Kingdom of Saudi Arabia
Ministry of Environment, Water and Agriculture
Ministry of Investment
Riyadh Chamber of Commerce

Kingdom of Saudi Arabia
Data Collection Survey on Water Saving, Leakage Measures and Water Quality Improvement in Saudi Arabia

Final Report

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Japan International Cooperation Agency (JICA)

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Kingdom of Saudi Arabia
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FINAL REPORT

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Abbreviation

Abbr.	Definition
AMR	Automatic Meter Reading
ASTM	American Society for Tesing and Materials
BOD	Biochemical Oxygen Demand
CEDA	Council for Economic and Development Affairs
COD	Chemical Oxygen Demand
DMA	District Metered Area
DO	Dissolved Oxygen
Estidamah	National Research and Development Center for Sustainable Agriculture
ETs	Execution Teams
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GIS	Geographic Information System
GPRS	General Packet Radio Service
GSM	Global System Mobile Communications
HDPE	High-density Polyethylene
ISO	International Organization for Standardization
JBIC	Japan Bank for International Cooperation
JCCME	Japan Cooperation Center for the Middle East
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
MDM	Mobile Device Management
MEWA	Ministry of Environment, Water and Agriculture
MHRSD	Ministry of Human Resources and Social Development
MISA	Ministry of Investment of Saudi Arabia
MLSS	Mixed Liquar Suspended Solids
MODON	Saudi Authority for Industrial Cities and Technology Zones
MOMC	Management and O&M Contract

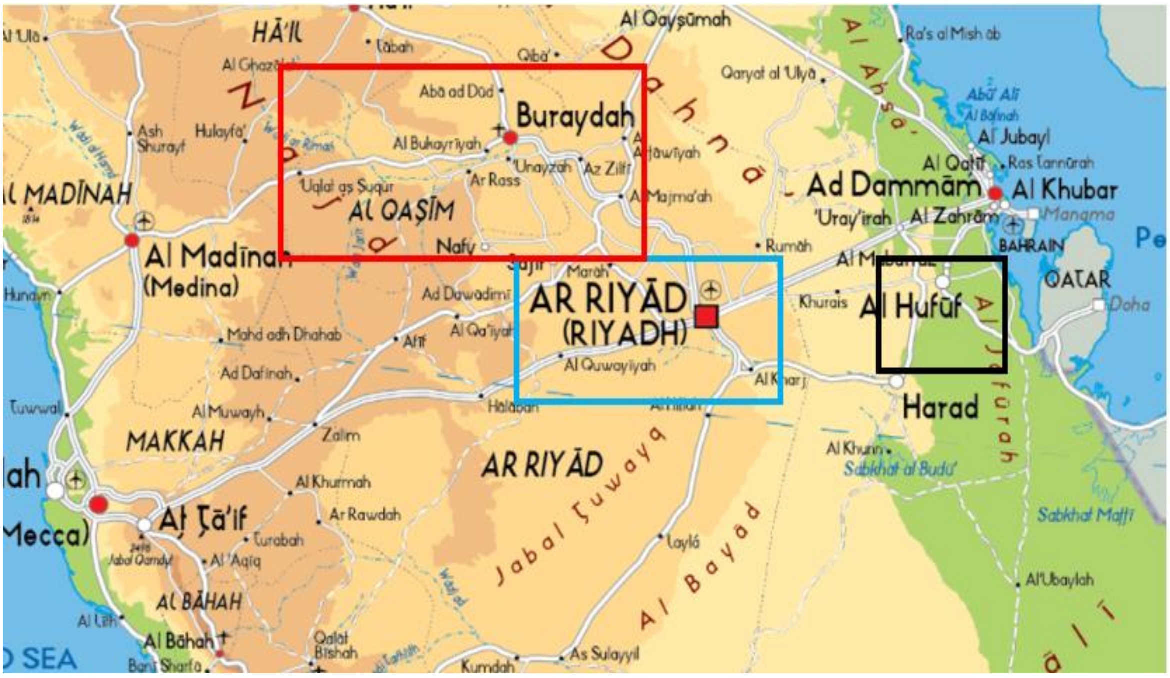
Monsha ‘at	Small & Medium Enterprises Development Authority
NCEC	National Center for Environmental Compliance
NCP	National Center for Privatization
NCWER	National Center for Water Efficiency and Rationalization
NCWM	National Center for Waste Management
NCWRS	National Center for Water Research and Studies
NEDO	New Energy and Industrial Technology Development Organization
NIDLP	National Industrial Development and Logistic Program
NWC	National Water Company
NWC RCBU	National Water Company, Riyadh City Business Unit
NWS2030	National Water Strategy2030
PPP	Public Private Partnership
PRV	Pressure Reducing Valve
PSCs	Privatization Supervisory Committee
PVC	Poly Vinyl Cloride
RO	Reverse Osmosis
SAR	Saudi Arabia Riyal
SASO	Saudi Standards, Metrology and Quality Organization
SCADA	Supervisory Control And Data Acquisition
SDGs	Sustainable Development Goals
SIO	Saudi Irrigation Organization
SMC	Strategic Management Committee
SWCC	Saline Water Conversion Corporation
TDS	Total Dissolved Solids
UF	Ultra Filtration
WHO	World Health Organization
YWBC	Yokohama Water Business Council
VRP	Vision Realization Program
ZLD	Zero Liquid Discharge

TARGETED SURVEY AREAS

(1) Riyadh City and its vicinity（National Capital Region: Densly populated areas）

(2) Al-Qassim Province（Major Agriculture Belt）

(3) Al-Ahsa District in the Eastern Province (Large-size Agriculture Areas)



Legend: Target Area (1): Target Area (2):

Target Area (3):

Chapter 1: Outlines of the Data Collection Survey

1.1 Background and Objectives of the Survey

1.1.1 Background and Circumstances of the Survey

In the Kingdom of Saudi Arabia, the amount of water use has been increased by an average of 7% per year, due to recent economic growth and industrial promotion policies. About 82% of the total water used in the entire Saudi Arabia (2018) is covered by fossil water, and it is believed that this fossil water will be completely depleted by 2080. In addition to the tightness of water resources, deterioration of water quality such as increase in salinity due to excessive pumping of groundwater and fossil water and increase of nitrate nitrogen due to drainage, are major challenges. Under such circumstances, it is required not only to ensure a safe and sufficient water supply to urban water supply systems, but also to take measures to reduce the amount of water use.

About 80% of the total water supply in Saudi Arabia is used in the agricultural field, most of which depends on fossil water. In order to reduce the amount of water used in fossil water, measures such as improving irrigation efficiency, reducing grain cultivation for which a large amount of water is used, and reducing water leakage are required, and Saudi Arabia aims to reduce the demand for water in the agricultural field by 26% by 2030. In the meantime, Saudi Arabia needs improvement of technology and know-how for the efficient use of water resources and improve water quality through water leakage and water saving measures in the water supply and agriculture fields. However, there is a shortage of information such as current situations, issues, local needs, and business practices, and business matching support for Japanese private firms has not yet been provided, although major Japanese firms and Small and Medium-sized private firms are considered to have a lot of room to contribute for solving problems in the water field. For these reasons, it is required to collect local information in the water supply and agriculture fields as well as the information on technologies and products of Japanese private firms, then consider the possibility of utilizing private company’s technology to solve these issues, and eventually deliberate the future cooperation policies of Japan and Saudi Arabia in the field.

1.1.2 Objectives of the Survey

The objectives of this study are to collect information on the current situation, issues, needs, and technologies and product resources of Japanese private firms regarding the efficient use of water resources and water quality improvement through water leakage detection and water saving measures in the water supply and agriculture fields of Saudi Arabia, and to support Japanese private firms to get into the markets by utilizing technologies and products owned by Japanese private firms which may solve problems in Saudi Arabia.

1.1.3 Targeted Survey Areas

The targeted survey areas under this Survey are as follows.

(1) Riyadh and its vicinity (Riyadh Capital Region: densely populated areas)

(2) Al-Qassim Province (Major Agricultural Belt in Saudi Arabia)

(3) Al-Ahsa District in the Eastern Province (the large-scale Agriculture Areas)

1.2 Contens of the Survey and Its Approaches

1.2.1 Contents of the Survey and Survey Items

The Survey Items and its outlines are as follows:

(1) Basic information gathering on water saving and leakage detection countermeasures and water quality improvement in the water supply and agriculture fields in Saudi Arabia (domestic work)

- Confirmation of basic information (Natural environment, social and economic overview, etc.) throughout the survey areas surveyed
- Collection and analysis of the past surveys on the national water sector, water saving and leakage detection, and water quality by domestic and foreign organizations, and summary of the situation, issues, and causes of problems
- Grasping and organizing specific standards, targets and objectives, measures, and recommendations related to water conservation, targets, measures, and recommendations related to water saving, water quality, and guidelines in the government's water-related policies, legal systems, standards, and guidelines (Water quality standards for water supply and agricultural water supply, wastewater regulations from factories, etc.)

(2) Collection of basic information on overseas corporate business environment in Saudi Arabia (Domestic and on-site work)

- Collecting information on the general overseas corporate business environment in Saudi Arabia and the business environment in the fields of water supply and agricultural water supply, and related legal systems, regulations, etc.
- Gathering information on the status and trends of firms from other countries in the above fields
- Collecting information on the actual conditions of Small and Medium-sized Enterprise (hereinafter referred to as SMEs) promotion measures in Saudi Arabia and the points to be improved in considering the expansion of Japanese private firms into Saudi Arabia
- Collecting information on the investment environment of the countries around Saudi Arabia and on the conditions for attracting foreign direct investment for the purpose of comparing with Saudi Arabia and for extracting improvement points

(3) Collecting information on products and technologies of Japanese private companies for water saving, leakage detection, and water quality improvement (Domestic work)

- Collecting information on the products and technologies of Japanese private firms in related fields through the Internet, company interviews, etc.
- Confirmation of the intention of Japanese private firms having specific products and

technologies in the related fields, for investing to the Saudi Arabia

(4) Grasping the current situation and issues related to water saving and leakage detection countermeasures and water quality improvement in the water supply and agriculture fields (Domestic works)

- Current status of water saving, leakage detection, and water quality in the water supply-related facilities (Water purification plant, water distribution plant, water distribution pipe, water supply equipment, etc.) and agricultural water supply facilities (Irrigation channels, water distribution pipes, irrigation facilities, etc.)
- Current status of water and equipment related to water saving, leakage detection, and water quality improvement at the facility, and the current state of their technology application and maintenance management
- Water saving and leakage detection countermeasures, promotion status of water quality improvement measures, and achievement status of national targets in the above two fields
- Analysis of irrigation methods, soil characteristics, water management techniques, and cultivation methods in the agricultural field
- Grasping of agricultural forms (Small, medium, large, self-sufficient, commercial purposes)
- Present conditions and countermeasure status of exudate from factory wastewater and garbage disposal sites (Hearing from stakeholders about the presence or absence of an anti-pollution facility when discharging into sewerage, treatment technology and management status, wastewater treatment technology and management status of factory wastewater and exudate)

(5) Understanding the current state of water supply and agricultural business environment in Saudi Arabia (Remote survey from Japan and on-site works)

- Local related organizations (Understanding the current situation and issues through interviews with government agencies, chambers of commerce, water and agriculture sector companies)
- Status of PPP in the water supply field and future policies of related organizations related to PPP
- Certification and certification of standards, etc. and conformity applicable to industrial products such as water supply materials and equipment
- Water charge system and its future outlook
- Usage status of products and technologies from other countries in the water supply and agriculture fields
- Understanding the running costs of seawater desalination facilities

(6) Listing of current status, issues, and needs for water saving and leakage detection countermeasures and water quality improvement in the water supply and agriculture fields of Saudi Arabia (Domestic work)

- Based on the information in (1) to (5), list issues and needs in Saudi Arabia

(7) Sharing survey results to Japanese private companies, introducing issues, needs, and proposals (Domestic work)
   - Holding interim report meetings on issues and needs organized in (6) to promote the use of technologies and products for issues and needs (for Japanese private firms having a keen interest)
   - After the second field survey, a final report meeting on the results of this survey was held (for Japanese private firms having a keen interest)

(8) Planning and operation of Delegation Programs to Saudi Arabia for Japanese private companies that are interested in solving the problems of Saudi Arabia in which they are determined to contribute for solving the problems in Saudi Arabia (Domestic and on-site works)
   - Based on the surveys mentioned in (6) and (7), the planning and operation of Delegation Programs for firms who believe that their technologies and products contribute to the efficient use of water and water quality improvement in Saudi Arabia (Specific preparations include coordination and coordination of points between participating companies and local related organizations (Central ministries, other government agencies, local private companies, etc.) The number of participating firms is deemed to be 5 to 10 companies, the number of participants is about 5 to 10 peoples, and the implementation days are about 12 days.

(9) Analysis of the potential use of Japanese private technology for this issue and examining the direction of future initiatives, including the possibility of private-sector collaboration (Domestic work)
   - Based on the survey results from (1) to (8) above, JICA survey team have set selection criteria for products and technologies of Japanese private firms that are expected to be utilized in Saudi Arabia for water saving, water leakage detection countermeasures, and water quality improvement.
   - Extraction of products, technologies, and firms that may meet the set standards
   - Examination of the direction of future initiatives

1.2.2 Implementation Method of the Survey

Under the domestic preparatory survey, first field survey, first domestic survey, second field survey, and second domestic surveys shall be conducted, this Interim Report summarizes the results of domestic preparatory surveys, first field surveys, and first domestic surveys only.

"NWS 2030” being adopted by the Government of Saudi Arabia targets reducing the amount of water consumption, especially in the water supply and agriculture sectors, by promoting efficient water use. In order to realize this objective, 10 items; 1) Improvement of water and water resource related legal systems, 2) Efficient management of water resources, 3) Improvement of risk tolerance (resilience) in the water field, 4) Promotion of technological innovation and capacity development, 5) Strengthening of water supply chain and improvement of service quality, 6) Improvement of water supply service related legal system, 7)

Reconstruction of The Saline Water Conversion Corporation (SWCC), 8) Privatization of wastewater treatment business, 9) National Water Company (NWC)'s water utilities services are to be improved its efficiency and promoting privatization,10) Rebuild the Saudi Irrigation Organization (SIO) and improve irrigation technology.

Under this Survey, while confirming the progress of the strategic articles mentioned hereinabove by questioning letters to the ministries and agencies of the Government of Saudi Arabia and related organizations such as the Ministry of Environment, Water and Agriculture (MEWA), as well as by questioning and answering through online meetings, and website research by local experts, identified development issues and extracted and analyzed these development issues. On top of that, JICA Survey Team has identified needs for assistance for solving problems and explored the possibility of utilization of technologies and products of Japanese private companies.

Specifically, since it was not possible to conduct the field survey during the planned period while the spread of Covid-19 in Saudi Arabia did not cease, JICA Survey Team has conducted online meetings with various Government organizations such as MEWA by online method following the domestic preparatory survey and tried to identify the issues in the concerned fields in Saudi Arabia. At the same time, JICA Survey Team has predicted development issues in the field of water use efficiency and water quality improvement in Saudi Arabia by making full use of the network of this joint venture, and conducted extensive surveys on seeds technologies possessed by Japanese private firms and research institutes that contribute to solving the issues. In the survey of seeds technology, JICA Survey Team has worked to gather information by providing opportunities to exchange opinions with the Faculty of Agriculture of Tottori University which has a proven track records in arid land agriculture, the National Agriculture and Food Research Organization (NARO), and the Yokohama Water Business Council which is one of the water utilities management entities in the major cities in Japan. Based on such surveys to the seed technologies, a "hypothese" was set on how to utilize Japanese seed technologies and products for solving development issues in the field of water saving, water leakage and water quality improvement in Saudi Arabia, and tried to "verify" the effectiveness of the “hypotheses” while collecting additional information through the process of field surveys.

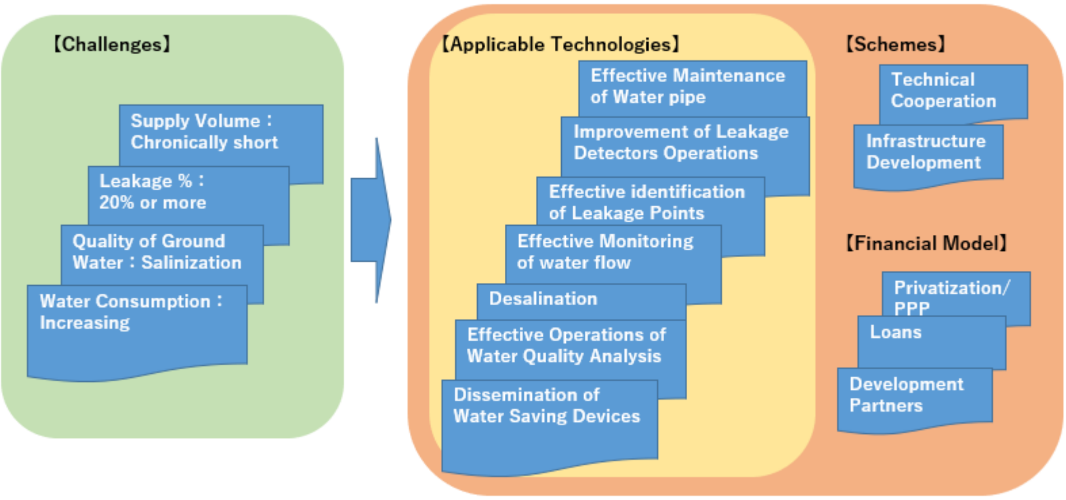


Figure 1-1: Consideration scheme for the Development Issues and Application of Technologies

Source: JICA Survey Team

In addition, in applying specific technologies of Japanese private firms, JICA Survey Team made efforts to propose an appropriate assistance scheme and recommending the most suitable type of investment for the deployment of technologies by Japanese private firms after due examining to various assistance schemes being provided by the Government of Japan.

(1) Domestic Preparatory Survey

1) Collecting information in Japan and collecting information through online meetings

As a survey during the domestic preparatory survey period, JICA Survey Team has conducted an online survey using online meetings with domestic organizations and various organizations in Saudi Arabia. The survey was carried out along with the contents described in (a) to (e) below. In conducting the survey of relevant organizations in Saudi Arabia, the survey was carried out in close coordination with the Embassy of Japan in Saudi Arabia, JICA Saudi Arabia Field Office, and the JCCME Riyadh Office. In conducting the survey, the actual survey was conducted in a manner to verify the hypotheses which were set along with an assumption on development issues in the water field in the Saudi Arabia and any proposed solution shall be examined in advance and discussed with the Government officials of Saudi Arabia.

In addition, from late August to early September, mini-seminars were held with Government officials and private firms in Saudi Arabia by using online meetings to provide an opportunity to directly introduce the technologies and products of Japanese companies. These mini-seminars were conducted in two different fields of water and agriculture for 2 days. The explanatory materials used in the mini-seminars are as described in Annex 1. The table below shows the outlines (activities and results) of mini-seminars in the water and agricultural fields.

Table 1-1: Overview of online mini-seminars in the fields of water supply and agriculture

Survey Method	Date	Participants	Content of Activity	Achievement
Mini Seminar (Agriculture)	8/25	・Saudi Arabia Government agencies such as MEWA、SIO、Estidamah, etc. ・Riyadh Chamber of Commerce ・Two Japanese private firms in Agriculture sector	・Presentation and Q&A Sessions were held on Japanese water-saving irrigation technologies, smart agriculture technologies and water leakage countermeasure technologies. ・Two Japanese agriculture firms also presented their technologies and products at the seminar	There is a request from the Riyadh Chamber of Comerce for holding a meeting with local firms on other day
Seminar for the Riyadh Chamber of Commerce and local private firms	9/9	・Riyadh Chamber of Commerce, several number of Saudi firms ・15 Japanese private firms (12 firms in water supply sector, 3 firms in agriculture sector)	・Presentation and Q&A Sessions were held on Japanese water-saving irrigation technologies, smart agriculture technologies and water leakage countermeasure technologies. ・In addition, 15 Japanese firms (12 firms are related to water supply and 3 firms are relaed to agriculture) also presented their own technologies and products at the seminar.	Q&A session was held from from Saudi Arabia's firms to Japanese firms in agriculture sector. Saudi firms showed their interest in the technologie and products of Japanese firms

Source: JICA Survey Team

The details of the survey activities during these domestic preparation survey periods are as shown in Tables 1-2~1-5.

Regarding the survey on the overall investment environment of Saudi Arabia, JICA Survey Team has conducted a comparison between the investment environment of Saudi Arabia and that of major neighboring countries in order to identify improvement points in the investment environment of Saudi Arabia, and actual surveys on the investment environment of neighboring countries of Saudi Arabia and the conditions for attracting foreign direct investment, by appointing a research firm which has the office in neighboring countries of Saudi Arabia.

(a) Business Environment and Issues faced by Japanese Private Firms.

During the domestic preparatory survey period, JICA Survey Team has tried to collect secondary data such as the results of the survey conducted by the World Bank and JETRO on business environment and issues in Saudi Arabia. Saudi Arabia was ranked 62nd position among 190 countries and regions in the World Bank Group's "Ease of Doing Business, 2020" ranking which has made a significant improvement of 30 positions from 92nd position in the previous year. Major factors for this improvement are improvement in terms of ease of entrepreneurship, ease of power supply, and ease of crossboarder trading. In the meantime, JETRO's survey on the investment environment to Japanese firms which have operations in the Middle East areas (December 2020) has pointed out such positive investment environments in Saudi Arabia as "Market size and growth potential (85.2%)" and "Good sentiment toward Japan (66.7%)", while "Sudden introduction and change of administration systems (77.8%)", "Lack of legal system and uncertainness of legal system (66.7%)", Issues related to soaring labor costs (59.3%), Labor shortages and difficulties in recruiting human resources (51.9%) and others are indicated.

(b) Current conditions and challenges in water saving and leakage measures in the water supply field.

JICA Survey Team has conducted survey works to gather information on the selected projects such as the SMEs and SDGs business support scheme being provided by JICA and made interview surveys via e-mail, telephonehone and online-meetings with various industry organizations such as the Japan Cooperation Center for the Middle East (JCCME) and different Ministries and Agencies of Japanese Government. After that, JICA Survey Team has interviewed with about 35 Japanese firms such as manufacturers, trading firms soft-ware developers, and water leakage survey firms whose having adequate technologies required for solving issues by asking for their technologies already developed as well as the technologies under development, and their intention to enter into the markets of Saudi Arabia. The following is an outline of the activities and results under the domestic preparatory survey period.

Table 1-2: Summary of interview results with private firms in water sector

Survey Method	Date	Target Person	Activity Content	Achievement
E-mail, Phone calls and online	End of May 2021- End of June	Japanese Private Company for Reviewing piping method	Conducted hearings with a manufacturer of water pipe fittings (PVC pipes / cast iron mechanical fittings for PE pipes)	Consider if there are needs for a fitting that does not require special tools, can repair leaks without water interruption, and can join between different and different types of pipes.
E-mail and Phone calls	May 25, 2021	Japanese Private Company for Water storage	Conducted hearings with a manufacturer of rain water storage tank	Demand may be low due to low rainfall.
E-mail and Phone calls	May 25, 2021- beginning of June	Japanese Private Company for Leak survey method	Conducted hearings with a manufacturer of easy leak detection device	Not considering overseas sales.
Emails and Phone calls	May 25, 2021- beginning of June	Japanese Private Company for Mapping System	Conducted hearings with a manufacturer of pipe network data creation and designing software, facility management ledger system.	This is only for sewage pipeline design, it is not sure if it fits this project purpose.
E-mail and Phone calls	May 25, 2021- End of June	Japanese Private Company for Reviewing piping method	Conducted hearings with a manufacturer of tapping saddle with a corporation stop	Consider if there are needs for a branching saddle with a valve which enables service saddle connection without interrupting water using special tools.
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for NRW reduction system	Conducted hearings with a manufacturer of water distribution management system（a system proposal）	Consider if there are needs for an electro-magnetic flowmeter and pulse electric meter for domestic houses
E-mail and Phone calls	May 25, 2021- beginning of June	Japanese Private Company for NRW reduction system	Conducted hearings with a manufacturer of NRW reduction service (a system proposal)	Hard to sell only at handy terminals. A systematic proposal is needed.
E-mail and Phone	End of May 2021- beginning	Japanese Private Company for Leak Detection	Conducted hearings with a manufacturer of permanently Installed	Consider if there are needs for detecting leakage by listening and correlation method.

Survey Method	Date	Target Person	Activity Content	Achievement
calls	of June	Method	automatic leak sound detection system (L-sign)	
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for Reviewing piping method	Conducted hearings with a manufacturer of stainless steel pipe for service pipe	Consider if there are needs for stainless steel pipe for service pipe.
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for Flow measurement	Conducted hearings with a manufacturer of Electro-magnetic flow meter/smart meter	Consider if there are needs for accurate water flow measurement for 5 years without any external batteries.
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for Flow measurement	Conducted hearings with a manufacturer of smart-meter	Consider if there are needs for accurate smart metering system
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for Flow measurement	Conducted hearings with a manufacturer of ultrasonic flowmeter / level gauge flow monitoring system	Consider if there are needs for install flowmeter without any interruption of water, and flow measurement by ultrasonic water level gauge and velocity sensor.
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for Leak detection method	Conducted hearings with a manufacturer of leak detection system	Already in the market but more market expansion is needed for multiple noise logging device to detect leaks.
E-mail and Phone calls	End of May 2021- beginning of June	Japanese Private Company for Reviewing piping method	Conducted hearings with a manufacturer of Gate valve/flow control valve	Consider if there are needs for robust and unbreakable gate valve, and flow control butterfly valve.
E-mail and Phone calls	End of May 2021- begginning of June	Japanese Private Company for Reviewing piping method	Conducted hearings with a manufacturer of Drilling machine	Consider if there are needs for non-water outage drill for tapping.
E-mail and Phone calls	End of May 2021- begginning of June	Japanese Private Company for Reviewing piping method	Conducted hearings with a manufacturer of Underwater/Drainage pump	Consider if there are needs for robust and unbreakable pump.
E-mail and Phone calls	End of May 2021- begginning of June	Japanese Private Company for Usage water saving	Conducted hearings with manufacturers of Water saving valves	Consider if there are needs for reducing water usage and keep the same pressure by inserting a valve into a water tap.
E-mail and Phone calls	End of May 2021- begginning of June	Japanese Private Company for Usage water saving	Conducted hearings with manufacturers of Water saving shower head	Consider if there are needs for reducing water usage in the shower head and keep the same water pressure.

Source: JICA Survey Team

(c) Current conditionss and challenges in water saving and leakage measures in the agricultural firld.

In Japan, JICA Survey Team has collected information from the reports related to the Agricultural activities which are publicly opened by JICA as well as from the JICA Website, and collected inforformation from various Ministries and Agencies of Saudi Arabia, industrial organizations such as JCCME Riyadh Office, academic institutions such as universities, and relevant Ministries and Agencies of Japanese Government by online-meetings. After that, JICA

Survey Team has interviewed with various Japanese firms having adequate technologies required for solving issues by asking for their technologies already developed as well as the technologies under development, and their intention to enter the markets of Saudi Arabia. The following is the outlines of the activities and results under the domestic preparatory survey period.

Table 1-3: Summary of activities and its results during domestic preparatory survey (1/2)

Survey method	Date	Target person	Activity content	Achievement
Web Meeting	23th June	JJCCME (Middle East Cooperation Center)	Implementation of hearing about the needs of smart agriculture and water-saving irrigation technology	For smart agriculture and water-saving irrigation technology, it is better to introduce them to MEWA first than to introduce them to private companies.
	25th June	Japanese trading company local branch	Implementation of hearings on overseas expansion of Japanese agricultural machinery	In the past, This Japanese trading company has ever sold construction machinery, but Marubeni has never sold Japanese agricultural machinery overseas.
	2nd July	Yokohama Water Business Council	Creation of presentation materials and attendance	Pipe rehabilitation technology such as pipe-in-pipe is a typical method for repairing water leaks in agricultural pipelines, and it is a very effective method for areas where excavation is difficult in urban areas. There was an opinion that the construction period would be longer and the construction price would be higher than other construction methods because it is necessary to bring in materials and equipment from Japan.
	7th July	MEWA(Agricultural field personnel)	Implementation of hearings on agricultural and irrigation issues and irrigation methods in Saudi Arabia	・ Agricultural issues in Saudi Arabia depend on traditional agriculture and irrigation methods, cultivated soil has poor water retention and fertilizer content, strategic food self-sufficiency is low, The network for sales and marketing distribution for small-scale farmers is scarce and the agricultural cooperatives are vulnerable. ・ As for the irrigation method, drip irrigation accounts for 72.3% and surface irrigation accounts for 27.7% for fruits, and drip irrigation accounts for 48.9%, sprinkler accounts for 36.3% and surface irrigation accounts for 14.1% for vegetables. ・ Expectations for Japanese techniques for agriculture are expansion of Japanese investment to small-scale irrigation regarding cutting-edge unique agricultural infrastructure technology in green houses and open fields, technology for improving irrigation efficiency, water management, leak exploration technology, water-saving irrigation technology, vertical farming and hydroponics.
	13th July	MEWA (Agricultural field personnel)	Implementation of hearings on the national strategic policy of agriculture and food security in Saudi Arabia, the self-sufficiency rate and production status of vegetables and fruits, and the technology expected to Japan.	・Establishment of a sustainable food production system and access to safety and nutrition as a national strategic policy for food security. ・ The self-sufficiency rate of fruits such as dates, squid, grapes and mango is 50% or more, and the self-sufficiency rate of vegetables such as eggplant, cucumber, okra and potato is high at 90% or more. ・ Fruit production is high in Ryadh, Qassim, Al-Jouf and Medina, and vegetable production is high in Mecca, Ryadh and Hail. ・ Expectations for Japanese agricultural machinery technology for sowing, harvesting and post-harvesting vegetables and fruits are found.
	14th July	Japanese company （Water retention material ）	Implementation of hearing about water-saving irrigation technology for Japanese private companies	・ The characteristics of the water retention material of the company are that waste glass such as empty bottles is used, the environmental load is small, the irrigation quantity can be reduced by 48%, and the yield is increased by 28%. ・ The company has partner companies in Morocco, UAE, Portugal, South America, China, etc. and has already conducted verification tests.
	16th July	International Cooperation Division, Ministry of Agriculture, Forestry and Fisheries	Request to introduce a Japanese company with unique water-saving irrigation technology	・ Japanese companies with film farming technology and biostimulant technology are famous and are likely to be interested in the Saudi market.
	19th July	Japanese company (Film farming)	Implementation of hearing about water-saving irrigation technology for Japanese private companies	・ As a feature of the film farming technology of the company, crops are cultivated using plastic film instead of soil and water, the film allows water and nutrients to permeate and does not allow pathogens to pass through, and crops such as tomatoes are watered through the film. When sucking up the tomatoes, water stress acts and the sugar content becomes high, and in UAE, tomatoes cultivated by this technology are sold at high prices to high-end restaurants. -The company is very interested in the Saudi market.
	5th August	Japanese agricultural technology research facility	Implementation of hearing about the current status of overseas expansion of smart agricultural technologies such as Japanese robot tractors and agricultural drones	・Until now, exports of Japanese agricultural machinery, including tractors, to the Middle East, including Saudi Arabia, have been limited. The reason is presumed that it is difficult to make a profit when considering the maintenance system after sales. ・Venture companies that do not specialize in agricultural machinery may show interest in drones.
	18th August	Estidamah Agricultural Research Center	Implementation of hearing about the needs of water-saving irrigation technology and the possibility of joint research with Japanese companies	・The center is researching agricultural technology with the goals of improving the unit yield of crops, reducing the use of pesticides, and improving irrigation efficiency. ・The center is hoping for joint research with Japanese companies, universities, and research institutes that have water-saving irrigation technology and vertical farming technology.

Source: JICA Survey Team

Table 1-4: Summary of activities and its results during domestic preparatory survey (2/2)

Survey method	Date	Target person	Activity content	Achievement
Web Meeting	20th August	Japanese university research facility (Crop cultivation)	Implementation of hearing about crop cultivation techniques in arid areas studied in this study	・In Saudi Arabia, grain is purchased and imported by investment companies of the Saudi government from Sudan and other foreign countries.
	25th August	Mini WS（Agriculture）	Presentations and Q & A sessions were held on Japanese water-saving irrigation technology, smart agricultural technology, and water leakage countermeasure technology. Two Japanese agricultural companies also presented their technologies and products at the seminar.	There is a request from the Riyadh Chamber of Commerce to hold a meeting with local companies on another day.
	26th August	Japanese company（Biostimulant）	Implementation of hearing about water-saving irrigation technology for Japanese private companies	・ The characteristics of the company's biostimulant technology are that it can improve the heat resistance and drought resistance of crops by the effect of fertilizer containing acetic acid as the main component, and can dramatically reduce the amount and frequency of irrigation water used. ・The comapny had previously sought to carry out joint research with the Estiderma Agricultural Research Center in Saudi Arabia.
	27th August	Japanese university research facility (Water saving irrigation)	Implementation of hearings on Japanese companies with water-saving irrigation technology and water-saving irrigation technology being studied in this study.	・ The research facility is conducting research on simulations to calculate the optimum amount of irrigation water. ・A demonstration test of irrigation using reclaimed water from urban sewage was being conducted in Palestine. ・The pressure-corrected drip irrigation tube is promising as a water-saving irrigation technology of Japanese companies.
	6th September	Japanese company（Drip irrigation tube）	Implementation of hearing about water-saving irrigation technology for Japanese private companies	・The pressure-corrected drip irrigation tube owned by the company can keep the water pressure of the irrigation tube constant in all sections, and can send water over a long distance with little head loss. ・Although the pressure-corrected drop irrigation tube will be commercialized after 2022, in the future, they are eager to make technical cooperation with a major water-saving irrigation equipment manufacturer in Israel which is an advanced country of water-saving irrigation technology and enter the market in the Middle East, which is an arid region including Saudi Arabia.
	7th September	SIO Al-hasa	Implementation of hearings on the needs of water-saving irrigation technology and leak detection / countermeasure technology for agricultural pipelines	・ The irrigation using reclaimed water from urban sewage is being conducted in Al-hasa. ・ SIO would like Japan to introduce technology for improving the quality of agricultural wastewater. -There is a need for non-cutting pipe rehabilitation technology, which is a Japanese technology, as a method of repairing leaks in areas where it is difficult to cut in urban areas
	9th September	Seminar for the Riyadh Chamber of Commerce and local private companies (agriculture)	Presentations and Q & A sessions were held on Japan's water-saving irrigation technology, smart agricultural technology, and water leakage countermeasure technology. In addition, three Japanese companies related to agriculture also presented their own technologies and products at the seminar.	Q&A session was held from Saudi Arabia's national companies to three Japanese companies related to agriculture. Saudi Arabia's companies showed their interest in the technologies and products of Japanese companies.
Web search	May to June	—	Web survey regarding Japanese water-saving leak technology that can be introduced for agricultural water	We have selected a large number of Japanese companies with water-saving irrigation technology, smart agricultural technology, and leak detection and repair technology.
		—	Web search by local dignitaries (Arabic)	We were able to obtain literature and data on the general condition of the agricultural sector, agricultural policies, location maps of irrigation facilities, and the use of reclaimed water in Saudi Arabia.
Others	June	MEWA	Creating a questionnaire to MEWA	A questionnaire was prepared on the general condition of the agricultural sector, agricultural policy, irrigation facilities, irrigation water, reclaimed water, etc. in Saudi Arabia, and submitted to MEWA through the Japanese Embassy in Saudi Arabia.

Source: JICA Survey Team

(d) Current conditions and challenges of water quality deterioration in water supply and agriculture fields.

In Japan, JICA Survey Team has collected information from the reports related to the water quality in water supply and agriculture fields which are publicly opened by various Ministries and Agencies of Saudi Arabia. Besides, JICA Survey Team collected the releated information through e-mail, telephone and online-meetings with industrial organizations such as Water Reuse Promotion Center (WRPC), Yokohama Water Business Council, etc. and relevant Ministries and Agencies of Japanese Government. After that, JICA Survey Team has also interviewed with various Japanese private firms having adequate technologies required for solving issues by asking for their technologies already developed as well as the technologies under development, and their intention to enter the markets of Saudi Arabia.

Major survey activities and its achievements in the captioned fields are shown in Table 1-5.

Table 1-5: Major activities and its results during the domestic preparatory survey

Survey method	Date	Target company	Activity content	Achievement
Web meeting（with agencies in Saudi Arabia）	6/9、21、24、7/13	MEWA	・On-line meeting with MEWA regarding applicable water treatment, analysis and monitoring technology in Japan for drinking water and reclaimed water and questionnaire for it	・Purpose and methodology of survey in the project and Japanese applicable technologies could be shared with the related agencies in Saudi Arabia.
	8/17	SWCC		
	8/18	Estidama		
	8/24、9/7	Chamber of commerce		
	9/7	SIO		
	9/14	SASO		
Web meeting（explanation to associations in Japan）	7/2	Yokohama Water Business Council	・Explanation of the project and request for cooperation with it	・Cooperation of related agencies in Japan for the project could be confirmed.
	7/6	Water Reuse Promotion Center (WRPC)		
Web meeting（hearing with ministries and associations in Japan）	7/15	Ministry of Economy, Trade and Industry (METI)	・Hearing of similar projects conducted by each ministry in Japan	・The information of similar projects conducted by each ministry in Japan could be acquired.
	7/16	Ministry of Agriculture, Forestry and Fisheries (MAFF)		
	7/16	Ministry of Land, Infrastructure and Transport (MLIT)		
	7/20	Ministry of Environment(MOE)		
Web meeting（hearing with private companies in Japan）	6/17, 25	Japan private companies	・Hearing of business environment in water sector in Saudi Arabia through private companies in Japan doing business in Saudi Arabia	・Information of business environment in Saudi Arabia could be acquired.
E-mail and telephone, etc.（Request for cooperation of associations in Japan）	7/5	Japan Analytical Instruments Manufacturers' Association(JAIMA)	・Explanation of the project and request for cooperation with it	・Cooperation of related agencies in Japan for the project could be confirmed.
E-mail and telephone, etc.（hearing with private companies in Japan）	August ～ September	Japanese private companies on each field - Water treatment companies - UV/Ozone companies - Water quality sensors - Water analysis equipment - Simplified microbiological analysis - Johkasou	・Hearing of interest of Japanese private companies for the project and collect the information regarding products/technologies of each private companies in Japan.	・The interest of Japanese companies with the project could be enhanced. ・Information of related technologies of each Japanese companies could be acquired.

Others	May	-	・Investigation of applicable water treatment, analysis and monitoring technology in Japan for drinking water and reclaimed water and making a presentation material for it. ・Preparation of questionnaire regarding water sector (water supply, reclaimed water, sewerage, reclaimed water in Saudi Arabia and Riyadh city , sewerage and reclaimed water in Qassim region)	・Information of applicable technologies (desalination, disinfection, Johkasou, etc.) could be acquired. ・Schedule of the survey in Saudi Arabia could be prepared.
	June～September	-	・Summarizing information acquired through related agencies in Saudi Arabia and in Japan	-
	August	-	・Preparing inception report (Japanese)	-
	September	-	・Preparing inception report (English)	-

Source: JICA Survey Team

(e) Current conditions and challenges related to Private Sector Collaboration

JICA Survey Team members have explained contents of the Survey to members of the Yokohama Water Business Association (hereinafter referred to as "YWBA"). YWBA is an organization that aims at sharng information, exchange opinions, promote, etc. with Japanese firms on the water businesses development such as water supply and sewage businesses to overseas markets through public-private partnerships. About 150 firms which are related to these businesses, such as trading firms, banks, manufactures, consultants are the associate members. The procedure for explanation of the Survey is as follows.

Early June: JICA Survey Team has discussed with one of the water works bureau of local Government authorities (hereinafter referred to as the “Water Works Bureau”), which is the secretariat of the YWBA, on how to implement the proposed briefing session.

June 15: YWWB sent a notice to all the members of the YWBA for conducting a briefing session.

July 2: Held the session. The contents of the briefing were (1) An overview of the investment environment in the Saudi Arabia, (2) Issues related to water saving and water leakage, (3) water treatment and water quality monitoring technology that could be introduced, and (4) the situation in the agricultural field. The firms that participated in the briefing session are as follows.

Table 1-6: Firms that participated in the briefing session

No	Category	Number of firms participated
1	Parts manufacturer of water supply works	4 firms
2	Measurement devices manufacturer	3 firms
3	Water leakage surveyer	1 firm
4	Filtering materials & Filtering equipment	2 firms
5	Water treatment equipment manufacturer	6 firms
6	Chemical products manufacturer	2 firms

Source: JICA Survey Team

As shown in the table above, the firms which have participated in the briefing session were varied in various water fields, and from large to small firms in its scale. Many of the participating firms were interested in this project. However, this list does not cover all water supply and sewage business firms that are interested in the water business of Saudi Arabia.

(2) First Field Survey

1) Positioning of the first field survey

The objectives of the first field survey is to collect additional information on the present conditions of water saving, leakage measures and water quality improvement which were not available through information gathering activities being conducted in the domestic preparatory survey period and information gathering activities conducted in an online manner with concerned public organizations and the private sector in Saudi Arabia, and to verify the hypotheses on development issues through face-to-face meetings with concerned organizations of Saudi Arabia and on-site inspections in the water supply and sewage treatment and agricultural fields. In addition, JICA Survey Team has also made efforts to collect information on technologies and products including that of foreign firms, which have been introduced into the markets of Saudi Arabia. Furthermore, JICA Survey Team has also made consultations with the related Government bodies of Saudi Arabia on the anticipated preparatory work for the second field survey (the delegation program).

2) Survey schedule

(a) Schedule

30 days from Friday, September 17, 2021 to Saturday, October 17, 2021

(b) Areas surveyed

From Saturday, September 18 to Thursday, September 23, 2021: Riyadh city and its surroundings

From Friday, September 24 to Thursday, September 30, 2021: Around Buraydah City, Al-Qassim Province

From Friday, October 1 to Tuesday, October 5, 2021: Al-Ahsa district and its vicinity, Eastern Province

From Wednesday, October 6 to Thursday, October 14, 2021: Riyadh City

(c) Site Visits

The first field survey was conducted in and around Riyadh city and its surrunding areas, Buraidah City in Al-Qassim Province, and in and around Al-Ahsa ditrict in the Eastern Province, with an attempt to collect information on water saving, leakage measures and water quality improvement in the fields of water supply and sewage and agriculture, and to clarify the following matters through these activities. In addition, a survey on the business environment in Saudi Arabia was also conducted.

- To grasp the current conditions and issues on water saving and leakage measures in water supply and sewage and agriculture fields in Saudi Arabia,
- To grasp the current conditions and issues of water quality improvement measures in the water supply and sewerage and agricultural fields in Saudi Arabia,
- To grasp the needs for support related to water saving and leakage measures in the water supply and sewage and agricultural fields in Saudi Arabia,
- To grasp the needs for support related to water quality improvement measures in the water supply and sewerage and agricultural fields in Saudi Arabia,
- To examination of the possibility of utilization of technologies and products owened by Japanese private companies which are anticipated to contribute to water saving and leakage measures and water quality improvement in the water supply and sewage and agriculture fields in Saudi Arabia

As shown in the table below, 25 organizations such as Government agencies, 16 local private firms, and 22 sites for site visist were conductedd during the first field survey period.

Table 1-7: Visited organizations during the First Field Survey

(1) Riyadh City

Government Organizations

No.	Name	No.	Name	No.	Name
1	The Embassy of Japan, Riyadh	2	JETRO/JCCME Riyadh Office	3	JICA Saudi Arabia Office
4	MEWA Head Office	5	MEWA NCWRS	6	MEWA NCWER
7	MEWA NCWM	8	MEWA NCEC	9	MEWA Environmental Agency
10	SWCC Head Office	11	NWC Head Office	12	NWC RCBU
13	SIO	14	Estidamah	15	MISA
16	Riyadh Chambers	17	Monsha'at	18	MODON

Private Firms

No.	Name	No.	Name	No.	Name
1	Japanese Trading Firm A, Riyadh Office	2	Japanese Trading Firm B, Riyadh Office	3	CEPCO
4	Aramoon	5	Alkhoraref Water &Power	6	Gulf Specialized Water Services
7	Al Bawani Water and Power	8	Advanced Water Technologies	9	Amehah Suleman Al-Enzi
10	UTS (Utilities Survey)	11	Samnan Holdings	12	Waterena
13	SMC (Saudi Meter Co.)	14	Bio Delta Trading	15	Miyahona

Site Visit

No.	Name	No.	Name	No.	Name
1	AlKhorayef Water & Power	2	Agriculture Farms	3	Irrigation Facilities

(2)Al-Qassim Province

Government Organizations

No.	Name	No.	Name
1	MEWA Buraydah Branch	2	Al-Qassim Chambers

Private Firms

No.	Name
1	Alwasael Factory

Site Visit

No.	Name	No.	Name	No.	Name
1	Portable Water Treatment Plant, Buraydah	2	Sewage Treatment Plant, Buraydah	3	Sewage Treatment Plant, Unayzah
4	Osailian Forest	5	Ghazal Resort	6	Hadhim Date & Food Products
7	Alwasael Factory	8	Mahasil	9	2 Local Farms (Low-tech) in Al Jadi dat

(3)Al-Ahsa District in the Eastern Province

Government Organizations

No.	Name	No.	Name	No.	Name
1	SIO Head Office	2	SIO Central Water Laboratory	3	Dates & Palm Center
4	Al-Ahsa Chambers				

Site Visit

No.	Name	No.	Name	No.	Name
1	Agricultural Experimental Station	2	Environmental Station & Forest Project	3	Dates & Palm Center
4	Natural Fountains	5	3 Sector for Reclaimed Water Facilities	6	Water Quality Laboratory
7	Kilo 7 Station	8	Kilo 25 Station	9	A Local Farm

Source: JICA Survey Team

(d) Detailed schedule

The detailed schedule of the survey activities carried out during the first field survey period are shown in Table 1-8.

The members and responsibilities involved in the first field survey are as follows.

- Junichiro Motoyama: Team leader/Overseas business environment, Japanese firm overseas
  extenton support
- Tsuyoshi Onozato: Water quality (water supply, agricultural water use, seawater desalination)
- Hiroki Niimura: Water supply (water saving and leakage measures)
- Takamitsu Inoue: Agriculture water use (water saving and leakage measures)
- Koji Kudai: Delegation program/business coordination

The entities that cooperated, supported and contributed to the implementation of the Japanese field survey project and the organizing of the joint Seminar:

- Embassy of Japan in the Kingdom of Saudi Arabia,
- JICA Saudi Arabia Field Office,
- Japan External Trade Organization (JETRO), Riyadh Office,
- Japan Cooperation Center for the Middle East (JCCME), Riyadh Office,
- Ministry of Investment of Saudi Arabia (MISA),
- Ministry of Environment, Water and Agriculture (MEWA),
- MEWA Al-Qassim Branch,
- National Water Company (NWC),
- Saline Water Conversion Corporation (SWCC),
- Saudi Irrigation Organization (SIO),
- National Research and Development Center for Sustainable Agriculture (Estidamah),
- National Center for Environmental Compliance (NCEC),
- National Center for Water Research and Studies (NCWRS)
- Saudi Authority for Industrial Cities and Technology Zones (MODON),
- Small & Medium Enterprises General Authority (Monsha’at),
- Saudi Agricultural and Livestock Investment Company (SALIC),
- National Agriculture and Fisheries Committee at the Federation of Saudi Chambers,
- Agriculture and Water Committee at Riyadh Chamber of Commerce,
- International Cooperation Department at Riyadh Chamber of Commerce,
- Al-Qassim Chamber of Commerce,
- Al-Ahsa Chamber of Commerce,
- Japanese private firms in Saudi Arabia,
- Many Saudi Arabian private firms in the Kingdom.

Table 1-8: Schedule during the first field survey period

Date（Day）	Venue	Destination	Interviewee（Title）	Agenda	J. Motoyama	T. Onozato	H. Niimura	T. Inoue	K. Kudai
Sept. 17(Fri)~ 18(Sat)	Tokyo ~ Riyadh	Proceeding to Saudi Arabia by night flight via Qatar		・Moved from Tokyo to Riyadh City					
19（Sun）	Riyadh	The Embassy of Japan in Riyadh	H.E. Mr. Iwai, Ambassador Iwai, Mr. Miyake, Minister, Secretary Mr. Hashi,	・Courtesy Visit ・Discussions on the Field Survey and Request for Support		●	●	●	●
		JICA Saudi Arabia Office	Mr. Kobayashi, Resident Representative	・Discussions on the Field Survey and Request for Support		●	●	●	●
		JETRO/JCCME　Riyadh Office	Mr. Sho, General Manager, JETRO Mr. Muto, General Manager & Mr. Naito, Deputy GM, JCCME Riyadh Office、	・Discussions on the Field Survey and Request for Support		●	●	●	●
20（Mon）	Riyadh	MEWA NCRWS	Prof. Mansour A. Al-gami	・Explanation on the Field Survey and Request for Support		●	●		
		MEWA Plant Management	Dr. Mohammad Almutari (Deputy Director of Agriculture Wealth Department)	・ Interview Survey on the issues of Agricultural Policies, Irrigation Systems, and Farming Technologies				●	●
		CEPCO	Mr. Hekmat Azem（Sales Director）	・Water-saving valvees, water-saving shower heads ・ Project for water leakage survey and construction of a rainwater distribution facility in Jeddah ・ Installation of Badger's open water flow meter ・Water leakage investigation using helium gas			●		●

21（Tue）	Riyadh	Estidamah	Dr. Abdulaziz Alharbi (Technical Consultant)	・ Observation to research facilities, ・Presentations by Estidama (facility outline, vertical farming, ・ Cost sharing on the joint research works with private companies, etc.)		●	●	●	●
		NWC	Mr. Jeremy White (Customer Service Quality Director)	・Explanation on the Field Survey and Request for Support		●			
		MEWA NCWER	Eng. Fahhad Aldosary, (General Mnanager)	・Explanation on the Field Survey and Request for Support		●	●	●	●
		Riyadh Chambers	Dr. Ibrahim Alturki (RCC chairman)	・ Presentation on water-saving irrigation technology in Japan		●	●	●	●
22（Wed）	Riyadh	SIO Riyadh Office	Eng. Fahad Al-Shammary (SIO Riyadh Operation Manager)	・ Observation to irrigation facilities (pumping stations, water distribution tanks) and farm-houses using sewage recycled waters		●	●		
		Agriculture Farm	Eng. Fahad Al-Shammary (SIO Riyadh Operation Manager)	・Observation to a farm lands that uses recycled water		●	●	●	
		Irrigation Facilities	Eng. Fahad Al-Shammary (SIO Riyadh Operation Manager)	・Observation to water supply facility to the farm land carrying recycled waters		●	●	●	
		MISA	Ms. Nuha Alhashash	・Discussion on the Delegation Program			●		●

23（Thu）	Riyadh	Preparation to the Survey		・ Data collection		●	●	●	●
24（Fri）	Riyadh ～ Buraydah			・Moved from Riyadh City to Buraydah City		●			●
25（Sat）	Riyadh or Buraydah	Preparation to the Survey		・Data collection		●		●	●
26（Sun）	Buraydah	MEWA Buraydah Branch	Eng. Alman Alsoweine (General Supervisor, NNW sectors)	・Presented Japan's water-saving irrigation technology, etc., ・There is a request for pest control technology for Date Tree		●		●	●
		Al Qassim Chambers	Mr. Mohammed Abdulkareem (Chief of Chambers)	・Presented Japan's water-saving irrigation technology, etc.,		●		●	●
		Ghazal Resort	No Name is given	・Observed the cultivation of strawberries in the green house, ・Presented Japan's water-saving irrigation technology, etc., ・Inspection to air cooling systems using evaporization heat method in gree house		●		●	●
	Riyadh	Making appointments with private firms		・Data collection					

27（Mon）	Buraydah	Sewage Treatment Plant	Eng. Thamer (BWWTP Manager)	・30 to 40% of recycled water is used for irrigation water		●		●	●
		Osailian Forest	Eng. Abdullah Alsubaihi (QNP Manager)	・ Recycled waters are used for afforestation and greening. ・A place for relaxation for residents who will enjoy picnics in the future are currently developing		●		●	●
		Portable Water Treatment Plant	Mr.Ibrahim Alhomaid(Supervisor)	・Visited to the Buraydah water purification plant		●		●	●
		Governor Meeting	The Governor of Buraydah	・Courtesy visit		●		●	●
		Alwasael factory	Eng.Saleh Almushaigeh (CEO)	・ Mainly irrigation pipes are manufactured and sold, but quality of products is poor		●		●	●
	Riyadh	NWC	Mr. Jeremy White (Customer Service Qualty Director)	・Selection methods for a smart meter ・Updating conditions of Meter (10 years is standard period) ・DMA management (flow rate, hydraulic pressure monitoring system) and procurement methods for water leakage investigation services ・Sahara, water leakage investigation using smart balls ・Water leakage from water pipes and saddles ・NWC's Basic Policy on Future Tube Types (HDPE)			●		
		Alkhorayef Water & Power Technologies	Eng. Fahad Faisal Al-jadaan	・Sharing market information and needs in the agricultural field ・Introduction of water supply personnel			●		

28（Tue）	Buraydah	Sewage Treatment Plant	Eng.Faris Alredi (Supervisor)	・Visit to the Sewage Treatment Plant in Buraidah City (including the Water Quality Test Labo)		●			
		Portable Water Treatment Plant	Mr. Ibrahim Al-Homaid (Supervisor)	・Visit to the Buraidah Water Purification Plant (including the Water Quality Test Labo)		●			
		Mahasil	Mr. Mohammed Almallouhi (GM)	・Observation to farms that have introduced a high-tech technology, where cultivating tomatoes at many green houses, recycling wastewaters generated in green facilities, controlling the climate in the facility, and conducting sorting after tomato's harvest and packaging.				●	●
		Hadhim Date & Food Products	Mr. Abdul Al-Twegry (President)	・Visit the company that cultivates, processes and sells dates				●	●
	Riyadh	Aramoon	Mr. Mujeeb M Kasim	・Market information on water leakage survey in Saudi ・DMA flow rate and hydraulic monitoring system ・About GIS conditions and outsourcing status for renewal ・Conditions of pipeline and leakage investigation due to intermittent water supply ・About the construction of a training yard for non-revenue water management			●		

29（Wed）	Unayzah	Sewage Treatment Plant	Mr. Essam al.dakheel (Supervisor)	・Observation to Unayzah city sewage treatment plant (including water quality test labo)		●			
	Buraydah	Portable Water Treatment Plant	Mr. Ibrahim Al-Homaid (Supervisor)	・Visit to the Buraydah Water Purification Plant (including the Water Quality Test Labo)		●			
		Local Farm A in Al Jadi dat (low tech)	Mr. Mohammed Al-Shaye (Farmer)	・Observed irrigation methods and cultivation methods in green houses, and listened to issues.				●	●
		Local Farm B in Al Jadi dat (low tech)	Mr. Mohammed Al-Shaye (Farmer)	・Observed to the farm where conducting irrigations such as center pipette and drip irrigation				●	●
		Local Farm C in Al Jadi dat (middle tech)	Mr. Mohammed Al-Shaye (Farmer)	・Observed to a farm where regulating temperature in the green house and removes salt from irrigation water by RO device				●	●
		Hatheem Agriculture Company	Mr. Mohammed Al-Shaye (Farmer)	・Observed to the attached vast date farm, center pivot and drip irrigation facility				●	●
	Riyadh	NCWER	Eng. Fahad Howaizy Al Dosari (CEO) Mr. Thabit Mehmoud Al Safad	・Market conditions for saddle faucets, construction tools, and stainless steel corrugous tubes ・Selection and procurement of equipment by EPC (Engineering Procurement Construction) companies			●		
		Utilities Survey Co.	Eng. Hashem Al Malki	・Pipeline survey using GPR and pipeline detectors ・About valve failure and buried valve exploration			●		

30（Thu）	Buraydah	MEWA Buraydah Branch	Mr. Salah Al-abduljabbar Mr.Aiman Y omoray (Operation and maintenance manager)	・Asked questions about the structure of related organizations in the agricultural sector in Al-Cassim, the status of irrigation facilities, the status of farming, the collection of irrigation water fees, and the use of recycled water.		●		●	●
		Central Water Quality Lab of MEWA	Mr. Ayad N.Al Dalbhi (Manager)	・Visited to the Central Water Quality Test Labo in Buraydah City		●			
		Portable Water Treatment Plant	Mr. Ibrahim Al-Homaid (Supervisor)	・Visited to the Buraydah Water Purification Plant (including the Water Quality Test Labo)		●			
30 (thu)	Riyadh	Alkhorayef Water & Power Technologies （Water Sector)	Mr. Hassan Gamal Ali Tahen (Director of Procurement Department) Mr. Phillip Zacharia (Purchase Specialist)	・Undertaking an O&M contract and providing services including meter installation at certain district in Riyadh. ・It is a business consignment that detects the water supply pipeline and install the meter in each household where no meter is installed, and after confirmation by temporary drilling to the pipeline, the meter will be installed. ・Water leakage investigation using helium gas is carried out. ・It is noted that the company is interested in saddle water plugs, punches, and stainless steel wave water pipes which are made in Japan, because they differ from the specifications applied in Riyadh City. ・Various tube types are used in Riyadh, and it is good if the same fitting can be used along with the O&M contract.			●		

	Riyadh	Amehah Suleman A l-Enzi	Mr. Amenah Suleman (CEO)	・Saddle faucets (cast iron) are not available in Saudi Arabia. ・There is a stainless steel tube, but wavy tubes are not available.			●		
		SAMMAN	Mr. Fahad Howaizy Al Dussamytif Ali Abdulkareem (Chief Executive Officer) Mr. Abdul Aziz Al-Abdlkareem (Vice Chairman & Managing Director)	・Water-saving equipment is highly competitive. ・Market for water leakage surveys ・Market information such as water pipes, saddle faucets, fittings, etc. at Riyadh			●		
1 (Fri)	Buraydah ～ Riyadh			・Move from Buraydah City to Riyadh City		●			●
2 (Sat)	Riyadh ～ Al Hofuf			・Move from Riyadh City to Al-Ahasan district		●			●
3 (Sun)	Al Hofuf	Dates & Palm Center	Mr. Khaled Al-Husseini (Manager of Dates and Palms center)	・Visited research institute which is conducting research works on dates cultivation techniques and involved in the development and production of dates products		●		●	●
		Al-Ahsa Chambers	Mr. Abdulaziz Al-Moosa (Manager)	・Presented Japan's water-saving irrigation technology. ・Interest was shown in viotech for dates cultivation, breeding technology, postharvest technology, fruit harvesting technology and water-saving irrigation technology		●		●	●
	Riyadh	Miyahona	Mr. Abdullah James Greenwood, (Engineering Manager) (Chief Engineering Manager of Medina and Tabuk Cluster) Mr. Nicolas (NRW management leader) participated remotely (On-line from Greek).	・Management representatives for Medina and Tabuk Cluster ・Negative effects by intermittent water supply on water quality, pipeline damage, and meter were discussed ・interest was shown in Japanese technology related to the reduction of non-revenue water. ・Water pressure monitoring in one in 500 homes			●		

4（Mon）	Al Hofuf	Natural Fountain	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Observation to water spring areas		●		●	●
		3 Sector Reclaimed Water Facility	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Observation to a facility that relays recycled water from sewage treatment plant. Water is sent from 300km away from the Hoba. The irrigation water (recycled water) is distributed to 1,200 farms by remote operations ・The salty waters discharged to agricultural drainage channel wants to be reused.		●		●	●
		Water Quality Laboratory	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Inspect and monitor the water quality of recycled water for irrigation and observed to the inspection facilities ・SIO is extending care for soil contamination by recycled water irrigation and by eggs of parasites, and monitering water quality of recycled water irrigated to vegetables and fruits that are eaten without heating		●		●	●
		Kilo 7 Station	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Observation to the pumping station which is relaying recycled water to Zone 10. A disinfection facility by UV and other (using equipment from Germany, Canada, Turkey, etc.) is attached.		●		●	●
		A local Farm	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Observed to the farm where rice cultivation is carried out		●		●	●

4 (Mon)	Al-Hofuf	Agricultural Experimental Station	5 (Tue)63:J65	・Visited to facilities that verifying the effects of irrigation systems using recycled water for plant cultivation, irrigation facilities and equipment. ・They are conducting empirical research on vegetable cultivation by hydroponic cultivation by vertical farming.		●		●	●
	Riyadh	Alkhorayef Water & Power Technologies	Mr. Ahmad Salem (Team Leader)	・Site Inspection to meter installated O&M site ・Pipeline exploration with a metal detector ・Conduct water pipe prospecting and check the pipeline conditions ・Take a picture of the water supply pipe and report it to NWC (after NWC approval, the installation work of the meter will be carried out)			●		
5 (Tue)	Al Hofuf	Kilo 25 Station	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Observation to the pumping station which is relaying recycled water. This facility is used only in emergencies.		●		●	●
		Environmental Station & Forest Project	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Visited a facility that providing irrigation to 100,000 trees using recycled water and agricultural wastewater, in order to make green belts.		●		●	●
		Meeting with SIO	Mr. Hesham Alabdulmohsen (SIO Manager of Environmental compliance)	・Set improvement targets to increase irrigation efficiency from 53% → 75% and reuse of irrigation water from 17% to 70% by 2030, use of dam's water, water quality improvement, entry of private maintenance service, establishment of water conservancy unions, capacity building for irrigation engineers, and the necessity of formulating agricultural master plans. ・Requested by SIO to introduce a technology to reduce the salinity of agricultural wastewater by half of the current level.		●		●	●

5 (Tue)	Al Hofufu ～ Riyadh			・Move from Al Ahasan district to Riyadh City		●			●
	Riyadh	Advanced Water Technologies	Mr. Eng. Ibrahim N. Alsubeh (CEO) Mr. Ashraf Mahammad Khayat (Executive Director of Business Development)	・The organization is supporting the expansion of overseas companies and conducts joint research works ・They can support the opening of a local factory and related activities with local agents. ・Since they are supporting the companies who wish to expand their business to Saudi market, they are also ready to support any company which is found through this survey.			●		
		Gulf Specialized Water Service Co.	Mr. Abdullatif I. M. Al-Shaikh (President) Mr. Nawaf A.I. Al-Shaikh (Vice President) Mr. Nabi Ahmed M. Hussain (Technical Manager)	・The company is involved in the construction of seawater desalination plant using RO membranes and implement O&M projects. ・The market is highly cost competitive and sometimes price takes precedence over quality ・Collected information on piping information and construction specifications ・Exchanged the information on internal blockages, floats, and sediments in water pipes. About the cleaning in the pipeline by pig			●		

6 (Wed)	Tokyo ~ Riyadh			・Moved from Tokyo to Riyadh City	●				
	Riyadh	Japanese Trading Firm A	General Manager, Riyadh Branch	・ Collected information on the business environment in Saudi Arabia	●			●	●
		MEWA Waste Management	Dr. Abdullar Faisal Alsebaei (Acting CEO)	・Interview on the current status of solid waste treatment (including sewage sludge), policies, and legal systems		●			
		National Center for Environmental Compliance	Mr. Saad Yahya Alzubaidi (General manager of partnership and revenues development)	・Interview on the current conditions of environmental monitoring and policies in the field of water quality		●			
		Al Bawani Water and Power	Mr. Ali Taheseen (Operation Director)	・Hearing on the business environment and procurement conditions by private companies in the water treatment field of Saudi Arabia		●			
		NWC Riyadh City Business Unit	Mr. Nasser Al-sahaoud (Manager, Valve operation unit) RCBU office Eng. Sami Aldoraihim (Acting Water Network Manager) Fawaz Alharbi (Smart Operation Manager) Asim Al-Turki (GIS Manager)	・Failure of partition valves (inspection of failure situation site) ・Helium gas leak investigation (site inspection) ・Repairing of leakage on water supply pipes (site inspection) ・About piping quality at leaking areas ・About GIS			●		

7 (Thu)	Riyadh	MISA	Mr. Shaheen Almutairi International Affairs	・Discussion on the Delegation Program	●				●
		Riyadh Chambers	Dr. Ibrahim Alturki Federation of Saudi Chambers	・Discussion on the Delegation Program	●				●
		Alkhorayef Water & Power Technologies	Mr. Ahmad Salem (Team Leader)	・Joint works for water supply pipes (site inspection)			●		
		Saudi Meters Company	Mr. Mohammed Khairy (Factory Manager)	・The company is desiring a collaboration with flowmeter manufacturers			●		
8 (Fri)	Riyadh ～ Tokyo			・Move from Riyadh City to Tokyo				●	
9 (Sat)		Preparation to the Survey		・Data Collection	●	●	●		●
10 (Sun)	Riyadh	SWCC	Dr. Ahmed Al-Arifi (Director General)	・Discussions on issues related to seawater desalination	●	●	●		●
		Riyadh Chambers	Mr. Mansour Al Ajmi	・Discussion on the Delegation Program	●	●	●		●
		MEWA Environmental Agency	Dr.Ali Omair Alomair (General Director of the General Department for Legistration and Environmental Performace, Deputy Minsitry of Environment)	・Obtaining environmental and wastewater standards in Saudi Arabia		●	●		

11 (Mon)	Riyadh	ksn Corporation	Tetsuya Ishibashi	・Confirmation on the progress of the survey for business environment at the neighboring countries of Saudi Arabia (Online)	●				●
		Estidamah	Dr. Abdulaziz Alharbi Technical Consultant	・Discussion and observation to the research activities in the agricultural field	●				●
		Agriculture Farm	Eng. Fahad Al-Shammary	・Site inspection to examples of irrigation project using sewage treated waters	●				●
		Waterena Factory	Mr. Nasser Alsenaid (General Manager) Mr. Tarek (Production Manager) Mr. Saiid (Commercial RO Section)	・Pump ・Tank (storage tank) ・RO membrane factory inspection ・Technical Cooperation with Japanese Companies			●		
12 (Tue)	Riyadh	JETRO/JCCME Riyadh Office	Mr. Hideki Sho,General Manager, JETRO, Riyadh Office Mr. Riku Inden, Vice President, Saudi Japan Vision Office Mr. Yuta Naito, Deputy GM, JCCME, Saudi Arabia Office	・Collected information on the business environment in Saudi Arabia ・Performance of Japanese companies' operations in Saudi Arabia, management issues, etc.	●	●	●		●
		Monsha'at	Mr. Fahada Alsaadoon (Partnership Analysist)	・Performance and supporting program to SMEs	●				●
		MODON	Mr. Abdulrahman Mahzari (Acting Director of Facility Management)	・Water supply and sewerage treatment in industrial parks	●	●	●		●
		Japanese Trading Firm B	Country Representative for Saudi Arabia General Manager	・Collected information on the business environment in Saudi Arabia	●		●		●
		Advanced Water Technology	Mr. Ashraf Mohammad Khayat (Executive Director of Business Development)	・Hearing on the business environment and procurement conditions by private firms in the water treatment field of Saudi Arabia		●			

13 (Wed)	Riyadh	MEWA	Mr. Fahad Al-Omani	・Report on the first field survey, etc.	●	●	●		●
		NWC	Mr. Jeremy White (Customer Service Quality Director)	・Report on the first field survey, etc	●	●	●		●
		Almokhtabrat Al-Arabia Trading Est	Mahmoud Abdelghany (Technical Manager)	・Hearing on the business environment and procurement condiitons by private firms in the field of water quality analysis in Saudi Arabia		●			
		Saudi Meters Company	Mr. Mohammed Khairy (Factory Manager)	・Company wishing to establish a cooperative relationships with Japanese companies dealing with water meters and flow meters	●		●		●
14 (Thu)	Riyadh	JICA Saudi Arabia Field Office	Mr. Tsutomu Kobayashi, Resident Representative, JICA Saudi Arabia Office	・Report and consultation on the first field survey	●	●	●		●
		The Embassy of Japan, Riyadh	・Mr. Kengo Hashi, Second Secretary ・Mr. Tomoya Ishiguro, Second Secretary	・Report and consultation on the first field survey	●	●	●		●
15 (Fri)	Riyadh ～ Tokyo			・Move from Riyadh City to Tokyo	●	●	●		●

Source: JICA Survey Team

3) Preparation of the Delegation Program

During the first field survey period in Saudi Arabia, JICA Survey Team has set following objectives for preparation of the Delegation Program:

1) Objectives of the Delegaton Program

- To have meetings with Government organizations, including MISA and Riyadh Chambers, and request them for cooperation on the implementation of the Program by explaining the Delegation Program.
- To have meetings with the Chamber of Commerce and Saudi private firms and request them for cooperation in inviting attendees to the Program as well as to grasp Saudi private firms' expectations towards Japanese companies' technologies/products.
- To visit water supply facilities, sewage treatment facilities, water quality examination laboratories, farmers, agriculture firms and irrigation facilities together with the other team members and obtain information for the site visit plans under the Delegation Program.
- To visit candidate venues for the Delegation Program and obtain information.
- To have meetings with Japanese agencies, especially JETRO and JCCME, and obtain information and points for considerations to conduct the Delegation Program
- To visit candidate accommodation facilities for Japanese attendees to the Delegation Program.

2) Achievement of the First Field Survey

As a result, JICA Survey Team achieved the following outcomes.

- After having meetings with MISA twice and requesting their cooperation, JICA Survey Team has received their positive feedback on our request.
- Having requested to Riyadh Chambers, JICA Survey Team has managed to have an offer to use the venue for the Delegation Program.
- Having requested to MEWA and Riyadh Chambers for attendances to the Program and deliveries of speeches, JICA Survey Team has received their positive feedback on our request.
- JICA Survey Team has obtained information for selecting site visit locations of the Delegation Program.

Based on the outcomes above, JICA Survey Team will design the details of the Delegation Program by hearing opinions and requests from Japanese firms who intend to join the Program.

(3) First Domestic Survey

All the information collected on the current conditions and issues in the water field of Saudi Arabia, information on the needs for support, and investment environment collected during the periods of the domestic preparatory survey and the information gathering survey from Government organizations and private firms of Saudi Arabia which were conducted by the online method, and the first field survey conducted by visiting Saudi Arabia, were sorted out and analyzed. In addition, those technologies and products possessed by Japanese private firms were reviewed from the view point that those technologies and products may contribute to the development issues of Saudi Arabia, then those were listed in the form of project sheets. In the listing, applicability of the technologies and products which are possessed by Japanese firms were judged by giving priority to the contribution to solve development issues and the needs for support anticipated by related organizations in Saudi Arabia, the penetration status of competitive products in the Saudi markets, sales price (market size), as well as competitiveness in terms of performance and price of Japanese firms' products (competitive advantage in the market). Therefore, such technologies and products that are not deemed by the Japanese firms as suitable to put into the markets of Saudi Arabia considering the scale of Saudi markets, were abandoned for listing as a project sheet. The interim report meeting toward Japanese private firms was held by organizing the information obtained through such analytical excercises. In addition, at the interim report meeting, participants to the interim report meeting were guided and called for the delegation program to Saudi Arabia. After the interim report meeting, opportunities for individual dialogue between investment firm related to the Saudi Government which JICA Survey Team met during the first field survey and Japanese private firms were organized, and information and opinions of both sides were exchanged for the possibility of future alliances.

1) Sorting out of information on the subjects to be surveyed (sorting out and analysis of current conditions and issues), summarizing the directions toward the second field survey and consultation with JICA

The long list shown in the following table was prepared on the technologies and products of the Japanese private firms by sorting out and analyzing the survey results carried out so far at the completion of the first field survey. In response to these longlists, JICA Survey Team has evaluated the market size of Saudi Arabia for which Japanese firms may consider as appropriate for them to entering the market, the superiority of Japanese firms' technologies and products in the Saudi Arabia market, and the degrees of preparadness of Japanese firms for entering to Saudi market, then JICA Survey Team has completed the shortlist.

Table 1-9: Evaluation of technologies and products that contribute for solving development issues in Saudi Arabia

Legend: ○: Agree, △: Somewhat agree ×: Disagree

Sector	No.	Technologies and products that are expected to contribute for solving the development issues identified	Market size that Japanese firms evaluate as an adequate	Competitive Edges of Japanese Technologies/ Products in the Markets	Already working in the Markets	Readiness for Market-in by the firms
Agriculture Sector	1	Film farming technologies contributing to water-saving agriculture	○	○	×	○
	2	Soil water retention material that enhances water retention and has water saving effects	○	○	×	○
	3	Biostimulant materials to reduce water intakes for agricultural crops	○	○	×	×
	4	Pressure-corrected drip irrigation tubes which increasing drip irrigation efficiency	○	○	×	×
	5	AI-based tomato ripeness assessment and robotic harvesting devices	○	○	×	×
	6	Introduction of technology for water-saving plant factories	○	○	×	×
	7	Introduction of small desalination equipment for agricultural well water which is becoming increasingly salty water	○	△	×	△
	8	Environmental monitoring systems (air cooling systems, etc.) for Agriculture lands and Greenhouses	○	△	×	×
	9	Pipelines and Irrigation Systems for Recycled Waters for Agricultural Uses	○	△	×	×
	10	Remote sensing technologies (drone + AI) for grasping pests damage on the Dates Trees	○	△	×	×
	11	Smaller Tractors made in Japan	×	△	×	×
Water Resource Sector	12	Smart meters for well water data collection survey	○	△	×	△
	13	Rehabilitation Technologies for Irrigation Water Pipelines (Non-excavation methods)	○	○	×	×
	14	Construction of underground dams for Rainwater Utilization	△	○	×	×
Water Supply Sector	15	Helium gas detector for water leakage investigations by helium gas	○	△	×	×
	16	Water tap valves with saddle	○	○	×	△
	17	Stainless wave tubes	○	○	×	×
	18	Soft seal partition valves made in Japan	○	○	×	△
	19	Ultrasonic flow meters and electromagnetic flow meters	○	△	×	△
	20	Diagnosis technologies for water supply networks by AI	○	○	×	×
	21	Integrated Water Management System in MODON (Industrial Parks)	○	△	×	△
	22	Training Yard for reduction of Revenue-free waters	△	△	×	×
	23	Review of water supply pipeline construction technologies and engineer qualification system	△	△	×	×
Water Quality Improvement Sector	24	Desalination technologies of recycled water for Irrigation, Various membrane separation technology (RO membrane, NF film, etc.), Electrodialysis technology, Evaporation drying technology using sunlight	○	○	×	△
	25	Disinfection technologies for recycled water for irrigation purposes (ultraviolet rays, etc.)	○	○	×	△
	26	Simple water quality analysis technologies for central water quality testing laboratories in SIO and Al-Qassim Province (pathogenic microorganisms, heavy metal measurement)	○	○	×	△
	27	Water quality monitoring units to monitor water pollution in environmental waters such as groundwater including water quality sensors (turbidity, COD, DO, etc.) and data collection and transmission equipment	○	○	×	△
	28	Introduction of Jyoukasou to the areas where sewage systems are yet to be introduced in Al-Qassim Province	○	○	×	△
	29	Zero Liquid Discharge (ZLD) Technology for Seawater Desalination Plants and Water Purification Plant in Buraydah City (High Temperature Groundwater Desalination Facility)	○	○	×	△
	30	facilities, water purification plants and sewage treatment plants in Buraydh City (water quality monitoring technologies using water quality sensors)	○	○	×	△
	31	Oxygenation ditch method treatment technologies for sewage treatment plant (aerobic and anaerobic zone control operation of OD method)	○	○	×	△
	32	High-efficiency sewage treatment machines for sewage treatment plant (sand collectors, screens, mechanical diffusers, dehydraters)	○	○	×	△
	33	Effective use of sludge for sewage treatment plant (composting devices,	○	○	×	△
	34	Introduction of Johkasou for MODON (industrial parks)	○	○	×	△
	35	Sludge treatment devices for MODON (industrial park) (composting devices)	○	○	×	△

Source: JICA Survey Team

JICA Survey Team has prepared a project sheet for the shortlisted projects and compiled it as explanatory materials to Japanese private firms. Prior to the reporting meeting to Japanese private firms, JICA was briefed in advance by JICA Survey Team on the contents of the explanatory materials (Annexes 1~4).

2) Collection and sorting out of information on the applicability of technologies and products and confirmation of intention to promot these into Saudi Arabia.

JICA Survey Team has conducted the matching of development issues and needs for support (results of issue-sorting and its analysis) in Saudi Arabia with Japanese technologies and products being listed in advance, and the results of these matching excercise and the interest of Japanese private firms in Saudi Arabia markets, intention to promote their businesses into Saudi Arabia, familiarity of the Japanese private firms with overseas operations, etc. were summarized in the Intelim Report. With regard to information on Japanese private firms which are particularly interested in and eager to expand their businesses into Saudi Arabia, the draft contents of the introduction to Saudi Arabia through the delegation program were clarified by keeping in mind that these firms will be participating to the delegation program.

3) Holding an Interim Report Meeting (online method) to Japanese private firms who are interested in solving problems in Saudi Arabia.

An online report meeting to Japanese private firms was held on October 25, 2021 and the activities performed were explained. There were 58 participants from Japanese private firms who attended this report meeting. As materials for the report meeting, the applicability of technologies and products of Japanese private firms in the field of agriculture and water supply was explained in detail, which was followed by detailed explanations on promising individual projects. The explanatory materials used at the Interim Report Meeting are as described in Annex 2. In the report meeting, two schedule were proposed for the delegation program, and encouraged the participants of Japanese private firms to take a part of the delegation program. At the end of the report meeting, JICA Survey Team has conducted an online survey on intention of the participants for attending the delegation program, and analyzed its results, then reflected these results for finalization of the delegation program.

4) Holding local online mini-seminars for each sector.

Those Japanese private firms having cutting-edge technologies and who had shown particular interest during the first field survey were called on by investment companies related to the Government of Saudi Arabia, then individual online meetings between the two agricultural firms and the investment company were conducted. In the water supply field, JICA Survey Team has also held online meetings with two Japanese firms, because water supply parts manufacturers in Saudi Arabia have expressed interest in the products of Japanese firms. In the field of water quality improvement, online meetings were held between two Johkasou manufacturers and a disinfection equipment manufacturer for water quality improvement.

Johkasou means a domestic wastewater treatment tank.

5) Examination of the business environment and its improvement plans for Japanese private firms.

Based on the results of the domestic preparatory survey and the first field survey, information on the business environment at Saudi Arabia was collected, sorted out and analyzed on important points and issues for Japanese private firms to conduct a business in Saudi Arabia. In addition, based on the results of the business environment survey conducted for Saudi Arabia and major neighboring countries (UAE, Turkey, and Egypt) which was undertaken by the outsourcing contract method, JICA Survey Team has examined points for business environment improvement for Saudi Arabia. Details are described in Chapter 5, 5.1 Business Environment of Overseas Companies in Saudi Arabia.

6) Examination of problem solutions related to water saving and leakage measures in the water supply field.

Following the information gatherings through online-meetings with Japanese Government Agencies, Government Agencies of Saudi Arabia, private industrial organizations and private firms during the domestic preparatory survey period, various Government Agencies and private firms were directly visited by JICA Survey Team in order to make interviews to confirm development issues and to identify needs for support. In addition, JICA Survey Team has set hypotheses for the technologies and products of Japanese firms that are expected to contribute for solving development issues, and tried to verify the validity of hypotheses during the first field survey period. Based on these activities, JICA Survey Team has examined the challenges and needs for support in the water supply field of Saudi Arabia and applicable technologies and products of Japanese firms during the first domestic survey period. Details are described in Chapter 3: 3.1.1 Present conditions and issues in the water supply sector.

7) Examination of problem solutions related to water saving and water leakage measures in the agricultural field.

All the information related to the problem in the water saving and leakage measures in the agricultural field of Saudi Arabia which were collected in domestic preparatory survey and the first field survey, were sorted out and analyzed. Based on these activities, solutions for the development issues by applying the technologies and the products of the Japanese private firms were examined. Details are as shown in Chapter 4: 4.1.2 Issues and Challenges in the Agricultural Sector.

8) Examination of improvement measures related to water quality deterioration in water supply and agriculture fields.

Based on the results of the domestic preparatory survey works and the first field survey works, the present conditions and challenges of water quality improvement in water supply, sewage treatment and agricultural fields in Saudi Arabia were sorted out and analyzed. Based on these activities, JICA Survey Team has examined the technologies and products of Japanese private firms that seemed to be applicable in terms of water quality improvement against the development issues and extracted needs for support. More information is described in Chapter 3: 3.1.2Present conditions and challenges in the fields of Sewage and Water Quality fields.

9) Examination of proposals related to private sector collaboration

The issues related to private sector cooperation gathered throughout the domestic preparatory survey period and the subsequent survey period were sorted out, and the issues related to private sector cooperation for business implementation by Japanese private firms in Saudi Arabia in the future were summarized. The details are described in Chapter 5 and 5.5 Business Environment for Private Sector Collaboration. In addition, JICA Survey Team has summarized various support systems being provided by Japanese Government and quasi-Government Organizations including JICA, which are deemed recommendable to Japanese firms for penetrating them into the markets of Saudi Arabia after this survey is over. Details of the support system by Japanese government-related organizations are described in Annex 3: List of the Supporting Schemes for Overseas Business Promotion by various Agencies of Japan.

10) Planning of the Delegation Program

Based on the information obtained during the first field survey to Saudi Arabia, JICA Survey Team has created the Delegation Program plan. First of all, the Delegation Program was planned with the duration of 12 days for both the Water Supply Sector and the Agriculture Sector, along with the initial plan. Then, these plans were presented to Japanese private firms at the interim report meeting and requested for their attendances to the Delegation Program. JICA Survey Team has presented two options for the schedules; one for the period of 5thth to 16th days of December 2021 and the other for the period of 5th to 16th days of January, 2022. Along with these plans, important information such as mandatory requirements for Covid-19 including vaccinations and quarantines after coming back to Japan, and estimated costs to be met by the attendees including flight fares and accommodations, were provided.

JICA Survey Team has conducted a survey to the attendees of the interim report meeting by asking for their intention to the Delegation Program. For those who responded that they decided not to join or still under consideration, JICA Survey Team has asked them of the factors that make the attendances difficult. The survey results are as follows:

Table 1-10: Survey results for the Delegation Program

Q1. Intention to attend the Delegation Program

（the number of valid answer: 24）

Intend to attend either in Dec. or Jan.	0
Intend to attend if it is in Dec.	0
Intend to attend if it is in Jan.	0
Under consideration	6
Intend not to attend	18

Q2. For those who chose “Under consideration” and “Intend not to attend” in the question above, what are your concern?
Please select choices that you think are concerns. You can choose more than one choice.

Timing of the Delegation Program (busy at the end and the beginning of the year)	8
Duration of the Delegation Program (difficult to leave Japan for long time)	2
Internal procedure for an approval (difficult to obtain an approval by the deadline)	3
Cost (difficult to afford the cost)	9
Skeptic about the Saudi Markets	2
Products do not much the needs in Saudi Arabia	3
Already doing business in Saudi Arabia and no need to attend the Delegation Program	1
Do not have a plan to expand the businesses to overseas	0
Others (Please specify)	11
Answers from those who chose “Others” above. (Answers that make idenfifying companies’ name are deleted from the table)	
Our products do not match the needs in Saudi Arabia yet (low priorities)	
The number of staff in charge of overseas markets is small and they are engated in some other projects at the moment.	
Ater attending the report meeting, we think it difficult for our products to meet the needs in Saudi Arabia. But we hope to exchange information because we can see an opportunity in the future.	
We can’t attend it unless the quarantine period for the Covid-19 is shortened.	
Overseas business trips are still prohibited in our company	
The quarantine period after coming back to Japan is too long to go for a business trip	
We need to examine business activities in the other areas and the other projects	
We have already a plan to work in a different country for the concerned period.	

The Agriculture Sector

Company	Intend to attend	Duration of attendance
Firm A	Attend from Japan	Full schedule
Firm B	Partner in Saudi Arabia will attend	Short schedule (Seminar + a part of the site visits)

The Water Sector

Firm C	Attend from Japan	Full schedule
Firm D	An expat employee in Saudi Arabia will attend	Only attend Seminar and Business Matching Meetings
Firm E	A national employee in Saudi Arabia will attend	Only attend Seminar and Business Matching Meetings
Firm F	A national employee in Saudi Arabia will attend	Only attend Seminar and Business Matching Meetings
Firm G	A national employee in Saudi Arabia will attend	Short schedule (Seminar + a part of the site visits)
Firm H	A national employee in Saudi Arabia will attend	Only attend Seminar and Business Matching Meetings
Firm I	The distributor in Saudi Arabia will attend	Shortened schedule (Seminar + a part of the site visits)

Source: JICA Survey Team

After the interim report meeting, JICA Survey Team contacted the Japanese firms and encouraged their attendance. As of November 22, 2022, nine firms have expressed their intention to attend the Delegation Program which are listed above.

Because the number of attendees from Japan is very limited, JICA Survey Team has decided to accept attendees from local offices located in other countries surrounding Saudi Arabia as well as attendees from local sales distributors. JICA Survey Team has also decided to allow online attendees in order to introduce wider varieties of Japanese technologies/products.

Also, since most attendees chose the shortened schedule or only the seminars, JICA Survey Team has reviewed and changed the schedule in order to accommodate their needs. The schedule below is an example of the full schedule but is not applicable to every attendee, because JICA Survey Team intends to set up different options for the other attendees.

Table 1-11: The delegation program (Draft)

Date	Day	Program
7/Jan 2022	Fri	Depart Narita Airport for Dubai
8/Jan	Sat	Arrive at Riyadh
9/Jan	Sun	Visit to the Embassy of Japan, JICA Saudi Arabia Office, JETRO/JCCME Office
10/Jan	Mon	Seminar "Japanese Technologies contributing to Water Saving, Leakage Measures and Water Quality Improvement in Saudi Arabia". Business Matching meetings between Saudi Government Agencies/Private Companies and Japanese Companies.
11/Jan	Tue	Site Visit and Discussion with National Research and Development Center for Sustainable Agriculture (Estidamah). Proceed to Buraydah in Al Qassim Province Site Visit to Modon Industrial Park on the way to Buraydah.
12/Jan	Wed	Seminar "Japanese Technologies contributing to Water Saving, Leakage Measures and Water Quality Improvement in Saudi Arabia". Business Matching meetings between Saudi Government Agencies/Private Companies and Japanese Companies.
13/Jan	Thu	Site Visit to Agricultural Farms (Greehouses with Advanced Technologies and Regular Technologies) Site Visit to Buraydah Water Purification Plant & Sewage Treatment Plant Proceed to Riyadh and PCR Test
14/Jan	Fri	Depart Riyadh for Dubai
15/Jan	Sat	Arrival at Narita Airport

Source: JICA Survey Team

JICA Survey Team will finalize the Delegation Program and detailed plans of the seminars. JICA Survey Team will also request the followings to Saudi counter parties:

・Arrengement for a venue for the Seminar/Business Matching Meetings

・Inviting attendees to Seminar/Business Matching Meetings

・Delivering speeches at Seminar

・Coordination for site visits

・Coordination with organizations which the attendees are to visit

Chapter 2: Basic Information of Saudi Arabia

2.1 Basic information

Saudi Arabia occupies a large part of the Arabian Peninsula and has the largest land area in the Middle East. It is a country with coastlines in both at the Red Sea and the Gulf of Persia (Arabian Gulf), and the majority of the Country is desert. The climate of Saudi Arabia is very varied between inland and coastal areas, and capital city of Riyadh which is located at inland area has a dry climate with daytime temperatures exceeding 40 degrees, but relatively easy to spend at night. On the other hand, Jeddah, the second-largest city facing at the Red Sea, has little seasonal temperature difference and high humidity. There is also a small amount of rainfall in the mountainous area facing the Red Sea. In the coastal areas of Arabian Gulf, the temperature difference is severe, it experiences high temperature and humidity in summer season but the temperature cools down in the winter because of strong seasonal winds from the northwest.

Saudi Arabia was founded by the Saud family in 1932, and the political system has been ruled by the Saud family. There is no Diet, and the King is the highest authority of legislation, judiciary, and administration. The roles of the legislative body are served by the Council of Ministers, and the Advisory Council gives advises to the King. Royal family occupies key posts such as Ministers and Governors. There are 13 provinces nationwide where state Governments and local councils are attached.

The official language is Arabic, but English is also commonly used. Saudi Arabia is well known as the birthplace of Islam, and Sunni-centered Islam is widely believed. Saudi Arabia is home to Mecca and Medina, the two great holy sites for Islam, and many pilgrims visit the Hajj every year. In Saudi Arabia, the koran's precepts are widely applied to social life, thus understanding of Islam is essential for doing business. The basic data of the Saudi Arabia is as follows.

Table 2-1: Basic data of Saudi Arabia

Article	Contents
Name of Nation	Kingdom of Saudi Arabia
Land area	2,149,700 square kilometers (about 5.7 times the area of Japan)
Population	35,558,180（November, 2021, Source: United Nation）
Capital City	Riyadh City
Religion	Islam (Sunni: 80-90%), Shiite (10-20%)
Form of Government	Monarchy (King Salman bin Abdulaziz Al Saud)
Parliamentary system	No parliament, 150 advisory council members (30 of whom are female members)
Nominal GDP	$701.5 billion (2020)
Major Export Items from Japan	Transportation equipment (62.1%), Products by raw material (17.3%), General machinery (11.6%)
Major Imports Items by Japan	Mineral fuels (95.9%), Chemical products (1.7%), Nonferrous metals (1.0%)
Japanese firms located	Number of Corporations: 113 (Source: Ministry of Foreign Affairs, "Survey on Japanese Companies Expanding Overseas" 2020 Survey)
Bilateral agreements	Saudi Arabia-Japan Tax Convention (effective on September 1, 2011) Saudi Arabia-Japan- Investment Agreement (effective on April 7, 2017) Saudi-Japan Vision 2030 (agreed on March 13, 2017) Saudi Vision 2030, 2.0 (agreed on June 18, 2019)

Source: JETRO, MOFA and others

2.2 Economic performance

2.2.1 Current Status of Economic Activity

Saudi Arabia is the largest oil producer in the Middle East and the second largest economy after Turkey. The Country is ranked as second only after U.S.A, the world's largest daily oil producer, and about 90% of total exports and about 80% of its fiscal revenue are dependent on oil. The economic structure of Saudi Arabia is a monoculture structure depending mainly by crude oil productions, and break away from the oil-dependent economy and increase employment opportunities for younger generation are considered as the challenges faced. The figures for nominal GDP and growth rates in Saudi Arabia over the past decade are shown in the figures below.

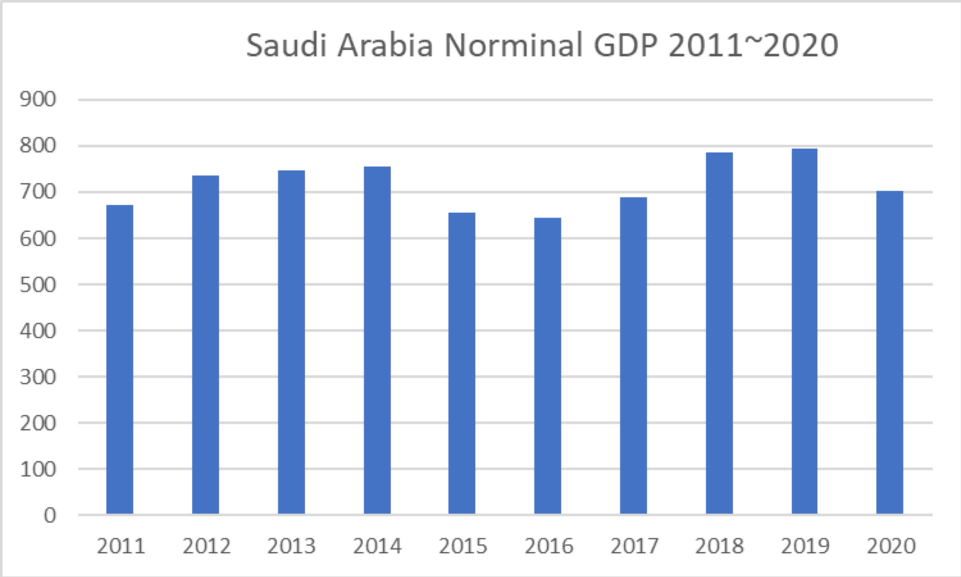


Figure 2-1: Changes in nominal GDP in Saudi Arabia

Source: Prepared by JICA Survey Team based on the Date of JETRO

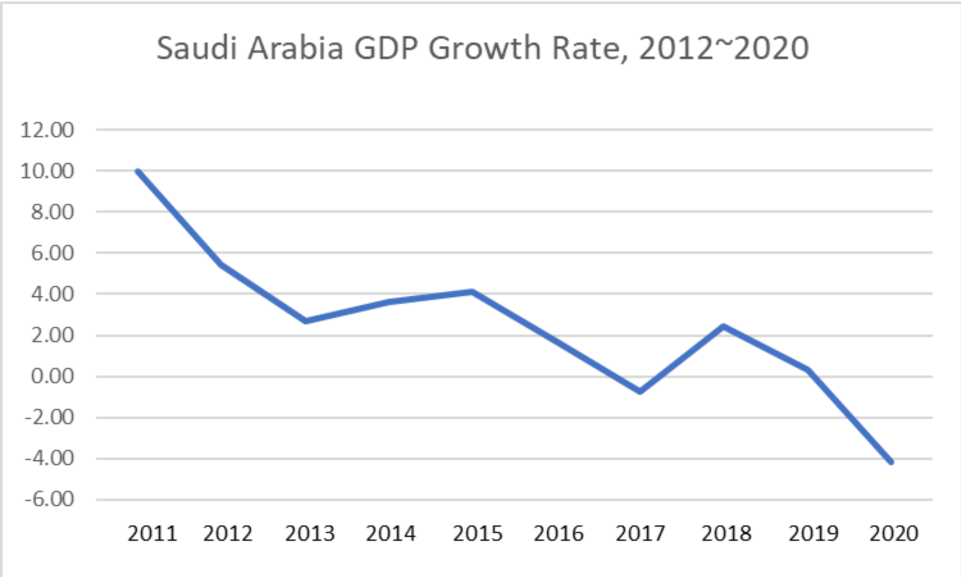


Figure 2-2: Real GDP growth rate in Saudi Arabia

Source: Prepared by JICA Survey Team based on the Date of JETRO

The nominal GDP of the Saudi Arabia has been sluggish for the past decade, and GDP growth rate during the same period has been consistently declining. In particular, from the years of 2019 to 2020, the double blow consist of the declines in oil prices and the constraints on the economic activity caused by Covid-19 has forced the economies of Saudi Arabia to a significant deceleration (negative growth). The figures of the major economic indicators of Saudi Arabia over the past five years are as follows:

Table 2-2: Trends in key economic indicators in Saudi Arabia over the past five years

Key Indicators	2016	2017	2018	2019	2020
GDP (Billion US$)	644.9	688.6	786.5	793.0	701.5
GDP per Capita (US$)	20,289	21,114	23,530	23,266	20,178
GDP Growht Rate (%)	1.87	-0.74	2.43	0.33	-4.14
Inflation Rate (%)	2.07	-0.84	2.46	-2.09	3.45
Imports (Million US$)	140,169	127,910	126,630	132,158	132,611
Exports (Million US$)	206,682	220,360	295,387	259,427	180,138
Net FDI (Million US$)	7,453	1,419	4,247	4,563	5,486
Investment to GDP Ratio (%)	11.56	2.06	5.40	5.75	7.82

Source: JETRO, "Information by Nation/Region", Basic Economic Indicators

2.2.2 Economic Policy

In order to promote these economic structural reforms, the Government of Saudi Arabia has formulated an action plan for economic reform called "Saudi Vision 2030" in April 2016, and the documents are focusing on reforming the economic structure such as the promotion of industrial development other than the oil sector and the active use of the Saudi labor force (Saudization). Saudi Vision 2030 has three reform themes: "a vibrant society", "an abitious nation" and "a thriving economy", based on three pillars: "the heart of the Arab and Islamic world", "the global investment nation", and "the transportation hub connecting the three continents".

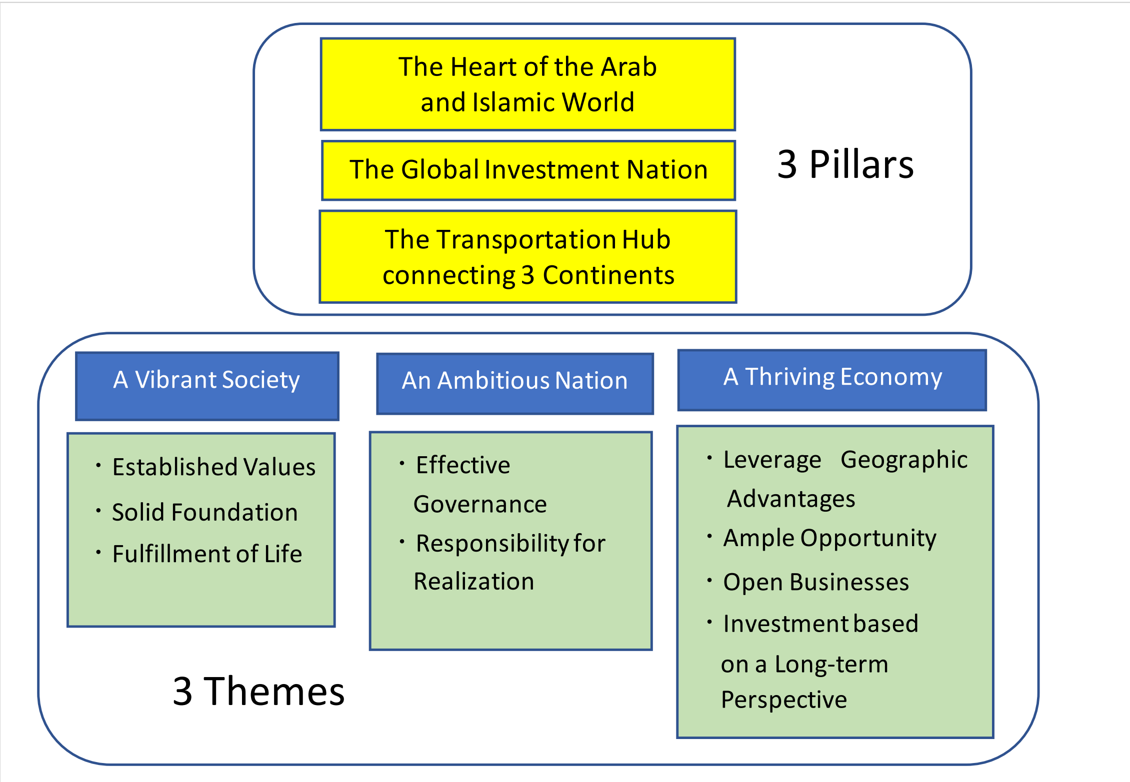


Figure 2-3: Three reform themes of Saudi Vision 2030

Source: Prepared by JICA Survey Team based on Saudi Vision 2030

Directives of Saudi Vision 2030 for economic reform are to provide sustainable, inclusive, environmentally friendly, service-driven reforms with strong governance. Among those directives, pledges to open up state-owned assets through privatization programs, increase private investors' participation, localize value chains in cooperation with domestic and foreign investors, implement giga projects to create an integrated economic ecosystem, and attract investors by improving the overall business environment, are declared. In addition, efforts for various reforms through human resource development, privatization, foreign investment introduction, market opening, etc. are empahsized.

In March 2017, King Salman and Mr. Shinzo Abe, the Prime Minister of Japan at that time have bilaterally agreed on the Saudi-Japan Vision 2030 between the two countries, saying that the Japanese Government would be ahead of other countries as a strategic partner in supporting such socio-economic change. The aim of this partnership is to develop the healthy socio-economy for both countries by mutually utilizing the Saudi Vision 2030 of Saudi Arabia and the Growth Strategy of the Japanese government, although the past cooperations were aimed at stable supply of oil from Saudi Arabia to Japan and the export of higher-quality products and investment to petro-chemical sector from Japan to Saudi Arabia. In order to achieve these objectives, the two countries are planning to establish a "Vision Office" in the other country to strengthen business promotion measures (Enabler) and to cooperate in the development of special economic zones.

Figure 2-4: Preparatory backgound and objectives of The Saudi-Japan Vision 2030
Source: https: //www.jetro.go.jp/ext_images/biz/seminar/2021/3f4e07086b6d11d0/shiryo1.pdf

2.2.3 Market potentials in the water sector.

Based on the Saudi Vision 2030 announced in 2016, the National Water Strategy (2030) was formulated in 2017. Under the National Water Strategy, five specific strategic areas: Abundance, Affordability, Quality, Environmental Sustainability, and Economic Sustainability are defined. In order to realize such a strategy, 10 strategic programs and subsequent initiatives are identified. The 10 strategic programs include; (1) water systems and water resource management regulations, (2) water resource management, (3) departmental response programs for emergency management, (4) R&D, capacity-building, (5) efficiency of supply chain and service quality, (6) control of water services, (7) reorganization of desalination corporations (SWCC), (8) private sector involvement in water production and wastewater treatment, (9) restructuring of water distribution and involvement of the private sector, (10) Reorganization of irrigation mechanisms and improvement of irrigation. Through these comprehensive initiatives, the water sector will need to invest in the following facilities in the future:

Table 2-3: Future achievement goals in the water sector

Areas of Activity	Contents
Desalination of Seawater	5.5 million cubic meters per day
Sewage Treatment Capacity	5.5 million cubic meters per day
Water Transmission Pipeline	1,952 km
Water Purification Facilities	30 water production plants and sewage treatment plants
Water Storage Facilities	33.56 million cubic meters

Source: Saudi Vision 2030

Futhermore, the Government of Saudi Arabia has set out the direction of privatization in the water value chain from water production to water distribution, sewage treatment and reuse. The direction of policy and Key Performance Indicators (KPIs) which are based on development strategies in the water field are as follows.

Table 2-4: Policy Direction and KPIs in the water sector

Policy areas		Policy Direction and KPIs (Unit)	Status quo	Target
Improvement of water and sewage services	Water Supply	Reduction of water leakage rate	25%	15%
		Extension of water storage period (days)	0.4 days	3 days
		Increase population coverage ratio	87%	92%
		Increase the cost burden ratio by users	30%	100%
		Number of days required to provide new services	68 days	30 days
	Sewage Systems	Increase population coverage ratio	60%	65%
		Improvement on coverage of wastewater (flood prevention)	25%	35%
		Number of days required to provide new services	44 days	30 days
The use of reclaimed water and Improvement of desalination Capability	Reclaimed water	Increase in the percentage of sewage treated water use.	17%	35%
	Desalination	Expansion of desalination capacity (M^3/ day)	51 days	73 days
		Increase freshwater production rates through strategic partner's participation.	16%	52%

Source: Data of Saudi Vision 2030,MISA Invest Saudi Presentation

Meantime, the National Water Company (NWC) is planning to privatize water supply and sewage treatment services by implementing a Management and O&M Contract (MOMC) with a private company which operates water and sewage facilities in six clusters nationwide. The outlines of the project are as follows.

Table 2-5: Privatization program for water and sewage projects by NWC

Project Name	Contents of the Project	Schedule
Northwest Cluster	Manage and operate water and sewage assets in the cluster and provide the services to 3 million residents.	Appointed in December 2020 ($52 Million) (Miahona-Saur-Manila Water)
Central (Riyadh) Cluster	Manage and operate water and sewage assets in the cluster and provide the services to 9.6 million residents.	Appointed in September 2021 ($95 Million) (AlKhorayef-Veolia)
Eastern Cluster	Manage and operate water and sewage assets in the cluster and provide the services to 4.9 million residents.	Appointed in October 2021 ($72 Million) (Miahona-Saur-Manila Water)
Southern Cluster	Manage and operate water and sewage assets in the cluster and provide the services to 4.8 million residents.	The RFP has been issued and the deadline for submitting bids is set in the third quarter of 2021.
Mecca Cluster	Manage and operate water and sewage assets in the cluster and provide the services to 8.6 million residents.	The RFP will be issued in the fourth quarter of 2021.
Northern Cluster	Manage and operate water and sewage assets in the cluster and provide the services to 1.5 million residents.	The RFP will be issued in the first quarter of 2022.

Source: NWC

In the above projects, comprehenseive surveys aimed at improving customer satisfaction through rationalization of operating costs, improvement of water leakage rate, efficiency improvement of water pipe networks, etc. shall be conducted over the contract period of 7 years, and then a concession contract for business operation over 20 to 30 years shall be concluded. The successful corporate groups so far appointed are joint ventures between a local company and a foreign company (France and the Philippines), and unfortunately the name of a Japanese company is not seen.

Considering the directivess of these policies and the Key Performance Indicator (KPI) in the water sector of Saudi Arabia, there will be a possibility of business opportunities for Japanese companies in the following fields.

The provision of technology for improvement of water and sewage services and support for system development.

Productivity improvement of recycled water systems and support for spreading its use to the non-potable water supply and agriculture fields.

Support for the introduction of production and environmental conservation technologies for further expansion of seawater desalination.

2.3 Industrial structure

2.3.1 Industry Contribution to GDP

As mentioned above, the Government of Saudi Arabia is aggressively promoting economic structural reforms through the strong leadership of the Crown Prince. However, from 2019 to 2020, economic activity has been forced to slow significantly due to the double blow of spread of Covid-19 and the falling oil prices. The total GDP of Saudi Arabia in 2020 was 2,664,537 million Saudi rials (US$701.5 billion), and the GDP composition shares by industry are shown in Figure 2-5 below. The largest industrial sectors in Saudi Arabia are the public service sector (21.6%) followed by the mining sector (19.4%), the financial and insurance sector (14.2%), the manufacturing sector (12.8%), and the wholesale, retail, food and beverage and accommodation sectors (10.7%).

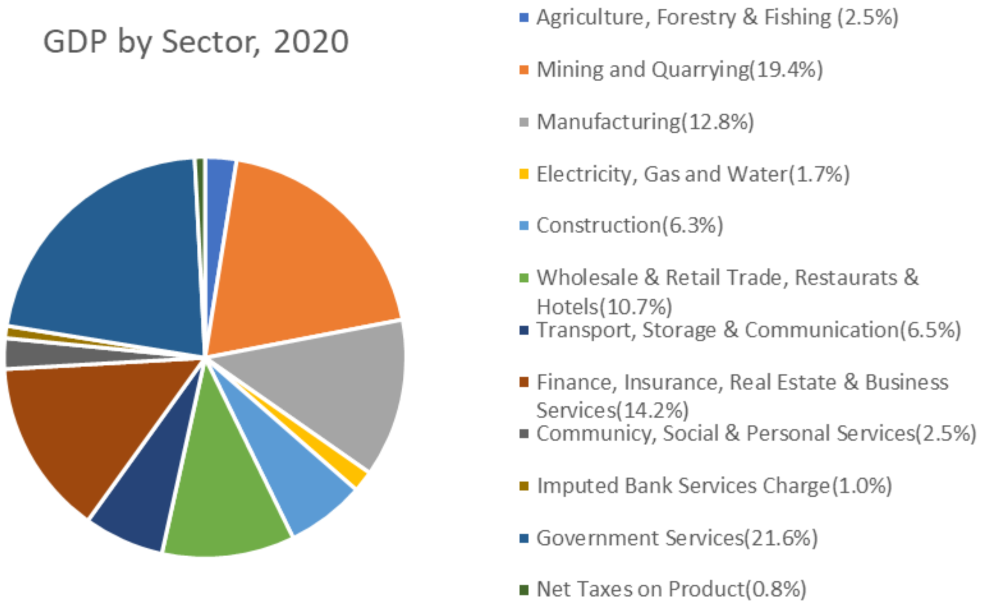


Figure 2-5: Ratio of GDP by industry sector (FY2020)

Source: Prepared by JICA Survey Team based on Statistic Data of Saudi Arabia
https: //database.stats.gov.sa/beta/dashboard/indicator/434

2.3.2 Initiatives to transform Industrial Structure

Based on the Saudi Vision 2030 policy objectives, the Government of Saudi Arabia has developed the National Industrial Development and Logistic Program (NIDLP), a national industrial development program with an attempt to contribute to the construction of diverse, sustainable and economic activities for prosperity. As a result, it is expected that products of Saudi Arabia will be able to penetrate into the global markets and become a pioneering leader in the fields of energy, mining, logistec and industry. NDILP hopes to achieve ambitious goals that will providing a mighty, long-lasting impacts toward future generations by promoting the following activities:

- Development and expansion of diversity of Saudi Arabia's Economy,
- Investment in the NIDLP fields,
- Expansion of local contents,
- Saudi Arabia to function as a source of leading industrial activities and convert it to a logistic hub,
- Increase of employment opportunities, especially employment opportunities that bring high added value,
- The maximum use of domestic resources,
- Improvement of trade balance of Saudi Arabia,

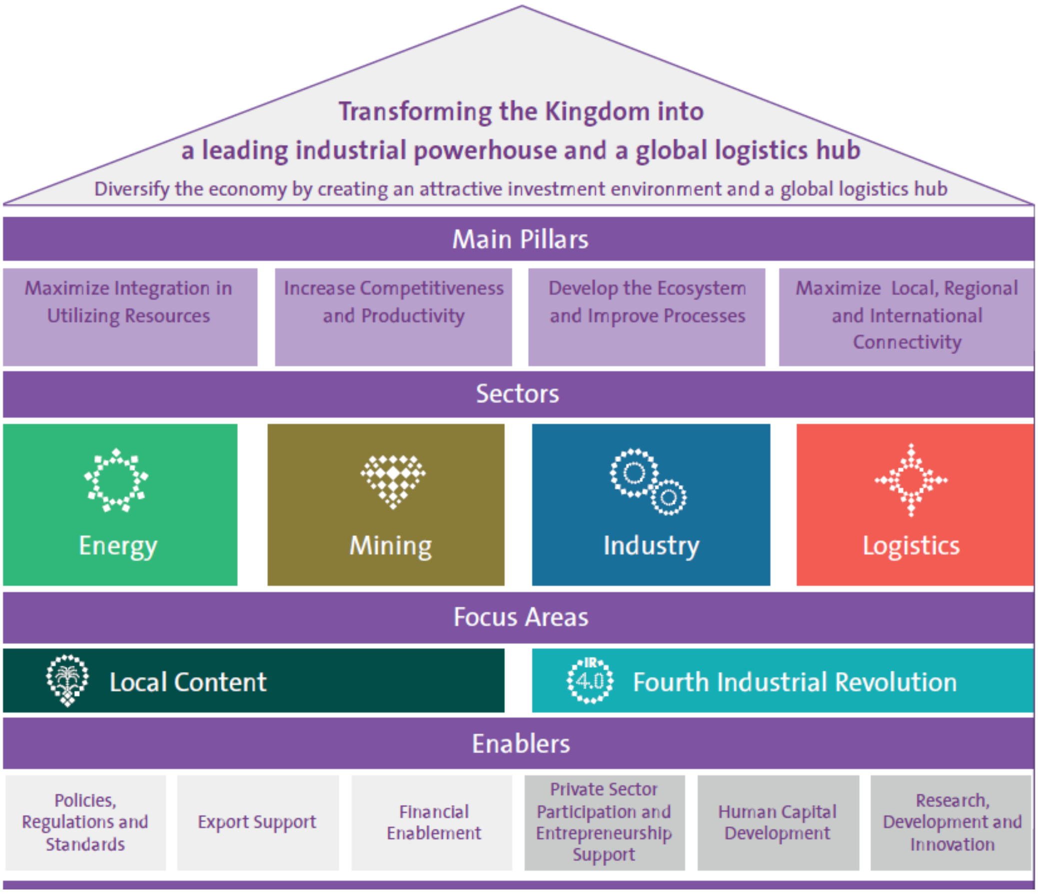


Figure 2-6: Components for transforming Saudi Arabia to lead industrialization and Logistics Hub

Source: https: //www.vision2030.gov.sa/v2030/vrps/nidlp/

From these activities, it is anticipated to promote entrepreneurship and support small and medium-sized enterprises in the designated fields, and develop supply chaines for the manufacturing industries by developing infrastructures such as special economic zones and logistics. It is a story of creating employment by doing so and establishing the presence of Saudi Arabia as an international manufacturing and export base. Since such activities are expected to be carried out in full scale in the near future, active investment by the Governments of Saudi Arabia and FDI are expected in the fields of Energy, Mining, Logistics, and Industry designated by NDILP, there will be higher possibility to lead considerable business opportunities for Japanese companies as well.

Chapter 3: Present Conditions, Issues, Needs for Assistance and Applicability of Japanese Private Firms' Technologies and Products in the Water Supply, Sewage and Water Quality Sectors in Saudi Arabia

3.1 Present conditions and issues in Water Supply and Sewage and Water Quality fields

JICA Survey Team has worked to gather a wider range of information on the current conditions and issues in the water supply, sewage and water quality fields in Saudi Arabia by conducting online meetings and submitting questionnaires as well as by conducting interviews by actually visiting offices and sites throughout the domestic preparatory survey period and the first field survey period,

In addition, JICA Survey Team has set a hypothesis on the subjects in the concerned fields in Saudi Arabia based on the information obtained before the first field survey was started, and verified its validity through the surveys being conducted in the first field survey period. The present conditions and issues in the water supply and sewage and water quality fields in Saudi Arabia which are obtained through such works, are as follows.

3.1.1 Present conditions and issues in the water supply sector

1) Present conditions in water supply sector

(1) Policies, laws and water tariff systems in the water sector and water quality in Saudi Arabia

1) National policy

【National Water Strategy 2030】

MEWA formulated National Water Strategy 2030 in 2018, which aims at sustainable water resources management and stable water supply. The Key Performance Indicators for water supply sector are shown below. The organizations related with water sector in Saudi Arabia are taking actions to achieve the target values in 2030.

Table 3-1: Key performance indicators for water supply sector (summary)

Field	KPI	2018	2030
Supply Security	Proportion of population accessing water services (%)	78%	100%
	Percentage of population accessing sanitation services (%)	60%	<75%
	Average water consumption in the municipal sector L/P/D （Liter/Person/Day）	271 L/C/D	230 to 255 L/C/D
	Average water consumption (Connections)	180	150
Customer Service	Ensure continuity of regular supply	58%	100%
Economic Sustainability	Cost recovery		100%
	ILI (Infrastructure Leakage Index)		1-3
	For the percentage of leakage within homes		<10%
	Technical loss	40%	15%

Source: National Water Strategy 2030, MEWA

2) Related Laws

【Water Act】

MEWA has formulated Water Act in 2021, which aimed at sustainable water resources development and management to implement National Water Strategy 2030. The outlines the Act are as shown below:

・Duties and responsibility on each agency	・Water resources and the ownership
・Priority for water use and set for water right	・Water tariff
・Water quality standard and set for water quality management agency	・Basic measures for protection of water resources
・Violations and penalties	

The National Water Company (NWC), which has jurisdiction over the water services sector under the Ministry of Environment, Water and Agriculture (MEWA), is a water services corporation that manages and operates over the entire country of 2.149 thousand km^2. NWC has been in charge of the water supply business in urban areas and has been implementing the operation and maintenance of the water supply business by advanced management methods since 2008. However, certain water supply services are still monitored and operated by MEWA in some regions in Saudi Arabia.

NWC has a policy of limiting water consumption to 150 L/C/D by 2030, as current per capita water consumption is 263 L/C/D (litters/Capita/day), which is relatively high compared to other countries. In addition, the current leak rate in Riyadh is 30%, and the target of reducing the leak rate to 15% by 2030 is set in the NWS 2030. NWC applies progressive wate tariff systems and it summarays as Table 3-1. The Government of Saudi Arabia has been providing high-cost water from the seawater desalination plants which are located 400 km away at a low price as a part of the service to residents. However, since the water tariff to residents is almost the same as the cost of water supply service, it can be said that the policy is being changed in the direction of demanding a burden after 2020,

Table 3-2: Comparison of water tariff between 2020 and 2016

	2020 Water (SAR)	2020 Wastewater (SAR)	2020 Total (SAR)	2016 Water (SAR)	2016 Wastewate (SAR)	2016 Total (SAR)
Upto $15m^3$	0.1	0.05	0.15	0.03	0.01	0.04
$16m^3$ ～ $30m^3$	1.0	0.5	1.5	0.27	0.14	0.41
$31m^3$ ～ $45m^3$	3.0	1.5	4.5	0.81	0.41	1.22

SAR: Saudi Riyal Source: NWC

(1) Privatization of O&M by cluster

MEWA and NWC are planning to privatize water and sewage operations in order to achieve those goals by appointing a Bank and other consultants as advisors. This plan divides Saudi Arabia into six clusters and outsources items in a period of 5 to 7 years such as water distribution, sewage collection, treatment, efficiencies of bill collection, reduction of non-revenue water, asset management, and human resource development to the private sector. The plan will be connected to the concession business in the future. Stricter qualification conditions are set for participating to the bidding, such as a track record of providing water and sewage services to a population of 1 million or more for at least 3 years in the water markets outside Saudi Arabia.

(2) Smart meters and IT

NWC manages and monitors water flow and pressure data from many flow meters, insertable flow meters, etc. via a data logger on a Global System Mobile Management (GSM) line in Riyadh city. These data are also used to control Supervisory Control and Data Acquisition (SCADA) through alarm systems etc. In addition, there are water pressure management areas where Pressure Reducing Valuve (PRV) is controlled by the data of the water pressure data logger being installed at the critical point near the end of the water pipe network.

The millions of conventional/mechanical water meters that were once used as customer meters in Riyadh, has now been replaced about 1 million in Riyadh and about 2 million in whole Saudi Arabia.

Since smart meters are ultrasonic or electromagnetic, there are no moving parts for flow rate measurement like mechanical flow meters. Therefore, even in intermittent water supply, there are few overreading due to air mixing and failure effects due to flow velocity exceeding the specified value. There is also an alarm system for the occurrence of internal and external water leaks. Smart meter data is sent to NWC's Automatic Meter Reading (AMR) server by incorporating a General Packet Radio Service (GPRS) transmitter into a stationary gateway device which installed in the city, a data collection system by automobile, or a data logger.

The smart meter data is converted to Mobile Device Management (MDM) (master data) and finally managed in Oracle's database. The data is converted into an oracle database about 6 minutes after transmission.

(3) Affects of intermittent supply

59% of Tap water distributed to the city of Riyadh in 2017 is supplied from the seawater desalination plant in Jubail. Furthermore, there is a plan that 90% of the water will be desalinated in 2030 to reduce ussage of underground water. Some area in Riyadh have been providing 24-hour water supply for the past few months. However, because the amount of water is still insufficient, water supply is continued by intermittent water supply. It is commonly said that intermittent water supply has the following affect.

・Malfunction of water meter due to higher speed turning of impeller by air reading

・Overreading of wter meter due to turning of impeller by air reading

- Sucking of muddy water and sand due to negative water pressure in pipeline
- Generation of wasted water due to opening the faucets
- Resident’s expenses for installation of underground water receiving tanks, booster pumps, rooftoptanks.
- Leakage from main pipe and service pipes due to instantaneous pressure fluctuation (water hammer)

1) Over meter reaading due to the air

According to the interview with the leak survey company, it is probably used to be occured that over-reading and malfunctioning of water meter due to air-reading in Riyadh city. NWC is currelty in the process of replacing from conventional/mechanical meters to smart meters. Therefore, at present, conventional/mechanical meters are rarely used in Riyadh city exept for some old meters.

NWC mentions that when introducing smartmeters, NWC used many many types of meters and has confirmed accuracy and robustness of each. One of the reasons for the ban on mechanical meters for the first time in the world may be of the couses of air reading by intermittent water supply and malfunction of mechanical meters, due to exceeding the specified water flow velocity and/or aif flow velocity.

2) Entry of foreign substances due to negative pressure

In some cases, negative pressure is generated when tap water flows into a semi-sealed pipeline during intermittent water supply. At that time, it is presumed that the water quality deteriorated due to the suction of foreign substances such as sand and soil caused by negative pressure into the pipeline. In the interview with the residents of Riyadh city, some answered that they used to have some experience of water quality deterioration. In addition, red colored water was generated when operating an old valve to change the flow direction at the leak survey site. This may be due to rust generated on the valve, however it is also possible that foreign substance is mixed in, due to intermittent water supply.

3) Installation of underground water receiving tank, booster pump, rooftop tank

In Riyadh city, there are many water receiving tanks, booster pumps, and rooftop tanks at home. This is because the residents prepare water receiving and water supply equipment to use the water in the situation of intermittent water supply. The pump is also operating during water supply, pumping the water from the underground water receiving tank, and storing and using the water in the tank installed on the roof.

4) Water leak due to excessive pressure on water pipe

Intermittent water supply causes excessive pressure, which causes a damage on the pipeline especially the joints of the pipeline. The occurrence of water leakage, which is presumed to be caused by high water pressure, was also obtained from an interview with some O&M company and/or leak survey companies.

(4) Free distbibution of water-saving equipment

NWC distributed water conservation awareness pamphlets and implemented a program to reduce water leaks in the home, and carried out activities to raise awareness of water conservation among Riyadh citizens. In the in-house leak reduction program, NWC's Riyach City Business Unit (RCBU) conducted an in-house leak survey on behalf of the customer and repaired the in-house leaks of residents, enven though it were the amount of revenue water. Furthermore, in 2015, NWC/MEWA distributed water-saving water supply devices free of charge, shower heads, water-saving boxes for toilet tanks, and blue coloring tools for checking internal water leaks in toilet valves. After that, it is said that it led to a water saving effect of about 25%. However, since the water tariff was revised in 2015, it has not been confirmed whether the water-saving effect is due to the free distribution of water-saving products or the revision of the water tariff.

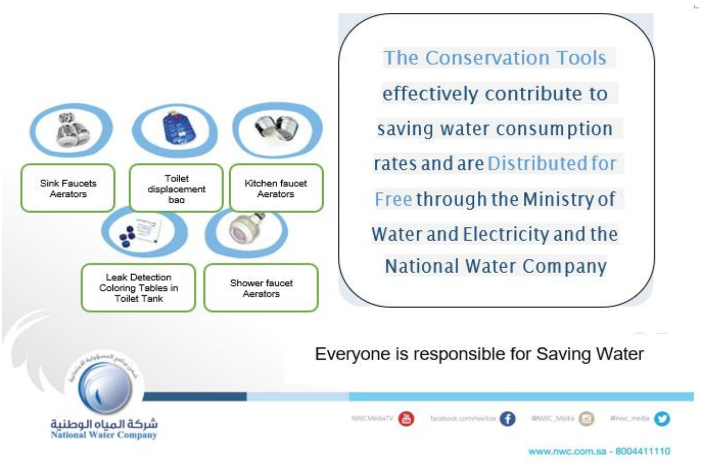


Figure 3-1: Water-saving products freely distributed by NWC

Source: NWC

(5)Current status of service connection plumbing

1) Service connection plumbing

Riyadh City Business Unit (RCBU) of NWC is carrying out the water supply pipe connection work in Riyadh city. High-density Polyethylene (HDPE) is used both for main pipe and service pipe for newly installed pipeline. Compression joint is used to join the service connections. It is assumed that there will not be much water leakage from new pipes if properly connected.

However, Poly Vinyle Cloride (PVC) and galvanized steel pipes are used as service connections, and the different kinds of pipes should be connected. Leakage from the joints of service connections are still common issues in Riyadh city. It is reported that about 30% of the leaks from the water servive pipes are from plastic saddles. The service pipe can be connected to plastic saddle on the main pipe without stopping water of main pipes.

2) Meter instllation

NWC outsources meter installation work to O&M contractors. New water meter is installed to unmeterd houses and/or used to be meterd house which has currently no meter. Using a metal detector to search for the meter or water stop valve of the water service pipe of a household that used to use water with a meter, test-excavate the position where the pipeline is expected to be, and if a water service pipe is found at the test-excavated location then take a picture and report to NWC. After the approval of NWC, a customer water meter is installed.

(6) Current status of Leak Survey

1) Current status of leak survey

Leak survey is carried out by the RCBU of NWC and outsourced to leak survey companies.

Most of the exisiting main pipes are PVC, ant the service pipes are PE pipes. There is a lot of water leakage from the joints of service connections and plastic saddles. The ratio of leakage that occurs in the service pipe is 20% from near the meter, 40% from the joints of vertical pipe for the meter, service pipe itself is 10%, and 30% is plastic saddles.

Since the booster pump operates due to intermittent water supply, the water pressure is constantly fluctuating, so there are cases where water leakage cannot be found at low water pressure and can be found at high water pressure only. Therefore, it is necessary to listen to the sound of leak repeated ly for acoustic leak survey.

2) Minimum Night Flow

NWC outsouses to create a District Metered Area (DMA) and water balance management and leak survey based on water pressure and flow control.

In Japan, the flow rate for a certain period of time without using tap water, which is called the minimum flow rate at night, is grasped as the "estimated leakage amount" and is used as an estimated value (reference value） for the leakage amount of DMA. However, in the case of Riyadh city, since the water supply is intermittent, many households store water in the water receiving tank as much as possible, and operate the pump to store the water in the water supply tank on the roof at night. Therefore, water is used even at night, regardless of whether people use it or not. Therefore, even if DMA is created and the minimum night flow rate at night is measured, it cannot be used as a reference value for the amount of water leakage.

3) Flow and pressure montiroing in DMA

Abount 150 DMAs are managed in Riyadh city. In the 150 DMA, some DMAs are pressure controlled by PRV using cricical poiont pressure monitoring by i2O. Figure III-2 shows an image of PRV control using pressure sensor at the critical point of i2O.

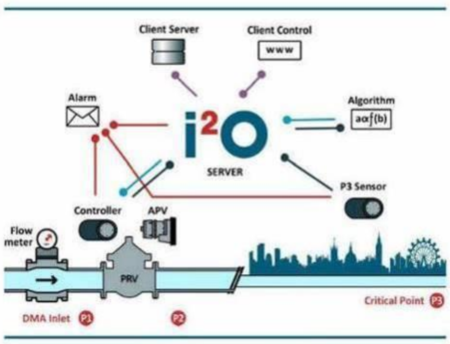


Figure 3-2: PRV control system using pressure sensor at critical point by i2O

Source: website of i2O https: //en.i2owater.com/

4) Advanced leak detection method (Sahara, Smart Ball)

NWC conducts various leak survey methods. At the suggestion of a leak survey consultant from Israel and other European countries, "Sahara", which insert a parachute-type sound hearing sensor inside the pipeline, and a Smart Ball, which has a builit-in sound logger, are inserted into the pipeline, and the leak sound is confirmed after recording from inside the pipeline. According to the local leak survey company in Saudi Arabia, the cost of the survey is very high, however, it is not clear whether the results are commensurate with it.

The figure 3-3 and figure 3-4 shows Sarara and Smartball respectively. NWC has adopted and is conducting the latest leak survey system. Information on its frequency and effectiveness was not available during this survey period.

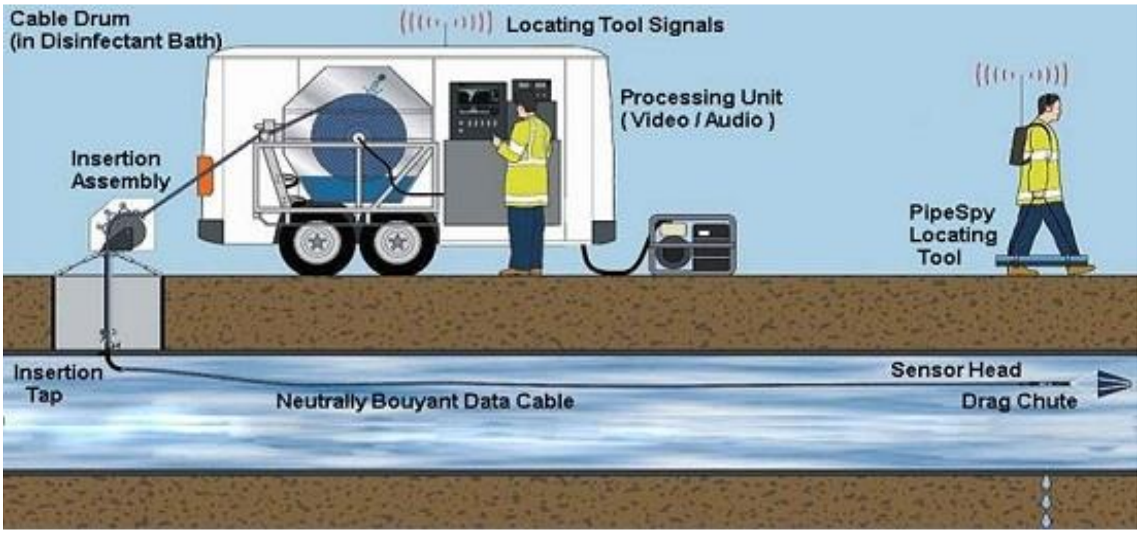


Figure 3-3: Sahara insertion sensor survey

Source: Sahara website (https: //puretechltd.com/technology/sahara-leak-gas-pocket-detection)

Figure 3-4: Smart Ball survey

Source: Smartball website (https: //puretechltd.com/technology/smartball-leak-detection)

5) Leak survey using helium gas

NWC is conducting a leak survey using helium gas. A vehicle equipped with an in-vehicle helium gas generator generates helium gas, fills the pipeline with the gas, and searches for helium gas reaching the road surface from the leakage point of the pipeline with an in-vehicle gas detector. This enables to detect leak point on the water mains and service pipe. This is considered to be an appropriate leak investigation method in Riyadh city where the external noise level is higher and the listening condition of the leak sound is not good because the booster pump and the outdoor unit of the air conditioner are always operating.

Injection of helium gas into the pipeline

Helium gas survey vehicle with helium gas generator

Photo 3-1: Leak survey using helium gas

Source: JICA Survey Team

2) Challenges for water supply sector

The following five points were confirmed as challenges in water saving and water leakage in the water supply and water distribution sector in Saudi Arabia.

(1) Service pipe connection

Water is intermittently supplied due to lack of water sources in Riyadh city. The pipeline is constantly exposed to the stress of fluctuation of water pressure. In addition, it is assumed that foreign matter is mixed in from the leak hole due to the generation of negative pressure caused by intermittent water supply. In order to cope with the fluctuation of water pressure closed to that of a water hammer, water supply pipeline such as water distribution and service connection pipes are required to have higher durability and toughness than the standards.

1) Leak from ferrule saddle

No data was obtained on the number or status of leaks in this survey. However, according to the NWC, 30% of leaks from service pipes come from ferrule saddles. JICA Survey Team received information that many leaks from plastic ferrule saddles were found. NWC's new policy is to use HDPE pipes for both of the main pipes and service pipes as standard specifications for future, and to connect the pipelines by electric heat fusion. In this electric heat fusion method, a pipeline that can withstand the fluctuation of water pressure peculiar to intermittent water supply can be installed regardless of the plumbers by using a formal electric heat fusion machine.

However, PVC is the main component of existing water distribution mains where water leakage occurs from the ferrule saddle. PVC is characterized by its excellent flexibility and elasticity, but when joining with a ferrule saddle, elastic PVC can cause water leaks depending on how the saddle bolts are tightened.

2) Leak from Joints

The water service pipe branched from the water distribution pipe using a ferrule saddle is raised about 1 m at the entrance wall of the home by using a 90-degree elbow and vertically installed to the meter box set on the wall of the entrance of the home. The water service pipe goes through the meter box, the flow rate is measured via the meter, and the 90-degree elbow is used again, and it is buried underground or connected to the water supply device in the home by an overhead pipe.

According to the information from NWC, about 40% of all the leak water from the water service pipe is from the joints to the meter.

One of the causes of water leakage is the need to connect new service connection to various kinds of old water service pipes. When installing a new smart meter, it occurs when removing the old meter used in the past from the water service pipe and connecting it to the new water service pipe.

PVC, GP, and HDPE are the main materials of old water service pipe, but the materials of buried water service pipes are not accurately indicated in the drawings.

Therefore, there are cases where it is necessary to adjust the pipe diameter on site, and the number of connection points may increase in order to adjust the diameter of the water service pipe. Intermittent water supply puts a heavy load on the joint due to fluctuations in water pressure, and water leakage from the joint is expected. Leakage is expected to occur frequently, especially when cast iron fittings are used in resin pipelines such as PVC and HDPE, but the detailed leak data was not obtained by this survey.

There is also room for improvement in the method of supervising plumbing work. At the site where the new meter was installed, there was a work situation in which the pipeline was connected underwater without closing service pipe by installing a temporary valve. Systems such as construction methods, supervision, and water service connection licence need to be reviewed.

(2) Malfunction of Valves

There are some cases that of failures of the valve (sluice valve) required for creating DMA and stopping water for leak repair. Although the cause is not clear, foreign substances including sand and soil due to intermittent water supply is caught in the threaded part, and rust is frequently generated by the air and iron parts used for the sluice valve.

(3) Mapping system with low integrity with site.

Although there is a Geographic Information System (GIS) map, there are cases where consistency with the site has not been confirmed. And there are cases where the pipeline is not found even though excavation is conducted according to the GIS map. It is necessary to improve the consistency of GIS mapping with the site.

(4) Not registrated water users

After creating the DMA, DMA management contaractor checked the customer meter and found that some customers did not have the meter and were not registered properly.

(5) Nighttime water usage and noise generation

Water is intermittently supplied in the city of Riyadh. Therefore, water is used to store water in household water storage tanks even at night. The sound of using water and the sound of flowing into the water storage tank are generated during the night. Therefore, there are cases that it is hard to do accoustic leak survey as in Japan by listening to the sound of the leak.

3.1.2 Present conditions and challenges in the fields of Sewage and Water Quality fields.

(1) Policies, laws and water tariff systems in the water sector and water quality in Saudi Arabia

1) National policy

① National Water Strategy 2030

MEWA formulated National Water Strategy 2030 in 2018, which aims at sustainable water resources management and stable water supply. The outlineof the Strategy are as shown below: The organizations related with water sector in Saudi Arabia are taking actions to achieve the target values in 2030.

Table 3-3: Outlines of National Water Strategy 2030

Vision: a sustainable water sector that develops and maintains water resources, protects the environment, provide safe supply, high quality service and efficiency that contribute to economic and social development.

Strategy:

1. Ensuring the continuous access to adequate quantities of safe water in normal and emergency situation
2. Improving water demand management (WDM) in all uses
3. Providing high quality and cost-effective water and sanitation services to ensure acceptable prices
4. Maintaining and improving water resources, while preserving the local environment for the benefit of the Saudi society now and in the future
5. Ensuring the competitiveness of the water sector and its positive contribution to the national economy

Indicators:

Indicators	Year 2020	Year 2030
Share of non-renewable groundwater for municipal water	35%	30%
Share of non-renewable groundwater for all the water	80%	50%
Share of renewable water for all the water	9%	20%
Coverage for sewerage	40%	70%
Reuse rate for treated wastewater	17%	70%

Source: National Water Strategy 2030, MEWA

2) Related Laws

① Water Act

MEWA has formulated Water Act in 2021, which aimed at sustainable water resources development and management to implement National Water Strategy 2030. The outlines of the Act are as shown below:

・Duties and responsibility on each agency
・Priority for water use and set for water right
・Water quality standard and set for water quality management agency
・Violations and penalties
・Water resources and the ownership
・Water tariff
・Basic measures for protection of water resources

② Water Quality Standards

MEWA has newly formulated some water quality standards which are equivalent to international standards including water quality standard for drinking water, environmental water quality standard and wastewater quality standard and enforced them in 2021. The water quality standards are shown below:

Table 3-4: Water quality standard for drinking water

Parameter	Unit	Saudi Arabia	Reference:	
			Japan※1	WHO
A. Physical Parameters				
Color	pt/Co	15	5	15
Total Dissolved Solids	mg/L	100-1000	500	1,000
Turbidity	NTU	5	2	5
Temperature	℃	40		Acceptable
pH	-	6.5-8.5	5.8-8.6	
Taste	-	Acceptable	Acceptable	Acceptable
Odor	-	Acceptable	Acceptable	
Residual Chlorine (Free)	mg/L	0.2-0.5(Recommend), 5(Max.)	0.1≧	0.5≧ at pH8<
Chlorine Dioxide	mg/L	0.1-0.7	0.6	
Calcium Hardness	mg/L as $CaCO_3$	30		
Total Hardness	mg/L as $CaCO_3$	300	300	
Langelier Saturation Index (LSI)	-	0-0.3(Recommend)、0.5((Max.)	-1- 0 (Recommend)	
B. Inorganic Chemical Parameters				
Aluminum	mg/L	0.2	0.2	0.2
Ammonia (NH_3)	mg/L	0.5		1.5
Boron	mg/L	2.4	1	0.5
Chloride	mg/L	250	200	250
Copper	mg/L	2	1	2
Cyanide	mg/L	0.07	0.01	
Fluoride	mg/L	1.5	0.8	1.5
Iron	mg/L	0.3	0.3	0.3
Nitrate (NO_3)	mg/L	50	44	50
Nitrite (NO_2)	mg/L	3	0.1	3
Sodium	mg/L	200	200	200
Sulfate	mg/L	250		250
Zinc	mg/L	3	1.0	3
C. Inorganic Chemicals Parameters (Trace Elements)				
Antimony	mg/L	0.02	0.02	0.005
Arsenic	mg/L	0.01	0.01	0.01
Barium	mg/L	1.3	(0.7)	0.7
Cadmium	mg/L	0.003	0.003	0.003
Chromium	mg/L	0.05	0.02 (as Cr^{6+})	0.05
Lead	mg/L	0.01	0.01	0.01
Manganese	mg/L	0.4	0.05	0.5
Mercury	mg/L	0.006	0.0005	0.001
Molybdenum	mg/L	0.07	(0.07)	0.07
Nickel	mg/L	0.07	0.02	0.02
Selenium	mg/L	0.04	0.01	0.01
Uranium	mg/L	0.03	0.002	0.002

D. Pesticides Parameters (Mostly)				
Acrylamide	mg/L	0.0005	(0.0005)	0.0005
Alachlor	mg/L	0.02	0.03	0.02
Aldicarb	mg/L	0.01		0.01
Aldrin& Dieldrin	mg/L	0.00003		0.00003
Atrazine	mg/L	0.1	0.01	0.002
Carbofuran	mg/L	0.007	0.0003	0.007
Chlordane	mg/L	0.0002		0.0002
Chlorotoluron	mg/L	0.03		0.03
Chlorpyrifos	mg/L	0.03	0.003	
Cyanazine	mg/L	0.0006	0.001	0.0006
2,4-D acetic acid	mg/L	0.03		0.03
2,4-DB butyric acid	mg/L	0.09		0.09
DDT	mg/L	0.001		0.002
1.2-Dibromo-3-chlorpropane	mg/L	0.001		0.001
1,2- Dibromo-ethane	mg/L	0.0004		
1,2-Dichloropropane	mg/L	0.04		0.04
1,3-Dichoropropane	mg/L	0.02	0.05	0.02
Dichloroprop/Dichlorprop-P (DALAPON)	mg/L	0.1	0.08	
Dimethoate	mg/L	0.006	0.05	
Endrine	mg/L	0.0006		
Epichlorohydrin	mg/L	0.0004	(0.0004)	
Ethylbenzen	mg/L	0.3		0.3
Ethylenediamine tetraacetic acid (EDTA)	mg/L	0.6	(0.5)	0.6
Isoproturon	mg/L	0.009		0.009
Lindane	mg/L	0.002		0.002
MCPA	mg/L	0.002		0.002
Mecoprop	mg/L	0.01	0.05	
Methoxychlor	mg/L	0.02		0.02
Metolachor/s-Metolachlor	mg/L	0.01		0.01
Microcystins	mg/L	0.001	(0.0008)	0.001
Molinate	mg/L	0.006	0.005	0.006
Pendimethalin	mg/L	0.02	0.3	0.02
Pentachlorophenol	mg/L	0.009		0.009
Perchlorate	mg/L	0.07		
Simazine	mg/L	0.002	0.003	0.002
2,4,5-T	mg/L	0.009		0.009
2,4,6-Trichlorophenol	mg/L	0.2		0.2
Terbuthylazine (TBA)	mg/L	0.007		
Trifluralin	mg/L	0.02	0.06	
E. Organic Parameters				
Benzene	mg/L	0.01	0.01	0.01
Benzo(a)- Pyrene	mg/L	0.0007		0.0007
Chlorobenzene	mg/L	0.3		0.3
1,2- Dibromo-ethane	mg/L	0.0004		
1,2- Dichlorobenzene	mg/L	1		1
1,4-Dichlorobenzene	mg/L	0.3		0.3
1,2-Dichloroethane	mg/L	0.03	0.04	0.03
Dichloromethane	mg/L	0.02		0.02
1,2-Dichloropropane	mg/L	0.04		0.04
1,3-Dichloropropene	mg/L	0.02		
Diphthalate	mg/L	0.008		
1,4-Dioxane	mg/L	0.05	0.05	
Hexachlorobutadiene	mg/L	0.0006		0.0006
Nitrilotriacetice acid	mg/L	0.2	(0.2)	0.2
Styrene	mg/L	0.02	(0.02)	0.02
Tetrachloroethene	mg/L	0.04		
Toluene	mg/L	0.7	0.4	0.7
Trichloroethane	mg/L	0.02	0.3	2
Vinyl chloride	mg/L	0.0003	(0.002)	0.005
Xylene	mg/L	0.5	(0.4)	0.5

F. Microbial Parameters				
Enterococci	Number/100ml	ND		
Escherichia Coli	Number/100ml	ND	ND	ND
Total Coliform	Number/100ml	ND	10000	
G1. Radioactive Parameters				
Gross Alpha activity	Bq/L	0.5		0.1
Gross Beta activity	Bq/L	1		1
Radioactivity (except Potassium 40)	mSv/RDL※2	0.1		
G2. Radionuclides Parameters				
Uranium-238	Bq/L	3		
Uranium-234	Bq/L	2.8		
Thorium-230	Bq/L	0.7		
Radium-226	Bq/L	0.5		
Lead-210	Bq/L	0.2		
Polonium-210	Bq/L	0.1		
Thorium-232	Bq/L	0.6		
Radium-228	Bq/L	0.2		
Thorium-228	Bq/L	1.9		
Caesium-134	Bq/L	7.2		
Caesium-137	Bq/L	10.5		
Strontium-90	Bq/L	4.9		
Iodine-131	Bq/L	6.2		
Tritium	Bq/L	7,716		
Carbon-14	Bq/L	236		
Plutonium-239	Bq/L	0.56		
Radon	Bq/L	300		
Potassium 40	Bq/L	22		
H. Disinfection and Chlorinated By-Products				
Bromate	mg/L	0.01	0.01	0.025
Bromodichloromethane	mg/L	0.06	0.1	0.06
Bromoform	mg/L	0.1	0.09	0.1
Caron Tetrachloride (Trichloromethane)	mg/L	0.004	0.06	
Chlorate	mg/L	0.7	0.6	
Chlorite	mg/L	0.7	0.6	0.2
Chloroacetic acid	mg/L	0.02	0.02	
Chloroform	mg/L	0.3	0.06	0.2
Cyanogen Chloride	mg/L	0.07	0.01	0.07
Dibromoacetonitrile	mg/L	0.07	(0.06)	0.1
Dibromochloromethane	mg/L	0.1	0.1	0.1
Dichloroacetic acid	mg/L	0.05	0.03	0.05
Dichloroacetonitrile	mg/L	0.02	0.01	0.09
Monochloramine	mg/L	3		3
N-Nitrosodimethylamine	mg/L	0.0001	(0.0001)	
Sodium dichloroisocyanurate	mg/L	50		
Trichloroacetic acid	mg/L	0.2	0.03	0.1
Total Trihalomethanes (THMs)	mg/L	※3	0.1	※3

※1 ( ) refers to "Items for further study" in drinking water quality standards in Japan
※2 RDL means "Reference dose level" as per WHO
※3 THM= Conc. Bromoform/LV of Bromoform + Conc. DBCM/LV of DBCM
+ Conc. BDCM/LV BDCM + Conc. Chloroform/LV Chloroform ≦1
"LV" means limit value of each parameter

Source: Water quality standard and specification in 2021 (MEWA)

Water quality standard for drinking water in Saudi Arabia consists of physical parameters, inorganic chemical parameters, pesticide parameters, organic parameters, microbial parameters, radioactive parameters, radionuclides parameters and disinfection and chlorinated by products. As characteristics of the standard, the standard values of each radionuclides parameter is set in

Saudi Arabia while it is not set in Japan and World Health Organization (WHO) guideline. (Only gross α activity as radioactive parameter, 0.1 (Bq/L), is set in WHO guideline.) Regarding the other parameters, almost the same parameters as in WHO guideline are set in Saudi Arabia.

Table 3-5: Water quality standards for water production from seawater desalination (SWCC plants)

Parameter	Unit	SWCC	Reference: Water Quality Std. for Portable Water		
			Saudi Arabia ※1	Japan	WHO
A. Physical Parameters					
Bicarbonate	mg/L as $CaCO_3$	45–65			
Calcium Hardness	mg/L as $CaCO_3$	60–80	30		
pH	–	8.1–8.5	6.5–8.5	5.8–8.6	
Residual Chlorine	mg/L	0.2–0.5	0.2–0.5(recommend), 5(Max.) as free-chlorine	0.1 as free-chlorine	0.5 at pH 8< as free-chlorine
Temperature	℃	38	40		Acceptable
Total Dissolved Solids (TDS)	mg/L	300–400	100–1000	500	1000
Turbidity	NTU	1	5	2	5
Langelier Saturation Index (LSI)	–	0–0.3	0–0.3(recommend), 0.5(Max)	−1–0 (recommend)	
B. Inorganic Chemical Parameters					
Boron	mg/L	2.4	2.4	1	
Bromide (Br^-)	ppb	※2			
Calcium	mg/L	25–35			
Chloride	mg/L	100	250	200	250
Copper	mg/L	1	2	1	0.5
Iron (Fe)	mg/L	0.3	0.3	0.3	0.3
Magnesium	mg/L	15–25			
C. Disinfection and Chlorinated By-Products					
Bromate(BrO_3^-)	ppb	10		10	0.025

※1 These values refer to the portable water quality standard issued by Ministry of Environment Water & Agriculture (MEWA) in 2021
※2 If disinfection is done with a substance other than chlorine dioxide, the maximum limit for Bromide is 50 ppb

Source: SWCC

Water quality standards for water production from seawater desalination (SWCC plants) consists of physical parameters, inorganic chemical parameter and disinfection and chlorinated by-products. The standard values of each parameter are set so as it can be met that of water quality standard for drinking water in Saudi Arabia.

Table 3-6: Environmental water quality standards
(coastal water, groundwater and surface water)

Parameter	Unit	Saudi Arabia					Reference: Japan※1
		Coastal Water			Surface Water	Ground Water	
		Normal	High	Industrial	(Undrinkable water)	(Drinkable Water)	
A. Physical Parameters							
BOD	mg/L	15	10	20	10	–	River:1 (as 1st grade)
COD	mg/L	25	20	40	25		
Color	pt/Co		5	5			
Dissolved Oxygen (DO)	mg/L	5≦	5≦	4≦	5≦	–	7.5≦(as 1st grade)
Oil & Grease	mg/L	2	1	3	3	ND	
pH/ΔpH※2	–	6.5–8.5 / 0.2	6.5–8.5 / 0.1	6.5–8.5 / 0.3	6.5–9	6.5–9	6.5–8.5
ΔTemperature※3	Celsius	3	2	4	Normal	Normal	
TOC	mg/L	10	10	15	10	Normal	
Total dissolved solids (TDS)	mg/L	Normal	Normal	Normal	5000	Normal	
Turbidity	NTU	3	2	5	30	Normal	
B. Chemical Parameters							
Aluminum	mg/L	0.2	0.2	1	0.2	0.2	
Ammonia (NH_3)	mg/L	0.1	0.05	1	0.1	0.3	
Calcium	mg/L	Normal	Normal	Normal	Normal	Normal	
Chloride	mg/L	Normal	Normal	Normal	Normal	Normal	
Copper	mg/L	0.003	0.003	0.00135	0.05	1.5	
Cyanide	mg/L	0.001	0.001	0.001	0.01	0.001	ND
Fluoride	mg/L	1.5	1.5	1.5	0.4	0.2	0.8
Iron	mg/L	0.5	0.1	1	0.5	0.2	
Manganese	mg/L	0.01	0.01	0.1	0.1	0.05	
Sodium	mg/L	Normal	Normal	Normal	150	150	
Sulfate	mg/L	Normal	Normal	Normal	200	Normal	
Sulfide	mg/L	0.002	0.002	1	0.002	0.002	
Zinc	mg/L	0.08	0.08	0.09	0.12	0.02	
C. Chemical Parameters (Heavy metals)							
Arsenic	mg/L	0.05	0.05	0.069	0.15	0.0075	0.01
Barium	mg/L	0.5	0.5	1	0.5	1	
Cadmium	mg/L	0.008	0.008	0.008	0.000025	0.003	0.003
Chromium	mg/L	0.05	0.002	0.05	0.05	0.037	Cr^{6+}: 0.05
Cobalt	mg/L	0.05	0.05	1	0.05	0.05	
Lead	mg/L	0.008	0.005	0.21	0.01	0.0075	0.01
Mercury	mg/L	0.0004	0.0004	0.0001	0.00007	0.00075	0.0005
Nickel	mg/L	0.05	0.05	0.2	0.05	0.02	
Selenium	mg/L	0.071	0.071	0.29	–	0.007	0.01
Silver	mg/L	0.0019	0.0019	0.2	0.0032	0.0032	
D. Pesticides Parameters (Mostly)							
Aldrin	mg/L	2.2×10^{-6}	2.2×10^{-6}	2.2×10^{-6}	2.2×10^{-6}	2.2×10^{-6}	
Chlordane	mg/L	4×10^{-6}	3.2×10^{-7}	0.00009	4.3×10^{-6}	3.1×10^{-7}	
DDT	mg/L	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	
Dieldrin	mg/L	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	
Endrin	mg/L	6×10^{-6}	6×10^{-6}	6×10^{-6}	8.6×10^{-5}	3×10^{-5}	
Heptachlor	mg/L	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5.9×10^{-6}	
Hexachlorobenzen	mg/L	2.9×10^{-7}	2.9×10^{-7}	2.9×10^{-7}	5×10^{-5}	2.9×10^{-7}	
Lindane	mg/L	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	0.0002	
Mirex	mg/L	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	
Pentachlorophenol	mg/L	0.00004	0.00004	0.005	0.019	0.00003	
Silvex (2,4,5-TP)	mg/L	–	–	–	–	0.05	
Toxaphene	mg/L	2×10^{-7}	2×10^{-7}	2.1×10^{-5}	2.1×10^{-6}	7×10^{-7}	
E. Organic Parameters							
Benzene	mg/L	0.05	0.05	0.05	0.05	0.002	0.01
Furans	mg/L	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	
MtBE	mg/L	5	5	5	10	0.02	
PAH	mg/L	0.003	0.003	0.003	0.003	0.0002	
PCBs	mg/L	1.9×10^{-6}	1.9×10^{-6}	1.9×10^{-6}	1.9×10^{-6}	1.9×10^{-6}	
Total Petroleum Hydrocarbons	mg/L	0.3	0.2	0.5	0.3	0.2	
Phenols	mg/L	0.05	0.05	0.1	0.05	0.005	
TCDD	mg/L	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	
Toluene	mg/L	0.002	0.001	0.002	0.002	0.002	
Trichloroethane	mg/L	0.01	0.01	0.01	0.01	0.001	1
Vinyl Chloride	mg/L	0.002	0.002	0.002	0.002	0.001	
Xylenes	mg/L	0.005	0.005	0.005	0.005	0.005	
F. Microbial Parameters							
Cyanobacteria	mg/L	5,000	5,000	5,000	5,000	–	
E.Coli	Number/100ml	500	250	500	600	ND	50 (as Total Coliform)
Enterococci	Number/100ml	200	100	200	230	ND	
G. Disinfection and Chlorinated By-Products							
Carbon Tetrachloride	mg/L	0.001	0.001	0.001	0.002	0.005	
Chloroform	mg/L	0.13	0.13	0.13	0.13	0.06	

※1 This standard refers to environmental standard for public water body in Japan
※2 ΔpH means the difference of pH between at the discharge point and at the surrounding area
※3 Δtemperature means the difference of temperature between at the discharge point and at the surrounding area

Source: Environmental Law in 2021 (MEWA)

Wastewater quality standards (coastal water, groundwater and surface water) consist of physical parameters, chemical parameters, organic parameters and microbial parameters. Almost the same parameters as in Japan are set in Saudi Arabia. But the standard value of most parameters in Saudi Arabia is set more strictly than that of Japan.

Table 3-7: Wastewater quality standard (coastal water, groundwater and surface water)

Parameter	Unit	Saudi Arabia			Reference: Japan※1
		Coastal Water	Surface Water	Ground Water	
A. Physical Parameters					
BOD	mg/L	25	20	40	River:160
COD	mg/L	50			
Dissolved Oxygen (DO)	mg/L	2≦	2≦		
Oil and grease	mg/L	2	5	ND	Mineral oil:5, Animal and vegitable oil:30
pH	mg/L	6.5–9	6–8.4	6–8.4	Sea:5.0–9.0, River:5.8–8.6
Residual Chlorine (Free)	mg/L	0.1≧	0.5–1	0.5–1	
△ Temperature ※2	Celsius	5	Normal	Normal	
Total suspended solids	mg/L	40	40	50	200
Total dissloved solids (TDS)	mg/L		2,000	2,000	
B. Chemical Parameters					
Ammonia (NH_4–N)	mg/L	1.9	1.9	5	100 (as T–N※3)
Aluminium	mg/L	5	5	5	
Boron	mg/L		0.75	0.75	Sea:230, River:10
Copper	mg/L	0.5	0.2	0.4	3
Cyanide	mg/L	0.05			1
Fluoride	mg/L	15	1	1	Sea:15, River:8
Iron	mg/L	1	5	5	10
Manganese	mg/L	0.2	0.2	0.2	10
Nitrate (NO_3–N)	mg/L	10	10	15	
Phosphate (PO_4)	mg/L	1	20–30	20–30	16 (as PO_4–P)
Zinc	mg/L	0.08	2	4	2
C. Chemical Parameters (Heavy metals)					
Arsenic	mg/L	0.036	0.1	0.1	0.1
Barium	mg/L	1			
Beryllium	mg/L		0.1	0.1	
Cadmium	mg/L	0.005	0.01	0.1	0.03
Chromium	mg/L	0.01	0.1	0.1	T–Cr: 2, Cr^{6+}: 0.5
Cobalt	mg/L	0.05	0.05	0.05	
Mercury	mg/L	0.001	0.001	0.001	0.005
Lead	mg/L	0.008	0.1	0.1	0.1
Lithium	mg/L		2.5	2.5	
Molybdenum	mg/L		0.01	0.01	
Nickel	mg/L	0.008	0.2	0.2	
Selenium	mg/L	0.07	0.02	0.02	0.1
Vanadium	mg/L		0.1	0.1	
D. Organic Parameters					
Phenols	mg/L	0.1	0.002	0.002	5
E. Microbial Parameters					
Total Coliform	MPN/100ml	1000	1000	2000	3.0×10^5
Enterococci	CFU/100ml	35			
E.Coli	CFU/100ml	126			
Egg of helminths	Number/L		1	1	

※1 This standard refers to wastewater quality standard for public water body in Japan
※2 Δtemperature means the difference of temperature between at the discharge point and at the surrounding area
※3 This is the value calculated with the following equation :
Total nitrogen (mg–N/L) = $0.4 \times NH_4\text{–N} + NO_3\text{–N} + NO_2\text{–N}$

Table 3-8: Water quality standard for re-use of treated sewage and irrigation water (SIO facility)

Parameter	Unit	Saudi Arabia: Treated Sewage (MEWA/NWC)	Saudi Arabia: Irrigation Water (SIO)	Reference: Treaeted Sewage in Japan※1
A. Physical Parameters				
BOD	mg/L	10		25 / 9※3
COD	mg/L		40	
Dissolved Oxygen (DO)	mg/L		4≧	
Floating material		ND		
Oil & Grease	mg/L	ND		Mineral oil:5, Animal and vegitable oil:5
pH	−	6-8.4	6-8.4	5.8-8.6
Residual Chlorine (Free)	mg/L	0.5≧	0.2≧	
Total Suspended Solid	mg/L	10	10	70
Total dissolved solids (TDS)	mg/L		2,500	
Turbidity	NTU	5	5	
B. Chemical Parameters				
Ammonia (NH_4-N)	mg/L	5	10	100※2 / 10※3
Aluminum	mg/L	5		
Boron	mg/L	0.75	0.75	10
Cupper	mg/L	0.4	0.4	1
Fluoride	mg/L	1		8
Iron	mg/L	5	5	3
Manganese	mg/L	0.2		1
Nitrate (NO_3-N)	mg/L	10	10	100※2 / 10※3
Nitrite (NO_2-N)	mg/L		1	100※2 / 10※3
Zinc	mg/L	4	4	1
C. Chemical Parameters (Heavy metals)				
Arsenic	mg/L	0.1		0.1
Beryllium	mg/L	0.1		
Cobalt	mg/L	0.05	0.05	
Cadmium	mg/L	0.01		0.03
Chromium	mg/L	0.1		T-Cr: 2, Cr^{6+}: 0.5
Lead	mg/L	0.1	0.1	0.1
Lithium	mg/L	2.5		
Mercury	mg/L	0.001		0.005
Molybdenum	mg/L	0.01		
Nickel	mg/L	0.2	0.2	1
Selenium	mg/L	0.02		0.1
Vanadium	mg/L	0.1		
D. Organic Parameters				
Phenol	mg/L	0.002		0.5
E. Microbial Parameters				
Egg of Helminthes	Number/L	1	1	
Fecal Coliform	Number/100ml	2.2	2.2	3.0×10^5

※1 These values refer to the effluent standard of sewage treatment plants in Yokohama city which are located in the catchment flowing into Tokyo bay in case the effulent is discharged into river.

※2 This is the value calculated with the following equation :

Total nitrogen (mg-N/L) = 0.4 × NH_4-N+NO_3-N+NO_2-N

※3 This value is the target effulent standard of sewega treatment plants in Yokohama city which are located in the catchment flowing into Tokyo bay in case the effluent is discharged into river , which was newly set in 2020.

Source: Water quality standard for sewage treatment is referred to water quality standard and specification in 2021 (MEWA) and water quality standard for irrigation water is referred to water quality standard (SIO)

Water quality standard for re-use of treated water and irrigation water (SIO facility) consists of physical parameters, chemical parameters, organic parameters and microbial parameters.

BOD 10mg/L or less, nitrogen (or nitrate-nitrogen) 10mg/L or less and suspended solids

10mg/L or less, which can be treated with tertiary treatment, are set in water quality standard for re-use of treated sewage in Saudi Arabia. The standard values in Saudi Arabia are almost the same as the target value for water quality in the treated water from sewage treatment plants in Japan which have introduced advanced treatment.

In addition, egg of helminth is set in water quality standard for re-use of treated sewage in Saudi Arabia while it is not set in Japan.

Table 3-9: Bio solids quality standard

Parameter	Unit	MEWA	Reference: Japan ※1
A. Chemical Parameters (Heavy metals)			
Arsenic (As)	mg/kg-DS	75	50
Cadmium (Cd)	mg/kg-DS	85	5
Chromium (Cr)	mg/kg-DS	3,000	500
Copper (Cu)	mg/kg-DS	4,300	
Lead (Pb)	mg/kg-DS	840	100
Mercury (Hg)	mg/kg-DS	57	2
Molybdenum (Mo)	mg/kg-DS	75	
Nickel (Ni)	mg/kg-DS	420	300
Selenium (Se)	mg/kg-DS	100	
Zinc (Zn)	mg/kg-DS	7,500	
B. Microbial Parameters			
Fecal Coliform	Number /g-DS	1000>	
Salmonella	Number /4g-DS	3>	
Egg of Helminth	Number /50g-DS	1>	
Enteric Virus	PFU /4g-DS	1>	
C. Others			
Others		Biosolids must be stabilized ※2	

※1 This is the standard in Japan for maximum content of hazadous substance in fertilizer which is made from the sludge generated from sewage treatment plant
※2 Sludge must be stabilized by aerobic digestion, anaerobic digestion, composting or lime stabilization.

Source: Water quality standard and specification in 2021 (MEWA)

Bio-solids quality standards consist of chemical parameters, microbial parameters, and so on. The standard values for each pathogenic microorganisms are set in Saudi Arabia while they are not set in Japan.

3) Water and sewerage tariff

Drinking water and sewerage tariff table are shown in Table 3-10. This tariff table is applied to throughout the country in Saudi Arabia.

Table 3-10: Water and sewage tariff

Water Consumption	Water Tariff	ewerage Tariff	Total
m^3/month	SAR/m^3	SAR/m^3	SAR/m^3
-15	0.1	0.05	0.15
16-30	1	0.5	1.5
31-45	3	1.5	4.5
46-60	4	2	6
60-	6	3	9

※SAR 5 is added as initial charge.

<u>Example of tariff calculation:</u>

Precondition: In case 38 m^3 is used for one month;

Water tariff = Initial charge + charge depending on water consumption
= SAR5 +SAR 0.1×15m^3+SAR 1×(30-15) m^3+SAR 3×(38-30) m^3
= SAR45.5

Sewerage tariff = charge depending on water consumption
= SAR 0.05×15m^3+SAR 0.5×(30-15) m^3+SAR 1.5×(38-30) m^3
= SAR20.25

Total tariff = water tariff and sewerage tariff
= SAR45.5+ SAR20.25
= SAR65.75

Souce: NWC SAR 1≒¥30

4) Role of each organization in water sector

Roles of each organization in water sector in Saudi Arabia are as shown in Table 3-11.

Table 3-11: Role of each organization in water sector in Saudi Arabia

Name of organization	Main role
Ministry of environment, water and agriculture (MEWA)	MEWA is the ministry for making the policies and developing on environment, water and agriculture in Saudi Arabia and managing the related organizations. MEWA is the higher organization of SWCC, NWC and SIO and supervise them. The headquarters are located in Riyadh city.
Saline water conversion corporation (SWCC)	SWCC is the governmental organization for operation and management of sea water desalination in Saudi Arabia and supply the production water to NWC. The headquarters are located in Riyadh city.
National water company (NWC)	NWC is the company invested with 100% governmental capitals in Saudi Arabia and operates and manages water supply and sewerage in Saudi Arabia. The headquarters are located in Riyadh city.
Saudi Irrigation Organization (SIO)	SIO is the governmental organization for operating and managing irrigation facilities including the drainage facilities. There are the headquarters in Hasa city and the branches in 7 cities.
Saudi water partnership company (SWPC)	SWPC is the organization affiliated with ministry of finance (MOF) and the organization for financing through MOF, supervising the bid and the contract with private companies regarding large-scale projects related with newly constructing sea water desalination facilities, drinking water treatment plants, sewage treatment plants, water reservoirs, dams and water distribution facilities. The headquarters are located in Riyadh city.

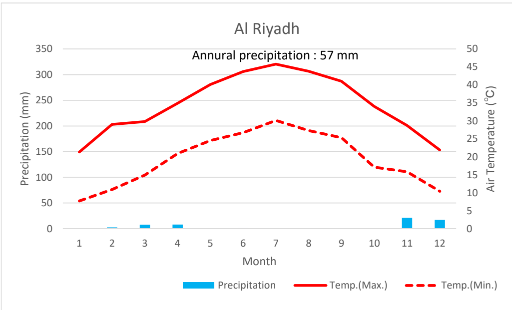
Source: Prepared by JICA Survey Team based on Web sites of each agency

(2) Present conditions in the water and water quality fields in the target cities

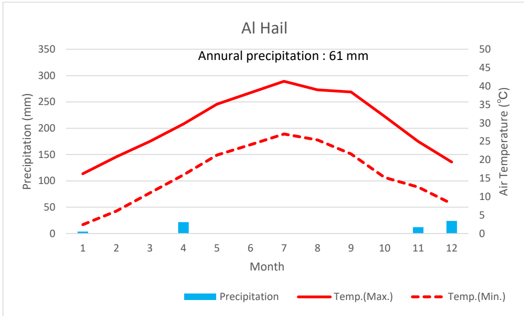
1) Basic information

a. Meteorology

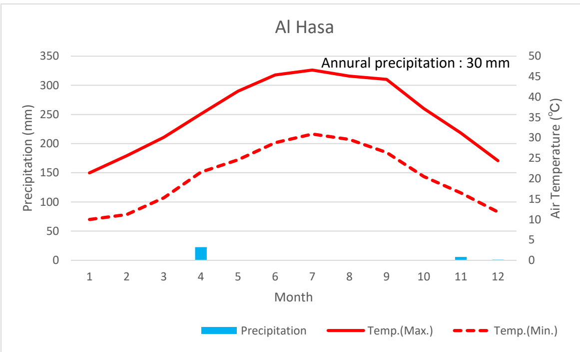
Monthly rainfalls and air temperature at maximum and minimum in 2020 in objective three cities are shown in Figure 3-5. As an additional note, because there is no meteorological data available for Buraydah city, which is one of the objective cities, the data of Hail city where is located near Buraydah city is shown in Figure 3-5. Besides as reference, the data of Tokyo is also shown in the same figure.



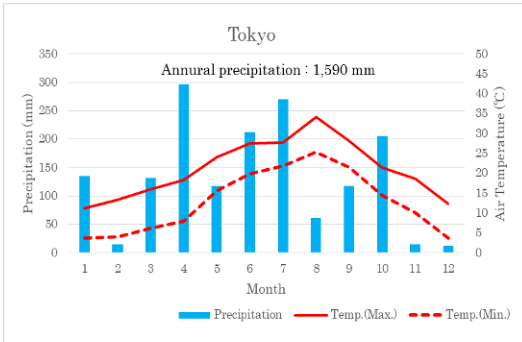
Riyadh City



Hail City



Al Ahsa City



As reference: Tokyo

Figure 3-5: Monthly rainfalls and air temperature at maximum and minimum in 2020

Source: Meteorological data in cities in Saudi Arabia is referred to statistics data in 2020 (MEWA) and meteorological data in Tokyo is referred to one in 2020 (Japan meteorological agency)

Annual rainfall in three cities in Saudi Arabia is less than 100mm, which is equivalent to 1/10 or less of annual rainfall than that of Tokyo, Japan. That is, objective three cities are located at extensive arid area. Besides, there are not a lot of rainy months through a year in the three cities in Saudi Arabia. Air temperature difference between at maximum and minimum in each month in three cities in Saudi Arabia is larger than that of Tokyo, Japan.

b. Domestic water consumption

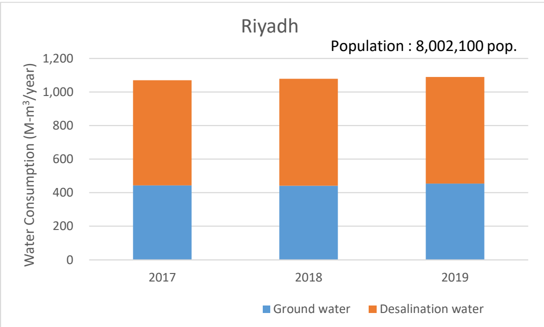
Population and unit water consumption for municipal water in 2019 in three target regions and at the entire Saudi Arabia are as shown in Table 3-12.

Table 3-12: Population and unit water consumption for municipal water in 2019

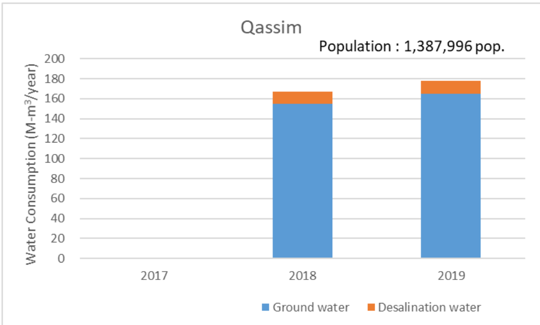
Region	Population (Pop.)	Unit Water Consumption in 2019 (LCD)
Riyadh	8,002,100	373
Qassim	1,387,996	351
Eastern Province	4,780,619	378
Saudi Arabia	31,742,308	301

Source: Population is referred to Demographic Survey in 2016 (General Authority for Statistics) and unit water consumption is referred to statistics data in 2019 (MEWA)

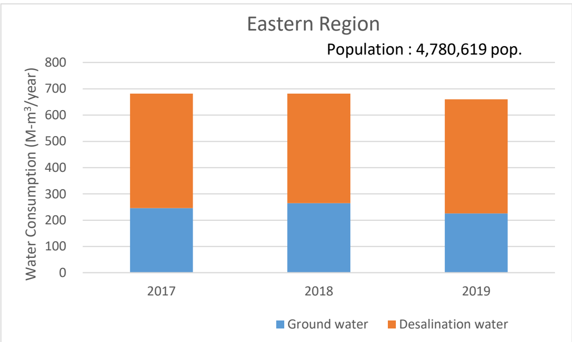
As reference, water consumption on each water source from 2017 to 2020 in the three target regions and at the entire Saudi Arabia were as shown in Figure 3-6.



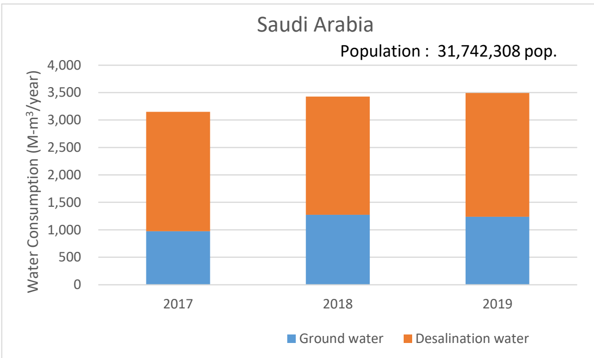
Riyadh Province



Al-Qassim Province



Eastern Province



Ref.: Nation-wide Saudi

Figure 3-6: Water consumption volume on each water source in 2019

Remarks: Data in 2017 at Al-Qassim Provice is not published.

Source: Statistics data in 2019(MEWA)

Groundwater and desalinated seawater are mainly used as the source of potable water in the urban areas in Saudi Arabia. The ratio of water consumption volume of the desalinated seawater against all the water consumption volume in at the entire Saudi Arabia in 2019 is approximately 65%. On the other hand, ratio of the desalinated seawater at Al-Qassim region where is located in the center of Saudi Arabia, was only approximately 7% in 2019, which means that the region is depending on the groundwater as main water source for municipal water there.

c. Total number of existing water purification plants for potable water, total design capacity and total water production

Total number of existing water purification plants for potable water, total design capacity and total water production in 2019 on objective regions are shown in the following Table.

Table 3-13: Total number of water purification plants, total design capacities and total water production in 2019

Region	Water purification plant (Before 2019)			Added plants in 2019	
	Total number of plants	Total design capacity	Total water production	Number of plants	Total design capacity
	(plants)	(m^3/day)	(m^3/day)	(plants)	(m^3/day)
Riyadh	87	1,468,250	1,060,333	1	14,000
Qassim	27	541,400	415,269	0	0
Eastern Province	61	No data	No data	No data	No data
Saudi Arabia	353	3,137,800	2,067,570	9	329,600

Source: Statistics data in 2019(MEWA)

d. Total number of sewage treatment plant, total amount of treated sewage and total amount of reused water from treated sewage.

Total number of sewage treatment plant, total amount of treated sewage and total amount of reused water from treated sewage in 2019 are shown in the following table.

Table 3-14: Total number of sewage treatment plant, total amount of treated sewage and total amount of reused water from treated sewage in 2019

Region	Number of sewage treatment plant in 2019	Treated sewage		Total amount of reused water from treated sewage	Percentage of reuse of treated sewage
		Total amount	(Percentage against portable water production)		
	(plants)	(m^3/day)	(%)	(m^3/day)	(%)
Riyadh	6	1,395,864	47	132,517	9
Qassim	5	218,869	45	59,819	27
Eastern Province	16	1,159,242	64	382,846	33
Saudi Arabia	99	4,936,640	52	852,307	17

Source: Statistics data in 2019(MEWA)

The ratio of total amount of treated sewage against total water consumption for municipal water in 2019 at the objective three regions was 45-64 %, the ratio of total amount of reused water from treated sewage against total amount of treated sewage was 9-33%.

e. Seawater desalination facility

Seawater desalination plants, total capacity of which is approximately 8,000,000m^3/day as of January 2021, is currently operated in total at 17 cities along the Persian Gulf and the Red Sea. The location map of seawater desalination plants being operated in 2019 is as shown in Table 3-7.

Most of seawater desalination plants constructed in 1980s becomes due for renewal at present.

So, they increase the capacity and are planned to be constructed near the existing facilities at the same site. Some of them are currently at the stage of selecting contractor or under construction.

Figure 3-7: Location map of seawater desalination plants operated in 2019

Source: Prepared by JICA Survey Team by referring to
Saudi Water Partnership Company (SWPC) 7 years Statement 2020-2026.

A part of desalination water produced at Jubail, where is located along the Persian Gulf (total capacity: 1,200,000m^3/day), is transporting the waters to Riyadh city and Al-Qassim region. Besides, a part of desalination water produced at Khobar, where is located along the Persian Gulf (total capacity: 700,000m^3/day), is transporting the waters to Al-Ahsaa city in the Eastern Province.

(3) Current situation of water sector and water quality in Saudi Arabia based on site survey

1) Water purification plant for portable water

For the purpose of collecting the information regarding the present conditions at water purification plant for portable water in Saudi Arabia, JICA Survey Team visited a water purification plant in Al-Qassim. The results of the site survey are as shown below. Meantime, JICA Survey Team could not visit any water purification plants for portable water in Al-Riyadh.

［Water purification plant in Buraydah city, Al-Qassim］

The design capacity of water purification plant is approximately 170,000m^3/day. In addition to the water purification plant which JICA Survey Team has visited, there is another water treatment plant in Buraydah city operated in 2010 that the capacity is approximately 50,000m^3/day. The purified water produced at two water treatment plants supplies to approximately 90% of total population in Buraydah city, approximately 700,000 population. The schematic flowsheet of water purification plant for portable water is shown in the following figure.

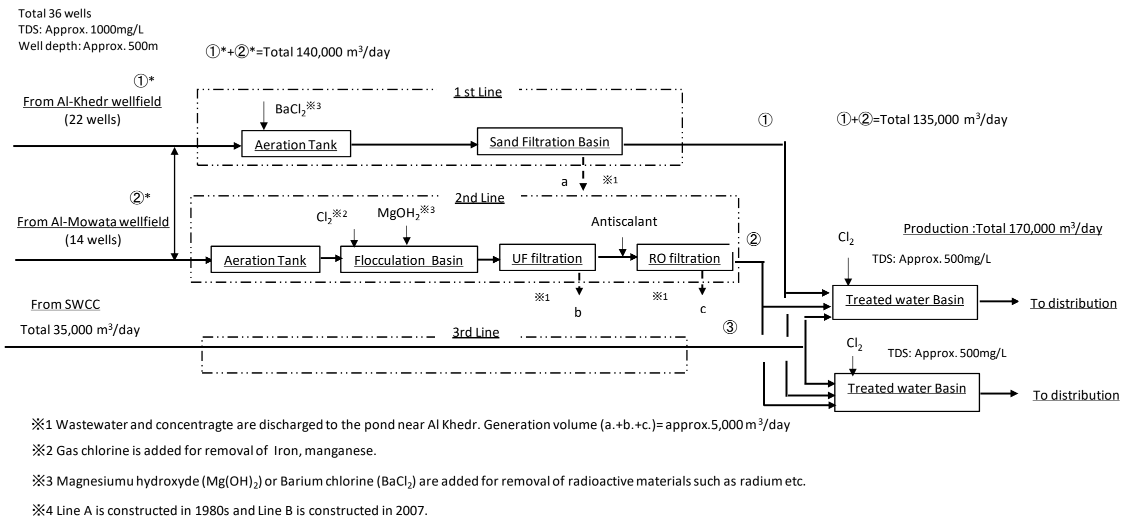


Figure 3-8: Schematic flowsheet of water purification plant for portable water in Buraydah city

Source: JICA Survey Team

Water treatment systems consist of the following three lines:

- 1st line (Water source: Well fields in Buraydah city): Aeration tank and sand filtration basin
- 2nd line (Water source: Well fields in Buraydah city): Aeration tank, flocculation basin, Ultra Filtration (UF) membrane facility and Reverse Osmosis (RO) membrane facility
- 3rd line (Water source: desalination water received from sea water desalination facility owned by SWCC)

The water source for 1st line and 2nd line is ground water located in Buraydah city which consists of total 36 wells having approximately 500m average depth. According to the report from the operator, the Total Dissolved Solids (TDS) in the water is approximately 1,000mg/L. The water treated at each of 1st to 3rd line is mixed in the treated water basin and finally adjusted so as to meet TDS 500mg/L. Then the water is distributed through two lines of water distribution mains to the city. 1st and 2nd line are constructed in 1980s and 2007, respectively.

Regarding 2nd line, an immersion type ceramic membrane, which is made by one of Japanese firms, is adopted at UF membrane facility. Besides, the membrane which is made by other Japanese firm, is adopted at RO membrane facility. The operator reported that the RO membranes never be replaced for 10 years or more.

According to the operator, wastewaters of total approximately 5,000m^3/day, being equivalent to approximately 3.5% against total amount of intake volume at 1st and 2nd line, which are derived from sand filter basin, UF membrane facility and RO membrane facility, are discharged into the lagoon in Buraydah city. But the operator explained that the groundwater for water source is not polluted by the wastewater, because it is separated with impermeable layer.

As one of the issues on water quality control, radioactive materials such as radium in the wells need to be removed completely. Those materials are insolubilized with adding magnesium hydroxide or barium chloride and removed through filtration.

Water quality analysis is conducted at water treatment plant in accordance with water quality standards in MEWA. The daily parameters analyzed at water treatment plant are TDS, hardness, alkalinity, iron, manganese, ammonium, nitrate, fecal coliform and radium, etc. The analysis is basically conducted using the simplified analysis method. Operation and management for water treatment plant is conducted by Saudi Arabian contractor, Zahran O&M Company. The contract period is for 3 years.

Regarding the price of receiving water from seawater desalination plant, the staff in central office of MEWA Bulaydah answered that costs of the receiving water from seawater desalination plant is definitely much higher than costs of the receiving water from wells in terms of water production cost, because water transmission costs from Jubail to Buraydah shall be added to the costs of water from the desaliation plant.

In addition, regarding the future plan of water source in Buraydah city, the staff in central office of MEWA Bulaydah answered that the groundwater level is currently going down due to excess water intake against water recharge, and it is necessary that seawater desalination water shall be received continueously to cover the water demand in the future.

RO Facilities

Raw Water (Ground water transported from Buraydah city)

Photo 3-2: Water treatment plant in Buraydah city

2) Sewage Treatment Plant

For the purpose of collecting the information regarding present conditions of sewage treatment plant, JICA Survey Team has visited sewage treatment plants in Al-Qassim. The results of the site survey are as shown below. Meantime, JICA Survey Team could not visit any sewage treatment plants at Riyadh areas, because a permission from Saudi Arabian side was not available.

① Sewage Treatment Plant in Buraydah city

The design capacity of sewage treatment plant is approximately 150,000m^3/day. According to the staff in MEWA, the treatment volume at present is almost the same as the design capacity. This sewage treatment plant is only one in Buraydah city and the first one which was constructed in Al-Qassim. It covers approximately 65% of total population in Buraydah city, approximately 700,000 pop. The schematic flowsheet of sewage treatment plant is as shown in the following figure.

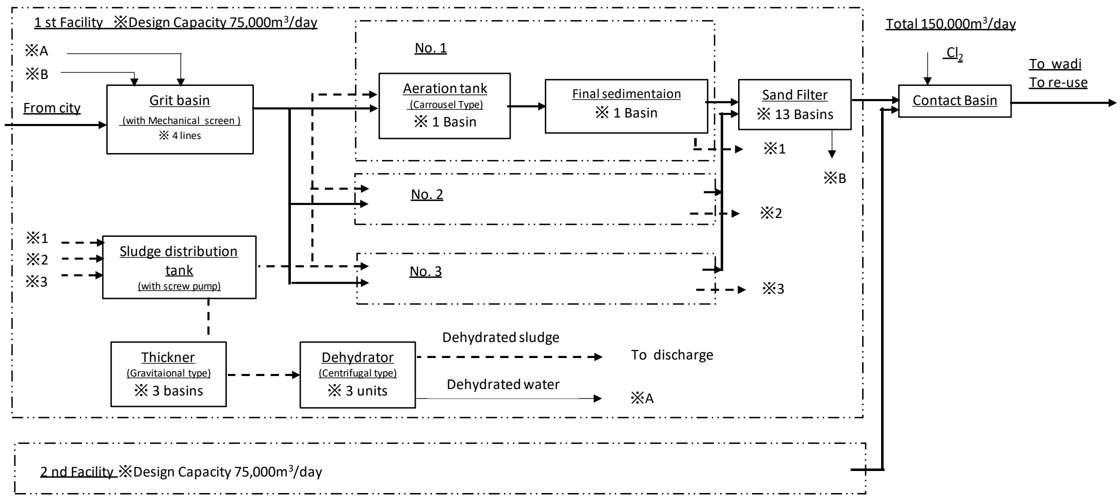


Figure 3-9: Schematic flowsheet of sewage treatment plant in Buraydah City

Source: JICA Survey Team

Sewage treatment plants consist of 2 lines, almost the same process, that the design capacity is 75,000m^3/day×2 lines. 1st line and 2nd line are constructed in 2002 and 2010, respectively. Applied water treatment process is carrousel typed oxidation-ditch. It consists of grit basin for pre-treatment basin, aeration tank, final sedimentation, sand filter and contact basin. Sludge treatment facility consists of gravitational thickener and centrifugal dehydrator.

There are auto screens, and the scraper is installed and moved on the front surface, in grit basin. But it looked that it could not lift the debris up efficiently due to the functional issues. In addition, there is a large grit lifter, which can take grit out of the basin, on the grit basin.

Approximately 30% of treated sewage is re-used for irrigation water for the agriculture and the trees in the park. The rest of treated sewage is discharged into the wadi near the treatment plant. Dehydrated sludge is disposed outside the treatment plant.

There is total 13 sewer pump stations in the city. Combined sewer system is applied as sewage collection system. According to the operator, flow rate at inlet of sewage treatment plant increases and sewage overflows when rain waters came in. Thus, dedicated drainage for rainwater is currently constructed and separated from sewer pipe.

Besides, according to the staff in MEWA, at the area uncovered with sewer system, private companies collect the septage and discharge it into a sewer pump station. Operation and management including daily water quality analysis is conducted by Saudi Arbian contractor, Alrawaf Co. The contract period is for 5 years.

Regarding water quality analysis, the daily parameters analyzed at sewage treatment plant are pH, nitrogen, ammonia, nitrate, phosphate, TDS, BOD, residual chlorine and fecal coliform in the raw water and the secondary effluent (water treated with final sedimentation basin). They are analyzed with the simplified analysis method. JICA Survey Team confirmed that the analysis equipment for these parameters was operating in site survey. In addition, sludge concentration of Mixed Liquor Suspended Solids (MLSS) in aeration tank and return sludge are analyzed and sludge volume after sedimentation is checked every day for the daily operation management.

The result of water quality analysis for treated sewage at discharging point using portable water quality analysis equipment which JICA Survey Team brought from Japan is as follows:
Water temperature: 31.5℃, pH: 7.75 (-), EC: 2,820 (uS/cm), turbidity: 0 (NTU), NH_4-N: 0.2mg/L or less, NO_3-N: 5mg/L, PO_4-P: 3mg/L, residual chlorine: 0.1mg/L as free chlorine, 0.2 mg/L as combined chlorine and fecal coliforms: not detected.

Aeration Tank

Sludge Settlement Test

Photo 3-3: Sewage Treatment Plant in Buraydah City

② Sewage Treatment Plant in Unayzah City

The design capacity of sewage treatment plant is approximately 50,000m^3/day. The treatment volume at present is approximately 35,000m^3/day. This sewage treatment plant is only one in Unayzah city and the second one which was constructed in Al-Qassim. It covers approximately 75% of total population in Unayzah city, approximately 200,000 pop.

The treatment plant at present started operating in 2012. Treatment process applied at previous treatment plant was aerated lagoon. The schematic flowsheet of sewage treatment plant is as shown in the following figure.

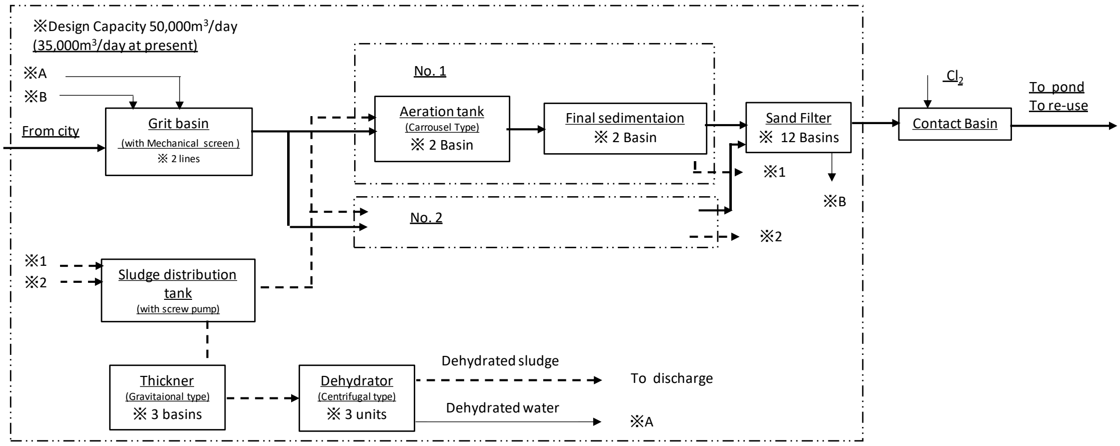


Figure 3-10: Schematic flowsheet of sewage treatment plant in Unayzah City

Source: JICA Survey Team

The water treatment process is almost the same process as one in Buraydah city, carrousel typed oxidation ditch. It consists of grit basin for pre-treatment basin, aeration tank, final sedimentation, sand filter and contact basin. Sludge treatment facility consists of gravitational thickener and centrifugal dehydrator.

Approximately 2,000m^3/day of treated sewage is re-used for cooling water at Saudi Electricity Company (SEC). Recently water transmission pump was newly installed in the treatment plant and all the other treated sewage is transported to Ghuwaymidi area, approximately 30km away from the treatment plant. In the area, the project for constructing a forest park and agricultural lands using re-use of treated water is currently implementing. All the other water was discharged into the wadi near the treatment plant before.

Dehydrated sludge is disposed outside the treatment plant. Polymer is used as dehydration assistant. Combined sewer system is applied as sewage collection system. According to the operator, flow rate at inlet of sewage treatment plant increases and sewage overflows when it rains.

Operation and management including daily water quality analysis is conducted by Saudi Arabian contractor, Al Jazea Contracting and Trading Ltd. According to the operator, when staff need the genuine spare parts for machinery such as auto screen installed at pre-treatment facility, reduction gear used in return sludge pump (screw pump) and dehydrator, etc. for the maintenance, they have to contact oversea manufactures in person and procure them because there are no local agencies in Saudi Arabia for the aftersales service. Also, regarding instruments such as electromagnetic flowmeter, dissolved oxygen sensor installed in the aeration tank, they have to contact oversea manufactures in person at the breakdown because there are no local agencies in Saudi Arabia.

Regarding water quality analysis, the daily parameters analyzed at sewage treatment plant are pH, nitrogen, ammonia, nitrate, phosphate, TDS, BOD, residual chlorine and fecal coliform in the raw water and the secondary effluent (water treated with final sedimentation basin). They are analyzed with the simplified analysis method. JICA Survey Team confirmed that the analysis equipment for these parameters was operating at site survey. In addition, sludge concentration of Mixed Liquor Suspended Solids (MLSS) in aeration tank and return sludge are analyzed and sludge volume after sedimentation is checked every day for the daily operation management.

The results of water quality analysis for treated sewage at discharging point using portable water quality analysis equipment which JICA Survey Team brought from Japan are as follows:

Water temperature: 29.9℃, pH: 7.28 (-), EC: 1,570 (uS/cm), turbidity: 0.1 (NTU), NH_4-N: 0.2mg/L or less, NO_3-N: 10 mg/L, PO_4-P: 3mg/L, residual chlorine: 0.1mg/L as free chlorine, 0.3 mg/L as combined chlorine and fecal coliforms: not detected.

Because staff in MEWA requested for the technology to enhance the performance of water treatment or facilitate the operation management or reduce the operation cost, JICA Survey Team recommended aerobic-anoxic zone-controlled operation which can treat the nitrogen in the treated sewage with stable at higher removal rate while reducing the electric power cost for aeration.

Secondary Effluent
（Treated water after final sedimentation basin）

Observation of Activated Sludge

Photo 3-4: Sewage Treatment Plant in Unayzah City

3) Irrigation Systems using Treated Sewage Waters

For the purpose of collecting the information regarding current situation of irrigation systems using treated sewage, JICA Survey Team visited the irrigation facility in Riyadh city and Al-Ahasan city. The result of the site survey is shown below.

① Irrigation Systems in Riyadh city

The schematic system of irrigation facilities (Diriyah PS, Wasil tank, etc.) which SIO owns is as shown in the following figure.

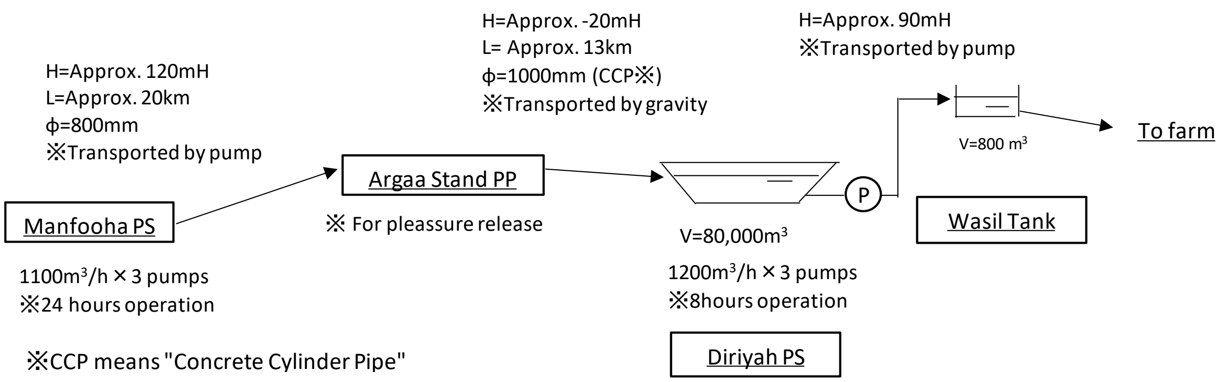


Figure 3-11: Schematic flow of irrigation systems in Riyadh City

Source: JICA Survey Team

【Diriya pump station】

This pump station is the facility for receiving the treated sewage, which is treated at Manfooha sewage treatment plant and transported from Manfooha pump station, and for transporting it to Wasil tank. This pump station consists of receiving basins with the upper part opened and pumps. The volume and dimension of the receiving basin are approximately 80,000m^3 and 250m×100mL×3.2mH. There is a chlorine gas storage and dosing facility. But chlorine is not dosed at Diriyah pump station. According to the operator, there are some issues on frequent de-sludge accumulated on the bottom of basin and corrosion of plastic sheet covering the wall and the bottom of basin and pipes, etc.

The results of water quality analysis for inlet water from Manfooha pump station using portable water quality analysis equipment which JICA Survey Team brought from Japan are as follows:

pH: 7.27(-), DO: 2.9(mg/L), EC: 2,150 (uS/cm), turbidity: 1.8NTU, NH4-N: 0.2mg/L, NO_3-N: 0.5mg/L , PO_4-P: 2(mg/L) , fecal coliform: Detected

※ JICA Survey Team could find relatively large size of particles which can be found easily when we took the sample with the bucket.

【WasilTank】

This tank is the facility for receiving the water transported from Diriyah pump station and transporting it by gravity to the farms at the surrounding area of this tank. It consists of upper open basins. The volume and dimension of the receiving basins are approximately 800m^3 and 12m×12mL×5.5mH. The operators monitor the flow rate and the water level by their eye and control them with manual.

This facility does not introduce the system which can monitor and control the operation from a central station. There is a small solar panel for electric power generation. The generated electric power is used for the electric power for the actuator of motor operating valve.

【Farms at the surrounding area】

The agricultural land area is approximately 40,000 m2. Olive, lemon, dates, palm, etc. are cultivated there. The farmer is using the water supplied from the facility operated by SIO for his farms while he uses his own ground water for domestic water of his family. According to the farmer, water does not reach from SIO facility for some days from July to October. He does not experience the issues on the water quality a lot until now.

Diritah Receiving basin of pump station

Frames at the surrounding area of Wasil tank

Photo 3-5: Irrigation facilities in Riyadh city

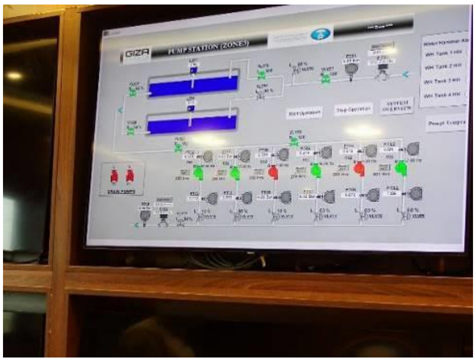
② Irrigation facility in Al-Ahasan city

【Water Transmission Pump A and the Farms Transported from the Pump Station】

This pump station is the facility for receiving the treated sewage from the sewage treatment plant in Al-Ahasan city and Kubar city, which is approximately 180km away from this pump station, and transporting it to the farms at the surrounding area of this pump station. A flow meter and an automatic valve are installed on each of total 1200 farms and open/shut of valve and flowrate on each farm are monitored and controlled from a central station. There is total 6 pumps, 4 pumps for duty and 2 pumps for stand-by. Number and rotational speed of pumps are controlled so that water can be supplied to each farm at designated pressure and flowrate.

The results of water quality for irrigation water transported from the pump station using potable water quality analysis equipment which JICA survey team brought from Japan are as follows:

Water temperature: 33.1℃, pH: 7.51(-), EC: 3,720 (uS/cm), turbidity: 5.4(NTU)、NH_4-N: 0.3mg/L or less, NO_3-N: 1mg/L, PO_4-P: 3mg/L, residual chlorine: 0 mg/L as free chlorine, 0.1 mg/L as combined chlorine and fecal coliforms: Not detected.



The panel for monitoring operation in the central monitoring room at pump station

Irrigation water used at farm

Photo 3-6: Water transmission pump A and the related facilities

【Water Transmission Pump B and the Farms Transported from the Pump Station】

This pump station is the facility for receiving the treated water from the sewage treatment plant with tertiary treatment, which is located next to this pump station and operated by NWC, and transporting it to the surrounding area. There is a UV facility, which is manufactured in WEDECO, in this pump station that the capacity is 150,000m^3/day. But the UV facility wat not operated due to under the maintenance during site survey. According to the operator, there are no local agencies for the manufacturer of the UV facility which can correspond to the aftersales service in Saudi Arabia. Basically, gas chlorine is dosed at the sewage treatment plant as disinfectant before receiving the treated sewage in this pump station.

The results of water quality for irrigation water in the agricultural test center transported from the pump station using potable water quality analysis equipment which JICA Survey Team brought from Japan is as follows:

Water temperature: 31.7℃, pH: 7.86(-), EC: 2,700 (uS/cm), turbidity: 3.1(NTU), NH_4-N: 0.2mg/L or less, NO_3-N: 5mg/L, PO_4-P: 3mg/L, residual chlorine as free-chlorine: 0 mg/L, residual chlorine as combined-chlorine: 0.1 mg/L and fecal coliform: Not detected

There is a desalination facility that the capacity is 50m^3/day in the agricultural test center, which consists of sand filter and RO membrane facility. It was procured from a local supplier in Saudi Arabia. According to the operator, when the facility is operated, a lot of leakage of water is generated. For disinfection of production water from the facility, dosing facility for sodium hypochlorite and UV equipment are installed in the facility. But UV equipment is not operated while sodium hypochlorite is dosed because choline gas is generated if they are operated at the same time.

UV disinfection equipment in pump station, under maintenance

Desalination facility in agricultural test center

Photo 3-7: Water transmission pump B and the related facilities

【Water Transmission Pump C】

This pump station is the facility for receiving the drain water discharged from agricultural land and transporting it to open channel for irrigation water at an emergency of shortage of it. According to the staff of SIO, there is some water flowing in the drainage channel through a year although it is a fluctuation to some extent between dry season and rainy season. The condition of drainage channel at the site visit is as shown in the following figure. SIO is interested in the technology which can re-use the brackish water in drainage channel for irrigation water by reducing the saline concentration from TDS 3,000 -5,000mg/l to 1,000mg/L or less.

Water transmission pump

Drainage channel discharged from agricultural land
(Inlet water of pump station)

Photo 3-8: Water transmission pump C and the related facilities

【Project Site for Environmental Forest】

SIO has been implementing the project for plantting approximately 150,000 trees in the area of approximately 3km ×3km using drain water discharged from agricultural land or treated sewage since 3 years ago. There is total 2 sites, one consists of 2 ponds with approximately 20m×10m×1m for storing treated sewage and another consists of a pond with approximately 65m×20m×1m for storing treated sewage and a water transmission pump. SIO plans to do demonstration test for cultivating trees using the brackish water.

There are solar panels near the ponds for electric power source of transmission pump installed in a pond, the installation area is approximately 20m×50m and the electric power generation capacity is approximately 40kw.

Reservor of treated sewage for irrigation

Solar panels (for electric power source of water transmission pump)

Photo 3-9: Project site for environmental forest

4) Water Quality Laboratory

For the purpose of collecting the information on the present conditions of water quality laboratory, JICA Survey Team has visited water quality laboratories in Buraydah city and

Al-Ahsa city. The results of the site survey are as shown below.

① Water quality laboratory in Al-Qassim

This laboratory is the central laboratory for regularly analyzing the parameters which cannot be analyzed at water purification plants for portable water and sewage treatment plants in Al-Qassim, the water samples regularly taken from water distribution and service pipe for portable water and the water samples regularly taken from ground water as water source of drinking water in the area uncovered with city water supply. This laboratory is organized with drinking water analysis division and wastewater analysis division. The drinking water analysis division is organized with physical and chemical section, microbiological section, instrumental section and radiation section.

There are the instruments for ion chromatograph (IC) to analyze bromine,etc., high-performance liquid chromatograph (HPLC) to analyze aromatic hydrocarbon, atomic absorption spectrophotometers (AA) and inductively coupled plasma atomic emission spectrophotometer (ICP) to analyze trace heavy metals, inductively coupled plasma mass spectrophotometer (ICP-MS) to analyze pesticides, total organic carbon analyzer (TOC) to analyze organic matters in the wastewater and radiation spectrometer to analyze radioactive substances such as radium, etc. These instruments are used by the staff at the visit of laboratory.

Water quality analysis for drinking water and sewage are conducted in accordance with the standard issued by MEWA in 2021. If the other public agencies in Saudi Arabia request for water analysis, this laboratory accepts it for free of charge. If private companies request for water analysis, this laboratory accepts it for a fee.


Bromine analysis using ion chromatograph


Radium analysis using radiation spectrometer

Photo 3-10: Water quality laboratory in Al-Qassim

②Water quality laboratory in Hasan city (SIO facility)

This is the central laboratory owned by SIO for analyzing the parameters which cannot be analyzed at pump station for irrigation water in Al-Ahsa city. This laboratory consists of the rooms for general water quality analysis, instrumental analysis, microbiological analysis, parasitology analysis and soil analysis. There are the instruments for atomic absorption spectrophotometers (AA) and inductively coupled plasma atomic emission spectrophotometer (ICP) to analyze trace heave metals. Heavy metals in the soil are analyzed every week or every month. Fecal coliform for microbial analysis is analyzed with simplified analysis method using EC blue manufactured by one of Japanese chemical products manufacturers.


Flame photometer


Panels for helminths found in treated sewage

Photo 3-11: SIO Water quality laboratory in Al-Ahsa city

5) Water quality for ground water

JICA Survey Team has conducted water quality analysis of ground water for municipal water or agricultural water using portable water quality analysis equipment which JICA Survey Team has brought from Japan. The results of water quality analysis are as shown in the following table.

Table 3-15: Result of water quality analysis for ground water
(Using portable water quality analysis equipment)

Sample		Well A	Well B			
Date		2021/10/5	2021/9/26			
Place		Riyadh city	Buraydah city			
Well depth		Approx.100m	Approx.100m			
Purpose of use		Domestic Water	Agricultural Water			
Parameter	Unit	Value		Reference: water quality standard		
				Drinking water※1	Irrigation water※1	Envinmental standard (Drinkable ground water)※2
Water Temperature	℃	26.8	36.9			
pH	–	7.5	8.1	6–8.5	6.5–8.4	6.5–9
EC	μS/cm	2,260	2,050	(100–1,000mg/L)	(2,000mg/L>)	
Turbidity	NTU	0.7	0.5	5 >		
Ammonia	mg-N/L	0.3	0.2>	0.4>		0.3>
Nitrate	mg-N/L	50<	10<	10 >	30>	
Phosphate	mg-P/L	0.3	0.1			
Fecal Coliform	CFU/ml	Not detected	Detected	Not detected	20/100ml	Not detected

Note:
※1 Water qulaity standard and specification in 2021(MEWA)
※2 Environmental law in 2021(MEWA)

Source: JICA Survey Team

As the result of water quality analysis, JICA Survey Team found some wells with approximately 100m depth in Riyadh city and Buraydah city that nitrate in the ground water exceeded 50mg-N/L, which is much higher than water quality standard for drinking water or irrigation water in Saudi Arabia. Besides, JICA Survey Team found a well contaminated by fecal coliform. Based on the data, it is implied that water pollution is progressing in ground water at some parts in the cities and the surrounding area.

6) Treatment for industrial wastewater and solid waste

JICA Survey Team visited National Center for Environmental Compliance (NCEC) and collected the following information regarding the situation of industrial wastewater treatment:

- NCEC is the responsible agency in Saudi Arabia for monitoring the status of industrial wastewater treatment. But, NCEC cannot actually grasp all the circumstances at present.
- MEWA formulated KSA National Environmental Strategy 2030 in 2017 and indicated appropriate treatment of industrial wastewater including monitoring of water environment.
- In accordance with the strategy, MEWA formulated Environmental Law including environmental quality standard and wastewater quality standard and enforced the law in 2021.
- For environmental quality standards and wastewater quality standards for coastal, surface and ground water in Saudi Arabia, please refer to Table 3-5 and Table 3-6, respectively. The new law strengthened by introducing a penalty for breaking the law.
- NCEC places total 80 stations for monitoring air throughout Saudi Arabia at present. The staff explained that NCEC is also responsible for monitoring water environment including ground water and is going to promote for monitoring public water body through installation of the stations.

Besides, JICA Survey Team has visited National Center for Waste Management (NCWM) and collected the following information regarding the situation of solid waste treatment:

- NCWM is the responsible agency for policy making and supervising the related agencies regarding industrial and domestic solid waste management in Saudi Arabia including monitoring the status of them. Although actually NCWM cannot grasp all the circumstances at present, most of solid waste is dumped at the landfill.
- MEWA indicated appropriate collection and disposal of industrial and domestic solid waste through KSA National Environmental Strategy 2030.
- In accordance with the strategy, MEWA is currently preparing a set of legal and institutional system for industrial and domestic solid waste management in Saudi Arabia
- NCWM is also responsible for disposal of sludge generated from sewage treatment plant. Although MCWM cannot grasp all the circumstances at present regarding disposal of the sludge, most of them is dumped at the landfill.
- Under the situation, MCWM is very interested in Japanese technologies for disposal and re-use of sludge generated from sewage treatment plant.

Dumping site for solid waste

Photo 3-12: Dumping site for solid waste

(4) Issues on water quality regarding water supply for portable water, agricultural water and sea water desalination

As the result of a set of survey, the issues on water quality regarding water supply for portable water, agricultural water and sea water desalination are summarized in the following 2 items:

- Promotion for re-use of treated sewage
- Prevention of pollution in water environment (ground water, coastal water) and conservation of water environment

Based on the results of survey in the project, the details on each issue are shown in Table 3-16.

Table 3-16: Issues on water quality regarding water supply for portable water, agricultural water and sea water desalination

Issues	Detailed issues
Promotion of re-use of treated sewage	1. Pollution of coastal water There is concern about negative effect to marine environment by concentrate discharges from seawater desalination plants.
	2.Pathogenic microorganisms in treated sewage Reuse of treated sewage water for crops is restricted because there is the possibility for being contaminated by pathogenic microorganisms including eggs of helminths with chlorine resistance in treated sewage water which cannot be killed with chlorine disinfection easily.
	3.Operation cost for sewage treatment Operation cost for sewage treatment increases when advanced treatment is introduced to the sewage treatment plant so that water quality of treated sewage can meet the requirements as irrigation water. Besides, operation cost increases due to decline of labor productivity caused by low-performance machines and increase of electric power consumption caused by low-electric-efficient machines, which are used at some facilities in sewage treatment plant.
	4.Stable water treatment with high water quality Water quality of treated water cannot be always secured for irrigation water because water quality sensors for turbidity, organic matters and nitrate, etc. are not installed in irrigation facilities although water quality analysis for the designated parameters is regularly conducted.
Prevention for pollution in water environment (ground water, coastal water), conservation of water environment	1.Pollution of ground water There are some wells polluted by nitrate that the concentration exceeds 50mg-N/L and/or contaminated by fecal coliform.
	2.Pollution of coastal water There is concern about negative effect to marine environment by concentrate discharges from seawater desalination plant

Source: JICA Survey Team

3.2 Needs for Assistance in the Water Supply, Sewage, and Water Quality fields

In the process of confirming challenges in the water supply, sewage and water quality fields in Saudi Arabia through domestic preparatory surveys and the first field survey, JICA Survey Team has identified needs for support that are expected to contribute to solving issuess through the utilization of technologies and products of Japanese private companies. Specific needs for assistance include the technologies for pipeline leakage control, AI-based facility deterioration diagnosis, and review for construction supervision in the water supply field. In the field of sewage and water quality fields, desalination technology of brine, disinfection technology (ultraviolet rays, etc.), high-effeciency sewage treatment technology, water quality analysis and monitoring technology, johkasou tank and sludge effective utilization technology, marine water pollution technology, and etc. are identified.

3.2.1 Needs for Assistance in Water Supply field

The needs for solving water saving and water leakage issues in the water supply firld are as follows.

1) Pipe materials, Joints, Ferrule Saddle,

Since the water pressure fluctuates greatly due to intermittent water supply, it is desirable to use a pipe and joints that does not easily leak because water leaks from the water supply pipe connection.

2) Valves

Since the sluice valve often breaks down, it is desirable to use a sturdy sluice valve that does not mix with sand or soil due to the generation of negative pressure due to intermittent water supply. In addition, it is desirable to propose ways to find the sluice valve cover and valve housing that are buried and covered with asphalt pavement.

3) Analysis for likelihood of failure on pipe using AI

It is necessary to predict areas with frequent leaks in advance and formulate an effective pipeline renewal plan.

4) Review of piping construction supervision

It was found that service pipe was connected under water because they do not attach temporary valve to stop water. The regulation of piping supervision should be reviwed referring to water service pipe construction engineer system etc.

In order to solve the above problems, it is desirable to introduce and disseminate water supply pipes, fittings, sluice valves with few failures, pipe deterioration analysis technology by AI, etc. owned by Japanese companies.

3.2.2 Needs for Assistance for water quality improvement in the fields of drinking water, agricultural water and seawater desalination.

Based on results of the survey, issues and the countermeasure technologies are summarized in the following figure.

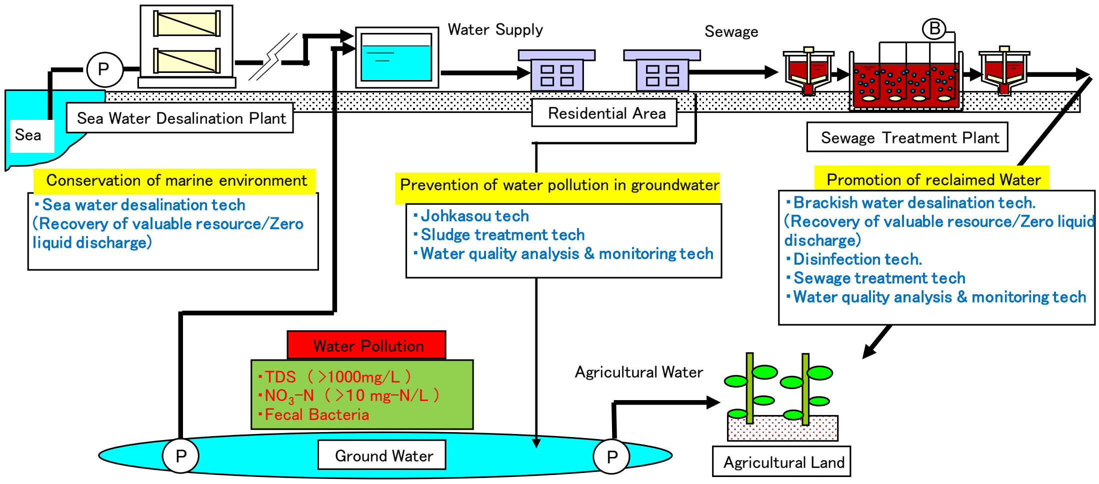


Figure 3-12: Issues and countermeasure technologies on water quality field in Saudi Arabia

Source: JICA Survey Team

Table 3-17: Issues and countermeasure technologies in water quality field in Saudi Arabia

Issues	Detailed issues	Countermeasure technology
Promotion of re-use of treated sewage	1. High salinity of treated sewage	・ Blackish water desalination technology (including recovery of valuables, zero liquid discharge (ZLD))
	2. Pathogenic microorganisms in treated sewage	・ Disinfection technology (UV disinfection, etc.)
	3. Operation cost for sewage treatment	・ Sewage treatment technology
	4. Stable water treatment with high water quality	・ Water quality analysis and monitoring technology
Prevention for pollution in water environment (ground water, coastal water) , conservation of water environment	1. Pollution of ground water	・ Johkasou (a plastic-made and pre-fabricated wastewater treatment facility) ・ Sludge recycling technology ・ Water quality analysis and monitoring technology
	2. Pollution of coastal water	・ Sea water desalination technology (including recovery of valuables, zero liquid discharge (ZLD))

Sourve: JICA Survey Team

3.3 Applicability of Japanese private firms' technologies and products in the Water Supply, Sewage and Water Quality fields

Based on the needs for support from related Government Agencies and private firms in Saudi Arabia being described in above, the applicability of technologies and products by Japanese private firms in this field was examined. In the water supply field, there is a possibility that saddle water plugs, heterogeneous pipe fittings, stainless steel wavy tubes, soft reel partition valves, deterioration diagnosis technology using AI, etc. may be utilized.

In the field of sewage and water quality, desalination technology for brine, proper treatment technology for concentrated water discharged from seawater desalination plants, chlorine disinfection substitute technology for irrigation water using sewage treated water, sand filtration substitute equipment (fiber filtration) for irrigation water and disinfection technology such as ultraviolet rays, sewage treatment technology (water treatment technology using aerobic and anaerobic zone control), sewage treatment technology (sewage treatment machine), recycling technology of dehydrated sludge, The possibility of utilization of water quality monitoring technology, simple water quality analysis technology (pathogenic microorganisms, heavy metal measurement), Johkasou technology, etc. has been confirmed.

3.3.1 Applicability of technologies and products of Japanese private firms in the fields of Water Supply field

In Riyadh, water is being supplied intermittently due to lack of water sources. The pipeline is constantly exposed to the stress of water pressure fluctuation. In order to cope with the fluctuation of water pressure close to that of the water hammer, the water distribution main, water service pipe, and other water supply facilities are required to have a higher level of durability and toughness than the other countries.

1) Cast Iron saddle with corporation stop

① Issues to be solved.

There was no data on leak status or number of leaks in this survey, but according to the NWC, 30% of leaks of service pipe occures at ferrule saddle. There was information that there were many leaks from plastic ferulle saddle.

② Expected technology form Japan

There are several Japanese companies that manufacture cast iron ferrule saddles. Reduction of leaks will be expected if cast iron ferrule saddles is used instead of plastic ferrule saddles to repair leaks. In the conditions where the water pressure fluctuates greatly, such as intermittent water supply, and the pipeline is heavily loaded, a sturdy cast iron ferrule saddle is used to reduce the amount of water leaks in order to achieve stable water supply.

However, it is the policy of NWC in the future to adopt HDPE pipes for the main pipes to be newly laid and to use HDPE-made ferrule saddle that can be connected without water interruption.

Since those are joined by electric heat fusion, the possibility of water leakage is relatively low. Therefore, Japanese cast iron ferrule saddle will not be used at the location where the new water pipe installation.

2) Service pipe

① Issues to be solved.

About 40% of the leaks from the water service pipes are from the rising pipe of the meter, and about 10% are from the water service pipe itself. They said that there is a little water leakage from the water service pipe itself, but there are many water leaks from the joints and fittings.

② Expected technology form Japan

There are several Japanese companies that manufacture corrugated stainless-steel pipe. The stainless-steel pipe is processed into a corrugated shape to make it bendable and used it for water service pipes. As a result, since there is no need for joints at curved parts, piping work is streamlined, and the wavy parts absorb displacement and vibration, resulting in excellent earthquake resistance. Stainless steel pipes have excellent corrosion resistance, and there is no concern that the inside will become thin due to the "rust hump" that is often seen in galvanized steel pipes, resistance will increase, and hygienic safety is fully guaranteed. Compared to galvanized steel pipes, it is lighter and easier to transport and connect.

This excellent earthquake resistance and the high durability of stainless-steel pipes have been highly evaluated, and stainless-steel piping systems using corrugated stainless-steel pipes for water supply have been adopted by many water systems at the local Government.

3) Pipe joints with elasticity (with various connection adapters)

① Issues to be solved.

According to the information from NWC, about 40% of all the leaked water from the water supply pipe is from the rising pipe near the water meter. One of the causes of water leakage is when installing a new smart meter, removing the old meter used in the past from the water service pipe, and connecting a new water service pipe to various kinds of old water pipes. In particular, it is expected that water leakage occurs when cast iron fittings are used in resin pipelines such as PVC and HDPE.

② Expected technology form Japan

Some Japanese companies manufacture expandable and flexible joints (sockets) that can be used to repair leaks in Saudi Arabia and can be expected to reduce leakages. The socket is expandable and flexible, absorbs pipe strain and provides higher earthquake resistance. Special FCV cast iron (vermicula cast iron) with a carbon content of 3.6% to 4.0% has high erosion resistance, can be joined without disassembling, and has excellent hand tightening and re-tightening workability.

4) Valve with few failurs

① Issues to be solved.

There are some malfunctions of the sluice valve necessary for creating DMA and stopping water for leak repair. The cause is not sure, but foreign matter such as sand and soil are caught in the threaded part due to intermittent water supply, and rust is generated from iron parts used for the valve, causing abnormal operation.

② Expected technology form Japan

Some Japanese companies manufacture soft-sealed valves that have powder-coated valve body to improve rust resistance, and no pockets on the bottom of the valve seat. By using it as a sluice valve in the Saudi Arabia, the effect of reducing the frequency of failures canbe expected. The surface of the valve box is coated with epoxy resin powder, which is excellent in rust prevention. Chlorine resistant rubber (EPDM) is used for the valve, and when fully closed, the rubber of the valve body is crimped to stop water. Since the bottom of the valve seat has a flat structure, the possibility of failure due to foreign matter contamination and accumulation are low.

5) AI Analysis of likelihood of pipe failur

① Issues to be solved.

It is necessary to manage and prioritize the leak-prone areas in advance and formulate an effective pipeline renewal plan. In areas where leaks are expected, NWC conducts accounstic leak survey or helium gas leak survey by themselves or outsource the work to private company. Although helium gas detector is made overseas, it is not common in Saudi Arabia and the current price is high. Leak survey using accoustic method the same method as in Japan is not easy due to noise from nighttime water use caused by intermittent water supply, noise from booster pumps for storing water in the rooftop water storage tank and noise from outdoor units of air conditioners. Therefore, it is recommended to analyse the possibility of water leakage in advance and used as a reference for the pipeline renewal plan by utilizing AI analysis of the likelihood of failur in pipeline.

② Expected technology from Japan

There is a company that has developed an online pipeline analysis software that can predict the deterioration rate of water pipes and optimize water pipe renewal plan in Japan. Water pipe data owned by the Waterworks Bureau, such as water pipe location, material, diameter, installation date, and leak history, is incorporated into an algorithm, and piping information and leak probability are color-coded on a map of a designated area. One can also check graphs and numbers that statistically organized piping information with a single click. Water utilities have data on water pipes, such as materials, installation year, and past leak history.

In addition to these, they have created their own database of about 100 types of environmental factors such as soil, topography, weather, transportation network, buildings, sea, and rivers. Then, in order to analyze more complicated relationships, they performed a process to create variables more than 10 times, and finally utilized about 1,000 environment variables for prediction. Then, AI/ machine learning was used to teach the computer for the purpose to improve the prediction accuracy for the correct and incorrect pattern of answers based on actual data, such as what kind of piping and environment has affected to the leaks.

The unique algorithm completed in this way has already learned a total of about 110,000 km of water pipes in the United States, and its high prediction accuracy and practicality have been fully proven. The software can diagnose the whole thing online, visualize risks on a map, and accurately grasp and analyze the probability of water pipe failure.

3.3.2 Applcability of technology/product of Japanese private firms in the sewage and water quality improvemet fields

1) Blackish water desalination technology

① Issues to be solved.

Under the shortage of surface water, ground water for irrigation water, re-use of treated sewage or drain water discharged from farms are required. But because treated sewage or drain water discharged from farms contains salinity of TDS 3,000-5,000mg/L, they are restricted to use for the use of agricultural water. For reference, the results of water quality analysis for treated sewage and drain water from farms using potable analysis equipment is as shown in the following table.

Table 3-18: Results of water quality analysis using potable analysis equipment
(Treated sewage and drain water from farms) ※1

Parameter	Unit	Value		Reference Water quality std. at SIO
		Treated sewage	Drain water	
Water Temperature	℃	33.1	–	
pH	–	7.5	7.5	6–8.4
EC	μS/cm	3,720	3,400	(2,500mg/L>)
Turbidity	NTU	5.4	1.5	5 >
Ammonia	mg-N/L	0.3	0.2>	10 >
Nitrate	mg-N/L	1	5	10>
Phosphate	mg-P/L	3	2	
Residual chlorine as free	$mg-Cl_2/L$	ND	ND	
Residual chlorine as total	$mg-Cl_2/L$	0.1	0.1	
Fecal Coliform	CFU/ml	Not detected	Detected	Not detected

Source: JICA Survey Team

※1 Treated water and drain water from farms in Al-Ahasan city (Date measured: October 4, 2021)

Irrigation water for farms (Treated sewage)

Drainage channel (Drain water from farms)

Photo 3-13: Irrigation water for farms (Treated sewage) and drain water from farms

It is thus required to reduce the salinity from TDS 3,000-5,000mg/L to 1,000 mg/L or less with low operational cost. Whereas, desalination process especially for drinking water generally adopts RO membrane which can reduce salinity up to very low concentration level, TDS 300mg/L or less. But this technology has an issue of high operational cost. Especially for agricultural users, they don't request for desalination technology which can reduce salinity to TDS 300mg/L or less, because of high operational cost, but they request one which can reduce the salinity to the concentration required for agricultural water, approximately TDS 1,000mg/L or less, with low operational cost.

② Expected technology from Japan

It is expected to develop a desalination technology especially for agricultural uses, which can reduce the salinity to TDS 1,000mg/L or less along with lower operational costs using membrane separation technologies (RO membrane, NF membrane, etc.), electro dialysis or the other elemental desalination technologies. Besides, it is expected to reduce the operational cost further by introducing solar power energy if necessary.

2) Appropriate treatment, ZLD and recovery of valuables in concentrate discharges from seawater desalination and blackish water desalination facility

① Issues to be solved.

It is concerned that the concentrate discharges from desalination plant have a negative effect on coastal water or surface water on ground. Thus, desalination plant which will generate non wastewater is requested.

② Expected technology from Japan

It is expected to develop a desalination process which does not generate any wastewater by using electro dialysis, evaporation, crystallization and the other concentration/drying technologies. Besides, it is expected to reduce the operational costs further by introducing solar power energy, if necessary

3) Alternative or supplemental chlorine disinfection technology for treated sewage waters (UV disinfection technology, etc.) for agricultural purposes.

① Issues to be solved.

Chlorine disinfection has an issue regarding effectiveness of disinfection for eggs of helminths in treated sewage waters which are supposed to have high resistance against chlorine disinfection. Besides, it has the other issue regarding corrosion of the systems (pump station, etc.) caused by the oxidation power. Thus, alternative or supplemental to the technologies using chlorine are required.

② Expected technology from Japan

It is expected to introduce UV disinfection technology to treated sewage water which will be used for agriculture purposes, because it can also kill chlorine resident microorganisms effectively in treated sewage water. In addition, it is expected to reduce corrosion against water facility because it doesn't have the residuality as featured by chlorine disinfection.

4) Alternative sand filtration technology (fiber filter) and disinfection technology with UV, etc. for irrigation waters

① Issues to be solved.

There is possibility that groundwater used as the water source for irrigation purposes includes turbidity and is contaminated by fecal coliform. Thus, it is required for irrigation water to remove turbidity with a filter to prevent blockage of pipes used in the irrigation systems and kill pathogenic microorganisms with disinfection. Generally, although sand filter is used as filter for turbidity reduction, it has issues such as low filtration velocity and needs for a large installation space.

②Expected technology from Japan

As the technology to improve the issue of water treatment facility for irrigation water consisting of sand filter, it is effective to introduce water treatment facility consisting of “fiber filter + disinfection equipment (UV etc.)”. Because fiber filter can be operated with high filtration velocity, it can reduce the installation space. The schematic system is as shown in Figure 3-13.

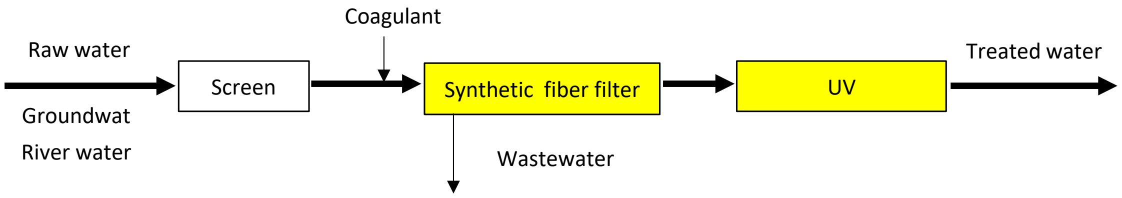


Figure 3-13: schematic system of water treatment facility for irrigation water, consisting of “high-speed fiber filter + UV disinfection equipment” (Draft)

Souce: JICA Survey Team

5) Sewage treatment technology (water treatment technology using the control of aerobic/ anoxic plant zone).

① Issues to be solved.

Sewage treatment plants in Buraydah city and Unayzah city adapt oxidation ditch with tertiary treatment. Results of water quality analysis for effluent from sewage treatment plant in Unayzah is as shown in Table 3-18. While tertiary treatment can treat nitrogen in sewage to 10mg-N/L or less, it has an issue of high operational cost. To reduce operation costs of sewage treatment, it is effective to save the electric power for aeration which is the main electric power cost for sewage treatment.

Aeration tank (Carrousel typed oxidation ditch

Inside of aeration tank

Photo 3-14: Aeration tank of sewage treatment plant in Unayzah
(Design capacity: 50,000m^3/day)

Table 3-19: Results of water quality analysis for effluent from sewage treatment plant in Unayzah using potable analysis equipment (Date analyzed: September 21, 2021)

Parameter	Unit	Value	Reference: Water quality std.	
			MEWA	SIO
Water Temperature	℃	29.9		
pH	–	7.3	6–8.4	6–8.4
EC	μS/cm	1570	(2500mg/L>)	(2500mg/L>)
Turbidity	NTU	0.1	5 >	5 >
Ammonia	mg-N/L	0.2>		10 >
Nitrate	mg-N/L	10	10 >	10>
Phosphate	mg-P/L	3		
Residual chlorine as free	mg-Cl_2/L	0.1	0.5<	
Residual chlorine as total	mg-Cl_2/L	0.3		
Fecal Coliform	CFU/ml	Not detected	Not detected	Not detected

Source: JICA Survey Team

② Expected technology from Japan

Mechanical typed aerator was installed and operated in sewage treatment plants in Buraydah and Unayzah city and the aerator was operated at the same rotation speed through a day. But if it is going to remove nitrogen at higher removal rate with lower operational cost, it is recommended to introduce the operation with control of aerobic/anoxic zone in aeration tank (see Figure 3-14 below).

Concretely, on the basis of biological nitrogen treatment process to treat nitrogen in sewage in a ditch typed tank, it is necessary to formulate two zones definitely, aerobic zone for oxidizing ammonium in raw water to nitrate by using nitrification bacteria and anoxic zone for reducing nitrate to nitrogen by using denitrification bacteria. To treat nitrogen at higher removal rate with lower electric power for aeration, it is important to especially formulate anoxic zone surely in aeration tank without being affected by fluctuation of flow rate and BOD/nitrogen load at inlet through a day. To do the operation, it is necessary to install a dissolved oxygen (DO) sensor at the back of aerobic zone and control rotation speed of aerator so that the DO value can be the designated value.

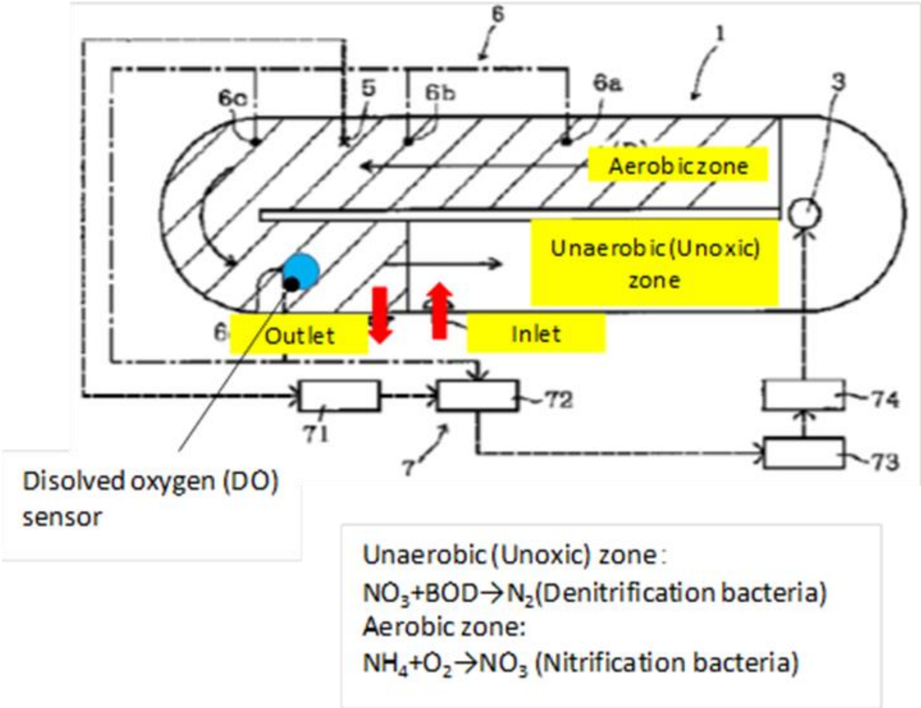


Figure 3-14: Schematic figure for nitrogen treatment typed oxidation ditch process
(aerobic/anoxic zone operation)

Source: Patent in Japan No.2938369

6) Sewage treatment technology (sewage treatment machinery)

① Issues to be solved.

There are auto screens and sand removal equipment installed in grit basin of sewage treatment plant in Buraydah and Unayzah city. But there are some machines which cannot remove sands and debris effectively. Besides, as dehydrator for sludge generated from sewage treatment, they are using centrifugal typed dehydrators, which is supposed to consume a lot of electric power in comparison with the other dehydrators.

In order to improve labor productivity and reduce electric power, it is required to introduce high- efficiency machinery for sewage treatment and improve treatment performance.

Auto screen（Grit basin）

Sludge dehydrator（Sludge treatment facility）

Photo 3-15: Sewage treatment machinery in sewage treatment plant in Buraydah city
(Design capacity: 150,000m^3/day)

② Expected technology from Japan

It is recommended to introduce auto-screen which can lift debris up efficiently and sand removal equipment which can discharge sands on the bottom of grit basin to outside of the basin efficiently. Besides, to enter into Saudi Arabian market, it is essential to appoint local agencies in Saudi Arabia who will provide aftersales systems so that machine manufacturers can correspond to the failure promptly and provide the spare parts for maintenance to customer.

7) Sludge recycling technology

① Issues to be solved.

The dehydrated sludge generated from sewage treatment plant in Buraydah and Unayzah city is not re-used and dumped it outside of sewage treatment plant. The dumping of sludge deteriorates the landscape and causes water pollution of the surrounding area by leachate generated when it rains. Thus, sludge generated from sewage treatment plants should be treated or re-used appropriately.

Dehydrated sludge

Photo 3-16: Dehydrated sludge in sewage treatment plant in Unayzah city

② Expected technology from Japan

Sludge generated from sewage treatment plant contains a lot of organic matters and high energy.

Thus, not only at point of prevention of water pollution but also at the point of promotion for utilizing renewal energy, it is recommended to re-use sludge using recycling technology such as compost, digestion and electric power generation using bio-gas.

8) Water quality monitoring technology

① Issues to be solved.

It is found that groundwater at some area is polluted by nitrate and/or contaminated by fecal coliform. To improve the situation, it is required to understand the situation of pollution in environmental water such as groundwater through water quality monitoring at first. On the basis of the water quality data, it is required to specify the source of pollution and take necessary actions including installation of wastewater treatment facilities.

Besides, treated sewage water is received from sewage treatment plant and supplied to farms for agricultural water in irrigation facility operated by SIO. In the facilities, it is recommended to continuously monitor water quality and feedback operation of sewage treatment plant which is located at the upstream of irrigation facility, and take necessary actions such as additionally dosing coagulant and/or disinfectant on the basis of the water quality data so that the water quality can be met water quality standards for agricultural water.

② Expected technology from Japan

As water quality monitoring for groundwater, etc., it is expected to install water quality monitoring units consisting of water quality sensors for monitoring turbidity, COD, dissolved oxygen (DO), nitrate in the groundwater, etc. and the data collection and transmission equipment.

Besides, as water quality monitoring for irrigation facility owned by SIO, it is expected to install water quality sensors in receiving basin at pumping station for monitoring residual chlorine, turbidity, nitrate, etc. in treated sewage.

9) Simplified water analysis technology (Pathogenic microorganism, heavy metals)

① Issues to be solved.

Treated sewage water which is anticipated to be used as agriculture water, is required as safe water with pathogenic microorganism free. So, microbiological analysis is especially important for agricultural water made by treated sewage water among water quality parameters.

But standard methods for microbiological analysis have an issue that it takes a lot of time to prepare it and to give the result, and it needs the sufficient experience for its analysis. Thus, microbiological analysis may be conducted by simplified method that even any analysts who don’t have sufficient experience can analyze easily.

Besides, to re-use sludge from sewage treatment plant, it is required to check that trace heavy metals contained in the sludge is less than each criterion of them. But standards methods for trace heavy metal analysis have an issue that it takes a lot of time to decompose sludge using acid or alkali for the pre-treatment before they are analyzed using AA or ICP. So, trace heavy metals analysis is also required by the simplified method.

Simplified fecal coliform analysis
(Water quality laboratory in sewage
treatment plant in Buraydah city)

Panels for helminths observed in treated sewage
(SIO central laboratory in Hasa city)

Photo 3-17: Microbiological analysis in water quality laboratory for irrigation water

② Expected technology from Japan

It is expected to introduce simplified and accurate microbiological analysis technology for pathogenic bacteria such as fecal coliform, salmonella, etc. Besides, it is expected to introduce the technology that pathogenic microorganisms including the eggs of helminths can be observed and identified with simplified and accurate ways.

Besides, it is expected to introduce simplified trace heavy metals analysis technology such as fluorescent X-ray analysis instrument that trace heavy metals in the sludge can be analyzed with simple and promptly.

10) Johkasou

① Issues to be solved.

In the area where sewage system is not covered, it is required to introduce water treatment facilities which can install in each household and community and treat domestic wastewater with tertiary treatment. Besides, it is required to introduce wastewater treatment facility which can be installed in stages depending on amount of inlet flowrate of wastewater gradually increasing year by year.

② Expected technology from Japan

It is expected to install Johkasou, a plastic-made and pre-fabricated wastewater treatment facility, which can treat domestic wastewater or wastewater from food processing factories to the water quality level for tertiary treatment (Figure 3-15).

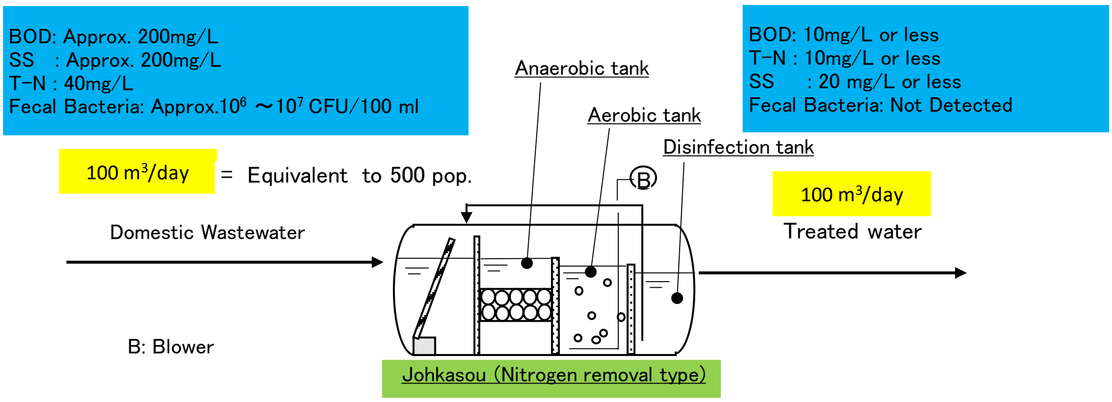


Figure 3-15: Schematic treatment flowsheet of Johkasou

Chapter 4: Present Conditions, Challenges, Needs for Assistance and Possibility for Application of Technologies and Products owned by Japanese firms in the Agriculture Sector.

4.1 Present Conditions and Challenges in the Agriculture Sector

4.1.1 Present Conditions in the Agriculture Sector

(1) Organizational structure of the agricultural sector

The departments that control the agricultural sector of MEWA are as shown in the figure below. MEWA has branch offices at the state level nationwide and also implement policies in the agricultural sector and provide guidance on farming. In addition, the construction, operation and maintenance of irrigation facilities are under the jurisdiction of the Saudi Irrigation Organization (SIO).

Figure 4-1: Organization chart of MEWA agriculture related departments

Source: MEWA

(2) Agricultural policy

1) National Strategic Objectives for Agriculture and Food Security

Food Security Goals of Sudi Arabia in “Agrecultural Renaissance in KSA 2021” from MEWA are as follows.

- Achieving a sustainable local food production system for commodities with comparative advantage
- Ensuring access to safe and nutritious food in the Kingdom and encouraging healthy and balanced eating habits
- Ensuring capacity building to face food security risks
- Developing an institutional business model at the national level and ensuring clear

governance

And National Strategy Objectives in “Agrecultural Renaissance in KSA 2021” from MEWA are as follows.

- Sustainability of natural resources
- Food security
- Well-being of the community and farms
- Economic Contribution

2) Implementation status of wheat production suspension

Since a large amount of irrigation water is used for wheat cultivation in Saudi Arabia, Saudi Arabia Government created the policy of Decree No.335 (2007) and stopped wheat cultivation for the purpose of reducing the amount of fossil water usage. Regarding the procurement of grains including wheat, the investment company of the Saudi Arabia Government such as SALIC buys agricultural land, cultivates and imports major grains from overseas, according to the policy of the Saudi Arabia Government. However, in response to the growing awareness of food security in recent years, the company is seeking investment destinations in Japan, so that the Saudi Arabia is seeking to resume grain cultivation within the country.

(3) Overview of the agricultural sector

Even though the agriculture sector of Saudi Arabia faces many challenges, the country has the largest dynamic agricultural projects in the Middle East related to dates, poultry, dairy and aquaculture. And Saudi Arabia is well known as a net food importing country. However, the country sustain self-sufficiency and even produce surplus food products: Fresh milk 122%, table eggs 115%, dates 115% and vegetables 70%. The outlines of the industry of the agricultural sector in Saudi Arabia are as follows.

- Agriculture sector provides 30% of the total food available for consumption
- This sector contributes 87.8 billion SR annually to the GDP (estimated at 3.3% of non-oil GDP).
- Total workers involved in Agriculture sector are 919,100
- The number of Agricultural Farms is 260,498. The number of Animal Herds and Fish Farmings is 22,697. The number of total Agricultural Holdings is 283,788.

In addition, the challenges of the agricultural sector in Saudi Arabia in “Agricultural and Irrigation sector in the KSA: Challenges and Opportunities, 2021” from MEWA are as follows.

- More reliance on traditional agricultural and irrigation methods
- Extremely hot desert weather for most of the year
- Sandy soil with poor water-holding capacity, high salinity and low organic matter content
- Limited self-sufficiency for several strategic commodities
- Lack of direct channels of sales and marketing services of crops for small farmers
- The lack and weakness of agricultural cooperative societies and their working cadres.

(4) Farming situation

1) Food production

Saudi Arabia's total food production has been declining in recent years. As for the production by crop, feed has decreased significantly, grains have not increased or decreased, and vegetables and fruits have increased.

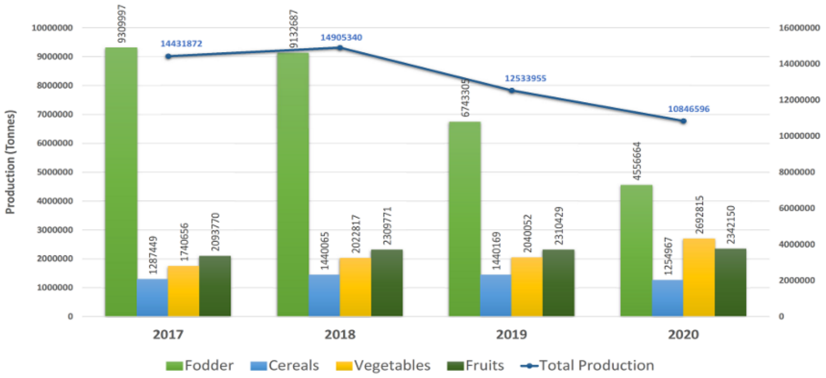


Figure 4-2: Saudi Arabia's total food production (2017-2020)

Source: MEWA, Agricultural and Irrigation sector in the Kingdom of Saudi Arabia: Challenges and Opportunities, 2021

2) Fruit production

The production of fruits in Saudi Arabia is increasing year by year. The production of fruits by region is 17.9% in Riyadh, 17.9% in Kathym and 14.8% in Al-Jouf.

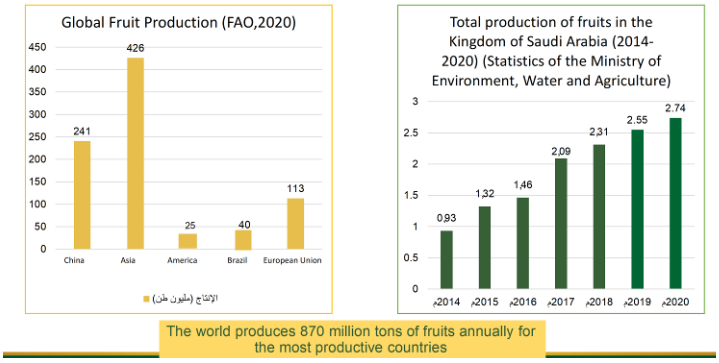


Figure 4-3: Fruit production in the world and Saudi Arabia

Source: MEWA, Agricultural Renaissance in KSA 2021

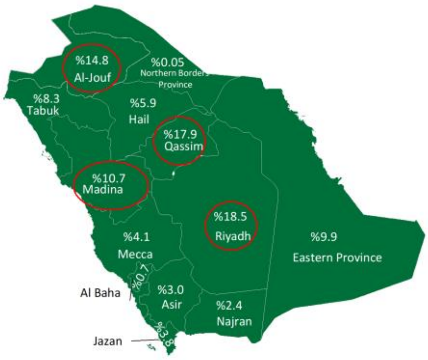


Figure 4-4: Fruit production ratio by region

Source: MEWA, Agricultural Renaissance in KSA 2021

3) Vegetable production

The production of vegetables in Saudi Arabia is increasing little by little every year. The production of fruits by region is 30.4% in Makkah, 28.2% in Riyadh and 10.5% in Hail.

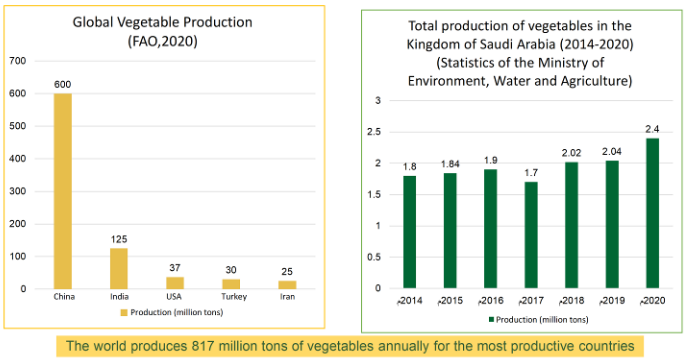


Figure 4-5: Vegetable production in the world and KSA

Source: MEWA, Agricultral Renaissance in KSA 2021

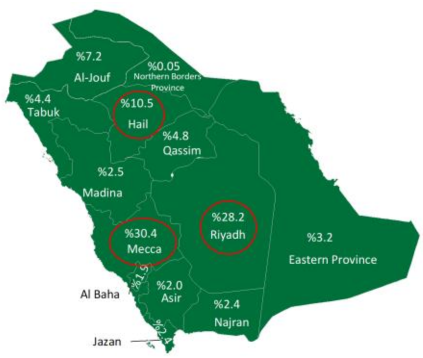


Figure 4-6: Vegetable production ratio by region

Source: MEWA, Agricultral Renaissance in KSA 2021

4) Self-sufficiency rate

【Vegetable】

Regarding the self-sufficiency rate of vegetables in Saudi Arabia, eggplant, cucumber, zucchini, okra, potato shows a high self-sufficiency rate of 90% or more.

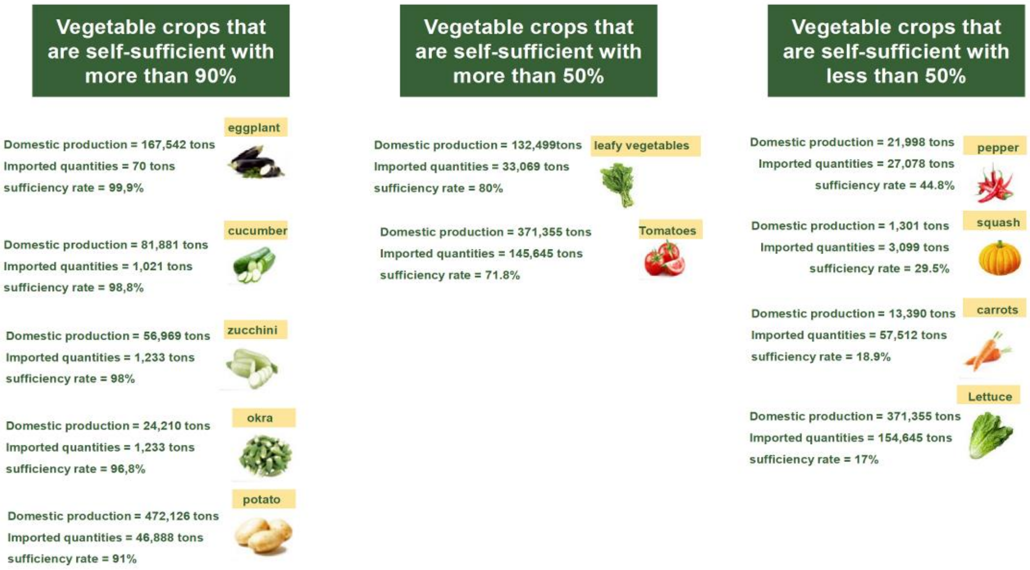


Figure 4-7: Self-sufficiency rate of major vegetables

Source: MEWA, Agricultural Renaissance in KSA 2021

【Fruit】

Regarding the self-sufficiency rate of fruits in Saudi Arabia, dates, watermelons, mangoes, grapes, etc. show a high self-sufficiency rate of 50% or more.

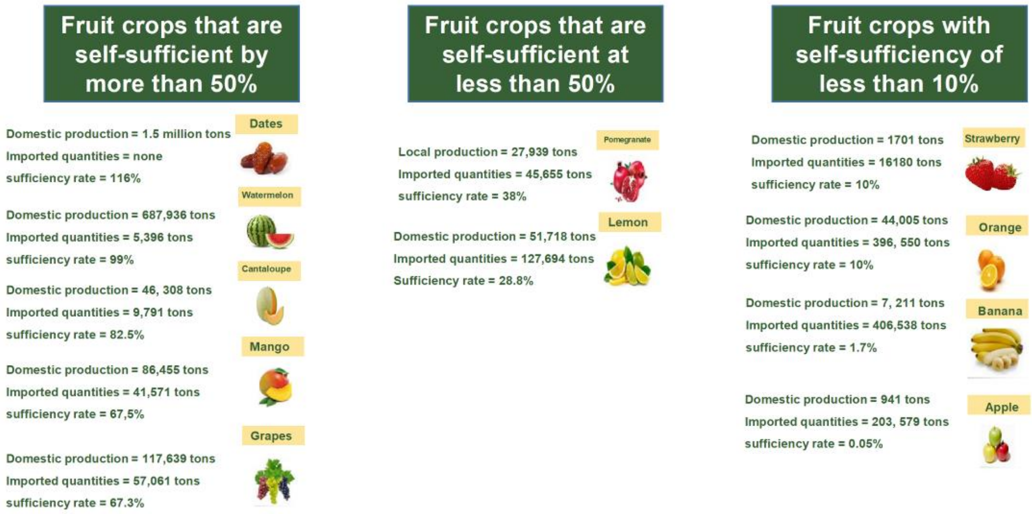
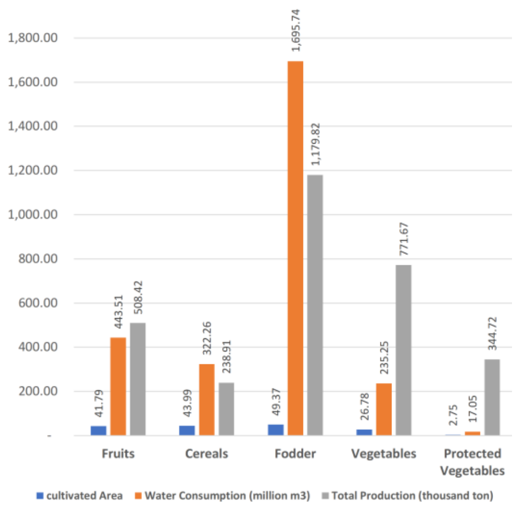


Figure 4-8: Self-sufficiency rate of major fruits

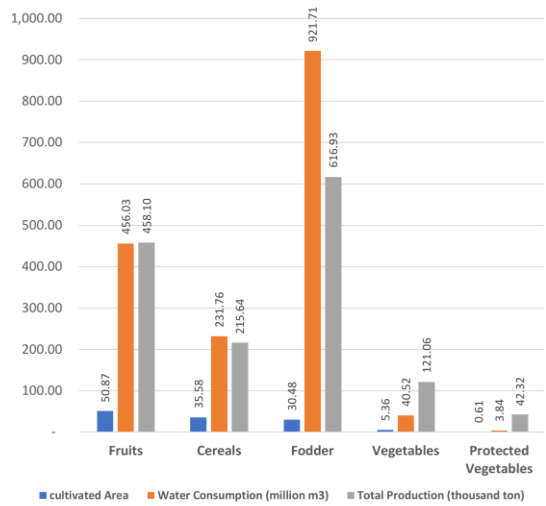
Source: MEWA, Agricultural Renaissance in KSA 2021

5) Cultivated area, total crop production, irrigation water usage

The total cultivated area in Riyadh Province is 164,795ha, the total food production is 3.044,140ton, and the total irrigation water usage is 2,714.5 Mℓ. The total cultivated area in Al-Qassim Provice is 122,888ha, the total food production is 1.454,062ton, and the total irrigation water usage is 1,654Mℓ.



（Riyadh Province）



（Al-Qassim Provice）

Figure 4-9: Cultivated area by crop, total crop production, irrigation water usage

Source: MEWA, Agricultural and Irrigation sector in the Kingdom of Saudi Arabia: Challenges and Opportunities, 2021

(5) Conditions of Irrigation facility

1) Irrigation facility

There is no irrigation facility such as dams, irrigation canal and headworks in Saudi Arabia. In this context, it generally seems that the irrigation water is pumped from a well at the farm and is pumped into an elevated water tank, then the water is distributed via gravity irrigation systems to such fruit trees as dates, oranges and lemons in the open field which are cultivated by watering by drip tubes, as well as tomatoes and vegetables in the green house and it also seems that similar irrigation methods are used in the most other areas of Saudi Arabia.

Photo 4-1: Well at the farm

Photo 4-2: Elevated water tank

Photo 4-3: Green house

Photo 4-4: Drip irrigation tube

2) Irrigation systems (upland irrigation facility)

The current irrigation systems on farm in Saudi Arabia are roughly divided into three types: (1) drip irrigation, (2) sprinkler irrigation, and (3) surface irrigation. Figures 4-10 to 4-12 show the proportion of irrigation systems by crop (grain, fruit, vegetable).

Sprinklers such as center pivots account for 46.7% of the irrigation for grains. Drip irrigation, which enables water-saving irrigation, is mainly used for irrigation of fruits and vegetables.

Photo 4-5: Sprinkler(center pivots)

Photo 4-6: Drip irrigation

Photo 4-7: Surface irrigation

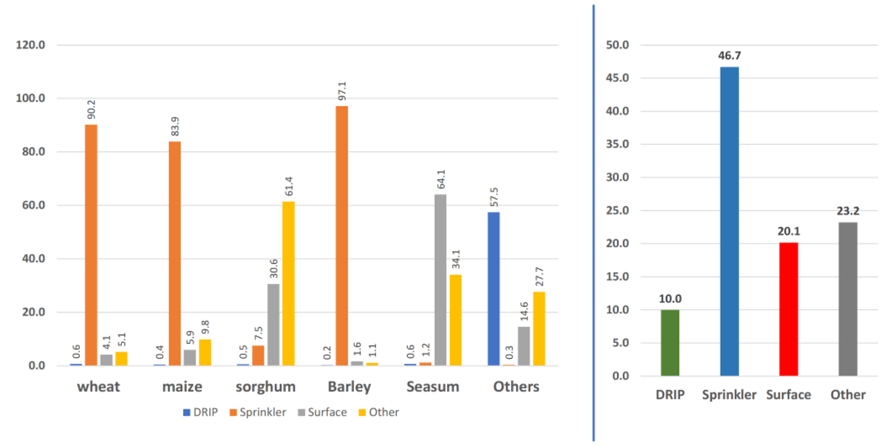


Figure 4-10: Percentage of each irrigation method of grain

Source: MEWA, Agricultural and Irrigation sector in the Kingdom of Saudi Arabia: Challenges and Opportunities, 2021

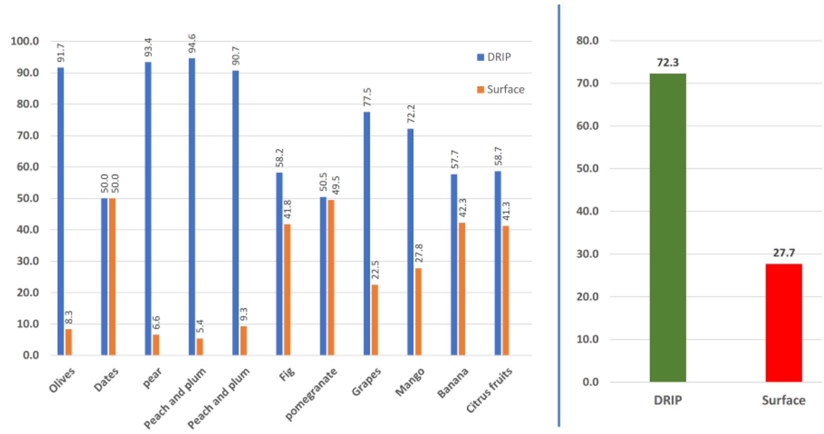


Figure 4-11: Percentage of each irrigation method of fruit

Source: MEWA, Agricultural and Irrigation sector in the Kingdom of Saudi Arabia: Challenges and Opportunities, 2021

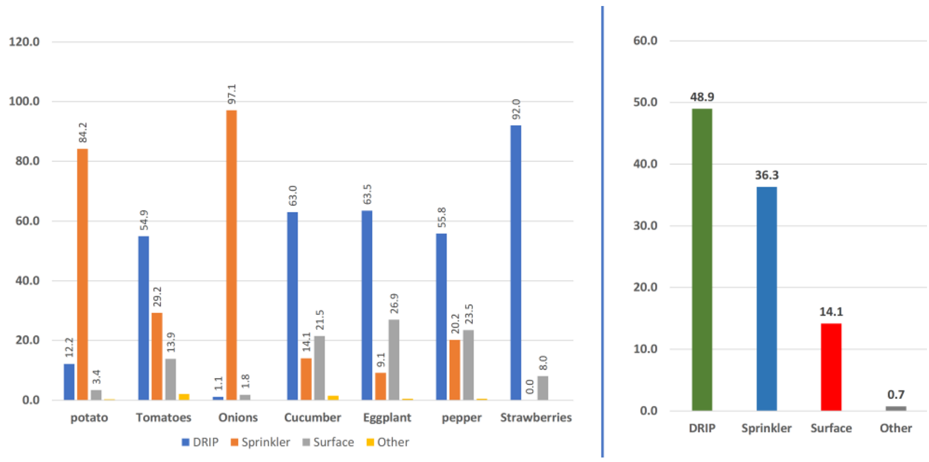


Figure 4-12: Percentage of each irrigation method of vegetables

Source: MEWA, Agricultural and Irrigation sector in the Kingdom of Saudi Arabia: Challenges and Opportunities, 2021

(6) Water quality and quantity of irrigation water

According to interviews with standard-class farms near Buraydah in Al-Qassim Province, there are many farms around Buraydah where the salinity of wells varies from place to place, and the salinity is high and affects the growth of crops. In addition, the water level of many wells continues to decline. New drilling of new agricultural wells is restricted.

(7) Status of introduction of water-saving agriculture

① Drip irrigation

As mentioned above in "2) Irrigation systems", the irrigation method using the drip irrigation tube which has a high water-saving effect, has been widely used in Saudi Arabia.

②Vertical farming

MEWA, Estiderma Agricultural Development Center, etc. are promoting vertical farming technology (multi-level hydroponic cultivation technology indoors and in facilities) throughout the country. In addition, at SIO's test farm in Al-Ahsa, empirical research on vegetable cultivation by hydroponics by vertical farming (technology: USA, equipment: China) is being conducted.

Vertical farming is a farming method which crops are cultivated in vertical and multi-tiered layers. Even if farmers have a vast agricultural land, it is possible to conduct farming (hydroponics) at a limited site such as a high-rise building in an urban area and indoors. In addition, because 98% of the irrigation water can be reused, and 15% of the labor force can be cut, no pesticides are required because it does not use soil, CO^2 emissions for transporting crops from the suburbs can be eliminated, and wastewater from urban houses and food waste from restaurants can be easily reused and is efficient, it is considered in Saudi Arabia that it may be a clue to solve global food problems such as the realization of sustainable agriculture.

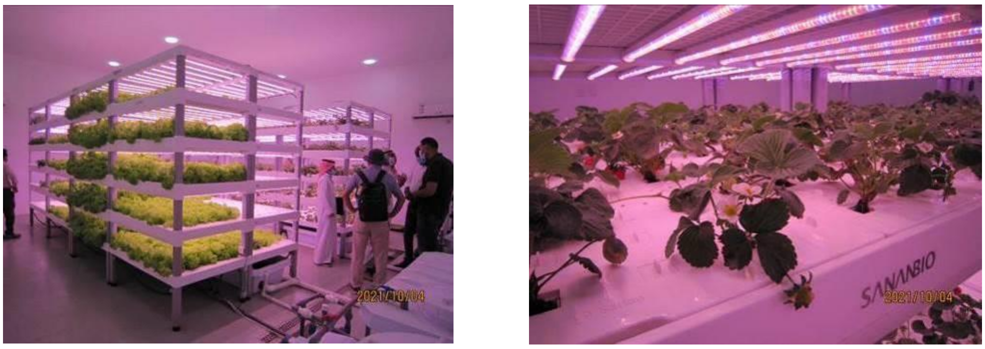


Photo 4-8: Vertical farming facility in SIO model farming in Al-Ahsa

③ Reuse of wastewater in the green house

At farms near Buraydah that have introduced high-tech technology, advanced water-saving measures are being implemented, such as reusing wastewater generated in the green house (collecting wastewater that has soaked into the soil with a drainage drain).

Photo 4-9: High-tech farm near Buraydah

Photo 4-10: Wastewater storage tank in the green house

④ Water retention material

Standard-class farms near Buraydah are implementing water-saving measures such as using natural water-retaining materials (mineral-based, which seemed not to have a very high water-retaining effects). In addition, it is said that a farmer in Al-Ahsa used a water-retaining material before, but it was clogged with salt and could not be used.

Photo 4-11: Natural water retention material

(8) Status of use of recycled treated water for agricultural water

In some areas near Al-Ahsa or Riyadh, where SIO manages irrigation facilities, reclaimed water from urban sewage is being actively used for irrigation. Water is sent to the farm by pipeline from the sewage treatment plant via the relay pumping station. However, in other areas, the use of reclaimed water for cultivating crops is generally avoided, and is used for roadside trees, green belts, and greening of recreational facilities.

Photo 4-12: Sewage treatment plant near Buraydah

Photo 4-13: Relay pumping station

Photo 4-14: Control center for reclaimed water

Photo 4-15: Outlet of reclaimed water supply by SIO in Al-Ahasan

(9) Dates tree damage by Pest

Pest damage for the dates tree caused by Rhynchophorus chinensis (English name: Red palm weevil) has spread throughout Saudi Arabia, and it has become a major problem even in Al-Qassim Province, where date cultivation is flourishing. The palm weevil is a large weevil that is distributed in the tropical regions of Southeast Asia and Oceania is known as a pest that causes palms to die. Since the end of the 20th century, it has spread to western Japan, the Middle East, and European countries, and is being watched as an alien species.

As a control method, among the registered pesticides in Japan, the use of MEP emulsion applicable to trees and weevil can be considered. Saudi Arabia is expecting Japanese technology for pest control technology for date trees.

Photo 4-16: Dates tree pest damage situation (farm near Buraydah)

Photo 4-17: Rhynchophorus chinensis

4.1.2 Issues and Challenges in the Agricultural Sector

The following 7 points were confirmed as issues related to water-saving and water leakage in the fields of agricultural water utilization and agricultural promotion in Saudi Arabia.

1) Depletion of irrigation water

80% of the total water consumption of Saudi Arabia is used in the agricultural sector, and most of it depends on fossil water. Since fossil water may be completely depleted in 2080, measures to reduce the amount of fossil water used are required. In field surveys it has confirmed that the water level in wells, the main source of irrigation, continues to decline. Also, new drilling of new agricultural wells is restricted.

2) Low irrigation efficiency

The feed and grain occupy 77% of the total cropping acreage in Saudi Arabia, and the pumped groundwater is mainly sprinkled by a Center Pivot Irrigation etc. for these cultivations. The irrigation efficiency by the same irrigation system is said to be around 75% and 85% at the world average, but it is only about 50% in Saudi Arabia. Saudi Arabia is working on introducing water-saving irrigation technology to improve irrigation efficiency from the current 53% to 75% by 2030.

3) No setting of water usage fee for irrigation waters

Since it has not been necessary for farmers to pay usage fee for irrigation water, agriculture has been carried out by excessive pumping of groundwater and inefficient watering, ignoring the efficient use of water resources.

4) Deterioration of irrigation water quality

According to interviews with standard-class farms near Buraydah, the salinity of wells varies from place to place around Buraydah, and many farms are using high salinity water and it affects the growth of crops. At those farms, small RO equipment (mostly made in Taiwan) is being purchased to remove salt from irrigation water.

In the test farm of the Estidamah and high-tech farms near Buraydah, RO equipment is installed and utilized to carry out high-quality crop cultivation and prevent clogging due to salts in the drip tube.

5) Improving the quality of agricultural wastewater

Reuse of agricultural wastewater is desired, but the salt concentration is high and it cannot be used directly unless the water quality is improved.

6) Shortage of agricultural labor

The labor saving in agricultural work such as tillage, sowing, cultivation, and harvesting in farming activities is required, because the shortage of agricultural workers is found.

7) Leakage in agricultural pipelines

Agricultural pipelines that send reclaimed water are long, and water leakage has occurred due to aging, water hammer pressure, electrolytic corrosion etc. in some areas near Riyadh and Al-Ahsa.

4.2 Needs for Assistance in the Agricultural Sector

The needs for assistance for solving the challenges related to water saving and water leakage in the agricultural field are as follows.

1) Since irrigation efficiency is low and water resources are scarce, it is desired to promote the introduction of water-saving irrigation technology, use of reclaimed water, and reuse of agricultural wastewater.
2) Most of the fruits such as dates and vegetables such as tomatoes which are actively cultivated in KSA, are irrigated with drip irrigation tubes. Although it is said that the irrigation pipes manufactured and sold locally which are produced according to international standards such as SASO, ASTM, ISO, etc., the quality is not good. In addition, there is a great need for drip irrigation tubes, because the reclaimed water and agricultural wastewater for irrigating 100,000 trees are being used to make a green belt in Al-Ahsa,
3) At farms where the salt concentration is high and the growth of crops is affected, a small RO device is purchased to remove salt from irrigation water. The farmers are interested in high quality, inexpensive and compact RO equipment made in Japan.
4) It is expected for Japanese technology to improve the quality of agricultural wastewater (reduction of salt concentration).
5) Saudi Arabia is expecting Japanese technologies such as vertical farming technology and date tree pest control technology.
6) There is a need for water usage measurement technology, because there is a high possibility that water usage fees for wells will be collected in the future.
7) There is a higher need for small tractors, as a way to solve one of the above-mentioned issues, "6) Agricultural labor shortage" at the green house and the farmlands where the field area per one plot is small which can be seen in the northern part of Saudi Arabia. Also, as a tractor function, it is not required to equipp with a function of high-tech such as an automatic driving function, but it is requested that it should have a good performance, highly durable and it shoul have a medium-tech multiple functions such as making ridges for planting crops, put vinyl and spraying chemicals etc by replacing the work attachment at the rear.

In order to address to the above challenges, JICA Survey Team would like to introduce Japanese water-saving irrigation technologies such as water retention materials, film farming technology, biostimulants and drip irrigation tubes, smart agricultural technology, pipeline water leakage countermeasure technology, water usage measurement technology using smart meters, desalinating equipment of small size etc. to KSA.

4.3 Applicability of technologies and products of Japanese firms in the agricultural sector.

The following are the technologies and products of Japanese private firms that are suitable for solving problems related to water saving and water leakage in the agricultural field and for needs for assistance.

1) Water retention material

① Issue to be solved

- Saudi Arabia is working on introducing water-saving irrigation technology to improve irrigation efficiency from the current 53% to 75% by 2030.
- At farms near Buraydah that have introduced high-tech technology, the advanced water-saving measures are being implemented, such as reusing agricultural wastewater in the green house (collecting wastewater that has soaked into the soil with a drainage drain).
- Dates cultivation is flourishing and the demand is high, but dates cultivation requires a large amount of water (182ℓ / day / tree).
- Standard farms near Buraydah are implementing water-saving measures such as using natural water-retaining materials (mineral-based, it seemed not to have a very high water-retaining effect).
- At the farm in Al-Ahasan, the water retention material used to be used. But it sometimes became clogged with salt and could not be used.

Photo 4-18: Natural water retemtion materials

Figure 4-13: water retention material

② Expected technology from Japan

It is recommended to mix water retention materials with cultivated soil to prevent downward penetration of irrigation water and save irrigation water.

a) Overview of water retention material

Soil improvement material (water retention materials) made by glass is used by mixing with cultivated soil in the farmland.

b) Benefits of introduction

- Water is stored in the pores of the improvement material and it enhances water retention and saves water.
- No environmental load (main raw material is glass)

- Since the roots can absorb more water with the same amount of irrigation, it leads to an increase in crop yield.

c) Degree of interest in the Saudi Arabian market

One Japanese company with water retention material technology has a local partner company and is currently planning a field demonstration test of water retention material for date cultivation with the technical support of the Estiderma Agricultural Research Center.

d) Comparative advantage of product / technology prices

① Viticulture

According to the results of the demonstration test on a grape cultivation using Japanese water-retaining material conducted in Peru, the yield was increased by 40 to 50% when the water-retaining material was used compared to the case which the water-retaining material was not used, and the reduction effects for fertilizer and irrigation water has been confirmed. Costs and benefits by introducing Japanese water-retaining materials in this viticulture are as follows.

In case 1, assuming that the amount of irrigation water does not save water and the yield increases by 20%, the recovery period for initial investment cost is 2.2 years and the IRR (internal rate of return) is 45.3% when granules of water retention material are used. If water retention powder is used, the recovery period for initial investment cost will be 1.3 years and the IRR will be 79.4%.

In Case 2, assuming that the amount of irrigation water is saved by 50% and the yield is increased by 10%, the recovery period for initial investment cost is 4.0 years and the IRR is 21.6% when granules of water retention material are used. If powder of water-retaining material is used, the recovery period for initial investment cost will be 2.3 years and the IRR will be 41.8%. In both cases, it is expected to increase profits by introduction of water-retaining material.

Table 4-1: Cost-benefit analysis of viticulture using Japanese water retention materials

●Case 1: The amount of irrigation water is not saved and the yield is increased by 20%.

Increased profit		Cost of Product	Pay-back period	IRR for 10 years
9,200 USD/ha/year	If granule product is applied...	19,800 USD/ha	2.2 years	45.3%
	If powder product is applied...	11,550 USD/ha	1.3 years	79.4 %

●Case 2: Saving 50% of irrigation water and the yield is increased by 10%.

Increased profit		Cost of Product	Pay-back period	IRR for 10 years
4,983 USD/ha/year	If granule product is applied...	19,800 USD/ha	4.0 years	21.6 %
	If powder product is applied...	11,550 USD/ha	2.3 years	41.8 %

Source: Technical data on water retention material of Japanese company

② Dates cultivation (using water retention material from the time of planting)

If Japanese water retention materials are used, the costs for irrigation water and fertilizer for the period from planting a seeding date tree to a matured tree which can harvest fruits will be reduced by 4,500USD/ha compared to a no-use case.

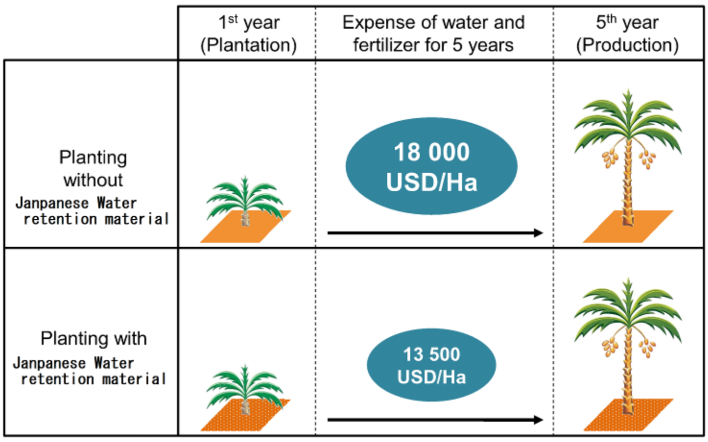


Figure 4-14: Cost comparison using water-retaining material for the period from planting a seeding date tree to a matured tree which ripe fruits

Source: Technical data on water retention material of Japanese company

In addition, due to the effects of reducing the costs for irrigation water and fertilizer which will be derived by introducing Japanese water-retaining materials, the initial investment costs related to the introduction of Japanese water-retaining materials at the time of planting seeding dates can be recovered within four years, and then the profit of 3,124 USD/ha/year is expected to increase.

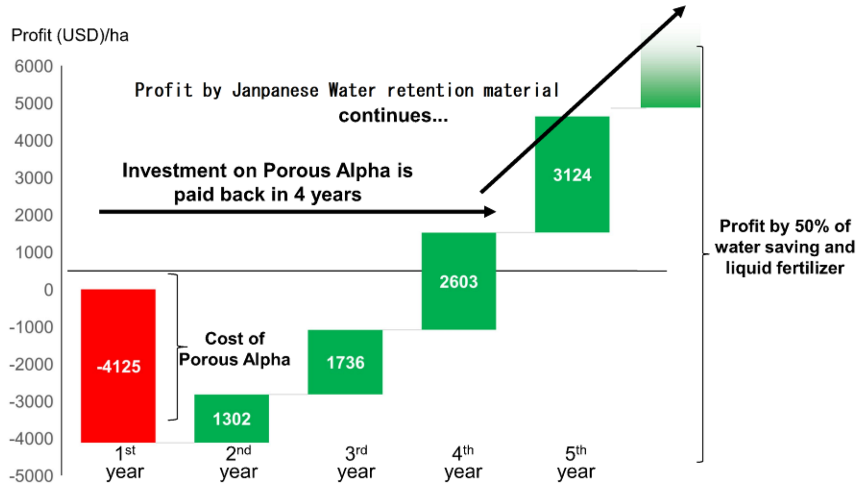


Figure 4-15: Cost-benefit analysis on date cultivation (from planting)
by using Japanese water retention materials
Source: Technical data on water retention material of Japanese company

③ Dates cultivation (in case water retention materials are used for adult trees)

Due to the effects of reducing the amount of irrigation water and fertilizer by the introduction of Japanese water retention materials, the initial investment costs for the introduction of Japanese water retention materials can be recovered within three years, and then the profit of 3,124 USD/ha/year is expected to increase.

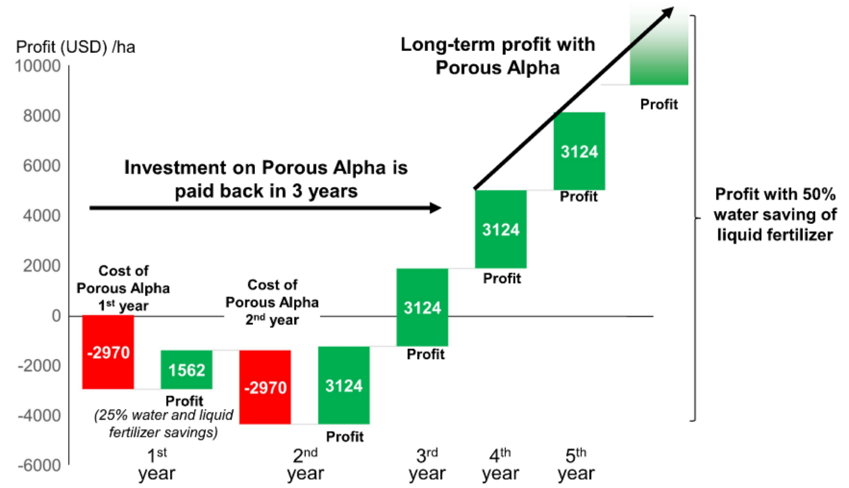


Figure 4-16: Cost-benefit analysis on date cultivation (from adult trees)
by using Japanese water-retaining materials
Source: Technical data on water retention material of Japanese company

Considering the above-mentioned cost-benefit analysis results in crop cultivation by using Japanese water-retaining materials, the use of water-retaining materials is currently limited in Saudi Arabia, and products from other competing countries have not been confirmed, it is presumed that the comparative advantage of this product/technology in the market is very high.

2) Film farming

① Issue to be solved.

- Because MEWA and Estidamah etc. are promoting vertical farming technology throughout the country, they requested Japan to introduce Japanese technology by all means. The need for hydroponic cultivation technology is very high.
- At SIO's test farm in Al-Ahsaa, experimental study is being conducted on vegetable cultivation by hydroponic cultivation by vertical farming (technology: USA, equipment: China), and the need for hydroponic cultivation technology is extremely high.
- Farms near Buraydah that have introduced high-tech technology are keenly interested in Japanese water-saving irrigation technology such as film farming technology. The farm mainly grows tomatoes, which have the highest demand for vegetables in the country and is highly profitable. It owns 20 green houses of 5000m2 in a farm of 10ha and plans to construct facilities in other states that are several times larger.

② Expected technology from Japan

It is recommended to apply the film farming technology to vertical farming. In addition, since the demand for tomatoes is high in Saudi Arabia, it is recommended to produce high value-added tomatoes with high sugar content and distribute using film farming technology.

a) Overview of film farming

On IMEC, plants grow on a thin film made of hydrogel. The film has numerous nano-sized holes that allow only water and nutrients to pass through. In addition, the system consists of a liquid supply device and a cultivation bed (film, non-woven fabric, waterproof sheet, two irrigation tubes).

Photo 4-19: Film farming

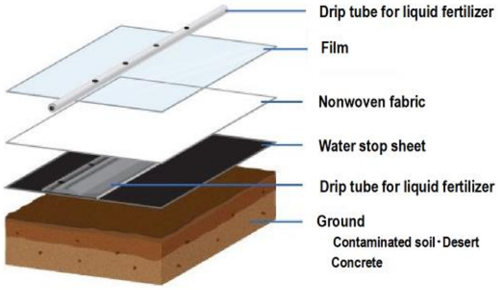


Figure 4-17: Film farming system configuration

b) Benefits of introductio

- Since it is completely isolated from the ground by a waterproof sheet, agriculture can be done anywhere, such as in desert areas or on concrete.
- Furthermore, since the water and fertilizer supplied by the waterproof sheet do not leak to the outside, the amount of water and fertilizer used is significantly smaller than that of the conventional farming method, and at the same time, it is a very environmentally friendly farming method.
- Tomatoes grown on IMEC have a good taste and aroma, and have a very high sugar content

and nutritional value (lycopene, amino acids, GABA, etc.).

c) Degree of interest in the Saudi Arabian market

One Japanese company with film farming technology wants joint research with Estiderma Agricultural Research Center.

d) Comparative advantage of product/technology

According to actual cultivation results in Japan, the production of tomatoes per unit area by film farming is one-third compared with the production of conventional hydroponics, but the wholesale price is much higher, due to the higher quality of the products. The film farming system is simple and the initial cost is low. Moreover, since the running cost is proportional to the production amount, the running cost of film farming is also low. Gross profit is much higher than that of conventional hydroponics, so it is superior in comparative advantage of costs (competitiveness) compared to conventional hydroponics.

Table 4-2: Economic comparison of film farming and
conventional hydroponics in tomato cultivation

Items	Film farming	Hydroponics
Annual Yield(tons)	120.0	350.0
Whole Sale Price($/kg)	＞10	4.0
Sales(M$)	1.2	1.4
Initial Cost(M$)	2.0	3.0
Running Cost(M$)	0.6	1.3
Gross Margin(M$)	0.6	0.1

Note: Farm Area：10,000m^2(1ha)

Source: One of the Film-farming materials Manufacturers

3) Biostimulant

① Issue to be solved

Since the irrigation efficiency of Saudi Arabia is low and water resources are scarce, promoting the introduction of water-saving irrigation technology is a major issue.

② Expected technology from Japan

It is recommended to promote Biostimulant which Japnese comapny has and provide drought resistance and heat resistance to all crops, reduce the amount and frequency of irrigation by the effect of acetic acid, and stabilize the productivity of crops in Saudi Arabia.

Figure 4-18: Biostimulant
Source: Biostimulant manufacturing company

a) Overview of Biostimulant

The biostimulant material contains acetic acid as an active ingredient that can dramatically resist drying and high temperatures.

b) Benefits of introduction

Since the frequency of irrigation can be reduced, it also saves water.

c) Degree of interest in the Saudi Arabian market

One Japanese company with biostimulant material technology had previously considered joint research with the Estiderma Agricultural Research Center in Saudi Arabia.

4) Drip irrigation tube

① Issue to be solved

- Most of the fruits such as dates and vegetables such as tomatoes, which are actively cultivated in Saudi Arabia, are irrigated with drip irrigation tubes.
- Although it is said that the irrigation pipes manufactured and sold locally, are produced according to international standards such as Saudi Standards, Metrology and Quality Organization (SASO), American Society for Testing and Materials (ASTM), International Organization for Standardization (ISO), etc., the quality is insufficient. Clogs and leaks from seams are found.
- In date cultivation, underground irrigation using drip irrigation tubes can reduce water by 27%.
- At SIO's test farm in Al-Ahsa, there are problems which thin irrigation tubes are often clogged when reclaimed water is used. (There is possibility that the water pressure drops at the end go down and clogging occurred.)
- In Al-Ahsa, 100,000 trees are irrigated using reclaimed water and agricultural wastewater with drip tubes to make a green belt.
-

② Expected technology from Japan

Since the needs for drip irrigation tubes are extremely high, it is recommended to promote the high-performance pressure-corrected drip tube which the Japanese company creates and disseminate it to Saudi Arabia. This pressure-corrected drip tube is more expensive than a normal drip tube, but it is a one-of-a-kind technology that can be expected to solve problems such as further water saving and prevention of tube clogging. Therefore, it is presumed that the competitiveness in the market is high.

a) Overview of pressure-corrected drip tube

The drip tube which can keep the water pressure of the irrigation tubes constant in all sections, have also less head loss, and can send water over long distances.

b) Benefits of introduction

- Water and fertilizer can be saved.
- Water can be supplied at a moderate supply rate, oxygen required for the roots of the plant can be secured, and the growing state of the plant can be well managed.

Photo 4-19: Pressure-corrected drip tube

c) Degree of interest in the Saudi Arabian market

One company with pressure-corrected drop irrigation tube technology will be commercialized after 2022, but in the future, they are eager to make technical cooperation with a major water-saving irrigation equipment manufacturer in Israel which is famous as an advanced country of water-saving irrigation technology and having been entering the markets in the Middle East including Saudi Arabia where is an arid region.

5) Tractor

① Issue to be solved

・There is a higher needs for small tractors as a way to solve one of the above-mentioned issues, "6) Agricultural labor shortage" at the green house and at farmlands where the field area of one plot is small which can be seen in the northern part of Saudi Arabia.

② Expected technology from Japan

It is recommended to expand the market share of Japanese tractors that are easy to use and have good durability.

a) Overview of small Japanese tractors

・It has good performance and it is highly durable.

・It has multiple functions such as making ridges for planting crops, put vinyl and spraying chemicals etc by replacing the work attachment at the rear.

Photo 4-20: Small-size Tractor

b) Benefits of introduction

・The total life cost is excellent because it is highly durable.

・Work efficiency is improved at farmland with a small field area, which can contribute to solving the shortage of agricultural labor.

c) Degree of interest in the Saudi Arabian market

Until now, exports of Japanese agricultural machinery including tractors to the Middle East and Saudi Arabia, have been limited. The reason is presumed that it is difficult to make a profit considering the maintenance system after sales.

6) Smart meter

① Issue to be solved

・Currently, data on the amount of irrigation water used from wells is being collected, and it seems that the need for smart meters for collecting water usage fees in the future is extremely high.

・According to an interview with a farmer near Buraydah, MEWA plans to install a flow meter in each well within a year.

・Although the penetration rate of smart meters for water supply in KSA is over 90%, the dissemination of smart meters for measuring the amount of pumped water from agricultural wells is yet to come.

② Expected technology from Japan

It is recommended to introduce and popularize Japan's high-performance smart meters for the purpose of measuring the amount of groundwater pumped from agricultural wells and the amount of irrigation water used. A feature of Japanese smart meters is that they are about the same size as conventional water meters and can be installed using the same fitting methods. In addition, the built-in battery allows it to be used for a long time in various different environments.

Figure 4-19: Smart meter

Source: Smart meter manufacturer

7） Pipeline water leakage countermeasure technology

① Issue to be solved

・Agricultural pipelines that send reclaimed water are long, and water leakage has occurred due to aging, water hammer pressure, electrolytic corrosion etc. in some areas near Riyadh and Al-Ahsa

・Leakage from mechanical joints is often found in irrigation pipes on farms.

② Expected technology from Japan

It is recommended to introduce and disseminate the technology for detecting leak points using leak detectors and in-pipe investigation robots and the pipe rehabilitation method which is a method of repairing and renewing leaked parts of pipes from inside existing pipes for repairing leak points that are difficult to excavate in urban areas of Al-Ahsa, etc.

Photo 4-21: Leak detector

Photo 4-22: In-pipe investigation robot

a) Overview of pipe rehabilitation method (No surface-excavation)

This is a construction method to prevent water leakage by pasting a resin-impregnated material, hard vinyl chloride material, etc. on the inner surface of an existing pipe with water leakage from a nearby manhole or shaft.

- Cured-place pipe inversion method
- Fold and formed method
- Spiral liner method
- Slipling method (Pipe in pipe method)

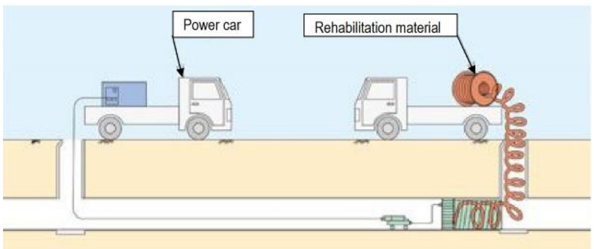


Figure 4-20: Spiral liner method

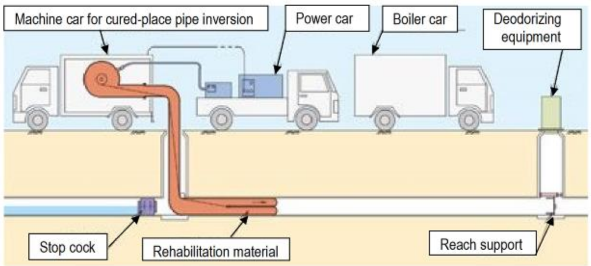


Figure 4-21: Cured-place pipe inversion method

b) Degree of interest in the Saudi Arabian market

Pipe rehabilitation technology such as pipe-in-pipe is a typical method for repairing water leaks in agricultural pipelines, and it is a very effective method for areas where excavation is difficult in urban areas. Compared to other rehabilitation methods, the construction period is longer and the construction price is higher because it is necessary to bring in materials and equipment from Japan.

8）Desalinating equipment

① Issue to be solved

・According to interviews with standard farms near Buraydah, the salinity of wells varies from place to place around Buraydah, and many farms have high salinity and it affects the growth of crops. At those farms, small RO equipment (mostly made in Taiwan) is being purchased to remove salt from irrigation water. Their farmers are interested in high quality, inexpensive and compact RO equipment made in Japan.

・In the test farm of the Estidamah and high-tech farms near Buraydah, RO equipment is installed and utilized to carry out high-quality crop cultivation and prevent clogging due to salts in the drip tube.

・Small RO equipment for drinking water is installed and used in many ordinary households in Saudi Arabia.

Photo 4-23: salinating equipment in the test farm of Estidamad

Photo 4-24: RO equipment in far near Bruydah

② Expected technology from Japan

It is recommended to introduce and disseminate high-quality, small, door-to-door desalinating equipment made in Japan to farms that have introduced high-tech technology and farms that have high salinity in well water. In Saudi Arabian farms, it seems appropriate to introduce small RO equipment, which is used by fishing boats in Japan, etc. that is durable, inexpensive, and easy to operate so that the weather conditions are severe and farmers can operate i

Chapter 5: Business environment of foreign firms in the Water Supply, SewageTreatment, Water Quality Improvement and Agriculture fields in Saudi Arabia

5.1 Business environment of overseas firms in Saudi Arabia

The business environment of overseas companies in Saudi Arabia was analyzed by dividing the general business environment and the business environment in the water supply and sewage and agricultural fields which is focused by this survey works. With regard to this, it was decided to identify issues for overseas companies, especially focusing to Japanese firms, to promote their businesses in Saudi Arabia and to deliberate improvement measures, along with business opportunities in the concerned fields in Saudi Arabia. In proposing improvement measures, JICA Survey Team has examined the actual situation of the business environment in neighboring countries of Saudi Arabia as well.

5.1.1. Business environment for overseas firms in Saudi Arabia.

The improvement of the business environment in Saudi Arabia is considered to be one of the most important issues in Saudi Vision 2030, and is under the jurisdiction of the Ministry of Investment of Saudi Arabia (MISA). MISA was established in February 2020 by reorganizing the Saudi Arabian General Investment Agency (SAGIA) which was established in 2000. The ministry will issue investment licenses to domestic and foreign investors who are considering to establish an entity in Saudi Arabia. In addition to the Headquarters in Riyadh, business centers are located in Jeddah, Arcobar and Medina. And furthermore, the Japan Desk has been established in premises of the Embassy of Saudi Arabia in Tokyo.

The legal bases for promotion of the Foreign Direct Investment (FDI) to Saudi Arabia are the "Foreign Investment Act" and the "Enforcement Regulation of the Foreign Investment Act". These two laws stipulate "gains and benefits", "incentives and guarantees", "conditions and standards of permits and licenses", "conditions for approval and criterion", "obligations of foreign investors" and "violations", which are key subjects for FDI.

In 2019, Saudi Arabia was ranked at 62nd in the World Bank's Ease of Doing Business ranking, which was ranked at 92nd in 2018. This promotion was made due to improvements in eight of the 10 assessment items in Ease of Doing Business. In particular, it is largely due to the improvement in the average costs for startup a business; in case of the Middle East and North Africa region, startup cost is 16.7% out of personal income, while it is possible to start a business at a cost of 5.4% only in case of Saudi Arabia. With regard to other assessment items, dramatic improvements in the areas of power supply and cross-border trading may be pointed out. In terms of protection to minority investors in Saudi Arabia, it has a higher evaluation comparable to the ranks of New Zealand and Singapore where are evaluated as the world's most developed business environment. Saudi Arabia is ranked fourth in the Middle East and North Africa rgions in the evaluation of Ease of Doing Business, after UAE, Bahrain and Morocco.

The following figure is a Rader Chart showing the scores in 10 evaluation items in the evaluation of Ease of Doing Business in 2020.

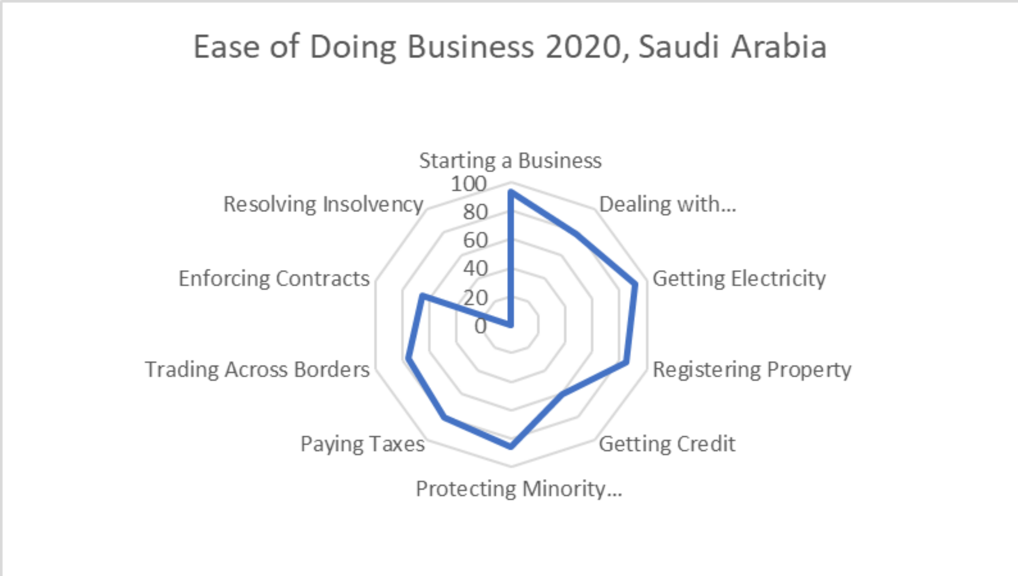


Figure 5-1: 10-point assessment of Ease of Doing Business for Saudi Arabia
Source: Prepared by JICA Survey Team based on Ease of Doing Business by WB Group

According to this chart, "Resolving Insolvency" has a zero rating, and it can be seen that the improvement of dispute resolution methods for business activities is a problem. In addition, it is still at a lower level evaluation in terms of "access to financial facility in the domestic market", and further improvement is expected in the future.

5.1.2 Evaluation of business environment by Japanese firms

According to the survey results conducted by Japanese insitutions in the past, the following points are identified as the business environment for Japanese firms to conduct the businesses in Saudi Arabia:

1) Introduction of administrative rules and procedures and its modification are made suddenly and it is unforseen when it happens,
2) Legal systems are rather difficult to understand,
3) It is difficult to predict when the administrative procedures will be completed,
4) There is a concern on the rocurement of human resources.

During the first field survey period, JICA Survey Team has visited the offices of Japanese Government agencies and several major Japanese trading firms in Riyadh in order to conduct an interview survey on the business environment in Saudi Arabia. The outline of the results is as follows.

1) Attractiveness of Saudi Arabia market and potential fields for Japanese firms.

- The market size in the water field will expand in the future due to increasing demands for water and further enhancement of the existing facilitiy's functions.
- In the water field, privatization program will be promoted in the future and sales promotion shall be changed to sale as "a system" from the sales as "parts alone".
- With regard to the privatization of water supply businesses, the projects require proven experiences in rather wider range of water business operations which makes Japanese firms to keep "wait and watch" attitudes, since they do not have enough qualification.
- Registration is required as a vendor to sell industrial products in KSA, and thereafter the procurement processes will be conducted through an open tender for which competitive edge in terms of price is important,
- In the sale of industrial products, it is required not only to deliver the products but also to establish a service system, thus SME is required to associate with a local partner,
- Since improvement of the self-sufficiency ratio on food supply is getting important in Saudi Arabia and some Government agencies are interested in investing to Japanese advanced technologies in Agriculture sector, there will be a good opportunity to collaborate between Saudi authorities and Japanese agriculturral firms in the future,
- Since the Government of Saudi Arabia is supporting those students returned from overseas learning by extending a finance and incubation facilitiies and mentoring by experts provided by SME agency, there is large number of start-ups in the fields of softwares and information technologies.
- In the consumer products field, the market is expanding significantly due to women's empowerment and improvement in living levels,
- In the future, the tourism, entertainment, and service industries will be opened up, and investment in these fields is expected to expand.
- It is comon sentiment that the economic and investment activities are heading to a positive direction as a whole, and people feels an improvement of living conditions.

2) Business environment issues

- One of the issues is the change of the administration systems without prior notice and due legislation.
- If a private company receives an order for a Government procurement contract in Saudi Arabia after 2024, a policy that such a firm should set up a district general office in Saudi Arabia was introduced and legislation is yet to be put in place,
- Sometimes it appears that the rules inside Governental entities are not necessarily totalized. Delays of contract payment and tax refunds are sometime seen.
- Since the wage level of Saudi Arabia is higher, careful planning for human resources hiring is requird,
- It takes longer time to get a license for local office and to get approval on the registrants.

5.1.3 Comparison with neighboring countries in terms of business investment environment

A comparative survey for the investment environment of Saudi Arabia with the other three major Middle Eastern countries (UAE, Turkey, and Egypt) was conducted. The survey summarizes and analyzes (1) The legal systems and implementation bodies involving in promoting FDI, (2) Incentive systems related to FDI (such as financial, tax, and employment incentives), and (3) The development status of FDI receipient facilities such as special economic zones and industrial parks, among the four Countries in the Middle East including Saudi Arabia.

The survey report was submitted separately as Annex 4. The survey results are summarized as shown in the table below. According to the ranking by Ease of Doing Business, 2020, it shows the ranking of UAE is 16th, Turkey is 33rd, Saudi Arabia is 62nd and Egypt is 114th. In comparison with these three other countries, the following three points of Saudi Arabia are remarkably different from others.

- A rating systems have been introduced for promoting the employment of local workers,
- The minimum capital amount for the incorporation is higher,
- The number of free zones where serve as the venues to accommodate investments and are able to enjoy various incentives, is small.

Table 5-1: Comparison on investment conditions with four neighboring countries

Comparison of FDI environment in the 4 countries

		Saudi Arabia	Turkey	UAE	Egypt
FDI Regulation	**Ruling and regulation clarity**	✓			
	Foreign capital restriction	Certain sectors are restricted, however, FDI allowed in most sectors			
	Local labor employment regulation	Rating system (Nitaqat) introduced by the government	No regulation	No regulation	No rating system, however, ratio of foreign to local employee is regulated
	Minimum Capital[5,6]	2 million SAR (approx. 530,000 USD)	50,000 TL (approx. 5,400 USD)	300,000 AED (approx. 82,000 USD)	250,000 EGP (approx. 16,000 USD)
	Corporate Tax Rate[5]	20%	22%	0%	20% / 25%[7]
FDI Incentives	**Financial**	Foreign capital companies enjoy similar incentive to local company (e.g. tax exemptions, subsidy on employee training etc)			
Establishment location (Currently operating)	**Free zones**	1	19	40+	9
	Industrial Areas	30	258	N.A.	130+
	Others	3 technology zones	63 Technology development zones	N.A.	N.A.

[5] Regulations for on-shore companies only

[6] Minimum Capital Requirement depends on the structure of the established entity. The figures in chart are for Joint stock companies

[7] 25% if the company's Revenue is over 10 million EGP (approx. 640,000 USD)

Soource: Business Environment Study in Saudi Arabia and Neighboring Countries, kns Corporation

5.2 Business environment of foreign firms in the water supply field

The outlines of the business environment of overseas enterprises in the water supply field are as follows.

(1) Water saving valves for water supply equipment/Water-saving shower heads

Since NWC has distributed water saving valves for water supply equipment and water-saving shower heads at free of charge to the citizen, awareness of citizen on the water conservation is raising, and many household goods stores in the city are trying to sell water-saving valves and water-saving shower heads. Swedish products claim to save 90% of the water, and the effect was assumed to be high. Since many types of Water-saving type of water supply equipment made in U.S.A and China are being sold in the market.

(2) Submersible pumps and booster pumps

Because of intermittent water supply, booster pumps are installed in most homes and many pumps made not only in China but also in Saudi Arabia are sold.

(3) Smart meter

As a smart meter for house uses, only three companies of (1) Sensus (USA), (2) Hydros (Germany) and (3) Wadad (Saudi Arabia) have been approved by NWC. Being selected these companies, many demonstration and experimental procedures are required. There is a possbility to select a manufacturer for other equipment, preparation for necessary selecting procedures is needed.

5.3 Business environment of foreign firms in the agricultural field

The outlines of the business environment of overseas companies in the agricultural field are as follows.

(1) Vertical farming

At the SIO test farm in Al-Ahsa, empirical research on vegetable cultivation by hydroponics of vertical farming (technology: USA, equipment: China) is conducted. Although the introduction of Japanese water-saving irrigation technology could not be confirmed in Saudi Arabia, there is a strong interest in Japanese advanced technology in this field.

(2) Agricultural machinery

Japanese tractors can be found on standard-sized farms near Buraydah. According to the owner, the agricultural machinery made in Japan is easy to use, but the maintenance system of the Saudi Arabian distributor that handles Japanese-made products could use some improvement. In the future, in order to expand the share of Japanese agricultural machinery, it is necessary to establish a local subsidiary of agricultural machinery manufacturer, transfer maintenance technology to a local agency, and to develop human resources.

5.4 Business environment of foreign firms in the field of water quality improvement.

Based on information obtained from various contractors and suppliers visited who are involved in the construction and operation activities for local water treatment facilities, the local business environment may be summarized as shown below.

- With regard to the water treatment facilities in relation to water quality improvement, there are seawater desalination plants, water purification plants, and sewage treatment plants, and the design of these water treatment facilities is undertaken by international consultants located in Saudi Arabia. Regarding construction works, there is many Saudi companies involved in the civil, architecture, mechanical and electrical engineering works, thus, foreign firms may undertake most of these construction works by forming a joint venture with Saudi companies without forming a joint venture with foreign firms.
- In addition, when NWC and SWCC outsource the operation and management works for water purification plants and seawater desalination plants, those works have been outsourced to local contractors. Overseas firms who have entered into local markets in the major products are as follows.

Table 5-2: Major Overseas Manufacturers operating in Saudi Arabia

Category	Number of firms already in Saudi markets
RO Membrane	Japanese: 2 firms, JV between Japanese and European: 1 firm, U.S.A.: 1 firm, Korean: 1 firm, others
Pump	European: 2 fims, Japanese: 1 firm, others
Electrical Instrumentation	European: 2 firms
Water quality analysis equipment	U.S.A. 3 firms, Japanese: 1 firm, European: 1 firm, others

Source: JICA Survey Team

While many overseas manufacturers have participated in the markets, relatively few foreign firms are found in the fields of sewage treatment machines and ultraviolet rays and only a few firms can respond to aftersale service.fields of sewage treatment machines and ultraviolet rays are relatively few foreign companies found and only a few companies can respond to after-sales service. When delivering equipment such as pumps and electrical instrumentation to a water treatment facility run by the Government offices, the following two cases can be considered; 1. Register the company on Etimad systems under the Ministry of Finance's website to get qualified for participating in bidding, then participate in bids and win bids, and 2. Deliver equipment via a contractor who is managing operations. In any case, in the highly competitive market, it is difficult for Japanese manufacturers to enter into markets by winning stiff price competition under the fixed specification among those who are already in the markets.

Under such circumstances, Japanese manufacturers who wish to entering into Saudi markets may be able to do so by conducting demonstration tests of Japanese technologies in the fields of higher market potential yet technical specifications are not established, together with relevant organizations in Saudi Arabia. In the water sector of Saudi Arabia, there is a certain information that the water supply and sewage works in 6 different clasters nation-wide will be outsourced as a comprehensive operation and maintenance package to overseas water majors. However, in interviews with MEWA officials and local contractors in Buraydah city, specific information couldn't be obtained on the impact at the operation level from the anticipated business flows in the water sector in future.

5.5 Business environment related to private sector collaboration.

Japan and the Saudi Arabia have built strong diplomatic relations since first established a political relationship in 1955. Saudi Arabia is largest and most stable oil supplier to Japan. In September 2016, the two countries agreed to launch a joint group of "Saudi-Japan Vision 2030", annoouncing the beginning of a new partnership era. The two countries aim at achieving solid economic development and socio-economic vision by activating complementary relations and maximizing synergistic effects through the "Vision 2030" of Saudi Arabia and the "Growth Strategy" of Japan.

The Government of Saudi Arabia advocates the promotion of privatization that makes full use of the funds and management capabilities of private companies in Saudi Vision 2030, and its main pillars are as follows.

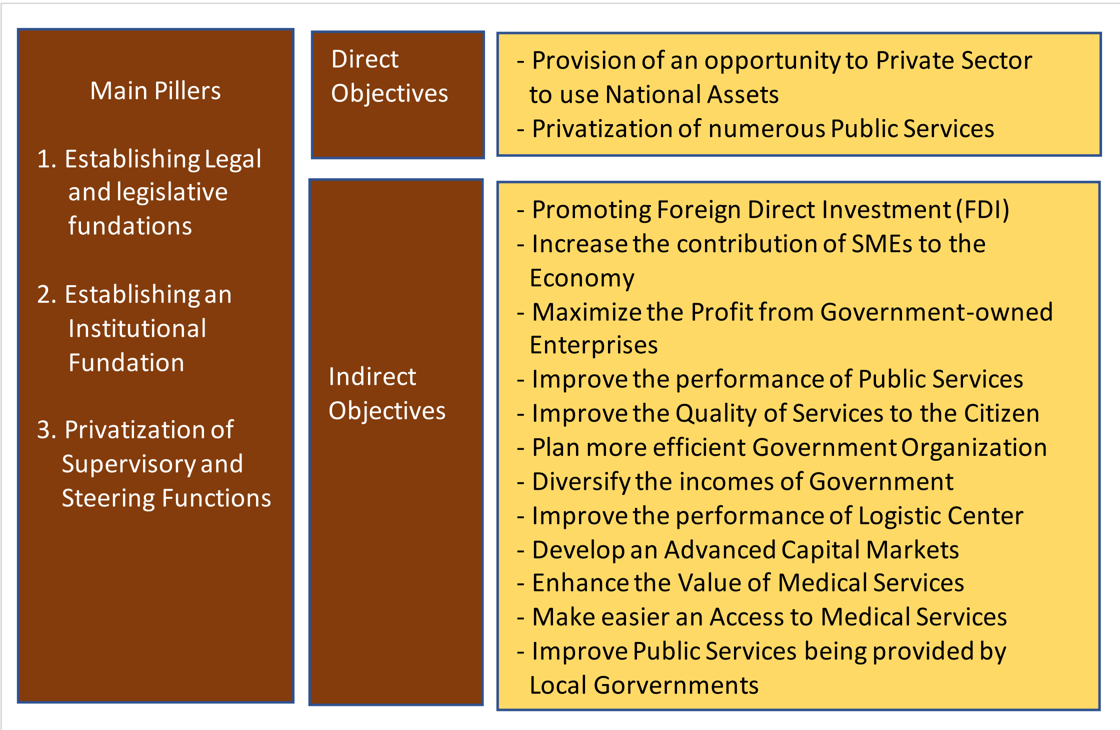


Figure 5-2: Key pillars and goals of privatization

Soource: NCP

As mentioned earlier, the Government of the Saudi Arabia has developed Saudi Vision 2030 to change the socio-economic systems in the Kingdom.The program for realizing many Visions presented in the Saudi Vision 2030 is called The Vision Realization Programs (VRPs). The privatization project is a key part of the Vision, and the National Center for Privatization: (NCP) has been established to develop a framework for the realization and management of the privatization.

The Government of Saudi Arabia has identified more than 100 projects to develop Government-owned assets by capitalizing the know-hows of private companies. NCP, together with Vision Realization Program Office (VRP Office), is expected to play important roles in managing the progress of privatization projects. The privatization program shall be implemented along with the model as shown in the following figure.

The Privatization Supervisory Committees (PSCs) and Executive Teams (ETs) which are established in each sector, embody the identified privatization projects to providing opportunities for private firms to participate and request the submission of proposals. Submitted privatization proposals are evaluated by PSCs with the assistance of NCP and VRP Office as necessary, and are evaluated by the Strategic Management Committee (SMC) and Council for Economic and Development. Be reviewed by Affairs (CEDA).   CEDA will also be providing guidance on privatization programs. The final approval of the proposal will be made by Council of Ministers.

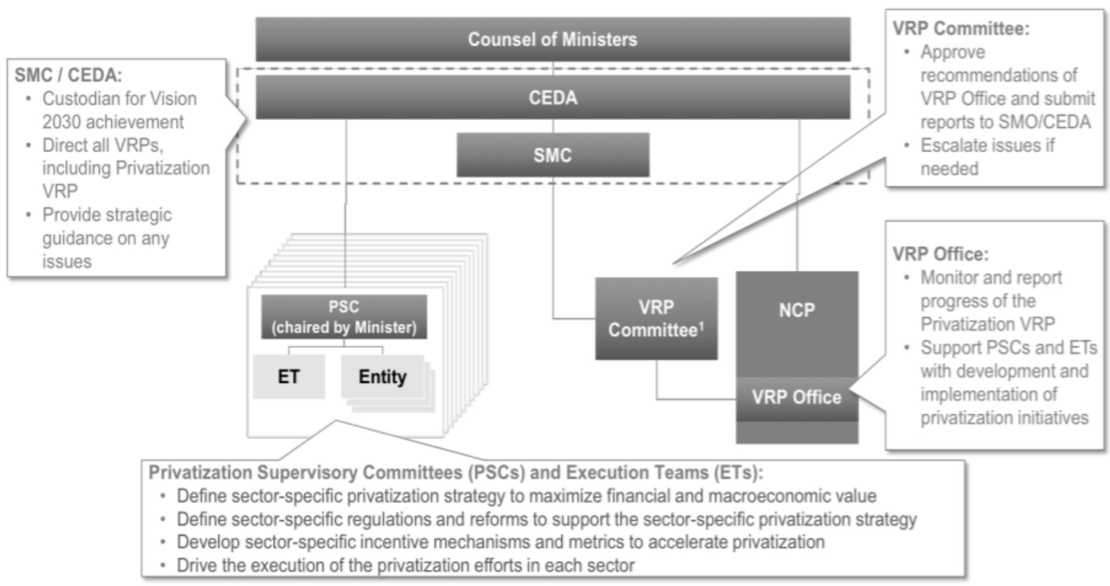


Figure 5-3: PPP operation model by NCP

Source: NCP

The Government of Japan hopes to build close cooperative relationships in many fields based on the "Saudi-Japan Vision 2030". Specific support measures to this includes project financing by the Japan Bank for International Cooperation (JBIC) and business promotion support by JETRO/ JCCME. JICA's supports for overseas expansion of SMEs and SDGs projects are also effective assistance measures.

In addition to these support measures, each Ministry and Agency of the Government of Japan has also prepared a number of programs to support the advancement of Japanese firms into

Saudi Arabia, and the support projects are summarized in Appendix 3. There are various Ministries and Agencies support projects, such as the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of Health, Labor and Welfare, the Ministry of the Environment, JICA, JETRO, NEDO and many others.

Chapter 6: Implementation of Delegation Program

6.1 Purpose of the Delegation Program

First, a list of the current situation, issues, and needs was created for water saving, water leakage countermeasures and water quality improvement in the water supply and agricultural sectors of Saudi Arabia. After that, an interim debriefing session was held for Japanese firms with high interest, and the survey results were shared. Issues and needs were introduced, and recommendations were made in the debriefing session. Then, the Delegation Program was planned for Japanese firms that have interests in this project and believed that their technology and products would contribute to solving the problems of Saudi Arabia. The contents of the program included presentations by ministries and agencies of Saudi Arabia, presentations by Japanese firms, and discussions between both sides.

The outline of the Delegation Program was that the number of participating firms would be 5 to 10, the number of participants was about 5 to 10, and the number of days would be about 12 days. The expenses for the trip to Saudi Arabia would be borne by each Japanese firm, while the expenses required for the participation of Saudi Arabia side would be borne by themselves. The venue would be arranged by the Saudi Arabia side.

Based on the logical framework of the Delegation Program mentioned above, the purposes of the Delegation Program were defined as follows.

1) To introduce the technologies and products of Japanese firms that contribute to solving various problems in the water and agricultural sector of Saudi Arabia.
2) To promote the understanding of Japanese firms on various issues in the water and agricultural sectors of Saudi Arabia.
3) To promote the understanding of Japanese firms about the market and potential business opportunities in the Saudi Arabia.
4) To promote investment from the Saudi Arabia side in Japanese SMEs and start-up firms in the agricultural field,

6.2 Planning of the Delegation Program

In planning the Delegation Program, JICA Survey Team corresponded to the rapid spread of Covid-19 in particular Omicron variant at the final stage of its planning, and changed the program from dispatch of Japanese firms to Saudi Arabia to implementation of the Online Delegation Program. The planning and composition of the Online Program including its history are described as below.

6.2.1 Implementation method and timing of Delegation Program

As stated in this report "Chapter 1, 1.2.2 (3) First Domestic Survey, 10) Planning of Local Delegation Program", as of November 22, 2021, nine firms, two firms from Japan and seven firms from the local subsidiaries or distributors in Saudi Arabia, were expected to participate. In addition, regarding the implementation time, a subsequent interview survey identified that it was easier for them to participate in January 2022 rather than in December 2021, which was originally planned. Therefore, JICA Survey Team decided to consider it starting from January 7th 2022. Moreover, since many Japanese firms requested a shorter program schedule, the schedule was shortened to 9 days despite it was initially planned for 12 days.

However, as preparations proceeded, there came up reports of the worldwide spread of the Omicron variant of New Coronavirus, that led to the announcement of a new government response policy by the Ministry of Health, Labor and Welfare of Japan. The response policy stipulated that the period of voluntary quarantine after returning to Japan was extended to14 days again from 3 days. Because of the announcement, two firms that had planned to join from Japan cancelled their voyages considering the infection control measures.

Under these circumstances, a dicision was made to change the Delegation Program to the online basis with an aim to encourage more Japanese firms to participate.

In response to the decision to hold the Delegation Program on onlice basis, firms participating in the interim report meeting held in October 2021 were invited to participate in the Online Delegation Program, and as a result, twenty firms applied for participation (among them, two firms applied for participation in two sectors) .

Regarding the schedule of the Program, it was decided to make it four-day program allocating each day for different fields, namely agriculture, water supply, water quality monitoring & analysis and water quality improvement so that the twenty firms could make a fulfilling presentation. Regarding the dates, it was set from January 17th (Monday) to January 20th (Thursday), considering the necessary preparation period for the Program and that the four-day program could be completed within the same week.

6.2.2 Contents of the Online Delegation Program

The contents of the Program included not only greetings from officials of both Japanese and Saudi Government agencies, presentations of products and services from Japanese firms, but also the following presentations:

(1) Introduction of overall survey results from the team leader of JICA Survey Team, including Japanese technology and products, and introduction of assistance schemes by the Japanese Government

(2) Survey results from the members of JICA Survey Team and introduction of Japanese technologies and products on each specific field that deemed to contribute for solving issues and

(3) Introduction of issues and business/investment activities in each field from the government-related organizations of the Saudi Arabia (see the title below):

- Estidamah: “Sustainable Agricultural Development and Advanced Research Works”
- NWC: "Non-Revenue Water Reduction Program"
- NCEC: "1. Environmental regulation for water quality and the rules of the national center”,
  "2. Building water quality monitoring system within NCEC"
- SIO: "Safe Reuse of Wastewater for Irrigation"

(4) Panel discussion among Saudi Arabia Governmental organizations, Japanese private firms, and members of JICA Survey Team, based on (3) above.

(5) Business matching meeting

JICA Survey Team used the breakout session function to separate participating firms from the others. One breakout room was assigned to each Japanese firm that participated in the Delegation Program, and Delegation Program participants from Saudi Arabia were freely visit the breakout rooms, ask for questions to the participating Japanese firms for cooperation in the future. In addition, JICA Survey Team took notes of the exchanges between Japanese firms and Saudi arabian visitors.

(6) In response to the suggestion of MISA, investment guide for water and agriculture in Saudi Arabia, “Invest in Saudi”, was presented every day.

The schedule of the Online Delegation Program was finalized as shown in Table 6-1 below.

Table 6-1 : Schedule of Online Delegation Program

Agriculture Sector, Jan 17, 2022 10:30 AM Riyadh.

Date (Day)	Time (Saudi Time)	Title of Speech/Presentation	Speaker	
Jan 17, 2022 (Mon) Agriculture Sector	10:30~10:40	Opening Remarks	H.E. Mr. Mohammed Al-Hassnah, Deputy Minister for International Relations, MISA	
	10:40~10:50	Opening Remarks	H.E. Mr. IWAI Fumio, Ambassador Extraordinary and Plenipotentiary of Japan to the Kingdom of Saudi Arabia	
	10:50~11:00	Keynote Speech	H.E. Dr. Abdulaziz Al-Shaibani, Deputy Minister for Water Affairs, MEWA	
	11:00~11:05	Welcome Speech	Mr. KOBAYASHI Tsutomu, Resident Representative, JICA Saudi Arabia Office	
	11:05~11:09	Welcome Speech	H.E. Dr. Ibrahim Al-Turki, Chairman of the National Committee for Agricultural and Fisheries at the Federation of Saudi Chambers and Chairman of the Agriculture and Water Committee at Riyadh Chamber of Commerce	
	11:09~11:14	Welcome Speech	Mr. NISHIURA Masaru, Senior Director for Global Strategy MIddle East, JETRO	
	11:14~11:19	Welcome Speech	Dr. MUTO Koji, Chief Representative, JCCME Saudi Arabia Office	
	11:19~11:29	Invest in Saudi (Agriculture)	Mr. Mohammed Alohaly, Food Products Segment Director, MISA	
	11:29~11:44	Report on JICA Survey and Introduction of Japanese Technologies and Projects	Dr. MOTOYAMA Junichiro, JICA Project Team Leader	
	11:44~12:00	Break		
	Presentations in Agriculture Sector by Estidamah and Japanese Firms			
	12:00~12:10	Technical Report	Mr. Inoue, Survey Team Member	Potential Technologies/Products applicable for dissolving challenges in the Agriculture Sector
	12:10~12:20	Technical Presentation	Estidamah	Sustainable Agriculture Development and Advanced Research Works
	12:20~12:35	Company Presentation No. 1	Company J-A	Film farming Water retention materials
	12:35~12:50	Company Presentation No. 2	Company J-B	Water retention materials
	12:50~13:05	Company Presentation No. 3	Company J-C	Cooling systems, Agricultural Robot, Traceability technologies, Vertical farming
	13:05~13:35	Panel Discussion	Panel Discussion by 5 Panelists and the participants	
	Online Business Matching Meetings			
	13:35~13:40	Preparation for the business matching meetings and explanation on how to enter the rooms		
	13:40~14:15	Online business matching meetings between Japanese firms and Saudi private companies which will be implemented parallelly by using ZOOM breakout room functions		

Water Supply Sector, Jan 18, 2022 10:30 AM Riyadh.

Date (Day)	Time (Saudi time)	Title of Speech	Speaker	Theme/Contents
Jan. 18, 2022 (Tue) Water Supply Sector	10:30~10:40	Invest in Saudi (Water)	Mr. Sultan Alsmri, Water Segment Director, MISA	
	Presentations in Water Sector by NWC and Japanese Firms			
	10:40~10:50	Technical Report	Mr. Niimura, Survey Team Member	Potential Technologies/Products applicable for dissolving challenges in the Water Supply Sector
	10:50~11:00	Technical Presentation	NWC	Non-Revenue Water Reduction Program
	11:00~11:15	Company Presentation No. 1	Company J-D	Water flow/pressure monitoring system
	11:15~11:30	Company Presentation No. 2	Company J-E	Ultrasonic flowmeter, Open channel flowmeter
	11:30~11:45	Company Presentation No. 3	Company J-F	Flow control valves, Water supply and sewage system
	Break			
	11:55~12:10	Company Presentation No. 4	Company J-G	Tapping saddle with cooperation stop
	12:10~12:25	Company Presentation No. 5	Company J-H	Pipe joints
	12:25~12:40	Company Presentation No. 6	Company J-I	Water leak detectors, Pipe locators, Valve locators
	12:40~12:55	Company Presentation No. 7	Company J-J	Water leak detectors, Water saving devices
	12:55~13:25	Panel Discussion	Panel Discussion by 6 Penelists and the participants	
	Online Business Matching Meetings			
	13:25~13:30	Preparation for the business matching meetings and explanation on how to enter the rooms		
	13:30~14:05	Online business matching meetings between Japanese firms and Saudi private companies which will be implemented parallelly by using ZOOM breakout room functions		

Water Quality Monitoring & Analysis Sector, Jan 19, 2022 10:30 AM Riyadh.

Date (Day)	Time (Saudi time)	Title of Presentation	Speaker	Proposed Theme/Contents
Jan 19, 2022 (Wed) Water Quality Monitoring & Analysis Sector	10:30~10:40	Invest in Saudi (Water)	Mr. Sultan Alsmri, Water Segment Director, MISA	
	Presentations in Water Sector by NCEC and Japanese Firms			
	10:40~10:50	Technical Report	Mr. Onozato, Survey Team Member	Potential Technologies/Products applicable for dissolving challenges in the Water Quality Management Sector (1)
	10:50~11:00	Technical Presentation	NCEC	1. Environmental regulation for water quality and the rules of the national center 2. Building water quality monitoring system within NCEC
	11:00~11:15	Company Presentation No. 1	Company J-D	Water quality monitoring instrument
	11:15~11:30	Company Presentation No. 2	Company J-K	Water quality monitoring instrument, Water quality analyzer on site, Water quality analyzer in lab
	11:30~12:00	Panel Discussion	Panel Discussion by 5 Panelists and the participatns	
	Break			
	12:10~12:25	Company Presentation No. 3	Company J-L	Water quality analyzer in lab
	12:25~12:40	Company Presentation No. 4	Company J-M	Water quality analyzer in lab
	12:40~12:55	Company Presentation No. 5	Company J-N	Analysis kit
	12:55~13:25	Panel Discussion	Panel Discussion by 6 Penelists and the participants	
	Online Business Matching Meetings			
	13:25~13:30	Preparation for the business matching meetings and explanation on how to enter the rooms		
	13:30~14:05	Online business matching meetings between Japanese firms and Saudi private companies which will be implemented parallelly by using ZOOM breakout room functions		

Water Treatment Sector, Jan 20, 2022 10:30 AM Riyadh.

Date (Day)	Time (Saudi time)	Title of Presentation	Speaker	Proposed Theme/Contents
Jan 20, 2022 (Thu) Water Treatment Sector	10:30~10:40	Invest in Saudi (Water)	Ms. Yara Aljebreen, Business Development Analyst, Energy and Water Sector, MISA	
	Presentations in Water Sector by SIO and Japanese Firms			
	10:40~10:50	Technical Report	Mr. Onozato, Survey Team Member	Potential Technologies/Products applicable for dissolving challenges in the Water Quality Management Sector (2)
	10:50~11:00	Technical Presentation	SIO	Safe Reuse of Wastewater Treatment for Irrigation
	11:00~11:15	Company Presentation No. 1	Company J-O	Fabric filter, water treatment machines
	11:15~11:30	Company Presentation No. 2	Company J-P	Fabric filter, Chemical dosing pump
	11:30~11:45	Company Presentation No. 3	Company J-Q	Membrane, Ion-exchange membrane
	Break			
	11:55~12:10	Company Presentation No. 4	Company J-R	Membrane
	12:10~12:25	Company Presentation No. 5	Company J-S	Johkasou
	12:25~12:40	Company Presentation No. 6	Company J-F	Water treatment machines
	12:40~12:55	Company Presentation No. 7	Company J-T	Disinfection equipment with UV
	12:55~13:25	Panel Discussion	Panel Discussion by 5 Panelists and the participants	
	13:25~13:55	Panel Discussion	Panel Discussion by 6 Panelists and the participants	
	Online Business Matching Meetings			
	13:55~14:00	Preparation for the business matching meetings and explanation on how to enter the rooms		
	14:00~14:35	Online business matching meetings between Japanese firms and Saudi private companies which will be implemented parallelly by using ZOOM breakout room functions		

6.2.3 Invitation to Saudi Participants

Participants from Saudi Arabia (participants other than the presenters) were invited as follows.

1) Riyadh Chamber of Commerce called the general public for participation through SMS and the website.

2) Invitation to members of Riyadh Chamber of Commerce and the Federation of Saudi Chambers

(1) E-mail from the Chamber of Commerce Secretariat to member companies belonging to the Agriculture and Water Committee of the Riyadh Chamber of Commerce and the National Committee for Agricultural and Fisheries of the Federation of Chambers.

(2) A list of Saudi Arabia firms was prepared in advance, and JICA Survey Team followed up by SNS or telephone calls for their participation.

3) Invitation to MEWA and related organizations

(1) Regarding MEWA and its related organizations (NWC, Estidamah, NCEC, SIO, etc.), JICA Survey Team submited a list of related parties (mainly those whom JICA Survey Team interviewed when traveling to the site) to MEWA, and MEWA invited them based on the list.

(2) JICA Survey Team followed up by SMS, e-mail or telephone calls and requested their participation.

4) Invitation to other Saudi Government Agencies

(1) Based on the prepared list of government officials, JICA Survey Team sent invitations to Government agencies such as MODON, Monsha'at, MISA, and Green Riyadh Initiatives by e-mail.

(2) JICA Survey Team followed up by SMS or telephone calls and requested their participation.

The realized number of registered and actual participants in the online program were as follows (including Saudi Arabia presenters, Japanese firm presenters, JICA Survey Team members, and JICA personnel):

- January 17, Agriculture, 175 registered, 104 participants
- January 18, Water Supply, 129 registered, 86 participants
- January 19, Water Quality Monitoring & Analysis, 119 registered, 79 participants
- January 20, Water Treatment, 127 registered, 72 participants

6.3 Implementation of Online Delegation Program

The Online Delegation Program was conducted according to the above-mentioned program.

6.3.1 Program Outline (Agriculture Sector) on January 17th 2022 (Monday)

1) Speech by the guest speakers

(1) "Opening Remarks", H.E. Mr. Mohammed Al-Hassnah, Deputy Minister for International Relations, MISA

- Importance of foreign investment in Saudi Vision 2030
- Partnership with Japan
- Importance of the agricultural sector
- Investment required in the water sector
- Message to Japanese investors

(2) "Opening Remarks", H. E. Mr. Iwai Fumio, Ambassador Extraordinary and Pleinpotentiary of Japan to the Kingdom of Saudi Arabia

- Cooperation projects in Saudi-Japan Vision 2030
- Importance of water and agriculture in Saudi Arabia
- Japanese technology in the fields of water and agriculture
- The enthusiasm of the Japanese side and the potential of Saudi Arabia
- Celebration of 70th anniversary of the establishment of diplomacy and the 10th anniversary of Saudi-Japan Vision 2030 in 2025.

(3) "Keynote Speech", H.E. Abdulaziz Al-Shaibani, Deputy Minister for Water Affairs, MEWA

- Discussion of water issue at the G20 in Riyadh in 2020, and signing of the Memorandum of Cooperation between Saudi Arabia and Japan.
- National Water Strategy 2030
- Overview of water use in Saudi Arabia
- Overview of MEWA and organizations under MEWA
- Challenges faced by Saudi Arabia
- Privatization program in the water sector

(4) "Welcome Speech", Mr. Kobayashi Tsutomu, Resident Representative, JICA Saudi Arabia Field Office

- JICA's achievements in Saudi Arabia
- Introduction of Kaizen training, etc. under Saudi-Japan Vision 2030

(5) "Welcome Speech", H.E. Dr. Ibrahim Al-Turki, Chairman of the National Committee for Agriculture and Fisheries at the Federation of Saudi Chambers and Chairman of the Agriculture and Water Committee at Riyadh Chamber of Commerce

- Agricultural sector goals for Saudi Vision 2030
- Bilateral cooperation in the business sector

(6) “Welcome Speech”, Mr. Nishiura Masaru, Senior Director for Global Strategy Middle East, JETRO

・Introduction of JETRO

・Introduction of Saudi-Japan Vision Office

・JETRO's activities in the fields of e-commerce, entertainment industry, and venture company support in the Middle East

(7) “Welcome Speech”, Dr. Muto Koji, Chief Representative, JCCME Saudi Arabia Office

・Introduction of JCCME

・Investment track records in Saudi Arabia

2) Presentation of investment opportunities by MISA

“Invest in Saudi (Agriculture)”, Mr. Mohammed Alohaly, Food Products Segment Director, MISA

・Introduction of Saudi Vision 2030

・Advantage of Saudi Arabia in business

・MISA's strategy in the agricultural field

・Overview of MISA

・Investment incentives

3) Report on the results of this survey by JICA Survey Team (Dr. Motoyama Junichiro, Team Leader)

・Purpose of the project

Outlines of the project (composition of JICA Survey Team, survey target area, survey schedule, survey method)

・Visited organizations (organizations cooperated) in the first field survey

・Survey results (issues in the agriculture and water sectors, needs for assistance, and introduction of technical products of Japanese firms)

・Investment environment in Saudi Arabia

・Introduction of support scheme by JICA

4) Technical discussions

(1) Technical Reports: JICA Survey Team / Team member Mr. Inoue (Agriculture water use)

・Current status, issues and pooints for improvements in agriculture and irrigation in Saudi Arabia

・Applicable Japanese technologies and products

(2) Technical Presentation: Dr. Abdulaziz R. Al-Harbi, Technical Consultant, Estidamah, “Sustainable Agriculture Development and Advanced Research Works”

・Introduction to Estidamah

・Introduction to greenhouse technology

・2022 survey project

・Future issues

(3) Company Presentation: Presentations about company profile, products, and achievements from three Japanese firms

(4) Panel discussion

Panelists: Moderator (JICA Survey Team, Team Leader), Dr. Abdulaziz R. Al-Harbi (Estidamah), Mr. Inoue, JICA Survey Team member, each Japanese firm presenter,

[Discussion theme]

・Applicability of the technologies and products of the Japanese firms to Saudi markets, which were presented in the Delegation Program,

・Possibillity on joint research between Estidermah and Japanese firms

[Content of discussion]

i) Applicability of the technologies and products of the Japanese firms to the Saudi markets which were presented in the Delegation Program

・Estidamah mentioned that the technologies of all three firms would be highly applicable in Saudi Arabia.

ii) About joint research between Estidamah and Japanese firms and other business entities

・Estidamah expressed its keen interest in cutting-edge agricultural technology of Japanese firms and hoped for joint research in many fields. In particular, Estidamah was very interested in joint research with Japanese universities, research institutes, and private firms in the fields of arid agriculture, vertical farming, and smart agriculture technologies. In addition to research activities, Estidamah mentioned that there would be the opportunity to test applicability of Japanese products before putting their products and technologies on the commercial market in Saudi Arabia. For firms that collaborate, Estidamah mentioned its support not only on the technical field but also on the marketing field such as test marketing.

・Japanese firm J-A told that it did not have a plan for joint research because the firm's size was small and did not have sufficient funds for joint research. It also told that it would be conceivable to utilize JICA's support schemes, but since it was currently working on a research project, it might be difficult to start a new research project in parallel, due to a lack of manpower and funds

・Japanese firm J-B told that it would like farmers and firms in Saudi Arabia to try out its own technologies and products. It hoped Estidamah to play a role in promoting collaboration (catalyst functions) between Japanese and Saudi firms.

・Through R & D (Research and Development) activities in Saudi Arabia, Japanese firm J-C mentioned its desiire to verify whether the technology and products could be applied not only to the improvement of technology but also to the commercial environment and meteorological environment of Saudi Arabia.

- JICA Survey Team Leader has proposed Japanese firms for joint research with Estidermah and to cooperate with investment firms in Saudi Arabia. The leader also mentioned that investment companies in Saudi Arabia were interested in Japan's highly advanced technology for improvement of food security in KSA.

iii) Applicability of water retention material to large-scale farming

- A Saudi private firm quesioned whether the water retention material technology could be economically applied to large-scale (million ha) agriculture activities.
- Japanese firm J-B told that, by reducing the amount of irrigation water and fertilizer application costs, the investment amount of water retention material could be recovered in a few years. It also mentioned profit could be expected since the effect of the product would last for a long period of time.
- JICA Survey Team Leader said that feasibility studies had been conducted on water retention materials in many places, and it had been verified whether they were economically feasible. In addition, the leader also told that, as one of the advantages of this product, it would be possible to use the waste of photovoltaic power generation panels, which was estimated to be discarded in large quantities in the future in Saudi Arabia, as the raw material for the product. Since the weight of water retention materials was heavy, it would be difficult to export from Japan to Saudi Arabia. The leader said that it might be necessary to build a production plant in Saudi Arabia in the future.
- Japanese firm J-A told that its current production of water retention materials was pilot scale and expensive, but it could be applied to large-scale agriculture because the price could be reduced, if it became a normal scale.

5) Business matching meeting

The number of meetings on the day was six. Also, within a week after the meeting, there were three other inquiries directly to Japanese firms. The outline is shown in Table 6-2.

6.3.2 Program Outline (Water Supply Sector) on January 18th 2022 (Tuesday)

1) Presentation by MISA

“Invest in Saudi (Water)”, Mr. Sultan Alsmri, Water Segment Director, MISA

- Seawater desalination business
- Privatization and localization
- Access to the Saudi Arabian market
- The investment environment

2) Technical discussions

(1) Technical Report: JICA Survey Team/ Team Member Mr. Niimura (Water supply)

・Current status and points for improvement in water supply in Saudi Arabia

・Applicable Japanese technology

(2) Technical Presentation: Eng. Turki Algarni, NRW Program Director, NWC,
"Non-Revenue Water Reduction Program"

・Introduction to NWC

・Current status of Non-Revenue Water ("NRW")

・Strategy for improving NRW

(3) Company Presentation: Presentations about company profile, products, and achievements from 7 Japanese firms

(4) Panel discussion

Panelists: Moderator (JICA Survey Team, Team Leader), Eng. Turki Algarni (NWC), Survey Team Member, Mr. Niimura, Presenters of Japanese firms

[Discussion theme]

・Applicability of the products and technologies of the Japanese firms that gave the presentation in the Saudi market

・Japanese technology that was expected to contribute to the reduction of NRW in NWC

・The equipment registration method as a material and equipment manufacturer to NWC (Saudi market)

・Possibility of entering the market while avoiding price competition by specifying the introduced products.

[Content of discussion]

i) Applicability of the technologies and products of the Japanese firms to Saudi markets which were presented in the Delegation Program

・NWC told that the technologies of all seven companies would be highly applicable in Saudi Arabia. It said that it was using other overseas products such as large-diameter tube flowmeters and control valves, but the introduction of Japanese technologies and products could be an opportunity to review the NWC guidelines. It also said that leakage repairs, plumbing materials, etc. could also be used in the project.

ii) Japanese technology that is expected to contribute to the reduction of NRW in NWC

・NWC told that the technologies and products of all seven companies would be expected to contribute to NRW reduction. NWC also said that leakage investigations, control valves, flowmeters for large diameter pipes, SCADA, etc. would also contribute. NWC also hoped that the sound-listening leak investigation method could also be used in the demonstration project. NWC also told that it would also like to pay attention to flow measurement and repair technology.

iii) Implementation of training programs for leakage detection, leakage repair, and pipeline laying technology

- NWC told that leakage detection, leakage repair, pipeline laying technology, and qualification system would be examined.

iv) How to register equipment as a material and equipment manufacturer with NWC

- NWC said that registration would be possible from the NWC website. NWC also said that it was using other overseas products, but this introduction of Japanese technologis and products could be an opportunity to review the NWC guidelines.

v) Possibility of entering the market avoiding price competition by specializing the introduced products.

- Japanese firm J-F mentioned that the efficiency of its products could be explained in more detail using videos and additional materials. In addition, the firm also mentioned that it would be good if there was an opportunity to introduce it locally, use it for trial operations, and demonstrate the effectiveness of the products.
- Japanese firm J-D expressed its desire to appeal the flexible response according to the site situation.
- NWC mentioned that the opportunity to demonstrate the effectiveness of products was also a good opportunity for NWC. NWC also said, however, that it would need to consider price to be an important requirement for a product. They continued that some products, such as household meters, they limit the supplier to three firms. They also said that they are giving preference to quality and specifications of products, if it would be considered important like flow meter.

(5) Business matching meeting

The number of meetings on the day was seven. Also, within a week after the meeting, there were 9 other inquiries directly to Japanese firms. The outline is shown in Table 6-2 below.

6.3.3 Program Outline (Water Quality Monitoring & Analysis Sector) on January 19th 2022 (Wednesday)

1) Presentation by MISA

"Invest in Saudi (Water)", Mr. Sultan Alsmri, Water Segment Director, MISA

- Seawater desalination business
- Privatization and localization
- Access to the Saudi market
- The investment environment

2) Technical discussions

(1) Technical Report: JICA Survey Team / Team Member Mr. Onozato (Water quality)

・Current status and points for improvement in water quality monitoring and analysis in Saudi Arabia

・Applicable Japanese technology

(2) Technical Presentation: Mr. Aziz Al-Othman, Executive Director of Monitoring Operations, NCEC, “Environmental regulation for water quality and the rules of the national center”, “Establishment of a National Environmental Monitoring Program on Groundwater and Surface Waters”

・Related regulations

・The water quality monitoring program

(3) Company Presentation: Presentations about company profile, products, and achievements from 5 Japanese firms

(4) Panel discussion

Part 1: Water quality monitoring

Panelists: Moderator (JICA Survey Team, Team Leader), Team Member Mr. Onozato, Presenters of Japanese firms,

* Mr. Aziz Alothoman (NCEC), who was scheduled to attend the Saudi side, was absent.

[Discussion theme]

・Applicability of the technologies and products in Saudi markets which were presented by each firm

・Needs for the products in the concerned organizations in Sudi Arabia

[Content of discussion]

i) Applicability of technologies and products presented by each firm to the National Environmental Monitoring Program of Groundwater and Surface Water implemented by NCEC

・Japanese firm J-D mentioned that its various sensors explained today could be used .

・Japanese firm J-K mentioned that it had a track record of delivery in other countries, and it believed that our know-how could be used for projects in Saudi Arabia.

Part 2: Water Quality Analysis session

Panelists: Moderator (JICA Survey Team, Team Leader), Mr. Abdulllah Butwaibah (SIO, Water Quality Management Manager), Team Member Mr. Onozato, Presenter of Japanese firms

[Discussion theme]

・Applicability of technologies and products in Saudi Arabia which were presented by each firm

・Needs for the products at the concerned organizations in Sudi Arabia

[Content of discussion]

i) Applicability of technologies and products to SIO, any needs for related technologies

・SIO told that it had been using an analysis kit made in Japan for 3 years (SIO).

- SIO also told that it also performed microbial analysis during reuse of treated water and heavy metal analysis in sludge, but it was looking for an analysis method that could be measured more quickly and with higher accuracy than the official method. In this regard, at this stage, HACH (made in the United States) simple analysis products were being used to analyze many water quality items.
- For simple analysis of microorganisms, Japanese firm J-N said that it would recommend its new products. It said that it had data and track records of reliable analysis results.
- Japanese firm J-M said that the X-ray fluorescence analyzer could quickly measure heavy metals in livestock feed and sewage sludge without pretreatment.
- Japanese firm J-L said that the fluorescent X-ray analyzer could easily measure heavy metals in a sample simply by placing the sample on a plate. It had a delivery record to SASO etc.

3) Business matching meeting

The number of meetings on the day was three. In addition, there were no individual inquiries within one week after the meeting. The outline is shown in Table 6-2 below.

6.3.4 Program Outline (Water Treatment Sector) on January 20th 2022 (Thursday)

1) Presentation by MISA

"Invest in Saudi (Water)", Ms. Yara Aljebreen, Business Development Analyst, Energy and Water Sector, MISA

- Seawater desalination business
- Privatization and localization
- Access to the Saudi Arabian market
- The investment environment

2) Technical discussions

(1) Technical Report: JICA Survey Team / Team Member Mr. Onozato (Water Quality)

- Current status and points for improvement in water treatment (sewage treatment, use of reclaimed water) in Saudi Arabia
- Applicable Japanese technology

(2) Technical Presentation: Mr. Abdullah Butuwaibah, Director of Water Quality, SIO, "Safe Reuse of Wastewater Tertiary Treatment"

- Introduction of SIO
- Strategy for agricultural use of treated water
- Regulations on agricultural use of treated water
- Dissemination to related parties
- Water quality monitoring
- Introduction of reports

(3) Company Presentation: Presentations about company profile, products, and achievements from 7 Japanese firms

(4) Panel discussion

Panelists: Moderator (JICA Survey Team, Team Leader), Mr. Abdulllah Butwaibah (SIO), Water Quality Management Manager), Mr. Fahad Algorashi (NWC, Buraydah City Sewage Treatment Plant, Operation Management Manager), Team Member Mr. Onozato, Presenters of Japanese firm

[Discussion theme]

・ Applicability of technologies and products to Saudi markets which were presented by each firm

・ Needs for products at the concerned organizations in Saudi Arabia

[Content of discussion]

i) Applicability of technologies and products presented for sewage treatment in Buraydah City, and needs for any related technologies

・NWC told that the Buraydah City Sewage Treatment Plant was seeking for water treatment technology that could efficiently remove nitrogen.

・NWC also said that they are interested in control systems of Japanese firms that meet the above needs.

・NWC said that reuse of treated sewage water was an urgent issue for Buraydah and was being promoted.

・NWC said that, at this stage, sewage sludge was dumped at the disposal site, but it would like to reuse it in the future. NWC told that it was interested in a dehydrator that could dehydrate with high efficiency and low power consumption with a view to proper treatment and reuse of sludge.

・NWC told that there was an area in Buraydah where sewage was not covered, and the needs for septic tank in this area was high.

・Japanese firm J-S said that, similar to sewage treatment, septic tanks could be treated at the tertiary treatment level (SS10mg / l, BOD10mg / l, T-N10mg / L or less). They also said that it would also be possible to pass an activated carbon tank through the latter stage, and there were cases where the treated water from the septic tank was used for sewage reuse.

ii) Applicability of the technologies and products to SIO, and needs for related technologies

・SIO told that the water quality required by SIO for irrigation water was at the tertiary treatment level.

・SIO also told that, in Al-Ahasa, there was a strong need for reuse (desalting) of wastewater discharged from agricultural land while there were restrictions on the available agricultural water. SIO said that all desalination techniques to improve it would be welcome and it would be also possible to conduct joint research with SIO.

- SIO said that, regarding the desalination technology currently being sought, it did not have an image of specific technology and cost.
- SIO said that microbial contamination in the water supply and distribution process was also an issue. As a countermeasure, SIO said that it would be interested in introducing UV disinfection technology on-site.
- Japanese firms J-Q and J-R said that, given the water quality conditions of raw water and treated water, they could propose equipment that meets the needs of SIO.

3) Business matching meeting

The number of meetings on the day was zero, but within a week after the meeting, one inquiry was made directly to a Japanese firm. The outline is shown in Table 6-2 on the next page.

Table 6-2：Results of Business Matching Meeting

	Japanese Company	Contact Date	Saudi Company	Saudi Company's characteristic	Main Interests	Meeting set up	Remarks
Agriculture	J-A Company	Seminar	S-A Company	A small company specialised in trading and manufacturing of healthy food with special focus on cereals, honey, coffee, and dates.	Distribution	To be set later	Q&A on the cost of the product.
		Seminar	S-B Company	Looks like an NPO or NGO to solve desertification problem	Purchase	To be set later	Q&A on the harm of the material to plants and trees.
		Seminar	S-C Company	The person did not disclose the official name of the company	Not known	To be set later	Q&A on the reduction rate of irrigation water Q&A on the duration of the effectiveness of the product.
		Seminar	S-D Company	Remote sensing company	Distribution	To be set later	
	J-B Company	Seminar	S-E Company	Private Farmer	Purchase	To be set later	Will contact each other later. Introduced a pilot project somewhere else.
		Seminar	S-D Company	Remote sensing company	Distribution	To be set later	Introduced a pilot project somewhere else
		Later	S-H Company	Smart Farming related to NEOM	Feasibility Study	Meeting is done	S-H Company showed its interests on working with J-B Company with a trial project to test the product with farmer and some crops. An web meeting has done. And we have agreed to exchange information to follow up the discussion.
		Later	S-K Company	Distributor	Distribution	To be set later	Both parties are considering partnership to explore Saudi Arabia market.
	J-C Company	Seminar	None				
		Later	S-H Company	Smart Farming related to NEOM	Distribution	To be set later	S-H Company is seeking a partnership with J-C Company for smart farming.

Water Supply	J-D Company	Seminar	S-D Company	Remote sensing company	Distribution	To be set later	Q&A about the leak monitoring irrigation network.
		Seminar	S-F Company	Private power & utility company	Purchase	To be set later	Q&A about the magnetic flowmeters
		Seminar	S-G Company	Distributor & Manufacturer	J/V		J-D Company's subsidiary has already visited S-G Company before.
		Later	S-H Company	Smart Farming related to NEOM	Distribution	To be set later	S-H Company is seeking a partnership with J-D Company for smart farming.
	J-E Company	Seminar	S-F Company	Private power & utility company	Feasibility Study	To be set later	Q&A about the water flowmeter.
		Later	S-H Company	Smart Farming related to NEOM	Distribution	To be set later	
		Later	S-I Company	Investment Company	J/V	To be set later	
		Later	S-J Company	Construction, city planning	Feasibility Study		
	J-F Company	Seminar	None				
	J-G Company	Seminar	S-D Company	Remote sensing company	Distribution	To be set later	
		Later	S-H Company	Smart Farming related to NEOM	Distribution		S-H Company is interested in the products. J-G Company sent the catalog and the company profile.
		Later	S-I Company	Investment Company	J/V		S-I Company is interested in the products. J-G Company sent the catalog and the company profile.
	J-H Company	Seminar	S-F Company	Private power & utility company	Purchase	To be set later	Asked for the presentation material.
		Seminar	S-D Company	Remote sensing company	Distribution	To be set later	S-D Company will introduce J-H Company to a Saudi company in the similar field
	J-I Company	Seminar	None				
		Later	S-I Company	Investment Company	J/V	To be set later	S-I Company is interested in setting up a J/V.
	J-I Company	Seminar	None				
		Later	S-H Company	Smart Farming related to NEOM	Distribution	To be set later	S-H Company is seeking a partnership with J-I Company for smart farming.
		Later	S-I Company	Investment Company	J/V	To be set later	S-I Company is interested in setting up a J/V.
Water Quality Monitoring & Analysis	J-D Comapany	Seminar	None				
	J-K Comapany	Seminar	S-D Company	Remote sensing company	Distribution	To be set later	
	J-L Company	Seminar	S-B Company	Looks like an NPO or NGO to solve desertification problem	Purchase	To be set later	S-B Company was interested in the analytical equipment for soil (agriculture purposes) because it would like to promote organic crops in Saudi Arabia.
	J-M Company	Seminar	S-D Company	Remote sensing company	Distribution	To be set later	S-D Company wishes to test the product.
	J-N Comapany	Seminar	None				
Water Treatment	J-O Company	Seminar	None				
	J-P Company	Seminar	None				
	J-Q Company	Seminar	None				
	J-R Company	Seminar	None				
	J-S Company	Seminar	None				
	J-F Company	Seminar	None				
	J-T Company	Seminar	None				
		Later	S-H Company	Smart Farming related to NEOM	Distribution	To be set later	S-H Company is seeking a partnership with J-T Company for smart farming.

6.4 Evaluation of the Delegation Program

After the Delegation Program was completed, JICA Survey Team conducted a survey by e-mail with the Japanese firms that made the presentation. It should be noted that this is an evaluation with Japanese firms, and the evaluation by the Saudi Arabia side may be different.

6.4.1 Degree of achievement of Delegation Program objectives

The above-mentioned "6.1 Purpose of the Delegation Program" was shown to Japanese firms, and their impressions were heard.

1) To introduce the technologies and products of Japanese firms that contribute to solving various problems in the water and agricultural sector of Saudi Arabia.
2) To promote the understanding of Japanese firms on various issues in the water and agricultural sector of Saudi Arabia.
3) To promote the understanding of Japanese firms about the market and potential business opportunities in the Saudi Arabia.
4) To promote investment from the Saudi Arabia Arabia side in Japanese SMEs and start-up companies in the agricultural field.

For 1) to 3) above, the Japanese firms' assessments were either positive or negative relatively to the same degree. For 1) and 2), as explained in the next clause 6.4.2, positive feedbacks were provided to the JICA Survey Team.

For 4) above, since there were no feedbacks from the Japanese firms in the agriculture field, no asseesments were obtained.

6.4.2 Evaluation of each program

When JICA Survey Team received feedbacks by e-mail on what was particularly good about each program, many firms mentioned "Presentations by Japanese firms". Their comments were as follows:

- It was a good opportunity to introduce the technologies and products to the Saudi Arabia.
- The technologies and products were introduced and were recognized to some extent.

The next most favorable program was "Technical Presentations from related Ministries (Estidamah, NWC, NCEC, SIO). Their comments were as follows:

- The Saudi Arabia's intentions for water infrastructure and future plans were heard.
- It was a good opportunity to directly hear about the sewage reuse policies of Saudi Arabia.

6.4.3 Recommendations for the program

Various comments, other than the comments shown in 6.4.2. and 6.4.3. above, were received from participating firms regarding this Delegation Program. Some of the comments are as shown below:

- It was good to be able to give a presentation while preventing infection via Online Delegation Programs and without spending travel costs.
- The presentation time tends to be exceeded, but it would be even better to set a time slot in which it could be absorbed.
- The details of the Saudi participants were not known to Japanese firms, and there is no way to confirm that the caller is a reliable one even if an inquiry is received.
- A local firm did not enter the particular breakout room.
- Whether the content of the presentation was in line with local needs, was doubtful, and preparations should have made more carefully so that a proposal could have appealed to the Saudi Arabia side more.
- It would be difficult to have a business matching meeting in a breakout room after the presentation is made.

6.5 Business development outlook

After the Delegation Program was completed, JICA Survey Team conducted a survey by e-mail with the Japanese firms that made the presentation, and obtained the following results.

6.5.1 Expansion into the Saudi market, sales channel expansion plan

The comment was that companies who have already bases or agents in Saudi Arabia, they would continue to receive orders for projects and sell solutions and products through the bases and agents. Firms planning to enter into the Saudi market have responded that they would like to find agents and manufacturing partners, and that they would like to find customers through consulting firms and Japanese trading firms.

6.5.2 Status of negotiations with Saudi Arabia after the Delegation Program and future prospects.

There were both responses that there was contact from the Saudi Arabia side and that there was no contact yet. Regarding the firms with which they had a contact, the answer was that they were negotiating by e-mail or online meeting. In addition, one firm commented that investors in Saudi Arabia said that financial support from Japan such as JICA was also necessary.

Chapter 7: Conclusions and Recommendations

7.1 Conclusions

1) Marketability and challenges in the water sector

Based on the Saudi Vision 2030 being announced in 2016, the National Water Strategy (2030) was formulated in 2017. The strategy specifies five strategic areas: Abundance, Affordability, Quality, Environmental Sustainability, and Economic Sustainability. In order to realize such a strategy, there are 10 strategic programs and accompanying initiatives. Along with these comprehensive initiatives, the water sector will be in need of investment to the following facilities in the future:

Table 7-1: Future achievement targets in the Water Sector

Areas of Activities	Contents
Desalination of Seawater	5.5 million cubic meters per day
Sewage Treatment Capacity	5.5 million cubic meters per day
Water Transmission Pipeline	1,952 km
Water Purification facilities	30 water production plants and sewage treatment plants
Water Storage Facilities	33.56 million cubic meters

In addition, the Government of the Saudi Arabia has set out the directions of privatization in the value chain of the water business from water production to water distribution, sewage treatment and reuse. Typical privatization projects in the water field include the privatization of water and sewage systems in six clusters nationwide by NWC and the privatization of SWCC. In the NWC privatization scheme, a successful tenderer will conduct a survey work for seven-year contract period for improvement of customer satisfaction through streamlining operating costs, improving water leakage ratio, streamlining water pipe networks, etc., then proceed to the signing of a concession contract for business operations over 20 to 30 years. The successful corporate groups in the past, are joint ventures between a local firm and foreign firms (France and the Philippines), and unfortunately the name of a Japanese firm is not found. According to the results of hearings from Japanese Government support organizations and major trading firms stationed in Saudi Arabia, Japanese firms lack experience in comprehensive water business operations related to privatization, thus they are still remain as watching.

Considering the directions of these policies and the business strategies and track records of Japanese firms, it may be considered that there is a possibility of business opportunities for Japanese firms in the water field of Saudi Arabia in the following fields.

・Provision of technologies for the improvement of water supply and sewage treatment services and assistance for the development of systems

・Improvement of the productivity of recycled water and support for dissemination of its use to the medium water supply and agriculture and irrigation fields.

・Support for the introduction of technologies for efficient production for further expansion of seawater desalination, and technologies for environmental conservation.

On the other hand, the following challenges have been identified in the water supply and water quality fields through this survey.

【Challenges in the water supply field】

1. Leakage from the water pipe connection.
2. Failure of cut-off valves
3. Drawings that are inconsistent with the conditions at the project site.
4. Existence of customers who are not officially registered.
5. Difficulty of conducting a leakage detection survey due to the use of tap water at night and the generation of tap running water sound.

【Challenges in the field of water quality improvement】

1. The reuse of sewage treated water is not disseminated.
2. Pollution of the water environment (groundwater, sea area) is progressing.

2) Marketability and challenges in the Agricultural field

According to "Agricultural Renaissance in KSA 2021" developed by MEWA, the following goals are set as national strategic goals for agriculture and food security in Saudi Arabia.

・Achieve sustainable local food production systems for products which have comparative advantages.

・Ensure an access to safe and nutritious foods and encourage healthy and balanced eating habits.

・Ensure capacity building to envisage the risks of food security.

・Develop institutional business models at the national level and ensure clear governance.

Saudi Arabia is the largest producer of dates, poultry, dairy products and aquaculture in the Middle East, with fresh milk at a self-sufficiency rate of 122%, table eggs at 115%, dates (115%), and vegetables 70% There is a field where it maintains self-sufficiency, and even surplus food is produced, too. However, according to MEWA's "Agricultural and Irrigation Sector in KSA: Challenges and Opportunity, 2021", the following challenges are listed in the Agricultural field of Saudi Arabia.

・It relies heavily on traditional agriculture and irrigation methods.

- The climate is the desert climate and very hot for most of the year.
- The soil is sandy soil with low water retention, high salinity, and low organic content.
- Crops with high self-sufficiency rates are limited.
- Direct channels for sales and marketing services for the crops produced by smallholders is insufficient.
- Agricultural cooperatives and their organizations are insufficient and weak.

On the other hand, the following 7 points have been identified through this survey as specific challenges in the Agricultural field.

1. Depletion of irrigation water.
2. Low irrigation efficiency.
3. No water tariff.
4. Deterioration of water quality in irrigation water.
5. The need to improve the water quality of agricultural wastewater.
6. Shortage of agricultural workforce.
7. The occurrence of water leakage at agricultural pipelines.

3) Applicability of Japanese firms' technologies and products in the Water and Agricultural fields

Based on these survey results, JICA Survey Team examined the technologies and products of Japanese firms which are expected to contribute to the resolution of 24 challenges faced by the water and agricultural fields of Saudi Arabia, and also considered proposed future action. The results of such consideration are as shown in Table 7-2 in the following pages.

The following perspectives are important for Japanese firms who are considering to enter into Saudi market.

- Technologies and products of Japanese firms are used to have higher quality and durable, but it is often set with higher prices.
- Many of the procurement methods in public works at Saudi Arabia are based on the open public bidding method among registered vendors, and evaluation of the bids is conducted not only the aspects of the quality but also the price competitiveness which is a big factor to become a successful bidder.
- In view of the above conditions, the sales strategy of Japanese firms shall not only emphasis the technical superiority of their technologies and products, but also to emphasis the lifetime costs which include initial investment outlays and operation costs, considering good durability of own technologies and products.
- It is important to obtain an opportunity for joint research works in order to confirm the

performance of firm’s technologies and products in the local environment and to improve it, and for experimental construction and verification project for certifying the technologies and products in Saudi Arabia.

In addition, certain activities such as provision of an opportunity to the potential clients for inspecting and observing track records on the technologies and products which were delivered in Japan and/or the third countries, shall be required.

With regard to "Proposed future action", it was described not only based on the information collected by JICA Survey Team from various Government bodies of Saudi Arabia, but also based on the hearing results on the policies of Japanese private firms towards Saudi markets.

As shown in Figure. 7-1 below, three types of approaches can be considered: (1) Expansion of sales channels in the market of Saudi Arabia through cooperation with local firms, (2) Entry into the Saudi Arabia market through joint research and experimental construction works with implementation agencies of Saudi Arabia, etc., and (3) Entry into the Saudi Arabia market through application for assistance schemes provided by Japanese Governmental organizations.

Since each approach has advantages and disadvantages, private firms are expected to carefully consider their directions with due consideration to their own management resources and management capabilities.

3) Business environment for overseas firms in Saudi Arabia

Regarding the business environment for overseas firms in Saudi Arabia, while the living environment has been improved along with the start of investment promotion to the tourism field and to the entertainment industry, it has also been pointed out that the business legal systems are yet to be developed and the application of these systems is not clear.

In addition, issues such as labor shortages and higher labor costs have been pointed out not only in agriculture field but also in other industrial fields. As a result of comparative survey on the business environment with three neighboring countries; UAE, Turkey, and Egypt, the following three points of Saudi Arabia are cited as differences from the other three countries.

- A rating system have been introduced for hiring local workers.
- The minimum capital amount for incorporation in the country is high,
- There are few free zones where are the venues used to accommodate foreign investment and investor can enjoy preferential incentives.

Table 7-2: Challenges in Water Supply/Sewage Treatment, Agriculture and Water Quality Sectors, Technologies and Products of Japanese Firms, and Proposed Future Actions

Area	No.	Challenges	Recommended Technologies/ Products of Japanese firm	Proposed future actions
Water Supply	1	Leaks from service connection and ferrule saddle	Metallic saddle, Stainless corrugated pipe,	Trial test for adaptation by NW and others
	2	Detect leak point mainly from service connections	Leak detection survey by Helium Gas	Trial test for leak detection using Helium Gas by NWC and others
	3	Malfunction of valves in water network	Application of soft seal valves	Trial test for adaptation of soft seal by NWC and others
	4	Lack of larger-size flowmeters	Introduction of Electro magnetic/Ultrasonic flowmeter more than 50mm dia.	Market-in through the collaboration with Saudi partner
	5	Difficult to predict potential leakage point in advance	Introduction of AI software which can predict potential leak in the near future	Prediction of potential leak points and reflection of these information to renewal plan of water network by NWC and others
Agriculture	6	Needs for water-saving irrigation systems	Introduction of water retention materials	Trial test for water-saving irrigation by applying water retention materials
	7	Needs for hydroponic and vertical farming technologies	Introduction of Film farming technology, Large-scale plant factory	Joint research with Saudi Research Institutes and operation of these technologies with Saudi private firms

Area	No.	Challenges	Recommended Technologies/ Products of Japanese firm	Proposed future actions
Agriculture	8	Shortage of workforce and need for laborsaving and intensified Agriculture	Smart Agriculture Technologies (harvest robot, cooling systems at greenhouse)	Joint research with Saudi Research Institutes and operation of these technologies with Saudi private firms
	9	Needs for introduction of water-saving irrigation systems	Introduction of Bio-stimulant which can save amount of irrigation waters	Joint research with Saudi Research Institutes and operation of these technologies with Saudi private firms
	10	Lack of efficient drip irrigation technologies	Introduction of pressure-corrected drip tube	Joint research with Saudi Research Institutes and operation of these technologies with Saudi private firms
	11	Lack of smaller-size tractor	Introduction of Japanese smaller-size tractor	Market-in of the products through Saudi agent and establishing maintenance systems
	12	Difficult in measuring water volume at well/ transmission pipeline	Introduction of a smart meter made in Japan	Market-in of the products through Saudi agent and establishing maintenance systems
	13	Leakage at joints in irrigation pipes	Introduction of leak detection device and in-pipe investigation robots	Market-in of the products through Saudi agent and establishing maintenance systems
	14	Higher salinity content at the wells	Introduction of smaller-size desalination equipment made in Japan	Market-in of the products through Saudi agent and establishing maintenance systems

Area	No.	Challenges	Recommended Technologies/ Products of Japanese firm	Proposed future actions
Water Treatment	15	Reduction of TDS from Irrigation water	Introduction of membrane separation technologies (RO, NF, etc.)	Demonstration test using these technologies at SIO and others
	16	Environmental deterioration by concentrated discharge from desalination plant	Introduction of Zero Liquid Discharge technology by concentration, evaporation and crystallization methods	Demonstration test using these technologies at SWCC and others
	17	Damage and deterioration by corrosion at irrigation facility by chlorine disinfection	Introduction of disinfection technologies by Ultra violet rays, Ozone, etc.	Demonstration test using these technologies at SIO and others
	18	Pollution risks by pathogenic microorganisms on water source (well/surface water)	Introduction of disinfection technology by Alternative sand filtration (fiber filter) + disinfection(UV etc.)	Demonstration test using these technologies at SIO and others
	19	Needs for improvement of performance at activated sludge with tertiary treatment in sewage treatment	Introduction of nitrogen treatment technologies using aerobic/ anoxic zone in aeration tank	Demonstration test using these technologies at MEWA Buraydah & Unayzah Cities
	20	Needs for labor productivity and reduce electric power costs	Introduction of Auto screen for debris clearance, Sand removal equipment, Efficient sludge dehydrator	Demonstration test using these technologies at MEWA Buraydah & Unayzah Cities

Area	No.	Challenges	Recommended Technologies/ Products of Japanese firm	Proposed future actions
Water Treatment	21	Lack of Sludge Recycling technologies at Sewage Treatment Plant	Introduction of Compost, Digestion with the electric power generation using biogas, etc.	Demonstration test using these technologies at MEWA Buraydah & Unayzah CitiesL
	22	Environmental and water quality deterioration at where central sewage systems is not covered	Introduction of Johkasou technologies	Demonstration test of Johkasou by MEWA、 MODON and others
Water quality Analysis	23	Lack of water quality monitoring systems for groundwater, etc.	Introduction of water quality sensors for turbidity, COD, dissolved oxygen (DO), nitrate, etc. and data collection and transmission equipment	Demonstration test using these equipment by NCEC and others
	24	Lack of technologies for analyzing, observing and specifying pathogenic bacteria, microorganizims and heavy metals	Introduction of technologies for easily and accurately analyzing these pathogenic bacteria/ microorganizims by fluorescent X-ray and others	Demonstration test using these equipment by MEWA, SIO central water quality laboratory, etc.

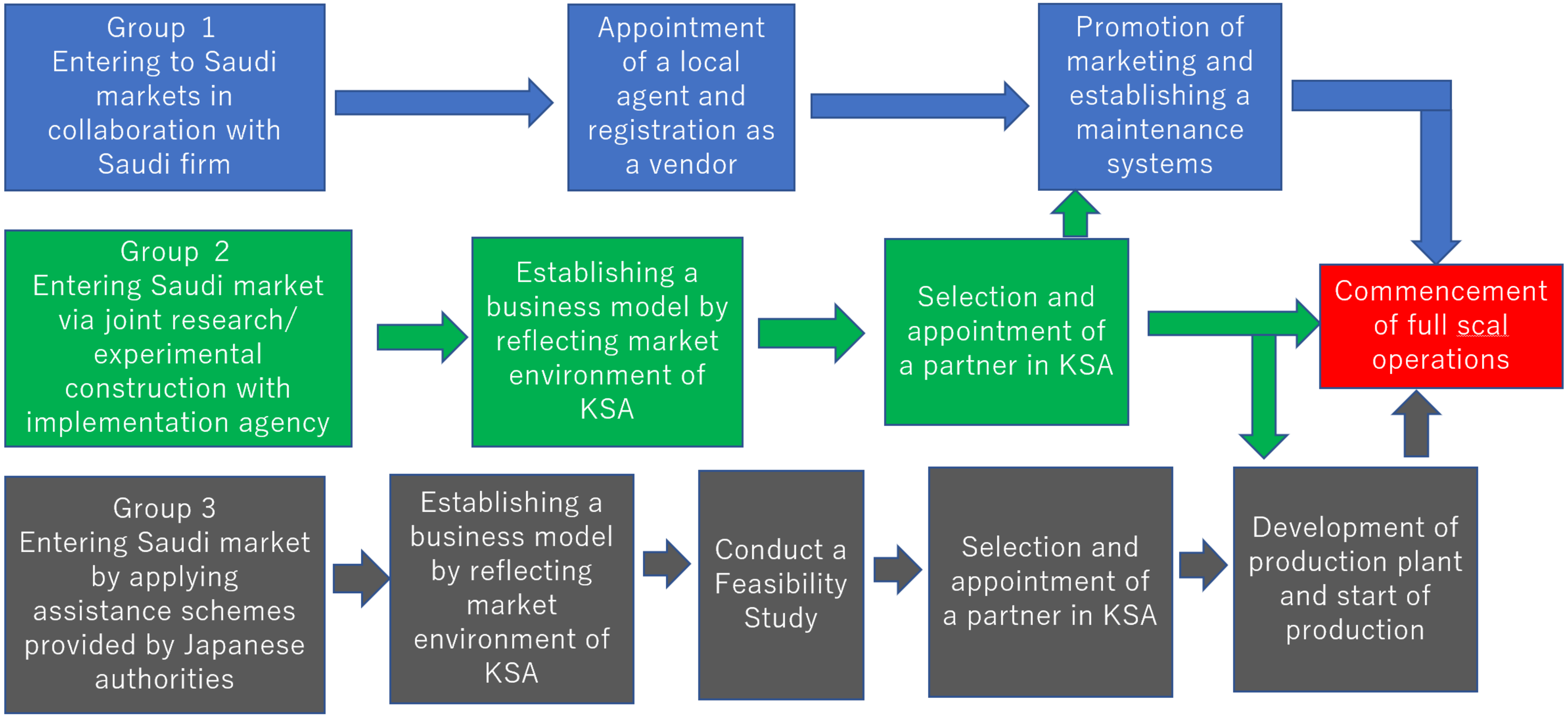


Figure 7-1: Anticipated flows by Japanese frims for future bushiness development

7.2 Recommendations

Based on the Conclusions of this survey, the following recommendations are proposed.

1) Supporting measures for introduction of Japanese technologies and products into the markets of Saudi Arabia

① **Enforcement of collaboration between Saudi Arabia organizations in the Water and Agriculture fields and Japanese organizations located in Saudi Arabia**

Saudi Arabia and Japan have agreed to cooperate each other towards the realization of the Saudi Vision 2030, and they have established their offices in each other country to perform cooperation program. As one of the cooperation programs of the two countries, it is recommended that the relevant organizations of Saudi Arabia in the water and agricultural fields (MEWA, NWC, SIO, NCEC, Estidamah, etc.) which have been contacted by this survey and Japanese Government agencies located in Saudi Arabia will hold a regular meeting to exchange opinions and confirm the progress of agreed cooperation program.

In addition, through strengthening public relation activities on JICA’s assistance schemes such as overseas expansion for SMEs and SDGs-related projects, and cost-share technology cooperation project towards various Saudi Arabia organizations who were merely know about these assistance schemes when JICA Survey Team had met with them, it is anticipated that such activities will generate a closer relationship between two countries.

② **Support for strengthening cooperation between the private firms of Saudi Arabia and Japanese private firms**

At the online seminars held along with this survey, many Japanese firms who participated to the online seminar deepened their awareness on future business plans and challenges faced by various Government organizations in Saudi Arabia, and were able to have initial contact with some of private firms in Saudi Arabia who have expressed their interest in the technologies and products of Japanese firms.

The Ministry of Investment, the Federation of Saudi Chambers of Commerce and Industry and the Riyadh Chamber of Commerce and Industry which had been visited during the first field survey were also very supportive to the survey and they have worked closely with JICA Survey Team for planning and implementing the online seminar. In addition, the Saudi Government SMEs Agency (Monsha'at) has also expressed their keen interest in promoting the cooperation between Japanese firms and SMEs in Saudi Arabia, and they have committed themselves to provide a database of registered firms, if the Japanese side wants it. Saudi Agriculture and Livestock Investment Company (SALIC), an investment wing of Saudi Arabia Government, has expressed their interest in partnering with Japanese firms who has advanced technologies in the agricultural sector for improving food security of Saudi Arabia.

Thus, it is recommendable to establish a mechanism for promoting such cooperative relationships further in the future. More specifically, a desk may be set up either at the premises of JICA Saudi Arabia Field Office or the Saudi Japan Vision Office in Riyadh City, in order to help support and follow up any inquiries from Japanese firms participated in the online seminar as well as from the private firms of Saudi Arabia, etc.

③ **Promotion of joint research works between the research institutes in Saudi Arabia and Japanese universities, research institutes, and private firms**

Estidamah, one of the research institutes in Saudi Arabia, desires to collaborate with universities, research institutes, and private firms in Japan who have advanced technologies in the field of agriculture. Specific research fields include Arid Agriculture, Vertical Farming, Smart Agricultural Technologies and other disciplines, and it may be possible to pursue the possibility of a partnership by defining particular research fields with prominent institutions of these areas in Japan.

2) Supporting measures to improve the business environment in Saudi Arabia

① **Establishment of a mechanism for improvement of the investment environment in Saudi Arabia**

Saudi Arabia has made significant improvement recently in the ranking of the Ease of Doing Business, which was initiated by World Bank Group, but there are still areas of the business environment that foreign firms feel difficult, according to the information gathered through this survey. Specifically, the introduction of the legal system without prior notice and the change of its system, etc. Furthermore, a lower evaluation was made to the point of business dispute resolution systems in the above referred ranking.

It is thus recommendable that the Japanese Association in Saudi Arabia will gather and summarize the opinions of Japanese firms that have already located in the Kingdom, and present these as proposal of Japanese firms on the business environment through the Embassy of Japan in Saudi Arabia and discuss with the Ministry of Investment of Saudi Arabia by setting up a place to exchange opinions regularly.

Annexes:

1. Presentation Materials for Mini-seminar with competent authorities of Saudi Arabia
2. Presentation Materials for the Report Meeting on the First Field Survey to Japanese Firms
3. List of the Supporting Schemes for Overseas Business Promotion by various Government Agencies of Japan
4. Report on the Business Environment at Saudi Arabia and its Neighboring Countries
5. List of Information and References gathered

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ANNEX:

1. Presentation Materials for Mini-seminar with competent authorities of Saudi Arabia

Data Collection Survey on Possibility of Private Sector Technical Utilization in Water Sector in Saudi Arabia

Issues on Water Sector in Saudi Arabia and the Countermeasures -Draft-

Tsuyoshi ONOZATO
Water Quality (Water Supply, Agricultural Water and Desalination)

JICA Study Team

1

Current situation of Water Sector in Saudi Arabia ※Based on National Water Strategy 2030

Water Balance in Saudi Arabia

Water Resources

Water Resources	M-m^3/day※1	%
Sea Desalination water	6.3	9.3
Non-renewable ground water	57.8	85.8
Renewable groundwater	7.7	11.4
Surface water (mostly from Dam)	4.4	6.5
Treated water	0.6	0.9
Total	67.4	

※1 In 2015

Water Use

Waster Use	M-m^3/day※1	%
Agriculture	55.6	82.5
Urban Sector	8.4	12.5
Industrial Sector	3.4	5.0
Total	67.4	

※1 In 2015

2

Current Situation of Water Sector in Saudi Arabia
※Based on National Water Strategy 2030

Issues on Water Sector in Saudi Arabia

Drinking Water

- Water losses in network is 25% or more.
- Approx. 60% of the total water supply in the urban sector depends on sea-water desalination, which is high production cost.
- The energy for seawater desalination depends on fuel and the consumption is equivalent to approx. 2.5% of the national fuel production which leaves high greenhouse gas emissions.
- In addition, in case the desalination water is transported from the coast to inside, it costs a lot.

Sewerage and re-use of treated sewage

- Coverage of sewerage is still relativity low, approx. 60%.
- Existing sewage treatment plants operates in an extremely high rate, resulting in reduced quality of treated water.
- Poor management of urban and industrial wastewater leads chemical contamination (toxic substances) to the river and the public water body .
- The amount of re-use of treated sewage is only 17% against the amount of the capacity of sewage treatment plant.

(Approx. 70% of re-used of treated sewage is used for agricultural sector.)

Agricultural Water

- Approx. 90% of water use in the agricultural sector depends on non-renewal resources
- Due to the intake of a lot of groundwater which exceeds the re-charge by natural rain precipitation, the water quality is deteriorating.

Current situation of Water Sector in Saudi Arabia
※Based on National Water Strategy 2030

Vision and objectives (Countermeasures against water issues on Saudi Arabia)

The vision :

a sustainable water sector that develops and maintains water resources, protects the environment, provides safe supply, high quality services and efficiency that contribute to economic and social development.

The strategic objectives:

1. **Ensuring** the continuous access to adequate quantities of safe water in normal and emergency situations.
2. **Improving** Water Demand Management (WDM) in all uses.
3. **Providing** high quality and cost-effective water and sanitation services to ensure acceptable prices.
4. **Maintaining** and improving water resources, while preserving the local environment for the benefit of the Saudi society now and in the future.
5. **Ensuring** the competitiveness of the water sector and its positive contribution to the national economy by promoting effective governance, private sector participation, capacity-building and innovation.

Current situation of Water Sector in Saudi Arabia
※Based on National Water Strategy 2030

Strategic Program and Initiatives (Countermeasures against water issues on Saudi Arabia)

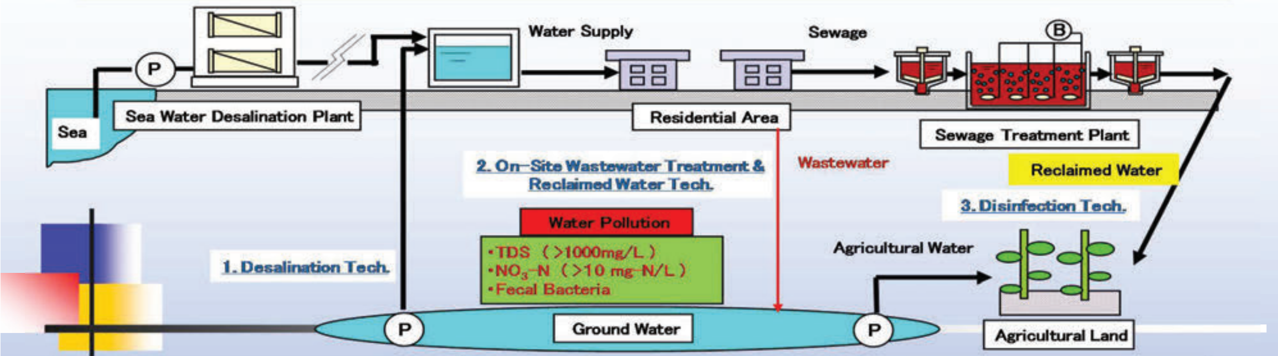
Program 2 Water Resources Management

1. Restructuring and developing the integrated water resources management capabilities.
2. Managing Information and digital systems contributing in the activation of the decision.
3. Developing and implementing the water rights system, establish water resource records and monitoring and control mechanisms.
4. Integrated water planning.
5. Reducing feed production and improving crop productivity through comparative advantage.
6. Water efficiency in buildings and household appliances.
7. Implementing awareness and education campaigns and changing the incorrect behavior and practices.
8. Developing the renewable groundwater resources and surface water.
9. Rehabilitating and developing the sewage treatment plants, and promoting the reuse of treated water.
10. Developing the sustainable desalination capacities.
11. Developing the non-renewable groundwater resources.
12. Expanding the production capacity to meet the demand of pilgrims (guests of Al Rahman).
13. Bedouin irrigation (soqya al badia) and social security.
14. Strengthening the contribution of the third sector in the water sector.
15. Compliance with the environmental regulations and requirements.

Applicable Water Treatment, Analysis and Monitoring Technology in Japan for Drinking Water and Reclaimed Water
-Draft-

Contents：

A. Applicable Water Treatment Technology in Japan for Drinking Water and Reclaimed Water (Draft)



1. Desalination Tech.
1) Membrane (RO, MF, UF, NF) for seawater and blackish water desalination
[redacted]
Source: [redacted]

2. Tertially Treatment Tech.
High speed finber filter for SS removal
[redacted]
Source: [redacted]

4. Disinfection Tech.
1) UV & related Tech.
[redacted]
Source: [redacted]

1. Desalination Tech.
2) Thermal evaporation (MED, MSF) for seawater desalination
[redacted]
Source: [redacted]

3. On-site Treatment for Domestic Wastewater
Johkasou with membrane
[redacted]
Source: [redacted]

4. Disinfection Tech.
2) Ozone & related Tech.
[redacted]
Source: [redacted]

7

B. Applicable Water Analysis and Monitoring Technology in Japan

Main Spectroscopic Analysis Devices for Water Quality Analysis

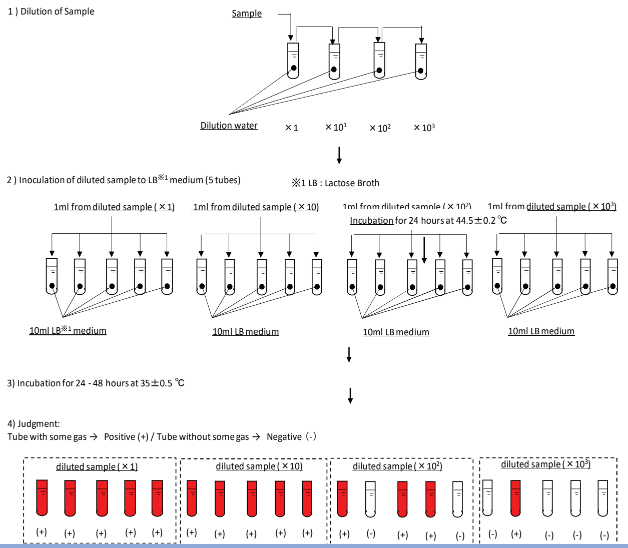
No.	Equipment	Measurable Parameters	Measurement Principal	Photo	Number of Patent ※1
1	UV-Vis Absorption Spectrophotometry (AS)	For wastewater analysis; Nitrogen and phosphate	This is the analysis equipment to measure the concentration of target substance in the water sample on the principal that the absorbance of UV or visible light has a certain relationship with the concentration of target substance in the water sample when UV or visible light is irradiated to the water sample including the target substance.	[redacted] Source: [redacted]	81
2	Atomic Absorption Spectrophotometer (AAS)	For drinking water and wastewater analysis; Metals (Cadmium, Chromium, Lead, Zinc, Aluminum, Calcium, Magnesium, Iron, Cupper, Sodium, Manganese) ※"Selenium and Arsenic" can be analyzed with hydrogenation ※"Mercury" can be analyzed with reduced evaporated	This is the analysis equipment to measure the concentration of target substance in the water sample on the principal that the absorbance of ionized target substance generated by heating the sample water against the light irradiated from the lamp made of the same substance as the target substance has a certain relationship with the concentration of target substance. This analysis equipment can measure the target substance of very low concentration below μg/L.	[redacted] Source: [redacted]	41
3	Inductively Coupled Plasma Emission Spectroscopic Analyzer (ICP)	For drinking water and wastewater analysis; Metals (Cadmium, Chromium, Lead, Boron, Zinc, Aluminum, Calcium, Magnesium, Iron, Cupper, Sodium, Manganese) ※"Selenium and Arsenic" can be analyzed with Hydrogenation)	This is the analysis equipment to measure the concentration of target substance in the water sample on the principal that the light intensity emitted from the target substance in the water sample, when the target substance is ionized by argon plasma formed in the high frequency induction heating coil, has a certain relationship with the concentration of target substance. This analysis equipment can measure the target substance of very low concentration below μg/L.	[redacted] Source: [redacted]	13
5	Ion Chromatography Device (IC)	For drinking water and wastewater analysis; Fluorine, Chloride, Calcium, Magnesium, sodium, ammonia, nitrate, nitrite and phosphate ※"Cyanide and Bromate" can be analyzed by adding post-Colum Absorption Spectrophotometry	This is the analysis equipment to measure the target ionized substance by passing the water sample into the column packed with absorbent and separating the target ionized substance depending on the differences of the affinity between target ionized substance and absorbent in the column.	[redacted] Source: [redacted]	16
6	X-ray fluorescence analysis(XRF)	For pre-analysis to measure the approximate concentration of each heavy metal such as Cd, Cr, Pb, As, etc. in the soil or solid waste before the quantitative analysis	This is the analysis equipment to measure the target substance in the solid sample on the principal that the intense of X-ray with specific wave length emitted from the target substance, when X-ray is irradiated to the solid sample, has a relationship with the concentration of target substance. This analysis equipment is mainly used for the screening analysis before the quantitative analysis of the target substance.	[redacted] Source: [redacted]	236

※1 This number means the number of the patent regarding main equipment and the peripheral equipment including pre-treatment device which was applied after 2000 and registered

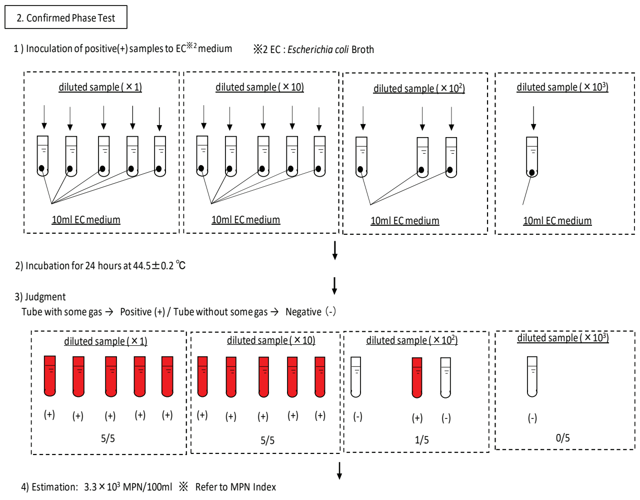
B. Applicable Water Analysis and Monitoring Technology in Japan

Microbiological Analysis in accordance with Standard Methods（Exp.：Fecal Coliform ）

Presumptive Phase Test



Confirmed Phase Test



Microbiological analysis with Standard Method consists of “Presumptive Phase Test”, “Confirmed Phase Test” and “Completion Phase Test” and takes 2 or 3 days. Besides, it needs a lot of works for the preparation of medium and glassware, the dilution of the sample and the inoculation/culture under a sterile environment, etc.

B. Applicable Water Analysis and Monitoring Technology in Japan

Rapid Microbiological Analysis Technique / Simple Microbial Test Kit

※1 Examples of the products with unique technology which the patents are registered after 2000 and registered them

Principal of Measurement	Advantages	Photo
Total Coliform and E.Coli in water sample are detected by incubating on the special medium which generates the colors once it contacts with the specific enzyme contained in Total Coliform, lactose dehydrogenase(β –galactosidase), and the specific enzyme contained in E.Coli, β – glucuronidase.	･This method can detect Total Coliform and *E.Coli.* only by putting the water sample in the special medium or soaking the test paper containing the special medium in the water sample. ･Total incubation time is approximately 24 hours.	[redacted] Source: [redacted]
This is a simple analysis kit in accordance with the standard method for the analysis of *E.Coli.* Water sample is put in the vessel and incubated on EC medium. Then, the density of Total Coliform/E.Coli. can be estimated by Most Probable Number (MPN) method.	･This method does not need the preparation of glasswares which are needed in standard method. ･Total incubation time is approximately 24 hours.	[redacted] Source: [redacted]
The sample including the bacteria detected as Total Coliform is incubated on selective medium especially which can make only the bacteria detected as Total Coliform grown for approximately 6 hours and them total coliform can be detected quantitatively using the special apparatus and the special reagent, luciferingaractoside + luciferine, which generates a fluorescence once it reacted with adenosine triphosphate (ATP) contained in the bacteria detected as Total Coliform	･This method can analyze Total Coliform using the light apparatus, less than 1 kg ･Total incubation time is approximately 6 hours.	[redacted] Source: [redacted]

B. Applicable Water Analysis and Monitoring Technology in Japan

Microorganism Observation Technology (Microscope)

	Type	Outline of Technique	Application	Photo	Number of Patent※1
1	Light Microscope	A light microscope is the device for projecting the small objects by enlarging them using lens and visible light. A light microscope is generally called "Microscpe". Most of microorganismes in water environment can be observed using light microscpe because it can observe even a virus in theory, which the diameter is approxymately 0.1 μ m. Recently the development of the surrounding parts such as a projector and the control devise in addition to the main parts of a microscope are advancing.	- Observe microorganisms in water environment - Observe microorganism in aeration tank at wastewater treatment		101
2	Phase-contrast Microscope/ Differential Interference Microscope	A phase contrast microscope is one of light microscope and it has the function changing the slope of the object into the contrast of lightness and darkness using phase plate installed in the microscope. A differential interference microscope is also one of light microscope and it has the function changing the thickness of the object into the contrast of lightness and darkness using polarizing plate installed in the microscope. Both microscopes can observe a colorless and transparent microorganism more clearly and three-dimensionally.	- Observe microorganisms in water environment - Observe microorganism in aeration tank at wastewater treatment		21
3	Fluorescence Microscope	Fluorescence microscope is the microscope having the function irradiating the light with a specific wavelength which make the fluorescent substance emit a specific light. It can observe the target microorganism clearly by making the cell membrane or the internal structure dyed with fluorescent substance	- Observe and detect pathogenic microorganism	[redacted] Source:[redacted]	62

※1 This number means the number of the patent regarding main equipment and the peripheral equipment which was applied after 2000 and registered

B. Applicable Water Analysis and Monitoring Technology in Japan

Sensors for Water Quality Monitoring (1/2)

※1 Examples of the products with unique technology which applied the patents after 2000 and registered them

Sensor	Measurable Parameter	Outline of Technique/ Measurement Principal	Installation Place	Photo
Turbidity / Color meter	Turbidity (Resolution: Less than 0.01NTU)	Turbidity meter is the instrument to measure the turbidity in the water sample using the relationship between the light intense of scatted or transmitted light and the turbidity in the water sample. Color meter is the instrument to measure the intense of color in the water sample using the relationship between the absorbance of the light with wavelength 390 nm and the intense of color in the water sample. Each product has the original function for preventing foulings on flow line (cell) or for removing the bubbles which cause the errors.	- Intake point at drinking water treatment plant - Treated water basin after sand filtration at drinking water treatment plant	[redacted] Source:[redacted]
Highly sensitive turbidity meter	Turbidity (Resolution 0.001NTU or less)	High sensitive turbidity meter is the turbidity meter which the resolution is enhanced and it can detect the number of particles in the turbidity. There are some types of high sensitive turbidity meter such as the one that a particle in the turbidity can be detected with scatted or transmitted light by using laser as light source or the one that a particle in the turbidity can be detected with the electric pulse caused by the shadow in the scatted or transmitted light emerged when the turbidity (a particle) passes through flow line (cell) irradiated by light.	-Treated water basin after sand filtration and/or membrane at drinking water treatment plant	[redacted] Source:[redacted]
Residual chlorine meter	Residual chlorine (free chlorine and combined chlorine)	This is the instrument to measure residual chlorine using the relationship between the electric current generated following the reduction of residual chlorine under electric field and the concentration of residual choline in water sample. There are mainly two types for residual chlorine meter, the one is for only measuring free-residual chlorine, which does not need to add chemicals, and the other one is for measuring both free-residual chlorine and combined residual chlorine, which need to add chemicals. Recently the residual chlorine meter which can detect both free-chlorine and combined chlorine by using the deference of oxidation-reduction potential between free-residual chlorine and combined residual chlorine and does not need to add chemicals was developed and it is currently being sold.	- Treated water basin and/or reservoir at drinking water facility	[redacted] Source:[redacted]
Organic matters sensor (UV meter)	COD	This is the instrument to measure chemical oxygen demand (COD) in the water sample using the relationship between the absorbance of UV light with wave length 254nm and COD consisting of the organic matters. COD meter with UV light is widely installed in the wastewater treatment plants located at Tokyo bay area and Osaka bay area , etc. in Japan, which are strictly regulated to discharge the pollutants into, because the principal of UV meter is very simple and it can monitor COD continuously. Each product has the original function to prevent the foulings on flow line (cell) which causes the error.	- Discharging point at sewage treatment plant and wastewater treatment	[redacted] Source:[redacted]

B. Applicable Water Analysis and Monitoring Technology in Japan

Sensors for Water Quality Monitoring (2/2)

※1 Examples of the products with unique technology which applied the patents after 2000 and registered them

Sensor	Measurable Parameter	Outline of Technique/ Measurement Principal	Installation Place	Photo
Oil sensor	Oil film	There are two types for oil sensor. One is contact type, which detects oil film by using the change of electrostatic capacity arisen when sensor is attached to oil film. The other is non contact type, which detects oil film by using the the change of reflection or detecting the fluorescence generated when light is irradiated to the water surface.	- Intake point at drinking water plant - Discharging point at wastewater treatment plant	[redacted]
Ion sensor	F^-(0.02mg/L~), Na^+(3mg/L~), K^+(0.4mg/L~), Cl^-(1mg/L~), Ca^{2+}(0.4mg/L~), Br^-(0.8mg/L~), Cu^{2+}(0.06mg/L~), Ag^{2+}(0.1mg/L~), Cd^{2+}(0.1mg/L~), I^-(0.01mg/L~), NH_4^+(0.1mg-N/L~) NO_3^-(0.2mg-	This is the instrument to measure the concentration of target ion using the membrane potential arisen between the selective thin membrane which can pass only target ion through.	- Treated water basin at wastewater treatment plant - Potable typed water meter for on-site water analysis - Desk installation typed water meter at water laboratory	[redacted] Source: [redacted]
(Fluorescence typed) Dissolved oxygen sensor	Dissolved Oxygen(DO)	Fluorescence typed dissolved oxygen sensor is the instrument to measure dissolved oxygen in the water sample at the principal that dissolved oxygen in the water absorbs the fluorescence light emitted when blue-LED※1 is irradiated to the membrane. Although dissolved oxygen sensor was commonly used the type with diaphragm until a few years ago, fluorescence typed sensor is currently being introduced instead of the type with diaphragm because it can reduce the maintenance work for replacing the diaphragm work.	- Aeration tank at wastewater treatment - Potable typed water sensor for on-site water analysis	[redacted] Source: [redacted]

※1 Blue-LED is the technology developed in Japan and it is received the Nobel Prize in Physics in 2014.

Data Collection Survey on Possibility of Private Sector Technical Utilization in Water Sector in Saudi Arabia

Issues on Water Quality for Irrigation Water and the Water Treatment Technology -Draft-

Tsuyoshi ONOZATO
Water Quality (Water Supply, Agricultural Water and Desalination)

JICA Study Team

1

Main Parameters Having Effect on Glowing Plants, Human health and Irrigation Facility

Parameters	Negative Impacts by the Parameter	Source of substance	Upper Limit Value	Water Treatment Method	Source
1.Parametes having effect on growing plants					
Salinity (or Total dissolved solids)	Crop growth, physical condition of soil	Naturally-occurred, domestic wastewater etc.	Approx. 450-2,000mg/L	Desalination (RO methods etc.)	FAO irrigation Water Quality Guideline, 2006
Nitrogen (or Nitrate)	Crop growth	Domestic wastewater etc.	Approx. 5-30mg-N /L	Desalination (RO methods etc.)	FAO irrigation Water Quality Guideline, 2006
2. Parameters having effect on human health					
E.Coli.	Human health, (plant disease)	Domestic wastewater etc.	For eating raw : 10^3 number/100ml Except for eating raw: 10^5 number/100ml	Disinfection	WHO guidelines for the safe use of wastewater, excreta and graywater,2006
Eggs of helminth※1	Human health	Domestic wastewater etc.	Not detected	Disinfection	WHO guidelines for the safe use of wastewater, excreta and graywater,2006
3.Parameters having effect on irrigation facility					
Suspended solids	Clogging of pipe or nozzle	Naturally-occurred, domestic wastewater etc.	Approx. 5-10mg/L	Filtration (Sand filtration etc.)	(Tertiary treatment)

※1 Helminthes means the general term for earthworm-like protozoa which moves with peristaltic move. Ascaris and Schistosoma, which cause serious disease, are typical examples of helminthes. Especially, eggs of helminthes have the resistance against disinfection with chlorine, UV and ozone and cannot be killed and/or inactivated easily using them.

2

Typical Desalination Process from Blackish Water (TDS: Approx. 1,000～10,000mg/L)

Typical Desalination Process from Blackish Water (TDS: Approx. 1,000～10,000mg/L)

Operation cost: Approx. US$1 per m^3-treated water※1

Raw water	After MF/UF membrane	Treated water
TDS:1,000～10,000mg/L	TDS:1,000～10,000mg/L	TDS:300 mg/L
NO3-N: 50mg/L	NO3-N: 50mg/L	NO3-N: 5mg/L or less
SS: 10～30 mg/L	SS: None	SS: None
E.Coli. : Many	*E.Coli.* : None	*E.Coli.* : None

Raw water (Groundwat, River water) → Screen → (Coagulant) → MF/UF membrane → (Antiscalant) → RO membrane → Treated water

MF/UF membrane → Wastewater

RO membrane → Concentrate

Note:

※1 Operating cost is including the cost for electric power estimated as US$ 0.07 /kwh and chemicals, not including the depreciation cost of the facility.

Abbreviation:

TDS: Total dissolved solids, SS: Suspended Solids, MF: Microfiltration, UF: Ultrafiltration, RO: Reverse osmosis

Desalination Tech with RO

[redacted]

Source: [redacted]

[redacted] Spriral wound type ([redacted])

[redacted] Hollow fiber type ([redacted])

3

Typical SS Removal Process from Surface Water (SS: Approx. 10～30mg/L)

Typical SS Removal Process from Surface Water (SS: Approx. 10～30mg/L)

Operation cost: Approx. US$0.1/m3-treated water※1

Raw water	After sand filter	Treated water
TDS:1,000～10,000mg/L	TDS:1,000～10,000mg/L	TDS:1,000～10,000mg/L
NO3-N: 50mg/L	NO3-N: 50mg/L	NO3-N:50mg/L
SS: 10～30 mg/L	SS: 5 mg/L or less	SS: 5 mg/L or less
E.Coli. : Many	*E.Coli.* : Many	*E.Coli.* : 1000 number /100ml or less

Raw water (Groundwat, River water) → Screen → (Coagulant) → Sand filter → (Sodium hypochlorite) → Disinfection basin → Treated water

Sand filter → Wastewater

Note:

※1 Operating cost is including the cost for electric power estimated as US$ 0.07 /kwh and chemicals, not including the depreciation cost of the facility.

Abbreviation:

TDS: Total dissolved solids, SS: Suspended Solids

SS Removal Technology for Reclaimed Water

High speed fiber filter for SS removal

[redacted]

Source: [redacted]

High speed fiber filter is an alternative technoloty for sand filter. The line velocity (LV) is approx. 500 m/day or more, which is equivalent to 2～3 times compared with conventional dual sand filter consisting of anthracite and silica sand. So the installation area can be reduced by 1/2～1/3 compared with that of conventional dual sand filter.

Study for the Ratio of Water Cost against Sales of Tomato and Carrot

1. Pre-condition
1) Water usage amount : $100m^3$/ha・day
2) Unit price and water cost of water
   - Desalination water : US$1 /$m^3$ = US$100 / ha・day
   - SS removed water : US$0.1/$m^3$ = US$10 / ha・day
3) Selling Price ※ Based on the statistics data of agricultural crops in Japan
   - Tomato : ¥342/kg=US$3.11/kg
   - Carrot : ¥146/kg=US$1.33/kg

3) Productivity ※ Based on the statistics data of agricultural crops in Japan
   - Tomato : 479kg/ha・day = US$1,489 /ha・day
   - Carrot : 304kg/ha・day = US$403/ha・day

2. Estimation of the ration of water cost against sales of tomato and carrot
1) In case of desalination water
   - ① Tomato US$100 / ha・day ÷ US$1,489 /ha・day ×100 = 6.7%
   - ② Carrot US$100 / ha・day ÷ US$404 /ha・day ×100 = 24.8%
2) In case of SS removed water
   - ① Tomato US$10/ ha・day ÷ US$1,489 /ha・day ×100 = 0.7%
   - ② Carrot US$10 / ha・day ÷ US$404 /ha・day ×100 = 2.5%

Measures for Reducing Water Cost against Production Cost

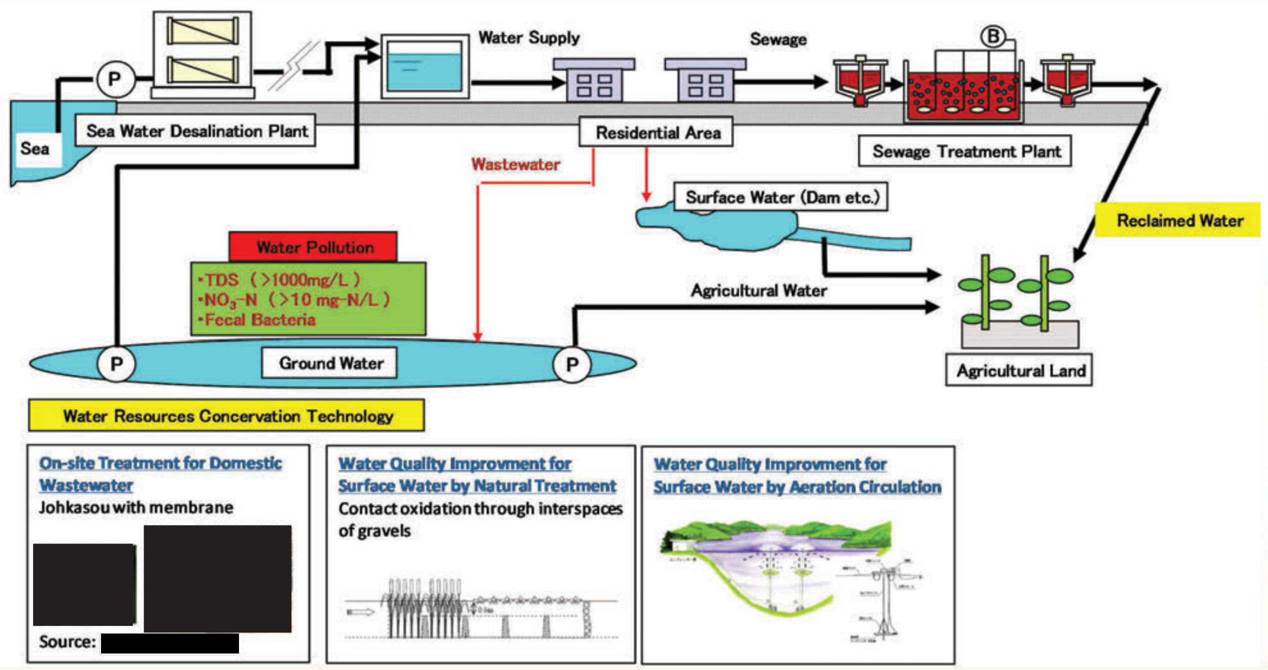
a. To reduce the water treatment cost for irrigation water

→ But the water treatment cost is principally depending on the water quality of raw water.

b. To take the other actions

To save water, To grow the crop with high selling price, To increase the productivity of crop

Reference: Importance of Water Resources Conservation
(※ Indirect Method of Water Treatment Technology for Irrigation Water)



Confidential

YACHIYO Engineering

Japan International Cooperation Agency (JICA)

Survey for promoting Saudi-Japan Cooperation
in Water Sector

Introduction of Japanese Technology for Water Saving and Leak Reduction in Saudi Arabia

September 9, 2021

Joint venture for the Project
World Business Associates Co., Ltd. (WBA)
Yachiyo Engineering Co., Ltd. (YEC)
Sanyu Consultants Inc. (SCI)
Yokohama Water Co., Ltd (YWC)

yec 八千代エンジニヤリング株式会社

Content

1. Water Saving/Leak Detection Equipment
   - [redacted]
   - [redacted]
   - [redacted]
2. Review of pipe connection/repair method
   - [redacted]
   - [redacted]
   - [redacted]
   - [redacted]
3. Metering
   - [redacted]
   - [redacted]
   - [redacted]
4. Ai analysis of Likelihood of Failure (LOF)
   - [redacted]
5. Submersible pumps
   - [redacted]

1. Water Saving/ Leak Detection Equipment

- [redacted]
- [redacted]
- [redacted]

New environment type water saving apparatus

A certain water saving control is achieved.

From individual water saving to the water saving of the entire facilities

The Eco Valve water saving system is a total system that improves the waste constitution of facilities.

Useless water is cut.

It is necessary to control each faucet to differ according to the place and to adjust the quantity consumed of water to a proper volume of water. The amount of the stream of water is made proper by improving hydraulic pressure by "Principle of the Orifice"(*1) and decreasing the volume of water, feeling is not changed, and Eco Valve is saved.

《*1. Principle of Orifice》

When water flows from a large pipe to a small pipe, hydraulic pressure rises and the amount decreases absolutely ..that...

This is "Principle of the Orifice."

The place is not chosen and water is saved also in a big building and the personal residence.

The lineup is abundant.

For instance, it is arranged it according to the shower kitchen rest room and all the usages. It is a system that can correspond to water saving according to the type of business business conditions usage also in a big building and the personal residence. Moreover, because the main cock need not be stopped while working, it is possible to construct in a usual state of the business.

The introduction expenditure will be collected in a short term.

The running cost is not necessary because there are neither damage nor changing in quality either. Wear-out and the damage of the apparatus such as the boilers are reducsd by using the valve by opening completely. The consumption of a warm hot water decreases, too and the boiler fuel can be saved. The bringing redemption period is a short term on many ..great water saving.. Sides as for the effect of the expenditure reduction.

Eco Valve installation part

Shower kitchen rest room etc.

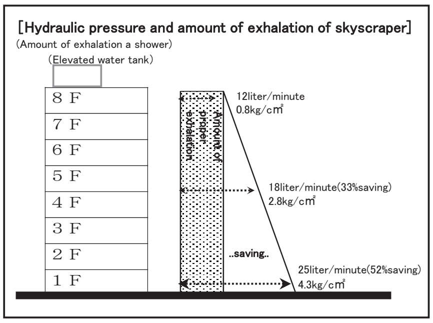
It is possible to install it in all the water taps.

Content of water saving

Useless various volume of waters flow out to the water service that we are usually using by the situation and the usage.

The Eco Valve water saving system controls this uselessness to the omission proper quantity.

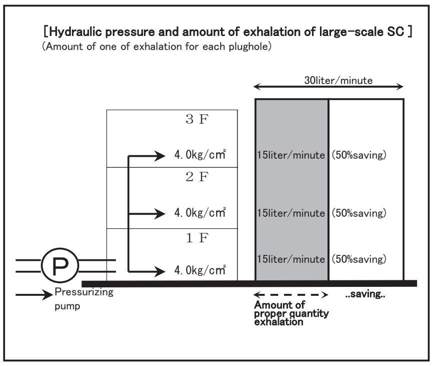
The one Basic ethics of Eco Valve water saving system



[For the skyscraper]

As for the skyscraper, hydraulic pressure and the amount of the exhalation are different by a constructional multistory floor and the low layer floor.

A left chart is showing of the amount of the exhalation in the shower in the skyscraper. Because the amount of the exhalation of the eighth floor is a reasonable amount 12 liters/a minute, this amount of the exhalation is assumed to be a proper quantity. All floor are matched and constructed to this proper quantity. It constructs it to the entire usual plughole apparatus by a similar idea.



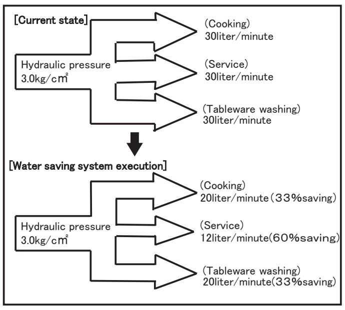
[For large-scale SC]

Water is usually supplied with the pressurizing pump for large-scale SC by each floor fixed pressure.

A left chart is showing of the amount of the exhalation of water free stopping of large-scale SC. The amount of the exhalation is set according to the usage of each faucet in each floor.

The two Content of water saving of Eco Valve water saving system

[For the kitchen]

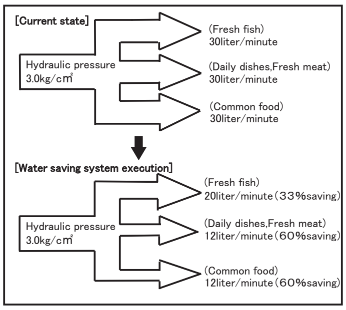


The usage is unrelated if plumbing and the plughole apparatus are the same for usual facilities and the amount of exhalation becomes the same.

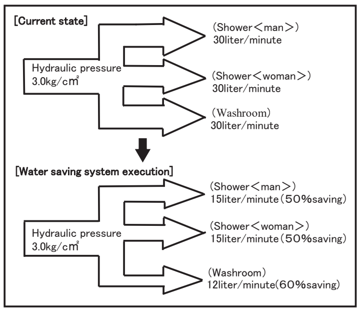
When the Eco Valve water saving system is set up, the stream doesn't change feeling and be set in the proper quantity. Uselessness is lost and it is maintained to a reasonable amount of the exhalation. The part of uselessness is saved and it accumulates as an effect of water saving. This becomes an amount of money of water saving.

The water system has the function to cancel flowing quantity shortage because of the use of the plughole simultaneously at the same time as using economy recently. It is a system of it is like killing two birds with one stone.

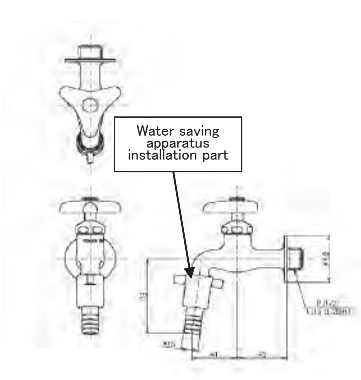
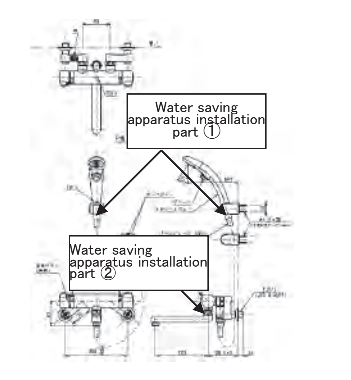
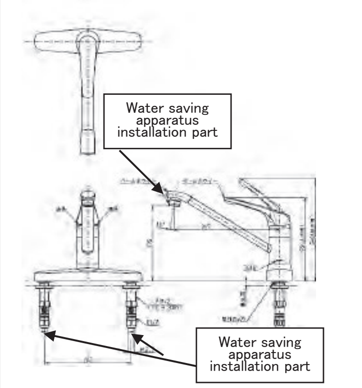
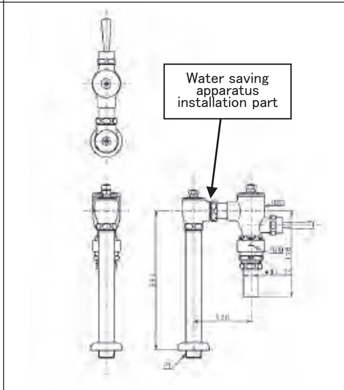
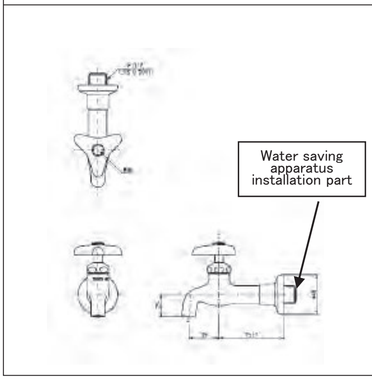
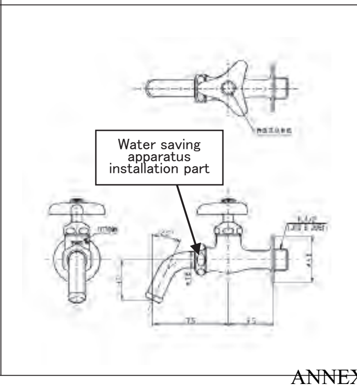
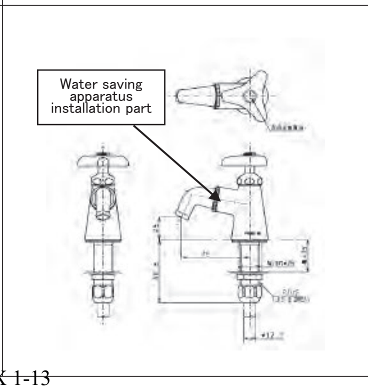
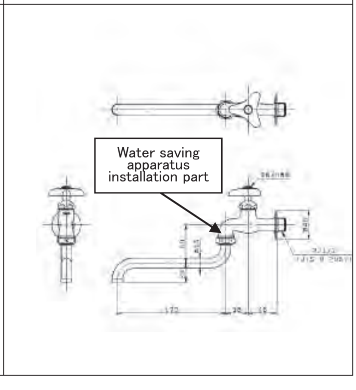
[For the supermarket]



[For sports facilities]

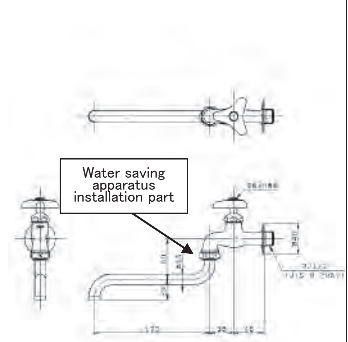


＜Eco Valve installation construction chart＞

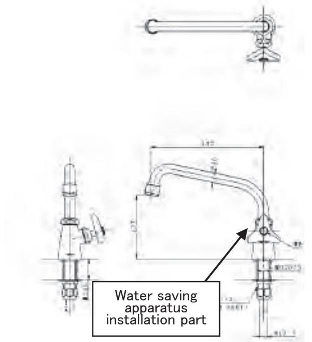
Water saving apparatus installation part of horizontal plughole with coupling	Water saving apparatus installation part in shower	Water saving apparatus installation part of single lever	Water saving apparatus installation part of flashbulb
			
Water saving apparatus installation part of horizontal plughole	Water saving apparatus installation part of swing faucet	Water saving apparatus installation part in washroom	Water saving apparatus installation part of water free stopping
			

＜Eco Valve installation construction chart＞

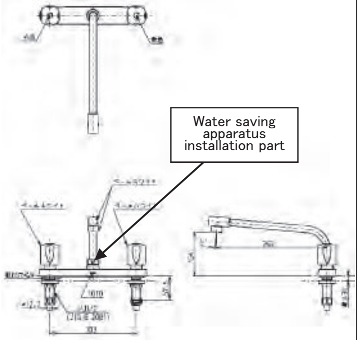
Water saving apparatus installation part of water (hot water) free stopping



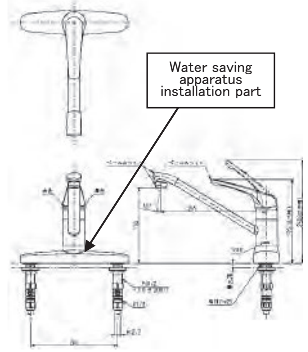
Water saving apparatus installation part of water (hot water) free stopping (downward)



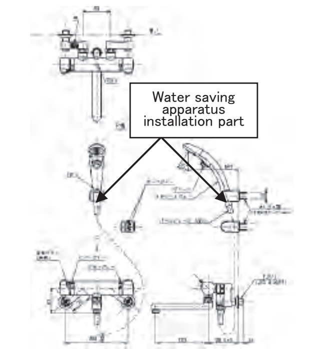
Water saving apparatus installation part of two valve mixture stopping



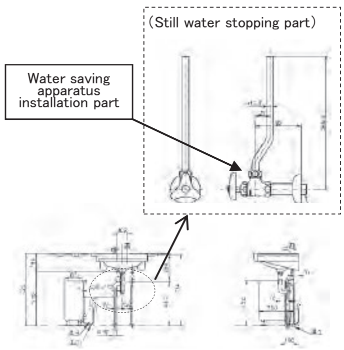
Water saving apparatus installation part of single lever



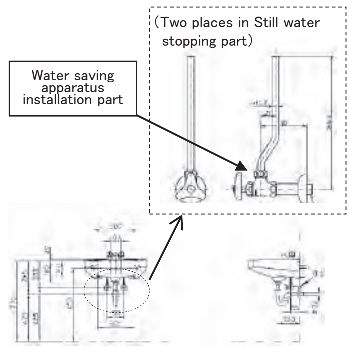
Water saving apparatus installation part in shower



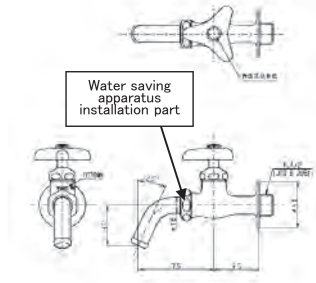
Water saving apparatus installation part in single water washroom



Water saving apparatus installation part in mixture washroom

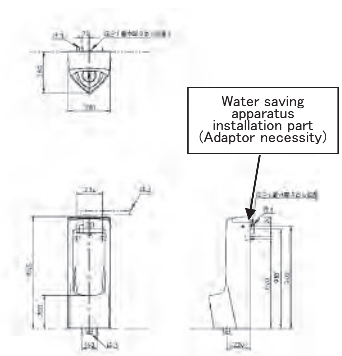


Water saving apparatus installation part of SK stopping

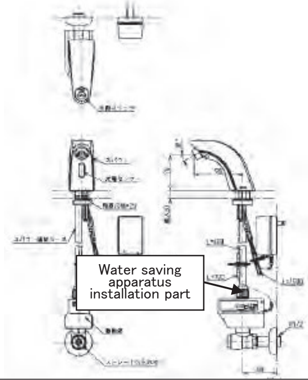


＜Eco Valve installation construction chart＞

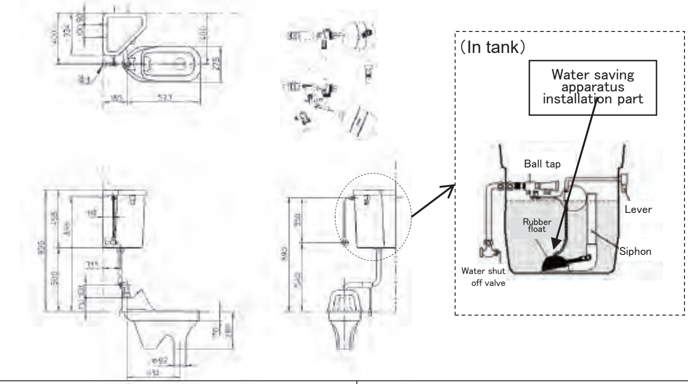
Water saving apparatus installation part of urinal



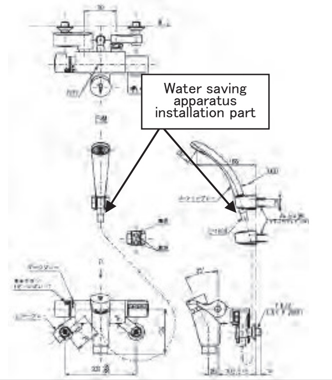
Water saving apparatus installation part of automatic plughole



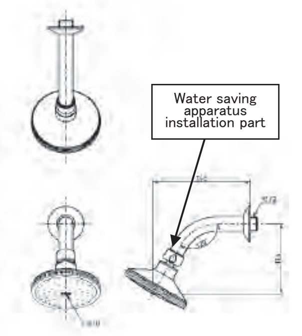
Water saving apparatus installation part of [Toilet tank]



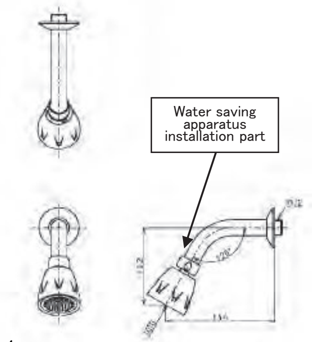
Water saving apparatus installation part in auto stop shower



Water saving apparatus installation part in fixed shower



Water saving apparatus installation part in fixed shower



~Contribution to reduction in NRW~

[redacted]s specialized in water leak detection and related services.
We provide total solutions to reduce your NRW.

[redacted]

[redacted]

Technical Training

We provide human resources development training in water leak detection and NRW measures abroad. We have conducted the training in Indian and Vietnamese water utilities, and transferred Japanese methodologies and our technologies to them.

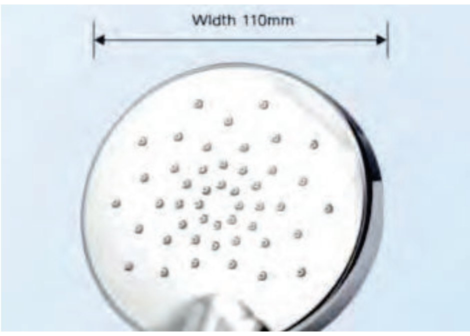
Water Leak Investigation

Our professional skilled team has more than 20 years experience n survey. We have been entrusted with water leak investigation from Japanese water utilities, facilities and factories for a long time, and detected a lot of underground, invisible and any other leakage.

Leak Monitoring Devices

Leak monitoring devices developed by us, are easy to install and enable anybody to identify whether leakage is around or not. We have conducted a demonstration in India and proved the effectiveness. These are reasonable and can be installed in large.

Water-saving shower head '[redacted]'



- Comfortable showering with the microbubble
- 0.035mm size bubble maximizing its detergency
- Stable producing a lot of bubbles
- Bubbles like showering a champagne
- Saving water and CO_2
  (50% reduction compared to conventional products)

Easy water saving to attach to tap

[redacted] (Patent Pending)

"Awa" means bubble in Japanese

Easy attachment and remarkable reduction to water charge

Prooduct

Adaptor

Body

Comparison of water volume at the same pressure

・50% air mixing enables <u>50% reduction to water usage</u>

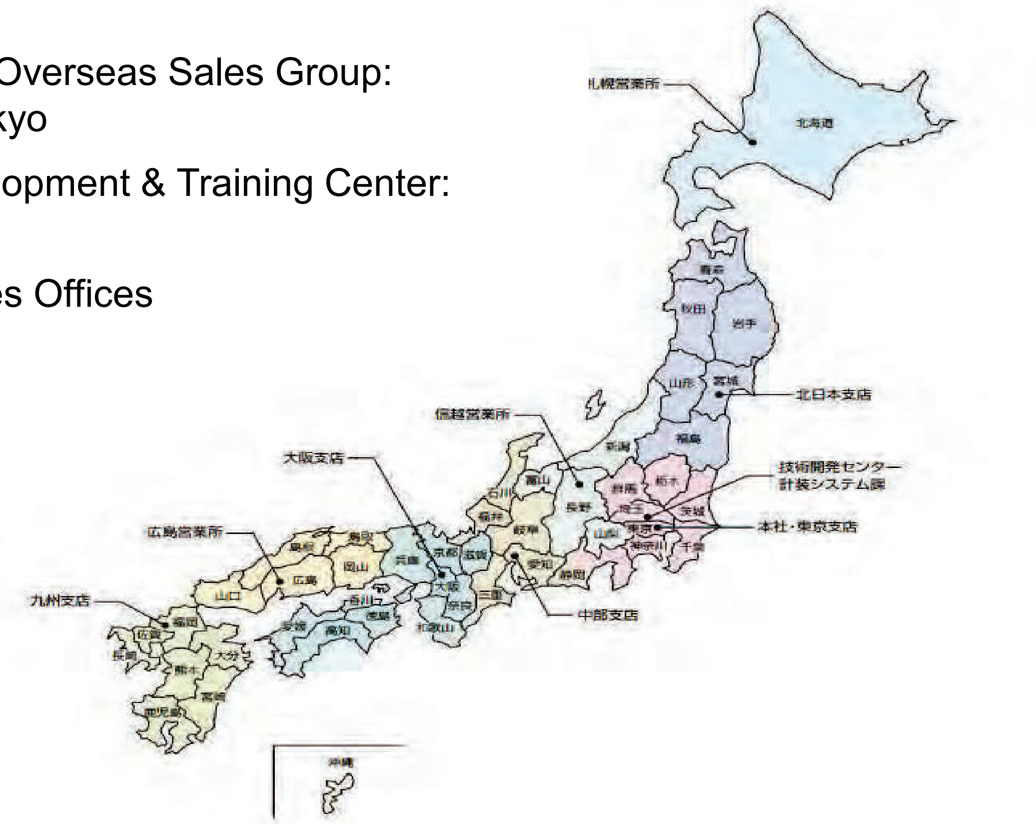
・<u>Vigorously rushing out</u> of the tap with light twist

Water Leak Detection Devices

[redacted]

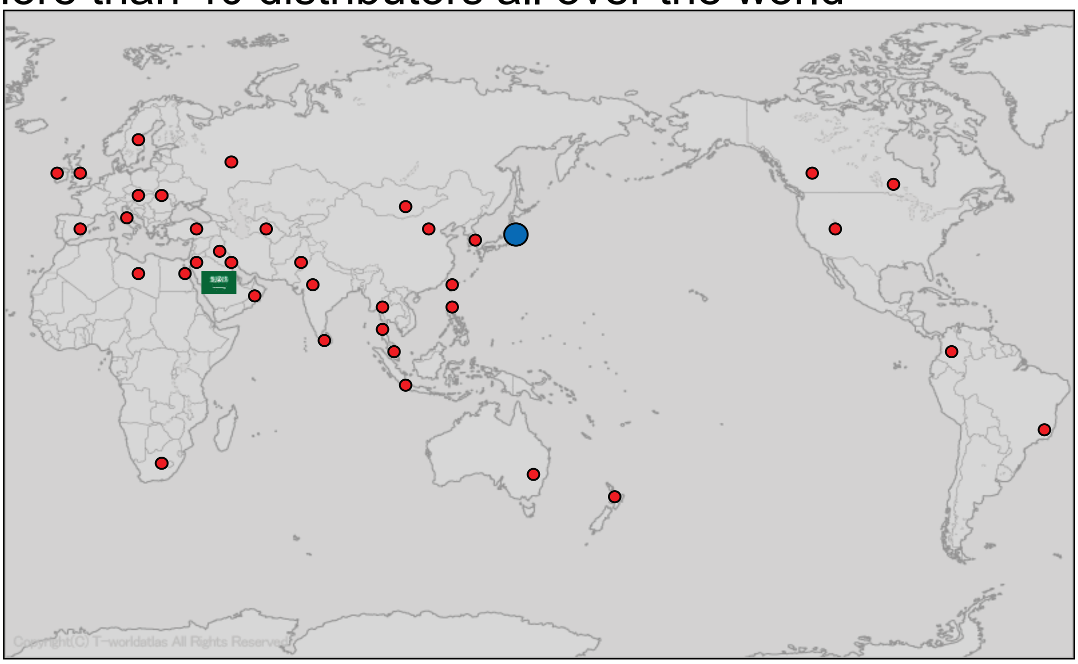
Domestic Offices and Service Network

- Headquarter & Overseas Sales Group:
  Chiyoda-ku, Tokyo
- Technical Development & Training Center:
  Niiza, Saitama
- 8 Regional Sales Offices



Worldwide Sales and Service Network

More than 40 distributors all over the world



Official Distributor in Saudi Arabia

[redacted]

Training Program

Training site

Buried Pipe Materials:
CIP/GP/LP/PVC/PE




1. Pipeline Operation / Maintenance and Leak detection
2. Introduction of survey equipment
3. Technical instruction of survey instruments
4. Comparison of various leak types & site conditions

Digital Quatro Correlator (Model: [redacted]

Features

・6 routes Simultaneous Correlation & Screen Display.

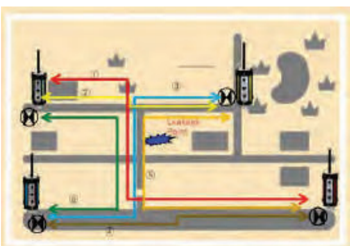
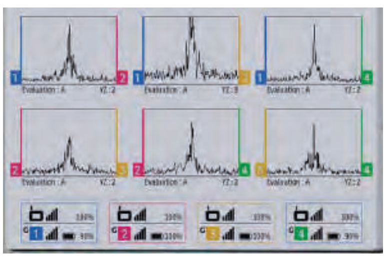
Enables for simultaneous correlation up to six ways with four sensors.

・Logger Mode

By setting the time in the logger mode, it is possible to perform correlation processing after acquiring sound data at the set time.

・Relay Function

Use of sensors as a relay receiver makes wireless communication distance way longer and avoids poor connection due to obstacles.

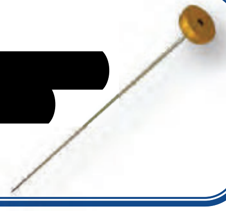

Other Water Leak Detection Products of [redacted]

Water Leak Detector
[redacted]

Digital Noise Reduction
Water Leak Detector
[redacted]

Digital Sound Detector
[redacted]

Listening Stick
Model: [redacted]



Water Pressure Data
Logger
[redacted]

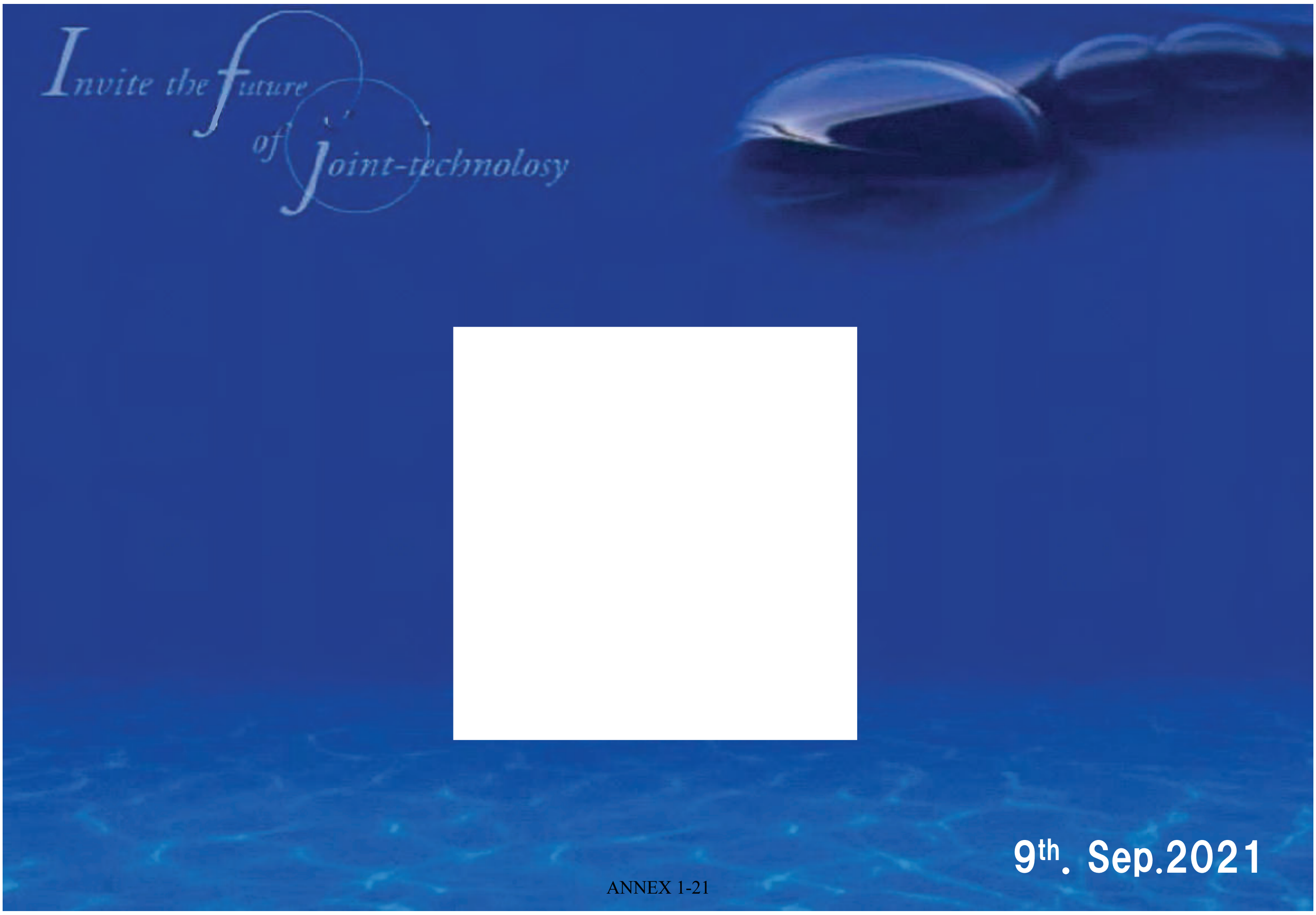
Pipe Line & Cable
Locator
[redacted]

For more details on our products, please visit our web
[redacted]

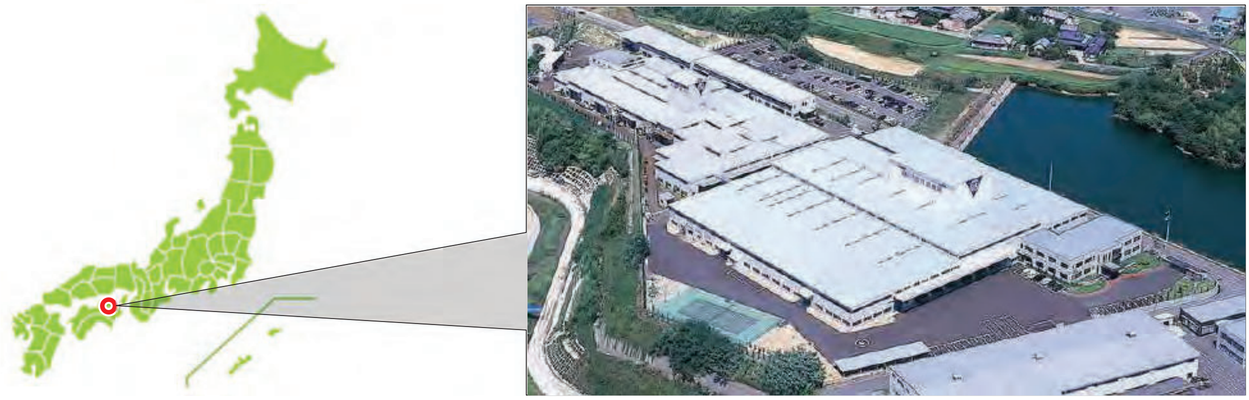
Thank you
for your attention!

2. Review of Pipe connection /Repair method

- [redacted]
- [redacted]
- [redacted]
- [redacted]



Company Profile



Company Introduction

Company Name	[redacted]
Inspection and Registration Agency (R.B)	
R.B Registration No.	
Specification	
Certification Scheme/Code	
Venue to be Inspected	
Quality System	

[redacted]

Features of small pipe joint

Easy Installation

[redacted] JOINT

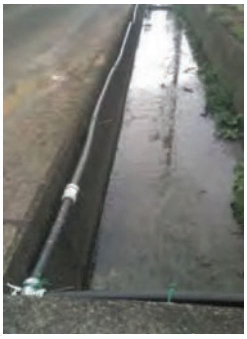
Shock Resistant

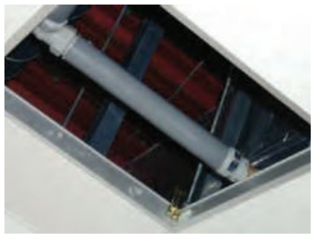
Applicable to all sorts of pipe connection

Safe

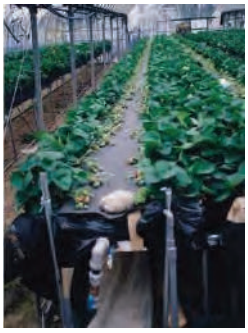
Anti-Corrosion

Active in various situations







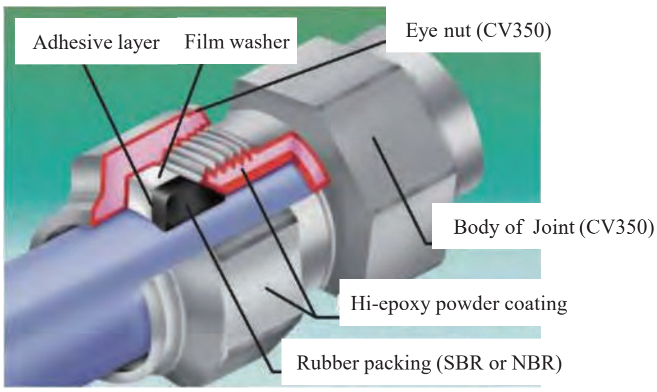
Easy Installation

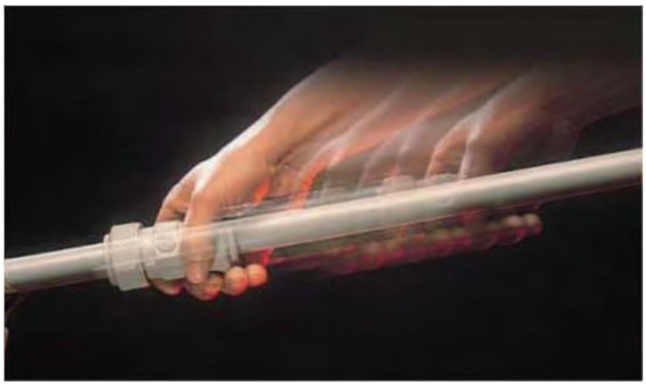
No need to disassemble

- Install by simply plunging onto the pipe and locking the eye nut.
- Film washer is used, and the water pipe can be fixed firmly with a rubber pad.

Slide-type connection pipe

- May easily slide in for connection when repairing destroyed pipe and for maintenance.





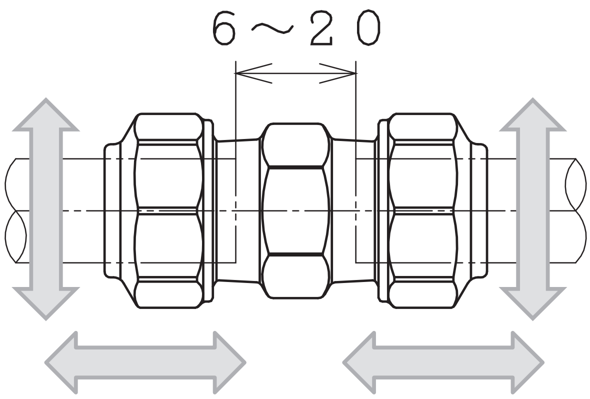
Shock Resistant

Expandability

- A 6-20mm gap is left between pipes inside the connector when the caliber is at 20mm, so that the pipes have room for expansion.

Pliability

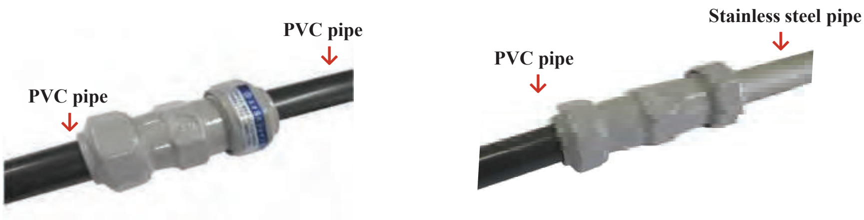
- The bendable angle for a single connection is above ±3°, and for double-side connection it is ±6°, which may be totally absorbed by the connectors. The pliability of the bendable pipes can serve an excellent shock-resistant function during earthquake.



Applicable to all sorts of pipe connection

Applicable pipe materials: PVC pipes, stainless steel pipes
Other pipe materials (PE pipes, steel pipes, PD･VD steel pipes, lead pipes, copper pipes)

Applicable caliber: marked pipe diameter 10 m/m - 50 m/m



Safe

Pressure resistant test	Caliber (m/m) 10～25	Hydraulic pressure 4Mpa Last for at least 1 minute OK at normal hydraulic pressure of 1Mpa
	Caliber (m/m) 30～50	Hydraulic pressure 2.5Mpa Last for at least 1 minute OK at normal hydraulic pressure of 1Mpa

Tensile Strength Test

As shown in the picture, the test pipe is installed with the test connector. Pull at a tensile speed of 10 mm/min in a constant-temperature environment until the pipe falls off, and the maximum anti-loose resistance (maximum loading) at the connection part is measured.

Test connector: SUPPON JOINT
Test pipe: hard PVC pipe is used (PVC made in Taiwan) Caliber 25m/m Average external diameter 32m/m

Fastening Torque of Eye Nut
(fastening rpm)

70 N・m (after fully fastened with hand ＋1・4.5/8 revolution)	8 N・m (OK when fully fastened with hand)

Pipe loosing side

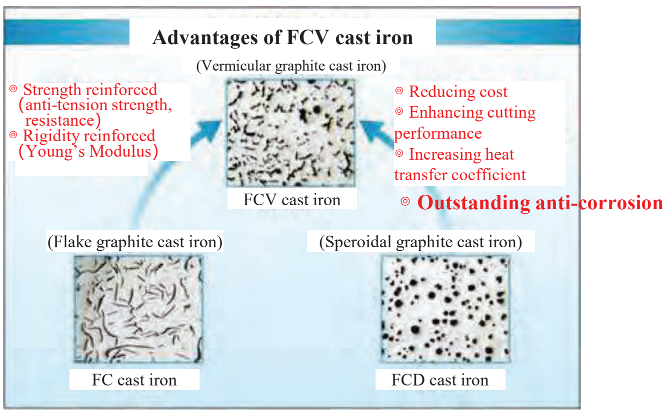
Opposite side

4.81 kN	0.62 kN

Max. tensile loading

Anti-Corrosion

Compacted graphite cast iron is used for all products (ISO 16112/JV/350).
- No bolt is used, and so no bimetallic corrosion problem.
- With a higher carbon content than FCD, it has better anti-corrosion feature.



Source: DAIHATSU METAL http://www.d-metal.co.jp/technology/fcvCi/

Epoxy powder coating universally used

Coating	External	Epoxy powder coating Film thickness above 0.08m/m
	Internal	Epoxy powder coating Film thickness above 0.2m/m

Please consider using our product
in the following situations

When joints are required to connect different types of pipes

Best solution for repair and maintenance

Introduction of
Service Saddle with Corporation Stop

3rd August,2021

History of the Service Saddle

Adopted in more than 1,600 cities in Japan.
Total Number of Adopted : over 10 million.

Benefits of introducing the Service Saddle

a) Leaked water into the soil can be recovered as a water bill.

b) No maintenance cost needed for a long period of time

<u>The service saddle can be used more than 40 years in Japan, where there are a lot of earthquake</u>

Thank you for your attention

The products of plumbing works on uninterrupted water supply
(Hot Tapping, for NRW reduction efforts)

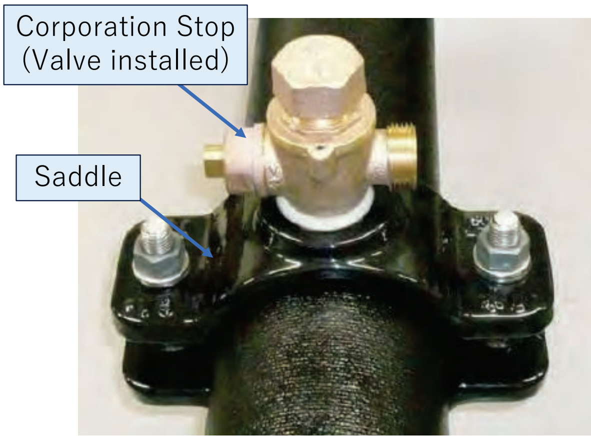
[redacted]

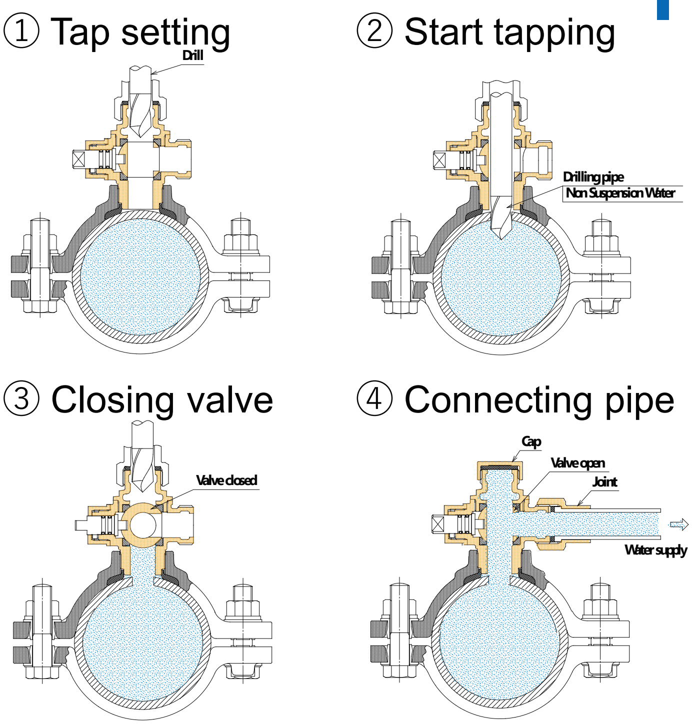
Saddle with Corporation Stop

Water supply devise for Hot Tapping

"Saddle with Corporation Stop"

Saddle and corporation stop is integrated to minimized NRW possibility





Hot Tapping Machine

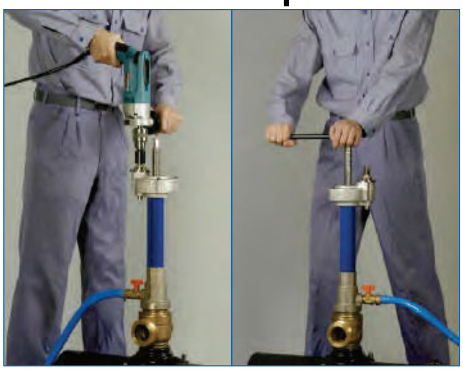
[redacted]

Weight: 6 kg

Wide variety of drills

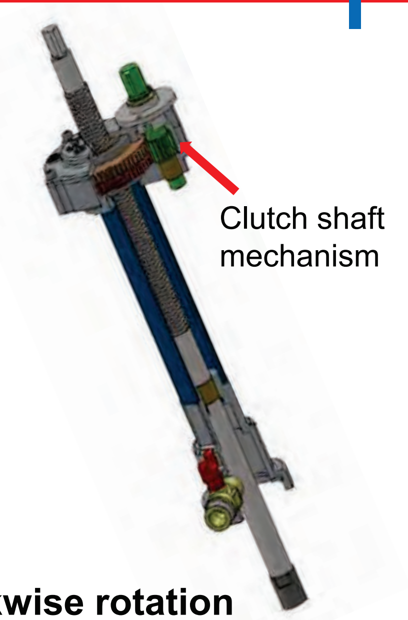
20～50mm drills and cutters for Cast Iron Pipe, PE Pipe, VCP, and Asbestos Pipe

Both Power Operation



Electric (with Power Drill)

Manual (with Ratchet)



Anticlockwise rotation

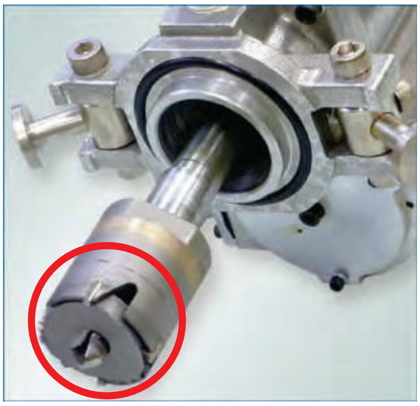
Designed to tighten the connecting parts of valve and saddle so that it would prevent water leakages.

Retaining cutting coupon and chips

Tapping to PE Pipe

The cutting waste of PE will be come into the cutter spirally, and the cutting chip will be fitted to the cutter.

Tapping to DIP



The cutter for DIP (cutting size 30-50mm) has a center-drill to hold the cutting chip.

Features and Merit

★ Only changing the saddles and tapping unit, It can be reduced the water leaking (**NRW Reduction**)

★ Drilling to any kind of pipes in a short time and easy operation
➢ex. 50mm tapping needs 1.5 min. to cast iron pipe
➢**Shorten the working time and cost**

"Bendable Innovation"

The Impact of Corrugated Stainless Steel Tube
< CSST：Water Service pipe >
CSST is one of our product, we have so many flexible tube.

[redacted]

[redacted]

What is CSST?

1. *Designed for Service Pipelines (CITY WATER SYSTEM*
2. *Partially Corrugated*
3. *Easily Bent*
4. *Made from Type 316L Stainless Steel*
5. *Official Test Certificates*

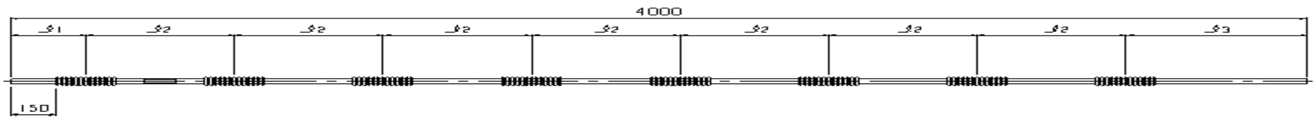
G119：2004

CNS 15604, G3276

BS EN 10312：2002

[redacted]

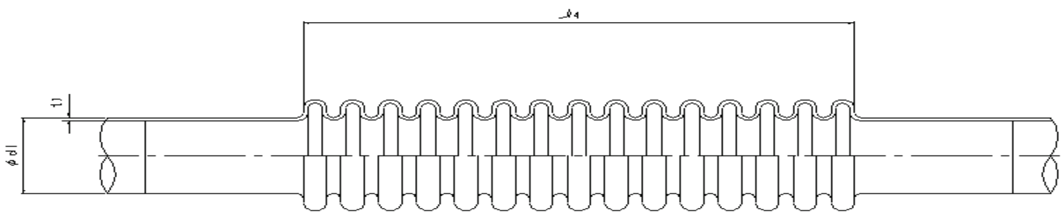
CSST Size *-Standard-*



<table>
<tr><th rowspan="2">Nominal Diameter (MM)</th><th>L</th><th></th><th>l1</th><th></th><th>l2</th><th></th><th>l3</th><th></th><th>l0</th></tr>
<tr><th>Length</th><th>Allowance</th><th>Length</th><th>Allowance</th><th>Length</th><th>Allowance</th><th>Length</th><th>Allowance</th><th>Reference</th></tr>
<tr><td>13</td><td rowspan="6">4,000</td><td rowspan="6">Not standardized</td><td>190</td><td rowspan="3">+10</td><td>475</td><td rowspan="6">±20</td><td>485</td><td rowspan="6">Not standardized</td><td>150</td></tr>
<tr><td>20</td><td>210</td><td>475</td><td>465</td><td>150</td></tr>
<tr><td>25</td><td>210</td><td>475</td><td>465</td><td>150</td></tr>
<tr><td>30</td><td>230</td><td rowspan="3">0</td><td>470</td><td>480</td><td>153.5</td></tr>
<tr><td>40</td><td>265</td><td>460</td><td>515</td><td>152.5</td></tr>
<tr><td>50</td><td>265</td><td>460</td><td>515</td><td>152.5</td></tr>
</table>

[redacted]

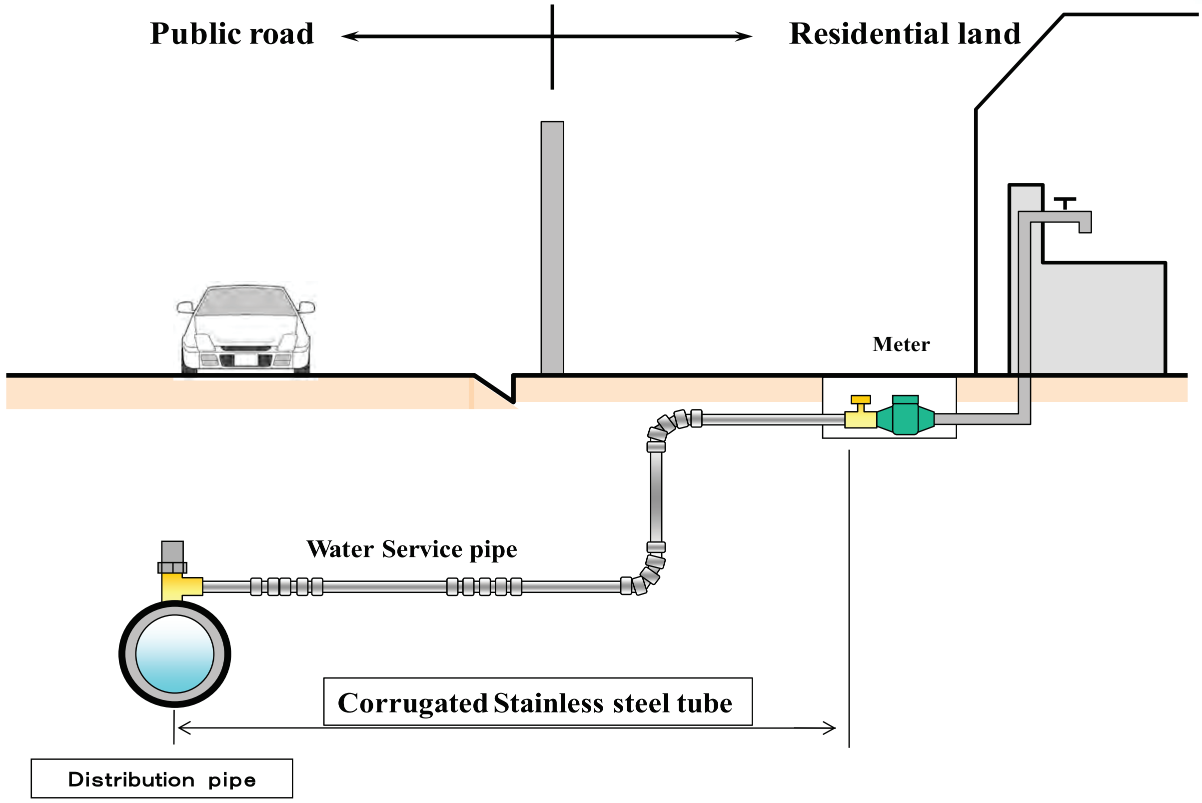
CSST Size *-Corrugation-*



<table>
<tr><th>Nominal size</th><th>External diameter of straight section</th><th>Thickness</th><th>Allowance</th><th>Length of corrugated section</th><th>Numbers of Corrugation</th></tr>
<tr><td>13</td><td>15.88</td><td>0.8</td><td>±0.08</td><td>80</td><td>15</td></tr>
<tr><td>20</td><td>22.22</td><td>1.0</td><td rowspan="2">±0.10</td><td>120</td><td>15</td></tr>
<tr><td>25</td><td>28.58</td><td>1.0</td><td>120</td><td>15</td></tr>
<tr><td>30</td><td>34.00</td><td>1.2</td><td rowspan="3">±0.12</td><td>153</td><td>15</td></tr>
<tr><td>40</td><td>42.70</td><td>1.2</td><td>225</td><td>20</td></tr>
<tr><td>50</td><td>48.60</td><td>1.2</td><td>225</td><td>20</td></tr>
</table>

[redacted]

CSST System Installation Image



[redacted]

Product Feature and Advantage

1) Mechanism
CSST reduces the number of Fitting and Joint.

↠

Reduced leakage point.

2) Quality Material
Using type 316L Stainless Steal material.
High Anti-Corrosion performance and Extremely Durable.

↠

Less corrosion and longer life of the entire pipeline.

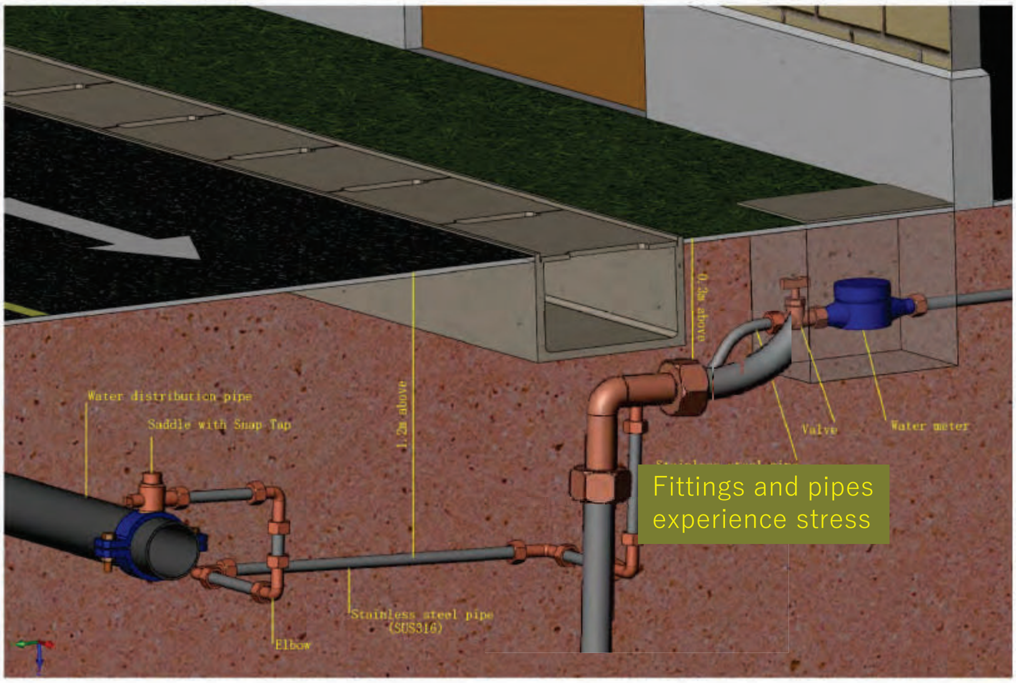
3) Easy handling
CSST allows easy instalation work.

↠

Reduce the time of installation and Labor saving/

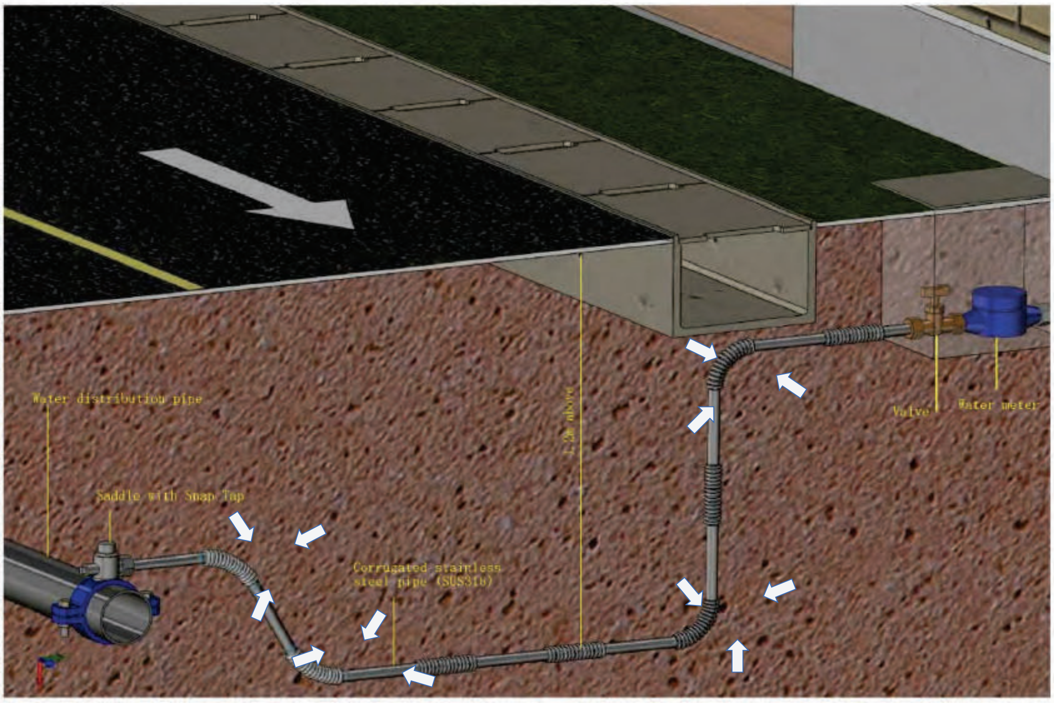
[redacted]

The Evolution of Service Pipelines
before 1982



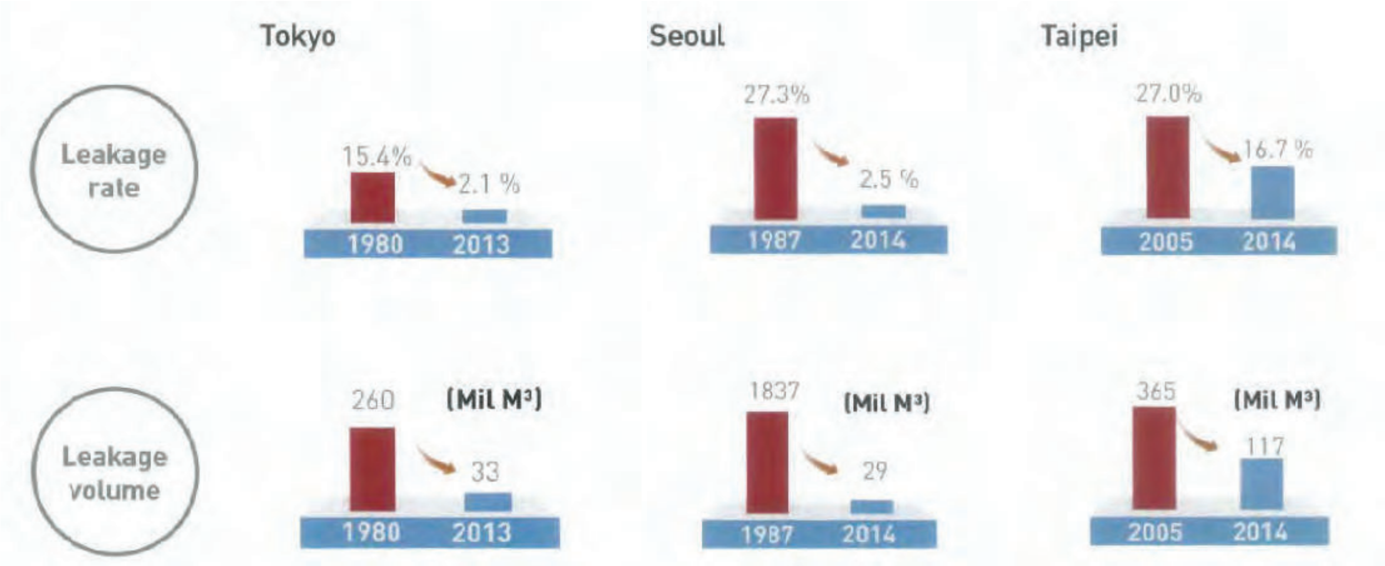
[redacted]

The Status of Water Service Pipelines
after 1998



[redacted]

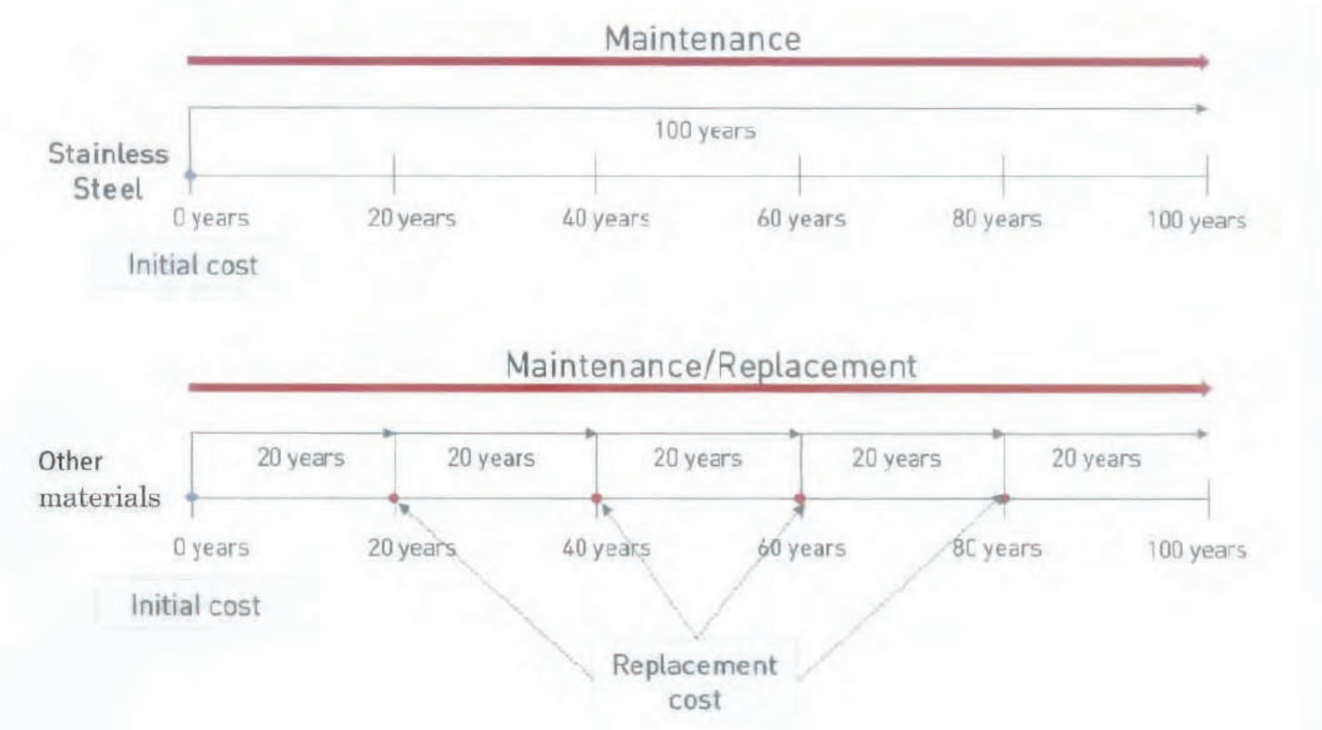
Results of the projects in Tokyo, Seoul and Taipei



Source : ISSF

[redacted]

Estimated CSST benefit



Source : ISSF

[redacted]

Thank you

[redacted]

3. Metering

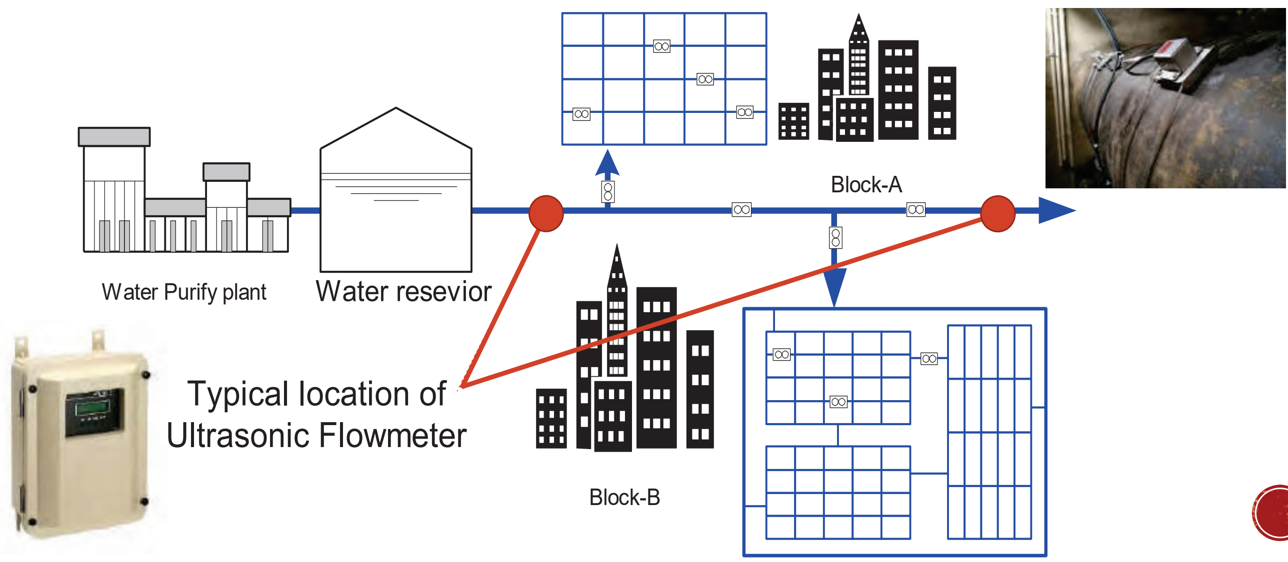
- [redacted]
- [redacted]
- [redacted]

UTILIZATION OF ULTRASONIC FLOWMETER FOR NON-REVENUE WATER

Introduction of [redacted] Products

THE CONTRIBUTION OF OUR ULTRASONIC FLOWMETER

- Contribution for SDGs no.6
- The collected data will be utilized for water leak detection
- For example, measuring before and after a network then compare the data.



SPECIFICATIONS-ULTRASONIC FLOWMETER

- Portable Ultrasonic Flowmeter[redacted]

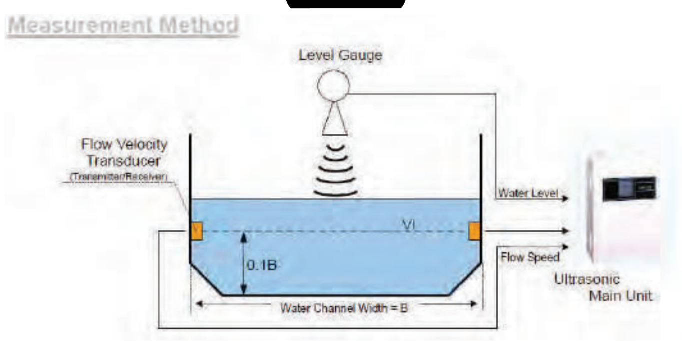
Diameter range : DN13 to DN5000mm
Accuracy : ±1.0%MAX
IP Class : IP65
Battery
Dual path, Dual channel
Thickness meter function (Option)

- Stationary Ultrasonic Flowmeter[redacted]

Diameter range : DN25 to DN6000mm
Accuracy : ±1.0%MAX
IP Class : IP67, 68
Four path function

OPEN CHANNEL ULTRASONIC FLOWMETER

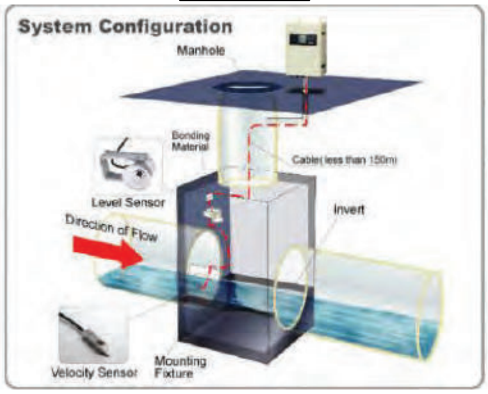
[redacted]



Water channel width : 0.3～20m
Application : Agricultural water, River water

Level gauge is included

[redacted]



Water channel width : 0.25～5m
Application : Sewage, Waster water, Industrial effluents, Other fluids with suspended matters or small bubbles which reflect ultrasonic

Level gauge is included

SPECIFICATIONS-RADAR LEVEL GAUGE

- Non-contact Radar Level Gauge [redacted]

Measurement range : 30m MAX
Accuracy : ±2㎜MAX
Output : 4-20mADC and HART
Rapid tracking : track up to 2m / sec
Antenna : cone, process seal, clamp selectable variety

- Microwave Level Gauge [redacted]

Measurement range : 20m MAX
Accuracy : ±10㎜MAX
Output : RS-485
Antenna : 8 inch cone
Rapid activation

MONITORING SYSTEM

PERSON IN CHARGE

[redacted]

- Measurement System Company
  Overseas Sales Sect. Sales Dept.

[redacted]

Introduction

Battery Powered
Electromagnetic Water Meter "The[redacted]

[redacted]

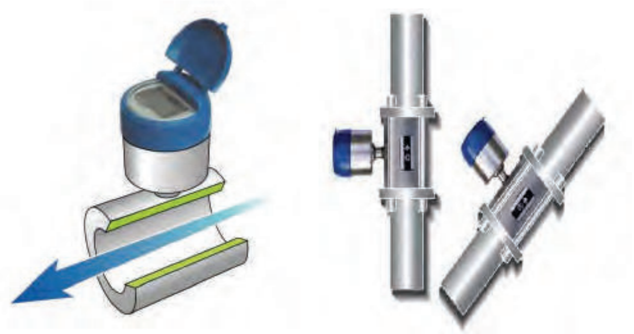
OIML R49 2013
Certified

September, 2021

What [redacted] measures?

- Accumulated flow volume & Instantaneous flow rate
  with wide range ability (R400) having its sampling rate every 0.5 sec.

No-moving Parts   Free Installation

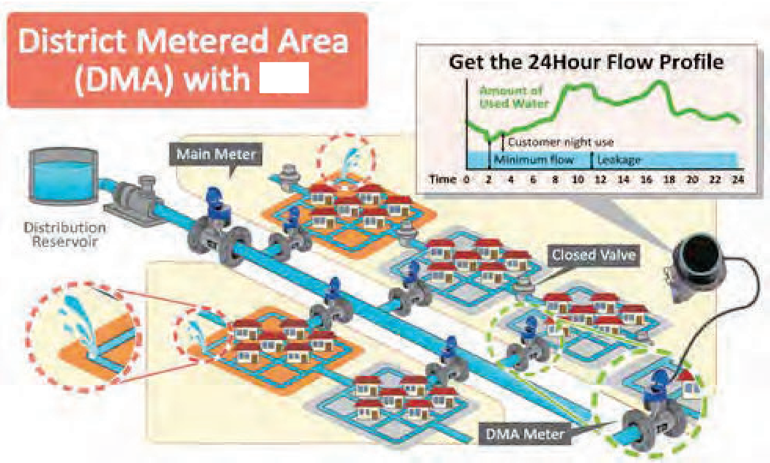


Meter Body: SUS 304
Electrodes: SUS 316L
Tube liner: Epoxy Resin Powder Painting
Country of Origin: JAPAN

Applications

A. Billing

B. Network management



Distribution

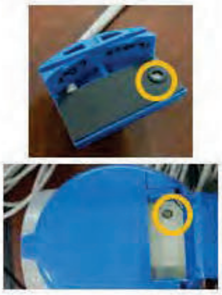
1. USA (NYC)
2. UAE (Dubai)
3. Europe
4. Oceania
5. China
6. South East Asia

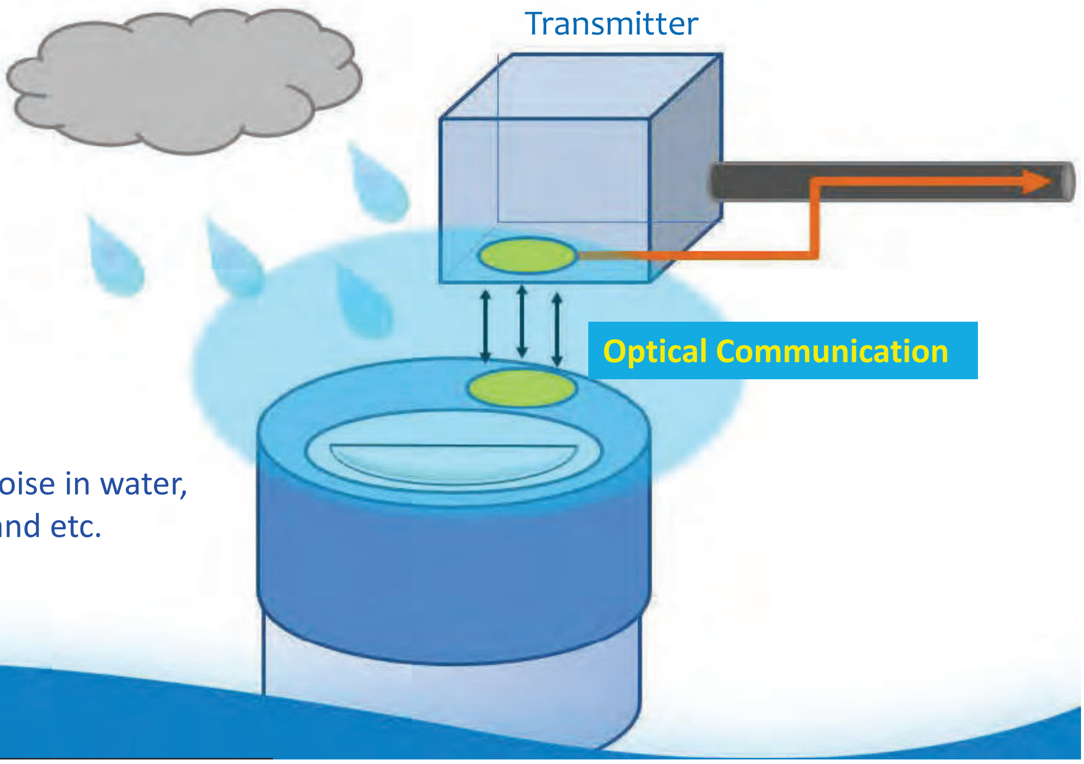
More than 80,000 pcs.
[redacted] meters have been sold !

C. Agricultural and industrial water management

SU also measures agricultural (e.g. farm's irrigation and sprinkler for grazing) and industrial water.

Genuine IP68 for water resistance

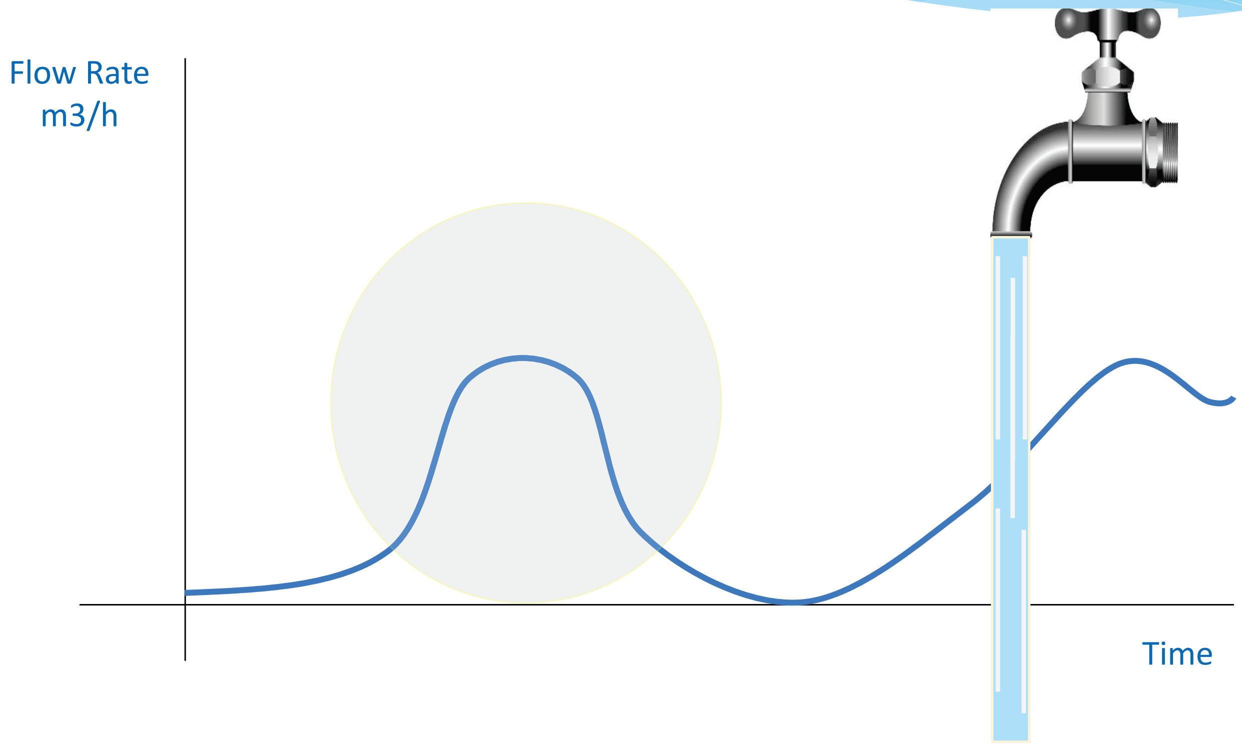




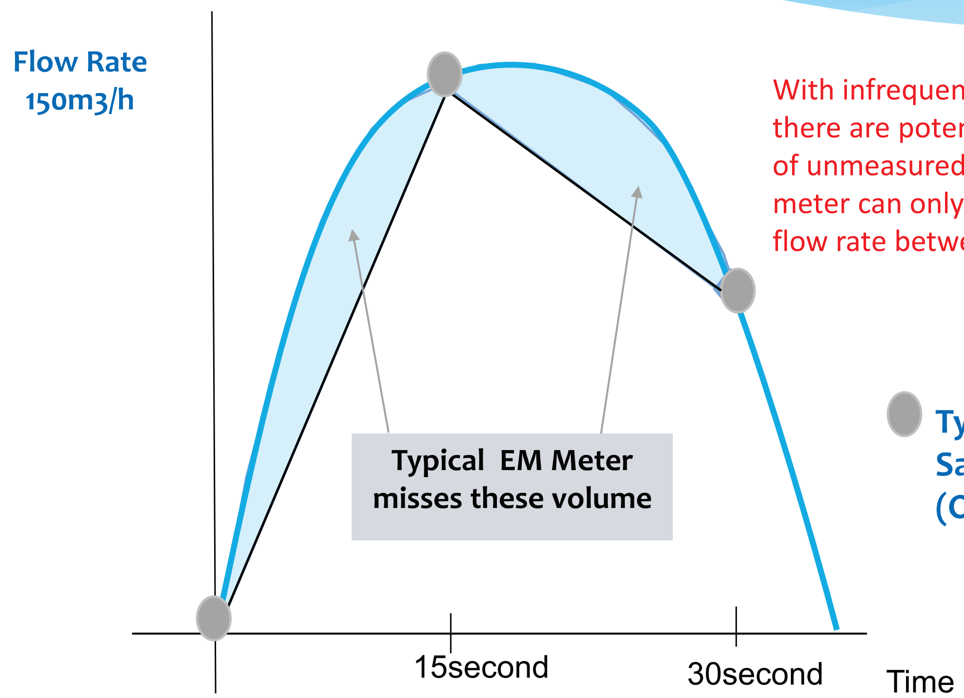
Robust against
Stray current & noise in water,
Lightning serge and etc.

[redacted] can be used submersible at any time

[redacted] can take Sampling Rate every 0.5 Sec. (High Accuracy)



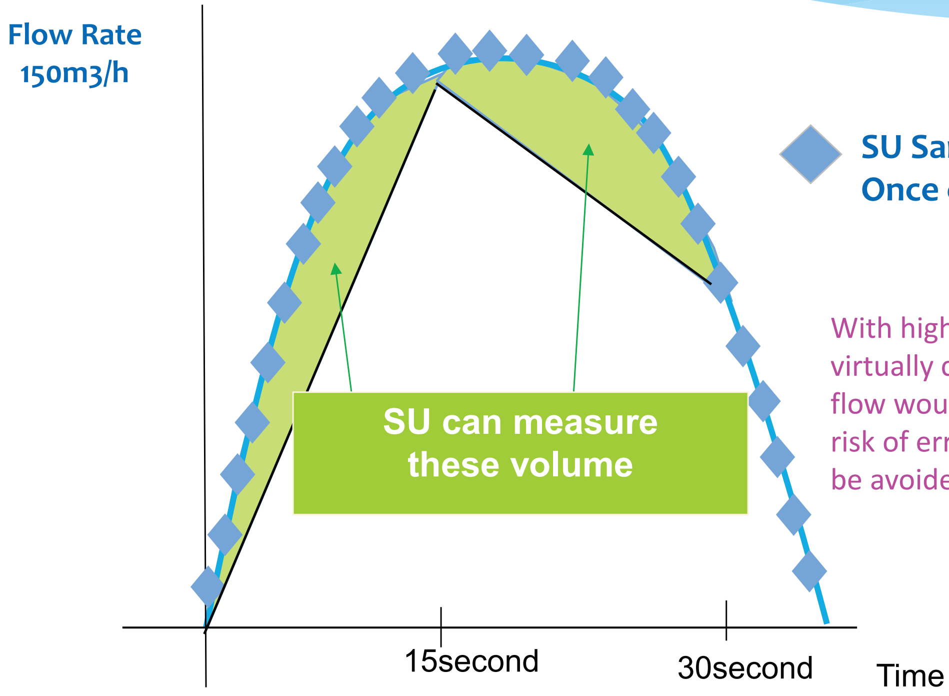
0.5 Sampling Rate & High Accuracy (Continued)



With infrequent (slow) sampling rates there are potentially large volumes of unmeasured flow, because the meter can only calculate an average flow rate between each sample point.

Typical EM Meter Sampling Points (Once every 15 sec)

0.5 Sampling Rate & High Accuracy (Continued)



SU Sampling Points
Once every 0.5 sec

With high-frequent sampling rates virtually correspond that all the flow would be measured and the risk of error (incorrect volume) can be avoided and minimized.

Compatibility with AMR / AMI & Data Logging System

[redacted]

[redacted]

[redacted]

Smart Metering System

[redacted]

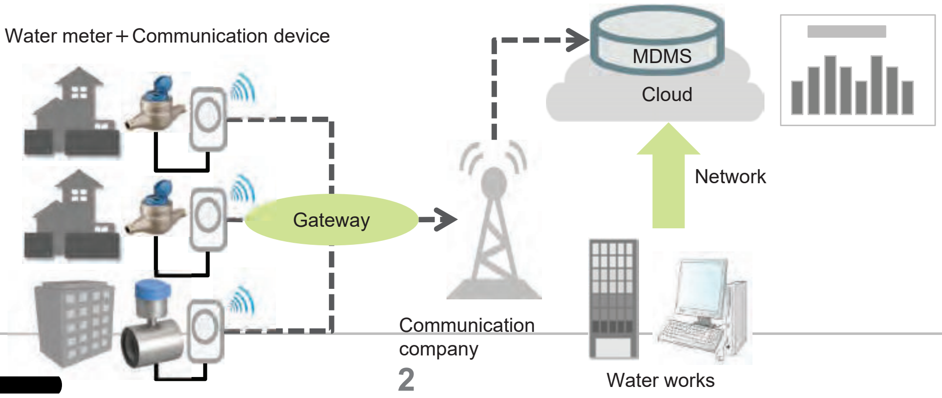
LPWA Wireless system

System components:

- Electronic water meter
- Wireless transmitter
- System (incl. Server, software, gateway etc.)

Description:

- Wireless meter reading system with LPWA technology which can transmit meter information directly to a server via an online network. Through that method, water meter data is transmitted from the radio transmitter to the network via an LPWA radio communication method. It is transmitted to the relay machine and is automatically transferred from the relay machine to the customer management server via a network. It is possible to manage multiple users 'status at once, as well as building a system capable of notifying users about upcoming bills etc. Servers and high-function systems must be built, and initial investment may prove expensive. However it is possible to drastically reduce the capital investment and server management expenses by using cloud servers.



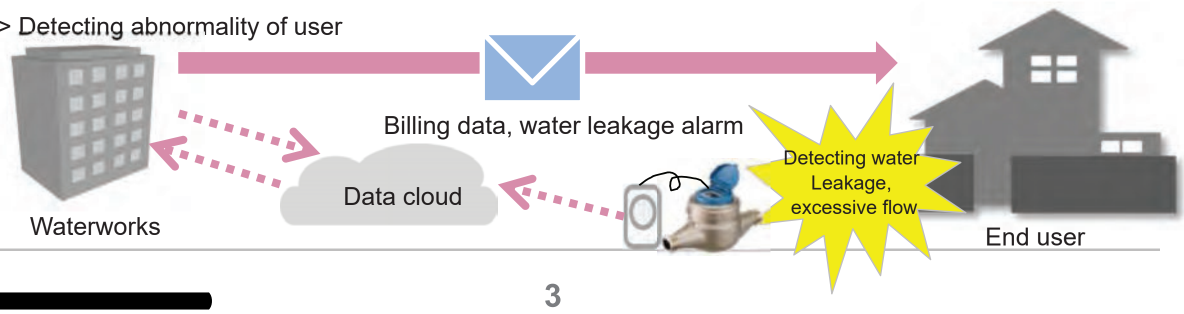
[redacted]

Usage examples

Electronic type water meter with communication device will make it possible to read water meters wirelessly, analyze usage amount every month and provide services like alarming of water leakage and excessive flow.

[Example of service and function]

- Water leakage alarm: Function for detecting water leakage from pipe or hydrant at downstream side from water meter. By setting the leakage flow value, water meter judges water leakage when the measured value is larger than the set value.
  > The early discovery of leakage
- Excessive flow alarm：Function for preventing meter performance deterioration and monitoring water saving.
  > Preventing meter performance deterioration and monitoring water saving
- Disuse of water：Judging disuse of water for ling time.
  > Detecting abnormality of user



[redacted]

Smart metering system

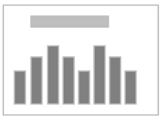
Electronic type water meter

Electronic type water meter have been produced since 1983 and we have a track record of sales for more than 35 years.
Not only getting the meter data, it can provide a lot of added various service with various meter functions.

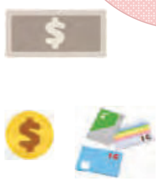
Looking after aged person with individual consumption

Detecting and monitoring leakage

Management of total consumption



Payment/billing control



✓*Contributing to better infrastructures!!*

Electronic type water meter

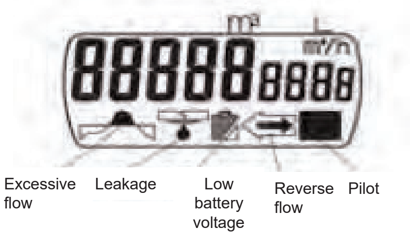
Electronic type water meter 13mm~100mm

Electronic type water meter is composed of mechanical measuring unit and electronic arithmetic unit. This meter can display integrated value and output both 8bit telegram and pulse. Furthermore, it can stores meter reading value and display leakage alarm and excessive flow alarm.

Functions

Regular meter reading	Storing meter reading value on designated date.
Occasional meter reading	Reading meter value any time at an arbitrary timing.
Instantaneous flow display	Displaying instantaneous flowrate.
Leakage alarm	Detecting waste usage of water.
Excessive flow alarm	Monitoring abnormal usage of water.
Reverse flow detection	Detecting wrong meter installation.
Regular meter calling	Sending meter reading value on designated date.
Load survey	Monitoring water usage.
Alarm calling	Monitoring abnormal state of meter.
Low battery voltage alarm	Checking battery remaining amount.
Flow rate 0 detection	Monitoring unexpected situations.

Integrated value
(Standard display)

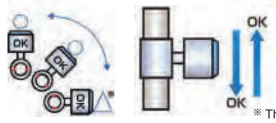


✓*Best functions for Smart Metering!!*

Battery Operated Electromagnetic Water Meter

- **Model: MGB12A**
- 50mm (2”) ~ 200mm (8”)
- Battery operated more than 8 years (10 years life expectancy)
- Suitable for large flow
- Cavity shape design avoids technical failure

- Flexible installing position



※ The flow tube has to be completely filled with water.

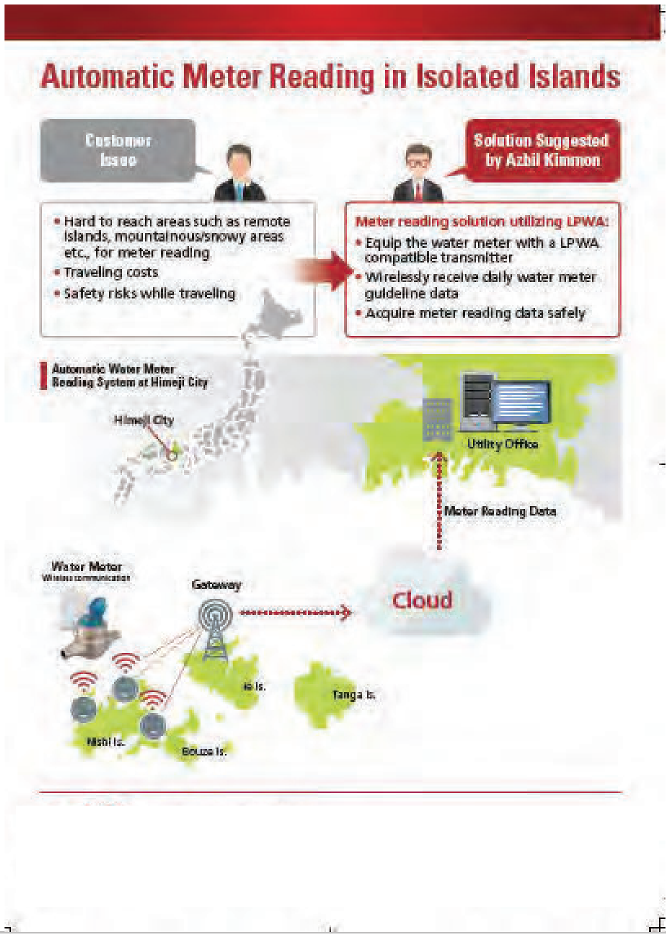
- IP68 (Submerged OK)

- Easy Installation (only 10% of our conventional meter weight)

- LED display with backlight

✓*Easy handling, no moving parts !!*

[redacted]



[redacted]

✓ Your smart choice!

[redacted]

[redacted]

4. Ai Analysis of Likelihood of Failure

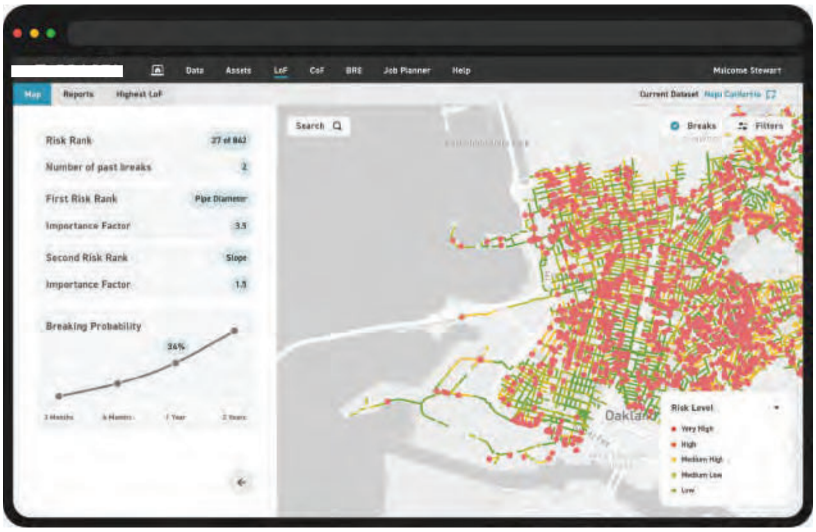
- [redacted]

[redacted]

4. AI analysis of Likelihood of Failure

Improve The Data Quality In Your Network
Use smart A.I. algorithms to plug holes in your existing data in order to make the best possible prediction decisions
Reduce NRW With A Data-Driven Approach
Objectively understand where the weaknesses in your water main network are more accurately, and more affordably than before

Apply over 150 different environmental and geological variables to improve the accuracy of your predictions
Just because a pipe is old does not mean it needs to be replaced.
[redacted] LOF tool helps utilities identify which pipes need to be replaced based on a myriad of factors, ensuring good pipe is left in the ground and bad pipe is replaced before it breaks.



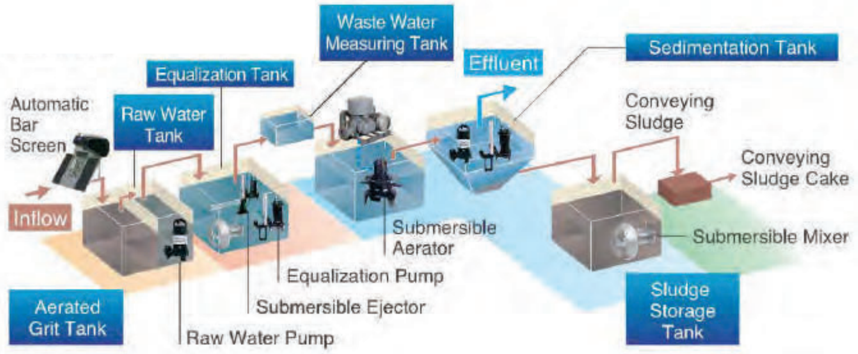
5. Submersible pumps

- [redacted]

Variety line up of wastewater treatment equipment

➢ Summary

Continue to be selected as the best partner in the design, construction, operation and maintenance of water treatment facilities by proposing optimum products such as submersible sewage pumps, aerators, mixers, blowers and screens which are indispensable in the process.



➢ Technology features / advantages

- Submersible pump：Extensive impeller line up that have both solid passing capability and efficiency
- Aerator : Saving maintenance by directly connecting motor without gear
- Mixer：Energy saving by high efficiency motor and propeller
- Blower : Optimum line up from high efficiency, Low noise and submersed type
- Screen : Small fine screen for on site treatment plant

Solve the Clogging Issue of Sewage Pump

Clogging Issue in the pumping station / lifting station

CNWX series

100% of bore size

High passing capability Pump

CNWJ series

Up to 80mm With Built-in chopper

★★★★ = Excellent ★★★ = Very good ★★ = Good ★ = Poor/Normal	Tennis Ball φ66	Sanitary Items	Plastic Bag	Steel Can φ53×L105mm	Pet Bottle 500ml
CNWX	★★★★	★★★★	★★★★	★★★★	★★★★
CNMJ	★★★★	★★★★	★★★	★★★★	★★★★
CN/CJ	★	★★	★★	★	★

Product for Saving Energy

Turbo Blower

- ***High Efficient Performance***
- ***Easy Maintenance***
  No Oil, No Grease, No Belt
- ***Low Noise***

Power Consumption in WWTP

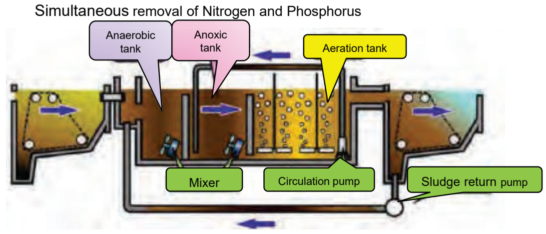
Aeration process uses "50-60%" of total energy consumption in WWTP

Vertical Mixer

Item	Vertical	Submersible
Agitated power consumption density	**Less than 2W/m3**	Around 6-8W/m3
Maintenance of drive unit	**Install on the ground**	Need to pull out from tank
Install workability	**Only on the ground**	Need work in the tank
Initial Cost	**High**	Reasonable

Improvement of energy saving and maintenance capability

- A2O method
  Simultaneous removal of Nitrogen and Phosphorus



YACHIYO Engineering

Current status, issues and countermeasures for water saving, leakage in the agricultural sector of Saudi Arabia

25th Aug, 2021

"Date Collection Survey on possibility of private sector technical utilization in water sector in Saudi Arabia " by JICA survey team

1. Current status and issues for water saving, leakage detection and water quality improvement in the agricultural sector of Saudi Araba（1/2）

①80% of the total water volume used in Saudi Arabia is used in the agricultural sector and most of them depends on fossil water. Since it is expected fossil water is completely depleted in 2080, **measures to reduce the amount of fossil water used are required.**

②The feed and grain occupy 77% of the total cropping acreage in Saudi Arabia, and **the pumped groundwater is mainly sprinkled by a Center pivot irrigation etc.** for these cultivations. The irrigation efficiency by the same irrigation method is said to be 75% to 85% on the world average, but **it is only about 50% in Saudi Arabia.**

③Since **it is not necessary to pay usage fee for irrigation water**, **agriculture has been carried out by excessive pumping of groundwater and inefficient watering**, ignoring the efficient use of water resources.

④**The concentration of salt and and nitrate nitrogen of groundwater used for irrigation water increases** due to excessive pumping of groundwater and fossil water, leachate from domestic wastewater and waste treatment plants, excessive fertilization in agriculture, etc.. So **deterioration of water quality has become a major problem.**

⑤The reuse of treated water for agricultural water is being promoted, but **there are problems with water quality**. In order to meet the water quality standards for agricultural water, **purification technologies such as membrane filtration and disinfection are required for removal of airborne substances, denitrification, harmful microorganisms.**

⑥**The labor saving in agricultural work** such as tillage, sowing, cultivation, and harvesting in farming activities **is required**, because **the shortage of agricultural workers is found.**

2. Applicable Japanese technologies which help to solve issues and challenge in Saudi Arabian agricultural sector（1/2）

(1) Water-saving technologies

1)Water-saving irrigation technologies

・Purposes of introduction are reduction of the amount of fossil water used and improving irrigation efficiency

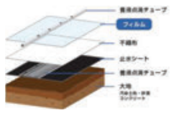
①Biostimulant
②Drip irrigation tube
③Film farming
④Water retention material



2)flow meter（Smart meter etc.）

・Purposes of introduction are Measurement of groundwater pumped from agricultural wells and irrigation water usage

Japanese water-saving irrigation technologies (1/2)

Classification	Name of new technology	Image	Overview	Benefits of introduction
Water-saving irrigation technology	**Biostimulant materials**		・**Biostimulant material containing acetic acid as an active ingredient that can dramatically dry and resist high temperatures.**	・Since the **frequency of irrigation can be reduced**, it also saves water.
	Pressure-compensated type drip irrigation tube	 	・ **Drip irrigation tube** of pressure-compensated type	・ **Water and fertilizer can be saved**. ・Water can be supplied at a moderate supply rate, oxygen required for the roots of the plant can be secured, and the growing state of the plant can be well managed.
Water-saving irrigation technology	**Film farming**	 	・**Plants grow on a thin film made of hydrogel.** The film has numerous nano-sized holes that allow only water and nutrients to pass through. ・The system consists of a liquid supply device and a cultivation bed (film, non-woven fabric, waterproof sheet, two irrigation tubes).	・Since it is completely isolated from the ground by a waterproof sheet, **agriculture can be done anywhere, such as in desert areas or on concrete.** ・Furthermore, since the water and fertilizer supplied by the waterproof sheet do not leak to the outside, **the amount of water and fertilizer used is significantly smaller** than that of the conventional farming method, and at the same time, it is a very environmentally friendly farming method. ・ Tomatoes grown on the film have a good taste and aroma, and **have a very high sugar content and nutritional value (lycopene, amino acids, GABA, etc.).**

Japanese water-saving irrigation technologies (2/2)

Classification	Name of new technology	Image	Overview	Benefits of introduction
Water-saving irrigation technology	**Water retention material, soil amendment**		・**Soil improvement material (water retention materials) made by glass** is used by mixing with cultivated soil in the farmland.	・ Water is stored in the pores of the improvement material and **it enhances water retention and saves water.** ・**No environmental load** (main raw material is glass) ・Since the roots can absorb more water with the same amount of irrigation, it leads to an **increase in crop yield**.

(2) Efficiency of agricultural work

1)Smart agricutural technologies

・Purposes of introduction are efficiency of agricultural work and increase of crop yield


①Farming & production control system
②Robot tractor
③Automatic steering system
④Remote control mower
⑤High-performance combine
⑥Assist suit
⑦Agricultural drones and artificial satelites
⑧ Farming & Facility environmental monitoring system

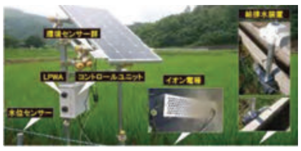

Japanese smart agricultural technologies (1/3)

Classification	Name of new technology	Image	Overview	Benefits of introduction
Smart agricultural technology	Farming/production control system		・Record of work plans and achievements for farming on PCs, tablets, and smartphones ・There is a wide range of products from inexpensive products with narrowed down functions to products with enhanced analysis functions for management optimization	・Visualization of work results for each farmland and crops ・Based on the recorded information, it can be used for visualization of production costs, improvement of cultivation plans and methods, harvest prediction, etc.
	Robot tractor		・Unmanned automatic driving in the farmland (automating steering wheel operation, transmission, stop and work equipment control) ・The user constantly monitors the automatically traveling tractor from around the farmland to judge the danger and perform emergency operations. ・One person can operate two units (manned-unmanned cooperation system)	・The manned-unmanned cooperative system enables shortening of work time and multiple work by one person (cultivation / leveling with an unmanned vehicle, fertilization / sowing with a manned vehicle).
	Automatic steering system		・It Is possible to control automatically the steering wheel and travel automatically on the set route ・It is possible to retrofit to tractors, combines, etc. ・ There are also products that can automatically control the amount of fertilizer applied.	・Since the work can be done automatically and accurately, the work becomes easier even for long straight line operations in large sections. ・Even unskilled workers can work with accuracy and speed equal to or higher than those of skilled workers. ・The overlap width of work is reduced, and the work area per unit time is increased by about 10 to 25%.
	Tractor (With automatic steering function)		・It is possible to automatically control the steering wheel and automatically drive on the set route. ・Some products can turn automatically	・Since it is possible to operate automatically and accurately, work becomes easier even with long straight lines in large sections. ・Even unskilled workers can work with accuracy and speed equal to or higher than those of skilled workers

Japanese smart agricultural technologies (2/3)

Classification	Name of new technology	Image	Overview	Benefits of introduction
Smart agricultural technology	**Remote control mower**		・**The mower can be remotely controlled by a remote control.** it can be used for weeding work **on steep slopes and abandoned cultivated land where people cannot easily enter.**	・Weeding work in dangerous places **can be carried out safely** ・Because it is lightweight and compact, it can be transported by light truck. ・**Working time can be reduced** (about 80% of conventional work (brush cutter))
	High-performance combine (with straight line assist function and variable fertilizer application function)		・It is possible to measure of yield, taste (protein value), water content, etc. at the same time as harvesting to **understand variations in yield, taste, etc. in each field.** ・ There are also products that can be linked with an automatic operation assist function and a drying adjuster.	・**It can be used for fertilization design for the next year**, etc. according to the variation in yield and taste in each farmland (yield increase rate will be 15% after 1 year, 20% after 3 years.) (At the same time, the taste is improved)) ・It is possible to improve the efficiency of drying by separating the dryers based on the protein value and water content at the time of harvesting.
	Assist suit		・**Reduction of load on the waist and arms when lifting and lowering heavy objects** by assisting with a motor and load distribution effect by artificial muscles, etc. ・There are also products that specialize in arm support and container lifting.	・**Reducing the load during lifting work** (When lifting a 20 kg container, 10 to 30% of the force is assisted) ・**Reduced work time** due to load reduction (20-30% reduction in work time) ・Supporting the employment of elderly people and women by reducing labor
	Agricultural drones and artificial satellites		・Drones equipped with tanks and nozzles for pesticides and fertilizers fly over crops and spray pesticides and fertilizers. ・Camera etc. are mounted on drones and artificial satellites **to sense the growth status of crops.**	・**The work time for spraying pesticides can be shortened.** ・**Lighten the work of spraying pesticides in places that are difficult for people to enter** such as steep slopes. ・By sensing, the variation between fields can be grasped, and **the yield can be increased by suitable fertilizer and elimination of variation**

Japanese smart agricultural technologies (3/3)

Classification	Name of new technology	Image	Overview	Benefits of introduction
Smart agricultural technology	**Farmland/facility environmental monitoring (including environmental control system)**		・**Various sensors automatically measure the environment inside and outside the farmland and house (temperature and humidity, amount of solar radiation, wind speed, CO2 concentration, etc.)** and can be confirmed on a tablet, etc. ・The environmental control system **automatically opens and closes the skylight and irrigates water based on the values set by the farmer and measured values.**	・By cultivation based on data, **it is possible to maintain the optimum environment in the house**, improve quality, increase and stabilize the yield (yield increase rate: about 15 to 25%). ・It is possible to check the environment in the farmland or house from a remote location.

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(3) Countermeasure for water leakage of irrigation canal's pipeline

The causes of water leakage from the pipeline are considered to be aging, an increase of load on the upper part of the pipe due to changes in land use, corrosion, electrolytic corrosion, water hammer pressure, and an increase in water pressure inside the pipe.

1)Water leakage detection technologies

①Leak detector

(electronic type, correlated type, time-integrated type, permeable type etc.)

②In-pipe survey robot

Leak detector

In-pipe survey robot

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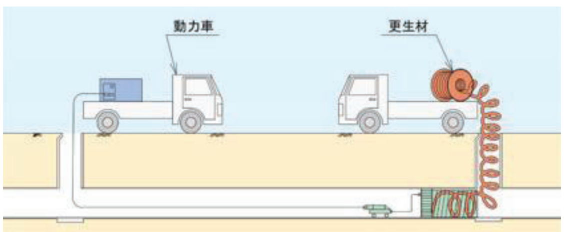
2)Repair and update of leaked parts

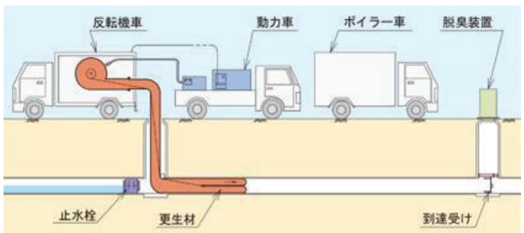
①Pipe rehabilitation method (Non-excavated surface)

This is a construction method to prevent water leakage by pasting a resin-impregnated material, hard vinyl chloride material, etc. on the inner surface of an existing pipe with water leakage from a nearby manhole or shaft.

- Cured-place pipe inversion method
- Fold and formed method
- Spiral liner method
- Slipling method (Pipe in pipe method)



Spiral liner method



Spiral liner method

ANNEX:

2. Presentation Materials for the Report Meeting on the First Field Survey to Japanese Firms

サウジアラビア国
節水・漏水対策、水質改善に係る情報収集・確認調査（QCBS)

第1次現地調査報告会

2021年10月25日

株式会社ワールド・ビジネス・アソシエイツ
八千代エンジニアリング株式会社
株式会社三祐コンサルタンツ
横浜ウォーター株式会社

本日のアジェンダ

1. 第1次現地調査の概要
2. サウジアラビアにおける本邦企業の技術・製品の適用可能性（農業分野）
3. サウジアラビアにおける本邦企業の技術・製品の適用可能性（上水道分野）
4. サウジアラビアにおける本邦企業の技術・製品の適用可能性（水質改善分野）
5. 「派遣プログラム」のご案内

第1次現地調査の概要

1．調査の目的：
・国内調査にて収集した情報について不足する情報を追加で収集
・国内調査で設定した開発課題に係る仮説について訪問調査や現場視察を通じて検証し、開発課題を確定する
・サウジアラビア国（サ国）の当該分野における開発課題に対する支援ニーズについて実施機関や民間企業等との議論を通じ確認する
・サ国の開発課題を解決するに資すると思われる本邦企業がもつ技術・製品を特定する
・サ国のビジネス環境を調査し、外国企業がビジネスを行ううえでの課題を抽出する

2．調査期間：2021年9月17日～10月16日（30日間）

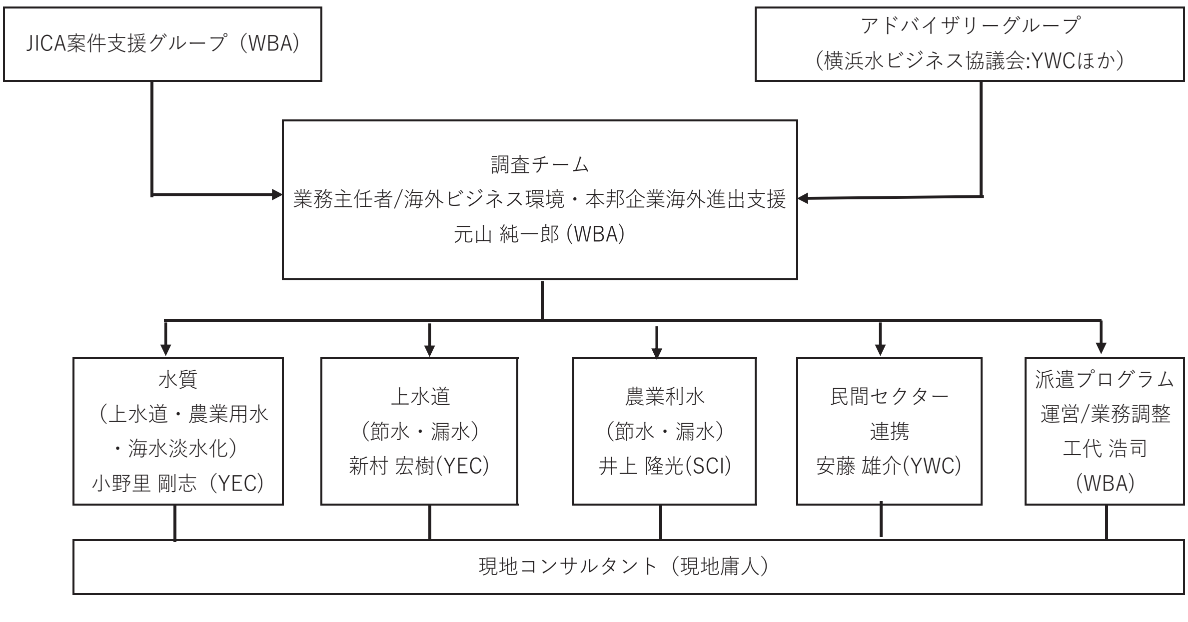
3．調査対象地域：サウジアラビア国リヤド市及び同市近郊、カシーム州ブライダ市及び同市近郊、東部州アルハサ地区、

4．調査の方法：訪問調査、現場視察、簡易的水質試験調査、

5．調査結果：
①サ国の限られた水資源を有効活用する観点から、下水処理水（再生水）の農業・植林事業への活用拡大が急務。
②農業用水の水量減少と塩分濃度の上昇が顕著で対策が必要。
③グリーンハウスでの垂直農法や効率的な水耕栽培、スマート農業に対する研究開発に熱心で日本の高度な技術・製品への期待が高い。

3

本調査の実施体制



4

サウジアラビア国における本邦企業の技術・製品の適用可能性（概要）

農業分野：

農業・灌漑方法

・ブライダは主農業地域でデーツ栽培は非常に盛んである、灌漑施設と呼べるものは無く、農場内にある井戸から揚水して高架水槽にポンプで汲み上げ、重力灌漑で露地ではデーツ、オレンジやレモン、グリーンハウス内ではトマト等果樹や野菜が点滴チューブにて散水し栽培しているのが一般的であり、サ国の他の大部分の地域においても同様の灌漑方法が行われていると思われる。ハイテク技術を導入した農場も見られる。

・SIO（灌漑公社）が灌漑施設を管理している地域であるアルハサ又はリヤド近郊の一部地域において、都市下水の再生水の灌漑への利用が盛んに行われている。下水処理場から中継ポンプ場を経由し、パイプラインで農場へ送水されている。ただし、他の地域においては、口に入るものの作物栽培に再生水を利用することは一般的に敬遠されていて、街路樹、グリーベルト、レクリエーション施設の緑化等に利用されている。

課題と本邦企業の技術・製品の適用可能性

・灌漑の主水源である井戸の水位が低下し続けている。また新しい農業用井戸の新規掘削は制限されている。
・灌漑効率が低く、水資源が乏しい事から、節水灌漑技術の導入の促進、再生水の使用、農業排水の再利用等が望まれている。
・農業排水の再利用が望まれているが塩分濃度が高く、水質改善しなければ直接使用出来ない。農業排水の水質改善（塩分濃度を低減）を日本の技術に期待している。
・バーチカルファーミング技術やデーツ木の害虫駆除技術を日本の技術に期待している。
・再生水を送水するパイプラインの老朽化等による漏水の発生がみられる。
・将来、井戸の水使用料徴収が実施される可能性が高く、水使用量計測技術のニーズが考えられる。
以上の課題を解決するために、本邦企業が持つ保水材、フィルムファーミング技術、バイオスティミュラント、点滴灌漑チューブ等の節水灌漑、パイプラインの漏水対策技術やスマートメーターによる水使用量計測技術、小型の塩分除去装置等をサ国に紹介・普及を図る。

（１）農業分野の本邦企業の技術・製品適用可能性

Project Sheet No. AG-1	Contents ：保水材
Project Authority	MEWAブライダ支所、ブライダ近郊イチゴ観光農園やハイテク農場、アルハサ商工会議所他
Challenge/Issue to be Solved	・サ国は節水灌漑技術を導入して灌漑効率を2030年までに現在の53%から75%に改善することが目標として取り組んでいる。 ・MEWAブライダ支所及びブライダ近郊イチゴ観光農園が日本の保水材に興味を示している。 ・ブライダ近郊にあるハイテク技術を導入している農場において、グリーンハウス内で発生する排水を再利用（土中に染み込んだ排水を排水ドレーンで回収）する等、高度な節水対策を実施している。  ・デーツ栽培が盛んで需要も大きいが、デーツ栽培には多量の水が必要(182ℓ/日/本)である。 ・ブライダ近郊の標準的な農場では、天然の保水材（鉱物系、保水効果はあまり高くないように思えた）を使用するなどして節水対策を実施している。 ・アルハサの商工会議所は、農家が簡単に導入できる技術を紹介して欲しいとの要望がある。また日本の高性能な保水材に興味を示している。以前、保水材を使ったが塩で詰まって使えなくなった事があった。
Expected Technology or Product from Japan	本邦企業T社及び本邦企業M社の保水材を耕作土混ぜ、灌漑水の下方への浸透を防止し、灌漑水の節水を図る。
Expected Action in the Future	サウジ政府の投資会社が日本の農業分野における先端的技術を持ったスタートアップ企業との連携に関心を示していることから、同会社と提携しサ国において保水材の実証試験を実施しつつ、サウジ市場に技術・製品を普及していく。

Project Sheet No. AG-2	Contents ：フィルムファーミング
Project Authority	MEWA本部・ブライダ支所、エスティダーマ農業開発センター、SIO試験農場、ブライダ近郊のハイテク農場、アルハサ商工会議所他
Challenge/Issue to be Solved	・MEWAやエスティダーマ農業開発センター等によりバーチカルファーミング技術（室内・施設内で多段棚的な水耕栽培技術）を国を挙げて推進しているため、是非とも日本の技術を紹介して欲しいとの要望があり水耕栽培技術のニーズが非常に高い。 ・MEWAブライダ支所がフィルムファーミング技術関心を示している。 ・アルハサのSIOの試験農場では、バーチカルファーミング（技術：アメリカ、装置：中国）による水耕栽培による野菜栽培を実証研究が行われており水耕栽培技術のニーズが非常に高い。 ・ブライダ近郊にあるハイテク技術を導入している農場はフィルムファーミング技術等の日本の節水灌漑技術に強く関心を示している。同農場はサ国における野菜の需要が１位であるトマトを主に栽培していて高い収益を上げている。敷地は10haで5000m²のグリーンハウスを20箇所を所有又、他の州にも規模が数倍程度の施設を建設予定している。 ・アスハサ商工会議所は、フィルムファーミング技術は国が推進しているバーチカルファーミングに適用可能であるとし興味を示している。
Expected Technology or Product from Japan	本邦企業M社のフィルムファーミング技術をバーチカルファーミングに適用する。またサ国においてトマトの需要が高い事から、フィルムファーミング技術を用いて高付加価値の糖度の高いトマトを生産・流通させる。
Expected Action in the Future	サウジの農業技術研究機関であるエスティダーマ農業開発センターは、節水灌漑技術について日本の本邦企業・大学、研究機関と共同研究を望んでいることから、同センターと技術提携し、JICAの実証事業や案件化調査の支援スキームを活用し活動・研究資金を確保し、サ国においてフィルムファーミング技術の実証事業を実施しつつ、サウジ市場に技術・製品を普及していく。

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Project Sheet No. AG-3	Contents ：バイオスティミュラント
Project Authority	エスティダーマ農業開発センター、ブライダ近郊のハイテク農場、アルハサ商工会議所他
Challenge/Issue to be Solved	・エスティダーマ農業開発センターは、バーチカルファーミングや節水灌漑技術について日本の本邦企業・大学、研究機関と共同研究を望んでいる。 ・ハイテク技術を導入している農場では、灌漑水の節水対策技術に非常に関心を持っている。 ・アルハサの商工会議所は日本のバイオスティミュラントに興味を示している。  ｴｽﾃｨﾀﾞｰﾏ農業開発ｾﾝﾀｰ  ｱﾙﾊｻSIOのﾊﾞｰﾁｶﾙﾌｧｰﾐﾝｸﾞ施設  ﾌﾞﾗｲﾀﾞ近郊のﾊｲﾃｸ農場
Expected Technology or Product from Japan	本邦企業A社のバイオスティミュラントを普及し、有効成分である酢酸の効果により、農作物全般に耐乾燥性・耐暑性を与え、灌漑水量及び頻度の削減し、サ国のの農作物の生産性の安定化を図る。
Expected Action in the Future	サウジ政府の投資会社が日本の農業分野における先端的技術を持ったスタートアップ企業との連携に関心を示していることから、同会社と提携しサ国においてバイオスティミュラントの実証試験を実施しつつ、サウジ市場に技術・製品を普及していく。

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Project Sheet No. AG-4	Contents ：点滴灌漑チューブ
Project Authority	リヤド商工会議所、MEWA本部・ブライダ支所、エスティダーマ農業開発センター、SIO試験農場、ブライダ近郊のハイテク農場、アルハサ商工会議所他
Challenge/Issue to be Solved	・サ国では栽培が盛んなデーツ等の果物やトマト等の野菜は、殆どが点滴灌漑チューブて灌漑されている。 ・リヤド商工会議所が、高性能の点滴チューブに興味を示している。 ・現地で製造し販売している灌漑用のパイプはSASO、ASTM、ISO等の国際標準規格で生産されているとの事であるが、品質が良くない。目詰まりや継ぎ目からの漏水が良く見られる。 ・デーツ栽培において、点滴灌漑チューブを使用した地中灌漑で27%の水を削減できる。 ・アルハサのSIOの試験農場では、現行の灌漑方法（ｽﾌﾟﾘﾝｸﾗｰ）は古いため、ドリップ灌漑方法に変更するよう検討中。再生水を利用した場合、細い灌漑チューブがよく詰まる等の問題ある。（末端部では水圧が低下して根詰まりが発生した可能性が考えられる） ・アルハサでは、グリーンベルト（緑化）を作るため点滴チューブで再生水や農業廃水を利用して10万本の木に灌漑している。 
Expected Technology or Product from Japan	点滴灌漑チューブのニーズが非常に高い事から、灌漑チューブの水圧が全ての区間一定に保て、水頭ロスが少なく長い距離送水することが可能な本邦企業Ｅ社の高性能な圧力補正型点滴チューブをサ国に紹介・普及を図る。
Expected Action in the Future	サウジの農業技術研究機関であるエスティダーマ農業開発センターは、節水灌漑技術について日本の本邦企業・大学、研究機関と共同研究を望んでいることから、同センターと技術提携し、JICAの実証事業や案件化調査の支援スキームを活用し活動・研究資金を確保し、サ国においてフィルムファーミング技術の実証事業を実施しつつ、サウジ市場に技術・製品を普及していく。

Project Sheet No. AG-5	Contents ：トラクター
Project Authority	リヤド商工会議所、ブライダ近郊の農場他
Challenge/Issue to be Solved	・リヤド商工会議所が、日本のトラクターに関心を示している。サウジ北部では日本の小さいトラクターのニーズが高い。 ・グリーンハウス内の作業で使用するための小型のトラクターのニーズが高い。ハイテクのものではなく中テク程度よい。日本製は使いやすいが日本製を扱っているサウジの代理店のメンテナンス体制が良くない。   ﾌﾞﾗｲﾀﾞ近郊の標準的な規模の農場で使用されていた日本製ﾄﾗｸﾀｰ及び部品
Expected Technology or Product from Japan	使いやすく、耐久性の良い本邦企業のトラクターのシェアーの拡大を図る。またロボットトラクターや農業用ドローン等のスマート農業技術も合わせてサ国に紹介・普及を図る。
Expected Action in the Future	サ国の国土が広大であるため、農機の販売を行うためには、販売のローカルネットワークを持った現地のディストリビューター（セールスエージェントとサービスエージェント）を契約し、サービス体制を確立し、農機の販売・普及を図る。

Project Sheet No. AG-6	Contents ：スマートメーター
Project Authority	MEWA、ブライダ近郊の農場他
Challenge/Issue to be Solved	・現在、井戸からの灌漑水の使用量のデータ収集中であり、将来水使用料徴収のためのスマートメーターのニーズが非常に高いと思われる。農場内の井戸の標準的な直径はで12inchである。 ・ブライダ近郊の農家へのインタビューによると、１年以内にMEWAが各井戸に流量計を設置する予定である。 ・サ国の上水道へのスマートメーターの普及率は90%以上であるが、農業用の井戸の揚水量計測のためのスマートメーターの普及開始はこれからである。   ﾌﾞﾗｲﾀﾞ近郊の農場内の井戸及び揚水ﾎﾟﾝﾌﾟ　ﾌﾞﾗｲﾀﾞ近郊の農場内のｾﾝﾀｰﾋﾟﾎﾞｯﾄと接続する井戸
Expected Technology or Product from Japan	日本の高性能の水道用のスマートメータの紹介・普及を図る。
Expected Action in the Future	サ国の国土が広大であるため、スマートメーターの販売を行うためには、販売のローカルネットワークを持った現地のディストリビューター（セールスエージェントとサービスエージェント）と契約し、サービス体制を確立し販売・普及を図る。 11

Project Sheet No. AG-7	Contents ：漏水対策技術
Project Authority	SIO
Challenge/Issue to be Solved	・リヤド近郊の一部地域やアルハサー体では、都市下水の再生水を利用した灌漑が行われており、アルハサにおいては3,000箇所の農地に送水されている。SIOは配水スケジュールに従って、コントロールルームから水圧、バルブ開閉等遠隔管理し再生水を送水している。農業用パイプライン(主にコンクリートシリンダー管)の延長が長く、老朽化、水撃圧、電食等により漏水が発生している。 ・農場内の灌漑用パイプで、メカニカルジョントからの漏水が良く見られる。   ｱﾙﾊｻのSIOの中継ﾎﾟﾝﾌﾟ場内にある再生水送水のためのコンロロールセンター
Expected Technology or Product from Japan	漏水発見器や管内調査ロボットによる漏水箇所の特定技術や、アルハサの市街地等で開削が難しい漏水箇所の補修には、近くのマンホールや縦坑より、熱又は光で硬化する樹脂を含浸させた材料や熱可塑性樹脂や連続パイプを既設管内に引き込み、管内から管の漏水箇所を補修・更新する工法である管更生工法のサ国への紹介・普及を図る。
Expected Action in the Future	サ国の国土が広大であるため、漏水探知器等の販売を行うためには、販売のローカルネットワークを持った現地のディストリビューター（セールスエージェントとサービスエージェント）と契約し、サービス体制を確立し販売・普及を図る。 12

Project Sheet No. AG-8	Contents ：塩分除去装置
Project Authority	エスティダーマ農業開発センター、ブライダ近郊の農園
Challenge/Issue to be Solved	・ブライダ近郊の標準的な農場で聞き取りによると、ブライダ周辺では井戸の塩分濃度が場所によって異なり、塩分濃度が高く作物の生育に影響が出る農園が多い。それらの農場においては、小型のRO装置（台湾製が多い）を購入し灌漑水より塩分除去を行っている。日本製の高品質て安価な小型のRO装置に関心を示している。 ・エスティダーマ農業開発センターの試験圃場やブライダ近郊のハイテク農場では、高品質の作物栽培の実施や点滴チューブ内の塩類による根詰まり発生防止のためRO装置を設置し活用している。 ・サ国の多くの一般家庭には、飲み水用の小型のRO装置が設置され使用されている。  ｴｽﾃｳｨﾀﾞｰﾏの塩分除去装置  ﾌﾞﾗｲﾀﾞ近郊農園のRO装置
Expected Technology or Product from Japan	日本製の高品質な小型の戸別の塩分除去装置をハイテク技術を導入している農場や井戸水の塩分濃度が高い農場に紹介・普及を図る。
Expected Action in the Future	サ国の国土が広大であるため、**塩分除去装置**の販売を行うためには、販売のローカルネットワークを持った現地のディストリビューター（セールスエージェントとサービスエージェント）と契約し、サービス体制を確立し販売・普及を図る。

サウジアラビア国における本邦企業の技術・製品の適用可能性（概要）

上水道分野：

1．現地調査における主な調査事項
・給水装置（工事・漏水）の現状と課題
・漏水調査及び無収水削減活動の現状と課題
2．現状の課題と対応策
・節水器具の市場は活発（5-6年前にNWCが住民へ配布、その後も米国欧州の企業活動活発）
・プラスチック製の分水サドルからの漏水が多発
・異種間接合の継ぎ手からの漏水あり（現在の仕様であるHDPE同士の熱融着には問題なし。）
・漏水調査工法としてヘリウムガス調査が主流だが、ガス検知器が高額である。
・配水管仕切弁の故障、漏水
・GISの図面と現地配管が一致しない。水道の顧客が登録されていないケースがある。
3．本邦企業の技術・製品の適用可能性
・サドル分水栓・施工工具・ステンレス波状管・給水管の継ぎ手
・ヘリウムガス検知器
・ソフトシール仕切弁
・流量計
・給水装置工事士、漏水調査士のような技術者研修制度の検討

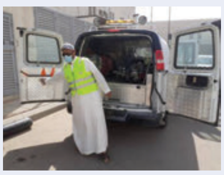
（２）上下水道分野の本邦企業の技術・製品適用可能性

Project Sheet No. WS-1	Contents
Project Authority	NWC
Challenge/Issue to be Solved	主に給水管からの漏水の発生を抑制する
Expected Technology or Product from Japan	サドル分水栓・分水栓用施工工具・ステンレス波状管・給水管継ぎ手
Expected Action in the future	試験採用による採用効果の証明

サドル分水栓（旧）	サドル分水栓（新）	継ぎ手	継ぎ手
			

（２）上下水道分野の本邦企業の技術・製品適用可能性

Project Sheet No. WS-2	Contents
Project Authority	NWC, Leak Detection Companies
Challenge/Issue to be Solved	主に給水管からの漏水の箇所を探査する
Expected Technology or Product from Japan	ヘリウムガス検知器
Expected Action in the future	試験採用による採用効果の証明

ヘリウムガス 調査車両	ヘリウムガス 検知器	ヘリウムガス 配管への注入
		

（2）上下水道分野の本邦企業の技術・製品適用可能性

Project Sheet No. WS-3	Contents
Project Authority	NWC
Challenge/Issue to be Solved	配水管上の仕切弁の故障を抑制する
Expected Technology or Product from Japan	ソフトシール仕切弁
Expected Action in the future	試験採用による採用効果の証明

仕切弁 （フランス製）	仕切弁 （ポーランド製）
	

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（2）上下水道分野の本邦企業の技術・製品適用可能性

Project Sheet No. WS-4	Contents
Project Authority	Private Company （SMC）
Challenge/Issue to be Solved	50mm 以上の流量計の販売
Expected Technology or Product from Japan	50mm以上の電磁流量計・超音波流量計
Expected Action in the future	現地メーカーとのLocalization を含む協力関係の構築

60％～70%の市場占有率	メータテストベンチ	電力メーターの製造ライン	超音波流量計をドイツから輸入
			

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サウジアラビア国における本邦企業の技術・製品の適用可能性（概要）

水質改善分野：

1. 現地調査における主な調査事項

- 対象都市の下水再利用、水質改善・管理の現状
- 各浄水施設における、現状の概略仕様、稼働状況及び課題・ニーズの把握
- 各種水質基準及びその遵守状況
- 各水質試験室における、測定水質項目、保有分析機材、稼働状況及び課題・ニーズの把握
- 調査団が持参した簡易水質分析機材を用いたオンサイト水質測定

調査団が持参したポータブル水質機材による水質測定

電気伝導率、濁度等

NO_3-N、NH_4-N、PO_4-P、残留塩素

糞便性大腸菌

2. 現状の課題と対応策

- 都市給水の約60%は、海水淡水化水を使用。海水淡水化に伴う化石燃料の消費量はサ国全体の燃料消費量の約2.5%に相当する。
- 農業用水、水道用水、工業用水を含めた全体の水使用量の約90%を化石地下水より取水している。再生可能な地下水、表流水からの取水は約10%に留まっている。
- サ国全体の下水道の普及率は約60%に留まっている。 ・このような状況下、地下水位が低下し、水質が悪化している。
- これら課題の解決すべく、下水処理水の再利用の推進（17%→70%）、再生可能な地下水・表流水の有効に活用するために（9%→20%）、適切な排水処理を推進している。

参考：現地調査結果に基づく下水再利用の現状
※カシーム州（ブライダ市、ウナイザ市）は、海水淡水化プラントのあるペルシャ湾岸地区から600km以上離れており、多大な送水コストを費やしている地域。
ブライダ市：約30%(下水道普及率約65%)、ウナイザ市：約100%(下水道普及率約75%)、ハサ市：約100%(下水道普及率約80%）更に下水処理水を別の都市から受水)

3. 本邦企業の技術・製品の適用可能性

- かん水（TDS5,000mg/L以下の地下水、表流水）の脱塩技術
- 海水淡水化、かん水淡水化設備から排出される濃縮水の適正処理、ゼロリキットディスチャージ（ZLD）、有価物回収技術
- 下水再生水の塩素消毒を補完、代替する消毒技術（紫外線他）・既存井戸水源の砂ろ過代替技術（高速繊維ろ過）を用いた濁度除去、消毒
- 安価な散気動力で高効率に窒素を除去する活性汚泥処理（オキシデーションディッチ法） ・高効率な下水処理機械
- 脱水汚泥のリサイクル技術（堆肥化） ・海水、陸水の水環境汚染を防止するための水質モニタリング技術
- 簡易で精度の高い水質分析技術（微生物分析、汚泥中の重金属分析他） ・下水道未整備地区の生活排水処理技術

（３）水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-1	Contents
Project Authority	サウジアラビア灌漑公社（SIO）、ハサ市
Challenge/Issue to be Solved	• かん水の脱塩（TDS約5000mg/Lの下水処理水等を農業用水等向けに約1,000mg/L以下に低減する）

ハサ市の灌漑施設

灌漑施設のポンプ場の受水槽
（125,000m3/槽×2槽、下水処理水を送水）

農場の灌漑用水

農場から排出される排水

排水路の水質例（2021年10月4日実施）

水質項目	単位	測定値	参考 運転管理の水質基準値 SIO
水温	℃		
pH	-		6-8.4
電気伝導率	μS/cm		(2,500mg/L〉)
濁度	NTU		5 〉
アンモニア	mg-N/L		10 〉
硝酸	mg-N/L		10〉
リン酸	mg-P/L		
残留塩素（遊離）	$mg\text{-}Cl_2/L$		
残留塩素（遊離+結合）	$mg\text{-}Cl_2/L$		
糞便性大腸菌	CFU/ml		不検出

Expected Technology or Product from Japan	• かん水の脱塩向けの各種膜分離技術（RO膜、NF膜等）、電気透析技術他
Expected Action in the future	当該技術を用いた実証試験

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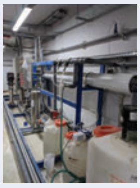
（３）水質改善分野の本邦企業の技術・製品適用可能性

<table>
<tr><th>Project Sheet No. WQ-2</th><th>Contents</th></tr>
<tr><td>Project Authority</td><td>海水淡水化公社（SWCC）、環境水農業省（MEWA）ブライダ市浄水場　他</td></tr>
<tr><td>Challenge/Issue to be Solved</td><td>

• RO膜濃縮水の海洋環境、陸水環境への影響回避、有価物回収

RO膜を用いた脱塩施設例

ブライダ市浄水場
（浄水能力約70,000m3/日、水源：地下水）



リヤド市のホテルの浄水設備
（水源：地下水）

主要項目の排水基準※1

<table>
<tr><th>水質項目</th><th>単位</th><th>基準値(mg/L)</th></tr>
<tr><td>蒸発残留物(TDS)</td><td>mg/L</td><td>2000</td></tr>
<tr><td>浮遊物質(TSS)</td><td>mg/L</td><td>50(35)※2</td></tr>
<tr><td>BOD</td><td>mg/L</td><td>40(25)</td></tr>
<tr><td>NO_3-N</td><td>mg-N/L</td><td>(15)</td></tr>
<tr><td>PO4-P</td><td>mg-P/L</td><td>10</td></tr>
</table>

出典：Environmental law (2019年制定)
※1　陸（Ground）に放流する場合。
※2 (　)は平均値

</td></tr>
<tr><td>Expected Technology or Product from Japan</td><td>• 海水淡水化、かん水淡水化設備から排出される濃縮水の適正処理、ゼロリキットディスチャージ（ZLD）、有価物回収技術
- 電気透析、蒸発、晶析技術</td></tr>
<tr><td>Expected Action in the future</td><td>当該技術を用いた実証試験</td></tr>
</table>

（３）水質改善分野の本邦企業の技術・製品適用可能性

<table>
<tr><th>Project Sheet No. WQ-3</th><th>Contents</th></tr>
<tr><td>Project Authority</td><td>サウジアラビア灌漑公社（SIO）、ハサ市、リヤド市</td></tr>
<tr><td>Challenge/Issue to be Solved</td><td>

• 下水処理水を使用する灌漑施設（ポンプ場等）における塩素消毒の課題：
-ぜん虫類（回虫等）の消毒　　-塩素消毒による設備の腐食

紫外線消毒の導入事例

ハサ市灌漑施設のポンプ場
（設計処理量150,000m³/日。調査時はメンテナンス中）

塩素消毒による腐食事例

リヤド市灌漑施設のポンプ場の受水槽
（総容量80,000m³、樹脂シートが塩素で腐食）

</td></tr>
<tr><td>Expected Technology or Product from Japan</td><td>• 下水処理水を使用する灌漑施設における塩素消毒を代替、補完する消毒技術
-紫外線、オゾン　等</td></tr>
<tr><td>Expected Action in the future</td><td>当該技術を用いた実証試験</td></tr>
</table>

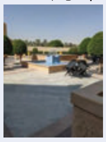
（3）水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-4	Contents
Project Authority	サウジアラビア灌漑公社（SIO）、ハサ市

Challenge/Issue to be Solved

- 既存井戸水源の糞便性大腸菌等による汚染

ハサ市の灌漑用井戸の放水口
（元々灌漑用水に使用していたが、
今は水遊びの場として一般開放）



JICAサウジアラビア事務所前の噴水

灌漑用井戸の水質（2021年10月4日実施）

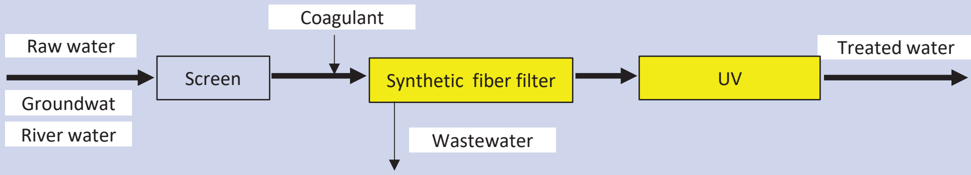
水質項目	単位	測定値	参考 運転管理の水質基準値
			SIO
水温	℃		
pH	−		6−8.4
電気伝導率	μS/cm		(2,500mg/L>)
濁度	NTU		5 >
アンモニア	mg−N/L		10 >
硝酸	mg−N/L		10>
リン酸	mg−P/L		
残留塩素（遊離）	mg−Cl_2/L		
残留塩素（遊離+結合）	mg−Cl_2/L		
糞便性大腸菌	CFU/ml		不検出

※　井戸深は、約120m

Expected Technology or Product from Japan

- 砂ろ過代替設備（繊維ろ過）+紫外線等の消毒技術

処理フロー案



Expected Action in the future

当該技術を用いた実証試験

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（3）水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-5	Contents
Project Authority	環境・水・農業省(MEWA)、ブライダ市、ウナイザ市

Challenge/Issue to be Solved

- 安価な散気動力で高効率に窒素を除去する活性汚泥処理（オキシデーションディッチ法）

ウナイザ市下水処理場（計画処理量:50,000m³/日）

曝気槽
（処理方式：オキシデーション
ディッチ法、馬蹄形）

曝気槽の内部

放流水の水質結果（2021年9月29日実施）

水質項目	単位	測定値	参考 運転管理の水質基準値	
			MEWA	SIO
水温	℃			
pH	−		6−8.4	6−8.4
電気伝導率	μS/cm		(2500mg/L>)	(2500mg/L>)
濁度	NTU		5 >	5 >
アンモニア	mg−N/L			10 >
硝酸	mg−N/L		10 >	10>
リン酸	mg−P/L			
残留塩素（遊離）	mg−Cl_2/L		0.5<	
残留塩素（遊離+結合）	mg−Cl_2/L			
糞便性大腸菌	CFU/ml		不検出	不検出

Expected Technology or Product from Japan

- 好気・嫌気ゾーン制御を用いた処理技術

Expected Action in the future

当該技術を用いた実証試験

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（３）水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-6	Contents
Project Authority	環境・水・農業省(MEWA)、ブライダ市、ウナイザ市
Challenge/Issue to be Solved	• 高効率な下水処理機械 • 故障時の対応、スペアパーツの供給を保証するアフターサービス体制

ブライダ市下水処理場（計画処理量:150,000m³/日）

自動除塵機（沈砂設備）

汚泥脱水機（汚泥処理設備）

Expected Technology or Product from Japan	• 自動除塵機、集砂装置、汚泥掻寄機、汚泥脱水機等
Expected Action in the future	当該技術を用いた実証試験

（３）水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-7	Contents
Project Authority	環境・水・農業省(MEWA)、ブライダ市、ウナイザ市、工業省（MODON）
Challenge/Issue to be Solved	• 脱水汚泥のリサイクル技術

下水処理場の脱水汚泥

ウナイザ市下水処理場

参考：現地の廃棄物処理事情

汚泥再利用基準

項目	単位	基準値	参考　日本の下水汚泥肥料※1
ヒ素	mg/kg-DS	75	50
カドミウム	mg/kg-DS	85	5
クロム	mg/kg-DS	3,000	500
銅	mg/kg-DS	4,300	
鉛	mg/kg-DS	840	100
水銀	mg/kg-DS	57	2
モリブデン	mg/kg-DS	75	
ニッケル	mg/kg-DS	420	300
セレン	mg/kg-DS	100	
亜鉛	mg/kg-DS	7,500	
糞便性大腸菌	Number /g-DS	1000>	
サルモネラ	Number /4g-DS	3>	
ぜん虫類の卵	Number /50g-DS	1>	
腸管系ウイルス	PFU /4g-DS	1>	

出典：Water act (2019年制定)
※１　肥料取締法を参照した。

Expected Technology or Product from Japan	• コンポスト装置等
Expected Action in the future	当該技術を用いた実証試験

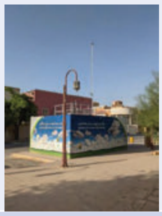
（3）水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-8	Contents
Project Authority	国家中央環境管理センター(NCEC), サウジアラビア灌漑公社(SIO)
Challenge/Issue to be Solved	• 海水、陸水の水環境汚染を防止するために、水質モニタリングを行う • 良好な水質の農業用水を安定的に送水する。

地下水の水質分析結果例

サンプル		井戸A	井戸B			
測定日		2021/10/5	2021/9/26			
測定場所		リヤド市	ブライダ市			
井戸深		約100m	約100m			
用途		生活用水	農業用水			
水質項目	単位	測定値		参考 水質基準値		
				水道	灌漑用水	環境基準（飲用可能な地下水）
水温	℃					
pH	–			6–8.5	6.5–8.4	6.5–9
電気伝導率	μS/cm			(100–1,000mg/L)	(2,000mg/L>)	
濁度	NTU			5 >		
アンモニア	mg–N/L			0.4>		0.3>
硝酸	mg–N/L			10 >	30>	
リン酸	mg–P/L					
糞便性大腸菌	CFU/ml			不検出	20/100ml	不検出

参考：大気のモニタリングステーション（リヤド市）



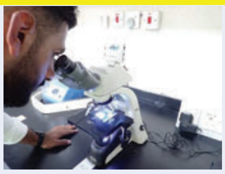
Expected Technology or Product from Japan	• 各種水質センサー(濁度、COD、DO、硝酸イオン等)、データ収集装置、伝送装置を搭載した地下水、表流水等の水質モニタリングユニット • 各種水質センサー（残留塩素、濁度、硝酸性イオン）を用いた、灌漑施設の受水槽における水質監視
Expected Action in the future	当該技術を用いた実証試験

（3）水質改善分野の本邦企業の技術・製品適用可能性

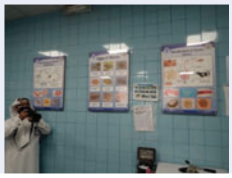
Project Sheet No. WQ-9	Contents
Project Authority	環境水農業省（MEWA）ブライダ市中央水質試験室、ブライダ市下水処理場、ウナイザ市下水処理場、サウジアラビア灌漑公社（SIO）ハサ市中央水質試験室
Challenge/Issue to be Solved	• 簡易に精度高く病原性微生物分析や病原性原虫及び卵の測定、観察、同定するための分析技術。 • 汚泥中の簡易重金属分析

微生物分析の様子

簡易大腸菌試験
(ブライダ市下水処理場内水質試験室)



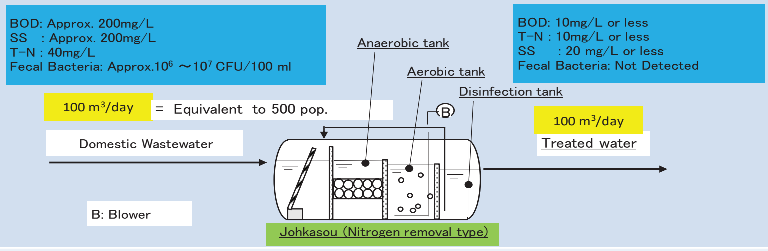
活性汚泥の観察
(ウナイザ市下水処理場内水質試験室)



下水処理水中に観察されるぜん虫類のパネル
(ハサ市中央試験室)

Expected Technology or Product from Japan	• 簡易糞便性大腸菌分析技術、簡易に高精度で病原性原虫及び卵を観察・同定するための技術 • 汚泥中の簡易重金属分析（蛍光X線分析）
Expected Action in the future	JICAの支援スキーム等を利用した各種、分析技術支援

(3)水質改善分野の本邦企業の技術・製品適用可能性

Project Sheet No. WQ-10	Contents
Project Authority	環境水農業省(MEWA)ブライダ市、地方自治省(MOMRA)?、工業省(MODON)
Challenge/Issue to be Solved	• 下水道未整備地区における生活排水による地下水・表流水の汚染防止 • 簡易に施工可能な民間食品工場排水向けの処理技術 参考:現地の汚泥収集車  ウナイザ市下水処理場
Expected Technology or Product from Japan	浄化槽 
Expected Action in the future	当該技術を用いた実証試験

「派遣プログラム」のご案内

・派遣の目的：
①サウジアラビアにおける水・農業部門の諸問題を解決する日本製品・技術の紹介。
②サウジアラビアにおける水・農業部門の諸問題についての理解を深める。
③投資対象としてのサウジアラビアのマーケットへの理解を深める。
④スタートアップ企業へのサウジアラビア投資会社からの投資を引き出すための一助とする。
・派遣期間：
2021年12月5日～12月16日（12日間）または2022年1月5日～1月16日
ご希望に応じて、一部行程のみの参加も可。
・派遣予定地：
【リヤド市】政府関係機関訪問、関係施設視察。民間企業との面談。添付日程表ご参照。
【カシーム州】政府関係機関、関係施設視察。農場視察。添付日程表ご参照。
・サウジ側参加予定者：
環境・水・農業省(MEWA)、投資省(MISA)、商工会議所、工業団地公団(MODON)、中小企業庁(Monsha'at)、民間企業
・参加の条件等：
新型コロナ関係：ファイザーあるいはモデルナの予防接種を二度済ませて、二週間が経過していること（証明書が必要）。帰国後２週間の隔離（自宅における隔離でも可）が必要。
自己負担：航空券（12月渡航約36万円、1月渡航約22万円）、宿泊費（１泊あたり約13,000円）、食費（1日あたり5000円程度）、海外旅行保険（1.5万円程度）、現地通信費(SIMカード、1万円程度)、PCR検査費用（4万円程度）、帰国後の隔離費用（ホテル代、ハイヤー代等）、VISA取得代（3万円程度）、VISA取得サポート代（約3.3万円）
JICA側手配・負担：サウジ国内交通、アル・カシーム州における通訳（通常リヤドでは英語が通じる）
申込締切10月29日（金、12月渡航の場合）、申込締切11月26日（金、1月渡航の場合）

「派遣プログラム」（上水道分野）の日程表（12月渡航案）

日程	曜日	活動内容
12月5日	日	成田発
12月6日	月	ドバイ経由リヤド着、日本大使館/JICA現地事務所を訪問。
12月7日	火	環境・水・農業省(MEWA)および投資省(MISA)を訪問
12月8日	水	水・農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催
12月9日	木	工業団地公団(MODON)本社訪問、リヤド近郊の工業団地の視察、リヤド市内水道関連施設の視察または中小企業庁(Monsha'at）を訪問、（短縮組はPCRテスト）
12月10日	金	フリー（観光）、（短縮組は帰国の途に着く）
12月11日	土	アル・カシーム州ブライダへ移動
12月12日	日	現地MEWA支所を訪問 現地上下水道処理場の視察
12月13日	月	農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催
12月14日	火	リヤドへ移動 PCRテスト JETRO/中東協力センターを訪問
12月15日	水	日本大使館/JICA現地事務所を訪問 リヤド発ドーハ経由
12月16日	木	成田着

注）：上記の日程案については現地側の状況により変更される可能性があります。

「派遣プログラム」（農業分野）の日程表（12月渡航案）

日程	曜日	活動内容
12月5日	日	成田発
12月6日	月	ドバイ経由リヤド着。日本大使館/JICA現地事務所を訪問。
12月7日	火	環境・水・農業省(MEWA)および投資省(MISA)を訪問
12月8日	水	水・農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催
12月9日	木	The National Research and Development Center for Sustainable Agriculture (Estidamah)を視察 **中小企業庁(Monsha'at）を訪問**
12月10日	金	フリー（観光）
12月11日	土	アル・カシーム州ブライダへ移動
12月12日	日	現地MEWA支所を訪問 現地農場（先端技術の農場および伝統技術の農場）を視察
12月13日	月	農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催
12月14日	火	リヤドへ移動 PCRテスト JETRO/中東協力センターを訪問
12月15日	水	日本大使館/JICA現地事務所を訪問 リヤド発ドーハ経由
12月16日	木	成田着

注）：上記の日程案については現地側の状況により変更される可能性があります。

「派遣プログラム」（上水道分野）の日程表（1月渡航案）

日程	曜日	活動内容	
1月5日	水	成田発	
1月6日	木	ドバイ経由リヤド着、日本大使館/JICA現地事務所を訪問。	
1月7日	金	フリー（観光）	
1月8日	土	フリー（リヤド近隣の農場見学を企画）	
1月9日	日	環境・水・農業省(MEWA)、投資省(MISA)および中小企業庁(Monsha'at)を訪問	
1月10日	月	水・農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催	
1月11日	火	工業団地公団(MODON)本社訪問、リヤド近郊の工業団地の視察 アル・カシーム州ブライダへ移動	工業団地公団(MODON)本社訪問、リヤド近郊の工業団地の視察、 リヤド市内水道関連施設の視察、PCRテスト
1月12日	水	現地MEWA支所を訪問 現地上下水道処理場の視察	リヤド発ドバイ経由
1月13日	木	農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催	成田着
1月14日	金	リヤドへ移動、PCRテスト	
1月15日	土	リヤド発ドバイ経由	
1月16日	日	成田着	

注）：上記の日程案については現地側の状況により変更される可能性があります。

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「派遣プログラム」（農業分野）の日程表（1月渡航案）

日程	曜日	活動内容
1月5日	水	成田発
1月6日	木	ドバイ経由リヤド着。日本大使館/JICA現地事務所を訪問。
1月7日	金	フリー（観光）
1月8日	土	フリー（リヤド近隣の農場見学を企画）
1月9日	日	環境・水・農業省(MEWA)、投資省(MISA)および中小企業庁(Monsha'at）を訪問
1月10日	月	水・農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催
1月11日	火	The National Research and Development Center for Sustainable Agriculture (Estidamah)を視察 アル・カシーム州ブライダへ移動
1月12日	水	現地MEWA支所を訪問 現地農場（先端技術の農場および伝統技術の農場）を視察
1月13日	木	農業分野についての現地企業・政府機関向けセミナー開催 現地企業・政府機関との個別ビジネスマッチング商談会の開催
1月14日	金	リヤドへ移動、PCRテスト
1月15日	土	リヤド発ドバイ経由
1月16日	金	成田着

注）：上記の日程案については現地側の状況により変更される可能性があります。

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皆様の
サウジアラビア国の水ビジネス・農業分野
へのご参加をお待ちしております。

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サウジアラビア国
節水・漏水対策、水質改善に係る情報収集・確認調査（QCBS)

第1次現地調査報告会

ご清聴ありがとうございました。

2021年10月25日

株式会社ワールド・ビジネス・アソシエイツ
八千代エンジニアリング株式会社
株式会社三祐コンサルタンツ
横浜ウォーター株式会社

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ANNEX:

3. List of the Supporting Schemes for Overseas Business Promotion by various Government
   Agencies of Japan

Appendix-2 Overseas business supporting schemes in Ministries and Agencies

No	Organizations	Scheme	Outline	Reward range	Target corporation	Department in charge	Application
1	JICA	Preparatory survey (Support to small and medium-sized enterprises(SMEs))	In the "Preparatory survey", public announcements are made about once or twice a year, proposals (business proposals) are solicited from SMEs , and business consignment contracts are concluded with SMEs that have proposed excellent businesses. For about a month to a year, JICA supports SMEs to collect basic information and formulation of business plans for businesses in developing countries.	■ Cost: Up to 8.5 million yen per case (9.8 million yen for remote areas) ■ Period: A few months to a year "	SMEs and those associations	JICA Private sector partnership and finance Department TEL +81-3-5226-3491、E-mail: sdg_sme@jica.go.jp	First public notice on early June ↓ Mid-June deadline Pre-registration required ↓ Credit check Scheduled from mid-June to mid-July ↓ Main registration, submission of application documents Early July ↓ Hearing (conducted as needed) Scheduled from mid-August to late August ↓ Notification and publication of examination results Mid-September ↓ After the contract is signed and the business starts in January of the following year (Estimated start time at the shortest) The open call for participants is usually held twice a year (June and December), and the open call for participants in December is off by half a year from the above. "
2	JICA	Formulation Survey (Support to SMEs)	In the "Preparatory survey", public announcements are made about once or twice a year, proposals (business proposals) are solicited from SMEs , and business consignment contracts are concluded with SMEs that have proposed excellent businesses. For about a month to a year, JICA supports information gathering on ODA projects, formulation of business models, and building relationships with government agencies of partner countries.	■ Cost: Up to 30 million yen per case (50million yen for transportation of the facilities) ■ Period: A few months to a year "			
3	JICA	Feasibility, Business Model Formulation Survey (Support to SMEs)	The businesses can contribute to solving problems in developing countries. Through the verification of business models including demonstration activities of technologies, products know-how, promotion of proposed products, possibility of utilization in ODA projects, business plans are formulated,	■ Cost: The maximum proposal amount is 100 million yen per case. (However, 150 million yen when dealing with complicated issues or introducing large-scale / advanced products, etc.) ■ Period: About 1 to 3 years from the start of the contract			
4	JICA	Formulation Survey (Support to SDGs business)	It formulates business model by considering business ideas and ODA projects that utilize technologies, products, know-how, etc. that can contribute to solving problems in developing countries.	■ Cost: Up to 8.5 million yen per case ■ Period: Several months to one year	Without above target enterprise and associations		
5	JICA	Formulation Survey (Support to SDGs business)	It formulates business plan by considering verification of business models including demonstration activities of technologies, products, know-how, promotion of proposed products, possibility of utilization in ODA projects., that can contribute to solving problems in developing countries.	■ Cost: Up to 50 million yen per case ■ Period: About 1 to 3 years			
6	Ministry of Health, Labor and Welfare (MHLW)	Project Formation Program in Water Supply Sector	In order to contribute to the project finding and formation capacity buildings in developing countries, it conducts research and examination from a professional and technical viewing through public-private cooperation on water facility development plans and water services operation plans in the countries concerned, and conducted excellent projects with high maturity. It is carried out for the purpose of giving advice and guidance to the country concerned.	6 million yen scale (2020 results)	Unified qualification of all ministries and agencies "A", "B" or "C" grade and have the qualification to participate in the competition in the Kanto / Koshinetsu area, on 2021, 22, 23	MHLW Minister's Secretariat International section	"Bid Announcement (Early May) Deadline for Receipt of Bid Documents Early July"
7	Ministry of Land, Infrastructure, Transport and Tourism (MLIT)	Urban development overseas support project	The aim is facilitation of entry of urban development in the overseas business. It supports that such as preliminary research on development plans and plans, feasibility studies, and holding seminars for overseas urban development project,	About 10million yen	Private enterprises, etc. (including Urban Renaissance Agency and general incorporated agency and general incorporated foundations)	MLIT City Bureau General Affair International section Tel:03-5253-8111	"Application period Early March to late March "
8	Ministry of Land, Infrastructure, Transport and Tourism (MLIT)	WOW TO JAPAN project(Wonder Of Wastewater Technology Of JAPAN project)	In order to understanding of Japanese technology to stakeholder of partner countries and promote the dissemination of the technology, It conducts that demonstration tests using local sewage water and work on dissemination activities.	■ Cost: Within the range of 40 million yen ■ Period: From the day after the contract date to the middle of March of the following year * In the case of 2021 "	Japan Registered Corporation	MLIT Water and Disaster Management Bureau Sewerage Department TEL:+81-35253-8427	"(Public announcement period) Mid-January to late March (Application acceptance period) Mid to late 3 (Performance period) From the day after the contract date to the middle of March of the following year "
9	Ministry of the Environment (MOE)	Intercity collaboration project to realize a carbon-free society	In this scheme, Japanese research institutes, private companies, universities, etc. are involved in the formation of a decarbonized and low-carbon society. The research projects are supported the to overseas local governments to form a decarbonized / low-carbon society and the equipment contributes the formation of a decarbonized / low-carbon society.	The upper limit of the contract amount (project cost) is assumed as follows per application survey project (the total number of adopted projects is assumed to be about 15 cases). ・Southeast Asia: 20 million yen / year (tax included) ・Middle East, South Asia: 22 million yen / year (tax included) ・Africa region, Central America region: 24 million yen / year (tax included) ■ Period: Up to 3 years (however, the contract is a single year)	Japan Registered Corporation	MOE Global Environment Bureau International Strategy Division International Cooperation Office TEL:+81-3-5521-8248	Public offering period Late March-Mid April
10	Ministry of the Environment (MOE)	Overseas CO2 reduction support project through strategic international expansion of Japan's recycling industry	Regarding businesses with specific overseas expansion plans in the field of waste treatment and recycling by Japan's recycling industry in Asia and Pacific developing countries, it supports the international expansion of the recycling industry, which has Japanese excellent waste treatment and recycling technology. This scheme is to reduce CO2 emissions and spread the 3Rs on a global scale, and to demonstrate Japan's leadership in the Asia-Pacific region.	■ Cost: SMEs subsidize 2/3, other private businesses subsidize 1/2 ■ Period: From the date of the grant decision to the completion of the project	Private corporation	Japan Waste Research Foundation. TEL+81-3-6659-6860	
11	Ministry of the Environment (MOE)	Bilateral credit system of the financial support project (the equipment subsidy project)	Japanese corporations implement greenhouse gas (hereinafter referred to as "GHG") emission reduction project that utilizes superior technology and measure, report, and verify (MRV) the effects of reducing GHG emissions. In the countries where JCM is being constructed, They go for issue the emission reduction amount as JCM credit.		International Consortium That is composed Japanese corporations (private company, independent administrative agency, incorporated association, foundation, etc.) and foreign corporations ,and promotes business implementation efficiently	Global Environment Centre Foundation Tokyo office TEL:+81^3-6801-8773 E-mail:jcm-info@gec.jp	Application period: Early April to late October
12	Ministry of the Environment (MOE)	Asian water environment improvement model project	In the first year, in the proposed area, feasibility study (FS) conducts a field demonstration test. and if the continuation of the second year is approved, a small-scale processing facility is built and introduced in the field. In the third year, they continue to carry out activities to build a local business model.	■ Cost: 10 million yen or less per project ■ Period: 3 year * In the case of 2020 "	Japan Registered Corporation (A consortium with local governments is possible)	MOE Environment Management Bureau Environment Management Bureau TEL:+81-3-5521-8312 E-mail: Water- Cycle@env.go.jp	Application period: Early April to late May

13	Ministry of Economy, Trade and Industry (MITI)	Project of promoting of low-carbon technology led by the private sector (Market creation promotion project using low-carbon technology (pre-demonstration survey)) ″	It consists of three phases: pre-demonstration survey, demonstration project, and quantification follow-up project. In the pre-demonstration survey, the formulation of a demonstration plan necessary for implementing of project, the probability of dissemination, the bilateral credit system (JCM), the greenhouse gas emission reduction effect due to Japan's contribution, and its quantification method are surveyed, the feasibility of the demonstration project and the dissemination of technologies and systems are examined. After the completion of the pre-demonstration survey, commercialization evaluation are conducted by outside experts and NEDO, and if the feasibility of the dissemination of the technology / system are highly recognized, the project will be performed to the demonstration project. ″	■ Cost: Pre-FS survey: 40 million yen or less per case (tax included) FS project: 1,000 million yen or less per case (tax included) Quantification follow-up project: Within 50 million yen (tax included) per case ■ Period: Within 3 years from the date specified by NEDO (1 year for development / installation, 2 years for demonstration. Adjustment is possible for each project) Quantification follow-up project: Within 2 years in principle	Japan Registered Corporation	International affair department Global environment technological promotion division TEL+81-044-520-5185 E-mail: askjcm@ml.nedo.go.jp	″Public offering period Late February-early April ″
14	Ministry of Economy, Trade and Industry (MITI)	Feasibility study business for overseas expansion of high-quality infrastructure	It promotes the overseas expansion of Japan's high-quality infrastructure in order to contribute to the economic development of the partner country and leads to strong economic growth in Japan. In this scheme, involved from the concept stage of the infrastructure plan of the partner country. (1) Investigation such as formulation of infrastructure development plans (master plans, etc.) for specific development areas that lead to the composition of individual infrastructure projects (2) Implementation of supporting for the project feasibility study (F / S) of individual infrastructure projects.	■ Costs, etc. Consignment: About 5-10 cases, max 100 million yen Subsidy: About 10-20 (subsidy rate is 1/2, max of 1 case is about 50 million yen) ■ Period: From the contract conclusion date to the end of February of the following year ″	Japan Registered Corporation	MITI Trade and Economic Cooperation Bureau, Trade Promotion Division +81-3-3501-6759	″Public offering period Middle January-late February ″
15	Ministry of Economy, Trade and Industry (MITI)	Feasibility study business for overseas expansion of high-quality energy infrastructure	By promoting the overseas expansion of Japan's high-quality energy infrastructure related to energy conservation and renewable energy, it reduces global energy-derived CO2 emissions. (1) Investigation such as formulation of infrastructure development plans (master plans, etc.) for specific development areas that lead to the composition of individual infrastructure projects (2) Implementation of supporting for the project feasibility study (F / S) of individual infrastructure projects.	■ Costs, etc. Consignment: About 5-10 cases, max 100 million yen Subsidy: About 10-20 (subsidy rate is 1/2, max of 1 case is about 50 million yen) ■ Period: From the contract conclusion date to the end of February of the following year ″	Japan Registered Corporation		
16	Ministry of Economy, Trade and Industry (MITI)	Social problem solving type international collaborative development project (subsidy for technical cooperation utilization type / emerging market development project)	[Product / Service Development Business (Jump out Japan!)] Japanese SMEs and collaboration with local universities, research institutes, NGOs, companies, etc. (hereinafter referred to as partner institutions) develop products and services to the solution of local social issues in developing countries. METI subsidize a part of expenses for the business.	■ Subsidy amount: A maximum of 30 million yen per company ■ Subsidy rate: 2/3 of the target expenses * In the case of a subsidy to support expansion into global growth markets ″	SMEs & Medium-sized enterprises and those associations	IC-NET ltd +81-48-600-2500	
17	Ministry of Economy, Trade and Industry (MITI)		[Business supporter support project] SMEs which develop B to B products and services in developing countries such as Africa (* hereinafter referred to as ″support target companies″) create expansion connecting local needs. METI subsidize a part of expenses for the business.	■ Subsidy amount: A maximum of 20 million yen per company ■ Subsidy rate: 2/3 of the subsidy target expenses ″	SMEs & Medium-sized enterprises and those associations	MITI Trade and Economic Cooperation Bureau, Technical Cooperation Division +81-3-3501-6759	
18	JETRO	Project for infrastructure system export	In order to promote the growth and revitalization of Japan, it conducts a project feasibility study on candidate infrastructure system overseas expansion projects. Through the project feasibility study, it proposes that utilize the superiority of Japanese technology and meet the needs of the partner countries. The projects in the partner countries is ordered from Japan. Collaborating with related ministries and agencies and public financial institutions from the initial stage, it makes consistent and competitive proposals from the projects to finance.	Max: 12million yen (Inclusive tax)	Corporation listed in Qualifications for Competition Participation of JETRO rated as A, B, C or D grade. In addition, those who have the qualification in the unified qualification of all ministries and agencies are considered to be rated at the same level.		Announcement date Mid May Deadline for receipt of public offering documents Mid-July
19	JBIC	Project survey	Implementing the survey necessary to realize the projects that lead to the following Promotion of overseas development and acquisition of resources that are important to Japan. To maintain and improve the international competitiveness of Japanese industry. Dealing with the turmoil in the international financial order. From October 2008, we changed to accepting it at any time.			Infrastructure and Environment Finance Group Social Infrastructure Finance Department TEL:81-3-5218-3953	Announcement as soon as there is a case
20	Infrastructure Development Institute	Project formulation survey	Supporting the social, economic development and environmental conservation of developing countries. Japan's ODA, public-private partnerships, or technical cooperation (research, research, expert dispatch, project technical cooperation, etc.), economic cooperation (grant aid projects and loan projects), and public-private partnership projects are the targets of the projects. It solicits project proposals widely for the purpose of discovering and forming excellent projects, investigate after examination.	1. Target countries: Developing countries (all regions) 2. Survey team: Proposing companies are the main 3. Field survey period: 1 to 2 weeks 4. Field survey implementation time: At any time 5. Survey cost sharing: One-third of the following costs for one member ・Round-trip airfare (Japan ⇔ destination country) ・Daily allowance (4,200 yen x total number of days) ・Accommodation fee (12,900 yen x total number of days-1) ・Survey fee (interpretation fee and rental car fee) ・Report preparation cost (labor cost for report preparation + printing fee 150,000 yen) (Kokukenkyo's share) ⇒ Subsidy for expenses of about 150,000 to 200,000 yen (Asia)	Member's corporation	IDI Research Laboratory Director TEL +81-3-5227-4102	Deadline for June-July
21	NEDO	International demonstration project of Japanese technology contribution to the efficiency of energy consumption	Through overseas demonstration of Japan's advanced technology that contributes to the realization of 3E + S (stable supply, economy, environmental compatibility, safety), it leads to the spread of the technology. Furthermore, it aims to return the results to Japan through demonstrations in the overseas energy market, which is institutionally ahead. Through these efforts, it contributes to the overseas expansion and market development of Japan's energy-related industries, energy conversion and decarbonization at home and abroad, and Japan's energy security.	Preliminary verification survey within 60 million yen Demonstration within 1 billion yen Follow-up within 50 million yen ″	Enterprise (including agencies) Local public agency	International department TEL:+81-44-520-5190	Open call for participants period About one month from the end of February The start time of the open call for participants may change. ″

ANNEX:

4. Report on the Business Environment at Saudi Arabia and its Neighboring Countries

Business Environment Study in Saudi Arabia and Neighboring Countries

8th October 2021

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1 Saudi Arabia

1.1 Ruling Laws and Regulations for Foreign Direct Investment (FDI)

In Saudi Arabia, the FDI is regulated by the Ministry of Investment of Saudi Arabia (MISA). MISA, previously known as Saudi Arabian General Investment Authority (SAGIA) is the foreign investment license provider for Saudi Arabia. SAGIA was established on April 2000, as part of measures geared towards formalizing the process of economic liberalization. SAGIA and MISA, since its establishment, have been marketing the investment sector in Saudi Arabia by studying and improving opportunities, utilizing them to lure investors at the domestic and foreign levels. It also enables them to carry out their business activities، extend their business and utilize their expertise and techniques in training and employment.

The ruling laws and regulations for FDI in Saudi Arabia are, “Foreign Investment Act” and “Executive Regulations of the Foreign Investment Act”. The 2 Acts define key aspects of FDI regulation such as “Benefits, Incentives and Guarantees”, “Licensing Conditions and Criteria”, “Licensing Procedures”, “Obligations of the Foreign Investor” and “Violations”.

An important regulation which a foreign investor shall take into account when considering to invest in Saudi Arabia is whether their business can be established with foreign ownership or not. The negative list (industry which does not allow foreign ownership) is defined within the “Foreign Investment Act”. Some of the industries included in the negative list are as follows:

- Oil exploration, drilling and production with some exception
- Manufacturing of military equipment, devices and uniforms
- Manufacturing of civilian explosives
- Catering to military sectors
- Security and detective services
- Real estate investment in Makkah and Madina
- Tourist orientation and guidance services related to Hajj and Umrah

The full negative list can be checked via the website of the embassy of Saudi Arabia, Washington DC.

Also, there is a minimum capital requirement to form an entity in certain industries. Some of the regulation includes following:

- The amount of capital invested shall not be less than 25 million Saudi Riyals (approx. 6.7 million USD[1]) for agricultural entities.

- The amount of capital invested shall not be less than 5 million Saudi Riyals (approx. 1.3 million USD[1]) for industrial entities.

- The amount of capital invested shall not be less than 2 million Saudi riyals (approx. 530,000 USD[1]) for other entities in accordance to detailed conditions and criteria laid down by Board of Directors.

Therefore, it is recommended to communicate closely with MISA when establishing an entity with foreign investment to make sure the activity is not on the negative list and the investment plan meets the minimum capital requirement.

Also, once an entity is established, it will be subjected to Saudization program (Nitaqat). Nitaqat requires private companies and enterprises to fill up their workforce with Saudi Arabian nationals up to certain levels. The Ministry of human resource and social development classifies the entities within each band as per varying degrees according to the Saudization Rates determined for each category. The enterprises are categorized according to their Saudization Rate and will be provided with benefits / penalties. Although there exists a regulation related to hiring local employees in Saudi Arabia, it is understood that depending on the size and form of investment made by the foreign entity, the investor may be eligible for negotiation with the Saudi Arabian government to ease the employment regulatory condition applied to the entity.

1.2 Incentives for FDI

There are several incentives provided by the government in the forms of financial incentives, fiscal incentives and employment incentives, which enterprise with foreign ownership can also enjoy. Some of the incentives include the following:

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[1] 1 SAR = 0.27 USD

Financial Incentive:

- Export credit financing, guarantee, insurance provided by the Saudi export program.
- Energy and utilities subsidies for power, water, natural gas, ethane, diesel, land.
- Financial incentives for R&D projects with potential to boost country's economic growth and self-reliance.
- Loan programs for public and private industrial investments.

Fiscal Incentive:

- Custom duty drawback and exemption on selected materials, equipment and machinery
- Tax credit and tax exemptions on Saudi national worker's payroll and training costs

Employment Incentive:

- Program offered by Human Resources Development Fund (HRDF) and aimed at encouraging training and employment of Saudi nationals
- On-the-job training program for Saudi graduates (Tamheer)
- Training in non-profitable institutes

Details of each incentive package can be found on the MISA website.

1.3 Inventory of the major Special Economic Zones/Industrial Cities

In Saudi Arabia, there is one Special Economic Zone (SEZ) named Integrated Logistics Bonded Zone (ILBZ) currently under operation. The Zone is located adjacent to the King Khalid International Airport in Riyadh and is operated and managed by Saudi Arabia's General Authority of Civil Aviation (GACA). The zone focusses on providing integrated logistics, forming part of a broader plan to attract more multi-national companies to the Kingdom by establishing a network of special economic zones in competitive locations, for sectors such as ICT, logistics, tourism, industrial and financial services. In March 2021, GACA released the special tax rates and regulations for ILBZ which includes 50 years tax exemption and other incentives for FDI enterprises. This includes a value-added tax waiver, while imported goods will be under the customs duty suspension arrangement. Companies operating in the Zone will also be exempt from corporate, income and withholding taxes on certain payments. All foreign entities operating in the Zone will enjoy up to 100% business ownership, 100% suspension of customs and import restrictions, and zero restrictions on capital repatriation. Companies operating in the Zone will be limited to certain activities in order to be eligible for the incentives, including maintenance, processing, modification, repair, development, assembly and storage of goods, after-sales services, import, export and re-export, and logistical and value-added services.

There are more than 30 Industrial cities and technology zones (including MODON Oasis and Private Cities) within Saudi Arabia. These cities and zones have been developed and supervised by Saudi Authority for Industrial Cities and Technology Zones (commonly known as MODON). MODON succeeded in raising the area of developed industrial lands until now nearly 200 million m^2. These cities manage 6,587 industrial and investment contracts and more than 4,000 factories between producer, existing and under construction and establishment. Some of the industrial cities and technology zones operated and managed by MODON are as follows (more detail can be found on the MODON Website):

Name	Location	Area (m^2)	Factory Count
Riyadh 1st. Industrial City	Downtown Riyadh on the western side of Riyadh Dry Port in Al-Malaz District.	500,000	63 industrial and service contracts
Jeddah 1st. Industrial City	South of Jeddah Province, east of Al-Rahmaniyah Market.	12,000,000	1,059 industrial and service contracts
Dammam 1st Industrial City	Southeast of Dammam near the coast of the Arabian Gulf.	2,400,000	169 industrial and service contracts
Riyadh Technology Valley	King Saud University's grounds in Riyadh	1,670,000	N/A

Source: [MODON Website]

The location of industrial cities and technology zones are well distributed around the country. There are also 3 technology zones (2 in Riyadh, 1 in Makkah) within Saudi Arabia.

Location of Industrial Cities within Saudi Arabia

Source: [MODON Website]

2 UAE

2.1 Ruling Laws and Regulations for Foreign Direct Investment (FDI)

In UAE, the federal government (Ministry of Economy) is responsible for implementing the laws and regulation whereas FDI attraction is conducted by the investment authority from each emirate. For example, Dubai FDI and Department of Economic Development, Abu Dhabi are the investment authority in Dubai and Abu Dhabi.

UAE initially implemented Federal Decree-Law No. 19 of 2018 on Foreign Direct Investment (FDI Law) in 2018. This law allowed foreign investors to hold more than 49% stake of the newly established company unless the company's activity is not on the negative list. (The foreign ownership of a company in UAE is regulated by the corporate law) Since the implementation of FDI Law, UAE has announced another change in regulation at the end of 2020, that the FDI law will be abandoned and "Amendments to Decree-Law No. (26) of 2020 for the Commercial Companies Law (CCL)" will be implemented. This Amendment was enforced at the end of March 2021, and following changes to FDI have been implemented.

According to the amendment to Article 10 of CCL, the general position will be that an LLC can be up to 100% foreign-owned unless it is carrying on "Activities of Strategic Effect". Activities of Strategic Effect will be specified by Cabinet Resolution based on the recommendations of a cross-emirate committee, following which, each emirate will set the UAE shareholding requirements in companies undertaking those activities in that emirate. This means that different foreign ownership restrictions could apply in each emirate for businesses undertaking such activities. Dubai and Abu Dhabi have released the list of activities which more than 50% of stake can be owned by foreign owners. Currently, Dubai's list consists of 1059 industries, and Abu Dhabi's list consists of 2225 industries.

Also, the Decree removes CCL article 329. The requirement for foreign branches to appoint a local service agent has been removed, wavering an administrative burden and reducing operating costs when establishing branch.

Overall, foreign ownership up to 100% is allowed both onshore and offshore (free zone), and the list of activities which allows 100% foreign ownership is defined by each emirate. To establish an onshore entity with more than 50% foreign ownership, the company will need to submit an application to investment authority in the emirate and once approved, will be provided with a license and will be able to proceed to entity establishment.

The minimum capital required to establish an onshore entity depends on the structure, however, with the most common LLC structure, the minimum capital required is 300,000 AED (approx. 82,000 USD[2])

2.2 Incentives for FDI

The incentives for FDI are provided by the investment authority and other related governmental organization from each emirate. In Dubai, Dubai FDI is the investment authority and they provide several measures to financially incentivize foreign investors. Some of the financial incentives provided by Dubai FDI include:

- The Mohamed Bin Rashid Fund For SME, which aims to finance innovative pilot projects, both small and medium enterprises, through dedicated efforts and a devoted focus on studying the project and providing appropriate assistance for start-up and expansion.

- Dubai Future Accelerators & Area 2071.
  Dubai Future Accelerators (DFA), an initiative by Dubai Future Foundation, facilitates the collaboration between government entities and private sector organizations with start-ups, scale-ups, and innovative SMEs from around the world to co-create solutions for future challenges.

  Area 2071 offers subsidized licensing fees to all startups and entrepreneurs. The fees amount to AED 1,000 annually for a commercial license allowing the entrepreneur to conduct three activities within the same segment.

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[2] 1 AED = 0.27 USD

- Investment from Dubai Angel Investors (DAI)
  DAI is a fully capitalized investment company, where angels range from seasoned investors, tech entrepreneurs, venture fund partners, senior executives of successful companies and one institutional investor.

As seen above, a lot of incentives provided by Dubai targets venture / SME which brings innovative technology to Dubai.

2.3 Inventory of the major Special Economic Zones/Industrial Parks

Special Economic Zones in UAE are called Free Zone. Free Zone is set up with the objective of offering tax concessions and customs duty benefits to foreign investors. There are over 40 multidisciplinary free zones within UAE and more than 30 Free Zones operate in Dubai. Free Zone in Dubai and the UAE are governed pursuant to a special framework of rules and regulations. A Free Zone Authority offers business licenses to foreign-owned businesses. Each Free Zone is designed around one or more industry categories and only offers licenses to companies within those categories. Most of the free zones in Dubai broadly offer trading, services, and industrial licenses to investors looking to set up their businesses.

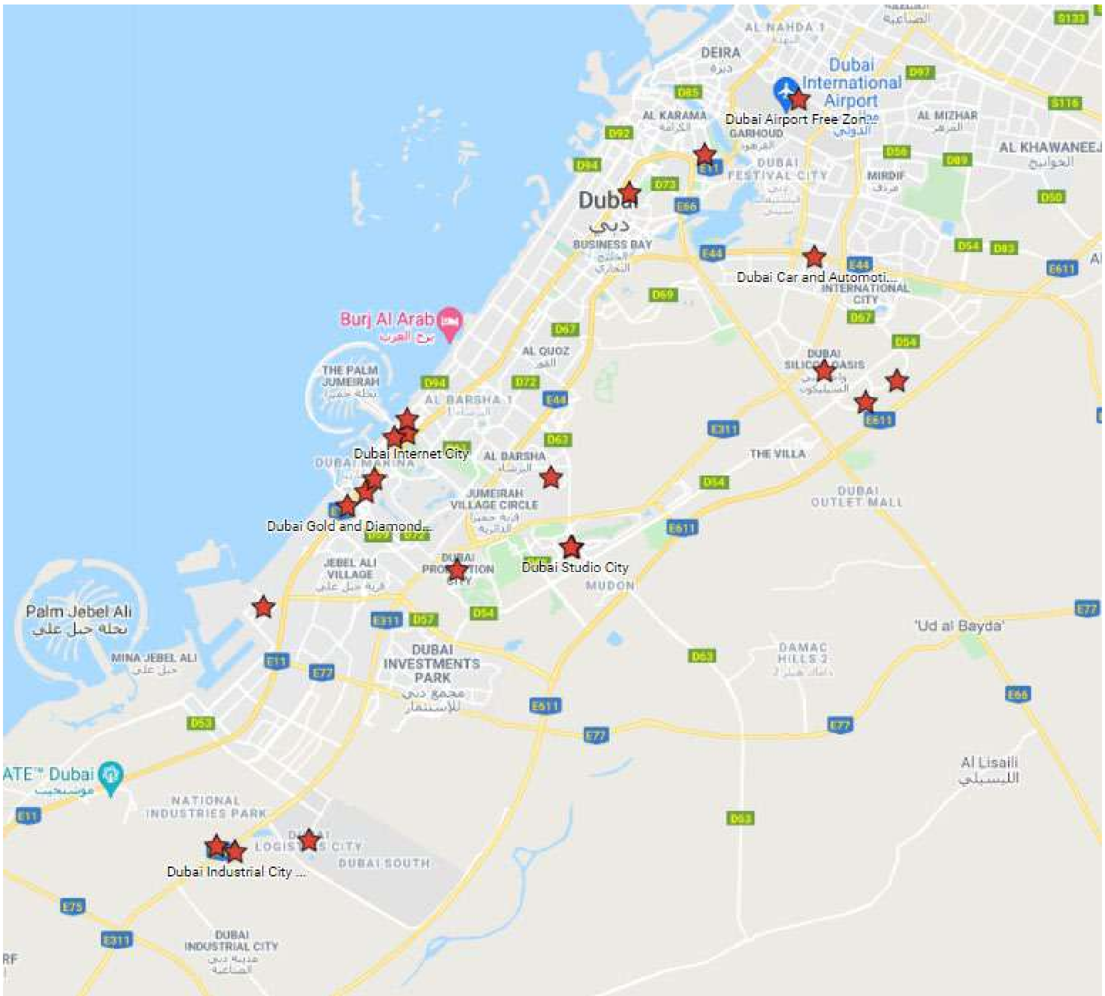
Some of the features of Free Zone include:

- 100% foreign ownership of the enterprise
- Access to world class logistic facilities
- Availability of a large pool of multicultural, skilled professionals
- Benefits from economies of concentration (given the zones dedicated to industries)
- Fast and easy business set-up procedures
- Tax holidays – usually guaranteed for 15 or 50 years
- 100% import and export tax exemption
- 100% repatriation of capital and profits
- Corporate tax exemptions for up to 50 years
- Eligibility to apply for the UAE Tax Residency Certificate
- Modern and sophisticated infrastructure

Most of the above features are available in the free zone. Some free zones provide additional incentive / features for certain business activities such as discounted utility rate. Below are some of the well-known free zones within Dubai and Abu Dhabi;

Name	Location	Industry	Characteristics
Dubai Airport Free zone	Next to Dubai International Airport	Trading/Logistics/ Others	Located next to the airport with bonded warehouse space. >10 Office buildings host vast variety of industries.
Jabel Ali Free zone	Near Jabel Ali port	Trading/Logistics/ Manufacturing/ Others	Located next to the sea port with bonded warehouse space. More than 20 office buildings host vast variety of industries.
Dubai Internet City	Near Jumeirah area	IT	Free zone specialized for IT companies. Habits companies such as Microsoft, Dell and Cisco.
Khalifa Industrial Zone Abu Dhabi	Abu Dhabi	Trading/Logistics/ Manufacturing	Located in between Dubai and Abu Dhabi central area, next to Khalifa port. Hosts number of logistics and heavy industry companies as well as food packaging and other daily necessities manufacturing.

Some of the free zones located within Dubai are pictured on the map below;



Source: Google Map

3 Egypt

3.1 Ruling Laws and Regulations for Foreign Direct Investment (FDI)

In Egypt, FDI is regulated by the General Authority of Foreign Investment (GAFI), which was established under the Investment Law. GAFI is an affiliate of the Ministry of Investment (MOI) and the principal government body regulating and facilitating investment in Egypt and oversees incorporation and licensing of businesses in Egypt. GAFI sets its mission as "Applying the stimulating investment strategies in accordance with international best practices and to be consistent with the adopted international standards in order to promote Egypt as a promising investment destination", and sets its strategic goals as:

- Promote Egypt globally as a safe and stimulating environment for investment.
- Reinforce cooperation with investment authorities worldwide, especially on the African level.
- Increase the competitiveness of Egypt in respect of attracting investment, especially the fields in which Egypt does not have a competitive advantage.
- Enhance Egypt's ranking in the relevant international reports.
- Coordinate and integrate with stakeholders on the local level to create a positive stimulating environment for investment.

The ruling laws and regulations for FDI in Egypt are, “Investment Law No. 72 of 2017” and “The Executive Regulations of the Investment Law No. 72 of 2017”. The Law defines key aspects of FDI regulation such as “facilitations and incentives for investors”, “the investment zones, technology parks and public free zones” and “regulation of the investment environment”.

Some of the important regulation which a foreign investor shall take into account when considering to invest in Egypt is whether their business can be established with foreign ownership or not. The law does not provide a comprehensive negative list (industry which does not allow foreign ownership), however, industries such as commercial agency (import and distribution of products in Egypt) is regulated by the Commercial Agency Law, which does not allow majority ownership of foreign capital. The full law can be seen on GAFI Website.

Also, there is a minimum capital requirement to set up an entity in Egypt:

Form of entity	Definition	Minimum Capital
Joint Stock Company (JSC)	Minimum of 3 shareholders is required with no maximum limit; can be a natural or juridical person.	250,000 EGP (approx. 16,000 USD[3]): However, the minimum capital of a JSC may vary depending on the company's activity and the decrees issued regulating such activity.
Limited Liability Company (LLC)	Minimum of 2 quota holders and a maximum of 50 quota holders	No minimum capital requirement.
One-Person Company (OPC)	Wholly owned by 1 person; can be a natural or juridical person.	50,000 EGP (approx. 3,200 USD[3]):

Therefore, it is recommended to communicate closely with GAFI when establishing an entity with foreign investment to make sure the activity is permitted and you meet the minimum capital requirement.

There is an employment regulation mentioned in the Investment Law, which states that "an Investment Project may employ foreign workers up to ten percent (10%) of the total number of Investment Project workers. This percentage may be increased up to twenty percent (20%), should employment of national workers having the required qualifications be not possible". Therefore, when establishing an entity, it is advised to consult with GAFI regarding the employment regulation too.

3.2 Incentives for FDI

There are several incentives and guarantees provided by the government in the forms of general incentives, special incentives and additional incentives, which

[3] 1 EGP = 0.064 USD

enterprise with foreign ownership can also enjoy. Some of the incentives include the following:

General Incentive:

- Memoranda of incorporation of companies and establishments, along with credit facility and pledge contracts pertaining to the business thereof, shall be exempt from stamp duty as well as notarization and publicity fees for a period of five (5) years from the date on which such memoranda and contracts are entered in the Commercial Register.
- Contracts of registration of lands required for formation of companies and establishments shall be exempt from the aforementioned duty and fees.

Special Incentive:

Projects set up in accordance with the investment map shall be granted an investment incentive, in the form of a discount off the taxable net profits, as follows:

- 50% discount off the investment costs of Sector(A): This sector comprises the geographic areas designated as most in need of development, based on the investment map, the data and statistics issued by the Central Agency for Public Mobilization and Statistics ("CAPMS") and the distribution of investment activities in such areas as specified by the Executive Regulations of the Investment Law.
- A thirty-percent (30%) discount off the investment costs of Sector (B): This sector covers the remaining geographic areas of the Republic, as per the distribution of investment activities.

Additional Incentive:

- Permission to establish special customs ports of entry for Investment Project importations or exportations, in agreement with Minister of Finance;
- Payment by the State for a part of the expenses incurred in course of providing personnel technical training

Full list of incentives and details of each incentive package can be found on the GAFI website.

3.3 Inventory of the major Special Economic Zones/Industrial Parks

Special Economic Zones in Egypt are called Free Zone. Free zones in Egypt are considered a special investment system governed by the provisions of Investment Law No. 72 of 2017 and its Executive Regulations, which enforcement is overseen by the GAFI. Currently, there exist 9 free zones in Egypt. All types of investment activities are allowed to be exercised inside free zones in accordance with the policy set by GAFI, mainly export-oriented industries, with the exception of the following:

- Weapons, ammunition, explosives and any industry relating to national security
- Wine and alcoholic beverages
- Fertilizers
- Manufacturing of iron and steel
- Petroleum refining
- Liquefaction, manufacture and transport of natural gas
- Energy-intensive industries

There are public and private free zones in Egypt. Public free zones are managed by the government and are well equipped with the necessary facilities and infrastructure for the operation and execution of projects (roads - electricity - sewerage stations - water networks - telecommunications), in addition to an integrated customs unit, a police station for ports' security maintenance, and a security unit in each zone, operating 24 hours a day.

Private free zones are unique establishment/system that represent only one independent project or more than one project exercising similar activities, as required (based on nature of the activities). It is imperative to be located outside the public free zone vicinity, due to the economics of the project, and the nature of its activities, which renders it essential to be located in specific places to benefit from the advantages offered by this site, in terms of proximity to raw material sources, production requirements, export markets or required labor, for integration with nearby projects, or due to proximity to a particular port or road. The private free zone site may be owned or rented by the investor.

In general, foreign entities will be more like to establish their entity in the Public free zone.

Some of the features of Public Free Zone include:

- No restrictions with regards to the nationality of the capital's owner, where a foreign investor can be the sole owner of the capital or can have any share in the investment (excluding projects set up in Sinai).
- Free transfer of invested capital and profits abroad.
- Freedom to select the field of investment and the legal form of projects.
- Free pricing of products and profit margin.
- There are no minimum or maximum limits for invested capital (for public free zone projects only).
- The ability to operate for others in order to maximize exploitation of the project's potential (in accordance with the rules adopted by GAFI in this regard)
- Providing foreign investors with residency facilities.
- Granting foreign workers residence permits as requested by the project.

The location of public free zones are as follows;

Source: GAFI Website

There are over 130 industrial zones across the whole country of Egypt. The industrial zones are also regulated by GAFI and the full list of industrial parks can be found on their website.

4 Turkey

4.1 Ruling Laws and Regulations for Foreign Direct Investment (FDI)

The ruling laws and regulations for FDI in Turkey are, "the FDI Law" and the "Regulation on the Implementation of the FDI Law". The FDI Law, which entered was enforced in 2003, has brought extensive changes in favor of foreign investors and liberated the foreign investment climate. The full law can be accessed on the Investment Office website.

The Investment Office of the Presidency of the Republic of Turkey is the official organization for promoting Turkey's investment opportunities to the global business community and for providing assistance to investors before, during, and after their entry into Turkey. Directly reporting to the President of Turkey, the Investment Office is in charge of encouraging investments that further enhance the economic development of Turkey.

Some of the important regulation which a foreign investor shall take into account when considering to invest in Turkey is whether their business can be established with foreign ownership or not. In general, Turkish law provides that foreign investors be treated equally to Turkish investors. There is no restriction on foreign shareholding except in a few specific sectors such as media, education and aviation. Other sectors which have foreign capital restriction includes Railway transportation infrastructure (No. 6461 Turkey Law on the Liberalization of Railway Transport), Fishery (No. 1380 Turkey Law on fishery) and Oil and Gas (No. 6491 Turkish Petroleum Law).

Also, there is a minimum capital requirement to set up an entity in Turkey:

Form of entity	Definition	Minimum Capital
Joint Stock Company (JSC)	company whose capital is definite and divided into shares and which is	50,000 TL (approx. 5,400 USD[4])

[4] 1 TL = 0.11 USD

	responsible for its debts only with its property holdings.	
Limited Liability Company	A limited company with a single shareholder can be established. The number of shareholders may not exceed fifty. Partners of a limited company may be real or legal persons.	10,000 TL (approx. 1,100 USD[4])

4.2 Incentives for FDI

The Turkish government offers a comprehensive investment incentives program with a wide range of instruments that helps to minimize the upfront cost burden and accelerate the returns on investments. These incentives may also be tailored for projects in priority sectors classified as key areas for the transfer of technology and economic development. In addition, the Turkish government provides generous support programs for R&D and innovation projects, employee training initiatives, and for exporters through various grants, incentives, and loans.

The incentives are provided in a form of General Investment Incentives, Regional Investment Incentives, Strategic Investment Incentives, Project-based Investment Incentive. Some of the incentives include the following:

General Investment Incentive:
- Customs duty exemption
- VAT Exemption

Regional Investment Incentive and Strategic Investment Incentive:
- Customs Duty Exemption
- VAT Exemption
- Corporate Tax Reduction
- Social Security Premium Support
- Land Allocation

・Interest rate Support

Project-Based Investment Incentive:
・Cash Support
・Qualified Personnel Support
・Energy Support
・Capital Contribution Support
・Purchasing Guarantee

Full list of incentives and details of each incentive package can be found on the Investment Office website.

4.3 Inventory of the major Special Economic Zones/Industrial Parks

There are 3 different special investment zones defined in Turkey:
Technology Development Zones (TDZ), Organized Industrial Zones (OIZ) and Free Zones (FZ).

TDZs are areas designed to support R&D activities and attract investments in high-technology fields. There are 84 TDZs, of which 63 are operational and 21 have been approved and are currently under construction. Some of the advantage of TDZs include the following:

- Income and corporate tax exemption
- VAT exemption
- Some proportion of social security premium covered by the government
- Customs duty exemption

OIZs are designed to allow companies to operate within an investor-friendly environment with ready-to-use infrastructure and social facilities. The existing infrastructure provided in OIZs includes roads, water, natural gas, electricity, communications, waste treatment and other services.

There are 353 OIZs in 81 provinces, 258 of which are currently operational, while the remaining 95 OIZs are being constructed throughout Turkey. In addition, more than 67,000 companies produce in over 32,000 parcels while more than 2 million people are employed through the OIZs. Some of the advantage of OIZs include the following:

- VAT exemption for land acquisition
- Real estate duty exemption (for first 5 years after plant completion)
- Subsidized water, natural gas and telecommunication utility cost
- Exemption from municipality tax

The OIZs are located widely across the country.

Source: [Invest turkey]

FZs are special sites deemed outside the customs area, although they are physically located within the political borders of the country. FZs are designed to boost the number of export-focused investments. Legal and administrative regulations in the commercial, financial and economic domains that are applicable within the customs area are either not implemented or partially implemented in FZs.

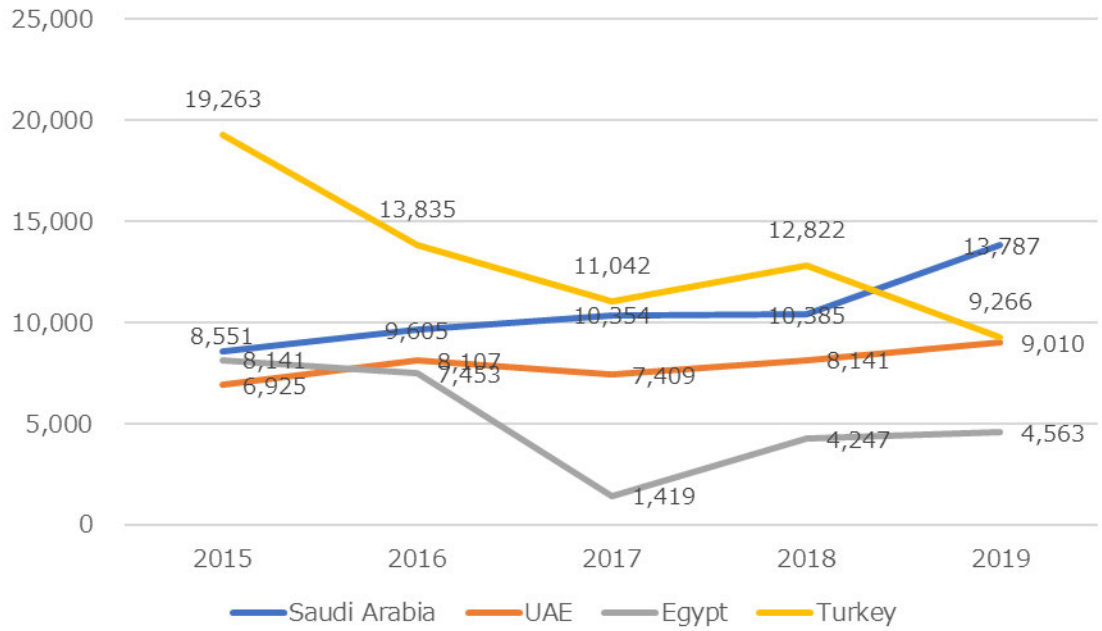
There are 19 FZs in Turkey located close to the EU and Middle Eastern markets, 18 of which are active and 1 is at the stage of establishment. FZs are strategically located at points that grant easy access to international trade routes via ports on the Mediterranean, Aegean Sea, and the Black Sea. Some of the advantage of FZs include the following:

- 100% exemption from customs duties and other assorted duties, corporate income tax (for manufacturing companies), value-added tax (VAT) and special consumption tax, stamp duty and real estate tax
- 100% exemption from income and corporate tax
- No restriction on profit transfer to outside of Turkey

5 Comparison of FDI environment

The World Bank discloses annual foreign direct investment net inflows data. According to their latest disclosure, the net inflow of FDI in Saudi Arabia is the highest among the 4 countries with 13,787 mil USD. It is then followed by Turkey (9,266mil USD), UAE (9,010mil USD) and Egypt (4,563mil USD).

Foreign direct investment, net inflows (Million US$)



Source: World Bank

The comparison of 4 countries in terms of FDI environment can be seen from the below chart;

Comparison of FDI environment in the 4 countries

		Saudi Arabia	Turkey	UAE	Egypt
FDI Regulation	**Ruling and regulation clarity**	✓			
	Foreign capital restriction	Certain sectors are restricted, however, FDI allowed in most sectors			
	Local labor employment regulation	Rating system (Nitaqat) introduced by the government	No regulation	No regulation	No rating system, however, ratio of foreign to local employee is regulated
	Minimum Capital[5,6]	2 million SAR (approx. 530,000 USD)	50,000 TL (approx. 5,400 USD)	300,000 AED (approx. 82,000 USD)	250,000 EGP (approx. 16,000 USD)
	Corporate Tax Rate[5]	20%	22%	0%	20% / 25%[7]
FDI Incentives	**Financial**	Foreign capital companies enjoy similar incentive to local company (e.g. tax exemptions, subsidy on employee training etc)			
Establishment location (Currently operating)	**Free zones**	1	19	40+	9
	Industrial Areas	30	258	N.A.	130+
	Others	3 technology zones	63 Technology development zones	N.A.	N.A.

[5] Regulations for on-shore companies only

[6] Minimum Capital Requirement depends on the structure of the established entity. The figures in chart are for Joint stock companies

[7] 25% if the company's Revenue is over 10 million EGP (approx. 640,000 USD)

Saudi Arabia have, when compared with other 3 countries, 2 aspects of FDI environment that could be suggested to be altered to attract more FDI to the country.

1. Easing local labor employment restriction / Providing education or training program to build the foundation of highly skilled local labor

Surrounding countries such as UAE and Turkey have not introduced any restriction on local labor employment. The cost of hiring local labor could become costly when deciding on which country to establish the entity. It would greatly help if the government provide support to higher education and job training to local workforce so that foreign capital entity can hire local labor with advanced skill and knowledge.

2. Operate more free zones to fully utilize the locational advantage of Saudi Arabia

Saudi Arabia is the only country with a coastline along both the Red Sea and the Persian Gulf. To utilize its locational advantage, it could be suggested to Saudi Arabia to develop more free zones in strategic locations, especially on the west coast (red sea side) where it is one of the important linkages between Africa, Europe and Middle East in the global supply chain, to encourage more FDI from foreign capital.

6 Reference

Country	Name	URL
Saudi Arabia	The embassy of the Kingdom of Saudi Arabia	https://bit.ly/3tG3evT
	Ministry of human resource and social development	https://hrsd.gov.sa/en/node
	Ministry of Investment of Saudi Arabia	https://investsaudi.sa/en/why-saudi-arabia/incentives-support
	Saudi Authority for Industrial Cities and Technology Zones (MODON)	https://modon.gov.sa/en
UAE	Department of Economic Development, Abu Dhabi	https://added.gov.ae/en
	Dubai FDI	http://www.dubaifdi.gov.ae/
	List of full foreign ownership activities (Abu Dhabi)	https://www.adbc.gov.ae/CitizenAccess/Report/ShowReport.aspx?module=Licenses&reportID=2129&reportType=LINK_REPORT_LIST
	List of full foreign ownership activities (Dubai)	https://ded.ae/DED_Files/ded_other/Full_Foreign_Ownership_Activities.pdf
Egypt	General Authority of Foreign Investment (GAFI)	https://www.gafi.gov.eg/English/Pages/default.aspx
	Foreign Direct Investment Law	https://www.gafi.gov.eg/English/StartaBusiness/Laws-and-Regulations/Pages/BusinessLaws.aspx
	List of industrial zones in Egypt	https://www.gafi.gov.eg/English/StartaBusiness/InvestmentZones/Pages/Industrial-Zones.aspx
Turkey	The Investment Office of the Presidency of the Republic of Turkey	https://www.invest.gov.tr/en/pages/home-page.aspx

	Foreign Direct Investment Law	https://www.invest.gov.tr/en/library/publications/lists/investpublications/fdi-law-in-turkey.pdf
	Industrial Park Maps	https://investturkey.or.jp/industrial_park

ANNEX:

5. List of Information and References gathered

List of the Reference Materials gathered

Area	No.	Name of the Reference Materials or Web-site	Form	Quantity	Source of material or Issuing organization
Basic Date of Saudi Arabia and Investment Environment	1	Basic Data of Kingdom of Saudi Arabia https://www.mofa.go.jp/mofaj/area/saudi/data.html	Web-site		Ministry of Foreign Affairs, the Government of Japan
	2	Basic Economic Data of Kingdom of Saudi Arabia https://www.jetro.go.jp/world/middle_east/sa/basic_01.html	Web-site		Japan External Trade Organization（JETRO）
	3	Saudi Vision 2030 https://www.vision2030.gov.sa/v2030/overview/	Web-site		Saudi Vision 2030 portal site
	4	Preparatory circumstances of Sadi-Japan Vision https://www.jetro.go.jp/ext_images/world/middle_east/sa/sj-visionoffice/links/sjvision_gaiyo.pdf	Web-site		Japan External Trade Organization（JETRO）
	5	Invest Saudi, https://www.enlit.world/partners/ministry-of-investment-saudi-arabia-invest-saudi/	Web-site		Ministry of Investment, Government of Saudi Arabia
	6	NWC, News and Events https://www.nwc.com.sa/English/OurCompany/MediaCenter/NewsandEvents/News/Pages/default.aspx	Web-site		National Water Company (NWC), Saudi Arabia
	7	Gross Domestic Product Fourth Quarter 2020, https://www.stats.gov.sa/sites/default/files/Gross%20Domestic%20Product%20fourth%20Quarter%202020%20EN.pdf	Web-site		General Authority for Statistics, Saudi Arabia
	8	Ease of doing business 2020, https://www.doingbusiness.org/content/dam/doingBusiness/country/s/saudi-arabia/SAU-LITE.pdf	Web-site		The World Bank Group
	9	2020 Survey on Business Conditions of Japanese Affiliated Companies in the Middle East https://www.jetro.go.jp/ext_images/_Reports/01/da9575ff4dfac6ec/20200021.pdf	Web-site		Japan External Trade Organization（JETRO）
	10	Survey on the strategy of other nations for participation and cooperation for prominent projects in Saudi Arabia (Japanese) https://www.jetro.go.jp/ext_images/_Reports/01/a944c4f2ade0db80/20180044_01.pdf	Web-site		Japan External Trade Organization（JETRO） Overseas Research Dept. Middle Ease & Africa Section, Riyadh Office Saudi-Japan Vision Office - Riyadh
	11	The Privatization Projects Manual, https://www.ncp.gov.sa/en/MediaCenter/News/Documents/Privatization%20Projects%20Manual_ENG.pdf	Web-site		The National Center for Privatization, Saudi Arabia
Water Supply Sector	12	Water Law, 2021	Report	1	Ministry of Environment, Water and Agriculture
	13	SWPC 7-years Statement 2020-2026	Report	1	Saudi Water Partnership Company
	14	National Water Strategy 2030	Pres. Materials	1	Saudi Water Forum 2019 (NWC)
	15	Utilizing Smart Technology for Water Distribution Management	Pres. Materials	1	National Water Company (NWC)
	16	Request for Qualification (Private Sector Participation in the Water Distribution Sector) https://www.nwc.com.sa/Arabic/Business/Tenders/Documents/NWC%20-%20RfQ%20-%20Private%20Sector%20Participation%20in%20the%20Water%20Distribution%20Sector.pdf	Web-site		National Water Company (NWC)
Water Quality Sector	17	Water Quality Standard and Specification, 2021 （English）	Report	1	Ministry of Environment, Water and Agriculture
	18	Water Quality Standard in SWCC （English）	Table	1	Saline Water Conversion Corporation (AWCC)
	18	Environmental Law (Concerned part was translated by the Survey Team)	Table	1	Ministry of Environment, Water and Agriculture
	20	Water Quality Standard for Irrigation Water in SIO	Table	1	Saudi Irrigation Organization (SIO)
	21	Water and Sewerage Tariff	Table	1	National Water Company (NWC),
	22	Statistics Data, 2019（Concerned part was translated by the Survey Team）	Table	1	Ministry of Environment, Water and Agriculture
	23	Statistics Data, 2020 (Concerned part was traslated by the Survey Team)	Table	1	Ministry of Environment, Water and Agriculture
	24	Meteorological Data（Tokyo、2020）	Table	1	The Meteorological Agency（Japan）
	25	Demographic Survey 2016	Table	1	General Authority for Statistics, Saudi Arabia

Agricultural Sector	26	Agricultural Production Survey Bulletin, 2019 (English)	Report	1	General Authority for Statistics, Saudi Arabia
	27	National Transformation Program, 2020 (English)	Report	1	Kingdom of Saudi Arabia
	28	Agricultural and Irrigation Sector in the Kingdom of Saudi Arabia: Challenges and Opportunities (English)	Pres. Materials	1	Ministry of Environment, Water and Agriculture
	29	Agricultural Renaissance in KSA, 2021 (English)	Pres. Materials	1	Ministry of Environment, Water and Agriculture
	30	Estidamah Introduction, 2020 (English)	Pres. Materials	1	Estidamah
	31	Vertical Farming Partnerships Program (English)	Pres. Materials	1	Estidamah
	32	Detailed Results of Agricultural Census (Arabic)	Report	1	General Authority for Statistics, Saudi Arabia
	33	General MEWA Annual Report, 2019 (Arabic)	Report	1	Ministry of Environment, Water and Agriculture
	34	SIO Annual Report, 2019 (Arabic)	Report	1	Saudi Irrigation Organization (SIO)
	35	SAGO Annual Report, 2020 (Arabic)	Report	1	Saudi Grains Organization (SAGO)
	36	The Executive Regulations of the Water System for the function of the Regulator, 2020, MEWA	Report	1	Ministry of Environment, Water and Agriculture
	37	Related Ministries and Agencies in Agricultural Sector (http://www.mewa.gov.sa/en/Partners/Pages/default. Aspx)	Web-site		Ministry of Environment, Water and Agriculture
	38	Irrigation 2015 (Arabic)	Report	1	Al-Ahsa Irrigation & Drainage Authority
	39	National Strategy MEWA (Arabic)	Report	1	Ministry of Environment, Water and Agriculture
	40	Water Statistical Report, 2014, MEWA (Arabic)	Report	1	Ministry of Water and Electricity
	41	MEWA Rainfed Agriculture Book (Arabic)	Report	1	Ministry of Environment, Water and Agriculture
	42	Agricultural Notepad (2018-2019) (Arabic)	Report	1	Ministry of Environment, Water and Agriculture
	43	SIO Experience of Reuse of Reclaimed Water in the Agricultural Field (Arabic)	Report	1	Saudi Irrigation Organization (SIO)