WWF

Report

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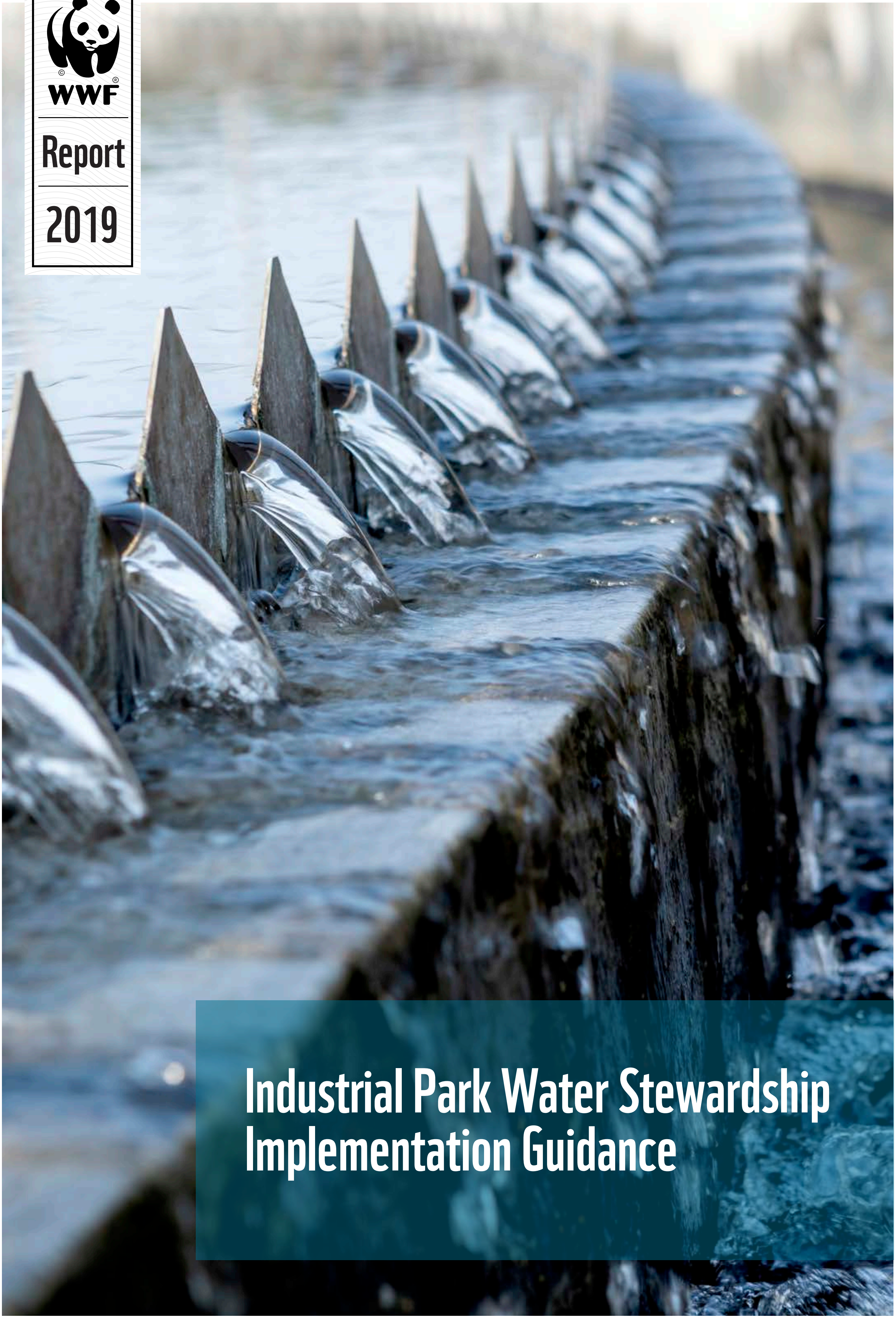

Industrial Park Water Stewardship Implementation Guidance

Preface

Experience at home and abroad shows that industrial parks are important to developing industries and promoting economic development. After more than three decades of development, China's industrial parks have played an important role in the country's social and economic development. According to relevant statistics, industrial parks have accounted for 50% of the gross industrial output in China. Industrial parks have strengthened China's competitive advantage through industrial agglomeration, aggregation of production factors, industrial upgrading, economies of scale and the reduced management costs. However, the increasing number of sites in an industrial park has resulted in large amounts of wastewater, with complex pollutant compositions of high concentrations and large fluctuations. As such, wastewater treatment is a demanding job and has imposed great pressure on the surrounding water environment. Therefore, in accordance with The Environmental Protection Law of the People's Republic of China, The Cleaner Production Promotion Law and The Circular Economy Promotion Law, various relevant State ministries and commissions have successively introduced a series of measures and standards, such as the "eco-industrial park", "green industrial park" and "circular economy park" to guide and regulate the construction and operation of industrial parks and promote the construction of ecological civilization in the industrial field.

To facilitate these national policies play out at local level, World Wide Fund for Nature (WWF), drawing lessons from global water stewardship experience and standards, has compiled the Industrial Park Water Stewardship Implementation Guidance, in cooperation with Tsinghua University, Tongji University, Nanjing University of Information Technology, Shanghai Academy of Social Sciences and Jiangsu Engineering Consulting Center. Through institutional innovation and platform building, the Guidance promotes the joint participation of relevant stakeholders in the industrial park water stewardship project, including the park's management committee, sites inside the park, environmental protection companies, financial institutions and NGOs. By encouraging sites inside the parks to learn from successful cases and explore a green PPP model, the Guidance helps to enhance both parks' and sites' water management levels and efficiencies. The Guidance also serves as a reminder for parks to attend to water risks in their catchments in a bid to better develop a shared value of sustainable utilization of water resources among relevant stakeholders.

A great variety of parks scatter across the Yangtze River basin. While promoting the social and economic development of the Yangtze River basin, these parks have also exerted great pressure on the local water environment. We expect this Guidance can help the 'green' transformation of China's Yangtze River economic belt and realize President Xi Jinping's vision of 'promoting well-coordinated environmental conservation and avoiding excessive development. Besides, as Chinese companies explore the overseas market along the route of Belt and Road Initiative using industrial parks as a vehicle, the Guidance is expected to facilitate the building of a "green 'Belt and Road' Initiative".

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Chapter 1

General Rules

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1.1 Background and Goals

China's per capita water resources account for only a quarter of the world's average. The spatial and temporal distribution of water resources varies greatly. Over the past three decades, the acceleration of China's industrialization and urbanization has caused severe environmental degradation. There is an increasing contradiction between water supply and demand, and a series of water security and water environment problems have emerged. These two factors are among the major constraints on social and economic development in many regions. Water safety and water environment protection are closely related to the long-term stability of the country and the vital interests of the people. Great importance has been attached to continuously strengthening the management of water resources and improving the quality of the water environment, which are reflected in a string of important documents issued by the central government, such as the Opinions on Accelerating the Construction of an Ecological Civilization, the Opinions on Implementing the Strictest Water Resources Management System, the Action Plan for Water Pollution Prevention and Control and the Outline of the 13th Five-Year Plan, etc.

The major trends and features of the status quo of water resources and water environment management are as follows: First, an emphasis on systematic optimization and promotion of water pollution prevention, water ecological protection and water resources management. Water safety risk, water ecological destruction, water shortage and water environmental pollution are intertwined topics that should not be addressed in isolation; thus, a comprehensive approach is needed. Water safety and water environment protection require not only fundamental changes in the development concept and mode but also continuous innovation in science and technology, policy and management systems. Second, the control of total water consumption, a goal that is clearly articulated in the above-mentioned two documents and the "13th Five-Year Plan". Third, saving water and tapping additional water sources. The above documents and "Opinions on Accelerating the Construction of an Ecological Civilization" posited developing and using unconventional water sources such as recycled water and seawater, scientifically exploring and using surface water and all types of unconventional water. Fourth, incorporating stricter and more transparent environmental supervision. The major measures include full coverage of automatic online monitoring, real-time disclosure of environmental information, strict management of pollutant emission into rivers (or lakes or seas), water use efficiency and pollutant emission intensity. Fifth, achieving higher standards and risk control, especially for environmental and health risks caused by specific and emerging pollutants.

The growth of China's demand for water resources currently and in the near future is different from that of other countries. According to the "Tracking Report on Future Water Resources by 2030", China's industrial water consumption will increase by 56.4 % between 2005 and 2030, the fastest growth rate. To reduce operational costs and improve the efficiency of sites to solve the challenges from water resources and the water environment, China must carry out the reform from its industries, especially improving the efficiency of industrial water use and reducing the environmental impact of industrial drainage.

After more than three decades of construction and development, China's industrial parks have played an important role in social and economic development and, as the pioneers and backbone of industrial development, have been important in promoting urbanization. China has a large number of industrial parks. An industrial park is the most important "workshop" in the "world factory". Because of the significant number of industrial activities, as well as the massive resource and energy consumption, there is great urgency for green, low-carbon development. There are significant difficulties in wastewater treatment in industrial parks due to the large number of sites inside the parks, the large amount of water consumed and wastewater generated, the complexity in the water quality and the high concentration, volatility and imbalance of nutrients in the industrial effluents. Therefore, advanced water management approaches for industrial parks should be applied. For many parks, their areas and catchments have poor water quality, serious ecological damage and many potential hazards for the hydrological environment. The green development of a park encounters many challenges and risks, such as water resources constraints, the intensive utilization of water resources and water pollution that requires prevention and control. Therefore, it is necessary to have an advanced water management approach for an industrial park that comprehensively considers all aspects of water pollution prevention and control, applies the concept of life cycle management, strengthens source control and systematic governance, designs integrated solutions, promotes the refined management of water resources, prevents and controls water pollution and reduces energy and water consumption.

World Wild Fund for Nature (WWF) is promoting water stewardship projects around the world. In China, WWF applies its water stewardship experience to industrial parks, an important link in promoting regional economic and social development, to help achieve sustainable water management. To this end, WWF has prepared the "Industrial Park Water Stewardship Implementation Guidance" to guide parks' management departments, key sites in the parks, financial institutions, NGOs and research institutions to jointly participate in the industrial park water stewardship project, through innovation mechanisms and information-exchange platforms. The Guidance also helps improve the parks' and sites' water management abilities and performances by encouraging sites in the parks to learn from successful cases and to explore new financing model. On this basis, we aim to raise the awareness of water risks within the park basin to form the shared value of sustainable utilization of water resources among relevant stakeholders.

Column

The Key Points of The Opinions of the State Council on Implementing the Strictest Water Resources Management System

Implement the Strictest Water Resources Management System

Total control of water consumption

- Control the red line for water resource exploitation and utilization, water allocation of main rivers and the index system for total water intake control.
- Plan and perform project construction in accordance with local water resource conditions and flood control requirements.
- Incorporate a water resource feasibility system for construction projects.
- Examine, approve and manage water intake permits.
- Prohibit and limit the scope of exploitation, reduce the over-exploitation of groundwater and compensate for the balance of exploitation (groundwater management and protection).
- Dispatch water resources in a unified manner.
- Fully employ market mechanisms to optimize the allocation of water resources (national water rights system).

Control water use efficiency

- Control water use efficiency, curb water resource waste and save water throughout the entire process.
- Formulate a water use efficiency index system for the region, the industry and the water products and establish a water quota and management plan.
- Monitor users whose water use exceeds a certain amount.
- Strictly limit the construction of high water consumption industrial projects in areas with insufficient water resources.
- Employ the “three simultaneities” of water-saving facilities in construction projects.
- Implement water-saving technology transformation, comprehensively strengthen enterprise water-saving management and popularize high-efficiency water-saving technology.
- Implement mandatory water-saving standards that eliminate water technology, equipment and products that do not meet the water-saving standards.

Restrict receiving pollution at the water functional areas

- Establish a pollution limit for water functional areas, and strictly control the total amount of sewage discharged into rivers and lakes.
- Limit the total discharge of pollutants, as an important basis for water pollution prevention and emission reduction.
- Where the sewage discharge exceeds the total sewage discharge limit in the water functional areas, limit the examination and approval of new water intakes and sewage discharges into the river.
- Establish a water quality standard evaluation system for the water functional reas, including monitoring and early warning supervision and a management system.
- Perform water source protection and emergency management of drinking water sources.
- Perform water ecological system protection and restoration using a water ecological compensation mechanism.

Responsibility and assessment of water resources management

- Hold the person in charge of local governments at or above the county level fully responsible for the management and protection of water resources in the administrative region.
- A water resources management assessment system (water resources development and utilization, conservation and protection) is an important basis for comprehensive assessment of local government leading cadres.
- Capacity building for water quantity and quality monitoring.

1.2 Scope

The Guidance addresses terms, definitions, guiding principles and methodological frameworks for industrial park water stewardship. It provides planning, goal setting, implementation, evaluation and improvement of industrial park water stewardship collective actions at the site, park and sub-basin levels.

1.3 Principles

This Guidance refers to important relevant documents released by the government and the instructions and management regulations of government-led activities related to ecological development, circular economy and low-carbon development of industrial parks, including but not limited to the following documents:

(1) Opinions of the Central Committee of the Communist Party of China on Accelerating the Construction of an Ecological Civilization (April 25, 2015)

(2) Action Plan for Water Pollution Prevention and Control (No. 17 Document of the State Council (2015))

(3) Overall Planning of the Ecological Environment Protection of Lakes with Better Water Quality (2013-2020)

(4) Planning of Water Pollution Prevention and Control in Key Drainage Basins (2011-2015) (No. 3 Document of the State Council (2012))

(5) The Opinions of the State Council on Implementing the Strictest Water Resources Management System (No. 3 Document of the State Council (2012))

(6) Notice on the Issuance of the Most Stringent Measures for the Assessment of Water Resources Management System (No. 2 Document of the Office of the State Council (2013))

(7) Notice of the State Council on the Issuance of a Circular Economy Development Strategy and the Recent Action Plan (No. 5 Document of the State Council (2012))

(8) Notice on the Issuance of the Implementation Plan of Water Efficiency Leaders Action (No. 876 Document of the Department of Resource Conservation and Environmental Protection of the National Development and Reform Commission (2016))

(9) Guiding Opinions on Strengthening Environmental Protection Work in Industrial Parks (Draft for Public Comments)

(10) Comprehensive Eco-industrial Park Standards (HJ 274-2009) and Revision Suggestions

(11) Discharge Limits of Main Water Pollutants of Urban Wastewater Treatment Plants and Key Industries in the Taihu Lake Area (DB32/1072-2007)

(12) The General Principles of a Water Balance Test in an Enterprise (GB/T 12452-2008)

(13) General Rules for Allocation and Management of Water Measuring Instruments in Water Consumption (GB 24789-2009)

(14) AWS International Standards for Sustainable Water Management (V1.0)

(15) Other industrial park water stewardship standards compiled by parks, including Environmental Quality Standards for Surface Water, Quality Standards for Groundwater, Discharge Standards for Urban Wastewater Treatment Plants, Comprehensive Sewage Discharge Standards and Discharge Standards for Sewage and Sludge of Urban Wastewater Treatment Plants.

1.4 Terms and Definitions

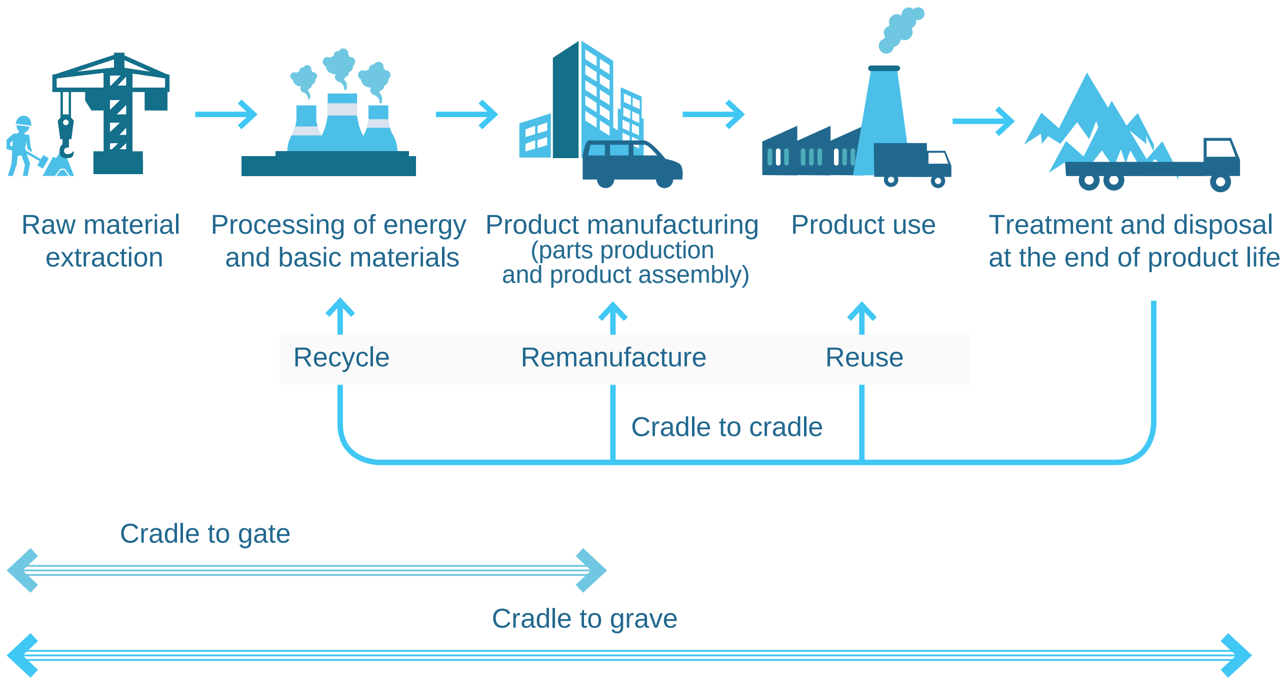
See Annex I for major terms in this Guidance and their definitions.

1.5 Guiding Principles for Industrial Park Water Stewardship Implementation

The innovation of the park's water management approach must apply the concept of life cycle management and systematically optimize of all stages of water pollution prevention and control. Based on the actual situation in the park, relevant parties should design integrated solutions to strengthen source control and system governance, establish phased goals and conduct dynamic assessment and continuous improvement.

(1) Whole Life-Cycle Management Principle

The 'life cycle principle' is core to the implementation of industrial park water stewardship. Based on the life cycle principle, a whole life cycle water stewardship implementation system should be established, which is comprised of key stages related to water management such as water supply (extraction), water use, wastewater treatment, emission, sewage recycling, sludge treatment and recycling, to prevent water risks and improve water quality. Whole life cycle water stewardship implementation also includes the amount of fresh water used in the manufacturing of a certain product, i.e. the indirect water usage of major raw materials in the supply chain.



Life cycle thinking helps to address the water management issue from a systematic perspective, identifying and avoiding the transfer of potential environmental burdens at all stages of the whole life cycle, and identifying solutions to prevent pollution in the early stages of the life cycle, rather than taking actions after pollution has occurred. Applying life cycle thinking to the analysis of critical issues of water management can help identify key points that require special attention and improvement, such as product design, engineering design, consumer behavior change and policy formulation.

Life cycle diagram

Key objects in the main stages of the life cycle of water pollution prevention and control:

- Generation of wastewater (sewage) – the pollution source
- Treatment and transportation of wastewater (sewage) – the wastewater collection and transportation system
- Treatment, recycling and utilization of wastewater (sewage) - sewage treatment plants, recycled water plants, treatment facilities and organizations for harmless treatment, resource-based treatment and disposal of secondary pollutants generated during the process
- Discharge of wastewater (sewage) - different water receiving bodies around the park

(2) Systematic Optimization Principle

Industrial park water stewardship encompasses three areas: the site, park and sub-basin (see Table 1-1). Industrial park water management is directly related to energy consumption and industrial structures, which involves multiple stakeholders. Industrial park water stewardship should hence be studied from the perspective of systematic optimization to establish an integrated industrial park water management model, namely:

Strengthen source control and process management and control total water consumption with a focus on water resource conservation and economical utilization. Comprehensively improve water use efficiency and achieve green development and utilization of water resources;

Guide sites that consume water to perform delicacy management of water intake, water use data collection and measurement. Apply advanced and applicable water-saving technologies and tap water-saving potential;

Promote the transformation of water treatment sites from pollution control to a green approach featuring low energy consumption, resource utilization, energy utilization and ecological safety. Improve the green level of water recycling and reuse treatment, and reduce the total discharge of wastewater (sewage), the total amount of pollutants discharged into the water and their ecological and environmental impacts; and

For parks and catchments, guide innovation practice with the concept of green development and build water-saving parks including measures like promoting clean production and a circular economy. Promote industrial transformation and upgrading, and promote the coordination between the parks' economic development and the capacity of the water resources and water environment in a bid to enhance the level of clean water from the origin.

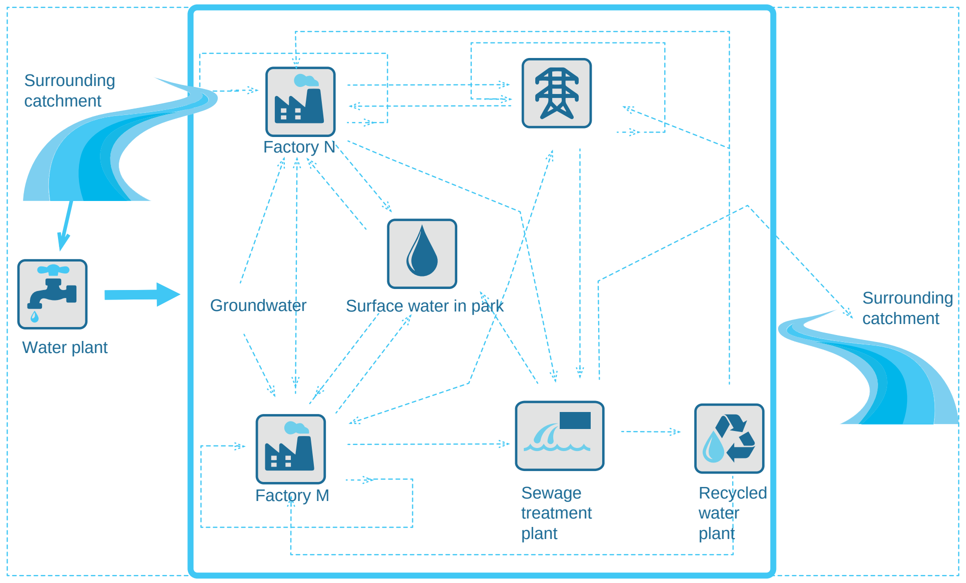


Fig 1-1 Interrelations of Relevant Industrial Park Water Stewardship Factors

Table 1-1 shows the interrelations among the three levels and across all stages of the entire water management life cycle. Water stewardship at the three park levels basically encompasses all stages of the life cycle including water supply, drainage, sludge treatment and disposal, effluent toxicity and sewage recycling. Therefore, sites, parks and sub-basins must be systematically considered and optimized in a concerted manner.

Table 1-1 Cross-correlation of whole life cycle management and the three levels of industrial park water stewardship

Life-cycles / Three levels	Water supply (taking)	Regional water environment	Water use (in production)	Water discharge (in production)	Sludge treatment and disposal	Effluent toxicity	Sewage reclamation and reuse
Site	√	√	√	√	√	√	√
Park	√	√	√	√	√	√	√
Surrounding Catchment	√	√		√	√	√	√

1.6 Methodology Framework

The methodology framework for industrial park water stewardship adopts the PDCA cycle and consists of four phases: problem identification, cause analysis, implementation measures and performance assessment of water stewardship (see Fig. 1-2).

(1) Problem identification

Based on the life cycle, problem identification evaluates the following aspects: water supply/taking, water use, wastewater treatment, wastewater drainage and discharge, sludge treatment and reclamation, toxicity monitoring and control of effluent from wastewater treatment plants, water pollution in the industrial parks and pollution of catchments surrounding the parks.

(2) Cause analysis

Industrial structure optimization and cleaner production and energy use are activities complementary to water stewardship. Systematic analysis of the causes of water risks and water environment problems need to take a close look at the industrial structure and spatial layout of the park, energy efficiency, cleaner production capabilities of the sites, delicacy management, wastewater treatment technology and facility operation management. Opportunities can therefore be identified to improve water resource efficiency, reduce the generation of pollutants and mitigate water risks.

(3) Implementation measures

Identify water stewardship practices at all levels, perform evaluation and select the best plan for implementation. The construction and capacity-building of a water stewardship delicacy management system are an important part of the programme. Implement whole life cycle water stewardship. Construct and improve the integrated water management system and integrate it into the daily management activities of park management departments and sites. Take targeted actions at the company, park and surrounding catchment levels.

(4) Performance assessment

Performance assessment emphasizes the implementation of water stewardship actions, water supply performance, water productivity and environmental impacts. The index system, composed of corresponding core indicators, constructs the park's water stewardship index, which facilitates the park management department in analyzing the annual changes of the park's water stewardship performance and making horizontal comparisons with other parks.

Not a one-off activity, the industrial park water stewardship practice should be considered a tool to periodically review water management performance and re-evaluate existing opportunities, providing sites and parks with a mechanism for continuous (self) assessment and improvement.

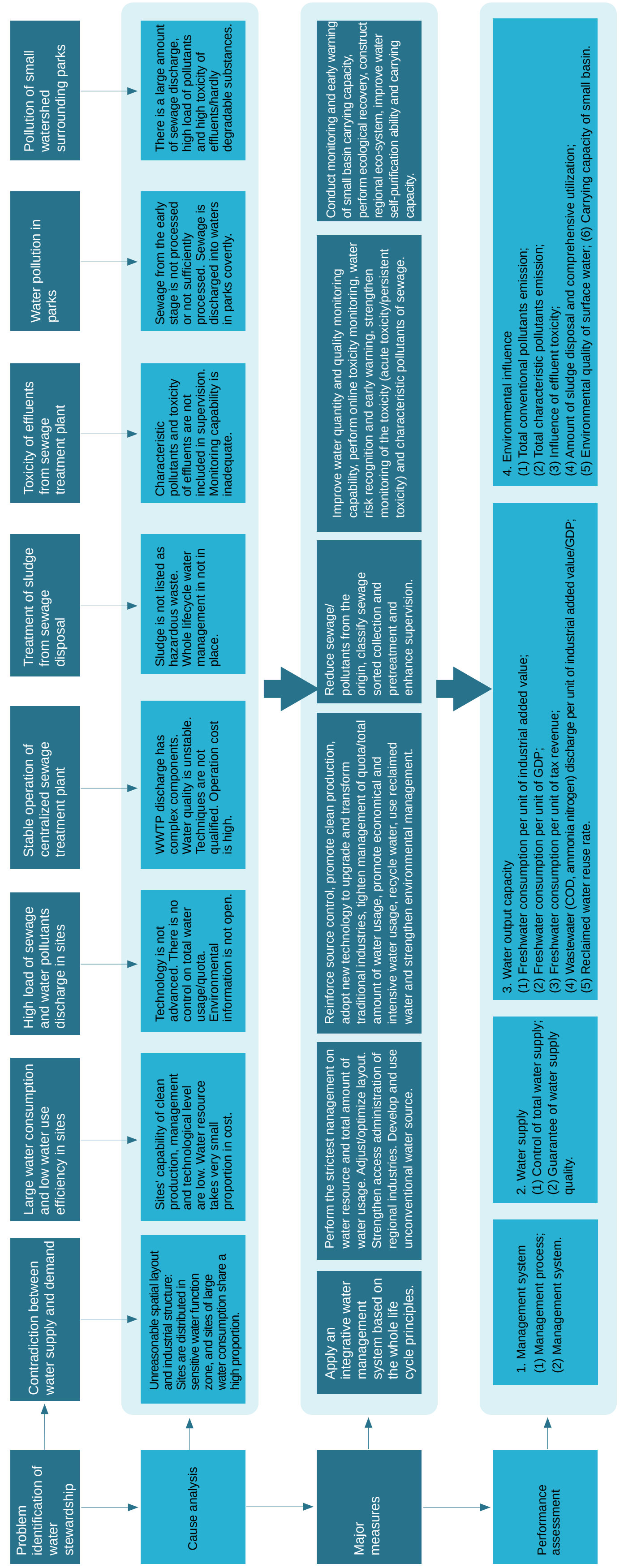


Fig. 1-2 Methodology Framework of Industrial Park Water Stewardship

1.7 Basic Procedures of Industrial Park Water Stewardship Implementation

The basic procedures for industrial park water stewardship implementation are shown in Fig. 1-3, including identification of demands of water stewardship, planning and organization, water management status analysis and evaluation at the site, park and surrounding sub-basin levels, water stewardship implementation plan formulation, innovative practices and effect evaluation.

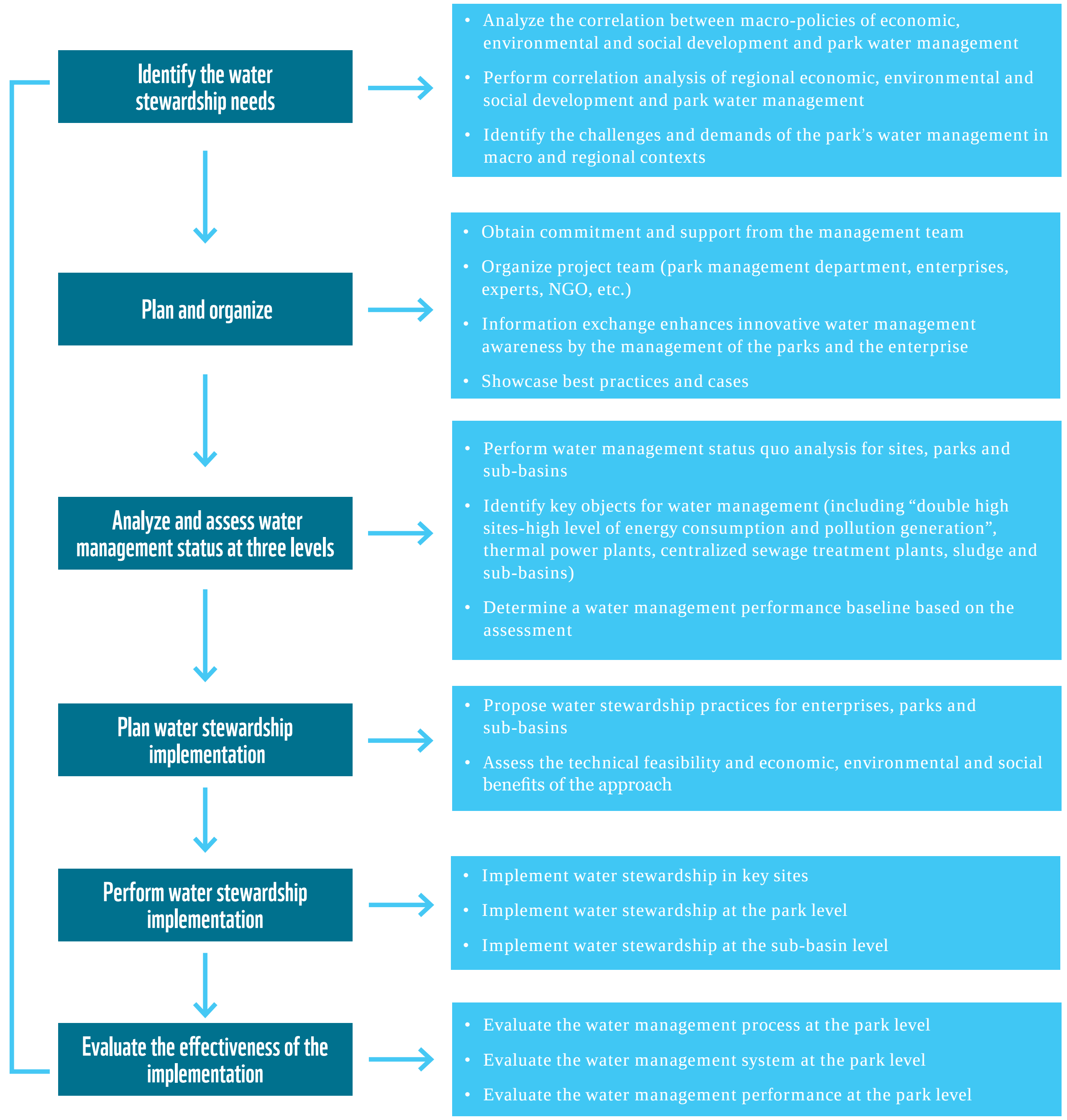


Fig. 1-3 Basic Procedures for Guidance Implementation

1.8 Implementation Bodies and their Obligations

The targeted bodies of industrial park water stewardship implementation are the parks' management organs and sites.

1.8.1 Industrial Park Management Organizations

Currently, there are three types of park management organizations, including a quasi-government management committee, a company development mode and a hybrid mode; the majority of the organizations fall into the category of management committees. Park management organizations are the main promoters, advocators and implementers of water stewardship activities and their obligations include but are not limited to the following:

1. Implement water-related laws, rules, regulations, policies, standards and norms at the national and provincial (municipal) levels and formulate and implement management systems, documents and measures related to park water stewardship.

2. Establish goals for industrial park water stewardship, formulate a park water stewardship implementation plan and programme, establish an industrial park ecological civilization performance assessment system, establish a statistical system and guide sites to carry out fulfill ecological civilization.

3. Perform publicity and training activities targeting the public and sites, guide sites in water stewardship implementation, establish an industrial park water stewardship information exchange platform and promote iconic cases on the innovation of the industrial park water stewardship.

4. Carry out relevant activities including infrastructure planning, construction, operations and services. The infrastructure closely related to water management includes water supply, centralized sewage treatment plants, water recycling plants, facilities for tapping and utilizing unconventional water resources, sludge resource utilization, treatment and disposal, central heating, public pipe network construction and cooperation and coordination involved in promoting inter-site water circulation.

1.8.2 Sites inside the Industrial Park

Sites implement water stewardship practices and their obligations include but are not limited to the following:

1. Construct an entire life cycle of a water stewardship production organization mode. Perform water saving, water resources cascading utilization and reuse in different processes within and between sites. Improve water use efficiency and reduce water consumption. Reduce water pollutant generation and emissions and reduce the secondary pollution in the process of pollutant treatment.

2. Implement a targeted responsibility system to refine water-saving management and strengthen the measurement and monitoring of water use and drainage data. Determine the key water-saving node and formulate a water-saving plan. Voluntarily apply advanced water-saving technology and equipment to strengthen the economical and intensive use of water and its continuous optimization.

3. Strengthen water-saving management. Place significant emphasis on staff training. Establish incentives to raise employees' awareness to save water.

4. Shoulder social responsibility. Integrate water stewardship into the daily production and management operations. Strengthen information disclosure and accept social supervision.

Chapter 2

Water Stewardship at the Site Level

Sites are advised to refer to the International Water Stewardship Standards for site level water stewardship to guide their actions. The Standard is a systematic water management framework developed by the Alliance for Water Stewardship (AWS), a dedicated organization co-founded by WWF and 10 other leading organizations engaged in water-related practices. The Standard contains 29 core criteria, which are built around six steps: commitment making, information gathering and analysis, plan, implementation, evaluation and communication and publication. The Standard aims to help sites to establish effective water management system, reduce water consumption, improve water use efficiency and reduce the impact of pollution emissions on environment. Through implementing the AWS standard, sites will achieve four expected outcomes of good water stewardship: namely, sustainable water balance, good water quality, sustainable water resources usage and the establishment of a sound water stewardship model. This chapter will illustrate the core requirements of AWS standards.

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2.1 Status Quo Analysis of Water Management for Sites

The status quo analysis of water management for a site should include but not be limited to the following: Collect information and data related to water stewardship at the sites; analyze water stewardship performance from the perspectives of the water management system, water consumption and discharge inventory, quality of water used and discharged, water balance test, chemicals inventory, indirect water consumption in the supply chain, important watersheds in the surrounding area and stakeholders of industrial park water stewardship. Compare data with the advanced level of cleaner production of the industry and identify the potential for improvement.

The analysis of industrial park water stewardship for sites includes technical and management levels. The former is centered on a water balance test. An assessment can be conducted either by the site itself or with the assistance of a third party. The aim of an assessment is to assist sites in clarifying the current industrial park water stewardship, identifying any deficiencies and potential water risks and analyzing the causes, with the goal of developing a solid foundation for targeted industrial park water stewardship implementation.

2.1.1 Analysis of a Water Management System

A sound water management system is an important guarantee for water stewardship implementation at sites. The analysis aims to look at whether the company has an established water-related management system,; established water technology archives; encouraged the full participation of its employees in water-saving actions through the introduction of various incentives; developed a water stewardship plan and upgraded it over time, as well as appointed a special personnel overseeing the implementation. Additionally, it analyzes the allocation of water meters across the site and analyzes water and energy-saving practices and look at their advantages and disadvantages. It also lists the current measures and plans for water stewardship and water and energy conservation technologies and analyzes input cost and benefits of water and energy conservation. The analysis also includes the comparison of water stewardship practices inside and outside the park and counterparts at home and abroad in order to identify any deficiencies in the site's current water stewardship implementation and potential water risks.

2.1.2 Establish the Water Consumption and Drainage Inventory

Having a clear command of sites' water consumption and drainage data is an important step towards water stewardship. Many cases under the guidance of WWF and AWS have proved that the establishment of a tertiary measuring system. Based on the primary and secondary levels of measurement, a third-tier analysis will look at groups, key energy-consuming facilities and products as the accounting units for delicacy management. The development of a detailed consumption and drainage inventory can help sites identify their water management shortcomings and discover opportunities for improvement. Sites are encouraged to establish ledgers for the costs of water consumption and drainage at the levels of workshops, shifts, products and months to

calculate the costs related to water usage. This helps comprehensively record the consumption and drainage data and costs in detail, as well as analyze and identify the problems in a timely manner. This assists sites' decision-makers to instantly understand water consumption and drainage, key water-use processes, the water consumption of products and the total cost incurred by water usage. Through financial analysis, sites can identify the key steps for the cost of water consumption and drainage and optimize production and management. See Table 2-1 for a site's water consumption and drainage inventory.

Table 2-1 Inventory of water consumption and drainage

1.Inventory of water consumption and relevant cost	2. Inventory of drainage and relevant cost
1.1 Water consumption (monthly, annual; for workshops, shifts and products)	2.1 Drainage amount (monthly and annual; for workshops, shifts and products)
1.2 Water-use source	2.2 Destination of discharged water
1.3 Price of industrial water	2.3 Construction cost and depreciation of wastewater treatment facilities
1.4 Price of tap water	2.4 Maintenance expense for qualified discharge of wastewater treatment facilities
1.5 Water-use cost (monthly, annual; for workshops, shifts and products)	2.5 Sewage charges
1.6 Steam consumption and cost	2.6 Fines for excess sewage discharge
1.7 Key water consumption links/products and their percentage	**3. Investment by public communities and cities**
1.8 Water reuse rate	3.1 Donation
1.9 Labour cost of water stewardship and treatment	3.2 Other water-related costs
4. Water productivity (monthly and annual)	
4.1 Sales revenue per unit of fresh water consumption	4.2 Sales revenue per unit of wastewater discharged

Note: Sites may add or remove items according to respective needs.

2.1.3 Quality of Water Consumed and Discharged by Sites

The command of the footprint of the quality and quantity of internal water consumption and discharge is significant for improving delicacy water management, which is conducive to realizing intensive and economical utility of water and reducing the ecological impact of drainage. It is important to command the site's water supply and drainage water quality and water quantity dynamics to evaluate the site's water use efficiency. Water quality and quantity should not be monitored only via two observation points, i.e. before entering the plant and after leaving the plant. It should also be monitored and analyzed at functional units such as the workshop, product and section levels. In addition to conventional parameters, it is also necessary to monitor the toxicity of particular pollutants and effluents.

2.1.4 Chemicals Inventory and Management

The majority of water pollution from sites is attributed to chemicals used in the production processes. Compile a list of the chemicals used by sites and screen those that potentially cause water pollution. Assess the baseline of the site's chemicals management, including whether the labels are clear, whether there are clear regulations concerning the trafficking, storage and use of chemicals, whether the chemicals have a normal origin and whether the use of dangerous chemicals meets the requirements of the Regulations on Safety Management of Dangerous Chemicals. Based on the prioritized list of chemicals that must be controlled, stop or replace the production or the use of high-risk chemicals.

2.1.5 Water Balance Test

A water balance test is an effective method for the scientific management of water and is the basis of water-saving practices. Based on the water consumption and drainage inventory and the water quality monitoring and chemicals inventory, compile a water balance diagram based on actual monitoring; refer to the General Rules for a Water Balance Test in an Enterprise (GB/T 12452-2008) and the General Rules for Allocation and Management of Water Measuring Instruments in Water Consumption (GB 24789-2009). A water balance diagram includes the network of pipes for the sites' water consumption and drainage and every functional unit that aims to identify the water balance relationship. A water balance diagram can be illustrated in the form of a Sankey diagram. A water balance test can help a site clarify the internal flow route of water and the corresponding characteristics of quantity and quality, analyze the level of reasonable water consumption and water productivity, and calculate water use efficiency and water productivity. Through comparison and analysis against an advanced industry level, a site can unlock its potential and find new approaches to achieve economical and effective water utilization.

2.1.6 Analyze Indirect Water Consumption by Raw Materials in the Supply Chain

Sites usually focus only on water consumption and drainage from their operations, and little attention is paid to water footprint and water risks in their supply chains. For the majority of sites, the water footprint in their supply chain is often larger than that of their own production and operation. Sites are facing a shortage of water resources and surge in water management costs, due to the global climate change, inefficient use of water resources, increase in water consumption and the implementation of new environmental protection laws and water pollution prevention and control action plans. Therefore, sites' operational and supply chain risks continue to increase. The Guidance serves to assist sites in understanding the indirect water consumption by major raw materials in their supply chains and pay attention to water resources and the water environment of raw material production. Based on the life cycle model, the Guidance will consider the water footprint of the supply chain and assist sites in the park better understand the water risks in the supply chain, identify potential risks to the water supply in raw material input and service outsourcing and actively formulate countermeasures. This is an important aspect of the life cycle water stewardship implementation promoted in this Guidance.

Chapter 2 Water Stewardship at the Site Level

2.1.7 Important Water-related Areas Surrounding Sites

Assess the important water-related areas, both artificial and natural, surrounding the sites. The assessment of artificial water-related areas includes the timeframe for construction, water quantity and quality, operation status and current condition (i.e., malfunction, severely deteriorated, partially deteriorated, acceptable, good and superb). Natural water-related areas are primarily sub-basins surrounding industrial parks. See section 4.1.2 for the assessment.

2.1.8 Stakeholders of Sites' Water Stewardship

Identify stakeholders related to the sites' water stewardship. Analyze the potential conflicts and water risks caused by stakeholders, including stakeholder types, their concerns and main interests, their water management and participation levels in catchment management and their influence over, and interactions with the sites. See Fig. 1-1 for details.

2.2 Critical Actions of Water Stewardship Implementation for Sites

A site is the practitioner of water stewardship innovation. Sites are suggested to undertake the following key actions based on the actual water management situation in the park, region and catchment to implement innovative water stewardship.

2.2.1 Develop Commitment to Water Stewardship

A successful water stewardship practice begins with support from the management (team). Explicit management support is significant to ensure that employees understand the importance of water stewardship in the daily operation of the site. The commitment of a site's senior decision-makers can be demonstrated to employees through such means as the company's written policies, setting targets for water consumption and wastewater emission reduction, designating project coordinators or working groups, announcing and acknowledging achievements, and providing staff training. A site's senior decision-makers' commitment to water stewardship helps better convey the concept of water stewardship to all personnel and influence other sites, motivating them to take more active, responsible and sustainable water stewardship actions. This suggests that the commitment shall be supported by the site's highest decision-makers and shall be signed and made public. The commitment shall be clearly related to water management. For the commitment form, please refer to Annex II.

2.2.2 Develop a Water Stewardship Action Plan for Sites

Develop a water stewardship plan that targets problems and potential water risks discovered during the assessments. The plan should focus on water challenges both inside and outside the site and help reduce site-related water risks. The plan should be concise and easy to implement, clarifying the main objectives, personnel in charge, major contents, process monitoring, budget and expected results. It should involve the participation of various stakeholders and clearly define their rights and obligations.

2.2.3 Comply with Water-related Laws and Regulations

Currently, China's water stewardship is in the midst of the emergence of intertwined issues and rapid changes in management mechanisms. In recent years, the central government has issued a series of environmental laws, administrative regulations and economic policies. Sites should organize their staff to study water-related laws, regulations and policies issued by the central and local governments to improve their ability and better adapt to the environmental protection changes. Employees should observe and implement the regulations in daily production and operation activities. They should discover and prevent potential risks and punishment due to violation of laws or regulations and reduce risks caused by deficient supervision.

2.2.4 Improve Water and Energy Balance and Assume Control of Discharged Water Quality

Water and energy rely on each other; therefore, energy-saving and water-saving are interdependent. Sites are suggested to adopt a three-level measurement and management mechanism for the use of water and energy. This will help enhance the delicacy management and control the total usage of freshwater and energy. Provide incentives to enhance employees' initiative to determine methods to expand water and energy savings. Strengthen exchanges within and between factories to identify methods for cascade utilization, recycled water saving and energy saving. Use water-saving appliances and processes to reduce water consumption, improve a site's water use efficiency and reduce leakage, evaporation and other losses. Utilize unconventional water sources such as rainwater collection and utilization and sewage reuse after advanced treatment to reduce freshwater consumption. Improve site sewage treatment level, strengthen the monitoring of routine drainage pollutants, particular pollutants, effluent toxicity and others, and constantly reduce the ecological impact of the drainage.

2.2.5 Reinforce Chemicals Management

It is suggested that manufacturers establish and strengthen their chemical safety management directives by formulating clear regulations for the transportation, storage and use of chemicals, and conducting delicacy management of chemical use. Organizing regular training concerning chemical management will ensure that all employees know the labels, hazards, prevention and control of chemicals, prevent potential water risks in the use of chemicals and prevent adverse effects on the environment, health and safety during transportation, storage, use and abandonment. Continue to perform process optimization and new technology development and application, improve the utilization of chemicals, reduce the amount of chemicals emitted into wastewater and develop substitutes with lower environmental impact or toxicity.

2.2.6 Strengthen Cooperation in the Supply Chain to Prevent Water Risks

With the continuous evolvement of and the complex socio-economic environment, the supply chain system also encounters significant management risks, with water risk being just one of these risks. With the gradual advancement of the producer responsibility extension system, the prevailing of the sustainable consumption concept, and the guidance of environmental protection policies, an increasing number of sites have showed interests in saving resources and reducing emissions in the entire product supply chain. Sites are advised to consult with a third party or learn from Ecolab's "water risk cost calculator" to identify the amount of freshwater they use and the potential water risks in the entire supply chain. To address the complex and variable risks in the supply chain, cooperation are encouraged between upstream and downstream sites, and raising suppliers' awareness of water stewardship is of importance. Furthermore, it is critical to guide suppliers to actively participate in water stewardship actions in a bid to reduce water usage, improve water efficiency, reduce water footprint to address the complex supply chain risks.

2.2.7 Enhance Sites' Ability to Respond to Water Risks

At the supply chain level, sites should place strategic focus on supply chain water risks. Basin water risk analysis needs to be incorporated into both short-term and long-term operation assessment of sites and industries. Therefore, water efficiency and supply chain cooperation could be considered from the procurement stage and plan in advance to strengthen supply chain coordination and mitigate risks. At the site operation level, establish an emergency response organization and management system, formulate a site water risk emergency plan, improve the construction of a rescue security system and define the responsibilities of departments and personnel before, during and after an event. Strengthen daily training to raise staffs' awareness of water risks and improve the site's ability to prevent and address water risks.

2.2.8 Actively Participate in Catchment Management and Jointly Address the Challenges of Water Stewardship

We suggest sites to actively participate in industrial park water stewardship implementation and catchment water planning and management. Participate in the management of specific rivers and assist industrial parks in the conservation and improvement of the catchment environment. Enhance the communication and cooperation among water management departments of industrial parks, catchment management agencies and stakeholders of water stewardship to jointly address challenges.

2.3 Sites' Performance Assessment and Information Disclosure of Water Stewardship

Sites are suggested to regularly assess the progress and performance of their water stewardship implementation, including the implementation of corporate water stewardship strategies, contributions, benefits and water risk changes. Define the accomplishment of periodic objectives, identify successful water stewardship practices and calculate costs and benefits (benefits for the sites as well as social, economic and environmental benefits) through comprehensive analysis of water management data. Disclose the efforts and achievements of water stewardship actions to the industrial park administration committee and the public. Information disclosure can be conducted through a company homepage, display board, experience sharing and report to the industrial park management department. The industrial park administration committee should encourage a plant to share its successful water stewardship practices and achievements within the industrial park.

Chapter 3

Water Stewardship at an Industrial Park Level

3.1 Status Quo of Industrial Park Water Stewardship

The industrial park water stewardship should assess the situation of water management at an industrial park during different stages of the entire life cycle, including water supply, water consumption, drainage, sludge treatment, recycling water and water risks in the supply chain. Parks should set indicators for gauging water use efficiency and water productivity, and make vertical and horizontal comparisons with similar parks in China. They should also analyze water use efficiency of key sites in the industrial park and compare the results with industry role models or with the cleaner production standards issued by the country. This will identify potential water risks in the park and major current and future constraints for improving water use efficiency and water environment during the development of the park. Assessment of industrial park water management status includes but is not limited to the aspects described in the following subsections.

3.1.1 Industrial Park Development

A summary of park development includes time of establishment, geographical location, synopsis of development, major resources, introduction of management institutions and relevant water management departments and their obligations. Economic development includes the economic, industrial and social development of the industrial park during the past three to five years. Required information includes the gross product of the industrial park and region, industrial increased value, rate of economic development, employment and proportions of the secondary and tertiary industries. Furthermore, it includes the leading industry, key sites, major products and general information concerning major infrastructure such as water resources supply, centralized wastewater treatment plants, energy infrastructure and general information concerning the surrounding water bodies that receive sewage. (See Chapter 4 for details.)

3.1.2 Water Supply for an Industrial Park

The water supply includes the water source, industrial water supply plant, domestic water supply plant and network of pipelines, which are specified as follows:

Water source: Analyze sources of industrial, domestic and reserve water and their water qualities, and the water supply capacity in flood and dry seasons.

Water supply plant: Analyze processes and technologies, water supply capacity, emergency reaction system, water supply for sites in the industrial park, water quality monitoring (whether there is an online quality monitoring system for the water supply) and statistical ledgers (electronic or manual). Identify whether the water from the water supply plants requires further process/purification before use in production and acquire any special water requirements of sites.

Water supply network: Understand the network layout, construction progress, maintenance, water supply pressure, leakage monitoring, water quantity and quality monitoring system.

3.1.3 Water Consumption in an Industrial Park

3.1.3.1 Total Freshwater Consumption and Water Productivity

Analyze total freshwater consumption and freshwater consumption intensity[1] of the industrial park during the past three to five years. From the perspective of water consumption, identify whether the industrial park is working towards relative decoupling in the economic development process, i.e., whether the total water consumption of the industrial park maintains moderate growth while freshwater consumption per unit of economic output continues to decrease. Currently, China's ecological industrial park demonstrations have almost entered the phase of relative decoupling, which provides an occasion to realize absolute decoupling. Absolute decoupling means that fresh water consumption remains stable or declines continuously while the total economic output of the park continues to grow.

3.1.3.2 Analysis of Total Freshwater Consumption and Its Consumption Intensity in Key Industries and Sites

Total freshwater consumption: Analyze sites' freshwater consumption in the industrial park, identify the top ten sites with the highest freshwater consumption in the past three to five years and their respective industries.

Freshwater consumption intensity: Analyze the freshwater consumption of per unit output value for sites above a specified level and identify ten sites with the highest freshwater consumption of per unit output value.

List sites that appear on both rankings of "highest freshwater consumption" and "highest freshwater consumption of per unit output value". Identify them as so-called "double high" sites and include the as important players in the industrial park water stewardship implementation.

3.1.3.3 Pressure Analysis from the Industrial Park Freshwater Consumption

In accordance with the industrial development plan of the park, determine the current total freshwater consumption and fresh water consumption intensity of various industries, analyze the growth of water demand in the medium- and long-term and study the corresponding pressure on the water supply and its capacity. Based on the comparison of water productivity between industrial parks or benchmarking analysis, identify gaps in water productivity and determine measures or approaches for improvement.

3.1.4 Industrial Park Drainage

Analyze the generation, treatment and discharge of wastewater and emission of water pollutants, including but not limited to the aspects described in the following subsections.

3.1.4.1 Wastewater Generation and Discharge in an Industrial Park

Analyze the quantity and quality of wastewater discharged into the sewage pipelines by sites in the past three to years, identify major pollution sources in the industrial park and list the "double high" sites (meaning high wastewater discharge and high discharge intensity). Analyze the quantity and quality of wastewater discharged by sites during the past three to five years. Analyze the quantity, quality and composition of water received by the centralized wastewater treatment plants and its effluent. Refer to relevant discharge criteria to assess the stability of qualified discharge. For industrial parks without centralized wastewater treatment plants, focus on assessing the quantity, quality, composition and stability of wastewater discharged into the sewage network (or

1 Fresh water consumption intensity is defined as the fresh water consumption caused by the output of per unit added value. In the comparison of figures of different years, the added value is that of 2005 or other comparable figures of the reference year. The smaller the value, the higher the efficiency of water resources.

the environment) by "double high" wastewater sites. Select indicators such as the total amount of wastewater discharged, wastewater discharge intensity and discharge intensity of major water pollutants; benchmark with similar industrial parks or with relevant standards.

3.1.4.2 Monitor Particular Pollutants in Wastewater or Effluent Toxicity

A water pollution prevention and control action plan has clearly stated the need to conduct analyzes on water environment baselines such as organic substances and heavy metals, water pollution impact on human health, risk assessment of new pollutants and water environmental monitoring and early warning. Since the introduction of the eleventh Five-Year Plan, China has continuously strengthened the prevention and control of conventional water pollutants. Monitoring and controlling specific pollutants or the toxicity of drainage water is becoming another focus of water management. It is suggested that a park's decision-makers conduct regular monitoring and analysis of the wastewater discharged into the network, specific pollutants and the toxicity of drainage water from the centralized sewage treatment plants and develop corresponding prevention and control measures through cooperation with industry, universities and research institutions. Monitor the intensity and quantity of specific pollutants and the toxicity of water discharged from sewage treatment stations of key sites and from centralized sewage treatment plants. All these pave the way for the thorough identification of a park's drainage risks. The processes for monitoring drainage toxicity are described in the following subsections and shown in Fig. 3-1.

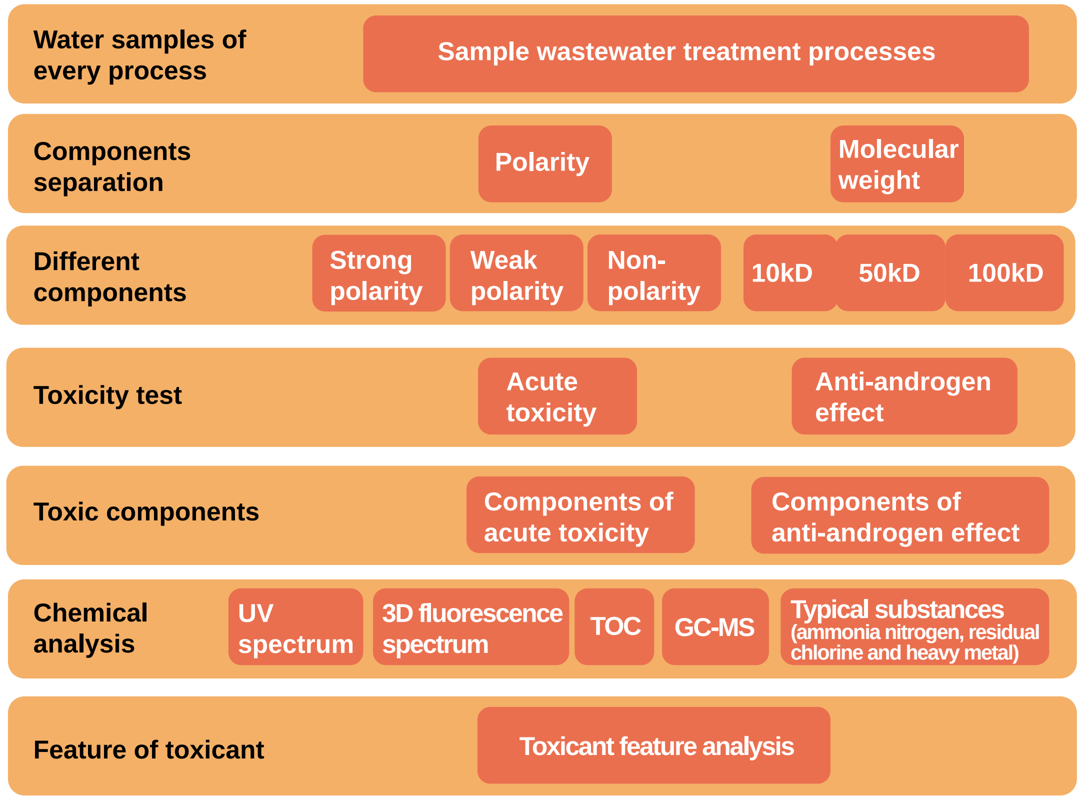


Fig 3-1 Monitoring process for toxicity of particular pollutants in wastewater or effluent

3.1.4.3 Park Infrastructure Construction and Operation

The objects for analysis are the sewage treatment stations of key sites in a park, a park's centralized sewage treatment plants, sewage pipe network, recycled water plants and thermal power plants.

The analysis of sewage treatment plants/stations includes the technology, operational status, online monitoring status, emission standards and qualified discharge. The sewage pipe network of the park is analyzed through the lens of its construction, implementation of rain and sewage diversion, location of the discharge outlet and general situation of the region/catchment. The recycled water plant in the park is analyzed from the lens of its processing technology, scale, amount for treatment, operation, operating costs and destination of recycled water. The thermal power plant is analyzed through the lens of scale, processing technology, fuel consumption, energy output, water consumption, drainage, steam supply, steam condensate collection and recycling of thermoelectric stations owned by key sites and a park's thermoelectric plants.

3.1.4.4 Sludge Disposal in Wastewater Treatment Plants

Sludge is a by-product of the wastewater treatment process and has become a new pollution source in an industrial park. From the perspective of whole life cycle management, strengthening sludge treatment and disposal is an important part and a major challenge of industrial park water stewardship. It is suggested that a park incorporate sludge disposal into its water environment management and strengthen its management. Assess the amount of sludge generated in key sites' wastewater treatment stations and in centralized wastewater treatment plants in an industrial park. Determine if it qualifies as hazardous waste and analyze its collection, transportation, treatment, treatment and disposal cost, final destination and environmental impacts.

3.1.5 Water Environment in an Industrial Park

The water environment of a park includes not only waters in the park but also sub-basins surrounding the park. It is suggested that a park focus on the following aspects:

1. Analyze the features of a river system in an industrial park and its surrounding catchments, including the amount, type and length of the rivers, the shape of the cross-section, the velocity, direction and amount of the river flows and the annual variation of the water level in flood and dry seasons.
2. Analyze the situation of pollutants received by major rivers in an industrial park and the surrounding catchments. Refer to appropriate criteria to analyze water quality changes in cross-sections where major rivers or catchments meet an industrial park during the past three to five years.
3. Identify key locations at which the social-economic development of an industrial park would influence major rivers in the industrial park and the water environment of the surrounding catchments. Pay special attention to the ecological and environmental impacts of specific pollutants on the receiving water caused by park drainage. In accordance with the industrial,

economic and social development of a park, analyze the environmental pressure of drainage and pollutant discharge on the major rivers in the park and surrounding catchments caused by the middle- and long-term development of the park. This will help park management decision-makers of the parks' management team to stay tuned to possible risks.

3.1.6 Water Saving and Re-utilization

Summarize typical cases of water saving and re-utilization conducted in an industrial park. Design an industrial park water stewardship pioneer project through an industrial park administration committee or a third party such as an NGO. Communicate with local mainstream media on such best practices, expand media exposure and ideally attract more players to be part of such initiatives. Examples of water saving and re-utilization include but are not limited to:

1. Examples of delicacy water management of water and energy savings in sites;
2. Examples of cascade utilization of water resources among sites;
3. Advanced treatment and reuse of effluent from centralized wastewater treatment plants;
4. Cascade utilization of water resources in sites to reduce freshwater consumption;
5. Collection and utilization of steam condensate water; and
6. Utilization of unconventional water sources such as rainwater.

3.1.7 Assessment of Industrial Park Water Management Performance

Table 3-1 provides relevant indicators to evaluate the performance of water resources management as well as the performance of water pollution prevention and treatment outlined in the following rules and documents: the Standards for Ecological Industrial Park Demonstrations, Opinions on Accelerating the Construction of an Ecological Civilization, the Water Pollution Prevention Action Plan, Opinions on Implementing the Strictest Water Resources Management System and the Made in China 2025 Plan. An assessment of water stewardship at the industrial park level can be based on the situation of an industrial park and refer to some or all of these indicators to establish a baseline of water performance and set goals for different development stages.

Note:
1. NA means that this indicator does not exist in the Standards for Ecological Industrial Park Demonstrations.
2. Three gradients are provided according to the per capita water resource of the region in which the industrial park is located in the Standards for Ecological Industrial Park Demonstrations (HJ274-2009). On August 6, 2012, the Ministry of Environmental Protection released the Announcement of Modification of Standards for Ecological Industrial Park Demonstrations (HJ 274-2009), in which the "ratio of water recycling" was deleted and was replaced by the following statements: "Industrial parks should actively develop water recycling projects and comply with related local policies and standards when doing so".

Table 3-1 Assessment of water stewardship at the industrial park level

No.	Water stewardship indicators	Units	Reference value in Standards for Eco-logical Industrial Park Demonstrations
1	Total freshwater consumption in the industrial park	Ten thousand m^3	NA[1]
2	Freshwater consumption per unit of industrial added value	m^3/ten thousand yuan	≤9
3	Water productivity	Ten thousand yuan m^3	NA
4	Ratio of industrial water reuse	%	≥75
5	Ratio of centralized treatment of domestic sewage	%	≥85
6	Wastewater generation per unit of industrial added value	ton/ten thousand yuan	≤8
7	COD emission per unit of industrial added value	kg/ten thousand yuan	≤1
8	Ammonia nitrogen emission per unit of industrial added value	kg/ten thousand yuan	NA
9	Ratio of water recycling	%	≥12-40[2]
10	Ratio of centralized sludge treatment	%	NA
11	Ratio of sludge reuse	%	NA

3.2 Identification of Water Risks in an Industrial Park

Water risk identification at the park level is an important task to assist park decision-makers in understanding potential risks in the process of development and gaining support. Third parties such as NGOs help parks' decision-makers in identifying water risks at all stages of life cycle management and the major industries and key sites involved, including but not limited to:

1. Competitive pressure and risks resulting from supply chain water risks, such as scarcity of water resources (scarcity of total amount and pollution-induced water shortage);
2. Uncompetitive water productivity and loss of advantage in market competition; and
3. A series of risks caused by water pollutants, including the impact of industrial parks on the catchment ecosystem.

WWF proposes identifying potential water-related risks caused by natural factors and human activities from the perspectives of physical, regulatory and reputational risks. The purpose is to help investors and regional economic decision-makers identify major potential water risks. WWF proposed water risk assessment index system and Water Risk Filter (http://waterriskfilter.panda.org/) questionnaire tool for from the country, basin and site levels. The adoption of questionnaire can be adjusted according to the actual situation of the park development and the regional catchment and with reference to methods listed in the literature[2].

2
Wei Na et al., Application of WWF Water Risk Assessment Tools in China—A Case Study in the Yangtze River Basin, Journal of Natural Resources, 2015, 30(3):502-512.

Major water risks in an industrial park are listed in Table 3-2. An industrial park can add or remove items based on its actual situation.

Table 3-2 Major water risks in industrial parks

Physical risks R1	Regulatory risks R2	Reputational risks R3
R1.1 Total water demand exceeds the available water supply due to a seasonal shortage of the water supply R1.2 Water shortage caused by water source pollution	R2.1 No control on total water consumption R2.2 High leakage rate of water supply pipelines	R3.1 Direct or indirect impacts caused by environmental safety incidents on regional water environment and the following reputational loss and risk
R1.3 Increase in freshwater consumption due to the growth of water-intensive industries	R2.3 No information system or accurate management	R3.2 Water supply crisis due to water source pollution and other public incidents
R1.4 Potential risks on industrial park infrastructures and water environment quality caused by combined/separate drainage system	R2.4 Low management efficiency due to the fact that different administrative departments are responsible for management of water supply, water use and water discharge.	R3.3 Government penalties or fines received by sites due to excessive discharge, non-functional environmental facilities, environmental pollution and environmental safety incidents
R1.5 No centralized wastewater treatment plants built yet in the industrial park R1.6 No automatic online monitoring for key sites' and centralized wastewater treatment plants	R2.5 Extensive recording of water use monitoring in industrial companies and management deficiency R2.6 Existence of self-owned wells in companies R2.7 Low water recycling rate of companies	R3.4 Press disclosure of companies' water pollution accidents (incidents) such as defrauding discharge, evading discharge and excessive discharge R3.5 Public incidents caused by environmental pollution or program construction
R1.7 Poor stability of qualified discharge of a centralized wastewater treatment plant R1.8 Technology, investment and operational cost-related risks facing centralized wastewater treatment plants due to higher discharge standards	R2.8 Excessive discharge by sites R2.9 Online monitoring system incapable of monitoring particular pollutants R2.10 High concentration of particular pollutants and high effluent toxicity	R3.6 Lower rankings in water efficiency or water productivity compared with other industrial parks or the same industry, uncompetitive water productivity and loss of advantage in market competition
R1.9 Potential damages to the ecosystem of receiving water bodies because effluent from centralized wastewater treatment plant has excessive particular pollutants and high toxicity	R2.11 Lack of prevention and response capability for emerging safety and environmental protection events R2.12 Inadequate supervision of secondary pollution in the process of sludge disposal or re-utilization in the wastewater treatment plant	R3.7 (Part of) Pollutant concentration exceeds those in the receiving waters even if the emission per se meets the relevant standards in the park.

3.3 Industrial Park Water Stewardship Key Practices

The water stewardship practices at the industrial park level aim to reinforce whole life cycle management, systematically improve industrial park water management and enhance water pollution prevention and treatment. Establish incentive policies and long-term mechanisms to guide sites in the park in water conservation, energy conservation and efficiency improvement actions. Promote the efficient use of water resources in the park. Promote the fundamental transformation of water utilization and management. Maintain the balance between socio-economic development of the park and water resources and build water-saving parks. Reduce the infrastructure water risk in the park and actively guide key sites to cut water resource consumption, lower consumption intensity and reduce the types and amount of particular pollutants in their effluents. Some key actions include but are not limited those listed in the following subsections. The industrial park can prioritize its agenda according to respective situations.

3.3.1 Establish a Water Management Information System in an Industrial Park

The application of information technology and the "internet plus" technology to construct a water management information system in the park is an important method to implement strict water resources management. Water management information system should address the entire processes of water supply, water use, drainage and sludge treatment in the park. It should be connected to the safety and environmental protection system, risk early warning system and emergency response system to establish integrated information management, which are designed to improve work efficiency, reduce management cost, increase the speed of collection of water resources information, and enhance park managers' response and emergency disposal capacity should pollution accidents occur. The park water management information system's main functions include but are not limited to the following:

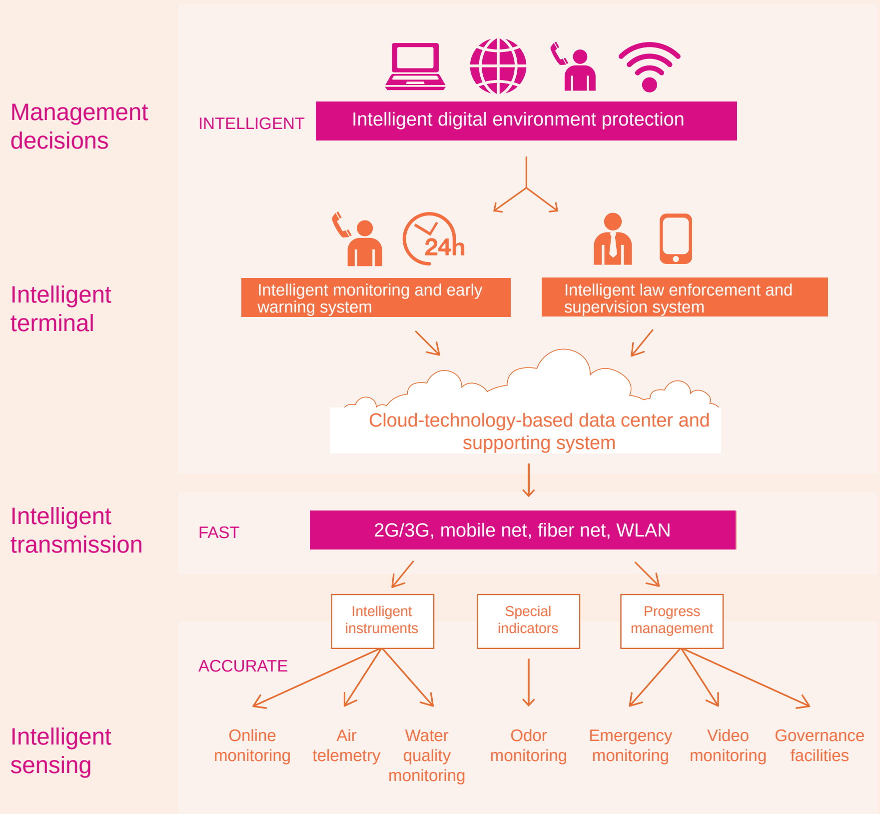
- Integration and real-time monitoring of information concerning water intake, freshwater consumption, circulating water consumption, quantity and quality of sewage discharging into the network, sewage discharge, and quantity and quality of water into and out of sewage treatment plants;
- Card swiping sewage discharge, discharge outlet (including clean sewage discharge outlet) remote control, water resources remote selling;
- Perform information recording, accounting, quota management and other functions during the entire process of water supply, water use, drainage and sludge treatment; and
- Explore water resources symbiosis, water-saving evaluation, water use prediction and warning between sites.

Column

Hangzhou economic and technological development zone - Smart environmental engineering project to achieve the six “Comprehensive” controls

To further improve the efficiency of environmental management to detect, respond and react to environmental emergencies in a timely manner and promote the disclosure of environmental information, the Hangzhou economic and technological development area has adopted an advanced internet of things technology and developed a leading environmental supervision and comprehensive information platform. Through “smart measures”, it solves environmental protection problems such as environmental management personnel shortages, delays in detecting and resolving problems, lack of on-site management and lack of public participation.

The intelligent environmental protection platform adopted by the Hangzhou economic and technological development zone includes the following four aspects: an environmental information software application system, a monitoring center, an entire process supervision system for key pollution sources and a pollution source video monitoring system. The platform relies on the internet of things technology to realize “six comprehensive” management featuring full supervision of the entire sewage discharge process during industrial and company production, full-time monitoring, full-direction monitoring, full records of sites’ environmental information, full transparency, full disclosure and, simultaneously and for the first time, full supervision in rubber, chemical, printing and other industries. The overall goal of the project is to supervise all key industrial sites to achieve all-rounded and seamless management. Currently, 26 of the 50 key industrial sites in the zone have been included in the supervision process, with over 50 percent of sites under supervision. In 2015, the zone will continue to promote the “intelligent environmental protection” project and ensure that the supervision coverage rate of key sites reaches 100 %.



3.3.2 Total Control of Water Consumption in a Park

A park should establish its goal for water consumption control, water saving management measures and water use assessment system in accordance with industrial development and planning. The total amount of water can be controlled by implementing the following measures:

- Regulate water taking permits for sites with high water consumption and low water productivity;
- Apply advanced technology to detect and reduce the leakage rate of the water supply network;
- Promote economical and efficient water use. Enhance water demand management; regulate demand according to water availability and curb unreasonable demands for water;
- Establish water efficiency and productivity admission indicators for new projects; and
- Use market mechanisms in the industrial park to achieve reasonable allocation of water resources.

3.3.3 Enhance Groundwater Management and Pollution Prevention and Treatment

Verify the number of park-owned wells and their abstraction amounts, strengthen the dynamic supervision of groundwater mining and control total water withdrawal and the water level. Improve the public water supply network and shut down industrial park-owned wells. Industrial parks involved in petrochemical production, storage and sales, mining and landfill should have sufficient seepage-proofing treatment to prevent soil and groundwater contamination.

Column

Excerpt concerning strengthening prevention and control of industrial sites and groundwater pollution from the Guiding Opinions on Strengthening Environmental Protection Work in Industrial Parks (draft for public comments).

Industrial park management departments should establish effective management systems to prevent sites from transferring pollutants to a site environment during production and waste disposal. Supervise and urge sites to implement pollution prevention and environmental risk control during shutdown, relocation, site redevelopment and site utilization. Industrial parks related to non-ferrous metals, petrochemicals, coal, chemicals, pharmaceuticals, lead-acid batteries and electroplating industries, as well as the production, storage and use of dangerous chemicals should establish an environmental investigation, risk assessment and filing system for a new industrial site.

Strengthen the prevention and control of groundwater pollution in industrial parks. Industrial parks involving petrochemical production, storage, sales, mining and landfill should undertake relevant seepage-proofing treatment measures to prevent soil and groundwater pollution. An industrial park with groundwater pollution that has directly threatened the safety of drinking water sources should perform groundwater pollution prevention and control measures such as closure, throttling, purification and recovery.

3.3.4 Take Water-Saving Actions

Pollution can be reduced by reducing water demand and sewage treatment. This will consequently result in the reduction of energy demand, chemical use and potential environmental impacts of improperly treated wastewater discharges. The following water-saving strategies can be implemented to help lowers total water consumption:

- Promote efficient water-saving technologies and products to facilitate the transformation of sites and strengthen water saving within sites;
- Renovate pipelines with water-saving equipment and regularly monitor and maintain them to prevent leakage in the water system;
- Gradually remove equipment and products in public buildings that do not meet water-saving requirements;
- Improve park greening activities and reduce water use, including the cultivation of xerophytes and the use of recycled water;
- Encourage the development and utilization of unconventional water sources such as rainwater and desalination of seawater; and
- Promote water recycling, build a symbiotic relationship between sites in terms of comprehensive water utilization, improve water reuse and reduce wastewater discharge.

3.3.5 Standardize the Operation and Supervision of Sewage Treatment Facilities

The primary strategies for standardized construction and operation of centralized sewage treatment facilities, sewage pipe networks and other supporting facilities in a park include:

- Achieve the goal of "diverting wastewater from clean water and rainwater". Transfer collected rainwater to a wastewater treatment plant. A clean sewage discharge outlet should meet the requirements of emergency precautions;
- Realize full coverage of centralized treatment facilities and install automatic online monitoring devices;
- Install automatic monitoring devices and video surveillance systems at the outlets of key pollution sources and discharge ports of wastewater treatment plants;
- Gradually install automatic control valves for key wastewater discharge sites to realize automatic sampling, card swiping and wastewater interception; and
- Regularly monitor specific pollutants of effluents and effluent toxicity of sewage treatment facilities, use online toxicity analyzers and various analytical tools for real-time monitoring and analysis of wastewater treatment to achieve delicacy management of wastewater treatment.

3.3.6 Strengthen the Management of Key Sites with High Water Risks

First, with reference to Chapter 2, conduct further assessment and water stewardship practices on sites rated "double high" (in either freshwater consumption or wastewater discharge). It is suggested that industrial park authorities take specific actions (or have a three-year action plan) to improve water efficiency. Carry out water quota management and establish the water quota for key industries. Enhance dynamic monitoring of sites listed in the management of water intake permissions and major water consuming sites. Park management departments should communicate regularly with "double high" sites and urge them to control total water consumption and improve water efficiency by conducting water consumption self-auditing, cleaner production review, three-level measurement management and regular water balance tests.

Second, focus on the sites that produce and use hazardous chemicals. It is suggested that the park, in accordance with the law, strengthen the registration of environmental management of hazardous chemicals, supervise and urge sites to conduct environmental management risk assessments for key hazardous chemicals, rigorously implement a system for reporting the release and transfer of key hazardous chemicals and their chemical pollutants. The park should take active measures to prevent and control the risks of environmental pollution, gradually reduce the production and use of key hazardous chemicals and promote the use of safer substitutions.

For industrial parks focusing on chemicals, electroplating, printing, dyeing, paper making and pharmaceuticals or parks where such industries have a higher level of concentration, sewage should be collected after classification and quality separation by special single or open pipes and transported to centralized sewage treatment plants or centralized wastewater monitoring and regulation pools in the park. Additionally, pretreatment should be strengthened.

3.3.7 Establish an Integrated Environmental Monitoring System in an Industrial Park

It is suggested that park management departments actively use information technology to build integrated management platforms for environmental monitoring. Gradually establish and improve a park's digital online monitoring platform, which features pollution source, working condition and environmental quality monitoring. Connect the platform with environmental protection authorities and gradually implement environmental information disclosure. Regularly monitor a park's groundwater and the environmental quality of the sewage receiving surface waters. While monitoring routine pollution, gradually strengthen the monitoring of specific pollutants. Perform an industrial park water risk assessment, prepare and revise the park water risk emergency plan in a timely manner. Publicize the plan to the sites in the industrial park, the public, NGOs, and other stakeholders to share information.

Column

Excerpt concerning the construction of an integrated monitoring and controlling system for environmental protection in industrial parks from the Guiding Opinions on Strengthening Environmental Protection Work in Industrial Parks (draft seeking public comments).

Park management departments should, in accordance with the monitoring regulations and the park's EIA planning, formulate park environmental monitoring programs and monitor the parks' groundwater, sewage receiving surface water, boundary atmosphere, environmental quality of the park and surrounding soil and environmental noise. While monitoring routine pollution, gradually strengthen the monitoring of specific pollutants. Park management departments should actively create conditions and gradually establish and improve the parks' digital online monitoring platforms, featuring pollution source monitoring, working condition monitoring and environmental quality monitoring. Additionally, connect with the local environmental protection departments at or above the county level.

Automatic monitoring devices and video monitoring systems should be installed at discharge outlets of main pollution sources in the park and the primary outlets of the sewage treatment plants. Parks with relevant equipment should gradually install automatic drainage control valves for key sewage discharge sites and gradually realize the automatic sample retention, card swiping and automatic sewage interception. Relevant regulatory authorities and sewage treatment plants should, according to the contract, use remote controls to limit or close the drainage valves for sites whose sewage flow, pollutant concentration and total amount of major pollutants emissions exceed the agreed-upon limit. Parks may provide centralized treatment for specific categories of wastewater in specific industries. In such cases, automatic monitoring devices should be installed for inlets of such wastewater into the park's centralized sewage treatment facilities.

3.3.8 Employ a Third-party through Innovative Mechanisms

Learn from the advanced industrial park water management practices from home and abroad. Designate a third-party, entrusted partners or operators who have expertise and experience in managing centralized wastewater treatment plants, recycled water plants and other infrastructures on the basis of specialization, standardization and delicacy management. Improve the operational performance of infrastructures in the industrial park and reduce the impact of water consumption and emission on the environment, through continuous research and optimization of water treatment technology.

Column

Opinions concerning implementing third-party governance of environmental pollution.

The third-party treatment of environmental pollution is a new method in which polluters entrust environmental service sites to perform pollution control by paying the fees agreed upon in the contract. Third-party governance is an important method to promote the construction, operational specialization and industrialization of environmental protection facilities. It is also an effective measure to promote the development of an environmental service industry.

The Opinions on the Implementation of Third-party Governance of Environmental Pollution (No. 69 document of the General Office of the State Council [2014]), developed by the general office of the State Council, requires that third-party governance of environmental pollution adhere to the principle that those who cause pollution should be held responsible. It also abides by the market-oriented rule under proper government guidance.

Avoid "arbitrary matchmaking", which is against the sites' desires, and create equal opportunities for social capital. The Opinion points out that by 2020, third-party governance in key areas such as public environmental facilities and industrial parks will have made significant progress because the efficiency and specialization level of pollution control will have significantly been improved and the vitality of social capital entering the pollution control market will have been further stimulated. The reform of the investment and operational systems of public environmental facilities has been basically completed. The market-oriented supply system of public environmental services, all of which feature high efficiency, high quality and sustainability, has basically been formed. The third-party governance format and mode have matured, with the mushrooming of a number of environmental service sites with strong technology prowess, high operational and management levels, sound credit levels and high international competitiveness.

3.3.9 Reuse Sludge from Wastewater Treatment Plants

Fully use resources such as energy infrastructures of an industrial park. Dehydrate the sludge, transfer it to adjacent thermal (power) plants and build a three-in-one industrial symbiosis of wastewater treatment plant-thermal (power) plant-sludge dehydration and incineration. Effectively use the waste heat from the power plant and effluent from the wastewater treatment plant to reduce the cost of sludge drying and heat loss in that process. Incineration can realize heat recovery as well as sludge reduction.

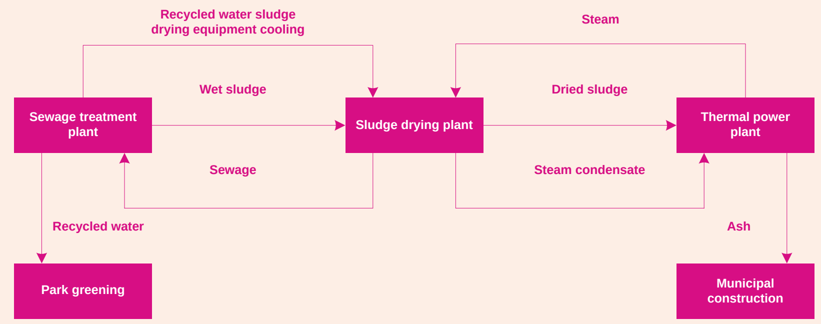
Column

The Suzhou industrial park - building a circular infrastructure symbiotic system.

Due to the large amount of sludge generated in the park, high energy consumption of the sludge drying process, high proportion of organic matter in sludge and high calorific value, the Suzhou Industrial Park has decided to dry the wet sludge (80% moisture content) generated in the sewage treatment process from the second sewage treatment plant by transporting them to the sludge drying plant. The two-stage drying equipment of the sludge drying plant utilizes the waste heat steam of

the thermal power plant to perform indirect heat exchange, and dry the wet sludge from 80 percent of moisture content to just 10%-20%. Because of the organic matter in the sludge, the heat value of the dry sludge is approximately 2600 to 2800 kcal, and the dry sludge can be used as low-heat-value fuel for recycling. Therefore, the sludge drying plant sends the sludge to the dry coal shed of the thermal power plant through a conveyer belt, and mixes and burns it with high-quality coal with a calorific value of 5500 kcal in a proportion of approximately 30%. In this manner, the calorific value in the dried sludge is fully recycled. The heat generated by the combustion of dry sludge and high-quality coal is used for power generation. The waste heat steam is used for central heating and refrigeration in the region. The steam condensate water with a temperature of 90 to 100 degrees generated after drying sludge is returned to the thermal power plant for recycling and heat energy recovery.

With a sewage treatment plant, a sludge drying plant and a cogeneration infrastructure as the core, the park, along with the Yueliangwan community, has formed a new energy supply mode that combines cooling, heating and power supply. This has replaced the traditional energy supply mode and realized the cascade and intensive utilization of energy. The industrial symbiosis mode can save 13,700 tons of standard coal per year, and the remaining slag after sludge incineration can be used as a building material.



Symbiotic mode of sludge drying in the thermoelectric industry in the Suzhou Industrial Park

Chapter 4

Industrial Park Water Stewardship Collective Actions at a Sub-basin Level

4.1 Identify Key Issues in Water Stewardship Collective Actions of IPs at a Sub-basin Level

Adopt a catchment ecological risk assessment method that combines life cycle assessment and a relative risk model to identify risk sources from sites, industrial parks and adjacent catchments that might cause damage to the ecosystem and the environment. Establish an environmental impact assessment system that identifies and analyzes the impacts of corporate and industrial park water stewardship actions on the surrounding catchment.

4.1.1 Definition of Sub-basin Boundary

A sub-basin of an industrial park usually refers to a relatively independent and closed natural catchment area that is formed by secondary and tertiary tributaries, bounded on the outlet section of a watershed and downstream river channel and with an area of less than 50 km2. There are generally three types of catchments: slope, interval and complete (See Fig. 4-1). A slope type (a) catchment is usually located on one side of a river and is a small catchment on the river bank. An interval type (b) catchment stretches across a section of a river. Its catchment area contains a small area on both sides. A complete type (c) catchment covers the entire river.

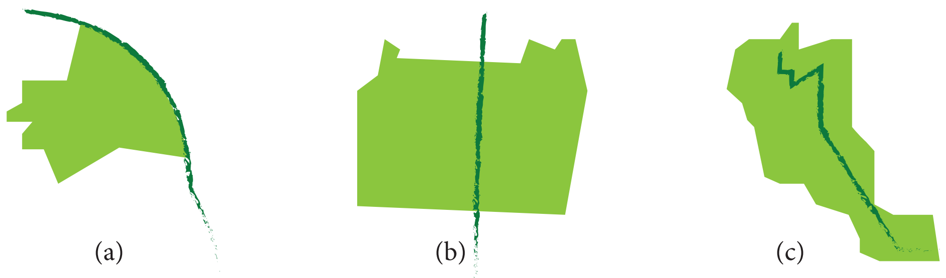


Fig 4-1 Types of catchments [3]

[3] A division of catchments in a plain area should follow four principles: catchment does not cross different watersheds, does not divide a single house, does not divide a single village and is relatively independent and closed. For a plain area where there is an abundant river system, such as the Taihu Basin, because the terrain is mainly plain and comes with a small slope, it is difficult to determine the boundary using the watershed concept. While hydrological simulation requires a significant amount of human and material resources, the "water convergence" method is recommended to determine the catchment boundary. The "water convergence" method uses the existing basin boundary and usually contains several catchments including the ones being researched.

Based on the location of the industrial park, investigate the hydrological conditions of the surrounding rivers, summarize the flow of rivers at all levels in the location of the park, determine the final inflow to rivers according to the flow direction of rivers and define small catchments.

4.1.2 Identification of Major Ecological Risk Sources in an Industrial Park

(1) Major Risk Sources

In an industrial park, sources of ecological risks are primarily the following: public infrastructures, such as centralized wastewater treatment plant, thermal (power) plant, hazardous waste incineration plant, waste landfill and construction projects.

(2) Major Stressors of Each Risk Source

Major stressors generated by risk sources include but are not limited to those shown in Table 4-1. In practice, stressors must be determined based on the specific types of industrial parks and drainage destinations and on the basis of correlation analysis.

Table 4-1 Identification of major risk sources and stressors in industrial parks

Risk source	Type	Stressors
Company	Water pollutant	Chroma, COD, BOD_5 and SS Heavy metal, sulfide, total nitrogen, total ammonia, total phosphorus, Cr VI and anilines
	Air pollutant	VOCs, SO_2, NO_x, CO_2
	Solid waste	Sludge of wastewater treatment, hazardous waste and general industrial solid waste
Wastewater treatment plant	Water pollutant	COD and SS
	Odor	Ammonia gas, hydrogen sulfide, methyl mercaptan and organic amines
	Sludge	Pathogen and heavy metal
Thermal (power) plant	Air pollutant	Falling dust, floating dust, SO_2, NO_x, PM and mercury emission from coal combustion
	Water pollutant	pH, COD, SS, F, As and thermal pollution
	Solid waste	Coal ash, FGD gypsum and slag
	Noise	High-frequency noise by boiler emitting gases
	Resource and energy consumption	Primary energy consumption and water consumption
Land utilization	Destruction to eco-system structure	Habitat destruction, soil erosion, change of surface runoff, and groundwater recession

4.1.3 Identification of Industrial Water Sources and Water Bodies Receiving Wastewater

Identify industrial water sources and water bodies in the sub-basin receiving the wastewater. Categorize them according to the following rules:

1. If the company sewage in the park is pre-treated and transported to a centralized sewage treatment plant through the collection pipe network for advanced treatment, the monitoring, supervision and prevention of the particular pollutants and toxicity-related risks of the sewage in the network should be strengthened. The concentrated industrial production in the park and the high load of effluent pollutants have imposed a significant and lasting impact on local water quality. The ecological environmental impact of the outlet of a centralized sewage treatment plant on the water area or sewage receiving body must be fully identified.
2. If there is no centralized wastewater treatment plant in the industrial park and sites process wastewater and discharge it into the surrounding water environment, it is suggested that the park management team fully identify the risks of the specific pollutants and toxicity, as well as the ecological impact on the catchment.
3. If the water source or sewage receiving body is not in the catchment where the research institute is located, it can either be categorized as indirect influence based on the actual situation or does not need to be marked.

4.1.4 Identification of Key Processes of an Industrial Park Causing Ecological Impacts to a Catchment Using a Life Cycle Assessment Method

Selecting an individual company or industrial park for analysis, construct a life cycle model (see Fig. 4-2), establish emission inventories, use LCA tools to identify major water-related environmental influences (such as global warming trends, ecological toxicity, eutrophication and acidification) caused by production activities of the company or the industrial park and the major processes generating these influences. Provide an analysis basis for an ecological risk assessment of the catchment.

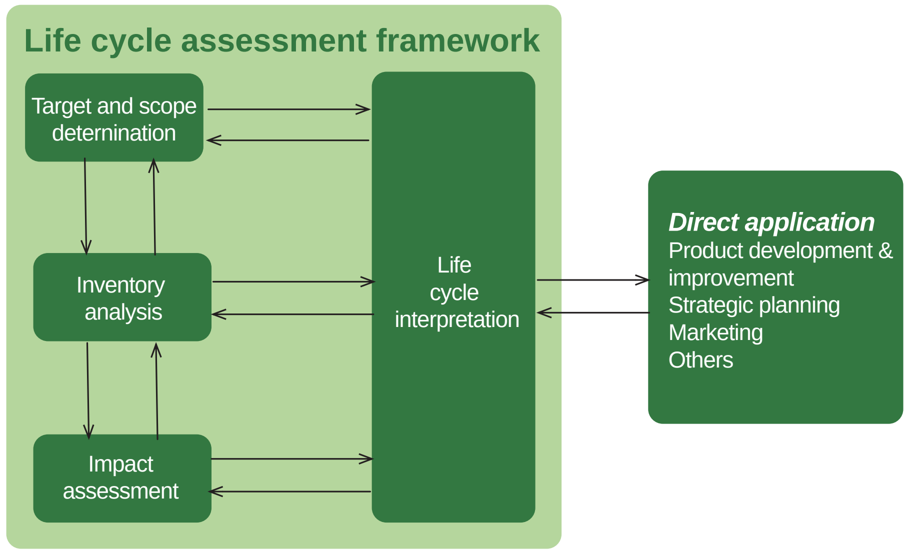
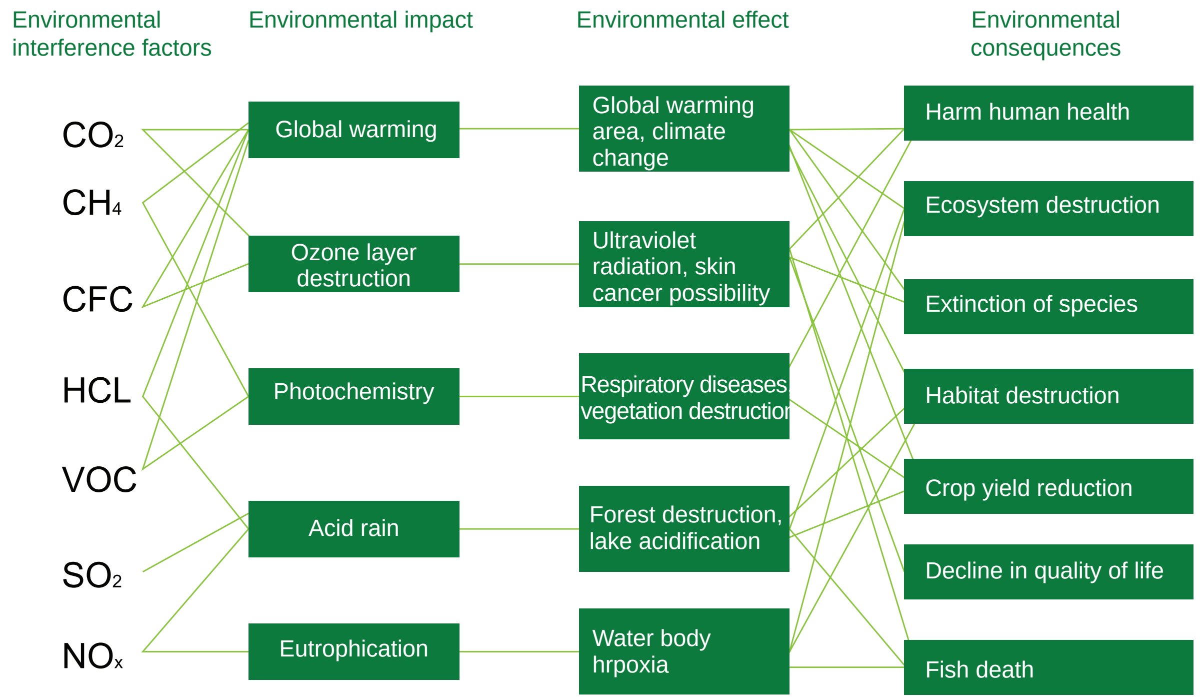


Fig. 4-2 Assessment model for a product life cycle

Causal chain relationship among environmental interference factors, environmental effects and environmental consequences



Source: Yan Jianxin, Xu Cheng. 2002, Method and Application of Product Life Cycle Assessment, Beijing: China Meteorological Press.

Industrial parks with a centralized wastewater treatment plant should use the annual emission of conventional pollutants and particular pollutants in the effluent as a major input to their emission inventory. Apply LCA tools to analyze the impacts of these pollutants on the catchment eco-system.

Industrial parks with no centralized wastewater treatment plant should use the emission of conventional pollutants and particular pollutants in the effluent released by "double high" sites as the primary input to their emission inventory, and conduct an LCA analysis accordingly.

4.2 Evaluation of Collaborative Water Stewardship in Parks and Sub-basins

In accordance with water quality standards and water functional area requirements of surrounding catchments, and in view of the EIA requirements of park planning, a park environmental monitoring scheme should be formulated, and monitoring of the park's groundwater, sewage receiving surface water, boundary atmosphere, environmental quality and environmental noise monitoring of the park and surrounding soil should be implemented.

Based on the park's digital online monitoring platform, evaluation of collaborative water stewardship between the park and the surrounding small catchment is performed based on the above monitoring data.

Establish the relative risk model between sites/parks and surrounding catchments, score the risk sources of parks and surrounding catchments by means of a watershed habitat survey and evaluate the ecological risks of surrounding watersheds influenced by industrial production in the parks. Score the main risk sources in the park, based on the identification of the main risk sources in the park and referring to the main impacts on the watershed ecological environment identified by the life cycle assessment and the related emission standards of the stressors. Additionally, identify the most important risk sources to provide information for park management decision-making.

4.2.1 Evaluation of a Sub-basin Habitat

Select rivers of a sub-basin habitat for evaluation. Investigate the current situation of the catchment ecosystem through a River Habitat Survey (RHS). Employ a "habitat quality index" and a "habitat degradation index" to assess the status of a catchment habitat and analyze major sources causing habitat destruction (see Annexes V and VI for specific methods).

Score the river habitats surrounding the monitored river section with these habitat assessment indexes (see Table 4-2). This score will be used in the calculation of the relative risk model to obtain the habitat relative risk value.

Table 4-2 Identification and scoring of the catchment habitat

Habitat	Score (0—6)	Criteria	
Physical habitat	0	Comprehensive assessment index	< 1
	2		1-4
	4		5-10
	6		> 10
Aquatic ecosystem	0	Interior class V, without any aquatic animals	
	2	Classes IV and V, small amount of fish and benthic animals	
	4	Class III, relatively more fish and benthic animals	
	6	Classes I and II, rich aquatic animals	
Ditches, ponds and wetlands	0	Serious blockage of ditches, filled ponds and no wetland characteristics	
	2	Small amount of water in ditches, small and fragmented pond water surface	
	4	A variety of aquatic plants growing in ditches and relatively abundant water in ponds	
	6	Well-preserved wetlands, existence of abundant species and obvious wetland characteristics	

According to the characteristics of the catchment habitat, define ecosystem integrity, biodiversity and hydrological safety of the catchment as assessment endpoints. The relationship between the habitat and the assessment endpoints can be found in Table 4-3.

Note 1:
Establishing a relationship table between a catchment habitat and assessment endpoints is one step in building a relative risk model, which is used to evaluate the influence of damage/improvement of the catchment habitat on the assessment endpoints. For instance, the Taihu Basin has a river network and a drainage system with typical plain features. When we assess the influence of the basin habitat on the assessment endpoints, riparian physical habitat and ditches, ponds and wetlands will reflect ecological integrity; biodiversity is closely related to riparian physical habitat, water quality and ditches, ponds and wetlands; and riparian physical habitat and ditches, ponds and wetlands together determine the flood discharge and water storage capability of the basin, which is related to hydrological security.

Table 4-3 Relation of sub-basin habitat and assessment endpoints[1]

	Physical environment	Aquatic ecosystem	Ditches, ponds and wetlands
Integrity of water eco-system	√		√
Biodiversity	√	√	√
Hydrological security	√		√

4.2.2 Industrial Park Sub-basin Ecological Risk Assessment

Assess the relative risk of the sub-basin according to formulas (1) through (3).

Relative risk value of risk source = risk source score × exposure factor (1)

Relative risk value of habitat = risk source score × exposure factor × habitat score (2)

Relative risk value of assessment endpoint = risk source score × exposure factor × habitat score × effector (3)

The exposure factor refers to the level of exposure risk when the habit is influenced by stressors, which is defined by the distance between the stressor, the habitat and the stressor's spreading scope (select 0, 0.5 and 1, respectively).

The effector refers to the level of influence on the assessment endpoints when the habitat suffers an exposure risk. The effect coefficient is defined by the sensitivity of the assessment endpoints to the stressor (select 0, 0.5 and 1).

Calculate the relative risk values of all risk sources, habitats and assessment endpoints before and after the industrial park water stewardship practices. Assess the risk sources and habitats with comparatively higher ecological risk, evaluate the influence of industrial park water stewardship implementation on the assessment endpoints, thus relating industrial park water management to catchment ecological risks, and provide timely feedback concerning the industrial park water stewardship practices. Rank the relative risk value of risk sources, habitats and assessment endpoints to identify risk sources and habitats with higher risks and assessment endpoints with significant influence.

4.3 Industrial Park Sub-Basin Collaborative Water Stewardship Actions

The expected goal of industrial park sub-basin collaborative water stewardship is to improve the connection between parks and the surrounding catchments and guide multiple stakeholders to cooperate to improve the ecological environment of a park's surrounding catchments.

4.3.1 Water Stewardship Actions to Improve the Relationship between an Industrial Park and a Sub-basin

4.3.1.1 Maintenance of the Riparian Habitat and the River Buffer Zone

A river habitat is an important component of a river ecosystem. It is the foundation for the survival of river species. In the process of industrial park development and construction, we should be aware of the importance of preserving the riparian habitat and conserving the river buffer zone. Determine the width of the river buffer zone according to the demand of treating non-point source pollution and the current land utilization. The following actions are recommended:

- Establish a thirty-meter buffer zone for rivers surrounding farmland and orchards; and
- Establish a ten-meter buffer zone for rivers that runs through villages or towns. Adjust according to the land's use.

4.3.1.2 Recover the network containing a tributary ditch and pond and restore a channelized river bank

For industrial parks in plain areas where there is a complex river system, combine water utilization in flood seasons to dredge ditches and connect them to ponds and main streams. Recover ditches, ponds and river network systems, and gradually increase self-purification capacity.

River channelization damages river habitat and weakens the river's self-purification ability; additionally, it limits the expansion of flood water to both sides of the river and causes faster water flow and more significant flood damage. From the perspective of river ecosystem protection and hydrological security, the existing channelized river bank should be restored. There are different restoration methods for flood-prevention, residential area and agricultural area river banks, which are listed as follows:

- For a flood-prevention river bank, soil and stone can be coated on the surface of the revetment structure to soften the rigid structure;
- For integral vertical reach near a residential area, the top priority is to restore revetment to ensure the safety of the cross-section. Riparian restoration may consider coating the soil on the surface of the rigid revetment structure; and
- For a river channel in an agricultural area, biological engineering may be considered for revetment treatment to recover the natural river bank. At the same time, lower the slope without reducing the cross-section to ensure flood discharge. Additionally, establish a concave wetland at the river banks and allow agricultural water discharge to overflow the concave wetland to intercept a portion of the non-point agricultural source pollution.

4.3.1.3 Determine the flow dynamics of a river system in the catchment and build a wetland ecosystem with a water-retarding function

Flow dynamics is an important indicator of river system health. However, investigations show that river culvert dams are so densely allocated that rivers lack hydraulic power and there is an obvious trend of eutrophication. Meanwhile, impounding facilities block the migration of fish and other aquatics, causing severe damage to the aquatic ecosystem.

Therefore, impounding facilities such as dams and sluices should be gradually reduced to connect river systems and increase hydraulic power. From the perspective of hydrological security and water conservation, impounding a wetland system can be built at river intersections to complete an integrated rain-flood security pattern along with regional river channels, ditches, ponds, bank protection forests and other landscapes.

4.3.2 Multiple Stakeholders Cooperate to Improve a Sub-basin Eco-environment

The improvement of a sub-basin eco-environment requires joint efforts from the government, industrial sites, sites in the environmental industry, financial institutions and NGOs. The cooperation of all stakeholders is the organizational basis of catchment environmental improvement. Establish coordination mechanisms among relevant local governments in the catchment, organize all stakeholders to establish a cooperation mechanism and coordinate relationships among all parties. Each party should be clear of its position and coordinate with other parties to achieve optimal allocation of resources and maximize environmental and economic benefits. See Fig. 4-3 for the relations among multiple stakeholders in the industrial park-catchment collaborative water stewardship action. action.

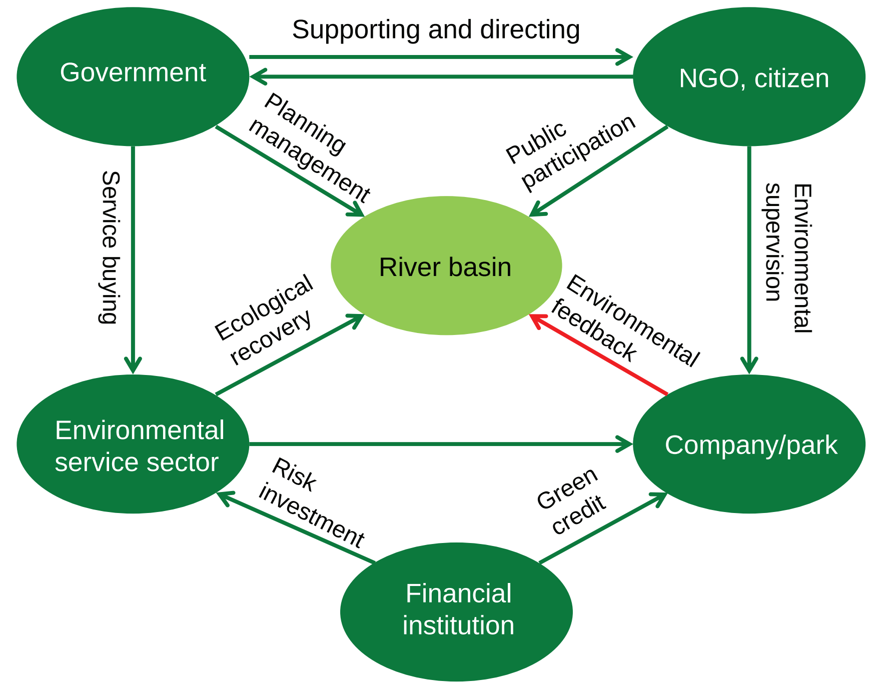


Fig. 4-3 Relations among multiple stakeholders in the industrial park-catchment synergized water stewardship action

4.3.2.1 Design of a Government-guided Scheme for Improving a Catchment Environment

Improving a catchment environment is a complex and comprehensive project that involves corporate management, industrial park planning and catchment management. The Government should lead industrial park water stewardship and the improvement of the catchment's environmental quality. Park management departments should encourage and guide sites to perform water stewardship practices through standard setting, environmental supervision, communication platforms building, public services improvement, , resource integration and mechanism innovation. Through mechanism innovation, sites can share best water stewardship practices through industrial chain collaboration and industrial symbiosis, and support environmental service sites and financial

Chapter 4 Industrial Park Water Stewardship Collective Actions at a Sub-basin Level

institutions to actively participate in catchment management. This would form effective joint efforts to reduce water consumption and reduce impact on the catchment's ecological environment. The park management department and the local governments concerned in the river basin can work together to improve the ecological environment by establishing effective cooperation mechanisms of joint defense and control, developing comprehensive management and ecological environment improvement plans, strengthening joint environmental supervision and law enforcement, improving infrastructure construction for ecological environmental protection, creating good communication within the river system of the river basin and building stagnant wetlands.

4.3.2.2 Eco-service Providers should Participate in Watershed Management through Contracts for Environmental Services

Eco-service suppliers can provide high-quality environmental governance services for local governments in parks and catchments through environmental services contracts. A contract is signed by the local governments (or park management departments) in the catchment and the eco-service providers. The basin's environmental improvement and governance project can either be treated as a whole or divided into several parts, with the goal of improving the catchment's environmental quality. The environmental responsibility can be handled in a centralized manner through government charges and purchase services. Alternatively, catchment eco-service providers can be subsidized by the local governments of the park or the catchment through tax incentives, environmental funds, financial subsidies and other forms. Catchment environmental governance projects are suggested to start pilot projects through ecological riparian construction, ecological function restoration of ditches, ponds and wetlands, transformation of channelized rivers and the construction of impounding wetlands and parks.

4.3.2.3 Financial Institutions Provide Support for Catchment Management by Leveraging Financial Capital

Environmental improvement at the company, industrial park and catchment levels require a significant amount of funding, which could incur investment risks and green credit for financial institutions. It is critical for relevant parties to leverage capital. Park administrative authorities and local governments in the catchment area are advised to provide financial support through various channels, establish special funds for catchment environmental governance and fiscal subsidies. Through the guidance and leverage of government financial input, social capital can also be directed into catchment environmental governance to promote joint governance.

4.3.2.4 Encourage the Active Participation of Public and Environmental NGOs

Public participation is an important part of catchment management. Non-governmental environmental organizations have become a principal part and a driving force that cannot be ignored in solving global and regional environmental problems. Environmental NGOs can actively participate in law enforcement supervision, public participation in environmental impact assessment and voluntary river monitoring. They also facilitate communities to participate in the supervision and management of projects. Moreover, by using their expertise in various areas, NGOs can guide sites and the public to adopt green production and lifestyle, which forms a solid foundation of public participation in catchment management.

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Chapter 5

Water Stewardship Implementation

5.1 Planning and Organization

Planning and organization are of great significance for delivering expected results. A working group composed of the park management committee, representatives of key sites, NGOs and consulting experts. First, gain the trust of the park and company managers by clarifying the expected investment and benefit of the project. Establish the park water management innovation working group, and gradually identify and include key figures in the company management departments into the process of promoting water stewardship. Fully employ new media means, organize online and offline seminars, cooperate with industry experts to help member sites diagnose water resource efficiency and establish improvement goals. Sites can also strengthen their relations with each other through the development of activities, learn from each other and improve together.

5.2 Target Indicators

Based on the evaluation of the current situation of key sites, parks and surrounding catchments and comprehensive investigation of the basic situation through qualitative and quantitative analysis, the emphases of water stewardship are determined at each of the three levels of sites, parks and surrounding catchments. The overall goal and/or phased goal of water management innovation practices in parks are formulated from the three aspects of improving the water management process, strengthening water management system construction and improving water management performance. Feasible target indicators are established. Refer to the corresponding paragraphs in Chapters 2 through 4 for specific goals at the three levels.

5.3 Implementation Plan

Identify the key processes of water consumption and wastewater and water pollutant generation through water balance tests. Propose every potential water stewardship action plan to solve the discovered issues via a brainstorming session; then, select feasible action plans through decision trees, multi-criteria ranking or other methods. Perform technological, economic and environmental analysis of the selected plans to determine the action plan to be executed. The aim of feasibility analysis is to evaluate the technological, economic and environmental benefits of medium- and high-cost plans, with reference to the cost/benefit analyzes of high-cost plans of cleaner production. When implementing the plan, established staged plans and goals at three levels and clarify the responsibilities and rights of the different stakeholders. The stakeholders should engage in the action in a timely manner and follow up with the implementation process. The action plan should be revised if necessary.

5.4 Support and Guarantee

Industrial park water stewardship action not only involves an administration committee, sites, catchment authorities and NGOs but also depends on market mechanisms, capital investment, human capacity investment, a management system, statistics and monitoring, information discharge, technical support, communication and promotion and public participation. Hereinto, an industrial park administration committee and key sites are the primary implementers of industrial park water stewardship practices; their support is crucial.

In accordance with the requirements of the Opinions of the State Council on

the Implementation of the Strictest Water Resources Management System and the Action Plan for Water Pollution Prevention and Control and in view of the local context, the industrial park administration committee should integrate a water stewardship concept into the daily operation of the industrial park, and encourage sites to closely connect water stewardship practices with their production and service provision processes. Establish a system of information collection, analysis and accounting to include in the daily statistics system of the industrial park and connect it to the statistics department of the government, providing management methods and data support to the industrial park's daily supervision, performance assessment and technical guidance from the national and regional government. The industrial park administration committee should strengthen their administrative supervision by establishing a strict monitoring system for water management, and engage the departments of water affairs, construction, environmental protection and statistics for collective approval and supervision of the water supply, water use, water discharge and sludge disposal and key sites to advance the practice of water stewardship in an industrial park.

Chapter 6

Evaluation and Improvement

6.1 Purpose and Scope of Evaluation

To advance water stewardship implementation in industrial parks, accelerate the transformation of water management perception and comprehensively evaluate the performance of water stewardship, a third-party agency should be introduced to independently perform an audit to identify the activities successfully performed and those to be corrected and improved. Under the support of the industrial park administration committee, WWF, AWS or other qualified institutions, evaluate the water stewardship performance and provide feedback to the industrial park administration committee and sites. The evaluation process should be objective, concise and progressive and a combination of universalism and individualism. Field study, literature research and analysis of monitoring data should be adopted.

Objects Evaluated:

The industrial park and the catchment are the two major objects evaluated.

Content of the Evaluation:

(1) Evaluate the water management standard system and water management process, including completeness of the process, compliance and infrastructure status.

(2) Evaluate the results. At the industrial park level, include water saving, efficiency of water use, reduction of wastewater discharge and compliance with the pollutant emission standard. At the catchment level, include improvement of water quality and control of water risks.

(3) Evaluate the cost, benefits and output of the economic investment.

Method of Evaluation:

This includes the overall evaluation plan, standards and processes. It can be a self-evaluation or a third-party evaluation of the industrial park.

Criteria for Evaluation:

The evaluation indicator system at the three levels is used for evaluation.

Application of Evaluation Results:

The feedback mechanism is applied to industrial parks in decision making such as business entry approval, and applied to decision making for water resource allocation to control the overall water use quota.

6.2 Content Evaluation

The Guidance not only evaluates the performance of water stewardship but also includes the water management system and institutional construction in the evaluation, thus forming an evaluation framework of "management process-institutional construction-performance improvement".

6.2.1 Industrial Park Water Management Process

The evaluation of a water management process is a process-based evaluation that uses empirical data to identify whether the water management process of an industrial park could support the achievement of the water stewardship goal. The process evaluation focuses on input and action and presents the benefit generating mechanism to stakeholders in a relatively transparent way. It is helpful for managers to clarify the project implementation's compliance with the plan and for assessors to distinguish whether the failure in achieving the expected results is due to the plan itself or its implementation, while simultaneously improving the management process for the next round of implementation. In addition, industrial park managers can discover the best practices of project implementation using process evaluation.

6.2.2 Industrial Park Water Management Institutional Construction

The evaluation of water management institutional construction is a process-based evaluation that examines whether an industrial park's water management institutional system is sound and can provide sufficient support for the implementation of industrial park water stewardship. Research and summarize the policies and actions related to industrial park water management released and performed by national, basin, provincial and municipal governments. Construct the framework and content of an ideal water management system and compare it to the existing system with assigned scores. The evaluation can provide a basis to improve the institutional construction of a water management system and provide references for all levels of government during policy development for industrial park environmental issues.

6.2.3 Industrial Park Water Management Performance

The evaluation of water management performance is a results-based evaluation with two goals. First, assess whether the consumption of water resources in the industrial park can maintain the basin environmental system to ensure the water consumption matches the naturally renewable water resources and mitigates the negative impacts of industrial park water consumption on basin water quantity. Second, assess the physical, chemical and biological natures of the industrial park's water bodies and those of the adjacent catchment to determine whether they can achieve the requirements of local standards and satisfy the regional ecological demands, thus mitigating the negative impacts of industrial park water consumption on basin water quantity and water quality. The performance evaluation adopts the "pressure-status-response" (PSR) model as its overall framework and chooses indicators that meet international practices and domestic policy orientation to establish a system of evaluation indicators. The performance of an industrial park water stewardship practice could be reflected through the evaluation, which provides references for the industrial park administration committee's decision making.

6.3 Evaluation Methodology

6.3.1 Evaluation of Management Process

The indicator system includes five primary indicators, 16 secondary indicators and 51 indicator parameters. Different parameters have different rating criteria, and the score of each parameter is between 0 and 3, rated based on the actual situation and the rating criteria. The indicators at all levels are calculated by summing the indicators at the lower level or their scores. (See the system of evaluation indicators and rating criteria in Annex VII Indicator System for the Assessment of Industrial Park Water Stewardship.)

6.3.2 Evaluation of Institutional Construction

The indicator system includes 6 primary indicators and 30 evaluation parameters. The score of each parameter is between 0 and 5, divided into 5 levels. The total score of each primary indicator is calculated by summing the scores of every parameter and the total evaluation score of system construction is calculated by summing the scores of the primary indicators. (See the system of evaluation indicators and rating criteria in Annex VII Indicator System for the Assessment of Industrial Park Water Stewardship.)

6.3.3 Evaluation of Management Performance

The indicator system includes primary indicators, secondary indicators and evaluation parameters; the evaluation parameters can be further divided into core and full-scale indicators. The score of each parameter is between 0 and 6 and different parameters are assigned based on their proximity to a target value. The total score of each primary indicator is calculated by summing the scores of every parameter and the total evaluation score of system construction is calculated by summing the scores of the primary indicators. (See the system of evaluation indicators and rating criteria in Annex VII Indicator System for the Assessment of Industrial Park Water Stewardship.)

6.4 Evaluation Approach

A performance evaluation can be a self-evaluation or a third-party evaluation of an industrial park, which is conducted by combining on- and off-site evaluations. On-site evaluation refers to field investigations and evaluations within the industrial park, organized by an authorized third-party using an indicator system after receiving the performance report, while off-site evaluation refers to an evaluation in combination with the performance report and relevant materials based on verification of the on-site evaluation.

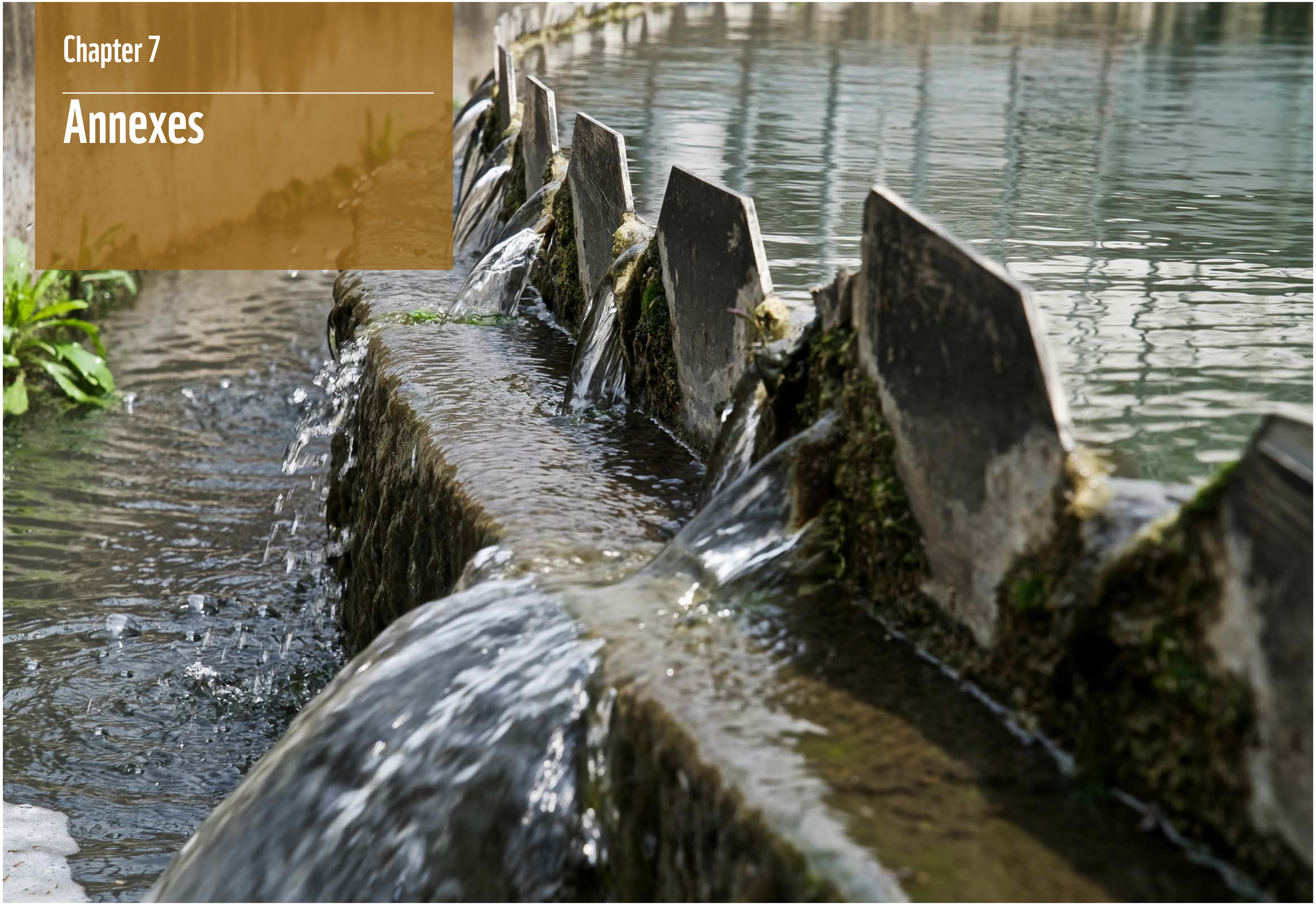
6.5 Continuous Improvement

Continuous improvement includes but is not limited to the following:

1. Industrial park water stewardship capacity building;
2. Continuous optimization of the industrial structure in the industrial parks;
3. Reduce resource and energy consumption and increase industrial park productivity;
4. Improve environmental quality and ecological benefits of industrial parks;
5. Focus on tackling the key environmental problems related to water management in the industrial parks;
6. Improve the capacity to respond to emergencies relevant to the industrial park water environment;
7. Enhance the construction of an ecological civilization;
8. Strengthen environmental information disclosure and public participation;
9. Increase awareness of creating an atmosphere for water stewardship action; and
10. Improve the statistics, monitoring and evaluation system for industrial park water stewardship.

Chapter 7

Annexes



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Annex 1 Terms and Definitions

1. Industrial Park

An industrial park is an area of concentrated industrial activity with a legal boundary and a defined coverage area that is managed by or provided services from uniform institutions. The main functions of the area should be product manufacturing and energy supply, including economic and technological development zones, high- and new-tech development zones, economic development zones and industrial parks of all types.

2. Eco-Industrial Park

An eco-industrial park is a new type of industrial park constructed in accordance with the concept of a circular economy, the principle of industrial ecology and the requirements of cleaner production, which connect different factories, sites and industries through innovation of concepts, systems and mechanisms and provide sustainable service systems. Hence, it forms a symbiotic industrial group that shares resources, exchanges by-products and employs a recycling mode of "producer-consumer-decomposer". It seeks closed-loop material recycling, energy cascading and information feedback, thus achieving industrial park sustainable development. Here, it specifically refers to the industrial parks certified and granted the title through the standard procedures of *The Management Methods of the National Eco-Industrial Park Demonstration*.

3. Water Stewardship

WWF defines water stewardship for a business as continual improvement of water use and a reduction in the water-related impacts of internal and value chain operations. More importantly, it is a commitment to the sustainable management of shared water resources in the public interest through collective actions with other businesses, governments, NGOs and communities.

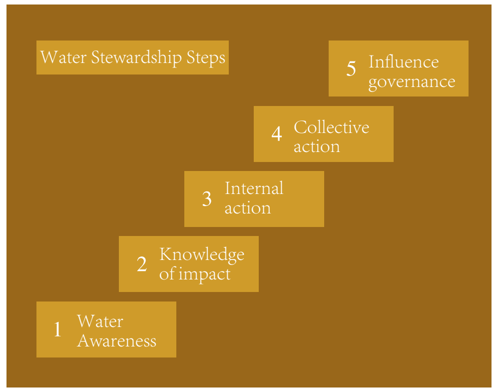

Fig. 1 Five steps of water stewardship

Each of the water stewardship steps in Fig. 1 represents an aspect of responsible engagement with water issues for a company or sector. These steps do not need to be taken in any particular order, but those with higher numbers are increasingly challenging and further from the "core" of normal business approaches to sustainability issues. Steps 4 and 5 are critical to a company's successful engagement with water. They are where the company goes beyond its own control and engages with risks, stakeholders and regulators "outside the factory fence". The stewardship approach emphasizes that sites and other actors share risks on water within a basin and that it is impossible for a company to address these risks in isolation.

4. Industrial Ecology

Industrial ecology considers the relationship between the industrial system and the surrounding environment interactively instead of separately. It is a methodology attempting to optimize the entire process of material recycling from raw materials, processed materials, by-products, products and waste materials to the ultimate disposal of products. The elements to be optimized include material, energy and capital. In industrial ecology, the development of an industrial park, as an anthropologic economic system, imitates the natural ecosystem. Within the industrial park, the exchange of raw materials, products and wastes between different sites maximizes its value and reduces consumption and pollution, propelling the industrial park to make long-term sustainable contributions to society and the economy.

5. Sub-basin

Sub-basin refers to an independent and closed natural water area under secondary and tertiary tributaries, smaller than 50 km^2, whose boundaries are usually watersheds and outlet sections of downstream rivers. This guidance primarily focuses on sub-basins surrounding industrial park.

6. Water Risk

The concept of water risk is jointly proposed by WWF and Deutsche Investitions- und Entwicklungsgesellschaft (DEG) and refers to the risks related to water caused by natural factors or human activities that directly jeopardise the development of human beings. It includes physical, regulatory and reputational risks, as shown in Fig. 2. On this basis, WWF and DEG released the Water Risk Filter in 2012, which is an online assessment tool of water risks on a global scale (http://www.waterriskfilter.panda.org), including an indicator system for water risk assessment at national, basin and site levels, aimed at assisting sites and investors globally to address water risks. WWF and DEG also formulated online questionnaires to assist sites in identifying the water risks in their supply chains and investment plans while providing pragmatic steps to mitigate water risks.

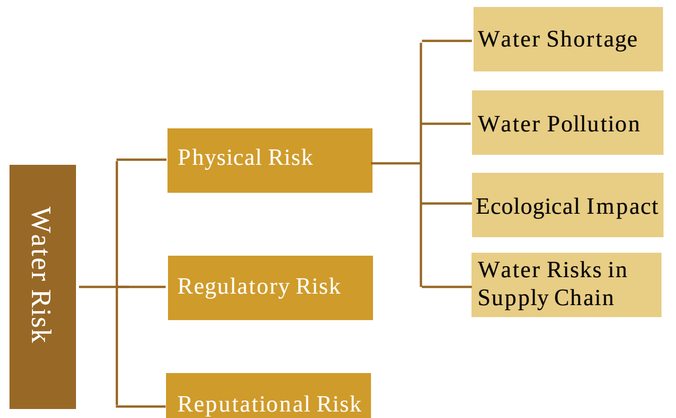

Fig.2 WWF's framework for water risk analysis

7. Water Balance Testing

Water balance testing refers to the process in which systematic tests, statistics and analyzes of water use units and water use systems are conducted and the water balance is obtained. Water balance is the equivalence between total water input and total water output in a defined water use system. See the detailed process in the General Principles of Water Balance and Test for Sites (GB/T 12452-2008).

8. Water Productivity

Water productivity refers to the gross value of products generated by consuming industrial freshwater resources. The higher the ratio, the more benefits generated by water consumption. Industrial freshwater refers to the total water acquired from any source by water use units or systems of sites in the industrial park for primary use in production and supporting activities, excluding the portion of domestic water measured and emitted separately (from industrial wastewater). In this guidance, it particularly refers to the added industrial value per unit of freshwater consumption in industrial parks.

9. Wastewater Discharge Intensity

Wastewater discharge intensity refers to wastewater discharge per unit of GDO. The lower the ratio, the less the wastewater is generated from economic activities, i.e., the better the performance. In this guidance, it particularly refers to the industrial wastewater discharged by industrial parks for one unit of added industrial value. Industrial wastewater refers to the wastewater emitted to the environment after being processed by a concentrated wastewater treatment plant and meeting certain emission standards.

10. Primary Pollutants

Primary pollutants refer to the four pollutants whose total emission is restricted by national regulations, i.e., chemical oxygen demand (COD), sulfur dioxide (SO2), ammonia nitrogen (NH3-N) and nitric oxides (NOx).

11. Particular Pollutant

Particular pollutant refers to the representative pollutants emitted by a certain industry, which can indicate the pollution level of the industry. According to the 13th Five-Year Plan of Environmental Risk Prevention and Chemicals Control, featured water pollutants include: petroleum, volatile phenol, cyanide, fluoride, sulfide, benzene, methylbenzene, ethylbenzene, anilines, formaldehyde, nitro benzoates, acids, dibutyl phthalate, dioctyl phthalate, acrylonitrile, chlorobenzene, chemical pesticides and phenol; specific air pollutants include: formaldehyde, benzene, methylbenzene, xylene, phenols, benzopyrene, fluoride, chlorine, hydrogen sulfide, anilines, chlorobenzenes and chloroethylene.

Note: 1) The water pollutants (petroleum, cyanide, benzene, methylbenzene, acids and phenol) and air pollutants (benzene, methylbenzene, xylene, chlorine, aniline and hydrogen sulfide) are also key chemicals to be prevented and controlled because they cause frequent and emergent environmental incidents. 2) persistent organic pollutants and heavy metals are not this list.

12. Water Recycling

Rainwater, industrial water and domestic water are properly processed or unprocessed by a wastewater treatment plant to achieve certain water quality standards and can be re-utilized. Here, water recycling refers to the water from the processed water of a wastewater treatment plant that is further purified through regeneration technology to achieve a water reclamation standard (See *The Quality Standard for Recycling Water (SL368-2006)*).

The water recycling ratio refers to the ratio between the amount of recycled water in the industrial park and the amount of total qualified wastewater emission from the industrial park's wastewater treatment plant.

13. Industrial Water Reuse Rate

The industrial water reuse rate refers to the percentage of reused industrial water in the production processes of sites in the industrial park to the total industrial water use during a defined time span. The total industrial water use refers to the total water consumed in definite water use units and systems by the sites in the industrial park, i.e., the sum of water withdrawal and industrially reused water in which water withdrawal refers particularly to the consumption of freshwater.

14. Life Cycle Assessment

Life cycle assessment (LCA) is a new environmental management tool. ISO defines it as the method of summarizing and assessing all the inputs and potential environmental impacts of a product (or service) system during its entire life cycle. The International Society for Environmental Toxicology and Chemistry (SETAC) defines it as a method to identify and quantify the environmental pressure of products, manufacturing technologies and activities that assess the utilization of energy and material and the impact of wastes on the environment, and identifies and takes opportunities to reduce environmental impacts. This assessment is performed throughout the entire life cycle of production, production processes and activities, including the extraction of raw materials, manufacturing, transportation and sales of products; use, reuse and maintenance of products; and recycling and final wastes. The eBalance LCA software and database used in this guidance is full-featured LCA analysis software independently developed by IKE, which supports data collection and LCA modelling analysis.

15. Basin Ecological Risk Assessment

Basin ecological risk assessment refers to the description and evaluation of the possibility of environmental pollution, human activities or natural catastrophes resulting in negative impacts to different types of ecosystems and the extent of such damages at a basin level.

16. Relative Risk Model

Currently, the relative risk model (RRM) is one of the most widely applied ecological risk assessment models at a basin level. It is a regional complex-pressure risk assessment model proposed by Landis et al. in 1997. The model grades the risk source, pressure factors (stressors) and the habitats in the assessment area with a hierarchical system and performs a quantitative assessment of risks by analysing the interaction between the risk sources, habitats and risk sufferers.

17. Risk Source

A risk source is a source that poses risks to the natural environment, including human activities, various natural disasters and human accidents (flood, typhoon, storm, earthquake, landslide, fire and nuclear leakage) in addition to pollutants.

18. Stressor

Stressor refers to the risk factors from risk sources, also known as pressure factors.

19. River Habitat Survey

The British River Habitat Survey (RHS) began in 1992. At the request of the European Water Framework Directive (WFD), the British Environmental Protection Agency published the RHS Field Investigation Handbook and completed it in 2003. The RHS assesses the quality of a habitat and determines the conservation value of river segments based on river types through investigation of the physical structure of rivers and the collection of basic anthropologic interference factor data, thus providing a decision-making basis for the management of a river environment, especially the ecological restoration of rivers and environmental impact assessment of construction projects that destroy the physical structure of rivers.

20. Habitat Quality Assessment

The Habitat Quality Assessment (HQA) assesses habitat quality from the aspects of nature, diversity and rareness.

21. Habitat Modification Score

The Habitat Modification Score (HMS) assesses the damage to river habitats caused by human activities.

22. Habitat Comprehensive Assessment

The Habitat Comprehensive Assessment (HCA) reflects the current status of habitats comprehensively; HCA=HQA/HMS.

23. Key Water-Related Areas

Key water-related areas include environmental areas with a high conservation value and the areas with high cultural and social value. The anthropologic water-related areas in industrial parks mainly include industrial water, tap water and wastewater treatment plants and some water outlets and inlets surrounding the industrial parks. Natural water-related areas mainly include lakes, rivers, wetlands, riverside areas, marshlands, river convergence areas and river banks.

24. Creation Of Shared Value

Creation of shared value mainly includes economic, social and environmental value. Economic value mainly includes workers' work and salaries, fees paid to governments and other expenses included in the operations cost and investment in communities. Social value includes the opportunities for improving sanitary conditions (water-related), education (water-related), public participation in basin management and water-related entertainment activities. Environmental value includes improving the integrity of freshwater or wetland habitats while reducing pollutant emissions, conserving freshwater species and enhancing a series of ecosystem services related to water.

Annex II Commitment to Corporate Water Stewardship Practices

Water is crucial to social development and we are fully aware that human activities and climate change will profoundly impact the usability of water. Hence, we will make efforts to implement the water stewardship standards, conserve water by strengthening corporate water management and water treatment technologies, and reduce the generation of wastewater. We will collaborate with stakeholders to launch activities and improve management related to water use. I, as a representative of the management team of the company, will remain committed to the implementation of this water management policy while encouraging and motivating our staff to participate in water stewardship actions.
According to our current environmental policy, we hereby promise to:

1. Support the company in being a responsible water steward and achieving water stewardship objectives, i.e., good water management and sustainable water balance.
2. Ensure safe water use by the staff, provide sanitary facilities and enhance the staff’s awareness of hygiene.
3. Encourage stakeholders to participate in the water stewardship action plan in an open and transparent manner and comply with relevant laws and regulations.
4. Support industrial parks to execute water-related plans and policies.
5. Maintain the departments needed to implement water stewardship actions and grant them corresponding rights, including manpower and material resources, required for the successful implementation of the water stewardship action plan.
6. Disclose important water-related information properly to stakeholders.

Signature:

Position:

Date:

Annex III Questionnaire to Sites

Table 2 Example of a questionnaire given to sites for investigation

1. Company profile

Name				Date of		Major Business	
Type	□state-owned □foreign invested □shareholding □private □others			Products mainly sold to		Annual Production Value (10,000 Yuan)	
				Number of Employees		Annual Production Days	
Contact Name		Tel/ Mobile		Position		Email	

2. Main products and consumption of raw materials, water resources and energy (Attach additional pages)

Main Product(s)	Name	Annual Output		Unit	Annual Production Value (10,000 Yuan)	Note
Input of Raw Materials (Attach additional pages)	Name	Annual Consumption		Unit	Proportion provided by the industrial park	Import Volume
Consumption of Water Resources	Input of Resources	Annual Consumption		Unit	Unit Price	Major Origin of Supply
	Tap Water					
	Surface Water					
	Recycling Water					
	Unconventional Water Resources (Indicate the name)					
Introduction of processes with major water consumption (Attach additional pages)						

	Name	Annual Consumption	Unit	Unit Price	Major Origin of Supply
Consumption of Energy	Coal		Ton		
	Natural Gas		10,000 m^3		
	Electricity		10,000 kWh		
	Renewable Energy				
	Steam (Purchased externally)	(Attach steam parameters)	Ton		
	Steam (Self-produced)	(Attach steam parameters)	Ton		
	Gasoline		Ton		
	Diesel		Ton		
	Heavy Oil		Ton		
	Others (Indicate the name)				
Information of equipment with major energy consumption: (Attach additional pages)					

3. Pollution treatment

Wastewater	□ discharged directly □ discharged indirectly	Wastewater treatment Process				Daily Wastewater Treatment Volume	
		Treatment of Sludge		□ landfill □ combustion □ land use □ construction materials		Annually Sludge Treatment Volume	
		Temperature of Inflow Water		Daily Water Discharge Volume		Water Recycling Ratio	

Indicators of inflow water quality in the company's wastewater treatment station (no unit for pH, TOC, unit for other indicators: mg/L)				Indicators of the quality of the water discharged into concentrated sewage collection pipelines (no unit for pH, TOC, unit for other indicators: mg/L)			
pH		Chroma		pH		Chroma	
COD		Ammonia Nitrogen		COD		Ammonia Nitrogen	
BOD_5		Sulfides		BOD_5		Sulfides	
SS		Cr VI		SS		Cr VI	
Total Phosphorus		Anilines		Total Phosphorus		Anilines	

Waste Gas	□emitted directly □emitted indirectly		Main processes producing emissions	Treatment Process	Emission Intensity
		Smoke			
		Air Pollutants (Indicate the type)			
Solid Waste	Name	Amount and Unit (Year)	Hazardous or not	Source Process	Treatment Process

4. Cleaner production measures featuring water saving that companies have taken (Attach additional pages)

Annex IV Water Risk Questionnaire with WWF Water Risk Filter

Table 2 Water Risk Questionnaire with WWF Water Risk Filter

OPERATIONAL WATER RISK QUESTIONNAIRE						
Risk Aspect	Risk Sub-Aspect	Short Version Questionnaire	Long Version Questionnaire	Question	Please select answer from list OR when question number marked with * then type in the answer	Scores (for upload template)
Physical	Scarcity (Quantity)	i	O1	In which ways does the site use water?		
		ii	O2	How important is the current and future use of water quantity and quality for operating/processing at this site?		
			O3	Has the site had problems withdrawing the required amount of water for its operations OR has the site experienced a significant flooding event affecting operations?		
			O4	What is the total annual amount of freshwater withdrawn (directly from any water source including municipal supply utilities) in m^3/year?		
			O4a*	What is the specific total annual amount of freshwater withdrawn from any source in m3/year?		
			O4b*	What is the total annual amount of freshwater withdrawn from fresh surface water (e.g., river, lake, rainwater) in m3/year?		
			O4c*	What is the total annual amount of freshwater withdrawn from brackish surface water (e.g., lagoon, estuary, but not seawater) in m3/year?		
			O4d*	What is the total annual amount of freshwater withdrawn from groundwater (e.g., well) in m3/year?		
			O4e*	What is the total annual amount of freshwater withdrawn from sea/ocean water in m3/year?		

Physical	Scarcity (Quantity)		O4f*	What is the total annual amount of freshwater withdrawn from produced water (e.g., mine dewatering, well) in m3/year?		
			O4g*	What is the total annual amount of freshwater withdrawn from third party water service providers (m^3/year)?		
			O5	What is the total annual amount of freshwater discharged from this site to any endpoint (including municipal wastewater utilities) in m^3/year?		
			O5a*	What is the specific total annual amount of freshwater discharged to any source in m^3/year?		
			O5b*	What is the total annual amount of freshwater discharged to fresh surface water (e.g., river, lake, rainwater) in m^3/year?		
			O5c*	What is the total annual amount of freshwater discharged to brackish surface water (e.g., lagoon, estuary, but not seawater) in m^3/year?		
			O5d*	What is the total annual amount of freshwater discharged to groundwater (e.g., returned to well/aquifer, injected, seepage, etc.) in m^3/year?		
			O5e*	What is the total annual amount of freshwater discharged to the sea/occean in m^3/year?		
			O5f*	What is the total annual amount of freshwater discharged to long term water storage (e.g., tailings ponds) in m^3/year?		
			O5g*	What is the total annual amount of freshwater discharged to a third party water service provider (e.g., local water utility) in m^3/year?		
			O6	What is the primary source(s) of energy serving the site?		

Physical	Pollution (Quality)		O7	Of your discharged freshwater, what percentage contains contaminants and is discharged directly to the environment (not to another entity such as on-/off-site water treatment plants)?		
			O7a*	What is the total annual amount of nitrogen (N) discharged to any source in T/year?		
			O7b*	What is the total annual amount of phosphorus (P) discharged to any source in T/year?		
		iii	O8	Is it necessary to treat/purify the water the site withdraws before its use in operations?		
		iv	O9	Is it necessary to treat/purify the water the site withdraws after its use in operations?		
			O10	Does the site use hazardous chemicals in its operations or store them on site?		
		v	O11	What is the potential impact of the site's operations on downstream water quality in terms of physical, chemical and biological parameters?		
Regulatory Risk	Laws & Policy	vi	O12	Relative to other water users in your local catchment (~ 50km radius), does this site face heavy water-related regulation and legal enforcement?		
			O13	Is the company exposed to planned or potential significant regulatory changes at this site?		
	Institutions & Governance	vii	O14	Is the site always in compliance with legal waste water quality standards?		
			O15	Has this site been subject to any fines, enforcement orders, and/or other penalties for water-related regulatory violations in the last year?		
			O15a*	If yes, please indicate the amount of the penalties/fines:		
			O16	Does an official forum or platform exist in which the site and stakeholders come together to discuss water-related issues of the basin?		

Reputational Risk	Media scrutiny		O17	Has there been any local/national media coverage that identifies this site (negatively) on a water issue in the past 5 years?		
			O18	Has there been any global media coverage that identifies this site or its parent company (negatively) on a water issue in the past 5 years?		
	Community conflict	viii	O19	Relative to other water users in your local catchment (~ 50km radius), would you consider the site a large water user/polluter?		
		ix	O20	Relative to other water users in your local catchment (~ 50km radius), is the company associated with the site a recognized brand (to the local public)?		
		x	O21	How would you describe this site's general water management/stewardship maturity?		
			O22	Has the company had involvement in any water-related disputes with other stakeholders in the basin within the last 5 years?		
Other	Other		O23	How important/material is this site to your company?		
			O24*	What is the annual production volume for the site (primary or all products)?		
			O25	Please select the appropriate production volume unit.		
			O26	Please select the approximate value of the annual production volume?		
			O26a*	What is the specific value of the annual production volume?		
			O27	Please select the currency for used to denote value?		
			O28*	What is the number of full time equivalent employees (FTE) work at this site?		
			O29*	If you have any final comments, please add them here.		

Response (these questions do not influence the risk assessment scores but only the set of recommended response actions in the Respond section)	xi	R1	How has this sites water-related capital expenditure changed (CAPEX) over the past 12 months compare to the previous 12 months?		
	xii	R2	How has this sites water-related operating expenditure (OPEX) over the past 12 months compare to the previous 12 months?		
	xiii	R3	Please specify to which level this site discloses and reports against their water useage?		
	xiv	R4	Please specify to which level this site engages in developing awareness and capacities around local water issues?		
	xv	R5	Please specify to which level this site builds water into its business planning and strategy processes?		
	xvi	R6	Please specify to which level this site engages in water-related collective action?		
	xviii	R7	Please specify to which level this site has developed its internal and external water governance efforts?		
	xviii	R8	Please specify the level of technology / infrastructure implemented at this site to address water challenges?		
	xvix	R9	Please specify to which level this site measures and manages it water use performance in operations?		
	xx	R10	Please specify to which level this site has developed its internal water policies, standards and plans?		
	xxi	R11	Please specify to which level this site has implemented external water policies, standards and plans?		
	xxiii	R12	Please specify to which level this site has developed its basin & operational water risk awareness?		
	xxiii	R13	Please specify to which level this site engages with its stakeholders on water challenges?		

	xxiv	R14	Please specify to which level this site engages with its suppliers on water related issues?		
	xxv	R15	Please specify to which level this site has engaged in climate scenario planning or specific policies, standards and plans to ensure adaptation/resilience to climate change/extreme weather events?		

Note: For more detail information, please visit Water Risk Filter (http://www.waterriskfilter.panda.org/) to download the Excel version questionnaire.

Annex V Habitat Quality Assessment

Table 3 Habitat Quality Assessment

No.	Scoring Items	Scoring Rules	Scores	Note
1	Flow Regime*	1 score: a flow regime among the ten surveyed sections is recorded as the main type of flow regime once 2 scores: recorded twice or three times 3 scores: recorded four to ten times		
2	Streambed Substrate*	1 score: natural streambed substrates such as bedrocks and fine sands are recorded as main streambed substrate once 2 scores: twice or three times 3 scores: four to ten times		
3	Characteristics of Streambed	1 score: a natural specific habitat (e.g., exposed bedrocks, boulders and river islands with/without vegetation) appears once 2 scores: twice or three times 3 scores: four to ten times		
4	Characteristics of River Bank (left bank)	1 score: a natural specific habitat (e.g., eroded/stable river banks, meanders/sidewise river islands with/without vegetation) appears once 2 scores: twice or three times 3 scores: four to ten times		
5	Characteristics of River Bank (right bank)	1 score: a natural specific habitat (e.g., eroded/stable river banks, meanders/sidewise river islands with/without vegetation) appears once 2 scores: twice or three times 3 scores: four to ten times		
6	Vegetation Structure on River Banks* (left bank for banks more than 10 m from the central section)	1 score: only one section with a vegetation level ≥ 2 2 scores: two to three sections 3 scores: four or more sections		
7	Vegetation Structure on River Banks* (right bank for banks more than 10 m from the central section)	1 score: only one section with a vegetation level ≥ 2 2 scores: two to three sections 3 scores: our or more sections		
8	Marginal Banks	1 score: a total of three to eight 2 scores: more than eight		
9	Vegetation on Banks	1 score: vegetation such as liverwort, moss, emerging forb, emerging cyperaceae/poaceae plants, floating leaf/floating/amphibious plants, submerged forb and submerged spire plants appears one to three times 2 scores: four to ten times		
10	Type of Land Use on River Banks* (left bank for banks more than 10 m from the central section)	1 score: a type of land use (only grade broad-leaved forest, natural pine forest, moor besom forest and wetland) appears in the surveyed segment 2 scores: covers ≥ 33 % of the segment 3 scores: there is only one type of land use among broad-leaved forest, natural pine and wetland		
11	Type of Land Use on River Banks* (right bank for banks more than 10 m from the central section)	1 score: a type of land use (only grade broad-leaved forest, natural pine forest, moor besom forest and wetland) appears in the surveyed segment 2 scores: covers ≥ 33 % of the segment 3 scores: there is only one type of land use among broad-leaved forest, natural pine and wetland		
12	Riparian Forest (left bank)	1 score: sparsely distributed arbors 2 scores: equal-spacing or patch distributed 3 scores: semi-continuously or continuously distributed		

13	Riparian Forest (right bank)	1 score: sparsely distributed arbors 2 scores: equal-spacing or patch distributed 3 scores: semi-continuously or con-tinuously distributed		
14	Fallen Wood Habitat	1 score: habitats such as branches covering riverbed, uncovered roots on river banks, submerged roots, coarse woody debris and downed logs appear 2 scores: downed log habitat appears in ≥ 33 % of the segment 3 scores: widely distributed coarse woody debris 4 scores: widely distributed downed log habitat		
15	Special Habitat	Once a special habitat (natural waterfalls with a fall >5 m, braid, plant debris in heaps, natural open water, shallow swamp, outlet of underground water, forest bog and ombrotrophic mire, etc.) appears, this type of habitat is scored 5		

Annex VI Habitat Modification Score

Table 4 Habitat Modification Score

Depth of Water: m	pH:	Dissolved Oxygen:
Water Temperature:	Transparency (cm):	Flow Velocity(0.6 time deep, m/s):

Type of Substrate	□ bed rock □ scree □ artificial sustrate □ boulder □ fine sands □ roundstone □ sludge □ gravel □ clay
Type of Surrounding Habitat	□ forest □ bushwood □ farmland □ bare land □ grassland □ residential area □ marshland □ others
Riverway Changes	□ channelization □ natural riverway □ earth dam □ concrete-reinforced embankment □ concrete-reinforced embankment
Aquatic Breeding	□ none □ a few (1/5<width of aquatic breeding<1/4) □ general(width of seine: width of river 1/4<1/2) □ serious(1/2<width of aquatic breeding<2/3) □ very serious(width of seine: width of river≥2/3)
Type of Breeding	□ fish, type: □ shrimp, type: □ Chinese mitten crab □ others (clam, etc.)
Type of Disturbance	□ fishing-boat, number; □ sight-seeing boat, number; □ free-range poultry □ others:

Vegetation information: relative abundance: 0—none, 1—rare(<5%=), 2—general - (<30%=) 3—abundant(<70%), 4—advantageous>70%)

Type and growth conditions of aquatic vegetation				Type and growth conditions of riparian vegetation (within 18 m from the bank)	
Submerged plants	Floating plants	Floating-leaved plants	Emerged plants	Arbor	Shrub

Scoring items and rules	Score	Note
1 reinforced bank 2 scores for one appearance every ten sections		
2 reinforced riverbed 2 scores for one appearance every ten sections		
3 smooth bank 1 score for one appearance every ten sections		
4 cascade bank 1 score for one appearance every ten sections		
5 banking 1 score for one appearance every ten sections		
6 bank trampled by livestock 1 score: three-five times 2 scores: six-ten times		
7 artificial riverbed 1 score: there is artificial bank		
8 wholly reinforced bank 2 scores: one side reinforced 3 scores: both sides reinforced		
9 only top or bottom of bank reinforced 1 score: one side reinforced 2 scores: both sides reinforced		
10 flat bank 1 score: one side 2 scores: both sides		
11 banking 1 score: one side 2 scores: both sides		

12 broadened riverway 1 score: one side 2 scores: both sides		
13 bank grasscluster eliminated 1 score		
14 pasture planted on bank 1 score: one side 2 scores: both sides		
15 discharge pipeline or culvert 8 scores for one appearance		
16 dam, sluice, rough road or sand excavation 2 scores for one appearance		
17 highway bridge 1 scores for one 2 scores for two or more		
18 flood bank or spur dike 1 scores for one 2 scores for two or more		
19 fflow rate variation 1 score the length of the flow-varying segment is < 1/3 2 scores: > 1/3		
20 diversion 5 scores: <1/3 segment diverges 10 scores: >1/3 segment diverges		

Annex VII Indicator System for the Assessment of Industrial Park Water Stewardship

Table 5 Indicator System for Water Management Process

Primary	Secondary	Specific Indicators	Full Score	Criteria	Scores
Data collection	Completeness	Collection of economic, resource and environmental data of the industrial park in the past 5 years	3	Economic data mainly include GDP, total industrial output value, industrial added value, total amount of taxes, number of employees, yield of main products; resource and environmental data include consumption of energy, water resources, total emission of pollutants, total discharge of wastewater and total discharge of waste gas. Years of collection are graded as follows: 1 point for two years or less, 2 points for two to four years, 3 points for five years.	
		Collection of economic, resource and environmental data of the company in the past 5 years	3	Economic data mainly include the revenue of the main business, total amount of taxes, number of employees, yield of main products; resource and environmental data include consumption of energy, water resources, total emission of pollutants, total discharge of wastewater, total discharge of waste gas, emission characteristics of pollutants and treatment techniques for key pollutants. Years of collection are graded as follows: 1 point for two years or less, 2 points for two to four years, 3 points for five years.	
	Standardi-zation	Number of sampling points for water risk assessment	2	Comply to AWS requirements[1], 2 points; if not, 1 point.	
Formulation of plans	Scientificity	Full understanding of national, provincial, municipal, basin and industry policies	3	Invite the authority to intepret policies, 2 points; invite experts to analyze the overall situation on this basis, 3 points.	
		Proportion of senior professional experts in the team	2	Invite universities, NGOs, governments, third-party professional consultation member to form a water management expert team. Proportion of senior and medium professional titles>50%, 2 points; if not, 1 point.	
		Frequency of stakeholder forums	2	Two times or more, 2 points; less than two times, 1 point; none, 0 points.	

Primary	Secondary	Specific Indicators	Full Score	Criteria	Scores
Formulation of plans	Approvability	Approved by the water stewardship industrial park expert group	3	The approval is graded as excellent, good, approved, unapproved; excellent, 3 points; good, 2 points; approved, 1 point; unapproved, 0 point.	
		Approved by the administration of the industrial park	3	The approval is graded as excellent, good, approved, unapproved; excellent, 3 points; good, 2 points; approved, 1 point; unapproved, 0 point.	
		Whether stakeholders reach a consensus on water stewardship industrial park practices	3	The approval is graded as excellent, good, approved, unapproved; excellent, 3 points; good, 2 points; approved, 1 point; unapproved, 0 point.	
Implementation	Compliance with relevant laws and regulations	Exploit underground water violating the rules	1	Yes, 1 point; no, 0 point.	
		Punitive price for water consumption out of limits	1	Yes, 0 point.	
		Illegal pollution discharge	2	None, 2 points; 1, 1 point; >1, 0 point.	
		Whether reduction of pollution discharge meets the higher level requirement	2	100%, 2 points; ≥ 80%, 2 points; <80%, 0 point.	
	Feed mechanism for industrial park water stewardship	The administration establishes (designates) a special management organization with a specific person in charge	2	Yes, 1 point; ≥3 persons in charge, 2 points.	
		Duration of managers' participation in training	2	≥ working days for each manager every quarter, 2 points; if not, 1 point.	
		Capital investment in water balance at the industrial parks level	2	>3% in the budget, 2 points; 1%-3%, 1 point; <1%, 0.5 point.	
		Professional equipment	1	Managers fully equipped, 1 point; if not, 0.5 point.	
	System construction	Special practice team for industrial park water stewardship	2	Yes, 2 points; no, 0 point.	
		Establish rules of follow-up data statis-tics for industrial park water stewardship	1	Yes, 1 point; no, 0 point.	

Primary	Secondary	Specific Indicators	Full Score	Criteria	Scores
Implementation	System construction	Establish special rules for public participation	2	Yes, 2 points; no, 0 point.	
		Establish special rules for accountability and incentives	1	Yes, 1 point; no, 0 point.	
	Infrastructure	Installation of water meters at key nodes in the production line of wastewater treatment works and water supply plants	2	Assessed by the water stewardship industrial park expert group: >90%, 2 points; ≤90%, 1 point.	
		Renovation rate of rain-sewage diversion facilities	2	> 90%, 2 points; 50%-90%, 1 point; <50%, 0.5 point.	
		Intake rate of sites' sewage	2	100%, 2 points; 70%-100%, 1 point; 0%-70%, 0.5 point.	
		Improvement of sewage discharge standards of wastewater treatment works	2	1A, 2 points; 1B, 1 points; others, 0.5 point.	
	Participation of stakeholders	Frequency of visitor reception	1	≥ 4 times in a year, 1 point; <4 times, 0.5 point; none, 0 point.	
		Number of public complaints about the environmental protection of sites	2	None, 2 points; ≤2, 1 point; >2, 0.5 point.	
		Frequency of stakeholder negotiation meetings while implementing industrial park water stewardship	2	These meetings should be held every quarter: four times, 2 points; three times, 1.5 points; two times, 1 point; one time, 0.5 points; zero times, 0 points.	
		Pollution emission sites invite the public to visit	1	Yes, 1 point; no, 0 point.	
	Data recording	Build special database	2	Yes, 2 points; no, 0 point.	
		Frequency of data recording	1	Record and report (including total water consumption, quality of supplied water, discharge intensity of sewage, yield of freshwater and investment in water management) regularly every month, 1 point; if not, 0.5 points.	

Primary	Secondary	Specific Indicators	Full Score	Criteria	Scores
Implementation	Data recording	Whether data recording addresses all sites	1	Yes, 1 point; no, 0 point.	
		Detail of data recording	1	All the required economic, resource and environmental data are recorded, 1 point; if not, 0.5 points.	
	Basin management	Submit plans and rules of industrial park water stewardship to the administration of the industrial park	2	Yes, 2 points; no, 0 point.	
		Participation in relevant meetings by the basin administration	1	Yes, 1 point; no, 0 point.	
		Provide suggestion to the basin administration	2	Yes, 2 points; no, 0 point.	
		Provide AWS data to the basin administration	1	Yes, 1 point; no, 0 point.	
		Participate in research projects related to basin management	1	Yes, 1 point; no, 0 point.	
Assessment	Completion of targets	Realize the water balance targets in the industrial park water stewardship plan	2	Fully realized, 2 points; not realized, 1 point.	
		Realize the water quality targets in the plan	2	Fully realized, 2 points; not realized, 1 point.	
	Assessment	Assessment of water performance by a higher-level authority	3	The assessment is graded as excellent, good, satisfying, dissatisfying: excellent, 3 points; good, 2 points; satisfying, 1 point; dissatisfying, 0.5 point.	
		Assessment of water performance by the basin administration	2	The assessment is graded as excellent, good, satisfying, dissatisfying: excellent, 2 points; good, 1.5 points; satisfying, 1 point; dissatisfying, 0.5 point.	
		Assessment of water performance in the industrial park water stewardship project	3	The assessment is graded as excellent, good, satisfying, dissatisfying: excellent, 3 points; good, 2 points; satisfying, 1 point; dissatisfying, 0.5 point.	
		Assessment of water performance by stakeholders	2	The assessment is graded as satisfying and dissatisfying: satisfying, 2 points; dissatisfying, 1 point.	

Primary	Secondary	Specific Indicators	Full Score	Criteria	Scores
Information disclosure	Information disclosure	Release the implementation of the industrial park water stewardship plan to the public through social channels	3	Release through the website, 3 points; release to a portion of the interested subjects, 2 points; if not, 0 points.	
		Disclose water management information to the public	3	Release through the website, 3 points; release to part of interest subjects, 2 points; if not, 0 point.	
		Disclose water quality improvement information to the public	3	Release through the website, 3 points; release to part of interest subjects, 2 points; if not, 0 point.	

Note 1: sampling requirement:

1. for the site with more than one drainage points, every drainage point should be stated if they are greatly different from each other;
2. samples of inflow water quality should be acquired (water source) from an upstream water body (≤50m). If the water is provided by water suppliers, its quality should be examined. And it should be examined on site;
3. samples of outflow water quality should be acquired (water body that is discharged into) from a downstream water body (≤50m).If the water is provided and processed by water suppliers, the sewage should be examined before it leaves the company.
4. the collected data should be used to determine the physical, chemical and biological state of the basin as well as feature pollutants and toxic substances so that we can identify the water quality and set targets on this baseline.

Table 6 Indicator System for Water Management System Construction

Primary Indicators	Parameters	Type of Indicator	Points	Reference	Code for Points					Total
					I	II	III	IV	V	
Entity responsibility	The administration is responsible for the environmental quality	Basic	5	The administration of the industrial park or the people's government above the county level with local agencies in the industrial park is responsible for the environmental quality. Environmental protection administrations establish local agencies in municipal districts, key towns and development zones (industrial parks).	0	1.25	2.5	3.75	5	
	Audit of natural resource properties of main leaders when they leave office	Advanced	4	The natural resource properties of main leaders should be audited when they leave office.	0	1	2	3	4	
Market access	Outlaw "ten small" sites	Basic	4	By the end of 2016, as required by the laws and regulations of water pollution prevention and control, outlaw all water-polluting production projects performing small papermaking, tanning, printing, dyeing, coking, sulfur smelting, arsenic smelting, oil refining, electroplating and pesticides that do not conform to national industrial policies.	0	1	2	3	4	
	The strictest emission standard for key sites	Basic	4	Strengthen pollution screening of industrial sites along the main stream and implement the strictest discharge standards for sites that directly discharge along a stream.	0	1	2	3	4	
	Renovation of industrial technology	Basic	3	By the end of 2017, the papermaking industry should fully adopt ECF of pulping or other low-polluting pulping technologies. Iron and steel sites should fully adopt CDQ for their coke ovens. The printing and dyeing industry should fully adopt low-drainage dyeing and finishing. The antibiotic and vitamin industry should fully adopt green PAP. The tanning industry should adopt chromium reduction and closed-loop utilization technology.	0	0.75	1.5	2.25	3	
	Control the construction of chemical parks	Advanced	3	Control the construction of chemical parks and examine the chemical sites that have access to an industrial park.	0	0.75	1.5	2.25	3	

Primary Indicators	Parameters	Type of Indicator	Points	Reference	Code for Points					Total
					I	II	III	IV	V	
Environmental management	Implement the "three meanwhile" system	Basic	3	The sites that have access to the industrial park must conform to national industrial policies, whose construction projects should adopt the "three meanwhile" system.	0	0.75	1.5	2.25	3	
	Supervise key sites of key industries	Basic	3	Optimize the warning mechanism for emergent environmental incidents and improve the ability to prevent and address emergent environmental incidents.	0	0.75	1.5	2.25	3	
	Plan the follow-up assessment of environmental impacts	Basic	3	Conduct follow-up assessment (review) of environmental impacts from an industrial park plan that has been executed for more than five years.	0	0.75	1.5	2.25	3	
	Promote sites' clean production	Basic	3	Adopt an ISO14000 environmental management system, environmental label product and other green certifications and build a number of green parks and sites.	0	0.75	1.5	2.25	3	
	Improve the reuse rate of tail water	Basic	3	By 2015, the reuse rate of the Taihu Basin Industrial Park should reach 20 %.	0	0.75	1.5	2.25	3	
	Improve the efficiency of industrial water	Basic	3	Focus on concentrated wastewater treatment and unveil engineering construction in high water consuming industries such as electricity, chemical engineering, printing and dyeing.	0	0.75	1.5	2.25	3	
	Promote water stewardship in an industrial park	Basic	5	Through the participation of stakeholders, industrial parks, basins and sites should jointly improve the water-related management mechanisms and technology and water consumption in industrial parks.	0	1.25	2.5	3.75	5	
Recycling economy	Build an industry chain of a recycling economy	Basic	4	Divide the industrial park by function and arrange sites, industries, infrastructure and living areas properly. Build the industrial chain according to the principle of "horizontal coupling, vertical extension and recycling linking"; professional industrial parks should extend their industry chain vertically. Comprehensive industrial parks should attract investment "within a supplementary industry cycle" and promote horizontal industrial coupling.	0	1	2	3	4	

Primary Indicators	Parameters	Type of Indicator	Points	Reference	Code for Points					Total
					I	II	III	IV	V	
Recycling economy	Promote efficient recycling use of resources	Basic	3	Produce cleanly and reduce consumption at the source. Perform waste exchange, sewage recycling, gradient use of energy and intensive use of land between sites in the industrial park.	0	0.75	1.5	2.25	3	
	Demonstration projects and parks of a recycling economy	Advanced	3	Through the demonstration project of recycling renovation, improve the main resources yield, land yield and resource recycling rate. The resource and environmental indicator of demonstration sites (parks) should reach the leading level both domestically and internationally.	0	0.75	1.5	2.25	3	
	Develop a service industry of a recycling economy	Advanced	3	A recycling economy serves the industrial system and provides service to the industrial park. Professional recycling economy service sites, connected to the industrial park, provide integrated solutions.	0	0.75	1.5	2.25	3	
	Develop emerging industries of a recycling economy	Advanced	3	Build several industrial parks featuring the processing and utilization of imported "urban mineral" resources that meet supervision requirements in coastal areas.	0	0.75	1.5	2.25	3	
Environmental infrastructure	Build concentrated wastewater treatment facilities	Basic	4	By the end of 2017, concentrated wastewater treatment facilities should be completed in industrial clusters with automatic online monitoring devices installed. The Beijing-Tianjin-Hebei Region, Yangtze River Delta and Pearl River Delta should complete their projects a year earlier.	0	1	2	3	4	
	Install automatic online monitoring devices	Basic	4		0	1	2	3	4	
	Recycling renovation	Basic	3	Promote the recycling renovation of industrial parks (development zones), encourage various industrial parks to build infrastructure for exchange of wastes, gradient use of energy, classified use and recycling of water and public service platform, realize efficient combination and recycled linking of projects, sites and industries within the industrial park and build "version 2.0" of an industrial park.	0	0.75	1.5	2.25	3	

Primary Indicators	Parameters	Type of Indicator	Points	Reference	Code for Points					Total
					I	II	III	IV	V	
Environmental infrastructure	Sludge harmlessness	Basic	3	Accelerate the renovation of sludge treatment facilities in wastewater treatment works in the industrial park.	0	0.75	1.5	2.25	3	
	Green infrastructure	Advanced	3	Conduct green renovation of public infrastructure within the industrial park such as water supply, electricity supply, heating, roads and communication. Accelerate the construction and renovation of concentrated pollutant treatment facilities, innovate the environmental service, advance the construction of sewage and waste treatment facilities and their professional and social operation.	0	0.75	1.5	2.25	3	
	Build sewage pre-treatment facilities in key industries	Advanced	3	Sites in electroplating, chemical and leatherworking that may have an impact on the operation of concentrated sewage facilities should build independent wastewater treatment facilities and pretreatment facilities and strengthen the treatment of particular pollutants and toxic (dangerous) pollutants and discharge them into wastewater treatment facilities only when they meet discharge standards and do not impact concentrated wastewater treatment facilities.	0	0.75	1.5	2.25	3	
Marketization	Introduce third-party environmental service sites	Advanced	3	Conduct concentrated and professional treatment of sites' pollution and perform environmental diagnosis, ecological design, clean production examination and technological renovation.	0	0.75	1.5	2.25	3	
	Emission trading	Advanced	3	Emission trading should be implemented in all pilot provinces in principle. Emission trading related to water pollutants is allowed only within the same basin.	0	0.75	1.5	2.25	3	
	Eco-industrial demonstration parks	Advanced	3	Accelerate the construction of provincial and national eco-industrial demonstration parks.	0	0.75	1.5	2.25	3	

Primary Indicators	Parameters	Type of Indicator	Points	Reference	Code for Points					Total
					I	II	III	IV	V	
Marketization	Low-carbon demonstration parks	Advanced	3	Accelerate the construction of provincial or national low-carbon demonstration parks.	0	0.75	1.5	2.25	3	
	Promote the management of a green supply chain	Advanced	3	Promote the management of a green supply chain, force the suppliers and procurers upstream to the industrial chain to take environmental protection measures by stimulating green procurement on the downstream, conduct green renovation of product design, material choice, manufacturing, logistics, recycling and final disposal and mitigate negative impacts on the environment.	0	0.75	1.5	2.25	3	
	Information disclosure	Advanced	3	Strengthen the disclosure of environmental information and assess and release the environmentally friendly index of the industrial park.	0	0.75	1.5	2.25	3	

Note: The point codes for I to V are: I-no policies; II-rough policies; III-policies with objectives and schedules; IV-policies, objectives, schedules, incentives and disincentives; V-policies, objectives, schedules, incentives, disincentives and designate a specific person to follow and assess the policies' progress.

Table 7 Indicator System for Water Management Performance

Primary Indicators	Secondary Indicators	Indicators	Explanation	Type of Indicator	Target Value	Points	Total
Pressure	Consumption of freshwater	Consumption of freshwater (m^3/a)	Pressure indicator for the water yield in the basin	Core	6		
	Emission of main pollutants	COD emission (t/a)	Pressure indicator for the water quality in the basin, restrictive indicators	Core	6		
		Ammonia nitrogen emission (t/a)	Pressure indicator for the water quality in the basin, restrictive indicators	Core	6		
		Total phosphorus emission (t/a)	Pressure indicator for the water quality in the basin, specific pollution factors in the Taihu Basin	Core	6		
		Total nitrogen emission (t/a)	Pressure indicator for the water quality in the basin, specific pollution factors in the Taihu Basin	Core	6		
	Emission of particular pollutants	Specific pollutant emission (t/a)	Specific pollution factors of industrial parks that have pressure on water quality	Comprehensive	1		
Status	Quality of the water environment	COD concentration (mg/L)	Indicator for water quality	Comprehensive	2		
		Ammonia nitrogen concentration (mg/L)	Indicator for water quality	Comprehensive	2		
		Total phosphorus concentration (mg/L)	Indicator for water quality	Comprehensive	2		
		Total nitrogen concentration (mg/L)	Indicator for water quality	Comprehensive	2		
		Dissolved oxygen content (g/L)	Indicator for water quality, showing the overall situation of water quality	Comprehensive	2		
Status	Quality of the water environment	Chlorophyll concentration	Indicator for water quality, representing algae	Comprehensive	2		
		Specific pollutant concentration	Specific water quality factors of industrial parks in addition to the factors above	Comprehensive	1		
	Water yield of surrounding catchments	Standard of water balance	Indicate the current water consumption of industrial parks and its rationality degree	Core	6		
		Difference in the actual volume of runoff of the upstream and downstream	Indicate the impact of industrial parks on the water yield in the catchment	Comprehensive	1		
		Difference between the actual volume of runoff and the water management objectives of the basin	Indicate the impact of industrial parks on the water management of the catchment	Comprehensive	1		
	Water quality of surrounding catchments	Difference in COD concentration between the upstream and downstream	Indicate the impact of industrial parks on the water quality of the catchment	Core	6		
		Difference in ammonia nitrogen concentration between the upstream and downstream	Indicate the impact of industrial parks on the water quality of the catchment	Core	6		
		Difference in total phosphorus concentration between the upstream and downstream	Indicate the impact of industrial parks on the water quality of the catchment	Comprehensive	2		

Primary Indicators	Secondary Indicators	Indicators	Explanation	Type of Indicator	Target Value	Points	Total
Status	Water quality of surrounding catchments	Difference in total nitrogen concentration between the upstream and downstream	Indicate the impact of industrial parks on the water quality of the catchment	Comprehensive	2		
	Water ecology of surrounding catchments	Difference in the diversity of large benthonic invertebrates	Indicate the impact of industrial parks on the water ecology of the catchment	Comprehensive	2		
Response	Construction of environmental capability	Proportion of environmental investment in total industrial output value	Indicate the emphasis of and investment in the environmental protection of industrial parks	Core	6		
		Sewage collection and treatment rate	Construction of sewage collection tubes and intakes	Core	6		
		Wastewater treatment capability	Mitigate the impact of sewage on the water environment	Comprehensive	2		
		Collection and treatment rate of rainwater	Mitigate the impact of sewage on the water environment	Comprehensive	2		
		Disposal capability for household waste	Mitigate the impact of household waste on the water environment	Comprehensive	2		
		Disposal capability for dangerous waste	Mitigate the impact of household waste on the water environment	Comprehensive	2		
	Level of water management	Saved freshwater consumption	Water-saving effect of improved water management	Comprehensive	2		
		Reduction of sewage emission	Emission-reduction effect of improved water management	Comprehensive	2		

Primary Indicators	Secondary Indicators	Indicators	Explanation	Type of Indicator	Target Value	Points	Total
Response	Level of water management	Proportion of sites that implement water stewardship in an industrial park	Promotion capability of improved water management	Comprehensive	2		
	Public participation	Frequency of announcing the environmental status	Information disclosure helps to improve environmental performance	Comprehensive	2		
		Frequency of public participation	Public participation for good environmental governance	Comprehensive	2		

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