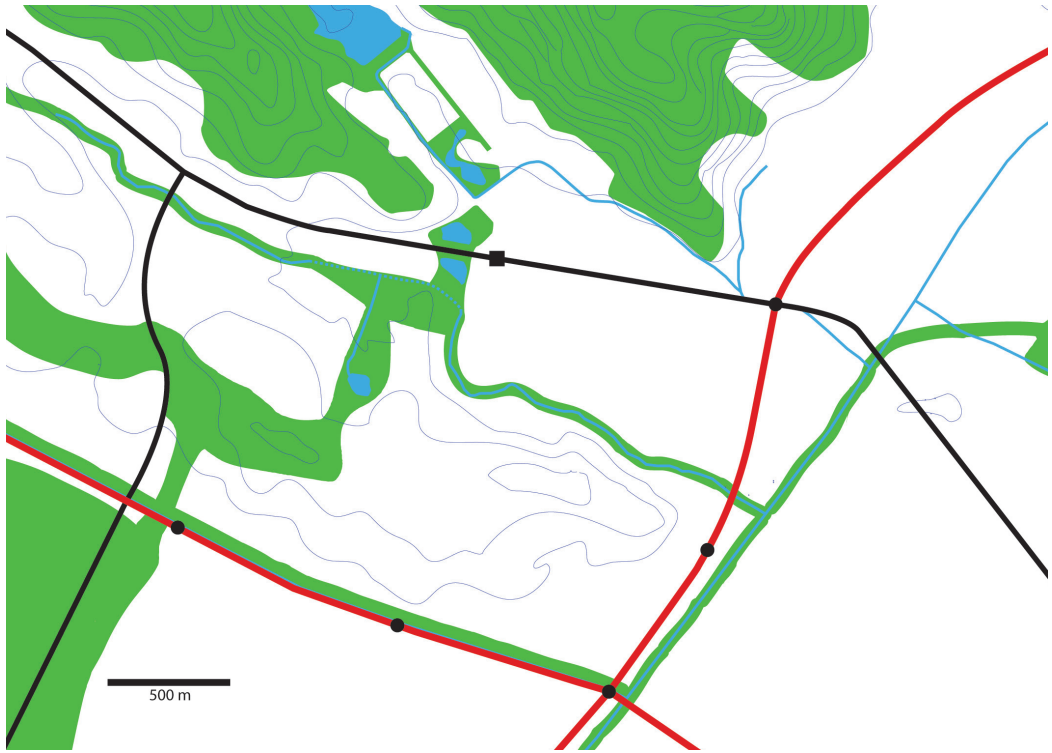
The purpose of creating connections through natural areas on the site is to create alternatives for mobility apart from cars, to enable a new conception of the site distinct from the network of roads, and to leverage existing investments in natural resources such as the protected forest on the high ridges north of the university, the university's beautifully landscaped campus, and agricultural land to the south.

> A Green Network

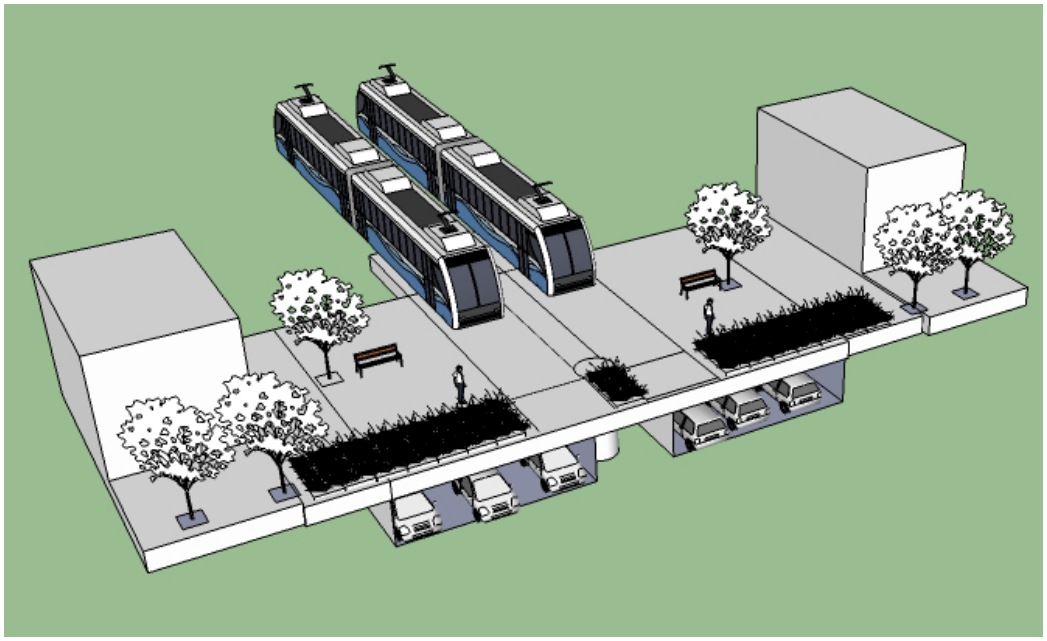
We propose creating a green corridor along the stream in the northern portion of the site to connect the new developments here to areas upstream and especially to communities downstream near Site A. Also, creating a convenient connection across the road by the university can link the open space behind the university and the campus itself to open space on the low ridge and agricultural areas beyond. The key to this connection making the road cross between the university and site effortless for pedestrians and cyclists. We propose an at-grade pedestrian crossing with the highway dipping underneath and the elevated light rail dropping to surface level at this location (see figure on the next page). Linked together, this network of green space would enable both movement to and from the site and free movement within the site independent of the roads.

> Models

As models for our design we considered Boston's Emerald Necklace, a network of waterways, corridors and parks connecting neighborhoods with the Charles River. LIke the Emerald Necklace, we envision Site B's green space corridor varying in width along its length to interact with surrounding land uses. We also looked to Boulder, Colorado for a model of building bicycle and pedestrian paths along creeks to create corridors through residential and commercial areas. Boulder's extensive paths form a fully parallel network to the traditional automobile-dominated road system. Moreover, they utilize underpasses to protect bicyclists' safety and minimize interference with traffic.



A map of Boston's Emerald Necklace (Source: Adriana Sassoon)



Our vision of an at-grade pedestrian crossing and light rail station connecting Shantou university to Site B

A path in Boston's Emerald Necklace (Source: Emerald Necklace Conservancy)

An at-grade pedestrian crossing in Atlanta, Georgia connecting the Georgia Institute of Technology's campus with a conference center and hotel (Source: Aspire: The Concrete Bridge Magazine)

A section of Boulder, Colorado's bike path network (Source: Shutterfly)

Create green public spaces

The purpose of creating green public spaces is to accommodate local residents' already high utilization of park spaces, anticipate growing demand for recreational opportunities, and promote residents' contact with nature to raise awareness of the importance of environmental protection. Open spaces also significantly increase real estate values on surrounding land.

We propose creating extensive areas of open space in a networked system including both areas for ecological protection and outdoor recreation and others for public parks, daily recreation and the arts.

We also envision applying best practices for the design of waterway environments through urban areas, to create opportunities for interaction and learning. By controlling water flows to prevent flooding, it becomes possible to bring people and structures very close to water in urban areas (see the tool "Regulating Flow of Waterways in Urban Areas").

Models

> The Punggol Waterway in Singapore provides an example of creating active recreational and public life by streams, locating both commercial and residential structures immediately adjacent to a waterway, whose flow levels dams at each end carefully control.

> The Cheonggyecheon River in Seoul, South Korea is a prominent example of waterway restoration as a means for redefining the character of an urban area. Covered for years by an elevated highway, the river now serves as an organizing axis through the city, a focus for leisure activities and a reminder of nature's place in the city.

(Left) An artist's image of the Punggol Waterway, currently under construction in Singapore with residential and commercial buildings close along the flow-controlled waterway (Source: Property Highlights of Singapore)

(Below) A vibrant space for recreation and public gatherings along the Cheonggyecheon River in Seoul, South Korea (Source: rip city to seoul)

SITE B PROPOSAL > CIRCULATION SYSTEM

> Limited access highways and arterials

The limited access highways and arterial streets that outline the site are derived Shantou's master plan. Automobiles will only be able to enter the site from the limited access highways at intersections with collector roads. Smaller roads will either end against the highway or connect across through underpasses. The interior grid will connect more extensively with the arterial streets on the northern and western edges of the site, although much of the traffic on these arterials will be through going and not tied closely to activity on the site.

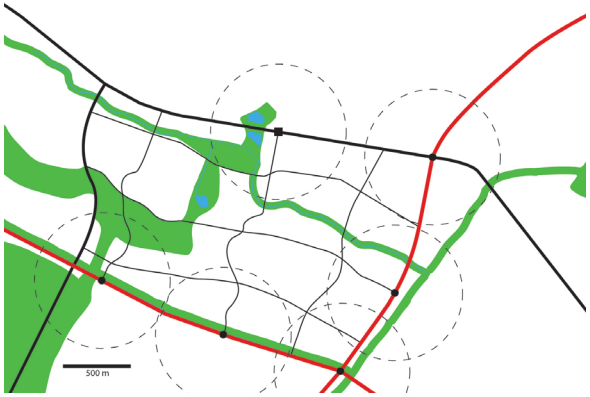
> Light rail and bus rapid transit

We assume that the light rail line running from downtown Shantou to the new airport will have a stop adjacent to the university. The earlier illustration of an at-grade light rail stop and pedestrian crossing enables transit riders to readily access both the university and the mixed use center right next to the station. A shuttle system will carry people disembarking from the light rail around the site on two routes.

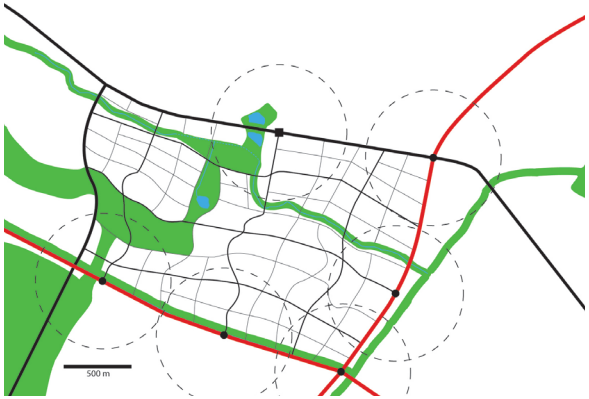
We assume that a complementary system of bus rapid transit will be built along the limited access highways ringing the site, with periodic stops creating other main entrance points to the site along the eastern and southern boundaries. Other local bus routes within the city's transit system will provide more local service along the roads ringing the site.

> Collector roads

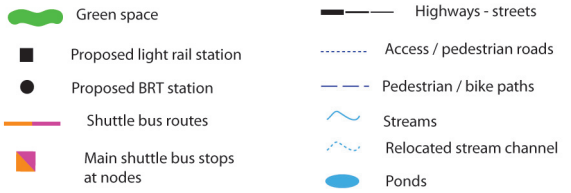
We propose a grid of three collector roads in each direction across the site, modeled roughly on the master plan's circulation diagram. These collector roads would carry most of the traffic crossing the low ridge from the university to the limited access highway and running along the ridge's length. While intended primarily for moving automobile traffic in and out and across the site quickly, we envision these roads as still being pedestrian and cycling friendly with wide sidewalks and dedicated bike lanes.



COLLECTOR ROADS



LOCAL STREETS



> Local streets

A grid of local streets between the collector roads would provide for movement within neighborhoods. Built with traffic calming measures such as green dividers, raised pedestrian crossings and roundabouts, these streets would accommodate automobiles, cyclists and pedestrians equally with separate lanes and sidewalks. We envision buildings closely engaging the street front to create and active environment and abundant green plantings and storm water control features to create a pleasing and environmentally sustainable streetscape.

Light rail in a Chinese city (Source: www.hqcx.net)

SITE B PROPOSAL > CIRCULATION SYSTEM

> Pedestrian /automobile shared access roads

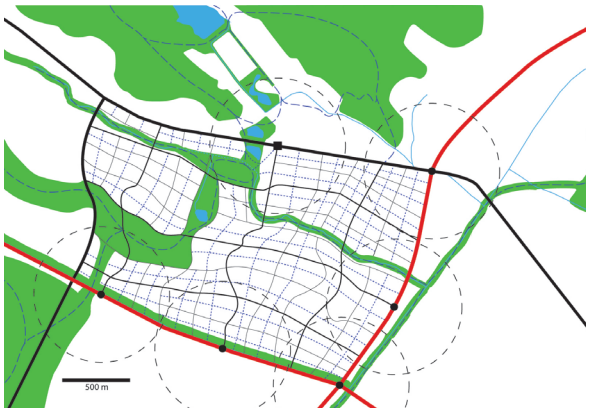
Pedestrian and automobile shared roads will penetrate the large blocks defined by local streets, discouraging through traffic but allowing access to buildings. With heavy traffic calming measures and narrow road beds, these alleyways would encourage pedestrians and cyclists to utilize the roads' full width amid only very slowly moving automobiles. Occupying the interiors of blocks across the site, these access roads would enable pedestrians and cyclists to move throughout the site without needing to follow local or collector roads. With many trees, permeable pavement and traffic calming landscaping these streets would form a localized green streets system to complement the wider open space network.

> Shuttle system

A free or low cost shuttle system will link centers of movement and activity around the site and encourage residents not to drive within the site. It will complement, not duplicate the public transit system running around the exterior of the site. It will pass within two blocks of every place on the site with shuttles running both clockwise and counterclockwise to maximize convenience. The two separate routes on the eastern and western sides of the site will meet at the light rail station and a transfer stop on the ridge in the center of the site.

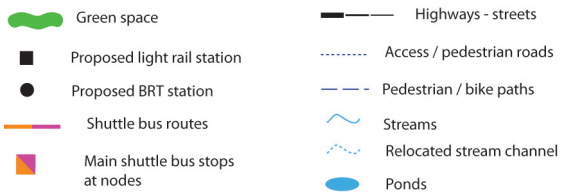
> Pedestrian and bike path network

Pedestrian and bike paths following the network of green spaces on the site will enable rapid movement free of the road grid to locations within the site and far beyond. We envision bicycle underpasses like those Boulder, Colorado has built to minimize interference from the automobile-based street grid.



SHARED ACCESS ROADS AND BIKE PATHS

SHUTTLE SYSTEM



A pedestrian and bike underpass at a road intersection in Boulder, Colorado (Source: Loris and Associates)

A local shuttle bus (Source: Towneley)

SITE B PROPOSAL > NODES AND CENTERS OF ACTIVITY

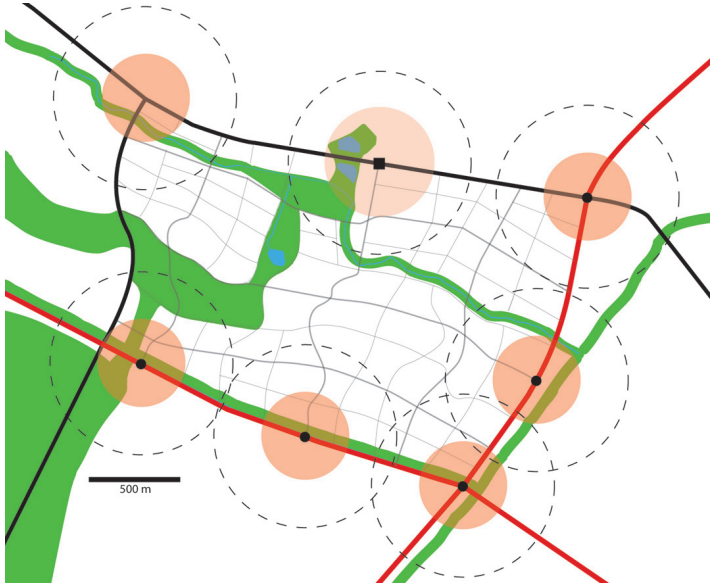
To organize the site we propose a hierarchy of nodes built around key connections in the circulation system, creating centers of activity. We envision higher densities at nodes, with concentrations of commercial space and community facilities.

> Outer Nodes

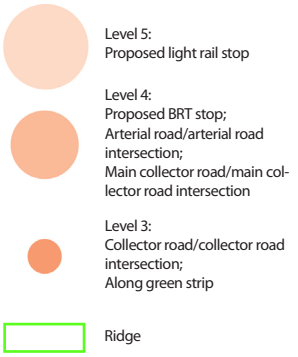
The highest level node on the site will be the area around the proposed light rail station, directly opposite the entrance to the university. Serving as a gateway to the university and this site from the airport and the wider city of Shantou, this area will receive heavy traffic from residents and visitors. The other nodes around the edges of the site will be located at intersections of limited access highways and arterials streets, or at proposed bus rapid transit (BRT) stations. As secondary gateways to the site along major roadways, these nodes will emphasize commercial actiivty and community facilities over housing.

> Inner Nodes

The largest of the nodes in the interior of the site will be located on the collector road connecting the light rail station across the low ridge to the proposed bus rapid transit station where it intersects with a second collector road running the length of the ridge. This is also the point where the two shuttle bus routes have a transfer station facilitating movement from one area of the site to the other. The remaining inner nodes will be at other collector road intersections, which also serve as primary stops on the shuttle bus routes. We envision the inner nodes as centers of community facilities oriented toward neighborhoods rather than outside visitors. These nodes will be central to creating vibrant and diverse environments within the large site.



OUTER NODES CONCEPT



INNER NODES CONCEPT

SITE B PROPOSAL > DENSITY > Floor to Area Ratio (FAR)

> High density (2.2-3.5)

Areas within 500 m walking distance of the light rail, BRT stations, and major roads will have higher densities. The area of highest density will be the mixed use stretch around the light rail station, which is primarily commercial office/laboratory space and retail, but will contain a small percentage of housing units.

> Moderate Density (1.8-2.2)

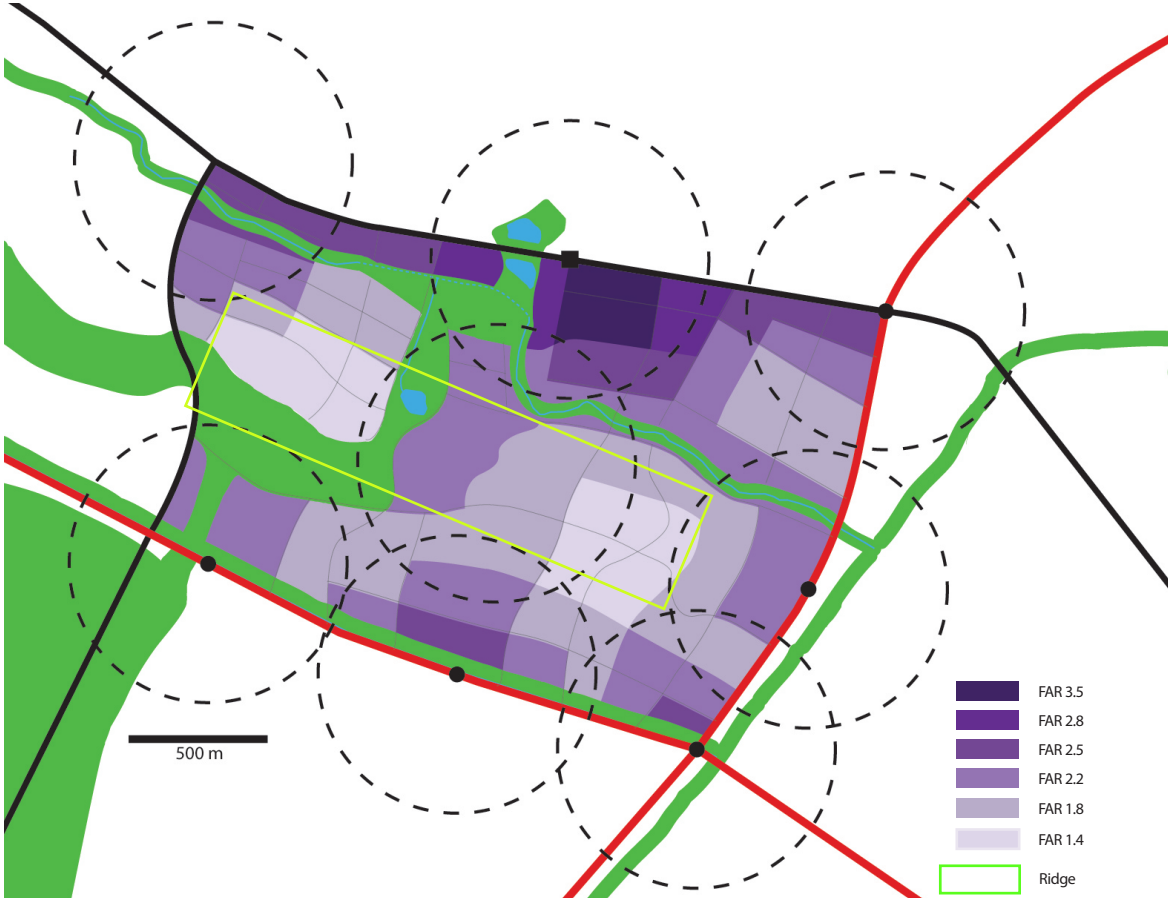
Areas near prominent natural features, such as parks and pedestrian paths along the stream, and mid-level nodes will have moderate densities to provide a seamless transition into lower density blocks that are further away from major transit nodes. These sections will be primarily residential with community facilities located throughout.

> Low Density (1.4-1.8)

Areas that are furthest from major nodes of activity will have the lowest densities. These are concentrated near major green space to minimize impact to the environment. Places with difficult topography, such as atop the ridge that runs across the center of the site, will have comparatively lower densities. These areas will be primarily residential.

Looking at the land uses and FAR, below is a summary of the average FAR of our proposal.

Average FAR with Open Space	1.7
Average FAR without Open Space	2.1
Average FAR of Mixed Use	3.0
Average FAR of Residential Area	2.0



DENSITY: FAR

Population Estimates

Based on our assumptions and our analysis, Site B's population is estimated to be approximately 99,000 people. This is comparable to the City of Cambridge, Massachusetts, USA (population 105,000). We anticipate that through our development plan and its emphasis on mixing uses with natural amenities, Site B will become an inclusive and vibrant community where university students, faculty, post-graduates can live, as well as professionals, families, artists, and workers.

The population estimates built upon assumptions in previous MIT studios that focused on residential development in Shenzhen and Hong Kong, as well as comparisons with other developments in the United States and Asia.

Assumptions

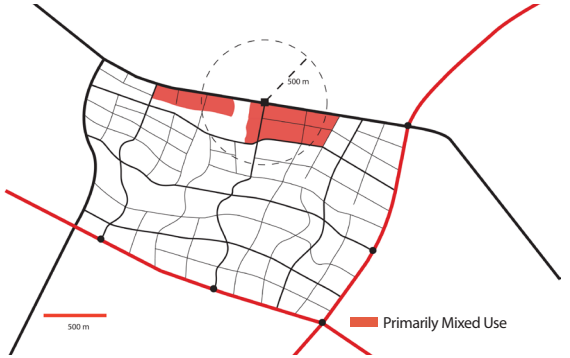
> 15% of affordable units is based on commonly used U.S. standards for affordable housing and is based on area median incomes and the percentage of people who cannot afford monthly rents by using at most 30% of monthly income. (See Site A's housing analysis for one way of deriving the number of affordable units).
> Market rate units are on average, 90 sqm while affordable units are smaller, with an average of 50 sqm.
> Average persons per unit is 2, taking into consideration a trend towards smaller families with a shift towards extended relatives or elderly living in separate units.
> 5% of units in higher density mixed use buildings have a mix of market rate and affordable residential units.
> 75% of land devoted to residential and community facilities is used for housing while the other 25% is used for public roads, open space, and sidewalks, among others.

Assumptions		Predominant Land Use	Land Area (hectares)	Land Area (sqm)	% Residential	FAR	Total Built Area (sqm)	# of Market Units	# of Affordable Units	Pop
		Mixed Use	9.9	98,960	5%	3.5	346,360	175	31	412
			12.8	128,002	5%	2.8	358,406	181	32	427
Percent of Units Affordable	15%		5.0	50,368	5%	2.5	125,920	64	11	150
Market Rate Unit Size (sqm)	90	Housing & Community Facilities	31.5	314,784	75%	2.5	786,960	5,972	1,054	14,053
Affordable Unit Size (sqm)	50		104.5	1,044,785	75%	2.2	2,298,527	17,444	3,078	41,045
Persons Per Unit	2		102.7	1,027,337	75%	1.8	1,849,207	14,034	2,477	33,022
			39.1	391,018	75%	1.4	547,425	4,155	733	9,775
		Green Open Space	68.5	685,000	0%	0.0	0	0	0	0
		Subtotal Mixed Use	**27.7**	**277,330**			**830,686**	**420**	**74**	**989**
		Subtotal Housing & Community Facilities	**277.8**	**2,777,924**			**5,482,119**	**41,605**	**7,342**	**97,895**
		Subtotal Green Open Space	**68.5**	**685,000**			**0**	**0**	**0**	**0**
		TOTAL	**306**	**3,740,254**			**6,312,804**	**42,026**	**7,416**	**98,884**

SITE B PROPOSAL > MIXED USE

The proposed plan includes a mixed used area adjacent to the light rail station and directly across from Shantou University. The area's high transport accessibility and proximity to the university provides an opportunity for the area to be developed into an anchor that stitches the university and the proposed developments within Site B.

This area will be developed into a vibrant place for students, faculty, professionals, families and children to live, work and play. The core of the mixed use zone includes commercial office/laboratory space for life sciences research and development (R&D), retail and arts/entertainment facilities, and transit oriented developments (TOD). At the heart of the district will be a scenic lake and stream that links the different land uses together. Combined, these uses help us to achieve our vision for a site that is driven by the knowledge economy, embodies diversity and facilitates integration.



BEFORE - Area opposite Shantou University today (background: university; foreground: proposed mixed use area in Site B)

AFTER - Area opposite Shantou University with mixed used developments

Research & Development

The mixed use area within Site B is envisioned to include developments such as office and laboratory buildings for life sciences/biotechnology research and development (R&D). This use coincides with the 2003 Shantou Master Plan's intention to concentrate science and technology activities across from Shantou University. The university's plan to move its medical college to its main campus also encourages a concentration of biomedical and health-oriented companies and facilities to demand this space. Major destination retail, a hotel/conference center, and university related facilities and housing will be located in this area to take advantage of the R&D space and access to light rail.

Case Study: Technology Square, Georgia, USA

Our proposal for this mixed use district is similar to the mix of uses found in Technology Square at Georgia Institute of Technology in the city of Atlanta, Georgia, USA. Technology Square covers an area of approximately 3.2ha and is located directly across from Georgia Institute of Technology as shown in the satellite photo .

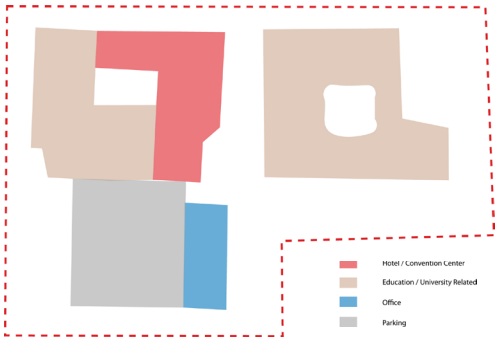
Technology Square was developed with a mix of uses including the College of Management, the Global Learning Centre, the Economic Development Building and a 252 room hotel with conference center. With a total built up area of about, 111,480 m^2, the site has a FAR of about 3.48 (ULI, 2004).

Technology Square provides conference and hotel facilities for the university. This helps to enhance the synergy between private sector technology businesses and Georgia Tech's research and academic resources. This dynamic development caters to the university's needs as well as the area's residents and businesses (ULI, 2004).

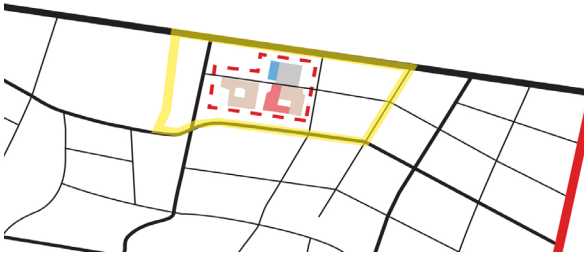
Likewise, having a similar mix of uses at the site immediately across from Shantou University would benefit both the university as well as the businesses and residents living in the vicinity.

Technology Square outlined in red. Gerogia Institute of Technology main campus to the left (Source: Google Earth)

Map of Georgia Institute of Technology with Technology Square outlined in red (Source: CNU18)



Building footprint & uses in Technology Square



Comparing Technology Square's development footprint with Site B's road grid

Sufficient room to accommodate four developments the size of Technology Square.

Restaurants & Retail

Retail, restaurants, and arts/entertainment uses in mixed use areas help to keep the area vibrant after dark when people leave the offices and R&D laboratories. This mix of uses accommodates activities during the daytime and nighttime hours and creates a destination for people with different interests. Developing some of these mixed use sites into TODs can help promote the integration between transit and the mixed use developments. Some examples of retail uses in such mixed use sites include the retail area in Technology Square as well as AMK Hub in Singapore which was developed as a TOD integrating a retail mall and bus interchange which are both linked by an underpass to the adjacent transit station.

Arts & Entertainment

In particular, arts and entertainment facilities, such as movie theaters, karaoke centers, and performing arts and cultural spaces take advantage of transit access, higher population densities and access to open space. These uses complement the young population of the university, local and regional visitors to the proposed athletic arena, and diverse business and residential population. Galleries and special events create a festive atmosphere that celebrates both Shantou culture as well as international ideas.

Some examples of successful arts districts include Beijing's 798 Arts District that converts former industrial buildings into artist studio spaces, live-work artist housing, and exhibition space. New York City's DUMBO arts district is a vibrant place that attracts people from all over the world.

Retail and vibrant street life at Technnology Square.
Atlanta, Georgia, USA
(Source: Georgia Tech)

Art galleries in Beijing's 798 Arts District.
Beijing, China
(Source: 798 Studio International)

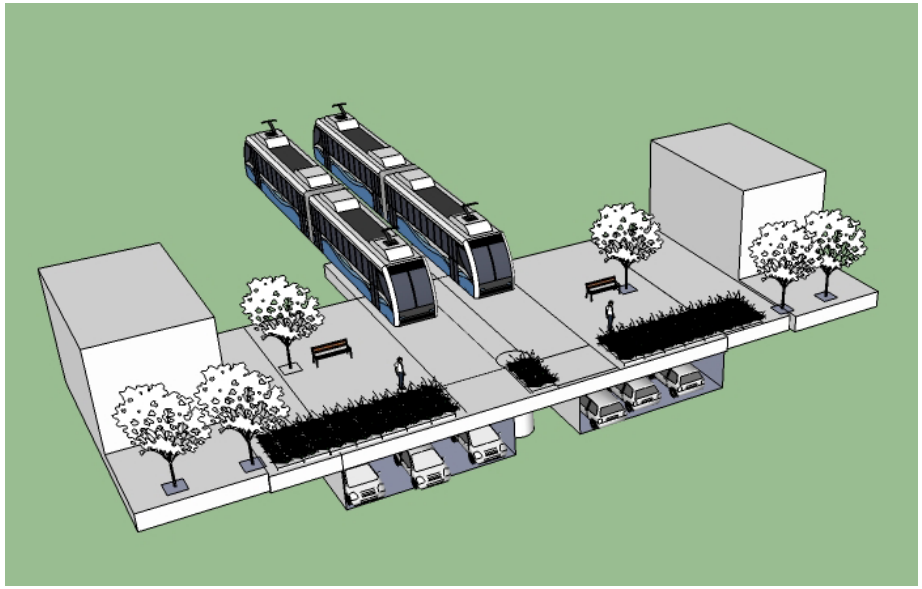
AMK Hub mixed use transit oriented development.
Ang Mo Kio, Singapore
(Source: Panoramio)

Restaurants in DUMBO complement live-work arts studios, galleries and performance spaces.
Brooklyn, New York City, USA
(Source: Julie Mack)

Open Space

In keeping with the vision of an environmentally responsive development area, a network of open space would also be integrated with the mixed use developments. This network of open space would not only provide some recreational space for the area, it will also serve as a link with the university, as described in greater detail under the 'Open Space and Natural Systems' section.

The rendering below illustrates a network of open spaces running through the mixed use area (foreground of rendering) and connecting right through across the highway into the university (background of rendering). The 3D model on the right illustrates how the connection to the university can be developed as a green pedestrian and cyclist friendly link spanning the highway.



Green pedestrian and cyclist friendly connection between Shantou University and Site B spanning highway

We envision that the central green open space and stream form the heart of the mixed use area. This will be the center of public gatherings, recreation and leisure. Restaurants, outdoor cafes, abundant seating areas and open plazas encourage the exchange of ideas and promote interaction between people of all backgrounds. This supportive and open environment is characteristic of cities boasting strong knowledge economies. It not only helps to stimulate creativity and innovation, but contributes to a high quality of life.

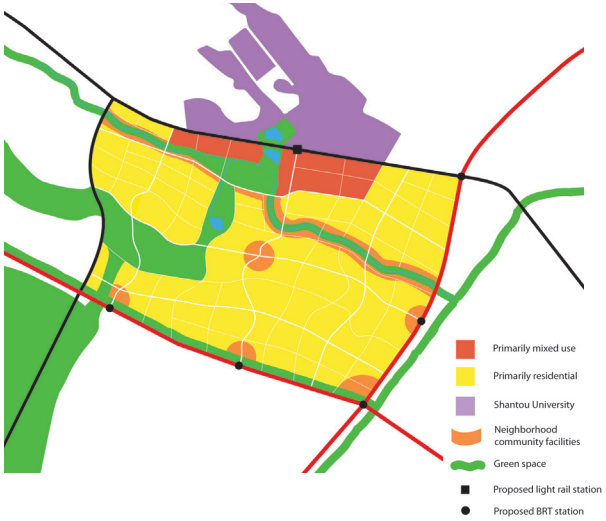
Open space network stretching through mixed use area (foreground) and across highway into Shantou University (background)

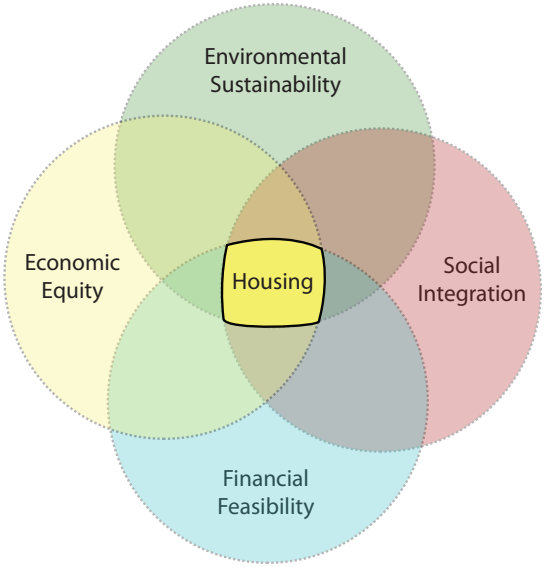
SITE B PROPOSAL > HOUSING > Overview and Goals

Site B is strategically positioned across from Shantou University and en route to the center city from the new airport. Currently a greenfield, Site B has the opportunity to serve as a model for sustainable development, taking into consideration a mix of uses that complement the university across the street and takes advantage of its existing topography and green space. To do this, we propose that any residential developments align with each of the following goals that complement our overarching vision:

New residential buildings in Shantou (Source: Julie Chan)

Model developments in a Shantou Office of Planning Exhibition (Source: Julie Chan)





> Environmental Sustainability

Residential development should use land in an efficient and environmentally conscious manner. It should respond to natural topographies and preserve networks of green open space for public use and create new networks to serve as natural buffer zones. It should utilize transit oriented development (TOD) to encourage density in areas that are highly accessible to public transportation.

> Economic Equity

Safe and high quality residential development should accommodate a range of people who support Shantou's growing intellectual, cultural, and service-oriented economy. Housing should adequately provide for the needs of a diverse workforce and growing elderly population.

> Social Integration

Residential developments should accommodate a diversity of people with a mix of incomes, family types, and living arrangements. Every effort should be made to develop safe and inclusive communities to minimize socioeconomic segregation. These developments should be integrated with other uses such as community facilities, parks and open space, and commercial office/retail. This encourages a vibrant, active, and inclusive environment.

> Financial Feasibility

In addition to those goals, we believe that residential development should be financially feasible by incentivizing high quality development with affordable components. Different policies and programs that have been successful in the U.S. are methods to ensure long-term affordability and sufficient financial return for developers.

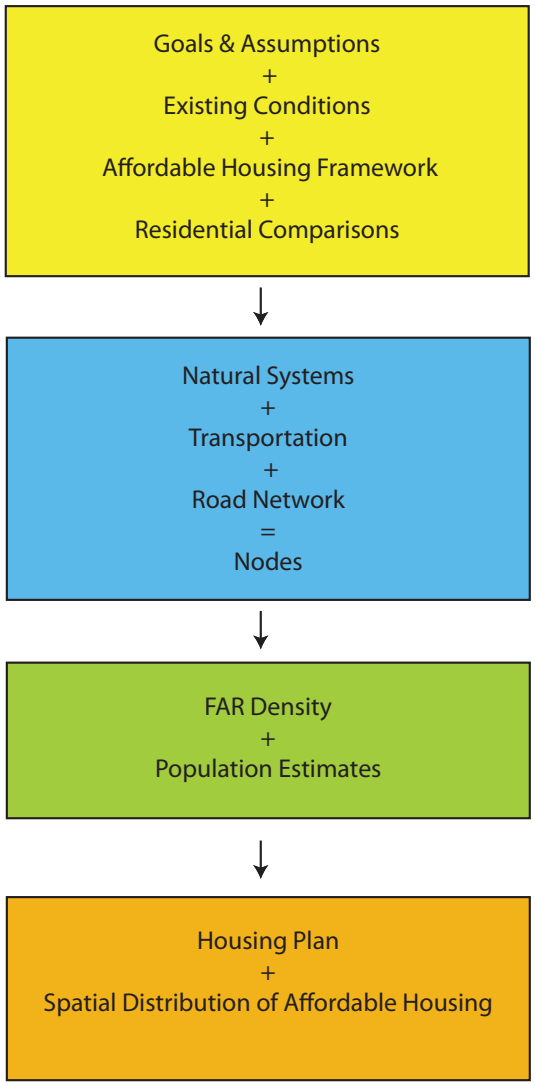
Methodology

1) Based on our goals and vision, existing conditions of the site, affordable housing framework, and comparisons with residential developments in the United States and Asia, we first determined how the site relates to the proposed road network, transit stops, and circulation patterns. From there, we formulated a hierarchy of nodes.

2) Using these centers of activity, we developed a scenario for site density that strives to use scarce land efficiently. Using land efficiently in areas accessible to transit is important because it maximizes public transit accessibility and maximizes the population served. This transit oriented development (TOD) resulted in higher densities around areas within a 500 m walking distance of light rail and bus rapid transit (BRT).

2) We determined population estimates based on assumptions about residential unit sizes for market and affordable-rate housing derived from previous studio studies using Shenzhen and Singapore as comparisons.

3) We developed a land use plan that contains a significant residential component to meet the needs of a growing and urbanizing city. We determined the spatial distribution of affordable housing units under proposed housing policies and programs. These include affordable housing units under the proposed inclusionary housing program as well as parcels that will contain individual affordable housing buildings under the linkage program.

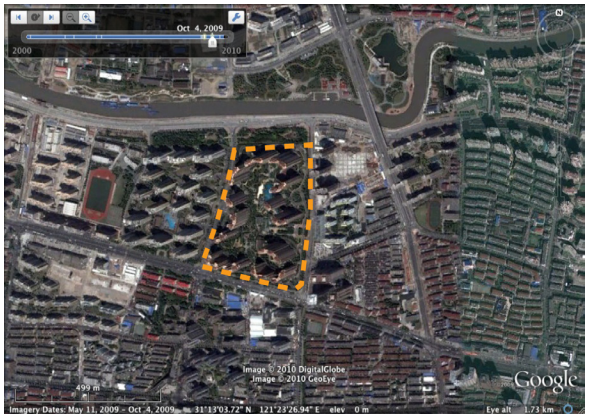


This is the first stage of determining the residential development plan for Site B. More detailed analysis on smaller scale site planning, design guidelines and building typologies, and financial feasibility will be necessary in future stages.

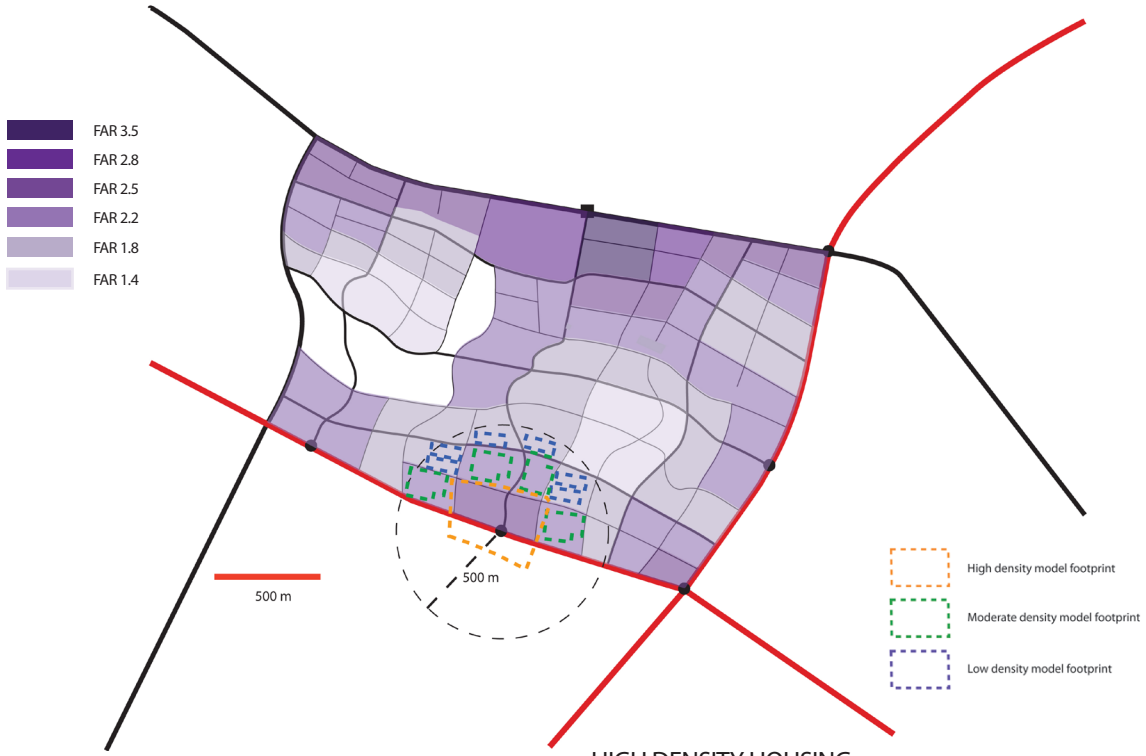
High Density

High density housing located immediately around transport nodes would come in the form of high rise blocks such as the ones located within the Oasis Riviera in Shanghai. Because these units are highly accessible to public transportation, we recommend that housing units include high-income as well as low-income units.

High rise blocks within Oasis Riviera
(Source: CapitaLand)



Site boundary of Oasis Riviera outlined in orange here and on our diagram to the right (Source: Google Earth)



HIGH DENSITY HOUSING

> Oasis Riviera in Shanghai, China

This residential development (outlined in orange on satellite photo) is located on a 10.8 ha site with a FAR of approximately 2.5. There are a total of 17 tower blocks within the development.

> Application to Site B in Shantou

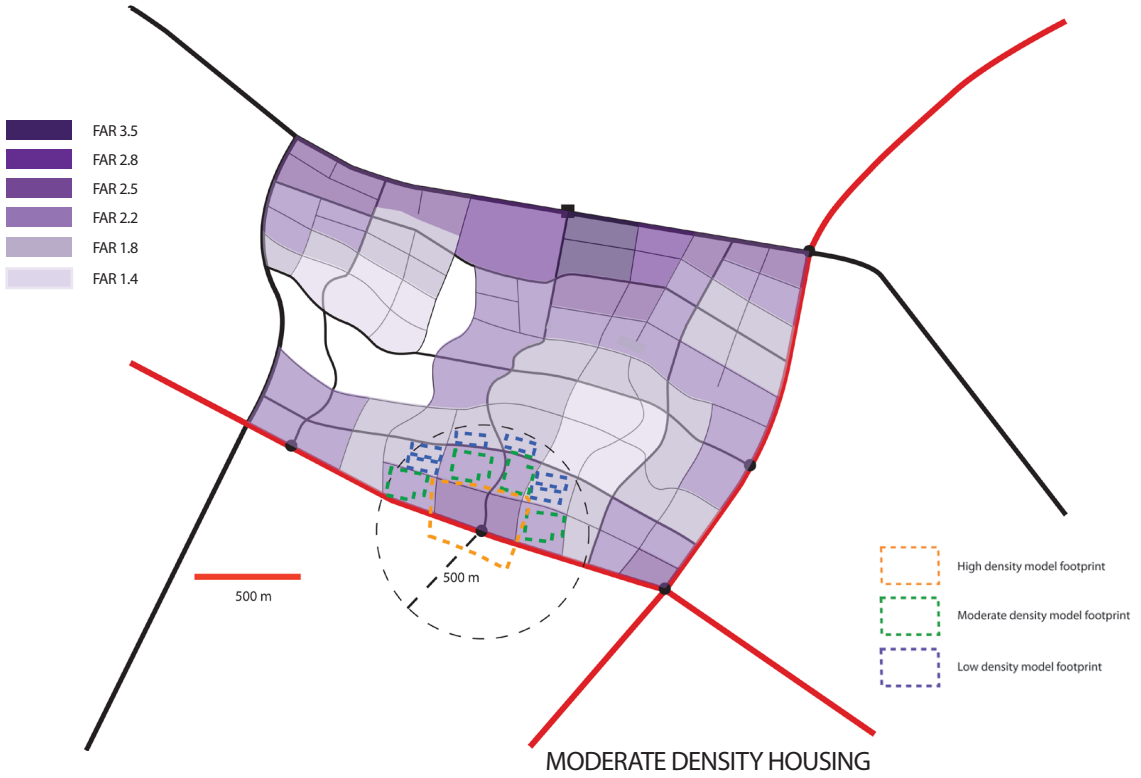
Superimposing Oasis Riviera's development boundary on to Site B above illustrates that the high density area immediately around the transport node in Site B can accommodate slightly more than half of the blocks located in Oasis Riviera.

Moderate Density

Moderate density housing is located slightly further from the transport nodes. Such developments would be similar to the Beau Residences in Foshan. While most housing types in moderately dense locations will be mid-rise buildings, our plan also includes

Moderate rise blocks within Beau Residences
(Source: CapitaLand)

Site boundary of Beau Residences outlined in green here and on our diagram to the right (Source: Google Earth)



MODERATE DENSITY HOUSING

housing for low-income artists that converts industrial buildings into live-work loft space. These industrial buildings, which currently exist, are well suited to be adapted and reused for artists' needs (See Individual Tool on "Live-Work Artist Housing")

> Beau Residences in Foshan, China

This residential development (outlined in green on satellite photo) is located on a 2.5 ha site with a FAR of approximately 1.8. The site comprises 1 big block and 2 smaller blocks as shown in the picture.

> Application to Site B in Shantou

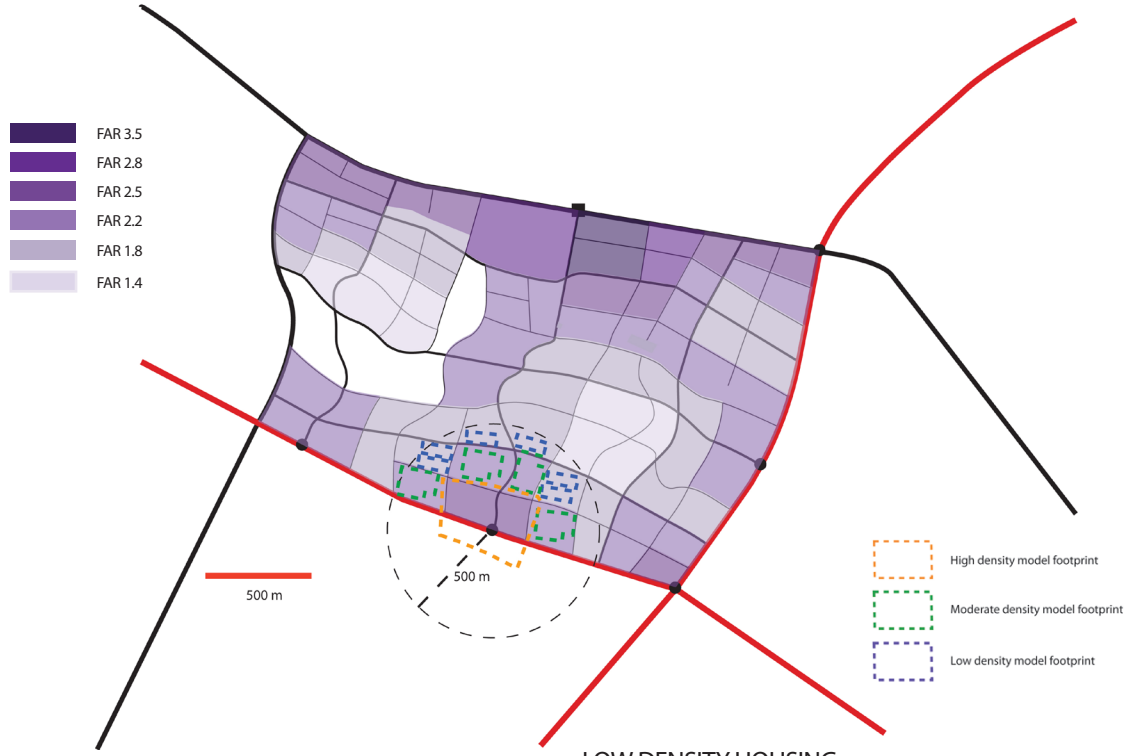
Superimposing Beau Residences' development boundary on to Site B above illustrates that the moderate density area within 500m of the transport node in Site B can accommodate about 4 medium density developments, each the size of Beau Residences.

Low Density

Low density housing is generally located on the fringe of the 500 m radius with the majority falling outside the 500 m radius. Such developments typically take the form of low rise buildings such as those found in Espa Condominium in Singapore. Housing in these areas will have lower FARs but will feature expansive views and capture breezes during the warmer seasons. These residences will support higher market prices.

Low rise blocks within Espa Condominium
(Source: ST701 Property)

Site boundary of Espa Condominium outlined in blue here and on our diagram to the right (Source: Google Earth)



LOW DENSITY HOUSING

> Espa Condominium in Singapore

This residential development (outlined in blue on satellite photo) is located on a 0.6 ha site with a FAR of approximately 1.4. The development is made up of low rise 5-storey apartments.

> Application to Site B in Shantou

Superimposing Espa Condominium's development boundary on to Site B above illustrates that the low density area within 500 m of the transport node in Site B can accommodate about 6 such low density developments, each the size of Espa Condominium.

Affordable Housing Framework

Ensuring that housing is accessible and equitable is an important facet of sustainable residential development. Typically, residents earning at or below 60% of the area median income (AMI) qualify for different types of low-income housing. As private developers play increasingly large roles in the real estate development sphere in China, and as land becomes scarce, market prices will surge ahead of people's incomes and demand for affordable housing will increase proportionally. vIt is thus necessary to have in place incentive programs that ensure that future residential development aligns with our goals of environmental sustainability, economic equity, social integration, and financial feasibility.

To do so, we present the following as some examples of policies in place in the U.S. that seek to incentivize the development of affordable housing.

> Inclusionary zoning (IZ)

This is a set of controls that require developers to allocate a specific percentage of residential units in new developments to low- and moderate-income households. As an incentive, developers receive non-monetary compensation that may be density bonuses, zoning variances, and expedited permits. Inclusionary zoning increases the supply of affordable housing while fostering mixed-income communities. This policy can have different regulations depending on the jurisdiction, such as whether it is voluntary or mandatory, and whether affordable units can be built in the development, off-site, or if money is contributed to an affordable housing fund instead. The rationale is that the profit of the additional market-rate space will subsidize the reduced rents on the affordable units.

> Case Study: New York City, USA

New York City has an aggressive inclusionary zoning program that requires developers taking advantage of the full density bonus to devote at least 20 percent of their residential floor area to housing that will remain permanently affordable to lower-income households. Developers in the densest parts of the city are then allowed to build a larger market-rate building than would be allowed under standard zoning. In 2005, the program was expanded to include medium-density areas of the city, and the terms were revised so that potential floor area bonuses increased from 20% to as much as 33% for qualifying projects. Within four years of the program's expansion, over 1,900 units of affordable housing were built or is under development, with 10,000 units expected to be produced through the program.

New York (Source: Hudson Companies)

New York (Source: Hudson Companies)

> Commercial Linkage

These policies are designed to raise revenue to support the production of affordable housing by assessing fees on new construction of retail, office, hotel and other non-residential development. They are based on the concept that commercial development creates new jobs, many of which will be at wage levels that indicate low or moderate income households. The addition of these households increase the demand for affordable housing.

> Case Study: Boston, Massachusetts, USA

Since 1986, Boston has allocated more than $45 million USD in linkage funds for the construction of 5,000 housing units, according to a 2000 study by the Boston Redevelopment Authority. Boston's linkage program requires that developers of large-scale commercial, retail, hotel, or institutional structures seeking zoning relief pay an exaction to construct affordable housing off-site. They associate the program's success with its high linkage fees, city-wide coverage, broad coverage of development types, and flexible payment schedule.

Source: Concert Properties

> Transit oriented development (TOD)

TOD is a planning and design trend that uses existing or emerging transit stations as nodes for compact, higher-density, mixed-use, pedestrian-oriented development. They are used in cities to more efficiently use scarce land in a way that encourages the development of a mix of development types, including housing, commercial office and retail. TOD encourages public transportation ridership as well as other modes, such as walking and biking. By concentrating uses and promoting pedestrian foot traffic, TOD is a tool that generates significant private revenues and public value. When used in conjunction with affordable housing policies, creating TOD with mixed income residential increases mobility and accessibility to facilities.

> Case Study: Collingwood Village, Vancouver, Canada

Developer Concert Properties approached the City of Vancouver for the rezoning of former industrial lands to high-density mixed-use next to the Joyce SkyTrain station. In consultation with current residents and stakeholders, they agreed to redevelop 27.3 acres of land for Collingwood Village, which contained 2,600 residential units in 11 high-rises and a number of low-rise structures. In exchange for higher densities, one-quarter of the site was devoted to parks. The construction of affordable housing, a school and a community center were funded by the developer.

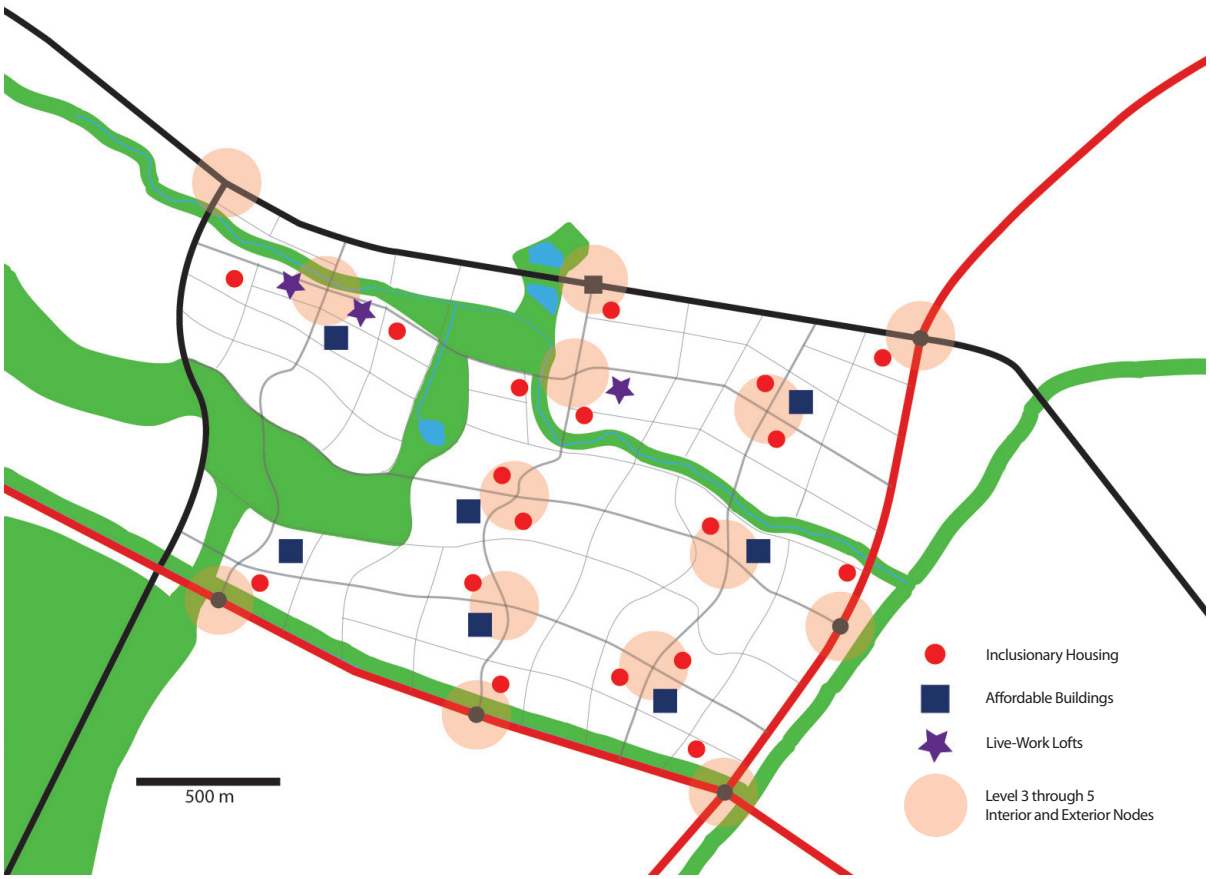
Spatial Distribution of Affordable Housing

Our projections indicate that there will be 42,026 market rate residential units and 7,416 affordable units located throughout Site B. A majority of the site will be devoted to residential development. Market rate units will be a mix of building heights and densities that will accommodate an average family size of 2.

The diagram to the right shows the the spatial distribution of the following affordable housing types:

1) Inclusionary zoning affordable units
2) Affordable housing buildings
3) Live-work artist housing

This diagram does not represent actual locations on a site level, but is a way of visualizing how affordable residential units will be dispersed throughout the site, as well as its relationships with nodes of activity. Our goal is to foster a mixed-income environment that ensures that low- and moderate-income populations can easily access public transportation and community facilities.



SPATIAL DISTRIBUTION OF AFFORDABLE HOUSING

SITE B PROPOSAL > HOUSING > Spatial Distribution of Affordable Housing

The diagrams below show the spatial relationships between affordable housing and various factors that impact location.

1) Circulation and Road Networks

Affordable units/buildings are highly accessible to major roads, public transportation and the interior bus shuttle circulator.

AFFORDABLE HOUSING + CIRCULATION

2) Land Use

Affordable units/buildings are relatively evenly distributed throughout the site in an effort to avoid the segregation of low and moderate income residents.

AFFORDABLE HOUSING + LAND USE

3) FAR Density

Affordable units/buildings are located in a range of FAR densities. Mixed income housing occurs at nodes to take advantage of transit oriented development.

AFFORDABLE HOUSING + DENSITY

The goal of sustainable community facility development is to provide the right quantity and quality of essential services that the people of Shantou can access and afford. These include facilities related to education, healthcare, retail, and parks/open space that contribute to high quality of life standards. They should be easily accessible by public transportation and other modes such as walking and biking, and located throughout the site to maximize the populations served. Integrating community facilities with residential areas will add to the accessibility and vibrancy of a neighborhood as people find new ways to interact with each other.

Examples of community facilities currently in Shantou, China.
Sources: Julie Chan, Tyler Corson-Rikert

Projected Quantity

Based on our estimated site population, and building upon previous MIT Shenzhen Studio research on comparable cities, we determined the ideal quantity of community facilities that would serve the expected residential population. The facilities form a hierarchy of systems that serve local, neighborhood and citywide populations. These facilities are located near major nodes and are concentrated in centers of activity.

Educational Facilities	# of Seats per Person	# of Seats Based on Population
Kindergarten	0.026	2,571
Primary school	0.08	7,911
Secondary school	0.055	5,439
Vocational school	0.023	2,274
College	0.023	2,274
Health Facilities	**# of Beds Per Person**	**# of Beds Based on Population**
Community Health Center	0.002	198
Nursing home bed/person	0.002	198
Community hospital bed/person	0.02	1,978
Tertiary hospital bed/person	0.0033	326
Recreation	**Sq m Per Person**	**Sq m Based on Population**
Pocket Park, Neighborhood Park, Green Network	(Min) 0.6 (Max) 0.94	59,330 92,951
Commercial	**Sq m Per Person**	**Sq m Based on Population**
Neighborhood Retail, Sub-District, District, Destination	(Min) 0.7 (Max) 0.91	69,219 89,984

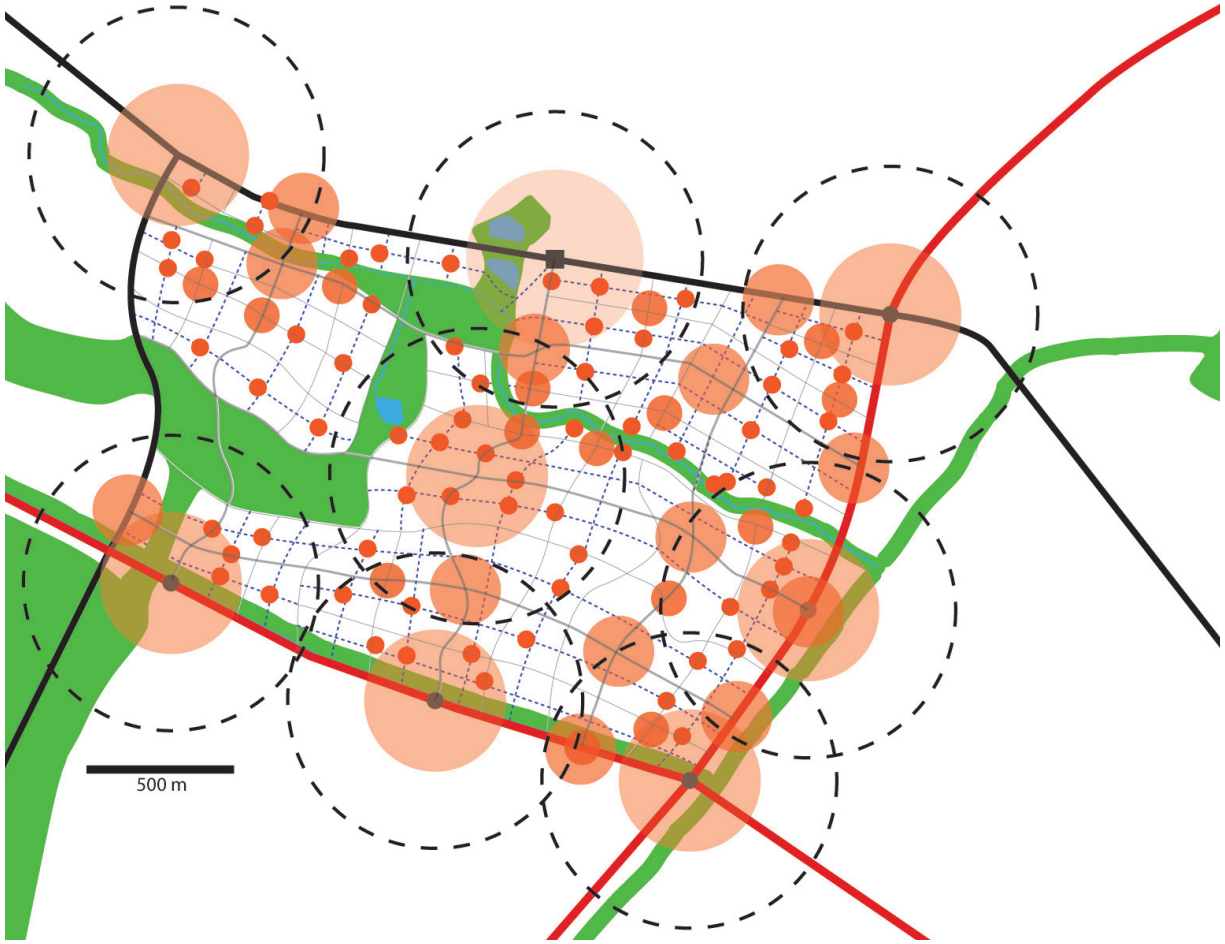
Level	Appropriate Node	Facility	Type	Lot Size (sqm)	Catchment Population	Number of Facilities: Focus Area	Number of Facilities: External Area	Total Number of Facilities
1	Pedestrian Road Intersection	Community Health Worker Kindergarten Pocket Park ~100 sqm Neighborhood retail	Healthcare Education Open Space Retail	N/A N/A 100 1,500	1,500 7,692 N/A 1,000	6 1 N/A 10	60 12 N/A 89	66 13 N/A 99
2	Local Road Intersection	Primary School Open Space Corridor / Green Boulevard Neighborhood Park Neighborhood Center	Education Open Space Open Space Retail	N/A M 500-800 5,680	18,750 N/A N/A 10,000	1 N/A N/A 1	5 N/A N/A 9	5 N/A N/A 10
3	Collector Road Intersection	Community Health Center Clinic Secondary School Specialty Retail (District Sub-Center)	Healthcare Healthcare Education Retail	N/A N/A N/A 14,200	20,000 20,000 65,455 40,000	0 0 0 0	4 4 1 2	5 5 2 2
4	Arterial Road Intersection	Nursing Home Community Hospital -200 beds Vocational School Destination Park Large Shopping Center	Healthcare Healthcare Education Open Space Retail	N/A N/A N/A 90,000 19,880	N/A 60,606 347,826 N/A 70,000	N/A 0 0 N/A 0	N/A 1 0 N/A 40,304	N/A 2 0 N/A 1
5	Transit Stop	Tertiary Hospital College	Healthcare Education	N/A N/A	121,212 347,826	0 0	1 0	1 0

SITE B PROPOSAL > COMMUNITY FACILITIES > Spatial Distribution

When considering where to place community facilities, access via different road types was taken heavily into account. We mapped different "nodes" based on the type of intersection formed by our road network. Larger road intersections create higher-level node types (for example, level 5), which are more appropriate for regional community facilities. Smaller road intersections created lower-level node types, which are more appropriate for local community facilities (for example, level 1).

The conceptual diagram to the right depicts different nodes based on road intersections. Different levels of community facilities can be located at the nodes, clustered or stand-alone (in the case of lower-level, more local community facilities, they are likely clustered). Refer to the table on the previous page for precise numbers of community facilities required for Site B's population.

This concept helped us determine the locations for education, healthcare, retail, and open space, which are discussed on the following page.



> Education

Facilities include kindergartens, primary schools, secondary schools, vocational schools and universities. In Site B, education will be of utmost importance because of its proximity to Shantou University.

> Healthcare

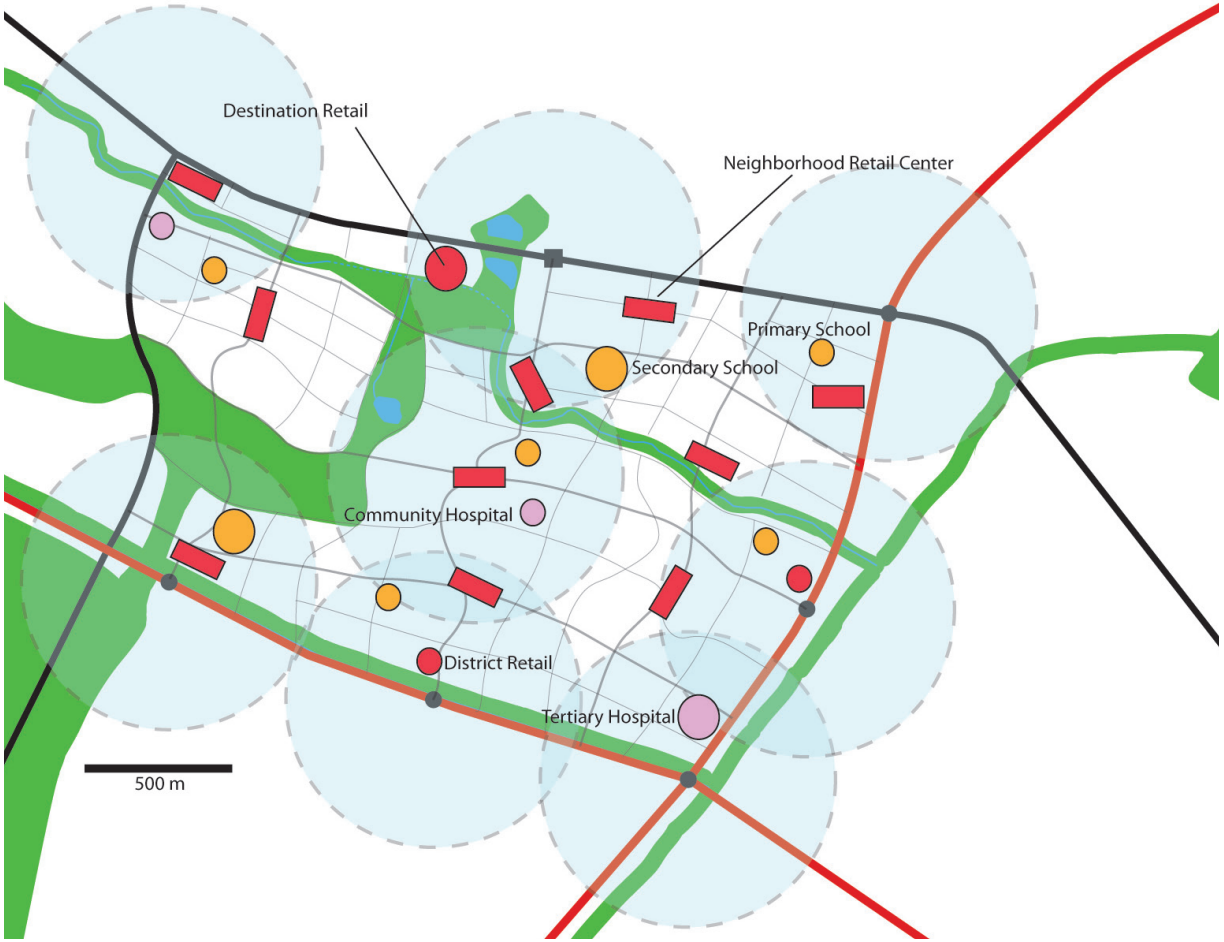
Facilities include community health workers, community health centers, clinics, nursing homes, and tertiary hospitals. On a local level, healthcare facilities should be accessible by residential populations and by public transportation. On higher levels, these facilities require a proximity to highways and major transit stops to allow for maximum accessibility.

> Retail

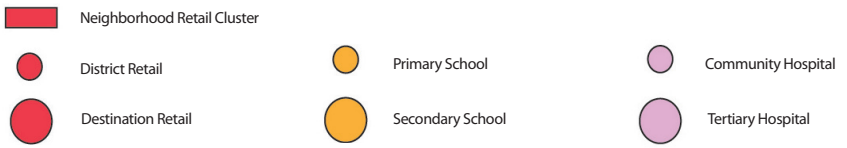
On a local level, there is neighborhood retail that serves a limited population and is located throughout Site B. As nodes encompass larger populations at higher district or regional levels, retail is concentrated around larger nodes that serve sub-districts, districts, and regions. Destination retail, for example, would serve the city and would be a draw for city and regional shoppers.

> Open Space

On a local level, pocket parks serve small populations while neighborhood parks and larger green networks serve much larger populations. Site B's open space network is integrated with a larger regional greenway that spans to the north and south. Smaller green spaces, such as pedestrian paths along the stream and larger neighborhood parks offer places for recreational as well as arts and cultural activities.



COMMUNITY FACILITY TYPES



Spatial Distribution of Community Facilities

The diagrams below show the spatial relationships between community facilities and various factors that impact location.

Neighborhood Retail Cluster
District Retail
Destination Retail
Primary School
Secondary School
Community Hospital
Tertiary Hospital

1) Circulation and Road Networks

Community facilities are highly accessible to major roads, public transportation and the interior bus shuttle circulator. Local community facilities will be located at more local nodes while regional facilities such as secondary schools are at more major centers of activity.

COMMUNITY FACILITIES + CIRCULATION

Shuttle Bus Routes and Stops

2) Housing

Community facilities are especially accessible to affordable units/buildings.

COMMUNITY FACILITIES + HOUSING

Inclusionary Housing
Affordable Buildings
Live-Work Lofts

3) Centers of Activity

Community facilities are accessible to major external and internal nodes, or centers of activity. These nodes are directly related to the road network and circulation.

COMMUNITY FACILITIES + CENTERS OF ACTIVITY

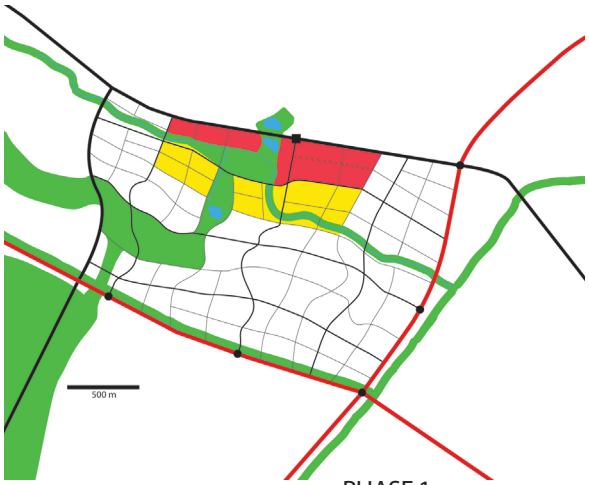
Level 3 through 5 Interior and Exterior Nodes
Level 4 and 5 Nodes, 500 m Radius

Examples of community facilities that align with our vision are presented to the right. These community facilities from Wonderland, Shenzhen, China encourage public interactions, recreation, and leading an active and social life.

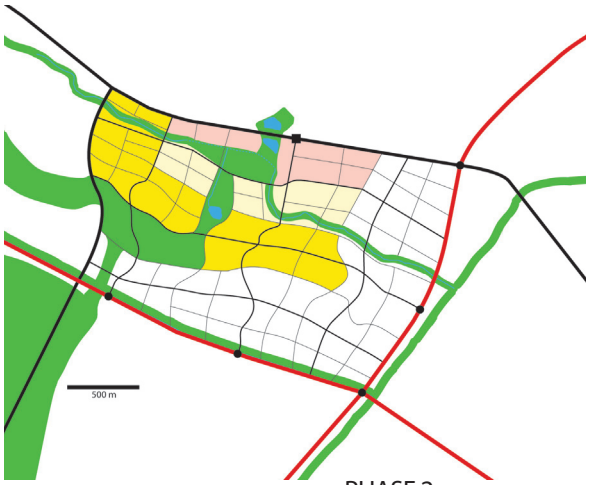
A pond we envision as one focus area for community facilities (Source: Tyler Corson-Rikert)

Examples of retail, open space, and a community center in Wonderland, Shenzhen, China (Source: Julie Chan)

SITE B PROPOSAL > PHASING



PHASE 1



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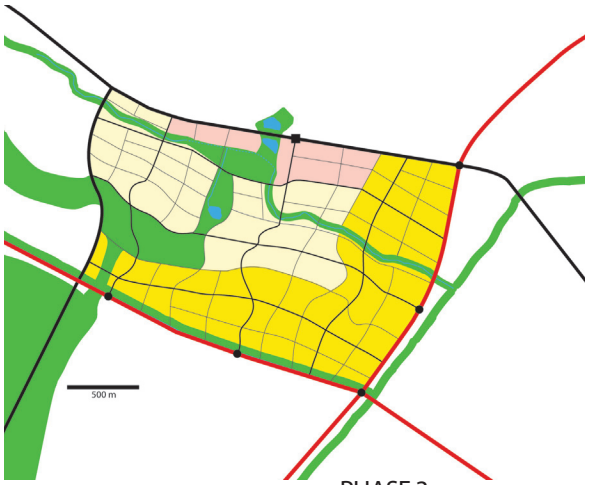


PHASE 3

Phase 1

Location:
Mixed use and some residential areas closest to Shantou University

Rationale:
1) Capitalize on proximity to light rail stop

2) Developments are mostly commercial in nature with a regional catchment and could potentially generate revenue to cover cost incurred to initiate development area

3) Establishes connection (physically and economically) with Shantou University

4) Residential area provides live-in population providing a ready workforce for the mixed use area and Shantou University

Phase 2

Location:
Residential areas in the northwest and center of the site

Rationale:
Higher income market rate housing could potentially cross-subsidize the more affordable housing near nodes

Phase 3

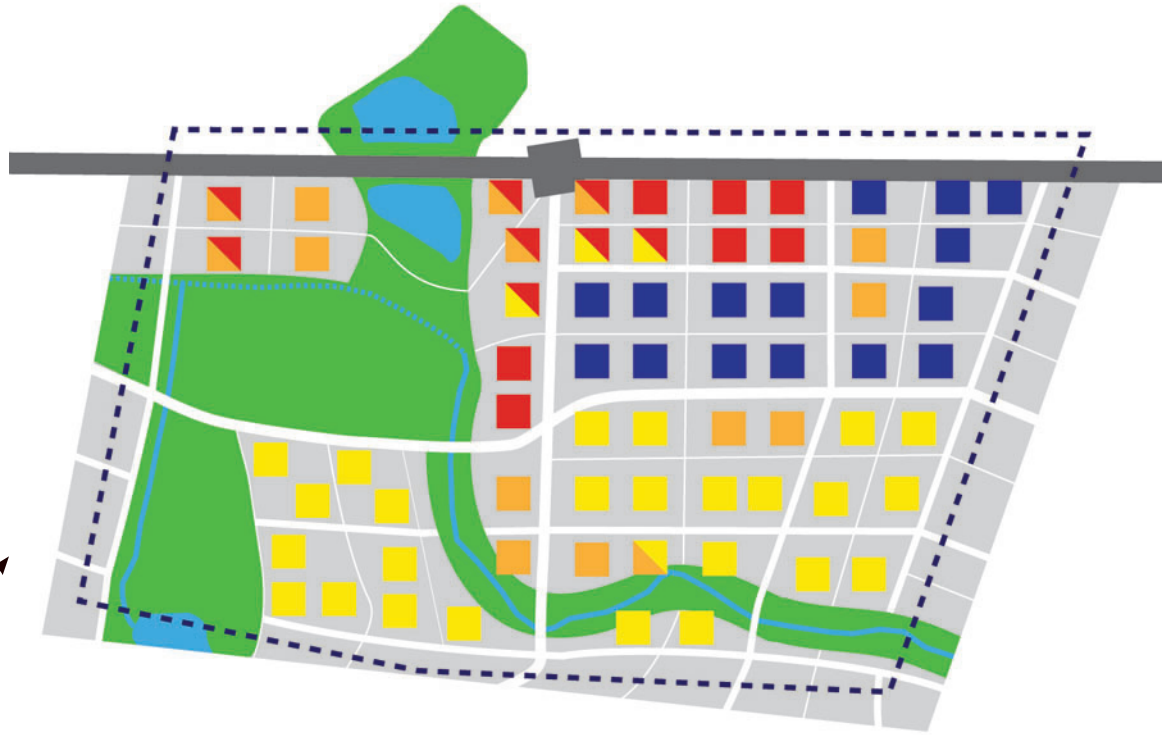
Location:
Residential areas in the south and east of the site

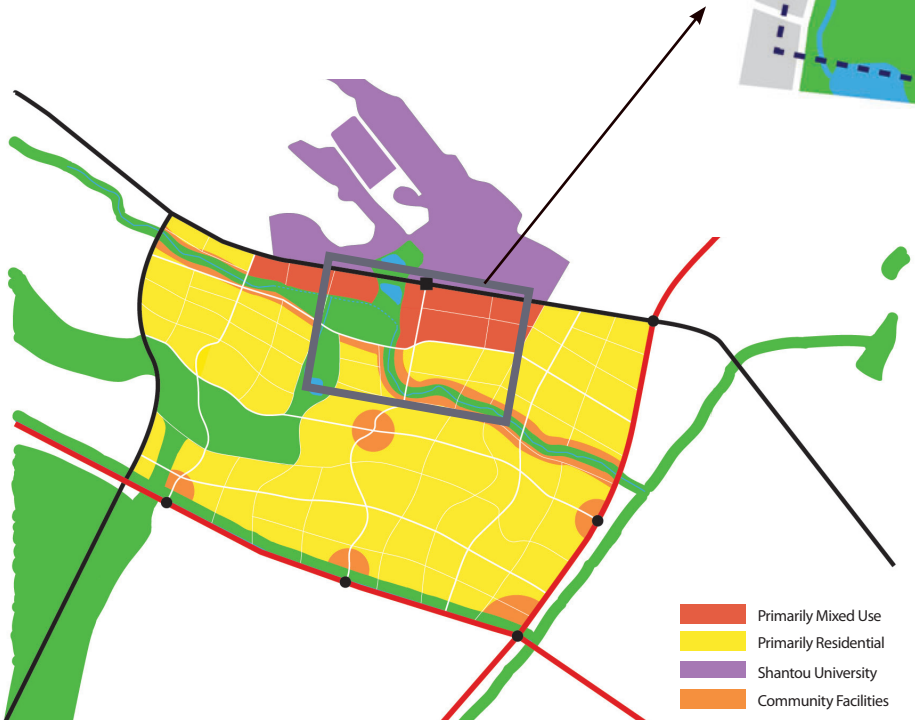
Rationale:
1) Residential area east of mixed use area is developed last to provide flexibility for any possible expansion of mixed use area pending demand for R&D space after launch of Phase 1 R&D space

2) Residential area to the south would be developed in tandem with development of BRT system which is likely to take place at a later stage

SITE B PROPOSAL > FOCUS AREA

The predominant land use proposal focuses on open space, mixed use, residential, and community facilities. To further illustrate our proposal, we present a diagram that shows an area of focus across from Shantou University. This area encompasses the light rail station as well as major elements of our land use proposal: mixed use, open space, residential and community facilities. The diagram illustrates how these diverse set of uses are thoroughly integrated in the site.





SITE B SUMMARY > A Vision for a Sustainable Community

OUR PROPOSAL ACHIEVES:

> Environmental Responsiveness

... BY maintaining ecological functions and creating green space connections and public spaces. Restored waterways and quarries, along with topographically sensitive design, will protect the natural assets that define the site and promote high quality environments for residents and visitors. Our proposal will open up a regional system of waterways, greenways, and agricultural land for mobility, recreation, and enjoyment by making key links. With a mixture of protected areas and public parks, this open space system will accommodate diverse uses ranging from leisurely walks to recreational sports and arts performances.

> A Knowledge Economy

... BY leveraging its unique location adjacent to Shantou University and a proposed light rail line to the new airport to create mixed-use research and development, retail, and entertainment activity in a new city hub. Complementing and building off the strengths of Shantou University and the talent and entrepreneurship of its students, our proposal will make space for research activities to expand, for private companies to locate nearby, and for graduating students to incubate new creative businesses.

> Diversity

... BY creating high quality and accessible residential options that accommodate a diverse, mixed-income population. From high-rise buildings in denser nodes and live-work artist housing, to high-end units in lower density areas, our proposal accommodates a range of housing preferences. Following best practices in the field, we propose incentivizing affordable housing within residential developments as well as providing community facilities throughout the site.

> Integration

... BY tying the design concept to multiple modes of transportation, from the proposed light rail station by Shantou University, to proposed limited access highways, to a new network of bicycle and pedestrian trails connecting green spaces throughout the area. Capitalizing on the site's location near the new airport and the center of the three-city region, our proposal will tie the university more closely with the growing economy of the city.

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[INDIVIDUAL TOOLS]

LIVE-WORK ARTIST HOUSING

ON-SITE WATER PURIFICATION SYSTEM

BUS RAPID TRANSIT (BRT)

INTEGRATED NATURE RESERVES

MICROSCOPIC TRAFFIC SIMULATION FOR MULTI-MODAL TRANSPORTATION PLANNING

University-RELATED Business Incubators

REGULATING FLOW OF WATERWAYS IN URBAN AREAS

INDUSTRY CLUSTERING

PCREATION OF A MARKET DISTRICT

PARTNERSHIP FOR AFFORDABLE HOUSING IN URBAN VILLAGE TRANSFORMATION

TRANSIT ORIENTED DEVLOPMENT

INTEGRATED SOLID WASTE MANAGEMENT

LIVE-WORK ARTIST HOUSING > Julie Chan

ArtSpace Hiawatha Lofts, Seattle, Washington
(Source: SMR Architects)

Introduction

Whether they work as painters, sculptors, photographers, or designers, creative artists add a level of vibrancy, visual interest, and vitality to cultural life in cities. They contribute to both community development and economic development by enriching the quality of urban life and paving the way for public and private investment. China, with its rapid development and industrialization over the past few decades, has an opportunity to leverage its growing creative economy and focus on cultivating artistic pursuits through the development of live-work housing.

In the 1960s and 1970s, pioneering artists sought out abandoned or deteriorating industrial buildings to convert into affordable live-work studio space in cities such as New York, Boston, Seattle, and Los Angeles. Their arrival helped to turn around marginal neighborhoods and jumpstarted the redevelopment of post-industrial cities. These cities built upon this movement by developing artist live-work housing, offering financial incentives, and encouraging arts cooperatives to revitalize former manufacturing and warehouse space. In turn, reductions in crime and improvements in quality of life caused these neighborhoods to become popular hubs of activity, drawing not only arts enthusiasts, arts related businesses, restaurants, residents and tourists, but also public and private investment. This chain of events has been witnessed in cities across the United States and is one method of leveraging the cachet of the artist millieu to generate economic activity.

With a limited supply of inexpensive live-work housing, this type of space is always in high demand. As a result, there has been a recent trend towards the conversion of historic buildings including former industrial buildings into live-work artist housing. Cities such as Boston, Seattle, and New York City in the United States, as well as Beijing in China, have used this method of adaptive reuse to preserve historic buildings and capitalize on creative talent.

Artists, however, are constantly facing the threat of displacement. Neighborhoods that were once neglected have become desirable places to live. As property values increase and wealthier residents move in, attracted by the newfound quality of life, it becomes financially unfeasible for artists to continue living there. Some of these cities have called upon public policy to ensure the long-term affordability of live-work units and some have designated specific "Arts Districts" using zoning codes to allow artists to flourish with less market pressure.

What is the Tool?

Developing artist live-work space with long-term affordability is one method of ensuring that artists have a physical space and continue to enrich communities with their art. These developments can come in many forms; they may be an adaptive reuse of old industrial buildings or brand new construction designed to meet specific needs; they can be developed as individual units or as part of an arts center. The overarching goal of the developments is to create a haven for artists to encourage creative pursuits of both individuals and the larger community. In general, successful artist live-work space:

> Accommodates artists with open, flexible, spacious live-work units
> Meets design, safety and ventilation requirements for artists
> Maintains long-term affordability through deed restrictions or leasing agreements to ensure that artists are not displaced
> Accommodates a diversity of artists and mediums
> Encourages interactivity among artists and community members to share in the creative experience

Often, live-work spaces will be part of an artist cooperative or arts center that includes shared spaces such as galleries, exhibition space, and multipurpose community rooms. Artist and business support services may also be provided, such as marketing assistance, educational workshops and seminars on grantwriting, presenting and selling art, and other topics that help artists promote their work. These services are usually provided in association with arts organizations whose mission is to stimulate artistic expression.

(L-R) Former warehouse in San Diego, California that is now live-work housing (Source: Jill Holslin); Live-work space (Source: Judd Foundation)

How does the tool apply and what is required to implement it?

In order to develop successful artist live-work space to ultimately create a more vibrant neighborhood, there needs to be physical, organizational, social, financial, and political support.

> Physical: Developing the Live-Work Space
Live-work housing often takes place in locations with existing historic or formerly industrial buildings. These buildings appeal to artists' aesthetic sensibilities because of their historic detail and large windows that ventilate the space and let in maximum amounts of light. In addition, they have the physical space in terms of size, layout, and ceiling heights to accommodate multiple large paintings, for example, and have the structural support to accommodate heavy metal or stone sculptures. In Shantou, repurposing previously developed land or buildings will be financially and politically easier to accomplish than building new construction on undeveloped land. In developing live-work space in Shantou, the city has an opportunity to celebrate its history with the adaptive reuse of historic village or industrial buildings for live-work use.

> Financial & Organizational: Accessing Funding & Incentives
In the United States, project financing is necessary to balance the cost of development against equity and revenues from rents or unit sales. Costs of converting a building or constructing one specifically for artists requires soft costs related to architectural and engineering services, environmental analyses, zoning code analysis, legal and marketing services, as well as hard costs related to construction. Sources of financing in the U.S. for live-work artist space

development and operations include government tax credits, tax exempt bond financing, low-interest loans, and grants.

To oversee the development process, an organization, usually a non-profit developer or government agency that may be working in partnership with a private developer and/or non-profit arts organization, is necessary to assemble an experienced development team to execute architecture and design, secure financing, and implement other components of the development process.

> Social: Supportive and Engaging Communities
Aside from providing quality, affordable space, cities with successful live-work spaces have other amenities that meet artists' needs. These include a social network of other artists and arts enthusiasts, availability of suppliers for arts materials and equipment, access to arts and community facilities for the display and sale of creative work, and access to continuing education and business support services. In addition, promoting arts as an important part of community life creates a supportive environment. This can be achieved through organized arts events, such as art walks, festivals, and conferences for the public.

> Political: Making Policies that Support Artists
Supportive policies and programs that cater to the needs of artists are important as well. For example, artists in New York City's SoHo neighborhood used to live illegally in vacant warehouses in the 1960s, since the areas were zoned for light industrial and manufacturing rather than for residential living. In 1971, a series of legal solutions resulted in SoHo's designation as the first mixed use zone for artist housing, thus paving the way for more flexible regulations about where live-work spaces could be located. The existence of programs that help artists focus on their craft and expose their work to larger audiences, such as Artists in Residence programs, university-related fellowships, and support grants, create an environment that is conducive to artistic creativity.



(L-R) Live-work housing in Boston and New York. (Source: Boston Arts Space Initiative, Cool Town Studios).

Why should this tool be used?

From an urban planning perspective, artist live-work spaces have a positive impact on community health, quality of life, and the local economy. Besides providing affordable space to a subset of the population that enriches community life, live-work spaces and arts communities provide additional public benefits. They:

> Reuse existing buildings as one form of sustainable development
> Serve as a buffer between industrial and residential zones
> Enliven less desirable spaces with positive activity
> Promote a uniquely talented group of artists, drawing in visitors and art buyers
> Catalyze public and private investment in a neighborhood

When should this tool be implemented?

This tool should be implemented when cities intend to revitalize former industrial zones and/or create new Arts Districts to attract visitors and investment. This tool occurs when cities are looking to stimulate the creative economy and improve the quality of life by attracting and retaining artists. The development of live-work housing is most effective when cities and their leaders recognize the importance of creative individuals and encourage the development of affordable live-work space as a means of creating culturally vibrant places.

DUMBO, a neighborhood of former industrial buildings, is now known for its live-work studios, galleries and special events,, like the DUMBO Arts Festival. (Source: New York Daily Photo)

Applying this Tool in Shantou

Shantou has the opportunity to take advantage of these methods and build upon Shantou University's strengths in arts and design, the young, talented population, and the Chinese government's support of expanding higher education in the arts. As Shantou becomes more connected to the rest of China and the world through the new airport, high speed rail, and public transportation routes, the city has an opportunity to celebrate its great architectural history, its long reputation as a center for crochetting and knitting, as well as its global arts and crafts manufacturing economy. These factors, combined with the presence of traditional village buildings around Site A and industrial buildings around Site B, make this tool well positioned to be applied in the near future.

Case Studies

> DUMBO, Brooklyn, New York, USA

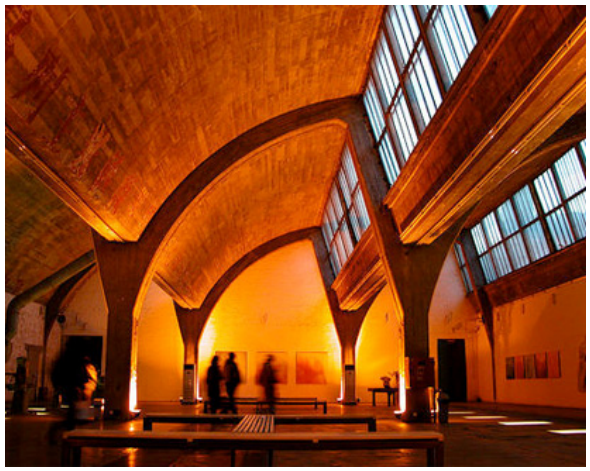
DUMBO, which stands for "Down Under the Manhattan Bridge Overpass" is a prime example of how pioneering artists in the 1970s looking for affordable live-work spaces helped transform a largely undesirable stretch of manufacturing warehouses near the waterfront into the premier arts district that it is known for today. In 1981, developer David Walentas sped this transformation with the purchase of 12 blocks, or 609,600 square meters, of industrial buildings, which he converted into live-work lofts, commercial and retail space. DUMBO is now known for a cluster of avant-garde art galleries, performance spaces, creative businesses, non-profit arts presenters, and restaurants.

> Boston Arts Space Initiative, Boston, Massachusetts, USA

Boston is leading the way in the creation of artists space through an innovative program called the Arts Space Initiative. Led by the Boston Redevelopment Authority (BRA) at the direction of Mayor Thomas M. Menino, the initiative aims to retain existing artists spaces and create new ones with an emphasis on permanently affordable live-work and work-only spaces. Following a survey done of artist needs, Boston modified its zoning to allow artist housing in areas zoned industrial in the form of zoning overlays. Since then, the BRA has created over 150 units, 131 of which are affordable. They also developed design guidelines for live-work space. This initiative was created out of an understanding that artists help make Boston a more livable city that is rich in cultural amenities.

> 798 Arts District, Beijing, China

The 798 Arts District transformed former industrial factories that produced military components into artist live-work housing in the Dashanzi area of northeastern Beijing. Started by the Central Academy of Fine Art, this popular district is known for its contemporary art galleries, studios, and cafes. It was named 798 because the numbers symbolized the country's cutting edge art movement led by the Chinese artistic vanguard. The district has around 300 artists in residence or represented in studios, and features a 3-week-long arts festival that attracts visitors from China and around the world. It is described as "an odd but harmonious combination of historical and artistic factors" where artists live and work in spaces that are in tune with both the past and present.



A former factory houses artist studios and galleries in Beijing's 798 Arts District. (Source: 798 Space)

> Da Fen Oil Painting Village, Shenzhen, China

This village has a unique talent for replicating oil paintings by world renowned masters. The first artist colony of its kind in China and quite possibly the world, the Da Fen Oil Painting Village mainly relies on producing original and imitation paintings that are sold at inexpensive prices. The success of the commercialization of this art has created an oil painting industry cluster in surrounding provinces with Da Fen at the center. Boasting over 622 galleries and over 5,000 artists, the Village was named in 2004 by the China Cultural Department as the country's "Cultural Industry Model".

Shenzhen's famous Da Fen Oil Painting Village is home to thousands of artists that make mostly imitation paintings of famous masterpieces. (Source: Da Fen Oil Painting Village)

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Water in Chinese cities

Currently, Chinese cities vary in the extent of their sewage collection and treatment systems. Some have complete systems treating most of the sewage generated, while others have incomplete systems that do not reach all areas and others do not do more than minimal sewage treatment before releasing it into waterways. Cities with incomplete systems and inadequate treatment clearly have very significant water quality issues. Yet, even the cities with the most developed sewage treatment systems have substantial water pollution due to nonpoint source pollution, inadequate enforcement of regulations, and other factors.

Chinese cities likewise vary in their management of storm water, with some quite adequately protected and others quite vulnerable. Existing approaches emphasize 'grey' or 'concrete' infrastructure to manage larger and larger volumes of stormwater. Outside of a few notable efforts, there has been little application of 'green' infrastructure approaches such as measures to retain and purify storm waters on site.

A polluted stream on Site B (Source: Tyler Corson-Rikert)

There is great potential for new solutions combining the functions of water quality improvement and stormwater management at the site level. Typical development projects in China do little to improve the quality of water passing through or to reduce flooding for areas downstream; in fact they add to the pollution and volume of runoff.

What is the tool?

This tool is a system to improve the quality of water as it flows over a site and also retain stormwater. The tool draws on insights from the Living Machine, the work of landscape architects such as Margie Ruddick, and best practices that have developed in the field of waste and storm water management. It demonstrates that utilizing wetlands and native plants, catchment basins, filtration, aeration, and velocity reduction, water quality can be improved while simultaneously reducing stormwater runoff. Implementation of this tool can also be a powerful educational tool to increase people's awareness of the hydrologic system, water quality, and stormwater issues and thus impact their behavior in positive directions.

What is the goal of using this tool?

This tool makes the assumption that Chinese cities will over time develop sewage and wastewater management systems reaching all developed areas and treating all waste, but that significant water management issues will remain. Polluted runoff, sewage leaks, and other factors will hurt water quality, while land use patterns and reduced storage capacity will make large rainstorms continue to cause flooding.

Wetlands plants at the Living Water Garden in Chengdu, China (Source: Keepers of the Waters)

The goal of this tool is to highlight the effectiveness of these natural treatment systems at cleaning water and their great utility within a larger project. One or even several of these installations would not be able to significantly alter the water quality of a larger area, but they can make a contribution, model the wider application of green infrastructure in stormwater mitigation, and educate urban residents about the value of clean water.

On what scale does the tool apply?

The tool can be implemented in the design and construction of a particular site, or as a piece of larger scale water quality and flood management strategy. While the cases here focus on site-level implementation, conceptually similar wetland treatment systems have been constructed to entirely replace conventional sewage treatment systems at neighborhood scales.

Who will use the tool and in what situations?

This tool applies in development or redevelopment projects where there is a goal to reduce negative impact or better yet create a positive impact on the surrounding natural environment. It is also useful in situations where the goal is to educate the public about water quality issues, and especially to show them that clean water is possible and wonderful. There must be significant surface water flow either originating on or passing through the site, and sufficient space available to install constructed wetlands and other features.

How do you measure the cost effectiveness?

The cost effectiveness of a natural water purification system depends greatly on how you run the numbers. They can be quite expensive to install. For example, the water park constructed for the 2010 World Expo in Shanghai cost 20 million yuan (nearly $3 million). However, the costs must be considered in light of other costs avoided. For example, a school district in Greensboro, North Carolina installed a Living Machine® wastewater treatment system specifically because it was cheaper than the cost of connecting to the distant municipal sewer system. It is also important to do a broad cost benefit analysis given natural treatment systems' extensive benefits, from water quality to the creation of green space and educational opportunities. For example, Chengdu has clearly reaped far wider benefits from the symbolic and education value of its Living Water Garden than it has from the relatively insignificant volumes of river water treated.

A key financial challenge that must be considered in the cost benefit analysis for such a system is maintenance. While advertised as relying on low-technology and natural organisms in place of expensive equipment and chemicals, these systems still include many key parts that are sensitive to breakdown over time. Pumps can break, flow management mechanisms can degrade over time, and noxious chemicals and metals can collect. Therefore when an entity evaluates whether to build a natural treatment system it must consider how much it will cost to maintain over time both in improvements and in the expertise necesary to maintain it.

What are possible implementation obstacles?

Possible implementation obstacles for this tool include issues of technology and maintenance. Some water cleansing systems, such as the Living Machines, require much specialized knowledge and experience to implement, and would require continued maintenance over time. Even if it is practical to engineer and construct them in the initial phase of a project, it may be too costly to maintain them over time. Those technologies that have been developed in North American contexts may also require adjustments to adapt them to the climates of various regions in China, where monsoon rains may strain their capacity. There is also a key question of scale and impact. These systems are often fairly small, so either the goals for their impact should be limited or they must be replicated throughout the area to bring about overall improvement in water quality.

What are the best practices?

The case studies on the following pages highlight a number of the most prominent applications of natural water purification systems, describe their basic functions and their purposes within these diverse contexts.

The site of the Living Water Garden in Chengdu, China where polluted river waters are drawn to the level of the park and cleaned while passing through water cleansing features on the site before reaching a space where park visitors can enjoy the naturally-transformed water (Source: Expo 2010 Shanghai China)

CASE STUDY > Living Water Garden, Chengdu, China

The Living Water Garden is a park and water cleaning exhibit in Chengdu, China. Located along a polluted river, the park utilizes a water wheel to lift part of the river's larger flow up to the level of the bankside park where the water flows through a natural treatment system to produce, at the end, water clean enough for human contact. There children play amid fountains, a vivid illustration of the possibilities for water quality in the city. The park thus cleans a portion of the river water passing by the site and creates a public space that simultaneously educates the public about the value – and possibility – of water quality.

The Living Water Garden cleans the river water by running it through flow forms that aerate the water, constructed wetlands with water-cleaning plant species, sand and gravel filters, and ponds with fish. Many of these water-cleansing feature are sculptural and interactive as well as functional, encouraging parkgoers to meditate on the aesthetics of water and its significance in their lives. For example, the whole park is shaped like a fish to evoke their symbolic meaning in Chinese traditional culture, and in one portion of the park a sculpture provides the means for aerating the water, through a stepped series of pools.

The park was designed by the American environmental artist Betsy Damon and landscape architect Margie Ruddick and opened in 1998.

Constructed wetlands in the Living Water Garden
(Source: Keepers of the Waters)

Children playing in the clean waters produced by the garden
(Source: Keepers of the Waters)

CASE STUDY > Chengdu City's Water Park at the Shanghai 2010 World Expo

Building off the success of its own Living Water Garden, the city of Chengdu has built a water park in the Urban Best Practices Area of the 2010 World Expo in Shanghai. The park is designed to purify up to 30 m^3 of stormwater a day, or in dry weather the same volume of water pumped from the Huangpu River. Rain water first collects in a 200 m^3 storage and sedimentation tank underground, then is pumped to the top of a series of 16 terraces planted with water-cleansing plants. Where the water emerges visitors can interact with it in its pure state.

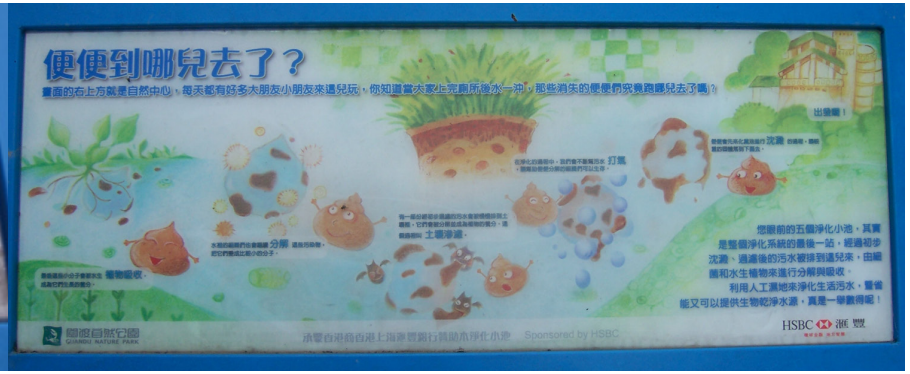
> Area: 2,680 square meters
> Cost: 20 million yuan (US$2.92 million)
> Water Purification Capacity: 30 m^3/day

EXPO 2010
SHANGHAI CHINA

Source: Shanghai Expo 2010

The Guandu Nature Park in Taipei is a park and education center along the interface between an urbanized area of northern Taipei and a large nature preserve running along the shore of the Danshui River estuary. Featuring a small nature museum and bird observation room, the park stands out for its exhibition of low-tech water cleaning technologies like bioswales, aeration, natural filtration, detention basins and existing wetlands. As water passes through the site from the urban neighborhoods uphill, these water cleaning structures and techniques substantially increase the water quality. At the location of each water cleaning feature, educational signs describe the function and efficiency of each technology, as well as the larger scope of non-point source pollution issues in Taipei. Other exhibits, such as those pictured at right ("What causes the indigestion of Old Gui Zi Creekf?" and "Where did the poop go?"), educate children about the most basic problems of water quality. The park makes a clear statement to park visitors about the importance of clean water, as they read related exhibits about wetland health and observe the large numbers of migratory birds stopping over at the preserve.

A waterway in the Guandu water cleaning system (above), and educational signs for children (below) (Source: Tyler Corson-Rikert and Andrew Heist)



The Hybrid Wetland Living Machine®, Guilford County Schools, Greensboro, North Carolina, USA

The Living Machine®
on the grounds of the
Guilford County Schools
(Source: Living Machine®)

Students learning about
wetland plants within the
Living Machine®
(Source: Living Machine®)

Living Machine is an idea developed by Worrell Water Technologies and implemented in numerous projects in the US and internationally. These systems take waste water and through careful control of water flow, settling tanks, wetlands, and disinfection prepare it to be reused on site.

The Hybrid Wetland Living Machine is a system developed by the company and implemented on the site of a new high school and middle school in Greensboro, North Carolina. Building this natural wastewater treatment system allowed the school district to avoid the $5 million cost of connecting to the nearest point on the municipal sewage collection system. In this innovative alternative the schools' wastewater passes through wetlands to purify it for reuse in iriri-gation or return to the groundwater systtem.

The Hybrid Wetland Living Machine works by running wastewater through underground sedimentation tanks and a then through a horizontal subsurface flow wetland. Next it enters tidal flow cells, which are pumped full and released multiple times a day to promote more rapid biological treatment. As a final stage the water is exposed to ultraviolet light and placed in a tank for reuse.

As an additional benefit, the Living Machine provides an opportunity for the school to teach students about water quality issues, chemistry and environmental science, and environmental engineering.

> Treats up to 30,600 gallons of wastewater/day
> Saved the school district $4.5 million it would have had to spend connecting to sewer lines
> Produces 5 million gallons of water each year for reuse at the site

What research already exists and what further research is needed?

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Further Research Needed

Key areas for future research include gaining a better understanding of the maintenance costs involved in keeping one of these natural treatment systems functional in the long term; investigating methods less complicated than the Living Machine that can be applied in settings like smaller Chinese cities where maintenance costs and the cost of locating expertise to build and maintain systems is too high. Certainly their potential in Chinese context at both site and larger scales is not well understood despite the highly visible success of the Chengdu park and its successor at the Shanghai 2010 World Expo. Such systems could become significant components of a wider strategies to address persistent issues of water pollution and stormwater runoff.

Source: Ecographica

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What is Bus Rapid Transit?

Bus Rapid Transit (BRT) is a high-quality bus-based rapid transit system that delivers fast, comfortable and cost effective urban mobility through the provision of segregated right-of-way infrastructure, rapid, frequent, and reliable operations, and excellence in marketing and customer service. The BRT concept was initially developed as a low-cost, high-performance alternative to rail-based rapid transit systems for cash-strapped developing world cities with significant congestion and/or demand for greater mobility.

According to the *Bus Rapid Transit Planning Guide,* published by the Institute for Transportation Development & Policy (ITDP 2007), modern BRT systems typically cost 4 to 20 times less than a tramway or Light-Rail (LRT) system and are 10 to 100 times less expensive than above- and below-ground metro systems.

Like rail-based transit solutions, BRT ridership is a function of the land use activities in the immediate vicinity of the transit corridor or system. According to Robert Cervero at University of California, Berkeley (Cervero 1998), light-rail systems (LRT) such as the METRO system in Phoenix, Arizona, can typically handle a maximum of 11,000 passengers per direction per hour (p/h/d) while heavy rail systems like Dubai's metro max out around 22,000 p/h/d.

Well-designed BRT systems in corridors with high demand can carry the same number of passengers, if not more, than rail-based solutions. As of 2007, *Interligado* in Sao Paolo, Brazil carried 20,000 p/h/d, *Transantiago* in Santiago, Chile carried 22,000 p/h/d, and Bógota's *TransMilenio* carried an astounding 45,000 p/h/d (Hidalgo et al 2007). In the Chinese context, Guangzhou's new BRT system, which opened in early 2010 is already carrying more than 25,000 p/h/d (Gunter 2010).

Where can Bus Rapid Transit be Used?

BRT systems of different types have been implemented on six continents. To date, there are more than 100 BRT systems of different styles and sizes in operation and/or under construction around the world. In China alone, there are eight cities with at least one line in operation and at least seven more cities with BRT systems planned and/or under construction.

Most BRT systems are mostly found in major, low-income cities in the developing world. They can be found as stand-alone mass transit networks in cities like Bógota, Colombia and Jakarta, Indonesia as well as compliments to existing metro systems in places like Mexico DF, Mexico, and Guangzhou, China. Existing systems serve populations ranging in size from only a few hundred thousand to more than 10 million.

At the local level BRT systems work well in corridors with high population densities, high levels of congestion and intense, diverse land uses.

Why should Bus Rapid Transit be Used?

There are several key reasons why BRT makes sense for many cities. The following are just a few of the major concerns for cities, regions, and consumers of public transport.

Gangding BRT Station, Guangzhou, China, Photo Courtesy of Duan Xiaomei (GMEDRI)

Low Capital Costs

BRT systems require significantly less capital investment than LRT systems and full-fledged metros. A recent survey of twelve major BRT systems (Hidalgo et al 2007) indicated that capital costs ranged between USD $1.35 million per kilometer and USD $8.2 million per kilometer. More expensive systems typically included significant construction costs, land acquisition costs and/or highly specialized buses. For example, when the corridors for the Bógota's *TransMilenio* system were under construction, hundreds of kilometers of sidewalks and bike paths were created, as

TransMilenio dual carriageway, Bógota, Colombia. Photo Courtesy of Karl Fjellstrom (ITDP)

well as many hectares of new urban green space, all adding to the overall project cost. Indeed, Hidalgo et al (2007) found that the cost of building *TransMilenio* (on a per kilometer basis) was 40% higher than the next most expensive system.

Looking at two recently completed rail-based systems provides a striking illustration of the cost savings realized by BRT deployment. The recently completed (December 2008) LRT line completed in Phoenix, Arizona cost USD 43.75 million per kilometer. In terms of recently completed metro (heavy rail) lines, Dubai's new Red Line, which opened in September 2009, cost approximately USD $138.46 million per kilometer.

The Chinese experience is no different. China's newest BRT system is in the city of Guangzhou. The Guangzhou BRT, which opened in February 2010, cost approximately 30 million RMB (USD $4.39 million) per kilometer to build, more than ten times less expensive (per kilometer) than Guangzhou's existing metro system. To put it differently, the entire 23km long Guangzhou BRT system was constructed for the same cost as 1.5km of the Guangzhou metro (Guangzhou BRT 2010).

High Capacity / Low Impact

As mentioned in the first section, BRT systems can be designed to carry as many, if not more passengers than rail-based systems. Higher capacity systems such as *Interlidago* in Sao Paolo and *Transmilenio* in Bógota feature dual carriageways, meaning they have two lanes in which buses may travel. This allows buses to leapfrog one another if stopping at different stations, allowing higher travel speeds and shorter headways. Most systems, however, are single carriageway, such as *Transjakarta* in Jakarta, Indonesia. In either case, it is much more economically feasible to take away lanes from existing automobile traffic and add dedicated bus lanes than it is to provide for fixed guideway (rail) solutions.

Level of Service

On the consumer side, BRT systems can offer high levels of service and amenity, comparable or exceeding rail-based systems. BRT systems are preferred to traditional bus services where demand dictates as BRT systems are able to run in a safer, more reliable and more efficient manner because they operate in segregated corridors rather than in mixed traffic. At the same time, BRT has the potential to offer signifi-

Transjakarta single carriageway, Jakarta, Indonesia. Photo Courtesy of Karl Fjellstrom (ITDP)

cant time savings for commuters who travel long distances. When *Transjakarta's* first three lines opened in 2004, travel time in one corridor was reduced from 90 minutes to 45 minutes (Sutomo 2006). Similar results are achieved in many other BRT systems around the world.

Short Development Cycle

Time is a major consideration. According to ITDP's BRT Planning Guide (2007), most BRT systems can be planned in 12-18 months with upfront planning costs ranging from USD $1-3 million. Metro systems on the other hand, often take a decade or more to proceed from initial concept to operation, costing tens of milliions of dollars (USD) in the process. For example, the Phoenix LRT system has been in the

planning stages since the 1990s. In Dubai, it took 4.5 years for the system to be operational once contracts had been signed, let alone prior considerations for conceptual planning and bidding for contracts. A short development cycle makes BRT very attractive to local politicians looking to maximize impact and make their mark during a short tenure in office.

Environmental Concerns

Overall energy consumption and GHG emissions can be reduced through well-implemented BRT systems. A recent study (Wang & Cui 2009) found that the total carbon footprint of Xiamen's BRT system was 55,927 tonnes of CO2 equivalent (tCO2e) per year. Direct emissions from fuel consumption totaled 13,059 tCO2e per year. Comparing these direct emissions to a no-build scenario, the authors suggest that BRT reduces emissions by about 25,000 tCO2e per year (meaning that emissions in the corridor prior to construction were roughly 38,000 tCO2e.

A study from Dublin, Ireland (McDonnell et al 2008) indicates that in one transport corridor, the introduction of BRT could reduce CO2 emissions by 50% and provide economic benefits in excess of USD $1 million. Similarly, ITDP has determined that more than 20% of *Transjakarta* users have given up their automobile in favor of BRT, reducing CO2 emissions by approximately 20,000 tonnes per year.

Economic Concerns

Many BRT systems are prime targets for private involvement. In some cases, such as *Metrobus* in Mexico City, public-private partnerships have been leveraged so that financial risk is shared between multiple stakeholders rather than being a purely public burden.

Much like rail-based transit, BRT systems, can be used to spur economic development by increasing land value and encourage density and increased land use mix (Ardila-Gomez 2008). In Bógota, Ardila-Gomez found that real estate prices in areas near select stations increased by some 30-35% between 2003 and 2005. In addition to rising property and housing prices, there is some initial evidence to suggest that densification around BRT stations may be occurring, including the development of large commercial centres. In 2000, roughly 4% of buildings in station areas were taller that five stories while by 2005, 8.8% were taller. In addition the number of housing units increased during this period by about 12% and the number of retail units increased by more than 27%. In a study of Seoul, Korea's BRT system, Cervero and Kang (2009) find that residential land value increases by 5-10% for properties within 300 meters of a station or stop. Commercial property values increase by 3-26%, but only when the properties are within 150 meters of a station. These findings are consistent with other studies that evaluate the impact of rail systems on land values.

In some cities like Leon (Mexico) and Santiago, planners have taken advantage of this phenomenon by partnering with the private sector to encourage station-area development. Private developers typically receive a concession to build a transit station which residential, retail, and commercial space into the design (or in the immediate surroundings). Depending on the terms of the concession, revenue from the sale and lease of space may be shared between the developer and the government, or the developer keeps all revenue but turns the station over to the government at the end of the concession period.

Cyclists in Bógota, Colombia. Photo Courtesy of http://www.partidoverde.org.co

What lessons have be learned so far?

Several key lessons have been learned since BRT was first introduced in 1970s. Two of the most important are listed below.

BRT can be used to promote Non-Motorized Transport (NMT) and modal shift

In Bógota, the development of *Transmilenio* , coincided with implementing a program named "Cyclovia" that called for the construction of more than 300km of separated bikeways and a significant amount of public green space. Commuters embraced the bicycle almost immediately; its mode share jumped

Elevated BRT system in Xiamen, China. Photo Courtesy of Karl Fjellstrom (ITDP)

MBTA Silver Line articulated bus running in mixed traffic, Boston, MA. Photo from Flickr.

from 0.4% to 3% over just a few short years. More importantly, the tandem investments in BRT and NMT had a significant positive impact on the city's mode share. Public transport's mode share increased from 64% in 1999 to 70% in 2005. At the same time, the non-motorized (cycling, walking) share increased from 8% to 15%, with private motor vehicle trips falling from 18% to 11%. Furthermore, an estimated 10% (2003) of *Transmilenio* riders gave up driving their cars to work in favor of the bus.

BRT systems must be completely segregated to maximize efficiency

One key predictor of success in BRT implementation is whether or not the system is completely separated from other traffic. Many successful BRT systems (e.g. *Transmilenio* and *RIT* in Curitiba, Brazil) are built at grade in the median of large arterial roads or even expressways. Other systems, such as Xiamen's BRT network, are largely built above grade when median bus lanes are not feasible.

When BRT systems are not segregated from normal traffic, many of the efficiency gains are lost and the level of service deteriorates. One example of a system operating in mixed traffic is MBTA's (Boston) Silver Line. While parts of the line do operate in bus-only tunnel, most of the system operates in mixed traffic where the level of service is no higher than regular bus service.

Unfortunately, cities do not necessarily learn from past mistakes. In 1975, an elevated BRT system was proposed for Bangkok (GTZ 1975). This study proposed an elevated busway network that could be converted to a rail system as demand warranted. This was a cutting edge idea, considering that BRT itself had only been introduced in Curitiba in 1974. Unfortunately, as of 2010, Bangkok has only constructed one BRT line. When this line will open in May, buses will operate in segregated lanes but be forced to stop at three major intersections, as they will not have signal priority. Wait times at these intersections can be 2-3 minutes long during peak periods, significantly reducing average vehicle speeds and increasing travel times for users.

What are the disadvantages to BRT?

One of the major disadvantages to this tool is its lack of glamour; trains are sexy, buses are not. In many places, especially in higher-income cities, the general public perceives buses as being dirty, unsafe and primarily for poor people. Since politicians typically wield control over purse strings and trains usually get votes, rail-based solutions are often pursued with great vigor even when they are much more expensive. This is true in places like Phoenix, Quito, Bangkok, and Delhi. Because politicians typically have short-term return on investments on their mind, simply announcing plans to study the feasibility of a train system can be more powerful than fully designing and implementing a BRT system

Other disadvantages may include (Hidalgo et al 2007):

- A lack of funding for initial planning (and lack of funding further down the line towards implementation)
- A lack of local expertise and conceptual knowledge of BRT
- Political interference that sets fares too low for adequate financial planning
- Necessary changes in regulations, definition of authority and even the creation of new authorities to plan, develop, and control projects
- Difficulty in organizing / including private operators (there is often strong opposition from private operators)
- It can be difficult to integrate with existing public transport network

What are the disadvantages to BRT?

Top-performing BRT systems and urban rail networks currently share a number of key characteristics. Several are listed below and are separated into broad categories for ease of assimilation.

Political Will

As previously mentioned, politics plays an important role in the development of any mass transit system. If the head of the municipality is not 100% behind the project, there is little chance that it will get built. Even when mayors and other influential politicians are supporting projects, success is far from guaranteed. Two of the world's most recognizable BRT systems would likely not exist without strong mayoral backing.

Jaime Lerner, former mayor of Sao Paolo Brazil and driving force behind the world's first BRT system. Photo Courtesy of http://www.biosferatv.com.br

Jaime Lerner (pictured above), a trained architect and then-mayor of Curitiba, Brazil opened the *Rede Integrada de Transporte*. Without his influence and guidance, the RIT project, credited as the world's first BRT system, may never have come to fruition. Similarly, the success of *TransMilenio* in Bógota, Colombia, is largely a result of the strong support and influence exerted by former mayor Enrique Penalosa.

Existing Conditions

- High bus ridership or medium-high population densities in proposed corridors
- Combination of financial, legal, and environmental aspects of planning with the engineering process
- Available / recurring pavement / infrastructure finance
- Coordinated land use planning helps a great deal

System Design

- Stations with prepayment and level boarding (reduces dwell time and increases accessibility)
- Segregated busways (buses operate in their own right of way, free of other traffic)
- Large buses with multiple doors (to reduce dwell time)
- Centralized control (headways, etc can be easily managed via GPS, communication with and between drivers is much more efficient)
- Distinctive Image (special marketing efforts are undertaken, similar to rail systems, to encourage ridership)
- Well coordinated feeder systems

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What is this tool?

This tool is a "park" or reserve within city limits which is integrated with the fabric and ethos of the host city's life in a structured and sustainable way. Rapid urbanization in many parts of the developing world has sometimes come at the cost of a certain quality of life for its inhabitants. The pace and scale of urbanization means that rural populations often make a very sudden transition to urban life and its attendant isolation from nature. Conversely, for children who grow up in cities all their lives, opportunities for meaningful interaction with nature are fewer and require concerted effort; the larger and more consuming our cities the less nature becomes a part of our frame of reference and notion of reality.

While many cities – New York, London – have a park within their city limits, I envision a larger scale natural reserve located at the current periphery of Shantou city with access points from central locations. As the limits of the city grow, this park would become more central. Cities such as Mumbai (see Figure 1) have been able to maintain natural reserves amidst a burgeoning city without drastically impacting the natural flora and fauna of the reserve. However, what is missing is a program for sustained and dynamic interaction between different groups of city inhabitants (schools, colleges, business etc) and the reserve. Especially in developing countries, where governments may sometimes have more pressing demands for their funding, facilitating such interaction and investing in the basic park infrastructure takes a backseat to other projects. This tool outlines the important rationales for such a project, guidelines for sustained interaction, and a financially viable model for maintaining such an integrated urban natural reserve.

Guidelines for Interaction, by Enabling Rationale:

I. Academic: The reserve will have a botanical garden, greenhouse and plant research center which can be used by school departments to enhance student's coursework and allow them a practical component to their studies. There will also be smaller patches of agricultural land for student projects and community gardening.

II. Recreational/Extra-Curricular: For schools, corporates and government institutions alike this venue is ideal to hold events such as picnics, treks, hikes conducted in a non-disruptive way.

The reserve will be divided into sections – with areas for agriculture and research as above, open spaces and clearings for small events and facilities for rappelling and other activities. However most of the park will be a natural reserve where nature is allowed to flourish relatively untouched. It is hoped that to the extent that is possible, animals would be able to roam freely in the area. There will be nature trails for groups to observe this part of the park.

III. Health and Wellness: The reserve will also have a small center for research, growing and production of natural Chinese herbs and remedies.

IV. Leadership/Personal Development: The reserve will also offer small meeting facilities and cottages where clients can hold leadership or other retreats. For instance, schools might organize overnight camps for students interested in hiking, nature trails, camping etc., while offices or other organizations might use this facility to hold retreats.

Who will use this tool?

Based on these uses, the target clientele for the reserve will be as follows. The idea is to open up the park to a smaller group initially to test the systems in place, and then gradually extend the client base and further tailor the activities.

I. Schools: Initially, the focus will be elementary and middle schools and later high schools and colleges if there is sufficient interest.

II. Corporates: Larger Chinese or multinational companies that locate in the Shantou area will be potential clients for use of the reserve. In time, this facility could be extended to smaller companies. Subscription (see below) will be staggered to suit different budgets and scale of use.

III. Government Institutions: Different government departments will be encouraged to make use of the facilities for department retreats, day-time events or even research purposes.

IV. Other: Initially, private members and subscriptions will not be allowed, but this avenue can be developed further as the park systems fall in place. This is also because group subscriptions are a more reliable and predictable source of revenue and this is important at early stages for budgeting purposes.

Funding Model

A. Initial Funding

The initial funding and land purchase/acquistion would come from the Shantou City Government. As detailed below it is expected that withing 3-4 years the reserve should recover the initial costs and become self-financing. The initial investment could be in the form of a loan with a 5-10 year repayment term.

B. Continued Financing Sources of Revenue:

I. Subscription Model: In order to generate a sense of ownership and investment and also to provide a dependable source of income, institutions wishing to engage with the park would pay a yearly subscription fee to gain access. This fee structure would be staggered based on the facilities that the institution wishes to avail of and the level and frequency of interaction. A subscription model allows the reserve's management to plan better for the future and ensure efficient allocation of their resources.

II. Farmer's Markets/Sales of Produce: Another source of revenue would be from the sale of products from the reserve. As currently envisioned these would include

a) Fruits & Vegetables: These will be grown on patches of agricultural land within the reserve and tended to by the park management with the assistance of specially set up programs through schools and colleges. The produce will be sold in farmer's markets in the city.

b) Traditional Chinese Herbs and Medication: There are already numerous Chinese natural medicine stores scattered through the city. The reserve will either serve as a source for fresh local ingredients or through its own processing center (which would hire local labour) produce medication and other treatment products for sale in the city.

III. Donors: Over the years the reserve will become integral to the character and ethos of the city impacting local residents lives through numerous channels – both direct interaction and the positive externalities of green space within the city. It is hoped that the Corporate Social Responsibility departments of corporates or other donors would be forthcoming to finance further investment in the reserve.

IV. National Government: There are numerous initiatives at the national level concerned with preserving biodiversity, encouraging conservation and mapping China's natural resources tat might have an interest in funding some aspect of the reserve under their programs.

a) EU-China Biodiversity Program: The €51 million EU-China Biodiversity Programme (ECBP) is a joint initiative between the European Union (EU), the Chinese Ministry of the Commerce (MOFCOM), the United Nation Development Programme and the Ministry of Environmental Protection of People's Republic of China (MEP). The programme started in 2005 and will continue until September 2011. It aims to conserve ecosystems in China by strengthening biodiversity management and helps develop the capacity of MEP, as China's secretariat to implement the Convention on Biological Diversity.

b) Hong Kong University Biodiversity Initiative: In 1998, HKU launched a major initiative to halt the decline of biodiversity in Southern China. The coastal tropical forests of South China in the provinces of Guangdong, Guangxi and Hainan are amongst the richest but also the most degraded biomes in the country. In recent decades many have kept aside as forest reserves but there is such little information on current species inventory etc that it is hard to manage these properly. In light of this problem, HKU began creating a species inventory. This builds on work being done by the Chinese Forestry Department to organize the National Terrestrial Wildlife Resources Survey while members of the Biodiversity Working Group (from the China Council of International Cooperation on Environment and Development) have set up a database of existing records of plant and vertebrate species.

Location Choice

Shantou already has a small reserve the Shantou Phoenix Mountain Nature Reserve (Fenghuangshan Ziran Baohuqu) which lies to the north of the city and is already accessible by road and some public transport. Since the city's growth is constrained by the South China that lies to the south, it is most likely that the city will extend northwards. The mountain area has a river and some dense forestation which makes it less conducive to building; given its elevation and thus partial separation from the city this would be an ideal location to begin the reserve.

Institutional Structure

The Shantou City Government will create the Shantou Reserve Committee which, along with its subcommittees below would assume ownership and management of the reserve. Thus the Shantou Reserve Committee will be housed within city government.

Shantou City Government

Shantou Reserve Committee

Client Relations | Park Management | Accounts Office | Research/Natural Sciences Team

Where does this tool apply?
What is required to make it work?

This tool applies in any small, medium or large size city with adequate natural resources in the surrounding area to create a natural reserve if one doesn't exist already. More importantly, the city should have a responsive, efficient and reliable city government who would acquire the land through transparent means and hand over responsibilities and collection of revenue to a governing board set up the manage the reserve. Given rapidly increasing land values in the context of rapid urbanization this political will and enforcement is critical. In China where there is no private ownership of land, this might be slightly less problematic. Interest from environmental groups or other civil society organizations would go a long way in engendering the continued success of such a program. A strong scientific establishment (or the potential and interest to build one) would be important to further academic and research activities in the reserve. Sufficient funding, either from the city government, or from state or national bodies, would also be helpful given the high up-front cost of setting up such a reserve.

Why should this tool be used?

- By creating a sense of ownership for the surrounding area and natural environment the tool helps ensure preservation of the natural habitat and encourages research in this area.
- It enhances the lives of residents by introducing an important missing component in urban life – meaningful and frequent engagement with nature beyond one-time scattered trips.

Case Studies:

The Dorset Trust for Nature Conservation, Dorset, UK

The Dorset Wildlife Trust is a wildlife trust covering the county of Dorset, United Kingdom. The Trust was originally founded in 1961 to protect and conserve the wildlife and natural habitats of the county and runs 42 nature reserves totalling over 12 square kilometres, which include 23 sites of special scientific interest. While most are owned by the trust, others are leased through agreements with landowners. The Trust currently also has six wildlife education and outreach centers around Dorset and is also involved in improving the habitats for wildlife in urban, and suburban areas. This model could be an extension of the role that the Shantou Reserve plays in the community.

Shaw Nature Reserve, St. Louis, Missouri, USA

The Shaw Nature Reserve is designed to showcase and preserve the best natural habitats of Missouri. The park is home to over half a dozen natural habitats, and visitors can see wildlife ranging from ducks and herons to deer and wild turkey. Overall the reserve has spans more than 2,500 acres with more than 14 miles of trails, cutting through a wide variety of native habitats, including tallgrass prairies, pine meadows and bottom-land forests. A number of trails also lead to a peaceful section of the Meramec River, where hikers can cool their feet in summer months. For those who don't wish to trek through the hillsides, the reserve also has large areas of cultivated native flower gardens. The reserve is an extension of the Missouri Botanical Garden with a stated intent to "[provide] environmental education, ecological research and public enjoyment of the natural world" and actively engages the local community through well-thought out events and activities.

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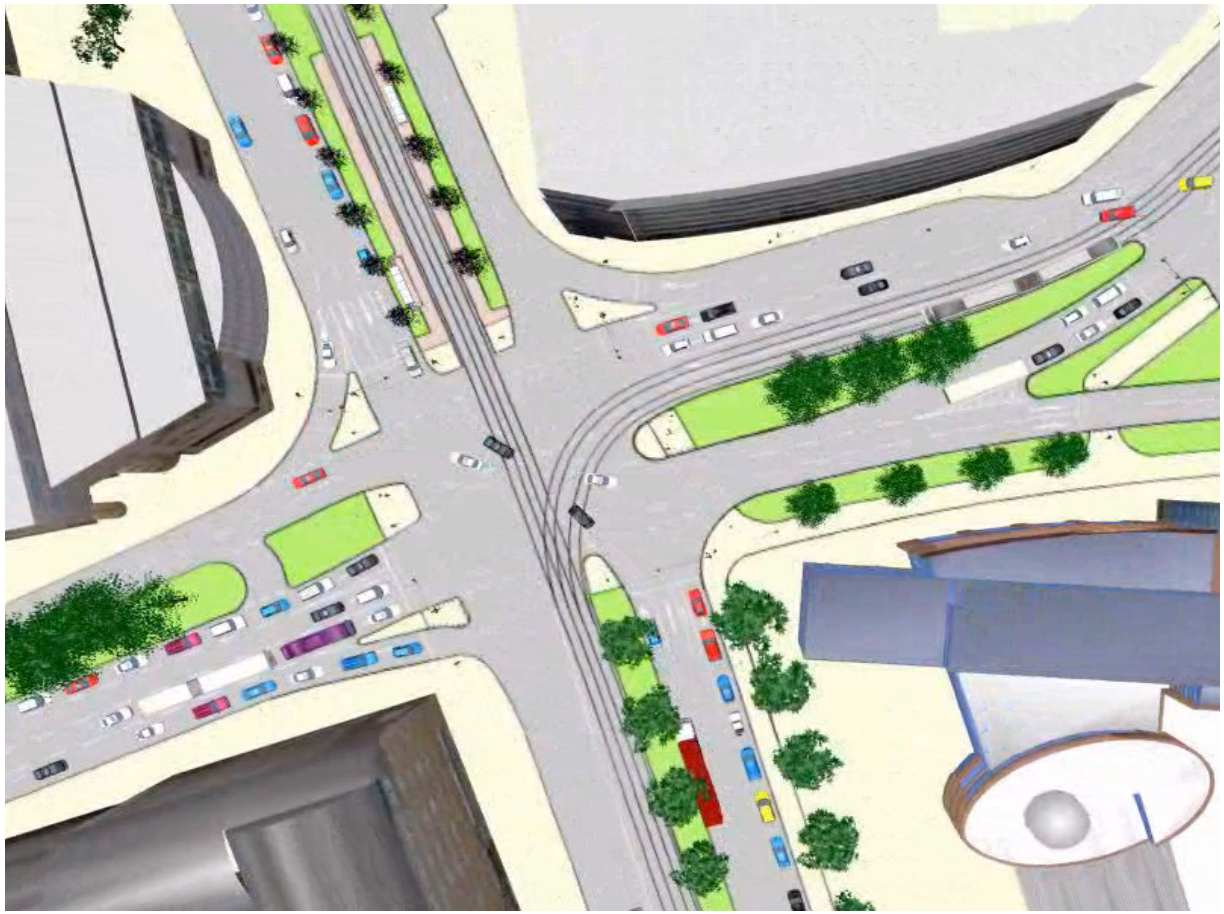
Introduction

As China is experiencing extraordinary processes of modernization and urbanization, the growth rate of motorization in China in the past decade has been astonishing. Consequently, many Chinese cities have seen severe traffic congestions, air pollution, and degradation of urban quality of life. Given such a context, designing efficient transportation systems which can accommodate multi-modal traffic (such as automobiles, public transit, pedestrians and cyclists) is very important for sustainable transportation development of future Chinese cities.

However, traditional planning support systems based exclusively on two-dimensional (2-D) geographic information systems (e.g., ArcGIS, and TransCAD) do not incorporate behavioral aspects in transportation systems, and therefore are not capable of predicting reliable estimates of functional and performance changes (Jiang and Murga, 2010). On the other hand, 2-D visualization is also not very effective in communicating with the public the technical and analytical results about the future alternatives of the transportation system improvements and their impacts on stakeholders' interests. Microscopic traffic simulation models, on the contrary, were developed to address these issues. To this end, this section will discuss the characteristics and advantages of microscopic traffic simulation models in planning and designing multi-modal transportation systems.



Source: A snapshot of a VISSIM micro-simulation model developed by PTV, 2010

What is this tool?

A microscopic traffic simulation (micro-simulation) model is a traffic planning/analysis tool (sometime called traffic simulator), which can simulate the movement of individual vehicles based on vehicle-following and lane-changing theories. In a microscopic traffic simulation model, vehicles enter a transportation network using a statistical distribution of arrivals (a stochastic process) and are tracked through the network over small time intervals (e.g., 1 second) (US DOT). Besides motorized vehicles such as cars, it also simulates non-motorized travel mode, such as pedestrian walking, cycling, and transit (e.g., light rail, tram, etc.).

Micro-simulation of a roundabout

Source: A snapshot of a VISSIM micro-simulation model developed by PTV, 2010

Table 1: A List of Popular Microscopic Traffic Simulation Packages

MODEL	ORGANIZATION	COUNTRY
Aimsun	Transport Simulation Systems	Spain
CORSIM	Federal Highway Administration & University of Florida	USA
MITSIMLab	Massachusetts Institute of Technology	USA
Paramics	Quadstone Paramics Ltd within Portrait Software PLC	UK
TransModeler	Caliper Corporation	USA
VISSIM	PTV AG	Germany

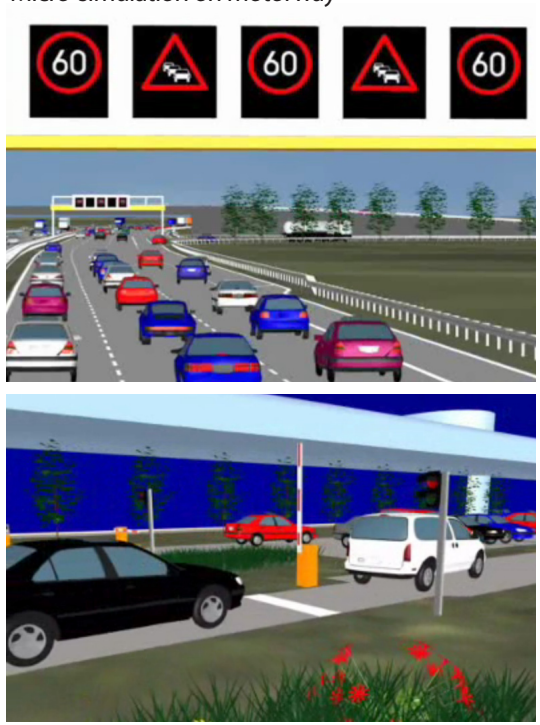
Sometime, a micro-simulation model also includes signal state generator which is a signal control module, polling detector information from the traffic simulator on a discrete time step basis, and then determines the signal status for the following time step and returns this information to the traffic simulator (PTV, 2009).

Table 1 provides a list of popular microscopic traffic simulation software packages worldwide. Among these micro-simulation packages, MITSIMLab is the only one for research purposes, while the rest are commercial packages.

Where does this tool apply?

Micro-simulation model can be applied in planning/designing physical and operational aspects of transportation systems. According to the traffic conditions that existing micro-simulation models can apply to, Algers and Bernauer et al. (2009) categorize a full list of micro-simulation models into four classes: (1) urban, (2) motorway, (3) combined and (4) other models usually developed for very specific objectives.

Micro-simulation on motorway



Source: PTV, 2010

Why should this tool be used?

The reasons for applying micro-simulation for transportation planning processes are the following:
>It can describe all the factors of the traffic system, including double parking, random traffic effects, and the non-linear behavior of traffic congestion.
>It can be employed to explore different scenarios of multi-modal transportation system.
>It can assist decision makers/transportation planners/traffic engineers to make well informed decisions.
>It facilitates the public to "vision" alternatives in a non-technical manner.

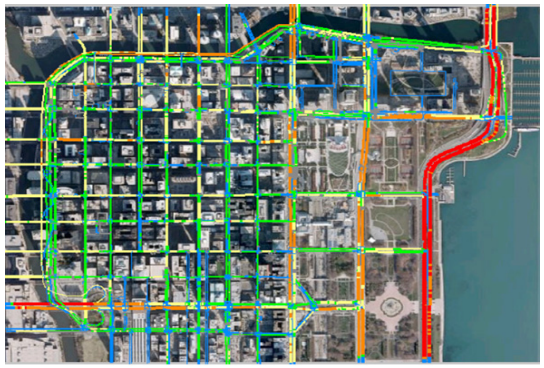
When is this tool implemented?

A micro-simulation model can be used in several circumstances. For example, it can be employed to replicate existing traffic conditions of a study area to help planners and engineers to better understand and detect problems to be tackled, which can also provide a base for future scenario planning.

More often, a micro-simulation model is used in a planning/designing phase for testing alternative scenarios of a new or improved transportation system, which can be a single corridor, a small determined network, or a large dynamic network, depending on the study focus. Some of the micro-simulation commercial software packages provide functions such as evaluation. For example, the package VISSIM, developed by PTV, provides functions of evaluating travel speeds (travel time, density, emission, etc.) of vehicles at the disaggregate level, and aggregated level (such as link level, section level, and network level, etc.) by time and by location. This is very helpful for planners and engineers to understand the tangible performance measures of the new or improved transport system to evaluate the alternative plans. For example, in the below picture, the different colors represent traffic volumes at the link level.

Micro-simulation studies for Chicago, IL

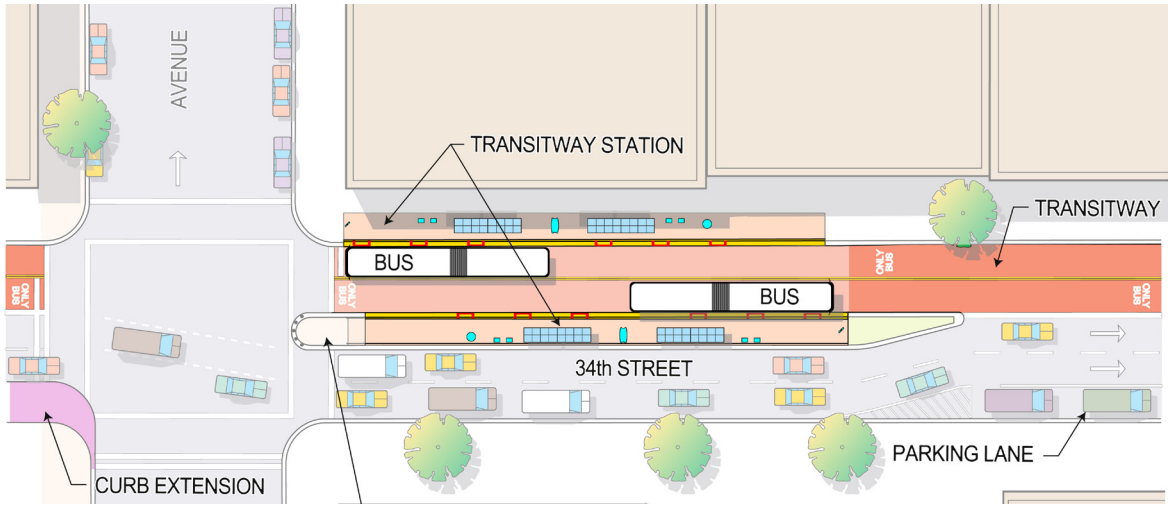
Source: Jiang, 2009, 2007.



Source: Jiang, 2009

More recently, micro-simulation models have been used in the public participation/ involvement phase, in which the public are invited to provide feed backs and comments on the planning alternatives. The micro-simulation model simulates the transportation systems in three dimensions (3-D) which are visually understandable, compared to complicated numbers and analysis that transportation planners often tend to provide. For this reason, using 3-D transportation simulation models to demonstrate the advantages of transit improvement to the public has been recently adopted by a number of transportation agencies in the U.S., such as the BRT improvement demonstration by the New York City DOT (NYCDOT, 2009, 2010). On the other hand, those 3D visualizations are often critical for planners, as they may reveal non-intuitive interactions among the different modes.

The 34th Street Transitway project employing a micro-simulation tool in New York City, 2010



Transitway rendering –station

Transitway rendering – plaza

Source: New York City Transit and New York City DOT, 2010

How has this tool been applied?

The 34th Street Transitway project in New York City, 2010

The 34th Street Transitway is a project that plans to construct a high quality bus right-of-way on the 34th Street in New York City, NY, USA (NYC Transit and NYC DOT, 2010). This project includes a dedicated bus lane, as well as passenger boarding islands, an off board ticketing system, and other bus operation improvements on the 34th Street. The project will also create a new pedestrian plaza in the middle of Manhattan and other pedestrian mobility, safety, and comfort enhancements along the corridor.

The New York City Transit and Department of Transportation have employed microscopic traffic simulation models in the process of operational and physical planning of the new transit corridor. Micro-simulation models have been used in this case to test different scenarios, and the animation of the 3-D visualization recorded from the micro-simulation models has also been utilized in the public meetings with local communities. By employing the micro-simulation model, the NYCDOT has been able to measure the performance improvement of the planned bus services—bus speed along 34th Street will be increased by an estimated 35%. Planners, decision makers and community members are envisioning a significant improvement of the overall quality of life along the corridor (NYC Transit and NYC DOT, 2010).

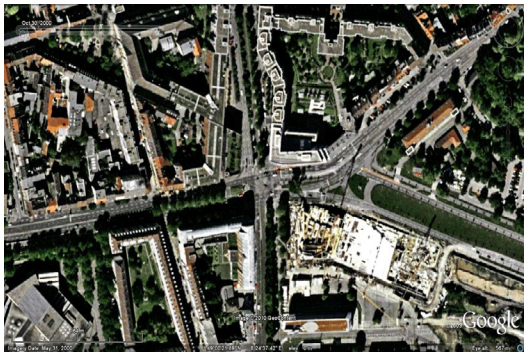
Multi-modal Urban Transportation System (Mendelssohnplatz, Karlsruhe, Germany)

PTV, the developer of VISSIM (one of the widely applied micro-simulation software packages) also provides a wonderful demonstration on how to use a micro-simulation model to integrate the multi-modal transportation systems.

In this Karlsruhe case, a VISSIM micro-simulation model was developed to demonstrate an intersection improvement around Mendelssohnplatz, Karlsruhe, Germany (PTV, 2010).

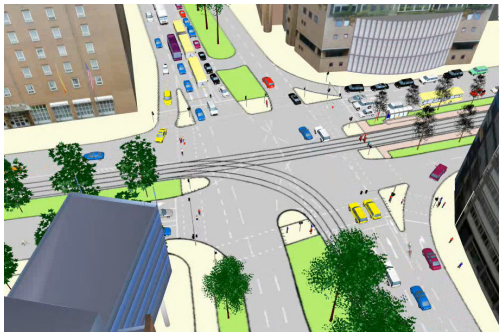
In this case, the integration of different modes includes:
>Automobiles
>Buses
>Street cars
>Pedestrians
> Cyclists

A satellite view of Mendelssohnplatz, Karlsruhe, Germany



Source: Google Earth

A multi-modal micro-simulation at Mendelssohnplatz, Karlsruhe, Germany



Source: PTV, 2010

Incorporating different transportation modes at a horizontal level is very challenging. However, this Karlsruhe VISSIM model exhibits to us how micro-simulation can help planners to tackle the complicated transportation planning problem.

What is required to make this tool work?

> Computer Resources

In order to make use of the micro-simulation model, first, a reasonably fast computer is required. A micro-simulation software package is also required. As discussed previously, there are several developers around the world providing commercial micro-simulation software packages. Depending on which software package is used, the computer system requirement may vary.

For example, to install the VISSIM micro-simulation model, a rule of thumb is that one VISSIM vehicle takes about 2 kB of RAM. So if a simulation contains 50,000 vehicles in the network, the vehicles alone take up about 100 MB of RAM. Quad-Core processor machines are recommended (PTV, 2009).

>Technical Personnel

Specialists (usually transportation planners or engineers) with good training and understanding of transportation system analysis will be required to develop micro-simulation models.

> Data

Since a micro-simulation model covers every element and settings of parameters of those elements, detailed data of the studied transportation systems are required. These data include the following:

For Automobiles
>Traffic network
>Traffic counts (or origin-destination data)
>Traffic speed (volume, density, etc.)
>Traffic signal plan
>Vehicle types and classes
>Driving behavior
>Parking lots (capacity and volume)

For Transit
>Bus network components
 >>Bus routes
 >>Bus lanes
 >>Bus stops
 >>Bus schedule
 >>Dwelling time model

>(Light) Rail network components
 >>Right-of-way
 >>Stations
 >> Schedule
 >> Dwell time model

For Pedestrian /Cyclists
>Walking Path
>Bike lanes
>Walking/Cycling Behavior

What are the best practices?

The following pictures show several examples of how micro-simulation models have been used well to demonstrate public transit improvement programs.

K-street bus way in Washington D.C.

Source: Newlands & Company, Inc, 2009

The first two pictures are demonstrations of the K-street bus way in Washington D.C. The third one is an illustration of Portland Transit Mall (Newlands & Company, Inc, 2009). Integrating urban design with the microscopic traffic simulation models will bring vibrant elements to the transportation planning processes. It will also facilitate planners to achieve the goal of integrating transportation planning with land use planning at the detailed level. By enabling multi-modal simulation in the microscopic traffic simulation models, a very important message is delivered that sustainable cities are not solely designed for cars, but for people who live there.

K-street bus way in Washington D.C.

Source: Newlands & Company, Inc, 2009

Portland Transit Mall

Source: Newlands & Company, Inc, 2009

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What Is This Tool?

Business incubators are programs designed to nurture the development of entrepreneurial endeavors during the start-up period, when they are most vulnerable. Incubators provide client companies with targeted business support services and resources. Services and resources include but are not limited to rental space, management guidance, technical assistance, business consulting, and intellectual property and legal assistance. Incubator tenants usually have to pay a monthly or annual fee to take advantage of the incubator's resources and services.

Universities are in the unique position to host or initiate business incubator programs, which can help the universities achieve economic and educational goals. Universities often produce knowledge that has commercial value, but there are few avenues to profit from them. A university-sponsored business incubator program can support start-ups that develop and sell university-owned technologies, thus becoming another revenue stream for the university. Additionally, engineering, management, and law curricula are enhanced when they are integrated with real-life incubated businesses. Other links between universities and business start-ups include resources (money and people) and knowledge-sharing.

Local economies are also positively affected by business incubator programs. Business incubators create jobs, retain an educated population, and diversify the local economy, which lead to local economic development.

Typical Elements of University-Related Business Incubators
(A single incubator may be characterized by some but not all of these attributes)

Facilities/Resources

- Rental office space (appropriately sized for 1 person to 20 people)
- Shared office facilities and equipment (i.e. conference room, copy/fax machines)
- Shared common spaces (i.e. break rooms)
- Reception services
- Telephone and Internet access
- Cleaning and maintenance
- IT network support

Services

- Business consulting
- Management guidance
- Technical assistance
- Legal/intellectual property assistance
- Seminars
- Networking events
- Scouting investors and funding
- Advertising and graphic design
- Marketing
- Finance and accounting
- Small Business Development Center

Relationship to University

- Development of university-owned technologies
- Science/engineering, management, law curricula enhancement through real-world businesses
- Faculty consultants and student interns
- Access to university facilities (i.e.. libraries)
- Collaboration and knowledge-sharing
- Fostering of entrepreneurial environment
- Increase technology transfer
- Increase university's competitiveness in recruiting and retaining faculty and students

Relationship to Local Economy

- Production of local viable firms
- Creation of local jobs
- Enhancement of local entrepreneurial climate and long-term advantage
- Retaining businesses and people
- Building and accelerating growth in a local industry
- Diversifying the local economy
- Increasing social capital within a local area and industry

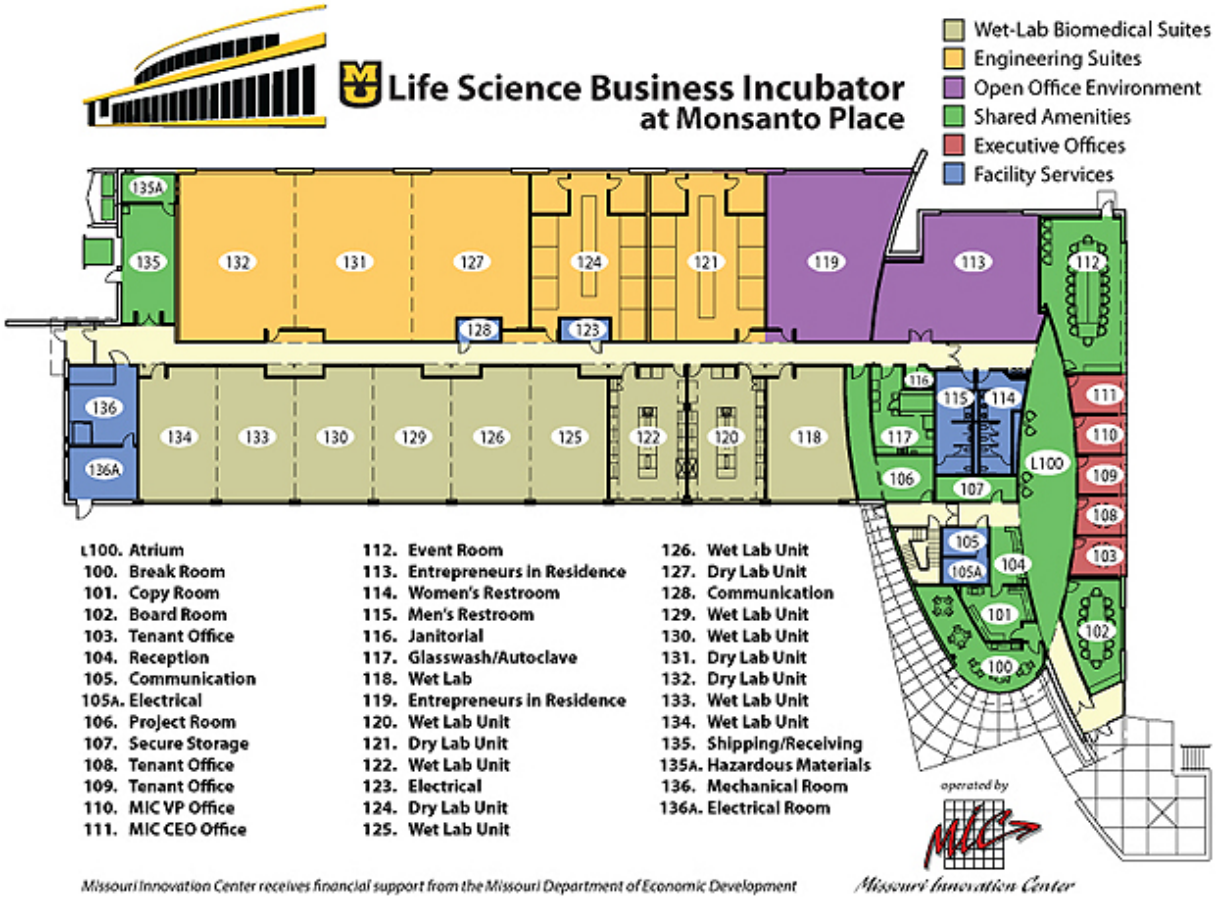
Example Facilities

Office space: Hull University Business School

Lab space: Boston University's Business Incubator

Main lobby: New Jersey City University Business Development Incubator

Break room: Missouri University Life Science Business Incubator



Floor plan: University of Missouri Life Science Business Incubator

Where Does This Tool Apply?

In North America, universities with business incubator programs are those that are typically not renowned science and engineering research institutions that naturally lead to business spin-offs. However, these small and medium-sized universities have strong science and engineering programs and connections with investors. Examples of universities with business incubator programs include Boston University, Hampton University, Northwestern University, Purdue University, Towson University, University of Florida, and the University of South Carolina.

Regarding business incubators in general, about half of those in North America operate in urban areas, about 30 percent operate in rural areas, and about 20 percent operate in suburban areas. A business incubator program's location is highly dependent on the industry targeted by the business incubator and the incubator's surrounding land uses, which can provide interactions suitable for networking and knowledge spillovers.

Because universities are centers of knowledge creation, they are ideal surrounding land uses for business incubator programs. The opportunities for knowledge sharing increase with physical proximity, encouraging innovation and an entrepreneurial spirit.

Why Should This Tool Be Used?

Since 1976, when a University of California biochemist co-founded Genentech Inc, the value of university research has been known. However, many institutes of higher education continue to struggle with transforming ideas into money. Technology transfer from academia to industry often takes low priority, even though it can provide an opportunity for universities to profit from their research and make itself more competitive among other research institutions. Ross C. Devol, an economist at the Milken Institute in Santa Monica, California, and lead author of a 2006 report on university technology spin-offs, says, "If universities don't get actively involved in technology transfer, there are so many others around the world who will and will be more successful."

University business incubators are an effective way to attract capital and nurture technology industries that have been born on campus. According to Tim Lavengood, Executive Director of Evanston, Illinois' Technology Innovation Center (TIC), the business incubator programs help to "make failure cheaper," which encourages innovation, risk-taking, an entrepreneurial spirit, and the creation of more start-ups.

Of course, business incubators' tenant businesses also benefit from the program. Successful completion of an incubation program increases the probability of a start-up's long-run viability. This is because incubators are specifically designed to meet the needs of start-up businesses, not well-established businesses.

Additionally, business incubators' surrounding communities also benefit from these programs. Business incubators produce local successful and viable firms that create a range of jobs in the community, enhance the community's entrepreneurial climate and long-term advantage, retain businesses and people in a community, build or accelerate growth in a local industry, diversify local economies, and increase social capital with a community and local industry.

Universities with Business Incubator Programs

University	Location	# of Undergraduates	# of Postgraduates	# of Faculty
Boston University	Boston, Massachusetts, USA	18,534	13,232	3,931
Hampton University	Hampton, Virginia, USA	4565	770	468
Northwestern University	Chicago, Illinois, USA	8,497	7,880	3,183
Purdue University	West Lafayette, Indiana, USA	31,145	8,552	3,093
Towson University	Towson, Maryland, USA	21,111	3,839	1,276
University of Florida	Gainesville, Florida, USA	49,679*	-	4,534
University of South Carolina - Columbia	Columbia, South Carolina, USA	27,488*	-	1,608

* Combined Undergraduate and Postgraduate

When Is This Tool Implemented?

Universities that are in a good position to initiate business incubation programs when they:

- Are well-established (that is, they are not newly founded)
- Have strong science and engineering educational programs that produce commercially viable technologies
- Have financial and human resources to invest in the incubator's facilities and services
- Know potential investors (i.e. successful alumni) who would fund the program's tenants
- Can offer facilities, resources, and services that will attract tenants to the incubator
- Are supported by the local government to promote local job creation through high technology industries

Boston University's Business Incubator has "spacious, fully furnished, IT equipped office suites."

How Has This Tool Been Applied?

> Case Study #1: Boston University's Business Incubator

Boston University's 22,000 square feet Business Incubator, which is housed in the Photonics Center, hosts up to 14 technology start-ups, which include those focusing in life sciences, biotechnology, medical devices, photonics, clean energy, and engineering. Companies originate from within BU or from outside BU. All companies contribute to the university's mission to educate students in entrepreneurial management. Financing for these companies is from venture capitalists, angel investors, and corporate and government sources.

The BU Business Incubation Program is specifically designed to:

- Facilitate the successful commercialization of revolutionary new technologies through the creation and support of new companies.
- Contribute to student education in Technology Entrepreneurship and Commercialization.
- Foster an entrepreneurial environment among faculty and students of the university.
- Create strong interactions between Boston University and the greater Boston business and financial communities.
- Contribute to economic development of the region by launching new businesses and job creation.

Companies entering the incubation program are encouraged to engage with faculty and students to enhance the entrepreneurial culture within the university. Companies may hire student interns, collaborate with faculty, or participate in funded university programs. Incubator companies may participate as real-world case studies for student education in entrepreneurial management.

Priority for admission to the program is given to companies that are working in areas closely related to the core technological competencies of Boston University. They are expected to contributed to BU's educational mission in one of the following ways: being a source of senior year projects for the College of Engineering, being a source for legal projects through the Boston University School of Law, being a source for strategy, marketing, and other projects in the School of Management, and being a source of ideas for research in other departments.

Three categories of ventures are targeted for incubation:

- *BU Spin-Outs*: Companies founded by BU faculty or students to develop technologies invented by them, owned by the University, and licensed to the company.
- *Spin-Ins*: Companies that are developing technologies not owned by BU but which could make a positive contribution to the intellectual life of the University through their direct participation in Boston University programs and by providing technology on campus that is relevant to the research interests of at least one or more faculty members.
- *Established Companies*: Venture-backed or venture-backable companies with no connection to Boston University will also be considered as an incubator candidate. Each will be evaluated on a case-by-case basis.

> Case Study #2: University of Florida's Sid Martin Biotechnology Incubator

The University of Florida's Sid Martin Biotechnology Incubator in Alachua is a 40,000 square feet facility outfitted with 22 wet labs, small and large animal facilities, pilot scale fermentation facilities, climate controlled greenhouses, and an extensive array of shared scientific, is fully occupied by one dozen start ups. Its vision is "to foster the development of new commercial ventures related to University of Florida research in all areas broadly relating to the molecular life sciences including medicine, agriculture, and the chemical and environmental sciences." This is done by providing space, equipment, and support services to expedite research and commercial development of promising biotechnologies in the context of viable, well managed start-up companies that will benefit the universities both economically and academically. To date, the incubator's companies have attracted over $300 million in equity investment and $150 million in contracts and grants.

The initiative to create a business incubator began in 2000, when the University of Florida tripled its tech licensing office staff to 19 in order to focus on small business development. The office began working with researchers to understand work being developed in labs, and it connected with two underutilized business incubators in metro Gainesville to provide subsidized space for these new businesses. The licensing office's annual budget is $5 million, and one of the staff's duties is to track university research to assess which inventions are worth patenting and licensing. Another duty is to find investors and company executives who might be interested in commercializing their inventions.

According to its website, these are the following are the incubator's goals:

In the academic area:

- Encourage commercialization of faculty and student discoveries
- Increase technology transfer
- Stimulate collaborative research projects between local companies and University faculty
- Provide opportunities for student research and employment
- Contribute to UF's academic competitiveness in recruiting and retaining faculty

In the economic area:

- Provide a financial return to the University and the State of Florida
- Encourage a return to public health from public investment in research
- Translate University research results into products that solve unmet needs
- Attract new and existing companies to Gainesville and Florida and stimulate the formation of new, small, high technology businesses in the State
- Stimulate economic development and competitiveness in Gainesville, Alachua, and the State of Florida through collaborations with regional and state entities committed to economic development

Incubator services include access to UF libraries and an onsite library, business seminars and business plan assistance, introduction to experienced attorneys, accountants, and venture capitalists, marketing support, and a variety of business development services. The business development process flows through multiple stages and services, ranging from identifying UF life science technology with commercial potential, to scouting for investors and entrepreneurs to match the technologies or startups, to funding, to inter-company mentoring. Client companies receive one-year terms with renewal contingent on progress. A regional Biotech Advisory Committee comprised of four biotech venture capitalists, four biotech entrepreneurs, and four faculty with industry experience assesses company needs and provides guidance at the time of admission and at the annual review of each company.

(Above) Exterior photograph of UF's Sid Martin Biotechnology Incubator
(Right) Inside one of the incubator's laboratories

> Case Study #3: Northwestern University's Technology Innovation Center (aka "The Incubator")

The TIC was established by Northwestern University and the City of Evanston in 1986, making it one of the oldest, largest, and best-known technology incubators in the United States. Its goals include supporting the growth of very early stage technology-based businesses and fostering collaboration among young companies. In April 2010, Forbes magazine named TIC one of the 10 incubators changing the world. TIC currently houses 38 companies and has nurtured 350 technology companies in the last 24 years. Even during the last two years of economic recession, graduates from TIC have managed to secure over $48 million in funding. Famous graduates include Peapod, the online grocery store and delivery service that pioneered the concept of e-commerce and online shopping, and Whitewater Group, which developed a precursor to Microsoft's Windows and was acquired by Symantec.

The TIC has 30,000 square feet of office space that costs $17-24 USD per gross foot per year. Spaces range from less than 200 square feet to a few thousand square feet. Tenants have access to conference rooms and shared facilities and resources.

The TIC works in tandem with Northwestern University's faculty, students, and alumni to motivate the University's technical, scientific, and management expertise to support tenant companies. The interaction between the TIC and Northwestern has created job opportunities for students and faculty. Each year, approximately 20 undergraduates and graduate students and several faculty work at TIC companies. Faculty partnerships include joint research, consulting in areas like prototype design and general business management, and access to students. Tenants of the TIC also have access to Northwestern's sporting and cultural facilities.

Special business support services make the TIC work as a successful business incubator. Services include the following:

- *Attorney*: Approximately 8 hours per week of pro bono time for tenants.
- *Kellogg Incubator Support Team (KIST)*: A group of business school alumni who assist TIC companies with business planning, marketing strategy and tactics, and financial planning to help empower them to reach their companies' goals. KIST members provide mentoring services and work with companies in an advisory board capacity.
- *Seminars* addressing specific issues confronting the high-tech start-up company. Past presentations include a patent seminar and a seminar on winning government grants that was led by panelists who have won a total of $11,000,000 in grants over the past 5 years.
- *Onsite Small Business Development Center (SBDC)*: A program of the Illinois' Department of Commerce and Economic Opportunity with experienced staff and counselors who can assist with: financing, securing federal grants and loans for new technology, referrals, documents, forms, and business kits.
- *Face to Face (FTF)*: A weekly, informal networking event open to prospective tenants, service providers, and people from Northwestern and the Evanston/Chicaco business community.

The TIC continues to have strong connections with the city of Evanston. Many companies that have graduated from The Incubator have remained in Evanston. In early 2010, the TIC was working with the city's Economic Development Committee to receive $100,000 in city funds as part of the city's economic development finance programs. According to the chairman of TIC's board of directors, "The city came to us because they have launched a new economic development plan for Evanston, and by helping business start-ups and job growth, we actually can help the economic development of Evanston out of this recession."

the incubator
820 Davis Street Evanston Illinois 60201
The Technology Innovation Center

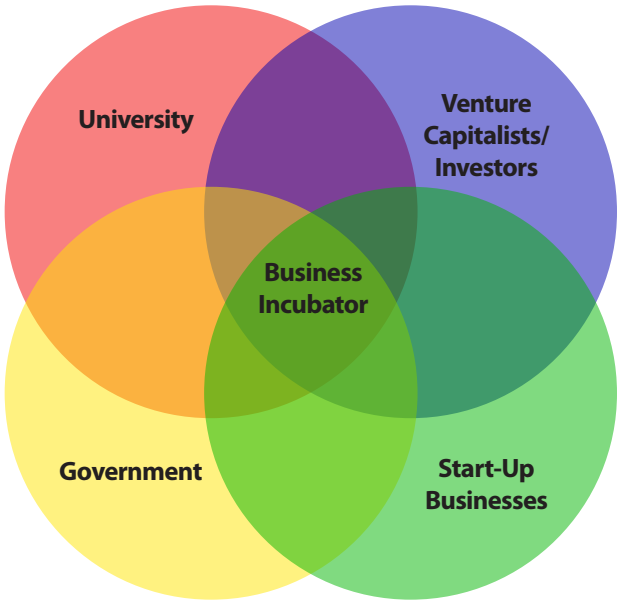
The Technology Innovation Center's logo and building

Peapod®
Online grocery shopping and delivery.

Peapod, one of the TIC's success stories

Case Study Comparisons

Incubator Program	Boston University Business Incubator	University of Florida Sid Martin Biotechnology Incubator	Northwestern University's Technology Innovation Center
City	Boston, Massachusetts, USA	Gainesville, Florida, USA	Evanston, Illinois, USA
Industry	Life sciences, biotechnology, medical devices, photonics, clean energy, and engineering.	Biotechnology, molecular life sciences (medicine, agriculture, and the chemical and environmental sciences)	General technology (does not have labs)
Year of Establishment	N/A	2000	1986
Facilities Square Meters	2,044 sq m (Office space and laboratory space)	3,716 sq m (Office space and laboratory space)	2,787 sq m (Office space only)
# of Current Tenants	14	12	38



Successful business incubator programs require partnerships between the university, investors, and the government, and start-ups

What Is Required To Make This Tool Work?

A successful business incubation program is really a collaboration between the university, investors, the local government, and community members. Commitment is required on behalf of all involved parties, even though the incubator

First, the university must invest in tracking their own research and searching for products with commercial potential. This should be done as a feasibility study, which helps determine whether the incubator project has a solid market, a sound financial base,a nd strong community support.

Of course, the university does not have to fully fund the business incubator. As seen in the previous case studies, some incubator programs are co-founded with the city government. This connection with the local government also makes it more eligible to receive funding from local economic development initiatives. Additionally, some business incubator programs are run by a non-university management firm. A number of configurations for funding and management of the incubator exist; key actors must collaborate to determine which set-up is most appropriate for the context.

Please see the best practices on the following page for guidelines that assist in creating a successful business incubation program.

What Are The Best Practices?

The United States' National Business Incubation Association identifies the following 10 best practices for business incubators. They have been modified for university-related incubators:

> Domain 1: Comprehensive Business Assistance Program

- Needs Assessment - Develop a process to address client needs that allows flexibility; Assess needs on a continual basis throughout program
- Coaching and Facilitation - Dedicate sufficient staff and time to meet the goals of client; Provide oversight and support
- Monitoring Client Progress - Develop milestones for clients; Monitor progress toward milestones

> Domain 2: Professional Infrastructure

- Know-how Network - Develop a broad pool of advisors; Limit exclusive arrangement with individual service provides to ensure range of services; Negotiate a fee structure to minimize impact on client; Facilitate interaction between service provider and client
- Mentors - Develop a willing pool of volunteers to serve as mentors, Ensure that mentors meet with clients
- Advisory Boards - Develop a pool of professionals, technologists, business owners, etc to volunteer their services by acting as clients' advisory boards

> Domain 3: Client Capitalization and Financing

- Provide access to dept and equity capital
- Establish linkages with "angel," venture capital and corporate equity investors
- Consider creating in-house equity and debt funds to fill financing gaps
- Create relationships with corporations that are willing to provide services for clients in lieu of capital

> Domain 4: Client Networking

- Proactively encourage client networking
- Consider facility design issues
- Hire incubator management that values client interaction and networking

> Domain 5: Technology Licensing and Commercialization

- Work with university's technology transfer office
- Manage conflicts between all parties; offer incentives for commercialization
- Establish a seamless interface between the incubator and the university's technology generator

> Domain 6: University and Federal Laboratory Linkages

- Leverage valuable assets of the university through linkages with incubator
- Provide clients with faculty consulting services, student interns and employees, access to technical facilities and equipment, databases, researchers, and R&D financing

> Domain 7: Facility Basics

- Ensure flexible space and necessary amenities (i.e. high-speed communications, security, etc)
- Encourage client interaction through common meeting areas
- Provide sufficient leasable space for the incubator to reach financial sustainability

Domain 8: Governance and Staffing

- Ensure that the incubator has an effective governing body with private-sector perspectives
- Achieve consensus among staff and major stakeholders on the incubator's mission
- Ensure sufficient, capable staffing

> Domain 9: Client Screening and Graduation

- Utilize an extensive screening process to select clients that can benefit from the program
- Ensure that screening processes determine client needs, ability of the incubator to provide value to the client, and the applicant's willingness to accept this value
- Establish appropriate graduation criteria

> Domain 10: Incubator Evaluation

- Utilize quantitative and qualitative measures to evaluate performance relative to the incubator's mission
- Obtain client feedback while they are tenants and after graduation
- Ensure evaluation processes are manageable and consistent

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Waterways in Urban Areas

People are often drawn to elements of nature especially in an urban environment because they appreciate the aesthetic value that waterways bring to their surroundings. However, waterways often do not exist in a state that allows people to capture their aesthetic value.

Often, the water flow is intermittent, the water is too filthy to add any aesthetic value or the waterway poses a big flood threat to its surroundings. Cities usually respond by either diverting the waterway away from the city altogether to prevent floods, or they cover it up to conceal the unsightly sewer that the waterway has evolved into.

Over time, many cities realize the hidden potential of these waterways. This realization prompts many cities to retrofit their canals by uncovering them and softening the edges in order to make them more visually appealing. This strategy helps the waterway to achieve its other potential of being a path along which activity-generating uses can choose to locate (eg. outdoor dining, river cruises, etc..)

What is this tool

The purpose of this tool is to help planners think of methods to regulate the flow of water in a channel running through a dense urban environment so that activities can be organized around it. These methods can be used in conjunction with the water purification and flood management system tool to create a pleasant waterfront environment.

Where does this tool apply

This tool applies to any place that has a waterway running through it, but is currently not in a condition that allows the city to leverage on its aesthetic and recreational value. This tool can also be applied to cities drawing up master plans to incorporate waterways into the city development plans.

Why should this tool be applied

This tool should be used because it helps a city achieve two important functions. Firstly, this tool helps cities to regulate the waterway to a state that creates an environment suitable for activities to take place along it. Such an approach captures the aesthetic value of the waterway and transforms it into increased land values for surrounding developments. Secondly, incorporating the waterway into the various aspects of people's lives creates a greater sense of stewardship towards the waterway. People are less likely to pollute the waterways when they are aware of the potential benefits it brings to them.

When is this tool implemented

This tool can be implemented as part of a larger master plan to incorporate a waterway in an urban environment or it can also be used to formulate guidelines for waterway revitalization projects where authorities are trying to retrofit a storm water channel into a pedestrian-friendly waterfront area.

What is required to make this tool work

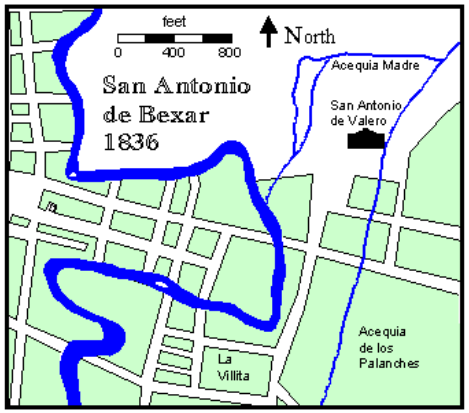
An effective water management system is required to ensure a regular and constant flow of water as well as a clean source of water. Systems controlling flow may include dams constructed upstream to prevent floods or an extensive storm water management system channeling water to streams with intermittent water flow. Systems ensuring a clean source of water include the introduction of water cleansing mechanisms such as biotopes. More detailed examples of such water purification systems are described in a separate tool in this publication titled 'On-site water purification and flood management system'.

What are the best practices

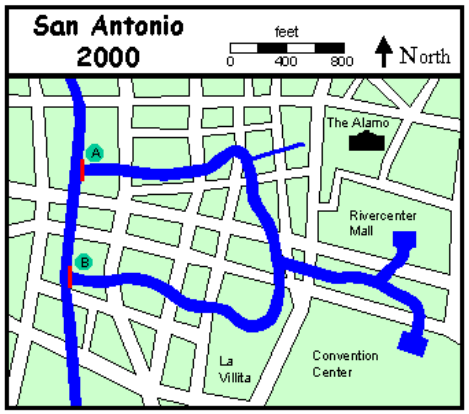
1) San Antonio Riverwalk, San Antonio, Texas, Unites States of America

In the 1800s and early 1900s, the city faced severe flooding whenever the stretch of San Antonio River running through the city overflowed its banks during a major storm. The upstream creeks that the river passed through had little vegetation to retain water, resulting in floods downstream in the city.

Many mitigation measures were suggested and these included diverting the river away from the city and converting the bend of the river running through the city into a driveway for automobiles. The city finally decided to create an upstream dam,

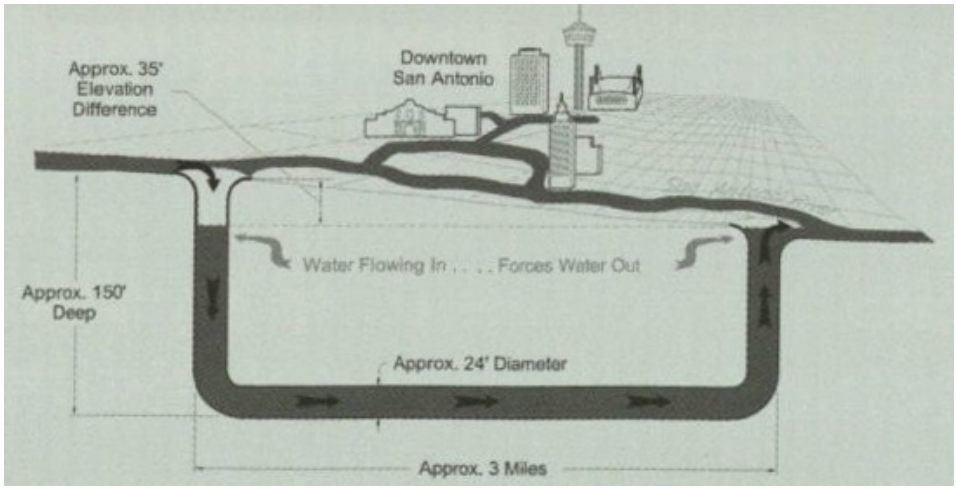


San Antonio River in 1836
(Picture source: http://www.edwardsaquifer.net/sariver.html)



San Antonio River in 2000 with
1) cut-off channel built between points A & B
2) canal extension to Rivercenter Mall & convention center
(Picture source: http://www.edwardsaquifer.net/sariver.html)

Outdoor dining & river cruises along San Antonio Riverwalk
(Picture source: http://www.skyscrapercity.com/showthread.php?p=35694536)



Flood control tunnel for excess water to bypass downtown San Antonio
(Picture source: Fisher, 2007: 145)

Cut channel (center) meets curved stretch of river (right) running through downtown San Antonio. Picture location: Point B in map above.
(Picture source: Fisher, 2007: 77)

a flood control tunnel and a floodwater cutoff channel to divert excess water away from the stretch of river running through the city. A regulated flow of water running through the city allowed the waterway to be used for recreational activities such as boating and water parades. Commercial uses such as restaurants, hotels and convention centers started to develop to capitalize on the aesthetic value of the waterway. The waterway was extended to the Rivercenter Shopping Center in 1987 (Fisher, 1996: 492) and there are plans to extend the river walk beyond the current downtown stretch (Wolff, 2008).

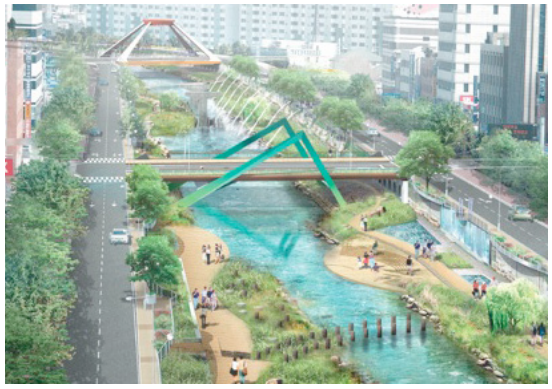
2) Cheonggyecheon, Seoul, South Korea

By the 1950s, the Cheonggyecheon became an open sewer running through the city center and posing a big obstacle to the redevelopment of Seoul. The city covered up the river and built an elevated freeway above to meet the increasing traffic demand of the growing city. By the turn of the century, the area had evolved into a run down industrial area with high traffic volumes. The elevated freeway was an eyesore and was an impediment to any redevelopment in the area. In 2001, the city decided to bring down the freeway and restore a 5.8km stretch of the river for recreational use.

However, the river in its natural state was not suitable for recreational use since the upstream source of the Cheonggyecheon was polluted and could not be depended for a clean supply of water. To overcome this problem, water was pumped in from the Han River instead. Groundwater that made its way to the city's subway system was also fed into the river. Sewer lines around the river protected the waterway from any sewer overflows. These measures were put in place to ensure that the river was kept clean and received sufficient water to achieve an average depth of least 40cm (Park, 2004: 13).

Cheonggyecheon running through dense urban environment
(Picture source: Lee, 2004: 33)

Elevated Freeway above Cheonggyecheon
(Picture source: Lee, 2004: 34)



Cheonggyecheon after freeway removal & river restoration
(Picture source: Lee, 2004: 37)

Summary

The two case studies above have shown that the tool can be developed to allow cities at different stages of urbanization to search for appropriate methods to modify waterways to leverage on their aesthetic and recreational value.

Some cities like San Antonio realized the potential of waterways early and developed measures to ensure a reasonable flow of water through cities without having to cover or divert the river. Others like Seoul saw waterways as an obstacle and covered them up but later devised methods to uncover and restore the waterway's natural beauty.

The table below summarizes how the two case studies can be applied to waterways in various states and what can be done to increase the aesthetic and recreational value of the waterways.

The methods adopted in the San Antonio example can be used by cities opening up a new development area with a waterway running through. Cities attempting to retrofit existing concrete storm water channels into recreational waterways can look at the methods adopted by Seoul.

The development of sites in Shantou can draw some inspiration from the two cases studies since both Sites A and B have waterways running through them.

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	Current Waterway Conditon	Case Study Reference	Methods Adopted
1)	Intermittent water flow	Cheonggyecheon	Pumping water from another river to ensure constant flow of water
2)	Prone to flooding	San Antonio Riverwalk	Creating upstream dams, cut-off channels & flood control tunnels to regulate flow of water
3)	Polluted with sewerage	Cheonggyecheon	Constructing separate sewage system to segregate sewage from waterway

Background

The government of Shantou aspires to develop Shantou into a regionally competitive hub and a central city of Guangdong province. While it was designated as one of China's original five special economic zones, it hasn't experienced the same economic performance as many of its contemporaries. In fact, its GDP has fallen relative to some of its neighboring cities. As Shenzhen and Xiamen have seen remarkable strides in local industry and economy and continue to attract substantial investment, Shantou remains left behind.

The government has already taken important steps to enhance the city's competitiveness including significant infrastructure improvements. Unfortunately, Shantou still suffers from a brain drain as much of its top talent leave the city to find more lucrative opportunities elsewhere. In addition, many Shantou University students, both local and national, similarly leave after graduation to pursue job opportunities in other cities.

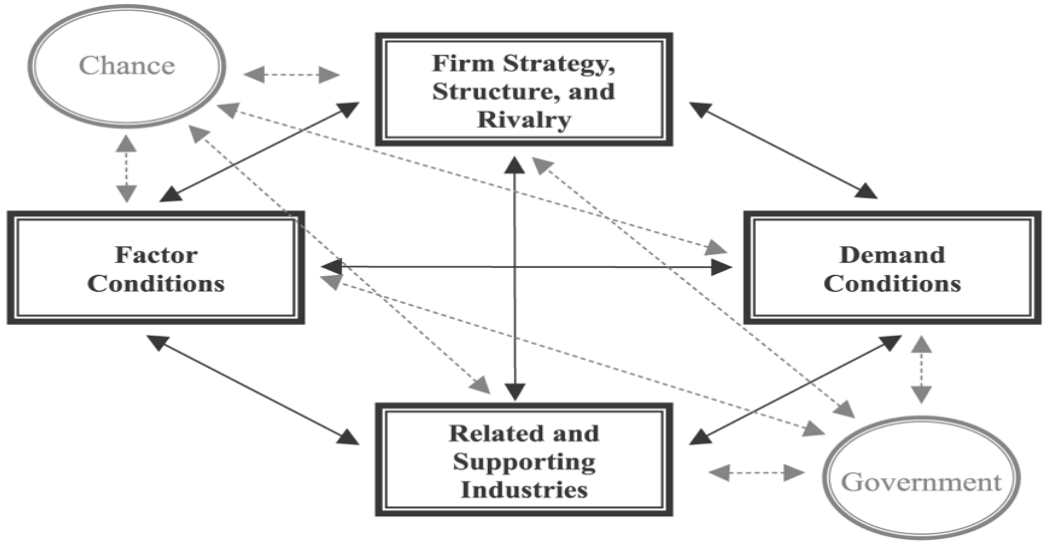
In order to become regionally competitive, Shantou needs to keep and attract a local talent pool through creating incentives and opportunities. By growing and cultivating local industry, Shantou can take the steps towards achieving this.

What is this tool?

Through industry clustering, Shantou can leverage the strength of its core industries to become a regionally competitive hub in the food processing sector. Food processing is currently one of Shantou's pillar industries, with activities in seafood, dried fruits and nuts, confectionary, and baby food among others. Given its strength in the packaging and retail industries as well, food processing has the potential to become an engine for the economy in eastern Guangdong.

Porter's diamond, developed by economist Michael Porter, examines competitiveness through clusters of industries and location. Clusters are geographically concentrated groups of interconnected companies, universities, and related institutions that arise out of linkages or externalities across industries. According to Porter's analysis, the competitive advantage of industry clusters derives from the common infrastructure that strong clusters can feed into as well as benefit from.

Porter's Diamond> These factors interact with each other to create conditions where innovation and improved competitiveness occur.



Shantou boasts a unique cuisine and culture, and Shantou can take advantage of its Chaozhou heritage towards developing a strong and unique food processing industry. Furthermore, multinational retailer, Wal-Mart, in addition to other national chains have found notable success in Shantou, which speak to the strong local purchasing power and potential for a robust food processing cluster.

Wal-Mart has experienced success throughout China
(Source: www.nydailynews.com)

Strong influence of unique Chaozhou culture as seen through its cuisine
(Source: english.cri.cn)

What is required to make this tool work?

Creating an innovation hub

In order to successfully develop an industry cluster and become regionally competitive, Shantou should focus its efforts on creating an innovation hub. This concept takes industry clustering a step further by directing the overall human and financial resources within the geographic concentration of interconnected companies and institutions towards innovative activity. Two mechanisms that can be implemented towards achieving such innovation within Shantou's food processing industry include workforce development and technology advancement, both of which require strong collaboration with Shantou University.

Shantou University: How an institute can dialogue with a city

Establishing partnerships between local industry and the University is important in order to foster the innovation necessary to make Shantou a competitive regional hub in the food processing industry.

>Workforce

The most important aspect to create an innovation hub is the development of the education sector, most obviously for the cultivation of a higher-skilled workforce. Strong university-industry linkages must be fostered in order to reinforce the bridge from education to jobs and companies. One method to enhance this is through scholarships that bring talented students to universities in the city and that would help with job placement there following graduation.

>Technology

The University can also create a link between technology and industry. An investment in R&D can generate technological advances that will improve Shantou's food processing industry. A university research center can lead to a technology upgrade and modernization of the industry that would enhance competitiveness.

Why should this tool be used?

> To stay competitive locally, regionally, and globally

> To attract both industry and labor

> To raise more money for city government

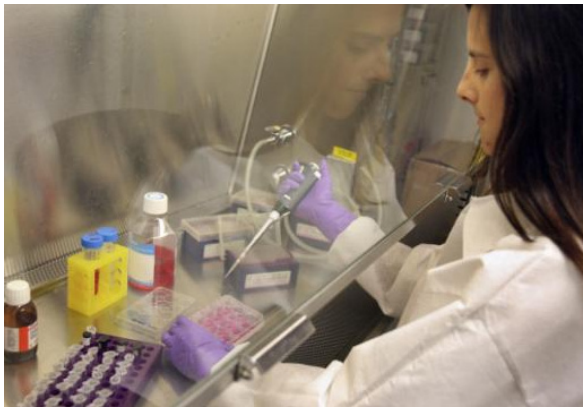
> To keep the city resilient to economic shock

> To create a higher standard of living

> To attract additional investment

Case Studies

>Cambridge, MA, USA: Biotech Hub



Cambridge serves as a center for the biotechnology industry within the United States
(Source: www.boston.com)

> Singapore: Chemical Hub

Singapore has little trouble attracting major chemical companies to set up operations (Source: www.teleport-myjob.com)

Local universities in Cambridge such as MIT and Harvard serve as R&D centers for the biotech industry (Source: commons.wikimedia.org)

> Bangalore: IT Hub

Bangalore has a number of IT parks to accomodate the industry's growth (Source: www.nationalpost.com)

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Shantou's Food Culture:

Utilizing Shantou's food culture as an economic development tool by creating a market district to benefit Shantou's economy.

A Culture of Food

Fresh Food

In most cultures around the world, food can be described as a social "glue" or social "lubricant." Food brings people together, instills comfort, and provides a common ground. In China, food is an integral part of the culture, as evidenced by the many types of cuisine throughout the country, and the proliferation and visibility of Chinese cuisine around the world. Chao Zhou culture (also called "Chiu Chow"), while famed for various aspects such as its opera and unique way of drinking tea, it is in many respects most renown for its cuisine. Fresh and flavorful, its culinary delights range from distinctively prepared seafood to soups to special braising techniques that extract the essence of the meats.

The two major cities of Shantou and Chao Zhou are encompassed within the Chao Shan region. Chao Zhou culture thrives in the whole Chau Shan region, including in Shantou. High-quality food is coveted by the residents of Shantou, much of it influenced by its Chao Zhou-rooted residents.

Selection of Chao Zhou side dishes Souce: USDA GAIN

Despite the area's limited arable farmland, fresh produce is still consistently grown and sold. Fresh fruits and vegetables such as citrus varieties, bananas, olives, lychees, radish, and cabbage are readily grown, and several types of fish and other seafood such as abalone are widely farmed. Specific varieties of geese and other livestock are also raised, with the expanded production of the "loin head goose" in recent years due to the high value of its large liver for pâté production[1]. Overall, fresh seafood, vegetables, and specialties such as geese necks and heads are sought after by the Shantou population.

Problem: The way in which food is sold and presented does not properly reflect the eminence of Chao Zhou cuisine. One of Shantou's most popular markets is unofficial and located off the side of a main street with a disorganized appearance. Here, produce from nearby small farms is informally sold, laid out on mats on the sidewalks that spill over onto the street.

Photo credit: Jasmine Tillu

The market is used not only as a place for daily food shopping needs, but also as a locale for socializing with neighborhood residents. As a result, there are usually a number of stagnant visitors that fill up the streets, adding to the congestion created by automobiles and other vehicles that go through the street. Bicycles and carts do not have a specific lane and are sometimes cumbersome with their baskets of produce, making it a somewhat unpleasant stroll to shop for food. Although functional and frequented by many, the current market is unsanitary and disorganized, creating a slightly chaotic experience. How can a formal market be created to make for a more organized and pleasant shopping space to attract consumers?

Processed Food

While Shantou covets fresh food, it is at the same time experiencing an increase in the purchasing of processed foods.

The food processing sector is a major industry in China. Over the past five years, this industry has grown at almost 30 % annually[2]. Shantou is considered as one of the leading cities that directs the way for food processing in China, with an yearly output of about US$ 880 million (RMB 6.7 billion), growing annually at a two-digit rate[3]. Shantou has a well-developed food processing factories for dried fruit, preserved vegetables, nuts, confectionary products, soymilk, and seafood. There are currently about 1000 major food processors in the Shantou area and many minor ones which are growing[4].

Shrimp Processing Factory - Source: USDA GAIN Report

The USDA Foreign Agricultural Service cites that rising disposable incomes and increasing urbanization rates in China contribute to the changing Chinese diet that is beginning to favor novel and convenient processed, packaged foods over natural, fresh foods. These reasons combined with the city's current position as an "Emerging City Market" makes it likely that the food processing industry will experience continued growth.

Problem: In recent years, a series of food scandals involving melamine in milk power and others have made food safety in processed, packaged foods a major concern in China. A survey conducted by A.T. Kearney Inc in 2007 showed that food safety has become "very important" to Chinese middle-class consumers, and that 83% are willing to pay a higher amount for a better brand to ensure safety[5]. Though not as widely well-known in China, an increasing number of Chinese consumers are paying attention to the fact that processed, packaged foods can be very unhealthy as many are made with a significant amount of preservatives to ensure a longer shelf-life and low-grade ingredients to cut costs. How can the food processing industry in Shantou expand by taking into account these considerations?

High Amount of Disposable Income Spent on Food

An emphasis on fresh food combined with the increasing availability and novelty of packaged, process foods, among other reasons, underscores the high percentage of disposable personal income spent on food in Shantou. Based on 2006/2007 figures, about 40% of per capita disposable income is spent on food[6]. In contrast, in the United States, about 9.6% of total disposable personal income was spent on food in 1998[7].

Clearly, food is an important aspect of the Shantou culture and economy. How can this theme be leveraged for the benefit of Shantou's economy and image?

What is this tool and where has it been applied?

Utilizing Shantou's food culture as an economic development tool can benefit Shantou's economy. The tool itself is the actual demarcation and implementation of a comprehensive market district, which will position the Shantou economy, create jobs, and become a local attraction, fostering identity and sparking tourism. The district would be located in a strategic part of the city and add another "neighborhood" to the city center. The district is comprehensive because it would incorporate several aspects, including an integrated food market-restaurant area, offices for the Shantou Food Commission or Food Authority*, a food possessing training center, and a possible culinary school focusing on Chao Zhou cuisine. *Inclusive in this tool is the establishment of a Shantou Food Commission, which can be located within the Tourism Board or another city agency.

Integrated market-restaurant area

The integrated public food market-restaurant section would be a permanent showcase for the area's farm products and local cuisine. It would open daily and sell produce from local farms and fisheries (versus wholesalers) in one area, and be located next to a series of restaurants and more casual hawker stalls with ample seating in another area. The current informal market vendors can be relocated to this area. As part of the experience, customers would be encouraged to choose their own piece of fresh seafood or meat from the marketplace to be cooked in their chosen restaurant or hawker stall. The establishment of a formal "food destination" allows for a display of local produce and delicacies and unique shopping and dining experience.

Many major cities around the world have a type of food district that is a major attraction within the city. Two examples of where this has been implemented is Pike's Place Market in Seattle, Washington, USA, and the Mercado Central, in Santiago, Chile. Pike's Place Market is a historic market that is one of the oldest continually operated public farmers' markets in the United States. Small farmers, fishmongers, and merchants display and sell their local products and small restaurants reside beside the hustle-bustle of the market. It is run by Pike Place Market Preservation and Development Authority (PDA). Pike's Place Market has become a cultural symbol of the best that Seattle has to offer.

The Mercado Central has long been known as the city's charming market-restaurant destination located in a steel art nouveau building built in 1872 in downtown working-class Santiago. It is known for its variety of seafood and goods that sit next to multiple restaurants that serve simple and authentic Chilean dishes with an emphasis on freshness. It is a must-see and must-experience in the city for first-time visitors.

Pike's Place Market - Source: *Food Markets of the World*

Mercado Central - Source: *Food Markets of the World*

Food Commission

The establishment of the Shantou Food Commission would be necessary in order to oversea all matters regarding food in the city. In response to improving the quality of health and cleanliness, the commission would set and implement specific standards. Standards would be created for the cleanliness of all food or beverage establishments, including restaurants and stall vendors. These would be implemented by having officials from the Commission inspect them on a regular basis and give ratings. These ratings would then be placed in a visible area of the establishment allowing customers to make an informed decision of where to purchase and dine. This would also provide incentives for the restaurants to increase their sanitary standards. Additionally, the Food Commission would have marketing responsibilities. The Commission would officially establish a list of traditional Chao Zhou dishes, creating a type of "Food Guide" for tourists and visitors. Other marketing schemes include initiating a "Food Festival" or "Restaurant Week," to generate attention and excitement, encouraging spending and consumption.

Singapore and Sydney, Australia are two cities that have dealt successfully with food marketing and standards. In Singapore, much of the food marketing lies within the Singapore Tourism Board. Every year, the "Singapore Food Festival" takes place mid-year for one month with core events, themed celebrations, culinary workshops, and nation-wide competitions. It is an extended event that celebrates local foods and encourages its consumption. An "Insider's Food Guide" has also been made as an easy-to-read, eye-catching pamphlet, distributed at the airport and other visible areas in the city. It has contributed to Singapore's international reputation as a diverse food haven. Both Sydney and Singapore have a hygiene food safety rating scheme in place. Since its implementation in Singapore a few years ago, there has been a 75% reduction in reported food poisoning cases[8].

Syndey's newly implemented scheme, called "Scores on Doors," is modeled after the Singapore scheme. It rates food establishments with a simple A (excellent), B (good), or C (acceptable). These scores will be posted on the front of the establishment as a way to improve food hygiene by rewarding those

Singapore Food Poster - Source:
National Library Board Singapore 2007

who are up to standards and get ones who are not to improve. This is implemented by the New South Wales Food Authority.

Food Processing Training Centers

Given the continued and projected expansion of the food processing industry, it would be beneficial to create a food processing training center in the district in order to spur economic development. The center would aim to train workers in order to generate employment. Any standards set by the Shantou Food Commission would be included in these trainings. These centers would help bring low-skilled and low-income residents into the industry and the mainstream economy.

Culinary Schools

For the long-term, the development of culinary schools focusing on Chao Zhou cuisine – dishes, ingredients, and techniques – would benefit Shantou in several ways. It would create new jobs in a new industry, bring further fame and attention to local delicacies, and draw tourism. Once the profile of Chao Zhou food is furthered and tourism in the area increases, cooking lessons can be introduced as a unique tourist activity.

The popularity of Thai food around the region and the world has sparked the explosion of Thai culinary schools. In Bangkok, Thai cooking classes have become a popular tourist pursuit, ranging from short one-day classes for the passing tourist to extended classes for long-term visitors.

Why should this tool be used?

This tool of creating a market district and food commission should be utilized in order to ignite economic development for Shantou. By leveraging Chao Zhou's famous food culture, the city can brand itself through this food angle to attract tourists, ultimately enhancing the city's economy.

- Integrated market-restaurant area + training center + culinary school --> create jobs
- Integrated market-restaurant area + food commission + culinary school --> increase the profile of the already well-known Chao Zhou cuisine --> increase tourism (attraction provides a unique window into Chao Zhou culture) --> create jobs
- Integrated market-restaurant area --> improves urban image
- Food comission --> improved food safety
- Chao Zhou's culture and delectable cuisine is reinforced and celebrated which builds community

Where does this tool apply?

This tool could also be applied in cities within southern China, as food culture reigns high, but can certainly be developed in other cities across China.

Aspects to Consider

The market district could be formed through a partnership effort between the Shantou city government and private food businesses, or private entrepreneurs and private food businesses. The city of Shantou would be in charge of demarcating and implementing the market district and must attract the necessary food vendors and restaurant owners. The implementation would depend on the available resources from a city government and the organizational bodies that would be available for its management.

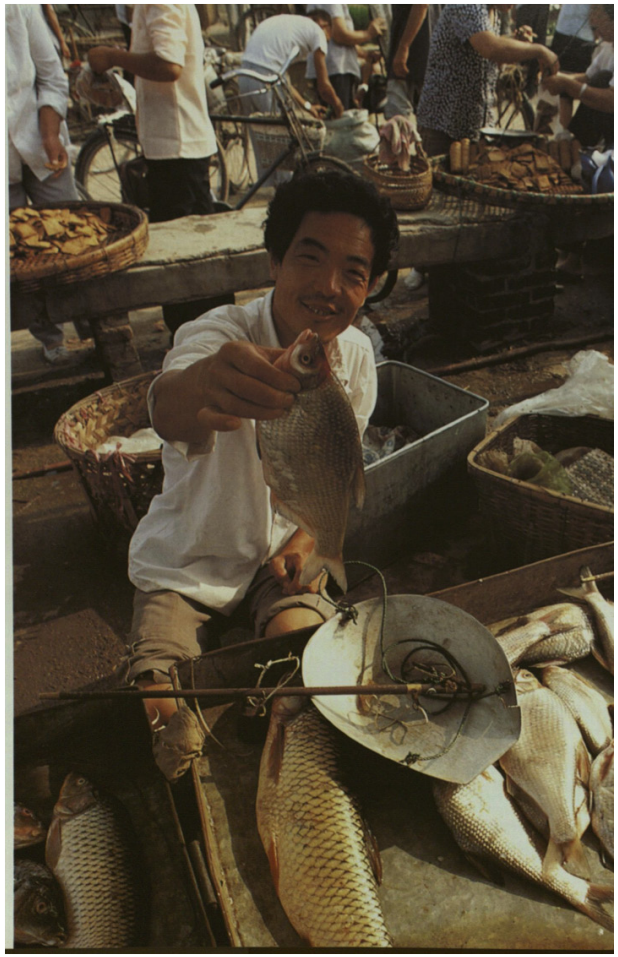
Location of the market district must be considered. Analysis should be conducted to find the optimal location. Ideally, the district would be located near public transit for easy access, residential centers to allow for resdiental customers, and/or places of work, so that workers can easily go after work to purchase items. It should expect a bigger crowd on the weekend hopefully from people that live in the suburbs or outside the immediate Shantou center area.

Size is another important aspect of the district. In the US, the size of public markets in cities varies widely from about 78,000 square feet in Philadelphia (population 1,540,351[9]) to about 29,000 square feet (population 433,748[10]). It is obvious that a true comparison cannot be made given the different densities and compositions of US versus Chinese cities,

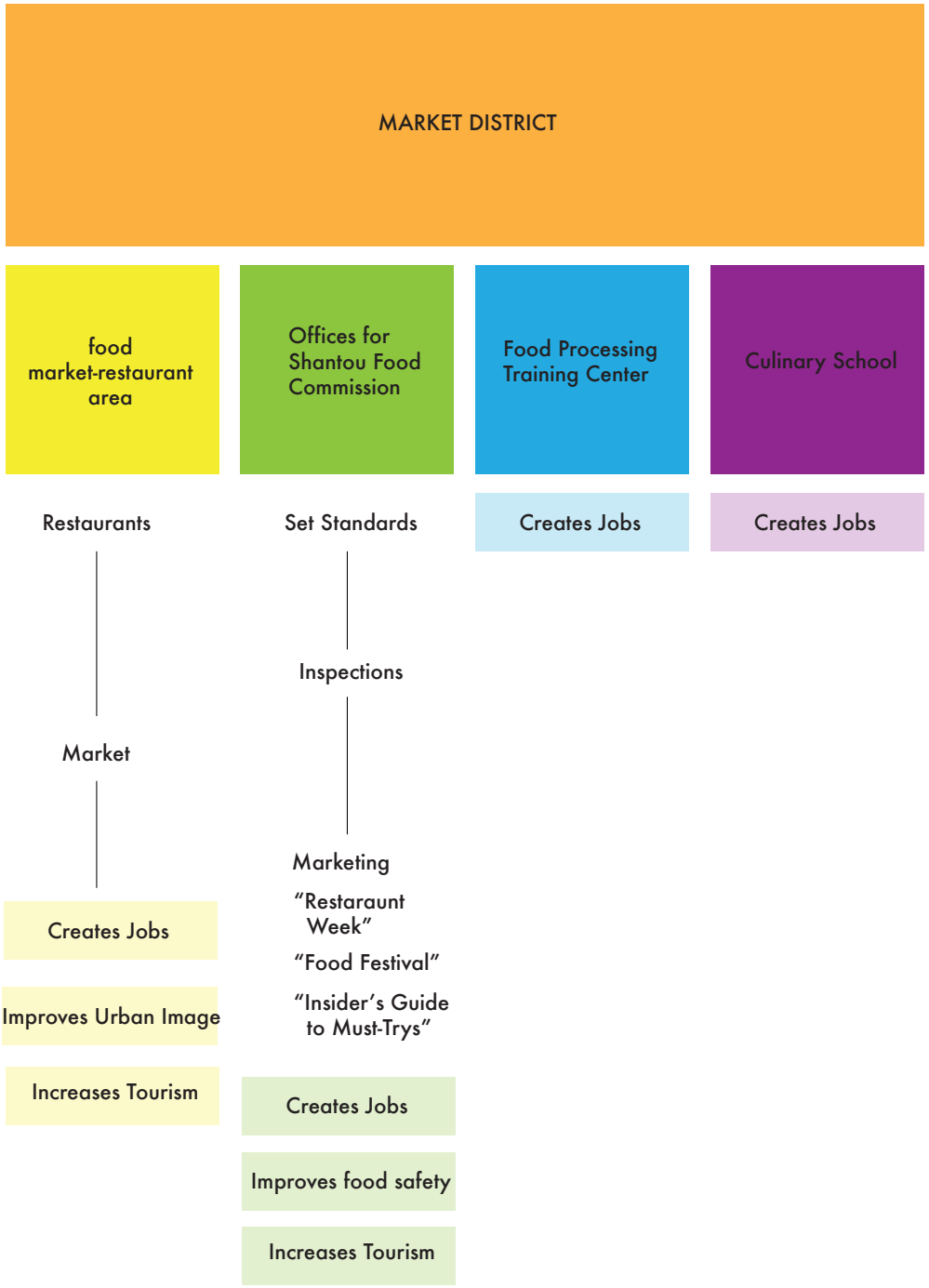
though citing some examples of other market sizes can still be helpful.

CONCLUSION

A new market district in Shantou will showcase and capitalize on its vibrant food culture and act as a catalyst for economic development in region



Fish Market - Source: *Food Markets of the World*



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What is the Tool?

The university and the villagers jointly transform the urban village into a mixed-income community that provides affordable housing under the regulations from the government.

What is the goal for the tool?

- Provide affordable and decent housing / incorporate affordable and decent housing into mixed-income community
- Incorporate original villagers into the decision-making process of urban village transformation, and provide them with long-term income source.
- Fair distribution of benefits among stakeholders according to contribution
- Preclude the substandard high-density urban village redevelopment mode that is common in fast expanding cities such as Shenzhen.
- Leverage the university's influence to garner funding for urban village transformation from broader sources as compared to limited financial resources of the villagers.

Where does the partnership approach apply?

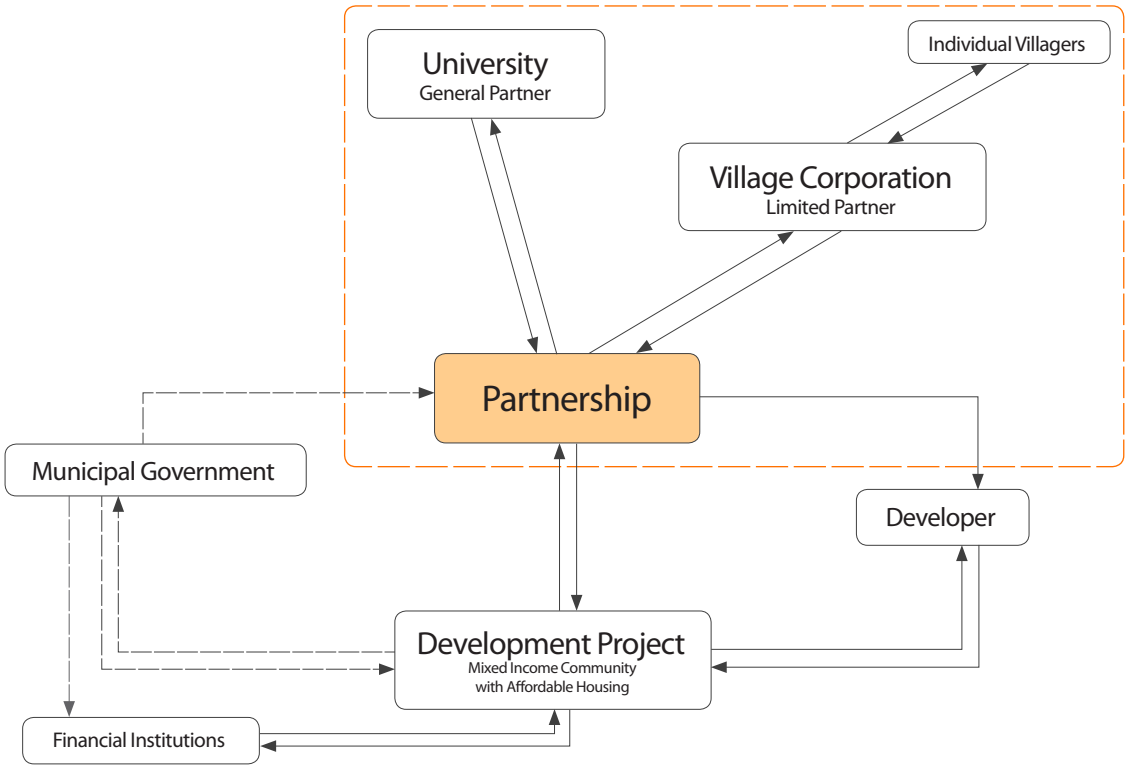
Urban village transformation that involves collectively owned land, AND bears the goal of providing affordable housing.

What is required for this tool to work?

The government should be actively involved to prohibit unregulated development projects and mandate the provision of affordable units as prerequisite for project permission.

Who are the participants and what are their roles?

The university – as the general partner in the partnership, the university provides management, technique support/expertise, leverages its influence in terms of social network and credibility to garner funding and government support. They contribute all the above in return for shares in the partnership and receive dividends.



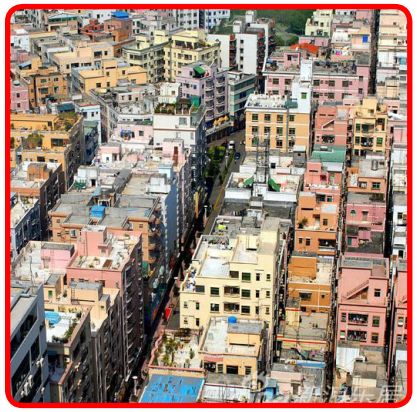
The village corporation – Villages form a corporation that transforms land ownership into shares. As shareholders, they participate in the decision-making process of the village corporation. The village corporation joins the partnership as limited partner, who participates in the decision-making process but is not directly involved in the daily management of the partnership. The village corporation contributes land in return for shares in the partnership and receives the dividends from shares in the partnership. The profit the village corporation generates is then further distributed to individual villagers as dividends according to their shares in the village corporation.

The government – The government has a critical role as it regulates what kind of development projects are permitted on the site. It mandates the percentage of affordable units as a prerequisite for permission. In addition, FAR (Floor Area Ratio) incentives can be applied to encourage a higher ratio of affordable units in return for higher FAR. The government therefore is able to provide affordable housing with little if any cost. The whole city benefits from these affordable units as a social return for their contribution to land value appreciation through the improvement of infrastructure, etc.

The developer – The developer is hired by the partnership to exercise the development of projects, they receive developer fee as a return for their service.

The financial institutions (banks) – provide funding through loans and get interest as return.

Background: The Current Two Prevelant Modes of Urban Village Redevelopment



Redevelopment Lead by Villagers
Affordable BUT substandard

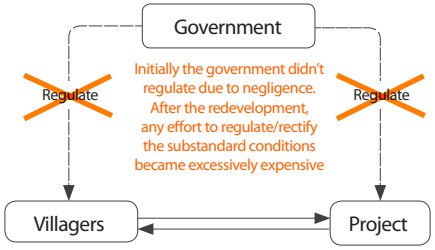
Photo Source: http://citylife.house.sina.com.cn/detail.php?gid=14683, Retrieved on May 12th, 2010

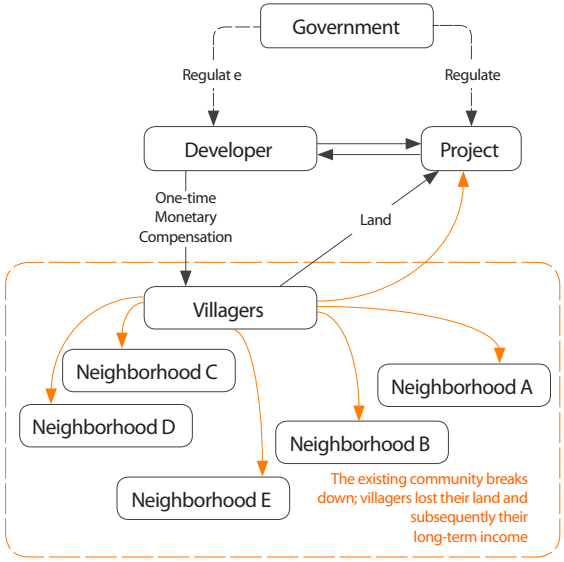
Alternatives?

Decent AND Affordable

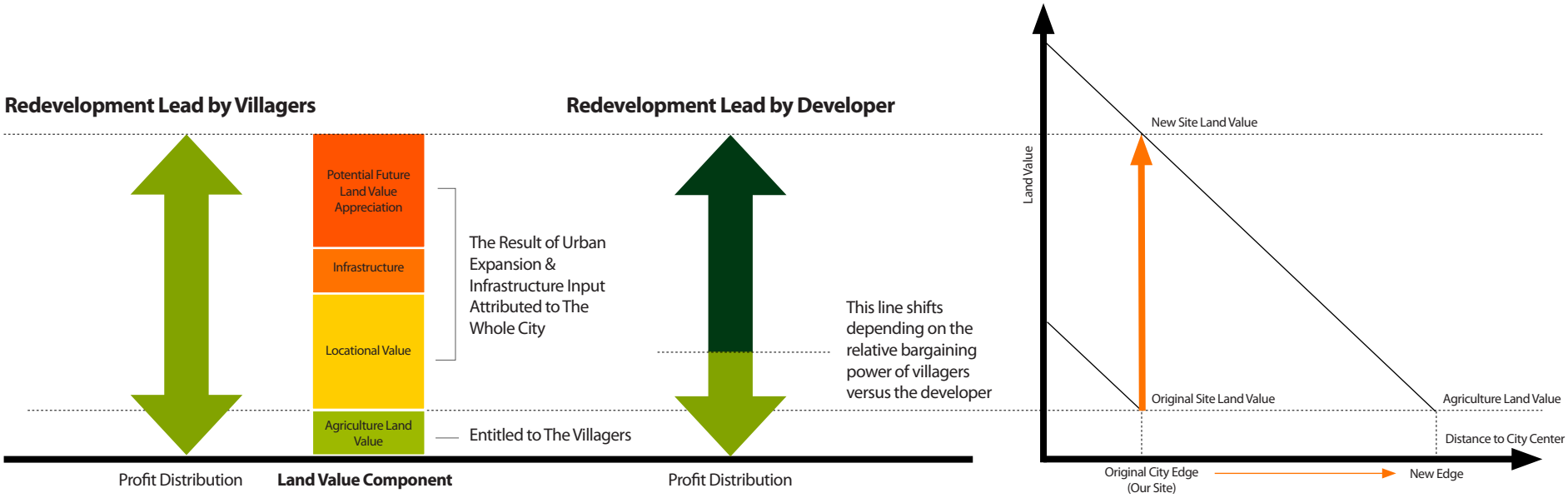
Redevelopment Lead by Developer
Decent BUT unaffordable

Photo Source: by author

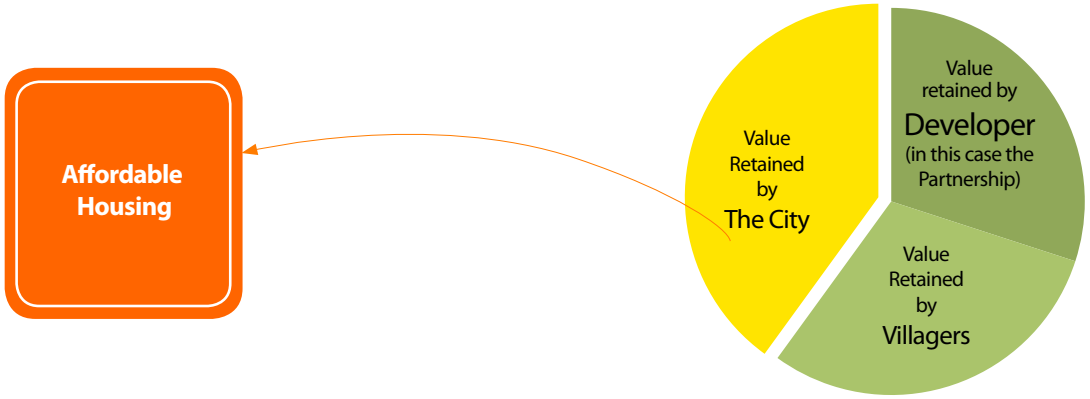




Unfair Distribution of Benefit under Current Modes of Urban Village Redevelopment



Under the current mode of redevelopment, land value is either retained by villagers or shared between villagers and the developer. (In the latter case, villagers are usually compensated in cash from the developer and relocate themselves into new neighborhoods through purchase of market-rate housing. The transition of villagers from rural popoulation who farm on their land to urban population is often accompanied with the loss of their stable income source as many of them do not have the expertise to quickly fit into the job market.) However, as shown in the graphics above, the appreciation of land value is a combined result from urban expansion, infrastructure improvement, etc., and therefore, as a contribute, the city as a whole should share the benefit, one of which is using the appreciation of land value to subsidize affordable housing.



Land Value Distribution

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1. INTRODUCTION

1.1 What is the tool?

A transit-oriented development (TOD) is a mixed-use residential or commercial area designed to maximize access to public transport, and often incorporates features to encourage transit ridership. [2]

This concept was first issued by Harrison S. Fraker, a professor of architecture and urban design in U.S, aiming at the problems of unlimited urban sprawling. [4]

A TOD neighborhood typically has a center with a train station, metro station, tram stop, or bus stop, surrounded by relatively high-density development with progressively lower-density development spreading outwards from the center. TODs generally are located within a radius of one-quarter to one-half mile (400 to 800 m) from a transit stop, as this is considered to be an appropriate scale for pedestrians. (Figure1)

1.2 What are the main goals of this tool?

The main goals of this tool include:

• Activating economic development and commercial activities;

• Promoting the circulation in the area and strengthening the connections between clusters with different functions;

• Cooperating with compact and mixed use development in land use;

• Building up a pedestrian-and- environment-friendly community;

• Creating a growth pole of the city.

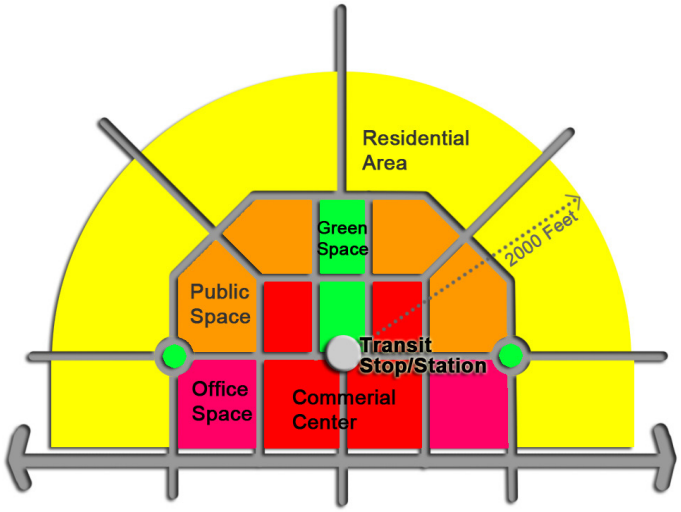
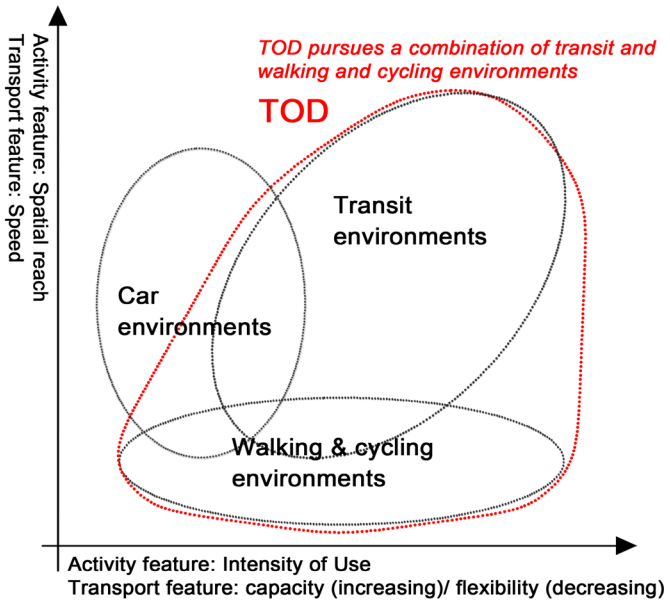


Figure 1 Land use mode in TOD

Resource: Refer to [http://trc.bjut.edu.cn/bbs/printpage.jsp?forumID=9&rootID=2134]; [http://www.fwwwd.com/content/2008-12/02/content_3434518.htm], Diagramed by Author

Figure 2 Transport and land use correlation

Resource: [1]



1.3 What are the advantages of this tool?

TOD pursue a combination of transit and walking & cycling environments. (Figure 2) Comparing to car environments, TOD could gain a better balance between speed, spatial reach and capacity of transportation, which could bring a greater efficiency and scale economy.

1.4 When and where should this tool be used?

There are some prerequisites of TODs:

• **New transit development**

Transit Oriented Development, as the meaning of its name, should be stimulated by some new changes in transit conditions.

The changes in both transit lines and stations are important. Transit lines determine the directions of connecting flows, which usually cause the different development sustainability; meanwhile, the stations are often the hub of these flows, which directly orient the local development in specific space.

• **Pedestrianization**

Pedestrainization in community is also another prerequisite for TOD, which require a walkable community with pedestrian and public-transit priority. Pedestrainization is a substitute alternative for motorization. The tradeoff between this two has already existed for a century. The diverse choices of cities are not only from the different living habits of the residents, but also the original urban form and national industrial strategies in the long history. [4]

• **Frontier of growth**

TOD is a pulling mode of development, and it needs flexibility of organization and spaces for

1.5 How to make this tool work by planning?

Some principles and steps should be followed in design or planning to make TOD mode work: [3]
1) In the regional level, there should be plans to organize and support a compact urban system with public transportation;
2) Commercial centers, residential areas, office spaces, parks and other public serving spaces should be appropriately arranged in walkable distances to some public transit station;
3) A network of pedestrian routes must be built up to connect all kinds of buildings and facilities in the community;
4) The type, density and price of housing in the community should be mixed up for different needs;
5) Reservation and environment protection on ecologic corridors such as riparian zones are essential, for high quality open space;
6) In community design, open spaces should be considered as spatial focuses and also centers in community activities.
7) Infill development should be encouraged, and new planning should also consider the original frame in transit and base on existing characteristics in the community,

2. TOD IN DIFFERENT REGIONS

2.1 TOD in U.S

---- Not very popular

Though the concept of TOD was first raised in United States, since TOD has closed relation with public transit system, the motor-dominant transit system in this country determines the use of TOD is not as popular and successful in regional level until now:

Primarily, the dependency of U.S. citizens on automobiles is firm, not only in real living habits, but also in mentality. This has resulted in a huge private ownership of cars in U.S. [4]

Also, infrastructure constructions on public transit system are costly but the accounting benefits are usually low, and the capital reclamations are slow, so in most of the regions, the developments in public transit normally rely on financial and other supports from the government. For US, this kind of investments will be dangerous and high-risk inferring too many stakeholders, which will limit the up-down supports on public transit and further public transit and TOD developments. [4]

2.2 TOD in HK

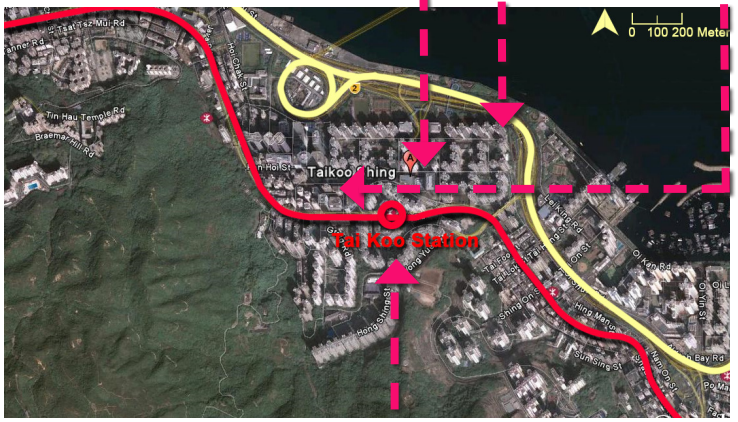
---- Very popular and sucessful

1) Reasons of TOD

The land resource in Hong Kong is very restricted, that is the reason for Hong Kong to invest a lot to develop public transit. Also, because of this urgent needs facing by HK, the researches on public transit, TOD and even financial modes are very advanced in HK.Based on the cooperation between developer, government and residents, the win-win balance between real estate development, transit construction and setting up of public facilities has been reached in HK. [4]

Figure 3 Case study on the development of Tai Kong Shing
Resource: Map from: Google earth; Photos from: [http://www.panoramio.com/], Diagramed by Author

Tai Koo Subway Station (Transit)



City Plaza (Commercial)

Open space

Real Estate

2) Case study: Tai Koo Shing

One of the most successful TOD cases in HK is the Tai Koo Shing, which was a private housing estate group in Kornhill, Hong Kong Island developed by Swire Properties.

The developments of the whole area surround and base on the subway station, Tai Koo. Some real estate projects started from 1980s. Later, the constructions of commercial center and open spaces have been completed gradually. [4]

2.3 TOD in Mainland of China
---- Develop in fast speed and broader scale

1) Regional context

For pulling the economic development and regional integration in mainland, the central government issued a master planning of High Speed Rail (HSR) system in China 2010~ 2020 and already started to construct HSR beyond province scale.

According to the planning of HSR, 2010~2012, China will build an 8-hours HSR commuting cycle with the center in Beijing. Until 2012, there will be 13 thousand km of HSR in operation, including 8 thousand km HSR in speed of 300~350 km/hr, and 5 thousand km in speed of 200~250. In the future transit system, there are 5 vertical lines, 4 horizontal lines and 3 cycle systems (Figure 5-3). The speeds of these HSR will all be beyond 200 km per hour. In 2020, the length of this kind of HSR (over 200 km per hour) in China will be more than 18 thousand km, which is almost the half of the total length in the world. [7]

These big scale constructions on High speed transit system could be considered as a TOD mode in regional scale (Figure 4), which are great pulling forces in developments of every evoluting metropolitan region in China (Figure 5-2). Also, this is also a regional context good for local transit development.

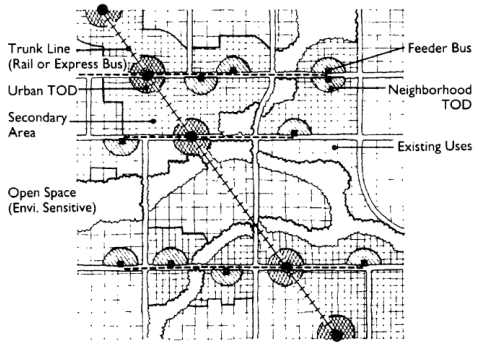


Figure 4 Regional TOD Model
Resource: Satish McKay Lion, 2003

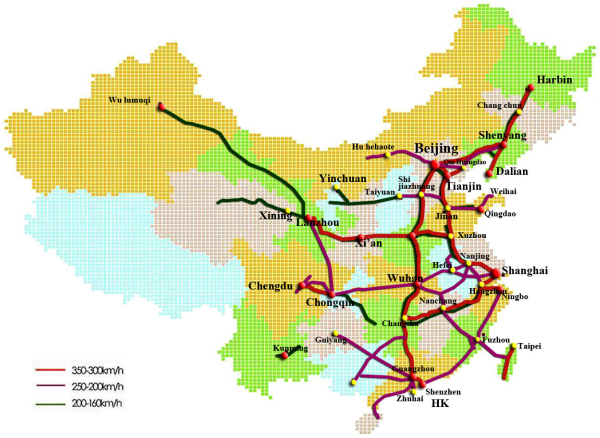


Figure 5-1 The speed levels in planned HSR system in China
Resource: Refer to master planning of HSR system in China, Diagramed by Author

Figure 5-2 The evoluting Metropolitan Regions in China
Resource: Refer to Ruxi Gao and Shougui Luo, 2007, Diagramed by Author

Supplement to Figure 5-3

5 Vertical lines:
Beijing---Shanghai
Beijing----Wuhan-----Guangzhou---Shenzhen---HK
Beijing---Shenyang---Harbin (Dalian)
Hangzhou---Ningbo---Fuzhou---Shenzhen
Beijing—Bengbu---Hefei---Fuzhou---Taipei

4 horizontal lines:
Xuzhou---Zhengzhou---Lanzhou
Hangzhou---Nanchang---Changsha---Kunming
Qingdao---Shijiazhuang---Taiyuan
Shanghai---Nanjing---Wuhan---Chongqing---Chengdu

3 HSR Cycle Systems
Bohai Cycle:
Beijing---Tianjin, Tianjin-Qinhuangdao, Beijing-Qinhuangdao, Tianjin-Baoding
Yangtze River Delta:
Nanjing—Shanghai, Hangzhou-Shanghai, Nanjing-Hangzhou, Hangzhou-Ningbo;
Pearl River Delta:
Guangzhou-Shenzhen, Guangzhou-Zhuhai, Guangzhou-Foshan

Figure 5-3 The frame of the planned HSR system in China for 2020
Resource: Refer to master planning of HSR system in China, Diagramed by Author

2) Case study: The new town in Jinan

Figure 6 The location of Jinan
Resource: Refer to Map of China

Jinan is the Province Capital and a doubtlessly political and cultural center in Shandong. (Figure 6) Comparing to Qingdao, the biggest port city in Shandong, the economic strength and development speed of Jinan still fall behind in many aspects.

Nowadays, under the promotions by the central authority, a construction of a national High-Speed Rails (HSR) has begun. In this system, Jinan is at a very crucial crossing node to join the north-south and west-east lines (Figure 7), which will totally change the outward transportation condition in Jinan, and will be helpful to raise the status of this center.

Figure 7 The HSRs passing Jinan
Resource: Refer to Master and Strategy planning of Jinan on 2002

Especially, for Jinan City itself, since the new Jing Hu High-Speed Railway line will pass through in the west, Jinan West Station is now uder constructions already. Also, an integrated transit system in the city by light rails and highways has been planned. (Figure 8) To take the advantages from transit-oriented development and station economy, the city planned a new town to build up before 2020 in 2002 (Figure 9 and 11), and the growth of city area in the west is already accelerated. (Figure 10)

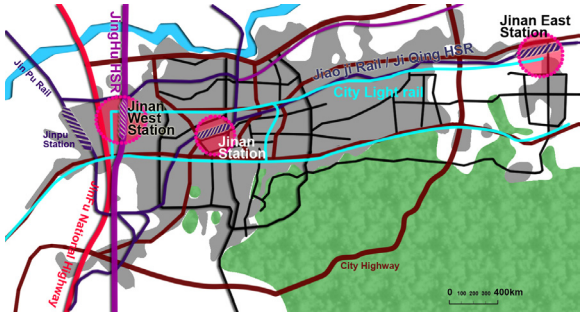
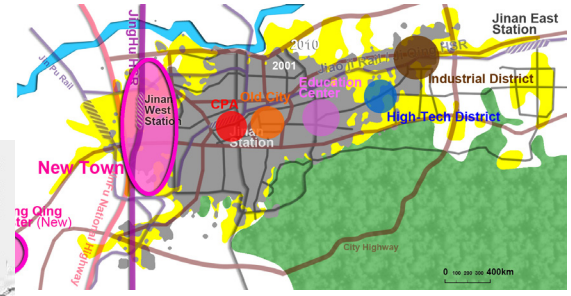


Figure 8 Master plan of transit system and new town in Jinan City



ure 9 The location and status of New town

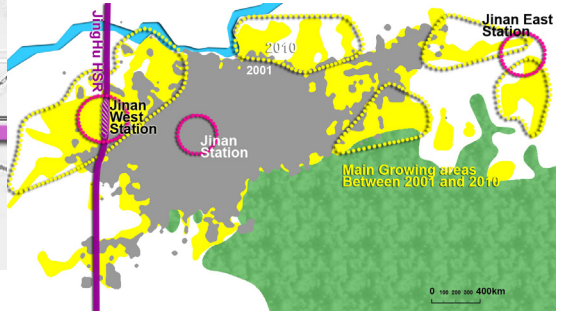


Figure 10 The Growth of Jinan City in 2001~2010
Resource: Refer to Master and Strategy planning of Jinan on 2002, Google map of Jinan in 2010, Diagramed by Author

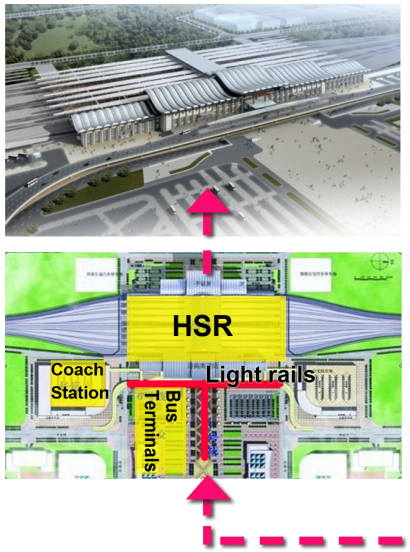


Figure 12 The Design of Jinan West Station
Resource: http://www.cr12ja.com/view.asp?id=1495

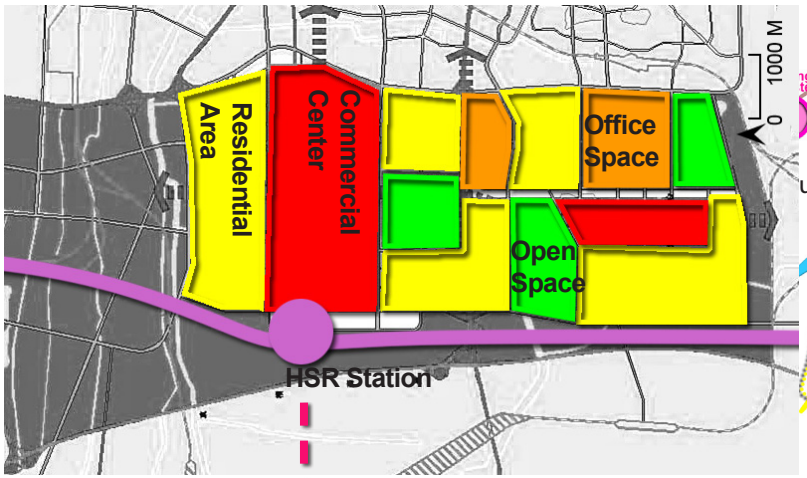
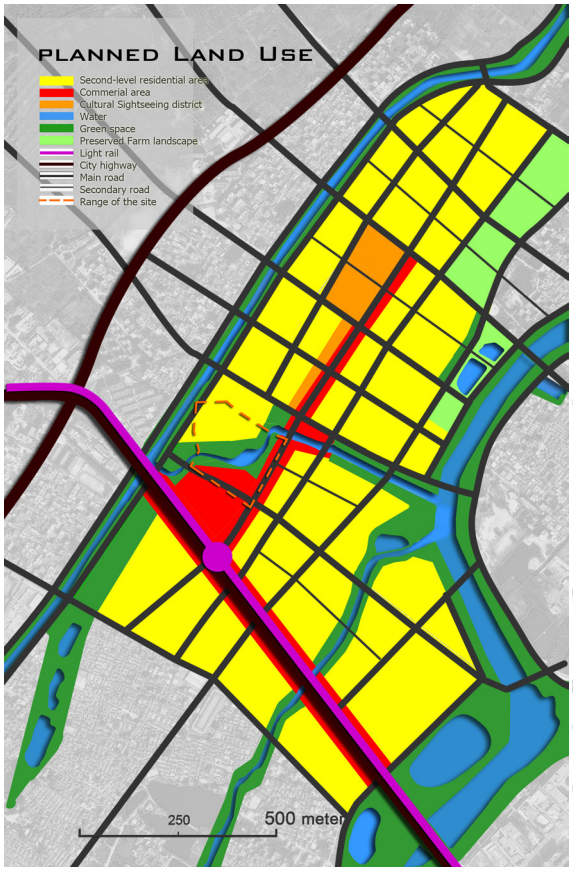


Figure 11 The land use structure in New town
Resource: Refer to Master and Strategy planning of Jinan on 2002

3.IMPLEMENTATION OF TOD IN OUR STUDY AREA OF THE STUDIO (SITE A)

The design ideas of our site and study area refer to the mode of TOD.
The area is centerized by a station of light rail in planning and is arranged with mix-used commercial and retail areas in closer distance to the station and mix-income residential areas in further surrounding cycles. (Figure 13)

Figure 13 Planned land use in our study area



Design ideas related to TOD:

Pole: Transit station
Axis: Commercial corridor
Land use: mix used and compact
Scale: Walkable distance
Transport system:
Automobile & Public shuttle & Cycling & Walking

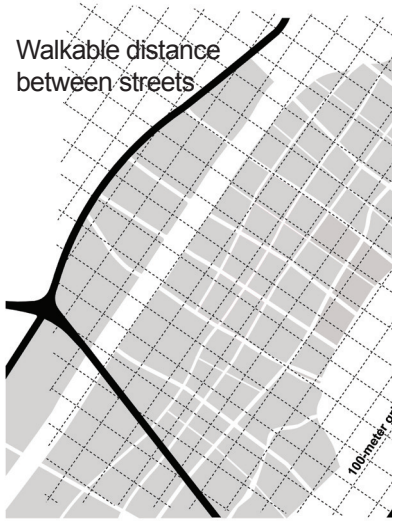


Figure 14 Griding the community

Figure 15 Commercial and retail area in the area

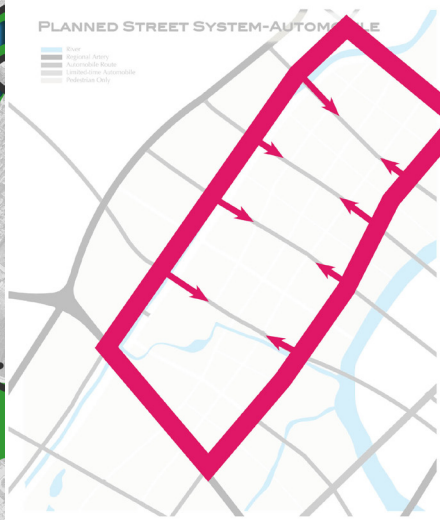


Figure 16-1 Automobile access

Figure 16-2 Routes of shuttle and cycling

Figure 16-3 Pedestrian routes

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Background: The Solid Waste Challenge for Chinese Cities

The dramatic increase of solid waste is a critical challenge for cities across China. Under rapid urbanization, the expansion of modern urban lifestyle brings about higher level of material consumption and simultaneously generates more solid waste. Among the 668 Chinese cities, more than 2/3 have reported solid waste problems.

Picture 1 A Landfill near Pudong, Shanghai
Source: Bloomberg Business Week:
http://images.businessweek.com/ss/09/08/0805_biggest_garbage_dumps/7.htm

Picture 2 Trash Truck Dumping Trash in the Landfill
Source: Adriana Sassoon' blog:
http://adrianasassoon.wordpress.com/2009/10/12/fashion-landfills/

The existing municipal sanitation facilities are not capable to properly handle the large amount of waste. Unregulated dump yards and landfills have been continuously taking over agriculture lands, creating persistent damage to soil and water. Meanwhile, the low recycling rate renders low efficiency of resource use. Threatened by the solid waste crisis, Chinese cities have started to enforce the policy priority of solid waste management, in pursuit for a systemic and long-term solution for the problem.

What Is This Tool?

Integrated solid waste management refers to an integrated system based on public-private partnership to secure the proper collection and treatment of urban solid waste, to enable efficient solid waste recycling and waste-to-energy energy generation, and to finally form a financially viable and self-sustainable "solid waste management industry".

The core concept of this tool is integration, which refers to:

> Enhanced linkage between the four solid waste management functions: collection, recycle, energy generation, and landfill disposal

> Strong partnership and cooperation established between key participants: residents, municipal sanitation services, private trash collectors, recycling companies, private investors, etc.

The tool consists of three major components:

> Partial privatization and formalization of solid waste collection services

> "Industrialization" of solid waste recycling activities on urban scale or even on metropolitan scale

> The waste-to-energy power plants and combustible gas production facilities introduced as a complement to traditional landfills

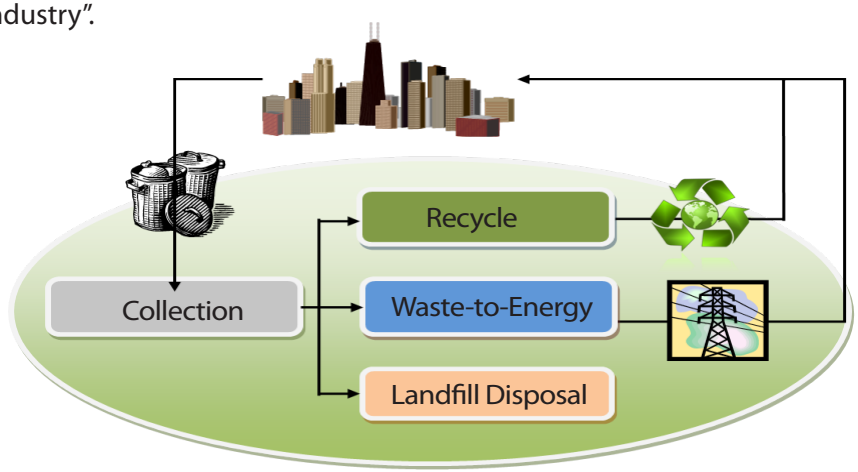


Diagram 1: Conceptual Framework of Integrated Solid Waste Management-

Why Should This Tool Be Used?

The tool is critical for Chinese cities for the following reasons:

> To expand the coverage of waste collection services to newly urbanized areas.

> To improve the efficiency of solid waste collection and transportation.

> To promote solid waste recycling in support of a sustainable society.

> To create new jobs and economic growth opportunities.

Overall, implementing this tool is a fundamental step to improve local environmental quality and create urban sustainability. Meanwhile, it is also a promising pathway towards job creation and economic vitalization. From a "3R" (reduce, reuse, recycle) perspective, solid waste is both a challenge and an opportunity. In developing countries where the residual value contained in solid waste is simply abandoned, there is much potential to explore.

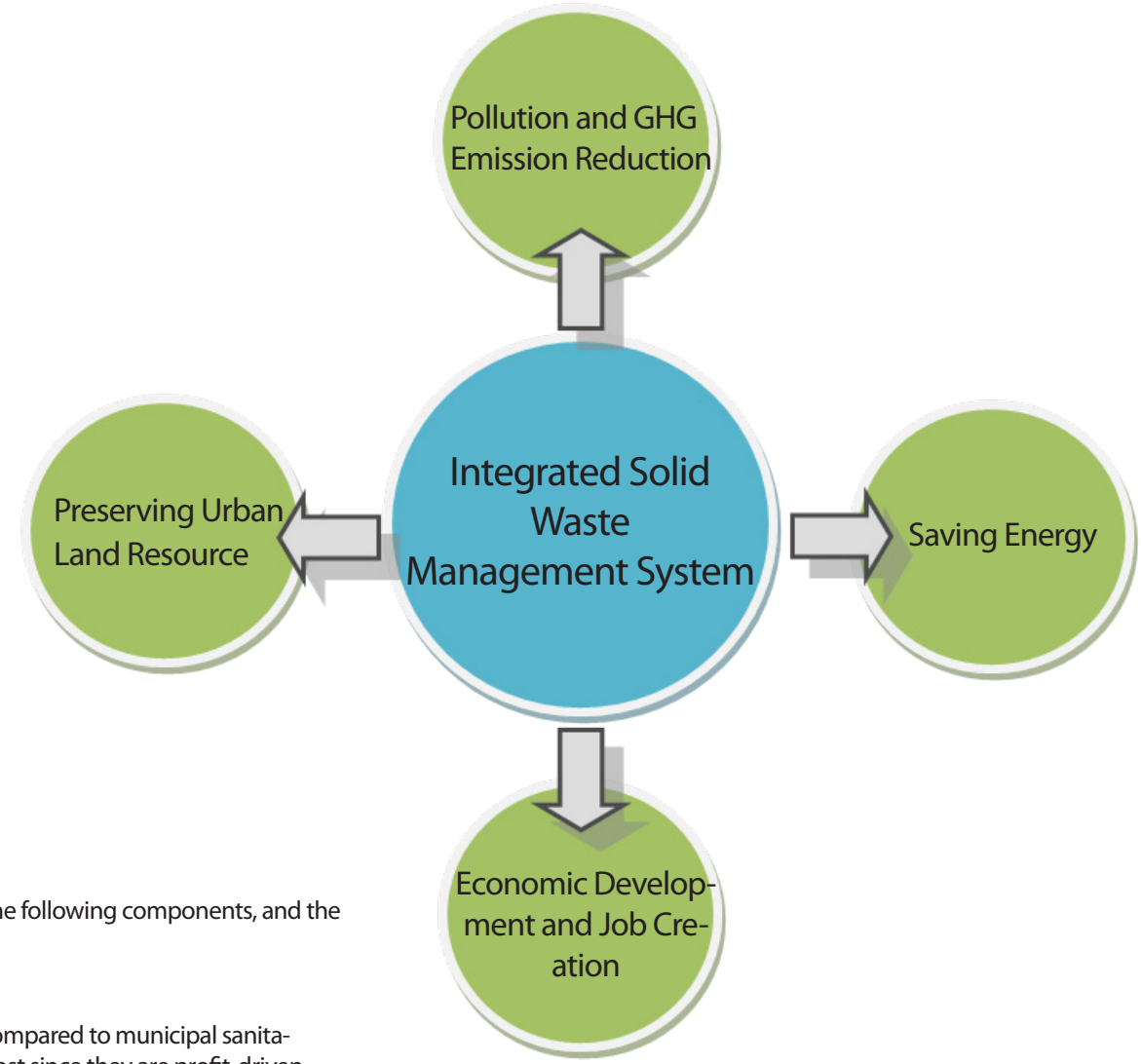


Diagram 2: Benefits from Integrated Solid Waste Management SystemMan-

How Does This Tool Work?

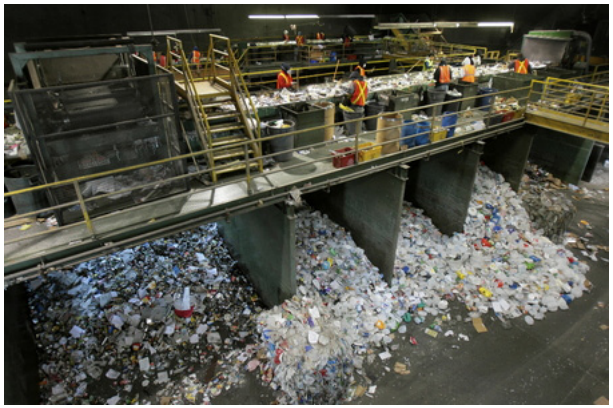
A full integrated solid waste management system contains the following components, and the ideal functions of these components are discussed.

1) Waste Collection

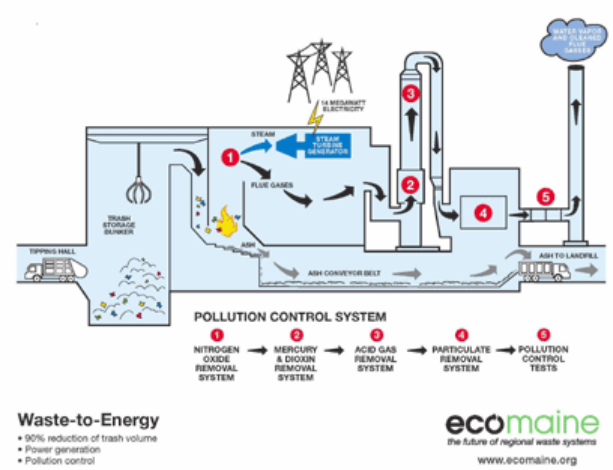
The waste collection service should be partially privatized. Compared to municipal sanitation, private firms operate with higher efficiency and lower cost since they are profit-driven. Contracting-out helps the government to cut budgets and meanwhile improve the quality of service delivery. Privatization will be especially important for new urbanized areas, where high density development starts penetrating while the municipal sanitation service has not yet followed up. Connection with industrial clients should also be established, through which industrial solid waste can be effectively collected and transported.

Picture 3 Traditional municipal sanitation in Chinese cities
Source: Suqian Daily, 2008
http://epaper.sqdaily.com/sqwb/html/2008-10/27/content_45673.htm

Picture 4 A private sector recycler in Guangdong
Source: John Richardson's Blog, ICIS
http://www.icis.com/blogs/asian-chemical-connections/china/



Picture 5 Recycling workshop of KB recycling Inc. Oregon, US
Source: John Richardson's Blog, ICIS
Doug Beghtel/The Oregonian
http://blog.oregonlive.com/pdxgreen/2008/01/recyclers_separate_the_good_fr.html



Picture 6 Waste-energy power plant -- Nanshan, China
Source: elecpedia.org
http://www.dianlitun.cn/wiki/index.php?doc-view-348.htm

2) Recycling

Effective recycling is based upon solid waste sorting in the collection stage. The ideal is that waste-sorting can be implemented on household level. But at the initial stages, the sorting work can be done by the private firms as part of the waste collection service. Local bone-men and trash-pickers can play important role in the sorting process, with formalized contracts with the private firms.

The "recycling value" contained in the solid waste can be ranked as follow: precious metal, normal metal, paper, glass, rubber and plastics, and other garbage.

The technical feasibility and recycling cost together determine the likelihood a certain type of solid waste getting recycled. From an economic perspective, the marginal revenue of recycling decreases since recycling starts from high value-containing waste. But meanwhile, if recycling can operate at massive scale, the marginal cost will decrease as well given the "economy of scale". To increase the recycling rate, three approaches are critical:

> Regional cooperation and scaling-up
> Advanced recycling technology
> Governmental subsidy and preferential policy

3) Waste-to-energy

The unrecyclable solid waste should be used for energy generation, making the waste treatment facilities self-sustainable without reliance on extra energy input. Electricity and heat can be generated either from burning solid waste directly, or from the combustible gas, such as methane, generated in underground landfill through biomass process. Using high-tech incinerators, the waste-to-energy power plants can considerably reduce heat and electricity cost of surround communities.

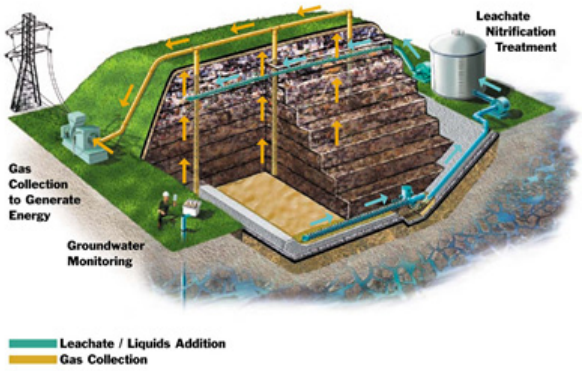
4) Landfill

Not all solid waste can be recycled or reused. The trade-off exists between waste-to-energy and landfill, given the concern of cost. The solid waste disposed in the landfill should be well managed by environmental safely techniques. Another stage of sorting might apply, separating organic waste from others to create opportunity for fertilizer production. New technology to promote methane production can also be used to activate the energy generation potential of the landfill, such as anaerobic bacteria injection.

5) Integration

The above functions can be planned and organized into a "solid waste management cluster" to enable streamline processing. The cluster can be established upon an existing landfill or a waste-to-energy power plant, gradually upgraded by adding in waste transportation centers, sorting centers and recycling facilities that take advantage of location proximity. The energy produced by the power plant can directly support the operation of other affiliated facilities.

Figure 1 Schematic of waste-to-energy power plant
Source: EcoMaine
http://www.ecomaine.org/electricgen/index.shtm



Picture 7 Schematic of environmental friendly landfill
Source: Waste Management Inc.
http://www.wm.com/wm/environmental/bioreactor_technologies.asp

Picture 8 Vestforbrænding, the largest solid waste management cluster in Denmark
Source: Danish Board of District Heating
http://www.dbdh.dk/artikel.asp?id=463&mid=24

Who Are The Key Stakeholders?

1) Local Government
Local government is responsible for the overall design of the solid waste management system, including the plans, supporting policies, and related regulations.

2) Municipal Sanitation
The municipal sanitation, which is under control of local government, will be in charge of the contracting-out and monitoring of the solid waste collection services. Meanwhile, it will maintain part of the important sanitation functions such as the landfill operation.

3) Private Solid Waste Collection Firms
The private solid waste collection firms will bid for the contracts from municipal sanitation. The firms will take full charge of waste collection and transportation in the assigned regions, covering both residential and industrial clients.

4) Solid Waste Recycling Firms
The solid waste recycling firms will "purchase" sorted recyclables form the waste collection firms and recycle for profit. Large-scale recycling factories which absorb recyclables from several cities to achieve "economy of scale" will be supported by subsidies and policies.

5) Other Private Investors
Other private investors will have plenty of investment opportunities in the solid waste treatment industry, such as equity investment and BOT (build-operate-transfer) of waste-to-energy power plansts. A competitive market with a large pool of investors will promote capital inputs, technology upgrades and the expansion of the industry.

6) Households
Households will be the direct beneficiary of the solid waste management system, provided with extended service coverage and higher quality service delivery. In the long-term, households will become the basic unit of trash sorting, which supports more efficient recycling and trash-based energy generation.

When Is the Tool Implemented?

The tool, which requires long-term stage-by-stage implementation, can be widely applied to cities at different development stages. For cities in developing countries, the privatization and formalization of waste collection has top priority, given the low efficiency of municipal waste management. For cities on higher development stage, "industrialize" the waste management system becomes the major task.

The implementation process is long-term and sector-specific. First, the guideline of the tool should come into play in the design and upgrading of the master plan. Second, special plans, such as urban solid waste management plan, should be conducted based on the tool concept. Third, on site planning at development-scale, the linkage with broader scale solid waste management system should be considered.

The strength of this tool is that it does not require immediate budget-intense upgrades of the current system. Instead, the improvement takes place through a step-wise manner with observable benefits cumulated in the long run.

Diagram 3 Impetus of system development

What Is Required To Make This Tool Work?

Promising as it is, the tool contains several institutional, financial and technical prerequisites to make it work:

> Proper incentives, such as subsidies, to promote privatization

> Effective monitoring and evaluation mechanism to secure high-quality private service delivery

> Intensive cost-benefit analysis to identify the profit potential and financial viability of the "solid waste treatment industry"

> Preferential policies established to attract potential investors with technical expertise and management capacity

> Technical cooperation and consultation with universities and research institutes; Continuous upgrades of technological capacity to enable the current "impossibles"

Best Practice: Lessons from Denmark

Denmark is a country with limited land resource. The land scarcity promotes a world-leading solid waste management system, featured by its high efficient recycling and pioneer application of waste-to-energy power plants. The key lessons from Denmark are as follow:

1) Inter-municipal waste management companies

Most municipalities in Denmark are too small to handle the waste treatment tasks in an economically viable manner. To pursue "the economy of scale", forty inter-municipal waste management companies are established, each serving several municipalities so that larger scale recycling and waste-to-energy can be achieved.

2) "Recycle first"

Recycling is the first priority in the solid waste management system of Denmark. According to 2003 statistics, more than 65% of the solid waste is recycled. To encourage recycling, various policies are established. For instance, if households sort their trash and send it to the recycling centers, no annual treatment fee will be charged. Strict regulations also apply. Trucks carrying trash to incinerators and landfills are under random sport testing. If recyclables are identified, a heavy fine will be charged.neighborhood level.

Picture 9: An inter-municipality solid waste treatment facility in Denmark
Source: RenoSam Association, Denmark, 2006

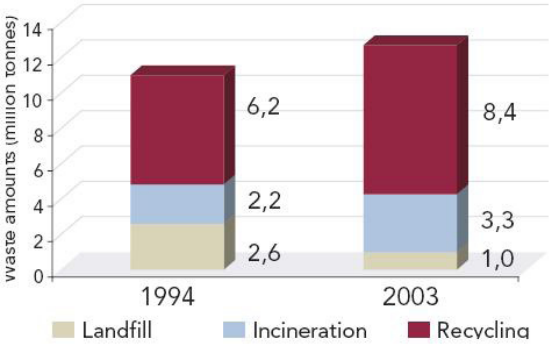


Figure 2: Solid waste treatment summary, Denmark
Source: RenoSam Association, Denmark, 2006

Picture 10 Modern design of waste-to-energy power plants in Denmark
Source: RenoSam Association, Denmark, 2006

3) Waste-to-energy: productive and environmental friendly

The waste-to-energy power plants in Denmark use the most advanced technology to produce heat and electricity through trash incineration. The facilities emit less pollution per unit of energy input than combustion plants fueled with coal or oil. The carbon dioxide emission is also controlled by carbon cleaning techniques. After incineration, the bottom ash can further be used as construction material.

The energy production efficiency is high. For each ton of waste incinerated, 2 MWH of heat or 2/3 MWH of electricity can be produced. For a typical community in suburban Denmark, 80% of household heat and 20% of household electricity can be produced by a waste-to-energy power plant incinerating the community's trash.

The landscaping of the waste-to-energy power plants are also carefully designed to fit into local context. Strict traffic regulations are established to avoid the disturbance of trash-transporting vehicles on local residents' daily life. Thanks to these efforts, residents hold very neutral attitude towards the incineration plants even in high-income communities.

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