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R2018-0095/1

May 17, 2018

Closing Date: Wednesday, June 6, 2018 at 6 p.m.

FROM: Vice President and Corporate Secretary

China - Liaoning Safe and Sustainable Urban Water Supply Project

Project Appraisal Document

Attached is the Project Appraisal Document regarding a proposed loan to China for a Liaoning Safe and Sustainable Urban Water Supply Project (R2018-0095), which is being processed on an absence-of-objection basis.

Distribution:
Executive Directors and Alternates
President
Bank Group Senior Management
Vice Presidents, Bank, IFC and MIGA
Directors and Department Heads, Bank, IFC and MIGA

Document of
The World Bank

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Report No: PAD2096

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED LOAN

IN THE AMOUNT OF US$250 MILLION

TO THE

PEOPLE'S REPUBLIC OF CHINA

FOR A

LIAONING SAFE AND SUSTAINABLE URBAN WATER SUPPLY PROJECT

May 15, 2018

Water Global Practice
East Asia and Pacific Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective January 1, 2018)

Currency Unit	=	Renminbi (RMB) Yuan (Y)
RMB 1.00	=	US$0.15
US$1.00	=	RMB 6.48

FISCAL YEAR

January 1 – December 31

ABBREVIATIONS AND ACRONYMS

ADM	Accountability and Decision-Making Framework (ADM)
AWSC	Anshan Water Supply Company
BP	Bank Procedure
BPS	Booster Pump Station
CLG	City Leading Group
CNAO	China National Auditing Office
CO2	Carbon Dioxide
CPMO	City Project Management Office
CPS	Country Partnership Strategy
CQS	Consultant Qualifications based selection
DA	Designated Account
DFIL	Disbursement and Financial Information Letter
DRC	Development and Reform Commission
EA	Environmental Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPB	Environmental Protection Bureaus
ESMAP	Energy Sector Management Assistance Program
ESMF	Environmental and Social Management Framework
FBS	Fixed Budget Selection
FIP	Financial Improvement Plan
FIRR	Financial Internal Rate of Return
FM	Financial Management
FsWSC	Fushun Water Supply Company
FxWSC	Fuxin Water Supply Company
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GIS	Geographic Information System
GRS	Grievance Redress Service
GW	Gigawatt
GWSC	Gaizhou Water Supply Company
IBNET	International Benchmarking Network for Water and Sanitation Utilities
IBRD	International Bank for Reconstruction and Development
ICB	International Competitive Bidding
ICR	Implementation Completion and Results
IWA	International Water Association
kg	Kilogram
km	Kilometer

kw	Kilowatt
LCS	Least Cost based Selection
LMC-1	Liaoning Medium Cities Infrastructure Project: Urban Transport I
LMC-2	Liaoning Medium Cities Infrastructure Project: Urban Environment II
LPAO	Liaoning Provincial Audit Office
LPCC	Liaoning Provincial Construction Commission
LPCD	Liaoning Provincial Construction Department
LPDF	Liaoning Provincial Department of Finance
LPDRC	Liaoning Provincial Development and Reform Commission
LPFB	Liaoning Provincial Finance Bureau
LPFB	Liaoning Provincial Finance Bureau
LPG	Liaoning Provincial Government
LPPSC	Liaoning Provincial Project Steering Committee
LUCRPMC	Liaoning Urban Construction and Renewal Project Management Company Limited
LXB	Liao Xi Bei
m^3	Cubic meter
MDG	Millennium Development Goals
MOF	Ministry of Finance
MoHURD	Ministry of Housing and Urban-Rural Development
MoWR	Ministry of Water Resources
NCB	National Competitive Bidding
NDRC	National Development and Reform Commission
NRW	Non-Revenue-Water
OECD	Organization for Economic Co-operation and Development
OP	Operations Policy
PAD	Project Appraisal Document
PCN	Project Concept Note
PDO	Project Development Objective
PIP	Project Implementation Plan
PIU	Project Implementation Unit
PMO	Project Management Office
PPMO	Provincial Project Management Office
QBS	Quality Based Selection
QCBS	Quality and Cost Based Selection
RAP	Resettlement Action Plan
RMB	Renminbi
SCADA	Supervisory Control and Data Acquisition System
SORT	Systematic Operations Risk- Rating Tool
UNICEF	The United Nations International Children's Fund
UPVC	Un-plasticized Poly-Vinyl Chloride
USD	United States Dollar
WA	Withdrawal Application
WB	World Bank
WSC	Water Supply Company
WTP	Willingness to Pay

Regional Vice President:	Victoria Kwakwa
Country Director:	Bert Hofman
Senior Global Practice Director:	Guang Zhe Chen
Practice Manager:	Sudipto Sarkar
Task Team Leader:	Khairy Al-Jamal

CHINA
Liaoning Safe and Sustainable Urban Water Supply Project

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PAD DATA SHEET

China

China: Liaoning Safe and Sustainable Urban Water Supply Project (P158713)

PROJECT APPRAISAL DOCUMENT

EAST ASIA AND PACIFIC

0000009391

Report No.: PAD2096

Basic Information		
Project ID P158713	EA Category B - Partial Assessment	Team Leader(s) Khairy Al-Jamal
Lending Instrument Investment Project Financing	Fragile and/or Capacity Constraints [ ] Financial Intermediaries [ ] Series of Projects [ ]	
Project Implementation Start Date 01-July-2018	Project Implementation End Date 31-Dec-2022	
Expected Effectiveness Date 01-Sep-2018	Expected Closing Date 30-Jun-2023	
Joint IFC No		

Practice Manager	Senior Global Practice Director	Country Director	Regional Vice President
Sudipto Sarkar	Guang Zhe Chen	Bert Hofman	Victoria Kwakwa

Borrower: PEOPLE'S REPUBLIC OF CHINA
Responsible Agency: Liaoning Urban Construction and Renewal Project Management Company Limited

Contact:	Yongjian Liu	Title:	Director
Telephone No.:	86-24-8690-7707	Email:	lucrpochina@vip.163.com

Project Financing Data (in USD Million)					
[X]	Loan	[ ]	IDA Grant	[ ]	Guarantee
[ ]	Credit	[ ]	Grant	[ ]	Other

Total Project Cost:	386.29	Total Bank Financing:	250.00
Financing Gap:	0.00		

Financing Source	**Amount**

Borrower	136.29
International Bank for Reconstruction and Development	250.00
Total	386.29

Expected Disbursements (in USD Million)

Fiscal Year	2019	2020	2021	2022	2023	0000	0000	0000	0000	0000
Annual	30.00	50.00	60.00	60.00	50.00	0.00	0.00	0.00	0.00	0.00
Cumulative	30.00	80.00	140.00	200.00	250.00	0.00	0.00	0.00	0.00	0.00

Institutional Data

Practice Area (Lead)

Water

Contributing Practice Areas

Proposed Development Objective(s)

The project development objectives are to improve water quality and operational efficiency of selected water supply utilities in the project areas.

Components

Component Name	Cost (USD Millions)
Component 1: Water supply service infrastructure improvement	287.14
Component 2: Water supply service management improvement	57.08
Component 3: Project implementation support and institutional strengthening	16.94

Systematic Operations Risk- Rating Tool (SORT)

Risk Category	Rating
1. Political and Governance	Low
2. Macroeconomic	Low
3. Sector Strategies and Policies	Low
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	Moderate
6. Fiduciary	Moderate
7. Environment and Social	Moderate
8. Stakeholders	Moderate

9. Other. Climate Change	Low
OVERALL	Moderate

Compliance

Policy

Does the project depart from the CAS in content or in other significant respects?	Yes [ ] No [X]
Does the project require any waivers of Bank policies?	Yes [ ] No [X]
Have these been approved by Bank management?	Yes [ ] No [ ]
Is approval for any policy waiver sought from the Board?	Yes [ ] No [X]
Does the project meet the Regional criteria for readiness for implementation?	Yes [X] No [ ]

Safeguard Policies Triggered by the Project	**Yes**	**No**
Environmental Assessment OP/BP 4.01	**X**	
Natural Habitats OP/BP 4.04		**X**
Forests OP/BP 4.36		**X**
Pest Management OP 4.09		**X**
Physical Cultural Resources OP/BP 4.11	**X**	
Indigenous Peoples OP/BP 4.10		**X**
Involuntary Resettlement OP/BP 4.12	**X**	
Safety of Dams OP/BP 4.37	**X**	
Projects on International Waterways OP/BP 7.50		**X**
Projects in Disputed Areas OP/BP 7.60		**X**

Legal Covenants

Name	**Recurrent**	**Due Date**	**Frequency**
Institutional Arrangements	**X**		Continuous

Description of Covenant

The Project Implementing Entity shall maintain a Provincial Project Steering Committee, the Provincial Project Management Office (PPMO) and the Project Implementation Units (PIUs) of the project water companies throughout the implementation of the Project with composition, powers, functions, terms of reference, staffing, facilities and other resources acceptable to the Bank. Project Agreement (PA)-Schedule, Section I.A.1.

Name	**Recurrent**	**Due Date**	**Frequency**
Project Implementation Plan	**X**		Continuous

Description of Covenant

Throughout the implementation of the Project, the Project Implementing Entity (Liaoning Province) shall carry out the Project, and shall cause each Project City, to carry out the Project, in accordance with the Project Implementation Plan in a manner that is acceptable to the Bank. PA-Schedule, Section I.A.2.

Name	Recurrent	Due Date	Frequency
Dam Safety		Six months after Effective Date	

Description of Covenant

No later than six (6) months after Effective Date, the Project Implementing Entity shall recruit and retain an Independent Expert with qualifications, and under the terms of reference, acceptable to the Bank. PA-Schedule, Section I.B.8(a).

Name	Recurrent	Due Date	Frequency
Annual Dam Safety Action Plan	**X**		Yearly

Description of Covenant

The Project Implementing Entity shall: (a) prepare a draft annual dam safety action plan pertaining to Project Dams; (b) furnish to the Bank – for its review and comments - the draft dam safety action plan so prepared by September 30 in each year, beginning in calendar year 2018; (c) taking into account the Bank's comments, finalize and approve the annual dam safety action plan acceptable to the Bank (Annual Dam Safety Action Plan); and (d) thereafter ensure the implementation of the Annual Dam Safety Action Plan during the following calendar year in a manner acceptable to the Bank. PA-Schedule, Section I.B.11.

Name	Recurrent	Due Date	Frequency
Non-revenue Water Reduction Plan		30-Jun-2019 and 30-Jun-2022	

Description of Covenant

1. No later than June 30, 2019, the Project Implementing Entity shall: (a) prepare and furnish to the Bank a comprehensive plan designed to reduce Non-Revenue Water in Project Cities; (b) exchange views with Bank on the plan; and (c) thereafter adopt the plan as shall have been approved by the Bank ("NRW Reduction Plan").
2. Following its approval, the Project Implementing Entity shall promptly implement the NRW Reduction Plan in a manner acceptable to the Bank.
3. The Project Implementing Entity shall - no later than June 30, 2022 - complete the implementation of the NRW Reduction Plan in the Project Cities in a manner acceptable to the Bank. PA – Schedule, Section IV.C.1, C.2 and C.3.

Name	Recurrent	Due Date	Frequency
Energy Management Plan		30-Jun-2019 and 30-Jun-2022	

Description of Covenant

1. No later than June 30, 2019, the Project Implementing Entity shall: (a) prepare and furnish to the Bank a comprehensive plan designed to reduce energy utilization by Project Companies; (b) exchange views with Bank on the plan; and (c) thereafter adopt the plan as shall have been approved by the Bank ("Energy Management Plan").
2. Following its approval, the Project Implementing Entity shall promptly implement the Energy Management Plan in a manner acceptable to the Bank.
3. No later than June 30, 2022, the Project Implementing Entity shall complete the implementation of the Energy Management Plan in the Project Cities in a manner acceptable to the Bank. PA – Schedule, Section IV.D.1, D.2 and D3.

Name	Recurrent	Due Date	Frequency

Financial Improvement Plan	**X**		Yearly

Description of Covenant

The Project Implementing Entity shall cause each Project City to: (a) prepare by December 31, 2018 a rolling five (5) year financial improvement plan - in accordance with the terms of reference acceptable to the Bank - outlining how its Project Company will improve its financial status (through a combination of measures aimed at improving user charge collection efficiency, reducing operating costs, and adjusting tariffs) and setting forth targets to these ends ("Financial Improvement Plan") and thereafter take - or cause to be taken - all necessary measures to meet the requirements set forth in its Financial Improvement Plan, in a manner acceptable to the Bank; (b) by December 31 of each year commencing on December 31, 2019, update in accordance with the terms of reference acceptable to the Bank and furnish to the Bank for review and comments, its draft updated financial improvement plan and; (c) take - or cause to be taken - all necessary actions to carry out its Financial Improvement Plan as prepared or updated pursuant to the sub-paragraphs (a) and (b) of this paragraph taking into account the Bank's comments thereon. PA- Schedule, Section IV.B.

Name	Recurrent	Due Date	Frequency
Utility Performance Reports	**X**		Yearly

Description of Covenant

The Project Implementing Entity shall, through its Provincial Construction Department: (a) beginning December 31, 2018, and thereafter by December 31 of each year, prepare and make public through the internet or in another manner acceptable to the Bank, an annual water utility performance report, including operational and financial performance data for all the water supply utilities in the Project Cities; (b) by December 31, 2019, expand such report to include at least fifty percent (50%) of the cities in Liaoning Province; and (c) by December 31, 2020, expand such report to include at least ninety percent (90%) of the cities in Liaoning Province. PA- Schedule, Section IV.A.

Conditions

Source Of Fund	Name	Type
IBRD	Subsidiary Agreements	Withdrawal

Description of Condition

No withdrawal shall be made under each of Categories (1)(a) through (1)(e) until the Bank shall have notified the Borrower and the Project Implementing Entity of its receipt of a copy of the Subsidiary Loan Agreement entered into between the Project City concerned and its Respective Project Company, acceptable to the Bank and in accordance with the provisions of Section I, paragraph D.1 of the Schedule to the Project Agreement. LA-Schedule 2, Section IV.B.1(b).

Team Composition

Bank Staff

Name	Role	Title	Specialization	Unit
Khairy Al-Jamal	Team Leader (ADM Responsible)	Sr. Water Supply and Sanitation Specialist	Water and Sanitation	GWA08
Yunlong Liu	Procurement Specialist	Procurement Specialist	Procurement	GGO08

Hua Xu	Procurement Specialist (ADM Responsible)	Sr. Procurement Specialist	Procurement	GGOPP
Yi Dong	Financial Management Specialist	Sr. Financial Management Specialist	Financial Management	GGO20
Feng Ji	Safeguards Specialist	Sr. Environmental Specialist	Environment	GEN2A
Huiying Guo	Team Member	Program Assistant	Administrative and Client Support	EACCF
Violeta Wagner	Team Member	Sr. Program Assistant	Administrative and Client Support	GWA02
Meixiang Zhou	Safeguards Specialist	Sr. Social Development Specialist	Social Development	GSU02
Pratibha Mistry	Team Member	Sr. Water Supply and Sanitation Specialist	Water and Sanitation	GWA02
Sing Cho	Team Leader	Sr. Water Supply and Sanitation Specialist	Water and Sanitation	GWA02
Toyoko Kodama	Team Member	Water Supply and Sanitation Specialist	Water and Sanitation	GWASO
Ximing Zhang	Team Member	Sr. Dams Specialist	Dam Safety	GWAGP
Evarist F. Baimu	Counsel	Senior Counsel	Legal	LEGES
Zhuo Yu	Team Member	Finance Officer	Finance	WFACS

Extended Team

Name	Title	Office Phone	Location
Chirong Huang	Sr. Wastewater Engineer		San Diego
Knud Lauritzen	Sr. Financial Analyst		Copenhagen

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
China	Liaoning	Shenyang	**X**		
China	Liaoning	Liaoning	**X**		
China	Liaoning	Gaizhou	**X**		
China	Liaoning	Fuxin	**X**		

China	Liaoning	Fushun	**X**		
China	Liaoning	Anshan	**X**		

I. STRATEGIC CONTEXT

A. Country Context

1. **China is making a shift towards resource conservation after a period of unprecedented economic growth and urbanization.** China has experienced economic growth that averaged ten percent (10%) a year for three consecutive decades. This was coupled with an unprecedented level of urbanization – where by 2016, more than half of the population was living in cities, compared to only 20% in 1978. The urban population in China is expected to reach 70% (about 1 billion people) by 2030[1]. GDP growth has also been strong, though in recent years the growth rate has been declining – from more than 10% in 2010 to almost 7% in 2015. To ensure wider inclusion and shared prosperity, medium-term policy has shifted towards reducing the economic, environmental, and social imbalances from the period of rapid economic growth. As a result, the 12th Five-Year Plan (2011-2015) emphasized green growth models, aiming to reduce pollution and increase energy efficiency. Moreover, it was the first five-year plan to include a specific section on water, including a target of 95% urban water coverage, measures for water resource conservation, and promotion of new technologies, together with continued focus on infrastructure investment. As a continuation of the policy of green and equitable growth, the 13th Five-Year Plan (2016-2020) highlights innovative infrastructure and green development, and plans to reduce energy intensity[2] by 15%.

2. **Water scarcity is recognized in China as a growing concern for cities, especially in northeastern provinces like Liaoning.** China is the world's second largest economy and home to a fifth of the world's population, yet only has 7% of the world's freshwater resources. Water scarcity, driven by both limited water availability and diminished water quality, remains one of the most pressing challenges to sustainable urban development. Nationwide, the urban water deficit is estimated at six billion cubic meters (BCM) a year, with 420 cities having insufficient water supplies and 110 facing severe water shortages.[1] Water pollution meanwhile imposes serious economic, ecological, and health-related costs. According to 2015 data, some 61% of monitored groundwater and 28% of major rivers failed to meet basic water quality standards. Gaps also remain in basic water services coverage. In 2014, some 100 million rural-dwellers lacked access to safe drinking water, and some 90% of the rural population lacked access to adequate wastewater management. Institutional and fiscal capacity enhancements are necessary to improve service coverage. Finally, China's rapidly-growing cities, especially along smaller waterways, are at a high risk of flooding, especially due to climate-related weather variability. Water resources are geographically unevenly distributed, with the northern regions being the most water scarce. In addition, climate change impacts also create uncertainties on the availability of water.

3. **China has adopted a series of ambitious and innovative policies to address these water sector challenges,** including the *Three Red Lines* which are strict water resources management measures: (a) limiting water abstraction to ensure sustainable use of its scarce water resources; (b)

[1] World Bank; Development Research Center of the State Council, the People's Republic of China. 2014. Urban China: Toward Efficient, Inclusive, and Sustainable Urbanization. Washington, DC. https://openknowledge.worldbank.org/handle/10986/18865 License: CC BY 3.0 IGO.

[2] Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of gross domestic product (GDP). High energy intensities indicate a high price or cost of converting energy into GDP.

improving water use efficiency and productivity to ensure better allocation of its water resources to sustain its socio-economic objectives; and (c) reducing water pollution to achieve its environmental objectives and *ecological civilization* construct. China has adopted key policies to address drought and flood risks and urban drainage; it has also developed policies for water use on navigation and hydropower. However, the challenge remains to translate these forward-looking policies into effective implementation on the ground.

4. **Reducing urban water losses is recognized as a driver of water use efficiency.** With the increasing urbanization, more and more water distribution networks have been built to meet the surging water demand. In this process, water loss is emerging as a big challenge facing the water supply sector. The Action Plan for Prevention and Control of Water Pollution issued by the State Council has set very clear goals to combat water loss: by 2017, the water loss rate for national public water distribution system should be controlled under 12% and by 2020 this figure should be further reduced to 10%. In early 2017, the National Development and Reform Commission (NDRC), Ministry of Water Resources (MoWR) and Ministry of Housing and Urban-Rural Development (MoHURD) jointly issued the 13th Five Year Plan for Building Water Saving Society. In March 2017, the Standard for Water Loss Control and Assessment of Urban Water Distribution System (CJJ92-2016) issued by MoHURD was put into effect. All these regulations represent the urgency in solving water loss challenges in urban water distribution networks.

B. Sectoral and Institutional Context

5. **The economic growth rate in Liaoning started to decrease in 2007 continues to decline due to downturn in heavy industry.** The province even had negative GDP growth in 2016. Over the past decade, the central government has prioritized the economic revitalization of the northeast provinces, including Liaoning. Liaoning Province is situated in the northeast of China, sharing a border with North Korea to the southeast. Prior to economic reforms in the late 1970s, Liaoning was one of the country's major industrial centers, focusing on heavy industry and mining. The province became one of China's most urbanized provinces where the urban population settled in medium-sized cities whose economies were anchored around a small number of state-owned industrial and mining enterprises. By 2015, Liaoning Province had a total population of 44 million, of which 67% live in urban areas.[3] Infrastructure development in those medium cities had difficulty catching up with the population growth, and they often suffered from inadequate infrastructure maintenance affecting service delivery such as urban water supply.

6. **There are challenges in maintaining water quality regulatory standards.** In 2012, the Government of China applied stricter criteria to drinking water quality and revised its Drinking Water Standards. As a result, the number of regulated water quality parameters has been increased from 35 (under the previous standard introduced in 1985) to 106 parameters, in line with the World Health Organization. Meeting the water quality standards is a major challenge. According to the Liaoning Provincial Government, the current water quality compliance rate for the province is around 50%, and for the cities under this project, the rate is 33%. Furthermore, the availability of water is low and the water sources are polluted. Liaoning Province's per capita water resources of 820 m^3/year which is one-third of the national average. The quality of the Liao River, one of the seven main river systems in China, and the most important river system in Liaoning Province,

[3] http://www.stats.gov.cn/tjsj/ndsj/2015/indexeh.htm

is also deteriorating.[4] In the face of over-exploitation and pollution of groundwater sources, Liaoning Province has taken strong steps to phase out all groundwater use by 2020.[5]

7. **Efficient delivery of services is also priority in the province.** Water distribution systems are outdated, with high levels of non-revenue water (NRW) reaching as high as 64% in some municipalities in the province. This leads to significant losses for water utilities, and puts additional pressure on meeting future demands in an already water scarce environment. In addition, there is need to strengthen the operational and managerial capacity to ensure quality and efficient service delivery. The province has established a target of 25% NRW which will help to reduce water losses. This will also lead to improvements in energy efficiency per unit of water supplied, along with the associated reduction of greenhouse gas (GHG) emissions. In general, energy efficiency in Liaoning water utilities is 45% below the national average in terms of specific energy consumption (i.e. 0.51 kW.hr/m^3 compared to the national figure of 0.35 kW.hr/m^3)[6]. Thus, better water network management and reduction of water losses will improve energy efficiency in delivering water.

8. **Water utilities are publicly owned and operated by the municipality, and are often dependent on subsidies.** Tariffs are not completely linked to capital and/or operational expenditure, and funds for sector investment are generally provided through fiscal transfers. Water tariffs tend to be low despite legislation to set them at cost-recovery levels. Particularly, the smaller water companies suffer from a financial loss and are provided operational subsidies from the Local Governments. Some of the major water companies are recovering their operational costs from tariff collection, but they are unable to reach full cost recovery. Tariff adjustments are made infrequently, around once every four years, and are mainly used to keep pace with inflation. Generally, utility fees are affordable, even for households with low disposable income[7]. This situation with water tariffs and fees presents a real challenge to water utilities in Liaoning province to be able to maintain financially efficient operations. This challenge has been recognized by governments at all levels.

9. **This current project will target five cities in Liaoning.** The project will improve water supply services in five cities in Liaoning Province. These five cities are: Shenyang (the province capital and the largest city), Anshan, Fushun, Fuxin and Gaizhou. A short description of the project cities is given in Annex 2. Water supply service improvements will be achieved through investment in the repair, rehabilitation, and upgrading of the water supply infrastructure facilities; as well as through the improvement of the water supply companies' operational and management capacity. These five cities were chosen because: (i) they have needs for improved water supply systems; and (ii) they are industrial cities prioritized for rehabilitation under government policies in Northeast provinces. Shenyang is the provincial capital; Anshan is a center of steel production; Fushun is a center of coal production; Fuxin is predominantly a coal-electricity producing city; and Gaizhou is a port city on the Bohai Sea. A combination of infrastructure investments and

[4] The 2015 State of the Environment Report reported that water quality of the Liao River is deteriorating, with Grade I-III water dropping to 40.0%, the lowest among China's seven major rivers, and the proportion of Grade V+ doubling from 7.3% to 14.5%. Water classified as 'unfit for human contact' rose from 58.2% to 60.0%.

[5] Provisions from Liaoning Province, on Banning Groundwater Extraction Liaoning Groundwater, Order of the People's Government of Liaoning Province No. 225, March 3, 2011

[6] Kate Smith et al "Impact of Urban Water Supply on Energy Use in China: a provincial and national comparison", Springer Science and Business Media, Dordrecht 2015

[7] Disposable income, also known as disposable personal income (DPI), is the amount of money that households have available for spending and saving after income taxes have been accounted for.

capacity building efforts are needed to improve the operational efficiency of water utilities in these cities.

10. **The project cities share common water supply challenges.** Despite differences in their sizes and levels of development, the project cities share the following common water supply challenges.

(i) Water sources are increasingly polluted, the majority of water treatment plants have not been upgraded since they were first constructed, and higher drinking water quality standards requires plant modifications and retrofitting of facilities. Treatment plants do not have adequate treatment processes, nor the technologies to treat the current raw water to the required standard.

(ii) Water pressure in city areas is insufficient beyond the first two or three floors of buildings, requiring booster pumps to lift it to higher floors. In some cases, booster pumps are operated and maintained by non-professional property management companies leading to inadequate service as compared to those operated and maintained by the water company.

(iii) Secondary distribution systems, in the older parts of the cities, have exceeded their service lives. Hence, pipe leaks and failures are common, leading to the inflow of groundwater, and impacting water pressure and water quality in the distribution system. In addition, old pumps are no longer running at optimal levels, thereby increasing energy consumption.

(iv) There is insufficient data collection and analysis capability to conduct network optimization and better manage water pressure, monitor distribution system efficiencies, and make well informed decisions regarding asset management and upgrading. Management information and telemetry systems are outdated, making integrated system management difficult.

(v) Lack of incentives for improving the service quality at the utilities. Despite efforts from the International Benchmarking Network for Water and Sanitation Utilities (IBNET) to promote a water supply service evaluation index system in 2011, the current local data collection system for most of water utilities still mainly focus on infrastructure, and not on more holistic factors such as reliability, non-revenue water, and customer satisfaction introduced by IBNET of the water supply service evaluation index system in 2011.

(vi) Water supply coverage and expansion of distribution networks lag the development of the city.

(vii) Water utilities increasingly focus on infrastructure management and water efficiency due to water scarcity, increasing cost of providing drinking water to customers, potential health risks posed by leaking pipes, and heightened awareness of the increasing cost of leakage. However, utilities only employ a reactive leakage management strategy, repairing failures that have been reported to them less timely, so utilities continue to see an increase in leakage losses due to a rising backlog of unreported failures in their distribution system.

Rationale for Bank Involvement

11. **Over the years, the Bank and China have developed a robust partnership in the water sector to address policy and institutional issues, testing new approaches.** The current Bank program supports the Government's priorities in China and it also provides examples from the China that can be taken to other countries. Bank-supported programs in China focus on addressing difficult development challenges, reinforced by key analytical underpinning based on international best practices. The Bank interventions brings value added in the form of: (i) technology and innovation; (ii) leveraging financing; and (iii) contribution on delivery of global public goods. Replicability is also an important consideration, with value added in the Bank projects expected to demonstrate benefits that would be the driver for similar interventions – both inside China and globally.

12. **Technical innovation and knowledge-sharing:** China has recently adopted a new standard for NRW for utilities (CJJ92-2016) which is based on the International Water Association (IWA) Water Loss Framework. The proposed project will introduce global knowledge and good practices in implementing this Framework to the water sector in China, by tapping into international resources which the Bank is well positioned to provide or convene, such as the IWA China Water Loss Task force, a comprehensive water loss reduction strategy that calls for a unified improvement in the physical, operational and institutional efficiency of water supply services delivery. The project design will introduce performance management among utilities and expand the use of benchmarking to 90% of the cities in Liaoning, ultimately promoting competition and customer satisfaction, and disclosure of utility performance for public information and scrutiny. Active customer engagement through social media will be introduced to promote citizen engagement and help improve water supply service. Liaoning Province has a longstanding partnership with the Bank in the water sector, going back to 1995[8]. The most recent engagement, through the Second Liaoning Medium Cities Infrastructure Project (LMC-2) (P092618), led to improvement in performance and sustainability of water supply services through: expanding service coverage, developing GIS-based network mapping, providing technical assistance to enhance water utilities capacity and successful pilot program implementation for NRW reduction. This prior project was rated Satisfactory[9], and based on its successful results, the Liaoning Government committed to scaling-up these activities and extending the scope to other cities in the province.

13. **Maximizing development impact and leveraging finance:** China's investment in water related projects during the 13th Five Year Plan (for the period between 2016 and 2020) is some US$385.00 billion and Liaoning Province's share accounts for US$9.47[10] billion (US$2.12 billion for urban water supply, US$4.97 billion for urban wastewater and US$2.48 billion for water resources development). Clearly, the government's finance in the water and wastewater sector is significantly large, and IBRD resources are used to catalyze innovations and reforms in the sector. The project will leverage direct counterpart funding commitment of US$136.29 million and the Bank's engagement will help in supporting good practices in management (provisions of leak detection programs, telemetry, district metering, pressure control and installation of supervisory control and data acquisition, SCADA, system), planning (development and implementation of

[8] Liaoning Environment Project (1995-2003), Liao River Basin Project (2002-2008)
[9] Implementation Completion and Results Report for the Second Liaoning Medium Cities Infrastructure Project, December 23, 2015, Report No: ICR00003237
[10] Data Source: Liaoning 13FYP, water supply, RMB 15.76 B, wastewater RMB 31.29 B, water resource RMB 15 B.

NRW and energy management plans and hydraulic network mapping and analysis) and institutional strengthening to support strategic targets for reduction of water losses and increase in energy efficiency. These techniques in managing water supply, including benchmarking of performance across utilities, will facilitate peer learning among water utilities in Liaoning and other provinces, in scaling up NRW and energy efficiency programs. The project will also complement a parallel local investment of US$104.4 million for Fuxin as the project will finance the transmission line from two planned surface water treatment plants, to be constructed entirely from counterpart funds, to the city.

14. **Global public goods and climate change:** Better management of water resources will continue to be ever more important in China to ensure water security as water scarcity and excessive depletion of groundwater stocks worsen. This project aims to promote climate resilience among utilities in Liaoning by encouraging uptake of international good practices of efficient water supply management, active leakage management, reducing NRW, and enhancing energy use efficiency. The Project will contribute to climate change adaptation and mitigation through water and energy savings. Climate change impacts are projected to affect availability of water resources in Liaoning, further aggravating the water situation in the province. The proposed activities will improve water distribution efficiency, optimize operations, enhance asset management capabilities, and control water demand. These activities ultimately contribute to more efficient use of water resources and building more resilient water supply utilities against the future climate change risks and vulnerabilities. The project has the potential to save around 105 million cubic meters of water per year and reduce electricity consumption by about 78 GW.hr/year. It is also expected that by 2022, the project will contribute to a reduction of 74.0 million kg CO_2. More details are included in Annex 2.

C. Higher Level Objectives to which the Project Contributes

15. **The project is consistent with the objectives of the Government of China as set out in both the 12th Five Year Plan, and the recently approved 13th Five Year Plan.** The project directly supports the Government of China's 12th Five-Year Plan (2011-2015) that emphasizes infrastructure investment with green growth models. It supports the target of 95% urban water coverage, measures for water resource conservation, and promotion of new technologies, aiming to reduce pollution and increase energy efficiency. It supports the 13th Five-Year Plan (2016-2020) as it continues to highlight innovative infrastructure and green development, and plans to reduce energy intensity by 15%.

16. **The project directly supports the Bank's commitment to enhance urban environmental services as set out in the Country Partnership Strategy.** The project is aligned with the FY2013-FY2016 World Bank Group's Country Partnership Strategy (CPS) for China (Report No. 67566-CN), discussed by the Board of Executive Directors of the World Bank on November 6, 2012, and the Performance and Learning Review discussed by the Board on February 4, 2016 (Report No. 95709-CN). The project is directly linked to: Strategic Theme 1, Supporting Greener Growth, specifically, Outcome 1.2 Enhancing Urban Environmental Services. The CPS recognizes that while urbanization will drive growth and raise living standards, it also brings tremendous service delivery challenges, particularly in smaller cities that are struggling to keep pace with demand. The project draws on global knowledge and adopts service delivery approaches that conserve energy and reduce water losses in urban water systems. The project directly

contributes to the CPS target of expanding safe water supply in more than 50 small towns and cities, while improving quality and efficiency of service.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

17. The project development objectives are to improve water quality and operational efficiency of selected water supply utilities in the project areas.

B. Project Beneficiaries

18. The project will impact the water supply services in five cities/counties, benefitting a total population of 5.69 million people, of which approximately 50% are women.

C. PDO Level Results Indicators

(i) Direct project beneficiaries (number), of which female (percentage)
(ii) Compliance with water quality health standards (percentage)
(iii) Non-Revenue Water in each project city (percentage)
(iv) Energy consumption by the water utilities in each project city (kWh/m^3)

III. PROJECT DESCRIPTION

A. Project Components

Component 1: Water supply service infrastructure improvement (Cost US$287.14 million, of which IBRD Loan is US$185.06 million)

19. The objective of this component is to support infrastructure investments required to improve water supply services, reduce NRW, and increase energy efficiency. It will focus on civil works construction and rehabilitation that will improve the quality of water supply and efficiency of water distribution. Improvement of water supply services' infrastructure in Project Cities through carrying out of Subprojects consisting of activities such as:

a) construction, upgrade, repair and/or rehabilitation of water reservoirs, treatment plants, pump stations, booster pumps, transmission and distribution pipelines and control valves;
b) installation and/or replacement of water meters for: (i) district and bulk water supply; as well as (ii) commercial, industrial and household customers; and
c) installation and/or replacement of household water service connections.

Component 2: Water supply service management improvement (Cost US$57.08 million, of which IBRD Loan is US$48.63 million)

20. The objective of this component is to enhance water supply service management through NRW reduction, water quality monitoring, energy savings, and effective asset management. Enhancement of water supply service management in Project Cities through such measures as:

a) mapping and modeling of all water distribution systems;

b) development and implementation of NRW Reduction Plan, including the development of monitoring and analysis systems for pipeline operation and leakage control as well as the purchase and installation of leak detection equipment and related monitoring instruments;
c) development of the Energy Management Plan;
d) development and upgrade of computerized water supply management systems;
e) enhancement of water quality monitoring for all water treatment plants and for the water distribution network and other system facilities;
f) upgrading of sampling and testing capacity of water testing laboratories;
g) preparation of Financial Improvement Plans; and
h) building the capacity of Project Companies in developing and managing Public-Private Partnership (PPP) arrangements.

Component 3: Project implementation support and institutional strengthening (Cost US$16.94 million, of which IBRD Loan is US$15.69 million)

21. This component will provide support for consultancy services in institutional capacity building for the water supply companies (in the participating cities), as well as project implementation support as well as incremental operating costs of the PPMO.

a) Building and strengthening the institutional capacities of the water supply companies in the Project Cities in inter alia (i) water utility management; (ii) operation, management and maintenance of the SCADA system including geographic information system, mapping and hydraulic modelling and asset management; (iii) water quality sampling and testing; (iv) operation and management of water treatment plants and pump stations, (v) leak detection as well as NRW and energy management; and (vi) project management.
b) Supporting the overall capacity of the Project Implementing Entity to coordinate, manage and supervise the implementation of the Project, including: (i) the operation of the Provincial Project Management Office and Project Implementation Units (including the purchase of office equipment); ii) carrying out training for the staff of the Provincial Project Management Office and Project Implementation Units; (iii) provision of consulting services to undertake engineering design and construction supervision; (iv) procurement of external environmental and social safeguards monitoring services; (v) and carrying out of capacity building activities to enable knowledge sharing, dissemination of study results and peer to peer learning among the Project Companies and other interested water supply companies.

B. Project Financing

22. The total project cost is estimated at US$386.29 million (including US$0.625 million front-end fee and an estimated US$24.50 million in interest during construction and commitment fees). Of this cost, US$250.00 million will be sourced from IBRD. The IBRD loan will account for 65% of the total project cost, and the remaining 35% (US$136.29 million) will be financed from counterpart funds to be provided by each participating city.

23. The proposed lending instrument for this project is an Investment Project Financing (IPF). The Borrower has selected a US Dollar denominated, commitment-linked variable spread loan based on six-month LIBOR plus an additional variable spread. It has also selected all the available

conversion options, level repayment of principal, and a repayment period of 26 years, including a 6-year grace period.

24. The Bank loan will be signed between the Bank and the People's Republic of China through its MOF. On-lending arrangements (or subsidiary loan agreements) for the Bank loan will be signed between PRC through its MOF and the Liaoning Provincial Government through Liaoning Provincial Finance Bureau (LPFB); and then between LPFB and the city government through their city finance bureaus. The loan will be on-lent from the Government of China to Liaoning Province, and the relevant portions will be further on-lent to Shenyang, Anshan, Fushun and Fuxin Water Companies. Since Gaizhou is a county-level city, an on-lending agreement will first be signed with Yingkou municipal government, and then the municipal government will on-lend to the city government. Loan repayment will be borne by the water companies.

25. The financial and fiscal analysis covering counterpart fund allocation and debt re-payment capacity is presented in Section VI (A). The summary of project costs by component and by water company are provided in Annex 3. With the exception for Gaizhou, the per capita investment is in the range of US$20 to US$80 in each city. In Gaizhou, the per capita cost is US$250.00 because its water supply network needs extensive rehabilitation and replacement and expansion of service. Moreover, Gaizhou has a plan to construct a new transmission pipeline to transport treated water from Yingkou Water Treatment Plant.

26. Details on how the funds would be disbursed are specified in Section VI (C), under the 'Disbursement' paragraph heading. Counterpart funds include provincial, and local government budgets, will follow a five-year planning cycle to allocate the fiscal revenue for the project.

C. Lessons Learned and Reflected in the Project Design

27. The following includes some of the lessons and innovations reflected in the project design:

(i) Over recent decades, the Bank has developed valuable international experience on the key governance and operational characteristics of well-performing utilities. The implementing entities under the project can draw on this experience to make operational improvements in the water utilities. Projects have helped clients achieve universal access to water through a mix of better governance, improved technical and commercial performance, building human capacity, and optimizing utility size. The Bank recognizes NRW reduction as a major factor to drive optimal use of scarce water resources and mitigate climate change impacts, and this perspective is aligned with the International Water Association's (IWA) guidelines for NRW reduction. The Government of China has set up a new standard of NRW reduction for utilities based on the IWA concept which will be used in the project. The project design incorporates best practice features by taking a comprehensive approach, integrating institutional capacity (see Annex 2, Component 2 for more details), infrastructure improvement, NRW reduction; and use of the latest technologies (development of comprehensive SCADA system for water supply system monitoring, data collection and instantaneous operational decision making) to better detect and manage losses, and through state-of-the-art spatial and temporal telemetry systems, in order to improve utility performance and quality of services. In addition, the introduction of customer satisfaction surveys to measure customer perception of water quality, pressure, safety, service continuity and service will improve customer orientation in project utilities.

(ii) Building on lessons learned from previous Bank-financed operations, this project will introduce an innovative incentive mechanism based on utility benchmarking (IBNET), focusing on more holistic parameters such as reliability, NRW, and customer satisfaction to promote sustainable utility operation. Currently, the IBNET approach in operation focuses mostly on infrastructure aspects to assess water supply service evaluation, which does not address fully aspects related to quality of services and operational sustainability of utilities which are fundamental for sustainable provision of water supply services. Moreover, the project will introduce use of latest IT applications, such as social media programs to collect customer feedback on quality of water supply services and citizen report regarding service disruptions and/ or damages to network. Active engagement of citizens in water supply services will complement the online monitoring and telemetry system to enhance real-time monitoring and control.

(iii) Linking WSCs' capital and operational plan to their financing is another innovative element of this project. Currently, tariff adjustment and subsidy transfers to WSCs in Liaoning are not linked to their capital or operational budgets, which undermines the sustainability of utilities and water supply services provision. This project will support participating water companies to prepare and disclose their operational plans (including NRW plan, financial improvement plans, water saving plan, energy saving plan, etc.) as well as their operational performance. Moreover, the project will support the water companies to prepare their annual (or multi-year) budget linked to their plans for capital and operational expenditure, ensuring adequate financial allocation (either through taking appropriate measures to adjust tariff and/or transfer of adequate subsidy). Utilities will be compared (through the benchmarking exercise) based on how adequately they meet their financial improvement plans.

(iv) The project has also benefitted from the lessons learned in the *Second Liaoning Medium Cities Infrastructure Project: Urban Environment* (LMC-2) (P092618), the *Jiangsu Water and Wastewater Project* (P096926), and other World Bank financed projects both in China and outside China[11]. The Second Liaoning Medium Cities Infrastructure Project (LMC-2) (P092618), which was completed in 2015, financed investments in water supply, wastewater, and solid waste management in seven project cities (Anshan, Haicheng, Fushun, Yingkou, Gaizhou, Panjin and Xingcheng). The major outcomes were improvement in performance and sustainability of water supply services through expanding service coverage, developing network mapping using GIS, technical assistance to enhance the capacity of water utilities, and successful implementation of pilot NRW programs. Based on the successful results of LMC-2, the Liaoning Government committed to scaling-up these activities and extending the scope to other cities in the province.

[11] Vietnam Water Supply Development Project (P073763), PPIAF (2015) Kenya: PPP Options Study for Accelerated and Sustainable NRW Reduction for Mombasa and Nairobi, PPIAF (2011) Non-Revenue Water Management Strategy for Surabaya Water Company

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

28. Institutional and implementation arrangements for this project involve two levels: the provincial level, and the city level. At the provincial level, the arrangements are very similar to the previous Bank-financed water project in Liaoning (LMC-2). The Liaoning Provincial Government will establish the Liaoning Provincial Project Steering Committee (LPPSC) to provide policy direction for the preparation and implementation of the project. Members include senior representatives from Liaoning Provincial Development and Reform Commission (LPDRC), the Liaoning Provincial Department of Finance (LPDF), the Liaoning Provincial Construction Commission (LPCC), the Liaoning Provincial Environmental Protection Bureau, and the Liaoning Provincial Water Resource Conservancy Bureau. The LPLG has designated Liaoning Urban Construction and Renewal Project Management Company Limited (LUCRPMC), under Liaoning Provincial Urban and Rural Construction Group Ltd. under the Liaoning Provincial State-owned Asset Supervision and Administration Commission, to serve as a PPMO.

29. At the city level, respective city-owned water supply utilities (namely Shenyang Water Supply Company, Anshan Water Supply Company, Fushun Water Supply Company, Fuxin Water Supply Company, and Gaizhou Water Supply Company) will be in charge of managing day-to-day operations, implementing subprojects, and coordinating with municipal governments, all in close collaboration with LUCRPMC. For this day-to-day management of the project implementation, each water company will establish a PIU.

30. Roles and responsibilities among key agencies are clearly defined in terms of project administration. For the subprojects under the water supply service infrastructure improvement component (Component 1) and the activities under the water supply service management improvement component (Component 2), the respective water supply companies in the five cities will be responsible. For activities under project implementation support and institutional strengthening component (Component 3), LUCRPMC will be responsible for the implementation.

31. LUCRPMC will function as a focal point for project management; and will coordinate activities among different government agencies, will report to the provincial government, and will coordinate activities with the Bank. Its responsibilities include: (a) overall project coordination, management and monitoring; (b) annual budget preparation; (c) project-wide quality assurance; (d) progress reporting (on physical implementation, achievements towards targets in the results framework, safeguards implementation, and financial management) to the Liaoning Provincial Government and to the Bank, including cost management, project impact and environmental improvement assessment; (e) interagency coordination and procurement support; (f) coordination support related to technical, social, and environmental matters during the project implementation; and (g) implementation of cross-city activities, such as training and capacity building of utility staff.

B. Results Monitoring and Evaluation

32. The monitoring and evaluation system for the project will monitor implementation progress and outcomes, and will provide special monitoring for safeguards compliance. These tasks will be

undertaken by LUCRPMC, PIU and LPDRC. LUCRPMC and PIUs, supported by an implementation support consultant team, will undertake monitoring and reporting of progress and results (including outputs and outcomes). Outcome indicators for the project and each component (with baseline values and target values) are provided in Section VII. Progress toward achieving the targets of the indicators will be presented in the semiannual progress reports, which will be prepared and provided to the Bank. Semi-annual implementation support missions will be conducted by the World Bank, and will support monitoring and evaluation, and assist in providing professional recommendations to facilitate project implementation towards the achieving of its development objective. A mid-term review will be carried out no later than December 31, 2020.

C. Sustainability

33. **Government Commitment and Ownership.** The development of the northeastern provinces is an important government priority, together with ensuring sustainable urban development in the face of rapid urbanization. The Government has already implemented a number of Bank projects in the province[12]. For this project, the Government has shown its commitment through the preparation support provided by multiple agencies, including Ministry of Finance (MOF), LPDF, NDRC, LPDRC, Project Cities, and LURCPO. This support is expected to continue during implementation. In addition, capacity building efforts at the provincial and city/county levels will help facilitate effective implementation and ensure the sustainability of the project. This includes institutional strengthening at the water utilities in the provision of quality water services.

34. **Infrastructure sustainability**. Operations and maintenance will be the responsibility of the participating water companies and their associated city/county governments. Together, these will finance the recurring costs for infrastructure and services through user fees and fiscal transfers. The project will further open the space for innovation in operations and maintenance through the development of comprehensive processes and information technology (IT) systems. Maintenance strategies for infrastructure will be developed by the water companies with support from the project.

35. **Financial sustainability**. In general, large water companies like Shenyang, Anshan, Fushun and Fuxin can cover their operating costs. Smaller companies like Gaizhou are subsidized and any shortfalls are filled through fiscal transfers. Financial sustainability of the water companies is expected to improve through the preparation of rolling, five-year financial improvement plans (FIP) – through which the water companies will strengthen their financial status through a combination of improved tariff collection rates, reduced operating costs, and adjusted tariffs.

36. **Introducing peer-to-peer experience exchange platform**. The participating water companies will have an annual workshop to share their experiences with NRW and energy management, as well as with the implementation progress of the FIPs and the improvement of water service quality. External institutions, like IWA, will be engaged to promote a peer-to-peer learning platform. Through the support of Energy Sector Management Assistance Program (ESMAP) grant activities, the participating project utilities have already attended a practitioners' workshop organized by IWA China Water Loss Task Force (which serves as the platform for

[12] Liaoning Environment Project (P003598**)** (1995-2003) and the Liao River Basin Project (P051859) (2002-2008), Liaoning Medium Cities Infrastructure Project (P099992) (2006–2013), Second Liaoning Medium Cities Infrastructure Project (P092618) (2007-2015)

knowledge exchange and communication for innovative concepts, advanced technologies and best practices), which focused on exploring how to implement and promote good practices for water loss control in China. The project will also assist in operationalizing the benchmarking system in utilities, building on previous efforts from International Benchmarking Network for Water and Sanitation Utilities (it is benchmarking system to assess performance of utilities). This benchmarking exercise is also expected to improve the performance of utilities, and will be expanded to 90% of the cities with the support from the Liaoning Association of Water Utilities, which was trained by IBNET in 2008 for benchmarking.

37. **Environmental and Social Sustainability.** Environmental and social safeguards management will be mainstreamed in the project documents and the project cycle. All sub-projects financed under the project will require environmental and social screening, as well as an assessment of potential environmental and social impacts, and the preparation of acceptable safeguard instruments and mitigation measures. Safeguards training will be provided as part of the project's capacity building activities. Moreover, three customer satisfaction surveys, based on IBNET design, will be carried out by each participating water company: the first at the end of the first year, the second at the mid-term review, and the third at the project closing. These will measure customer perceptions on water quality, pressure, safety, service continuity, and service level generally.[13] The results of the surveys will provide useful information for the project water companies to focus on and improve customer service, and to ensure the sustainability of the project.

D. Role of Partners

38. The project will be financed by the World Bank, together with counterpart funds. The project will be implemented as set out in this Project Appraisal Document, and the Loan Agreement and Project Implementation Plan, irrespective of the source of financing.

V. KEY RISKS

A. Overall Risk Rating and Explanation of Key Risks

39. The overall risk of the proposed project in achieving the intended PDO is rated as Moderate The major driver of risk in the project is the fiduciary risk – this is based on experience from the previous LMC-2 project where the capacity for financial management varied across different PIUs. However, with the measures described in Section VI (C), the fiduciary risk can be satisfactorily mitigated, and be rated as Moderate. All other risks are rated Low or Moderate.

40. Implementation arrangements for this project are complex, as they cover the provincial government, and five city governments, along with their associated utilities. However, the PPMO (LUCRPMC) does have ample experience working with World Bank funded projects. Similarly, all participating cities have earlier experience with Bank funded projects. LUCRPMC is maintaining key personnel who successfully managed the LMC-2 project. Moreover, both Anshan

[13] The baseline data are taken from the results of Shenyang in "Customer Satisfaction Indicators Survey in 40 Chinese Cities," conducted by China Water Supply Service Promotion Alliance, in 2012. The survey covers the main five areas that the project intends to focus on.

and Fushun Water Supply Companies were part of the LMC-2 project which recently closed on December 31, 2015. With such experience, the implementation arrangement risk has been rated as Moderate.

41. Other potential risks include: (a) lack of timely completion of two linked WTPs financed by local funds in Fuxin; (b) proper implementation and sustainability of the large number of innovations introduced under this project (in terms of MIS, SCADA, telemetry system, online monitoring, etc.); and (c) and potential delay in procurement of goods/ technologies/ software. Due diligence regarding the linked project was conducted, and included financing and safeguards aspects, the engineering design has been carried out since late 2016, and the project is expected to be completed and to become operational in late 2019. The risk is small as the construction of the two linked WTP is at final bidding stage. To help mitigate these risks, an experienced project management consultant will be hired by the PPMO to assist the utilities to implement the project.

VI. APPRAISAL SUMMARY

A. Economic and Financial

42. **Institutional Setup.** The implementing water supply companies (WSC) all have water supply services as their main business area. None of the companies provide wastewater services. The water supply companies have varying degrees of institutional and financial autonomy, with the smallest WSC in Gaizhou being mainly supported by local government. The project will improve the operational efficiency of the WSCs by reducing cost associated with energy, raw water sourcing, chemical use, and repair and maintenance activities, while at the same time reducing commercial losses through improved metering.

43. **Tariffs and Cost Recovery.** Water supply tariffs are within the range of 1.85 yuan/m^3 to 3.06 yuan/m^3 for residential consumers. While the current tariff levels support recovery of operation and maintenance costs, the tariffs are below the levels required for full cost recovery. Financial support from the Government is needed for the utilities to fully recover costs.

44. **On-lending and Governments' financial support.** The loan from the World Bank will be on-lent to the WSCs, which will be responsible of carrying the debt service obligations. Both Shenyang and Fuxin water supply companies are in the position to provide the counterpart funding needed without government support, while the other three WSCs will receive financial project support from their local governments: Fushun WSC will receive equity contribution for counterpart funding and receive support for debt service obligation related WB loan; Anshan WSC will receive support for debt service obligations related WB loan; while Gaizhou will receive support for all funding. Currently Gaizhou receives ongoing financial support from local Government, and the WSC will rely on such support throughout the project.

45. **Financial Projections and investment return analysis.** Projections of the companies' financial position after the project is implemented indicate that the project companies will be able to meet their debt service obligations, given the assumed funding strategies and government support for each company (Annex 4). The financial projections, moreover, indicate that the investments will produce positive financial returns above the cost of capital (Table 1); and as such,

will be financially beneficial to the companies[14]. These projections were prepared using the assumed, post-project (reduced) levels of NRW and energy consumption (as presented in this document), as well as assuming an increase in unit costs and tariff rates in line with inflation. It is envisaged that the working ratio (the degree of operational cost coverage) of all companies will be continuously improved to increase operational cost coverage capabilities.

Table 1. Financial Internal Rate of Return

Project City	Shenyang	Anshan	Fuxin	Fushun	Gaizhou
FIRR	17%	18%	20%	9%	4%

46. **Tariff Affordability.** The current water tariffs are affordable for the residents in all project cities, with conservative planning assumptions of small growth in disposable income. The combined water and wastewater bill is at a level of 1% for households in the low-income bracket.

47. **Fiscal Analysis.** All project cities with counterpart funding and debt service obligations have sufficient financial resources required to service their obligations. Counterpart funding and debt service constitute, at a maximum, 3% and 1% respectively of their total budget revenues. As such, this World Bank funded project is only a small part of the cities' total budget revenue.

48. **Economic Analysis.** The project's investments in the cities are selected based on urgency (as measured by, for example, the number of leakage incidents); and the investments have been designed to increase the overall efficiency of service delivery in the project cities. Alternative technical options were investigated to identify solutions with the least lifetime costs. The main economic benefits from implementation are cost savings from reduced leakages, and reduced costs at renovated pumping facilities (together these reduce electricity costs, costs of chemicals for treatment, and costs for repair and maintenance). The water saved from reduced leakage can also be used to meet additional demand. At the same time, water demands in all cities are expected to increase in the future, and reduced leakage can also be used to offset new demands. Based on the quantification of these benefits and costs, the Economic Internal Rate of Return (EIRR) for the project was calculated, and the results are summarized in the table below. The figures for Shenyang, Anshan, Fuxin, and Fushun indicate that the investments are justified from an economic perspective, (Table 2). For Gaizhou while the quantitative benefits are not high compared to the costs, there are qualitative benefits - prevention of seawater intrusion and pollution of groundwater due to over exploitation of groundwater and associated ground settlement that would endanger various infrastructures – which will result due to the interventions of the project.

Table 2. Economic internal rate of return of project investments

Project City	Shenyang	Anshan	Fuxin	Fushun	Gaizhou
EIRR	+40%	31%	30%	11%	3%

B. Technical

49. All priority investment subprojects have been identified, and feasibility studies have been prepared by Chinese design institutes. At project appraisal, the design criteria, design principles,

[14] While the financial returns for Gaizhou is only slightly above the cost of capital and are relatively low compared to the others, there is a technical imperative to finance the new water source and production in Gaizhou, given the impending closure of the current main source due to environmental issues.

and technical feasibility of proposed sub-projects were confirmed. Preliminary designs have also been prepared. The detailed designs of facilities and infrastructure will be reliable and robust to withstand the expected extreme events – storms, winds, and flooding – that Liaoning may face as predicted from potential climate change in the region. All selected sub-projects represent least-cost investments, selected from among a set of viable alternatives, and considered on the basis of availability, price, reliability, and technical merits. Realistic projections for population and water demand were considered to ensure least cost designs. Realistic unit costs/rates were used in making cost estimates; and for these recently awarded and completed contract costs were referenced.

50. Project preparation has benefitted from the parallel Energy Sector Management Assistance Program (ESMAP) activity that supported the energy audit and efficiency improvement in the project cities. The baseline data for specific energy consumption, NRW, and related performance targets were identified and confirmed accordingly.

51. Except for the small city of Gaizhou, the NRW rate in town networks in the cities is estimated to be in the range of 25.7% to 38.8%. Gaizhou has major commercial losses that brings its NRW to 64.1%. The proposed network renovation is expected to show a substantial reduction in system losses. The goal is to create a model for NRW reduction that can be replicated as a regular part of water company operational activities.

C. Financial Management

52. The World Bank loan proceeds, including overseeing the Designated Account (DA), will be managed by Liaoning Provincial Finance Bureau (LPFB). The primary financial management (FM) responsibilities of the PPMO will be reviewing expenditure reporting submitted by the city WSCs and consolidating financial reports as well as communicating those reports with the Bank. The primary FM responsibilities of WSCs are preparing the annual plan and ensuring counterpart funds included in the project annual plan are committed, requesting timely payments to contractors, recording project activities and investment and preparing regular financial reporting. An action plan to strengthen FM capacity has been agreed upon with the implementing agencies, including preparation and distribution of the FM manual, provision of extensive training, establishment of a systematic monitoring of project counterpart funds. The FM assessment concluded that with the implementation of the proposed actions, the Project's FM arrangements satisfy the Bank's requirements under OP/BP 10.00.

53. **Risk.** The FM capacity assessment conducted in November 2016 identified the principal risks that three out of five project water companies do not have experience with World Bank-financed projects. However, and as mentioned earlier, the PPMO and five cities (owners of the water companies) do have experience in World Bank financed projects. In addition, the implementing entities of the Provincial Government have past and ongoing experience in managing World Bank financed projects. Mitigation measures, to address the above risk, which have been agreed upon, include: a) FM training (formal and ad hoc) to be provided to the project financial staff by PPMO; and b) issuance of a Financial Management Manual (FMM) prior to loan negotiation so as to standardize project FM procedures and provide guidance to FM staff. Overall, the residual financial management risk, after mitigating measures, for the project is assessed as Moderate.

54. **Budgeting**. The annual project implementation plan, including the funding budget and the resources, will be prepared by the city WSCs, and approved by PPMO. The budget for counterpart funds committed by local government will be reviewed and approved by local People's Congress, and will be included in their annual budgets. Based on the approved budget and implementation progress, the city finance bureaus will provide government appropriations to the project. According to Decree 85 issued by MOF, the World Bank loan is required to be included in the government budgeting system, and the loan proceeds will be managed through the government treasury system. Budget variance analysis will be conducted on a semi-annual basis by the relevant WSCs, and necessary actions will be taken to ensure that the project is implemented as planned. The World Bank will work with PPMO and city WSCs by supervising the annual project plan to enhance budget preparation and execution during project implementation.

55. **Funds flow.** The loan proceeds will flow from the World Bank into the project DA (to be set up at and managed by the treasury division of LPFB in the form of a special account). LPFB will be directly responsible for the management, maintenance and reconciliation of the DA activities. Supporting documents requesting payments will be prepared and submitted by city WSC to PPMO for review and verification via city finance bureau before sending to LPFB for further disbursement processing. Except under circumstances where the funds will be delivered to city finance bureau and then be paid to contractors/suppliers, the requested funds will be paid to the contractors/suppliers directly. The counterpart funds will be paid to contractors/suppliers by city finance bureaus according to related domestic regulations and procedures.

56. **Accounting and financial reporting**. In order to fully use the project companies' existing system, it was agreed that Gaizhou and Anshan would use Circular #13: "Accounting Regulations for World Bank-financed Projects" issued in January 2000 by MOF to account for project expenditures. The other three cities will use their own existing accounting systems.[15] However, financial reporting should be prepared in the format stipulated by Circular 13 to facilitate PPMO's consolidation of project financial reporting.

57. City WSCs will be managing, monitoring and maintaining their project accounting records for the activities they execute. Original supporting documents will be retained by city WSCs. All city WSCs will use accounting software to account for project activities and prepare financial reporting. Project financial statements will be consolidated by PPMO manually. The unaudited semi-annual project interim financial reports (IFRs) (format and content) in accordance with the aforementioned Circular No.13 agreed with MOF, will be prepared and furnished to the World Bank by PPMO no later than 60 days following each semester, in form and substance acceptable to the World Bank.

58. **Internal control.** The related accounting policy, procedures and regulations were issued by MOF to uniformly align the financial management and disbursement requirements for the World Bank financed projects. Additionally, the project implementation plan (with one annex on project financial management) will align the entire project's financial management policies and procedures across the PPMO and PIUs, and which will serve as the basis for project implementation and management.

[15] In the year 2000, MOF issued Circular 13, named "*Accounting Regulations for World Bank-financed Projects".* The basis of this circular is the accounting regulation for the state-owned construction enterprises. All projects financed by the Bank loan are required to use this circular to account for project activities. Some state-owned enterprises have been authorized by MOF to use their own systems.

59. **Audit.** The Liaoning Provincial Audit Office (LPAO) has been identified as the auditors for the project. An annual audit report will be issued by LPAO, and will be submitted to the Bank within 6 months after the end of each calendar year. Following the World Bank's formal receipt of the audited financial statements from the borrower, the World Bank will make them available to the public in accordance with the World Bank Policy on Access to Information.

60. **Disbursements.** Three disbursement methods: (i) advance; (ii) reimbursement; and (iii) direct payment, are all available for the project. Supporting documents required for World Bank disbursement under different disbursement methods will be documented in the Disbursement Letter issued by the Bank. One DA in US dollars will be opened at a commercial bank acceptable to the World Bank and will be managed by the treasury division of LPFB. The ceiling of the DA will be determined and documented in the Disbursement Letter. The Bank loan will be disbursed against eligible expenditures (taxes inclusive) as shown in the following table, (Table 3):

Table 3: World Bank loan breakdown by disbursement category and percentage of eligible finance.

Disbursement Categories	**IBRD Loan**	
	Allocated	**Percentage of Expenditures**
	Amount	**to be financed**
	(US$ million)	**(percentage)**
(1) Works and Goods	**240.235**	
i. Shenyang Water Supply Group	85.04	**100%**
ii. Anshan Water Supply Co.	40.05	**100%**
iii. Fushun Water Supply Co.	61.89	**100%**
iv. Fuxin Water Supply Co.	28.605	**100%**
v. Gaizhou Water Supply Co.	24.65	**100%**
(2) Non-consulting services, consultants' services, Training and Workshops, and Incremental Operating Costs	**9.14**	**100%**
(3) Front-end Fee	**0.625**	**100%**
(4) Interest Rate Cap	**0.00**	**100%**
TOTAL AMOUNT	**250.00**	

61. The World Bank disbursement guidelines will apply, together with specific instructions to be detailed in a disbursement letter issued by the World Bank. The main steps for disbursement are:

- LUCRPMC submits an electronic withdrawal application (WA) and copies of supporting documents to the World Bank in accordance with the terms and conditions contained in the disbursement letter; and

- The World Bank reviews each WA submitted in accordance with its applicable policies and procedures to verify that the amount requested is in accordance with the respective loan agreement.

D. Procurement

62. **Procurement institutional arrangement.** The project implementation agencies comprise a PPMO and five PIUs. According to the internal arrangement, LUCRPMC (PPMO), which is an existing organization under the Liaoning Provincial Urban and Rural Construction Group Ltd. under the Liaoning Provincial State‐owned Asset Supervision and Administration Commission, will take charge of the leadership, coordination, supervision and oversight of the whole project implementation at the provincial level. The whole procurement process will be supported by professional procurement agent with experience on World Bank funded projects with the official review of the process by the PPMO and supervision of relevant government supervisory departments as well as the active participation and ownership of the water company PIUs.

63. The procurement activities include preparing and updating procurement plans, publication of Invitation for Bids (IFBs), preparation and issuance of bidding documents, clarifications and amendment to issued bidding documents, organizing bid evaluation process, preparation of bid evaluation report, complaint handling, as well as public notice of contract awards. Procurement and contract management of goods and works contracts and consulting services contracts within each subproject will be undertaken by the PIUs. However, the procurement and contract management of consulting services contract covering the project as a whole will be implemented by the PPMO, with participation of the relevant PIUs. The PPMO is also responsible for overall coordination and communication with the World Bank, including obtaining World Bank approvals, as required.

64. **Procurement risk assessment and mitigation measures.** The PPMO has implemented seven Bank-funded investment projects in the past 20 plus consecutive years and has a team of competent and qualified procurement and contract management staff with rich procurement knowledge and experience in Bank-funded investment projects. However, most of the procurement staff at the PIUs lack procurement knowledge and experience with international finance institution (IFI) funded projects, but do have prior experience or knowledge on local procurement procedures under the domestic laws and regulations. The key risks concerning procurement for implementation of the proposed project are: (i) procurement delays and non-compliance with World Bank procurement guidelines either due to unfamiliarity with specific World Bank procurement policies and procedures or following local procedures when local regulations conflict with World Bank procurement guidelines; and (ii) weak capacity of the PIUs procurement staff in procurement cycle management and contract management.

65. To mitigate these risks, the following actions have been, or will be, carried out during project preparation and implementation: (i) employment of a procurement agent and project management company with experience in procurement and contract management for Bank-financed projects to support and guide the procurement and contract management work of the PPMO and PIUs; (ii) provision of regular training to the PIUs procurement staff on the Bank's procurement policies, methods, and procedures, as well as the use of standard bidding/proposal documents and evaluation principles; (iii) preparation of a procurement manual to provide

guidance to project implementers as part of the project implementation plan; (iv) early procurement support missions by the Bank's procurement specialist, where necessary; (v) annual field procurement supervision missions to review procurement actions where needed; (vi) close coordination between the client and the World Bank team; and (vii) attendance of World Bank procurement training sessions by the PPMO and PIUs.

66. The bulk of the World Bank loan will be used for the procurement of works, goods, and consulting services, and works and goods contracts will be procured via National and International Competitive Bidding (NCB and ICB), and QCBS/LCS/FBS, or Consultant's Qualifications (CQS) will be adopted hiring consulting firms.

67. The PPMO and the two (2) PIUs – Fushun and Anshan have done World Bank and ADB's financed projects. The other three (3) PIUs – Shenyang, Gaizhou and Fuxin have not done MDB's financed projects. The PPMO will hire a procurement agent and consulting firms for project management. They will coordinate and have sufficient capabilities to carry out the procurement of the proposed project with the professional support of a procurement agent and project management consulting firms for each PIU. The World Bank procurement specialist will provide necessary training to the PPMO and PIUs when required to strengthen their capacities. Therefore, the overall procurement risk for the proposed project is assessed as Moderate.

68. **Procurement policies and guidelines.** Procurement for the proposed project will be carried out in accordance with the World Bank's "*Guidelines: Procurement of Goods, Works, and Non-Consulting Services under IBRD Loans and IDA Credits and Grants by World Bank Borrowers*" dated January 2011, revised July 2014, and "*Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits and Grants by World Bank Borrowers*" dated January 2011, revised July 2014, and the provisions stipulated in the legal agreements. "Guidelines on Preventing and Combating Fraud and Corruption in Projects Financed by IBRD Loans and IDA Credits and Grants dated October 2006 and revised Jan 2011" shall apply to the project. "Guidelines on Preventing and Combating Fraud and Corruption in Projects Financed by IBRD Loans and IDA Credits and Grants, dated October 2006 and revised Jan 2011" shall apply to the project.

69. **Procurement of works, goods and non-consulting services.** Procurement will be done using the Bank's Standard Bidding Document for all International Competitive Bidding (ICB) contracts and National Model Bidding Documents agreed with or satisfactory to the World Bank for all NCBs. The works, goods and non-consulting contracts will cover the water distribution infrastructure improvement including water distribution pipe network reconstruction, supply and installation of equipment, materials for water source pumping station & water plant and IT systems. Further details are provided in the Procurement Plan.

70. **Selection of consultants.** The World Bank loan will finance consulting services contracts to assist the PPMO and its subsidiaries in capacity building, detailed design, project management, as well as construction supervision services during project implementation. The Bank's Standard Request for Proposal shall be used for all consulting assignments with firms. Short lists of consultants (firms) for services estimated to cost less than US$500,000 equivalent per contract may be composed entirely of national consultants in accordance with the provisions of paragraph 2.7 of the Consultant Guidelines.

71. **Procurement plan.** The project procurement plan dated January 17, 2018 for the whole period of project implementation, prepared by the PPMO, has been submitted and reviewed by the

World Bank. It will also be available in the project's database, on the World Bank's external website and at PPMO's office. The procurement plan will be updated in agreement with the World Bank annually or as required to reflect actual project implementation needs and improvement in institutional capacity. Further details on procurement are provided in the project procurement plan.

72. **Procurement methods and Bank prior reviews.** The thresholds for procurement methods and Bank prior review are indicated in Table 4 below, and will be followed during project procurement implementation. Specific prior review requirements will be indicated in the project procurement plan. In addition to the prior review supervision carried out by the World Bank offices, World Bank procurement supervision missions will visit the field to carry out procurement supervision and post-review of procurement activities at least once every 12 months. The post-review sampling ratio would be one out of 10 contracts.

73. **Advance contracting and retroactive financing.** The project has no provision for retroactive financing in the World Bank loan agreement.

Table 4: Thresholds for Procurement Methods and Prior Review

Expenditure Category	Contract Value Threshold (US$)	Procurement Method	Prior Review Threshold (US$)
1. Civil works	≥40,000,000	ICB	
	<40,000,000	NCB	≥US$15 million
	<500,000	Shopping	
2. Goods	≥10,000,000	ICB	
	<10,000,000	NCB	≥US$4 million
	<500,000	Shopping	
3. Consultant services	≥300,000	QCBS/QBS/LCS/FBS	≥US$2 million
	<300,000	CQS	
		Individual Consultant	≥US$400,000

Notes:
ICB: International Competitive Bidding
NCB: National Competitive Bidding
DC: Direct Contracting
QCBS: Quality- and Cost-Based Selection
QBS: Quality-Based Selection
CQS: Selection Based on the Consultants' Qualifications
SSS: Single Source Selection
IC: Individual Consultant selection procedure
FBS: Fix Budget Selection
LCS: Least Cost Selection

E. Social (including Safeguards)

74. **Stakeholders.** The project primary stakeholders include: local residents, especially women and the poor people, as well as the PIUs, project owners, design agencies, and government agencies (including the water resources agency, financial bureau, and other relevant bureaus). The roles of key stakeholders are outlined as follows:

a) Local residents in project areas are the primary beneficiaries, with improved quality of water services and facilities. Beneficiaries will be able to provide opinions on their needs related to this project, participate in consultations, and report on issues, accidents and complaints, if any.
b) The PPMO will take an overall leading role in project management and provide progress reports to the Bank. The local PIU will be responsible for the management of project

preparation, design, implementation, and internal monitoring and semi-annual progress reporting to the PPMO.

c) The local government agency like water resources bureau will provide technical and administrative guidance on water tariffs, planning, budgeting and procurement of water facilities in project.

d) An external monitoring and evaluation institute will be hired to conduct external monitoring and evaluation for the project's social risk and impacts management, provide training and advisory services for the implementation of the project safeguards instruments. Most of the stakeholders participated in consultation for the project preparation and design, and will be engaged in project implementation, monitoring and evaluation.

75. **Social impacts.** The project will have significant positive social impacts by improving water quality (mainly turbidity due to overloaded water treatment plants and possible contamination from leaking pipes) and services for project areas. Most of the civil works will be water pipe network rehabilitation, pump and pump station and water treatment plant upgrading and expansion, mainly on existing public land. However, small amounts of land will be required and the involuntary resettlement policy (OP 4.12) is triggered. In Fuxin, 3.024 mu collective land will be acquired with no affected household, and the acquired land will be used in this project for a new booster pump station. Furthermore, 354.9 mu of collective land will be acquired for temporary use of pipe line network, and 1,308.3 mu of state-owned land will be also temporarily used in project sites in Fuxin and Gaizhou, respectively. This will temporarily affect 275 households with 902 people. The rest of the project sites are in urban areas with no need for land acquisition.

76. **Resettlement.** A Resettlement Action Plan (RAP) has been prepared to address land acquisition and resettlement for both Gaizhou and Fuxin. For any potential land requirement under the project after appraisal, a Resettlement Policy Framework (RPF) has also been prepared as an annex to the RAP. The RAP will include: (i) land demands, social impacts, and risks, (ii) social and economic surveys of the affected project city/county in Gaizhou and Fuxin, (iii) compensation standards and packages, (iv) procedures for land acquisition and resettlement, (v) mechanisms for grievance redress, (vi) time frame, budget and implementation agencies for involuntary resettlement. The RPF will include: (i) the legal framework, planning principles, procedures for involuntary resettlement, (ii) the compensation and rehabilitation approach, (iii) consultation and participation requirements, (iv) grievance redress mechanisms and procedures, and (v) organization and monitoring arrangements. A professional and experienced consulting firm will be contracted to monitor and evaluate the implementation of the RAP, ESMF and or other planned social actions.

77. **Linked projects**. A linked project is identified in Liao Xi Bei (LXB) Water Supply Supporting Project in Fuxin City, because the Bank supported water pipe line will need to use the water treatment plant (WTP) and connecting pipe network for water supply. This linked project is going to construct two WTPs with capacity of 100,000 m^3/day each, and 45 km of water distribution pipe networks. The land acquisition from this linked project will affect Fumeng County, Xinqiu County, Xihe District, Qinghemen District, Science and Technology Park of Fumeng County and High-Tech Park in Fuxin City. The total land occupation area is 2,789.86 mu, of which, there are 226.62 mu of permanent land acquisition and 2,563.24 mu of temporary land occupation; there will be 1820 people from 521 households affected. The compensation standard

and measures for land acquisition and resettlement are in line with what this project will apply as covered by the above-mentioned RAP.

78. **Grievance Redress.** A grievance redress mechanism is established as shown in the RAP for the project. Grievances may be received orally or in writing and will be filed in writing. Starting at the village and neighborhood committee levels of local residents, grievances can be elevated to the county/district or provincial level if the complainant is not satisfied with the resolution at the lower level. The affected people may also file cases in a court of law, if they are not satisfied with the resolution of their grievance by the project authority. All grievances and their resolution will be recorded. The Grievance Redress Mechanism (GRM) has been disclosed to the local population and will be further disseminated as needed.

79. **Gender.** Gender considerations have been integrated in project design, in particular through the Social Assessment (SA) and RAP preparation, even though the proposed activities under the project will benefit both men and women alike. A gender analysis, which was carried out as part of the SA, showed that women were less aware or informed of the project, although they are key stakeholders (given that they often carry out housework and use water for domestic consumption). Many women were not satisfied with the current water quality and low water pressure, which affected their housework, such as cooking and cleaning. Some women expressed concerns over secondary contamination at pump stations and its impacts on health, and others suggested having more information on water conservation at the household level. At the same time, over 90% of the women expressed their interest in working in temporary jobs at construction sites, if the sites were close to their homes. Women's opinions and participation will be encouraged further during project implementation to increase their awareness of the project as well as reflect their opinions in the design. Equal compensation and resettlement support will be ensured when there is land acquisition and resettlement. Gender is embedded in the project Results Framework and gender disaggregated information will be included in semi-annual progress reports.

80. **Citizen engagement.** Citizen engagement was a key aspect of the project SA and RAP preparation. Consultation activities included two rounds of field investigations with a range of relevant government agencies, local residents and other stakeholders. The social consulting teams conducted questionnaire surveys (with 600 copies distributed and 590 valid copies returned), in-depth interviews with 169 people and key informant interviews with 78 people, and held 20 community/village-level focus group discussions. Public consultations were held for the selection of locations civil works from November 1 to December 31, 2016. These consultations helped in collecting feedback and concerns regarding water quality, water pressure, willingness to pay, and compensation and livelihood restoration for displaced people. Feedback and concerns from the consultation have been addressed in the project's safeguards documents. In order to strengthen the public participation in the project throughout the project preparation, implementation and operation stages, the PPMO and PIUs should engage with the beneficiaries and periodically share project information, including project details and impacts, construction schedule, and employment opportunities during the construction. The PPMO and PIUs shall also strengthen the customer relations functions under this project. For example, the project will help improve the water companies' responsiveness to complaints and requests from customers. The participants also raised the needs to build awareness and offer training on water conservation though public campaigns and school education. Based on the consultation, these concerns were incorporated into project design and the PPMO will engage with the WSC to design and launch such campaigns..

81. **Customer feedback.** Public consultation and participation will continue to draw on local people's views and feedback on project implementation, building on the established customer service hotline of WSC, an effective for pipe bursting or leakage reporting. Under the project, water companies will carry out customer satisfaction surveys to measure the customers' satisfaction with the quality of water services. This has been incorporated in the project design as one of the intermediate level indicators. The surveys will be conducted in the mid-term and prior to the project closing to assess the impact over the course of the project implementation. Moreover, there will be personnel assigned at the PPMO and PIU levels to implement the recommendations from the consultations and the outcomes of the customer surveys. Information on potential social impacts, and mitigation measures have been and will continue to be disclosed to the affected people and the public. Citizen engagement is part of the Results Framework through the following indicators: (i) percentage of customer satisfaction of the quality of water supply services; and (ii) grievances responded and/or resolved within the stipulated service standards for response times.

82. **Implementation Arrangements.** A multi-level organization has been established to implement project RAP and other social action plan. During project preparation, the client has engaged experienced social consultants to prepare RAP and SA documents. LUCRPMC, which has rich experience in the World Bank financed projects since 1989, has designated experienced social staff to take charge of social risk management for the project. Moreover, all five cities have experience in World Bank financed projects and will designate staff for social safeguards management. During preparation, training has been provided for the PIUs on social safeguards management and the World Bank requirements for safeguards policies, gender, and public participation. During implementation, more training will be provided for PIUs, project owners, and other stakeholders on addressing social risks and impacts. Additionally, during project implementation, independent social consultants will be hired for monitoring resettlement implementation and livelihood restoration. The capacity of the borrower to manage the project's social aspects is deemed to be satisfactory.

F. Environment (including Safeguards)

83. This is a **Category B** project. Applicable environmental safeguard policies for the project include: Environmental Assessment (OP4.01), Physical Cultural Resources (OP4.11), and Safety of Dams (OP4.37).

84. **Environmental Assessment (OP4.01):** The project mainly focuses on the rehabilitation of existing water supply and treatment facilities in five major cities of Liaoning Province. Most of the physical investments under the project will be in urban areas, while some investments (e.g. water supply pipelines) will be in peri-urban areas. Negative impacts are predictable and manageable with standard methods and tools. These relate to construction activities and include airborne dust, exhaust emissions from vehicles and machinery, noise, waste (spoil materials and construction waste), and risks to the health and safety of local communities (especially due to increased traffic, particularly from heavy machinery and trucks). During project operation, there will be the handling and use of chemical agents (i.e. disinfectants) at the WTPs to be rehabilitated by the project, and noise reduction management for pumping stations. During operation, the project will mainly bring positive impacts. For example, the improved access to quality water supply services will benefit 5.69 million people, the rehabilitation of the existing water supply system will have the potential to reduce water leakage and improve the operational efficiency of

water supply utilities, which will also lead to electricity savings. There would be some limited adverse impacts such as noise from the pumping stations, and the risk associated with the accidental leakage of disinfectant (e.g. chlorine) at the WTPs. These will be addressed and mitigated as part of routine operations and with established technical procedures. In addition, the improved water supply capacity (e.g. from the reduction of water leakage rate) would help to meet future water demand from domestic, commercial and industrial users. This could lead to increased wastewater quantities from the cities. After reviewing the wastewater treatment capacity of the five cities, the EMP shows that the cities can accommodate the maximum anticipated increased quantity of the wastewater without negative impacts on effluent quality. As part of the Environmental Assessment (EA) process, due diligence for the existing WTPs and the water sources have been conducted. The issues identified such as the aging of equipment/treatment units/pipes would be addressed by the project and included in the project design.

85. **Physical Cultural Resources (OP4.11):** The rehabilitation of the water supply network along an existing street (i.e. Xishuncheng) in Shenyang would cause traffic disturbance to Nanguan Catholic Church, which was re-built in 1912 and has a footprint of 1,100 m^2. The Church was classified as a municipal level Physical Cultural Resources (PCR) in February 1985 and a provincial level PCR in December 1988. It is the catholic community center in Shenyang, serving religious services for about 2,000 catholic believers. The church is in the vicinity (with a separation distance of 180 m) of the rehabilitation of water supply network. The network rehabilitation will not acquire land nor encroach on the property of the church, and will provide better service for the local communities after the construction is completed. However, the construction will cause short disturbance to local traffic and accessibility to the church. Public consultation with the affected church has been conducted, based on which no construction will be allowed during the religious festivals. This requirement and Chance Find Procedures are included in the EMP.

86. **Environmental Management Plan:** An Environmental Management Plan (EMP) has been developed for the project covering each of the cities in accordance with Chinese environmental policy frameworks as well as the World Bank safeguard policies. Mitigation measures consist of (i) Environmental Code of Practices to address general construction related impacts; for example, civil work contractors are requested to water construction sites during dry and windy seasons, mitigate noisy construction activities and avoid night-time construction, and manage traffic around construction sites; (ii) specific mitigation measures during design, construction and operation phase, for example, (a) the project will install energy efficient and water saving equipment; (b) non-trenching methods (e.g. pipe jacking/drawing) are proposed to minimize construction impacts on streams and public facilities; (c) the replaced pipes, pumps and water meters will be sent to designated sites for recycling; and (d) an emergency plan has been proposed for the accidental leakage of disinfectant at the WTPs. Measures for the construction phase will be entered into bidding documents and civil works contracts. The EMP also includes applicable policies, environmental standards, monitoring plan, institutional arrangement, capacity building and the estimated budget for the mitigation measures and monitoring programs for both construction and operation phases.

87. **Environmental and Social Management Framework:** The project may include small additional investments under Component 1 (e.g. water distribution pipes, pumping stations) which are not known during project preparation. To cover such additional activities, an ESMF has been prepared. The ESMF sets out the guidelines and procedures to screen, assess, and address environmental and social impacts of the proposed activities as well as guidance on their

management and mitigations. The ESMF includes, among others: safeguards policies and guidelines and procedures to address safeguards issues caused by physical activities financed by the project. Each of the proposed investments will be screened to identify/define potential social and environmental impacts; which safeguards policies triggered; which EA category; safeguards' instruments to be prepared; and the related consultation and disclosure requirements.

88. **Public Consultations and Information Disclosure:** In accordance with OP4.01, public consultations have been conducted during the safeguards preparation process, including a questionnaire and meetings with project affected people. The consultation was undertaken in November-December 2016. Feedback and concerns from the consultation have been addressed in the safeguards documents. The safeguards documents (EMP, ESMF, RAP and SA) were locally disclosed on the Government website from February 28 to March 29, 2017; and first disclosed on the World Bank website on March 30, 2017. After appraisal, the updated EMP and ESMF were redisclosed on the World Bank website on July 11, 2017 and the revised RAP was redisclosed on July 31, 2017 while the SA has no update since its initial disclosure on March 30, 2017.

89. **Institutional arrangement:** The LUCRPMC has rich experience with the World Bank financed projects, since 1989. The LUCRPMC has designated one member of staff for the overall environmental management of the project and for the supervision of the safeguards document implementation. LUCRPMC will engage a project management company including experienced environmental specialists to provide LUCRPMC and city-owned utility with technical guidance. All water supply projects will be implemented by the respective city-owned utility. All five localities have experience with the projects financed by the World Bank and have designated staff for environmental safeguards management. Under the supervision of LUCRPMC and the local Environmental Protection Bureaus (EPBs), the city-owned utility will be responsible for implementing the safeguards documents, ensuring that safeguards clauses are integrated into the construction contracts. The city-owned utilities will hire on-site supervision company to monitor the performance and compliance of the safeguards documents during construction. A grievance mechanism has been established at local EPBs and will be established at the city-owned utilities and civil works contractors. During project preparation, the client has engaged experienced environmental and social consultants to prepare safeguards documents. During project implementation, external monitoring consultants will be engaged by the city-owned utilities to monitor and report on the compliance of the safeguards documents. The capacity of the borrower for these efforts is deemed to be satisfactory.

G. Other Safeguards Policy – Dam Safety Policy

90. The project triggers the Safeguards Policy on Safety of Dams (OP4.37), since the project-financed water supply facilities will draw water from reservoirs associated with four existing dams — Dahuofang Dam in Fushun City, Shimen Dam in Gaizhou City, Naodehai Dam in Fuxin City and Tanghe Dam in Liaoyang City. The project does not modify the management of these reservoirs. However, failure of these dams could cause extensive damage, or failure, of the World Bank financed structures. The safety status of the dams including operation and maintenance arrangements were assessed. All of these dams were found to be operationally safe, all had operation and maintenance teams well established, and all dams had operation and maintenance procedures and emergency preparedness plan well prepared. Hence, it was considered sufficient for the Borrower hired independent dam safety expert, instead of Panel of Dam experts, to (a)

inspect and evaluate the safety status of existing dams (including their appurtenance, and performance history); (b) review and evaluate the owners' operation and maintenance procedures; and (c) provide written reports of findings and recommendations for any remedial work or safety-related measures necessary to upgrade the existing dams to an acceptable standard of safety. Dam Safety Review Reports have been submitted to the World Bank and have confirmed the safety of operation of the four dams. Operation and maintenance procedures and emergency preparedness plans have been prepared for the four existing dams. The Borrower will assign special staff to work with the World Bank task team to ensure the project is implemented in line with the OP4.37. During the implementation, the Borrower will prepare an Annual Dam Safety Action Plan and provide relevant dam safety information to the independent dam safety expert and the World Bank and arrange field trips to review the safety status the relevant dams, and take dam safety measures recommended by the dam safety expert and the World Bank to improve the safety status when necessary to ensure the safety of dams.

H. World Bank Grievance Redress

91. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and World Bank Management has been given an opportunity to respond. Information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS) is available at http://www.worldbank.org/GRS. Similarly, information on how to submit complaints to the World Bank Inspection Panel is available at www.inspectionpanel.org.

VII. RESULTS FRAMEWORK AND MONITORING

92. The project Results Framework and performance indicators are illustrated in Annex 1

Annex 1. Results Framework and Monitoring

Project Development Objectives

PDO Statement

The proposed development objectives are to improve water quality and operational efficiency of selected water supply utilities in the project areas.

These results are at	Project Level

Project Development Objective Indicators

Indicator Name	Baseline	Cumulative Target Values					
		YR1	YR2	YR3	YR4	YR5	End Target
Direct project beneficiaries (Number) - (Core)	0	180,000	1,600,000	3,200,000	5,300,000	5,690,600	5,690,600
Female beneficiaries (Percentage - Sub-Type: Supplemental) - (Core)	0	49%	49%	49%	49%	49%	49%
Compliance with water quality Health Standards. (%)	Shenyang:33%	33%	50%	80%	100%	100%	100%
	Fushun:33%	33%	50%	80%	100%	100%	100%
	Anshan:33%	33%	50%	80%	100%	100%	100%
	Fuxin:33%	33%	50%	80%	100%	100%	100%
	Gaizhou:33%	33%	50%	80%	100%	100%	100%
	Weighted Average: 33.04	33%	50%	80%	100%	100%	100%

Non-Revenue-Water in each project city (%)	Shenyang: 33.0	32.2	31.6	31.0	30.4	29.8	29.8
	Fushun: 38.8	33.0	29.0	25.0	23.5	22.1	22.1
	Anshan: 30.9	28.0	27.0	26.0	25.0	24.0	24.0
	Fuxin: 25.7	24.0	22.0	20.0	18.0	16.2	16.2
	Gaizhou: 64.1	58.0	48.4	37.6	35.1	35.1	35.1
Energy consumption by the water utilities in each project city (kWh/m^3)	**Weighted Average: 0.61**	**0.58**	**0.56**	**0.54**	**0.52**	**0.51**	**0.51**
	Shenyang: 0.58	0.54	0.52	0.51	0.49	0.47	0.47
	Fushun: 0.60	0.56	0.53	0.52	0.52	0.51	0.51
	Anshan: 0.46	0.46	0.46	0.45	0.45	0.45	0.45
	Fuxin: 0.96	0.94	0.91	0.87	0.85	0.84	0.84
	Gaizhou: 1.11	0.93	0.75	0.61	0.58	0.36	0.36

Intermediate Results Indicators

		Cumulative Target Values					
Indicator Name	Baseline	YR1	YR2	YR3	YR4	YR5	End Target
Working Ratio (Ratio)	Shenyang:0.85	0.85	0.85	0.85	0.80	0.80	0.80
	Fushun:0.95	0.90	0.90	0.90	0.85	0.85	0.85
	Anshan:1.02	1.00	0.95	0.95	0.90	0.90	0.90
	Fuxin:0.88	0.90	0.90	0.90	0.85	0.85	0.85
	Gaizhou:1.30	1.30	1.20	1.10	1.00	0.95	0.95
Customer satisfaction with the quality of water supply services (%)	65%	--	--	70%	--	75%	75%

Percentage of women satisfied with the quality of water supply services (Percentage - Sub-Type: Supplemental)	65			70		75	75
Length of new or rehabilitated main pipelines for water supply (kilometers)	0	50	140	220	290	300	300
Number of secondary booster pumps installed or rehabilitated (Number)	0	110	170	240	270	270	270
Number of district water meters installed (Number)	0	35	470	600	850	945	945
Number of water meters installed (Number)	0	17,000	60,000	80,000	100,000	115,000	115,000
Number of cities that have hydraulic network models with 24 hours' simulation capability (Number)	0	0	1	2	3	3	3
Number of cities that have computerized Asset Management systems.	0	0	0	2	2	5	5
Number of water utility	0	130	307	510	664	754	754

staff received training on asset management systems, water quality monitoring, and pipe leakage detection and repairing (Number)							
Number of Female staff (number - Sub-Type: Supplemental)	0	50	110	180	245	300	300
Grievances responded and/or resolved within the stipulated service standards for response times (%)	99%	99%	99%	99%	99%	100%	100%
Number of implementation ready PPP transactions prepared under the project	0	0	0	1	1	2	2

Indicator Description

Project Development Objective Indicators

Indicator Name	Description (indicator definition etc.)	Frequency	Data Source / Methodology	Responsibility for Data Collection
Direct project beneficiaries	Direct beneficiaries are people or groups who directly derive benefits from an intervention.	2 times a year	Semi-annual project progress report	PMO/ PIU

Female beneficiaries	Percentage of the direct project beneficiaries who are female. This indicator is calculated as a percentage of total population	2 times a year	Semi-annual project progress report	PMO/ PIU
Compliance with water quality Health Standards. (%).	Percentage of water samples that meet the health-related water quality standards requirement from the total number of samples. Total number of samples shall be determined by the prevailing regulatory requirements to monitor the water quality health standards parameters. As per the new standards, total number of water quality parameters increased to 106. However, the water companies are still in transition and are monitoring 35 parameters only as per the superseded standard and hence the base line value of compliance is around 33%. At any point of time, the compliance will be measured against the prevailing standard and not measured parameters will be treated as failing samples. Compliance is fully met (100%) when 98% of water quality test samples meet the standards, and failing samples should pass within 24 hours from the failing date.	2 times a year	Semi-annual project progress report	PMO/ PIU (Data collection from local Centre of Disease Control (CDC) in each province under the Ministry of Health (MOH) is responsible to conduct the mandatory water quality compliance test twice a year)
Non-Revenue-Water in each project city (%)	Average non-revenue-water including both physical (leakages) and commercial losses in supply area of each water company and calculated as: NRW= (1-Quantity Sold/Quantity Produced). "Weighted average" is the average of five water companies NRW, weighted with their sold volumes.	2 times a year	Semi-annual project progress report	PMO/ PIU

Energy consumption average of 5 water companies (kWh/m^3)	Average energy consumption per m^3 of water sold (billed) of each water company. Energy consumption accounts for all energy consumed in the treatment, transmission, and distribution. "Weighted average" is the average of five water companies, weighted with their sold volumes.	2 times a year	Semi-annual project progress report	PMO/ PIU

Intermediate Results Indicators

Indicator Name	Description (indicator definition etc.)	Frequency	Data Source / Methodology	Responsibility for Data Collection
Working Ratio	Ratio of all operating costs (excluding taxes, interests, depreciation and debt service) divided by the total revenues including water charges and fees, subsidies, revenues from other services.	2 times a year	Semi-annual project progress report	PMO/ PIU
Customer satisfaction with the quality of water supply services (%)	Percentage of survey responses "satisfied" or above for the cumulative total responses in a customer survey, carried out by each water supply company for the customers directly benefiting from the project. The survey will cover five key themes: turbidity, water pressure, safety, service continuity, and customer service of the water company. These key themes will be considered in measuring the level of satisfaction. The surveyed samples from each city will be proportionate to the number of direct beneficiaries, disaggregated by male and female respondents.	3 surveys for each participating water company, first at the end of the first year, second at midterm review and the third is at the project closing	Surveys	PMO/PIU

Percentage of women satisfied with the quality of water supply services (Percentage - Sub-Type: Supplemental)	Percentage of women who respond “satisfied” or above in the cumulative total responses in the customer survey, carried out by each water supply company. It also indicates that they receive project information through consultations and participate in the improvement of the services	1 time in 2 years	Semi-annual project progress report	PMO/PIU
Length of new or rehabilitated main pipelines for water supply (kilometers)	Total length of new or rehabilitated pipelines (diameters bigger than 200 mm) for water supply in each project city.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of secondary booster pumps installed or rehabilitated (Number)	Number of secondary booster pumps installed or rehabilitated in each city.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of district water meters installed (Number)	Number of district water meters installed in each city.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of water meters installed (Number)	Number of water meters installed in each city under the project.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of cities that have hydraulic network models with 24 hours’ simulation capability (Number)	Number of project cities that establish hydraulic network models based on GIS with 24 hours’ simulation capability. This target will be three, including: Shenyang, Anshan and Fushun.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of cities that have computerized Asset Management systems.	Number of project cities that constructed remote monitoring and control system for pressure detectors, pumping stations.	2 times a year	Semi-annual project progress report	PMO/ PIU

Number of water utility staff received training on asset management systems, water quality monitoring, and pipe leakage detection and repairing (Number)	Number of staff in the five project water utilities that received training on asset management systems, water quality monitoring, and pipe leakage detection and repair under the project.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of Female staff (number - Sub-Type: Supplemental)	Number of female staff who receive training under the project.	2 times a year	Semi-annual project progress report	PMO/ PIU
Grievances responded and/or resolved within the stipulated service standards for response times (%)	Percentage of grievances that are responded to, and/or resolved within the stipulated service standard time at customer center of each water company.	2 times a year	Semi-annual project progress report	PMO/ PIU
Number of implementation ready PPP transactions prepared under the project (Number)	Number of PPP arrangements prepared under the project.	2 times a year	Semi-annual project progress report	PMO/ PIU

Annex 2. Detailed Project Description

1. **The project activities will achieve the PDOs- to improve the water quality and operational efficiency of the selected water supply utilities in the Project areas.** A comprehensive and innovative approach will be taken to improve the distribution system performance, and the operational and management efficiency of the water companies in the project cities. The project will introduce use of latest approaches and technologies in water supply network replacement and rehabilitation (such as use of selected pipe materials, latest meters and more efficient pumps and accessories) to reduce NRW and energy use, accompanied with state-of-the art SCADA system and other telemetry and platforms to promote online real-time monitoring and decision-making capability. Hence distribution system, equipment and facilities will be readily equipped and compatible with components for telemetry and online data handling purposes, and capable to conduct network performance analysis to monitor pipe bursts in critical sections 24/7 for active leakage control. The project activities will also enhance the operational and management efficiency of water companies by improving their institutional capacity to use innovative tools for monitoring and decision making, as well as by introducing incentive mechanisms to encourage good utility performance. The project will ensure active citizen engagement through the use of the available social media to report on public complaints as well as reporting problems related to failure of service or pipe bursts. The project activities will directly contribute towards climate change adaptation and mitigation (climate co-benefits) through more efficient use of water resources, energy efficiency, and reduction of GHG emissions. These can be achieved through financing replacement and rehabilitation of water pipes, booster pumps and pump stations, leak detecting equipment, development and installation of SCADA systems and water systems analysis platforms, water meters, water quality testing equipment, and capacity building. Both of these parallel investments are dedicated to NRW reduction and energy efficiency. This will raise the financial leverage of the IBRD finance to 60% (US$372.89 million total counterpart fund to US$250.00 million IBRD). The project consists of the following three components[16].

Component 1: Water supply service infrastructure improvement (Cost US$287.14 million, of which IBRD Loan is US$185.06 million)

2. The objective of this component is to support infrastructure investments required to improve water supply services, reduce NRW, and increase energy efficiency. It will focus on civil works construction and rehabilitation that will improve the quality of water supply and efficiency of water distribution. These investments include: (i) water treatment plant upgrading and rehabilitation; (ii) water service reservoir/tank construction and rehabilitation; (iii) pump station construction, replacement, repair, and rehabilitation (including the installation of new pumps, motors, and electrical panels); (iv) pipe construction, replacement, repair, and rehabilitation; (v) control valve construction, replacement, repair, and rehabilitation; (vi) meter construction and replacement for district, bulk, and commercial customers; (vii) household customer meter construction and replacement; and (viii) service connection construction and replacement.

[16] Note that the cost breakdowns presented in this section exclude the front-end fee of US$0.625 million, and the estimated interest during construction and commitment fees of US$24.50 million. Accounting for these costs together with the costs of the three components will bring the project cost to US$386.29 million.

3. The project will pioneer the use of durable pipelines in Liaoning, with longer life and higher corrosion resistance that will be appropriate to the local conditions (use of pre-stressed concrete pipe, sand inclusion glass fiber reinforced plastic pipe, three-stage pre-stressed pipe, and UPVC pipe materials are planned). In addition, all active and passive monitored equipment and facilities will be made ready for telemetry and/or online monitoring and control in order to be compatible with the management information systems (MIS), Supervisory Control and Data Acquisition Systems (SCADA), and other telemetry systems. The proposed activities will build more resilient utilities by reducing leakage rates, and therefore ultimately reducing raw water abstraction. In addition, the pumps to be installed under this component (including motors and electrical panels) will be high-efficiency, variable speed pumps. Replacement and repair of pipes will reduce water leakage as well as energy consumption. Detailed description of activities in each city is as follows.

(i) Shenyang

4. This sub-component finances the following: construction and replacement of secondary pipes; construction, replacement, and rehabilitation of control valves; installation of bulk meters; and construction and expansion of tertiary networks in older urban zones. Approximately 16 km of pipe will be replaced, about 34 bulk meters will be installed, 35 district valves will be upgraded, and seven new valves installed. Tertiary network in the older urban zones will be replaced and expanded. This will include about 115 km of pipe, and rehabilitation of about 107 valves.

(ii) Anshan

5. This sub-component will finance the following: rehabilitation of the Wangjiayu Water Treatment Plant; construction, replacement, and rehabilitation of secondary pump stations; construction and replacement of pipes; replacement and rehabilitation of valves; replacement of water meters; and replacement of household service connection and yard pipe networks.

6. The Wangjiayu Water Treatment Plant is the largest water treatment plant in Anshan, supplying more than 70% of the city's total water. The plant was put into operation in 1993, with an initial capacity of 200,000 m^3/day, and was upgraded in 2010 to reach a design capacity of 350,000 m^3/day. The plant is not able to meet required treatment standards. The raw water from the Tanghe reservoir has increasing levels of organic matter and algae due to the eutrophication of the reservoir. The project will finance the upgrading of the raw water pump station at Tanghe Reservoir; rehabilitation of the water treatment plant (including replacement of the mixers, flocculation chambers, and disinfection system; as well as rehabilitation of pumps (including motors and electrical panels), pipes, backwash recycling and reclamation systems, screens, ventilation systems and instrumentation).

7. Out of the total of 406 secondary pump stations in the network, 80 pump stations will be rehabilitated. These pumps serve a population of around 200,000 people. The pumps are older than 10 years and need replacement. Network rehabilitation will include the replacement of about 40 km of pipes, replacement and rehabilitation of control valves, replacement of around 84,000 old water meters, and replacement of about 29,000 household service connection pipes to buildings without property management.

(iii) Fushun

8. This sub-component will finance the following: rehabilitation and upgrade of pump stations; construction, replacement, and rehabilitation of secondary pipes; construction and

replacement of house service connections; construction of district meters; construction of pressure and flow control valves; and construction of commercial and industrial meters.

9. The project will focus on replacement and rehabilitation of 58 km of the older sections of the distribution network, 653 km of tertiary and service connection pipes, and replacement of about 336,000 household service connection pipes to buildings without property management. About 70 pump stations will be upgraded, repaired, and rehabilitated; and 76 district meters, 15 pressure control valves, and about 2,080 commercial and industrial meters will be installed.

(iv) Fuxin

10. This sub-component will finance the following: rehabilitation of the Naodehai Water Treatment Plant; construction replacement and rehabilitation of secondary pump stations; construction and rehabilitation of distribution network; and construction and replacement of secondary and tertiary water supply pipes.

11. Naodehai water treatment plant is a surface water treatment plant located to the east of Fuxin City. It was designed to treat and supply 100,000 m^3/day, but is only able to currently operate at a maximum supply of 70,000 m^3/day. The plant was built in the early 1990s. Equipment has reached the end of its useful life, the building structure is falling into disrepair, and the treatment technology is outdated. Rehabilitation of Naodehai water treatment plant will include: the reinforcement of building structures; renovation of the heating system, power supply system, and instrumentation control system; and equipment upgrading for clarifiers, dosing, filtration, and chlorination.

12. The sub-component will also include construction of about 36 km of new network and rehabilitation of 22 km of the existing network, and replacement of about 41,000 household service connection pipes to buildings without property management. Two new secondary pumping stations (with capacities of 15,000 m^3/d and 10,000 m^3/d, respectively) will be constructed, and 58 km of residential tertiary water supply pipeline in residential areas will be replaced.

(v) Gaizhou

13. This sub-component will finance the following: construction and rehabilitation of secondary pump stations; construction and replacement of pipes (including a transmission main for bulk water supply from Yingkou to support the switching of water sources from groundwater to surface water to meet with the above stringent order issued by the Provincial Government in 2016 [17]); replacement and rehabilitation of control valves; replacement of water meters; construction and rehabilitation of water service reservoir/tank; as well as household service connections and tertiary pipe networks.

14. The distribution system rehabilitation will focus on the older parts of the city that are not managed by property management companies. It will include 49 km of residential water distribution network, 17 residential secondary booster pump modification, and replacement of about 345 km of tertiary and service connection piping. The project will also support rehabilitation of about 32,000 customer meters and associated connection pipes which will help to improve the

[17] In the event the utilities failed to switch to surface water supply by 2020, the new provincial regulation requires that consumer tariffs be increased 1.5 times and this penalty be paid to the local government

service to about 25% of urban population suffering from low pressure due to high NRW and poor maintenance, and 147 district meters, as well as construction/ rehabilitation of two tanks (3,000 m^3 and 5,000 m^3). Table A2.1 summarizes planned outputs from each city under this component.

Table A2.1: Planned Investments for Each City under Component 1

Type	Shenyang	Anshan	Fushun	Fuxin	Gaizhou	Total
Distribution network (km)	125.8 (new, 53.55km DN300-1000; replacement 72.25km DN200-1200)	40 (replacement DN300-1200)	58 (DN200-900)	50 (New 30, DN100-1200; + 20 replacement)	12 (new, DN1000 - transmission main)	285.8
Tertiary and service connection replacement	111,558	29,266	336,015	41,392	32,050	550,281
Main pump stations	0	1 (raw water PS - electrical system rehab)	0	2	0	3
Secondary booster pump stations (rehabilitation)	99	80	70	9	14	272
District meters	34	138	622	0	147	941
Pressure control valves	149	0	36	0	0	185
Commercial and industrial meters	0	257	2,080	0	0	2,337
Intelligent water meters (HH)	0	83,766	0	0	32,000	115,766
Rehabilitation of water treatment plants (WTP) (m^3/d)	0	350,000 (Phase I - 150,000, Phase II - 200,000)	0	70,000	0	420,000

Component 2: Water supply service management improvement (Cost US$57.08 million, of which IBRD Loan is US$48.63 million)

15. The objective of this component is to enhance water supply service management through NRW reduction, water quality monitoring, energy savings, and effective asset management. Activities to be financed under this component are categorized as: technical assistance to prepare plans and data collection; purchase of necessary software, computer programs, and user licenses; procurement and installation of info-system hardware (including computers and other networking and telemetry equipment). Specific activities will include: (i) mapping and modeling of all water distribution systems in selected cities, using GIS and hydraulic modelling software; (ii) development and implementation of comprehensive NRW reduction plans, focused on reducing technical and commercial losses, and including the development of on-line monitoring and analysis systems for pipeline operation and leakage control, as well as procurement of leak detection equipment and related monitoring and measuring instruments; (iii) development of comprehensive energy management plans; (iv) development and upgrading of computerized water supply management systems, including MIS and SCADA systems; (v) enhancement of water quality monitoring schemes for all water treatment plants, as well as monitoring of the distribution

network and other system facilities, vi) upgrading of sampling and testing capacity of water testing laboratories; (vii) preparation of Financial Improvement Plans; and (viii) building the capacity of Project Companies in developing and managing Public-Private Partnership (PPP) arrangements.

16. Hydraulic analysis of the water distribution system using GIS-based hydraulic modelling software, in addition to MIS and SCADA systems, will help to identify system design improvements, and maximize energy savings by optimizing the water distribution network system. The computerized water supply management systems will help the implementation of NRW reduction plans through active leakage control measures – which will be carried out during and after the project by the WSCs, as routine operations to strengthen their capacity in NRW reduction.

17. This component will also finance activities to strengthen water quality testing capacity. Water testing laboratories will be upgraded with state-of-the-art analytical laboratory equipment consistent with new regulatory requirements for monitoring an increased number of water quality parameters (i.e. from 35 parameters to 106, as required by the Drinking Water Standards).

18. Participating water companies will prepare a rolling, five-year financial improvement plan (FIP) outlining improved financial performance through a combination of improved collection efficiency, reduced operating costs, and adjusted tariffs. Additionally, the water companies will prepare yearly performance reports (Utility Performance Reports) containing key operational and financial performance data for all water and wastewater facilities.

19. Finally, in order to promote additional water management efficiency mechanisms, this component will support building staff capacity in the water utilities to make and manage Public-Private Partnership (PPP) arrangements. This will involve preparation of draft tender documents and contract(s) for some feasible PPP arrangements (e.g. like performance based contracts, etc.).

20. These activities are applicable to all of the five project cities, with some tailored specifications particular to individual cities – as related to the level of complexity and comprehensiveness of the SCADA systems to be installed, and specific requirements for the water quality monitoring.

(i) Shenyang

21. This sub-component will finance a SCADA system to enable online monitoring and control of water treatment plants, pump stations, and secondary booster pump stations. This will provide real-time data acquisition on all major aspects of the water supply system, including: raw water quality, supplied water quality, treatment processes, and distribution system. This sub-component will also finance the integration and further development of existing information systems, including the GIS-based hydraulic model, pressure monitoring and management system, district metering system, as well as customer information and billing systems. Data will be used to drive decisions and optimize water supply processes, which will result in the reduction of per-unit production costs, as well as in the improvement of system reliability by reducing the probability of failures. Main dispatch and control centers will also be developed and equipped.

(ii) Anshan

22. This sub-component will finance a SCADA system to enable real time online monitoring of water quality for all water treatment plants, pump stations and flow meters. It will also finance the integration and further development of existing information systems, including the GIS based

hydraulic model, pressure monitoring and management system, district metering system and customer information. In addition, it will finance software and security updates, construction of a data center, development of a laboratory information system and purchase of equipment.

(iii) Fushun

23. This sub-component will finance the establishment of a SCADA system that will cover the monitoring of water quality at the water treatment plant intakes, within the water treatment plant, and at selected monitoring points along the water distributing system. Some of the comprehensive set of parameters[18], to the extent it is practical, will be covered by online monitoring, while others will require laboratory analysis. Online monitoring will also cover monitoring and control of the water treatment process, district and bulk meters, pumps, and other automated elements of the distribution system. A common monitoring and dispatch center will be established and equipped.

(iv) Fuxin

24. This sub-component will finance a SCADA system for: (i) automatic control and video monitoring of the Naodehai Water Treatment Plant and the two new pump stations; (ii) monitoring and telemetry systems for 194 existing secondary pump stations; (iii) monitoring of pressure at selected points (around 50 points) throughout the network; (iv) establishing around 30 online water quality monitoring points at various points in the network; and (v) online quality monitoring at the water source that is connected to early warning system to handle possible contamination resulting from organic matter, algae, biological toxicity and other parameters. In addition, it will finance water quality testing equipment to increase testing capability from 35 to 106 parameters.

(v) Gaizhou:

25. This sub-component will finance the development of a simplified SCADA system that will include the development of a central control and dispatch center and a management information system to support the operation of the water treatment plant and pumping stations.

Component 3: Project implementation support and institutional strengthening (Cost US$16.94 million, of which IBRD Loan is US$15.69 million)

26. This component will provide support for consultancy services in institutional capacity building for the water supply companies (in the participating cities), and project implementation support as well as incremental operating costs of the PPMO. The institutional strengthening will emphasize water company reforms in terms of organizational arrangements to achieve the project objectives (especially for leakage control and SCADA system management).

27. Support for activities will include training and study tours (domestic and international); and capacity building of water company staff, particularly in: (i) utility management (which entails water company management, financial management, commercialization and PPP modalities, customer service and public engagement, improved accountability, and an expansion of water company benchmarking to enhance performance competition between public utilities); (ii) operation and management of SCADA systems, including GIS mapping, hydraulic modeling, and asset management; (iii) water quality sampling and testing; (iv) operation and management of

[18] This will cover the 106 parameters which include: water temperature, pH, turbidity, conductivity, dissolved oxygen, permanganate index, total organic carbon, total nitrogen, total phosphorus, ammonia nitrogen, chlorophyll a, biological toxicity, alkalinity, volatile organics.

water treatment plants and secondary pump stations; (v) leakage detection, and NRW and energy management; and (vi) project management.

28. Project implementation support will include activities such as: (i) office equipment; (ii) domestic and international training for the provincial project management office (PPMO) and project implementation units (PIUs); (iii) project management consultants for design reviews and construction supervision; (iv) external monitoring of implementation and adherence to environmental and social safeguards; and (v) organization of conferences, workshops and meetings to enable knowledge sharing, dissemination of study results and peer to peer learning among the participating water companies, as well as other interested water companies.

29. **The project will contribute to climate change adaptation and mitigation through water and energy savings.** Climate change risks affect the quality and quantity of available water resources in Liaoning. The proposed civil works and TAs under components 1, 2 and 3 (with an estimated loan amount of US$250.00 million) will improve water distribution efficiency, optimize operations, enhance asset management capabilities, and control water demand. These activities ultimately contribute to more efficient use of water resources and building more resilient water supply utilities against the future climate change risks and vulnerabilities. These can be achieved through financing replacement and rehabilitation of water pipes, booster pumps and pump stations, leak detecting equipment and capacity building, development and installation of SCADA systems and water systems analysis platforms, water meters, water quality testing equipment, and capacity building. Similarly, the project will also improve energy efficiency at the utility-scale, through efficient energy use and energy loss reduction by rehabilitating water supply and distribution pipe networks and making replacements for more energy efficient pumps. Energy efficiency will also be improved through institutional strengthening, training, and investigations that build more capacities among the participating utilities for energy efficient operations. Detailed designs under the project will be reliable and robust to withstand the expected extreme events, such as high temperature, cyclones, droughts, and floods that Liaoning may face from potential climate change in the region. Table A2.2 summarizes values from each of the participating cities for the following: water sold, current and target energy consumption per cubic meter, current and target NRW, and energy savings as a result of NRW reduction. The project has the potential to save around 105.6 million cubic meters of water per year (of which 66.76 million cubic meters per year are a direct result of the project finance) [19], 77.9 GW.hr/year of electricity, and reduce 74.0 million kg/year of CO_2 emission by 2022 (assuming 0.95 kg of CO_2/kW.hr of electricity[20]).

[19] The project activities do not include any capacity expansion of the water systems. The increased volume of water supplied to consumers will be generated from leakage reduction, and not from new production capacity.

[20] Moti L. Mittal, et al, "Estimates of Emissions from Coal Fired Thermal Power Plants in India", Department of Environmental and Occupational Health, University of South Florida, Tampa, Florida, USA, https://www3.epa.gov/ttnchie1/conference/ei20/session5/mmittal.pdf

Table A2.2: Water and Energy Savings based on Improvement Targets

Water Company	Water Sold (million m^3/year)	Water Consumed (million m^3/year)	Energy Consumption (kWh/m^3 sold)		Leakage (%)		NRW (%)		Energy Savings due to NRW and Energy Management (GW.hr/year)	Physical Water savings from Leak reduction (million m^3/year)	Reduction in CO_2 emissions (million kg/year)
			Current	Target	Current	Target	Current	Target			
Shenyang	442.53	486.12	0.582	0.467	26.40%	24.1%	33.00%	29.80%	50.85	20.01	48.30
Fushun	92.44	107.08	0.604	0.513	29.11%	13.99%	38.80%	22.10%	8.41	26.55	7.99
Anshan	113.87	125.74	0.462	0.450	23.70%	19.20%	30.90%	24.00%	1.37	9.18	1.30
Fuxin	78.57	84.34	0.960	0.835	20.24%	13.13%	25.70%	16.20%	9.82	8.66	9.33
Gaizhou	9.78	20.14	1.113	0.355	26.10%	19.10%	64.10%	35.10%	7.41	2.36	7.04
Total	**737.19**	**823.41**							**77.86**	**66.76**	**73.96**

1. The water saving efforts in Shenyang will have the potential to reach 58.86 million m^3/year from the parallel, self-financed project that will bring leakage reduction further down to 19.2%. Hence, the total annual water savings from this project and other Shenyang investments will be 105.60 million m^3/year.

2. Physical water savings are calculated assuming the same quantity of actual water demand. For instance, in Shenyang, the actual demand will be 486.12 million m^3/year, but because of the current non-revenue water rate of 26.4%, the water supplied must be 660.49 million m^3/year. Based on the planned leakage reduction under the project (i.e. from 26.4% to 24.1%), the required water production will drop from 660.49 million m^3/year to 640.47 million m^3/year. Hence, leakage (physical loss) will drop from 174.37 million m^3/year to 154.35 m^3/year and the physical water savings will be 20.01 million m^3/year. In addition, the water quantity sold will increase by 7.09 million m^3/year.

3. Per the order issued by the Liaoning Provincial Government (LPG) in 2016 (para. 3), Gaizhou needs to switch their water sources away from ground water by 2020 or they need to pay a penalty 1.5 times the raw water fee to the local government. Consumers are also instructed to switch to city water under the same order by the LPG issued in 2016 (para 3), if not they need to pay 1.5 time of city consumer water tariff by order to the local government.

4. 22% out of the total 29% NRW reduction in Gaizhou will be the result of the provision or replacement of the water meters, which is the first priority for the water companies; as well as improved accounting of supplies made to currently non-billed government and public users. The remaining NRW reduction is only 7%, and within the normal range.

30. Anshan, Fushun, and Shenyang WSCs were all established over a hundred years ago. Their facilities were constructed or installed decades ago, especially within the old city districts which are typically the most populated areas. These three WSCs are also slowly merging with adjacent WSCs which originally were independent. Fuxin WSC was established in the late 1950's, and was originally responsible for serving urban areas of the city, and certain industries. Though industrial reform has caused industrial water demand to drop since 2013 for Fuxin WSC, residential water usage increased due to service area expansion. Gaizhou WSC was the latest to be established among the five participating companies, yet its facility conditions are comparatively worse – with the highest levels of non-revenue water (NRW). Its service area has been expanding due to urban development, yet aging infrastructure, operational efficiencies, and managerial efficiency are far behind proper performance requirements.

31. Pipeline water loss is a major measure of utility performance. Gaizhou WSC has the highest rate of NRW among the five WSCs, but the smallest water supply system, mainly due to insufficient attention and support from the city to deal with its malfunctioning and aging water supply system. Even though Shenyang is not the worse NRW performer among the project cities, it has the highest volume of losses ($0.5m^3$/day) due to its high average supply volume (1.6m m^3/day). Fuxin WSC is doing well on its NRW control as compared to other WSCs, yet its overall performance is still below the requirement set by the National Standard. Both Anshan and Fushun WSCs have tried reducing NRW via leak detection plans, yet achievements were limited, and both have decided to rehabilitate/replace secondary and tertiary pipes to reduce NRW to acceptable levels. Variable pressure settings define the available head within the water distribution systems; and among the project cities, Fushun provides the highest pressure, and Fuxin is the lowest. These pressure settings govern the distribution pumping scenarios, and ultimately have significant effect on power consumption. The pressure settings for distribution systems vary from one WSC to another, owing to the nature of the water supply system that was originally designed, especially for different topographic conditions, as well as different service coverage and locations of major users with respect to the water source for each WSC. Hence, the secondary booster pump stations (BPSs) have become important for the operations of the WSCs, particularly for those with low pressure settings, e.g. Shenyang, Fuxin and Gaizhou.

32. When compared to other WSCs in China, the average power consumption per unit water produced in Shenyang and Fuxin is relatively high (ranging from 0.56 to 0.69 kWh/m^3). These high levels of power consumption are due to high pumping energy consumption at the raw water intake. Fuxin WSC is planning to obtain raw water from a less energy-intensive source through a large parallel water diversion project of the Province. On the other hand, about 50% of the total raw water source for Shenyang WSC is currently provided from two private WSCs. The NRW leakage reduction activities under this project will reduce the dependence on energy-intensive groundwater sourcing. Shenyang WSC expects to further cut down energy consumption in its water production by phasing out its dependence on groundwater, in line with Provincial legislations. This will be done through another parallel project of the City, currently planned for the short- and medium-term in line with the City's Water Supply Master Plan (2016-2020). For the remaining three WSCs, Fushun, Anshan, and Gaizhou, energy consumption will be further lowered as a result of effective leak reduction and the reduction of power consumption for all pumping stations.

Annex 3. Project Cost

a. Project Cost by Component

Project Component	Cost including Contingencies (US$ million)	Counterpart Financing (US$ million)	IBRD Financing (US$ million)	% IBRD
1. Water supply service infrastructure improvement				
i. Shenyang Water Supply Group	92.80	34.05	58.75	63%
ii. Anshan Water Supply Co.	50.32	17.49	32.83	65%
iii. Fushun Water Supply Co.	85.19	31.37	53.83	63%
iv. Fuxin Water Supply Co.	29.54	9.98	19.56	66%
v. Gaizhou Water Supply Co.	29.29	9.20	20.09	69%
Subtotal Water supply service infrastructure improvement	**287.14**	**102.09**	**185.06**	**64%**
2. Water supply service management improvement				
i. Shenyang Water Supply Group	23.11	2.96	20.14	87%
ii. Anshan Water Supply Co.	8.67	1.54	7.13	82%
iii. Fushun Water Supply Co.	9.97	2.02	7.95	80%
iv. Fuxin Water Supply Co.	10.14	1.20	8.94	88%
v. Gaizhou Water Supply Co.	5.19	0.73	4.46	86%
Subtotal Water supply service Management improvement	**57.08**	**8.45**	**48.63**	**85%**
3. Project Implementation Support and Institutional Strengthening				
i. Shenyang Water Supply Group	10.67	0.79	9.88	93%
ii. Anshan Water Supply Co.	1.02	0.08	0.94	93%
iii. Fushun Water Supply Co.	1.15	0.09	1.06	93%
iv. Fuxin Water Supply Co.	1.54	0.11	1.42	93%
v. Gaizhou Water Supply Co.	2.57	0.19	2.38	93%
Subtotal Project Implementation Support and Institutional Strengthening and Capacity Building	**16.94**	**1.25**	**15.69**	**93%**
Total Project Investment Cost	**361.16**	**111.79**	**249.375**	**69%**
Front-End fee	0.625	-	0.625	100%
Financial Charges During Implementation (interest during construction and commitment fees)	24.50	24.50	0.00	0%
Total Cost to be Financed	**386.29**	**136.29**	**250.00**	**65%**

b. Project Cost by Water Company

Beneficiary	Total Budget (1) (RMB million)	Total Budget (US$ million)	Fund source (US$ million)	
			Counter-part	World Bank
Shenyang Water Supply Group	949.72	137.64	48.64	89.00
Anshan Water Supply Co.	437.60	63.42	22.42	41.00
Fushun Water Supply Co.	690.47	100.07	37.07	63.00
Fuxin Water Supply Co.	309.34	44.83	14.83	30.00
Gaizhou Water Supply Co.	278.27	40.33	13.33	27.00
Total	**2,665.40**	**386.29**	**136.29**	**250.00**

(1) Note that the total budget includes contingencies (RMB184.59 million), the interest during construction and commitment fees (RMB169.06 million) and front fee (CYN4.31 million)

Annex 4. Financial and Economic Analyses

I. Financial Analysis

1. A Financial Analysis was conducted to: (i) identify the optimal debt allocation and repayment strategy, taking into account that the water companies are differently positioned from a technical and financial perspective; (ii) document that the current tariff level and proposed government support is sufficient to make the project financially viable; and (iii) confirm that the proposed counterpart funding is affordable to local governments.

Institutional and Financial Background and Objectives

2. *Financial Status of Project Companies*. Currently, only Fuxin Water Supply Company (WSC) is profit making (with income contribution from its sizable non-core business e.g., piping construction). Although the other four WSCs are not profitable, all except Gaizhou WSC are able to cover their operating costs i.e., have working ratio at or below 1.0. Gaizhou WSCs receives financial support from the local government to meet its operating expenses.

3. *Financial Objectives*. The project's financial objective is to improve the companies' financial performance by increasing unit sales revenue and simultaneously reducing the unit operational cost base through targeted rehabilitation efforts. Improving the technical capacity of the companies has the aim of providing a basis for improved management of ongoing maintenance and rehabilitation investments in the future. It is envisaged that the working ratio of all WSCs will be continuously improved to increase operational cost coverage capabilities (including for Gaizhou WSC which is expected to not require operating cost support by the end of the project). Without the project, and given current levels of leakage, the companies will be facing increased costs of repairs and maintenance (just to maintain the current level of production). In addition, for Gaizhou, the project is implementing infrastructure to facilitate supply from a new water source as the city is facing total production losses due to impending closure of its current main source of ground water for environmental reasons.

a. Financial Analysis of Project Companies

4. *Financial Projections and Assumptions*: To document the water supply companies' ability to afford the investments, financial projections were prepared. The projections are based on the following main assumptions: Year 2016 financial status as baseline and Year 2017 as the first year of projection; inflation at nominal terms assumed at 3% per annum; increase in all other costs (other than labor) in line with inflation and labor costs increase at 5% per annum, in real terms; tariff revisions every five years to cover inflation; reduction of NRW and energy consumption as presented/proposed under this project; increase in demand over the coming years, which is partly seen as an increase in per capita consumptions.

5. *Financial Projection Results.* Overall, the financial projections indicate that all the companies are expected to improve their working ratios and generate sufficient cashflow to service the financing obligations related to their subprojects. However, with the current assumptions of tariff revisions only sufficient to keep up to inflation, none of the companies are projected to be profitable in net profit terms. As such, the companies and their local government shareholders will benefit from carefully planning future tariff revisions. A larger tariff increase progression will increase profitability and will help reduce or reverse the erosion of shareholders' equity in the long term.

6. *Fuxin Water Supply Company - projections.* The financial projection, Table A4.1, indicates that Fuxin Water Supply Company will be in a financial position to cover the debt service of interest and loan repayments from its cash flow after project implementation. Working ratio is expected to improve from 0.90 currently to 0.85 at the end of the project. The projections however indicate that the company will be operating with net losses after tax in the near future given the modest tariff increase assumption. It is expected that the local government will step in to increase its financial support to the company should this be needed.

Table A4.1: Financial Projection of Fuxin Water Supply Company

	Base years		**Implementation**					**Operation**	
	2015	2016	2017	2018	2019	2020	2021	2022	2023
									Production and sales
Water produced (1000 m^3/day)	81	82	85	85	87	88	86	85	86
Water sales (1000 m^3/day)	61	61	63	65	68	70	71	71	72
Average water tariff (yuan/m^3)	3.23	3.20	3.63	3.61	3.62	3.63	3.64	4.23	4.24
Income Statement (million yuan)									
Water sales revenue	196	195	230	233	246	255	257	300	304
Other revenue	41	35	37	39	41	43	45	47	49
Total Revenue	237	230	266	272	286	297	302	346	353
Water supply expenditures	-199	-195	-234	-244	-256	-265	-273	-286	-303
Other expenditures	-12	-9	-10	-10	-11	-11	-12	-13	-13
Total Expenditures[1]	-211	-204	-244	-254	-267	-277	-285	-299	-316
Operating Income	26	26	22	18	20	20	16	48	37
Cash flow statement (million yuan)									
Cash flow - operation	42	27	17	18	17	19	17	35	37
Cash flow - investing	-29	-28	-24	-80	-81	-60	-40	0	0
Cash flow - financing	-7	-9	23	68	68	48	26	-32	-32
Cash closing balance	14	3	19	25	29	36	39	41	47

[1]Excluding depreciation and financial charges;

7. *Shenyang Water Supply Company - projections.* The financial projection in the table below, Table A4.2, indicates that Shenyang Water Supply Company will be able to cover the debt service of interest and loan repayments from its cash flow after project implementation. Working ratio is expected to improve from 0.85 currently to 0.80 at the end of the project. With the project and given the modest tariff increase assumption, the company will remain producing losses after tax. It is expected that the local government will step in to increase its financial support to the company should this be needed.

Table A4.2: Financial Projection of Shenyang Water Supply Company

	Base years		**Implementation**					**Operation**	
	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production and sales									
Water produced (1000 m^3/day)	664	584	606	611	615	619	625	630	641
Water sales (1000 m^3/day)	443	391	407	414	421	427	435	443	450
Average water tariff (yuan/m^3)	2.07	2.82	2.84	2.84	2.83	2.83	3.28	3.27	3.27
Income Statement (million yuan)									
Water sales revenue	917	1,104	1,157	1,175	1,193	1,209	1,427	1,449	1,471
Other revenue	63	0	0	0	0	0	0	0	0
Total Revenue	980	1,104	1,157	1,175	1,193	1,209	1,427	1,449	1,471
Water supply expenditures	-872	-857	-912	-951	-990	-1,031	-1,077	-1,124	-1,185
Other expenditures	-5	-4	-4	-4	-4	-4	-5	-5	-5
Total Expenditures	-876	-861	-916	-955	-994	-1,035	-1,081	-1,129	-1,190
Operating Income	104	244	241	219	199	175	345	320	281
Cash flow statement (million yuan)									
Cash flow – operation	115	198	237	220	199	175	316	320	282
Cash flow – investing	-550	302	-49	-221	-299	-219	-88	0	0
Cash flow – financing	590	56	-33	137	211	127	-6	-171	-169
Cash closing balance	747	1,304	1,460	1,596	1,707	1,791	2,013	2,162	2,276

8. *Gaizhou Water Supply Company - projections.* The financial projection below, Table A4.3, indicates that Gaizhou Water Supply Company, with the planned extensive financial support from local Government, will be in a position to cover the debt service of interest and loan repayments from its cash flow after project implementation. Working ratio is expected to improve from 1.30 currently to 0.95, enabling the company to meet its operating expenses by the end of the project. With the project, and given the modest tariff increase assumption, the company will remain producing losses after tax. It is expected that the local government will step in to increase its financial support to the company should this be needed.

Table A4.3: Financial Projection of Gaizhou Water Supply Company

	Base years		**Implementation**					**Operation**	
	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production and sales									
Water produced (1000 m^3/day)	14	14	14	13	13	12	12	13	13
Water sales (1000 m^3/day)	5	5	5	5	6	6	6	7	7
Average water tariff (yuan/m^3)	2.34	2.34	2.33	2.33	2.33	2.34	3.18	3.18	3.18
Income Statement (million yuan)									
Water sales revenue	11	11	12	12	13	14	20	23	23
Other revenue	4	2	3	3	3	3	3	3	3
Total Revenue	15	14	15	15	16	17	24	37	37
Water supply expenditures	-18	-17	-19	-19	-20	-21	-22	-36	-39
Other expenditures	0	0	0	0	0	0	0	0	0
Total Expenditures	-19	-18	-19	-20	-21	-21	-22	-36	-40
Operating Income	-3	-4	-4	-5	-4	-4	2	1	-2
Cash flow statement (million yuan)									
Cash flow - operation	0	-4	-7	-4	-5	-5	-1	0	-2
Cash flow - investing	0	0	-7	-53	-111	-44	-41	0	0
Cash flow - financing	0	11	7	57	120	56	54	0	0
Cash closing balance	2	8	1	2	7	14	26	25	23

9. *Fushun Water Supply Company - projections.* The financial projection below, Table A4.4, indicates that Fushun Water Supply Company, with the planned financial support from local Government, will be in a position to cover the debt service of interest and loan repayments from its cash flow after project implementation. Working ratio is expected to improve from 0.90 currently to 0.85. With the project and given the modest tariff increase assumption, the company will remain producing losses after tax. It is expected that the local government will step in to increase its financial support to the company should this be needed.

Table A4.4: Financial Projection of Fushun Water Supply Company

	Base years		**Implementation**					**Operation**	
	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production and sales									
Water produced (1000 m^3/day)	151	147	148	139	132	127	125	124	124
Water sales (1000 m^3/day)	92	90	93	93	94	95	96	96	97
Average water tariff (yuan/m^3)	2.33	2.79	3.03	3.01	3.00	2.97	3.59	3.58	3.57
Income Statement (million yuan)									
Water sales revenue	215	251	282	281	281	283	343	344	345
Other revenue	12	7	7	7	7	7	7	7	7
Total Revenue	227	258	289	288	288	290	350	351	352
Water supply expenditures	-223	-232	-250	-253	-256	-264	-272	-282	-293
Other expenditures	-1	-1	-1	-1	-1	-1	-1	-1	-1
Total Expenditures	-224	-233	-251	-254	-257	-265	-274	-283	-294
Operating Income	3	26	38	34	30	25	76	68	58
Cash flow statement (million yuan)									
Cash flow - operation	140	21	42	34	29	27	74	69	59
Cash flow - investing	0	-3	-69	-135	-143	-144	-175	0	0
Cash flow - financing	-132	-7	69	135	143	144	175	0	0
Cash closing balance	18	30	72	106	136	162	236	305	363

10. *Anshan Water Supply Company - projections.* The financial projection below, Table A4.5, indicates that Anshan Water Supply Company, with the planned financial support from local Government, will be in a position to cover the debt service of interest and loan repayments from its cash flow after project implementation. With the project and given the modest tariff increase assumption, the company will remain producing losses after tax. It is expected that the local government will step in to increase its financial support to the company should this be needed.

Table A4.5: Financial Projection of Anshan Water Supply Company

	Base years		**Implementation**					**Operation**	
	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production and sales									
Water produced (1000 m^3/day)	136	137	139	141	142	145	147	150	154
Water sales (1000 m^3/day)	94	95	99	101	104	107	111	113	116
Average water tariff (yuan/m^3)	2.87	2.86	3.32	3.32	3.32	3.32	3.32	3.86	3.87
Income Statement (million yuan)									
Water sales revenue	271	271	328	336	345	355	369	436	448
Other revenue	31	6	22	21	20	17	20	19	19
Total Revenue	302	277	350	357	365	372	389	477	488
Water supply expenditures	-288	-283	-313	-326	-343	-361	-381	-406	-434
Other expenditures	-1	-1	-1	-1	-1	-1	-1	-1	-1
Total Expenditures	-289	-284	-314	-327	-344	-361	-381	-407	-434
Operating Income	13	-7	36	30	21	11	8	71	54
Balance sheet statement (million yuan)									
Current assets	1,111	911	916	939	909	887	879	924	952
Fixed assets	1,397	1,423	1,380	1,424	1,527	1,524	1,450	1,348	1,233
Other assets	27	27	27	27	27	27	27	27	27
Total assets	2,536	2,361	2,323	2,391	2,464	2,439	2,356	2,299	2,212
Current liabilities	198	160	131	131	132	132	133	133	134
Long term liabilities	1,308	1,198	1,224	1,332	1,459	1,501	1,491	1,466	1,441
Equity	1,029	1,002	969	928	873	806	732	700	637
Total Equity and liabilities	2,536	2,361	2,323	2,391	2,464	2,439	2,356	2,299	2,212
Cash flow statement (million yuan)									
Cash flow - operation	74	-43	7	28	19	8	4	53	51
Cash flow - investing	-104	-50	-34	-121	-180	-74	-5	0	0
Cash flow - financing	0	297	32	114	129	41	-11	-27	-26
Cash closing balance	250	455	461	482	449	424	412	438	462

11. *Financial Internal Rate of Return Analysis*. The FIRR analysis was prepared based on the companies' operations, and by comparing with and without project alternatives, Table A4.6.

12. *With the project,* the companies will rehabilitate their water supply systems, provide technical upgrades, and improve metering of system and supply. The project will result in several direct financial benefits to the project companies: (i) the network rehabilitation and the technical upgrade of pumping stations will reduce leakages as well as reduce costs for repair and maintenance, water resource fees, energy, and chemicals; and (ii) the metering and management program will increase sales revenue by reducing commercial losses. For Gaizhou, the project will add net costs due to change in water source. The additional costs will to some extent be offset by savings from closure of facilities servicing the current water source.

13. *Without the project,* the companies will see increased costs of repair and maintenance, and will be challenged to maintain supply capacity and coverage of water demands in the future. Analysis covering repairs and maintenance over the last three years shows that maintenance efforts related to breakage incidents for selected communities has increased by 3-4% annually, along with the associated increases in costs for repairs. Without the project, Gaizhou is facing a compulsory closure of their main water source, which will thereby reduce their capacity to serve demands for water in the city.

Table A4.6: Cost Savings of Water and Energy in Project Cities – With / Without the Project

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
Water cost savings *(thousand yuan)*									
Fuxin	0	1,592	4,186	7,018	9,878	12,698	14,543	16,513	18,706
Shenyang	901	7,498	15,180	23,600	32,817	42,589	51,457	61,283	72,013
Gaizhou[1]	0	385	510	775	1,002	2,976	3,208	3,889	3,896
Fushun	1,203	4,872	8,468	12,121	14,320	16,714	18,457	20,350	22,458
Anshan	712	1,679	2,749	3,949	5,500	6,579	7,821	9,267	10,708
Energy cost savings *(thousand yuan)*									
Fuxin	468	986	2,664	5,106	6,473	7,600	7,933	8,256	8,614
Shenyang	5,805	11,839	18,077	24,439	31,141	37,977	38,610	39,253	39,828
Gaizhou	0	484	963	1,553	2,264	3,079	3,667	3,890	4,348
Fushun	499	2,769	5,258	5,854	6,203	6,797	7,042	7,299	7,586
Anshan	288	456	562	767	1,001	1,145	1,208	1,283	1,339

[1]Gaizhou will see increased costs of water due to new water source and despite savings in volume of water. The cost presented is the net impact, and also includes a penalty for keeping the water source in the 'without project' scenario

14. Based on the estimated financial costs and benefits, the internal rate of return was calculated for the project, and is shown in Table A4.7 below. The positive financial results overall indicate that the project will have a positive impact on the water companies' financial performance, as compared to the no-project scenario. The FIRR is above the weighted average cost of capital, (i.e. below 3%). Note that while the FIRR for Gaizhou is relatively low compared to the others, there is a technical imperative to finance the new water source and production in Gaizhou, given the impending closure of the current main source due to environmental issues, i.e. prevent the sea water intrusion due to over exploitation of ground water source, and associated ground settlement. The financial analysis assumptions are presented in Table A4.8.

Table A4.7: Financial Internal Rate of Return

Financial Benefits					
(i) Cost savings due to system rehabilitation, leakages reduction, and technical upgrades (energy, raw water, chemicals, repair and maintenance) (ii) Increased sales of water due to reduction of commercial NRW (iii) Incremental supply of water to existing connections					
Financial Internal Rate of Return					
Project City	Shenyang	Anshan	Fuxin	Fushun	Gaizhou
FIRR	17%	18%[1]	20%	9%[1]	4%[1]
Sensitivity[2]	16%	17%[1]	18%	8%[1]	3%[1]

[1] Excluding the government's financial support for the project

[2] Sensitivity case is combination of: project delayed one year; 5% increase in project costs; and 5% decrease in financial benefits

Table A4.8: Financial Analysis Assumptions

The financial analysis was prepared under the following assumptions

General forecast methodology:

- Financial cost benefit analyses were based on the with/without methodology. The methodology estimates the status of each individual company with the project implemented and compares it to the status without the project implemented.
- The forecast of the status includes 25 years starting from 2017, which is the first year of implementation.
- The forecasts were based on actual results from several base years.

Water demand development assumptions:

- The volume of water supplied in the cities of Shenyang, Fuxin, Fushun and Anshan will increase from implementation onwards. Detailed demand forecasts were prepared to identify the water demand year on year.
- The growth in demand derives from existing consumers connected, as well as from future consumers connected. In general, the demand from residential consumers in China sees an increased demand. For the analysis, it was assumed that growth in water demand from existing connected consumers will be 2% p.a. over the first 10 years. The current demand from residential consumers in the four cities is at around 100 litres per capita per day (LCD).
- For Gaizhou specifically, the water demand from residential households is expected to decline, as a result of the improved implemented metering of the consumers. Gaizhou currently has the highest residential consumptions of the project cities, and it is estimated that the current demand of around 140 LCD will fall to below 110 LCD in line with the residential consumption in the other cities.

General assumptions on benefits from implementing the project:

- The project will reduce leakages from the current level, as presented.
- The project will reduce energy consumption, partly from the reduced leakages, and partly from rehabilitated pumping stations and wells. Carbon benefits have been included.

- The volume of water extracted and produced will decline as leakages are reduced. This will result in lower demand for raw water and chemicals for water treatment
- The rehabilitation of infrastructure is overall expected to slightly reduce the cost of repair and maintenance, but the reduction varies across companies.
- The saved water from reducing leakages will benefit the increased demand from existing connected consumers.
- The reduction of commercial NRW will increase revenue to the companies.
- For Gaizhou specifically, the water demand will decline as the cost of water increases with the metering program. Moreover, the current discount on raw water will remain in place until the new piped water source is in operation.

Assumptions on situation without the project:

- Leakages will increase by 1% annually over the next ten years, due to ongoing deterioration of the networks.
- For Gaizhou specifically, the water demand will remain at a high level due to the partial non-metering of the supply. The current discount on raw water will be discontinued; and there will be a fee of 50% on the cost of raw water, as it is assumed that groundwater will be used.

b. *Tariff and Affordability*

15. Low-income households' affordability of the water supply service was analyzed. The analysis shows that utility fees overall are fully affordable to the residents, even under conservative planning assumptions of low growth in disposable incomes. Specifically, the analysis show that combined water and wastewater bill will be at a level of 1% of low-income urban households; and as such, will be fully within the generally accepted level of 5% of income or less for utility fees. The table below, Table A4.9, summarizes the affordability of a four-person, low-income urban household in Anshan.

Table A4.9: Tariff Affordability of Low-Income Urban Household of four members in Anshan

	2015	2016	2017	2018	2019	2020
Water supply tariff (yuan/m^3)	2.50	2.50	2.90	2.90	2.90	2.90
Wastewater tariff (yuan/m^3)	0.60	0.60	0.70	0.70	0.70	0.70
Total tariff (yuan/m^3)	3.10	3.10	3.60	3.60	3.60	3.60
Total fees (yuan/year)	453	453	525	525	525	525
Family low income (yuan/year)	59,886	62,550	66,359	70,401	74,688	79,236
Total fees as % of low income	0.8%	0.7%	0.8%	0.7%	0.7%	0.7%

[1] Family of four members with water consumption each of hundred liters a day

[2] Low income family of four with annual income of 59,886 yuan in 2015 with annually 5% real increase

c. *Fiscal Impact Analysis*

16. In line with the province's overall fiscal growth, the local governments have seen increases in the total fiscal revenue of about 10% annually. Based on information provided by the participating municipalities, a fiscal impact analysis was conducted. The analysis estimates whether the project cities have sufficient resources to support the project through counterpart funding contribution and servicing of the World Bank loan if needed. The analysis indicates that the impact from the project on local government revenue is generally low, with counterpart funding commitments below 3%. Debt service of the World Bank loan will only account for a minor part

of the total revenue – at a level below 2%. Therefore, the financial obligations under the project are assessed to be affordable for all local governments.

II. Economic Analysis

17. Economic analysis was conducted to: (i) determine the most cost-effective solution for the rehabilitation efforts and the investments in new facilities; and (ii) document that the investments have an economically positive result, by comparing economic benefits with capital investments and operational expenditures.

a. Cost Effectiveness of Selected Solutions

18. China's Central Government and Liaoning Provincial Government have set targets for physical water losses in the supply network to be reached: i.e. 15% in 2020, and 12% in water-scarce cities like Fuxin. The selection of rehabilitation projects within each project city was based on optimizing the effectiveness from the investments made. Communities within cities with the highest rates of incidents of pipe repairs were selected for the project. The communities with high number of incidents are primarily those with older networks of 10 to 20 years and above 20 years, while only a few communities with networks under 10 years old were selected for rehabilitation efforts. Based on the data from the last three years, analysis shows that maintenance efforts related to incidents for the selected communities have increased by 3-4% annually, with similar increases in the associated costs for repairs and maintenance. With the ongoing aging of supply networks in the communities, this trend is expected to continue if the rehabilitation efforts of the project are not implemented.

19. For rehabilitation of pumping, those facilities with the oldest pumps, as well as pumps with the poorest performance statistics were chosen for rehabilitation efforts. The selected pumps include both extraction pumps as well as booster pumps that support water flow in the network. As an example of other project facilities selected for implementation, the new raw water pipe in Gaizhou was included in the project as the shift to surface water is a regulatory requirement.

20. Least cost analysis was conducted to identify the most technically appropriate options for the individual solutions. Alternative solutions for the locations of pipeline/treatment plants and material costs were also investigated so as to identify the most optimal solution.

b. Cost Benefit Analysis of Implemented Project

21. A cost-benefit analysis was prepared to document the economic return of the project. The project will bring a number of economic benefits to the population in the project's area of influence. Apart from direct benefits from providing a more efficient utility service (and also expanding the supply capacity of the existing facilities), the project will provide economic benefits such water conservation – which creates opportunities for economic development in a water-scarce region. The economic benefits are presented in the Table A4.10 below. The related project costs are for investments and operation and maintenance.

22. The shadow price of domestic water supply was based on willingness-to-pay, while industrial water was determined based on previous research results. For energy consumption, the

economic cost of CO_2 in China was included. The direct economic benefit to the companies from reducing commercial NRW as a part of the metering program was considered to be offset by a same-size economic cost to the consumers. The commercial NRW reduction is expected to have a positive indirect economic impact, as it promotes water savings. On the cost side, a shadow price (cost minus taxes) for the investments was introduced. The assumptions made for conducting the economic cost-benefit analysis are summarized in Table A4.11. The benefits and results are summarized in the table below. The results document that the project is viable from an economic perspective.

Table A4.10: Economic Benefits and Analysis Results

Economic Benefits

(i) Cost savings due to system rehabilitation, leakages reduction, technical upgrades and switch of water source

- Energy
- Raw water
- Chemicals
- Repair and maintenance – for selected cities
- CO_2 – related to energy savings
- For Gaizhou: cost savings of wastewater treatment due to consumption savings. Due to current non-metering the water consumption per household is expected to drop with the metering project. This will reduce volume of wastewater and thereby cost of wastewater treatment.

(ii) Economic value of covering demand increase of existing connections from water saved by reducing leakages

- Valued at shadow prices

Economic Internal Rate of Return

Project City	Shenyang	Anshan	Fuxin	Fushun	Gaizhou
EIRR	+40%	31%	28%	11%	3%
Sensitivity[1]	+40%	28%	25%	10%	2%

[1] Sensitivity case is combination of: project delayed one year; 5% increase in project costs; 5% decrease in financial benefits.

Table A4.11: Economic Cost Benefit Analysis Assumptions

The specific assumptions made for the economic cost benefit analysis are as follows:

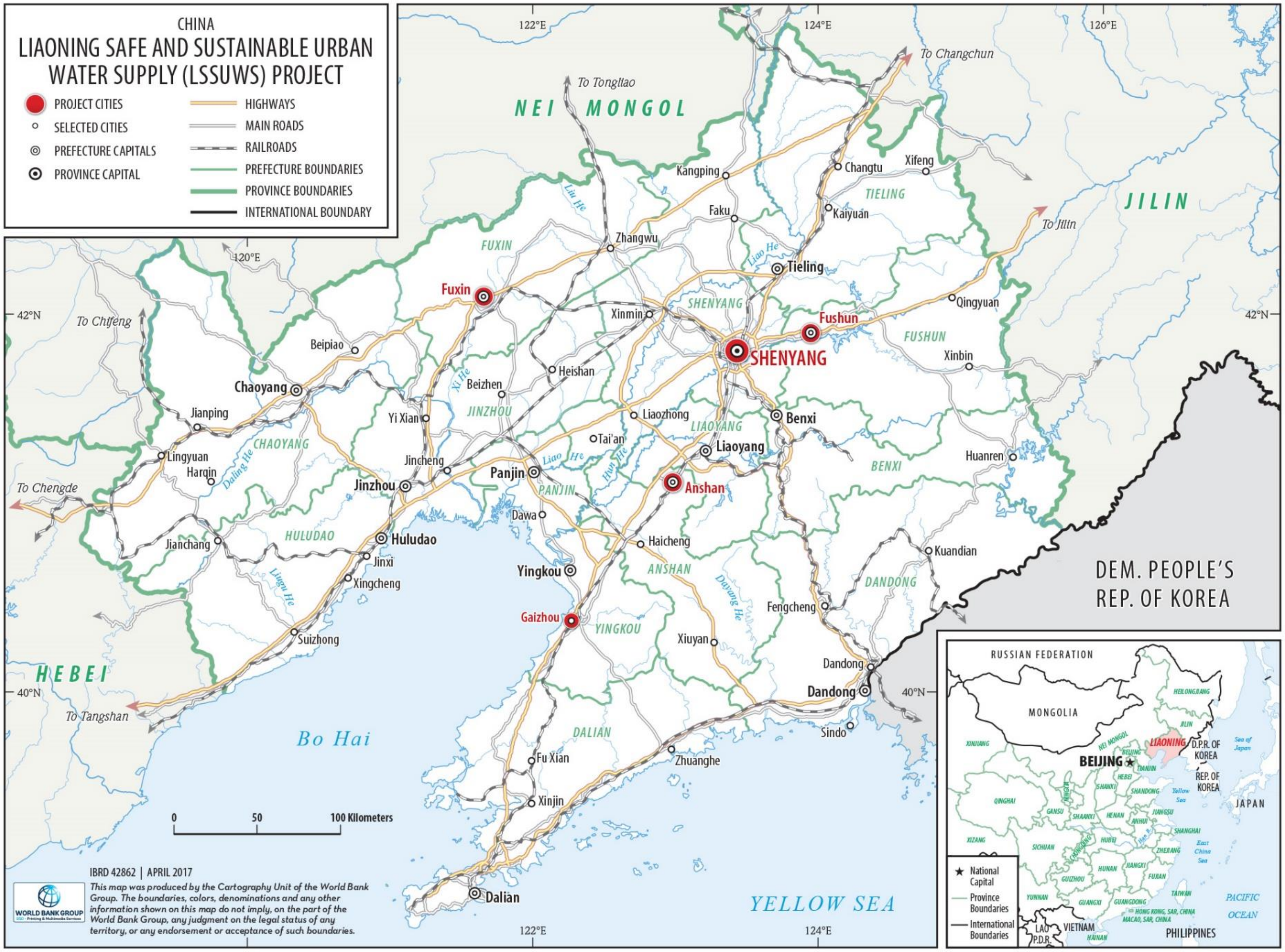
- The economic cost-benefit analysis was prepared in real terms.
- Economic prices for investment, expenses, and sales were introduced:
  - The economic cost of the investments was assumed to be 90% of the financial costs.
  - The economic costs of other cost items such as electricity, chemicals and raw water was assumed to be at the same level as the financial costs.
  - The shadow price of water supplied for industries was determined based on Liu, Chen, Li and Zhang[1]. The shadow price was estimated at 4.57 yuan/m^3 and will increase to 7.17 yuan/m^3 in 2030 in 2017 prices. The shadow price is not estimated to increase beyond

2030. As a comparison, the current of water tariffs to industries range between 3.37 yuan/m^3 in Fushun to 4.81 yuan/m^3 in Fuxin.

- The shadow price on water to residents was estimated at 10.0 yuan/m^3 based on Liaoning willingness to pay survey in 2008 of 4.8 yuan/m^3, and increase in families' disposable income. Increase in WTP is based on inflation of 3% p.a. and increase in household income in real terms of 5% p.a. The value is justified as 4-5 times increase of current combined water and wastewater bill will be within an acceptable level of 5% of the income of low-income families
- The shadow price on carbon dioxide was assumed at 20 yuan/ton – as the value of CO_2 in China.

[1]"Calculate and Forecast Shadow Price of Water Resources in China and Its Nine Major River Basins" by Xiuli Liu, Xikang Chen, Jinghua Li and Hongxia Zhang

Annex 5. MAP


CHINA
LIAONING SAFE AND SUSTAINABLE URBAN WATER SUPPLY (LSSUWS) PROJECT
PROJECT CITIES
SELECTED CITIES
PREFECTURE CAPITALS
PROVINCE CAPITAL
HIGHWAYS
MAIN ROADS
RAILROADS
PREFECTURE BOUNDARIES
PROVINCE BOUNDARIES
INTERNATIONAL BOUNDARY
NEI MONGOL
JILIN
HEBEI
DEM. PEOPLE'S REP. OF KOREA
Bo Hai
YELLOW SEA
To Tongliao
To Changchun
To Jilin
To Chifeng
To Chengde
To Tangshan
SHENYANG
Fuxin
Fushun
Anshan
Gaizhou
Tieling
Benxi
Liaoyang
Panjin
Jinzhou
Huludao
Yingkou
Dandong
Dalian
Chaoyang
Kangping
Changtu
Xifeng
Kaiyuan
Faku
Zhangwu
Xinmin
Qingyuan
Xinbin
Beipiao
Heishan
Beizhen
Yi Xian
Liaozhong
Tai'an
Jianping
Lingyuan
Harqin
Jincheng
Dawa
Haicheng
Jianchang
Jinxi
Xingcheng
Suizhong
Fengcheng
Kuandian
Huanren
Xiuyan
Sindo
Zhuanghe
Fu Xian
Xinjin
FUXIN
SHENYANG
TIELING
FUSHUN
JINZHOU
LIAOYANG
CHAOYANG
BENXI
PANJIN
HULUDAO
ANSHAN
DANDONG
YINGKOU
DALIAN
Liu He
Liao He
Xi He
Hun He
Daling He
Dayang He
Lingu He
120°E
122°E
124°E
126°E
42°N
40°N
0
50
100 Kilometers
IBRD 42862 | APRIL 2017
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