BALANCING THE BLUE-GREEN-GREY NETWORKS

THE SPONGE CITY PLANNING IN A COLD COSTAL CITY IN NORTHEAST CHINA

Project Name: Balancing the Blue-Green-Grey Networks:The Sponge City Planning in a Cold Costal City in Northeast China

Project Address: Zhuanghe, Liaoning Province, China

Area: 2,080,000m^2

Year of Planning: 2024

Award Category: Analusis & Master Planning(Unbuilt Projects)

Project Statement

Zhuanghe City is one of the important nodes of the coastal economic belt in Northeast China, surrounded by both the Bo Sea and the Yellow Sea. Rapid urbanization and dramatic climate change have led to an increase in the hardened area of the city and an increase in extreme precipitation situations. As a result, the city is often subject to extreme risk situations of tidal waves and extreme precipitation during the rainy season in the summer, and large-scale concentrated snowfalls in the winter, which drive the city into a grey infrastructure paralysis situations.

The theme of this project is ‘Balancing the “Blue-Green-Grey” Networks’, which aims to create a cross-seasonal, cross-spatial networks of urban landscapes. By creating a sustainable urban water networks, a rain-flood resilient urban green networks, and an urban grey networks that allow snow to be piled up in winter, the project aims to achieve a balance between supply and demand of ecological, living, and production functions in both time and space. Therefore, this project integrates sponge planning with landscape enhancement, and puts different strengths of resilience demand into different landscape systems to achieve comprehensive enhancement of sponge resilience and landscape quality.

Project Narrative and Contents

1.Design background and problem analysis

Zhuanghe City is located in the southeast of Liaodong Peninsula of China, nearly 143 kilometres away from Dalian City, the first port city in Northeast China, surrounded by the Yellow Sea and the Bo Sea. It is affected by the warm temperate monsoon climate, which is located between 39°25′ and 40°12′ north latitude, and also by the winter climate in cold regions.

The project is located in the new urban area of Zhuanghe City, with an area of about 17,100 square metres. Rapid urbanization and drastic climate changes have led to an increase in hardened areas and extreme precipitation situations in Zhuanghe City. In the summer, the city is often exposed to extreme risk conditions of seawater tides and extreme precipitation during the rainy season, while in the winter, large-scale concentrated snowfalls drive the city into a grey infrastructure paralysis condition. At the same time, the site faces problems of seawater intrusion into the groundwater, high levels of surface pollution, and severe salinisation of the land.

Therefore, the design objective of this project is to " balancing the 'blue-green-grey' networks", aiming to establish an inter-seasonal and inter-spatial urban landscape network system. By creating a sustainable urban water networks, a rainwater resilient urban green networks, and an urban grey networks that can pile up snow in winter, the project will achieve a balance between supply and demand of ecological, living, and production functions in both time and space. This project plans to integrate sponge planning with landscape enhancement, placing different strengths of resilience needs into different landscape systems, realising the comprehensive enhancement of sponge resilience and landscape quality, and solving the multi-scale and multi-level risk problems faced by the city.

2.Rainfall simulation and sponge demand analysis

The project takes 3 and 20 years of return period as the rainfall simulation analysis situation, identifies the rainfall risk points and risk causes within the design scope, and the requirements of surface pollutant control, and simulates the situation of rainfall and tidal water; determines the total amount of rainfall, rainfall drainage channels, rainfall retention module locations, and adjusts the water system, green networks, and grey infrastructure planning with the existing spatial layout, so as to satisfy the design requirements.

3.Planning Vision and Planning Strategies

Based on the rainwater simulation and sponge demand in the above steps, the project tries to respond to the issues of sustainable urban water networks, ecological resilience of urban green networks, and multi-seasonal resilience of urban grey networks, and to create a multi-functional mixed urban landscape networks system, which can be expressed in two levels: basic sponge strategies and special sponge strategies.

(1) Special Sponge Strategies

Facing the cross-seasonal and cross-spatial rainfall and flooding problems in the cold coastal area, the project creates an urban resilient wetland park that meets the extreme precipitation and extreme tidal wave superimposed on each other, in order to meet the risk of flooding in multi-dimensional situations; and creates a grey infrastructure to meet the snow piling and melting situations in winter and combines with the design of the road section to meet the space for snow piling and pedestrian traffic at the same time.

(2) Basic Sponge Strategies

Through the building of a "redundant" coastal sponge water system, a "multi-level" urban green habitat networks system, and a "mixed- functional" urban green spaces, in order to meet the demand for ecological resilience to rainfall and flooding, biodiversity, and public activities in the city.

4.Specific strategies and realisations

(1) Special Sponge Strategies

■ Facing the co-occurrence of rain and tide (SPATIAL)

In order to face the co-occurrence of rain and tide on the project, the project has set up a partially floodable eco-park in the area close to the coastal area. In the newly installed sponge system, the project has set up floodable areas with different intensities. At the mouth of the sea, ecological floating islands are set up to meet the demands of production and ecology at the same time; in the area of the central park, the project has set up wet plant landscape communities to meet the requirements of inundation; in the landscape corridor, ecological dykes of different elevations are placed.

■ Dealing with winter snow disasters (seasonal)

In order to face the problem that the green infrastructure is unable to dissipate solid snow when large-scale snowfall occurs in winter; the mature winter diversity snow stacking cross-section of pavements in Japan and other countries is adopted; the amount of snow stacking on the road cross-section is calculated and planned based on the data of past winter snowfalls in Zhuanghe City; and the snow stacking, pedestrians and motor vehicle traffic are satisfied at the same time during the winter season.

(2) Basic sponge strategy

■ Constructing a coastal urban sponge system

The project creates a multi-level coastal urban sponge system coupled with " dot (miniature green space) - line (road) - plane (large-scale green space or lake)". In the non-rainy season, several small sponges in the city can backfill and nourish groundwater and springs to achieve water circulation; in the rainy season, floating islands, green networks and grey networks in the city can jointly achieve rainwater drainage and dissipation; in the event of storm surges, roads become the main drainage channels in the city, and can realize rainwater channels in extreme situations. Meet the urban sponge needs under different scenarios.

■ Enhance the green space habitat quality of sponge system

In the urban sponge planning, the selection of native plants and the construction of stable plant communities are considered at the same time to achieve the enhancement of the habitat quality of green space. In different flooded areas, the project plans wet plant communities and semi-wet plant communities, and combines the habitat habits of different organisms to achieve rapid urban ecological environment restoration.

■ Enriching public activities in green space

In the urban landscape upgrading, with the urban ecological sponge structure as the base, according to the different intensity of construction density and the intensity of public activity demand, and combining the spatial relationship between different urban functions and ecological structure, implanting the slow travelling system, open space system and nature education system. And around the blue-green space axis planning urban business district, cultural industry park and sports integrated area, the citizen life, public education, urban economy, clean energy and other urban development plate and sponge ecosystem closely integrated.

5. Comprehensive Benefit Enhancement

The sponge planning of this project is based on the enhancement of the city's rainfall and flood risk capacity.

In order to meet the overall requirements of improving the quality of urban green space habitat and the quality of urban public activities.

The project tries to create a 'balanced blue-green-grey' landscape networks system of urban ecology, which is planned to achieve a 15% increase in the green network's ability to resist the risk of co-tidal flooding, a 60% increase in the carrying capacity of the urban grey infrastructure in winter, a 26-fold increase in the richness of the urban plant species, a 40% improvement in the quality of the urban green habitats, and a 300% increase in the urban biodiversity in a period of 5-10 years, which is a comprehensive benefits enhancement targets.

BALANCING THE BLUE-GREEN-GREY NEWORKS

THE SPONGE CITY PLANNING IN A COLD COSTAL CITY IN NORTHEAST CHINA


BACKGROUND
30° 0° 30° 60° 90° 120° 150° 180° 150° 120° 90° 60° 30°
• AVERAGE WINTER TEMPERATURE BELOW -8.7
• DISTRIBUTION OF COLD WINTER REGIONS IN THE WORLD
COLD REGIONS
39.70 North latitude
TEMPERATE MONSOON CLIMATE
· HUGE SEA-LAND THERMAL CONTRAST
· SIMULTANEOUS RAIN AND HEAT, WARM, HOT AND RAINY SUMMERS, COLD AND DRY WINTERS, AND LARGE ANNUAL CHANGES IN TEMPERATURE
BOHAI ECONOMIC CIRCLE
PAN-BOHAI ECONOMIC CIRCLE
PAN-YELLOW SEA ECONOMIC CIRCLE
BEIJING
NORTH KOREA
PYONGYANG
ZHUANGHE
SOUTH KOREA
SEOUL
JAPAN
TOKYO
YELLOW SEA ECONOMIC CIRCLE
ZHUANGHE IS THE CENTER OF THE NORTH YELLOW SEA COAST, WITHIN THE DALIAN ONE-HOUR ECONOMIC CIRCLE AND LIAONING PROVINCE TWO-HOUR ECONOMIC CIRCLE. AT THE SAME TIME,IT IS IN A STRATEGICALLY IMPORTANT POSITION IN THE CHINA-JAPAN-KOREA ECONOMIC CIRCLE AROUND THE YELLOW SEA.
COASTAL CITY
MAJOR PORT CITY
The average annual temperature is 8.9℃
The lowest temperature is -25.2℃
The highest temperature is 36℃
The average precipitation is 789.5 mm
The average evaporation is 1,388 mm
The rainfall during the flood season (June-September) accounts for more than 75% of the whole year
there is an obvious phenomenon of uneven tide heights
Q1: HOW TO CARRY OUT URBAN SPONGE CONSTRUCTION?
Q2: HOW TO DEAL WITH THE IMPACT OF TIDES ON CITY?
Q3: HOW TO RESPOND TO THE PARTICULARITY OF WINTER IN COLD REGIONS?

PROBLEM ANALYSIS

ISSUE 1: FLOODING IN THE CITY

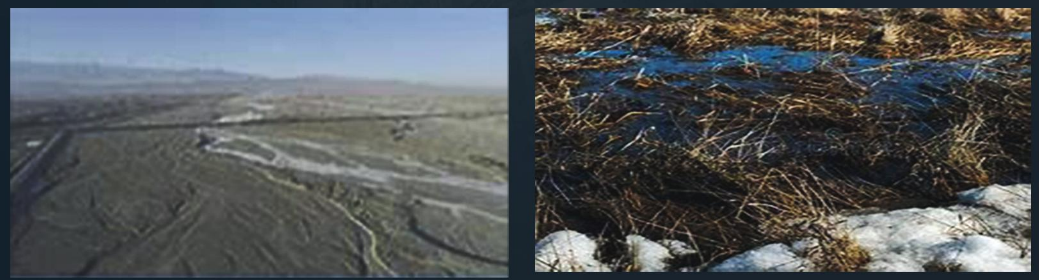
ISSUE 2: DISCHARGE WATER WASTAGE

ISSUE 3: SALTWATER INTRUSION

ISSUE 4: LAND SALINISATION

ISSUE 5: URBAN WATER LOSS IN WINTER

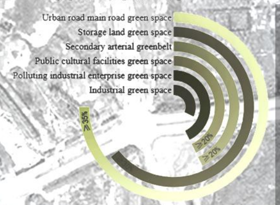
ISSUE 6: FRAGMENTATION OF THE URBAN WATER NETWORK



CATCHMENT ZONING

The site is divided into seven catchment zones

CLASSIFICATION ACCORDING TO CATCHMENT COEFFICIENTS



THE OVERALL GEOLOGICAL TYPE OF ZHUANGHE CITY BELONGS TO MUDFLATS WITH A HIGH WATER LEVEL LINE. MANY SURFACE RUNOFFS WITHIN THE CITY ARE AFFECTED BY SEAWATER, AND THE OVERALL GEOLOGY HAS A LOT OF SALINE AND ALKALINE LAND, WHICH NEEDS TO BE CONTROLLED BY PLANNING TO IMPROVE THE ENVIRONMENT OF THE AREA

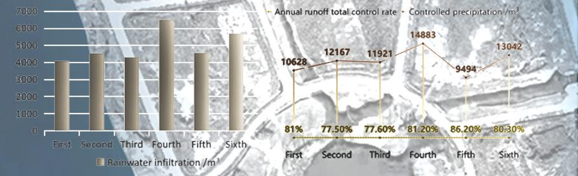
PROGRAMME BASIS

LESS ADJUSTMENTS TO THE CONTROL PLANNING

LESS AMOUNT OF EARTH VOLUME

LOWER COST IN MANAGEMENT AND MAINTENANCE

SMALLER WATERBODY AREA, LESS DAILY RECHARGE-WATER RE-



GREEN SPACE SYSTEM STRUCTURE DIAGRAM

CLASSIFICATION: LANDSCAPE WITHIN THE SITE ARE DIVIDED INTO THREE LEVELS IN ACCORDANCE OF THE LANDSCAPE CHARACTERISTICS

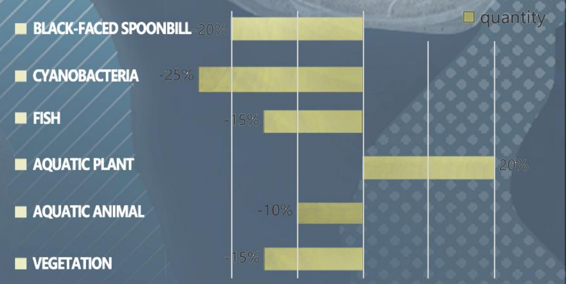
COORDINATION: EACH PART OF THE CLASSIFICATION BETTER MATCHES THE SURROUNDING DIFFERENT BASE ENVIRONMENT

MAJOR DESIGN: THE MAIN WATER SYSTEM NETWORK AND PARK WETLAND ARE DESIGNED AS THE MAIN GREEN LANDSCAPE AREA

SECONDARY DESIGN: THE SUB-NETWORK OF THE WATER SYSTEM AND ARE DESIGNED AS SECONDARY GREENING LANDSCAPE AREAS.

AUXILIARY: ROADSIDES OF THE BYPASSES AND URBAN STREET GREEN SPACE ARE DESIGNED AS AUXILIARY GREEN LANDSCAPE

CLASSIFICATION | COOPERATE | MAJOR DESIGN | SECONDARY DESIGN | AUXILIARY



RETENTION

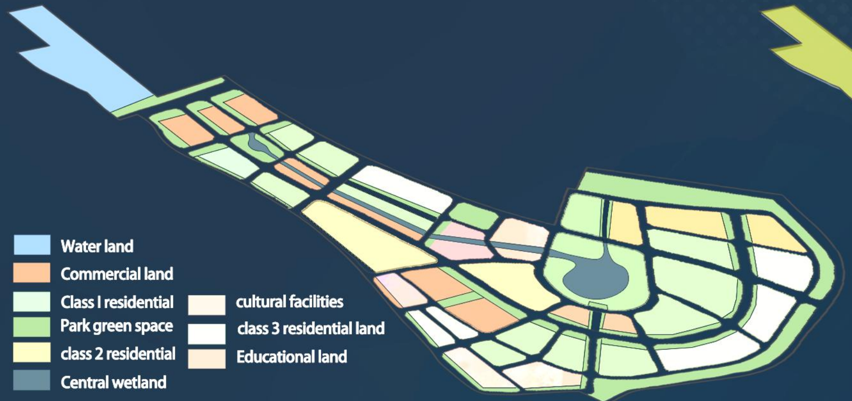
RETENTION OF NATURAL PRECIPITATION IN THE CITY'S WATER SYSTEM

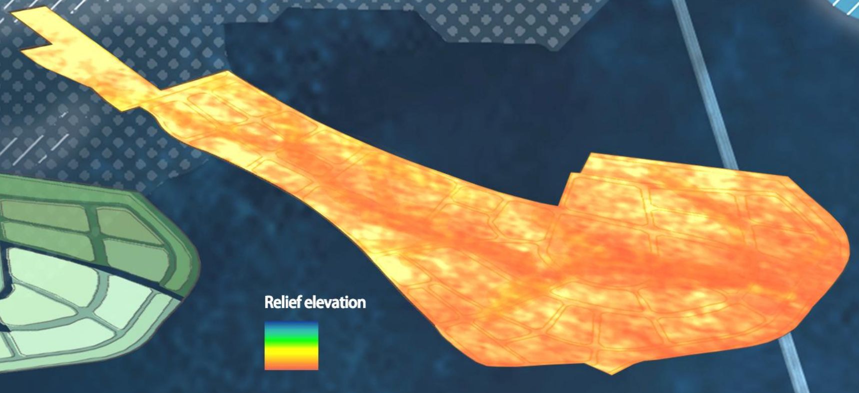
STORAGE

THE STORAGE CAPACITY OF THE STORAGE SPACE WILL BE SIGNIFICANTLY INCREASED COMPARED TO THE PRE-DEVELOPMENT

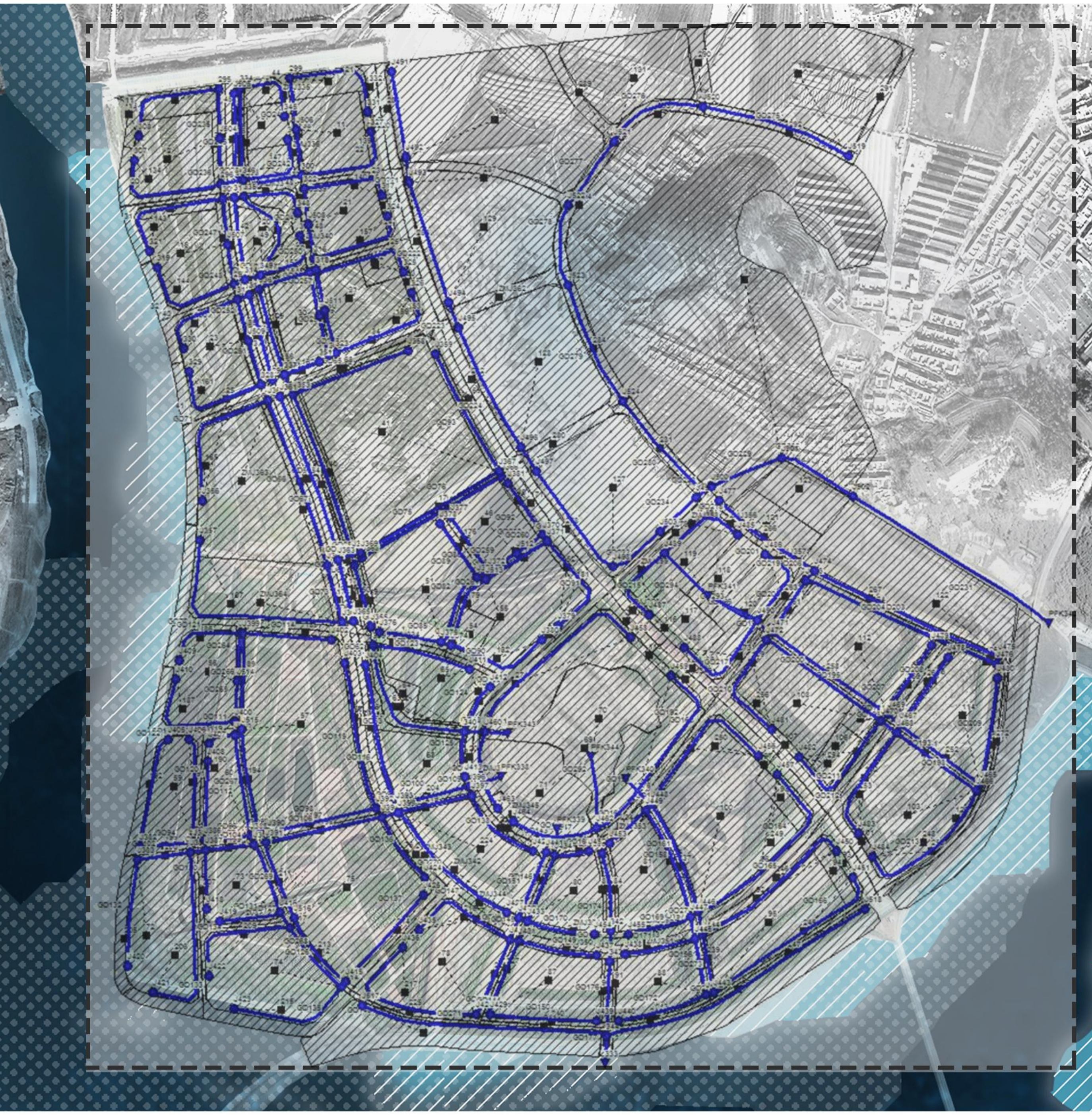
DRAINAGE

TO AVOID FREQUENT FLOODING, THE CITY'S DRAINAGE CAPACITY WILL BE IMPROVED SO THAT





RISK ANALYSIS AND SIMULATION OF STORM FLOOD IN COASTAL CITIES



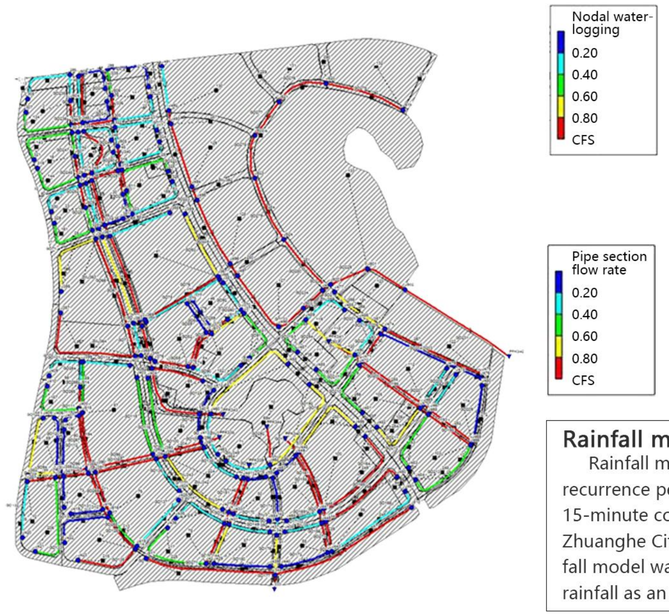
SWMM MODEL CONSTRUCTION

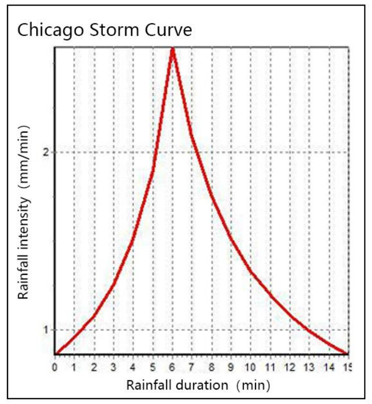
SWMM model building:

Based on the preliminary constructed surface zoning, the following model is constructed based on the urban stormwater network plan

he model is divided into a total of 306 SUB-CATCHMENT AREAS, sub-catchment areas occupy the ground change range of 0.22~8.35ha, 218 RAINWATER OUTLETS, 218 SECTIONS OF RAINWATER PIPES, pipe diameter changes in the range of 1,200mm ~ 2,400mm, 8 END OUTLETS.

15-MIN RAINFALL MODELLING FOR A 3-YEAR RETURN PERIOD

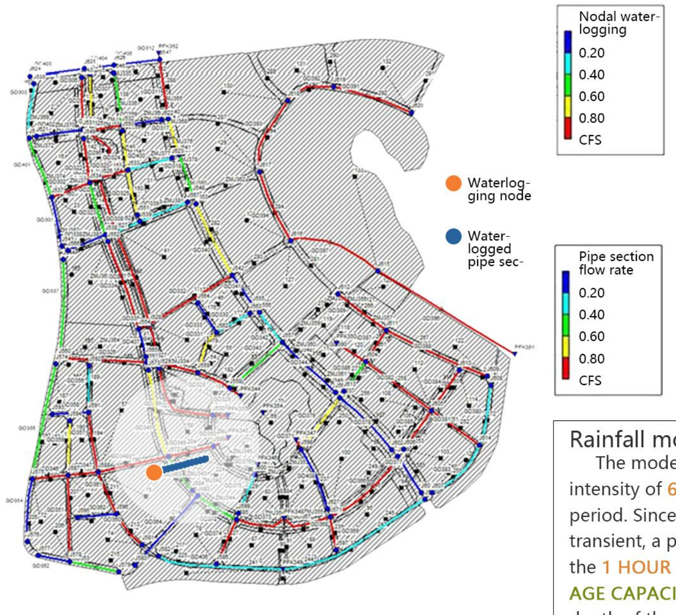


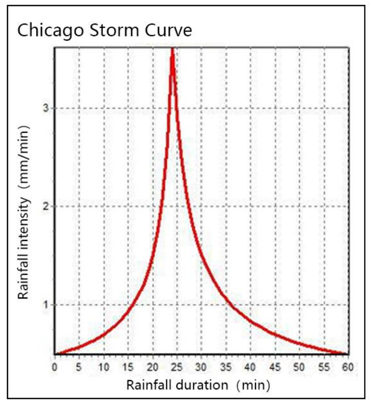


Rainfall model:

Rainfall modeling: rainfall for the triennial(3-years) recurrence period was modeled as 21.9 mm using a 15-minute concentrated rainfall model, and rainfall in Zhuanghe City is mostly transient, so a preliminary rainfall model was constructed using 2-HOUR transient rainfall as an example

1-HOUR RAINFALL MODELLING FOR A 20-YEAR RETURN PERIOD

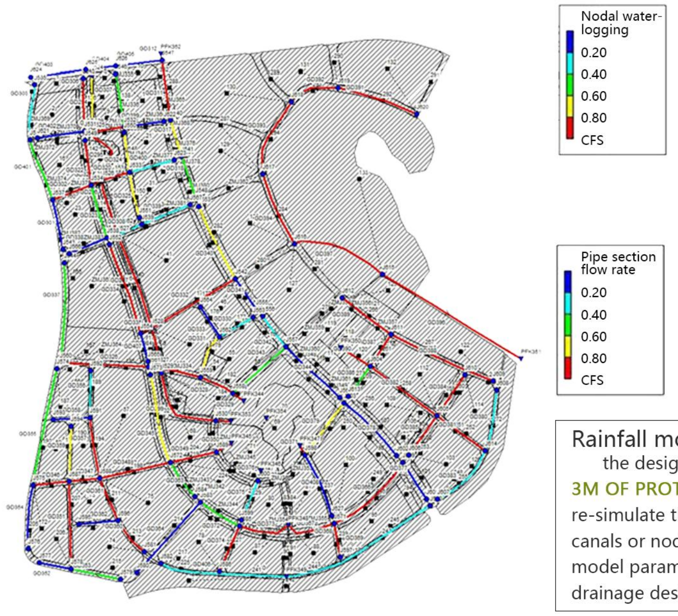


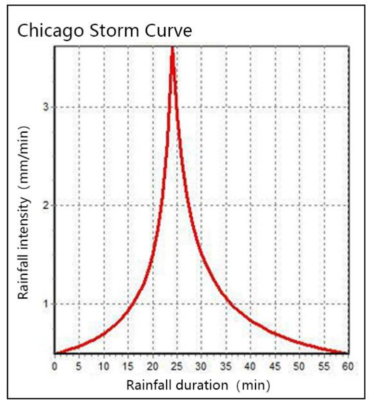


Rainfall model:

The model is constructed for the 1-hour rainstorm intensity of 62.2 mm rainfall based a 20-year return period. Since most of the rainfall in Zhuanghe City is transient, a preliminary rainfall model is constructed for the 1 HOUR transient rainfall to calculate the DRAINAGE CAPACITY of the river system and the drainage depth of the road floodway

1-HOUR RAINFALL MODELLING FOR A 20-YEAR RETURN PERIOD (modified)



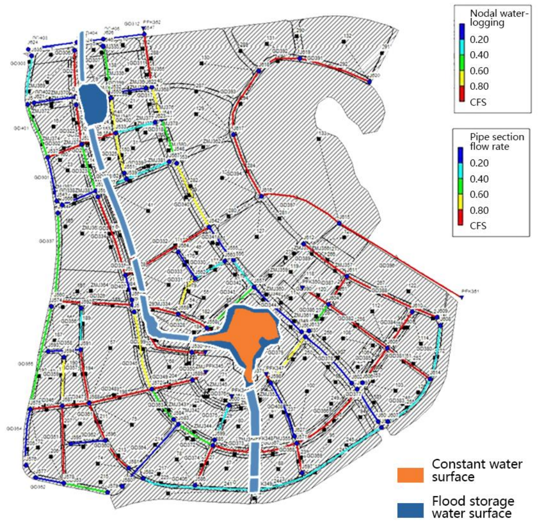


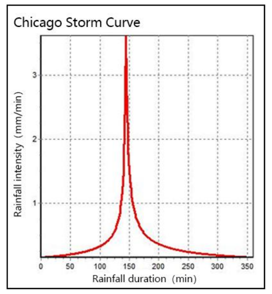
Rainfall model:

the design of the pipe canal 349 widened by 3m (3M OF PROTECTIVE ROADSIDE GREEN BELT), to re-simulate the test; the results turn out that no pipe canals or nodes are found overloaded; indicating the model parameter settings to meet the needs of the drainage design

FLOOD SIMULATION

6-HOUR RAINFALL MODELLING FOR A 20-YEAR RETURN PERIOD





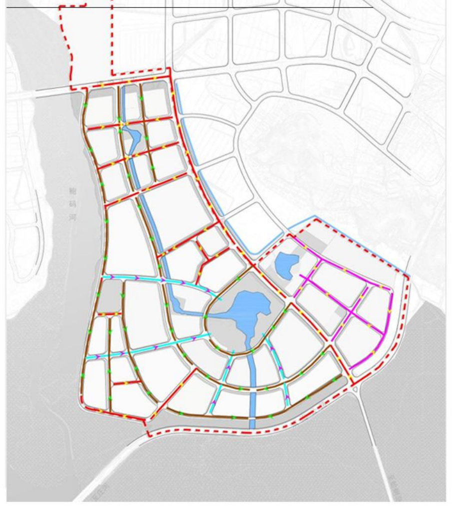
The rainfall model is designed to be constructed with the rainfall of 182mm IN 6 HOURS during the 20-year return period, to calculate the WATER STORAGE CAPACITY of the wetland space in the river system, and to determine the size and depth of the wetland water storage space.

The total precipitation in the planning area is 232,000 m³ for 6 hours of precipitation in the 20-year return period, about 60,000 m³ for SOURCE CONTROL reduction, and 172,000 m³ for END-OF-PIPE STORAGE space.

FLOOD STORAGE WATER

Our project takes the central wetland park as the main water storage node, city parks as auxiliary water storage nodes, and the water system corridor as the catchment drainage channel, to carry the rainfall of 232,000m³within 6 hours in the 20-year reproduction period, and completely store the rainwater

20-YEAR RETURN PERIOD STORMWATER FLOODWAY DESIGN



When a rainfall situation exceeding the 3-year return period occurs, and the discharge of rainwater exceeds the discharge load of the stormwater pipe, a large drainage flood channel system is planned, and the vertical design of the road system is designed to discharge the exceeding rainwater into the flood storage facilities efficiently

The main principles followed:

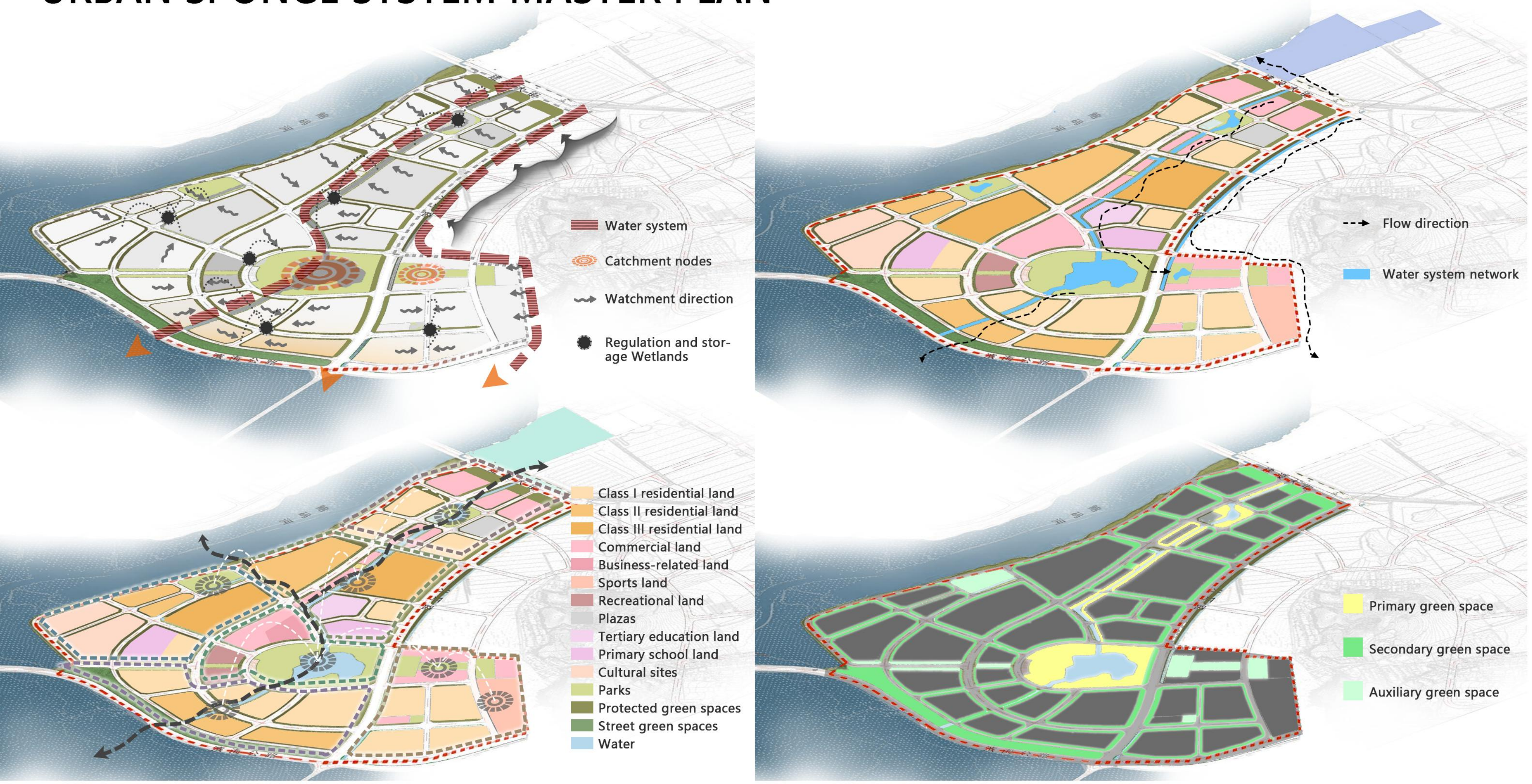
1, EXTERNAL WATER RETENTION. Ensure that rainwater outside the red line of the northeast catchment area does not enter the interior zone of the site, and control the flow by intercepting flood ditches

2, QUICK DISCHARGE OF INTERNAL WATER. Excessive rainwater within the planning area is drained away as quickly as possible

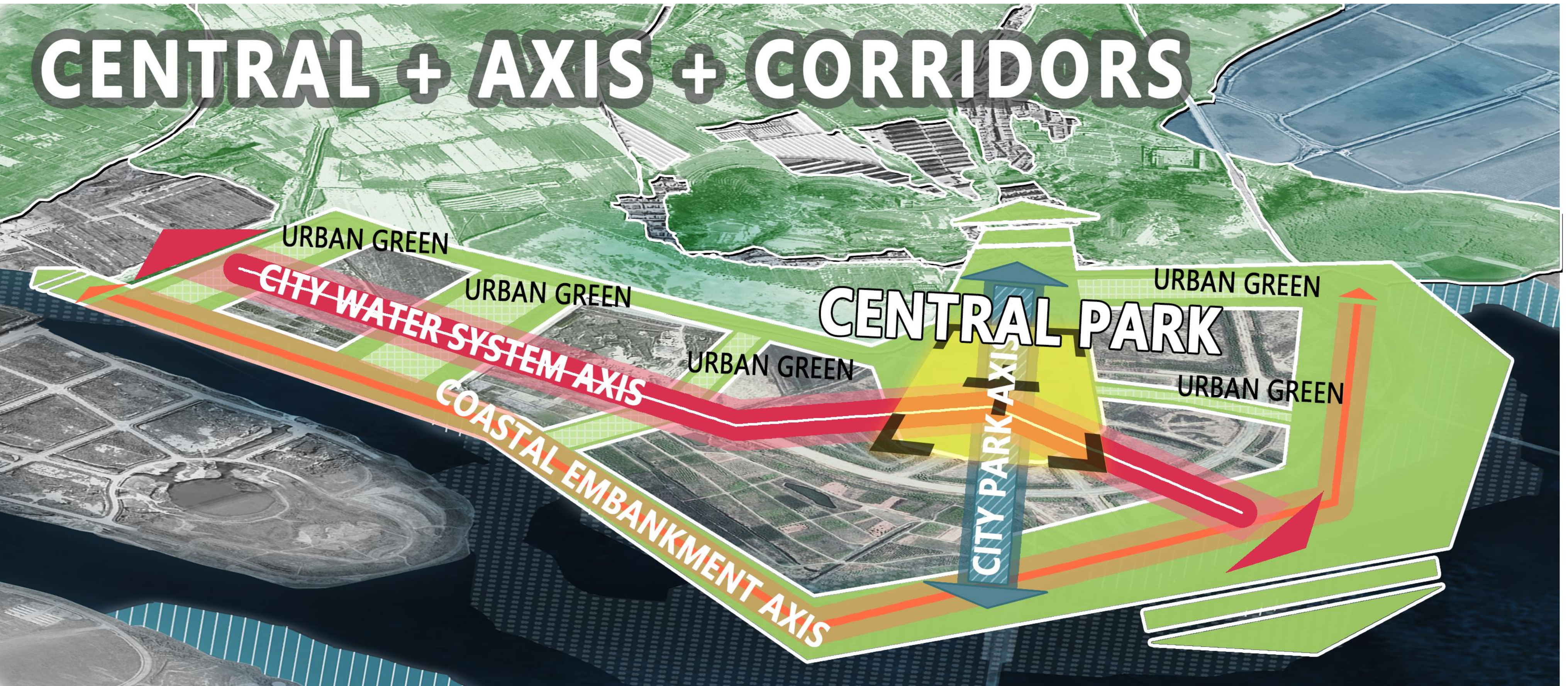
3. SUB-AREA DRAINAGE. Reduce the impact of water diversion between the districts

SPONGE PLANNING AND LANDSCAPE PLANNING IMPROVEMENT

URBAN SPONGE SYSTEM MASTER PLAN



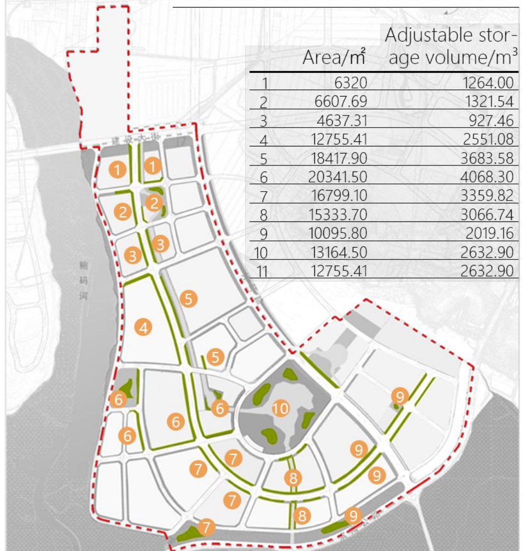
PUBLIC REALM FRAMEWORK



SPECIFIC ARRANGMENT OF URBAN SPONGE

SUNKEN GREEN SPACE

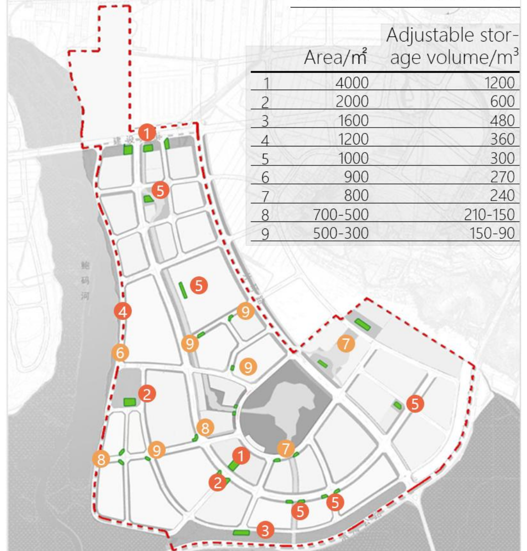
	Area/m²	Adjustable storage volume/m³
1	6320	1264.00
2	6607.69	1321.54
3	4637.31	927.46
4	12755.41	2551.08
5	18417.90	3683.58
6	20341.50	4068.30
7	16799.10	3359.82
8	15333.70	3066.74
9	10095.80	2019.16
10	13164.50	2632.90
11	12755.41	2632.90



· Percentage of total green area: 13%
· Adjustable storage volume: 21,900 m³

RAIN GARDENS

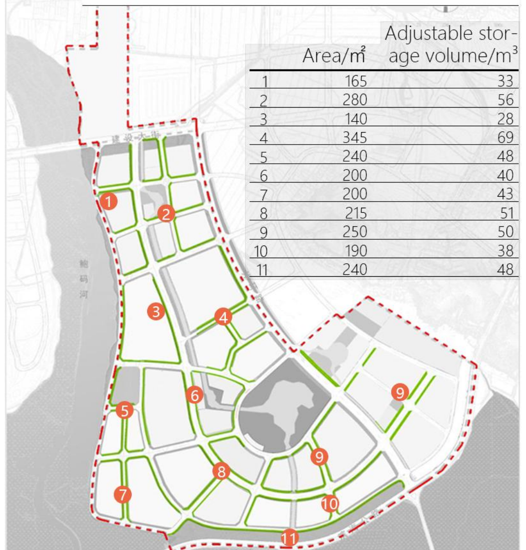
	Area/m²	Adjustable storage volume/m³
1	4000	1200
2	2000	600
3	1600	480
4	1200	360
5	1000	300
6	900	270
7	800	240
8	700-500	210-150
9	500-300	150-90



· Percentage of total green area: 1.5%
· Adjustable storage volume: 7470 m³

GRASS-PLANTING TRENCHES

	Area/m²	Adjustable storage volume/m³
1	165	33
2	280	56
3	140	28
4	345	69
5	240	48
6	200	40
7	200	43
8	215	51
9	250	50
10	190	38
11	240	48

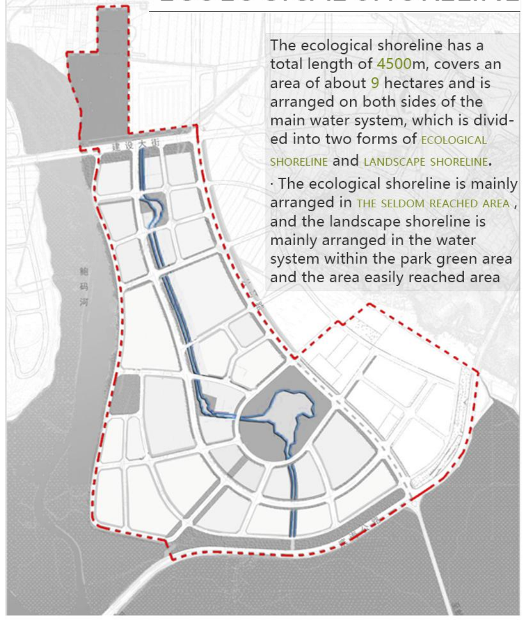


· Percentage of total green area: 0.44%
· Adjustable storage volume: 504 m³

ECOLOGICAL SHORELINE

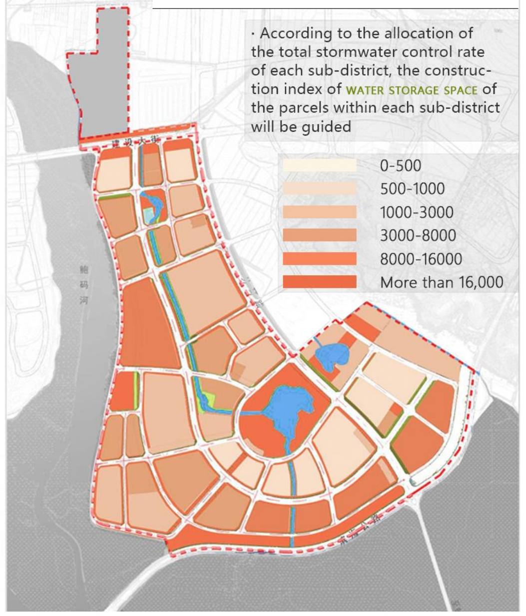
The ecological shoreline has a total length of 4500m, covers an area of about 9 hectares and is arranged on both sides of the main water system, which is divided into two forms of ECOLOGICAL SHORELINE and LANDSCAPE SHORELINE.

· The ecological shoreline is mainly arranged in THE SELDOM REACHED AREA , and the landscape shoreline is mainly arranged in the water system within the park green area and the area easily reached area

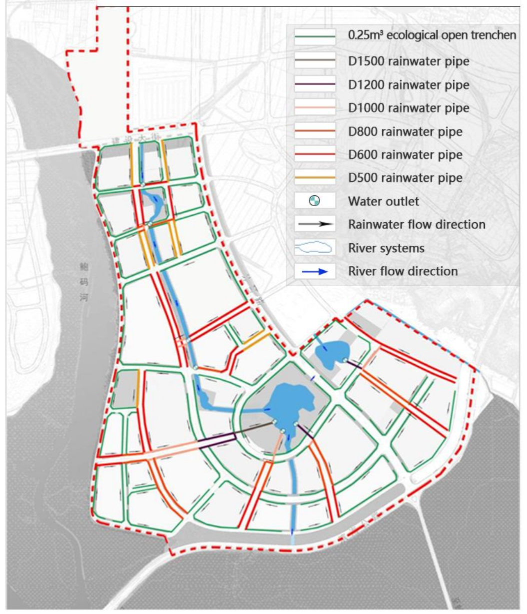


WATER STORAGE SPACE

· According to the allocation of the total stormwater control rate of each sub-district, the construction index of WATER STORAGE SPACE of the parcels within each sub-district will be guided



RAINWATER PIPE NETWORK



VISION OF THE PROJECT

RISKS AND CHALLENGES

LACK OF STABILITY OF URBAN WATER SYSTEM

- Uneven spatial and temporal distribution of precipitation
- Rough infiltration and Frequent flooding
- Lack of urban water sources

LOSS OF URBAN RESPONSE TO TIDAL RISKS

- Land salinization due to seawater intrusion
- Negative effect of seawater tide level top support
- Double tide superposition stressing on the drainage system

INVALID OF GREY INFRASTRUCTURE IN WINTER

- Snowmelt use accompanied by high input and high pollution
- Lack of snowfall utilizing leads to urban water loss in winter

MULTI-FUNCTIONAL OF LANDSCAPE NETWORKS

IMPROVING THE GREEN NETWORK STABILITY

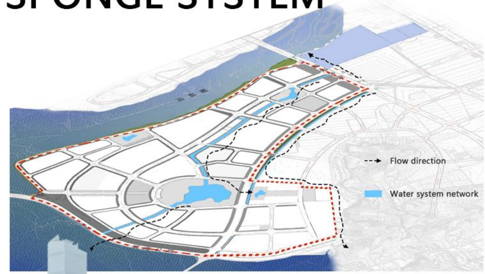
ENRICHING THE GREEN NETWORK RESILIENCE

ENHANCING THE GREY INFRASTUCTURE USES

STRATEGIES

Basic Sponge Strategies + Specific Sponge Strategies

1 BUILDING A COASTAL SPONGE SYSTEM



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2 IMPROVING THE QUALITY OF GREEN HABITATS

+

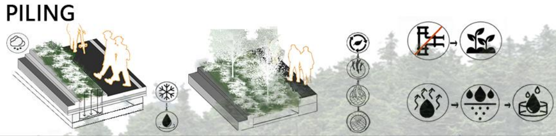
3 ENRICHING THE FUNCTIONS OF GREEN SPACES

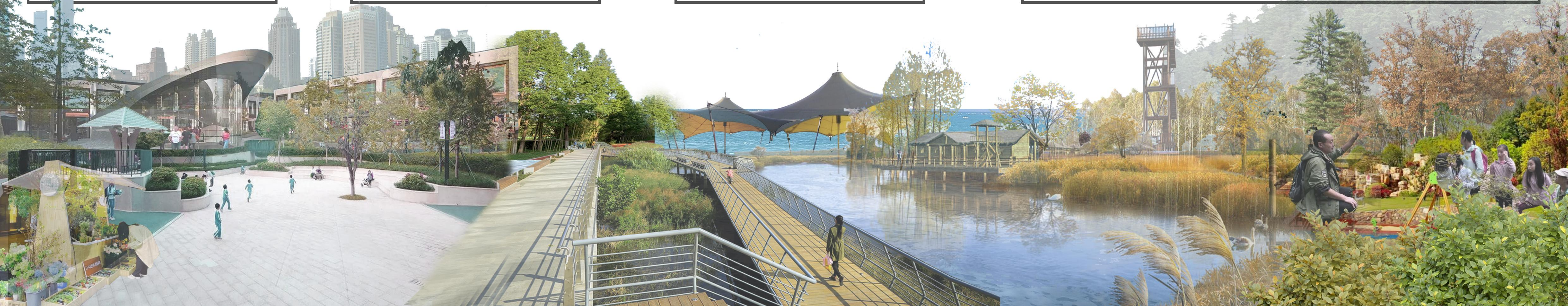
1 FACING THE CO-OCCURRENCE OF RAIN AND TIDE (SPATIAL)

Plan embankment space to meet tide buffering

2 DEALING WITH WINTER SNOW DISASTERS (SEASONAL)

Reserve resilience area to satisfy snow piling





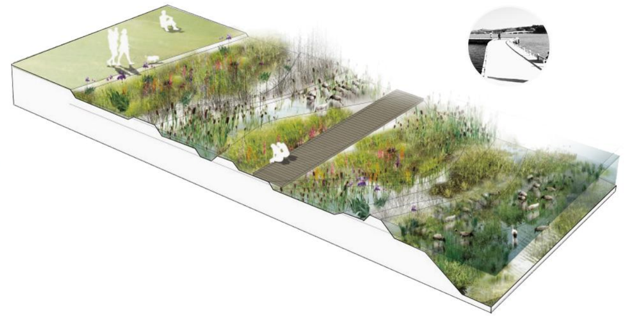
SPECIFIC SPONGE STRATEGIES

FACING THE CO-OCCURRENCE OF RAIN AND TIDE (SPATIAL)

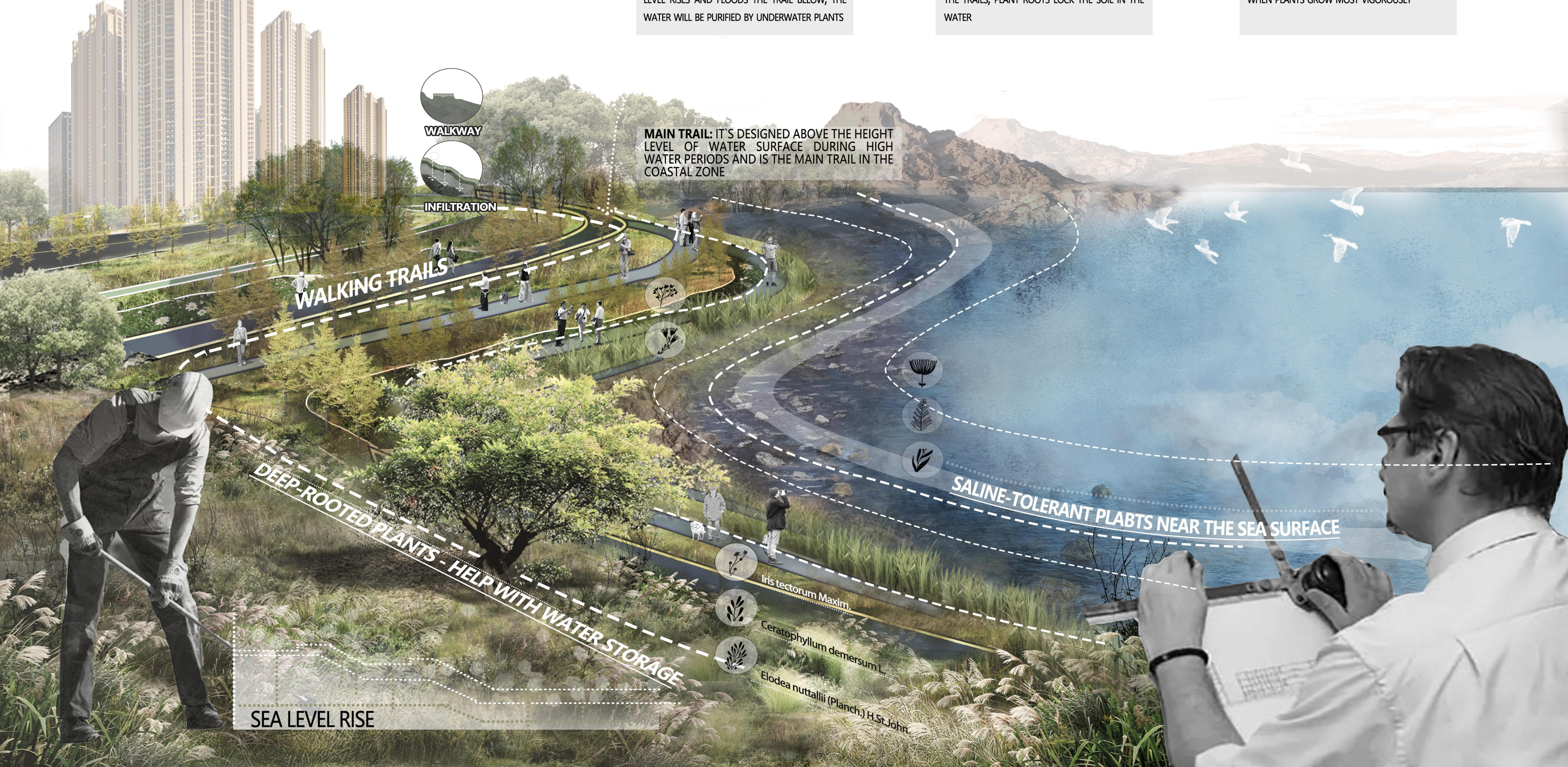
THE COASTLINE SUFFERS FROM PERIODICAL SEAWATER EROSION MAINLY DURING THE RAINY SEASON(FROM JUNE TO AUGUST),AND WINTER THAWING TIME. IN RESPONSE TO THIS SITUATION, WE HAVE DESIGNED A COASTAL WALKWAY SUITABLE FOR BOTH PERIODS. IN RESPONSE TO THE SEAWATER INUNDATION DURING THE RAINY SEASON, WE HAVE PLANTED SALT-TOLERANT PLANTS AIMED AT SOIL AND WATER CONSERVATION

During the rainy season ---when the sea level rises and floods the trail below, the water will be purified by underwater plants

During low water, water does not flood the trails, plant roots lock the soil in the water



The period of standing water is the time when plants grow most vigorously



SPECIFIC SPONGE STRATEGIES

DEALING WITH WINTER SNOW DISASTERS (SEASONAL)

THE PLANNING IS BASED ON THE CALCULATION OF ROAD SURFACE SNOW ACCUMULATION, AND THE INTERIOR GREEN AREA CAN BE USED AS A PILING SITE.

IN ROAD CROSS-SECTION DESIGN, THE INFLUENCE OF SNOWFALL FACTORS IS CONSIDERED IN DETAIL. AS A GOOD DEMONSTRATION FOR THE DESIGN OF THE CROSS-SECTION IN THE COLD WINTER REGIONS, THE ROAD CROSS-SECTION IS DESIGNED TO SATISFY THE WIDTH OF THE SNOW PILING IN SNOWY AREAS

ONE SNOW PILE CALCULATION

A PILE OF SNOW WIDTH REFERS TO THE NEW SNOW REMOVAL OPERATIONS SUCH AS SNOW TEMPORARILY PILED UP TO THE SIDE OF THE ROAD WIDTH

$$W_4=\begin{cases}1.543\sqrt{V_1} & V_1\le 0.722\mathrm{m3}/m\\ 0.909V_1+0.655 & V_1>0.722\mathrm{m3}/m\end{cases}\qquad V_1=K_1\bullet\frac{P_1}{P_2}\bullet h_1\bullet\omega_a$$

Where: V_1 for a pile of snow (m^3 / m); k_1 for a pile of snow coefficients; p_1 for the density of new snow (g/cm^3); p_2 for the density of primary snow (g/cm^3); h_1 for the planning of the object of the depth of the snow (m); wa for the one-time pile of snow removal object width (=$W_1 + W_2 + W_3$) (m); W_1 for the width of the winter driveways; W_2 for the width of the middle road side strips; W_3 is the width of the road shoulder side strip

SECONDARY SNOW CALCULATION

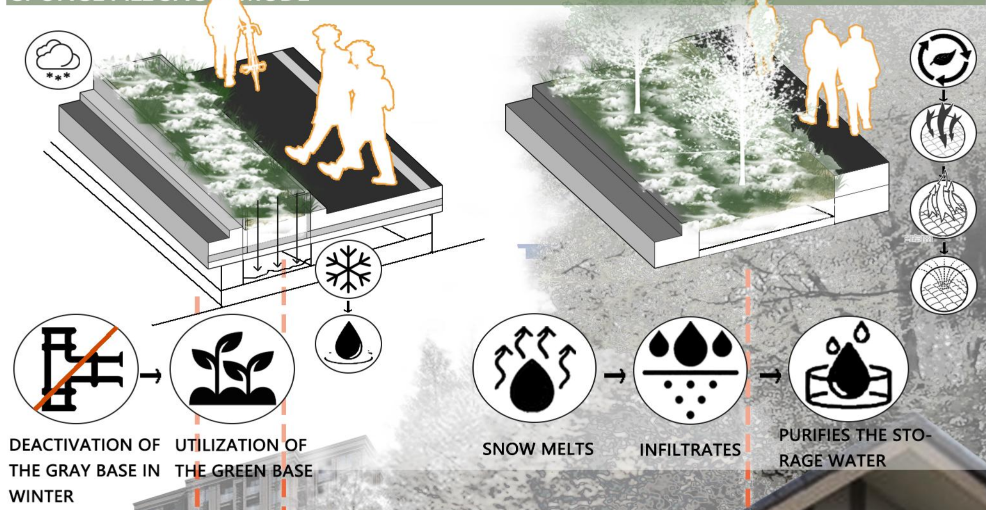
THE SECONDARY SNOW PILE WIDTH REFERS TO THE WIDENING OF SNOW REMOVAL OPERATIONS, SUCH AS LONG TIME SNOW PILE WHEN THE ROAD WIDTH

$$W_5=\begin{cases}2\sqrt{2.25+V_2}-3 & V_2\le 10\mathrm{m3}/m\\ \frac{1}{3.5}(V_2+4) & V_2>10\mathrm{m3}/m\end{cases}\qquad V_2=k_2\bullet\frac{p_3}{p_4}\bullet h_2\bullet\omega_b$$

Where: V_2 for the secondary snow pile (m^3 / m); k_2 for the secondary snow coefficient; p_3 for the natural snow density (g/cm^3); p_4 for the secondary snowfall density (g/cm^3); h_2 for the planning object snow depth (m); wb for the secondary snow pile snow removal object width (= $W_1 + W_2 + W_3 + W_4 + W_5 + W_6$) (m); W_4 for the primary snow piling width; W_6 is the winter sidewalk width

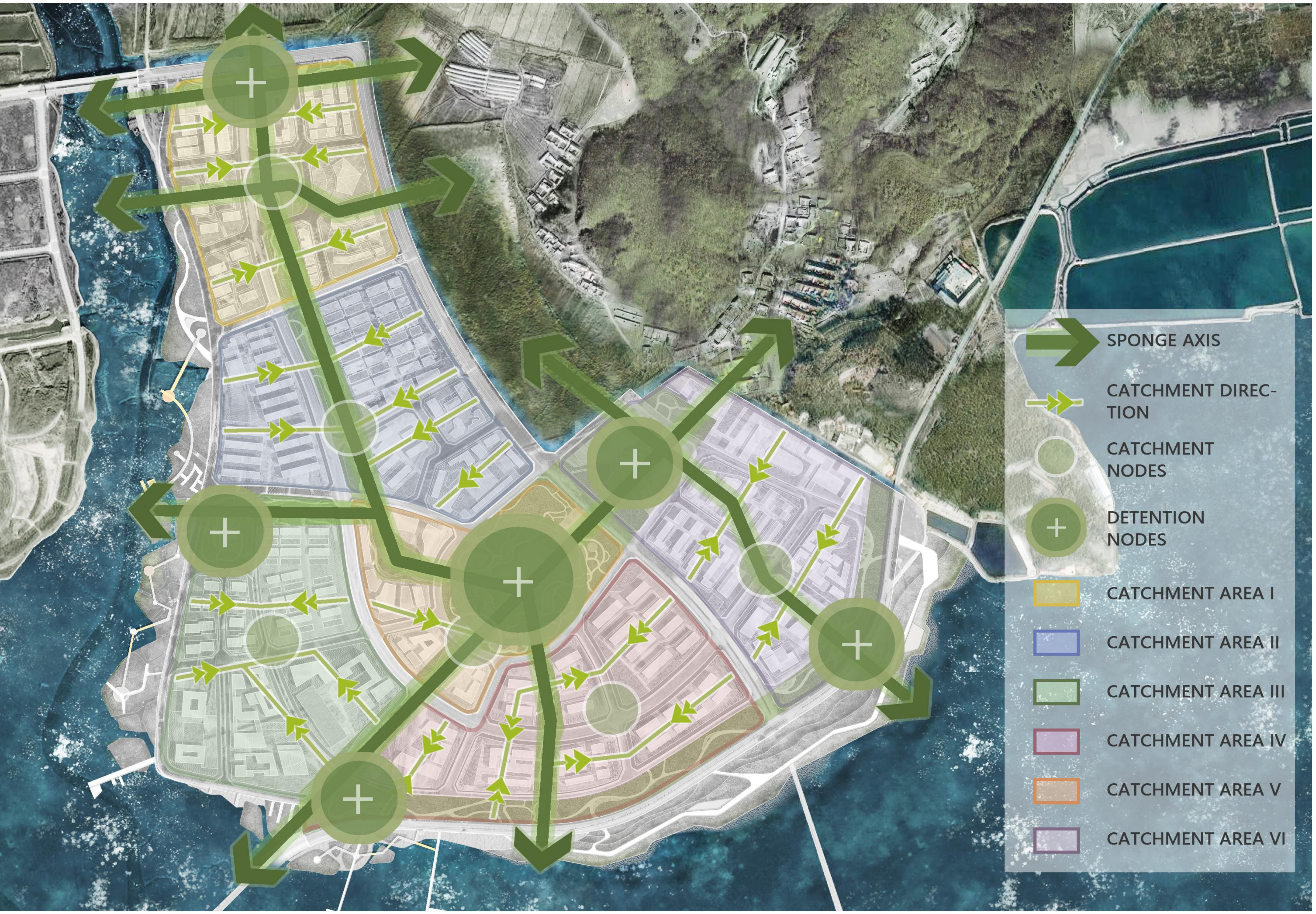
TRADITIONAL SNOW REMOVAL MODE

SPONGE PILE SNOW MODE

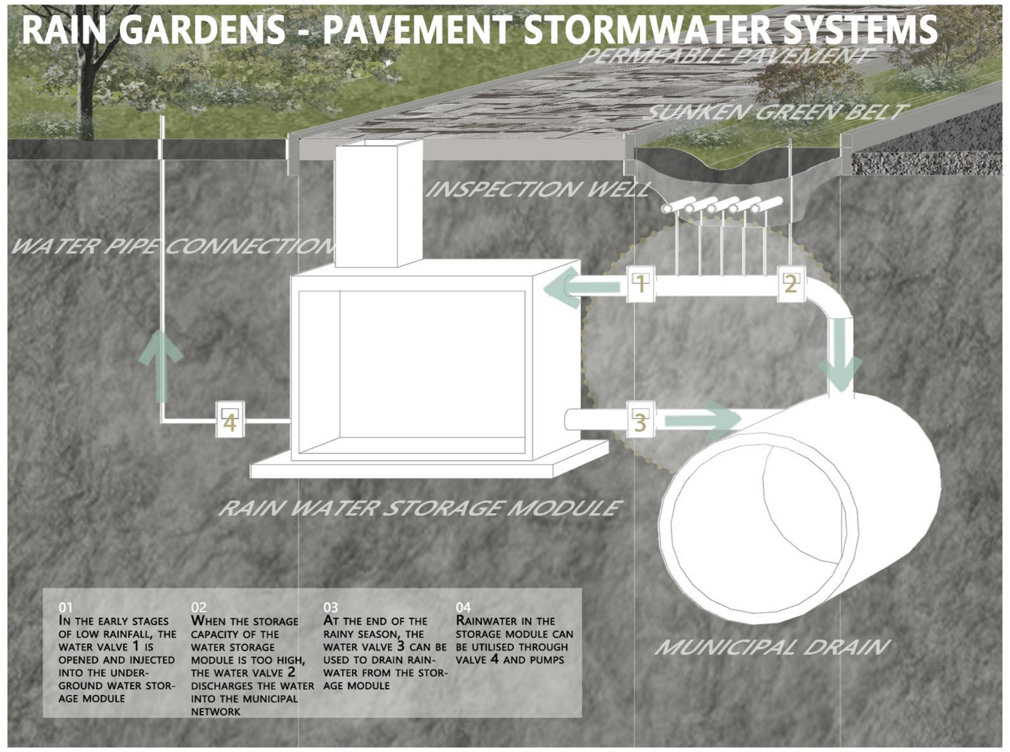


BASIC SPONGE STRATEGIES

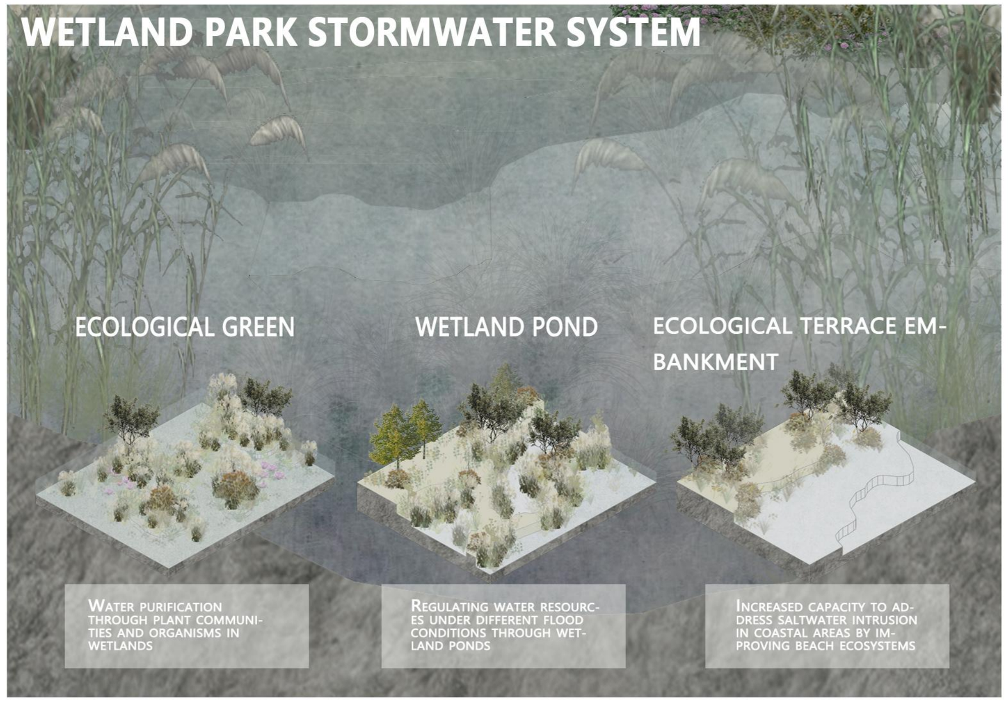
BUILDING A COASTAL LANDSCAPE SPONGE SYSTEM



RAIN GARDENS - PAVEMENT STORMWATER SYSTEMS

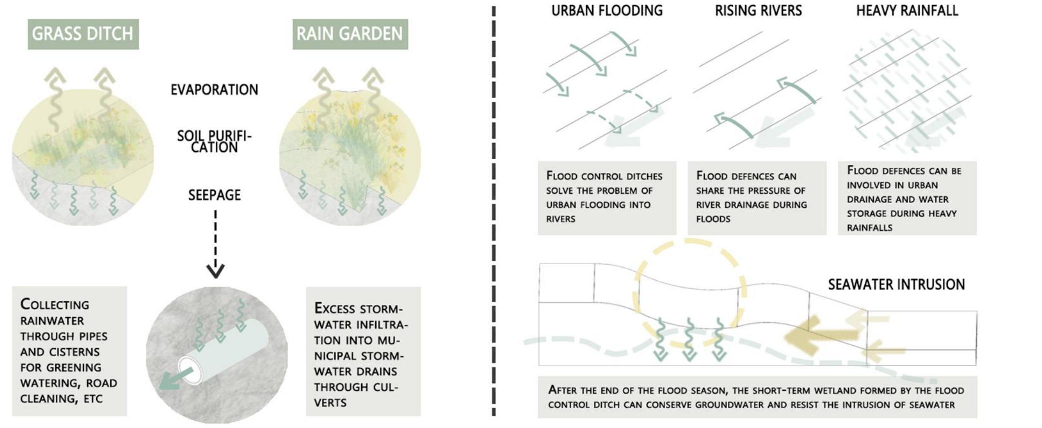


WETLAND PARK STORMWATER SYSTEM



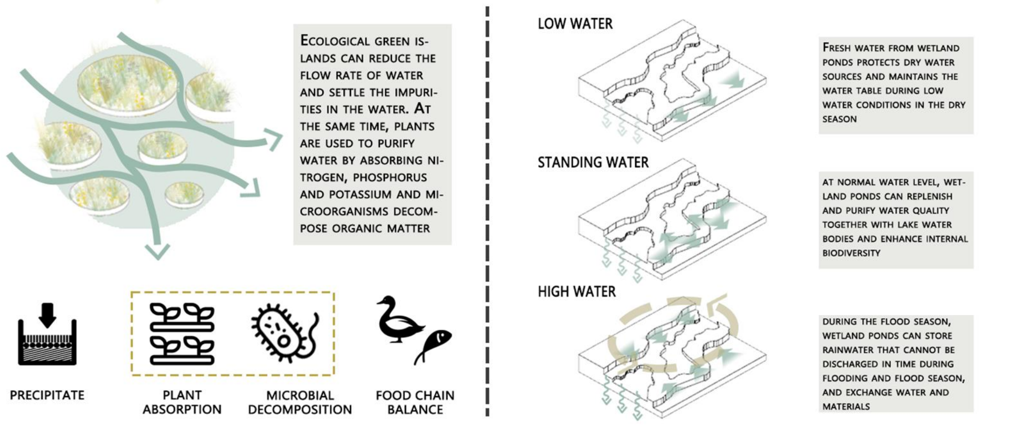
STORMWATER RETENTION

URBAN WATER NETWORKS AND PIPE NETWORKS IN CROSS ACTION



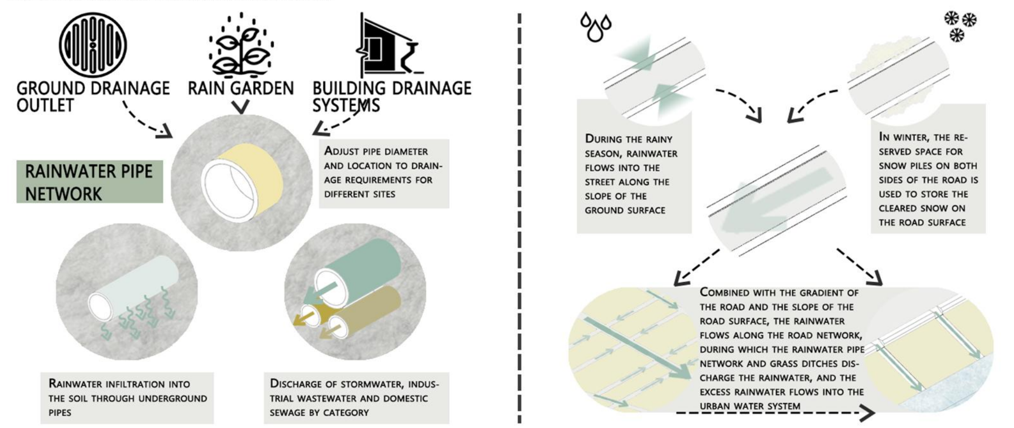
RAINWATER PURIFICATION

INTEGRATED TREATMENT THROUGH WETLAND SYSTEM



PROTECTION OF FRESHWATER RESOURCES

PREVENTING SALTWATER INTRUSION



BASIC SPONGE STRATEGIES

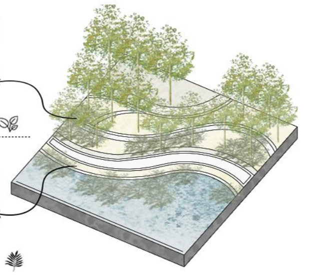
IMPROVING THE QUALITY OF GREEN HABITATS

ECOLOGICAL CONSERVATION MEASURES

NATURAL BERM

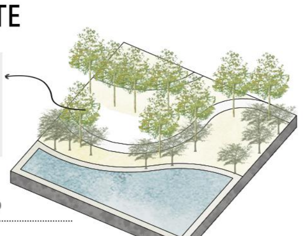
DECORATIVE SHRUBBERY

ECOLOGICAL VALUE OF GRAMINACEOUS PLANTS CAN BE USED TO CREATE AN ECOLOGICAL LEISURE SPACE



ACTIVITY SITE

THE PLANTING PRINCIPLE OF THE WATERFRONT WALKWAY IN THE CROWD ACTIVITY SPACE IS BASED ON ECOLOGICAL VALUE, PLANT MORPHOLOGY AND SAFETY

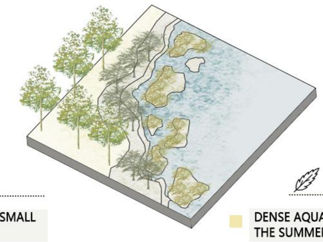


WETLAND ECOLOGICAL STYLES

SPRING WETLAND COAST

IN THE SPRING IT IS A SMALL MICRO-WETLAND

SUMMER WETLAND COAST



DENSE AQUATIC PLANT GROWTH DURING THE SUMMER MONTHS

WINTER WETLAND COAST

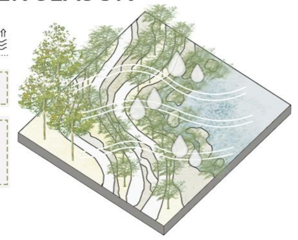
IN WINTER THERE ARE A LOT OF REEDS ALONG THE WATER'S EDGE

ECOLOGICAL WATER STORAGE PATTERN

HIGH WATER SEASON

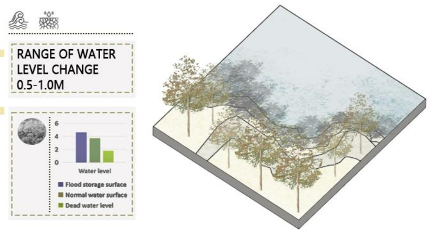
RISING WATER SURFACE

GROUNDWATER TABLE DEPTH 0.5-3.0MM



LOW WATER SEASON

RANGE OF WATER LEVEL CHANGE 0.5-1.0M

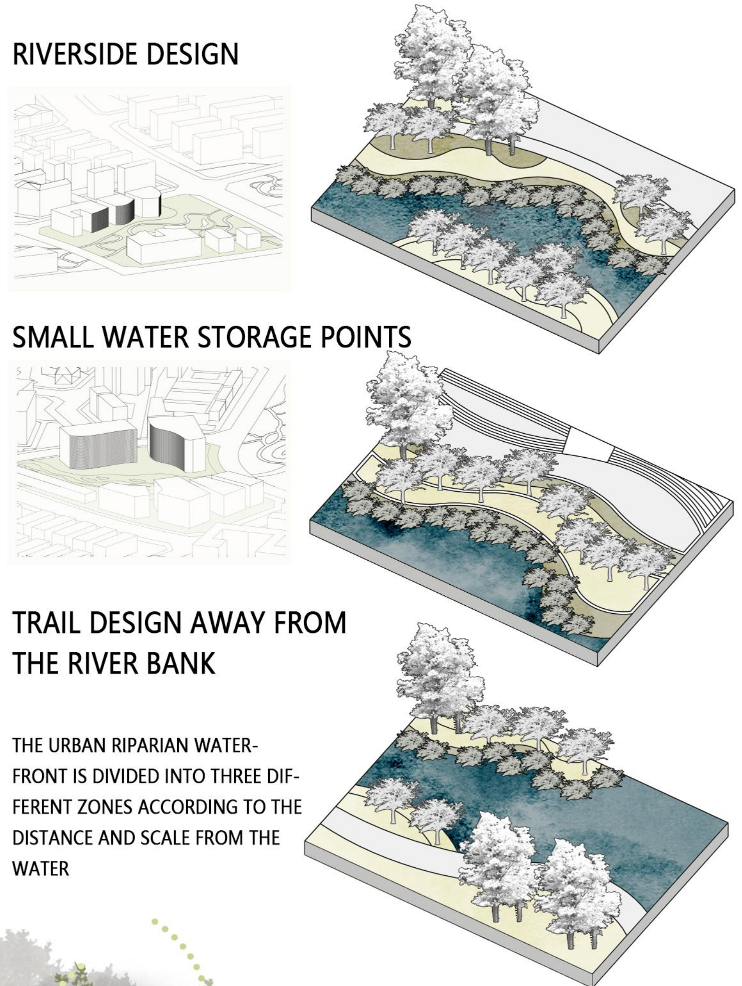


ECOLOGICAL RIPARIAN VEGETATION COMMUNITIES

RIVERSIDE DESIGN

SMALL WATER STORAGE POINTS

TRAIL DESIGN AWAY FROM THE RIVER BANK



THE URBAN RIPARIAN WATERFRONT IS DIVIDED INTO THREE DIFFERENT ZONES ACCORDING TO THE DISTANCE AND SCALE FROM THE WATER

Fraxinus chinensis

Picea asperata Mast.

Pinus sylvestris var. mongholica Litv.

Magnolia grandiflora L.

Amygdalus persica L. var. persica f. rubro-plena Schneid.

Cotinus coggygria Scop.

Amorpha fruticosa L.

Forsythia suspensa (Thunb.) Vahl

Spiraea salicifolia L.

WETLAND ECOLOGICAL PLANT COMMUNITIES

IN THE SPRING IS A SMALL MICRO-WETLAND

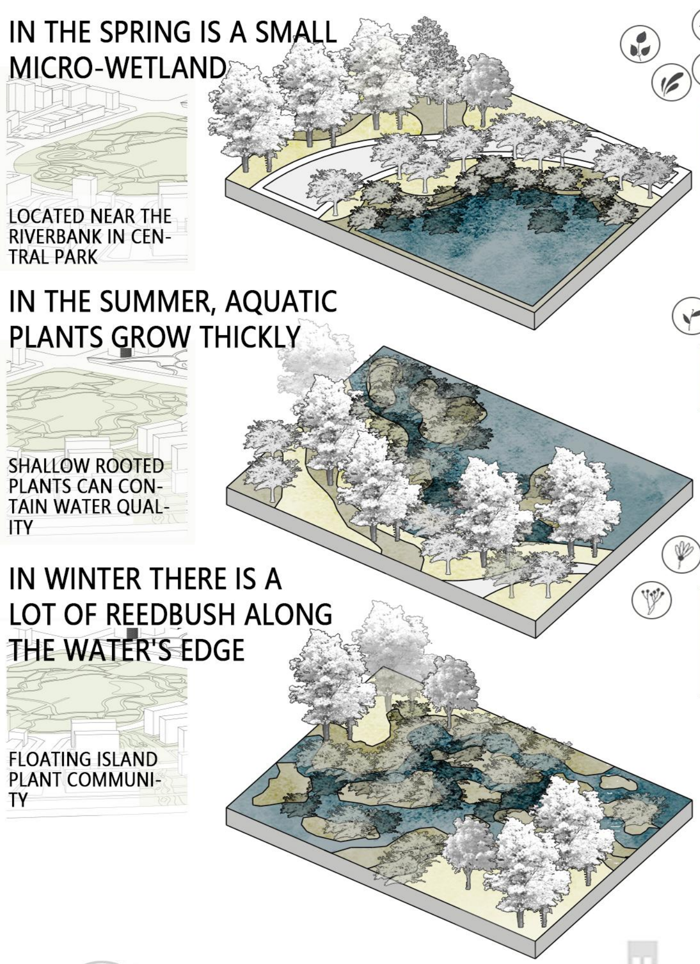
LOCATED NEAR THE RIVERBANK IN CENTRAL PARK

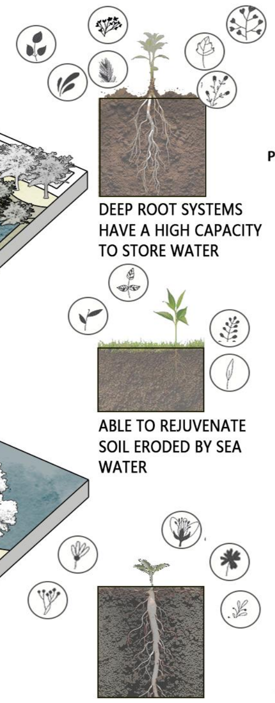
IN THE SUMMER, AQUATIC PLANTS GROW THICKLY

SHALLOW ROOTED PLANTS CAN CONTAIN WATER QUALITY

IN WINTER THERE IS A LOT OF REEDBUSH ALONG THE WATER'S EDGE

FLOATING ISLAND PLANT COMMUNITY





DEEP ROOT SYSTEMS HAVE A HIGH CAPACITY TO STORE WATER

ABLE TO REJUVENATE SOIL ERODED BY SEA WATER

DEEP ROOT SYSTEMS BETTER CONSERVE NUTRIENTS AND PURIFY SOIL AND WATER QUALITY

Physocarpus (Cambess.) Maxim

Philadelphus pekinensis Ruprecht

Nelumbo sp

Typha orientalis C. Presl

Acorus calamus L.

Lemna minor L.

Porphyra

Eichhornia crassipes (Mart.) Solms

Vallisneria natans (Lour.) H. Hara

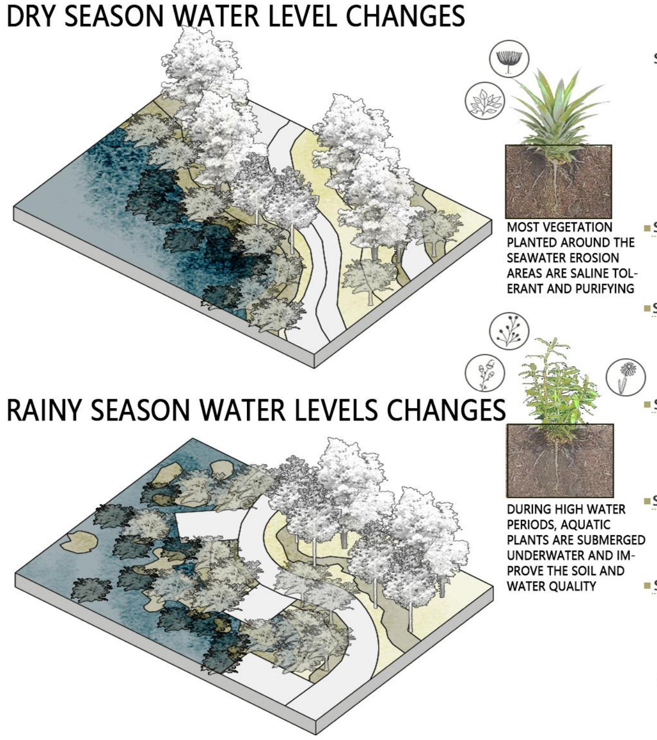
Schoenoplectus tabernaemontani (C. C. Gmelin) Palla

Arundo donax L.

COASTAL ECOLOGICAL PLANT COMMUNITIES

DRY SEASON WATER LEVEL CHANGES

RAINY SEASON WATER LEVELS CHANGES



MOST VEGETATION PLANTED AROUND THE SEAWATER EROSION AREAS ARE SALINE TOLERANT AND PURIFYING

DURING HIGH WATER PERIODS, AQUATIC PLANTS ARE SUBMERGED UNDERWATER AND IMPROVE THE SOIL AND WATER QUALITY

Salinity tolerance 0.3% ~ 0.4%
Robinia pseudoacacia L.

Nitraria tangutorum Bobrov

Salinity tolerance 0.2% ~ 0.3%
Albizia julibrissin Durazz.

Salinity tolerance 0.3% ~ 0.4%
Melia azedarach L.

Salinity tolerance 0.3% ~ 0.6%
Ailanthus altissima (Mill.) Swingle

Salinity tolerance 0.2% ~ 0.3%
Salix matsudana Koidz.

Salinity tolerance 0.3% ~ 0.6%
Toona sinensis (A. Juss.) Roem.

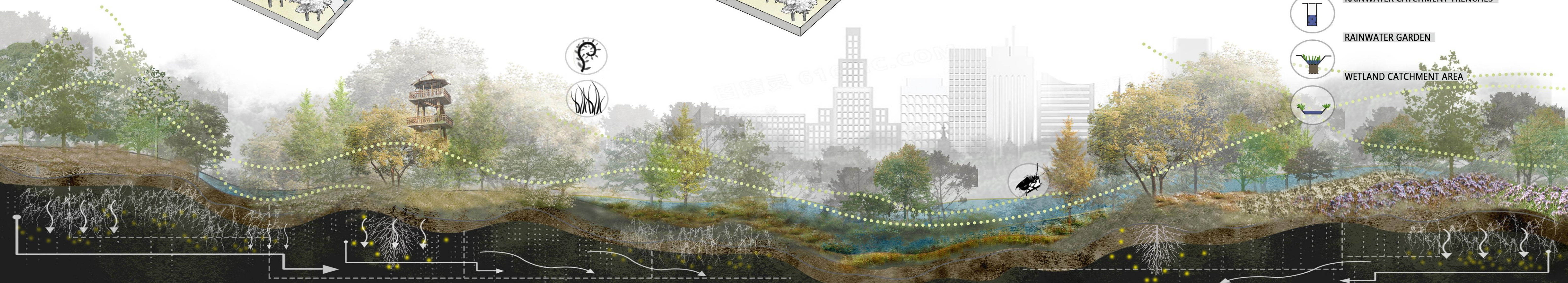
Salinity tolerance 0.3%~0.4%
Pyrus betulifolia Bunge

RAIN-COLLECTING GRASS SWALES

RAINWATER CATCHMENT TRENCHES

RAINWATER GARDEN

WETLAND CATCHMENT AREA



RIVERBANK CHANNELS | BANKSIDE PUDDLES | ZONAL PLANT COMMUNITIES | CENTRAL WETLAND PARKS | SALT-TOLERANT PLANTS | RAINWATER FLOWER FIELDS

BASIC SPONGE STRATEGIES

ENRICHING THE FUNCTIONS OF GREEN SPACES

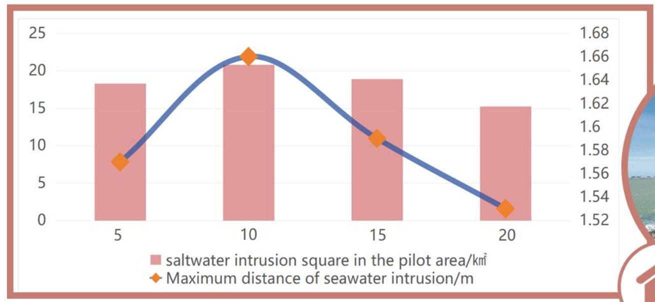
EVALUATION OF SPONGE PLANNING BENEFIT IMPROVEMENT

THE CITY AND THE REGION WILL DEVELOP IN A COORDINATED APPROACH WITH A FAVORABLE URBAN ECOLOGICAL ENVIRONMENT

BUILDED A HARMONIOUS RELATIONSHIP BETWEEN PEOPLE AND WATER, CONTINUE THE WATER SYSTEM CULTURE, AND CREATE A WATER LANDSCAPE WITH REGIONAL CULTURE

- ACHIEVE A **15%** INCREASE IN THE GREEN NETWORK'S ABILITY TO RESIST THE RISK OF CO-TIDAL FLOODING
- A **60%** INCREASE IN THE CARRYING CAPACITY OF THE URBAN GREY INFRASTRUCTURE IN WINTER
- A **26-FOLD** INCREASE IN THE RICHNESS OF THE URBAN PLANT SPECIES

ECOLOGICALLY SENSITIVE AREAS SUCH AS NATURAL LANDFORMS, VEGETATION, WATER SYSTEMS AND WETLANDS ARE EFFECTIVELY PROTECTED; GREEN SPACES ARE REASONABLY DISTRIBUTED. BIODIVERSITY IS ON THE INCREASE, SO AS TO FORM A ADVANCED URBAN GREEN SPACE SYSTEM



- A **40%** IMPROVEMENT IN THE QUALITY OF THE URBAN GREEN HABITATS
- A **300%** INCREASE IN THE URBAN BIODIVERSITY IN A PERIOD OF 5-10 YEARS