NATURAL HEART

YANGCHUN LAKE SUB-URBAN CENTER MASTER PLAN

Yuxin Wang

Natural Heart

Yangchun Lake Suburban Center Master Plan

by

Yuxin Wang

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ABSTRACT

Urbanization in China is rapidly improving with the economic growth. But the development that ignores environment has caused lots of environmental problems in Chinese cities, especially the large ones. As the capital of Hubei Province, Wuhan is the fifth among China cities for its size and its economic production. Because of extreme urbanization and high dense population in Wuhan city, some significant issues have been constantly emerged: lack of adequate wastewater management and water resources protection, urgent need for efficient solution to sludge treatment and disposal, serious urban flooding because of the natural flow or urban lakes and streams restriction, degradation of water quality, and so on. These issues have been seriously impacted the quality life in the city. Along with the urbanization, the conflicts between urban development and ecosystem are inescapable. How can urban development balance environmental sensitivity to support ecological health in the vulnerable urban ecosystem and mitigate the problems in the city?

This project tries to redesign a master plan for Yangchun Lake sub-urban center in Wuhan city and find suitable ways to mitigate these problems with attention to the environmental, functional, economic, social and aesthetics aspects of the proposed solutions. The design will balance the urban development and environmental protection, support and enhance the development of a new ecological urban center.

Introduction

Problem Statement

The urban development in China is flung into a dilemma. For three decades, urbanization in China has moved along in high gear in agreement with the rapid economic growth. “It was a function of the surpluses produced from the agricultural sector, massive employment opportunities created by the influx of direct foreign investment, tremendous economic growth and higher wage rate in cities.” (Qi Chen 2012). After huge numbers of rural residents flocked into the cities, domestic consumption was boosted in real estate, and through a chain effect, the domestic aggregate demand also was raised. Constructions are happening in every city and town in China to build human habitat for people’s living, recreation and entertainment. In despite of the benefits which urbanization will normally have, environmental problems caused by ignoring impacts for environment during urban development have been nagging almost all the Chinese cities, especially the large ones. Although these are common issues for other countries as well, they are tend to impose a huge negative impact and extremely serious, damaging to China. Chinese people and government now are paying a heavy price for these mistakes.

High Density Development in China

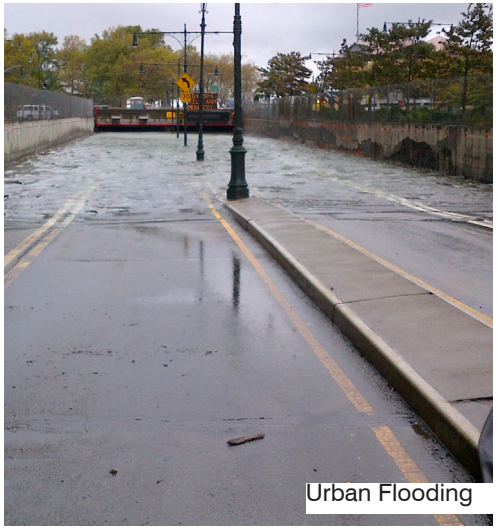
High Density Development in China

The Yangchun Lake is located in the Wuhan city, Hubei province, China. As the capital of Hubei province and a modern metropolis, there are more than 10 million people who live in Wuhan city. Situated at the crossroads of central China, Wuhan is a transportation hub for air, railway as well as ferry traffic. It is also recognized as the political, economic, financial, cultural, and educational center of central China. Urbanization plays a huge role in stimulating growth of Wuhan city, but it has imposed serious environmental problems. Like other cities, the most prominent environmental issues concern the following areas in Wuhan city: **air and water pollution, and urban flooding.**


Air Pollution


Water Pollution


Vehicle Increase


Urban Flooding

Air pollution is the harm caused by chemicals, particulate matter, or biological materials particularly the emissions of carbon dioxide from industries and vehicles, to humans and environment. Vehicle emission is the main pollution source (47% of the total pollutant) in Wuhan city, and it is even worse because each year more than 100,000 new vehicles will be added to the existing large number. Industrial emission and the construction dust are other pollution sources which lead to heavy emission of polluted dust.

Water pollution also has become increasingly a critical problem in Wuhan city. With an average annual precipitation of 1200 mm and average annual water resources amounted to 700 billion cubic meters, Wuhan is ranking on the top list of cities all over the world in terms of the available fresh water resources. However, because of industrialization and urbanization, undoubtedly increasing fishery, emission of industrial wastewater and city wastewater have led to a serious deterioration of ecological environment in the city. Most of the wastewater is discharged, either without purification, or not up to the standard requirement even if being purified. On the contrary, Wuhan city is facing the problem of insufficient fresh water supplies in rural areas even there are lots of fresh water resources.

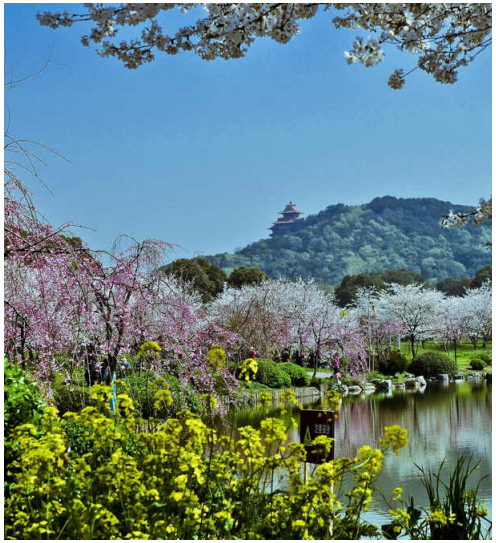
Urban flooding, happened in many cities, continues to increase in Wuhan. Increase of impervious surfaces, decrease of flood plains and disappearance of water bodies cause urban flooding to appear frequently.

Existing City Proposal

Existing City Proposal

Research Question

How can urban development balance environmental sensitivity to support ecological health in the vulnerable urban ecosystem and mitigate the problems in the city?



Project Description

Chinese economy is booming at the cost of environmental ecology deterioration. After ravening development in several decades, the environmental ecosystem in China is pretty vulnerable. Now the construction of "Eco-city" in China is in the ascendant. It shows that Chinese cities have begun to make sharp response to the environment constraints in the rapid urbanization. The city of Wuhan is included in this construction. This master's report summaries environmental problems happened in Wuhan city, and explores appropriate ways to balance ecological health and urban development in the urban center to protect urban ecosystem. The project specifically looks at an transportation and service center - the Yangchun Lake Sub-Urban Center (YLSUC) in Wuhan city, China. To compare with the exiting city proposal, it is intended to create an urban design alternative that better address the needs of environmental health, economic development and the creation of open space and its ecology.

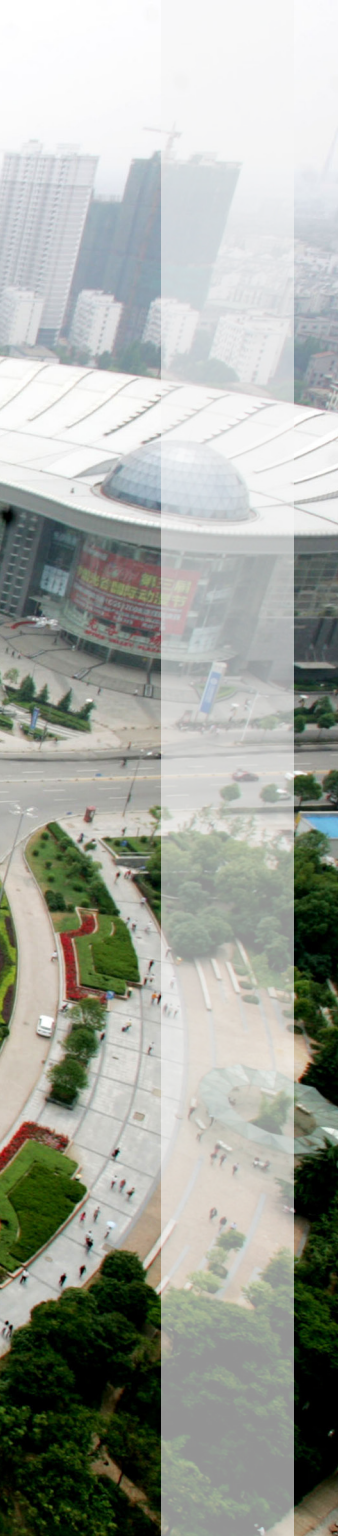
Project Goal and Objectives

Goal

This master's report is to support and enhance the development of a new ecological sub-urban center which improves the quality and the efficiency of the urban development as well as keeps and fosters the environmentally ecological health, create multi-functional spaces for inhabitation, work, relaxation, recreation, education and communication, increase the quality of life.

Objectives

- Clean polluted water to improve water quality in the urban lakes and water channels. Reuse reclaimed water for irrigation and people's life, reduce freshwater use.
- Enhance surface water circulation and help alleviate flooding.
- Consider mixed-use within neighborhoods, blocks and buildings, create jobs and improve the economy in communities.
- Promote walkable neighborhoods and non-vehicle traffic, increase the connectivity.
- Provide local foods for residents.
- Emphasize on aesthetics, comfortable, human-scale architecture and outdoor spaces within community for gathering and communication.
- Enhance public awareness of urban environmental and related public health issues.



Literature Review

The design project in this document tries to rationally develop new sub-urban center which can avoid environmental problems and contribute benefits and values for the city. To complete the design visioning, this literature review focuses four areas to supply basic urban design and landscape architecture knowledge to finish a innovative and ecological design. First discussion is to mitigate air pollution and transportation problem by vehicle control. Next, the water problems in Wuhan city including pollution and flooding are researched. Water management as a solution is used to improve the environment. Landfill in the site is also an issue and needs to be revitalized. Finally, this literature is interpreted for design implication to be applied.

Vehicle Control

As an instrument of improved urban mobility, appearance of automobile changed human's life. People can go far away conveniently and fast. But at that time, nobody realized that the car brought with it major unanticipated consequences for urban life. It has become a serious source for environmental, social, and aesthetic problems in cities. The automobile changes street life, damages the social fabric of communities, fosters suburban sprawl, causes air pollution, endangers street users, water resources and creates machine-made cityscape (http://www.carfree.com/intro_cfc.html). Today, more and more people begin to think the solution to mitigate these problems.


Car-Free Street


Car-Free Street


Car-Free Street

Car-Free Planning

Car-Free Planning refers to design specific areas for minimal automobile use. The goals of Car-Free Planning is to create high quality of life, efficient use of resources and fast transport in the city. It can be used in the following situation (Victoria Transport Policy Institute 2012):

- Developing urban districts (such as a downtown or residential neighborhood) where personal automobiles are unnecessary and automobile traffic is restricted. Housing developments where residents are discouraged from owning private cars.
- Pedestrian-oriented commercial streets where driving is discouraged or prohibited.
- Resorts and parks that encourage or require non-automotive access.
- Car-free days and car-free events.
- Temporary restrictions on driving, such as during an air pollution emergencies or a major sport event that would otherwise create excessive traffic problems.

Car-Free Planning can support urban revitalization and economic development (West 1990; Robertson 1990), and create a livable place that attracts people (Rodriguez 2010). Some guidelines are provided for Car-Free Planning application:

- Provide good travel alternatives and fast access to public transit and parking.
- Particularly appropriate in high-density areas with convenience public transportation; mixed use and mixed incomes within a community.
- Keep urban traffic dispersed and low speed in car-free areas.
- Create green streets, public spaces with unique social and environmental amenities.
- Build with proper scale for people.

T*ransit-Oriented Development (TOD)*

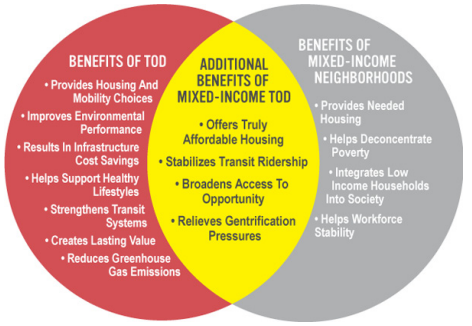
During promoting "livable communities" and "smart growth", transit-oriented development (TOD) has been more and more used to mitigate urban problems such as traffic congestion, air pollution and incessant sprawl.
TOD "is a mixed-use residential and commercial area designed to maximize access to public transport, and often incorporates features to encourage ridership" (Wikipedia). TOD is not just about enhancing ridership and improving traffic conditions. It also could “contribute more benefits to do with widening choices on quality of life such as where to live, how to travel, rejuvenating urban fabric, enhancing urban social and cultural diversity”.

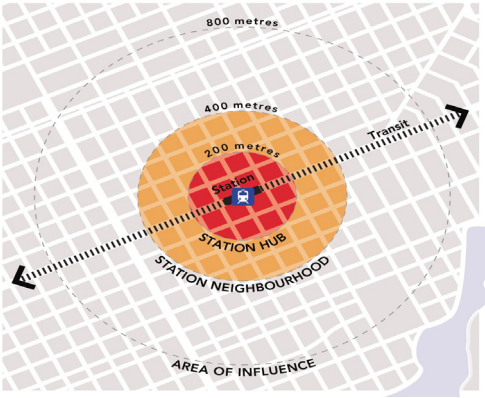
Elements

- Mixed-use development includes a mixture of residential, commercial, employment, civic uses in communities (Still 2002).
- High density development around transit stops, concentrating higher numbers of people to use public transportation.
- Development that maximizes access to public transport and be conducive to transit ridership. The transit center extends roughly a quarter mile and a half mile from a transit station, a distance that can be covered in about 5-10 minutes by foot (Bernick and Cervero 1997).
- Provide pedestrian and cycle-friendly environments.
- Public and civic spaces near stations to create more convenience life (California Depatment of Transportation 2001).

Benefits

- Provide mobility choices to reduce driving by creating transit "activity nodes" linkage.
- Create all day busy active places and increase public safety for pedestrians, transit-users, and many others.
- Increase transit ridership and enhances the efficiency and effectiveness of transit service investments.
- Increase households’ disposable income by reducing the need for more than one car and reducing driving costs.
- Reduce air pollution and energy consumption rates by limiting the driving.
- Consumes less land and conserve resource lands and open space.
- Help to revitalize aging downtowns and declining urban neighborhoods, and enhance tax revenues for local jurisdictions.
- Decrease local infrastructure costs for water, sewage, and road (Arrington and Parker 2001).






Transit-Oriented Development

Urban Lakes Pollution Control

Urban lakes are one of the landscape features that have the potential to significantly improve the quality of life in urban areas because of their intrinsic aesthetic, recreational and educational values, and the contribution for mitigating the urban climate (Martinez-Arroyou and Jauregui 2000). But urban development creates a lot of problems in urban areas that can have serious impacts on urban lakes especially urban lake pollution. Pollution affects water quality in lakes and other freshwater resource. It can take nutrients, pesticides, herbicides, sewage, litter and sediments into urban lakes and transforms them in potential risks for human habitat and health.

Pollution Sources

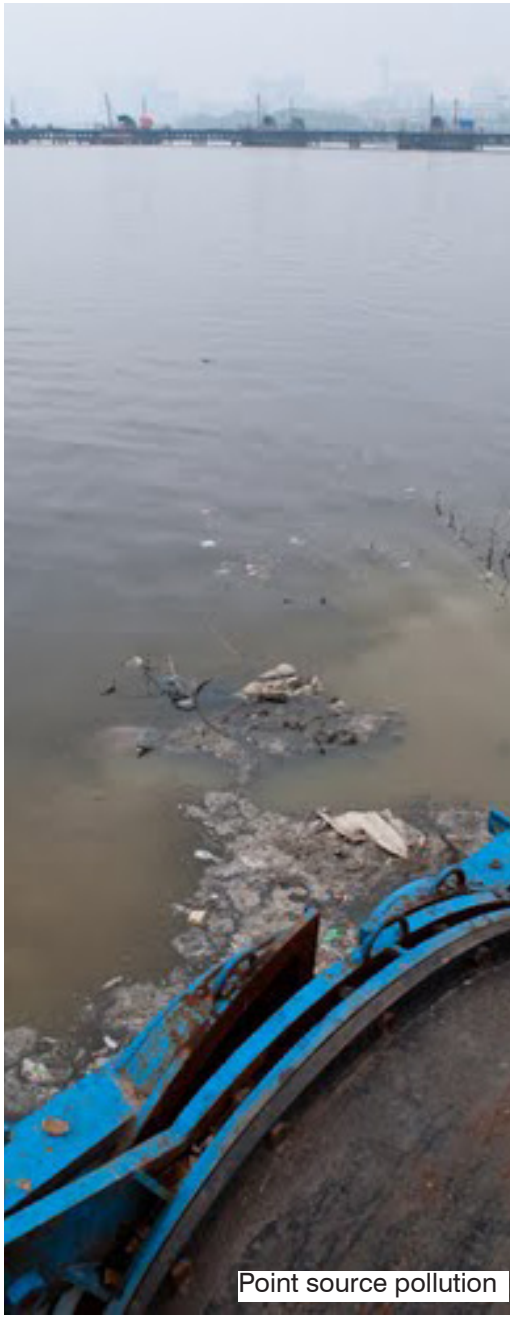
Point Source Pollution

Point source pollution is contamination that enters the water body through "any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." (U.S. Environmental Protection Agency). It can be traced back to a specific source, location, and offender. Point source pollution remains a major cause of pollution to water.

Effluents from Industrial plants and sewage treatment facilities are two common types of point sources. (Krantz, Kifferstein, 2010). The effluents from some industrial plants are discharged directly into water bodies without any treatment; others are treated by industrial plants themselves before released; or others are sent to sewage treatment plants for treatment. Sewage treatment plants treat human wastes and send the treated effluent to a stream or river.

Except discharging to water bodies, some factories and sewage treatment plants mix wastewater with urban runoff in a combined sewer system (CSS). CSS is used to capture and transport stormwater and untreated sewage and wastewater. Runoff runs directly into CSS after flowing over surfaces and picks up chemicals and pollutants. When the volume of runoff exceeds the capacity of CSS, the overloaded water and sewage pollutants will be discharged into local water systems (U.S. Environmental Protection Agency) .

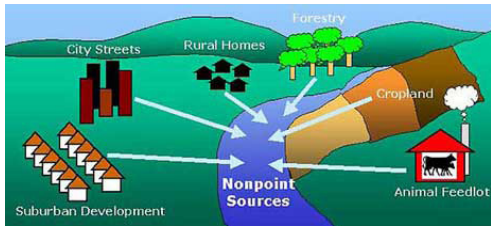
Point source pollution



Point source pollution

Non-Point Source Pollution

The source, location and offender of non-point pollution Contaminants are hard to be traced back before they enter a water body. This pollution comes from many diffuse sources which are small amounts and not exactly calculated. After entering in lakes and other freshwater resources, it can become concentrated (U.S. Environmental Protection Agency). Generally it is caused by rainfall or snowmelt flowing over and through the ground. During the runoff flows, it picks up and carries away natural and human-made pollutants, finally draining and depositing them into lakes, rivers, wetlands, coastal waters and ground waters (U.S. Environmental Protection Agency). The pollutant sources include: "excess fertilizers, herbicides and insecticides from agricultural lands and residential areas; oil, grease and toxic chemicals from urban runoff and energy production; sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks; salt from irrigation practices and acid drainage from abandoned mines; bacteria and nutrients from livestock, pet wastes and faulty septic systems; atmospheric deposition and hydromodification" (U.S. Environmental Protection Agency). Because of the uncertain sources' locations, it is very important to understand what sources cause and how to cause non-point source pollution to control it.




Non-Point Source Pollution


Non-Point Source Pollution


Non-Point Source Pollution

The Impacts of Lake Pollution

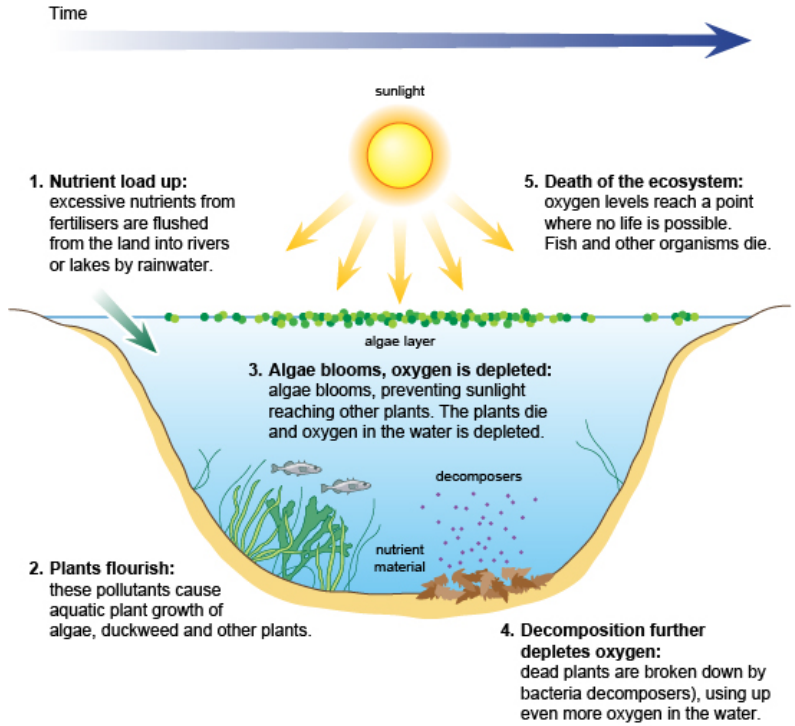
Regardless of the source, pollution can disrupt aquatic life in many ways. In general, these pollutants especial fertilizers and pesticides from agricultural and urban runoff and sewage pollution leads to eutrophication, which can be harmful to both aquatic life and human health. Industrial runoff containing heavy metals can cause illness or death to fish, other animals, or humans.

Eutrophication

Eutrophication is a significant pollution problem for urban lakes. It has been shown to negatively affect water use for fisheries, recreation, industry, agriculture and drinking (Carpenter 1998). It generally shows an increase algal growth because of an increase in nutrients such as nitrogen and phosphorus in lakes. Normally, the process of eutrophication is considered a natural process. Many water basins are filled slowly by of nutrients, sediment, and plant material as time goes on. It needs to spend over centuries. However, this process is greatly accelerated by human influence and is termed cultural eutrophication. Human activities such as the application of fertilizer and manure to crops, lawns and gardens, increased soil erosion and runoff from fields, feeding animals, and the discharge of urban and industrial wastes are important sources of phosphorus and nitrogen in water (Bennet 1999; Deunert 2003; Drolc and Koncan, 2002; Schroder 2004). But urban watersheds generally produce higher unit area phosphorus and nitrogen loads from runoff, compared to other watersheds. Following a heavy rainstorm, urban runoff, by flowing on impervious surface, larger amount of nutrients are washed out and collected, and becomes the primary source of nutrients (Schueler and Simpson 2001).

Heavy Metals and Toxic Organic Compounds Pollution

Pesticides and herbicides are not the only pollutants: other sources of urban pollution can cause sediment contamination by heavy metals. High concentrations of automobiles, homes and industry plants are the characteristic of urban areas. A large amount of pollutant particles produced by City automobile traffic, home heating and air conditioning, industrial functioning fall down on the paved urban areas and are easy to transport to urban lakes by the runoff. Some chemicals such as arsenic, cadmium, chromium, leas, mercury, nickel and zinc are often detected in the sediment of urban lakes (Mahler 2006). They are toxic for the organisms in the lake and seriously harm the structure of lake ecosystem.



Eutrophication Process

Polluted Water Purification

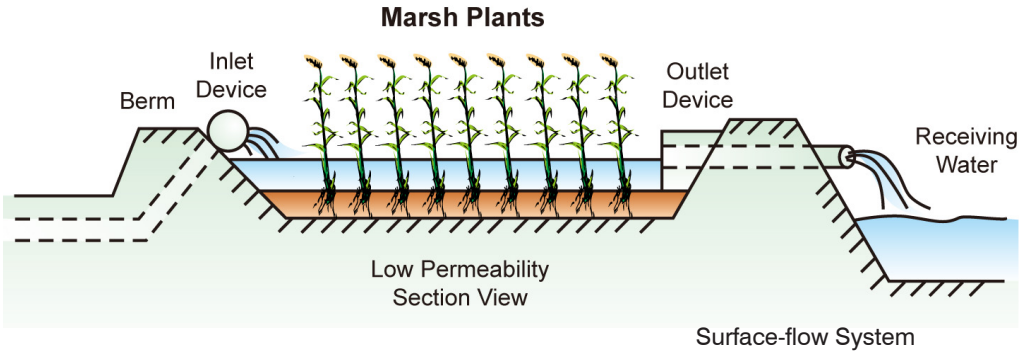
A much more successful management strategy to control urban lake pollution is stormwater management coupled with a large-scale watershed management (Ruley and Rush 2004) and wastewater treatment. Stormwater management practices can remove up to 90% of the phosphorus loading (Caraco 2001) and improve the water quality.
Some solutions are provided here:

Shoreline Buffer Zones

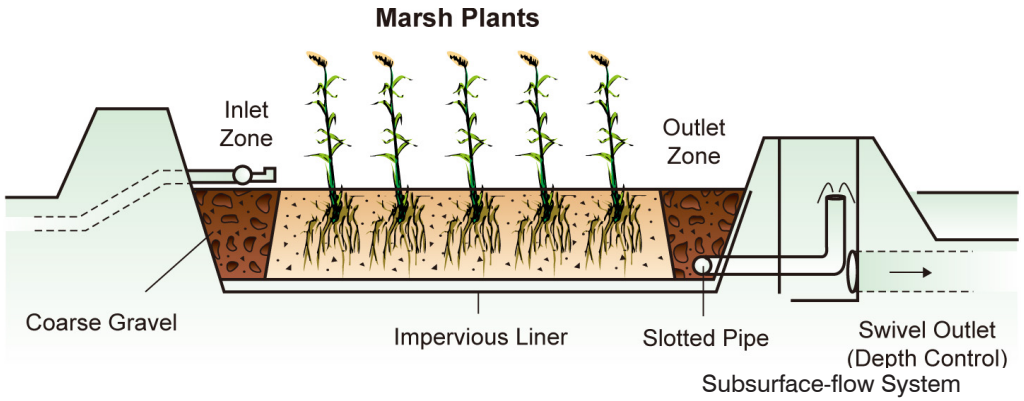
It has been observed that conserving natural areas within the watershed and around the water bodies is particularly useful to improve water quality (Carpenter and Caraco 1998). These areas are generically "buffer zones". When natural shoreline buffer zones are maintained, they can intercept non-point pollution between the source and the watershed to prevent pollutants and erosion from occurring in these systems. Shoreline buffer zones are interfaces between water bodies and lands, and have been created near waterways in an attempt to filter pollutants, deposit sediment and prevent nutrients from traveling too far, reduce erosion and runoff loads, and provide the habitat for wildlife and fish (Cappiella and Schueler 2001). The width for shoreline buffer zones ranges from 20 to 100 meters in relation to water uses.

Constructed Wetland

"A constructed wetland is an artificial wetland created as a new or restored habitat for native and migratory wildlife, for anthropogenic discharge such as wastewater, stormwater runoff, or sewage treatment, for land reclamation after mining, refineries, or other ecological disturbances such as required mitigation for natural areas lost to a development" (Wikipedia). Constructed wetland is considered to be designed to mimic features of natural wetland. Generally, a wetland begins from water at one end and flows over the surface or through the substrate, and then is discharged at the other end which needs to control the water's depth. During this process, the wetland act as a biofilter to remove sediments, pollutant. Its treatments may include swamps and marshes.
Constructed wetlands are classified into two types: Horizontal-flow System (HFS) and Vertical-flow System (VFS). The water flows in HFS from the inlet to the outlet horizontally, and drains vertically through the drainage pipes in VFS. HFS includes two types: Surface-flow System (SFS) and Subsurface-flow System (SSFS). The water in SFS is visible at a relatively shallow depth above the surface of the basin, but in SSFS free water is not visible and flows through the root zone of the vegetation.



Surface-flow System



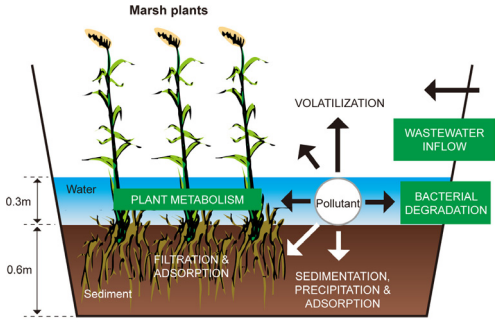
Subsurface-flow System

There are two stages to establish a constructed wetland: wetland construction and vegetation establishment. Wetland construction needs to clear site, construct landform and install water control structures. For the removal pollutants, wetland plants play a vital role. They can provide good conditions for physical filtration, improve soil hydraulic conductivity, release organic compounds as food for microbes, enhance microbial growth and create aerobic soils to prevent eutrophication.

The treatment of wastewater by constructed wetlands can be a low-cost, low-energy process requiring minimal operational attention. To be more effective in treating pollutants in constructed wetlands, some mechanisms need to be paid attention to. These mechanisms include:

- Settling of suspended particulate matter
- Filtration and chemical precipitation through contact of the water with the substrate and litter
- Chemical transformation
- Adsorption and ion exchange on the surfaces of plants, substrate, sediment, and litter
- Breakdown and transformation of pollutants by microorganisms and plants
- Uptake and transformation of nutrients by microorganisms and plants
- Predation and natural die-off of pathogens.

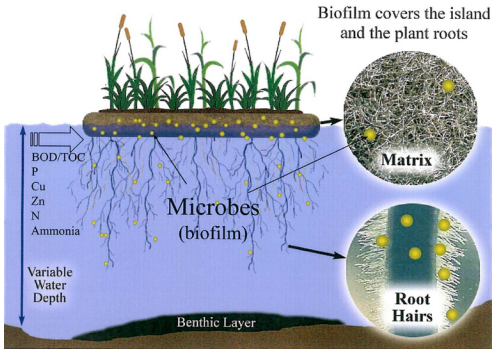
The most effective treatment wetlands are those that foster these mechanisms (USDA-Natural Resources Conservation Service, US Environmental Protection Agency-Region III).

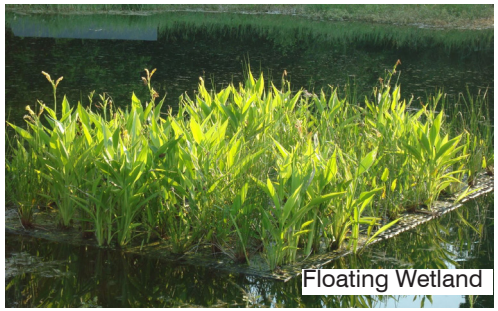


Pollutant removal processes in a constructed wetland system

Constructed Wetland in Beijing Olympic Forest Park

With the pollution of the watersheds in the city, the requirement to mitigate and reverse pollution is urgent. Macrophytes (an aquatic plant that grows in or near water) have been widely applied in ecological engineering for the treatments of surface water and wastewater due mainly to their efficacy in assimilating nutrients and creating favorable conditions for microbial decomposition of organic matter. However, the restoration of macrophytes is inevitably restricted by water depth, wave, water turbidity and transparency, sediment physicochemical properties, to name a few (Wang, 2009a). The planted floating-bed system is an innovative variant of wetlands with substrates-rooted plants and free-floating aquatic plant systems, which consists of aquatic or terrestrial plants growing in a hydroponic manner with buoyant frames floating on the surface of water bodies. The entire underwater surface of the plants serves as a base for the attaching of microorganisms, which favors the break-down of organic matters and the entrapment of suspended solids. Moreover, the plants are enforced to attain nutrition directly from the water column as they are not rooted in any substrate, which may improve the uptake rates of nutrient into biomass. In addition, the plant products can be further used as animal even human food or be processed into biogas, biofertilizer and biomaterial, impelling the practical application of the technology due to the potential economic returns. The planted floating-bed holds great promise for shallow turbid eutrophic lakes characterized by low transparency, strong wave and poor sediment conditions, as it is minimally affected by the aforementioned restraints. More importantly, planted floating-beds have the unique advantage of occupying no land area as compared to conventional macrophyte-based constructed wetlands (Coveney, 2002;Wu, 2006; Iamchaturapatr, 2007).



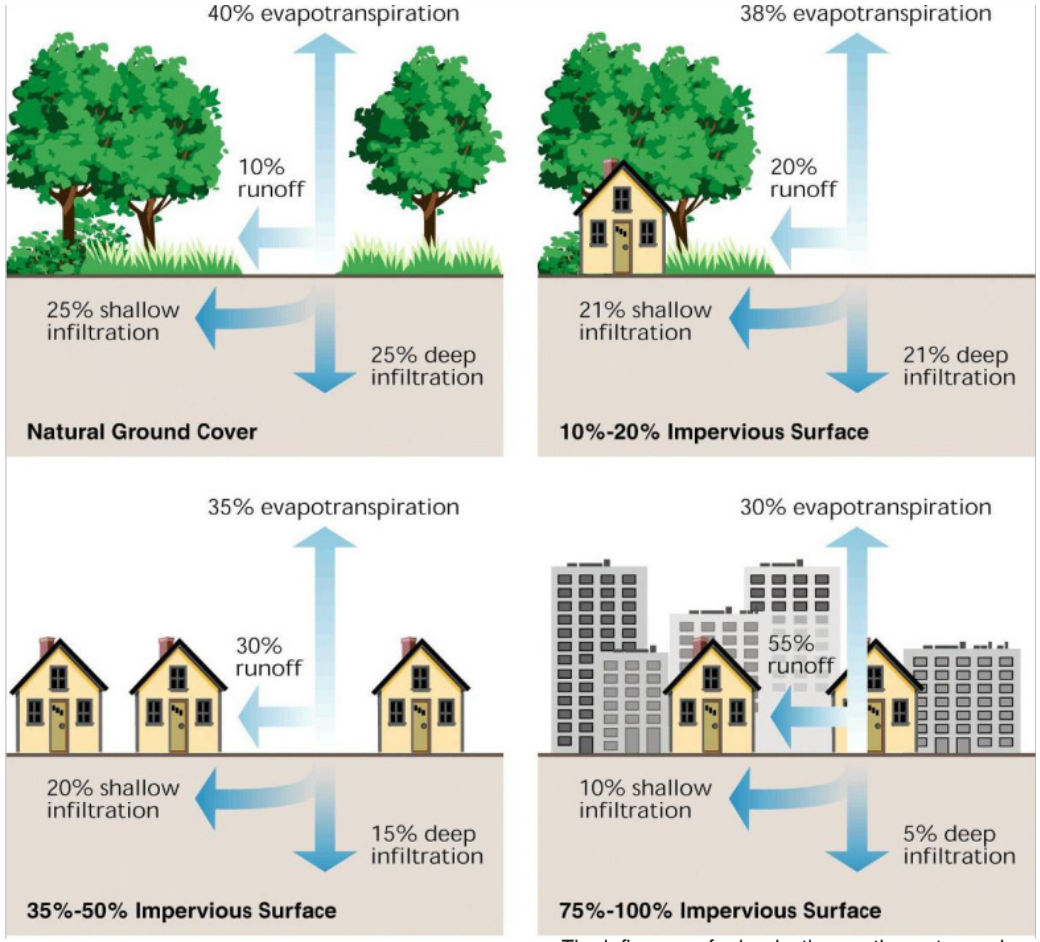


Floating Wetland

Floating Wetland

Urban Flooding

Expansion of cities and increase of urbanization over the past of century has resulted in a steady shift from nature to built environments and impervious surfaces. This situation directly causes an increase in urban runoff volumes and flow rates. The runoff occurs along impervious surfaces such as roads, parking lots, pavements and rooftops to the local storm drainage system instead of allowing water to percolate through soil during heavy storm events. This system conveys the runoff to the community's primary drainage system, typically a main river channel or the nearest lake, which act as flood absorbers. Increased runoff as a result of urbanization can cause more frequent and higher volume floods and dramatically increase stream-channel erosion (Booth 1991). The sediments from the erosion are carried by stormwater and transit into water bodies. Meanwhile, the floodplain of rivers and urban lakes are gradually filled up and built upon due to urbanization and the system cannot carry enough runoff from impervious areas. When high surface runoff is in excess of local drainage capacity, urban flooding can be caused (World Meteorological Organization 2008).



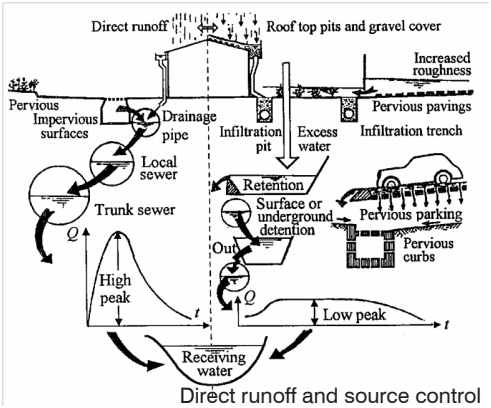
The influence of urbanization on the water cycle


Urban Flooding


Urban Flooding

Reduction of Surface Runoff

There are two major concepts for urban storm management: direct runoff and source control. Direct runoff is normally used in the city. Runoff flows directly into sewage system through pipes. Source control concept is intended to retain or reduce stormwater runoff to prevent the overuse of the drainage system and to mitigate the generation of flood hazards downstream (World Meteorological Organization 2008).



Direct runoff and source control


Open Space Preservation

Open Spaces Preservation

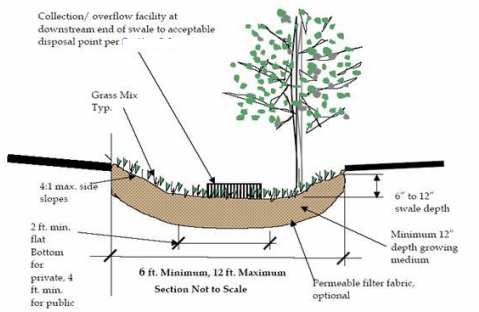
The reduction of surface runoff can be achieved by a variety of measures that increase infiltration, evaporation and/or transpiration from the catchment areas that contribute to urban flooding. The easiest way to do so is to preserve unsealed and green spaces in the city. For open spaces preservation in urban areas, dwelling units are concentrated in a compact area; lot sizes, setbacks and frontage distances are minimized to allow for open spaces. The open spaces preservation creates less impervious surfaces to reduce urban runoff. It also can be used to increase infiltration, retain water through interception, filter the percolating water, recharge groundwater resources, reduce air pollution and improve the urban microclimate, and provide recreation in the form of parks and gardens.

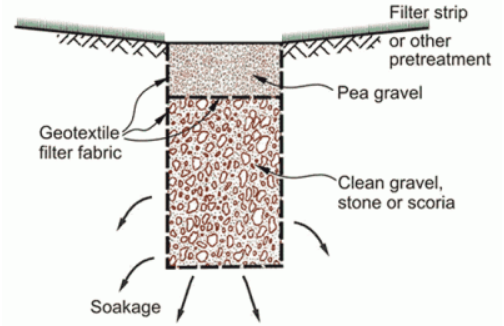

Urban Park


Green Roof

Infiltration Systems

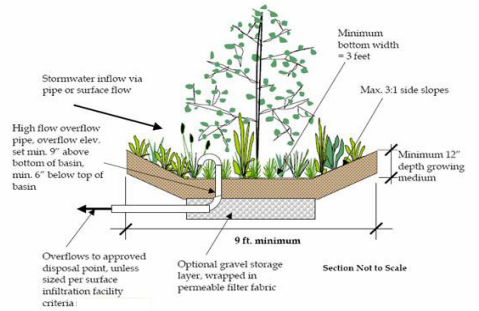
Since the availability of open spaces is highly limited in cities, less extensive measures that enable effective in-town infiltration can also be used. They are infiltration basins, infiltration swales, infiltration trenches, soak-aways, and the permeability of surfaces. Infiltration basins are man-made depressions to hold stormwater. It requires a relatively large spaces to collect water during peak storm events as an intended function of the drainage system. Infiltration swales are shallow, flat-bottomed drainage features. They are used to capture stormwater at source, infiltrate and convey them. Infiltration trenches are narrow, excavated strips, filled with gravel. They are designed to capture rain water from lateral flows, and let them infiltrate into the surrounding soils. Soakaways are excavated underground chambers (http://www.engineeringnaturesway.co.uk/product-techniques/infiltration-basins-swales-trenches-and-soakaways/). They provide source control for small impermeable areas to attenuate surface water and allow them to infiltrate to the soil. Instead of impervious surfaces, surfaces made of permeable materials can also contribute significantly to the reduction of runoff.

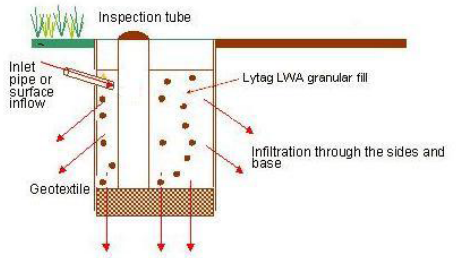




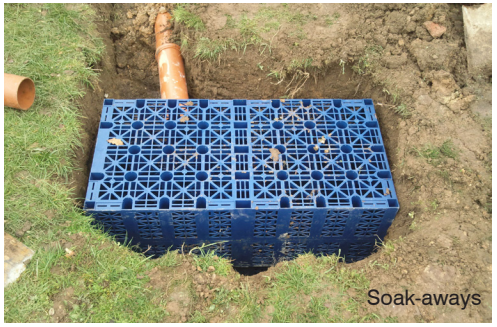

Infiltration basin


Infiltration trench






Infiltration swale


Soak-aways

Stormwater Retention

Multipurpose detention

Because the potential for the infiltration and evapotranspiration are limited in cities by urban development, especially in urban areas where convective precipitation and non-absorptive soils prevail, stormwater retention are very important for the mitigation of urban floods as well as for the prevention of downstream floods. There are different kinds of retention basins and ponds which are open or covered, wet or dry, online or offline to temporarily store surface runoff and release it subsequently at a controlled rate. With the function for water retention, they also can be used for a various purpose such as recreation and entertainment. The advantage of multipurpose dry ponds is the maximization of land use. There are many creative possibilities that can be applied to daily use areas as well as spaces for occasional flooding. Furthermore, detention or retention ponds in the form of artificial lakes can add aesthetic value to an area. Temporary stormwater retention can be used in sport courts, parking sites, and playgrounds, to name a few. In all cases sedimentation has to be considered a likely problem in basins and ponds. These retention basins require flow equalization facilities to prevent flooding of and damage to such facilities (World Meteorological Organization 2008).


Sports Field


Sports Field as Water Detention

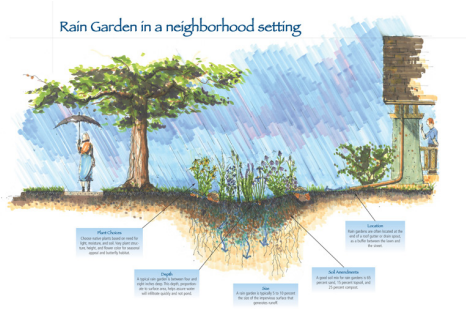

Green Space as Water Detention


Sports Field as Water Detention

Rest Space as Water Detention

Rain Garden (Bioretention Areas)

Rain gardens are planted intentional low areas where the runoff from impervious urban areas is contained and allowed to infiltrate into the soil. Rain gardens were first used in Maryland in the early 1990's in the Chesapeake Bay. These rain gardens were created to mimic the natural water retention areas that occurred naturally before development of an area (U.S. Environmental Protection Agency). Since that time, a number of people, municipalities and organizations have influenced and enhanced the rain garden movement in the United States. Rain gardens have been used at large construction sites, communities and small residential lots to deal with stormwater runoff from impervious surfaces. The purpose of rain garden is to create a more natural flow on site to infiltrate and reduce stormwater that runs into streets and sewer system. The primary components which have to be considered are soil, drainage and plants. Rain gardens are an integral part of the landscape and water infiltration. Because water should stand in a rain garden no longer than 48 hours after the rain stops to prevent mosquitoes, soils in rain gardens have to be permeable enough to allow water to drain and filter properly. The best mixtures usually contain 60% sand, 20% compost, and 20% topsoil. Plants selected for rain garden should tolerate both saturated and dry soil. Native plants are typically a better selection and can contribute to urban habitats for native butterflies, birds, and beneficial insects.



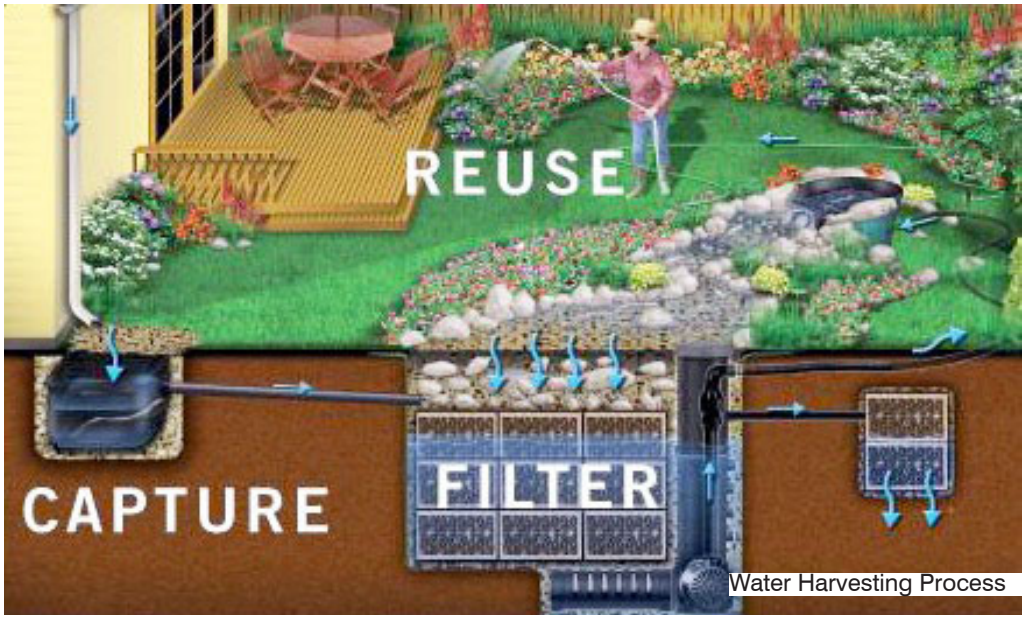

Rain Garden


Rain Garden

Rainwater Harvesting

Rainwater harvesting is a complementary multipurpose retention strategy which stores stormwater as a source of water supply. This is particularly useful in semi-arid areas that experience water stress. Because of economic and environmental advantages and its potential for mitigation of urban floods, rainwater harvesting is not only applicable in cities where fresh water resources are scarce but also constitutes a reasonable measure in almost all cities. Rainwater collected from existing structures such as rooftops, parking lots, playgrounds, parks, ponds, flood plains, has few negative environmental impacts because it is relatively clean and its quality is usually acceptable for many purposes with little or even no treatment (United Nations Environment Programme, 2012). Rainwater harvesting collect the rainwater and reuse it, also reduce rainwater flow into storm drains by collecting rainwater in green spaces and can reduce the dependence on the watershed. Every drop of water counts and conservation is the most sustainable, cost-effective source of water supply for people.

The primary components of a rain harvesting system include the collection area, the transport system, filtration, storage, delivery and distribution. The collection area can be primarily impervious or a mix of green spaces and impervious surfaces. Areas with bare soil should not be collection areas because of the sediment that is entrained in the runoff. Water is transported from the collection areas to storage through a combination of pipes and open channels. Storage can be a tank (cistern) or a pond. Tanks can be buried or set on the ground. Before water is reused, suspended materials have to be removed. The filtration may need to be considered. If the surface the rainwater is captured from is fairly inert and clean, the quality of the stormwater will be suitable for irrigation without a lot of treatment to the water. The water typically does not contain the detergents and chemicals that present in greywater, but can have pollutants from the impervious surfaces.



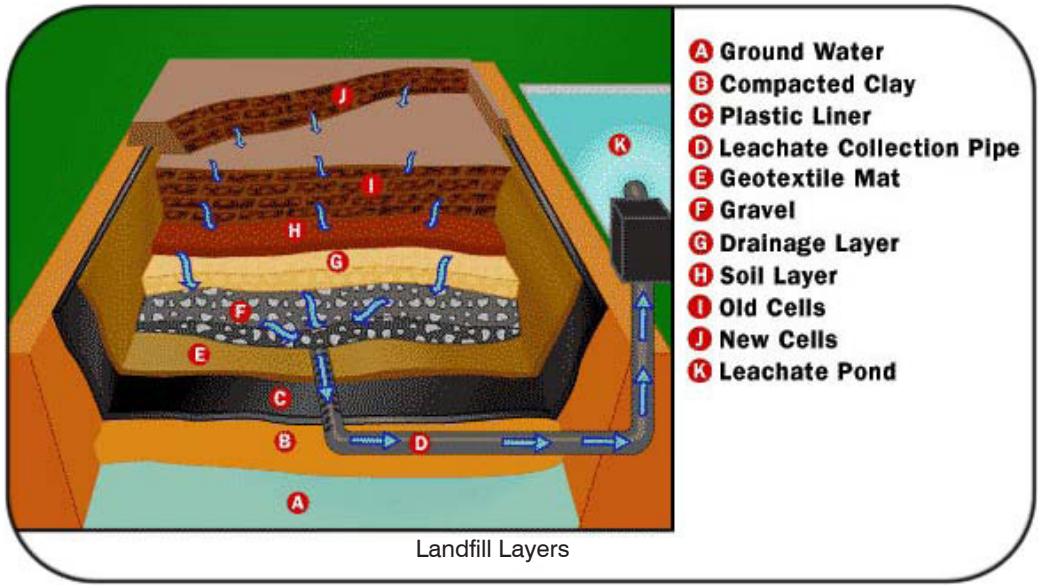
Water Harvesting Process


Water Harvesting Tank

Landfills

Introduction

A landfill is a carefully engineered depression in the ground into which wastes are placed. There are four critical elements in a secure landfill: a bottom liner system, a leachate collection system, a cover, and the natural hydrogeologic setting. A bottom liner is one or more layers of clay or a synthetic flexible membrane (or a combination of these). The function of the bottom liner is to prevent waste migrate into the environment. Leachate is a badly contaminated water by contacting wastes. Generally it oozes to the bottom of a landfill and can be collected by pipes and treated at a wastewater treatment plant. A cover or cap is an umbrella over the landfill to keep water out (to prevent leachate formation). It includes several sloped layers from bottom to top: clay or membrane liner, permeable layer of sandy or gravelly soil, and topsoil in which vegetation can root. If the cover (cap) is not maintained, rain will enter the landfill resulting in buildup of leachate to the point and wastes enter the environment (Environmental Research Foundation).



Landfill Layers

Landfill

Impacts

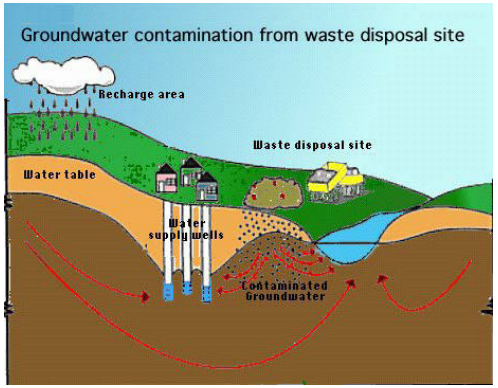
Landfills are necessary in modern society because we need centralized locations for the collection and disposal of waste materials to minimize risks for public health and safety. The waste sources in landfills may be variety. Solid, semi-solid, and small quantities of liquid wastes from households, businesses, restaurants, medical facilities, and schools all can be accepted. Even modern landfills are federally regulated and engineered to minimize their environmental impacts, they still can potentially impact soil, water quality, air quality, global climate change and public health.

Groundwater Pollution

Landfills present long-term threats to groundwater and surface waters that are hydrological connected and leachate is the most important source of pollution. Combined with disposed liquid waste, the precipitation falls into a landfill and causes the extraction of the water-soluble compounds and particulate matter of the waste and the formation of leachate. Leachate is a major thread to the current and future quality of groundwater near a landfill site (Odunlami 2012). Its composition changes based on the amount of precipitation and the quantity and type of waste disposed. The constituents in leachate include dissolved metals, salts, common anions and cations, heavy metals, etc. which do not usually exist in natural groundwater (Fred and Jones, 1991) and may cause several risks such as aquifer unusable for drinking water and other use, a danger to environment and to aquatic species. Monitoring wells at landfills are used to intercept contaminants and monitor their movement. To control groundwater pollution from leachate, some strategies are considered. Plastic liners are set below the waste and covered to separate waste and groundwater when the landfill stops placing waste. These systems are designed to reduce leachate generation by restricting moisture and precipitation. Pumping and directing leachate from the bottom of a landfill to the leachate pond with wetlands for treatment (McGinley and Kmet, 1984).

Air Pollution

Composed of approximately 50% methane and 50% carbon dioxide, landfill gas (LFG) is produced by the decomposition of organic waste under anaerobic conditions. The gas released into the air smells bad, causes local smog, and contributes to greenhouse effect and global climate change. Aside from environmental concerns of gas emissions and unpleasant odors associated with LFG, uncontrolled LFG can present a serious explosion hazard. For this reason, the gas from large landfills has to be controlled, usually by the drilling of wells into the landfill and establishing a system of collection pipes to draw the gas out of the landfill. In this collection system, air may be added to the methane to reduce the hazard. Today, this flared gas is found to be reused as an energy (http://www.gassep.com/lfg.htm).




Air Pollution Caused by Landfill


Public Health Problems


Landfill Gas

Landfill Reuse

"Sustainable landfill regeneration is the management, rehabilitation and return to beneficial use of landfill in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways within the particular regional context." (RESCUE 2005)

Gas-to-Energy

Capturing LFG and using it as an energy resource can produce significant energy, environmental, economic, and other benefits. A number of factors, including the availability of an energy market, project costs, potential revenue sources, and other technical considerations, can determine which technologies are most appropriate for a particular LFG energy project. Technologies for converting landfill gas into energy include: electricity generation, combined heat and power, and alternate fuels.

Electricity generation

Electricity from LFG can be generated using a variety of technologies, including internal combustion engines, gas turbines, and microturbines, with 85 percent of landfill gas electricity generation projects using internal combustion engines or turbines in USA (U.S. EPA, 2009c).

Combined heat and power

LFG also can be used as a fuel source for combined heat and power (CHP) or cogeneration systems that generate both electricity and thermal energy. CHP systems can achieve substantially higher efficiencies than separate heat and power systems that do not use the waste heat produced in electricity generation. Thermal energy cogenerated by LFG energy projects can be used for on-site heating, cooling, and/or process needs, or piped to nearby industrial or commercial users to provide a second revenue stream for the project (U.S. EPA, 2009d).

Alternate fuels

Production of alternate fuels from LFG is an emerging area and can involve several technologies. Municipalities can deliver LFG to the natural gas pipeline system as both a high- and medium-BTU fuel. LFG can also be converted to vehicle fuel. Vehicle fuel applications involve using LFG to produce compressed natural gas (CNG), liquefied natural gas (LNG), or methanol (U.S. EPA, 2009).

Landfill Revitalization

Many landfills are traditionally located in rural areas. As these areas become more and more densely population during urban sprawl, available land for development become more difficult to find. Recreational space in urban areas has always been scarce. Because of the intense pressure for land use and available capping materials form large excavation and construction projects, urban landfill conversions are gradually attracting people's view. More and more landfills have been successfully converted into parks, golf courses, sport fields and nature preserves. Technologies for landfill closure and monitoring become advanced and make landfill reclamation be viable. Two prior problems: public health and safety also are ensure in these projects. "The more environmentally sound the landfill closure and monitoring process becomes - coupled with the long-term success of past and current landfill reclamation projects - the more opportunities will exist for land reuse" (Hauser 1994).

Landfill Reuses as a Park

Landfill Reuses as Golf Course

Landfill Reuses as Sports Fields

Case Reviews

Case review is an effective method for landscape designers to study predecessors and learn advantages and disadvantages in their works. The knowledge is build up through assessment for written and visual documentation of projects, and then contributes values to education, innovation and the profession.

In this report, case selection is based on existing conditions in the project to mitigate problems and elevate design.

As a sub-urban center, the project site has a big problem about flooding and pollution. Stormwater management is an effective way to mitigate these problems. Four case reviews are chosen to seek methods, two for urban flooding control and two for pollution mitigation.

Also reviewed was landfill reuse projects. Because a landfill exists in the site and gradually impacts the land and communities, transformation from a landfill to a public space is considered. This idea is not new, there are lot of successful projects that settled landfills in great parks.

The assessment for case reviews focus on the balance of five criteria: functional, environmental, economic, social/cultural, and aesthetic issue.

Qunli Stormwater Park

Location:
Huaerbin City, Heilongjiang Province, China

Designer:
Turenscape

Constructed:
2009

Area:
84 acres

Project Description

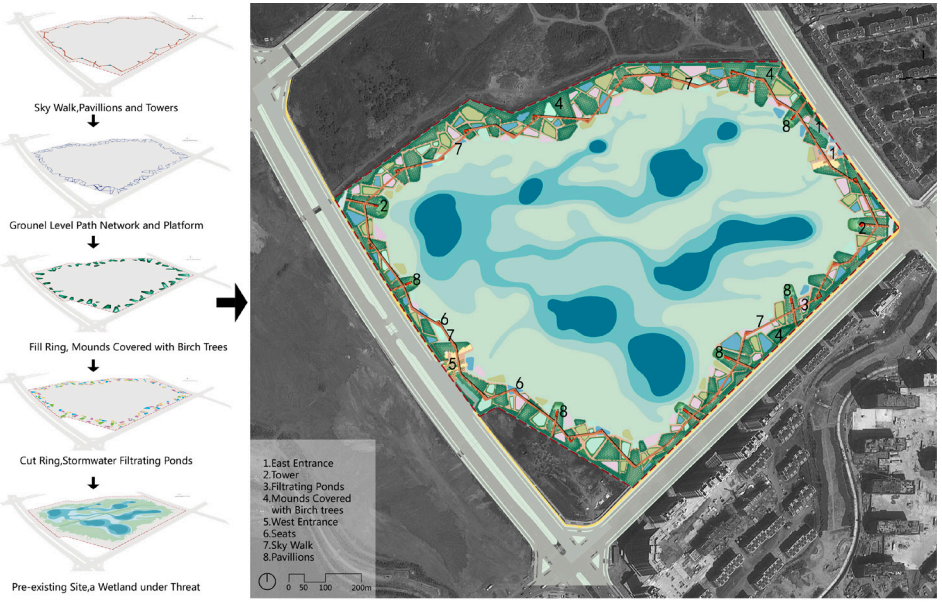
Covered 6753 acres, the new urban district named Qunli will be covered with impermeable concrete in the majority of the former flat plain. Only about 16.4%of the development land was zoned as permeable green space. More than one third of a million population are expected to live here. The annual precipitation in this area is 567mm and 60%-70% of annual rainfall is concentrated in June through August. Flooding and waterlogging have occurred frequently in the past, meanwhile the groundwater table continues to drop due to its overuse.

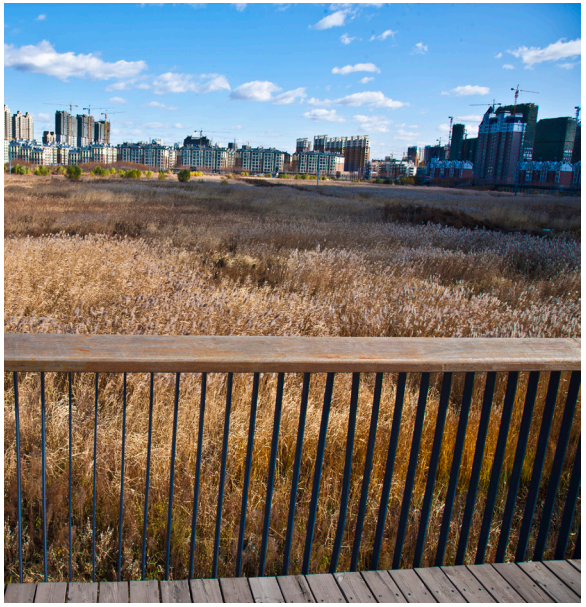
This stormwater park perform many functions as a green sponge to mitigate problems during urban development. The park is designed in a natural wetland and surrounded on four sides by roads and dense development. To preserve the wetland, all development and activates are arranged around it. Cut-and-fill strategy is used to create a ring of mounds and ponds which use for collect and filtrate stormwater. And then, filtrated water is released into the wetland and provides the water source for wetland restoration. The network of different elevation walkways links the ring of ponds and mounds, providing visitors various experiences.

This project successfully transforms a wet land to a stormwater park and provide many benefits for human habitat and natural ecology.

Design Implications

- Use stormwater to restore existing wetland and protect native habitats
- Cut-and-fill earthwork create ponds and mounds to collect and clean stormwater
- Filtrate stormwater to recharge aquifer
- Provide public spaces to recreation and education
- Different elevation walkways combine with environment to reduce disturbance for the wetland and create various aesthetic experiences.





Buffalo Bayou Promenade

Location:
Houston, Texas

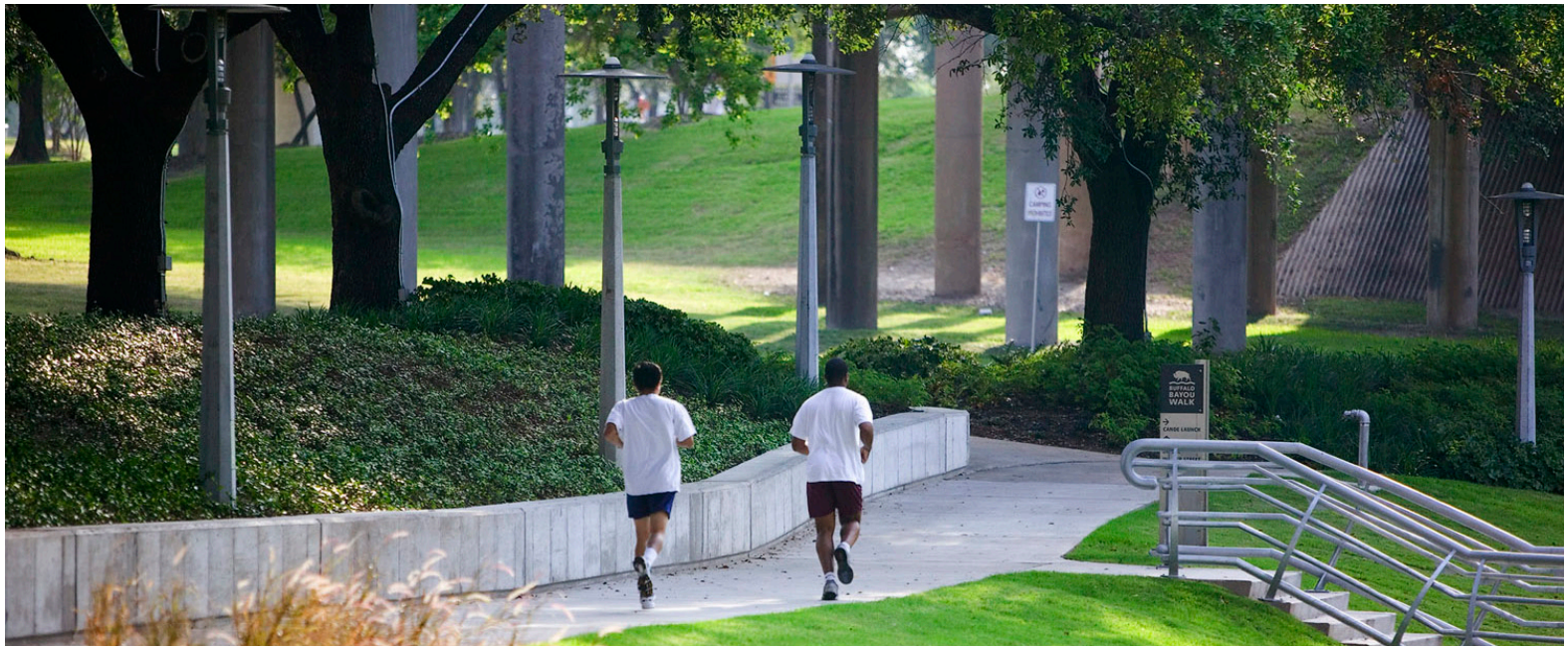
Designer:
SWA Group

Constructed:
2010

Area:
23 acres

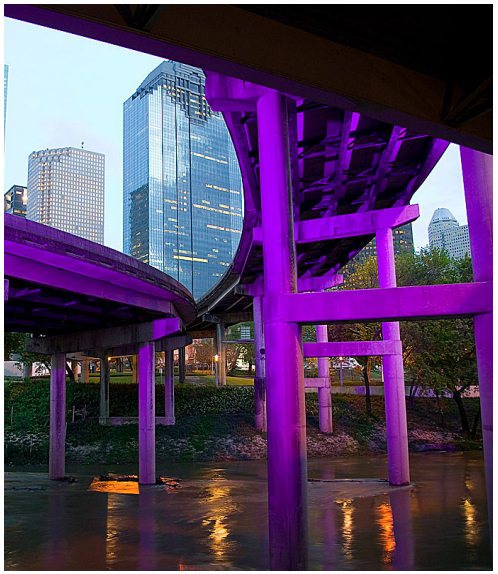
Project Description

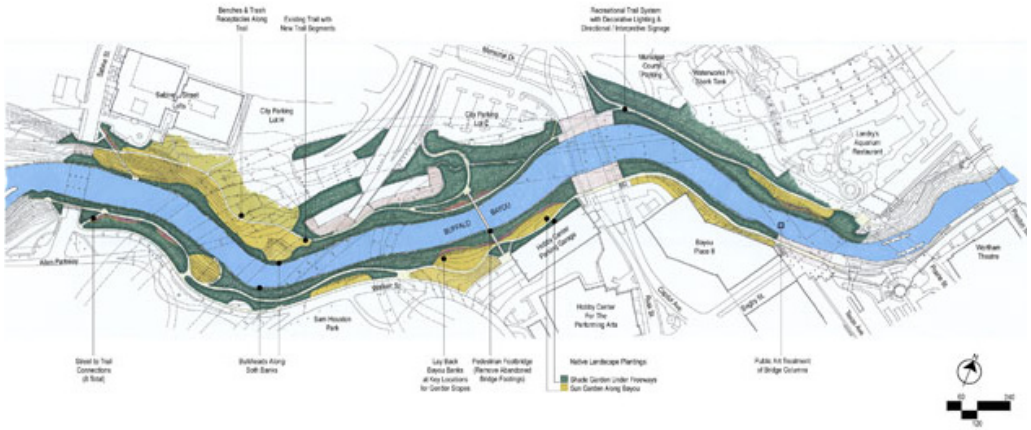
Connected Houston's downtown core to the river park, the Buffalo Bayou Promenade was ignored by the city before. It was a trash-soaked, unsafe and flooding place. The Bayou's new image is partly based on addressing flooding, trash, and pollution problems. It will also be based on a change in its visual appearance. Opening up the banks of the Bayou makes it more visible. Providing paths, trails, landings and related amenities allows people to safely come to the water's edge. Creating more ponds collects stromwater and creates more surface water for people to see and enjoy. Shallower banks with more wetlands and riparian areas will create a greater diversity of wildlife to watch. Large expanses of open marsh will create dramatic vistas up and down the Bayou. Over time, clearer water resulting from basin-wide mitigation measures will create a more visually appealing Bayou. Construction of carefully designed and appropriately scaled buildings will provide an attractive urban edge. And people in boats and on the Bayou's banks will signal that it is an inviting, safe, clean place to be and this in turn will generate more use. Changing the visual appearance the image of the Bayou, can bring about a major change in people's perception and use of the Bayou and its banks.



Design Implications

- Regrading site to improve flood water convey and reduce erosion
- Recycle concrete cobble link swales to reduce surface water runoff
- Treat the waterway and its banks with special care such as gabion edge and gabion cage
- Use stepped design to provide water egress and allow floating storm debris to pass through
- Add light for night safety
- Design all lighting, planting and walkways to withstand the natural, periodic flooding of the bayou
- Use native plants to enhance the habitat





Shanghai Houtan Park

Location:
Shanghai City, China

Designer:
Turenscape

Constructed:
2010

Area:
34.6 acres

Project Description

The linear site is located on the Huangpu River waterfront in Shanghai. As a landfill, it was largely used as a laydown yard for industrial materials. The water of Huangpu River is highly polluted and unsafe for swimming, recreation and devoid of aquatic ecosystem. The 6-foot daily tidal fluctuation is blocked by the concrete floodwall and inaccessible to the public.

To solve these problems, great design strategies are provided. A linear constructed wetland is settled as a living machine to treat 500,000 gallons polluted water per day from the river and also acts as flood protection buffer to control the tidal fluctuation. Cascade and terraces are used to oxygenate the water, remove nutrient, and reduce suspended sediments, and reminiscent the Chinese agricultural heritage. Reclaimed industrial structures and materials present the celebration of the industrial spirit.

An ecological recovered landscape shown as the wetland, urban agriculture in terraces and industrial spirit woven together and provide multiple ecological services.

Design Implications

- Design constructed wetland to control flood, clean polluted water, and restore native habitat
- Use reclaimed water for the 2010 Expo
- Revitalize landfill as a great urban park
- Provide urban agriculture for food and public education
- Reclaim existing abandoned structures and materials and transform them to please landscape feature

Gowanus Canal Sponge Park

Location:
Brooklyn, New York

Designer:
Dlandstudio, llc

Constructed:
Not built

Area:
11.4 acres

Project Description

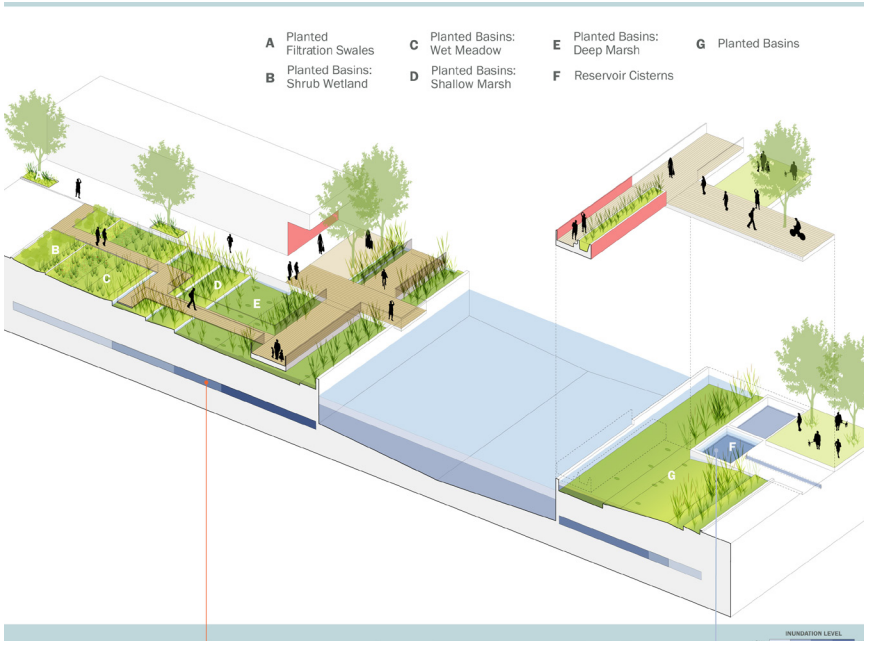
Gowanus Canal has deteriorated due to years of exposure to industrial waste and water pollution. The main source for water pollution is combined sewer system. During heavy rainfall, the sewage and stormwater overflow into Gowanus Canal, discharging over 1.1 million cubic meters of combine sewage. Extraordinary poor water quality causes canal bulkhead erosion, high clean cost and minimal private investment.

Some strategies are used to treat contaminated water. Using different plants in different level of inundation to draw heavy metals out of contaminated water; floating remediation wetlands and oyster beds absorb organic toxins, heavy metals and other pollutants; the private canals are activated to manage stormwater.

the Sponge Park system integrates stormwater management with the cultural context of important historic sites, recreation areas, and neighborhood facilities in a way that creates programmable urban open space while improving the environment. This environmental urbanism is a synthetic idea that can be implemented across the country. It is applicable to mature cities whose infrastructure is taxed by age and growth as well as in areas where industrial development has left behind inhospitable toxic landscapes.

Design Implications

- Connect the public and private lands adjacent to water to create a continuous esplanade with recreational spaces
- Provide open spaces for all kinds of activities
- Link culture context with development
- Use different layers plants and floating wetland to treat polluted water
- Reconfiguration of sewer and storm-water systems to reduce reliance on expensive engineered solutions
- Restore wetland habitat



Alumnae Valley Restoration

Location:
Wellesley College, Wellesley, MA

Designer:
Michael Van Valkenburgh Associates, Inc.,

Constructed:
2002

Area:
13.5 acres

Project Description

Build on a toxic brownfield with physical plant, industrialized natural gas pumping, the site in Wellesley College successfully transforms to a ecological functioning landscape structure by a remedial purification system. The restored Alumnae Valley reclaims its place in the natural hydrological system that structures the Wellesley College campus. The conceptualization of the site includes an understanding of its history, from glacial valley to industrial dumping ground to parking lot. The dual role of topography on the site—both a means to a design solution and an experiential enhancement—forms the foundation of a landscape that is at once willfully artificial and unabashedly picturesque.

Hazardous soil was dealt with in two ways in the design: removal and in situ treatment. Heavily toxic soil was located, excavated, and removed offsite for treatment. Dense non-aqueous phase liquid, a byproduct of natural gas processing, found the ancient watershed beneath the parking lot and collected there. Pumping infrastructure was incorporated into the design, and toxic residue is periodically removed for treatment. Capped with clean fill, mildly contaminated soils could be kept on site and used as fill for a trio of meadow-planted, drumlin-like mounds. As a result, the entire site was raised 6 feet above the previous grade and a new wetland, the engine of our design, was artificially perched. Toxicity caused many problems, and each inspired a creative solution.

As a link between its 80-acre watershed and the adjacent Lake Wanban, the valley is restored an intermittent wetland, a series of sedimentation forebays and basins hold and treat the site runoff water, which mingles with forbs, sedges, and cattails before trickling back into Lake Waban. A geosynthetic clay liner simultaneously seals contaminated soils and prevents water from prematurely returning to the original water table.

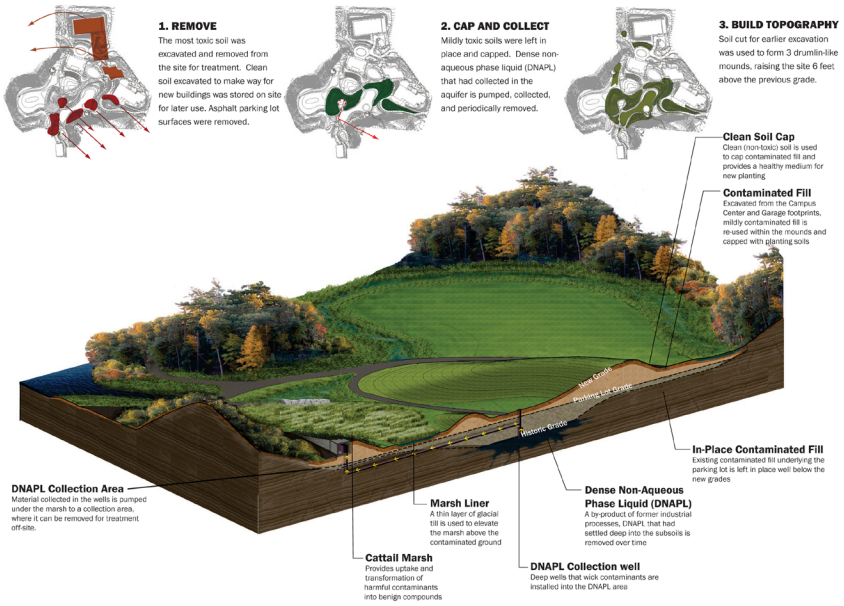
Design Implications

- Successfully transform a toxic brownfield to a pleasant public space

- Treat contaminated soils in site and removal to reduce the impact for environment

- Use geosynthetic clay liner to seal contaminated soils and protect water table

- Create wetland to treat runoff water, deposit sediments, and restore habitat



Brownfield Restoration - Efficiently Dealing With Toxicity
A variety of soil remediation techniques are used to treat the contaminated site and restore it as a living system.

Olympic Sculpture Park

Location:
Seattle, Washington

Designer:
Weiss, Manfredi

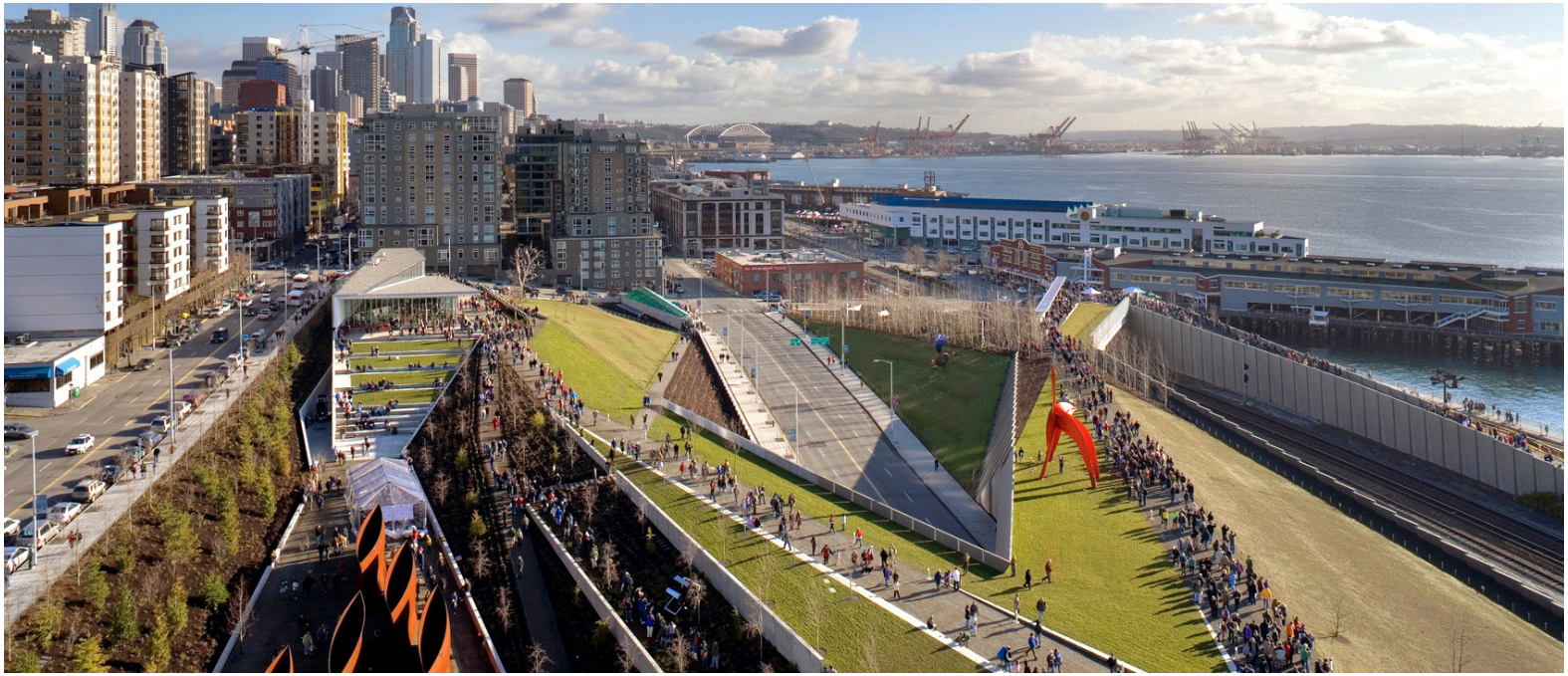
Constructed:
2007

Area:
9 acres

Project Description

The site is located on Seattle's last underdeveloped waterfront property - an industrial brownfield sliced by train and an arterial road. Formerly owned by Union Oil of California (Unocal), the area was used as an oil transfer facility. Before construction of the park, over 120,000 tons of contaminated soil was removed. The remaining petroleum contaminated soil is capped by a new landform with over 200,000 cubic yards of clean fill, much of it excavated from the Seattle Art Museum's downtown expansion project.

The design connects three separate sites with an uninterrupted Z – shaped "green" platform, descending 40 feet from the city to the water, capitalizing on views of the skyline and Elliot Bay, and rising over existing infrastructure to reconnect the urban core to the revitalized waterfront. As a "landscape for art", the Olympic Sculpture park defines a new experience for modern and contemporary art outside the museum walls. The topographically varied park provides diverse settings for sculpture of multiple scales. Throughout the park, landforms and planting collaborate to direct, collect, and cleanse storm water as it moves through the site before being discharged into Elliott Bay.



Design Implications

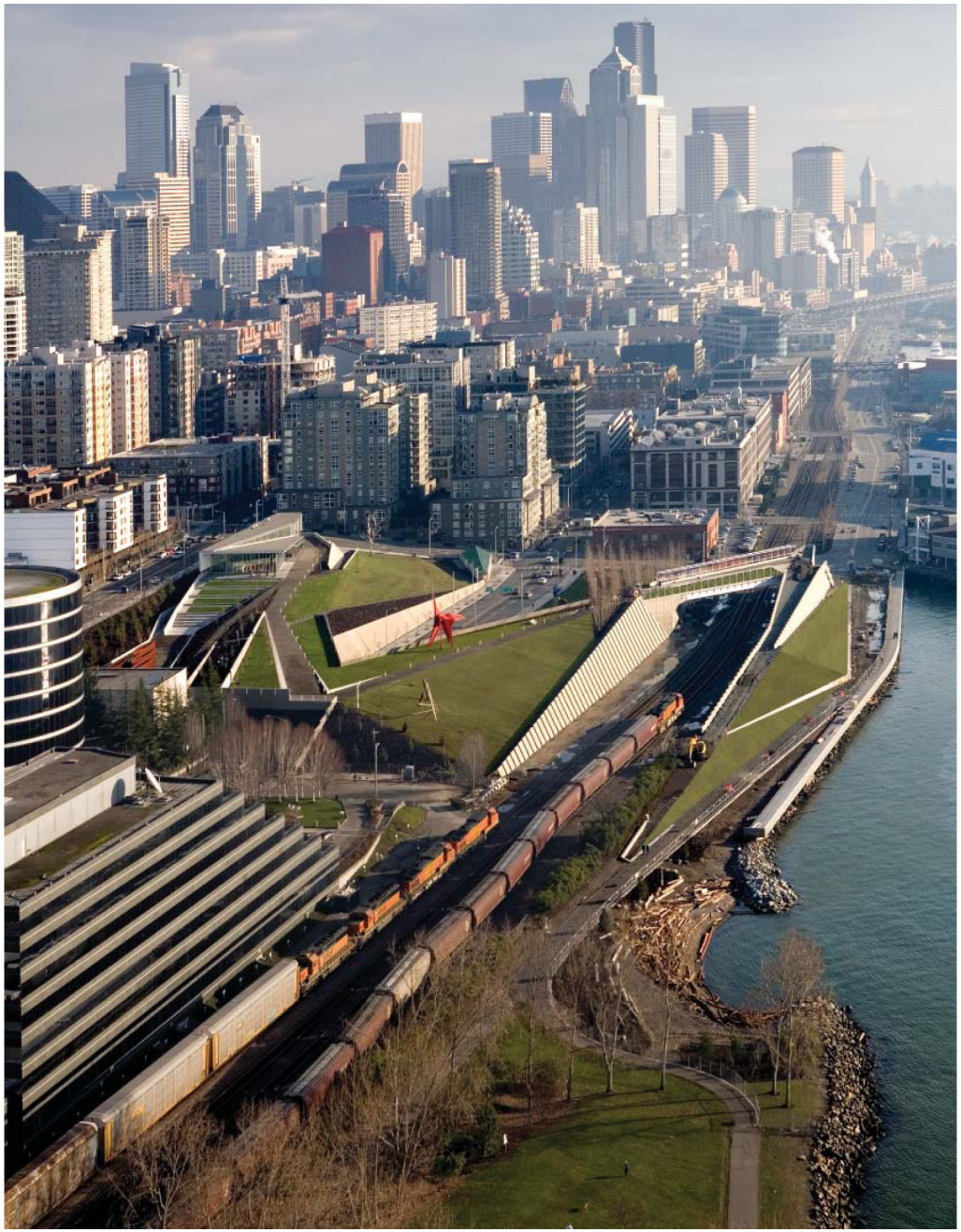
- Remove the contaminated soil and cap clean fill to create new landform

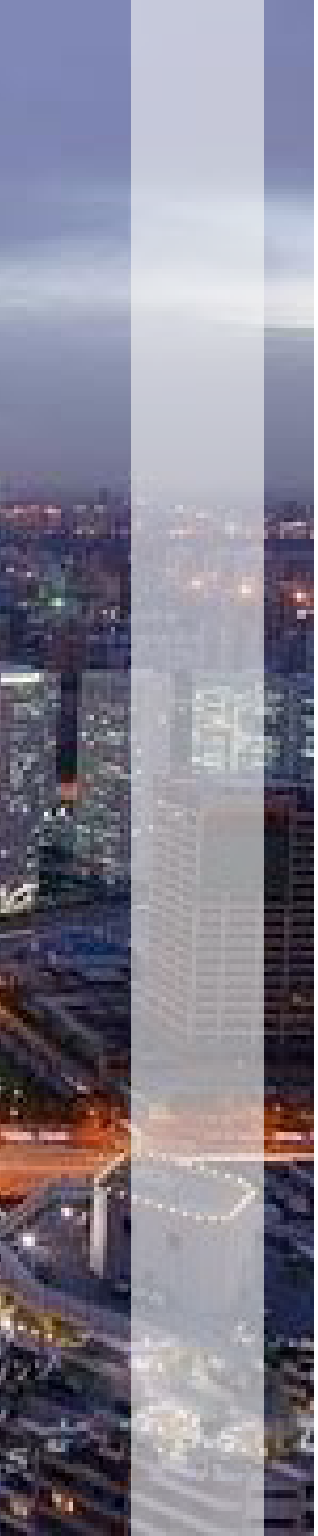
- Work with plantings, landform use to manage stormwater

- Create a dynamic link to make the water front accessible

- Provide outdoor exhibition area and new pedestrian experience

- Restore different habitat such as evergreen forest, deciduous forest, saltwater vegetation and salmon habitat .

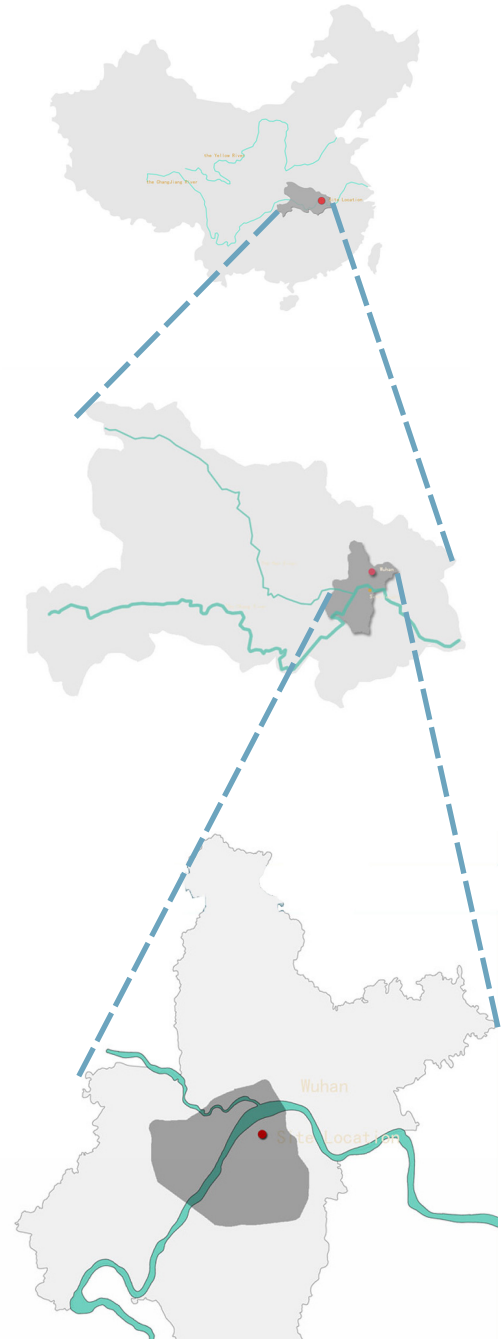




Site Inventory and Analysis

LOCATION

The project's site is located in the Wuhan city, Hubei province, China. As the capital of Hubei province and a modern metropolis, there are more than 10 million people who live in this city. Situated at the crossroads of central China, Wuhan is a transportation hub for air, railway as well as ferry traffic. It is also recognized as the political, economic, financial, cultural, and educational center of central China. Yangtze River and Han River intersect in the city and divide it into three parts - Wuchang, Hankou and Hanyang. The site is located in the north of the Wuchang, and just west of Wuhan high speed train hub, and north of East Lake which is the biggest urban Lake in China.

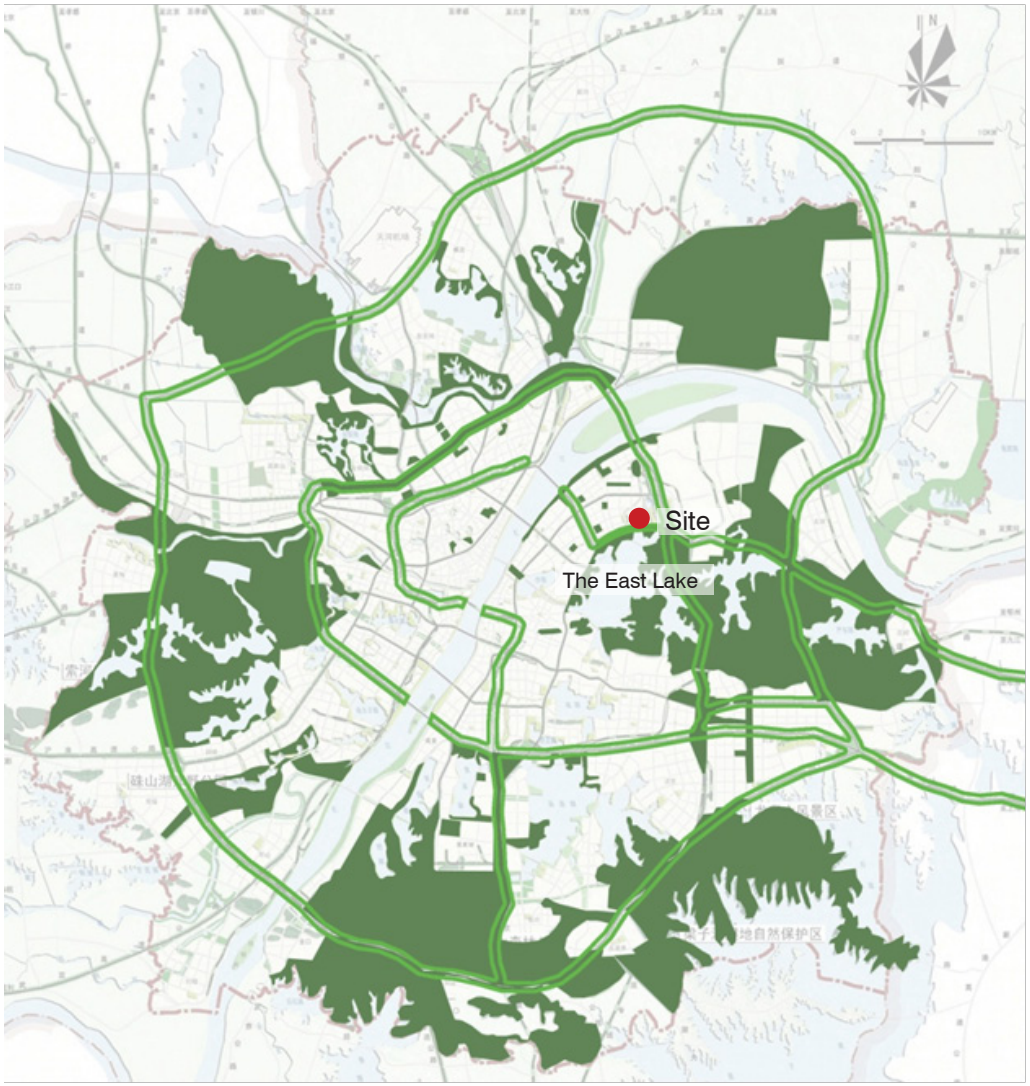


GREEN SPACE NETWORK IN WUHAN CITY

Wuhan city has a large comprehensive green space network plan. The structure of green spaces in the city is "radial and circular network". The network links major water bodies, large open spaces and bring green spaces into the city to improve access to them. This linkage mitigates the conflict between nature and the urbanization.

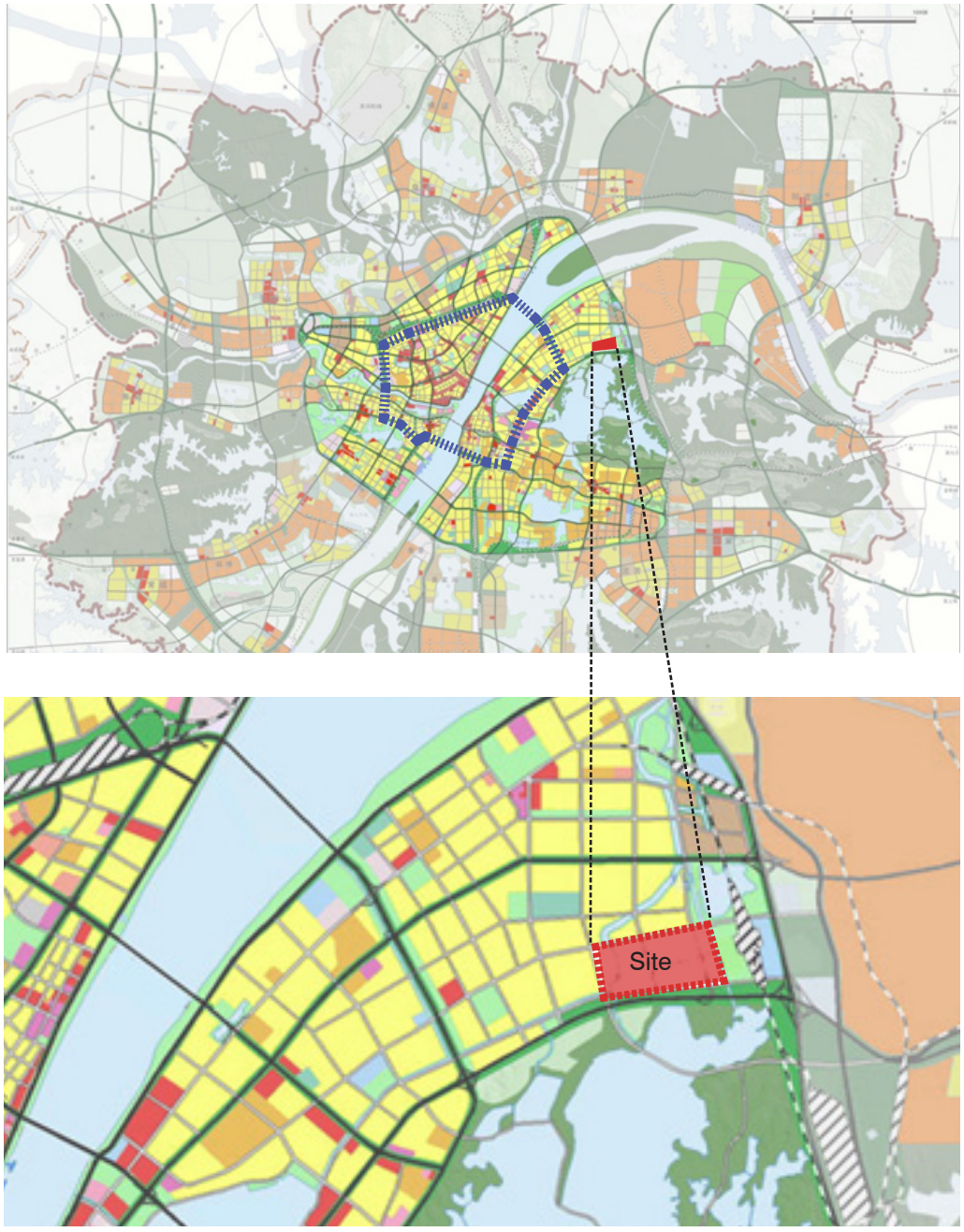
Three "green necklaces" are around the city and connect six large parklands with inner city areas. These green corridors follow the ring road in the city and separate the whole city into the urban core, inner and outer city. Green spaces are brought into the urban core and inner city which do not have enough green spaces for residents. Six large parklands are located on the outer city and provide the green barrier.

The site in the graphic is highlighted in red. As shown, the site is just in the intercross between two green necklaces, and the north of a large parkland which is the East Lake Park.



ZONING

As the zoning map shown, the residential areas are mostly concentrate in the urban core and the inner city; the industrial areas are mainly distributed in the outer city with less residential areas. The commercial and mixed-use can be found in the core more than other places in the city. Comparing with the other places, the land uses surrounding the site are relatively simple: most areas are used for residential, and only very few commercial areas are located in. The site also is an interface between residential area and heavy industrial area. So how to treat the connection between residential area and industrial area is an important consideration.



ACCESSIBILITY

As the national transportation hub, Wuhan city has conveniently transportation which connects the city with other cities. Highway, regional train, high speed train, air plane bring a large number of people into the city. The site is also very accessible. Highway, the freeway, subway are easy to connect the site with the whole city. The great accessibility brings lots of users into the site which not only comes from the surrounding areas and the whole city, but also from the whole country.

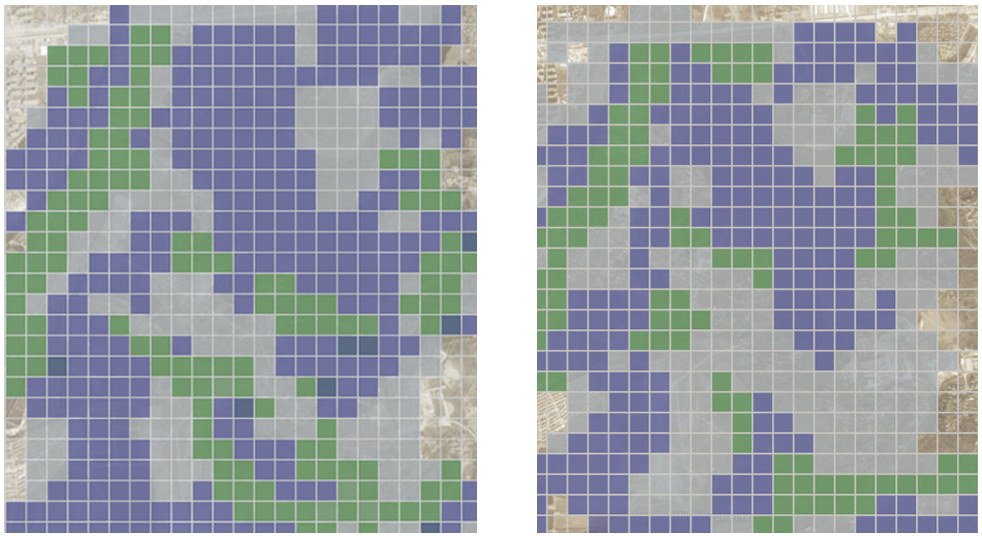
WATER

Pollution of Water Bodies

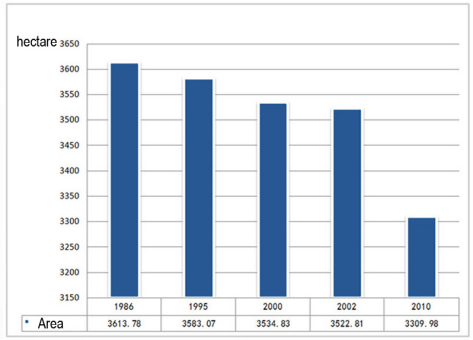
The city of Wuhan has a plenty of water resources which is uncommon and precious especially the East Lake. Wuhan East Lake, located in the south of the site, is the largest urban lake of China, with a water area of 33 square kilometers. It is not only the big tourist attraction, but also the big fresh water source in the city. However, during industrialization and urbanization over last 30 years, uncontrolled increasing fishery, industrial and city wastewater flow directly into lakes and have led to a serious deterioration of ecological environment. Same thing happened in the Yangchun Lake. The water quality of Yangchun Lake is currently classed as Class V which is the lowest level for water quality. This situation has already strongly effected people's life.

Decrease of Water Bodies

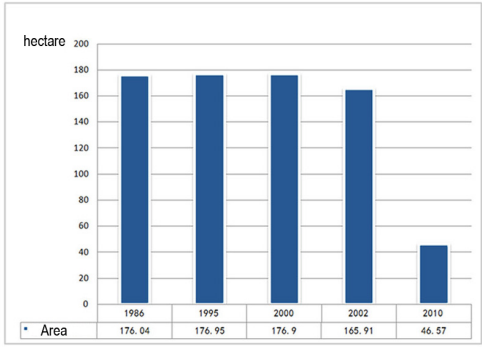
Water bodies have decreased rapidly because urban sprawl and creating new farmland. The area of the Yangchun Lake has changed a lot. From 2005 to now, because of the construction of Wuhan high speed train hub, the total area of water already reduced by more than 74%.



The Change of the Water Bodies in The Site



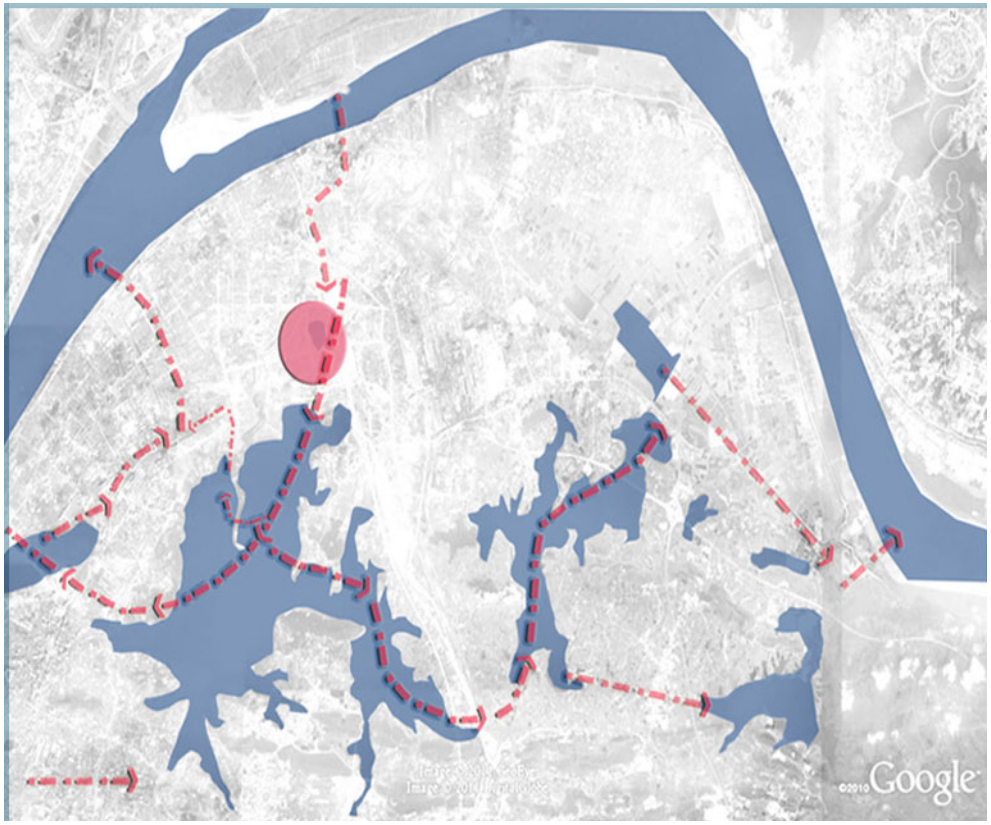
1986–2010 The Area of East Lake



1986–2010 The Area of Yangchun Lake

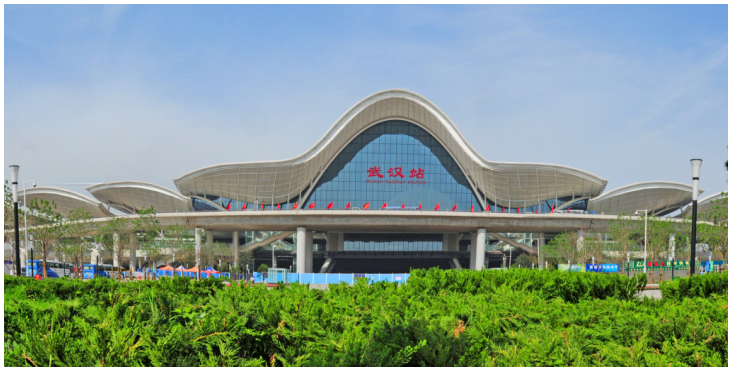
GREAT EAST LAKE PROJECT

The East Lake is the largest urban lake of China, with a water area of 33 square kilometers. The East Lake Park has been built around the lake as the biggest tourist attraction in Wuhan and the middle of China, covering an area of 87 square kilometers. It is also the one of fresh water sources in Wuhan city. But now because wastewater discharges directly from the sewage system, home and farmland, water in the lake is seriously polluted. In 2009, the Great East Lake Project begun to launch. It connects six lakes in Wuhan city with Yangtze River by constructed water channel to activate lake water for better water quality. Yangchun Lake is included in this big project to connect with the East Lake.



SITE CONDITIONS

Heavy industrial area is located in the east of the site. It is one of pollution sources of the pollution in the site.



High speed trains bring 100,000 passengers per day into Wuhan which is a great opportunity for tourism.

The East Lake is the biggest tourist destination in the city and contributes lots of benefits for the city and the site.

The East Channel is located in the west edge of the site which connects with Yangtze River and bring river water into the site.

The site is mostly vacant. The existing features include existing residential and water bodies.

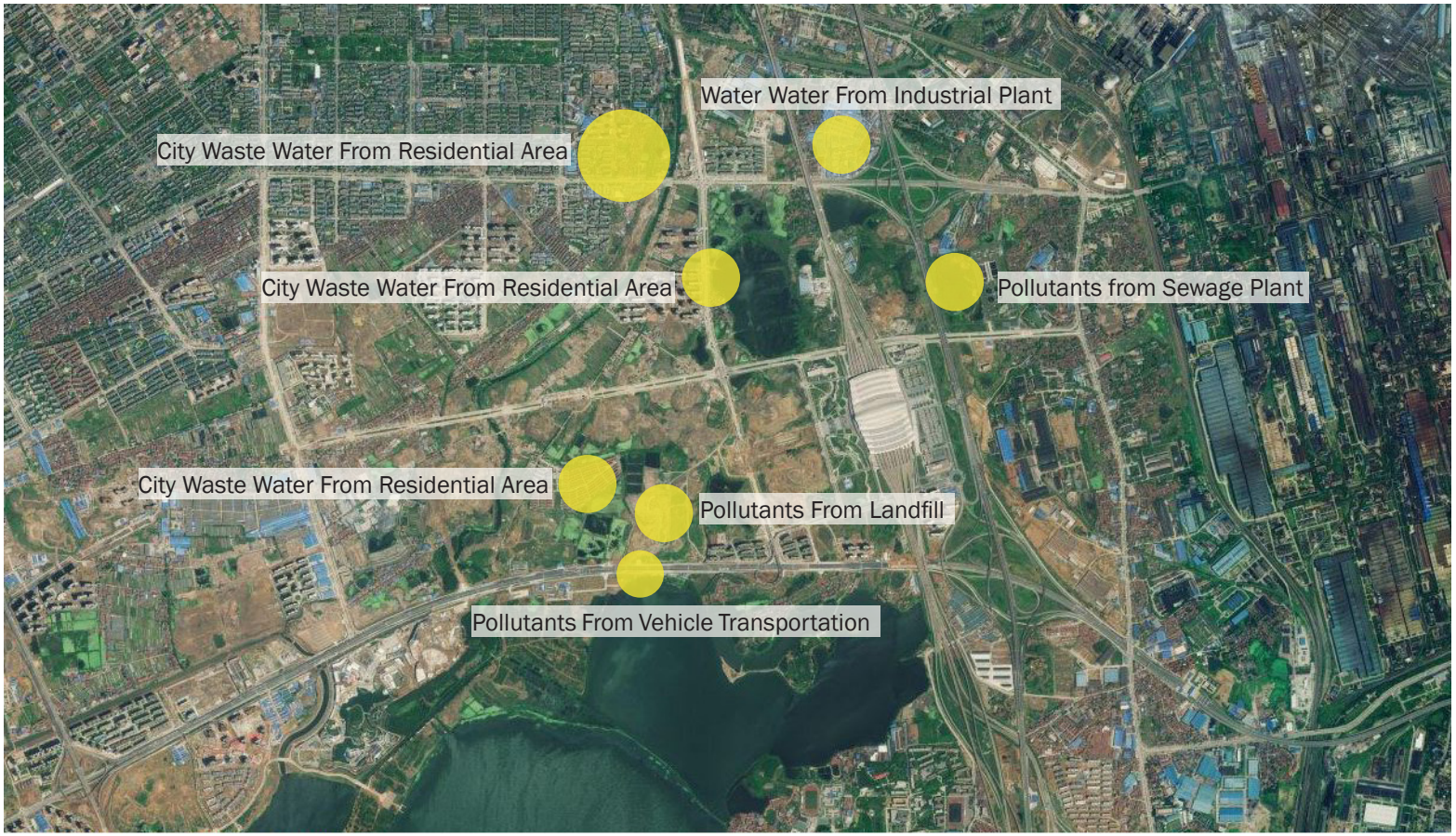
Some fish ponds in the site have been polluted.

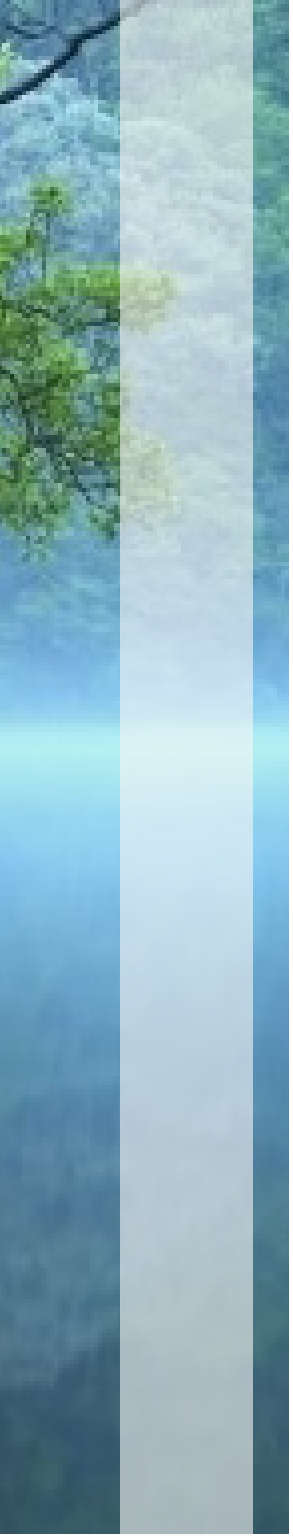
CIRCULATION

Circulation in and surrounding the site includes highway, the ring road of the city, main road, and secondary road. The highway connects Wuha city with near cities. The ring road connect whole Wuhan together. But in here, it blocks the site and the East Lake. Also as the non-point pollution source, the ring road can be a part reason to cause the lake pollution.

POLLUTION SOURCES

Water pollution is a big problem in the site. The pollution sources include the city waste water from residential areas, the waste water from industrial areas, pollutants from sewage plant, pollutants from landfill and from vehicle transportation. Because of urban ization, the residential areas increase rapidly. The sewage systems can't afford increase of waste water and distribute directly into waterbodies in the site with the runoff. Combining with industrial waste water, these pollutants cause the serious pollution in the site.

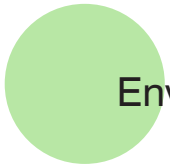




Design

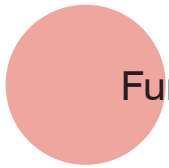
This section covers the planning and design process of the project. The process began with the 3 different concepts that based on the analysis of problems in the site. Based on these concepts, the final concept generated from the synthesis of environmental, economic, functional, social/cultural and aesthetic analysis. Then the master plan, focused areas, sections and perspectives were created.

PROGRAMS



Environmental

Control stormwater
Improve water quality
Reduce freshwater use
Restore habitats

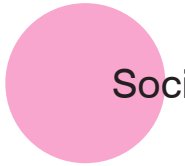


Functional

Limit vehicle
Improve low carbon footprint
Ensure easy access to the site

Economic

Increase multi-use of spaces



Social-Cultural

Create green spaces for people's communication
Provide recreation and environmental education
Promote walkability

Aesthetic

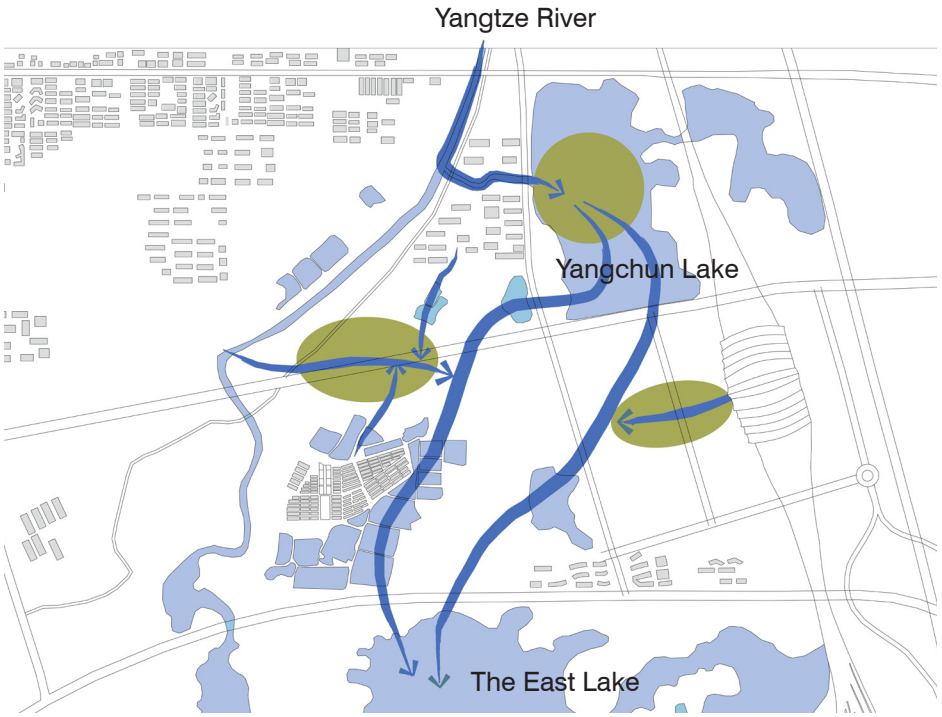
Create the unique design that celebrate the nature and the urban

CONCEPT PROCESS

The concept process is based on problems happened in the city and the site and tries to mitigate them.

Problem: Water Pollution

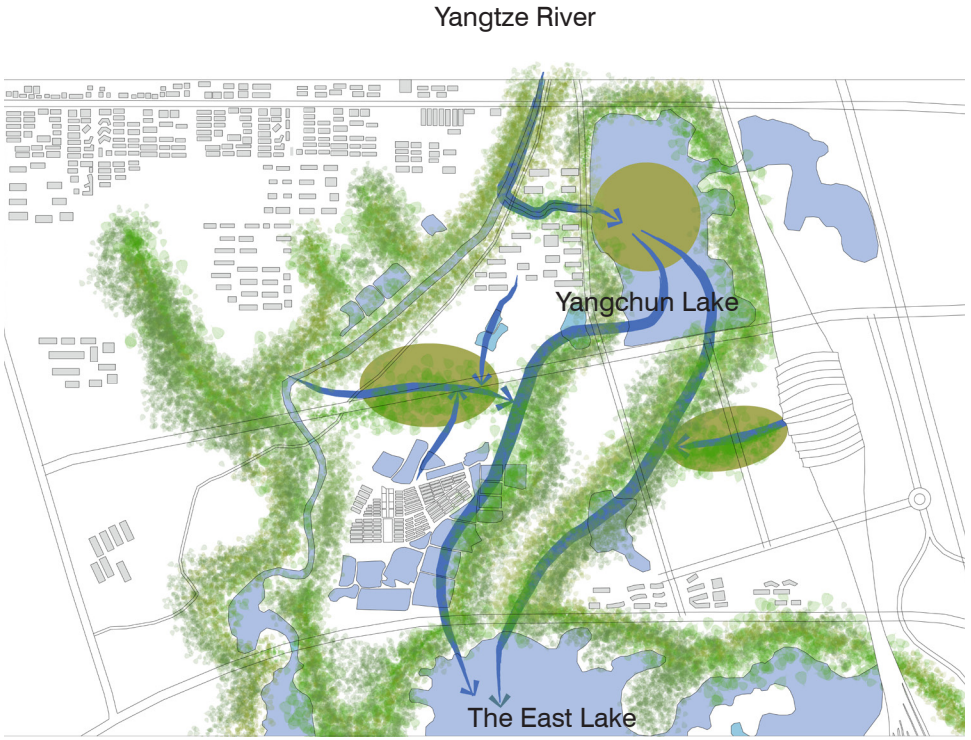
Solution: Water Strategy



To mitigate water pollution, the project connects Yangtze River with Yangchun Lake through the East Lake Channel. Also some channels in the site are created which connect the Yangchun Lake and the East Lake together to activate the polluted lake water.
To control water pollution sources from the residential areas, industrial areas, sewage plant, different sizes' wetlands are designed near these pollution source to mitigate problems.

Problem: Urban Flooding

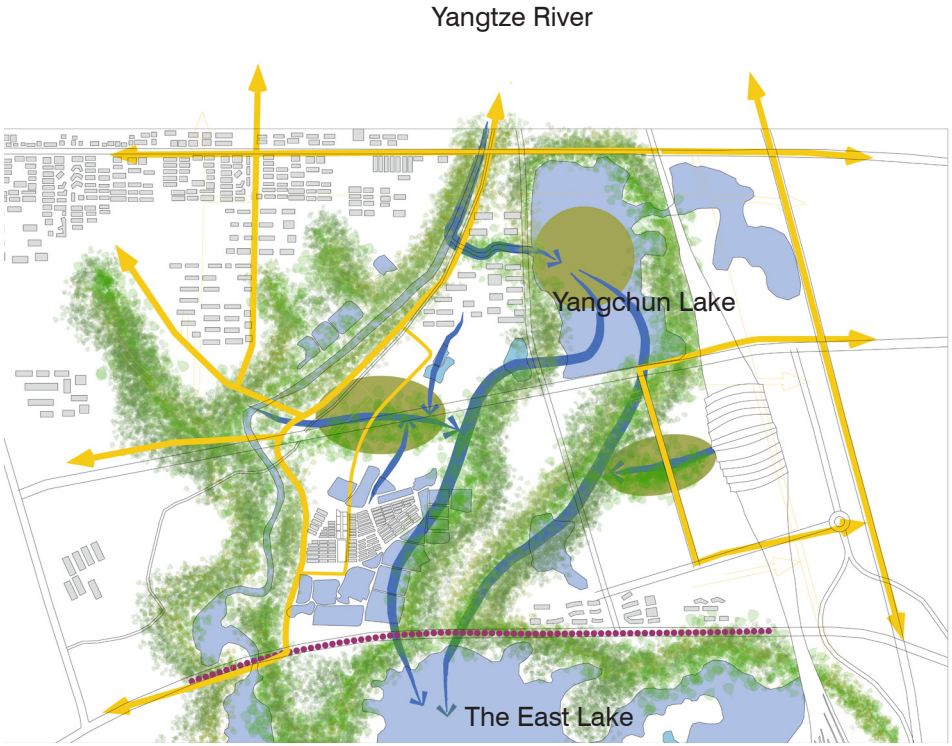
Solution: Green Space Strategies



Urban flooding generally happens around the site. Preserving and creating more green spaces are effective way to control urban flooding. They can be used as detentions to store stormwater and reduce runoff. In this project, green spaces are designed not only following water bodies, but also extend into residential areas to reduce impervious surfaces as far as possible.

Problem: Air Pollution and Traffic Jam

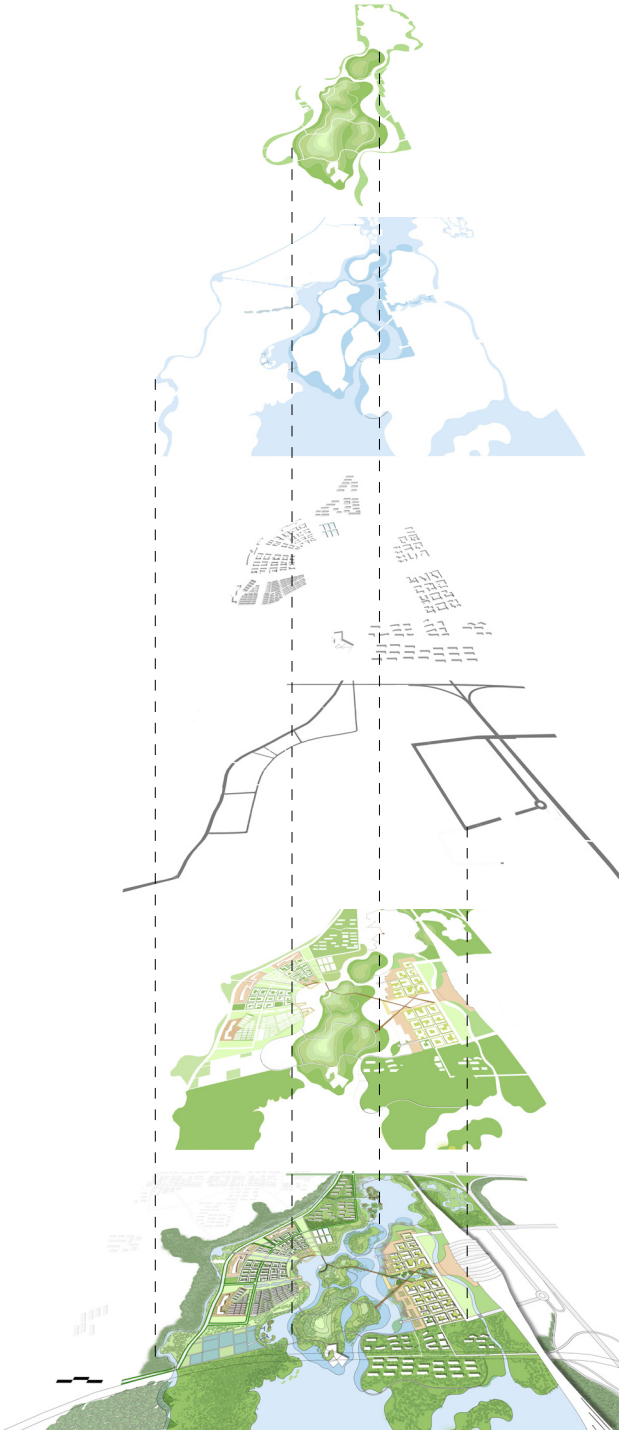
Solution: Transportation Strategies



For creating low carbon city and mitigating traffic problems in Wuhan city, this project limits the vehicle transportation and promotes the walkability in the site. The Vehicle transportation only can be found on the edge of the whole area, the center area is used for pedestrians. Multiple transportation opportunities will be created here which include bikes, water taxi and walking.

MASTER PLAN

The final master plan synthesizes programs and strategies taken from previous analysis. The primary goal is to create the “sustainable urban center” which can balance urban development and environmental protection.
The whole area is divided into three main areas for future design development which include: the east commercial-focused mixed-use, the west residential focused mixed-use and central natural park.



Environmental Strategies

- Connect water to create water network and activate polluted lake water.
- Constructed wetlands filtrate wastewater.
- Create green space as the water retention, slope along the lake as the buffer zone for seasonal flooding.
- Grey water reuse for landscape.
- Green network connects pedestrian pathway for comfort and walkability.

Economic Strategies

- Create mixed-use areas for on-site employment.
- Reuse existing fish pond and farmland not only for local food supply, but also for tourism and recreation.
- Provide business services areas to attract people in and out of the city.

Function Strategies

- Promote limited and non-vehicle traffic, improve walkability.
- Use multiple transportation which includes subway, bikes, boat taxi and pedestrian.
- Provide underground parking and parking along the vehicle road.

Social-Cultural Strategies

- Open spaces, green ways work together for people's communication, education and recreation.
- Green spaces and pedestrian walkways promote the walkability and attract people to stay.

Aesthetic Strategies

- Create landscape to balance urban and nature.

WATER NETWORK

Water flows from Yangtze River to Yangchun Lake through the East Lake Channel. In the site, different size's water channels are created to connect water from Yangchun Lake to the East Lake. The channels also are created in the development areas to collect runoff which can reduce the distance of the runoff as far as possible.

GREEN NETWORK

Green network is composed of central natural park, gardens, pedestrian connections and water management systems.

Natural park is in the center area. It used for habitat restoration. Pedestrian connections link green spaces and pathway together and create spaces for communication, recreation and education. Gardens and small rest spaces are distributed in the mixed-use areas not only provide spaces for people's activities, but also work with stormwater management systems to collect runoff and treat waste water. Cut-and-Fill strategy is used in the site to create slopes which follow the water channel and work for the seasonal water level change.

TRANSPORTATION

In order to reduce automobile and promote low carbon footprint, the multiple public transportation are encouraged in the site. The plan contains bus route, subway and boat taxi. The bus routes along two permitted automobile road which are in the edge of the site. The center area in the site forbids automobile, the main public transportation are subway and boat taxi. People will walk no more than 5 to 10 minutes in the whole site (400-800 meters).

BUILDING ORIENTATION

Buildings face north and south to accept sunlight as far as possible. This orientation can significantly increase in comfort and energy savings.

FOCUS AREAS

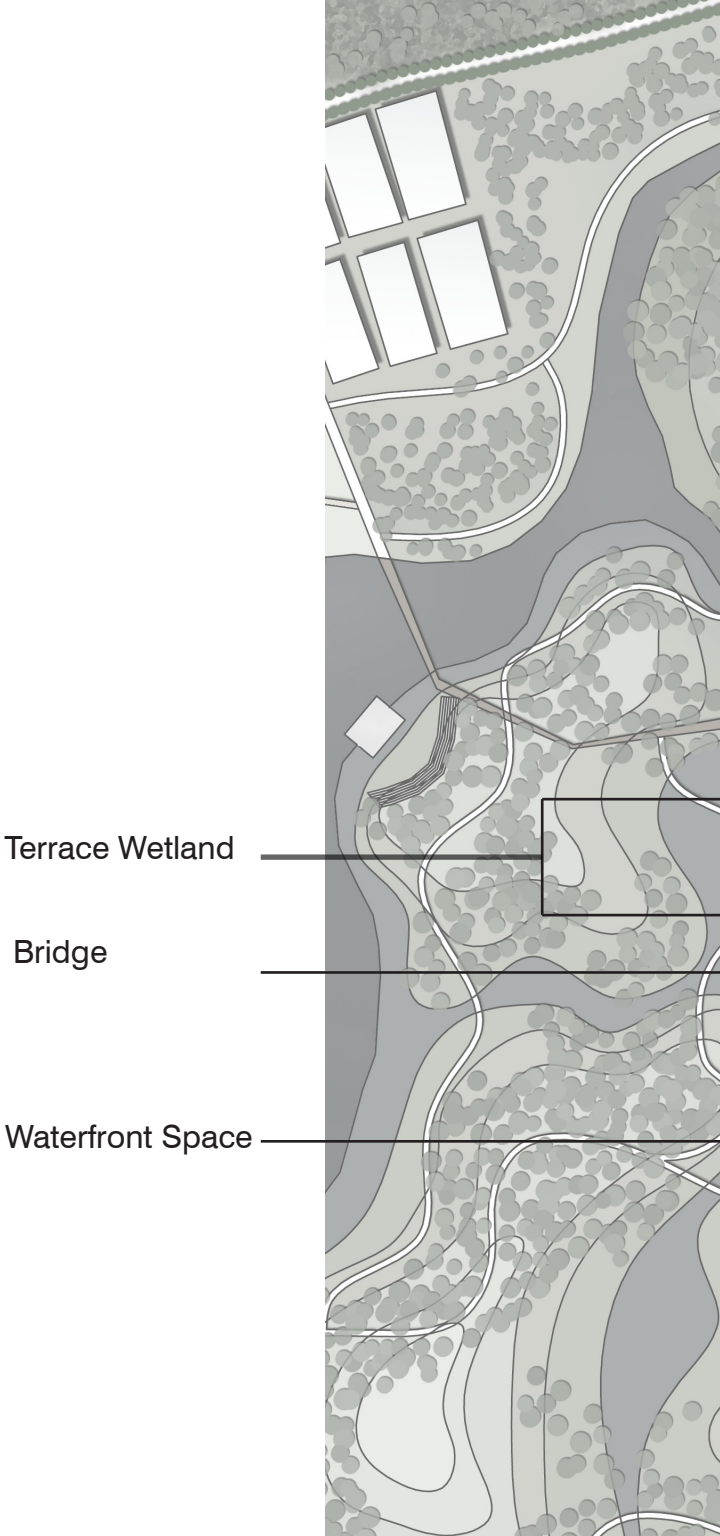
The following section looks in depth at "Focus Areas" within the master plan. The three main areas include the CBD Centre Garden (east of the site, near train hub), The Nature Heart Park (in the center of site, surrounded by water), The West Community and Waterfront (west of the site). These focus areas are selected based on problems happened in Wuhan city and the site. They contribute the important effect to mitigate the problems and create the quality of life.

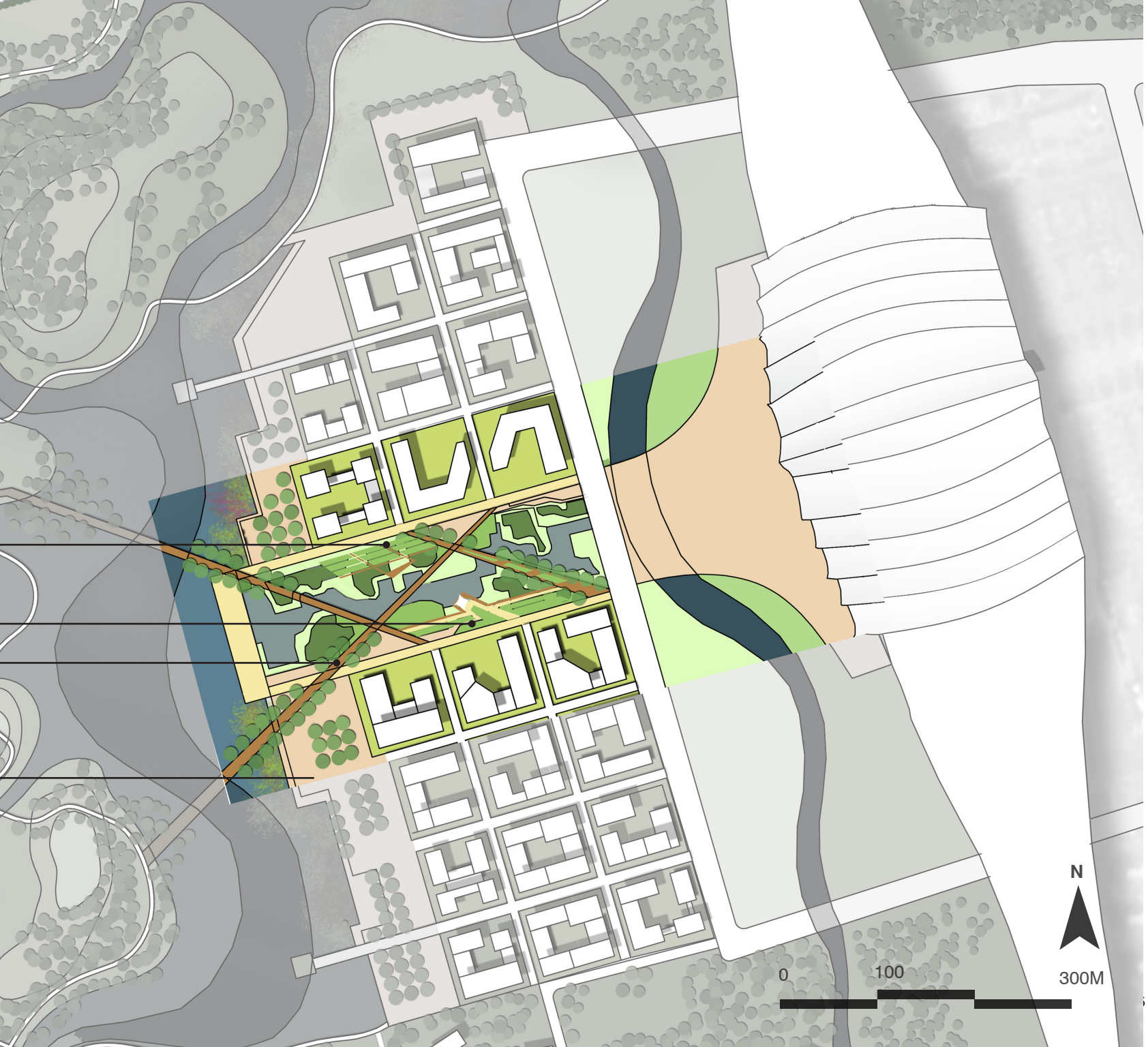

WEST COMMUNITY
AND WATERFRONT
CBD CENTRE GARDEN
NATURAL HEART PARK

CBD CENTRE GARDEN

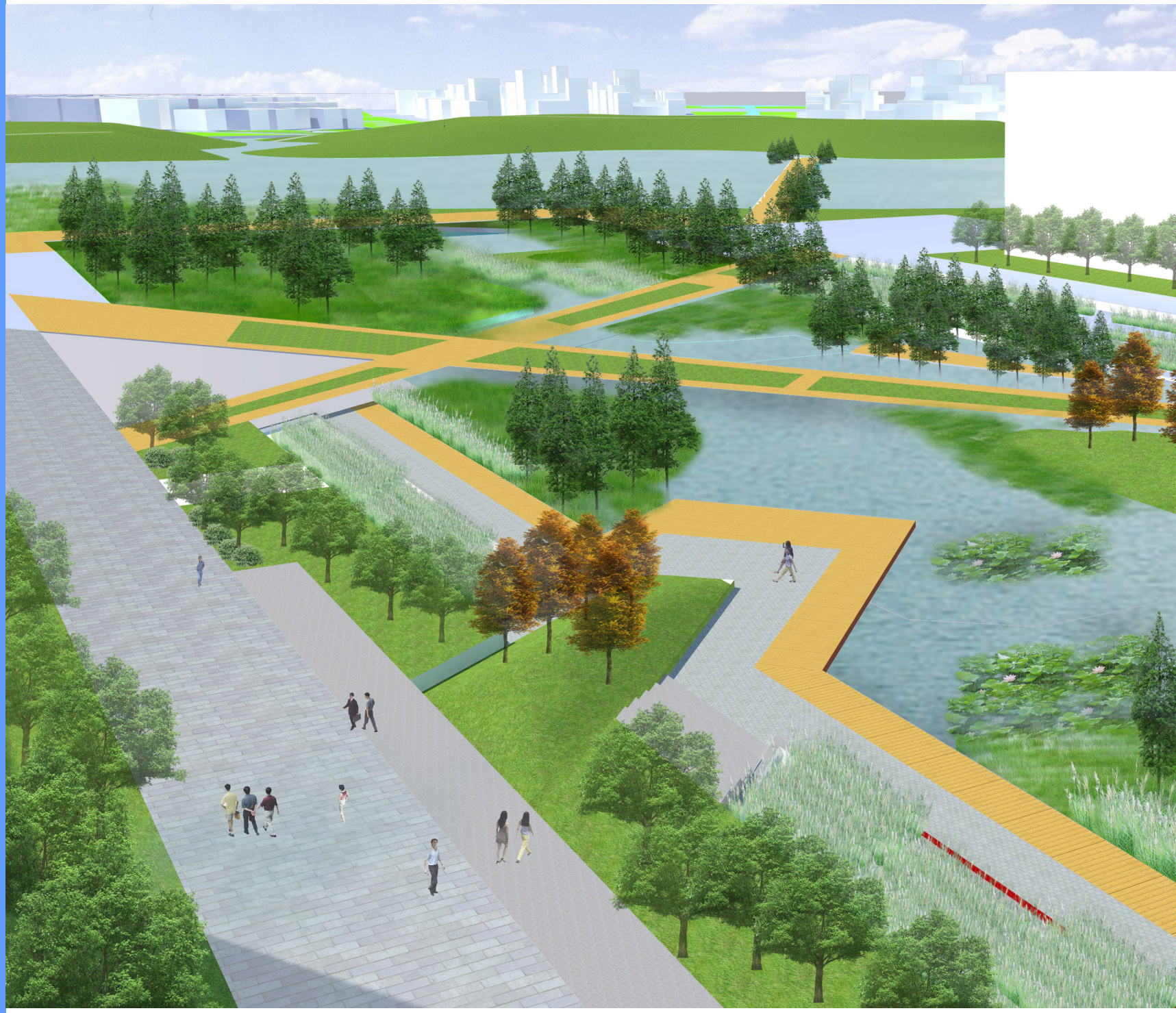
CBD center garden is located in the east side commercial focused mixed-use area. The design tries to create multiple functional spaces for people who work, visit and live here. The design strategies include:

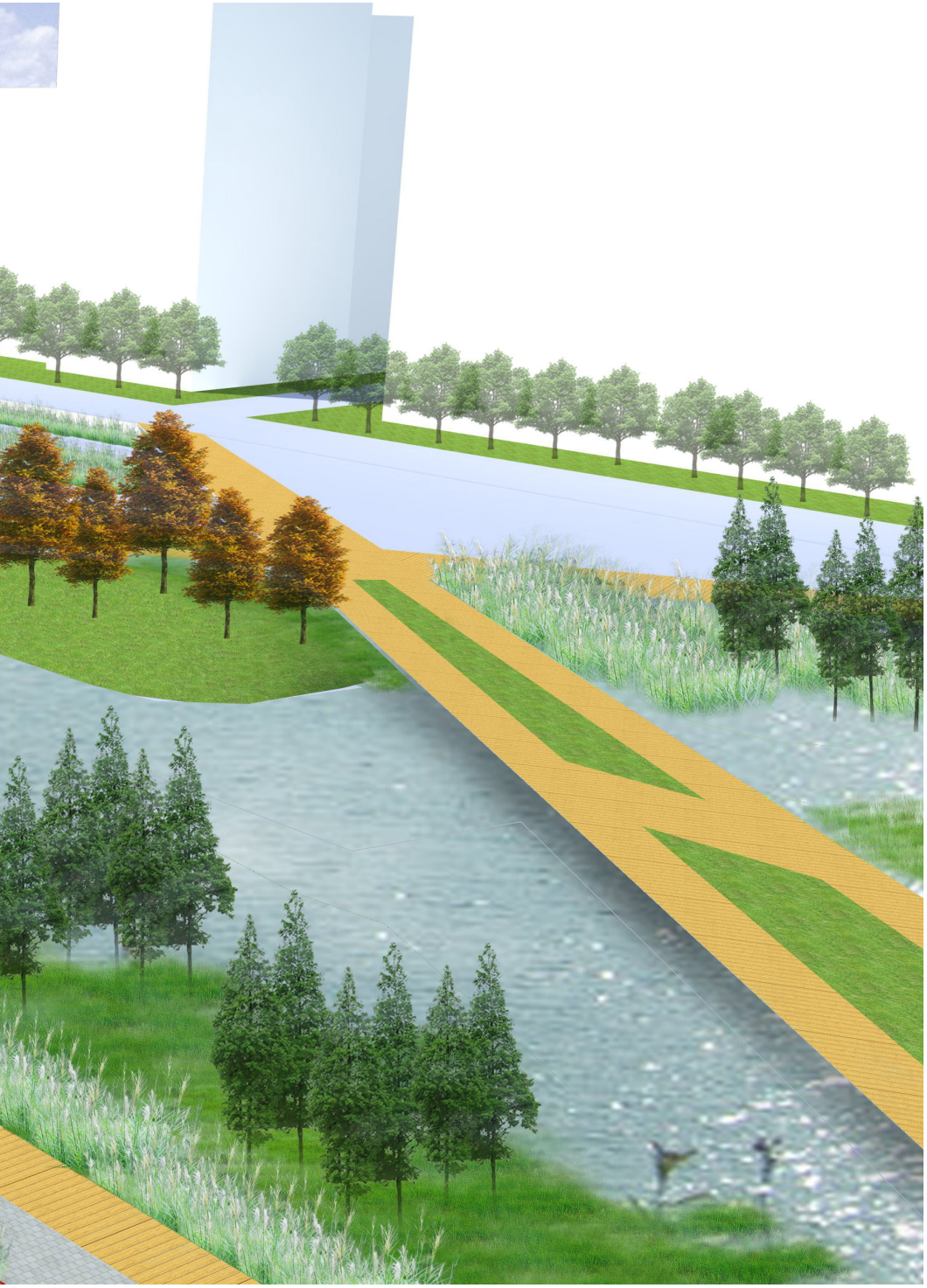
- Create center water channel as water detention to store stormwater.
- Provide terrace wetlands to treat greywater from buildings.
- Reuse reclaimed water.
- Use multi-transportation which include bus, boat taxi, bike and foot.
- Easy access to other areas.
- Design multiple level open spaces to make different experiences for visitors.
- Create education spots.

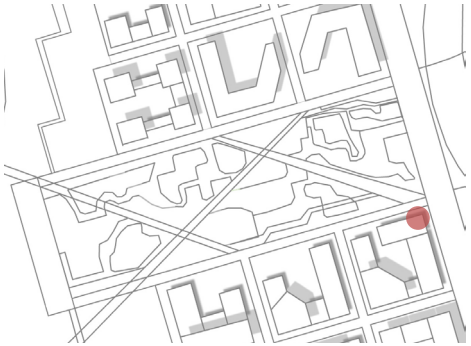




DESIGN





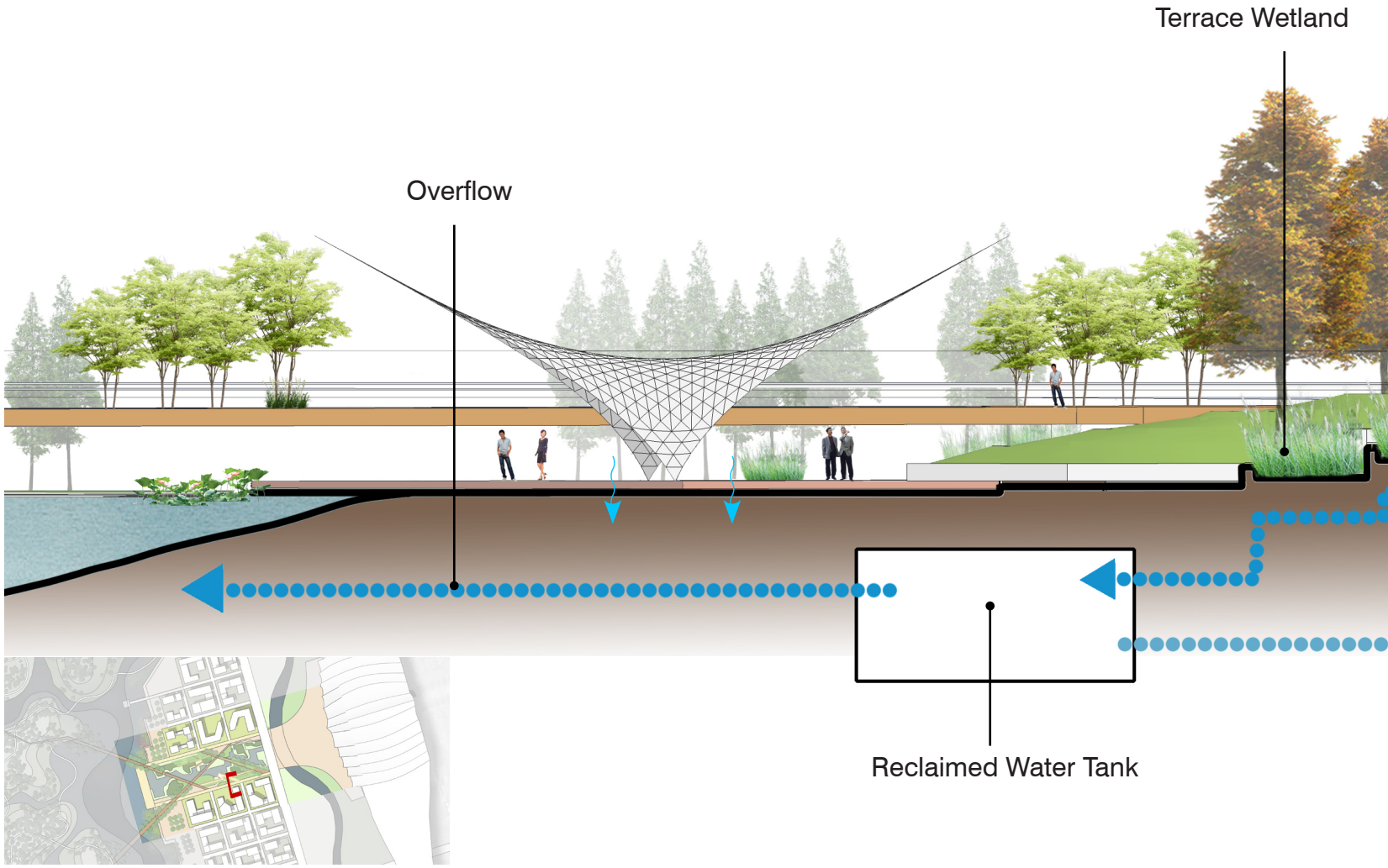


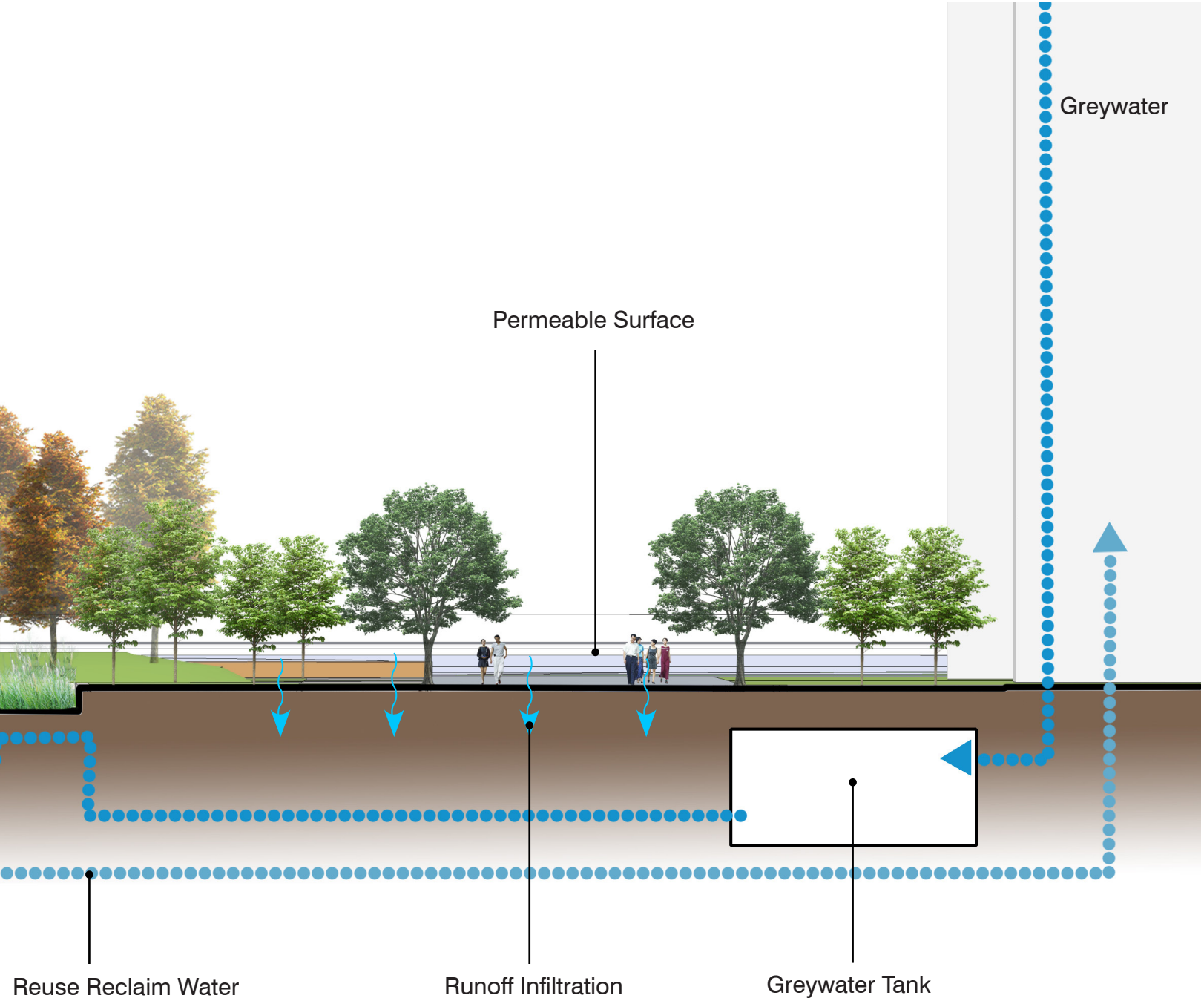
Overview

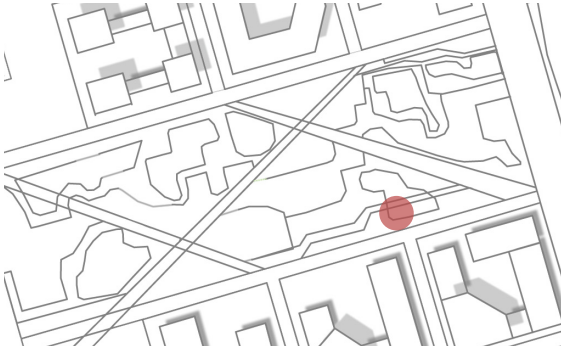
Multiple-level and multiple-functional open spaces are created in the garden. Visitors can find different views in different spaces. These spaces provide the places for people's communication, recreation and education. The garden is accessible. Raised bridges connect both sides of the garden, also connect with the centre natural park. The design tries to create the balance between the urban and nature.

Water Management

Water management in the garden includes two aspects: greywater treatment and runoff reduction. Greywater can be collected and treated in terrace wetlands. The recaimed water can be reused for landscape irrigation and other requirements of buildings. Green spaces and permeable surfaces permit the runoff to infiltrate into the soil and reduce the urban flooding.




Greywater
Permeable Surface
Reuse Reclaim Water
Runoff Infiltration
Greywater Tank



Waterfront

The waterfront permits visitors to touch the water. Some hydrophyte species are used in the garden to create a hydrophyte classroom. It is also a water treatment education spot to let people realize water problems that we are facing.

NATURAL HEART PARK

The natural heart park is located in the center which connects the Yangchun Lake and the East Lake together. The main functions of the park are stormwater retention and habitat restoration. For stormwater retention, the cut-and-fill strategy is used here. The landfill is created by the soils from digging water channels. Slopes are used as buffer zone which can control the seasonal water level change and store the stormwater.

The park is less developed and the whole area is kept natural as far as possible. Native habitats are restored in this area that include woodlands, grasslands, waterfront and aquatic.

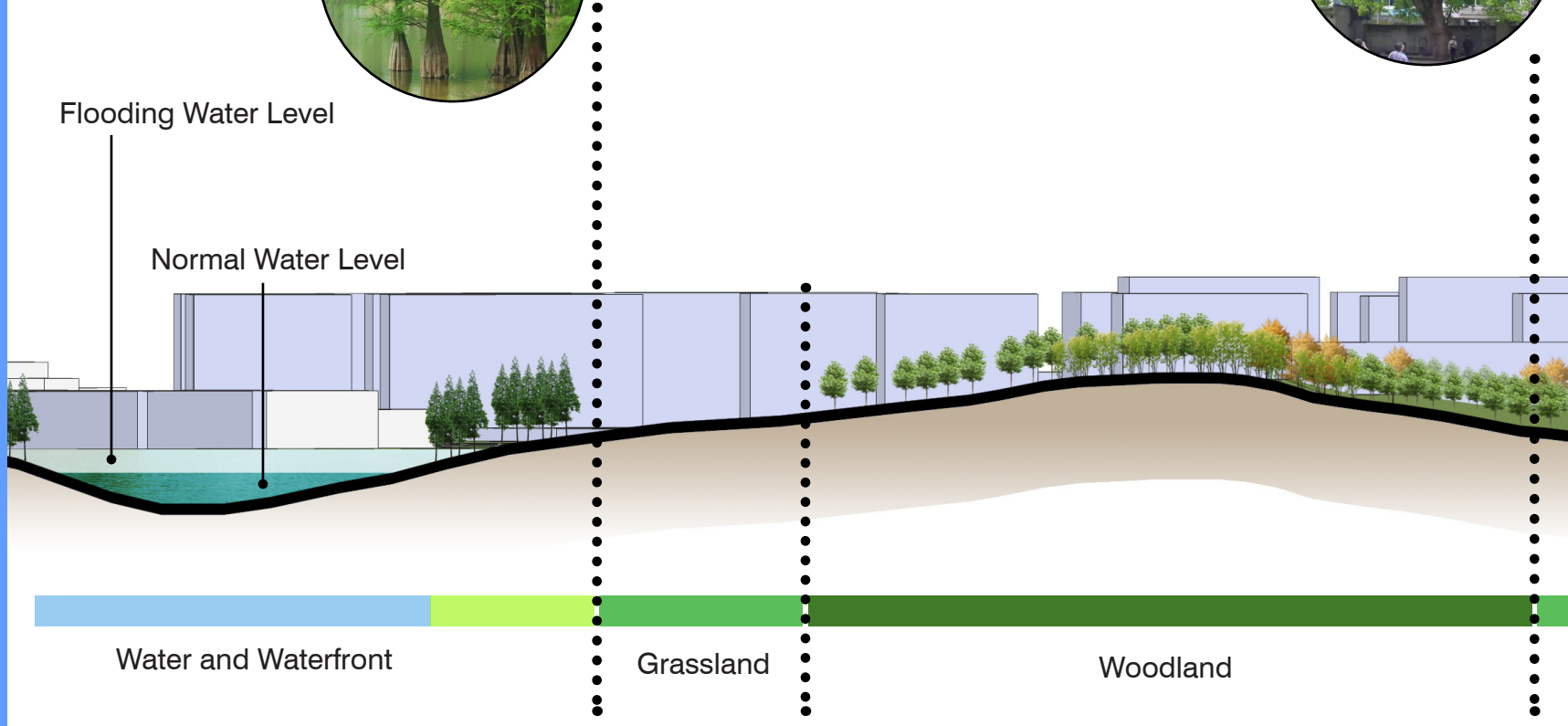
The development areas only focus on the edge of the park which are the amphitheater and the research center. The research center is a learning center used for ecosystem research and eco-tourism education. People can learn about problems about urban ecosystem and efforts that the world is doing now.


Amphitheater
Research Center
N
0
100
400 M

Seasonal Water Level & Habitat Restoration

Nelumbo nucifera

Metasequoia glyptrobides



Liquidambar formosana

mosana

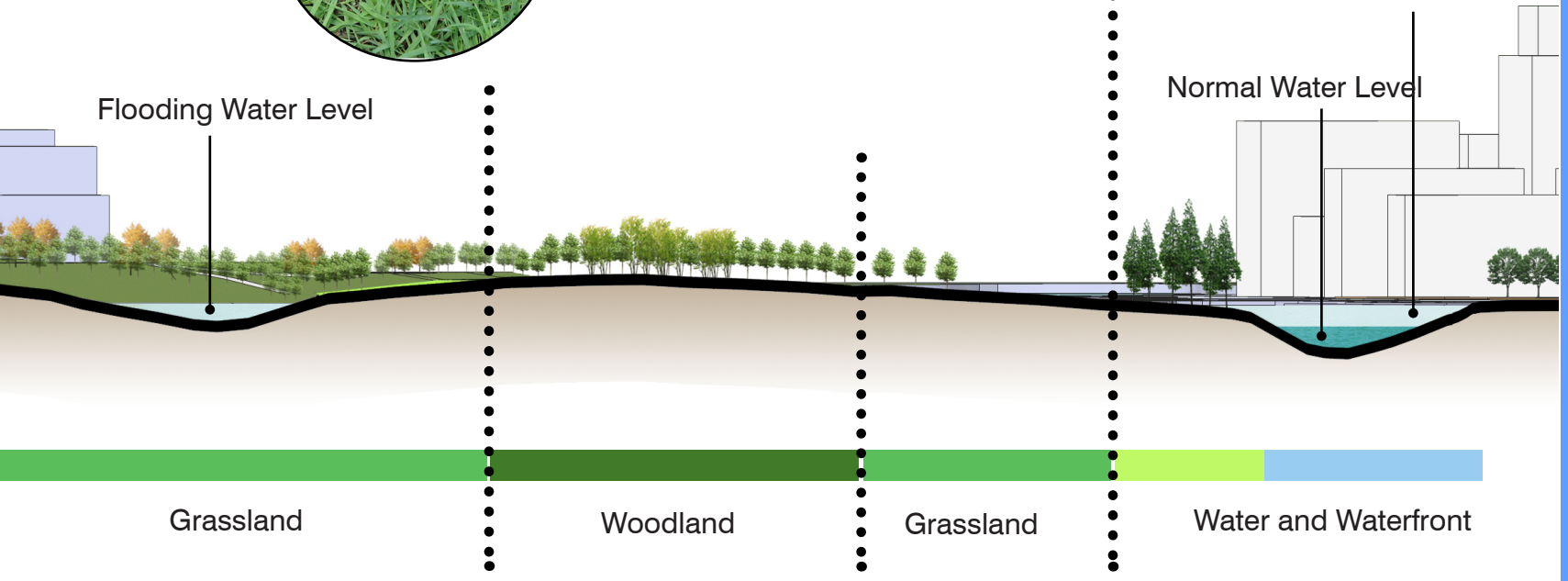
Phragmites australis

Cynodon dactylon

Flooding Water Level

Normal Water Level

Flooding Water Level



DESIGN

Waterfront

The waterfront in the natural park is less development. Grasslands with gentle slope can provide spaces for many activates.

Connection

The park is accessible. Bridges directly connect it with the east and west development areas. They work with pedestrian pathways to promote walkability. During walking, different views and landscapes are created for visitors.

WEST COMMUNITY

As the residential focused mixed-use area, the west community is located in the west side. Some design strategies are used:

- Limit car transportation in the community, provide public transportation and pro- mote pedestrian transportation.

- Use underground parking to reduce land use for parking on the ground.

- Mixed-use provide on-site job opportunities and convenience service for residents.

- Revitalize urban agriculture such as green houses and fish ponds for local food supply and eco-tourism.

- Design the waterfront as the buffer zone for seasonal water change.

- Create rain gardens and water harvesting systems in neighborhoods to control storm-water.

- Provide enough spaces in neighborhoods and the waterfront for people's communication and recreation.

Boat Taxi Stop

Floating Eco-island

Water Harvesting Garden

DESIGN

Waterfront

The waterfront in the community is very important area to connect water and neighborhoods. It designs as a botanic garden for people's communication, recreation and education. It is also a buffer zone for seasonal water change. Species of Plants near the water can live both in the water and on the land to adapt the water change.

Neighborhood Garden

In the high density community, open spaces are vital role for social activities.

Conclusion

This project is a great opportunity to face the challenge between urban development and nature conservation. It shows that landscape architects can play a big role during urban design to find all relationships between urban and nature, development and conservation, finally design a network to balance them.

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