JOURNAL OF ENVIRONMENTAL SCIENCES 26 (2014) 1818–1823

Available online at www.sciencedirect.com

ScienceDirect

www.journals.elsevier.com/journal-of-environmental-sciences

Integral stormwater management master plan and design in an ecological community

Wu Che[1], Yang Zhao[2,*], Zheng Yang[1], Junqi Li[1], Man Shi[3]

1. Key Laboratory of Urban Stormwater System and Water Environment, Beijing University of Civil Engineering and Architecture, Ministry of Education, Beijing 100044, China. E-mail: chewu812@163.com
2. Beijing Yuren Rainwater Eco-technology Co., Ltd., Beijing 100044, China
3. China Aviation Planning and Construction Development Co., Ltd., Beijing 100120, China

ARTICLE INFO

Article history:
Received 7 November 2013
Revised 16 May 2014
Accepted 16 May 2014
Available online 9 July 2014

Keywords:
Ecological community
Oriental Sun City
Integral stormwater management
Master plan
Green stormwater infrastructure
Low impact development

ABSTRACT

Urban stormwater runoff nearly discharges directly into bodies of water through gray infrastructure in China, such as sewers, impermeable ditches, and pump stations. As urban flooding, water shortage, and other environment problems become serious, integrated water environment management is becoming increasingly complex and challenging. At more than 200 ha, the Oriental Sun City community is a large retirement community located in the eastern side of Beijing. During the beginning of its construction, the project faced a series of serious water environment crises such as eutrophication, flood risk, water shortage, and high maintenance costs. To address these issues, an integral stormwater management master plan was developed based on the concept of low impact development (LID). A large number of LID and green stormwater infrastructure (GSI) approaches were designed and applied in the community to replace traditional stormwater drainage systems completely. These approaches mainly included bioretention (which captured nearly 85th percentile volume of the annual runoff in the site, nearly 5.4×10^5 m^3 annually), swales (which functioned as a substitute for traditional stormwater pipes), waterscapes, and stormwater wetlands. Finally, a stormwater system plan was proposed by integrating with the gray water system, landscape planning, an architectural master plan, and related consultations that supported the entire construction period. After more than 10 years of planning, designing, construction, and operation, Oriental Sun City has become one of the earliest modern large-scale LID communities in China. Moreover, the project not only addressed the crisis efficiently and effectively, but also yielded economic and ecological benefits.

Introduction

From 1999 to 2012, urban residential construction areas in China have increased from 476×10^6 to 790×10^6 m^2 annually (Cheng et al., 2011), rising by nearly 66%. In most of these communities, the stormwater drainage system was designed by applying traditional processes and methods. These methods directly discharge water from sewers into bodies of water (Che and Zhao, 2012), thus causing water pollution, eutrophication, urban flooding, and resource loss from stormwater. Based on

* *Corresponding author*. E-mail: autoflighter@qq.com (Y. Zhao).

http://dx.doi.org/10.1016/j.jes.2014.06.028
1001-0742/

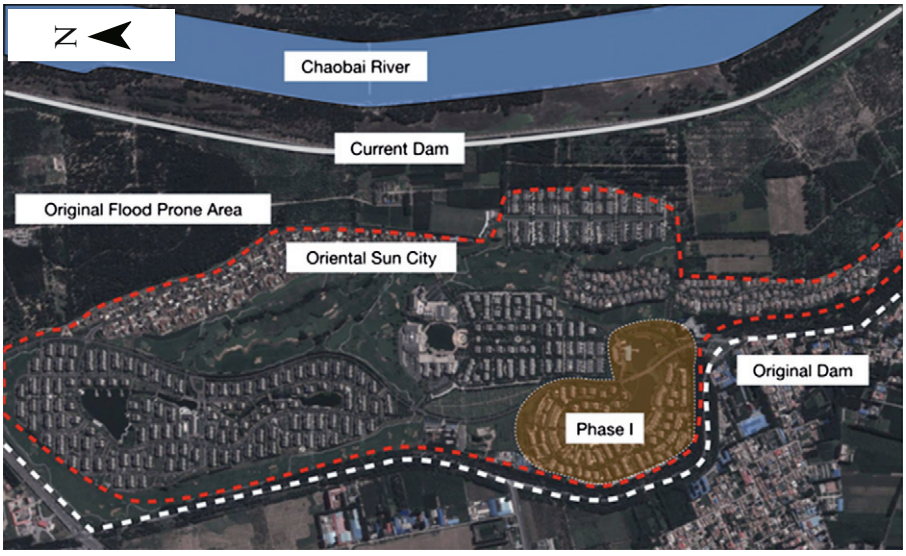

Fig. 1 – Overview of Oriental Sun City.

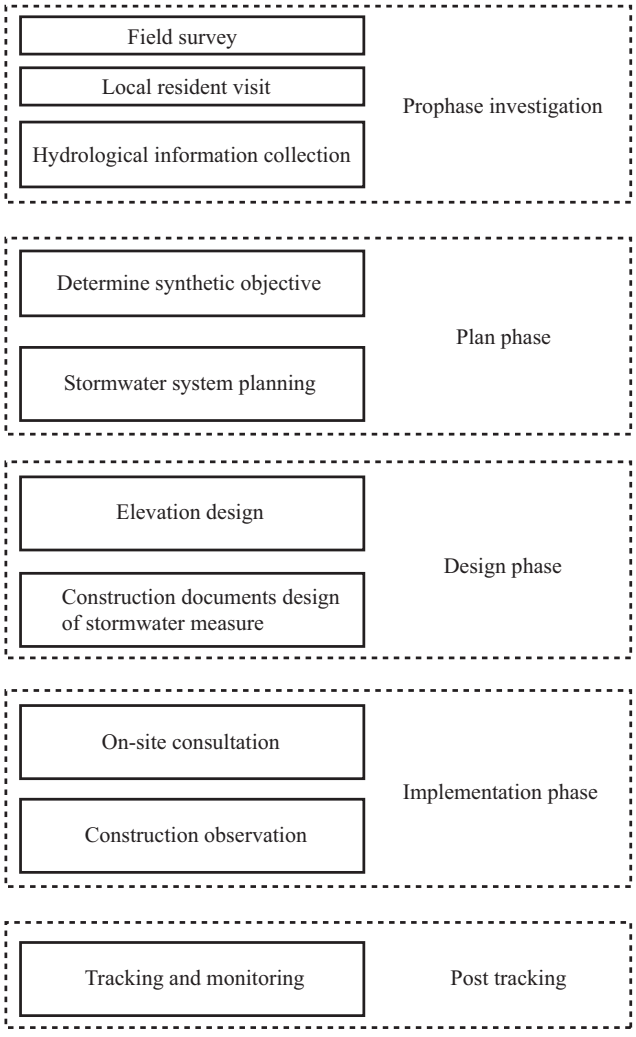

Fig. 2 – Schematic diagram of the project construction processes.

the natural hydrologic cycle, runoff can return to the water system through various effective means, including storage, detention, infiltration, and evaporation. Therefore, the key points to consider when designing a comprehensive stormwater management system are the local hydrologic process and human living requirements.

Based on the aforementioned concept, a low impact development (LID)/green stormwater infrastructure (GSI) stormwater management system can effectively address water environment issues caused by traditional stormwater drainage systems (Prince George's County, 1999). However, these innovative technologies require multidisciplinary teamwork. Providing a comprehensive and cost-effective solution to planning, designing, and construction, among others, involves a series of challenging tasks in China. This study discusses a typical, large-scale residential community project to introduce the integral stormwater management plan and to describe how an effective LID/GSI system can be developed.

1. Project background

1.1. *Background*

The Oriental Sun City community is located in eastern Beijing, with a construction area of 234 ha. The community has an 80 ha building area, a 16 ha lake area, and a 75 ha green space. The objective of the development site was to establish an ecological and comfortable retirement community. To achieve this objective, community planning included three internal lakes as the core landscape of the water environment. The project was divided into three phases. The first phase ended in 2002, whereas the last phase ended in 2010.

However, the project did not proceed as expected because of limitations in terrain, hydrological conditions, and shortage in integral stormwater management planning and design. Consequently, the project faced a series of serious water environment crises during the beginning of its development (phase I), including eutrophication, water shortage, and high