

A CASE STUDY OF ENVIRONMENTALLY SENSITIVE PLANNING AND URBAN DESIGN IN PROVINCIAL CHINA

David J. EDELMAN

*School of Planning, University of Cincinnati, PO Box 210016, Cincinnati, OH 45221-0016, USA
david.edelman@uc.edu*

Menelaos TRIANTAFILLOU

*School of Planning, University of Cincinnati, PO Box 210016, Cincinnati, OH 45221-0016, USA
Menelaos.triantafillou@uc.edu*

Abstract

This paper introduces the subject of environmentally sensitive planning and urban design in provincial China by first providing a framework for considering the topic and then reviewing the Anyang Eastern New Town Conceptual Plan prepared by the School of Planning, University of Cincinnati, within that framework. The experience of the faculty leading this project with field work, the planning process (methodology), plan preparation, and the engagement of students through a studio exercise has revealed great interest among the Chinese for creating more sustainable, livable and environmentally pleasing urban areas to address expanding urbanization and environmental pressures.

Keywords: Chinese urbanization, environmentally sensitive urban design, sustainability, landscape urbanism.

1. INTRODUCTION

Since the 1980's, urbanization in China has accelerated, but, more recently, it has also changed fundamentally in a structural sense. Now, however, China is 47% urban and has 89 cities of one million people, including the world cities of Beijing and Shanghai. The level of urbanization in China was less than 20 percent of the population in 1978, with 50 percent anticipated by the year 2020 (Heikkila, 2007). While China's cities in the Maoist era were both production and administrative centers of economic planning, the functions of business and commerce were curtailed. (Brunn, et al, 2012). That is no longer the case. During the past quarter-century, Chinese society has undergone dramatic and fundamental change. This change echoed the determination and commitment of the Chinese government towards a market economy system with strong Chinese characteristics. That is, the Chinese urban transformation is not a manifestation of a global external process imposed on the Chinese city, but is also indigenously driven (Wu and Ma, Chapter 14 in Wu and Ma, 2005). Friedman calls it a transformation from within (Friedman, 2005). Institutional shifts have been critical and have

included moving to market coordination, fiscal decentralization, more local autonomy, negotiated land use prices based on location and commodified housing production (Ma and Wu, Chapter 1 in Wu and Ma, 2005). This new approach of reform produced spectacular successes, established one of the world's fastest-growing economies and created some of the world's most vibrant cities (Ding, 2004).

Along with economic progress, urbanization has taken place at an unprecedented pace. That is, economic reforms unleashed a strong demand for urban physical construction, which had been firmly controlled by central planning for thirty years (Zhu, 2004). The number of new cities, the urban population and built-up urban areas has increased dramatically during the past two and a half decades. Urban populations increased from 30 per cent to as much as 200 per cent. Moreover, the urban landscape has been reshaped and restructured as old industrial uses have been replaced with office space and commercial buildings (Ding, 2004). Nevertheless, the large and extra-large cities remain the centers of capital investment and production (Lin, 2002), and as late as 2006, Chinese planning was dominated by the problems and achievements of only some of the largest and newest cities, mainly Beijing, Shanghai, Guangzhou, and Shenzhen (Abramson 2006). Moreover, while foreign investment and the growth of the private sector are an important driving force behind China's economic growth in the recent three decades (Deng, 2004), this has now spread to the cities of the hinterland, including third order cities like Anyang in Henan Province, which is the case study of this paper. Decentralization brought by economic reforms has given local authorities greater power in the organization of urban development. The marketization of land in 1987 further transferred the control of State land to municipalities, which have become the managers of leased land, and this has enabled urban planning to play a greater role. The rising status of urban planning has been further enhanced by the enactment of the 1989 City Planning Act, which for the first time in the history of the People's Republic of China set up a comprehensive urban planning system that stipulates that all urban land development is subject to the control of the municipal planning authority (Wu and Yeh, 1999). Thus, with a population of 1.5 million, Anyang, which is neither the capital nor the largest city in the province, provides a vivid example of how provincial cities are now beginning to control their own planning processes and are increasingly attuned to sustainability issues.

As part of this accelerating urbanization and structural transformation, over the last ten to fifteen years, planning and design professionals in the United States and Europe have increasingly been engaged in consulting work in China. Major A&E firms from the UK and the US, for example, have been opening offices in Beijing and Shanghai. Recently, the concern with sustainable urban development and China's policies to alleviate pressures of urbanization has been an engine for commissions for new town plans and city expansion plans across China's provinces. Parallel to this, schools of planning from several

American and European universities have been increasingly involved with research on Chinese urbanization, collaborations with Chinese scholars, and consultations at the national, provincial and city levels. Although most such work has until now been found in major Chinese world cities such as Beijing and Shanghai and in the large coastal industrial cities such as Guangzhou, provincial cities increasingly have the resources and interest in involving international universities and consultants in the planning and design process (Triantafillou and Edelman, July 2008).

American universities have become quite active in China, and many academic planning units are participants. Excluding the University of Cincinnati's School of Planning, thirty accredited programs are active. As the attached table illustrates, these activities have encompassed faculty and student research, studios, presentations by faculty, study tours, etc. However, there appear to be no other instances of a Chinese city funding an American academic planning unit to create a conceptual plan for a new district or town.

TABLE 1 - ACADEMIC ACTIVITY IN URBAN AND RURAL CHINA--ACCREDITED PLANNING PROGRAMS

College	Program	Professor(s) Involved	Urban/Rural	Notes
Auburn University, Auburn, AL	Student exchange and Professor research	Dr. Jack Williams	Rural	Received Asian Cultural Council Fellowship for research on small villages in China; currently a Fulbright Senior Specialist consulting with overseas institutions in Panama, China, Portugal, Mexico, and Colombia on environmental and urban issues
Cal Poly Pomona, Pomona, CA	China Studio	Dr. Gwen Urey Dr. Irma E. Ramirez	Urban	Lead an interdisciplinary studio in China
UC Berkeley, Berkeley, CA	China studio in Jiaxing, China (Spring 2007)	Dr. Judith Stilgenbauer	Urban	Interdisciplinary studio to develop designs for prototypical sustainable neighborhoods in Jiaxing, China; conducted in collaboration with faculty and students in the College of Architecture and Planning, Tongji University, Shanghai
UCLA, Los Angeles, CA	Professor research	Dr. Randall Crane	Urban	Numerous papers and presentations on urban china
University of Southern California, Los Angeles, CA	International labs	Dr. Eric Heikkila	Urban	Numerous publications about China and SE Asia
University of Colorado Denver	Professor research	Dr. Yuk Lee	Urban	Numerous publications about China
University of Illinois at Urbana-Champaign, Champaign, IL	Professor research	Dr. Arnab Chakraborty		Research and publications about China

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College	Program	Professor(s) Involved	Urban/Rural	Notes
Iowa State University, Ames, IA	Field Studies in Chinese Art and Architecture, Research	Paul Shao (Architecture)	Urban	Architecture students can travel to China for three weeks to study Chinese art, architecture, landscape, and urban design
University of Maryland--College Park, College Park, MD	NCSGRE research	Dr. Gerrit-Jan Knapp, Professor and Executive Director of the NCSGRE	Urban and Rural	China Land Policy Program - Land Issues In China with the Lincoln Institute
Harvard University, Cambridge, MA	Yearly China studios; Professor research and publications	Dr. Richard Peiser Dr. Peter Rowe	Urban	Peiser: taught the studio "Alternative Futures for the West Lake, Hangzhou, People's Republic of China"; Rowe: Vice chairman of the International Advisory Council of the People's Municipal Government of Wuhan, China (2005 to present), Honorary Professor at Tongji University, China (2003 to present), Honorary Professor at the Xi'an University of Architecture and Technology (1999 to present)
MIT, Cambridge, MA	Professor research and publications; China studio (taught by Lee)	Dr. Ralph Gakenheimer (Emeritus) Dr. Tunney Lee (Emeritus) Dr. Lisa Peattie (Emeritus) Dr. Karen Polenske	Urban and Rural	Gakenheimer: Research and publications about China; Lee: China studio; Peattie: article about China; Polenske: extensive research about energy and environment in China's Shanxi and Liaoning Provinces
Eastern Michigan University, Ypsilanti, MI	Professor research and publications	Dr. Yichun Xie	Urban and Rural	Research and publications about regional development, urban design and planning, and agricultural development in China
Michigan State University, East Lansing, MI	Professor research and publications	Dr. Peilei Fan	Urban	Research and publications about the globalization of innovative Chinese high-tech firms, specifically telecom-equipment firms; and land use and urbanization in contemporary China
University of Michigan, Ann Arbor, MI	Professor research and publications	Dr. Lan Deng	Urban	Comparative studies of housing market and public housing in US and China
Wayne State University, Detroit, MI	Professor research and publications	Dr. Rayman Mohamed	Urban	Comparative studies of urban infrastructure in US and China
University of Minnesota, Minneapolis, MN	Professor research and publications	Dr. Xinyu (Jason) Cao	Urban	Transportation studies

College	Program	Professor(s) Involved	Urban/Rural	Notes
Rutgers, New Brunswick, NJ	Professor research and publications	Dr. John Pucher	Urban	Urban transport trends and policies in China, India, and Korea
Cornell University, Ithaca, NY	Professor research	Dr. Susan Christopherson Dr. Michael Tomlan	Urban	1) economic development, 2) urban labor markets, and 3) location patterns in service industries, particularly the media industries; historic preservation in China
Hunter College, New York, NY	Professor research and publications	Dr. Peter Kwong	Urban and Rural	Modern Chinese politics
New York University, New York, NY	Professor research and publications	Dr. Jonathan Morduch	Urban and Rural	Financial access to under-served populations
University at Albany (SUNY), Albany, NY	Professor research, publications, and courses	Dr. Yoquin Huang Dr. Christopher Smith	Urban	Huang: Research on Migration/Mobility, Housing, Neighborhood Change, Urbanization in China, courses in urban development in contemporary China; Smith: Asian and Chinese cities
UNC-Chapel Hill, Chapel Hill, NC	Professor research, publications, and courses	Dr. Thomas Campanella Dr. Yan Song	Urban	Campanella: American planning and landscape history and the rapid transformation of urban China in the post-Mao period; Song: evolution of China's urban land and housing policies and urban spatial structure in the era of China's transition toward a market economy
University of Oklahoma, Norman, OK	Professor research, publications, and courses	Dr. Guoqiang Shen	Urban	Urban design and planning in USA and in China
Portland State University, Portland, OR	International exchange--Chinese professionals come to Portland for training in sustainable development	Dr. Connie Ozawa	Urban	China-U.S. Sustainable Land Use Training Program
University of Pennsylvania, Philadelphia, PA	Professor research, publications, and professional activities	Dr. Jonathan Barnett	Urban	Prepared a transit-oriented design plan for the City of Xiamen in China
University of Texas--Austin, Austin, TX	Professor research and publications	Dr. Ming Zhang	Urban	Strategies for integrated land use/transportation development in Chinese cities

College	Program	Professor(s) Involved	Urban/Rural	Notes
Virginia Commonwealth University, Richmond, VA	Professor teaching, research and publications	Dr. Weiping Wu	Urban	Study of China's urban development
University of Washington, Seattle, WA	Professor research and publications; exchange program with Chongqing Institute of Architecture and Engineering	Dr. Daniel Abramson	Urban	Research about how national or global norms of urban design and historic preservation take local forms
University of Wisconsin--Milwaukee, Milwaukee, WI	Study abroad program	Dr. Zhong-Ren Peng	Urban	Led summer study abroad program to study planning and design issues and challenges facing the rapidly growing cities in China
University of British Columbia, Vancouver, BC	Professor research, publications, and professional activities	Dr. Larry Beasley Dr. John Friedmann Dr. Michael Leaf	Urban	Beasley: Urban planning in China, provides consultation services for Chinese cities; Friedmann: urbanization in China; Leaf: research, publications and teaching about urbanizing China

Source: Compiled by the authors

As a result of these efforts, a growing literature is emerging on the subject of Chinese urbanization, urban planning, and urban design. Some of the important references are listed at the end of this paper.

1.1. Case Study: Anyang Eastern New Town Conceptual Plan

This paper discusses innovative and sustainable urban design in provincial China within the context of the Anyang Eastern New Town Conceptual Plan. The Plan was prepared by the Urban Studio of the School of Planning at the University of Cincinnati. A Design Collaborative Agreement between the City of Anyang, Urban Planning Administration Bureau, and the University of Cincinnati, School of Planning, outlined the scope of work and procedures used to prepare the plan as a consultancy. Starting in April 2007, the preparation of the plan including revisions, and the completion of the final document took place over a period of fifteen months.

For pedagogical purposes and in order to engage its students in real projects with a high probability of being implemented, the School of Planning uses the Sponsored Studio structure. Local government units through an agreement with the School of Planning seek specific plans and planning strategies that are undertaken by a team of professors and students as research projects and/or studios. The

preparation of the Anyang Eastern New Town Conceptual Plan was structured on the basis of a Sponsored Studio.

1.2. Methodology: The Planning Process

The planning process followed by the School of Planning for the project included four components:

- A visit to Anyang. This involved meetings with officials to gain input regarding the specific requirements for the plan, for reconnaissance and to conduct field surveys. This lasted five days. Field data and other information were collected and were supplemented by documented information provided by the Anyang officials.
- Research on Chinese urbanism and the key associated issues of environmental problems and sustainable urban development. The objective here was to gain knowledge about urban development laws, the planning process, and the local administrative structure at province, county, and city levels. The research focus was on the review of information on population, economic development, land use, transportation and other relevant information for Henan Province and the City of Anyang. During this research period, the Urban Studio members gained an understanding of Chinese models of contemporary new town development, environmental issues and development morphology. These activities engaged four graduate planning students under the direction of one of the planning professors.
- Preparation of three alternative conceptual plans that explored distinct urban development approaches. The objective here was to give the Anyang officials exposure to a variety of ideas in planning for the New Town. The first alternative explored the possibility of innovative sustainable urbanism as a major departure from current Chinese models of urban development. The second alternative explored urban development according to current and emerging Chinese standards for modern city planning, characterized by wide streets, very large city blocks of uniform high rise housing, and land use separation. The third alternative explored urban development that would preserve the majority of existing urban villages in the area of the New Town and incorporate them into a new urban structure. The document that was produced was sent to Anyang officials for their review. Subsequently, a delegation of Anyang officials visited the School of Planning, and the major part of one day was spent in presentations and discussions. The officials' comments were extensive. Based on this, the Urban Studio was able to prepare a more specific program to guide the preparation of the final plan.

- Preparation of the final plan and presentation of the plan to the officials in Anyang. The final plan was prepared within the framework of the Urban Studio. The studio included 24 students, who were a mix of graduate planning and architecture students and advanced undergraduate planners. The final plan was presented to the Chinese officials during a four-day visit to Anyang. Following the presentation, during a meeting with the director of the Anyang Urban Planning Bureau, the director of the Urban Planning Institute, and heads of various departments, additional input was given to the Urban Studio team that would need to be addressed in the final report that would present the Final Conceptual Plan. After the Final Plan was completed, however, the School of Planning received a request from the Anyang officials to make changes to the high speed rail line and train station, which were incorporated into a revised final plan.

1.3. City Of Anyang

Anyang is situated at the north edge of Henan province, at the junction of Shanxi, Hebei, and Henan provinces. The city of Anyang is a prefecture-level city, occupying an area of 7,355 sq km with a population of 5.22 million people (2002), and consists of one city, four counties, and four administrative districts. Within the prefecture-level city, Anyang city's built-up area is approximately 95 sq. km. of which 72 sq. km. (75.7%) is in urban land use with a population of 826,000. In 2005, Anyang's GDP was RMB 55.6 billion, its per capita GDP was RMB 10, 400, and its municipal income budget was RMB 2.9 billion.

1.4. Final Conceptual Plan: Anyang Eastern New Town

The rest of this paper presents the overall Final Conceptual Plan and its specific elements and explains the key objectives and planning structure in six sections, with each addressing a specific element. These are: 1: Overall Plan Description: Innovative / Sustainable Urbanism, 2: Green and Open Space Network, 3: High Speed Train Station Precinct, 4: Residential Districts and Housing Typologies, 5: Green Urbanism and 6: Transportation System. The material is drawn from the work of the Urban Studio (Triantafillou and Edelman, June 2008).

2. OVERALL PLAN DESCRIPTION: INNOVATIVE / SUSTAINABLE URBANISM

The Final Conceptual Plan is a major departure from the contemporary Chinese model of development. Sustainable development is the main theme of the conceptual plan, and maintaining environmental resources, saving energy, encouraging the use of green technology and constructing green buildings

can be seen not only in the design of the city, but in the residential neighborhood designs at block and building levels.

The respect for historical/cultural conditions is also one of the basic concepts of the plan in that it maintains the traditional urban form of selected existing villages. Although the villages' structures, for the most part, will be replaced by new development, the plan demonstrates the possibility of maintaining the villages' footprint and the rural culture. New development is sensibly integrated to create a smooth transition from modern life to rural culture. In addition, mixed land use is encouraged throughout the entire plan at the different density levels.

This Conceptual Plan addresses the goals of the Master Plan for the City of Anyang and incorporates its conceptual program requirements, but its strength is that it departs from conventional modernist planning principles, and, instead, attempts to develop smaller scale, humane and sustainable building blocks at the residential level. The use of two flexible grids establishes the transportation system and defines the structure of the proposed urban development.

2.1. Innovation In Planning And Urban Design

The current and emerging trends in urban development in the United States are increasingly characterized by a strong emphasis on what is called landscape urbanism, a planning and urban design approach that promotes the landscape instead of the built form as the key organizer of space. This in turn, contributes to a built environment that can offer a more enhanced experience and livability. The cover of the urban environment as opposed to the structures is equally and at times more important in achieving sustainability in the urban environment. Core areas and high densities along are not enough to address the diffused and fragmented urban environment of emerging regions.

Innovation and sustainability principles are integrated into the structure and form of the Eastern New Town driven by the tenets of landscape urbanism. Newest and emerging technology trends in energy conservation, best management practices to at site development scales are included in the concept of innovative/sustainable urban development. Transportation network design, and public transit integration into the Eastern New Town fabric especially the distribution of bus stops on specific locations within walkable radii, and the provision of substantial areas for open space and greenways offering connectivity, walkability, and trails are also included as key elements of innovation into the Eastern New Town.

2.2. Guiding Principles

The following serve as the guiding principles for the development of the Anyang Eastern New Town.

- Creation of an attractive town, capable of establishing livable neighborhoods with an intensified landscape urbanism.
- Preservation of the traditional urban form and rural lifestyle.
- Commitment to healthy urban development, based on respect for the traditional urban form of the rural villages.
- Preservation of natural resources and energy conservation.
- Development of a unique identity that connects the local cultural heritage to the new development.
- Presentation of an opportunity for economic innovation and development through the creation of a unique center connected to the region.
- Provision of opportunities to attract talent and skills in new businesses – technology, telecommunications, new media, biomedical firms.
- Maintenance of easy movement and access to and connectivity with the existing circulation system and the greater region.
- Provision of efficient and imaginative use of open space and agricultural resources.
- Commitment to green urban development, alternative energy sources, and sustainable performance from development at site and building scale.
- Dedication to mixed-use development.

Thus, the Final Conceptual Plan defines specific land use activity precincts as a way to structure urban development. The urban pattern and scale of built form are smaller than what has become the norm in new Chinese developments, and they have the potential to become more sustainable. A humane and more manageable character of the built environment is projected for the residential mix of housing and open space. Technology and innovation are incorporated into the planning and development to achieve a *green* architecture and infrastructure. The use of public transportation and the high speed railway are major contributors to sustainable development and to achieving efficiency in land use.

2.3. Urban Precincts

The center of the Anyang Eastern New Town is defined by five precincts, which are planned as foci of land use development and traffic hubs. They each have a specific role and are integrated with the grid system of streets. Together, they define the central area of the new town.

1. High Speed Station Urban Core Precinct – This includes the passenger area, freight/commercial area, bus terminal, mixed use development, commercial shopping center in the station, hotel/conference center, office complex, residential towers, open space, and parks. The reasonably comprehensive system of vehicular and pedestrian elements is integrated with substantial landscape improvements, gardens, and water features.
2. Hospitality Precinct –This includes uses amenable to tourists, visitors and conferences. Thus, it includes hotels, conference centers, entertainment venues and other uses that support visitors to Anyang. This precinct is located to the east of the railway, next to the Cultural Precinct.
3. Government / Administrative Precinct – County government offices and facilities are included here. This precinct is located to the east of the railway station. The civic center can be seen from the station and vice versa through a 100m-wide open space. This space is designed to conform to human scale for outdoor exhibitions and cultural activities.
4. Visual and Performing Arts / Cultural Heritage Precinct – This precinct includes galleries, performance halls, exhibition space, and other cultural facilities. It is located along both sides of the 100m-wide open space that runs from the civic center to the station.
5. Technology/Science/Education Precinct – This is an area that is planned as a compact campus to accommodate research and development, as well as to offer an educational environment integrated with the actual application of knowledge to product/service making. This precinct is located along the main boulevard, to the north of the station, and is close to the riverfront and both vertical and horizontal greenbelts.

2.4. Grid Pattern for Main Roads

A flexible grid of main arterial roads and second order collector roads is used to structure and organize space. The plan shows the order of the road system in terms of the roles the roads play in connecting the Anyang Eastern New Town with the present City of Anyang and its region, in handling movement and various volumes of traffic within the new town, and in providing access. Three major horizontal arterial roads connect the new town with the old city. The main arterial roads define the macrostructure and are placed at approximately 1000 meter intersections to provide areas for land use development. The secondary collector roads dissect the 1000 meter spacing at approximately 300 meters apart. The blocks within this spacing are of varying sizes and are further subdivided by local roads to provide direct access to land use areas. Finally, each type of road has its own streetscape character.

2.5. Green Space System

Critical to the Final Conceptual Plan is the recommended development of a highly functional and comprehensive green space system for the Anyang Eastern New Town.

2.6. Open Space Corridors:

A major open space corridor along the expressway serves as a buffer between the existing urban development of Anyang and the Eastern Anyang New Town, while there is also a green corridor to provide quality visual character along the rail line, to serve as a wildlife corridor, and to connect with the Huan and Honghe River riparian zones. Another north-south green corridor connects the east-west green belts and to the riverfront, while three east-west green belts provide relief from the built form and access to the north-south corridors. These green belts include trails, pedestrian systems, environmental education gardens and other such features. The existing canal is also used as a major structuring element as it runs through the open space axis which leads to the high speed train station.

2.7. Riverfront Greenspace:

The Final Conceptual Plan also uses the riverfront as an important green space for the Anyang Eastern New Town, and an eco-park connects to the rail line green corridor.

2.8. Parks at Sub-District Level:

A system of parks is distributed throughout the new town to serve the recreational needs of the inhabitants. These parks include active recreational uses, as well as facilities for multi-generational needs, and are linked to the green belts and open space corridors.

2.9 Residential Block-Level Green Space:

Within each residential block, there is green space to provide for a healthy living environment for residents. Those green/open spaces are well-connected to each other to ensure the ability of pedestrians to walk easily from block to block.

2.10. Residential Neighborhoods

Most residential development in the Eastern New Town is planned on the basis of four specific block typologies, each having specific dimensions and sizes. These blocks are distributed within the grid structure. The blocks are designed to accommodate a variety of housing types, open spaces and recreation, and small convenient commercial facilities and services to support the residents of the

neighborhood at close, walkable proximity. Remaining residential development is of smaller blocks distributed on the footprint of the rural villages. Inside each block, the traditional lifestyle of rural residents is preserved and encouraged, but still incorporated into urban life. Building height, housing typology and open space inside the blocks are based on the traditional form and are guided by green sustainability principles. These residential neighborhoods preserve the cultural identity of the rural villages and are located near the site boundary of the new town. In total, then, there are five different residential block types and densities.

2.11. Villages

The School of Planning's Urban Studio is well aware that the inclusion of villages into modern urban development is not a common practice in modern urban planning in China. However, its Final Conceptual Plan recommends these urban concentrations as a viable community form and it achieves a real and effective integration with the entire urban structure and land use for the Eastern New Town. Most of the existing scattered villages will be redeveloped for other types of land use. The Final Conceptual Plan identifies several villages to remain and recommends rehabilitation and infrastructure improvements in order to 'modernize' them as viable alternatives for residential living. In addition, the Final Conceptual Plan allocates space for new urban village type urban development based on the use of traditional design principles as explained in this section. These constitute the fifth type of residential block. They have been mostly developed from the existing footprint of the rural areas and either have a traditional design or new designs based on Chinese traditional architecture.

Each whole village has a green buffer from the busy and main roads, which gives it the feel of a community. The local commercial area and the community garden are located where the two main roads passing through the village intersect. This commercial area serves only the locality and consists of a grocery store, pharmacy, open market, etc. Most of the buildings are aligned north to south. The traditional village consists of courtyard houses along with more modern structures. Some of the courtyard houses are laid out so as to form a pedestrian inner courtyard. Other houses have green gardens for household farming. The urban villages are designed with traditional village form in mind, with small streets, a lot of T-crossings and small alleys allowing people to walk through the village comfortably. Gardens are located at the back of the houses. Garden space between two rows of houses creates a large open space for people to work and communicate. Pedestrians also can walk through the gardens using a small pedestrian pathway running in between them. There are also sheds in which farmers can keep farming tools and products. The Final Conceptual Plan also recommends

the development of a biogas treatment facility to be located to the north-east of the area, close to the river.

2.12. Traffic Flow

Since the Anyang Eastern New Town is planned on the basis of sustainable development criteria, the development of a public transit system will contribute to lessening the use of cars and should provide the primary access of workers to the employment areas. East-west traffic volumes can be managed if the City of Anyang officials follow the recommendations of the plan for the street arterial system and the development of an effective public transportation system. Traffic flow will be distributed over the entire network of major arterials and minor roads. These roads should be designed on the basis of a unified set of standards to handle traffic. The plan avoids the designation of one or two such arterial roads as primary routes because in this case, these roads will soon become congested. Evenly based distribution of traffic with high interconnectivity should be the key criteria in transportation design. The Final Conceptual Plan organizes space through the use of two flexible grids that establish extensions of west-to-east existing transportation arterials. These arterials are intersected with new north-south arterials and local transportation system.

During School of Planning presentations, it was suggested that a new interchange to connect Jingzhu Highway with a new arterial that will afford direct access to the high speed train station would prove necessary. Such an interchange will increase accessibility between the station's multi-modal function with the City and its region. The train station precinct will be the most important land use of the Eastern New Town and will define it regionally and nationally. The station's direct connection with the regional highway transportation system is necessary and will assist in better traffic flow and better distribution of traffic volumes.

It is anticipated that traffic around the train station and in the recommended mixed use precinct will be heavier due to the importance of the station. The Urban Studio's plan shows an effective network of streets including underpasses to accommodate at grade crossings with the high speed trains. The two interwoven grids will provide for multiple access and connectivity points. A new interchange with the existing north-south highway will make strong contributions to the management of traffic flows. The Final Conceptual Plan recommends that the existing east west arterial roads be integrated into the overall transportation system. These arterials will continue to function as important corridors and existing land use concentrations of commercial development, while hospitals and schools will be improved and included in the overall plan.

2.13. Storm Water Management

The change from agricultural and vacant, open land to urban uses will be managed through the inclusion of storm water runoff ecological design practices so that the total amount of impervious surface is reduced. Site plans for land use development should incorporate on-site performance measures as discussed in the Living Green section prior to approval for construction. Storm water will be managed at the site and district levels based on sustainable development principles as explained in this paper. The use of constructed wetlands, retention basins, and open vegetated swales should be used in order to reduce the use of conventional engineered storm sewer lines only to address the most necessary conditions. Sewer line capacity, retention, and location of infrastructure will need to be determined through preliminary engineering design and are well beyond the scope of the Final Conceptual Plan.

3. GREEN AND OPEN SPACE NETWORK

Green space in the Anyang Eastern New Town is addressed on four levels: the railway/parkway, the buffer area, the riverfront, and the green corridors. Each of these spaces is interconnected to create a strong and encompassing network of green within the Eastern New Town.

The railway is a major transportation corridor within the Eastern New Town and as a critical environmental education and recreation area. The buffer adds a great deal of passive recreational space and a signature landscape element to the fabric of the green network. The riverfront area makes up a large portion of the green space network and continues with the ecological and natural concepts that are featured in other areas of the green space plan. This space is made up of predominately constructed wetlands and preserved agriculture. The corridor spaces are the connecting fibers of the neighbourhood and green system. These have active and passive spaces and serve as connectors to the individual neighborhood blocks. Together, these spaces create a good mix of recreation and natural spaces that will serve the Eastern New Town.

3.1. Railway/Parkway

The most important reason for open space is the improvement of the physical environment and the development of a liveable and sustainable urban form. That's why the design of open space should be attractive and should include ecological planning principles. In addition, open spaces can fulfil a number of needs such as safe spaces for solitary time, social interactions, and physical activity. Thus, this Final

Conceptual Plan takes into account that several types of facilities in open space are required to make it into an active, useful space. This space needs:

1. To be reasonable to manage and keep up: Most of the pillars of the railroad viaduct have their foundation under water so that they are unreachable for the park visitors. No graffiti or damage can be done to the pillars, and the area will not be welcoming to vandalism. In addition, the enormous green space is divided into several smaller parks, which makes it easier to maintain such a large open space.
2. To provide a surplus to the value of the Eastern New Town: The park changes gradually in space from an ecological park (with purifying marshlands and wind turbines), to a more scientific park (adjacent to the technological center, also with wind turbines and also some green spaces for the use of scientific research), with then a more urban park (with playgrounds, rest areas, small ponds, more organically placed trees), and the last part is a more commercial park (adjacent to the railway station - with a similar design, marketplace, large scale grass fields for mass events, a big water feature). The fact that the various parks are related to the adjacent neighborhoods fosters a sense of ownership so that the residents become involved in maintaining the space.
3. To be divided into smaller, more human scale parks when it is as enormous as the railway park. It is divided in dozens of different parks that make the space adaptable and flexible in use. Moreover, people with different backgrounds and interests will be in the park at the same time, which generates a social mix.
4. To have a positive impact on the surrounding natural resources. It collects water from the railway viaduct, the railway station and the connecting roads and tries to infiltrate the water and leads the overflow towards the riverside where it will flow into a constructed wetland purifying system before being flowing into the river.
5. To be of high visual quality with a variety of things to explore and see. The paths through the railroad park separate the space into smaller individual places, which makes the park into a very interesting park to be in. Another important point here is the visual quality of the railroad construction. Consequently, the surface of the pillars and the underside of the railroad are built as a triangle wire frame construction with some triangles filled in with perforated/translucent material and light. That way the railroad becomes a landscaping feature in its own right.

6. To have water features as a cooling element, a playful element and an aesthetic element. Water also fosters a higher sense of place and spirituality. The water features isolate some parts of the park to make them into very peaceful places to rest away from the business of the city.
7. To provide different recreational areas for people of different ages and activity interests.
8. To present sculptural features and interactive art. The park educates and draws on local history. It inspires joy and delight. It actively engages people and encourages interaction among them through local artists and a variety of media at an appropriate scale for a given location within it.

3.2. The Buffer Area

The large green space that separates the old City of Anyang from the Anyang Eastern New Town serves as a transitional space that calls upon natural and agricultural elements to create a functional space. New and old design concepts are incorporated to create a unique green space. The site is bordered by a large raised highway to the west and residential neighborhoods or villages to the north and east. The green space provides passive recreational amenities to the community and helps to establish an identity for the new residential blocks.

Sculpture

The central feature of the buffer area is a large earthen sculpture, which is a representation of the Chinese symbol for change and acknowledges the transitional quality of this dividing space from the existing Anyang to the future New Town in the east. It is a constructed mound of roughly 3 meters tall and 50 meters wide and covered in grass. It is visible from the raised highway through the strategic placement of landscaping and buffer trees and is encircled by tree plantings, which define its location.

Agricultural Heritage

Space is reserved around the existing village forms for agricultural production, which is a continuation of the current land use. Although the built form and architecture of the buildings in these villages changes in the Anyang Eastern New Town, the village footprints remain much the same. These spaces act as community gardens where residents of the neighborhoods and villages can farm their own garden plots.

Passive Recreational Space

In the Eastern Anyang New Town, passive recreational space is a mixture of trees and natural plantings. Meandering paths made of natural recycled materials are utilized in these spaces. The landscape works to complement the structure of the large sculpture by remaining subtle and unstructured. These spaces serve as the connections to the Eastern New Town and its recreational areas.

3.3. Connectivity

There is a strong corridor connection within the green space that is adjacent to the earth sculpture. This main corridor flows directly into this large open space, and the connection serves as the transition between active open spaces and uses and passive recreation. Furthermore, these spaces have strong connections across the intersecting streets that will be addressed with wide crosswalks and medians as well as pedestrian bridges to create fluency between these open spaces.

3.4. Riverfront

The riverfront is a critical environmental area in the green network. It is comprised predominately of constructed wetlands to fuel the natural water systems and work as a filtration system for the city. It also features small pocket agricultural parcels that are connected to the new village structures by the river. Raised paths and trails are interwoven in this space to promote ecological education and provide passive recreation (walking, jogging, or biking) space that correlates with the natural beauty of the river.

3.5. Corridors

The corridor parks play a vital role in connecting both people and places. Instead of simply having destination parks and large public areas, a network of greenways connects elements of nature to urban society. Various types and intensities of green space are implemented in these spaces to compliment the surrounding context, which plays an integral part in deciding what form and moderation of recreation is used. In addition, careful consideration of traditional Chinese culture, as well as its integration with Western trends, is articulated throughout the landscapes.

Bicycle Trails

Trails take on curvaceous, meandering forms to add leisure riding appeal while still navigating between activity nodes, run the entire length of each individual corridor and connect to other corridors through bicycle lanes along select adjacent roadways. Consideration is made for constructing bicycle paths

from recycled tires or other rubber materials. Finally, paths are integrated into the blocks of each corridor in a way that enhances and does not disrupt natural flows.

Canal Offset

In the third corridor, redirection of the canal enhances this public space by creating more diversity in landscape. This area is unique because it relies on the canal to provide landscapes that are not available in other green corridors. The canal offset makes a transition as its design flows from an organic appearance to a structured, sharp one. This symbolic transition is yet another metaphorical representation of the changing face of Anyang from old age to a new age symbolized by the Eastern Anyang New Town. Lastly, the green areas surrounding the canals benefit from additional canal side walking paths and bike paths.

Eco-Bridge

An eco-bridge is an innovation to span the distance over the width of the canal. It is built in much the same way as a typical green roof. This hi-tech, cutting edge designed bridge is adorned with plants, shrubbery and low impact root-system trees. The concept behind the eco-bridge is to connect the areas divided by the canal with green space. Thus, this bridge of green appears as a continuation of green space rather than a complete obstruction by harsh materials. The eco-bridge's design was inspired by rolling hills and is successful in promoting sustainability because low lying areas drain directly back into the canal.

Tai Chi Squares

Specially designated spaces are set aside for use by citizens for morning tai chi in the form of a square that is present in each of the corridors for accessibility and proximity to each neighborhood area. Each of the tai chi spaces, however, is designed dynamically so it can all be used for alternative uses in addition to tai chi. Natural features such as lush green space and water features are present in these areas to foster tranquil, serene spaces.

Large Scale Parks

Park and recreational centers are positioned in the denser areas of the Eastern Anyang New Town, and their designs are more contemporary in the large scale parks. Hi-tech architecture blends better in high activity, high traffic centers. Fountains, systematic tree arrangements and public art are also featured in these areas.

Passive Recreation Spaces

Blocks of the corridors, which are characterized by surrounding areas of considerably lower density should be less organized. More random placement of forest space is standard. A more hierarchical path system is used here because land is less controlled. Trails and small paths are much more likely here than in the large scale parks. The conscious low maintenance of shrubs and vegetation makes this area appear and feel more wild and rugged, and the placement of small community gardens and playgrounds is welcomed in these portions of the greenway corridors.

Traditional Chinese Gardens

A few areas are based on the elements inherent in traditional Chinese gardens. Consequently, water gardens give residents the opportunity to escape to serene settings within the heart of a bustling city. These areas contrast sharply with the large scale public parks by being intimate and less social. Ornately landscaped spaces are the main attraction here.

4. HIGH SPEED TRAIN STATION PRECINCT

4.1. Recommended Mixed Use High Speed Train Station

The Eastern New Town Conceptual Plan envisions a train station that is much more than a train station building for passenger exchanges, and it identifies the High Speed Train Station Precinct as an area that includes the station building and a mixed use environment with integrated open space and landscape green. The precinct and the station structures will introduce modern and unique architecture and will become the main identity focus for the Eastern New Town. In addition, the station precinct is planned and designed to become a multi-modal transportation hub where high speed passenger trains will converge with local and regional transit service, passenger cars, and taxis.

The form of the high speed train station complex in the Anyang Eastern New Town is derived from a circle with branches radiating from the center. The radiating branches create a sense of inward movement and draw the general public and transportation to the station center. The station building itself has 4 levels, including 2 underground levels. High speed train tracks are elevated 15 meters above ground level.

In order to create a comprehensive pedestrian oriented complex at ground level, vehicle lanes are placed below grade and intersect with the station building at underground level where a bus station and grand parking lot are located. An underground commercial level is located directly above the bus

station and grand parking lot level, serving as a transitional level before access to the train station facilities. Pedestrians can access the entries of the station from different directions at ground level, and the circular form of the station building creates an unconventional concept of multiple entries (façades) around the perimeter. The station building is also designed so that a possible future subway system can be accommodated within the complex.

4.2. Plaza Description

The plaza surrounding the train station acts as a receptor and dispenser of pedestrians and bicycles. To make the whole area work, different function perimeters are incorporated. Every perimeter has its own flow of users that utilizes the plaza surrounding it. The commercial/residential/office building blocks are positioned in the same dynamic form as the train station. The ground level of the building blocks contains a shopping area and a service area to provide travelers with a multi-modal amenity. Travelers can approach the station from all different directions; hence the accessible circular form. The travelers who are people who live in the entire City of Anyang can utilize the shopping area and enjoy the setting of the surrounding plaza and green spaces. The station is placed within a differentiated space of green and plaza to act as a resting area or transit area for all kinds of slow traffic.

4.3. Landscape Description

Following the cosmic nebula pattern, all green spaces and the overall landscape, both hard and soft, compliments the overall layout of the station design. The scale of the site allows for plenty of space to be allocated between the built forms and the surrounding context. This area is filled by simple modern landscape forms and paths. Extending from the center of the station there is a series of grand avenues. These pathways provide travelers with fast and direct access to the station. There is also a pathway surrounding the circumference of the site, which provides travelers with an opportunity to explore the unique surroundings of the site. The use of water is an important feature within Chinese landscaping, and this site includes two large water features. These features resemble large reflecting ponds with space for sculptures and play. Underneath the elevated rail tracks are areas of pasture green divided by areas of paving to provide rest spaces. These areas are connected to the surrounding green networks throughout the city.

5. RESIDENTIAL DISTRICTS AND HOUSING TYPOLOGIES

Residential land uses occupy the majority of the land in the Anyang Eastern New Town. The Final Conceptual Plan has developed a system for determining blocks sizes, block typologies, housing

arrangements per block types, and overall site planning. The transportation system is also integrated into the residential allocations offering vehicular and pedestrian access. In addition, green spaces at the block level and connections with the entire open space and greenways are integrated with the residential neighborhoods.

5.1. Livability Guidelines

Anyang must be livable. This key directive drove the design of Anyang's residential neighborhoods. In the rush to urbanize throughout China, quality-of-life issues have too often been neglected in the face of merely accommodating the massive urban migration that is occurring. To counter this trend, new urban centers like the Anyang Eastern New Town are embracing the idea of livability guidelines in their design process.

Anyang Must Be Sustainable

Livability and sustainability are synonymous. Cities may be large, but they don't need to be polluted. Guiding all of the design work in the Anyang Eastern New Town's neighborhoods is the belief that sensitivity to the environment and urban living are complementary ideas — that making a city more livable for residents means minimizing the presence of toxic materials, maintaining high air-quality and providing every citizen with plenty of clean, drinkable water. The Final Concept Plan for the Anyang Eastern New Town shows that urban living can be synonymous with a high standard of living in China.

Anyang Must Be Built to a Human Scale

The urban fabric of the Anyang Eastern New Town must be sensitive to its residents and how they move through the city. Whereas many Chinese cities have grown to a massive scale at the street-level with huge roadways and massive buildings, this new area is designed to be comfortable for the pedestrian, with smaller streets and lower buildings fronting streets if possible.

Anyang Must Synthesize

To satisfy each of the preceding guidelines while still creating a functioning urban metropolis is a challenge, but this synthesis is achieved in the Final Concept Plan, which creates a living, breathing, working New Town, and one that meets the mandate to house large numbers of residents (300,000 – 350,000) while minimizing their ecological footprint in a comfortable setting.

5.2. *Horizontal Neighborhoods*

In designing the horizontal neighborhoods of the city, i.e., the super blocks, the guiding idea is to create city blocks that weren't self-contained, generic stamps placed on the landscape. Each block is designed to be reactive to its surroundings, to be a piece of a larger neighborhood — not a neighborhood in itself. Therefore, prior to designing the individual super blocks of the project, a methodology to guide the design process was developed to ensure that each of the blocks met these goals. Six steps were ultimately included in the process to take the site from urban setting to urban fabric.

Edge Conditions

First and foremost in the design is each super block's edge conditions. Each one's surroundings and most likely neighbors are considered, as well as any connections to open space and road types adjacent to it. In this way, each of the super blocks is reactive to its neighbors and not a generic, one-size-fits-all solution. Essentially, each block resembles a puzzle piece, precisely connected with its specific surroundings.

Block Subdivision

Once the edge conditions are determined, the super blocks, each of immense size (originally between 200 and 300 meters on each side) are broken down through the placement of roads and pathways in the interior. In this way, smaller blocks are easy to visualize and design, and it brings the blocks down closer to human scale. No longer are the buildings merely placed in a great expanse, they are thoughtfully connected to one another and to a street network.

Density Layout

Density is the next consideration — driven primarily by edge conditions, but also working with the interior street grid. In each case, the super block edge bordering the use of greatest land use intensity becomes the most intensely developed edge of the block. Conversely, lower intensity edges are matched with lower intensity development on the interior. In this manner, no set of buildings is overwhelmed by its immediate neighbors, and circulation is simplified by providing visual clues in surrounding densities and structures. Furthermore, using densities in this way, nodes are created within the Anyang Eastern New Town itself, of high-, medium-, and low-density, not confined to the blocks but stretching across them. Referring again to puzzle pieces, the density is another element of that piece,

with high-densities linking to other high-densities, open space with open space, and so on, thereby creating a coherent web of densities across the Eastern New Town.

Open Space Design

Open space is the next consideration in the design process and is divided into two main arenas—public and semi-private. In an attempt to create a more livable city, the large open public spaces (accessible to anyone and everyone) are designed to connect across super blocks with the green spaces of the surrounding super blocks to create a cohesive city-wide network of parks. Conversely, wherever possible, private spaces are created by forming courtyards with buildings to create open spaces with a sense of ownership by designated users. In this way, a comprehensive system of open spaces and parks accessible to all the citizens of Anyang is created.

Commercial Uses

Commercial uses are placed within blocks with an eye toward density and walkability. Wherever the density is great enough, large commercial spaces are incorporated into the blocks to serve the large population centers around them. On the other hand, in the lower density blocks, only small pockets of commercial space are included to accommodate the neighborhood-scale services required by citizens on a daily basis. As a result, everyone living in the Anyang Eastern New Town is within easy walking distance of at least the basic necessities of life, which hopefully eliminates the auto-centric developments that these large-scale projects can easily become. Moreover, a variety of commercial offerings are presented in the nodes. This includes more expensive boutiques and large-scale stores in the dense areas and family-owned or traditional market type offerings in the less dense and village areas.

Shadows

Studying the building codes in X'ian and other Chinese cities gives a general idea of how to address building shadows in the Anyang Eastern New Town. In X'ian, every unit of every building is required to receive a certain amount of natural sunlight everyday — an approach that is utilized here in Anyang. Therefore, shadow diagramming is utilized to trace building shadows throughout the day and year. Each block is modeled to ensure that this requirement is met and that the greatest possible amount of sunlight reaches the ground whenever possible.

5.3. Villages

Incorporating the existing village fabric into the village blocks becomes possible with the density level in this super block layout. The Final Conceptual Plan adopts the existing street grid of the villages (not the structures of the village, but the street network) to create a substantive link with the history of the site. Furthermore, the connection, where the two differing forms meet, is cemented with commercial uses and open space. Utilizing these and making the connective areas functional, the new and old are married through use and function, rather than just by adjacency, making for an infinitely stronger bond. Lastly, new structures are built within the framework of the old village streets to modernize and make them livable today. Providing links to the history of the site maintains the memories and attachments individuals have with the site once the village as they knew it is rebuilt in a new form, while it allows a glimpse of the former lifestyle of the place for new residents.

5.4. Housing Types, Density, and Population Projections

Based on the typologies of housing arrangements and their distribution in the Eastern New Town, the total number of people is greater than the 300,000 originally considered. The actual number of people will depend on the detailed plans that will be made by the interested developers and the phasing plan that should be followed for population absorption, infrastructure extensions, and services. The number can easily be lowered to desirable levels by adjusting height of the taller buildings. The School of Planning's objective is to recommend that a more livable and viable environment can be achieved only through the mixing of densities, housing styles and patterns, inclusion of commercial services, and integration with the open and green space.

High densities are used as a green building strategy in each block type. Housing areas close to jobs and other commercial areas reduce the transportation demand of commuters. Designing housing and neighborhood centers with commercial uses allows for living with less dependence on automobiles. The highest density of people and housing can be found in Block A's. The high-rise towers provide housing in a vertical density orientation. Block A's and B's provide housing for the largest densities, while housing in Block C's and D's are at lower density.

In total, each 4.14 hectare sized Block A includes three 30 storey high-rise condominiums and four 18 storey apartment houses at a density of 1232 people per hectare. This block offers commercial and residential development. Here, mostly non-chain retail shops and restaurants are located along the main arterial and tucked beneath housing. All residential and commercial parking for this block type is underground.

Each Block B of 6.16 hectares includes 576 unit mid-rise condominium buildings, 280 unit low-rise buildings, and 160 unit garden apartments at a density of 447 people per hectare. This block offers commercial developments consisting of retail along the main arterial and tucked beneath housing. Underground parking provides the majority of off street parking for the commercial and housing developments, with some surface lots for the mid-rise housing.

Each Block C allows for more space per person in its 6.6 hectares. The block is made up of 175 low-rise units, 120 unit garden apartments and 100 townhouse units at a density of 109 people per hectare. This block contains market stalls along the perimeter that allow for locals to sell produce, food, and personal care items to those in the surrounding area.

Block D is the least dense block. In its 6.6 hectares, each block contains 120 townhouses and 200 single-family detached homes at a density of 86.2 people per hectare. Here, housing is clustered and located on small plots of land with little yard maintenance required for each house.

5.5. Green Strategies for Housing and Neighborhoods

Sustainability is important in an area like the Anyang Eastern New Town because densities per block are high and traditional buildings consume too much energy and water resources. Conservation and reuse are effective strategies that help large density blocks behave more efficiently. The Anyang Eastern New Town housing structures include mixed-use commercial development that incorporates sustainability approaches. In these blocks, each area is walkable and well connected to other blocks. The concept behind the housing design in this Final Conceptual Plan is to create housing that leaves less of an impact on the environment. Many of the buildings are more self-sustaining than traditional buildings. Many other sustainability strategies such as high housing densities, solar orientation, walkability, bioswales and detention ponds are integrated into the block designs to enable energy conservation and water reuse.

5.6. Solar Orientation

In some cities, shadows cast by high rises can cause other lower rise areas and open space to be overcast most of the day. Thus, the orientation of buildings is important to allow for maximum amounts of sun on lower rise buildings and open space during the day. Building heights and designs also minimize shadows cast onto other lower rise buildings. Anyang's location in the Northern Hemisphere causes the strongest hours of daylight to be those along the east-west axis. Since the majority of the year the climate is cold, and heat retention for buildings is important for energy savings, the building designs in this Final Conceptual Plan maximize solar gains.

5.7. Bioswales

Another feature that is important to the sustainability of the Anyang Eastern New Town's neighborhoods is the use of bioswales. Bioswales are sustainable systems consisting of natural vegetation, detention ponds and rock beds located throughout the blocks, as well as near parking lots. Features such as the pond and plantings provide a functional sustainable purpose as well as a park-like feature in the center of a bustling city block. The landscape is a feature residents can enjoy. The plants in a bioswale are drought tolerant and native to the area. Runoff from parking lots and other impervious surfaces is collected here and can be absorbed and treated naturally. Plants help remove 80% of the total suspended solids annually from runoff leaving the site. The soils and sediments in the bioswale act as a natural system to treat water that contains oil/grit from parking lots and other paved surfaces before it returns to the groundwater or sewers.

5.8. Walkability and Open Space

Many other cities in China have several housing types that are disjointed from one another as well as from commercial areas, and many busy arterial roads divide and isolate blocks from one another. It is important in a sustainable city that each block is connected and accessible to other blocks, that the blocks contain green space, and that they provide commercial areas that are easy to get to without a car. The design of each block for the Anyang Eastern New Town helps foster walkability for residents and addresses this through functional and well connected pathways throughout the blocks and with places that include inviting seating to encourage people to linger in a space. Access for pedestrians across busy roads by green bridges and the placement of several bus stops around the blocks provide alternatives to automobile transportation. Walkable cities allow people to stroll, explore and experience a large city that has multiple close-by destinations such as groceries, museums and a variety of restaurants. All of this makes a city more livable. Finally, a pedestrian friendly community leads to more social interactions, encourages physical fitness, and creates a sense of community.

5.9. Vertical Neighborhoods

Extending sustainability to the building level, the idea of Vertical Neighborhoods brings all-inclusive planning ideals from the neighborhood to the building. With the relatively higher density of the densest blocks of the Anyang Eastern New Town, creating any sense of community life is unrealistic using conventional building design. Densities approaching 1000 people per hectare make any notion of traditional, interactive, representative community life highly unlikely. Thinking of the New Town as a traditional neighborhood is like forcing a square peg into a round hole. Consequently, the ideas of

neighborhood design in the horizontal plane are also applied to the vertical towers creating Vertical Neighborhoods.

Vertical Neighborhoods are Complete

Only used in the 30 story high rise, vertical zoning takes the traditional ideas of horizontal zoning at the neighborhood level and applies them vertically. All the traditional land uses of a neighborhood are incorporated into the tower at various levels. These include residential areas, commercial uses, green space, educational areas, and service spaces.

Vertical Neighborhoods are Alive

Residential space, as in a traditional neighborhood, constitutes the greatest percentage of space with large sections of the tower devoted to it. Just as neighborhoods often have smaller sub-units, so the tower can be broken down into sub-units containing a variety of apartments, so the tower can host a variety of residents. Instead of segregating units for families, singles, or the elderly into certain areas of the building, a percentage can be created for each type of apartment by floor to ensure a diversity of residents in each sub-unit.

Vertical Neighborhoods are Convenient

Commercial space is also thought of differently than in a traditional tower. Many neighborhoods aren't restricted to a single commercial node, which is often the case in traditional building design. Instead of having a single commercial node located at the ground floor, an area is allocated on the 20th floor for another commercial space. In this way, the large-scale commercial space on the ground floor can serve the larger community as well as the residents of the tower, while the commercial space on the higher floor serves the residents of the tower exclusively. Additionally, space reserved in select towers at on the uppermost floors can accommodate luxury restaurants or boutique hotels.

Vertical Neighborhoods Breathe

Open space, another feature often neglected in high-rise design, is heavily incorporated into the towers to achieve the sustainability goals set for the Anyang Eastern New Town, but also for the well-being of the residents of the tower. Referring again to horizontal design where parks are spread around a neighborhood, such is the case here. Essentially, each tower has what amounts to one large park and smaller pocket parks around the building. Constituting the largest percentage of green space for the structure is the 20 story greenhouse concept (detailed later). This represents the largest single green

space in the building; additionally, 'pocket parks' take the form of green roofs at the plaza level, the 20th floor, and the roof (detailed later).

Vertical Neighborhoods Work

Space is reserved for the necessary institutional and service uses that are required for every neighborhood. Near the base of the tower, between floors 0 and 10, space is allotted for a kindergarten or school to serve the children of the tower. Just as in a horizontal neighborhood, such space becomes an obvious center of community activity, with people from different areas of the building mixing and meeting in the shared, community space. Lastly, the service spaces of the building run in the center atrium of the building. These include elevators, piping and ductwork, with a central service location at ground level and another smaller area in the top third of the tower. Parking is located underground in the basement area of the tower.

Water Catchment System

Dealing with storm water run-off is one of the key sustainable concepts in the residential plan. Typically, storm water run-off is treated as a problem; it is collected and piped offsite. However, this removes water perfectly acceptable for non-consumptive uses and fails to slow the runoff. At times, this overwhelms the system. This is especially true in river towns that are prone to flooding, such as Anyang. In the Anyang Eastern New Town residential plan, storm water is seen as a resource that can be used for a variety functions before it is ultimately discharged. This slows the runoff of water and creates a usable system of water management.

Rainwater is collected in a large sculptural basin on the roof. The basin has two chambers separated by a sealed plunger. Holes in the upper portion of the basin allow water to trickle down onto the green roof through small holes, watering the plant material covering the roof. Any water not absorbed by the grass itself percolates down through the soil on the roof to drains below the substrate and is collected as treated gray water into a holding tank. The holding tank flows into the bottom chamber of the basin. Once it begins to flow into the overflow chamber, it cascades down into the atrium of the building as a water feature. A pool collects the water of the water feature at no lower than the 20th storey. The evaporation of the water cools the upper third of the atrium, an area that typically has higher air conditioning requirements, thereby saving energy. Finally, any remaining water is piped down to green roofs and the vertical greenhouse lower down in the building to water the greenery there. In this way, storm water that is often seen as a nuisance is instead used to water the green roofs and vertical greenhouse, passively cool the building, and create artistic features within the building.

5.10. Green Roofs

Green Roofs Benefit

Utilized on many of the buildings in Anyang Eastern New Town to enhance buildings' performance, green roofs aid water consumption, energy usage and livability. Both intensive and extensive green roofs are utilized. Intensive green roofs are used in areas where high use makes them worthwhile, that is, in the higher density towers, and extensive green roofs are found in lower density areas where the sustainability benefits are worthwhile, but additional green space cannot cover the added cost.

Green Roofs Retain

Green roofs considerably slow the rate of storm water run-off, reducing the stress on the storm water treatment system implemented at the block and district levels. Instead of receiving a deluge during heavy downpours, green roofs retain water and slowly allow it to trickle through substrate material before reaching the bioswales and detention basins. Additionally, the green roofs and soil, in the case of the large towers, provide limited filtering before the water is released into the catchment system for use within the building.

Green Roofs Reduce

Acting as rooftop insulation, energy consumption is reduced, especially in the smaller buildings such as the garden apartments, townhouses, and single family homes. In these cases, traditional black, tar shingle roofs are replaced with the vegetation and substrate, which provides greater insulation, both in retaining heat in winter and repelling heat in summer. However, the value added for this feature is far greater in smaller buildings where the roof constitutes a larger portion of the total exterior surface of the building.

Green Roofs Recreate

Larger towers receive the added benefit of usable, private green space. Adding a whole new dimension of livability, green roofs act as the pocket parks of the Vertical Neighborhood. These smaller private spaces allow for more intimate outdoor experiences than can be afforded in the large public parks or the enclosed greenhouse, thereby filling a crucial niche for Anyang's tightest living residents.

5.11. Vertical Greens: Greenhouses in the Sky

As a component of the Vertical Neighborhood concept within the highest tower, the vertical greenhouse acts as the major park and gardening area of a neighborhood. The vertical greenhouse provides opportunities for a variety of environments and ecologies within a single building, which is accessible to all the building's residents. Physically, the greenhouse is built as a separate structure from the main building with connections at each floor. This ensures that the greenhouse can have a separate environment from the apartment units and keep costs down.

The vertical greenhouse takes on all the functions of a neighborhood park and garden space within the building envelope. A variety of activities can be programmed into the levels of the greenhouse space. For instance, certain floors may contain small areas that building residents can use for personal gardening, others may have space for residents to grow plants for local commercial use, and some floors might contain active recreational spaces for residents of the towers to enjoy.

Lastly, the vertical greenhouse weaves the neighborhood together by providing a green space for all residents of the tower. Residents have opportunities to maintain contact and create relationships in this space by gardening or taking part in recreational activities together. This social contact is one of the fundamental aspects of neighborhood life that is essential to the vertically-zoned high rise.

5.12. Private Courtyards/Access

The single family housing types are clustered to help create a sense of community and also to create a transition from the new larger block style development to the more historical villages. This clustering can occur in different variations and creates private courtyards and access for the different clusters. The private courtyard acts as a social interaction point for the residents within each particular cluster. Furthermore, there is private access to each one of the units from the courtyard. This access comes through a stairwell that is connected to the parking located below each sub-block. The courtyards also allow for a seamless airflow from one end of each unit to the other, providing a passive cooling system. The units are oriented in a northwesterly fashion to maximize the flow of the prevailing winds.

5.13. Stepped Buildings

The garden apartment structures are built in a stepped fashion for several reasons. The first is that it allows each unit to get the most sunlight when combined with the orientation of the building. This allows for passive heating and lighting within each unit. Secondly, the stepped design allows each unit to have an open space directly connected to it that could be utilized in a number of ways. Finally, a solar panel

structure is erected along the side of the building above the service portions (stairways, lobbies, etc). An angular design is optimal for the solar panel system and fits seamlessly into the design of the structure. Once again, the proper orientation of the building allows for this system to be most effective.

6. GREEN URBANISM

The form and structure of the Eastern Anyang New Town incorporates green urbanism principles in building design, energy conservation, waste management, and storm water management. Green urbanism is an approach to urban development that allows for multiple small scale interventions in planning, design, and construction. Leadership in Energy and Environmental Design (LEED) standards for high performance green buildings are used to achieve energy efficiency and healthy and supportive building environments for the people who use them. At the district level, standards for sustainable neighborhoods are used to reduce the impact of the built environment, to reduce energy efficiency, to achieve environmentally sound places, and to increase walkability.

6.1. Electricity Demand

This table represents total electricity use for each type of building that is proposed for the Anyang Eastern New Town. These assumptions are based on electricity information found for all of China. Residential electricity use accounts for a sizeable majority of the total electricity use for the New Town. In order to reduce electricity use, energy efficient appliances are in every housing unit. Energy Star appliances can, on average, reduce electricity use by 25%.

TABLE 5.1 - ELECTRICITY DEMAND

Eastern Anyang New Town					
Electricity Demand - Based on Assumptions using			Electricity Information from China		
	# of Units	Persons Per Unit	Total People	Electricity Use Per Person (kWh/year)	Total Electricity Use (kWh/year)
High Rise	448	2.8	1254.4	1886.75	2,366,739.20
Mid Rise	126	2.8	352.8	1886.75	665,645.40
Low Rise	30	2.8	84	1886.75	158,487.00
Garden Apartment	20	2.8	56	1886.75	105,658.00
Townhouse	1	2.8	2.8	1886.75	5,282.90
Detached House	1	2.8	2.8	1886.75	5,282.90

Source: <https://www.cia.gov/library/publications/the-world-factbook/print/ch.html>

6.2. Electricity Production

This table represents total electricity production for the Anyang Eastern New Town. The main goal of the Final Conceptual Plan with regard to electricity production is to reduce the amount of electricity that

is generated using fossil fuels by 30%. This means that alternative forms of energy are used to produce electricity.

TABLE 5.2 - ELECTRICITY PRODUCTION

Eastern Anyang New Town		
Electricity Production - Based on Assumptions using Electricity Information from China		
Total Production (kWh)	769,753,411	
Fossil Fuel	80.20%	617,342,235.85
Hydro	18.50%	142,404,381.09
Nuclear	1.20%	9,237,040.94
Other	0.10%	769,753.41

Source: <https://www.cia.gov/library/publications/the-world-factbook/print/ch.html>

6.3. Alternative Energy Options

Solar energy is the main energy priority of the Final Concept Plan for the Anyang Eastern New Town. Solar energy improves air quality by decreasing the need to generate electricity from fossil fuels. 10 MW of electricity produced by solar energy reduces by 15,000 tons carbon dioxide emissions and provides power to 5000 homes. The application of solar technology integrated with green roofs increases the efficiency of the photovoltaic arrays. China currently has the manufacturing capabilities for solar technology to lower costs for building applications (<http://www.powerlight.com/success/pdf/BavariaSolarparkFactSheet.pdf>).

Many countries around the world are incorporating solar energy into their electricity production options. The Bavaria Solar Park in Germany consists of a ground-mounted photovoltaic system. It utilizes silicon technology to convert sunlight directly into electricity. The solar park system capacity is ten Megawatts, and it uses 57,600 panels covering twenty-five hectares (<http://www.powerlight.com/success/pdf/BavariaSolarparkFactSheet.pdf>).

One solar panel produces 390.38 kWh per year. Thus, 95,000 solar panels reduce fossil fuel energy consumption in the Eastern Anyang New Town by 20%. In order to apply this technology, mini solar parks are incorporated into the open green space, and solar panels are incorporated into the green roof systems of the single family detached homes. 95,000 solar panels cover 41.23 hectares (http://www.sunpowercorp.com/For-Businesses/Case-Studies/~media/Downloads/for_business/SPWR_LVVWD_CS.ashx and http://www.sunpowercorp.com/For-Businesses/Case-Studies/~media/Download/for_business/SPWRLVVWD_CS.ashx).

For the Anyang Eastern New Town, however, it is not efficient to use wind as a form of energy. On average, a gentle wind or breeze speed is 4.5 m/s. The average wind speed for the City of Anyang, unfortunately, is 3.18 m/s with the windiest month running at 4.19 m/s. Consequently, Anyang does not have strong enough winds to fully support this technology in Anyang Eastern New Town (<http://www.gaisma.com/en/location/anyang.html>).

6.4. District Energy System

District energy systems produce electricity, hot water, steam and/or chilled water at a central plant and then distribute the energy through underground wires and pipes to adjacent buildings connected to the system. Buildings connected to district energy systems also have lower capital costs for their energy equipment because they don't need conventional boilers and chillers. This saves valuable upfront money that can be invested elsewhere. In addition, a district energy system saves building space that can be used for other, more valuable purposes. Electricity for lights, appliances, equipment, machinery, etc. is also managed through the energy system, which has a high sustainability rating due to its efficiency and cost savings. Many countries have burned biomass to be used in the system, which could be a viable use for organic/agricultural waste, or waste such as wood shavings from industry (http://www.districtenergy.org/what_is.htm). The Anyang Eastern New Town would obtain substantial financial benefit from implementing this system, and these savings would allow the system to adapt more easily to new energy source inputs. System construction commences at the front end of development.

A program in Charlottetown, Canada resulted in less capital being tied up in individual building heating systems and heating-oil inventories, the elimination of heating system maintenance and replacement costs for customers and greater local self-sufficiency. The Charlottetown District Energy System burns some 66 000 tons of Prince Edward Island waste materials to displace 17 million liters of imported light heating oil, which increased local employment from constructing and maintaining the district energy system. The provincial government estimates that for every dollar spent on biomass fuel, 70 cents stays in the local economy, and that the company that supplies the sawmill waste is more profitable, and a former liability is now an asset (http://www.canren.gc.ca/renew_ene/index.asp?CaID=47&PgID=956).

6.5. Residential Water Use

The Anyang Eastern New Town also is planned to have ultra low-flush (<6 lpf) toilets, which can save up to 35 liters per person each day. Moreover, by replacing traditional showerheads with low-flow heads and installing aerators on all faucets, an additional 56 liters per person or 168 liters for a three-

person unit is saved. Another area where water savings are achieved is in the use of washing machines for clothes. Installing high-efficiency, horizontal-axis machines instead of top-loading agitators saves an average of 55 liters per unit per day.

Water Savings and Usage

TABLE 5.3 - WATER SAVINGS (IN LITERS PER PERSON PER DAY)

	Original	New	Savings
Toilets	73.05	37.85	35.2
Washing Machines	63.59	44.66	18.93
Showers	113.55	70.31	43.24
Faucets	43.15	30.20	12.94
TOTALS	293.34	183.03	110.31

Toilets

Using sink grey water effluent in toilets reduces water usage in a unit by about 20,000 liters per year. The aqua catches the water flowing down the sink drain, filters and disinfects it, and stores it ready for the next toilet flush. Gravity and a small electric pump transport the water from the 21 liter holding tank installed under the sink. A device in the toilet tank prevents fresh water inflow as long as sufficient water is available. In addition, an extremely efficient alternative to traditional urinals in public buildings is the waterless urinal made by Kohler. This saves an additional 150,000 liters of water per year in public restrooms with high traffic in the Anyang Eastern New Town (Water Saver).

According to statistics from the UN Human Development Report of 2006, China uses 86 liters of water per person per day. However, an aggregate view is not very useful for this model. It is assumed that urban residents use significantly more. Cities are also areas where water savings technologies can be implemented, which will have the most impact.

Water Usage by Building Type

TABLE 5.4: WATER USAGE BY BUILDING TYPE

Assumptions:

Liters per person per day
183

Liters per person per year
66,795

	No. of Units/Housing Type	# of Residents/Building (2.8/unit)	Water Use/Housing Type (L)
High-Rise	448	1,254	83,760,930
Mid-Rise	144	403	26,918,385
Low-Rise	35	98	6,545,910
Garden Apartment	20	56	3,740,520

Using the technologies outlined above, each high-rise building in the Anyang Eastern New Town saves over 50 million liters per year. With improvements in water-efficient appliances such as the toilets outlined above, further savings are possible.

6.6. Rain

Rainfall levels in the area of northern Henan Province vary widely from season to season. Considering the rain shortages that occur in the winter months (August to April), an effort is made to conserve the rain that does fall. Water collected during summer is used for watering in dryer months and for irrigation. Each Block A yields an average of up to 1.7 million liters per month in runoff, while in each Block D, the runoff reaches as high as 5.5 million liters per month. Assuming a significant portion of the runoff that would normally go to municipal drainage is captured and used to water plants or feed fountain systems, this reduces significantly the need for expensive infrastructure upgrading to handle the storm runoff.

6.7. Constructed Wetlands

As a decentralized and sustainable alternative to conventional treatment technology, wetlands are constructed to filter and remove contaminants. Vegetated submerged beds (VSB) use layers of gravel and geological, biological and chemical processes to clean grey water. For the Anyang Eastern New Town, this technology will be used as a secondary treatment process. VSB's use significantly less energy, require less maintenance and operate at lower costs than traditional treatment technologies.

6.8. Waste

At present, there is room for improvement in management of municipal waste in urban China, where the majority of waste is produced. Much of it goes untreated into waste dumps. For example, Beijing has 700 solid waste dumps throughout the city (Rissanen, Juho, et. al. 2004). Organic waste still accounts for the majority of waste, although as the country develops, plastic and paper are making up a larger proportion. In rural China, there is an impressive amount of informal recycling taking place, and urban areas should attempt to develop similar practices through encouraging people to buy personal cloth reusable grocery bags and reusable water bottles (instead of buying cases of individual bottles, like in the United States) and to adopt other such sustainable practices. Measures such as these make a substantial difference over a long time period. In this Final Conceptual Plan, the Anyang Eastern New Town has a large-scale program to manage organic waste, which makes up 45%-55% of the total waste produced in China's urban areas. Organic waste can cause increased leaching and can be a strong

contributing factor in groundwater contamination. This organic waste is valuable as an energy source and in agriculture as a soil conditioner.

With regard to waste production, the Anyang Eastern New Town will have a recycling policy: different recyclables will be sorted at source, meaning that residents are provided with facilities to dispose of varying recyclables that can be collected. Another alternative is a system of sorting after collection, but an at-source recycling system is optimal for the New Town given that it is less expensive in higher density areas. Thus, the apartment buildings will be built with chutes to make the recycling process more streamlined.

The Anyang Eastern New Town will also use incinerated waste, i.e., ash, as a road building material, as is done in Singapore. Ash is increasingly popular as a building material, and, in this Final Conceptual Plan, the organic waste is incinerated in the district energy system.

TABLE 5.5: SOLID WASTE PRODUCTION

Expected Trash per Person, per Year in Kilograms

City Type	Organic Waste (kg)		Inorganic Waste (kg)		Recyclable Waste (kg)	
	low	high	low	high	low	high
Developed Cities	198	242	66	110	110	154
Well-Developed Cities	220	264	88	132	66	110
Ordinary Cities	198	242	154	198	22	66

Source: http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/Streams/fi/Dokumenttiarkisto/Viestinta_ja_aktivointi/Julkaisut/Kansainvaliset_selvitykset/S24045_Waste_Management_Review.pdf

6.9. Sustainable Parking Solutions

In order to mitigate the urban heat island effect and reduce surface storm water runoff, parking lots are kept as small as possible in the Final Concept Plan. When it is necessary to construct large lots, permeable pavement is included in the design. Permeable concrete blocks allow water to infiltrate through the joints, which aids in groundwater recharge and allows the natural soil processes to filter and break down chemicals present in runoff.

6.10. Green Streets

Designing a roadway with a diversely planted center median that functions as both a traffic calming device and a storm water bio-retention area improves pedestrian safety, minimizes storm water runoff, dampens street noise and improves air quality. Designing a right-of-way with a reduced impervious pavement area, high-albedo (reflectivity) pavements and maximum shading by trees substantially helps

reduce local urban heat build up, improves air and water qualities, increase pavement durability and calms traffic (www.pedbikeimages.org/danburden).

In China, where the bicycle is frequently used as a mode of transportation, roads need to be cyclist friendly. Thus, the Final Concept Plan for the Anyang Eastern New Town:

- Provides bike paths with adequate widths, smooth surfaces and proper drainage;
- When possible, separates bike lanes from vehicular traffic and pedestrians through the use of small medians or other features;
- Where space is limited for dedicated bike lanes, builds combined, dedicated bike and bus lanes, as well as part-time bike lanes;
- Uses traffic calming to improve the safety of bicyclists;
- Uses light colored pavement where possible to differentiate bike lanes;
- Uses highly visible pavement markings and signage to indicate bicycle zones and to alert cars to drive safely and share road space with bicyclists;
- Uses bike friendly catch basins, and
- Has bike only boulevards or 'thru streets' to separate bike and vehicular traffic.

6.11. Energy Efficient Transit

The energy efficient transit system to be used in the Anyang Eastern New Town is a system similar to the system in London. It uses hybrid and fuel cell buses. The hybrid buses operate using a combination of a conventional diesel engine and an electric motor, reducing emissions of local pollutants and carbon dioxide by at least 30 %. The fuel cell buses operate with zero emissions in which the fuel cell works like a battery. As hydrogen flows into a fuel cell, the hydrogen combines with oxygen and is converted into water and in the process produces electricity (<http://www.tfl.gov.uk/corporate/projectsandschemes/environment/2017.aspx>).

6.12. Solar Powered Street Lighting

To reduce energy use, the Anyang Eastern New Town will have a solar powered street lighting system that is entirely independent of any external power supply. Solar panels are planned to be connected in such a manner as to charge a maintenance free storage battery with sufficient capacity to light street

lights and/or traffic signals. An auxiliary generator is also to be provided with a wind driven vane for charging the battery if sufficient sun light is not available.

6.13. Noise Pollution

Most noise pollution can be attributed to transportation sources. It comes from an engine (mostly diesel), the friction of wheels over rails and whistle blowing. Furthermore, when trains are moving at high speed, aero-acoustic noise becomes more important than other sources. Depending on train aerodynamics, noise emissions are from 50 to 80 times the logarithm of train speed and become significant at speeds higher than 200 km/hr (<http://people.hofstra.edu/geotrans/eng/ch8en/appl8en/ch8a3en.html>). Since residential areas are located adjacent to the high-speed rail station, measures are taken to ensure that these neighborhoods are disrupted as minimally as possible.

The noise management solutions to be adopted in the Anyang Eastern New Town include: earth berms to absorb sound; constructed walls serving as sound barriers; noise-producing activity/structures located at the center of the site; position openings in structures that face away from residential areas; sound absorbing materials, and dense vegetation.

Luckily, the site is large enough to provide buffers on all sides of the station, and the structure itself is designed to use some sound absorbing materials in construction. Vegetation is used in the buffer zone to absorb and refract sound, and the following items are used within the station: acoustical absorber and barrier materials; mass loaded vinyl; noise control blankets and panels; acoustical foam; vibration isolation mounts; soundproof door and window gaskets, and quiet windows (http://lahosken.san-francisco.ca.us/departures/chicago/07/4079_iit_el_sound_barrier.jpg).

Other measures to reduce sound that have already been adopted in China and are planned to be used in the Anyang Eastern New Town are: streamlining locomotives; low-noise bogies; train skirts; disc brakes, and reduction in the number of pantographs. Thus, the A-weighted sound level of a passing train is decreased by 4–10 dB using these measures. (http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WM3-4J91R7N-2&_user=2629161&_coverDate=06%2F13%2F2006&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000058264&_version=1&_urlVersion=0&_userid=2629161&md5=8520b4e6881de52b637410434974f990).

7. TRANSPORTATION SYSTEM

The transportation system for the Anyang Eastern New Town includes the street pattern developed from the two flexible grids, the public transit system, green infrastructure as it relates to transportation, and relationships with the pedestrian realms, streetscape and tree amenities.

7.1. Transportation

The proposed street/arterial system is structured on the basis of the role of each street to facilitate vehicular movement. This hierarchy and the system are shown in the supportive maps and drawings included in this Final Conceptual Plan document.

Primary Arterials

The primary arterial routes follow the grid-like pattern in order to achieve the most efficient coordination of traffic flow. The Anyang Eastern New Town primary arterial system has been divided into two distinct road types: primary open space and primary urban routes.

Primary open space routes are undulating corridors that have urban land uses and structures on one side of the street and continuous open space on the opposite side. This unique route is scaled in size compared to its urban counterpart. The road length from curb to bike lane is 34.4 meters. At the edge of the open space corridor is a bioswale, which acts to limit urban runoff, nutrients and pollutants from disturbing and damaging the contiguous open space and gardens. Between the bioswale and the street is a bike lane 4 meters wide. Each of the 6 lanes is designated for cars and is 3.4 meters in width.

The center of the arterial is used as a designated bus lane, which could be expanded for bus rapid transit (BRT). When both of these systems are implemented, the entire space allocated in the center of the street will be 13 meters and will provide for two bus lanes, bus stop islands on either side 3 meters in width, and a landscaped center median with canopy trees. Pedestrians will be able to access the median via designated pedestrian crossings. The designated bus only lanes operate in the center of the right-of-way. Buses load and unload after clearing an intersection. This limits congestion before the intersection and decreases travel time for buses. There are left-turn restrictions and special left-turn phasing where left turns are permitted. Once buses cross the intersection, the bus lane encroaches upon the bioswale and stops at the bus stop island.

The Urban Studio recognizes that the location of a transit median in the center of the street is not a common practice in China. The intent, however, is to establish a well designed and effective median system, raised from the street elevation that will include the required infrastructure. The presence of

this 13 meter island in the street will have a more attractive character and scale by dividing the street open space into two parts.

Primary urban routes are the major arterials running through the district. The urban primary route provides a vegetative bioswale 4.5 meters in width in the center median throughout the length of the corridor. This swale will accommodate urban runoff based on sustainable principles and will add as strong visual character through the use of native and wild flowers for low maintenance. The width of the urban primary route is 39.9 meters. Two bike lanes account for 9 meters, 4.5 meters on both sides at the curbs, and provide a buffer between vehicular and pedestrian traffic. The 6 car lanes are 3.4 meters wide and the two bus lanes are 3.5 meters in width.

Collectors

There are three types of collectors implemented in the Anyang Eastern New Town. Open space, high-density, and low-density collector types are used throughout the New Town.

Open space collectors, like the primary open space arterials, are typically undulating corridors with one side devoted to the built environment and the opposite side to continuous open space. This enables efficient use of the right-of-way while providing pedestrian scale and bike lanes. The road length from curb to bike lane is 19.6 meters. At the edge of the open space corridor is a bioswale, which acts to limit urban runoff, nutrients, and pollutants from disturbing and damaging the contiguous open space and gardens. Between the bioswale and the street is a bike lane 6 meters wide. Each of the 4 lanes is designated for cars and is 3.4 meters in width, while 3 meters on both sides are used for on-street parking and pedestrian and bus stop bulbs. These bulbs, which extend into the driver's line of sight, act as a traffic calming device and create a safer pedestrian environment while maximizing road space for vehicular traffic.

High-density collectors incorporate the use of bike/bus lanes similar to those seen in Europe, Australia, and the United States. Tree-lined sidewalks act as a buffer between pedestrian and vehicular traffic. The high-density collectors are 37.1 meters from curb to curb, while the 4 lanes dedicated to cars are each 3.4 meters in width. A tree-lined vegetative bioswale 4.5 meters in width occupies the center median. The dedicated bike/bus lanes are 6 meters wide and located near the sidewalks.

Low-density collectors are situated in the peripheries of the Anyang Eastern New Town. The width of the street is 19.6 meters from curb to curb. This includes 4 vehicular lanes each 3.4 meters wide, 2 bike lanes 3 meters wide, and space for trees to buffer between the bike lanes and vehicular lanes.

Green Infrastructure

Bioretention or bioswale areas are designed to allow for partial or full infiltration of urban runoff where site conditions are suitable. Alternatively, bioretention is used for detention and filtration only, with the entire design storm volume eventually discharging to the municipal storm sewer via a perforated drain. Runoff from very large storm events is either diverted completely or enters an overflow structure to avoid flooding. Bioretention is an ideal best management practice (BMP) for highly urbanized areas because it can be designed to reduce, detain, and treat runoff, and it can be retrofitted into small spaces like medians, planting strips, traffic islands, and so on, adding to the green character of the urban environment.

7.2. Bus System

In the Anyang Eastern New Town, the mass transit is designed to be readily available to the entire population. This includes a bus system that is well integrated into the built environment, and the various neighborhoods and density areas. The curvilinear blocks create a route system that helps to structure the major functions of the new town. Each of the routes is dotted with bus stops that allow residents to easily find where to get on the bus, and each bus stop is positioned in order to take advantage of the population or function surrounding it. The bus stops are distributed and are positioned within walkable radii. In addition, the stations are placed to saturate the Eastern New Town with bus stops and promote ridership that is significantly higher than elsewhere in Anyang. The routes will be clear, concise, and easily manageable. The new system uses the highest technology available, and sets a new and innovative level of excellence for bus systems around the world. In fact, the bus design itself is very modern and creates a new image of mass transport that is radically different than that represented by the old and worn out bus systems seen throughout China.

Along with the bus routes, pedestrian activity in the Anyang Eastern New Town is aided by the addition of wide sidewalks and streetscape guidelines. The wide sidewalks allow more people to access easily all of the businesses and residences along roads, and also provide a transportation system for short range travel. Pedestrian activity is also encouraged by the use of streetscape improvements. The sidewalks are attractive and safe places to walk, separated from the road by trees and other attractive landscaping. These factors will make Anyang Eastern New Town a very pedestrian friendly city.

Bus Stops

The design for the Anyang Eastern New Town transit bus stops is a sustainable symbol for this new town in that it signifies innovative, forward-thinking, while the bus stops are readily accessible to all and

easy to identify. The bus stops' design is derived from the traditional Chinese character for Anyang. As the graphics show, the bus stops have a modern feel to them, but at the same time incorporate the city's identity through their form.

One of the most striking features of the new design is the ease of identification for these bus stops. The new bus transit system utilizes color-coded bus routes, which help identify which buses serve a particular bus stop. This is achieved by the use of sensors mounted on buses and receivers on the bus stops, which light up an array of LED lights according to the bus' route. The bus stops change their ambient color so that passengers can recognize what bus is approaching the bus stop. Ranging from red to blue to green, the bus stops are easily identified by their colors and form so that passengers can plan their trips without having to rush.

During the day, the bus stop has LCD screens, which present passengers with all the information required for their trip. The screens provide passengers with an estimate of when the next bus will approach the station. At the same time, passengers are able to consult an interactive map that highlights the entire bus system of the new town. Passengers will be able to purchase bus tickets for any bus route at any station. All stations have ticketing machines that dispense tickets prior to boarding the bus, thus reducing congestion and boarding times.

Another feature that will distinguish the bus stops in the Anyang Eastern New Town is the use of photovoltaic cells. In line with the sustainable character of the New Town, the bus stops have a small array of solar panels on their roofs to collect sufficient solar power to generate electricity for the lighting features and ticketing machines. The bus stops are completely off the grid and generate enough power to light not only the stations, but landscaping features around the stop as well.

The adoption of universal design principles is a basic design element of the bus stops. Thus, each bus stop has ample space for people with disabilities (using wheelchairs) and also for regular commuters that pedal their bicycles to the stations. The new transit system allows passengers to board the bus with their bicycles, or, if a passenger chooses, he or she may leave their bicycle conveniently parked in one of the bicycle storage facilities, which are located adjacent to the bus stops. These bicycle storage facilities are located at the major and most utilized bus stops in order to present passengers with the option of boarding with or without their bikes.

8. CONCLUSIONS

The enthusiastic acceptance of the Final Conceptual Plan by the Anyang authorities demonstrates the increasing interest of the Chinese in creating a more sustainable and environmentally positive way of

living in their cities through innovative urban design based on sound landscape urbanism principles. Although most international urban research in China has been focused on the world cities of Beijing and Shanghai, this paper demonstrates that attention to the urban environment has spread to the authorities in third tier cities in the country's provinces. This is a promising and welcome development.

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