APEC Guideline for Quality of Water Infrastructure

Committee on Trade and Investment

November 2018

APEC Project: CTI 06 2017S

Issued 2018

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APEC# CTI 06 2017S

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Abbreviation List

No.	Abbreviation	Official Name
1	APEC	Asia-Pacific Economic Cooperation
2	BCP	Business Continuity Plan
3	BOD	Biochemical Oxygen Demand
4	CAPEX	Capital Expenditure
5	COD	Chemical Oxygen Demand
6	DB	Design Build
7	DBFO	Design Build Finance and Operate
8	DBO	Design, Build, Operate
9	EPC	Engineering, Procurement, Construction
10	FS	Feasibility Study
11	ISO	International Organization for Standardization
12	JICA	Japan International Cooperation Agency
13	JV	Joint Venture
14	LCC	Life Cycle Cost
15	O&M	Operation and Maintenance
16	OPEX	Operating Expense
17	P/Q	Pre-Qualification
18	PDCA	Plan, Do, Check and Action
19	PI	Performance Indicator
20	PPP	Public-Private Partnership
21	QWI	Quality of Water Infrastructure
22	TSS	Total Suspended Solid
23	STPR	Social Time Preference Rate
24	T-N	Total Nitrogen
25	T-P	Total Phosphorus

Introduction

The APEC Guideline for Quality of Water Infrastructure is intended to provide a non-binding approach, framework, methodologies and lessons learned, for the purpose of ensuring quality of water infrastructure (QWI), on the basis of conforming to economies' domestic conditions and development levels, being inclusive and broadly beneficial, promoting economic growth, and ensuring economic efficiency. We encourage usage of this guidebook with a view to promoting policy coordination, facilities connectivity, financial integration, and people-to-people bonds in the Asia-Pacific region.

Background and objectives

Urban water demand is on the rise in the APEC region due to rapid population growth and economic growth, along with the resulting increased wastewater volume and pollution load on the water environment. An adequate and stable water supply and appropriate wastewater treatment have important effects on living standards and economic activities. Inadequate or improper water infrastructure, delays in maintenance, and service outages are serious risks for an economy, hampering economic activities and environmental protection and posing obstacles to maintaining people's health and living standards. Securing an adequate and stable water supply and ensuring appropriate wastewater treatment are among the most urgent and important challenges facing every APEC economy.

These challenges can be met through appropriate planning, investigation, design, and construction of water infrastructure in each economy, commencement of operations in accordance with approved plans, and implementation of appropriate operation and maintenance (O&M).

Water supply and sanitation facilities are increasingly recognized as important priorities, as exemplified by the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015. In addition, the world faces the shared challenge of taking steps such as reducing greenhouse gases to reduce society's environmental burden, as exemplified by the Paris Agreement at the 21st Conference of the Parties for the United Nations Framework Convention on Climate Change in the same year. Every economy is encouraged to minimize the environmental impact of its infrastructure to the extent possible. Consideration shall be given to impacts on society and externalities in this regard, in addition to the standpoint of cost effectiveness.

In a joint statement in November 2017, the APEC ministers expressed that they welcome advances in ensuring the quality of infrastructure. Further deepening and acceleration of these efforts is anticipated, and the Guidebook on Quality of Infrastructure Development and Investment was revised by APEC in 2018. In response, this guideline was formulated specifically for the water sector.

The objectives of this guideline are as follows.

- To give readers a deeper understanding of how water infrastructure is planned, built, and operated
- To share case studies related to water infrastructure with readers
- To provide readers with useful suggestions on methods for securing the QWI

Scope and target

Water infrastructure consists of a wide range of systems, including water supply and sewage systems in urban areas, distributed water supply and wastewater treatment facilities in suburban areas, and industrial water supply and industrial wastewater treatment facilities. To ensure that the content of this guideline can be sufficiently detailed to ensure the QWI, we have focused mainly on water treatment plants and wastewater treatment plants in urban areas. This guideline provides approaches, performance indicators (PIs), and evaluation methods and metrics to be used with these facilities. However, water and sewerage networks, industrial water supply and wastewater treatment facilities, and other infrastructure facilities are just as important as water treatment plants and wastewater treatment plants, and the basic approach is applicable to these kinds of infrastructure as well.

The primary intended readership of this guideline consists of the regional government organizations and business entities that handle water and sewerage projects in each economy, policymakers at central government ministries and agencies related to water infrastructure investment, companies that supply goods, services, and financing for water and sewerage projects, and other stakeholders.

Organization of the Guideline

First, this guideline presents five elements that ensure the QWI and important considerations for the QWI (Chapter 1). Next, specific measures to ensure the QWI are discussed with regard to the feasibility study (FS), design, procurement, and construction phase (Chapter 2) and the O&M phase (Chapter 3). Chapter 4 describes specific capacity development measures that ensure the QWI.

Several columns are provided throughout the guideline to provide additional information for a deeper understanding. Appendices are also included to supplement the technical discussions of Chapters 2 and 3.

Chapter 1　Quality of Water Infrastructure (QWI)

For water infrastructure to contribute to the inclusive and sustainable development of each APEC economy, the QWI shall be maintained and continually enhanced throughout its life cycle. This chapter focuses on the five elements that ensure the QWI and important considerations with regard to ensuring the QWI.

1.1　Five elements that ensure the QWI

The APEC Guidebook on Quality of Infrastructure Development and Investment, which was revised in 2018, identifies the following five elements as the principal elements that ensure quality of infrastructure: (1) Alignment with Development Strategy/Openness/Transparency/Fiscal Soundness; (2) Stability/Safety/Resiliency; (3) Economic and Financial Soundness: Cost-effectiveness including LCC and utilization of markets; (4) Social and Environmental Sustainability; and (5) Local High-quality Development: Job creation/capacity building and transfer of technologies.

The same elements included in the guidebook will be covered in this guideline with regard to the QWI.

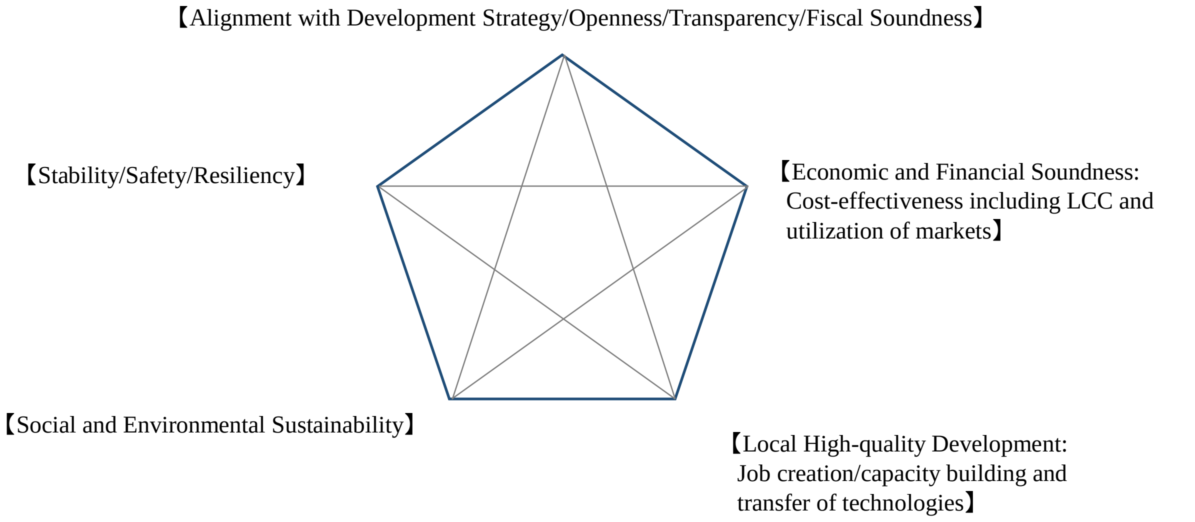


Figure 1: Five elements that ensure the QWI

1.1.1　Alignment with Development Strategy/Openness/Transparency/Fiscal Soundness

In promoting the QWI, it is important to pursue comprehensive development in collaboration with a wide range of stakeholders, including economies and regions, the public and private sectors, contractors and residents. First, it is necessary to promote alignment with economic and development strategies as well as climate change and environmental strategies at the level of economies and regions. As a basis for economic growth, ensuring the QWI improves regional location competitiveness, which helps to promote private sector investment including development of factories and commercial facilities; and at the same time, consideration in development should be given to climate change and the local natural environment. In the development of water infrastructure, it is also important to make effective use of the capital, technology, and expertise of private sectors. At every phase of planning, FS, design, procurement, construction, O&M, while complying with local laws and regulations on water infrastructure projects, it is also necessary to pursue appropriate communication with neighborhood residents, focus on local needs and conditions, and contribute to the local economy through local job creation, capacity building, and transfer of technology and expertise. Coordination with administrative entities in charge of existing water projects is also important.

1.1.2 Stability/Safety/Resiliency

In order to ensure stable, safe, continuous, affordable, reliable and universal access to water infrastructure for all people, appropriate consideration shall be a prerequisite to each phase of a project, i.e. planning, design, construction, and operation. Counter-mechanisms shall be secured at the phase of water infrastructure construction in order to provide safe water infrastructure services that satisfy international standards. It is important to carefully consider risks related to natural disasters, terrorism, and unforeseen events, and to take steps to ensure safety by avoiding and transferring such risks. It is necessary to consider and develop mechanisms and measures to ensure resiliency in order to minimize the effects of such eventualities on business and the local population through rapid restoration of services and economic recovery.

(1) Stability

Stability is defined as to providing a stable volume and quality of water at water treatment plants, and to improving water quality through stable operation at wastewater treatment plants. Because water infrastructure facilities are essential for the daily lives of users, stability is important in water treatment.

To ensure stability, it is necessary to conduct planning and design that can contribute to stable services, prevent defects in construction, and prevent an unplanned approach to maintenance, so that performance goals stipulated in the planning phase can be fully realized upon completion and the facility can be continuously maintained. It is important for the government contract agency, who employs a project contractor or operator, to conduct appropriate evaluation in the procurement phase and appropriate monitoring in the construction phase. During the maintenance phase, O&M should be optimized by establishing a cycle for the stable provision of services in which plans are developed and reliably implemented, followed by evaluation and study of improvement measures.

In installation of water infrastructure in urban areas, considering the use of local water resources, the location will generally be subject to various constraints in relation to construction, O&M. For example, such constraints may include difficulty in land acquisition and size constraints, water resources with large fluctuations in raw water quality, and long-term population growth or decline.

To achieve service stability under these kinds of constraints, it is effective to incorporate various innovations by private enterprise in the design phase. Examples of creativity in the design phase could include using techniques that address location conditions such as small sites in urban areas, giving consideration to fluctuations in the quality and quantity of influent water, building facilities that can continue stable treatment even under sudden changes in water quality and quantity due to rainfall, or considering efficiency in maintenance, such as reduction in inspection hours or simplification of the flow of people carrying equipment to and from a facility . In addition to selecting appropriate treatment processes based on the target water treatment volume and quality of the treated water, it is also important to consider in the design phase potential future stepwise facility expansion based on changes in the business environment including future demographics and water demand, in order to achieve stable treatment on the long term.

In these cases for activating innovation by private enterprises, it is also effective to use appropriate procurement methods and evaluation.

(2) Safety

Safety is defined as the capacity to prevent or limit harm to people. Safety would be discussed in the following categories: a) preventing harm to site workers and neighborhood residents during construction and O&M, and b) preventing health hazard to users with delivered water.

a) Safety for site workers and neighborhood residents

Because the construction of a water treatment plant is a large-scale, long-term project, it is important to ensure the safety of neighborhood residents, workers, and others by preventing accidents during construction. In construction and O&M, accidents and harm on the part of workers can be prevented or limited by adopting a design that considers safety during inspections, such as installing handrails and scaffolding throughout the facilities. Facility inspection and repair plans shall be developed and facility information shall be well- organized. In addition, to prevent accidents due to factors such as aging facilities, it is effective to retain maintenance data based on inspection results and make use of this data in plant operations.

b) Safety of users

In the O&M phase of a water treatment plant, the matter of utmost importance is to ensure public hygiene and prevent harm to users' health by supplying safe water that conforms to international standards over the long term. Appropriate wastewater treatment shall also be continued reliably, because safety is assured through public hygiene, which is the fundamental responsibility for a wastewater treatment plant.

For a water treatment plant, appropriate water treatment processes shall be designed based on local needs and conditions in order to ensure an adequate capacity of water treatment and safe water quality. Safe water quality standards should be determined according to users' needs and the circumstances of each economy, with reference to Guideline for Drinking-water Quality of the World Health Organization (WHO). For a wastewater treatment plant, the planned discharge water quality shall be determined based on the water quality standards at the discharge location, and appropriate water treatment processes shall be selected.

(3) Resiliency

Resiliency is defined as the capability of responding to natural disasters and other unforeseen events through disaster prevention, disaster mitigation, and prompt recovery measures.

Earthquakes, tsunamis, torrential rains, and other natural disasters have struck frequently in recent years, and there has been increasing damage to water infrastructure itself. When water infrastructure is shut down for a long period of time, it results in enormous harm to users and neighborhood residents. Therefore, resiliency is increasingly important in water infrastructure. Specifically, there is a need for advance disaster damage prevention, disaster mitigation to minimize damage at the time of a disaster, and prompt recovery after a disaster.

To prevent and reduce the risks of natural disasters and other unforeseen events, the recommended approach combines "hardware" solutions, or building highly robust water infrastructure, with "software" solutions, or developing systems that can function at times of disasters. For example, it is important to design and build robust structures according to the facility's level of importance, with consideration for factors such as earthquakes and changes in weather conditions. Securing alternative water resources, construction of bypass or connecting pipes, and networking of transmission and distribution pipelines are effective measures for improving resiliency of water infrastructure.

When an unforeseen event occurs, such as a natural disaster or terrorist attack, it is necessary to respond promptly and accurately according to business continuity plans (BCP) formulated in advance, and to quickly restore the facility. Specific measures that are effective include developing a BCP, strengthening the emergency system based on mutual aid agreements with other water and sewerage utilities in the area, and routinely holding emergency training sessions.

1.1.3 Economic and Financial Soundness: Cost-effectiveness including LCC and utilization of markets

At the planning phase of a water infrastructure project, in terms of maximizing value for money, (VFM) it is necessary to verify not only the cost of investment, but also the benefits that will be obtained. In addition, because a water infrastructure project needs to be operated and maintained for decades, it is important to consider not only the initial investment, but the overall financial impact including costs over the entire life cycle of the project. It is important to take into consideration of affordability to local people who use the facilities and services of the infrastructure.

A water infrastructure project requires a great deal of funds for construction, expansion, renovation due to aging, and O&M. Therefore, these projects may use a variety of financing sources in their operation, including support from multilateral developing banks, other development partners, and private finance in addition to investment by the public sector. Because these projects may rely in large part on debt-based financing, it is necessary to ensure financial sustainability based on the future outlook.

(1) LCC

LCC is defined as the total cost over the entire life cycle of a water treatment facility, from construction to disposal. It includes the costs of design, procurement, and construction which arise as capital expenditures, O&M expenses such as the costs of power, chemicals, labor, and waste disposal, and the costs of reuse or demolition of facilities at the end of the project period. Because a water infrastructure project extends over a long period of time, it is important to consider its overall financial impact, including costs during the period of O&M in addition to costs during the construction period.

In large-scale water infrastructure projects, because the maintenance period lasts for decades, the maintenance costs that arise over this entire period are generally quite substantial. Maintenance costs are dependent on the initial design and the quality of the constructed facilities, and it is difficult to achieve any large cost reductions after operation has begun. Therefore, the basic conditions of the project and the facility should be determined during the FS and design phase by performing a comparative study of various project schemes and treatment plant processes, with consideration given to operating expenses (OPEX) as well as capital expenditures (CAPEX), which is initial investment costs during design and construction.

Next, in the procurement phase, LCC can be taken into consideration by providing a model for LCC calculation on the specification sheet and evaluating various factors that can affect LCC when selecting contractors. It is relatively difficult to accurately evaluate OPEX at the time of bidding, but for government contract agencies who conduct LCC evaluations, the recommendation is to estimate LCC to the extent possible by collecting and using detailed information on actual figures (e.g. past data and records on variable unit costs or consumption). It should be noted that the government contract agency needs to obtain the capability for evaluation in order to conduct LCC evaluations at the time of procurement.

In water infrastructure projects, power expenses account for a large proportion of OPEX. The cost of electric power to operate pumps and blowers and the cost of fuel to operate incineration facilities are large components. Therefore, it is important to take steps to reduce LCC in the design and construction phases, such as by procuring equipment with consideration for costs during the O&M period. Even during the O&M period, actual operation should continuously make attempts to lower LCC. Another important factor in the calculation of LCC is the development of an asset management plan, including the costs of repairs when responding to problems such as unforeseen breakdowns, medium to long-term repairs to extend their usable life and when facilities undergo aging, and rehabilitation or renovation plans.

(2) Use of diverse sources of financing including private sector investment

Water infrastructure projects require a great deal of funds for initial construction, expansion due to growth in the user base, rehabilitation due to aging and O&M. Therefore, a variety of financing sources may be used in the operation of such projects, including support from multilateral development banks, other development partners, and private financing in addition to public investment. We advocate for a transparent, friendly, non-discriminatory and predictable financing environment. We support greater openness to foreign direct investment as appropriate.

In infrastructure investment in the public sector, it is important to procure the necessary funding for a long period of time through public fiscal measures such as budgeting for multiple years at a time. Wide-ranging improvements in governance are needed to improve the investment environment, including measures to prevent corruption and ensure transparency. Transparency and fairness are especially important at the procurement phase. For example, it is important for water and sewerage utilities that procure water treatment plants to be subject to capacity development, regulatory oversight, and monitoring of projects by the central government and third-party organizations.

In a public-private partnership (PPP), where design, construction and O&M are entrusted to the private sector, when private capital is used to implement a project, the investors should determine risks such as the credit risk of the government contract agency, political risk, and demand risk. When there is participation by overseas investors, the impact of foreign exchange risk shall also be recognized. Therefore, if private financing is used, it is important to reach an agreement on risk sharing so that risks are borne by those who can manage those risks appropriately, based on the economic situations and legal systems, etc. of each economy.

(3) Debt sustainability

Water and sewage treatment plants are frequently funded through debt because they require huge amount of funding. However, they cannot be expected to produce income immediately after plant construction in cases where the construction of water and sewerage networks has not kept pace with treatment plant construction. In such cases, there is a risk that ongoing investment in water infrastructure may be hampered in the long term by the continued accumulation of debt.

To ensure the sustainability and adaptability of a water infrastructure project, it is important to evaluate the current financial situation and debt situation as well as the long-term fiscal outlook to consider how the sustainability of debt and finances will be impacted by water infrastructure investment.

1.1.4 Social and Environmental Sustainability

Important aspects to be considered from the standpoint of coexistence with the project-affected communities and natural environment include controlling and reducing the direct, indirect and cumulative negative impacts on the local community, and contributing to the local economy. These factors are important in enhancing the feasibility and resilience of water infrastructure projects. Consideration of both social and environmental impacts reduces the overall risk of the project by identifying opportunities to increase public acceptance, improve the livelihoods of project-affected communities, protect biodiversity, and develop mitigation strategies.

Due to its characteristics, the construction and O&M of water infrastructure has major environmental and social impacts. Therefore, it is important to devise effective preventive measures to avoid or reduce these impacts. To accomplish this, thorough environmental and social impact assessments should be conducted to design and implement necessary improvements to the project O&M plans and execution to reduce risks of negative environmental impacts. The environmental and social impact assessment will: assess factors affecting the environment starting at the project planning phase, review measures for environmental conservation, consider project alternatives, assess impacts of associated facilities, include cumulative impacts, and develop appropriate mitigation plans for implementation to help reduce risks, and integrate these recommendations into the project design to support resilient infrastructure projects.

In order to minimize adverse impacts, it is very important to consider controlling and reducing the environmental burden, preserving biodiversity, conserving energy and using renewable energy, and developing the system for material recycling, energy recovery, and water reclamation.

(1) Impact on society

The social impacts on the local community should be assessed and evaluated, including odors, noise, and other forms of pollution due to water infrastructure construction and any resettlement of residents; and continuous and transparent stakeholder consultations with the project-affected communities is necessary to ensure concerns are considered and addresses with appropriate measures through the design of the project. If involuntary resettlement of neighborhood residents is unavoidable for the sake of construction, the project should include compensation measures which are planned and implemented to maintain the quality of life and livelihoods of affected residents. In addition, wastewater treatment plants, in particular, are generally considered a nuisance. For this reason, appropriate communication shall be performed, such as by proactively disclosing information and establishing a means for listening to concerns or complaints.

(2) Impact on the environment

Because it transports and processes large amounts of water and sludge, the construction, operation, maintenance, and other activities of water infrastructure have significant environmental impacts. Therefore, it is very important to reduce the seriousness of those environmental impacts, including the traffic congestion and noise that arise during construction, and the air pollution and odors emanated during operation. Controlling and reducing the impacts on the local community, including selecting the least environmentally destructive construction methods and taking steps through careful planning to reduce traffic congestion from transportation of construction materials and equipment and the safe removal of sludge and construction materials, are critical.

Preserving biodiversity shall also be a focus of the efforts, because water infrastructure can have an impact on public water bodies including rivers, lakes, and ocean areas. This includes careful selection of discharge locations and periodic monitoring of water quality at discharge locations and in surrounding areas. It is necessary to actively consider ways to conserve energy including incorporating renewable energy, because enormous amounts of energy are consumed in the transportation and treatment of large amounts of water and sludge. Various plans and their impacts should be assessed to ensure the project implements the best and least negatively impactful method. For example, this could include utilizing a high-efficiency incinerator, making use of exhaust heat and reclaimed water, using sludge in biogas power generation, recycling sludge for biomass fuel or fertilizer, and using the space above a water treatment facility for solar power generation. It is important to actively exploit these technologies in water infrastructure for material recycling, energy recovery, and water reclamation.

In considering the impact of the project on the environment and local community it is important to take into consideration potential associated facilities, and cumulative impacts of the project in consideration with ongoing activities in the region. The project is part of a great infrastructure ecosystem, and the impacts of existing facilities in relation to those potentially imposed by the project should be considered together in any assessment of the risks associated with the project. These should all be considered in developing mitigation plans and considering project alternatives in order to ensure overall project risk is reduced.

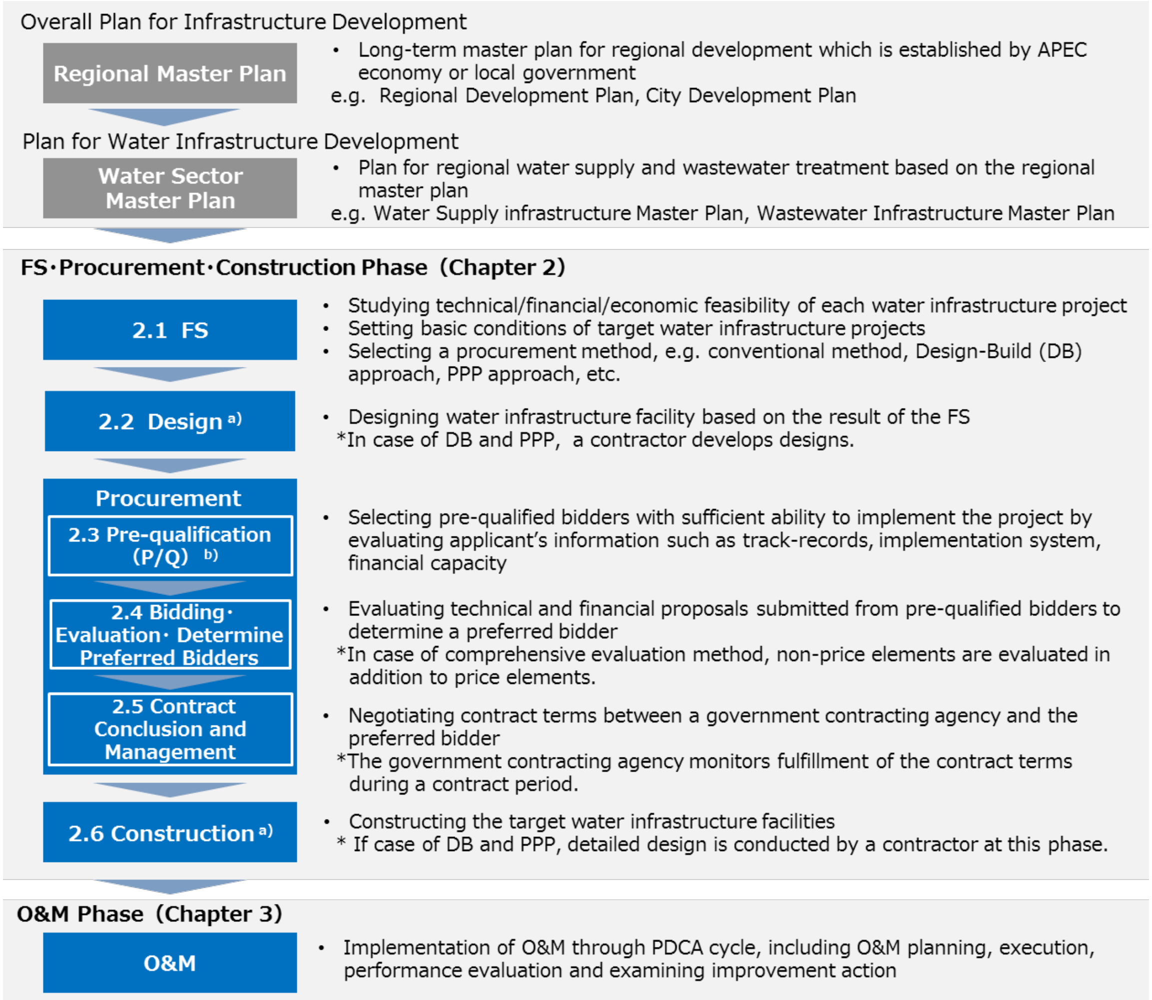
1.1.5 Local High-quality Development: Job creation/capacity building and transfer of technologies

Water infrastructure also has a significant impact on the local economy, because it involves large-scale public works projects and generally without competing water utilities in the area. Therefore, for water infrastructure to continue to function sustainably, it is important to expand local employment opportunities by encouraging active and long-term employment of local human resources and other similar endeavors. It is equally important for local people to get easy access to the benefits of water infrastructure to achieve inclusive growth. In addition, contributions can be made to sustainable development of the local economy by taking steps to ensure the proper transfer of technology and expertise by holding training programs for local human resources and developing operation manuals, etc.

1.2 Phases of water infrastructure development and important considerations for each phase

1.2.1 Phases of water infrastructure development

The phases of water infrastructure development are shown in Figure 2.



Note: a) When using the DDB approach or a PPP (Design-Build-Operate (DBO) or Design-Build-Finance-Operate (DBFO) approach), after contractor selection, a private enterprise performs the design (see 2.2 Design), from equipment selection to preparing the layout drawings, etc.

Note: b) In some cases, a post-qualification may be performed.

Figure 2: Phases of water infrastructure development

First, the APEC economy or local government formulate a regional master plan, such as a long-term master plan for regional or city development. Based on regional factors including demographics, the direction of urban development, and the situation of water resources, this regional master plan determines the overall picture of the water infrastructure, including the area to be served, the target population, and the general placement of the facilities.

Based on the regional master plan, a plan for water supply and wastewater treatment (water sector master plan) is formulated by the government contract agency. This water sector master plan determines the details of the water treatment facility and a general outline of the water distribution network, with consideration for factors such as the local topography, the raw water quality of the water resource, and the current situation of urban development.

In a FS, based on the water sector master plan, the government contract agency determines whether it is feasible to build and maintain the specific water infrastructure. If the project has been confirmed as fully feasible through the FS, the next step is design, followed by procurement. The procurement phase consists of pre-qualification (P/Q); bidding, evaluation, and contractor selection; and contract execution and management. Construction of the facility takes place after these procurement processes; and when construction is completed, the O&M phase begins.

In the following chapters, the necessary considerations at every phase are described, focusing on feasibility studies, design, procurement, construction, and O&M for individual projects in water infrastructure development, based on the assumption that a regional master plan exists and is being followed.

1.2.2 Importance of the planning phase

To ensure the QWI, it is important that the basic information prerequisite to the FS for a project is specified in a master plan.

In a regional master plan for water infrastructure development, the preconditions for water infrastructure development shall be established, based on forecasts of future urban development, urban planning, and demographics, etc. In a water sector master plan for water and wastewater treatment plants, the service area for the water supply and wastewater treatment services and the placement of facilities need to be determined based on information such as medium to long-term water demand and pollution load in the region or city. The regional master plan for water infrastructure development shall be consistent with other related plans, and in the planning process consultation and coordination among the relevant departments of the central government and local governments (urban planning department, construction department, environmental department, etc.) need to be maintained.

Specifically, in the case of a water supply project, at the phase of formulating a water sector master plan, it is necessary to secure a water resource for the water treatment plant, formulate a development plan for the distribution network that will carry water from the water treatment plant and determine the requirements for the water treatment plant to be constructed, based on demographics and urban development plans in the target area.

Meanwhile, in the case of a wastewater treatment project, when a master plan is prepared for a region or city, the pollution load that will be generated from households and economic activities in the target area is first calculated based on demographics and urban development plans in the target area. Next, the amount of wastewater to be treated to reduce the pollution load is calculated, and the necessary treatment capacity of the facilities is determined. A decision is also needed as to whether wastewater will be handled collectively (off-site at a wastewater treatment plant) or individually (on-site using septic tanks, etc.) or by a combination of the two, based on factors such as population density.

Depending on circumstances in the urban area, some simple water infrastructure may already be present in many cases (such as septic tanks for wastewater treatment); so it is important to develop flexible, but feasible plans based on local conditions, such as planning new facilities to complement existing systems, or developing infrastructure in an incremental manner in accordance with urban development.

Since the research and analysis during the above planning phase is closely interrelated with the research and analysis during the FS and design phase, which is covered in subsequent sections, considerations related to feasibility and design should also be kept in mind at the planning phase. If the government contract agency lacks any of the necessary experience and expertise for plan development, it should obtain support from experts in relevant fields in the public and private sectors.

Table 1: Issues to be addressed in the plans

Plan level	Definitions	Matters to be determined
Regional Master Plans: **Regional development plans, City development plans**	• Long-term development policy for a region or society, formulated by an economy or local government • Master plan for urban planning Examples: An urban development plan or an economy's master plan	• Basic policies on urban planning • Long-term future outlook for a city • Medium to long-term plan for infrastructure development
Water Sector Master Plans: **Water supply infrastructure master plans,** **Wastewater infrastructure master plans**	• Higher-level plan or basic plan on water infrastructure development in a city or region Examples: A water supply system master plan or sewage system master plan	• Population forecast for the region • The region's water demand and wastewater treatment demand (amount of necessary pollution load reduction) • Choice of combined or individual wastewater treatment • Arrangement of water and sewerage facilities and networks • Capacity of facilities • Securing water resources, establishing multiple systems, etc. • Asset management • Long-term maintenance plan

1.2.3 Important considerations in each phase

Water infrastructure projects generally can be divided into two phases: the FS, design, procurement, and construction phase; and the O&M phase. To ensure the QWI, it is very important to consider and implement all elements that will ensure the QWI in each phase. For example, even if a water treatment plant is designed and constructed with adequate consideration for the QWI, accidents may occur if O&M are not handled appropriately during the O&M phase, potentially leading to problems including interruptions of the water supply.

The table below summarizes the considerations in each project phase with respect to the factors that ensure the QWI. Chapters 2 and 3 describe specific measures that will ensure the QWI according to this breakdown of project phases.

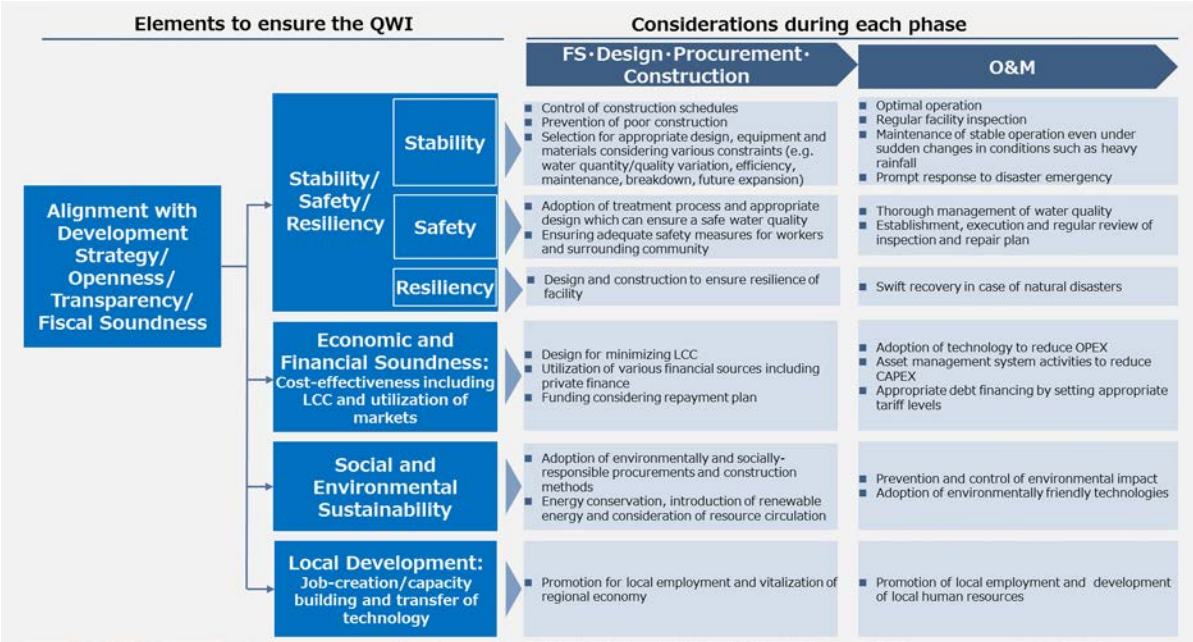


Figure 3: Important considerations during each phase

Column 1: The importance of ensuring the QWI

Failure to take appropriate measures at each phase of water infrastructure development introduces risks of adverse effects on the environment and economy. The following are potential risks due to inadequate QWI. It is important to avoid these risks by implementing the FS, design, procurement, construction, O&M of water infrastructure facilities on the basis of thorough study concerning each factor of the QWI.

Examples of risks resulting from the inadequate QWI

<Examples of risks in the FS and design phase>

- Increased environmental burden and decreased durability
  If a wastewater treatment plant is designed with an insufficient capacity to handle the amount of influent wastewater and the pollution load, it will be operated in an overloaded state, meaning a risk of failing to meet the legal requirements for treated wastewater quality and causing foul odors and other environmental problems, in addition to the risks of increasing the energy consumed during operation and impairing the long-term durability of the facility.
- Increased LCC
  If LCC does not receive the proper consideration in designing a water infrastructure facility, this carries the risk of the improper selection of the optimal water treatment process for LCC minimization and resulting in higher LCC.

<Examples of risks due to contractor selection in the bidding phase>

- Halted construction
  If the companies bidding for the construction project are not properly assessed before selecting a winning bidder, there is a risk of accidents occurring during construction, halting the project. If the company is unable to resume construction, construction may be abandoned before completion.
- Delayed construction
  If a winning bidder for a water infrastructure facility is selected without properly evaluating past track records related to specific types of construction projects, there is a risk of selecting a private company that lacks experience in site and process management, leading to major delays in construction.
- Decline in service
  If inappropriate materials are used at the phase of water conduit construction, there is a risk of frequent leaks after installation, cutting off water to tens of thousands of households in the area every time this happens and affecting many people's lives.
- Increased LCC
  If the priority is minimizing the initial investment and LCC without proper consideration of LCC, this carries a risk of equipment breakdowns, replacement, and other problems in O&M, which could lead to higher LCC and rate increases.

Column 2: Establishing the legal framework needed to ensure the QWI

Each economy needs to have a basic legal framework in place before it can properly address water infrastructure development. First, it is important to establish basic laws and regulations concerning water and sewerage projects in that economy, applying to both water supply and wastewater projects. The basic legal framework should include provisions covering at least the following topics.

- Creation of long-term plans and basic plans for water and sewage systems
- Governance of water utilities by the central government (including business permits and regulation of business entities)
- Subsidies and other support from the central government
- Technical guidelines and standards
- Water quality standards
- Setting and changing rates and usage fees

In addition to establishing a basic legal framework for water and sewerage infrastructure, including the above provisions, each economy should establish laws and regulations in related areas such as environmental protection, river management, water resource management, waste disposal, consideration for residents, and procurement, as needed.

Related laws and regulations include provisions covering the following topics.

- Appropriate waste disposal
- Ensuring transparency and preventing corruption
- Procurement (including use of the private sector)
- Consideration for the environment and neighborhood residents

The use of PPP in the area of water and sewage systems has been on the rise in recent years in many economies. It is important to establish a basic legal framework concerning PPP in order to utilize PPPs effectively. Basic laws and regulations on PPPs should include provisions covering the following topics.

- Organizations that promote PPPs
- Procedures for PPP projects (project formation, procurement, and implementation)
- Areas for PPP involvement (including the water and sewerage area)
- Applicability of and consistency with related laws and regulations
- Government support for PPP projects

To advance water infrastructure development efficiently and effectively, it is important to establish a long-term plan and basic plan for the sector, based on a medium to long-term vision, in accordance with laws and regulations such as those mentioned above. At the level of the economy or region, these plans should be consistent with medium to long-term cross-sectoral economic and development strategies as well as strategies for climate change and the environment.

Column 3: The organizations and human resources needed to ensure the QWI

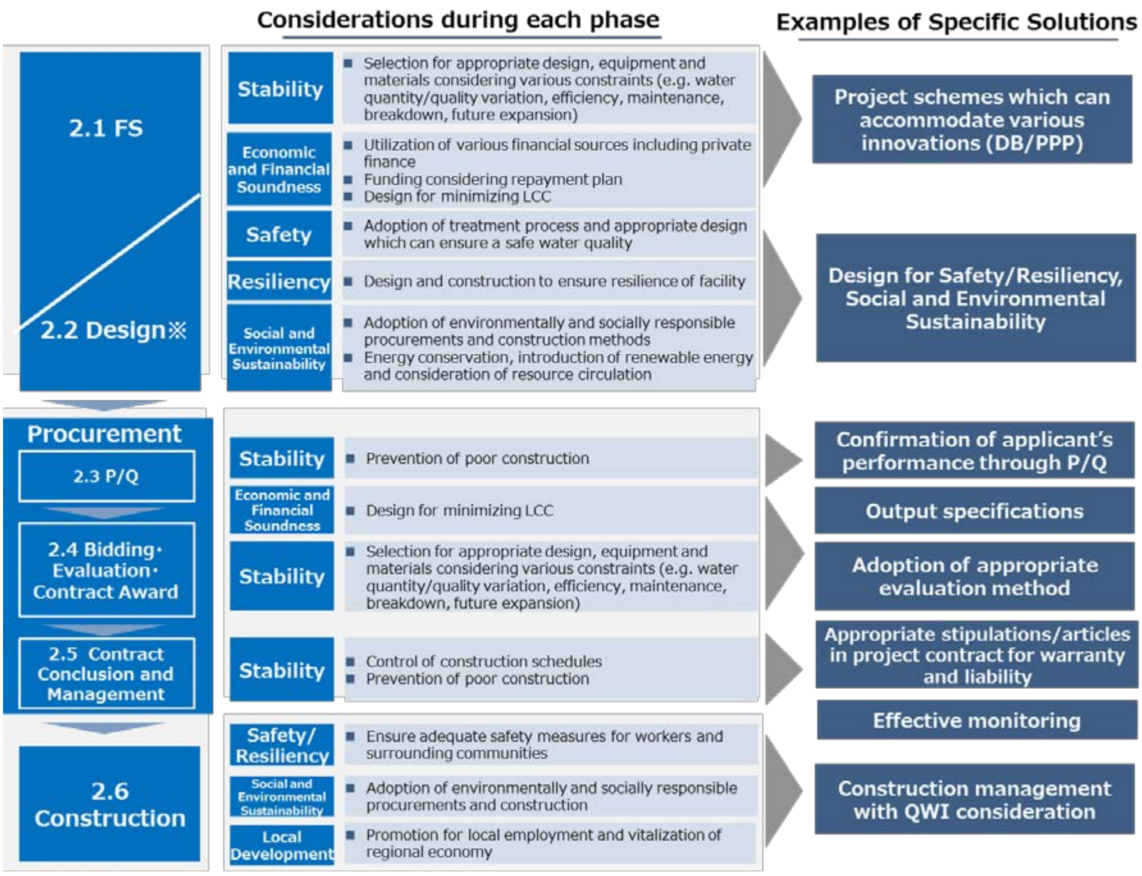
To ensure the QWI, in addition to the legal framework described in Column 2, it is essential to have properly functioning organizations that will implement and oversee projects, and those organizations need to have personnel with adequate experience, skills, and expertise.

It is necessary to establish specialized organizations with oversight over water and sewerage projects within government organizations at the central and regional levels, clearly defining their roles and the scope of their authority. If a public corporation exists that will implement such a project, it is necessary to clarify its relationship with government organizations, especially at the regional level. Apart from government organizations, the establishment of a public body to maintain and improve the level of technology and information sharing of water utilities is also encouraged.

It is important to train and maintain human resources with adequate experience, skills, and expertise with regard to water and sewerage projects. In addition to personnel with technical skills, capabilities in the areas of management and finances are also needed. Government organizations need to continuously implement capacity development for their members in a conscious, planned manner. Activities for cooperation and support within the APEC economies are also important for such purposes. In a mature organization where the water utility has adequate management skills, it is important to enhance organizational efficiency by utilizing the human resources and technical capabilities of the private sector.

Chapter 2 Feasibility study (FS), design, procurement and construction phases

Figure 4 shows the overview of consideration and specific solutions to secure the QWI, which is discussed in Chapter 1. Because there are many duplicate considerations in both the FS and design stages, all the items listed under these phases must be integrally examined.



* Note: In case of DB and PPP (DBO and DBFO), the selected contractor will implement Design (section 2.2) including equipment selection and preparation of drawings after the bid is awarded.

Figure 4: Example of procedures and specific solutions for water infrastructure development

Column 4: Considerations for renovation projects

After entering service, water infrastructure may decline physically and functionally as a result of aging or other deterioration. For that reason, any facility renovation plan must be based on organized information obtained through daily O&M of existing facilities.

In the renovation of water supply/wastewater facilities, it is vital to consider the following points.

- The renovation must be planned based on the overall master plan. For example, when expanding facilities in a location not previously scheduled for future expansion in the master plan, the overall master plan must also be reviewed.
- Before conducting a renovation, the information obtained through daily O&M must be organized and the irreplaceability/necessity of the facility must be taken into account. Planning must also consider long-term targets such future population trends and climate change.
- Renovations are carried out by updating existing facilities or by extending their life. For mechanical and electrical equipment, in particular, safety or efficiency and energy-efficiency improve with technological advances, so an understanding of the latest technology trends is vital. On the other hand, due consideration must also be given to the supply status of parts etc., as facility maintenance may become difficult if the production of old machine types is halted or there are parts supply difficulties.
- The water purification or wastewater treatment facilities cannot stop, as they are fundamental public infrastructure. Therefore, renovation must be undertaken while the water treatment or wastewater treatment plants are under operation. For example, where there are multiple treatment systems in a water supply/wastewater facility, by renovating them in sequence from the treatment system of highest priority in terms of processing efficiency, a halt in operations can be avoided.
- When expanding water supply/wastewater facilities, securing land for the expansion may be an obstacle. For this reason, during the initial establishment of new water supply/wastewater facilities, a site with sufficient space for future expansion should be chosen.

In renovating water supply/wastewater facilities, it is vital to minimize the impact on the surrounding environment. For example, when pipelines are installed, the impact on public and economic activities due to road traffic congestion, etc., can be avoided by using a non-cut method of construction instead of a cut-and-cover method.

2.1 FS

To secure project sustainability in O&M as well as in procurement and construction, all potential scenarios must be studied from technical, financial and environment perspectives during the FS.

In order to achieve 'Stability' as one of the key QWI components, appropriate design, equipment and materials must be selected, taking into account various constraints. To secure 'Economic and Financial Soundness: Cost-effectiveness including LCC and utilization of markets', financing in consideration of private funding and the repayment schedule are of importance. Further, to increase 'safety' and 'resilience', adoption of a treatment method that can secure water quality safety, and the design and construction of resilient facilities, are required. To increase 'Social and Environment Sustainability' it is important to adopt procurement schemes and construction methods that consider the environment and the public as well as energy-efficiency and reusable energy, effective use of water and sludge, and resource recycling considerations.

To secure such quality, at FS stage where the framework and basic items of the water infrastructure facilities project are studied, sufficient research that takes geographical and urbanized conditions into consideration is required. Specifically, for appropriate procurement, the following items should be sufficiently studied: adoption of a project procurement scheme under which private contractors can exercise innovation; treatment methods that secure water quality safety; design and construction that achieves resilient facilities; appropriate design and equipment/materials that take into account various constraints; energy efficiency; resource recycling, reduction of life cycle costs and application of information and communication technology.

In the FS, project feasibility will be studied primarily from a technological, economic, profitability and legal viewpoint. Additionally, in many cases the project procurement scheme will also be considered at this stage.

Under the FS, the basic information required for the project including the natural conditions, status of existing facilities, and the present and future demands for the project, shall be obtained and analyzed. Based on this basic information, the detailed conditions including treatment methods and the facility design proposals shall be determined. Table 2 outlines typical items for the FS.

If the government contract agency has limited capacity to implement the FS by itself, use of private sector consultants is encouraged.

Table 2: Research items in a typical FS

Study items	Description
1. Policies, master plans, relevant laws and regulations	Check compliance with government policies, master plans, relevant laws and regulations
2. Current status and natural conditions	Check of project location and surrounding natural conditions
3. Demand forecasts	Future demand forecasts for the required services
4. Facilities basic conditions	Consideration of the function, scale and specifications etc. for the required facilities
5. Estimates	Estimate of the project costs (site acquisition, construction, O&M, etc.)
6. Profitability	Profitability analysis based on project costs and demand forecasts
7. Economic efficiency	Analysis of the project's economic benefit (beneficial effect) to society and the economy
8. Procurement methods and funding	Study of the procurement scheme and funding techniques
9. Evaluation of environmental and social impact	Analysis of project impact on environment, the public and the economy (including pollution prevention and biodiversity)
10. Implementation schedule	Consider the implementation schedule and action plan

(1) Use of procurement scheme to take advantage of innovation

In order to realize the key QWI components including 'Stability' and 'Economic and Financial Soundness', private sector innovation should be fully embraced. In terms of preconditions for allowing the private sector to exercise creativity and innovation, it is important to allow a certain degree of freedom in design requirements. However, the extent of the private sector's freedom is ultimately defined by the procurement type. Therefore, the most suitable type of procurement for securing the QWI must be adopted from among the schemes available to the government contract agency based on the various policies and systems, the natural conditions, the calculated demand for the service and the basic conditions of the facility as investigated in the FS. The main procurement methods for water supply and wastewater projects are Design-Bid-Build schemes, DB schemes and PPP (DBO and DBFO) schemes. The features of each method and the advantages and use challenges are listed below.

Table 3: Outline of the water supply/wastewater project procurement methods and relative characteristics

Method	Outline of method	Advantages	Challenges
Design-Bid-Build	Facility design, construction and O&M are separately procured. Funds for facilities are procured from public funds.	• Since the government contract agency decides the specifications to a detailed level, a procurement order that incorporates the public intent in the detail is possible.	• Where there are many technical constraints or a number of possible technology candidates, it may be difficult to capture private sector innovation.
DB	Procurement where facilities design and construction are both outsourced to one private sector entity. Funds for facilities are procured from public funds.	• The private contractor can provide a design that considers the construction. Also, the creativity and innovation of the private contractor in terms of construction can be utilized in the siting and design of the facilities. • A faster design to construction process can be anticipated because one entity is responsible for every process.	• The government contract agency should have sufficient capacity in management of contract including an appropriate technical evaluation capability since a range of technologies are permitted during bid evaluation. • Preparation of tender and evaluation may take longer in comparison with DBB scheme. • The number of private sector entities able to participate in the tender may be limited because DBO requires a certain technological capacity.
DBO	Procurement where facilities design, construction and O&M, are outsourced to one private sector entity. Funds for facilities are procured from public funds.	• For the private contractor, it is possible to develop designs that take into account not only construction but also O&M, and propose plans that consider siting of facilities and safety, security and economic efficiency. • By contracting O&M to a private contractor, the government contract agency can pass on the risk of unforeseen issues in the trial operating period to the private sector.	• The government contract agency should have an appropriate technical evaluation capability since various technologies are allowable during bid evaluation. • There is a danger that DBO procurement could be more costly than Design-Bid-Build procurement since there are more expenses at the procurement preparation stage and there is less scope for innovation. • The number of private sector entities able to participate in the tender may be limited because DBO requires a certain technological capacity.
DBFO	Procurement where facilities design, construction and O&M are all outsourced to one private sector entity. The funding is also included in the project scope of the private sector.	• The private contractor can propose a plan that optimizes construction and O&M and also takes into account funds procurement. • For the government contract agency, in addition to the advantages of DBO, DBFO procurement can ease or reduce financial expenditure.	• Since the greatest risk and the primary responsibility are borne by the private contractor, the appropriate listing of project schemes and contracts, and proper monitoring, are important. • The number of private sector entities able to participate in the tender may be limited because DBFO requires a certain capacity in both technology and financing.

In Design-Bid-Build procurement, the government contract agency undertakes detailed design and sets the specifications. A private contractor undertakes construction work based on the specifications. For that reason, exercising private sector innovation during the construction stage is limited to a narrow scope.

On the other hand, in DB and PPP (DBO and DBFO) procurement, design and construction are integrally implemented by the private sector. Therefore, the private sector is allowed to apply its own unique technology and innovation in order to secure the QWI in consideration of the infrastructure's life cycle including design, construction and O&M.

The government contract agency should understand the nature of each method and is encouraged to apply DB or PPP schemes in water infrastructure projects if the project has sufficient room to allow private sector to exercise their innovation.

Specifically, the following are common conditions for application of DB or PPP schemes. However, such conditions may depend on the legal conditions in each economy.

- Bankability
- Major constraints on site conditions etc. (e.g. small sites), and high expectations are placed on private contractor innovation to implement the project
- Application of new technology
- Application of more than one technical specification may be assumed for achieving project objectives
- The government contract agency has sufficient capacity in evaluating technical proposals
- More than one private contractor has expressed interest in participating in bids under DB or PPP procurement

Additionally, LCC is generally seen as an effective evaluation method as a bid mechanism if DB or DBO procurement is applied.

Column 5: Example of appropriate tariff setting and revision in water projects

In PPP projects in the water supply/wastewater field, tariffs must be set and revised to an appropriate level for the project to be sustainable, and project expenses must be covered by tariffs collected from the users. Examples of the successful setting and revision of tariffs may be seen in the Cebu water supply project and the Subic Bay water concession project, both in the Philippines.

In the Cebu water supply project, private contractor Cebu Water won a 30-year water supply project from Metropolitan Cebu Water District (MCWD). Payments to Cebu Water were fixed at 22 pesos/m3 on condition that KPIs for water volume, quality and water pressure were satisfied. Since MCWD collects water utility tariffs of approximately 26 pesos/m3 from the user, MCWD applies that difference to pipeline maintenance expenses. As described above, this project is financially sustainable for MCWD.

In the Subic Bay Water concession project, Subic Water and Sewerage, a PPP, concluded a 25-year water supply agreement. Approval authority for price revisions had been transferred from Subic Bay Metropolitan Authority (SBMA) to the more independent Subic Bay Water Regulatory Board (SBWRB), so price revisions could be reviewed through an appropriate process without political interference. Specifically, water supply tariffs could be reviewed in accordance with project operating costs that included O&M costs and facility upgrade costs. As a result, project continuity has been secured and tariffs have been properly set at a payable level.

(Reference) JICA Project research regarding private sector use in water infrastructure projects Final Report (June 2017)

2.2 Design

The lifespan of water infrastructure facilities is considerably long. Therefore, at the design stage, it is important to focus not only on the construction phase, but also to provide a design that takes into account the stability, cost performance including LCC, safety, resilience and social and environmental impacts of O&M over the long-term.

The design phase includes the basic configuration of the facilities including the treatment method, treatment process, and the required standards of each facility, preparation of drawings and estimated costs.

Raw water quality has a significant influence on water treatment plant design. In the sewerage sector, the design and technology applied in the treatment plant depends on inflow sewage quality and precipitation conditions. Additionally, the structural requirements for the facility depends on climate and geographic conditions. In order to ensure safe water quality and structural stability, it is important to design facilities based on the latest knowledge of what is best suited to local conditions.

The environmental impact also depends on the environmental performance of technology employed in the water infrastructure facilities and the use of renewable power and the energy efficiency of each piece of equipment. Because various new technologies come onto the market every year, it is important to design the facilities based on the latest information. Current examples of such latest technologies include high-efficiency type incinerators, reuse or recycle of waste heat and reclaimed water, use of sludge for power generation or fertilizer in agriculture, and solar power generation on the roof of water treatment plants.

Design work is often commissioned by consultants specialized in water sector. It is important to employ a consultant who has sufficient experience in similar works, familiarity with local natural and urban conditions, and knowledge of cutting-edge technologies that can contribute to improving the QWI.

(1) Design that considers safety, resilience, the environment and LCC

From a QWI perspective, the following technical factors should be sufficiently considered. Such factors include treatment methods that ensure water quality and safety; design and construction that achieves structurally resilient facilities; most appropriate design and equipment/materials within the specific project constraints; energy efficiency; use of reclaimed water; material recycling; and reduction of LCC. For example, in a case where water demand is expected for the long-term, downsizing the capacity of the water treatment facility could lead to decreased LCC. Additionally safety measures for the local residents and regional revitalization are both important factors. Appendix 1 summarizes the components consisting of design and relation with the QWI.

2.3 Pre-Qualification (P/Q)

To ensure consistent service for the users, it is important to appoint an appropriate contractor with sufficient experience in similar facilities and strong organizational structure to avoid delays in the schedule and defects in construction. For this purpose, the government contract agency should require the bidders to submit such information including but not limited to their credentials of similar work, organization structure for implementation, and financial soundness, to confirm that the bidders have sufficient capacity to undertake the project and satisfy the QWI. In addition to P/Q, qualification may be assessed as part of the evaluation of the technical proposal or even as a post qualification (after selection of the lowest bidder). The most suitable methods should be applied in consideration of the procurement schedule and characteristics of the specific projects.

(1) Confirmation of bidder credential in P/Q

P/Q should not be merely a perfunctory process but should function as a framework for securing the QWI. In order to achieve the QWI through P/Q, such practices including demanding evidence (written testimonials from former clients) of objective proof of quality of work, or performance credentials including certification by former clients should be maintained.

Examples of items for verification or supporting evidence for P/Q are shown in the table below. Appendix 2 illustrates sample P/Q examination criteria.

Table 4 Example of PIs/conflicts of interest in P/Q

Item	Example of PIs	Sample evidence
1 Eligibility	Applicant has no conflicts of interest. Applicant is not ineligible as indicated by the government contract agency (for example, is not a designated suspended contractor).	Declaration signed by the responsible manager at the bidder
2 Past contract non-performance	No history of contract non-performance (e.g. In past 3 years). Pending litigation will not impact on contract performance.	Declaration signed by the responsible manager at the bidder
3 Financial status	Audited financial statements and profit/loss statements from past (e.g. 3 years) (where laws in the local economy do not require an audit, other financial statements recognized by the government contract agency)	Annual financial statements certified by a public accountant
4 Applicant qualifications		
a) Experience and track record with similar contracts	Track record of construction (or operation) of facilities of a similar size (in terms of manufacturing/treatment capacity or project size, etc.) (Project name, client name, construction term, contract value, project work details, etc.)	Copy of contract, or client-issued certification or letter of certification, etc.
b) Capacity for construction or manufacture	Facilities (or equipment/construction equipment) required for construction (or manufacture) of facilities of a similar size (in terms of manufacturing/treatment capacity)	Certificate from a public organization such as a local or industry organization, or international standard certifications
c) Track record	Track record of installations of a similar nature operating normally in a natural disaster above a certain scale (e.g. an earthquake of magnitude ●● or above)	Client-issued certification or letter of certification, etc.

2.4 Bidding

The bidding process is an important stage at which the price and technology proposed by the private contractor are determined as these factors are directly linked to LCC and stability of the services of the water infrastructure. Appropriate evaluation of the bids are of importance in securing and stabilizing the services provided by the infrastructure. Additionally, selection of the bidder who initiated the lowest LCC is significant in securing the financial sustainability of the project.

The government contract agency announces the tender in accordance with the applicable laws and regulations in each economy, and publishes the following documents.

- Invitation to tender
- Application requirements
- Specifications (Required standard document)
- Contract (draft)

- Evaluation criteria
- Forms of Tender, etc.

The bidder prepares and submits bid documents and proposals to the government contract agency based on the conditions set in the tender. The government contract agency evaluates the submitted documents in accordance with pre-set conditions, and selects the successful bidder, providing them with priority right to enter into negotiations. An example of requirements in tender documents is shown in Appendix 3.

Particularly in DB, DBO and DBFO projects, the most important factor in ensuring the QWI through encouraging private sector technology and innovation is the specifications set and the evaluation method chosen. Optimal specifications setting and suitable evaluation methods must be selected to encourage bidder to be innovative.

(1) Appropriate differentiation of input and output specifications

For input specifications, which define the facility specifications and the standards for parts and materials, the government agency conducts all the equipment selection and design to ensure the QWI and the facilities are constructed as specified and designed by the government contract agency and therefore, the room for the private sector bidder to exercise innovation is limited.

On the contrary, for output specifications, for which only the basic conditions such as raw water quality/volume and treated water quality/volume and basic operating conditions (location, construction criteria) are specified, the private sector is responsible for undertaking the design that secures the best QWI. Therefore, these procurement methods are considered to elicit the private sector's innovation and technology. The output specifications set prior to the tender also become the standards for monitoring by the government contract agency during construction and O&M phases.

(2) Adoption of appropriate evaluation method

The evaluation methods generally include the least cost evaluation method, the LCC evaluation method, and the comprehensive evaluation method. The least cost evaluation method is an evaluation method which evaluates only the cost estimated by the bidder. The LCC evaluation method is an evaluation method which converts technical factors into costs. The comprehensive evaluation method is an evaluation method that combines both cost and non-cost elements (such as credential and technical aspects etc.).

a) Least cost evaluation method

In the evaluation of Design-Bid-Build procurement, traditionally the government contract agency submits detailed specifications for designs and construction methods and cost-oriented evaluation (or least-cost evaluation) is typically adopted to select the successful bidder. This method is preferred if (i) there are no constraining conditions in project implementation, (ii) the facilities to be constructed are standard and relatively simple and (iii) there are no major differences in the QWI or LCC expected among the bidders.

b) LCC evaluation method

The LCC evaluation method is a method of evaluation that is based on LCC which takes into account the required OPEX as well as CAPEX. The LCC evaluation method has the advantage that technical factors are evaluated upon conversion into cost factors. The successful bidder is selected based on the quantitative competition in costs. Thus the LCC evaluation method, converts technical factors into costs and ensures fairness and transparency. Additionally, use of the LCC evaluation method is valuable from the perspective of optimizing the project's LCC and controlling public expenditures.

In cases where the LCC evaluation method is applied in a DB project, it is necessary to have a guarantee of O&M performance (cost, treated water quality, water content of treated sludge, etc.) since the subject project does not include the O&M, while OPEX generated during O&M are included in the evaluation. Under such a DB project that uses the LCC evaluation method, a performance demonstration period (approximately one year) is set. During the period, the private contractor conducts O&M and the performance of O&M is evaluated during this period.

The LCC evaluation method is expected to work more effectively in case of DB or DBO.

LCC evaluation items and calculation methods are shown in Appendix 4. A sample LCC evaluation sheet is attached in Appendix 5.

c) Comprehensive evaluation method

Under the comprehensive evaluation method (combination of technical and financial evaluation), both technical and cost factors are evaluated as respective scores. Additionally, depending on the specific scoring allocation for cost and technical elements, the evaluation can emphasize either technical elements or cost elements. Adopting the comprehensive evaluation method is encouraged if (i) a number of constraints are involved in construction, (ii) various alternative technologies or combinations of equipment can be utilized in the treatment process in the plant, or (iii) a great difference in the QWI among the bidders can be foreseen because the method allows for evaluating the technical aspects and the quality of the services. However, in the process of evaluating technical points, it is essential to ensure sufficient transparency and fairness in setting pricing criteria and evaluation rationales. Additionally, the government contract agency's official shall be highly qualified to be able to evaluate non-cost elements including technology, etc.

Column 6: Multi-criteria evaluation method and evaluation of non-price elements

When a multi-criteria evaluation method is adopted, non-price elements are evaluated and scored, so the non-price element evaluation method should be formulated from a QWI perspective. Sample evaluation items are indicated below.

When evaluating non-price elements, in order to ensure transparency and fairness, in addition to the prior publication of evaluation criteria, the establishment of an evaluation committee composed of a number of people, and if necessary the involvement of external specialists, is important.

Table 5 Sample non-price element evaluation items

Type	Evaluation element			
	Safety and resiliency	Provision of stable services	Social and environmental impact	Financial sustainability
Overall	・Disaster measures	・Payment schedule ・Number of similar track record contracts	・(Energy) consumption efficiency	・Investment capacity ・Business plan
Design	・Facilities performance	・Design capabilities		
Construction	・Equipment efficiency and suitability	・Construction capacity (no. of years' experience of assigned personnel) ・Construction to schedule or completion date of handover	・Rate of environmental standard compliance ・Knowledge of local economy, materials use	
O&M	・Safety of quality control methods	・Project implementation process ・Long-term O&M implementation organization	・Rate of employment of local economy residents	・O&M costs

(References) ADB (2015) Procurement Guidelines

World Bank (2014) Guidelines; Procurement of Goods, Works, and Non-Consulting Services. Under IBRD Loans and IDA Credits and Grants

(Note) It is also useful to refer to World Bank (2016) Procurement Guidance; Evaluation Criteria Use of evaluation criteria for procurement of Goods, Works, and Non-consulting Services using RFB and RFP

Column 7: Example of LCC evaluation (Maynilad, Philippines)

At Maynilad Water Services, Inc., a private water and wastewater services provider, the DB method of project procurement was adopted for the development of facilities that are high-cost in the O&M phase, such as water treatment and wastewater treatment, and LCC evaluation was used in the bid. Through LCC evaluation, the pre-qualified bidder was able to propose the optimal design that took into consideration the balance of initial cost and maintenance costs in the life cycle, and successfully reduced LCC while maintaining quality.

Maynilad emphasize that the following points must be considered during an LCC evaluation.

- In order to ensure water infrastructure quality in the bid, a competent contractor must be selected. For that purpose, it is important for the government contract agency to employ a consultant with high skill levels.
- Continuous training of in-house engineers is important in order to spread the technical understanding regarding best available technology, methods to ensure quality in infrastructure development, and effective maintenance management throughout the organization.
- The government contract agency needs experienced and knowledgeable personnel in order to be able to independently evaluate the O&M costs proposed by the contractor. Reference data from similar projects and post-contract monitoring is also important.

(Reference) Maynilad (2017). MAYNILAD PROCUREMENT PROCESS (High Quality Water Infrastructure Seminar Presentation Material)

Column 8: Concept of discount rate in LCC evaluation

In the LCC calculations, costs during O&M period are converted to present value using an appropriate discount rate. The discount rate has a significant impact on the LCC amount, so an appropriate value must be used. In theory there are three methods of calculating the discount rate, as follows.

[1] Weighted Average Cost of Capital (WACC)

[2] Social Time Preference Rate (STPR)

[3] Expected Rate of Return (ERR)

Of the above, [1] is difficult to calculate because many public institutions do not have the concept of investment and also they do not procure funds from financial institutions or markets. Regarding [2] as there is no set method for setting the Social Time Preference Rate, it is difficult for a public institution to set it in an actual project. On the other hand, [3] can be calculated even by public institutions, who can obtain data about investment in water projects (construction cost) and revenue (income from water supply tariffs).

2.5 Contract conclusion and management

The government contract agency secures the QWI by monitoring the conditions of the contract and the contractor's performance. Therefore, appropriate management of contract fulfillment contributes to securing the QWI by controlling construction schedules and preventing poor construction.

In practice, appropriate provisions on warranties and penalties (incentives) and effective monitoring can be the key factors in ensuring solid and on-schedule construction works and to prevent defective construction. The government contract agency concludes a contract through bid award and contract negotiation. After concluding a contract, monitoring fulfillment of the contract terms is essential for ensuring the QWI.

(1) Appropriate conditions on warranties and penalties

In general, it is common practice to provide a performance bond and Liquidated Damages for the purpose of ensuring fulfillment of the contract conditions and determining damages to be covered in the event of non-fulfillment of the contract conditions (for example, a construction delay), respectively.

These amounts, applicable currencies and validity period must be reasonable in light of international business practices. This also applies to DB schemes or PPP schemes.

In the similar manner, bid security bonds may be adopted to increase participation in tender.

In the case of PPP schemes, various conditions are set in the contract document for risk sharing between the public and private sectors. In risk sharing, risk must be allocated under the principle that "those who can best manage the relevant risk should bear the risk". It must be recognized that forcing the private sector entity to take on excessive risk directly corresponds to an increase in the value of a company's bid and represents an obstacle to smooth and efficient project implementation, for example, by increasing the bidding company's need for reserve funds at the bid stage to account for higher liability costs. Consequently, this results in an increase in bid amount and obstacles smooth and efficient project implementation.

Use of contract provisions that comply with international standards in defining fair risk-sharing between the government contract agency and contractor is effective as a means of avoiding such conditions.

(2) Effective monitoring

The government contract agency shall be conscious of maintaining the QWI through the continuous and effective monitoring of the project and through appropriate management of the contracts. For instance, regarding financial sustainability, it is important to plan financing that is appropriate to the scale of construction, and to monitor the implementation carefully. Any deviation from the initial plan should be analyzed and measures to improve the situation should be implemented.

Additionally, since the government contract agency must have adequate contract management capabilities, continuous capacity development is necessary.

2.6 Construction

The development of water infrastructure facilities has a major impact on employees and the local community that varies with the size of the project and length of the construction period. Such construction can also have an impact on the environment and community in that region. Since the construction accounts for the major portion of the cost of a water infrastructure project in a regional economy, local employment and vitalization of the regional economy should be given consideration.

Any impacts derived from the construction works shall be carefully analyzed during the planning and design stage. However, the impacts of the construction must also be also carefully monitoring on a daily basis through supervision of the construction work. As indicated in Part 1, from the perspective of securing the QWI during construction phase, it is important to recognize that there are many factors and items that should be monitored during the construction phase in order to ensure the QWI.

(1) Construction management with QWI considerations

The safety of the neighboring residents must be secured through appropriate public notification of the construction project, arrangement of fences and walls around the site and hiring of security personnel to monitor the site. In addition, occupational safety of the workers is essential, so handrails, fencing, lighting etc. to prevent falls or other accidents shall be installed. To secure resiliency, construction work shall be conducted with strict adherence to commonly applied guidelines and international standards, with appropriate factory testing, construction site and personnel management and quality control. Preparation for unforeseen circumstances such as natural disasters and accidents, fires etc. is also an important factor during the construction phase.

Regarding Stability (stable provision of service), the proposed construction schedule should fully take into account local conditions such as meteorology, and construction should be conducted in accordance with the mutually agreed schedule. It must be recognized that any delay in the delivery of water supply/wastewater services to the community due to non-observance of the schedule will have major impacts on urban development.

In order to secure Social and Environmental Sustainability, various anti-pollution measures that address air pollution, noise, vibration, water pollution (turbid water) etc. should be thoroughly implemented. Construction methods and working hours shall be carefully selected and scheduled in consideration of the local community. In particular it is essential to provide sufficient information and explanations to local residents prior to the commencement of the construction work in order to gain the local community’s understanding. The impacts of the construction works on the surrounding environment should be kept to a minimum level. Additionally, active employment of local workers and appropriate local companies and procurement of local products are encouraged as a contribution to the vitalization of local economies.

Chapter 3 Operation and maintenance (O&M) phase

In order to implement the items that will secure the QWI as described in Chapter 1, specific strategies shall be implemented as indicated in Figure 5. Those specific strategies are described in 3.1 and 3.2.

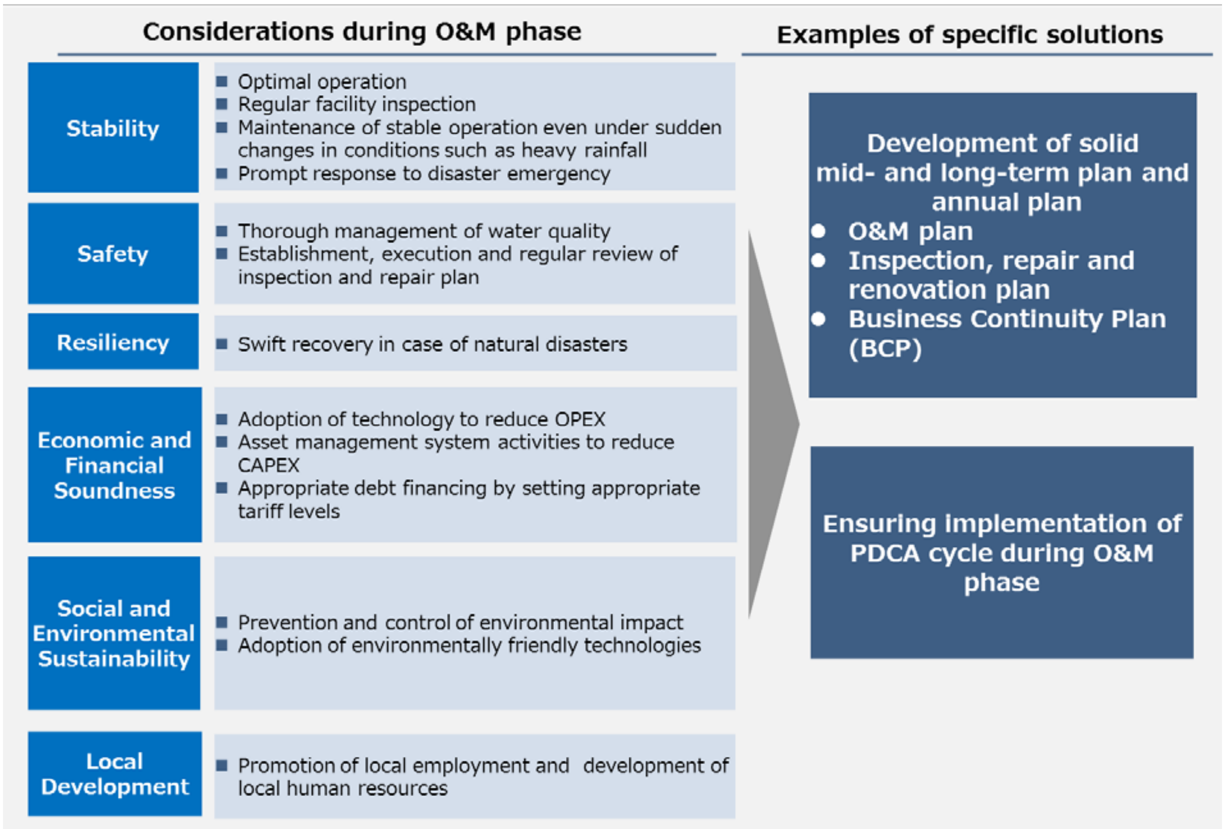


Figure 5: Items to be considered for O&M and examples of specific strategies

In order to confirm whether the QWI has been achieved or not through the conduct of O&M, it is important to verify the PIs set to objectively demonstrate the QWI. Since, as far as possible, quantitative verification is important, comprehensive project PIs for each of the QWI elements that can be measured quantitatively should be set. The following shows an example of PIs in line with relevant factors that ensure the QWI. Reference should be made to Appendix 6 for the measurement methods of various PIs.

Water/wastewater contractors in each economy should refer to the following documented standards as guidelines in formulating PIs suitable for their conditions: international standards ISO24510: 2007 (consumer services), ISO 24511: 2007 (wastewater services), ISO 24512: 2007 (water supply services).

Table 6: PIs in the O&M phase

Five factors that ensure the QWI	Applicable facility	PIs	Appendix 6
Stability/Safety/Resiliency	Water supply	Water quality standard non-compliance rate	No.1
	Wastewater	Target water quality achievement rate	No.2
	Wastewater	Rate of compliance with legal water quality criteria	No.3
	Water supply Wastewater	Incident rate at water supply/wastewater facilities	No.4
	Water supply Wastewater	Aging rate of facilities	No.5
Economic and Financial Soundness: Cost-effectiveness including LCC and utilization of markets	Water supply Wastewater	Total cost per $1m^3$	No.6
Social and Environmental Sustainability	Water supply Wastewater	Energy consumption per $1m^3$ volume of distributed/treated water	No.7
	Water supply	Reclaimed water usage rate	No.8
	Wastewater	Wastewater sludge recycling rate	No.9
	Water supply Wastewater	Employment rate of local labors	No.10

3.1 Formulation of mid- to long-term and annual O&M plans

O&M of water infrastructure is conducted over the long term of several tens of years after construction is completed. Therefore, O&M has a great impact on the QWI. For that reason, in the O&M phase, a mid- to long-term O&M plan shall be formulated. The mid- to long-term O&M plan consists of the following 3 plans.

- O&M plan
- Inspection, repair and renovation plan
- BCP

Also, for the effective implementation of the formulated mid- to long-term plan, it is important to be more specific about the project details having considered constraints such as the single fiscal year budget. Therefore it is essential to formulate a detailed O&M plan for each fiscal year (annual plan), based on the mid- to long-term plan, and secure the QWI by repeating the PDCA cycle. The annual plan mainly considers implementation methods, organization, and scheduling, for the O&M plan.

In addition, in both the mid- to long-term plan and the annual plan, it is important to set appropriate PIs relevant to water supply/wastewater project O&M, and to monitor as appropriate to ensure that no deviations from plan occur in implementation.

3.1.1 Mid- to long-term O&M plan

(1) O&M plan

The O&M plan shall define requirements for the long-term water quality target and water quantity, the facility operational and performance requirements (hardware requirements), requirements regarding operating methods (software requirements), and risk control measures etc., for water quality and water quantity.

For securing the QWI in particular, it is important to consider the following and reflect them appropriately in the plan.

- Thorough management of water quality
- Optimal operation
- The maintenance of stable operation even under sudden changes in conditions such as heavy rainfall
- Prevention of environmental impacts
- Promotion of local employment and development of local human resources

Water quality targets should be determined in accordance with the public health and environmental situation and the user needs in each local economy, while at the same time, for example, referencing international standards such as those of the World Health Organization (WHO) for water supply.

(2) Inspection, repair and renovation plan

The inspection, repair and renovation plan should set the frequency of inspections and repair work over the long-term, forecasting the aging and need for replacement of each facility or piece of equipment, identify the risks concomitant with aging, and the amount of renovation work that will be possible while incorporating realistic assessments of financial resources available for this work.

For securing the QWI in particular, it is important to consider the following items and reflect them appropriately in the plan.

- Establishment, execution and regular review of inspection and repair plan
- Regular facility inspections
- Adoption of environmentally friendly technologies
- Adoption of technology to reduce OPEX
- Asset management system activities to reduce CAPEX
- Appropriate debt financing by setting appropriate tariff levels

Repair and renovation represent massive expenditures in and of themselves, and may not be sufficiently covered within a single fiscal year. Therefore, first it is important to identify areas where repair and renovation are truly required by thoroughly investigating the aging status of the water supply and wastewater facilities, and then to formulate a repair and renovation plan based on forecasts of mid- to long-term water demand and the mid- to long-term fiscal balance forecasts. It shall also be emphasized that preventive maintenance is one of the key concepts for reducing OPEX.

Also, by undertaking small- scale repairs at an appropriate planned frequency, the lifespan of equipment can be extended. As a result, repair and renovation costs can be minimized overall, with resulting reductions in LCC. This plan is important in understanding the current status of facilities and equipment, and for setting repairs and renovation from a long-term perspective in order to ensure the best possible outcomes from a LCC perspective. ISO55001:2014 - Asset management systems will be a valuable reference for this process.

(3) Business Continuity Plan (BCP)

The BCP shall identify risks such as natural disasters and terrorism, estimate damage, and establish counter measures that will secure the safety of the facilities and worker, clarify the chain of command, set a protocol for ensuring managers and relevant workers are on site, assign specific personnel to emergency roles, and solidify work flow chronologically (initial response, recovery response).

The following items are particularly important in securing the QWI and should be reflected appropriately in the plan.

- Prompt recovery after disaster/emergency
- Prompt initial response to disaster/emergency

It is also valuable to conclude mutual support agreements with surrounding water supply and sewerage organizations and to strengthen the organization for such emergency situations.

3.1.2 Annual O&M plan

The annual O&M plan consists of an O&M plan and an Inspection, repair and renovation plan. These are formulated based on the mid- to long-term O&M and inspection, repair and renovation plans.

In the annual plan, the work to be implemented within the fiscal year, implementation method, organization and project schedule are formulated based in particular on changes in water demand, population dynamics, socioeconomic trends, that fiscal year's budget, the status of the organization and personnel.

3.2 Sound implementation of Plan, Do, Check and Action (PDCA) cycle during O&M phase

O&M of water infrastructure is conducted over the long-term of several tens of years after construction is complete. Therefore, to maintain and improve the QWI, the formulation of realistic plans for O&M in both the mid- to long-term and also for a shorter time period are all important, as indicated above.

Also, based on these plans, it is important to conduct appropriate PDCA, consisting of the 'Annual implementation plan' at the start of the period, and 'Sound implementation to plan', 'QWI evaluation' and 'Study of improvement measures' during the period.

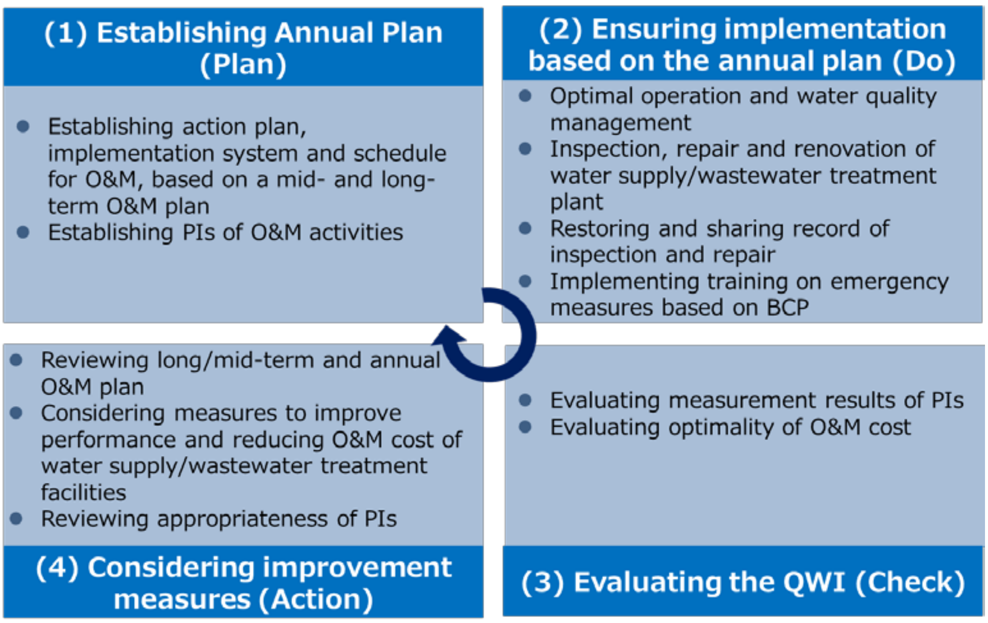


Figure 6: PDCA cycle in O&M

(1) Establishment of annual implementation plan (Plan)

For the effective implementation of the mid- to long-term plan, it is important to be more specific about the project details having considered the budgetary and other constraints in individual fiscal years. For this reason, at the start of each fiscal year in the O&M phase, annual plans for the 'O&M plan' and the 'Inspection/repair/renovation plan' are developed. These plans define the specific schedule, work methods and implementation organization for O&M. O&M PIs for each year are also set. Note that for the BCP, where required, review of the annual training plans etc. is envisaged.

(2) Sound implementation based on the plan (Do)

To secure the QWI, sound implementation of the project by the employees in accordance with the annual plan is important. Specifically, this involves the conduct of operations management and water quality management, inspection and repair of water supply/wastewater facilities, logging and sharing of inspection and repair record information, and implementation of emergency response training based on the BCP.

For the conduct of an O&M plan, the provision of a detailed operations management manual is essential. Also, water quality is ensured through water quality inspections at an appropriate frequency. Regarding the results of water quality inspections, publishing the results and sharing them with users increases public acceptance.

Regarding the inspection, repair and renovation plan, it is important to formulate an inspection and repair plan for the facility, and summarize the latest information about the facility in a facility register or similar record. It is also valuable to accumulate O&M information based on inspection results and use the information to plan measures that can prevent accidents caused by facility aging, etc. from occurring.

Concerning the BCP, by storing emergency and disaster supplies and equipment and conducting daily training based on the formulated BCP, disaster response effectiveness increases markedly.

(3) QWI Evaluation (Check)

At the end of each fiscal year, checks should be conducted to see whether the implemented O&M has led to the QWI. It is important to evaluate performance from both a quantitative and qualitative perspective. In the QWI evaluation, actual performance is compared to the O&M PIs (refer to Table 6) set at the beginning of the term. Where differences arise, analysis is performed and appropriate measures are implemented where necessary.

In evaluating the O&M plan, from the perspective of whether water quality has been appropriately secured and whether services have been consistently provided, project progress and PIs are evaluated.

In the evaluation of the inspection, repair and renovation plan, checks are conducted on each of the inspection/repair/renovation works to see if they have been implemented on schedule. Evaluation also considers whether facility performance is meeting its goals, whether environmental load is being reduced, and whether O&M costs are being kept low, and so on.

Regarding the BCP, checks are made on the implementation of the annual plan, and issues that are identified in training etc. are summarized. Also, where required, BCP content is revised.

(4) Study of improvement measures (Action)

It is important to maintain and improve the QWI in a sustainable way by analyzing the issues that have arisen through the evaluations, and revising the annual plan and mid- to long-term plan for the next period with appropriate measures based on the findings.

In the O&M plan, for example, if a water quality incident has occurred during the fiscal year, consideration should be given to whether new risks should be identified or countermeasures should be added, and to subsequent organizational restructuring.

In the inspection, repair and renovation plan, if there is a problem with facility performance, repair and renovation work shall be increased while simultaneously securing funds for the increased work. If rising O&M costs are an issue, additional investigation into measures targeting additional repairs and renovations and reducing costs further may be necessary, while taking LCC into account.

Concerning the BCP as well, if issues have been identified through training, a review of workflow and resource allocation shall be conducted so that prompt action is possible in the case of a disaster.

After reviewing each of the plans above, if necessary, a review of the PIs shown in Table 6 should be conducted.

Chapter 4 Capacity development

Systematic and continuous implementation of capacity development for organization and individuals is important for continuous improvement of the QWI.

4.1 Items developed in capacity development

Items and skills that should be developed to improve organizational capabilities are as follows.

Table 1 Items that should be developed in capacity development

Item	Description
Financial	･Finance/accounting knowledge ･Financing ･Tariff structure and cost forecasting
Technical	･Basic technical and engineering water treatment expertise ･Design and process management ･Operation expertise in maintenance/repair ･Expertise in disaster and accident response
Managerial	･Securing compliance and expertise about preventing corruption ･Securing transparency in implementing project ･Communication and coordination with stakeholders ･Expertise in PIs and management reform
Legal	･Legal expertise relating to water supply and sewerage works, and PPP ･Risk analysis in water supply and sewerage works

These skills and areas of expertise, which should be obtained as an organization, include the skills obtained by individuals and the expertise which should be secured as mechanisms of the organization. Skills obtained by individual workers can be permanently maintained within an organization through appropriate training programs.

If DB, PPP, comprehensive evaluation, or the LCC evaluation method is applicable, the government contractor shall have advanced expertise in evaluation of technical proposals, engineering and approval of designs/drawings.

4.2 Education for project operators

In capacity development, it is important to provide sufficient opportunity for primary training as well as continuous development of individuals' skills based on mid- and long-term training plans. Additionally, creation of training manuals and subsequent training and iteration of good and poor practices into the manuals are also required.

If a shortage of human resources is forecast, utilizing consultants and other resources are effective means of complementing the workforce.

4.3 Qualification programs and continuous improvement

Qualification programs are useful in objectively identifying and demonstrating the skill level of the employees. Such qualifications are also effective in increasing motivation and long-term career development success.

It is desirable for qualification programs to be designed objectively and fairly. It is also desirable that such qualification programs are developed and run in a unified manner by the central authorities or water supply and sewerage works association.

Since the technology constantly evolves and advances, those who obtain qualifications must continue to improve their skills even after obtaining qualifications.

4.4 Coordination among concerned parties

In capacity development, information sharing and coordination among the parties concerned with water supply and sewerage projects are important. Details of suggested coordination programs are as shown in Table 8.

Through coordination between the water supply and sewerage works operators and related 3rd parties, capacity development can be effectively implemented despite economic and technical restraints. Moreover, it can be beneficial to appoint outside experts who have sufficient experience in water infrastructure construction as advisors in the organization as applicable.

Table 8 Details of coordination between water supply and sewage works operators and 3rd parties concerned with water supply and sewage works

Concerned party	Details of coordination
Other economies, international organizations	Support international technical cooperation • Utilization of technical cooperation projects, etc.
Domestic operators	Information exchange and coordination through associations, private sector industry organizations, technical support organizations, etc., related to water supply and sewage works • Comparison of PIs of water supply and sewage works operators • Sharing examples of infrastructure success and lessons learned • Adherence to unified technical standards • Prompt response and cooperation in emergency situations, such as disaster • Exchange of information about water sources and ideal effluent locations
Private sector companies	Securing technical support and technical abilities by outsourcing and PPP

Column 9: Examples of technical assistance

As a method of planned and continuous capacity building, development of human resources in the sewerage sector can be implemented in order to improve the organizational capacity of local governments. For instance, JICA has been conducting the Technical Assistance Project for Enhancing Management Capacity of Sewerage Works in Viet Nam.

While development of wastewater treatment plants and related facilities are underway throughout Viet Nam, particularly in major urban areas, human resources for appropriate business operation of sewerage works are limited, and there is a lack of knowledge and technology. In addition, ability to manage sewerage works is limited in fields such as maintenance of facilities (necessary for sustainable sewerage works), financial planning and proposal for facility maintenance, development of investment plans based on financial plans, and establishment of organizations and systems for their implementation. Moreover, in small and medium-sized cities where development of future public wastewater treatment plant is planned, there is a lack of sewerage engineers and there are many fields of expertise (such as sewerage development planning) in which the capacity to implement sewerage works is lacking.

In order to respond to those issues, the project has been assisting in planning, operation and management education in the sewerage sector, based on the model of the Japan Sewage Works Agency. The project has the three roles; a “training role” for local government personnel and private sector company engineers, a “research and development role” for creating technical standards appropriate to Viet Nam, and “project implementation support role” for sewerage planning and business implementation in cities with little or no experience in sewerage works.

(Reference) Preliminary evaluation table for JICA “Technical Assistance Project for Enhancing Management Capacity of Sewage Works” and website of the Japan Sewage Works Agency

Appendix 1: Main Component Factors of Design Standards

Regarding the design standards of the water supply/wastewater treatment facilities in Japan, the following table shows the main component factors for each facility. Among the factors which ensure the QWI, the factors of the design standards which satisfy the Stability/Safety/Resiliency mainly related to the design of facilities and the Social and Environmental Sustainability are summarized as follows.

Water Supply / Wastewater	Structural Facilities	Component Factors	Relationship with the QWI		
			Stability/	Safety/ Resiliency	Social and Environmental Sustainability
Water Supply Facilities	Water Intake Facilities	• Durability		○	
		• Selection of water intake locations	○		○
	Water Conveyance Facilities	• Durability		○	
		• Backup function	○		
		• Pollution control during water conveyance		○	○
		• Ease of maintenance	○		
		• Energy saving			○
	Water Purification Facilities	• Durability		○	
		• Investigation of introduction of advanced water purification treatment technology (Pretreatment facilities corresponding to declining water quality of raw water)		○	
		• Stable supply of tap water which conforms with city water quality standards	○	○	
		• Calculation of scale	○		○
	Water Supply / Distribution Facilities	• Durability		○	
		• Appropriate water pressure for demanded volume which varies over time	○		
		• Efficient and easy maintenance/ management	○		
		• Renewal of water supply and drainage pipes	○	○	
		• Maintaining water quality of tap water	○	○	
Wastewater Treatment Facilities	Wastewater Network	• Durability		○	
		• Discharge Capacity	○		
		• Retention of Pressure	○		
		• Manholes	○		
		• Volume of rain water	○		
		• Capacity to cope with sudden changes in atmospheric pressure	○		
	Treatment Facilities	• Durability		○	
		• Measures against odors			○
		• Calculation of rain water and sewage quantity estimates	○	○	
		• Suitable treatment methods	○	○	
		• Setting targets of water quality at discharge destination			○
		• Suitable treatment of sludge			○

Appendix 2: Examples of Examination Criteria of P/Q for Participating in Bidding

	Items	Requirements	Remarks
1. Eligibility			
1.1	Conflict of interest	There should be no conflict of interests defined separately.	
1.2	Ineligible applicant specified by government contract agency	The applicant is not recognized as being ineligible by the government/entity offering the tender (government contract agency) in the context of other regulations.	
2. Previous History of Breach of Contracts			
2.1	Previous history of breach of contracts	Breach of contracts has not occurred within the last xx years prior to the deadline for the submission of documents for bidding, based on information concerning the settlement of disputes or litigation. The settlement of disputes or litigation means that disputes or litigation have been resolved based on individual contracts according to the dispute settlement system, and all the rights of intermediate appeal of the applicant have expired.	
2.2	Pending litigation	All pending litigation in total shall not exceed xx% of the net assets of the applicant, and shall be treated as resolved against the applicant.	
3. Financial Capability			
3.1	Performance	Submission of audited balance sheets for the last xx years or, if not required by the law of the applicant's economy other financial statements acceptable to the government contract agency, the applicant must submit other financial statements acceptable to the government contract agency to demonstrate the soundness of the current financial conditions and long-term profitability. As a minimum requirement, the net asset value which is the difference between the total assets and total liabilities must be a positive value.	
3.2	Net sales	Submission of audited income statements for the last xx years or, if not required by the law of the applicant's economy other financial statements acceptable to the government contract agency, the applicant must submit other financial statements acceptable to the government contract agency. Based on the ongoing or completed contracts in the nearest xx years, the minimum annual average sales calculated from the total amount of payments officially received must equal or exceed USD xx or an equivalent amount.	
Notes: 3.1 Financial Performance 1. In contracts for procurement of works, bidders will be required at the bidding stage to demonstrate their cash flow to verify the soundness and stability of their financial circumstances. The cash flow should be calculated by following the procedure below:			

"Indicate the construction cash flow for a number of months (to the nearest half-month), determined as the total time needed by the government contract agency to pay a contractor's invoice, allowing for (a) the actual time consumed for construction, from the beginning of the month invoiced, (b) the time needed by the engineer to issue the monthly payment certificate, (c) the time needed by the government contract agency to pay the amount certified, and (d) a contingency period of one month to allow for unforeseen delays. The total period should not exceed xx months. The assessment of the monthly amount may be based on a straight-line projection of the estimated cash flow requirement, over the particular contract period, neglecting the effect of any advance payment and retention monies, but including contingency allowance in the estimated contract cost. "

Reference: EVALUATION GUIDE FOR PREQUALIFICATION AND BIDDING UNDER JAPANESE ODA LOANS, Procurement of Goods and Services (except Consulting Services), JICA June 2000 (Amended January 2007 and June 2010

2. The financial information provided by the applicant must be that of the applicant, or a joint venture (JV) partner and not a sister or parent company.

3. The financial statements provided by the applicant must be examined accurately, and acceptance or rejection based on the financial conditions must be determined based on an accurate examination. If any issues arise which could lead to financial problems, it is necessary for the government contract agency to request that a specialist to review or interpret the statements in detail.

4			
4.1	General construction experience	The applicant must have business experience as a contractor, management contractor or subcontractor under construction business contracts for at least the last xx years before the application submission deadline.	Attach a copy of the contract, certificate issued by a customer, or a letter of proof, etc.
4.2	Specific construction experience	The applicant must have completed xx cases of similar contracts satisfactorily in the last xx years outside of the domestic economy/region of the applicant as an independent EPC contractor. The similarity mentioned above refers to the physical size (purification volume, sewage treatment volume (m^3/day)), complexity, methods/technology or other characteristics as described in the "scope of works." In order to guarantee compliance to the performance required by the government contract agency, it is also necessary for the applicant to submit performance test results. The applicant is required to have satisfied all the guaranteed items for xx% or more of the delivered projects.	Attach a copy of the contract, certificate issued by a customer, or a letter of proof, etc.
4.3	Specific operating experience	Among the results presented by the applicant, xx hours or more of successful commercial operation experience of at least xx cases of contracts of a plant are required before the P/Q submission deadline. Technical data and information concerning the contracts including the contract information of the end user of the plant must be submitted. The applicant must submit the original copy of the certificate (free format) from the end user of the plant at the time of bidding.	Attach a copy of the contract, certificate issued by a customer, or a letter of proof, etc.

Appendix 3: Examples of Specified Requirements in Bidding

Specific requirements are defined in accordance with the terms of reference of the projects. The following table includes update of information, financial capability and personnel requirements, as typical examples.

<table>
<tr><th>Requirements</th><th>Remarks</th></tr>
<tr><td>1. Update of information</td><td></td></tr>
<tr><td>The applicant and their subcontractors shall continuously satisfy the requirements including the contents proposed in the P/Q phase.</td><td></td></tr>
<tr><td>2. Financial capability</td><td></td></tr>
<tr><td>The applicant shall prove that they have sufficient current assets, real estate without rights of pledge, credit lines, or other sources of funds (independent of any contractual advance payments) that satisfy the following requirements.
a) Cash in the amount of USD xx that is estimated to be required for the subject contract. In the overall JV, each member shall satisfy xx% or more of the concerned requirements, and at least one company must satisfy xx% or more of the related requirements.
b) The cash flow requirements concerning ongoing and future contracts. In the case of a JV, all the members shall satisfy the necessary requirements.</td><td></td></tr>
<tr><td>3. Personnel</td><td></td></tr>
<tr><td>The applicant shall indicate that they have the personnel to satisfy the following requirements for the key positions.
<table>
<tr><th></th><th>Position</th><th>Work experience (Years)</th><th>Similar work experience (Years)</th></tr>
<tr><td>1</td><td>Project manager</td><td>xx</td><td>xx</td></tr>
<tr><td>2</td><td>Lead engineer</td><td>xx</td><td>xx</td></tr>
<tr><td>3</td><td>Quality control manager</td><td>xx</td><td>xx</td></tr>
<tr><td>4</td><td>Safety manager</td><td>xx</td><td>xx</td></tr>
<tr><td>5</td><td>Onsite manager</td><td>xx</td><td>xx</td></tr>
<tr><td>6</td><td>Civil engineer</td><td>xx</td><td>xx</td></tr>
<tr><td>7</td><td>Hygiene engineer</td><td>xx</td><td>xx</td></tr>
<tr><td>8</td><td>Process management engineer</td><td>xx</td><td>xx</td></tr>
<tr><td>9</td><td>Mechanical engineer</td><td>xx</td><td>xx</td></tr>
<tr><td>10</td><td>Electrical engineer</td><td>xx</td><td>xx</td></tr>
<tr><td>11</td><td>CAD operator</td><td>xx</td><td>xx</td></tr>
</table></td><td>The requirements for engineers for city water and sewerage projects are different.</td></tr>
</table>

Appendix 4: LCC Evaluation Items and Calculation Method

The LCC evaluation items shall include the items related to the design costs, procurement and construction costs that are generated as CAPEX, and the items related to OPEX. OPEX may be subdivided into fixed cost such as labor costs and variable costs such as power costs.

Cost Items		Costs Included
CAPEX	Design cost	–
	Procurement and construction costs	Preparation costs (Survey, ground leveling, fund procurement, insurance, offices and storage costs, safety and hygiene)
		Construction (Civil engineering and construction, machinery, electrical), spare parts, construction supervision
		Trial operation
		Rehabilitation, reconstruction or demolition
OPEX	Fixed costs	Power costs
		Renewal costs
		Maintenance and repair costs
		Labor costs
	Variable costs	Power costs
		Chemical costs
		Waste disposal costs
	Inspection requirements	–
	Others	–

LCC is calculated according to the following procedure.

- Calculation of each CAPEX item

  Add up each of the items shown in the CAPEX of the facility.

  * Add up the costs based on the plant designed capacity and required output indicated in the bidding specifications, etc. by the government contract agency

- Calculation of each OPEX item for each fiscal year

  Add up the cost of the OPEX for each fiscal year.

  * The government contract agency indicates the unit cost of power, etc. as required, and the applicant examines the quantity based on the unit cost.

  * The period applicable for evaluation shall be determined in consideration of the renewal period of the major equipment in the facilities (generally 15 to 25 years).

- Total and discount calculation for each fiscal year

  Calculate the current value based on the discount rate for the OPEX for each fiscal year.

  The total of the OPEX for each fiscal year converted into CAPEX and the current value is LCC.

  * It is common to use the expected rate of return (ERR) of the government contract agency where the discount rate can be calculated based on the value of the investment (construction costs) and revenue (income from service charges) related to the waterworks business. In economies where a risk-free rate can be calculated, the risk-free rate is commonly used.

Appendix 5: LCC Evaluation Sheet

	Main Items	Items	0th Yr.	1st Yr.	2nd Yr.	3rd Yr.	4th Yr.	5th Yr.	6th Yr.	7th Yr.	8th Yr.	9th Yr.	10th Yr.	Nth Yr.	Total
CAPEX	Design cost														
	Procurement and construction costs														
		Preparation costs													
		Civil engineering and construction													
		Machinery													
		Electrical facilities													
		Inspection and trial runs													
		Others													
OPEX	Fixed costs														
		Power costs													
		Reconstruction renewal costs													
		Maintenance and repair costs													
		Labor costs													
	Variable costs														
		Power costs													
		Chemical costs													
		Waste disposal costs													
	Inspection requirements														
	Others														
Total Cost (Before discount)															
Total Cost (Current discounted value)															

Appendix 6: Business Index and Measurement Method in O&M Phase

No.	1	**PI**	Water quality standards non-conforming rate
Elements to ensure the QWI	**Index unit**	**Facility**	**Evaluation period**
Stability	%	Water supply	The last 1 year
Purpose of evaluation			
• To evaluate whether a stable quality of treated water is secured.			
Evaluation method/Logic			
• Among the number of water quality examinations performed, calculate the frequency rate in which the water quality did not conform to the water quality standards.			
Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)			
• Formula for the water quality standards non-conforming rate Water quality standards non-conforming rate = Water quality standards non-conforming count / Total number of examinations x 100			
Notes			
• The frequency of the water quality examinations of raw water, and the water quality standards of raw water must be separately but appropriately selected based on the circumstances in each economy.			

No.	2	**PI**	Target water quality achievement rate
Elements to ensure the QWI	**Index unit**	**Facility**	**Evaluation period**
Stability	%	Wastewater	The last 1 year
Purpose of evaluation			
• To evaluate whether stable wastewater treatment is being performed by calculating the target water quality achievement rate.			
Evaluation method/Logic			
• Calculate at what frequency the target water quality is being achieved.			
Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)			
• Formula for the target water quality achievement rate Target water quality achievement rate = Number of times target water quality was achieved / Number of water quality examinations x 100			
Notes			
• Select the necessary items among the candidates, including COD, BOD, TSS, T-N, and T-P, etc. as the test items for target water quality.			

<table>
<tr><th>No.</th><th>3</th><th>PI</th><th colspan="2">Legal water quality standards compliance rate</th></tr>
<tr><td>Elements to ensure the QWI</td><td colspan="2">Index unit</td><td>Facility</td><td>Evaluation period</td></tr>
<tr><td>Stability</td><td colspan="2">%</td><td>Wastewater</td><td>The last 1 year</td></tr>
<tr><td colspan="5">Purpose of evaluation</td></tr>
<tr><td colspan="5">• To evaluate whether stable wastewater treatment is being performed by calculating the legal water quality standard compliance rate.</td></tr>
<tr><td colspan="5">Evaluation method/Logic</td></tr>
<tr><td colspan="5">• Calculate at what frequency the legal water quality standard is being complied to.</td></tr>
<tr><td colspan="5">Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)</td></tr>
<tr><td colspan="5">• Formula for the legal water quality standards compliance rate
Legal water quality standards compliance rate = Number of times the legal water quality standards are in compliance / Number of legal tests of water quality examinations x 100</td></tr>
<tr><td colspan="5">Notes</td></tr>
<tr><td colspan="5">• Select the necessary items among the candidates, including COD, BOD, TSS, T-N, T-P and the coliform bacteria count, etc. as the test items for target water quality.</td></tr>
</table>

<table>
<tr><th>No.</th><th>4</th><th>PI</th><th colspan="2">Incident rate of water supply and wastewater facilities</th></tr>
<tr><td>Elements to ensure the QWI</td><td colspan="2">Index unit</td><td>Facility</td><td>Evaluation period</td></tr>
<tr><td>Safety
Resilience</td><td colspan="2">Case (per 3 years and per location)</td><td>Water supply
Wastewater</td><td>The last 3 years</td></tr>
<tr><td colspan="5">Purpose of evaluation</td></tr>
<tr><td colspan="5">• To evaluate whether the ability to prevent incidents caused by deterioration is ensured by calculating the incident rate of the water supply and/or wastewater facilities.</td></tr>
<tr><td colspan="5">Evaluation method/Logic</td></tr>
<tr><td colspan="5">• Calculate the rate of the number of cases of unplanned treatment stoppage incidents in the overall water supply and wastewater facilities.</td></tr>
<tr><td colspan="5">Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)</td></tr>
<tr><td colspan="5">• Formula for the incident rate of water supply and wastewater facilities
Incident rate of water supply and wastewater facilities = Number of water supply stoppage incidents and wastewater facilities in the last 3 years / Number of water supply and wastewater facilities</td></tr>
<tr><td colspan="5">Notes</td></tr>
<tr><td colspan="5">• Specify the target water supply and wastewater facility e.g. purification plants or sewage treatment plants.</td></tr>
</table>

No.	5	**PI**	Rate of aging facilities
Elements to ensure the QWI	**Index unit**	**Facility**	**Evaluation period**
Safety Resilience	%	Water supply Wastewater	The last 1 year
Purpose of evaluation			
• To evaluate whether the ability to guarantee safety and resilience of the pipelines and facilities is ensured by calculating the rate of aging of the water supply and wastewater facilities.			
Evaluation method/Logic			
• Evaluate the aging condition of the water supply and wastewater facilities by the rate of aging.			
Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)			
• Formula for the rate of aging of water supply and wastewater facilities Rate of aging of water supply and wastewater facilities = Purification and treatment capacity of the facilities exceeding the legal durable years / Total facilities capacity x 100			
Notes			
N/A			

No.	6	**PI**	Total cost per 1m^3 (water supply cost and sewage treatment cost)
Elements to ensure the QWI	**Index unit**	**Facility**	**Evaluation period**
Economic and Financial Soundness: Cost effectiveness including LCC and utilization of markets	$ (or local currency) /m^3	Water supply Wastewater	The last 1 year
Purpose of evaluation			
• To clarify the cost in the waterworks and sewage works.			
Evaluation method/Logic			
• Calculate the cost required for water supply and sewage treatment per 1m^3.			
Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)			
• Formula for water supply cost Water supply cost = Ordinary expenses / Revenue water volume per year x 100 Revenue water volume per year • Formula for sewage treatment cost Sewage treatment cost = Ordinary expenses / Revenue water volume per year x 100			
Notes			
N/A			

<table>
<tr><th>No.</th><td>7</td><th>PI</th><td colspan="2">Energy consumption per 1m^3 of the water distribution volume and treatment volume</td></tr>
<tr><th colspan="2">Elements to ensure the QWI</th><th>Index unit</th><th>Facility</th><th>Evaluation period</th></tr>
<tr><td colspan="2">Social and Environmental Sustainability</td><td>MJ/m^3</td><td>Water supply
Wastewater</td><td>The last 1 year</td></tr>
<tr><th colspan="5">Purpose of evaluation</th></tr>
<tr><td colspan="5">• To evaluate the extent of the negative effect mainly on the environment by calculating energy consumption.</td></tr>
<tr><th colspan="5">Evaluation method/Logic</th></tr>
<tr><td colspan="5">• Calculate the annual energy consumption for the water distribution volume and treatment volume.</td></tr>
<tr><th colspan="5">Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)</th></tr>
<tr><td colspan="5">• Energy consumption per 1m^3 of the water distribution volume and treatment volume
Energy consumption per 1m^3 of the water distribution volume and treatment volume = Energy consumption / Water distribution volume and treatment volume per year</td></tr>
<tr><th colspan="5">Notes</th></tr>
<tr><td colspan="5">N/A</td></tr>
</table>

<table>
<tr><th>No.</th><td>8</td><th>PI</th><td colspan="2">Reclaimed water usage rate</td></tr>
<tr><th colspan="2">Elements to ensure the QWI</th><th>Index unit</th><th>Facility</th><th>Evaluation period</th></tr>
<tr><td colspan="2">Social and Environmental Sustainability</td><td>%</td><td>Wastewater</td><td>The last 1 year</td></tr>
<tr><th colspan="5">Purpose of evaluation</th></tr>
<tr><td colspan="5">• To evaluate the extent of the positive effect on the environment by calculating the usage rate of water reclaimed from treated waste water.</td></tr>
<tr><th colspan="5">Evaluation method/Logic</th></tr>
<tr><td colspan="5">• Calculate the volume of reclaimed water used compared to the volume of water treated in the wastewater treatment plant.</td></tr>
<tr><th colspan="5">Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)</th></tr>
<tr><td colspan="5">• Formula for the reclaimed water usage rate
Reclaimed water usage rate = Reclaimed water usage volume / Treated water volume x 100</td></tr>
<tr><th colspan="5">Notes</th></tr>
<tr><td colspan="5">N/A</td></tr>
</table>

<table>
<tr><td>No.</td><td>9</td><td>PI</td><td colspan="2">Wastewater sludge recycling rate</td></tr>
<tr><td colspan="2">Elements to ensure the QWI</td><td>Index unit</td><td>Facility</td><td>Evaluation period</td></tr>
<tr><td colspan="2">Social and Environmental Sustainability</td><td>%</td><td>Wastewater</td><td>The last 1 year</td></tr>
<tr><td colspan="5">Purpose of evaluation</td></tr>
<tr><td colspan="5">• To evaluate the extent of the positive effect on the environment by calculating the wastewater sludge recycling rate.</td></tr>
<tr><td colspan="5">Evaluation method/Logic</td></tr>
<tr><td colspan="5">• Calculate the rate of sludge usage volume for the volume of sludge that is generated in the wastewater treatment plant.</td></tr>
<tr><td colspan="5">Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)</td></tr>
<tr><td colspan="5">• Formula for the wastewater sludge recycling rate
Wastewater sludge recycling rate = Sludge usage volume / Generated sludge volume x 100</td></tr>
<tr><td colspan="5">Notes</td></tr>
<tr><td colspan="5">N/A</td></tr>
</table>

<table>
<tr><td>No.</td><td>10</td><td>PI</td><td colspan="2">Target economy resident employment rate</td></tr>
<tr><td colspan="2">Elements to ensure the QWI</td><td>Index unit</td><td>Facility</td><td>Evaluation period</td></tr>
<tr><td colspan="2">Social and Environmental Sustainability</td><td>%</td><td>Water supply
Wastewater</td><td>The last 1 year</td></tr>
<tr><td colspan="5">Purpose of evaluation</td></tr>
<tr><td colspan="5">• To evaluate the point of view of returning value to the target economy by job creation.</td></tr>
<tr><td colspan="5">Evaluation method/Logic</td></tr>
<tr><td colspan="5">• Evaluate the water supply and wastewater-related employment rate in the target economy based on the number of employees hired locally from the target economy out of the overall number of employees in the water supply and wastewater facilities.
• If there is a high turnover of employees, evaluate the employment rate according to the number of employees as of the end of the fiscal year.
• The employees hired locally refers to the employees who are citizens of the target economy.</td></tr>
<tr><td colspan="5">Measurement method (Method of acquiring information on the five elements to ensure the QWI and on this index)</td></tr>
<tr><td colspan="5">• Formula for the target economy citizen employment rate
Target economy citizen employment rate = Number of employees hired locally / Overall number of employees’ x 100</td></tr>
<tr><td colspan="5">Notes</td></tr>
<tr><td colspan="5">N/A</td></tr>
</table>