1. 从生态滤水池流出的水被打造成景观溪流
1. The water flowing from ecological filter was turned into landscape stream

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常德市穿紫河流域生态治理实践

PRACTICE OF ECOLOGICAL MANAGEMENT IN THE CHUANZI RIVER BASIN, CHANGDE CITY

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前言

随着城市居民对居住环境品质的要求日益提升，治理黑臭水体这类直接影响居民生活的水环境的呼声也愈加强烈。而黑臭河的治理往往投资巨大，与此同时，城市建设空间匮乏也局限了治理工作的开展。如何在改善水质的同时，恢复生态水系，创造高品质的城市景观，并实现投资回报，对工程师、设计师和政府职能部门而言都是艰巨挑战。

项目背景

常德市是湖南省的一座中等城市，多年平均降雨量为1 400mm左右，降雨分配不均，暴雨强度大。穿紫河是中心城区的重要水系，长约17.3km，流域面积27.97km^2，最终汇入沅江。流域所属城区地势平坦，地面高程约32m，低于外江（沅江）洪水位（百年一遇洪水水位41.8m）；原穿紫河防洪堤堤高34.6m；地下水位高，达29m左右；土壤透水性较差。20世纪80年代，因城市扩张，部分河道被填埋，穿紫河被分割成多段水体。由于城市排水系统带来的污染，穿紫河变成了一条黑臭河，严重影响了居民的生活质量。

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摘要

针对常德市穿紫河的黑臭水体问题，项目以恢复可持续的自然水循环系统为原则，以改善水质、创造生态水环境为目标，通过多专业结合来进行流域的生态综合治理。景观设计、海绵城市建设、水处理工程、防洪等多项措施的融合，实现了多种功能的共同实施。该项目结合周边产业共同开发，探索了黑臭水体城市环境治理的循环经济途径。

关键词
黑臭水体；海绵城市；流域；河道生态治理；景观

ABSTRACT

Aiming at polluted water of the Chuanzi River, Changde City, and in order to restore the sustainable natural water circulation system, improve the water quality, and create an ecological water environment, this project carries out the comprehensive management of the river basin through multi-disciplinary integration. The integration of various measures, including landscape architecture, sponge city construction, water treatment, and flood control, achieves concurrent implementation of a variety of functions. The project incorporates development of the surrounding properties, to explore a circular economy approach to urban environmental management.

KEY WORDS
Polluted Water; Sponge City; Ecological Management of River Basin; Landscape Architecture

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项目地址：
湖南省常德市
项目面积：
约28km²（流域面积）
项目委托：
常德市经济建设投资集团有限公司、常德市规划局
项目设计：
德国汉诺威水有限公司
首席设计师：
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项目合作：
常德市规划设计院、常德市建筑勘测设计院、天城规划建筑设计有限公司
设计时间：
2010年至今
建设时间：
2012年至今
建成时间：
2017年

LOCATION:
Changde, Hunan
AREA (SIZE):
Around 28 km² (basin area)
CLIENT:
Changde Economic Construction Investment Group Co., Ltd., Changde Planning Bureau
PROJECT DESIGN:
Wasser Hannover GmbH
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PROJECT COOPERATION:
Urban Planning and Design Institute of Changde, Construction Survey and Design Institute of Changde, Tancheng Planning & Architectural Design Co., Ltd.
DESIGN PERIOD:
2010 to present
CONSTRUCTION PERIOD:
2012 to present
COMPLETION TIME:
2017

2. 生态修复前受污染的水体
3. 穿紫河流域范围

2. Polluted water before ecological restoration
3. Chuanzi River basin

常德市于2004年开始对穿紫河进行水系治理，完成了清淤、岸线改造和补水工程，但其水质和水环境并没有发生根本性转变。德国汉诺威水有限公司自2008年以来，在穿紫河流域开展了一系列水系规划、泵站改造、河道修复及海绵城市建设的设计实践，以期实施综合的环境整治措施。

问题和条件

穿紫河的环境问题是中国南方城市内河问题的典型体现，包括如下几个方面：

（1）排水管网错接严重，雨水泵站为河道最大污染源。穿紫河流域排水体制名义上为分流制，但雨污混接严重。由于城区高程低于洪水水位，雨水无法通过排水系统直排入穿紫河，因而被收纳入8个雨水调蓄池和泵站。暴雨时，水流的冲击导致泵站蓄水池内沉积的污染物涌起，而后被抽排入河道。再加上污水处理厂的尾水排入，使得穿紫河水质属于《地表水环境质量标准》中的V~劣V类水。

（2）城市内涝频发：由于常德市地势平坦，加上雨水泵站启排水位高，排水管网水力坡度小，因而时常发生内涝。

（3）水生态严重恶化，几乎无自净能力：出于抵挡沅江洪水和美化城市景观的考虑，在穿紫河汇入沅江的位置，采用水闸人工控制水位。这一措施使它成为了几乎静止的湖泊。由于水流速度缓慢，污染物淤积严重。穿紫河沿岸几乎全为硬质驳岸护坡，加之上游断源，水系中又有多处阻断，使河流丧失了自然特性。

（4）水环境恶劣：河岸两侧为垃圾堆砌地和临时菜地，水体黑臭，居民避而远之。

（5）城市与水系隔绝：高耸的堤坝把河道和城市完全隔离，而土地的稀缺也使得河道空间变窄或被填埋，原有河道的调蓄空间被严重侵占。

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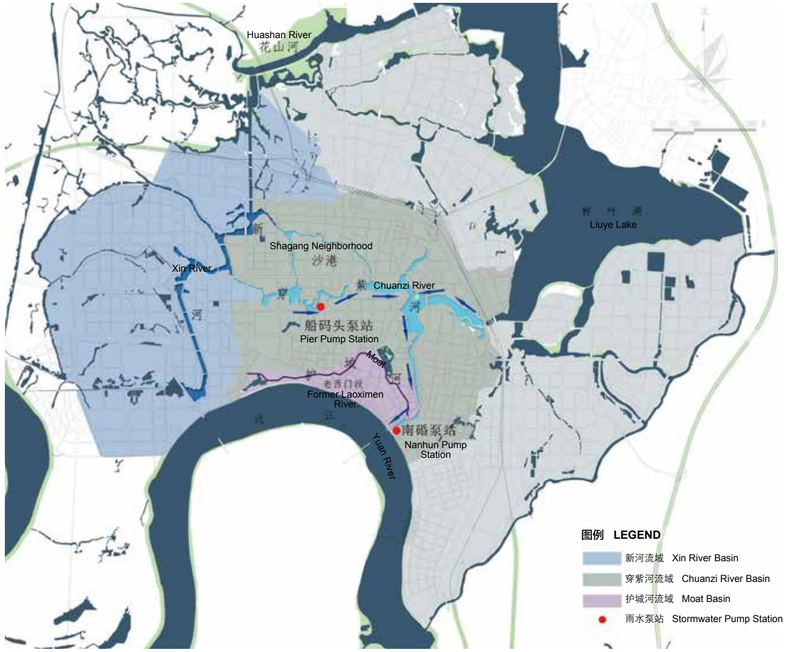

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6）复兴水文化，使居民可以在城市中体验自然，穿紫河恢复通航，打造富有本地特色的“水城常德”水文化。

设计理念

黑臭河成功改造的前提是水质改善，而非单纯的景观改善。可持续的水质改善的关键在于污染控制和生态修复。在这一项目中，我们运用海绵城市建设理念对排水系统进行综合改造，减少河流污染，降低雨水径流峰值，保障非降雨期的河道基本生态流量，并利用集水区的雨水补给河道，减少外来补水。

可持续水系生态修复这一系统性的工程需要科学的总体规划，首先需要运用数学模型对排水管网和水系进行模拟和分析，分析河流在枯水、洪水等不同状态下与排水系统的互动关系，确定污染源头，制定相应的治理方案，模拟治理效果，并对具体的实施工程提出要求。

水系是城市空间的重要骨架之一，应将水生态修复与城市开放空间、土地利用、城市交通体系，以及未来的城市开发作为整体来考量。通过水环境改善，提升水系相邻地区的价值，为污染治理带来投资回报。

上述目标的实现需要城市排水、水利工程、生态工程、湖泊学、景观设计等专业紧密配合，以实现多目标的协调。

设计目标

该项目意在恢复穿紫河的自然生态、构建安全的水环境，同时与相邻城市区域协同建设，具体包括：1）穿紫河水质达到地表水IV类标准；2）修复岸线，生态岸线比例大于90%；3）逐步展开流域内海绵城市建设，实现年径流总量控制率大于78%；4）提高水安全：城市排水系统满足两年一遇降雨要求，重要地段达到3~5年一遇要求；穿紫河调蓄和排放达到百年一遇洪水要求。5）建设临水居住、生活的休闲空间，提升城市河流公共空间景观品质、开发新的经济潜力。

设计过程

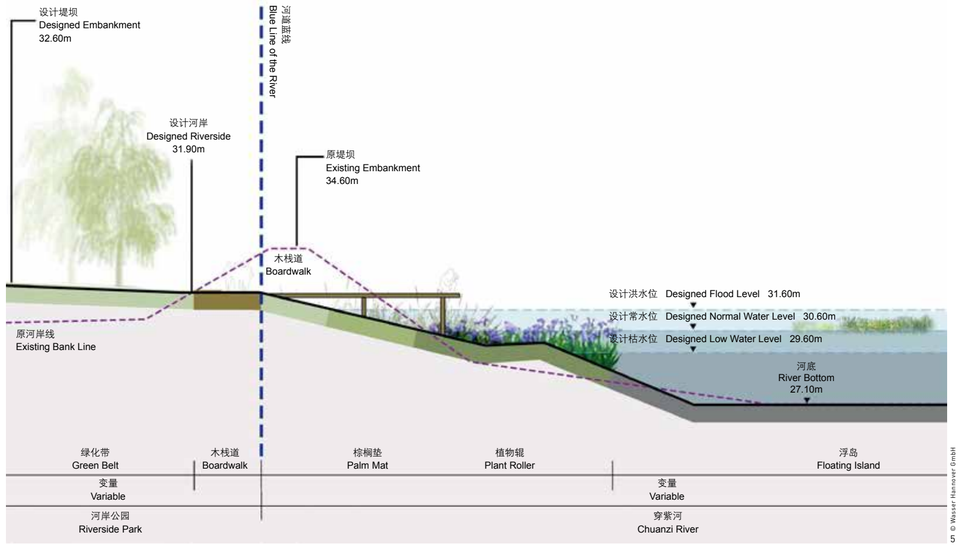
排水及水系总体规划

基于对排水管网和水系进行数学模型模拟，我们分析了排水系统与河流水力的关系，以及对污染源进行控制和未来水质改善的目标，从而规划出整体的排水系统和水系。同时基于对整个城市的空间规划、水文、地形地貌、绿地、历史水系、当地文化等方面的研究，提出建设三道“蓝绿环”，将已有的山地、绿地、公园、湖泊等连成一体，使原来被隔断的穿紫河重新连接起来，并实现穿紫河与其他水系的连通。

图例 LEGEND

1 生态河床
Ecological riverbed
2 新增连通上游的河道
New river channel connected to upstream
3 水生植物区
Aquatic plants area
4 河岸公园
Riverside Park
5 设置慢行道的堤坝
Embankment with slow lane
6 边界种植区
Edge planting area
7 入口广场
Entrance plaza
8 步行桥
Pedestrian bridge
9 泵站
Pump Station
10 地下调蓄池与地上停车场
Underground detention tank and ground parking lot
11 露天调蓄池
Open detention tank
12 蓄水型生态滤池
Water-storage ecological filter
13 沅江补水点和其上的广场、水景
Yuan River compensation station with plaza and waterscape on it
14 小溪与暴雨排放渠
Stream and stormwater drainage canal
15 浮岛
Floating island
16 码头
Pier

4



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4. 船码头泵站及其河道改造项目平面图
5. 穿紫河河道断面改造

4. Master plan of Pier Pump Station and the river canal
5. Transformation of the river section

洪水管理

原有防洪堤隔离了城市与河道。通过连通穿紫河与上游的新河、拓宽新河河道断面、增设新水闸、改造穿紫河沿线所有的雨水泵站等措施，使穿紫河防洪堤降低2m。根据河流水动力模型模拟，确定穿紫河设计水位为：枯水位29.6m，常水位30.6m，洪水位31.6m，百年一遇防洪堤32.6m。为给河道腾出更多的调蓄空间，我们将堤坝后移，并将位于原防洪堤后的绿地前移至临水一侧，设计成可被淹没的滨水空间。同时，逐步在流域内的居住区中推广海绵城市建设措施，通过在源头就地调蓄雨水、延缓径流过程、降低径流峰值，降低洪水风险、减轻城市内涝。

水量保障

穿紫河的补水主要来源于城市排水系统和周边天然汇水。目前以一处管道从沅江取水补给（流速1m^3/s）；未来计划通过连通穿紫河与新河，将上游水源引流入穿紫河。与此同时，在沿线原有的8个雨水泵站的改造中均增加蓄水型的生态滤池、地下调蓄池和沉淀池，形成调蓄空间。这些被滞留的雨水在经过沉淀和生态滤池的净化后，排入穿紫河，连同经现有公园绿地、居住区、道路、广场收集、调蓄、净化后的雨水，作为穿紫河的补充水源。

水污染控制

首先，我们对穿紫河主要污染源——沿线的8个雨水泵站——进行了全面改造。非降雨期的污水排往污水厂；小雨和中雨径流通过在泵站进行沉淀、过滤、净化后排入河道；大暴雨直接排入河道，从而保障河道的补水，同时降低河道污染。此外，新建的一处污水处理厂（日处理能力5万立方米），有效提高了污水处理能力。下一步，我们计划通过生态湿地净化现有污水处理厂的尾水，使其达到地表水III类水标准，以消除最后的污染源。

与此同时，开展排水管网的排水管道闭路电视检测（CCTV），修复破损管网，改造过流能力低的管网，减少内涝灾害。

河流自净能力提升

为了提升河流的自净能力，项目利用疏浚船对穿紫河河道进行清淤疏浚，共处理了37万方淤泥，并清除了鱼游通道障碍，保障了水系的连通。

驳岸断面均设计为双梯形断面。在设计常水位与设计枯水位之间，敷设棕榈垫与植物辊。在其中种植耐湿且耐旱类植物，如芦苇（*Phragmites communis*）、再力花（*Thalia dealbata*）等，保护驳岸不被冲刷，并为动物（如两栖类等）提供栖息地。在设计常水位和设计洪水位间的驳岸敷设棕榈垫并种植草皮，降低驳岸在洪水期间滑坡的风险。

我们在设计中尽可能地采用天然的河道形态，并通过建设岛屿，营造出不同水深的生态空间。在河湾区以及泵站排水口附近设置生态浮岛。未来逐步在河道内补充沉水植物，进一步改善水质。

滨水空间营造

结合防洪堤，在堤前增设略高于洪水位的景观步道及亲水平台，居民在河岸景观区域内可以毫无阻隔地亲近并享受美丽的水景。

将河流改造与周边的城市开发相结合，通过部分跨河桥梁的改造，既保障了水上交通，同时也建立了贯穿整个水系的步行游道和自行车道系统，把穿紫河改造成城市的次级交通系统。

水文化

穿紫河的改造使得健康的河流重新回到了居民的生活之中，重现了常德市的水城文化。在穿紫河东段北岸——常德市的起源地，重建了常德历史上的大河街、小河街，展现了当年的河街风情。同时在尼姑桥段（8个升级改造的泵站之一）设计了德国风情街，记录了10年来德国专家对穿紫河治理的支持，不仅创造出新的文化和特色，也吸引了德国企业入驻，扩大了对外合作。

项目效果

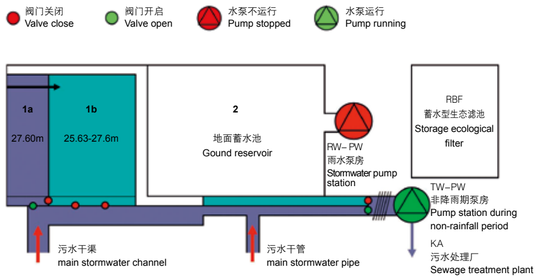
穿紫河流域的生态治理使一条曾经的黑臭河变成了多功能开放式的河岸公园，创造了多元化的临水休闲场所和生活空间。这一净水过程对于城市居民也有着重要的教育意义。随着穿紫河环境的改善，其成为了常德市内的第一条水上旅游线路，穿紫河旁的德国风情街、历史街区改造也已成功开发，为河道治理投资带来了经济回报渠道。**LAF**

Introduction

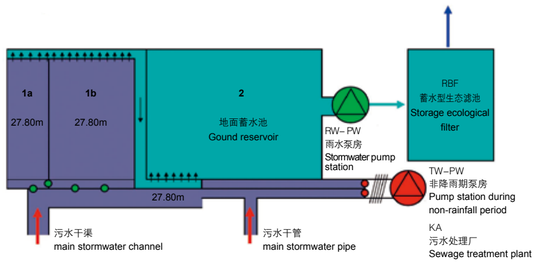
With rising demand from the public for quality living environments, the appealing voice for improvement of water environments such as polluted water bodies has become increasingly strong. However, the cost of managing contaminated rivers is often high, while the city also faces problems such as lack of construction space. This poses a critical challenge for engineers, designers, and government departments to improve water quality, restore the ecological water system, create high-quality urban landscapes, and at the same time achieve returns on investments.

Project Background

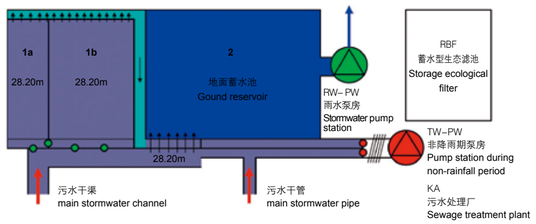
Changde, a medium-sized city in Hunan Province, experiences an average annual precipitation of approximately 1,400 mm, and heavy rain intensity due to uneven annual rainfall distribution. As a major water system of the city center, the Chuanzi River stretches 17.3 km long, with a catchment area of 27.97 km^2, and finally flows into the Yuan River. The watershed area is fairly flat, with a ground elevation of about 32 m, which is lower than the flood level of the main river (Yuan River, with 41.8 m as its 100-year flood level). With the original embankment height being 34.6 m, and the relatively high groundwater level of 29 m, the riverbank soil has low water permeability. In the 1980s, due to expansion of the city, some parts of the river were buried, and Chuanzi River was divided into several fragments. Due to the pollution caused by the urban drainage system, Chuanzi River turned into a black and odorous river which seriously impacted the livability of the city.



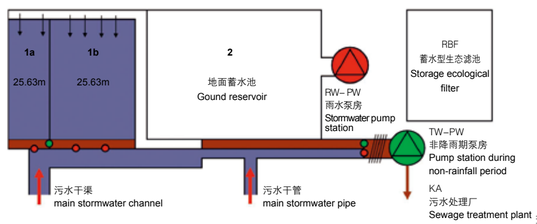
非降雨期来水工况　Stormwater during non-rainfall period
送往污水处理厂，流速300L/s　Deliver stormwater to the sewage treatment plant carrying 300L/s
来自1a蓄水池的水注满1b蓄水池，作为蓄水型生态滤池的起泵调蓄量。
When the stormwater fills up 1a and then 1b reservoir, the pump of the storage ecological filter starts to operate.



小雨/中雨期来水工况，小于2.4m^3/s
Stormwater during light / moderate rain period, flows to the pump station with less than 2.4 m^3/s
来水流经1a及1b蓄水池，进行沉淀，再经过雨水泵房输送到蓄水型生态池进行处理。
The runoff will be deposited in 1a and 1b reservoir, then transferred to storage ecological filter by the stormwater pump station.



暴雨期来水工况，大于2.4m^3/s　Stormwater during heavy rain period, flows more than 2.4 m^3/s
来水流经1a及1b蓄水池，同时污水干渠及干管直接向2号蓄水池排水，通过雨水泵站将水送往河流。
Stormwater flows from 1a and 1b reservoir, and from the main intake channel and pipe directly. Then, it flows through stormwater pump station to the river.



降雨结束反冲洗工况　Flushing after rain season
在冲洗过程中来水在管网及配水槽内停留，冲洗用水送往污水处理厂。
Flushing water stays in the pipe network and distributing channel for a while, then will be delivered to the sewage treatment plant.

6. 船码头泵站不同降雨情况下处理流程
7. 用于调蓄来自步道和广场雨水的植草沟
8. 经生态滤池处理过的水流

6. Pier Pump Station running processes during different rain events
7. Bio-swales regulates the stormwater from adjacent paths and squares
8. The clean water flowing out after the treatment by ecological filters

In 2004, Changde City began water restoration efforts for the Chuanzi River. While it completed dredging, shoreline construction, and water replenishment, the program did not bring fundamental improvement to the water quality and water environment of the Chuanzi River. Since 2008, Wasser Hannover GmbH has carried out a series of practices, including water system planning, pump station transformation, river revitalization, and sponge city construction, with the goal of implementing comprehensive environmental remediation.

Problems and Conditions

The environmental problems of the Chuanzi River are typical examples of river problems in the southern cities of China, which include:

(1) Misconnected pipes abound in the drainage system, and stormwater pump stations are the largest river pollution source. The drainage system in the Chuanzi River basin is supposedly a diversion system, but there are in fact a huge number of misconnected rainwater and sewage pipes. As the city elevation is below the flood level, the drainage system cannot be drained into Chuanzi River by gravity, thus the rainwater is collected into eight detention tanks and pump stations. During heavy rain events, the water flow stirs up contaminants deposited in the tanks, then pumps them into the river. Coupled with the tail water discharge from sewage treatment plant, this has placed the water quality of the Chuanzi River in the worst class of the China Environmental Quality Standard for Surface Water (EQSSW).

(2) Frequent urban waterlogging: The flat terrain of Changde City, coupled with the high draining water level of stormwater

pump stations and low hydraulic gradient of drainage pipes, causes a high incidence of waterlogging.

(3) Serious deterioration of water ecology, with almost no self-purification capacity: To resist the flooding of the Yuan River and promote the urban landscape, a manually operated sluice gate located at the confluence of the Chuanzi and Yuan River controls the water level. This measure makes the river almost as still as a lake, with slow water flow and serious deposition of pollutants. The majority of the riverbank has been paved to avoid soil erosion; coupled with the upstream blockage, this has caused the river to lose its natural characteristics.

(4) Poor water environment: The banks of the river on both sides have turned into garbage dumps and temporary farmland, resulting in dark and malodorous water, from which residents keep their distance.

(5) The water is isolated from the city: Towering embankments completely separate the river and the city. The scarcity of land has also narrowed or buried the river channel in many places, seriously diminishing the space available for water detention.

9-1

9-2

Design Goals

The project is intended to restore the natural ecology of the Chuanzi River, build a safe water environment, and jointly develop with neighboring urban areas. Specific goals include: 1) achieving water quality levels for the Chuanzi River which meet the standard of surface water class IV according to EQSSW; 2) restoring 90% of the riverbank to an ecological shoreline; 3) gradually expanding the sponge city construction to reach an annual runoff control rate of 78%; 4) improving flood security to withstand a 2-year storm event in the urban drainage system, a 3- to 5-year storm event in key areas, and a 100-year flood for the detention and drainage of the Chuanzi River; 5) building waterfront space for living and recreation, and enhancing the landscape quality of urban public space to develop new economic potential; 6) reviving water culture so that residents can experience nature in the city, and reopening navigation on the Chuanzi River, and create a "Water City"culture with rich local characteristics.

Design Concept

Water quality improvement is a prerequisite for successful transformation of a contaminated river. The key to sustainable water quality improvement is pollution control and ecological restoration. We used the sponge city construction concept to achieve a comprehensive transformation of the drainage system, so as to relieve river pollution, reduce peak runoff, and protect the river's ecological base flow in non-rainfall periods. Rainwater from the catchment area is used to refill the river, in order to reduce its dependence on external water resources.

Sustainable ecological restoration of the water system is a systematic project, which needs an overall scientific master plan. We started by using mathematical modeling to simulate and analyze the drainage pipe network and surface water system, and the interactive relationships between them in rainy and dry seasons. We determined the source of pollution, developed an appropriate management plan, and simulated the results. Then we defined the specific requirements for implementation of the project.

The water system is one of the most important spines of urban space. Water ecological restoration should be considered together with urban open space, land use, urban traffic systems, and future urban development as a whole. Through improvement of the water environment, the value of adjacent lands can been increased, thus generating returns on the investment in pollution management.

In order to achieve these goals, professionals of urban drainage, hydraulic

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9. 生态驳岸
10. 生态浮岛及栈道
11. 滨水植被提高河流的自净能力

9. Ecological revetment
10. Floating islands and boardwalk
11. Riparian vegetations improving the self-purification capacity of Chuanzi River

11

engineering, ecological engineering, limnology, and landscape architecture need to work together integratively on this multi-objective scope.

Design Process

Drainage and Water System Master Plan

Based on the mathematical model simulation of the drainage network and water system, we analyzed the relationship between the drainage system and the river's hydraulic force, as well as the indicator of pollution sources and future water quality, so as to plan the overall drainage system and water system. Meanwhile, based on research into the city's spatial development, hydrology, topography, green space system, historical water system, and local culture, we proposed to create three "blue-green rings" to link the existing mountains, green space, parks, and lakes, reconnect the once cut off Chuanzi River, and connect the river with other water systems.

Flood Management

The original embankment isolates the river from the city. By connecting the Chuanzi River with the upper Xin River, widening the Xin River, building new sluice gates, and remodeling all stormwater pump stations along the Chuanzi River, we were able to lower the embankment by 2 m. According to the river hydrodynamic model simulation, we determined the design water levels of the Chuanzi River: 29.6 m as low water level, 30.6 m as normal water level, and 31.6 m as flood water level. The 100-year flood control embankment was set at 32.6 m. In order to return more detention space back to the river, we retreated the embankment, and shifted the green space originally located behind the embankment, turning it into a floodable waterfront. At the same time, we gradually promoted the sponge city construction among the nearby residential areas to reduce the risk of waterlogging in the city by regulating rainwater from beginning, slowing down the runoff process, and reducing the peak runoff.

Water Supply

The Chuanzi River mainly relies on the city's drainage system and surrounding catchments for its water supply. To date, a water supply pipeline from the Yuan River has been installed carrying 1 m^3/s; a future connection of the Chuanzi and Xin Rivers will lead the upstream water into the Chuanzi. At the same time, during the remodeling of the eight original stormwater pump stations, ecological detention filters, underground detention tanks, and sedimentation tanks were added to increase storage volume. The collected rainwater flows through the ecological detention filter for precipitation and purification, then drains into the Chuanzi River. The existing parks, residential areas, roads and squares, are also fully used to collect, store, detain and purify the rainwater as a supplement to the Chuanzi River.

Water Pollution Control

First of all, we remodeled the eight stormwater pump stations along the river — the main source of pollution in the Chuanzi River. In the dry season, discharge sewage will be drained to the sewage treatment plant; in small and moderate rains, mixed rain and sewage water will be drained into the river after biological cleansing; runoff in extreme storm events will be drained directly into the river. This approach reduces pollution in the river and supplies water to the river. In addition, a new sewage treatment plant (daily treatment capacity of 50,000 m^3) was built, which effectively alleviates the serious lack of sewage treatment capacity. Our next plan is to purify the tail-water of the sewage treatment plants through constructed wetlands, ensuring the water will meet the class III standard for surface water according to EQSSW.

At the same time, we plan to carry out closed-circuit television (CCTV) detection on drainage pipes to monitor the drainage network, repair and maintain damaged pipes, and improve the flow capacity of pipe networks in order to reduce waterlogging disasters.

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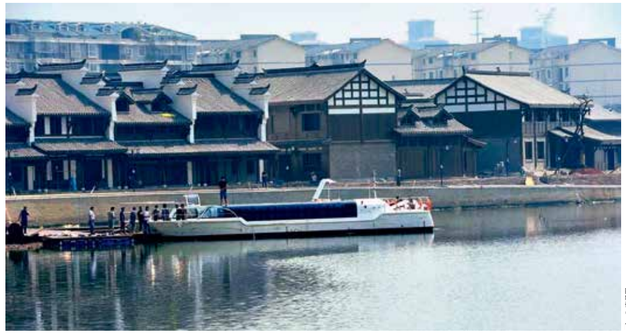
12. 沿滨河道路设置雨水渗沟
13. 停靠在大小河街码头的水上巴士

12. Stormwater ditches along the riverside path
13. Water bus at the Big River Street and Small River Street pier



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River Self-purification Capacity Upgrade

In order to enhance the river's self-purification capacity, over 370,000 m^3 of sludge was dredged out of river, ensuring connection of the water system and removing barriers for fauna.

The cross section of the bank is designed in a double trapezoidal shape. Between the designed normal water level and low water level, palm mat and plant rollers were installed, in which we planted moisture- and drought-tolerant plants, such as *Phragmites communis*, *Thalia dealbata*, etc., to protect the bank from erosion and provide habitat for animals such as amphibians. Between the designed normal water level and flood water level, we installed palm mat and planted grass, in order to reduce the risk of erosion during flood.

The design proposal reflected the natural river morphology, and created ecological spaces of different depths through new islands. Ecological floating islands were set up in the river bend and near the pump station outlet to improve the river's ability to self-purify. Submerged plants will be gradually added to further improve water quality.

Waterfront Space Construction

Landscape paths and waterfront platforms were created in front of the embankment. In the riverbank landscape area, residents can enjoy the beautiful waterscape.

We integrated the river transformation with the surrounding urban development. Through transformation of some of the cross-river bridges, we not only ensured water traffic, but also established walkway and bicycle lane networks throughout the water system, making the Chuanzi River part of the city's secondary traffic system.

Water Culture

The transformation of the Chuanzi River brings a healthy river back into residents' daily life, recreating the water city culture of Changde. On the north shore of eastern part of the river, Changde City's original area, Changde's historical Big River Street and Small River Street were reconstructed, to demonstrate the city's ancient river street culture. At the same time, a German Street was designed at Niguqiao (Niguqiao is one of the eight upgraded pump stations), which represents the 10 years of German experts' support to the restoration of the Chuanzi River. This creation of new cultural characteristics will help attract German enterprises to join in, and expand foreign cooperation in Changde.

Project Result

The ecological management of Chuanzi River basin has transformed a once black and odorous river into a multi-functional open river park, creating diversified waterfronts and living spaces. The water purification process played an important educational role for urban residents as well. With the improvement of the water environment, the Chuanzi River has become the first water travel route in Changde. The success of the waterfront German Town and historic district have also brought economic returns to the river restoration investment. LAF