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Study on Design Idea of ADB-funded, Integrated Treatment Project of Huainan Urban Water System

Abstract: The paper is based mainly on the design and planning concepts summarized from the implementation of ADB-funded, Integrated Treatment Project of Huainan Urban Water System. The integrated treatment of the water system follows the principle of “sewage interception for point sources, control of plane sources, treatment of internal sources, and remediation of ecological system” to improve the sewage collection and transport system, urban water environment, flood management, and urban lake works, and to ultimately enable an effective management of surface water resources. Through such means as sewage interception, water system interconnection, improvements in flood discharge standards and surrounding environments, and ecological remediation for water bodies, a safe and healthy water environment has been established, beautiful and coordinated water landscapes and harmonious waterfront spaces created, and local unique humanistic connotations promoted.

Keywords: Urban water system, Sewage interception, Flood discharge, Lakes, Integrated treatment

1 Introduction

The Integrated Treatment Project of Huainan Urban Water System was established by Huainan Municipal Government to solve urban water environmental issues with the loan provided by the Asian Development Bank (ADB). The project, with a total investment of about RMB 1.9 billion, covers the main itemized projects like sewage interception, urban water system treatment, flood drainage pump station upgrading as per improved standards, ecological remediation for lakes and water quality monitoring; by taking a series of engineering and non-engineering measures, Huainan’s standards for urban flood prevention and drainage, together with its water environmental functions, can thus be improved. In combination with the survey find-
ings of the water system and the concept of “building a sponge city”, the paper pro-
vides the idea for the integrated treatment of urban water system.

In recent years, with the promotion of scientific development philosophy and
the enhancement of ecological protection consciousness, the competent authorities
in different places are endeavoring to achieve a win-win situation in flood prevent-
tion (including drainage) and the ecological protection in urban water system im-
provement [1,2]. Due to different characteristics in topography and water system and
different levels in social and economic development, the planning of the integrated
treatment of urban water systems is still at a stage of exploration with many aspects
worthy to probe into [3].

2 Considerations and Treatment Principles for
Urban Water System Treatment

2.1 Considerations for Urban Water System Treatment

2.1.1 Survey and Analysis of Present Situation within the Scope of the Project

The planning and design of the project are normally based on the full understand-
ing of present state, and that is especially true for the urban water system treatment.
For example, the project design schemes will be directly influenced by such factors
as the quantity and positions of existing sewage drainage outlets, the accuracy in
general survey of existing pipeline network, the relationship between a river course
and buildings on both sides, the surrounding environment, the incoming water
quality and the area of urban lakes, as well as lake outlets and their surrounding
environment.

2.1.2 Basic Data Analysis

Basic data analysis and derivation are fundamental to the expansion and diver-
gence of the ideas for the integrated treatment of urban water systems; the urban
construction is often viewed as a complex, in which the hydrological conditions of
urban water system is greatly influenced by external environment, and the selection
of parameters play a significant in planning and designing water system, and
demonstrating the scale of a pump station.
2.2 Idea of Treatment

From the overall thinking of “treatment of system, processes and basin”, the core eight-hierarchy philosophy featuring water-themed safety, resource, environment, ecology, water landscape, culture, management and economy can be drawn, which goes further to develop the itemized treatment idea characterized with “discharge reduction at internal sources, dredging at external sources, water quality purification and ecological remediation”.

In the integrated remediation planning, overall considerations should be given to the safety of flood prevention and discharge, environmental ecology, smooth transportation and other requirements; with the water system treatment as a link, the existing water system should be fully utilized to completely improve urban flood prevention and discharge capabilities; through the separation of rainwater from sewage, the water quality can be improved; and urban water system landscapes can be established. When all these means are taken, a network of urban water systems, composed of “streams–wetlands–lakes–pump stations”, can be finally achieved, and thus make come true a beautiful city featuring “interdependent water system and city, interconnected water systems, harmony between human and nature, and clear water and green gardens”.

2.2.1 Improvement of the Sewage Collection and Transport System

The sewage design should be directed by the guideline which highlights area and systematic discharge while observing the sequence from sewage interception to pollution control and then to river regulation, and bringing into practice green design and sustainable utilization; through sewage interception at the discharge outlets along the river course in the project areas, it should be secured that no sewage will flow into the river course.

2.2.2 Urban Water Environment and Flood Management

On the precondition that the basic functional requirements of an urban water system, including flood prevention and discharge, are met, the integrated treatment for the urban water system is expected to be planned and designed to reflect the following features:

1) Perspectiveness. The water system treatment is combined with a general urban development program, tourism demands, and urban construction; through overall consideration and integrated coordination, the water system resources are developed and utilized comprehensively, which can lay a consolidated foundation for sustainable urban development.
2) Coordination. The relationship between flood prevention and natural environment creation should be well coordinated; global considerations are required for rivers, city, human and nature; while the requirements for flood prevention and discharge are to be met, the demands for landscape environment should not be ignored, either.

3) Diversity. A diversified water ecological environment is to be built, and the integrated function of different channels is to be fully exploited for the maintenance of ecological balance, the adjustment of area microclimate, recreation and entertainment, so as to achieve the sustainable development of waterfront green landscapes.

4) Water accessibility principle. The accessibility of the urban river water system is to be highlighted and an approachable waterfront space be created, which can realize good visibility, adjacency and touchability and promote the integration between human and nature, resulting in a good waterfront landscape environment.

5) Integrated principle. In the planning process of a water system, the water resource allocation, hydrogeology, urban planning, landscape design, environmental aesthetics and other expertise shall be well coordinated, so that a reasonable and feasible scheme for the integrated treatment plan can be put forward.

2.2.3 Urban Lake Improvement Project

Lake regulation works: In line with principle of “ecological treatment and introduction of clean water through natural and harmonious means”, different but specific ecological schemes (scientific desilting, ecological remediation, ecological slope protection, long-term management and other measures) are designed to cut down inflowing pollutants and hold back pollutant sources through the interception of slope protection, ensuring the introduction of clean water, the improvement in both water quality and regional environment, and the creation of self-regulating and healthy ecological systems in lakes. In addition, a combination of aeration, plant ponds, subsurface wetlands and ecological floating islands is adopted to ensure stable water quality in lakes [4].
3 Issues in Design Process of Urban Water System Treatment and Relevant Measures

3.1 Hydrological Computation

The calculation of flood flows to be controlled is rather complex, as the towns are mixed with crop fields and villages, and the flood from upstream mountainous area need to be taken in during drainage period. Different calculation methods for flood control are to be adopted on the basis of specific conditions in each drainage area, including terrain, landform and ground cover.

3.2 Improvement Works for Sewage Collection and Transport System

The urban sewage collection and transport system feature a broad coverage and long pipelines. The primary and secondary trunk pipes for the sewage collection should be combined closely with the urban planning, and the framework for sewage collection systems in areas is to be built up, so that the collection rate can be improved and the treatment and reuse be facilitated.

3.3 Treatment of Urban Water Systems

The modern, integrated treatment of urban rivers is expected to establish a design philosophy for river course treatment with ecological water conservancy and the conventional ideas regarding engineering water conservancy may have to be renovated. The new philosophy should reflect the ideas as follows: an idea concerning the harmony between human and nature, sustainable development of rivers, and humanistic features of rivers. On the condition that flood prevention and discharge are met, the design should include “safety, nature, ecology, water accessibility and landscape” into its objectives. Aesthetic conception, design and practice are to be utilized to construct urban rivers with integrative, multiple functions, which will further contribute to a clean, beautiful, ecologically healthy living environment with convenience and comfort.

Diversified forms of a river plane. The plane form of a natural river normally has its twists and turns; while the requirements for flood prevention and discharge are met, the multiple forms of the existing river plane are to be kept to the greatest extent by adapting the design to the natural bends.

Diversification and naturalization of a river course section. A river space is to be reasonably utilized; single, compound, or anomalous and asymmetrical sections
can be adopted, according to the conditions in a specific river segment, to meet human desire in sharing the river body as well as their demands for leisure, water accessibility and closeness to nature.

Ecologization and landscaping of bank protection along the river course. Simple, hard bank protection is not to be used preferably, and the ecological bank protection materials and structures are to be selected according to the actual local status, while considerations are also given to the demands for safety, ecologization and landscape.

Characteristics of river waterfronts. Different segments of a river have different natural scenes, land usage, history and cultures, so it is required to create featured and pleasant river environment.

The improvements in urban channels, flood prevention and discharge facilities should be combined with a number of functions, including flood prevention, discharge and ecological remediation. Therefore, a safety lifeline for flood prevention and discharge along the river is to be built in a scientific and reasonable manner, engineering and ecological measures are to be taken to control the soil loss along the bank, while the ecological environment is to be actively restored, which should fully demonstrate the organic combination of water-related safety, environment, landscape, culture and economy. Ecological water conservancy should be established in present cities, including water accessibility, healthy water quality in rivers and lakes with the function of flood and disaster control, ecological water system remediation, as well as landscape waterfront space.

Given the fact that most of the designed urban channels in the project are located in the built-up areas of the city, the plane layout and section design of river courses followed the principle that made adjustments according to local conditions and fully considered surrounding premises and migrant status in an aim to cut down workload and demolition. For some river segments with dense residential quarters and a large amount of demolition, upright ecological retaining walls were adopted on the cross sections of the river course, and the planes were appropriately re-routed according to the house removal and actual surrounding conditions.

In combination with the administrative requirements for flood prevention and discharge, an open channel was reserved with a 10 m-wide boundary line for management on both sides, and a 4m-wide colored flood prevention channel, made of pervious concrete, were set up, which was coupled with a green belt. For flood prevention channels, pervious ecological pavement was adopted, which were reasonably connected with municipal roads. On the first place, the flood prevention can be kept unblocked in a flood period; secondly, no ponding or light reflection exists on the pavement, as the rainwater can infiltrate directly; finally, the flood prevention channels (also for flood discharge) can form a green corridor together with the green belt along the river, thus capable of intercepting initial rainwater, and by forming a green urban system for pedestrians and bicycles, providing surrounding residents with a good place for rest and exercise. The main technical difficulties were found in
structure design of the pervious pavements and the allocation of signs and green belts.

### 3.4 Non-engineering Measures

The non-engineering measures for a urban water system mainly include general survey of flood disasters, designation of dangerous areas, determination of early-warning indicators, including critical rainfall and water level, setting-up of monitoring and early-warning system, establishment of responsible organization system, perfection of prevention plans, publicity, training and drillings. These are non-engineering measures mainly targeted at the monitoring and early-warning of a flood caused by the rainfall in the internal water system, and at mass prediction and disaster prevention, so as to reduce the casualties and property loss.

In addition, they also include general survey of flood disasters in an urban area, designation of dangerous areas of flood disasters, construction of automatic collection and manual observation sites to form a monitoring site network for rain status, construction of a monitoring and early-warning center integrating networks, database and geographic information technology; establishment of alarming system consisting of the early-warning center and key prevention areas; preparation of flood forecast schemes reflecting the hydrological characteristics of the area, as well as scientific and operable flood prevention plans, establishment of an early-warning mechanism and an organization system with mass prediction and disaster prevention, in-depth publicity of knowledge about flood prevention and disaster reduction, thus setting up a non-engineering measure defense system incorporating technologies and management.

### 4 Conclusion

As a water system is seen as an important subsystem in the urban ecological system, a good urban water system becomes one of the foundations for a “resource-saving and environment-friendly”, harmonious community; the treatment of urban water environment, like the revitalization of blood capillaries of a city, lays a solid foundation for healthy development of other urban construction works. The improvement of a water system not only serves as a key content in urban construction, but also becomes an important way to improve urban ecological environment and reconstruct urban ecological system. Therefore, it is of great significance to explore and perfect main principles, final plans and realization approach for the integrated treatment of urban water systems which is based on actual conditions in a local and on the experience of completed projects. Such an endeavor will definitely benefi-
cialy to the construction of a “harmonious and healthy” urban water system, to the
development of regional advantages and to the realization of a faster and better
growth.

References

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