No.

THE BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT
OF
WATER SUPPLY SYSTEM
IN
THE NORTHERN PYRAMIDS AREA IN GIZA CITY
IN
THE ARAB REPUBLIC OF EGYPT

NOVEMBER, 2001

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.

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PREFACE

In response to a request from the Arab Republic of Egypt, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Water Supply System in the Northern Pyramid Area in Giza city and entrusted the study to the Japan International Cooperation Agency (JICA).

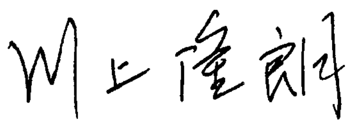
JICA sent to Egypt a study team from July 16 to August 29, 2000.

The team held discussions with the officials concerned of the Government of Egypt, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Egypt in order to execute the Implementation Review Study and discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Arab Republic of Egypt for their close cooperation extended to the teams.

November , 2001



Takao Kawakami
President
Japan International Cooperation Agency

November, 2001

LETTER OF TRANSMITTAL

We are pleased to submit to you the Implementation Review study report on the Project for Improvement of Water Supply System in the Northern Pyramids Area in Giza city in the Arab Republic of Egypt.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from June 15 to November 22, 2001. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Egypt and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

瀬野 正敏

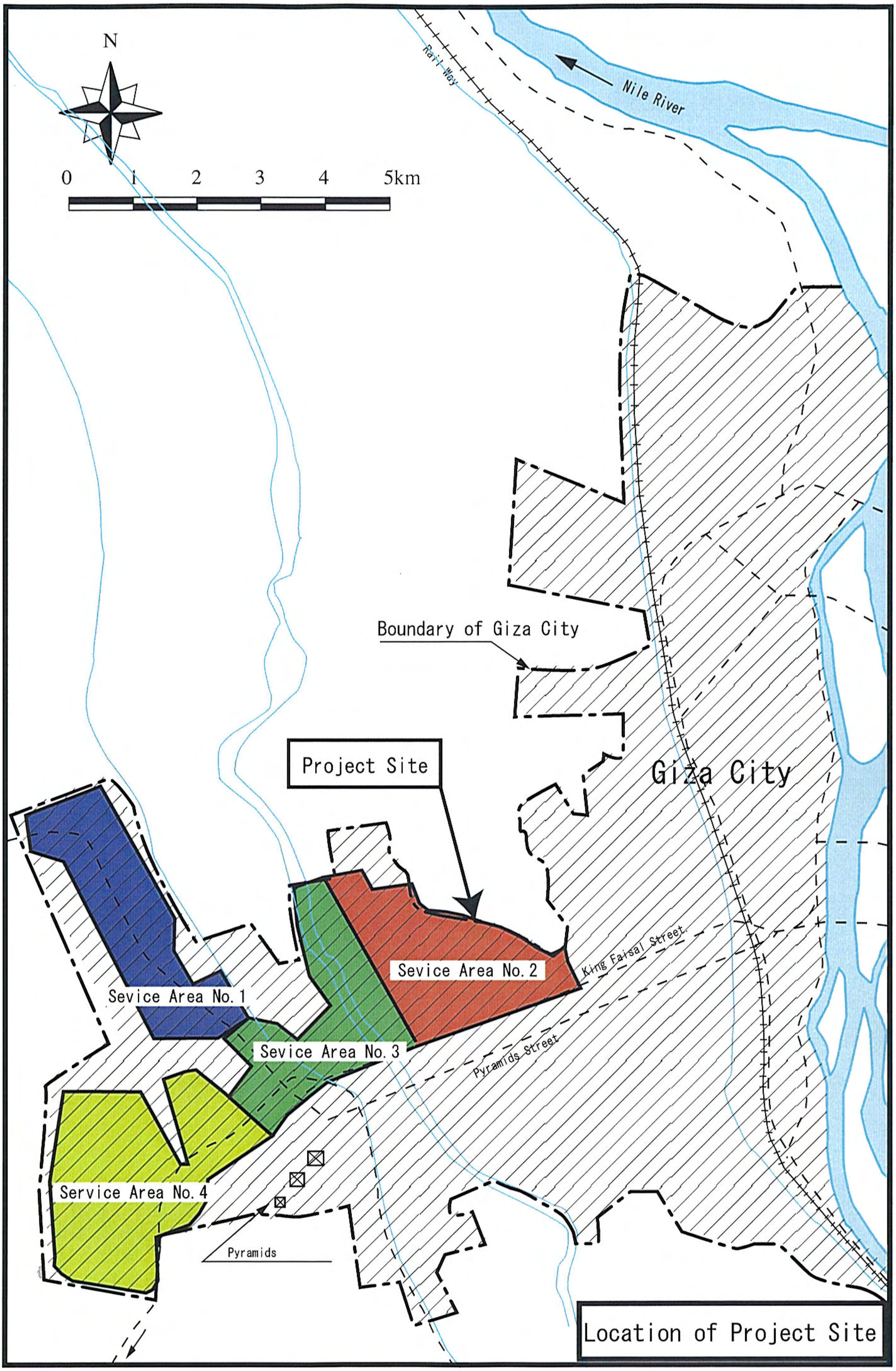
Masatoshi Seno

Project Manager,

Implementation Review study team on

the Project for Improvement of Water Supply
System in the Northern Pyramids Area in Giza City

Yachiyo Engineering Co., Ltd.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0 1 2 3 4 5km
Rail Way
Nile River
Boundary of Giza City
Project Site
Giza City
Sevice Area No. 1
Sevice Area No. 2
Sevice Area No. 3
Service Area No. 4
King Faisal Street
Pyramids Street
Pyramids
Location of Project Site

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ABBREVIATION

DCI	Ductile Cast Iron
E/N	Exchange of Notes
GOGCWS	General Organization for Greater Cairo Water Supply
GDP	Gross Domestic Product
GNP	Gross National Product
HWL	High Water Level
LWL	Low Water Level
IMF	International Monetary Fund
JIS	Japanese Industrial Standards
JICA	Japan International Cooperation Agency
LE	Egyptian Pound
M/D	Minutes of Discussion
MOIC	Ministry of International Cooperation
M/P	Master Plan
PC	Prestressed Concrete
RC	Reinforced Concrete
PVC	Polyvinyl Chloride
USAID	US Agency for International Development
FY	Fiscal Year
WTP	Water Treatment Plant

SUMMARY

The Arab Republic of Egypt (hereinafter referred to as Egypt) is a country located in the northeastern corner of the African Continent and has a land area of some one million km^2 and a population of approximately 60.35 million (1997 data). Some 94% of the national land is either desert or wetland and most of the population live in the delta facing the Mediterranean or valleys along the Nile valley.

Since 1991, the Government of Egypt has been implementing full-scale economic reform under structural adjustment policies with the guidance of the IMF and the World Bank with a view to transforming the national economy from a controlled economy to a market economy. The current Fourth Five Year Plan (1998 – 2002) adopts policies which mainly aim at achieving the successful transition to a market economy and the active use of the vitality of the private sector.

The GDP growth rate in Egypt has been around 5% for the last few years and the GNP per capita in 2000 stood at US$ 1,490. The unemployment rate is still high and the difficult situation is still continuing, particularly among the poor.

The political and economic centre of Egypt is the Greater Cairo Capital Region (hereinafter referred to as the Greater Cairo Region) which consists of Cairo, Egypt's capital, neighbouring Giza City and the southern part of the Qulyubiya Governorate. The population of the Greater Cairo Region has been steadily increasing due to the impacts of four Middle Eastern wars in the past and migration from rural areas to seek employment with the Greater Cairo Region becoming an excessively populated area with a population of some 16 million as of 2000. Meanwhile, the development of such social infrastructure components as water supply and sewerage systems, road and public transport networks and others has been slow with negative impacts on local lives and the development of socioeconomic and industrial activities in the Greater Cairo Region.

Giza City, in which the target area of the Project is located, is adjacent to Cairo, the capital of Egypt, across the Nile and is an important part of the Greater Cairo Region. With the recent improvement of access to central Cairo, there has been a rapid population inflow to Giza City with a population increase rate of 3.5%. However, the development of infrastructure is lagging behind the rapid population increase. The Northern Pyramids Area of the city which accommodates a large proportion of the new population has been experiencing slow development of the water supply system despite the fact that it is a densely populated area with a population of some 400,000 even though the water distribution network is in place,

except for some areas. Because of its location at the end of the water distribution network and the large water consumption volume of central Giza situated in the upstream of the network, the water supply pressure in the Northern Pyramids Area (Project Site) of 0.5 – 1.0 kg/cm^2 is extremely low. As a result, the water supply volume in the northern part of Giza City of 50 – 100 litres/person/day is insufficient and supply is not even available in some parts during peak hours.

To supplement the insufficient water supply, groundwater from local wells is used to top up the water supply to the distribution network. However, the excessive pumping of groundwater in recent years has led to an increase of the salt content of well water and some wells have been abandoned as the salt content has exceeded the criterion for drinking water, forcing residents to rely on water trucks or water vendors to obtain drinking water.

To improve the situation, the Government of Egypt formulated a project to construct a water transmission main from the Embaba Water Treatment Plant (WTP), the expansion work of which was completed in 1997, to the Project Site, a reservoir to regulate hourly fluctuations of the water distribution volume and to mitigate adverse impacts on the water supply caused by an abnormality and a water distribution pumping station and distribution network to ensure a stable water distribution volume as well as pressure in order to improve the water supply situation at the Project Site.

The water supply system in Giza City is being improved in accordance with the Master Plan for Water Supply for City of Giza which was formulated in 1987 with German assistance. However, Egypt's tight fiscal situation means that it is inevitable for the Government of Egypt to rely on foreign aid for the continuous implementation of this Master Plan.

Under these circumstances, the Government of Japan has conducted a series of grant aid projects to improve the standard of living of local people, i.e. the Project for Omrania West Water Supply and Sewer Upgrading, Giza City in FY 1988 and FY 1989, the Project for Water Supply and Sewer System Upgrading in Monib, Giza City (Phase 1 and Phase 2) from FY 1992 through FY 1996 and the Project for Improvement of the Water Supply System in the Southern Pyramids Area, Giza City from FY 1997 through FY 1999. All of these grant aid projects have been highly evaluated by both the Government of Egypt and local people.

Against this background, the Government of Egypt formulated a further project to improve the water transmission and distribution systems to the Project Site and requested the Government of Japan's provision of grant aid for those components which could not be implemented with the self-help efforts of Egypt.

In response to this request, the Government of Japan decided to conduct the Basic Design Study for the Project for Improvement of Water Supply System in the Northern Pyramids Area in Giza City in the Arab Republic of Egypt and the Japan International Cooperation Agency (JICA) sent a study team to Egypt for the period from 16th July to 29th August, 2000. While this study was subsequently suspended due to various reasons, a project formulation team was dispatched to the Project Site from 19th to 30th June, 2001, followed by the dispatch of a new study team from 10th to 21st September, 2001 to explain the Summary of the Basic Design to the Egyptian side.

Based on consultations with related people in Egypt and the field survey results, the study team acknowledged the tight water supply situation in Egypt and confirmed the urgent need for the improvement of water supply to the Project Site because of the considerably delayed development of the water supply system in the area despite its importance as part of the Greater Cairo Region. The study team also recognized that residents of the Project Site were suffering from a poor living environment, including poor health and sanitation conditions, due to a chronic water shortage and established that the Project Site covers some 24 km^2 of land and that the design population in the target year of 2010 will be approximately 685,000.

The planned length of the new water transmission main (1,600 mm in diameter) under the Project is approximately 2.7 km. The Egyptian side commenced the basic surveying and basic design for the open-cut work at the relevant rural sections during the original Basic Design Study period and the study team confirmed that this work will be completed by the Egyptian side as stated in the request. It was decided that the scope of Japan's grant aid cooperation would include (i) the complicated open-cut work along the major trunk roads of King Faisal Street and Desert Road which have a heavy traffic volume and many underground structures, (ii) the underground work using the jacking method to cross El Canata Street, the Cairo-Alexandria railway line and Desert Road where the traffic cannot be halted and the aqueduct work to cross the Mariotia Drain, the Lebeni Drain and the Man Soriya Canal because of the perceived difficulty of completing the required work given the existing technical capability of the Egyptian side.

However, the aqueduct crossing the Lebeni Drain which was added at the Basic Design Study stage to the originally requested items has been dropped from the scope of the cooperation as the Lebeni Drain was found by the project review study team to have been buried for road construction.

In addition, the total length of the transmission main to be constructed with Japan's grant aid cooperation has been increased from some 2.4 km at the time of the original request to some

2.7 km because of the relocation of the planned water distribution station at the Basic Design Study stage to a site located some 200 m northwest of the original site.

It has been decided to locate the water distribution station, consisting of a water reservoir and a water distribution pumping station, at the existing El Rameya Well WTP as originally requested.

The scale of the water reservoir is set at 30,000 m^3, i.e. equivalent to 5 – 6 hours supply of the maximum daily water supply volume in the target year (2010), which is the target value adopted by the GCGCWS. The planned reservoir is a ground-type reservoir as the site is subject to building height restrictions. Water distribution pumping facilities capable of distributing water to four separate distribution systems are planned to match the four systems of the existing water distribution network and to effectively use the said network.

In regard to water distribution pipes, the procurement of 200 – 600 mm diameter pipes for a total length of 30 km under the grant aid was originally requested. However, these small diameter pipes are produced in Egypt and their procurement by the project implementation body should not pose any problems. Given this situation, it has been decided that the subjects for cooperation will be the water distribution main (200 – 400 mm in diameter) which will be the backbone of the water distribution network requiring improvement at the Project Site and connection pipes (300 – 1,000 mm in diameter) between the existing water distribution main along Desert Road and the water distribution station which has become necessary because of the change of the planned site for this station. The scope of procurement under the grant aid cooperation has been limited to fittings and valves because of the difficulty of procuring high quality products in Egypt to prevent the high leakage rate associated with these products.

In formulating the Project, it has been decided to use local equipment, materials and labour as much as possible with a view to fostering industries, vitalising economic activities and improving the technical capability in Egypt. Considering the fact that the Project Site is located in a densely populated area, temporary facilities and construction methods have been carefully selected in order to avoid any adverse impacts on local lives, socioeconomic activities, transport and the housing environment.

The contents of the Basic Design finalised on the basis of the field survey findings are shown below.

Contents of Basic Design	
(1) Construction of Water Transmission Main	• 1,600 mm in diameter x approx. 2.72 km in length • Jacking work: three sites • Aqueduct: three sites
(2) Construction of Water Distribution Station	• Water reservoir (30,000 m^3): 1 • Water distribution pumping station: 1
(3) Procurement of Water Distribution Pipes	• Fittings and valves only for distribution main lines (200 – 400 mm in diameter x approx. 12.5 km) and connecting pipes (300 – 1,000 mm in diameter x approx. 1.24 km) from the water distribution pumping station to the existing water distribution main

The bodies involved in the implementation of the Project on the Egyptian side are the Giza Governorate acting as the supervising body, the Giza Municipal Authority acting as the coordinating body with the Japanese bodies involved and the implementation body for the construction of the trunk water transmission main and improvement of the water distribution station and water distribution network at the Project Site and the GOGCWS as the implementation body for the construction of the trunk water transmission main up to the Project Site. All of the facilities constructed under the Project will be handed over to the Giza Municipal Authority after their completion while the responsibility for the operation and maintenance of these facilities will be immediately transferred to the GOGCWS from the Giza Municipal Authority. The GOGCWS has the staff and system to maintain the new facilities following the completion of the Project. From the financial point of view, its operating balance will improve with the implementation of the Project as the operating loss rate in the target year (2010) will be 0.7% lower than in the case without the Project. This suggests that the operation and maintenance of the new facilities by the GOGCWS after the completion of the Project will be feasible. However, both the operating balance and the current balance of the GOGCWS as a whole will remain in the red.

Facing this financial prospect, the GOGCWS should pursue measures designed to improve its financial and technical strength without fail. These measures include the business management improvement programme of the USAID, consisting of the application of an adequate water charge, improvement of the chargeable supply ratio and the assignment of staff members to appropriate positions, and the training improvement programme under Japan’s project-type technical cooperation for five years from June, 1997.

In the case of the Project’s implementation with grant aid provided by the Government of Japan, the estimated cost to be borne by the Egyptian side is about LE139 million. The total implementation period of the Project is estimated to be 30 months: five months for the detailed design, two months for the tender and the selection of the Contractor and 23 months for construction.

With the implementation of the Project, a water transmission and distribution system capable of supplying water of up to 240 litres/person/day will be in place to serve local residents of the Northern Pyramids Area, i.e. a new residential area in Giza City, (benefiting population: 685,000 in 2010), commanding important status in the Greater Cairo Region which is the political and economic centre of Egypt. As a result, the living environment and convenience will be directly improved together with the improvement of public hygiene. The planned connection during the project period between the water transmission main in the Southern Pyramids Area and the new water transmission main to be constructed under the Project will form a water transmission loop in Giza City, contributing to a more stable water supply in the city.

The continuous expansion and improvement of water supply facilities, which constitute important components of the social infrastructure in Giza City, following the achievements of the previous project will facilitate the implementation of the development plan for Giza City and will contribute to the stable socioeconomic development of the Greater Cairo Region.

The implementation of the Project with grant aid provided by the Government of Japan is feasible provided that the Egyptian side fulfils its tasks, ranging from the necessary funding for its work and the improved management of the water service to the connection of service pipes to households, an adequate response to new technologies and improvement of the technical strength, etc. Given the scale of the perceived benefits, the Project should prove highly significant and its implementation under the grant aid scheme of the Government of Japan is judged to be suitable.

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CHAPTER 1 BACKGROUND OF THE REQUEST

CHAPTER 1 BACKGROUND OF THE PROJECT

The Arab Republic of Egypt (hereinafter referred to as Egypt) is a country located in the northeastern corner of the African Continent and has a land area of some one million km^2 and a population of approximately 62.36 million (1995 data). Some 94% of the national land is either desert or wetland and most of the population live in the delta facing the Mediterranean or valleys along the Nile valley.

Up until the 1980's, Egypt experienced difficult economic conditions, including stagnant production and increasing external debts. If the aftermath of the Gulf War, however, there has been an increasing trend in international aid circles to provide assistance for Egypt and, since 1991, the Government of Egypt has been implementing economic reform under structural adjustment policies with the guidance of the IMF and the World Bank with a view to transforming the national economy from a controlled economy to a market economy. The current Fourth Five Year Plan (1998 – 2002) adopts policies which mainly aim at achieving the successful transition to a market economy and the active use of the vitality of the private sector.

The GDP growth rate in Egypt has been around 5% for the last few years and the GNP per capita in 2000 stood at US$ 1,490. The annual inflation rate, which previously exceeded 20%, has dropped to some 5% although the unemployment rate of 9% is still high. Because of subsidy cuts following the progress of the market economy, the difficult situation is still continuing, particularly among the poor.

Giza City, which is the Project Site, is adjacent to Cairo, the capital of Egypt, across the Nile and is an important part of the Greater Cairo Region. With the recent improvement of such major trunk roads as Pyramids Street and the Greater Cairo Ring Road to improve access to central Cairo, there has been a rapid population inflow to Giza City, the population increase rate of 3.5% of which in the last five years is well above the national average of 2.1%. However, the development of infrastructure is lagging behind the rapid population increase. The Northern Pyramids Area of the city which accommodates a large proportion of the new population has been experiencing slow development of the water supply system despite the fact that it is a densely populated area with a population of some 400,000.

The Northern Pyramids Area, i.e. the Project Site, is located some 20 – 30 km away from the three existing water treatment plants. Because of its location at the end of the water distribution network and the large water consumption of central Giza situated in the upstream of the network, the water supply pressure in the Northern Pyramids Area of 0.5 – 1.0 kg/cm^2

is extremely low. As a result, the water supply volume in the northern part of the Project Site of 50 – 100 litres/person/day is insufficient and supply is not even available in some parts during peak hours.

To supplement the insufficient water supply, the El-Rameya Well and the Jolie Ville Well are operated to top up the water supply to the distribution network. However, the excessive pumping of groundwater in recent years has led to an increase of the salt content of well water and some wells have been abandoned as the salt content has exceeded the criterion for drinking water. Meanwhile, smaller wells are also experiencing an increasing salt content due to excessive pumping and contamination by foul water leaking from sewers and cesspits.

People living at the Project Site face poor water supply conditions, including water from wells with a high salt content or contaminated wells, with serious health implications and it is not unusual for people to rely on water bought from water vendors. Against this background, the Government of Egypt formulated a water transmission and distribution system improvement project for the Northern Pyramids Area and requested the Government of Japan's provision of grant aid for those components of the project which cannot be implemented by self-help efforts alone.

To improve the water supply system in Giza City, "the Master Plan for Water Supply for City of Giza" was formulated with German assistance in 1987 during the First Five Year Plan period and the development of infrastructure, including the water supply system, is a priority target of the current Fourth Five Year Plan. However, Egypt's tight fiscal situation means that it is inevitable for the Government of Egypt to rely on foreign aid for the development of such infrastructure.

Under these circumstances, the Government of Japan has conducted a series of grant aid projects to improve the standard of living of local people, i.e. the Project for Omrania West Water Supply and Sewer System Upgrading, Giza City in FY 1988 and FY 1989, the Project for Water Supply and Sewer System Upgrading in Monib, Giza City (Phase 1 and Phase 2) from FY 1992 through FY 1996 and the Project for Improvement of Water Supply System in the Southern Pyramids Area, Giza City from FY 1997 through FY 1999. All of these grant aid projects have been highly evaluated by both the Government of Egypt and local people.

The field survey and analysis in Japan for the Basic Design Study for the Project for Improvement of Water Supply System in the Northern Pyramids Area where the water supply system is at the lowest level in Giza City was conducted from July, 2000 to February, 2001 before its suspension due to various reasons. However, a project review survey to restart the Project was conducted from June to October, 2001.

With the completion of the planned improvement of the water supply system, the water transmission network in Giza City will form a looped configuration, ending the immediate need for the development of a trunk water supply network in the city.

CHAPTER 2 CONTENTS OF THE PROJECT

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2.1 Design Concept of the Project

In Egypt, the rapid increase of the urban population makes the implementation of projects designed to improve and maintain the urban living environment, including the water supply and sewerage system, an urgent task. The water supply system is upheld as an important area for development in the ongoing Fourth Five Year Plan.

Under these circumstances, the Giza Municipal Authority is improving the water supply system to supply clean water in sufficient quantity and supply pressure in accordance with the Master Plan for Water Supply for the City of Giza which was formulated in 1987 with a target year of 2000 (hereinafter referred to as "the Master Plan"). The construction of the main facilities listed in the Master Plan has been made steady progress with Japanese and French assistance.

However, the development of new water supply facilities is lagging behind the rapid development and population increase in recent years at the Project Site, i.e. Northern Pyramids Area, partly because of its furthest location from the Embaba WTP which is the water supply source. As a result, the Project Site is currently suffering from the worst water supply situation in Giza City.

The water distribution main and branch pipes have already been laid at the Project Site except for some areas. The Project Site is located 20 – 30 km away from the Embaba WTP and at the end of Giza City's existing water transmission and distribution network, meaning that much of the clean water supplied to the network is consumed upstream (Central Giza) prior to reaching the Project Site and that the required water supply volume and water supply pressure are unavailable at the Project Site. The present water supply pressure of 0.5 – 1.0 kg/cm^2 is extremely low compared to the required pressure of 2.0 kg/cm^2 while the water supply volume is only 50 – 100 litres/person/day compared to the target volume of 240 litres/person/day. Water supply is unavailable in some parts during peak hours.

In order to improve the situation, the GOGCWA uses the El-Rameya Well and the Jolie Ville Well to boost the water supply to the Project Site. However, the well water is unsuitable for drinking purposes because of its high salt content resulting from excessive pumping in recent years (the TDS concentration of water from some wells in operation exceeds the WHO's upper limit of 1,000 mg/litre).

Residents at the Project Site are not only unable to receive a proper supply of clean water because of the insufficient supply volume and pressure but also have a poor living environment, including the use of well water with a high salt content. The purchase of water from water vendors is not unusual.

The Project aims at improving the water transmission and distribution facilities at the Project Site, where the water supply level is the lowest in Giza City, to raise the daily water supply volume from 50 – 100 litres/person/day to 240 litres/person/day and the water supply pressure from 0.5 – 1.0 kg/cm^2 to 2.0 k g/cm^2.

To achieve the above targets of the Project, a new water transmission main (1,600 mm x approx. 27.72 km) will be constructed using the jacking method at three sites in addition to the construction of an aqueduct at two sites, the construction of a water distribution station to distribute clean water to the Project Site and the laying of new water distribution pipes (extending to a total of some 38 km) in those areas where no distribution system currently exists. At the same time, the proper operation and maintenance of these facilities will be ensured. It is hoped that the presence of the new facilities will solve the problems of the local living environment, including poor health and sanitation conditions, originating from the shortage of water for drinking and other purposes and the use of poor quality well water.

The scope of cooperation under the Project includes the construction of a new water transmission main (1,600 mm x approx. 2.72 km), jacking work (at three sites), aqueduct construction (at two sites), water distribution station construction and the procurement of materials to improve the water distribution network (fittings and valves for the water distribution main only), all of which appear difficult for the Egyptian side to complete because of technological and financial limitations.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Natural Conditions

1) Climatic Conditions

The Project Site belongs to the desert arid climate zone with extremely low annual rainfall of 25 mm. From March to April, a seasonal wind called the Hamseen which contains a large amount of sand dust assaults the Project Site from the desert to the west. The mean annual temperature is 21.8°C while the maximum and minimum temperatures are 40°C in August and 3°C in February.

While the planned water supply facilities under the Project do not require any anti-freezing measures for the winter, only a minimum structural earth covering will be required for the water transmission main. No thermal insulation is required for the pumping facilities and it is possible to design the water reservoir on the ground. A ventilation system and anti-dust measures will be considered for the pump facilities and electrical installations in view of the high ambient temperature in summer.

2) Topography and Geology

The Project Site is situated at the southern end of the Nile Delta and its topography is roughly flat except for the El Rameya and Pyramid Hills Housing Complexes where water will be supplied from the planned water distribution station.

As the water transmission main is pressurized pipeline, topographical undulations will not pose any problems.

In regard to the four canal/drain crossing points, aqueducts will be required at three points.

At open cut excavation sections along the route which is often lined with many 5 - 10 story buildings or points where the excavation depth exceeds 10 m for jacking method, retaining work using sheet piles, etc. should be conducted to prevent any adverse impacts on the existing structures.

Direct foundations will be used to support the structures at the water distribution station as a water reservoir is to be constructed at the cut section with a sufficient bearing strength. In the case of a pumping station, as part of it is to be constructed on the banking section with an insufficient bearing strength, soil replacement work will be conducted.

3) Earthquake and Wind Loads

For the design of the structures to be constructed under the Project, Japanese design standards will be adopted because of (i) their extremely high reliability originating from many cases of application, in turn reflecting their systematic provisions by international criteria, and (ii) their familiarity to people involved in the Project through previous Japanese grant aid projects. Taking the local characteristics of the design load conditions into consideration, however, Egyptian design standards will be used for the earthquake and wind loads. It is unnecessary to take the snow and sand dust loads into consideration.

There is currently increasing interest in Egypt in the inclusion of earthquake-proof features in the structural design requirements because of the earthquake which occurred in 1992, the first earthquake in 70 years. The following load conditions will be employed under the Project, taking (i) the values already employed by the GOGCWS for existing structures and (ii) the importance of the planned facilities as public structures which are closely linked to BHN (basic human needs) into consideration.

① Seismic coefficient : 0.05

② Wind load : 150 kgf/m^2

(2) Social Conditions

As concluded by the evaluation of the previous project, the subject area of the project was a new residential area serving ordinary workers in the Greater Cairo Region. As the beneficiaries of the project were not restricted to a special group of people, the project offered excellent benefits for the local community. The purpose of the project was to improve the water supply and the project is highly evaluated by the local community because of its contribution to improving public hygiene as well as the general standard of living.

The present Project also aims at improving the water supply to a densely populated, new residential area which fails to receive a stable supply of water in terms of both volume and pressure because of the insufficient water distribution facilities.

The planned route for the water transmission main crosses two trunk roads and one railway line (including adjoining canals). As these currently function as arteries for physical distribution not only for the local area but also for Egypt, the traffic flow on these roads and railway line cannot be blocked. The standard open cut excavation method, therefore, cannot be employed at these three crossing points and the jacking method which does not require the blocking of traffic will be employed.

(3) Local Construction Industry and Availability of Construction Materials

In the Greater Cairo Region where the Project Site is located, a variety of construction work is actively taking place, ranging from public works for road and bridge improvement and the construction of a subway line to the construction of many high-rise buildings by private developers. Under these circumstances, many companies are acquiring practical experience and improving their technical expertise in all construction-related fields, including general contracting, leasing of construction machinery, fresh concrete supply, piling, transportation and manpower supply. With the development of the construction industry and supporting businesses, general construction materials of a satisfactory quality are now locally available.

One company manufactures ductile cast iron water pipes of up to 1,000 mm in diameter. However, it is necessary to import pipes of more than 1,000 mm in diameter from Japan or a third country. In regard to fittings, the manufacturer has commenced the production in ductile cast iron following the transfer of technology from a European country although the fittings were locally produced in only cast iron until recently.

In regard to the RC pipes to be used by the jacking method, there are two local companies which supply such products. One is a joint venture with a French manufacturer and is renowned for its product quality and punctual delivery. Many foreign construction companies, including Japanese contractors, and major construction companies in Egypt use the products, including RC pipes, of this company.

Given the construction boom in the Greater Cairo Region, however, the Project may face a supply shortage and/or late delivery in view of its requirement of large inputs of labor and materials in a short period of time. Accordingly, it will be necessary for the procurement plan to take the local supply capacities of labor and materials into careful consideration.

(4) Use of Local Companies

As mentioned earlier, there are many well experienced local construction companies and suppliers of construction materials in many fields relating to construction. As the construction and equipment installation work planned under the Project is not particularly difficult, the construction and procurement plan will mainly feature local companies to conduct the general construction work and the procurement of general construction materials.

Given the necessity to simultaneously conduct a number of different types of work in a short period of time, careful planning of the general construction plan, schedule control and construction material procurement control will be necessary. Moreover, the technical expertise in Egypt is not sufficient in such special fields as the construction of highly water-tight water tanks using prestressed concrete and the jacking method. Consequently, the dispatch of the necessary engineers and technicians and the transportation of materials will be planned for the general supervision of the work, specialist work and the test operation and adjustment of equipment.

The following materials and engineers appear to be difficult to secure in Egypt and, therefore, will require import/dispatch from Japan or a third country.

- Ductile cast iron pipes for the water transmission main and materials for aqueducts
- PC steel cable, steel bars and prestressing equipment for PC concrete work and specialist engineer(s)
- Equipment for jacking method and specialist engineer(s)
- Equipment for pump facilities and specialist engineer(s)

(5) Maintenance Capability of Project Executing Organization

1) Giza City

While Giza City will act as the project executing organization, the facilities constructed under the Project will be transferred to the GOGCWS for their operation and maintenance after completion. This arrangement makes it unnecessary to consider the maintenance capability of Giza City. However, as the basis of proper maintenance is the good quality of the subject facilities, a detailed check of the specifications of the water distribution pipeline and house connection work to be conducted by Giza City with its own funding will be conducted in order to minimize any leakage from such connections.

2) GOGCWS

The GOGCWS, which will be responsible for the operation and maintenance of the water transmission and distribution facilities to be constructed under the Project, currently supplies a daily average of some 6.4 million m^3 of water to a service population of some 16 million in the Greater Cairo Region and is systematically maintaining its water supply network. The Project Site is served by a maintenance body called the Pyramids Water Distribution Center. Although the counted water amount reached at only some 60% and there are various maintenance problems, they have a strong will to improve the situation, including a change of the piping material to ductile cast iron, USAID assistance for the business improvement and manpower development program and Japanese project type technical cooperation.

Accordingly, the continual improvement of the maintenance and other areas of water supply operation by the GOGCWS is anticipated.

The Water Supply Technology and Training Improvement Project, a Japanese technical cooperation project, commenced in June, 1997 and is planned to continue until May, 2002. The main themes of this project are the operation and control of water treatment plants and maintenance of the water distribution network through the training of core Egyptian engineers by Japanese experts dispatched for a long period.

(6) Design Scope and Appropriate Technical Level/Grade for Facilities, Equipment and Materials

Having considered the conditions described in (1) through (5) above, the following basic principles are adopted for the design scope and appropriate technical level/grade for the facilities to be constructed and the equipment and materials to be procured under the Project.

1) Design Scope for Facilities, Equipment and Materials

The following works will be conducted to improve the water supply system to four service areas in the Northern Pyramids Area in Giza City, i.e. (i) area along Desert Road, (ii) area to the north of King Faisal Street (east side), (iii) area to the north of King Faisal Street (west side) and (iv) El Rameya and Pyramid Hills Housing Complexes.

① Construction of a some 2.72 km long water transmission main (ϕ 1,600 mm) from the crossing point of Lebeni Drain and King Faisal Street to the water distribution station

② Construction of a distribution reservoir and a water distribution pump station to distribute water to each service area

③ Applying Jacking method at the three points where the transmission main crosses either a railway line or a trunk road

④ Construction of aqueducts at the two points where the transmission main crosses either a canal or a drain

⑤ Procurement of water distribution main piping materials to improve the water distribution network (fittings and valves)

2) Appropriate Technical Level/Grade

① Piping Materials

The GOGCWS has adopted the principle of using ductile cast iron pipes for water transmission and distribution pipelines except for house connection pipes and is currently using such pipes for the construction of the water transmission and distribution network. The existing old pipes and asbestos pipes in Giza City are gradually being replaced by ductile cast iron pipes, following the said principle of the GOGCWS. Given this situation, ductile cast iron pipes will be used under the Project.

② Water Distribution Pumping Station

Flow control for water distribution will be required at the planned water distribution station because of (i) the impossibility of introducing an elevated water tank due to restrictions on the building height at the planned site, (ii) fluctuations at the site of the pressure of water fed from Embaba WTP and (iii) the expected gradual increase of the average daily water distribution volume at the Project Site towards the target year. A pumping system capable of regulating the flow rate by means of inverter control system, therefore, will be installed at the new pumping station as in the case of the previous project in the Southern Pyramids Area. This system is more energy efficient than the system involving control of operation pump number and valve opening/closing operation, which is marked by a high energy loss level.

(7) Construction Schedule

The Project aims at improving the water supply volume and pressure and completing the water distribution network in the Northern Pyramids Area which is currently suffering from an inadequate water supply due to an insufficient supply volume and pressure by means of constructing a water distribution pumping station with a water storage function to receive water from the Embaba WTP of which the expansion was completed in 1997.

The planned facilities under the Project will be linked to the water transmission main (1,600 mm in diameter running from the Embaba WTP to the Northern Pyramids Area) to be constructed by the GOGCWS. The construction schedule for the Project should, therefore, be carefully planned, taking the schedules for the water transmission main construction work of the GOGCWS and the distribution pipe laying work of Giza City into consideration.

2.2.2 Basic Plan

2.2.2.1 General

(1) Service Areas at the Project Site

The Project Site is the Northern Pyramids Area situated in the northwestern part of Giza City (see the drawing "Location of the Project Site").

Both the water supply volume and pressure at the Project Site are currently very low because of (i) its distance from the three WTPs which are located along the Nile and which are the water supply sources for Giza City and (ii) its location at the western end of the existing water distribution network. In order to cover the water shortage, additional water supply is made to the area from the El Rameya Wells and the Jolie Ville Wells through the existing water distribution network. Based on the existing distribution network, the Project Site can be divided into four service areas as shown on the drawing "Location of the Project Site" as well as in Table 2-2-1 below.

Table 2-2-1 Service Areas at the Project Site

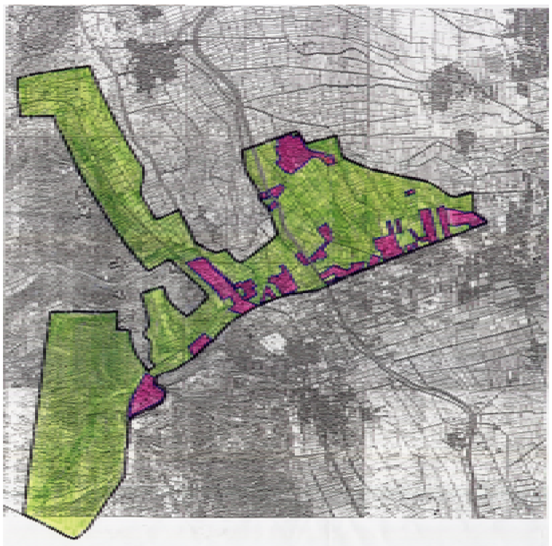
Service Area	Description	Area (km^2)	Diameter of Existing Distribution Main (mm)
No. 1	Area along Desert Road	4.7	300
No. 2	North of King Faisal Street (East Side)	5.5	1,000
No. 3	North of King Faisal Street (West Side)	5.6	600
No. 4	El Rameya and Pyramid Hills Housing Complexes	8.2	1,000
Total		24.0	

(2) Population of the Project Site

According to a survey conducted by Giza City at the time of planning the Project, the population at the Project Site in 1999 was 400,000 and the estimated population in 2015 is 720,000. These figures were examined in more detail using the field reconnaissance findings, existing reference materials (Study Report of Giza Environment Profile 1998 and others) and information provided by the people concerned.

1) Estimation of Population Growth Rate

The first step is to calculate the average annual population growth rate for the period of 23 years from 1977 to 2000 based on the rate of urban area increase which is established by comparing the map of urbanized areas at the project site, prepared based on aerial photographs taken in 1977, with a similar map for 2000. Using the above population growth rate, the population growth rate from 2001 to 2010 is estimated. Fig. 2-2-1 and Fig. 2-2-2 show the maps of the urbanized areas in 1977 and 2000 respectively.



Note: Areas in pink are urbanized areas while areas in green are either farmland or open space.

Fig. 2-2-1 State of Urbanization at the Project Site in 1977

Fig. 2-2-2 State of Urbanization at the Project Site in 2000

The population of the Project Site in 1977 is calculated by multiplying the size of urbanised areas by the population density. Based on the results of the field interview surveys conducted by the Consultant and the relevant reference materials for Giza City, the population density concerned is estimated to be 300/ha.

The size of urbanised areas in 1977 is calculated to be 310 ha based on Fig. 2-2-1 while that in 2000 is calculated to be 1,304 ha based on Fig. 2-2-2. The standard housing style in Giza is 3 – 5 story apartment blocks and this style is believed to have little changed between 1977 and 2000. Accordingly, the population density per ha is assumed to be constant at 300, resulting in an estimated population size at the Project Site in 1977 and 2000 as shown in Table 2-2-2.

Table 2-2-2 Population of Project Site in 1977 and 2000

Year	Size of Urbanized Areas (ha)	Population Density (persons/ha)	Population (persons)
1977	310	300	93,000
2000	1,304	300	391,200

The population growth rate R for the period of 23 years from 1977 to 2000 is calculated to be 6.4% using the following formula.

$$[\text{Population in 1977}] \times (1 + R)^{23} = [\text{Population in 2000}]$$

As the Project Site is situated in the western part of Giza City where space for housing development is still available unlike the eastern part along the Nile where the population has almost reached saturation point, it is estimated that the population growth rate at the Project Site will continue to be relatively higher than the population growth rate for entire Giza City for some time.

The annual population growth rate at the Project Site (excepting Service Area No. 4 where a housing complex is located for occupation in the near future and those areas with saturated population) from 2001 to 2010 is, therefore, estimated to be 4% compared to the some 3% for entire Giza City in recent years.

Given this population growth rate of 4%, the population of the Project Site will approach saturation point after 2011 and, accordingly, it is assumed that the population growth rate from 2011 to 2015 will gradually decline to 3% and further to 1%.

2) Design Population

Based on the above examination results, the conditions to estimate the population of the Project Site are shown in Table 2-2-3.

Table 2-2-3 Conditions to Estimate Population at the Project Site

Service Area	Description	Population Density (persons/ha)	Annual Population Growth Rate (%)
No. 1	Area along Desert Road	100	4.0 up to 2010 followed by gradual decline to 3.0 and further to 1.0 from 2011 to 2015
No. 2	North of King Faisal Street (East Side)	1,000 (along Faisal Street)	1.0 along Faisal Street because of almost saturated state
		300 (further north of Faisal Street)	Same as No. 1 Service Area
No. 3	North of King Faisal Street (West Side)	300	Same as No. 1 Service Area
No. 4	El Rameya and Pyramid Hills Housing Complexes	El Rameya to be fully occupied by 2007 Pyramid Hills to be fully occupied by 2012	

The estimated population figures based on the above conditions are shown in Table 2-2-4. The figures are similar to those established by the survey conducted by Giza City at the time of planning the Project and those shown in Table 2-2-4 are adopted as the design population for the Project.

Table 2-2-4 Estimated Population at the Project Site

Service Area	2000	2003	2008	2010 (Target Year)	2015
No. 1	21,200	23,800	28,900	31,300	34,900
No. 2	235,400	248,200	271,900	282,300	302,400
No. 3	100,800	113,400	138,000	149,200	166,300
No. 4	33,800	76,300	183,800	222,000	242,000
Total	391,200	461,600	622,600	684,800	745,600

The above figures are shown in the form of a graph in Fig. 2-2-3.

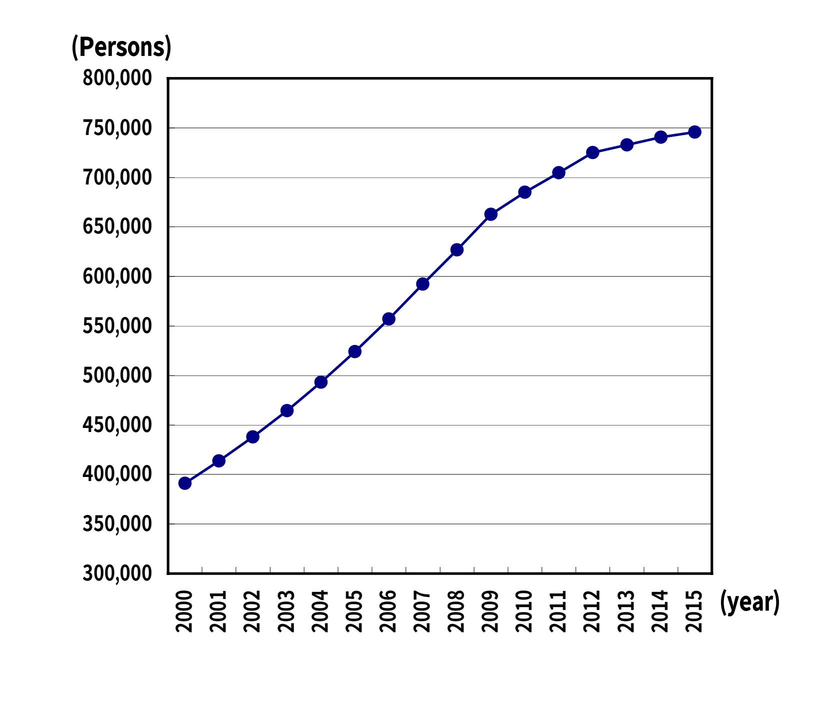


Fig. 2-2-3 Estimated Population Changes at the Project Site

3) Water Demand at the Project Site

The GOGCWS sets the maximum daily water supply volume at the Project Site in 2010 at 240 liters/person. This figure is judged to be reasonable because (i) is not far below 269 liters/person/day, the target water supply volume in Egypt, (ii) the target water supply volume is 236 liters/person/day in Giza City in 2000 under the Water Supply Master Plan and (iii) the water demand at the Project Site is estimated to be higher than the 210 litres/person/day adopted for the Southern Pyramids Area because of the higher proportion of middle and high income people at the Project Site.

Consequently, a daily water supply volume of 240 liters/person/day is adopted for the Project. Using this unit water supply volume, the water demand in the target year is estimated as shown in Table 2-2-5.

Table 2-2-5 Water Demand at the Project Site (m^3/day)

Service Area	2000	2003	2008	2010	2015
No. 1	5,090	5,720	6,950	7,520	8,380
No. 2	56,500	59,570	65,250	67,760	72,580
No. 3	24,200	27,220	33,110	35,810	39,920
No. 4	8,120	18,320	44,120	53,280	58,080
Total	93,910	110,830	149,430	164,370	178,960

4) Water Distribution Capacity to the Project Site

① Water Treatment and Distribution Capacity of Water Treatment Plants

The present and future design water production capacities of the WTPs are shown in Table 2-2-6. At present, the total design water production capacity is 1.27 million m^3/day but it is planned to increase the water production capacity of the Embaba WTP and the South Giza WTP by 200,000 m^3/day each after 2010. The water distribution capacities are shown in Table 2-2-7.

Table 2-2-6 Design Water Production Capacity from WTPs in Giza City

(Unit: m^3/day)

WTP	2000 (Present)	2001 – 2010	2011 and after
Embaba	700,000	700,000	900,000
Giza	150,000	150,000	150,000
South Giza	420,000	420,000	620,000
Total	1,270,000	1,270,000	1,670,000

Note: These figures do not include the water supply volume from wells (approximately 47,000 m^3/day)

Table 2-2-7 Water Distribution Capacity of WTPs in Giza City

(Unit: m^3/day)

	Embaba WTP	Giza WTP	South Giza WTP	Giza City Total
Average Daily Distribution Volume	600,300	158,100	410,300	1,168,700
Annual Distribution Volume	219,102,000	57,700,000	149,770,000	426,572,000
Design Distribution Volume	700,000	150,000	420,000	1,270,000
Maximum Possible Distribution Volume	840,000	180,000	500,000	1,520,000

② Water Distribution Capacity and Water Quality of Wells

To compensate for the insufficient water supply volume and pressure to the Project Site, additional water supply is made from the El Rameya Wells and the Jolie Ville Wells. The water distribution capacity of the wells and typical aspects of the water quality (analysed in March, 2000) are shown in Table 2-2-8 and Table 2-2-9 respectively.

Table 2-2-8 Water Distribution Capacity of Wells

(Unit: m^3/day)

Well	Main Service Areas	Water Supply Volume
El Rameya	Service Area No.1: area along Desert Road Service Area No.4: El Rameya and Pyramid Hills Housing Complexes	32,400
Jolie Ville	Service Areas No. 2 and No. 3: north of King Faisal Street (east and west sides)	14,400
Total		46,800

Table 2-2-9 Wells Water Quality

Item	Drinking Water Standards in Egypt (mg/liter)	El Rameya Wells		Jolie Ville Wells
		Wells in Operation (9 Sites)	Abandoned Wells (8 Sites)	Wells in Operation (7 Sites)
TDS	1,200 or less	534 - 1,750	802 - 1,706	650 - 968
Chloride	500 or less	90 - 660	260 – 650	90 - 190
Hardness	500 or less	300 - 620	336 – 610	340 - 440

Wells are usually abandoned when the TDS value exceeds 1,000 mg/liter (the upper limit set by the WHO) or when they become dry. However, some of the wells have still been in operation even TDS value exceeds the figures in drinking water standards because of the need to maintain a certain level of water supply. And Colon bacilli have been detected at some wells, indicating the possibility of their contamination by foul water.

③ Water Distribution Capacity to the Project Site

The required water distribution volume to the Project Site in the target year of 2010 will be approximately 164,400 m^3/day while the maximum water distribution volume from the Embaba WTP will be 840,000 m^3/day. As the

GOGCWS intends to make the Project Site the highest priority area for water distribution, no problems in regard to water distribution at the Project Site are anticipated. When the water distribution volume to the Project Site is subtracted, the Embaba WTP has a water distribution capacity of 675,600 m^3/day (840,000 m^3/day - 164,400 m^3/day) for other areas. As the present daily average water distribution volume is 600,300 m^3 from the Embaba WPT to north and central Giza, the present water distribution capacity of the Embaba WTP should be sufficient up to 2010.

(2) Facility Layout Plan

The Project intends the construction of (i) a water reservoir to regulate hourly fluctuations of the water distribution volume and to mitigate the adverse impacts of an extraordinary situation on water supply and (ii) a water distribution pump station to ensure a stable water supply in terms of both volume and pressure at the Project Site where the water supply is inadequate due to an insufficient water supply, in view of improvement of the water supply volume and pressure at the Project Site together with the completion of the distribution network. One of the purposes of the Embaba WTP expansion work is the provision of a sufficient volume of water to the Project Site.

The construction of the following facilities is required to achieve the objectives of the Project (see Basic Design Drawing GPN-GN-01).

① Water transmission main from the Embaba WTP to the Project Site (Water Distribution Station)

② Water Reservoir to regulate hourly fluctuations of the distribution volume and to mitigate the adverse impacts of an extraordinary situation on the water supply

③ Water Distribution Pump Station to ensure a stable water supply in terms of both volume and pressure

④ Water distribution network to ensure a stable water supply to the Project Site

(3) Design Conditions

Based on the results of the examination of the above conditions, the following design conditions are set to determine the scale and specifications of the planned facilities.

1) Area and Elevation of the Project Site (Service Areas)

The area and elevation of the Project Site (Service Areas) are shown in Table 2-2-10.

Table 2-2-10 Area and Elevation of the Project Site

Service Area	Location	Area (km^2)	Elevation
No. 1	Area along Desert Road	4.7	AD + 65 m (northern end)
No. 2	North of King Faisal Street (East Side)	5.5	AD + 20 m
No. 3	North of King Faisal Street (West Side)	5.6	AD + 20 m
No. 4	El Rameya and Pyramid Hills Housing Complexes	8.2	AD + 89 m (existing distribution reservoir)
Total		24.0	

Notes: AD (Alexandria Datum Level)
Embaba WTP: AD + 19 m; planned distribution reservoir site: AD + 27.5 m

2) Design Hourly Factor for Maximum Water Supply

In the Water Supply Master Plan for Giza City, the hourly fluctuation factor for the water distribution volume in Giza City in 2000 is set at 1.3 for peak hours and 0.7 for off-peak hours.

Although no hourly water distribution data for the Project Site is available, the results of a survey conducted by the GOGCWS in neighbouring areas are shown in Table 2-2-11 with a maximum hourly factor (peak hours) of 1.24.

Table 2-2-11 Time Load Fluctuation Factor for Water Distribution Volume Near the Project Site

	Summer	Winter	During Ramadan
Peak Hours	1.12	1.11	1.24
Off-Peak Hours	0.85	0.91	0.94

Source: GOGCWS

Since the hourly factor is increasing in line with improvement of the water supply situation, the figure of 1.3 is adopted for the Project as the design hourly factor (time factor: ratio of maximum water distribution volume to time average water distribution volume) according to the Master Plan.

3) Design Target Year: 2010

4) Design Daily Maximum Water Supply Per Person: 240 liters/person/day

5) Design Daily Maximum Water Supply: 164,370 m^3/day

6) Design Capacity of Distribution Reservoir

The design capacity of the Water Reservoir is set at 30,000 m^3 in order to store a water volume equivalent to 5 - 6 hours supply based on the design daily maximum water supply.

7) Climatic Conditions

① Mean temperature (in shade) : 22°C

② Maximum temperature in summer (in shade) : 45°C

③ Minimum relative humidity : 40%

④ Average humidity (summer) : 60%

⑤ Average humidity (winter) : 65%

8) Standards Applied

① Mechanical and electrical equipment : JIS and related Japanese standards

② Civil engineering and building design: JIS and related Japanese standards

③ Locally procured materials : Egyptian standards

(4) Basic Flow of the Proposed Facilities

The basic flow which takes the conditions described above into consideration for the proposed facilities is shown in Basic Design Drawing GPN-GN-02.

2.2.2.2 Water Transmission Main Plan

The basic plan for the water transmission main will be decided based on the design principles set out in 2.2.2.1, taking the field survey results into consideration. The plan will also meet to the water supply improvement program which is being planned by the GOGCWS.

The concept of the planned water transmission and distribution system is shown in Fig. 2-2-4.

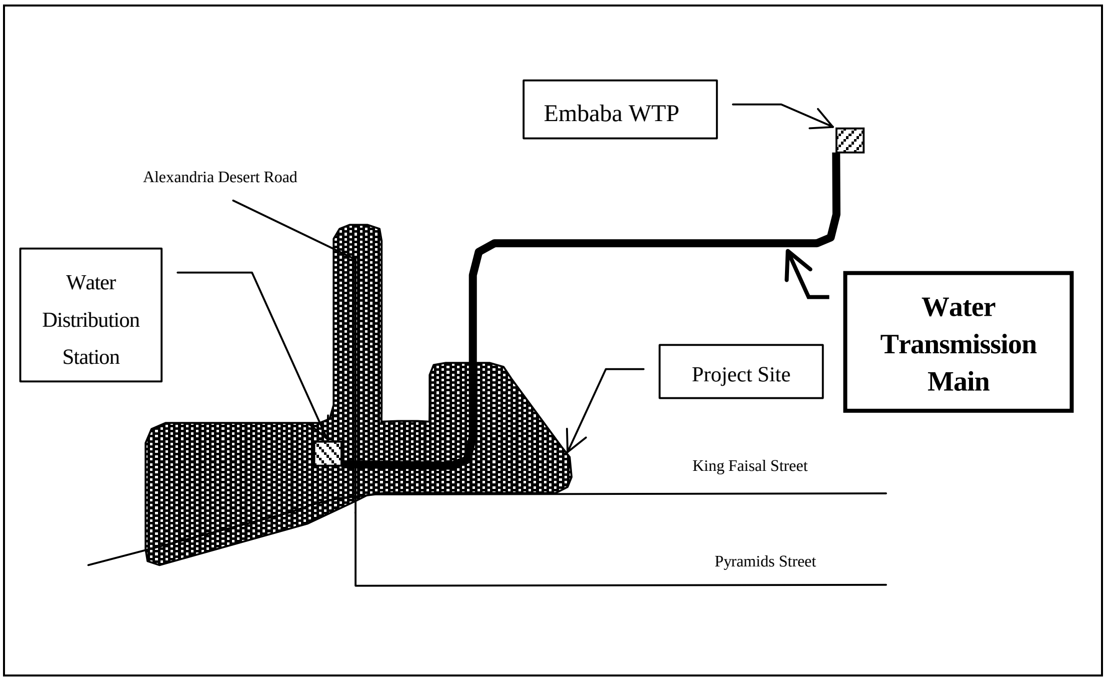


Fig. 2-2-4 Conceptual Drawing of Planned Water Transmission and Distribution System

The planning flow for the water transmission main to be constructed under the Project is shown in Fig. 2-2-5.

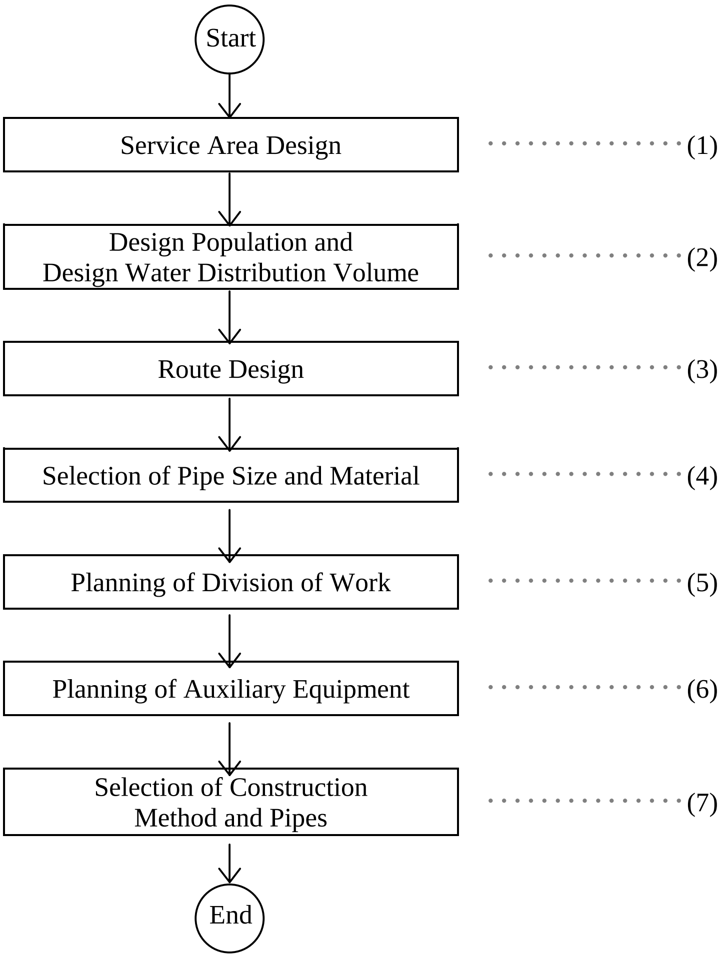


Fig. 2-2-5 Flow of Basic Planning for Water Transmission Main

Each of the flow items (Fig. 2-2-5) is described next.

(1) Service Area Design

The service area is the Project Site (24 km^2) indicated on the drawing "Location of the Project Site". The service area is further divided into four areas as shown in Table 2-2-1, i.e. Service Area No.1 [area along Desert Road], Service Area No.2 [north of King Faisal Street (east side)], Service Area No.3 [north of King Faisal Street (west side)] and Service Area No.4 [El Rameya and Pyramid Hills Housing Complexes].

(2) Design Population and Design Water Distribution Volume

The following design population and design water distribution volume are adopted for the Project as described earlier in 2.2.2.1-(1).

- Design population : 684,800 (year 2010)
- Design water distribution volume : design maximum daily water supply (164,370 m3/day in 2010)

(3) Design Route

1) Planning of Route

The Project Site is located in the southwestern part of Giza City and is the farthest away from the three WTPs which are the water supply sources for Giza City. Even though there is a water distribution main which reaches the Project Site, the water distribution capacity of this main is insufficient to fully meet the water demand at the Project Site. In addition, as this main runs through central Giza, most of the distributed water is consumed in central Giza, i.e. upstream of the Project Site, resulting in failure of the system to secure the required water supply volume and pressure at the Project Site. It is, therefore, necessary to arrange a new independent water transmission main to the Project Site.

There are three main alternative routes as described below for the planned new water transmission main from the Embaba WTP, the water supply source for the Project Site, to the new water distribution station to be constructed under the Project (see Fig. 2-2-4).

① Route-1

This is the shortest route of the three routes and runs under the Greater Cairo Ring Road from the northeast to the southwest of Giza City. (Total length: approximately 14 km)

② Route-2

This route runs from the Embaba WTP to King Faisal Street along either the Nile or the Zomor Canal and then reaches the water distribution station along King Faisal Street. This route is some 7 km longer than Route-1 but is some 5 km shorter than Route-3. (Total length: approximately 21 km)

③ Route-3

This route runs from the Embaba WTP along the Zomor canal but turns west before reaching the urbanized area along King Faisal Street to go through the rural area and then turns south to King Faisal Street along the Mariotia Drain. It finally reaches the water distribution station along King Faisal Street. (Total length: approximately 26 km)

The characteristics of each route are described in Table 2-2-12. It has been decided to adopt Route-3 in view of the viability of obtaining work permits, workability and period of the construction work even though Route-3 is the longest route.

Table 2-2-12 Characteristics of Alternative Routes

Route	Characteristics
Route-1	This is the shortest route and is the most advantageous in terms of cost. However, as most parts of the Greater Cairo Ring Road are made up of banking, it is not permitted to lay water conveyance pipes, such as water supply and sewer lines, underneath. It is, therefore, extremely difficult to opt for this route.
Route-2	This route is shorter than Route-3 but runs through central Giza. It is extremely difficult to newly lay large diameter pipes for a long distance because of the amount of existing underground structures and traffic volume in central Giza. This route is superior to Route-3 in terms of length (some 5 km shorter) but inferior in terms of workability and length of the construction period.
Route-3	Although this route is the longest, 90% of it runs through rural areas. The workability is, therefore, superior to that of Route-2. In addition, the length of the work section along King Faisal Street where the work is difficult due to the existence of many underground structures and heavy traffic volume is minimized to approximately 2.72 km.

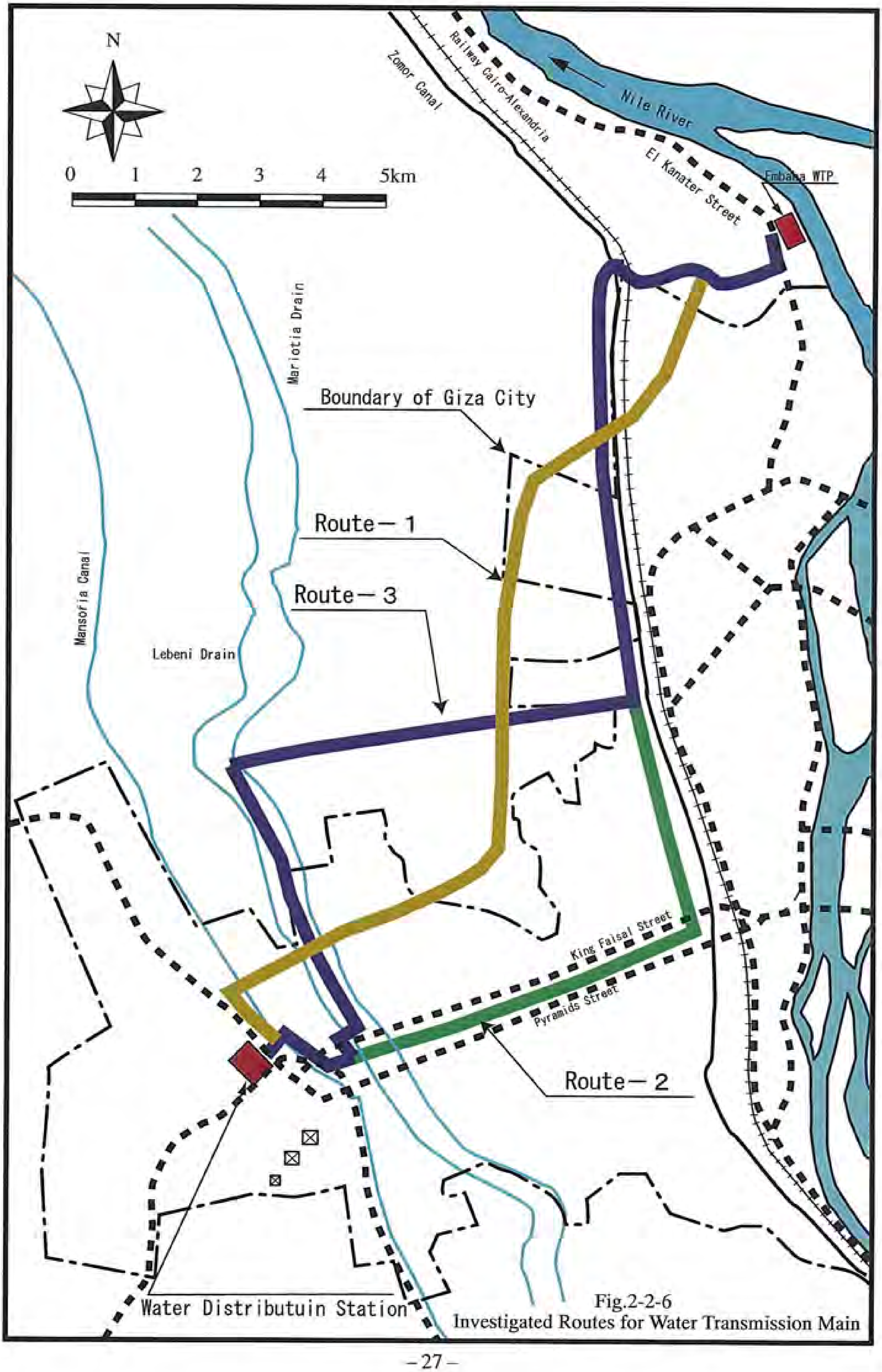


Fig.2-2-6
Investigated Routes for Water Transmission Main

2) Current Conditions of Design Route and Points to Note

The current conditions of the design route (Route-3) and points to note in terms of the planning and construction work are described below.

① The starting point of the planned water transmission main will be in Embaba WTP. The new main will be connected to the outflow pipe of the existing water transmission pump.

② After leaving the Embaba WTP, the route will cross El Kanater Street which is a trunk road running north from Giza City along the Nile. As it is not permitted to block the traffic flow, it will be necessary to employ the jacking method.

③ The route will run south for some 500 m along El Kanater Street and the Nile. Because of the wide road width of 18 m or more, the open cut method can be employed.

④ The route will turn towards Zomor Canal along a rural road. The open cut method can be employed because of the sparse traffic.

⑤ The route will cross the railway line linking Cairo with Alexandria and Zomor Canal running along the railway line. As it is impossible to block the railway traffic, it will be necessary to employ the jacking method.

⑥ The route will now run south for approximately 8.5 km along Zomor Canal. Although there are sections with busy traffic, the open cut method can be used with the introduction of night work and traffic adjustment.

⑦ Before entering the urbanized area along King Faisal Street, the route will turn west (towards Mariotia Drain). As this section still runs through a rural area, the open cut method can be employed.

⑧ As the route will cross Mariotia Drain, the largest in Giza City, an aqueduct will be required to cross the canal.

⑨ The route will turn south for approximately 4.5 km along Mariotia Drain. Even though the traffic volume is fairly high near King Faisal Street, it will not be difficult to employ the open cut method because of the small number of existing underground structures.

⑩ The original request suggested crossing Lebeni Drain (currently a road after refilling in June, 2001) after reaching King Faisal Street. However, there are many underground structures under King Faisal Street and many structures cross Lebeni Drain at the suggested crossing point, and crossing with a new large diameter pipe is difficult. Accordingly, it has been decided that the crossing point for Lebeni Drain will be moved to a point some 200 m north of King Faisal Street.

⑪ Next, the route will run along King Faisal Street, a trunk road in Giza City. As the route does not cross the road, it will be possible to employ the open cut method at a side of the road. The extremely busy traffic and many existing underground structures mean that the construction work will be complicated, taking methods such as siphon culvert. It will also be necessary to conduct the construction work in this section at night between 24:00 and 06:00.

⑫ Before reaching the water distribution station, the route will cross Mansoriya Canal and an aqueduct will be required at this point.

⑬ The water distribution station is located along Desert Road which is a trunk road between Cairo and Alexandria. It will be necessary to conduct open cut work for approximately 500 m at the side of Desert Road and to cross Desert Road to reach the water distribution station. It will be necessary to conduct this open cut work at night as in the case of similar work at King Faisal Street. Employment of the jacking method to cross Desert Road will be necessary because of the impossibility of blocking the road traffic.

(4) Selection of Pipe Size and Material

1) Selection of Pipe Size

It will be necessary to decide the diameter of the new water transmission main based on the following conditions.

- The new transmission main must have a water transmission capacity to meet the design water transmission volume of 164,400 m^3/day (2010).
- The head of the water transmission pump at the Embaba WTP is 40 m in minimum.
- The elevation difference between the water transmission pump and the water reservoir must be taken into consideration.
- Given the HWL of the water reservoir of 11 m as described later in 2.2.2.3-(2), the effective head of the water transmission main at the entrance of the water distribution station should be at least 11 m.

2) Examination Results of Pipe Size Based on Hydraulic Analysis

The required pipe size for the water transmission main is examined taking into consideration (i) the average water velocity in the transmission pipe should be within the standard range of between 1.0 and 1.5 m/s and (ii) the remained head at the water distribution station located at the end of the water transmission main should be higher than the HWL of the water reservoir. Given the design water transmission volume and the standard average water velocity in the transmission main pipe, three pipe sizes are subject to analyze, i.e. 1,600 mm, 1,500 mm and 1,400 mm, and hydraulic analysis is conducted for each pipe size.

The remained head at the water reservoir is shown in Table 2-2-13 while the hydraulic analysis results are shown in Fig. 2-2-5 through Fig. 2-2-7.

Table 2-2-13 Remained Head at Water Reservoir

Pipe Size (mm)	Remained Head at Water Reservoir (m)	HWL at Water Reservoir (m)	Difference (m)
1,600	15.04	11.0	+4.04
1,500	8.98	11.0	-2.02
1,400	0.01	11.0	-10.99

As shown in Table 2-2-13, the pipe size of the water transmission main which is capable of constantly supplying water to the reservoir is 1,600 mm. Consequently, a pipe size of 1,600 mm is appropriate for the planned water transmission main.

3) Pipe Type

Pipe material for the planned water transmission main is selectable from ductile cast iron, steel pipe, PVC, etc. In Egypt, ductile cast iron pipes are used for water supply pipes, ranging from small and medium-size pipes (100 mm - 600 mm in diameter) to large pipes (800 mm - 1,600 mm in diameter). The existing water transmission and distribution mains use ductile cast iron pipes of 1,600 mm in diameter. As shown in Table 2-2-14 – Comparison of Characteristics of Ductile Cast Iron Pipes and Steel Pipes, ductile cast iron pipes are more advantageous than steel pipes in many aspects, including pipe maintenance by the GOGCWS. Accordingly, ductile cast iron pipes will be used.

Table 2-2-14 Comparison of Characteristics of Ductile Cast Iron Pipes and Steel Pipes

Characteristics	Ductile Cast Iron Pipes	Evaluation	Steel Pipes	Evaluation
< Safety > Resistance to External Pressure	- Less deformation caused by deflection under the same load	O	- Liable to deformation due to deflection, in turn caused by high ductility	X
< Workability > - Excavation - Pipe Joining	- Small spot excavation is sufficient for push-on T-shaped joints - Joining can be quickly conducted using simple tools. The work is not affected by underground water or the weather and can be completed as planned	O O	- Large spot excavation is required at joint sections to accommodate welding work - Welding and X-ray inspection are time-consuming and require advanced skills. The work is affected by underground water or the weather	X X
< Quality > - Corrosion Resistance - Inner Surface Corrosion Resistance - Electro-Corrosion Resistance - Durability	- Corrosion resistance unique to cast iron - Excellent corrosion resistance due to alkaline corrosion resistance effect of the cement lining - Insulation of joint sections by rubber ring - Long at 40 years (low life-cycle cost)	O O O O	- Less corrosion resistance than ductile cast iron pipes - On-site corrosion resistance painting of the inner surface of the weld is difficult to perfect - Likely electro-corrosion at the welded joints - Short at 25 years (high life-cycle cost)	X X X X
< Local Characteristics and Work Conditions >	- High adaptability to night work imposed by the large traffic volume	O	- There is a limit to the number of welders to work at a small welding work site. It is difficult to complete the excavation, pipe laying, welding and refilling work in 6 hours at night when the visibility is less than ideal - Both the outer and inner surfaces of the weld must be painted. It is impossible to refill on the same day as painting because the external paint must be dry before refilling	X X
< Work Cost >	- Some 8% higher than the steel pipe cost	X	- Some 8% lower than the ductile cast iron pipe cost	O
Overall Evaluation		O		X

Transmission Main 1400

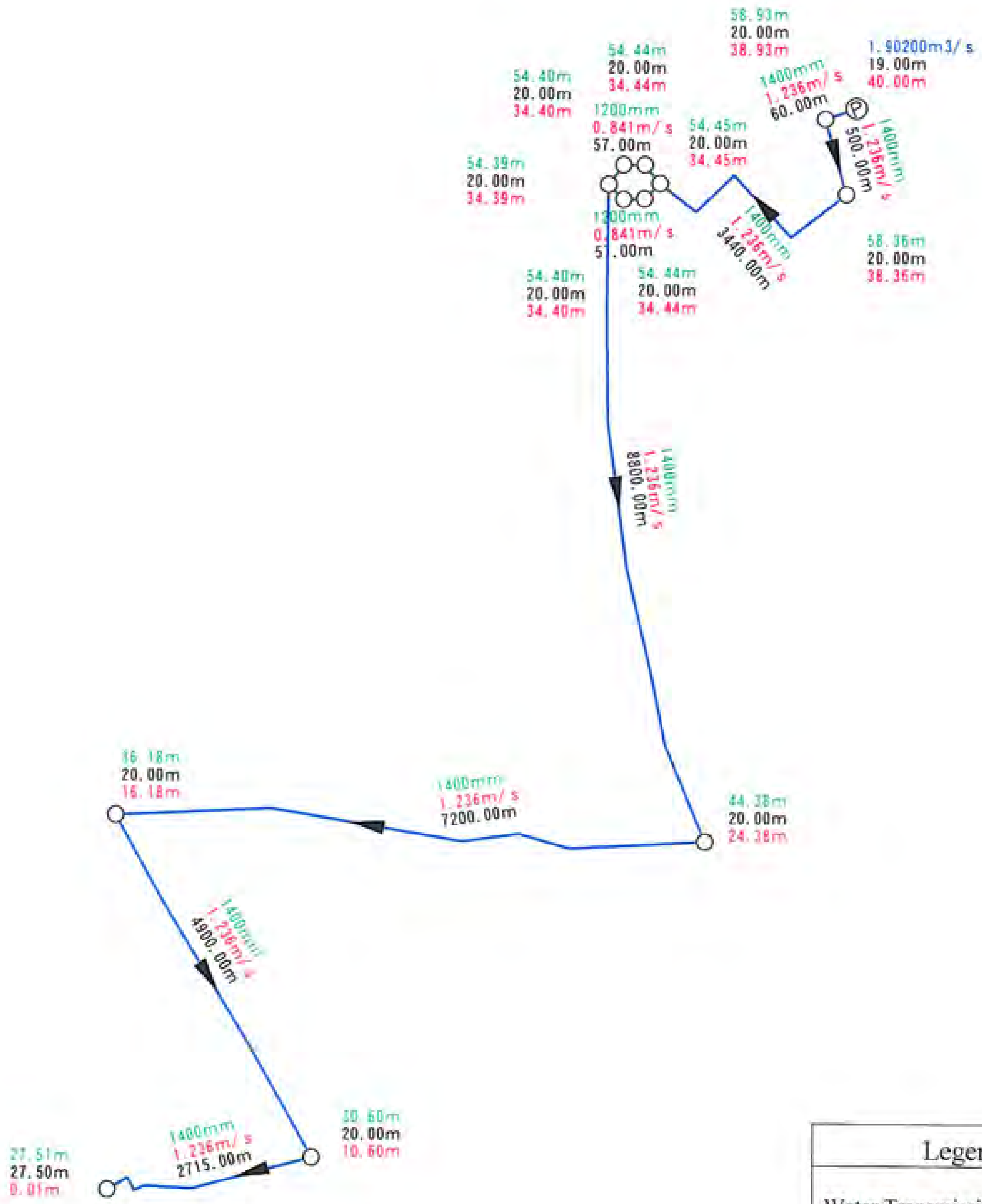


Fig.2-2-7 Result of Hydraulic Analysis
for Water Transmission Main (dia.1400mm)

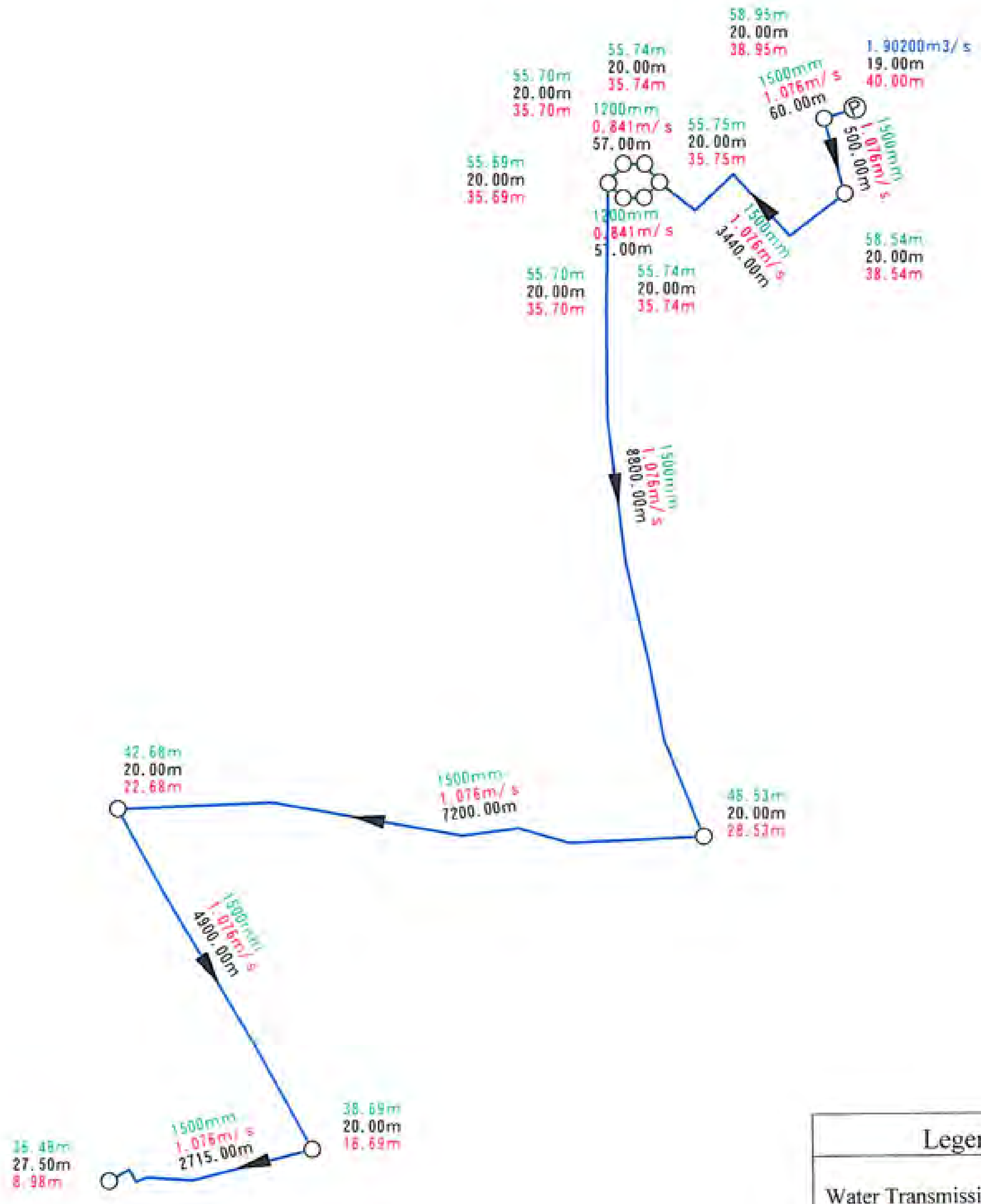
Legend

Water Transmission Main
- Diameter (mm)
- Velocity (m/sec)
- Length (m)

Calculation Point
- Hydraulic Water Level (m)
- Ground Level (m)
- Effective Head (m)

Transmission Pump
- Discharge Rate (m^3/sec)
- Ground Level (m)
- Total Pumping Head (m)

Transmission Main 1500



Legend

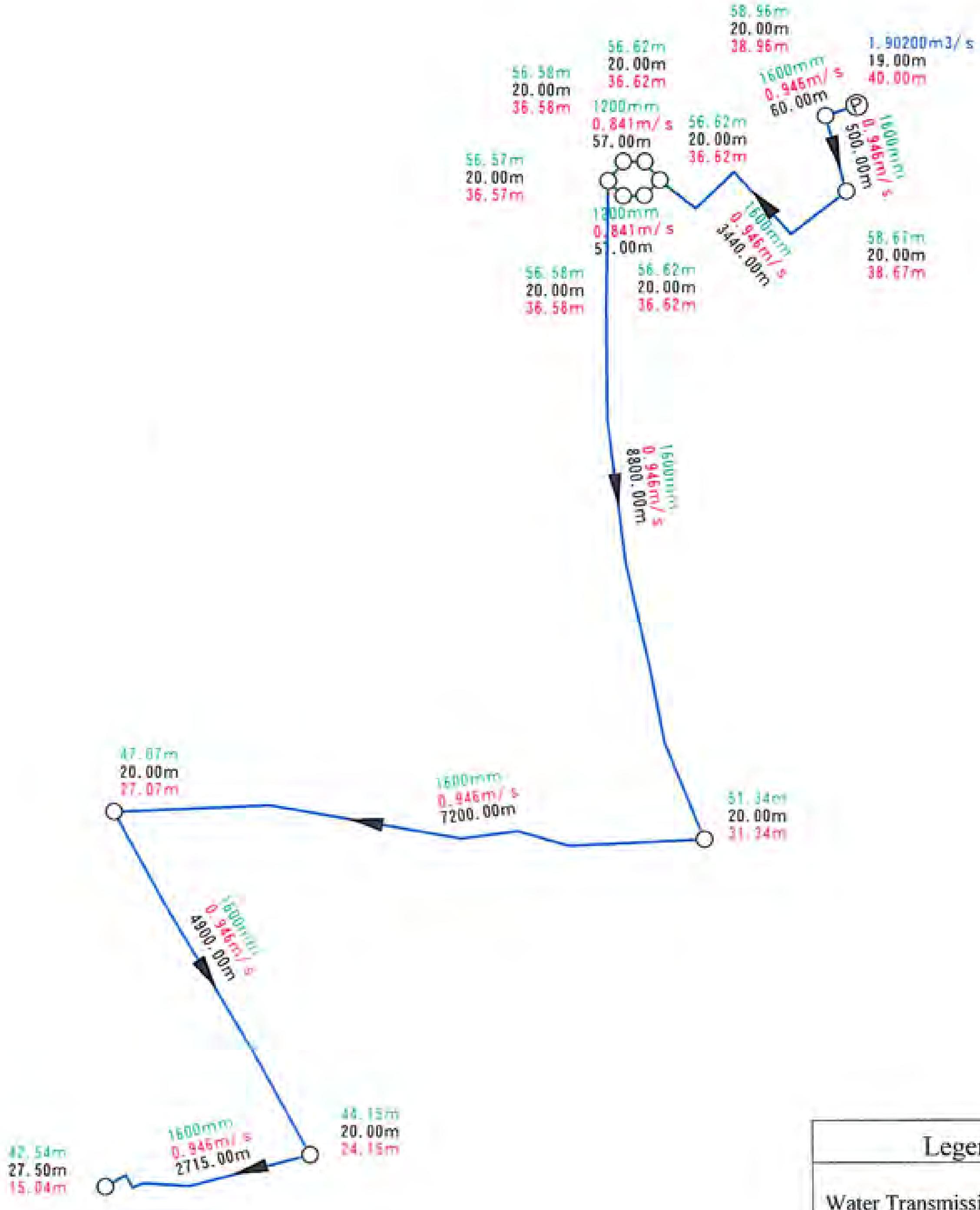
Water Transmission Main
Diameter (mm)
Velocity (m/sec)
Length (m)

Calculation Point
Hydraulic Water Level (m)
Ground Level (m)
Effective Head (m)

Transmission Pump
Discharge Rate (m^3/sec)
Ground Level (m)
Total Pumping Head (m)

Fig.2-2-8 Result of Hydraulic Analysis for Water Transmission Main (dia.1500mm)

Transmission Main 1600



Legend

Water Transmission Main
- Diameter (mm)
- Velocity (m/sec)
- Length (m)

Calculation Point
- Hydraulic Water Level (m)
- Ground Level (m)
- Effective Head (m)

Transmission Pump
- Discharge Rate (m^3/sec)
- Ground Level (m)
- Total Pumping Head (m)

Fig.2-2-9 Result of Hydraulic Analysis
for Water Transmission Main (dia.1600mm)

(5) Planning of Division of Work

The following sections pose technical difficulties for the construction of the planned water transmission main.

① Crossing work at El Kanater Street where employment of the jacking method is required

② Crossing work at the railway line and Zomor Canal where employment of the jacking method is required

③ Crossing work at Mariotia Canal where the introduction of an aqueduct is required

④ Open cut work along King Faisal Street and Desert Road where the introduction of a complicated siphon culvert and others is necessary because of the high traffic volume and existence of many underground structures

⑤ Crossing work at Mansoriya Canal where the introduction of an aqueduct is required

⑥ Crossing work at Desert Road where employment of the jacking method is required

As all of the above work will require advanced technologies and total work control techniques and as it is likely that Egyptian companies will find it difficult to satisfactorily conduct such work given their present technological level, the above six items will be included in the scope of Japan's grant aid for the Project.

All of the remaining construction work is expected to apply the open cut method which is relatively easy because of the low traffic volume and small number of underground structures even though the overall work volume is relatively large. Accordingly, this work will be conducted by the self-help efforts of the Egyptian side.

The scope of the Japanese cooperation and the scope of the work to be conducted by the Egyptian side for the Project are summarized in Table 2-2-15 and Fig. 2-2-10.

Table 2-2-15 Division of Work Between Japanese and Egyptian Sides for Construction of Water Transmission Main

Egyptian Side	Japanese Side
Open Cut Construction Work From the Embaba WTP to the crossing point of Lebeni Drain at King Faisal Street: approximately 25 km (including detailed design, procurement of materials and construction work)	**Open Cut Construction Work** From the crossing point of Lebeni Drain at King Faisal Street to the water distribution station: approximately 2.72 km
	Special Construction Work • Jacking method to cross El Kanater Street (in the section to be constructed by the Egyptian side) • Jacking method to cross the railway line and Zomor canal (in the section to be constructed by the Egyptian side) • Aqueduct to cross Mariotia Drain (in the section to be constructed by the Egyptian side) • Aqueduct to cross Mansoriya Canal (in the section to be constructed by the Japanese side) • Jacking method to cross Desert Road (in the section to be constructed by the Japanese side)

The construction cost (including the materials procurement cost, etc.) of the section of the water transmission main to be constructed by the Egyptian side is estimated to be approximately LE 125 million. This work will be conducted by the GOGCWS and is scheduled to be completed by the end of September, 2003.

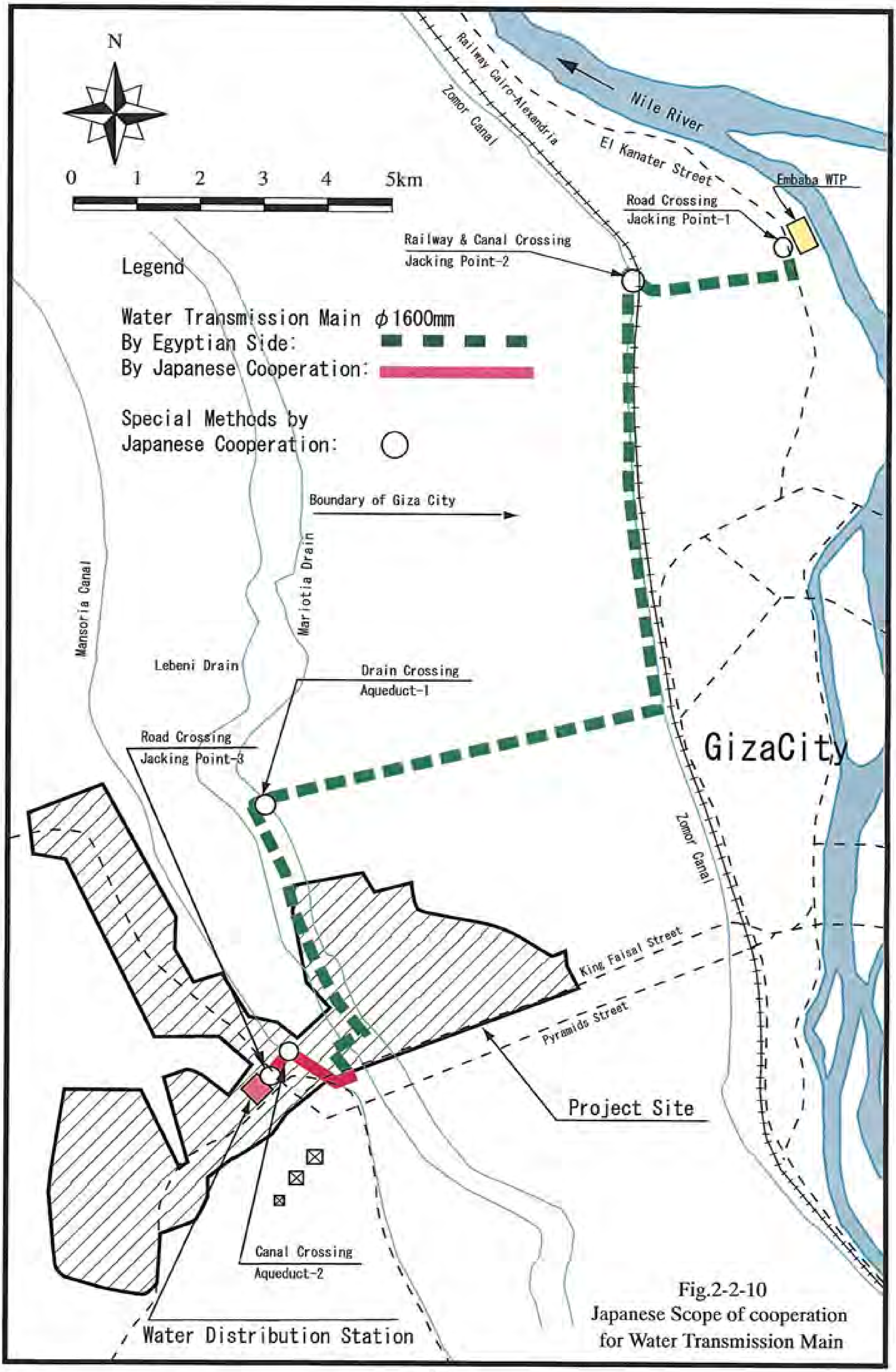


Fig.2-2-10
Japanese Scope of cooperation
for Water Transmission Main

(6) Auxiliary Equipment Plan

Such auxiliary equipment as gate valves and air valves, etc. are planned in the following manner based on the agreement with the GOGCWS while also referring to the relevant Japanese standards (Japan Waterworks Association: Water Facility Design Guidelines Explained).

1) Gate Valves

Gate valves will be installed at approximately 1 km intervals along the route as well as at the diversion points, crossing points and aqueducts. The main specifications are given below (see the Basic Design Drawing GPN-TM-02).

① Type : butterfly valve

② Material : ductile cast iron

③ Joining Method : flange joint

④ Others : to consider the joint on both sides of the valve to accommodate uneven settlement

2) Wash-out Valves

The wash-out valves will be installed at the lower sections of the route and at the aqueducts. The main specifications are given below (see the Basic Design Drawing GPN-TM-02).

① Type : sluice valve

② Diameter : 400 mm (for 1,600 mm pipe) or 300 mm (for 1,200 mm pipe)

③ Joining Method : flange joint

④ Others : a drainage pit will be introduced next to the valve and drainage will be regularly conducted using a portable pump

3) Air Valves

The air valves will be installed at the higher sections of the route and at the aqueducts. The main specifications are given below (see the Basic Design Drawing GPN-TM-02).

① Type	:	two outlet air valve
② Accessories	:	a gate valve will be installed between the main and air valves in preparation for future repair work
③ Joining Method	:	flange joint
④ Others	:	a steel cover will be installed to the air valves at the aqueducts to prevent theft or damage

4) Protection of fittings

Fittings will be protected by anchor blocks in concrete against water pressure.

(7) Selection of Construction Method

The scope of the Japanese cooperation for the construction of the water transmission main consists of the pipe laying of the water transmission main (for approximately 2.72 km in length) using the open cut method at King Faisal Street and Desert Road, the pipe laying using the jacking method at three sites and the installation of aqueducts at two sites as described in (5) above. The construction methods applied for these three types of work are described in more detail below.

1) Pipe Laying Open Cut Method

The planned water transmission main under the Project comprises an artery of the water transmission and distribution network for entire Giza City. As the planned pipe size is as large as 1,600 mm, these pipes will not be replaced for a long period. The direct installation of house connections on this transmission main is not planned. Moreover, there is no plan to branch out from this transmission main in the future. Accordingly, the new main will be buried deeper than other underground facilities to avoid any interference with other underground facilities (such as mains and branch pipes of water supply and sewer and electric power cables, etc.) during the construction period or in the future. As other underground facilities are buried between several tens of centimeters and some 1.2 m below the existing ground level, the standard earth cover for the new water transmission main will be applied 2.0 m.

King Faisal Street and Desert Road along which the new transmission main will be constructed are arteries for physical distribution in Giza City as well as Egypt and, as such, face constant heavy traffic. Because of the wide road width of some 20 m, it will be possible to lay the new pipes along the end of the roads by means of the open cut method while maintaining the traffic flow. However, as it is inevitable that any construction work at the side of these roads will be objection of the traffic flow, construction work during the daytime is not permitted. The work shall, therefore, be conducted at night (between 24:00 and 06:00) when the traffic volume is relatively light.

From the heavy road and pedestrian traffic and very deep excavation (approximately 4 m in depth) at dense housing area of more than 10 stories, highly rigid and strong earth retaining work is required to ensure safety. In order to meet this requirement, steel sheet pile earth retaining work will be employed in view of its strength and high work safety level.

In regard to the standard pipe joint, T-shape joints (push-on type) will be used because of their good workability, low cost, low work cost and reasonable water-tightness. At bending and siphon sections, K-shape joints (mechanical type) will be used because of their good workability.

2) Jacking Method

Employment of the jacking method will be required at the following three sites under the Project. Of these, Site ① and Site ② are located in the section to be constructed by the Egyptian side and the connection work will be conducted during the construction period.

① Crossing point at El Kanater Street

② Crossing point at the Cairo-Alexandria railway line and Zomor Canal which runs along the railway line

③ Crossing point at Desert Road

(a) Construction Method to be Employed

Egypt has no special regulations on the jacking method to cross a road. With the use of ductile cast iron pipes designed for the jacking method, the direct water pipe jacking is possible. Meanwhile, the Egyptian national railway standards make it compulsory for any piping work under the railway bed to use the double piping method where the main piping is set inside sleeve pipe (RC concrete) for inspection and maintenance purposes. These standards demand that the diameter of the sleeve pipe is at least twice the diameter of the pipes to be set inside and this requirement applies to the Project.

In case of the Project, the total length of the railway line or road crossing section at the three sites is short at approximately 90 m. As the procurement of machinery for the jacking method is impossible in Egypt, the machinery will be imported from Japan. Accordingly, it will be more economical to adopt the double piping system at all of the sites using one set of machinery given the fact that the rental cost in transportation period and transportation costs of machinery constitute a large proportion of the machine cost. The double piping method using RC concrete sleeve pipe of the same diameter will, therefore, be used at all three sites. The diameter of the sleeve pipe used for the jacking method under the Project is set at 2,400 mm in view of the following reasons.

① According to Japanese standards, when the double piping type jacking method is used to lay water pipes, the diameter of the sleeve pipe should be approximately 60 cm - 80 cm larger than that of the water pipe. This means that the appropriate sleeve pipe diameter to wrap a 1,600 mm water pipe is 2,200 - 2,400 mm.

② If the Egyptian National Railway Standards are followed, the diameter of the sleeve pipe must be 3,200 mm, i.e. double the water transmission main diameter of 1,600 mm. This means that the design, construction work and machinery must deal with a pipe diameter which exceeds the standard pipe diameter (3,000 mm) for the jacking method.

③ Jacking work involving a pipe diameter of up to 2,400 mm is frequently conducted in Japan and it is not difficult to lease the required machinery in the leasing market.

④ At the railway crossing section, the diameter of the water main is restricted to half of that of the sleeve pipe. As the cross-sectional area of the 1,200 mm water transmission main (half of the 2,400 mm sheath pipe) is approximately half of that of the 1,600 mm water pipe, the required cross-sectional area of the water transmission main can be obtained by introducing two parallel pipes.

In regard to the jacking method, the soil pressure type jacking method will be used in view of the following reasons.

- The use of the semi-shield method is appropriate given the large diameter of 2,400 mm and sandy soil.

- It is necessary to consider against various soil types, as the soil at the sites is composed of sandy soil or alternations of sandy and clayey soil.
- The N value of the soil is 20 or higher, indicating fairly firm ground.
- The scale of the drainage work is relatively reduced.

Fig. 2-2-11 shows the conceptual drawing of the jacking method to be employed under the Project.

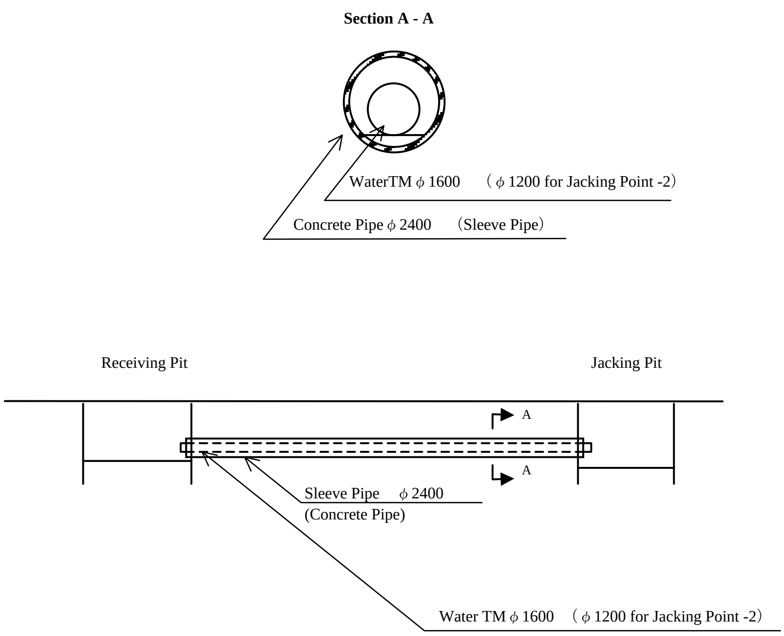


Fig. 2-2-11 The conceptual drawing of the jacking method

(b) Points to Note for Design of Jacking Method

The following points must be noted for the design of the jacking method.

① The standard clearance between the jacking pipe and existing structures (railway tracks, road surface and canal bed, etc.) should be at least 1.5 times larger than the diameter of the jacking pipe (sleeve pipe: 2,400 mm).

② The depth of the jacking pit and receiving pit should be approximately 10 - 15 m. The implementation of steel sheet pile earth retaining work will be necessary to ensure the safety of underground work and to prevent any adverse impacts on the surrounding ground and structures.

③ The Nile and a canal lie near the jacking and receiving pits and the groundwater level is supposed to be near the water level of the Nile and this canal (approximately 2 - 3 m below the ground level). It will, therefore, be necessary to employ the groundwater drainage method for the pits. It will also be necessary to consider soil improvement work at the bottom of pits and around jacking pipe in the pits in view of the possible blowing out of groundwater, boiling and heaving at these places.

④ The jacking and receiving pits located at public roads must be covered in order to ensure traffic safety when the work is not in progress or when it is unnecessary to keep them open during the work.

The jacking work at the three sites is outlined below. The locations and details of the jacking work based on the results of consultations with the Egyptian National Railways, Giza City and GOGCWS are shown in Basic Design Drawing GPN-TM-03-05.

<u>Jacking Point No. 1: crossing point at El Kanater Street</u>

- Sleeve (jacking pipe) diameter : 2,400 mm
- Water pipe diameter : 1,600 mm
- Jacking length : approx. 17.8 m
- Subject of crossing : El Kanater Street
- Jacking Pit : approx. 6.8 m deep; inside the Embaba WTP; no road occupation required
- Receiving Pit : approx. 8.6 m deep; on El Kanater Street; road occupation required (occupation width of 4 m leaving a road space width of some 14 m for traffic)

<u>Jacking Point No.2: crossing point at railway line and Zomor Canal</u>

- Sleeve (jacking pipe) diameter : 2,400 mm x 2
- Water pipe diameter : 1,200 mm x 2
- Jacking length : approx. 43 m x 2 = 86 m
- Subject of crossing : railway line (Cairo-Alexandria) and Zomor Canal running in parallel
- Jacking Pit : approx. 9 m deep; side of the gateman’s house; no road occupation required

- Receiving Pit : approx. 10 m deep; occupation of the road along Zomor Canal required (occupation width of 8 m leaving no road space for traffic; a temporary bridge for detour purposes will be introduced over Zomor Canal or its branch canal)

Jacking Point No.3: crossing point at Desert Road

- Sleeve (jacking pipe) diameter : 2,400 mm
- Water pipe diameter : 1,600 mm
- Jacking length : approx. 30.5 m
- Subject of crossing : Desert Road
- Jacking Pit : approx. 11.5 m deep; inside the planned water distribution station; no road occupation required
- Receiving Pit : approx. 11.5 m deep; on Desert Road; road occupation required (occupation width of 4 m leaving a road space width of some 16 m for traffic)

3) Aqueducts

The construction of an aqueduct at each crossing section at Mariotia Drain and Mansoriya Canal is considered appropriate as in the case of the previous project in view of the continued operation of these drains and canal, workability, construction cost, easy maintenance and past performance of aqueducts in Egypt. The outline of an aqueduct is shown in Fig. 2-2-12.

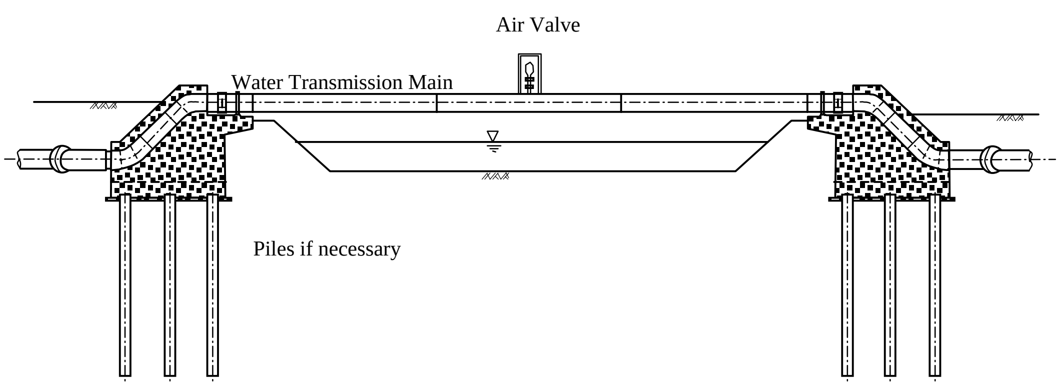


Fig. 2-2-12 Conceptual Drawing of Aqueduct

Careful attention should be paid to the following points in the aqueduct design.

- The existence of gases, such as hydrogen sulfide, from the drains, etc. should be taken into consideration in the painting design.
- As people are expected to step on the aqueducts, an extra load for people should be considered in the design load. In addition, fences or similar should be erected to deter people.
- The aqueducts will be made of steel.
- The minimum clearance between the design high water level for the drain/canal and the bottom of the aqueduct should be 100 cm based on the relevant standard of the Ministry of Public Works and Water Resources in Egypt.
- Flexible pipes should be used at the buried ends of the aqueduct to absorb possible uneven soil settlement.
- An air valve should be installed at the highest point of the aqueduct, i.e. the center point. This air valve should be protected by a steel cover against theft or damage.
- Expansion joints should be used at both ends of the aqueduct in view of the possible expansion/contraction of the steel pipes.
- Pile foundations should be used if the bearing capacity of the ground at the site is found to be insufficient.

The aqueduct at the three sites is outlined below. The locations and details of these aqueducts based on the results of consultations with the Ministry of Public Works and Water Resources, Giza City and the GOGCWS are shown in Basic Design Drawing GPN-TM-06-08.

Aqueduct No. 1: crossing point at Mariotia Drain

- Aqueduct diameter : 1,600 mm
- Aqueduct length : approx. 64 m
- Subject for crossing : Mariotia Drain and parallel branch drain
- Foundations : pile foundations

Because of the long length of this aqueduct, a central support will be required (to be installed at a site between the main drain and the branch drain). At this central site, the aqueduct will be protected by a box culvert so that a dredging machine can travel on top to conduct dredging work.

Aqueduct No. 2: crossing point at Mansoriya Canal

- Aqueduct diameter : 1,600 mm
- Aqueduct length : approx. 20 m
- Subject for crossing : Mansoriya Canal
- Foundations : direct foundations

2.2.2.3 Water Distribution Station Plan

The water distribution station has three main components, i.e. water distribution pump facilities, water reservoir and auxiliary civil engineering and building facilities. The planning details of each component are described next.

(1) Water Distribution Pump Facilities Plan

To distribute water to the four service areas, each of which has a different distance to the water distribution station and a different head, an independent pump system is planned to serve each service area. The details of the pump facilities are described below.

1) Planning Conditions for Pump Facilities

The planning contents for the pump facilities are the design flow rate and design total head.

① Design Flow Rate

The design maximum hourly water supply is used as the design flow rate for the pump system. The design maximum hourly water supply for each service area can be calculated based on the design maximum daily water supply for the target year of 2010, taking the time factor (time load fluctuation factor) [see 2.2.2.1-(3)] of each service area into consideration. The resulting values are shown in Table 2-2-16. In the case of water distribution to the Service Area No.4, the time factor will be 1.0 as the system transfers water to the exiting distribution reservoir in this service area, making consideration of the time fluctuation of water consumption unnecessary.

$$Qh = Qd/24\ h \times f$$

Where,

Qh : design maximum hourly water supply (m^3/hr)

Qd : design maximum daily water supply (m^3/day)

f : time factor (1.3 except for the Service Area No.4 of which the time factor is 1.0)

Table 2-2-16 Design Flow Rate of Pumping System

Pump Line	Service Area	Design Maximum Daily Water Supply: Qd (m^3/day)	Time Factor: f	Design Maximum Hourly Water Supply: Qh (m^3/hr)
No. 1	No. 1	7,520	1.3	408
No. 2	No. 2	67,760	1.3	3,671
No. 3	No. 3	35,810	1.3	1,940
No. 4	No. 4	53,280	1.0	2,220

② Design Total Head

The design total head for the pump can be calculated using the following equation.

H = ha + hl + he

Where,

H : design total head (m)

ha : actual head (head at the line end level - head at the pump center level) (m)

hl : head loss between the pump and line end (m)

he : required head at the line end (m)

The design total head calculation results for each pump line are shown in Table 2-2-17.

Table 2-2-17 Design Total Head for Pumping System

Pump Line No.	Line End Level	Actual Head: ha (m)	Friction Loss: hl (m)	Required Pressure at Line End: he (m)	Total Head: H (m)
1	AD + 65	37	28.11	> 25	93
2	AD + 20	-8	42.43	> 25	62
3	AD + 20	-8	58.71	> 25	77
4	AD + 89	61	3.18	> 7	74

Notes
1) The pump center level is AD +27.5.
2) The required pressure at the line end is the required pressure at the end of the distribution network for Pump Lines Nos. 1, 2 and 3 and the required pressure at the existing water reservoir in Pyramid Hills Housing Complex for Pump Line No. 4.
3) Pressure at the end of the distribution network (Pump Lines Nos. 1, 2 and 3) > pressure at the end of the branch water distribution line (20 m) + 5 m = 25 m
4) Pressure at the end of the water distribution main for Pump Line No. 4 > GL of the existing water reservoir + 5 m = 7 m

2) Pump Specifications and Number of Pumps in Operation

The pumps to be installed should have the same specifications and be of the same model for each pump line to ensure easy operation and maintenance and the exchangeability of spare parts. More than one pump, including one stand-by pump, should be installed to maintain water supply operation during the necessary stoppage for maintenance or due to a breakdown, to respond to hourly fluctuations of the water demand and to meet the expected demand increase in the future. The pump type and number of pumps for each line are decided based on the design maximum hourly water supply for 2010 in view of a low construction/installation cost, easy operation and maintenance, reduction of the spare parts cost and space for pump installation.

Multiple stage centrifugal pumps will be used for Line 1 because of the high head compared to the water distribution volume while general-purpose centrifugal pumps will be used for the other lines. In order to ensure efficient pumping operation, Line Nos. 1, 2 and 3 will adopt the speed control method for pumping operation, taking the time factor fluctuation (fluctuation range: 0.7 - 1.3) in the respective service areas into consideration, as in the case of the previous project (Project for Improvement of Water Supply System at the Southern Pyramids Area in Giza City). The common fixed speed operation method will be used for Line No. 4 because of the constant pumping flow rate due to the absence of any load fluctuation.

Line No. 1

- Number of pumps : two pumps for operation and one stand-by
- Pump type : single suction multiple stage centrifugal pump
- Pumping operation method : speed control

Line No. 2

- Number of pumps : three pumps for operation and one stand-by
- Pump type : double suction centrifugal pump
- Pumping operation method : speed control

Line No. 3

- Number of pumps : two pumps for operation and one stand-by
- Pump type : double suction centrifugal pump
- Pumping operation method : speed control

Line No. 4

- Number of pumps : two pumps for operation and one stand-by
- Pump type : double suction centrifugal pump
- Pumping operation method : fixed speed

3) Calculation of Motor Capacity

The motor capacity is calculated as follows based on the relevant JIS standards.

$$P\ (kW) = 0.163 \cdot \gamma \cdot Q \cdot H/\eta \cdot C$$

Where,

P : motor output (kW)
γ : water density (1 kg/litre)
Q : discharge rate per pump (m^3/min)
H : total head of pump (m)
η : pump efficiency
(value to be decided by the relative speed of each pump)
C : margin factor (1.15)

The discharge rate per pump (Q) is calculated using the following equation based on the design maximum hourly water supply of each line.

$Q\ (m^3/min) = (Qh/60\ mins/number\ of\ pumps\ in\ operation)$

The required motor capacity based on the above calculation for each line is shown in Table 2-2-18.

Table 2-2-18 Motor Capacity

	Design Maximum Hourly Water Supply: Qh (m^3/hr)	Discharge Rate per Pump: Q (m^3/min)	Total Head of Pump: H (m)	Pump Efficiency: η	Rated Output of Motor: P (kW)
Line No. 1	408	3.41	93	0.73	90
Line No. 2	3,671	20.38	62	0.81	300
Line No. 3	1,940	16.32	77	0.82	290
Line No. 4	2,220	18.51	74	0.82	320

4) Examination of Pump Diameter

The pump diameter of the centrifugal pumps to be used under the Project is expressed in terms of the pump inlet diameter and is determined using the following equation.

$$D\ (mm) = 146 \cdot \sqrt{Q/V}$$

Where,

D : pump diameter (mm)

Q : discharge rate per pump (m^3/min)

V : flow velocity at pump inlet (3 m/sec)

The pump diameter calculation result for each line is shown in Table 2-2-19.

Table 2-2-19 Pump Diameter

Pump Line	Discharge Rate per Pump: Q (m^3/min)	Calculated Pump Diameter: D (mm)	Selected Pump Diameter: D (mm)
No. 1 Line	3.40	155.4	150
No. 2 Line	20.39	380.6	350
No. 3 Line	16.17	339.0	350
No. 4 Line	18.50	362.6	350

5) Instrumentation and Control Equipment

① Operation Method

The pump operation method to be adopted for the Project will be manual speed set type by visually monitoring the water pressure for easy maintenance of the system and also for an easy response to system failure by operators.

② Instrumentation and Control Equipment

The following instruments and control equipment will be installed to ensure easy operation and monitoring of the water distribution system by operators and to conduct the safe and appropriate operation of the water distribution station.

a. Central console: to be installed in the control room to select the number of pumps to be operated and the operation speed, to start and stop pump operation, to monitor the water pressure of the water transmission main and distribution main and to display a warning.

b. Reservoir water gauge: to monitor the water level of the water reservoir and to display a warning on the central console in the case of an abnormally high or low water level.

c. Pressure sensors: two pressure sensors to be installed at the following points to set up the pump start-up conditions and to control the opening level of the flow control valve at the inlet of the water reservoir with their readings displayed on the central console.

- Water transmission main in the water distribution station
- Water distribution main in the water distribution station

d. Flow sensors: flow sensors to be installed at the water distribution main in the water distribution station and at the delivery pipe of the pump system for water demand control with their readings displayed on the central console.

e. No water detector: No water detector to be installed at the gate valve on the delivery side of the pump to prevent idle operation due to unbalanced pump revolutions during multiple pump operation; the detector is designed to make an emergency stop to protect the pump when no water is being pumped.

6) Countermeasures to Water Hammer

When a pump in operation suddenly stops due to a power cut, etc., abnormal pressure may occur because of a sudden change of the water velocity inside the discharge pipe. This phenomenon is called "water hammer". If this pressure exceeds the allowable value, it can cause severe damage, such as the breakage or rupture of the pump and its pipes. The phenomenon of water hammer may be caused by an initial pressure decline accompanied by water column separation which occurs immediately after pump stoppage and by a subsequent pressure increase. Suitable measures must, therefore, be taken in response to specific situation. The adverse impacts of water hammer are particularly worrying when the line is long and the flow velocity in the line is fast, particularly when there is a large elevation difference between the pump's center and outlet. The impacts of water hammer are expected to be small in the case of the Line No. 2 and No. 3, as the elevation of these areas is almost the same as the elevation of the water distribution station. In the case of Line No. 1 and Line No. 4, some measures will be required against water hammer (particularly that caused by a pressure decline) because of the large elevation difference between the water distribution station and the discharge outlet.

On each line, a bypass line will be connected to the pump discharge pipe and this pipe can be expected to function as a surge presser (function of supplementing water to negative pressure sections in the line). The measures against water hammer for each line, taking the effects of the bypass pipe into consideration, are shown in Table 2-2-20.

Table 2-2-20 Measures against Water Hammer

Line	Characteristics	Measures against Pressure Decline	Measures against Pressure Rise
No. 1	Major impact of pressure decline due to a large elevation difference between the pump center and discharge outlet of the line	(1) Installation of a flywheel (2) Surge presser effect of the bypass pipe	Installation of a slow closing check valve on the discharge side of the pump
No. 2	Minor impact of pressure decline due to a small elevation difference between the pump center and discharge outlet of the line	(1) Surge presser effect of the bypass pipe	As above
No. 3	As above	(1) Surge presser effect of the bypass pipe	As above
No. 4	Major impact of pressure decline due to a large elevation difference between the pump center and discharge outlet of the line	(1) Installation of a flywheel (2) Surge presser effect of the bypass pipe	As above

7) Electrical Installation Plan

① Division of Electrical Installation Work

The planned water distribution station is an important water supply facility which will directly affect the daily lives of the public among various public facilities. It is a compulsory requirement for such an important water supply facility to receive electricity from the public power distribution network by two lines (10.5 kV) to reduce the risk of operation stoppage due to a power cut caused by a breakdown of the power distribution equipment.

A substation to receive low voltage power supply by two lines (10.5 kV) and low voltage switchgear for power supply to the pumps will be installed in the electrical room of the water distribution station planned under the Project. The division of the electrical installation work between the Japanese side and Egyptian side is as follows.

<u>Egyptian Side</u>

- Installation of the service cable (two lines) from the 10.5 kV local power distribution lines to the incoming panel to be installed by the Japanese side
- Procurement and installation of integrating watt-hour meters

Japanese Side

- All electrical installations required to operate the water distribution station other than that conducted by the Egyptian side

② Power Supply

The power system for the water distribution station will be as follows.

High voltage : 10.5 kV, 3 phase, 3 wire, 50 Hz
Low voltage

- Power equipment : 380 V, 3 phase, 4 wire, 50 Hz
- House power supply (lighting and heating, etc.): 380 - 220 V, 3 phase, 4 wire, 50 Hz
- Monitoring and control : DC 100 V
- Instruments : DC 24 V

③ Circuit Configuration

The power receiving unit will be a two line, 10.5 kV system. No emergency power generator will be provided because of the decrease of the number of power cuts, in turn resulting from the improvement of the local power distribution system in recent years. Three transformers, including one stand-by which is required by the regulations in Egypt, will be installed.

④ Equipment Specifications

The main equipment specifications are described here. Special care is taken to ensure the adoption of the same capacity and specifications of the breaker and other equipment in view of the exchangeability of spare parts.

10.5 kV incoming panel : indoor-type, self-contained, enclosed switchgear
< Main Components >
vacuum circuit breaker (VCB); lightning arrester; watt-hour meter; ammeter; voltmeter; power factor meter; reactive power meter; integrating watt-hour meter (to be procured by the Egyptian side)

Main transformer : 10.5 kV/380 V, 50 Hz, Dyn 11, outdoor type, oil-immersed transformer

Low voltage switchgear : indoor type, self-contained, enclosed switchgear

< Main Components >

air circuit breaker (ACB); voltmeter; ammeter; power factor meter; watt-hour meter; pump start-up circuit (with inverter control); power circuit for auxiliary power equipment; transformer for house power supply

(2) Water Reservoir Plan

1) Capacity

In Japan, the standard capacity of a water reservoir is set at the storage of at least 12 hours supply based on the maximum daily water supply. The GOGCWS adopts 5 - 6 hours supply based on the maximum daily water supply as the target capacity of the water reservoir. For the Project, the capacity of the planned water reservoir is set at equivalent to at least 5 - 6 hours supply based on the design maximum daily water supply in accordance with the facility improvement policy of the GOGCWS.

As already described in 2.2.1-(1)-3), the design maximum daily water supply in the target year of 2010 of the Project is 164,370 m^3/day. This means that the construction of a reservoir with a water storage capacity of at least some 35,000 m^3 - 41,000 m^3, i.e. 5 - 6 hours supply, based on the above daily water supply will be necessary. There are already two distribution reservoirs at the Project Site (at the El Rameya Housing Complex: 2,000 m^3 and at the Pyramid Hills Housing Complex: 6,000 m^3) which can be effectively used, making the construction of a new water reservoir with a storage capacity of some 27,000 m^3 - 33,000 m^3 necessary. A new water reservoir with a storage capacity of 30,000 m^3 will, therefore, be constructed under the Project. With the addition of this new water reservoir, a volume of water equivalent to some five and a half hours supply based on the design maximum daily water supply in the target year of 2010 will be secured at the Project Site.

2) Shape and Dimensions

Two types of water reservoir, i.e. ground water tank and elevated water tank, are subject to consider advantages. Their advantages and disadvantages are summarized in Table 2-2-21.

Table 2-2-21 Comparison Between Elevated Water Tank and Ground Water Tank

Type	Advantages	Disadvantages
Elevated Water Tank	- Simple system configuration - Capable of continually supplying water during a power cut - Easy operation	- A high head transmission pump or booster pump is required - High construction cost
Ground Water Tank	- Low construction cost - Easy alteration of the facilities to meet changes of the demand	- Slightly complicated system configuration - A distribution pump is required

The following points must also be taken into consideration in the selection of the most appropriate type of distribution reservoir.

① Effective head (remained head) of the water transmitted from the WTP to the water reservoir

② Height restrictions on structures and the landscape in the area where the planned water reservoir is located

③ Availability of land on which the water distribution pump system will be installed

As described in 2.2.2.2-(4), the effective head (remained head) at the planned water reservoir will be 16.75 m for the 1,600 mm diameter water transmission main. This will make it possible to set the HWL of the water reservoir at approximately 16 m. With this HWL, however, it will be difficult to secure the required water pressure (2 kg/cm^2) at the end of the distribution network without introduction of distribution pumps. The need to install either booster pumps to raise the HWL or distribution pumps reduces the advantages of the elevated water tank system.

As the planned water reservoir site is near the three large pyramids in Giza, many hotels and other facilities serving tourists are located in the area. The construction of high buildings/structures which reduce the visibility of the pyramids or which damage the surrounding landscape is prohibited and the maximum height of any structure is 20 m.

Taking the above conditions into consideration, the planned water reservoir under the Project will be a ground water tank with a height of not more than 20 m and will be accompanied by a distribution pump system required for water distribution. In this case, the HWL of the water reservoir will be approximately 11 m as a roof above the HWL, etc. will be required. The planned water reservoir will have a cylinder shape which does not structurally generate bending moment, except hoop tension, at the horizontal cross-section and which provides high storage efficiency.

3) Structural Type

A ground water reservoir can generally be constructed using reinforced concrete (RC), prestressed concrete (PC) or steel. Table 2-2-22 shows the characteristics of these three structural types.

The structure for the planned water reservoir will be a PC structure which is superior in terms of water tightness/durability, earthquake resistance, maintenance, appearance and economy as judged from Table 2-2-22. High quality work can be ensured by the dispatch of a specialized engineer in PC water tank from Japan. Such a PC water tank was constructed under the previous project and it has been confirmed that the construction of a PC water tank in Egypt can be satisfactorily conducted under the supervision of a Japanese engineer.

Table 2-2-22 Comparison of Structures for Ground Water Reservoirs

Item	PC	Score	RC	Score	Steel	Score
Structure	- Large span possible due to small dimensions and light weight of members - Better resistance to dynamic water pressure than RC and less likelihood of cracking	3	- Larger foundations required than PC in the case of a large water reservoir due to heavier weight resulting from large dimensions of members	2	- Better ductility than concrete but inferior rigidity - Internal anti-chlorine painting and external weatherproof painting required	1
Water Tightness/ Durability	- Little cracking due to tension fastening with use of high strength concrete - Little corrosion of concrete or steel materials due to no cracking	3	- Likely appearance of cracks due to drying contraction of concrete and increased fatigue due to tensile force at full capacity	1	- Better water tightness than concrete and inferior durability due to likely corrosion	2
Work Supervision	- Slightly more complicated than RC, demanding strict work supervision - Strict work supervision leading to high quality structure - Requires high strength concrete of not less than 300 kg/cm^2 - Neither screening nor expansion joints are required	1	- Conventional work supervision sufficient to deal with this popular method - Screening and expansion joints may be required depending on reservoir shape - Use of normal strength concrete	3	- On-site assembly and welding of all joints - Welding work to be conducted by qualified personnel, followed by non-destructive testing to check welds	2
Maintenance	- Less maintenance work than RC or steel due to little prospect of cracking, rusting or corrosion	3	- Less maintenance work than steel but more than PC due to the need for the filling of cracks, etc.	2	- Regular anti-chlorine painting and weatherproof painting required, resulting in a high volume and costly maintenance work	1
Economy	- Lower construction cost than RC for a large reservoir (cheaper foundation piles and other costs due to lighter weight than RC) (construction cost index: 100)	3	- Higher construction cost than PC for a large reservoir (construction cost index: 120)	2	- One third of the durability of PC or RC, resulting in a much higher depreciation per year (inferior economy) (construction cost index: 170)	1
Miscellaneous	- Thin wall thickness and cylinder shape with domed roof make an attractive sight with a symbolic effect - Relatively new method in Egypt points to the positive effect of technology transfer	3	- Normal square shape is less attractive than PC in appearance - Established method in Egypt with a little effect of technology transfer	2	- Wall design variation is virtually limited to painting - No past example in Egypt for a large reservoir	1
Overall Evaluation	○	16	△	12	×	8

Note: 3 (○) = advantageous, 2 (△) = slightly advantageous, 1 (×) = not advantageous

4) Foundation Type

The planned construction site of the new water distribution station is located on sloping land of which the elevation ranges from approximately El. 25 m to El. 43 m, making large-scale land preparation work necessary to enable the construction of the water distribution station. It has been confirmed in the Minutes of Discussions at the time of the project feasibility assessment study that this work will be conducted by the Egyptian side.

The layout of the facilities of this water distribution station has been decided based on the main principles of effectively using the small land of 100 m by 100 m and making the maintenance of the facilities after their completion easy. After the preparation work, the ground will be levelled to reduce the amount of surplus soil to be generated, taking the optimal facility layout and the balance between cutting and banking into consideration. The elevation of the new ground will be 27.5 m to avoid the creation of a large-scale cut slope and to ensure the positioning of the heavy water reservoir on firm ground at the cut section.

The main structures of the water distribution station are the water reservoir and water distribution pumping station and these will be supported by the following methods.

In the case of the water reservoir, direct foundations will be employed as the water reservoir will be positioned above the sand layer with a sufficient bearing capacity of more than 30 – 40 (N value) after cutting as shown in the soil profile diagramme (Appendix 6).

In the case of the pumping station site, the design elevation of the bottom of the pumping station (northern section of the pumping station) is above the current elevation of the ground, necessitating banking at this section. As this section cannot be expected to have sufficient bearing strength, 1 m in depth of the surface soil of the present ground at this site will be removed and improved soil consisting of a mixture of sand and cement will be placed between the bottom of the pumping station facility and the supporting layer.

5) Inlet Pipe, Suction Pipe and By-Pass Pipe

① Inlet Pipe

The height of the inlet pipe shall be the same height as the HWL at the water reservoir to prevent the reverse flow of water towards Embaba WTP when the conveying pressure at Embaba WTP is insufficient.

As the head of the inlet pipe fluctuates with fluctuations of the pump head at Embaba WTP, regulation system is necessary to make the flow rate constant in the inlet pipe. In order to achieve a constant flow on the inlet pipe, the valve to be installed on the inlet pipe will be a flow regulating valve which is capable of controlling the flow rate through half opening operation. In addition, an ordinary valve will be installed to allow maintenance of the flow regulating valve.

The inlet pipe will be mounted to the wall using a strong metal support and the pipe material will be stainless steel to avoid corrosion.

② Suction Pipe

The suction pipe will extend from the suction pit of which the elevation is lower than the low water level (LWL) and will be connected to the pump.

③ By-Pass Pipe

A by-pass pipe will be installed to connect the outflow pipe of each pump line to the water transmission main prior to its inflow to the water reservoir. Water will be directly distributed to each service area via this by-pass pipe during maintenance of the water reservoir or when extraordinary pressure occurs with the water transmission main.

6) Overflow Pipe and Drain Pipe

An overflow pipe will be installed at the height of the HWL to prevent water storage above the HWL at the water reservoir while a drain pipe will be extended from the suction pit of which the elevation is lower than the LWL. The downstream ends of both the overflow pipe and drain pipe will be connected to the sewer manhole.

7) Ventilator, Manholes, Inspect Holes, Staircase and Ladder

Ventilator will be installed to prevent the occurrence of extraordinary pressure in response to the expected water level fluctuation inside water reservoir. At the time of such maintenance work as repainting of the water reservoir, inspect holes will be used for forced ventilation. Manholes, a staircase and ladder will be used for maintenance work. A landing area will be introduced for the internal ladder because of its height.

8) Painting

Epoxy resin paint will be used for the internal painting of the water reservoir in view of its excellent waterproofness, durability and strength vis-a-vis concrete cracks. Acrylic paint will be used for the external painting because of its good waterproofness and weatherability.

(3) Civil Engineering and Building Facilities Plan

1) Contents

The following civil engineering and the building works will be conducted at the water distribution station.

- Pump house : RC single story with building services total floor area: approximately 1,140 m^2
- Equipment foundations : foundations for water distribution pump and electrical equipment, including transformer
- Inside road
- Drainage system

2) Facility Layout Plan

The facility layout at the planned water distribution station is shown in Basic Design Drawing GPN-WD-01.

3) Details of Main Facilities

Each facility at the water distribution station is designed based on the plan, section plan and flow plan in order to ensure the proper functioning of the planning pump system under the Project. The selection of the materials required for the construction of the planned facilities is based on local availability, construction schedule, future maintenance requirements and durability. The main functions of each facility are described next.

① Pump House (refer to the Basic Design Drawings GPN-WD-09-11)

- Main Specifications
  - Foundations : direct foundations (partially replace soil with a mixture of sand and cement)
  - Superstructure (beams and pillars, etc.) : RC
  - Piping and cable pit, etc. : RC
  - Floor : RC and checkered plate in part
  - Partitions : concrete blocks
  - External walls : RC
  - Fittings : aluminum or steel

- Main Rooms and Floor Area, etc.

  The main rooms, their floor area and building service facilities of the pump house are described in Table 2-2-23.

Table 2-2-23 Room Arrangement of Pump House

Item No.	Room	Floor Area (m^2)	Building Services, etc.
1	Pump Room	864	Lighting; air-conditioning; fire-fighting; overhead travelling crane
2	Electrical Room	194	Lighting; air-conditioning; fire-fighting
3	Control Room	34	Lighting; air-conditioning
4	Staff Room	36	Lighting
5	Toilets	12	Sanitary fixtures; lighting; ventilation
Total		1,140	

- Building Services
  - Lighting system : JIS standards will be used for lighting. In principle, lamps will be either fluorescent lamps or mercury lamps
  - Ventilation system : ventilation fans or natural ventilation using louver windows

- Air-conditioning system : package type air-conditioner
- Fire-Fighting system : ionic fire detector and ABC fire extinguisher (3 kg type) in each room
- Transformer shade : a shade will be provided for the 10.5 kV transformers which supply power to the pump system

② External Work, Including Inside Road

- Inside Road

An inside road will be constructed from the entrance of the water distribution station to circle the pump house in order to assist valve operation, instrument checking and maintenance. This road will be constructed of asphalt concrete and cross-grade will be introduced to facilitate rainwater drainage. Parking spaces will be provided for operation and maintenance staff cars.

- Outdoor Lighting

Outdoor lighting will be installed around the pump house, at key sites for the night inspection/maintenance of the water reservoir and valves and along the premise road.

- Drainage System

Because of the extremely low rainfall level at the Project Site, rainwater on the inside road will be left by natural infiltration. Meanwhile, water overflow from the water reservoir, water drain from the cleaning of the bottom of the water reservoir, water drain from the pump cooling system and treated water from the septic tank attached to the pump house will join together in the site and will be discharged to the public sewer line under the road in front of the water distribution station by means of the gravity method. In regard to discharge of the overflow, etc. from the water reservoir, the work downstream of the drainage pit will be conducted at the expense of the Egyptian side as it will not interfere with the work schedule of the Japanese side.

2.2.2.4 Water Distribution Pipe Procurement Plan

(1) Water Distribution Network Arrangement Plan

1) Principles of Arrangement Plan

The arrangement of the water distribution network under the Project will be planned with the following conditions.

- The development work will be conducted in the service areas No.2 and 3 which are urbanized by 2003 when the planned facilities under the Project will be completed but which do not currently receive water supply through distribution pipes.
- The scope of procurement will cover distribution mains with a diameter of 200 mm or more which form the trunk distribution network but will only for fittings and valves and excluding straight pipes.
- All pipes (diameter of 100 - 150 mm) for branch lines will be procured by the Egyptian side.
- The planned routes of the distribution pipes will take the current spread of urbanized areas into consideration to allow easy pipe laying work.
- The configuration of the planned routes will be such that the distribution network will provide a stable water supply.

- Connecting pipes from the water distribution station to the existing distribution main will be required to distribute water from the station to the distribution network. The scope of procurement by the Japanese side will be restricted to fittings, excluding straight pipes and valves.

The water distribution pipes are classified into the following two categories.

- Water distribution main : conveys clean water to the water distribution branch pipes and has no house connection
- Water distribution branch pipes : distribute water from the main to users through house connection

2) Design of Water Distribution Network

(a) Design Conditions

The design conditions of the water distribution network are given in Table 2-2-24.

Table 2-2-24 Design Conditions of Water Distribution Network

Item	Design Conditions
1. Design Maximum Daily Water Supply	
- Service Area No.2	67,760 m^3/day
- Service Area No.3	35,810 m^3/day
2. Design Maximum Hourly Water Supply	Design Maximum Daily Water Supply x Time Factor (1.3)
3. Minimum Water Head at End of Distribution branch Pipe	2.0 kg/cm^2 (head: 20 m)
4. Pipe Material	Ductile cast iron pipe
5. Minimum Diameter	100 mm
6. Auxiliary Facilities	
(1) Gate Valve	- Butterfly valve: Ø400 mm or more
	- Sluice valve: up to Ø350 mm or less
(2) Air Valve	- Double outlet air valve: Ø400 mm or more
	- Single outlet air valve : Ø350 mm or less

(b) Results of Hydraulic Analysis of the Network

The results of the hydraulic analysis of the network for the Service Areas No. 2 and No. 3, taking the conditions described in the above into consideration, are shown in Figs. 2-2-14 and 2-2-15.

(c) Details of Connecting Section Between Water Distribution Station and Existing Water Distribution Main

The existing water distribution main will be used to distribute water from the water distribution station to the planned Service Areas. Connection between the pumping station and the existing distribution main is illustrated in detail in Fig. 2-3-13. The limit for the work to be conducted by the Japanese side will be 1 m outside the perimeter fence of the water distribution station and the remaining connection work to the existing distribution main will be conducted by the Egyptian side.

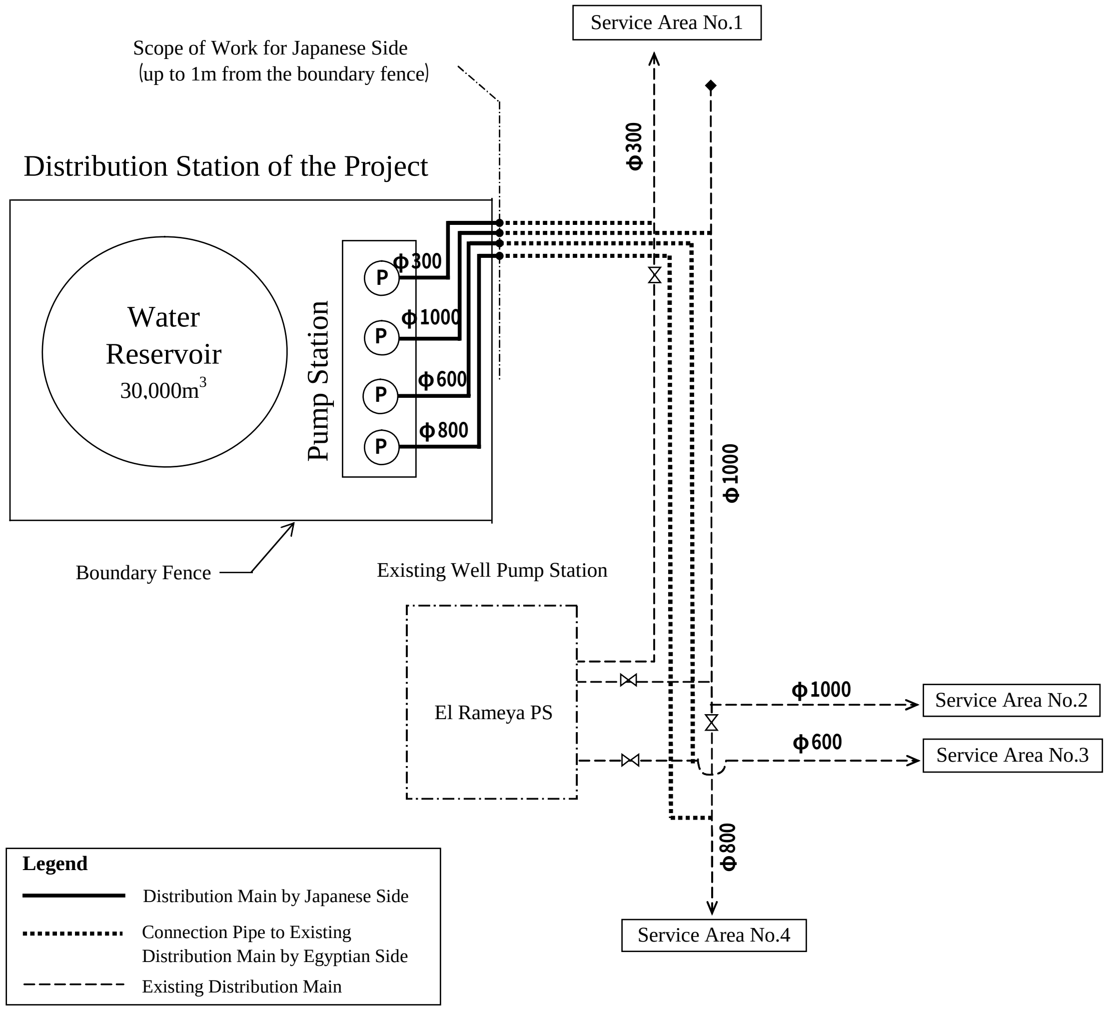


Fig. 2-2-13 Details of Connection Between Water Distribution Station and Existing Distribution Main

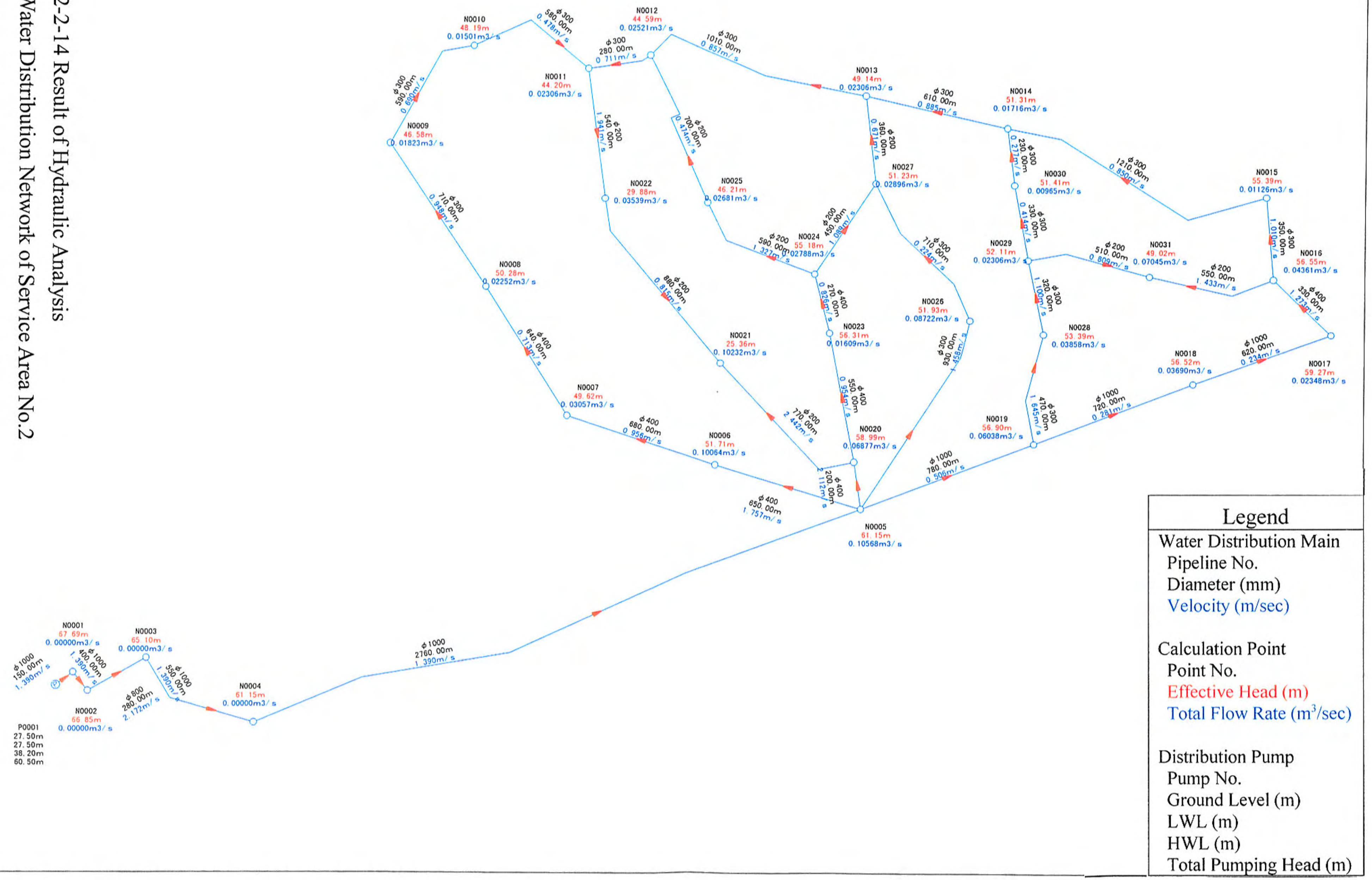


Fig.2-2-14 Result of Hydraulic Analysis for Water Distribution Network of Service Area No.2

Legend

Water Distribution Main
- Pipeline No.
- Diameter (mm)
- Velocity (m/sec)

Calculation Point
- Point No.
- Effective Head (m)
- Total Flow Rate (m^3/sec)

Distribution Pump
- Pump No.
- Ground Level (m)
- LWL (m)
- HWL (m)
- Total Pumping Head (m)

Fig.2-2-15 Result of Hydraulic Analysis
for Water Distribution Network of Service Area No.3

(2) Total Length of Water Distribution Pipes

The total length of the water distribution mains and branch pipes required for the planned arrangement of the distribution network, calculated on the basis of the hydraulic analysis results, is shown in Table 2-2-25.

Table 2-2-25 Total Length of Water Distribution Pipes Required for Planned Distribution Network

Category	Diameter	Total Length (m)		
		Service Area No.2	Service Area No.3	Total
(1) Water Distribution Main	400	0	1,440	1,440
	300	6,170	0	6,170
	200	3,700	1,230	4,930
Sub-Total		9,830	2,670	12,540
(2) Water Distribution Branch Pipe	150	4,830	0	4,830
	100	20,790	0	20,790
Sub-Total		25,620	0	25,620
Total		35,490	2,670	38,160

(3) Length of Connecting Pipes Between Water Distribution Station and Existing Water Main

As shown in Fig. 2-3-13, it will be necessary for the Egyptian side to conduct the connection work from the 1 m point outside the perimeter fence of the water distribution station to the existing water main buried under Desert Road. The length of the connecting pipes to be used is shown in Table 2-3-26.

Table 2-2-26 Length of Connecting Pipes Between Water Distribution Station and Existing Distribution Main

Destination	Pipe Diameter (mm)	Length (m)
Service Area No. 1	300	110
Service Area No. 2	600	510
Service Area No. 3	1,000	120
Service Area No. 4	800	500
Total		1,240

(4) Capability of Giza City and Scope of Japanese Cooperation

In the previous project (Project for Improvement of Water Supply System at the Southern Pyramids Area in Giza City), Giza City applied its own funds to lay the water distribution pipes provided by Japan and to procure and lay those pipes which were not included in the scope of the Japanese grant aid within a set schedule. The extent of the work conducted in the previous project is shown in Table 2-2-27.

Table 2-2-27 Development of Water Distribution Network in Giza Under Previous Project

Project Title	Pipe Diameter (mm)	Total Pipe Length (km)	Work Conducted by Giza City
Project for Improvement of Water Supply System at Southern Pyramids Area in Giza City	100- 150	119	Procurement and pipe laying work
	200 – 600	28	Laying of pipes (procured by Japanese side)
	Total	149	

Under the previous project, Giza City completed the procurement and laying of branch pipes for 119 km and the laying of mains procured by Japan for 28 km without a substantial delay. As the planned total length of the water distribution pipes (100 - 400 mm in diameter) under the Project is approximately 38 km, Giza City is supposed to be fully capable of conducting the planned work.

In the case of the water distribution mains (200 mm in diameter or larger) which form the trunk distribution network, high quality fittings and valves must be used in view of the risk of leakage due to high internal pressure. Even though fittings and valves are now manufactured in Egypt, their manufacturing experience is not sufficient. In addition, they face quality problems and their production volume is low. Accordingly, out of the components of the connecting distribution mains (300 – 1,000 mm in diameter; 1,240 m in length) between the water distribution station and the existing distribution main and of the distribution mains (200 – 400 mm in diameter and 12,540 m in length) forming the distribution network in Service Area No. 2 and Service Area No. 3, fittings, excluding straight pipes and valves, will be procured under the Japanese cooperation. Table 2-2-28 and Table 2-2-29 list the necessary fittings and valves.

Table 2-2-28 Required Fittings and Valves for Connection between Water Distribution Station and Existing Distribution Main

No.	Item	Size, Spec.	Q (sets)	No.	Item	Size, Spec.	Q (sets)
1	All Socket Tee	300 x 300 T	1	14	Collar	300 K	5
2	All Socket Tee	600 x 600 T	1	15	Collar	300 K	1
3	All Socket Tee	1,000 x 800 T	1	16	Collar	300 K	7
4	All Socket Tee	1,000 x 1,000 T	1	17	Plane End w Puddle	600 x 3,000 T	1
5	Bend	600 x 45 T	2	18	Plane End w Puddle	1,000 x 3,000 T	1
6	Bend	800 x 45 T	4	19	Flanged Spigot w Puddle	600 x 3,000 T	1
7	Flanged Socket	300 T	1	20	Flanged Spigot w Puddle	1,000 x 3,000 T	1
8	Flanged Socket	600 T	1	21	Flanged Adapter	600	1
9	Flanged Socket	1,000 T	1	22	Flanged Adapter	1,000	1
10	Flanged Spigot	300 T	1	23	Butterfly Valve	600	1
11	Flanged Spigot	600 T	1	24	Butterfly Valve	1,000	1
12	Flanged Spigot	1,000 T	1	25	Air Valve	300	1
13	Collar	300 K	1				

Table2-2-29 Required Fittings and Valves for the Water Distribution Main

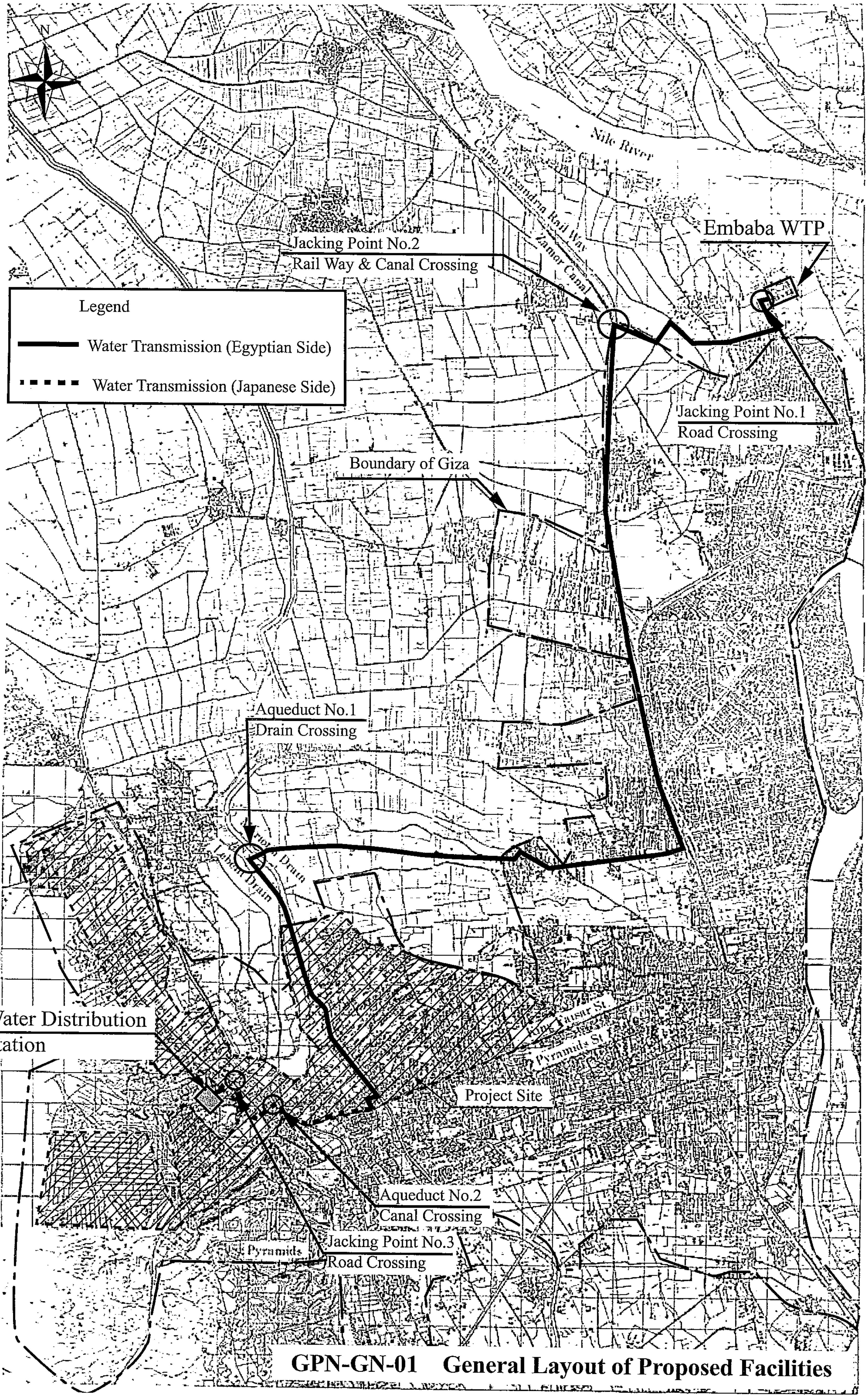
No.	Item	Size, Spec.	Q (sets)	No.	Item	Size, Spec.	Q (sets)
1	All Socket Tee	200 x 100 T	48	40	Plug	200 T	1
2	All Socket Tee	200 x 150 T	5	41	Collar	100 K	83
3	All Socket Tee	200 x 200 T	2	42	Collar	150 K	12
4	All Socket Tee	300 x 100 T	24	43	Collar	200 K	45
5	All Socket Tee	300 x 150 T	7	44	Collar	300 K	47
6	All Socket Tee	300 x 200 T	7	45	Collar	400 K	26
7	All Socket Tee	300 x 300 T	2	46	Collar	600 K	4
8	All Socket Tee	400 x 100 T	11	47	Collar	1000 K	5
9	All Socket Tee	400 x 200 T	2	48	Plane Ends w Puddle	400 x 3000 T	8
10	All Socket Tee	400 x 300 T	1	49	Plane Ends w Puddle	600 x 3000 T	1
11	All Socket Tee	400 x 400 T	2	50	Plane Ends w Puddle	1000 x 3000 T	1
12	All Socket Tee	600 x 400 T	1	51	Double Flange Tee	80 x 250L	22
13	Double Socket Taper	300 x 200 T	3	52	Double Flange Piece	100 x 250L	1
14	Double Socket Taper	350 x 300 T	2	53	Double Flange Piece	150 x 250L	1
15	Double Socket Taper	400 x 300 T	2	54	Flanged Spigot w Puddle	400 x 3000 T	8
16	Double Socket Taper	600 x 350 T	2	55	Flanged Spigot w Puddle	600 x 3000 T	1
17	Double Socket Taper	1000 x 600 T	1	56	Flanged Spigot w Puddle	1000 x 3000 T	1
18	Bend	200 x 45 T	6	57	Flanged Adapter	400	8
19	Bend	200 x 22 T	10	58	Flanged Adapter	600	1
20	Bend	200 x 11 T	8	59	Flanged Adapter	1000	1
21	Bend	300 x 45 T	11	60	Restrained Coupling	100 T	512
22	Bend	300 x 22 T	12	61	Restrained Coupling	150 T	48
23	Bend	300 x 11 T	15	62	Restrained Coupling	200 T	334
24	Bend	400 x 11 T	5	63	Restrained Coupling	300 T	348
25	Bend	600 x 45 T	4	64	Restrained Coupling	350 T	4
26	Bend	1000 x 45 T	2	65	Restrained Coupling	400 T	107
27	Flange Tee	200 x 80 T	8	66	Restrained Coupling	600 T	23
28	Flange Tee	300 x 80 T	10	67	Butterfly Valve	400	8
29	Flange Tee	400 x 80 T	4	68	Butterfly Valve	600	1
30	Flange Tee	600 x 100 T	1	69	Butterfly Valve	1000	1
31	Flange Tee	1000 x150 T	1	70	Sluice Valve	100	83
32	Flanged Socket	100 T	83	71	Sluice Valve	150	12
33	Flanged Socket	150 T	12	72	Sluice Valve	200	20
34	Flanged Socket	200 T	20	73	Sluice Valve	300	20
35	Flanged Socket	300 T	20	74	Air Valve	80	17
36	Flanged Spigot	100 T	83	75	Air Valve	100	6
37	Flanged Spigot	150 T	12	76	Air Valve	150	1
38	Flanged Spigot	200 T	20	77	Valve Box	100 – 200	115
39	Flanged Spigot	300 T	20	78	Valve Box	300	20

note: ISO standards applied

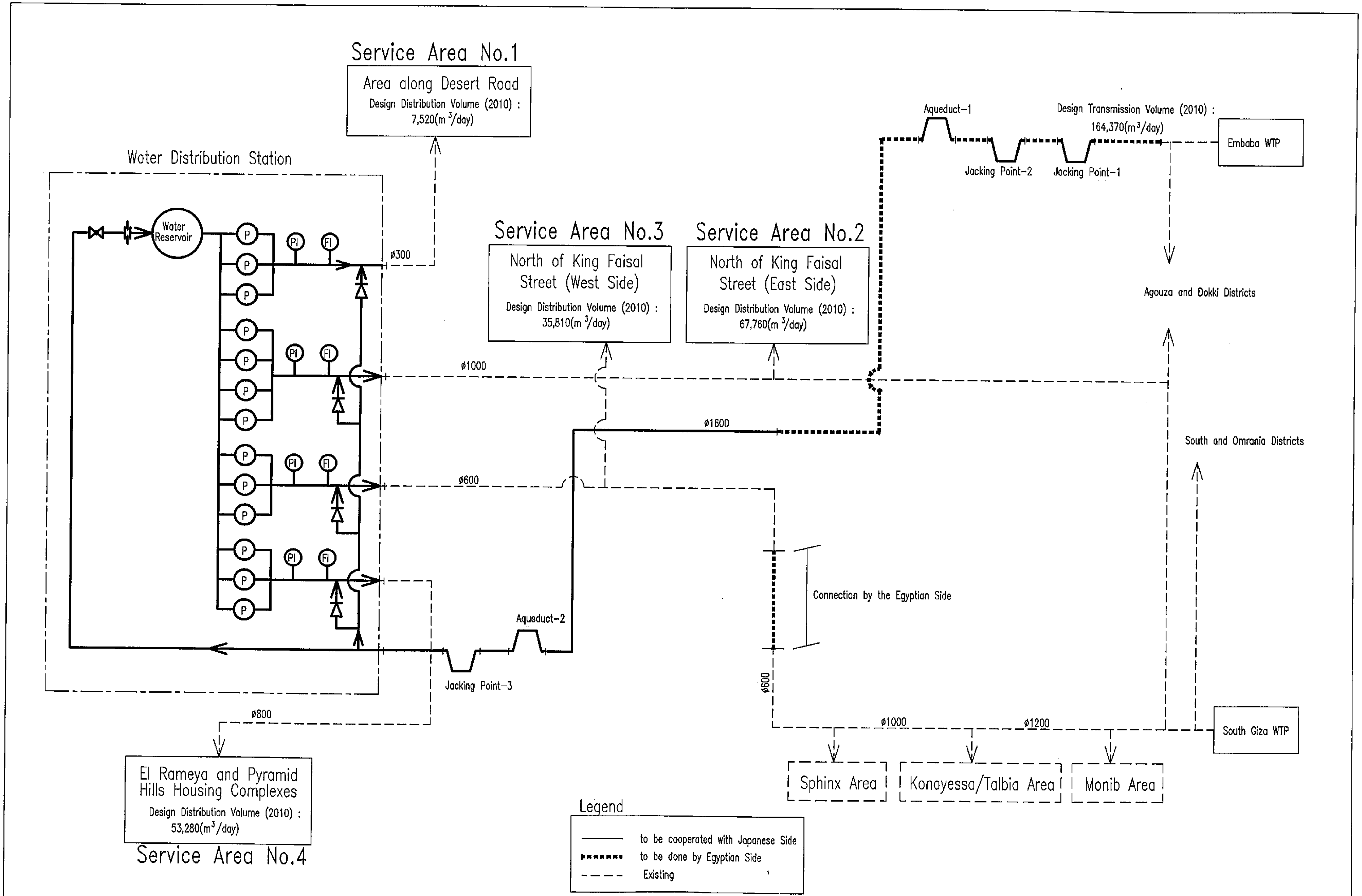
2.2.3 Basic Design Drawings

The Basic Design Drawings of the Project are as follows and attached from next page.

GPN-GN-01	General Layout of Proposed Facilities
GPN-GN-02	Basic Flow of Proposed Facilities
GPN-TM-01	Plan of Water Transmission Main
GPN-TM-02	Standards Structure of Auxiliary Facilities
GPN-TM-03	Plan and Section of Jacking Method (1/3)
GPN-TM-04	Plan and Section of Jacking Method (2/3)
GPN-TM-05	Plan and Section of Jacking Method (3/3)
GPN-TM-06	Plan and Section of Aqueduct (1/3)
GPN-TM-07	Plan and Section of Aqueduct (2/3)
GPN-TM-08	Plan and Section of Aqueduct (3/3)
GPN-WD-01	General Layout of Water Distribution Station
GPN-WD-02	Water Reservoir – Plan and Section
GPN-WD-03	Water Reservoir – Piping System (1/2)
GPN-WD-04	Water Reservoir – Piping System (2/2)
GPN-WD-05	Distribution Pump Facilities - Plan
GPN-WD-06	Distribution Pump Facilities - Section
GPN-WD-07	Flow Chart of Distribution Pump Facilities
GPN-WD-08	Single Line Diagram of Distribution Pump Facilities
GPN-WD-09	Pump House - Plan
GPN-WD-10	Pump House - Section
GPN-WD-11	Pump House - Elevation



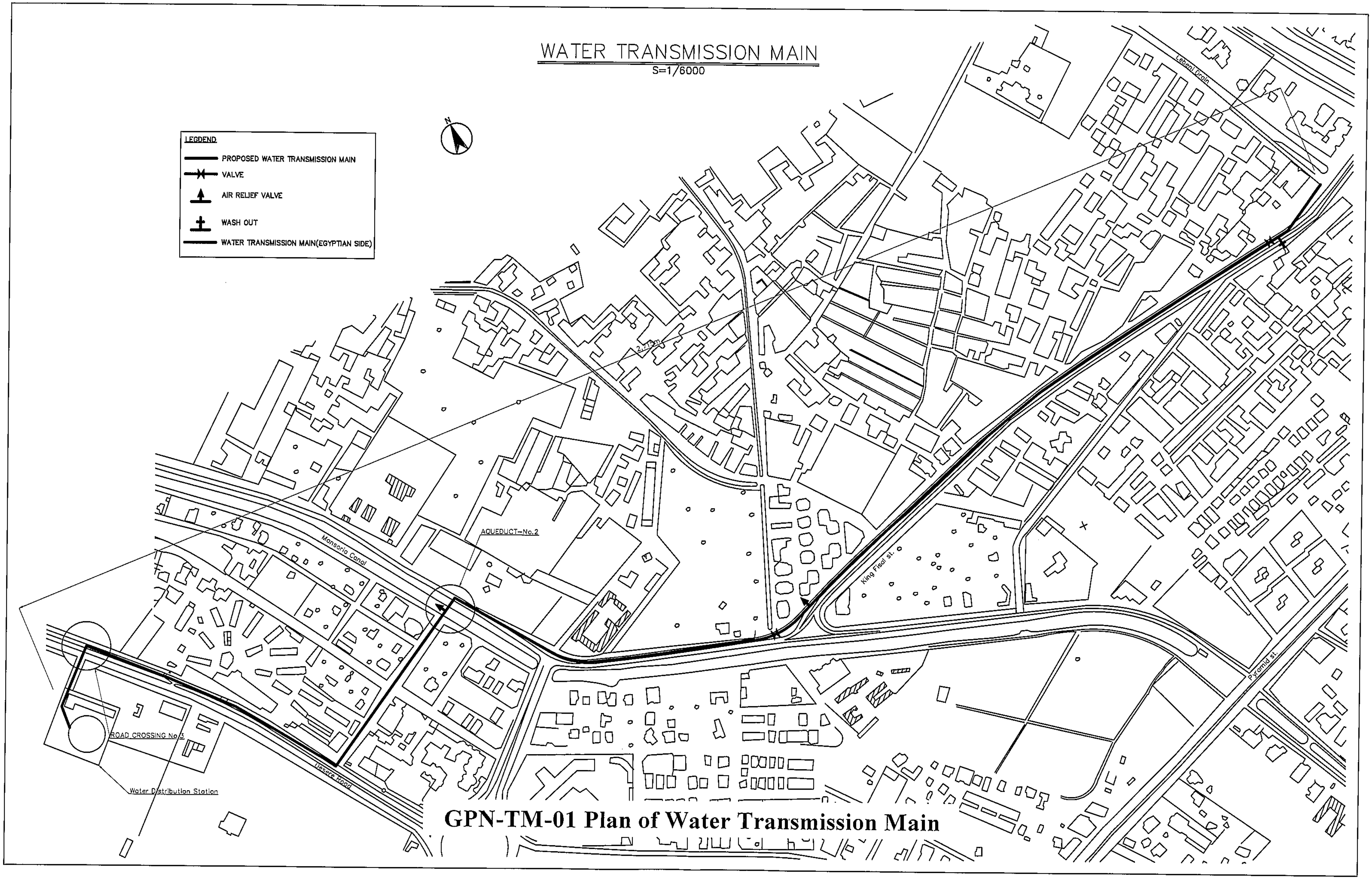
GPN-GN-01 General Layout of Proposed Facilities



GPN-GN-02 Basic Flow of Proposed Facilities

WATER TRANSMISSION MAIN

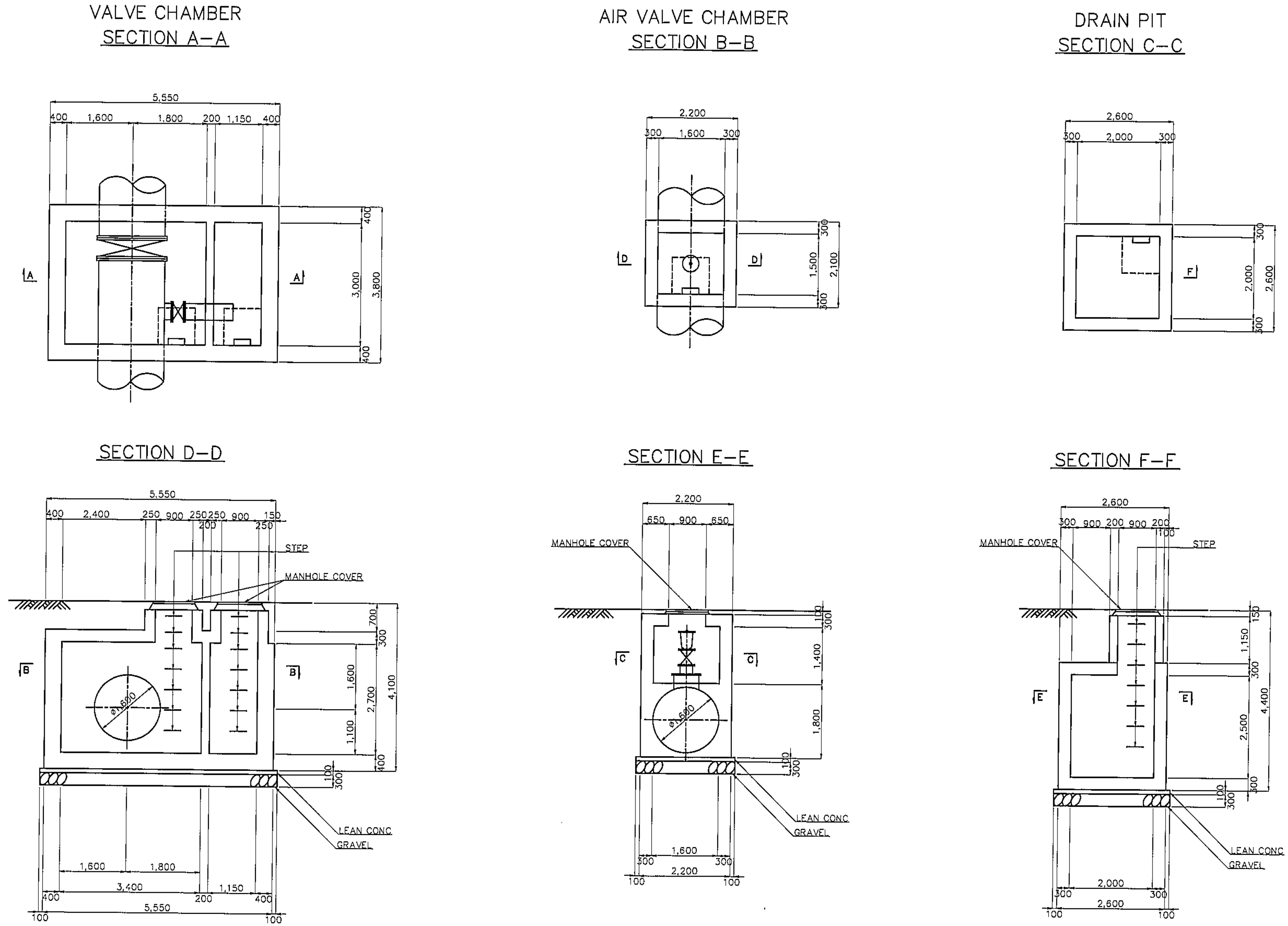
S=1/6000



GPN-TM-01 Plan of Water Transmission Main

VALVE CHAMBER

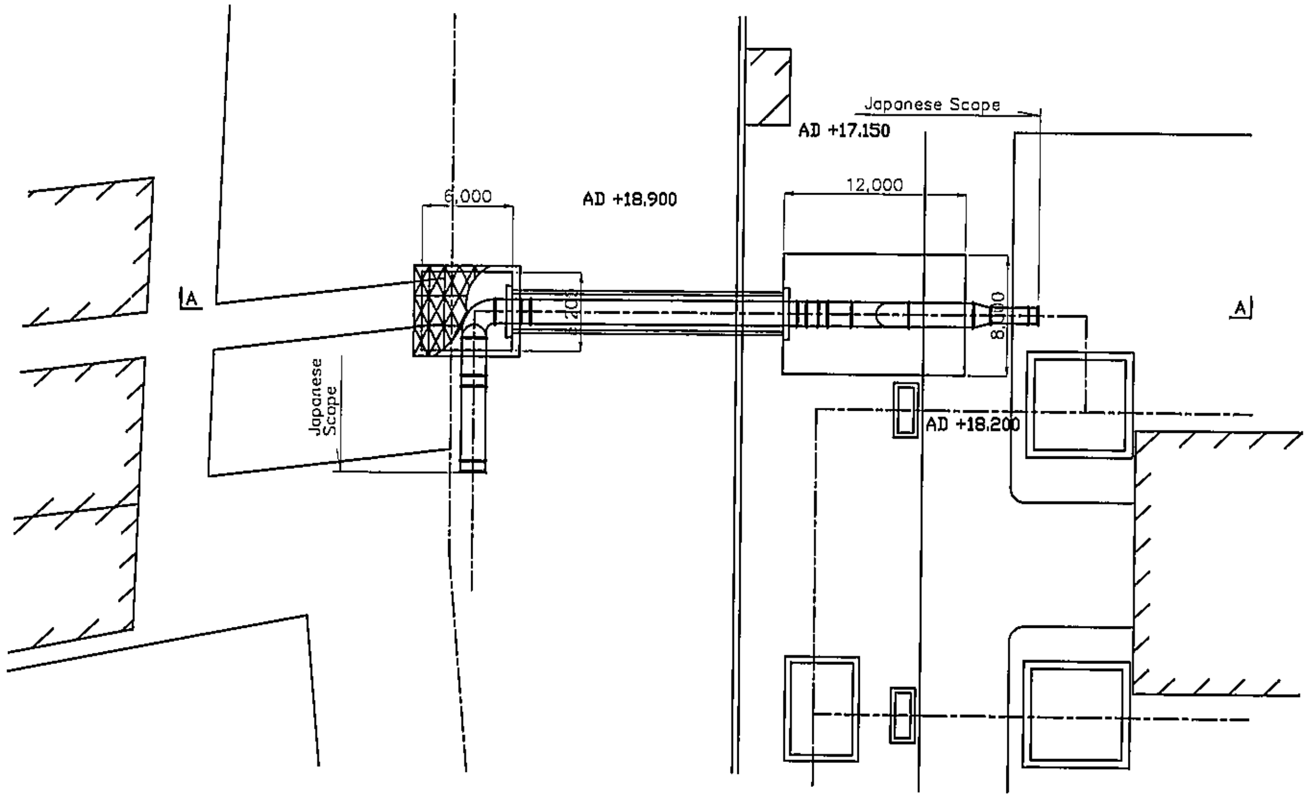
S=1/100



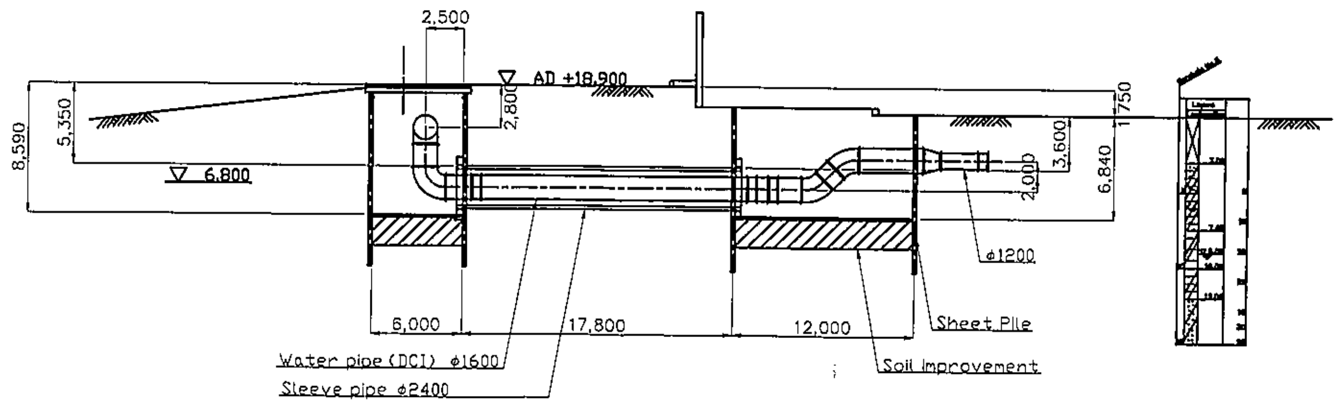
GPN-TM-02 Standard Structure of Auxiliary Facilities

JACKING POINT−1
(EMBABA)

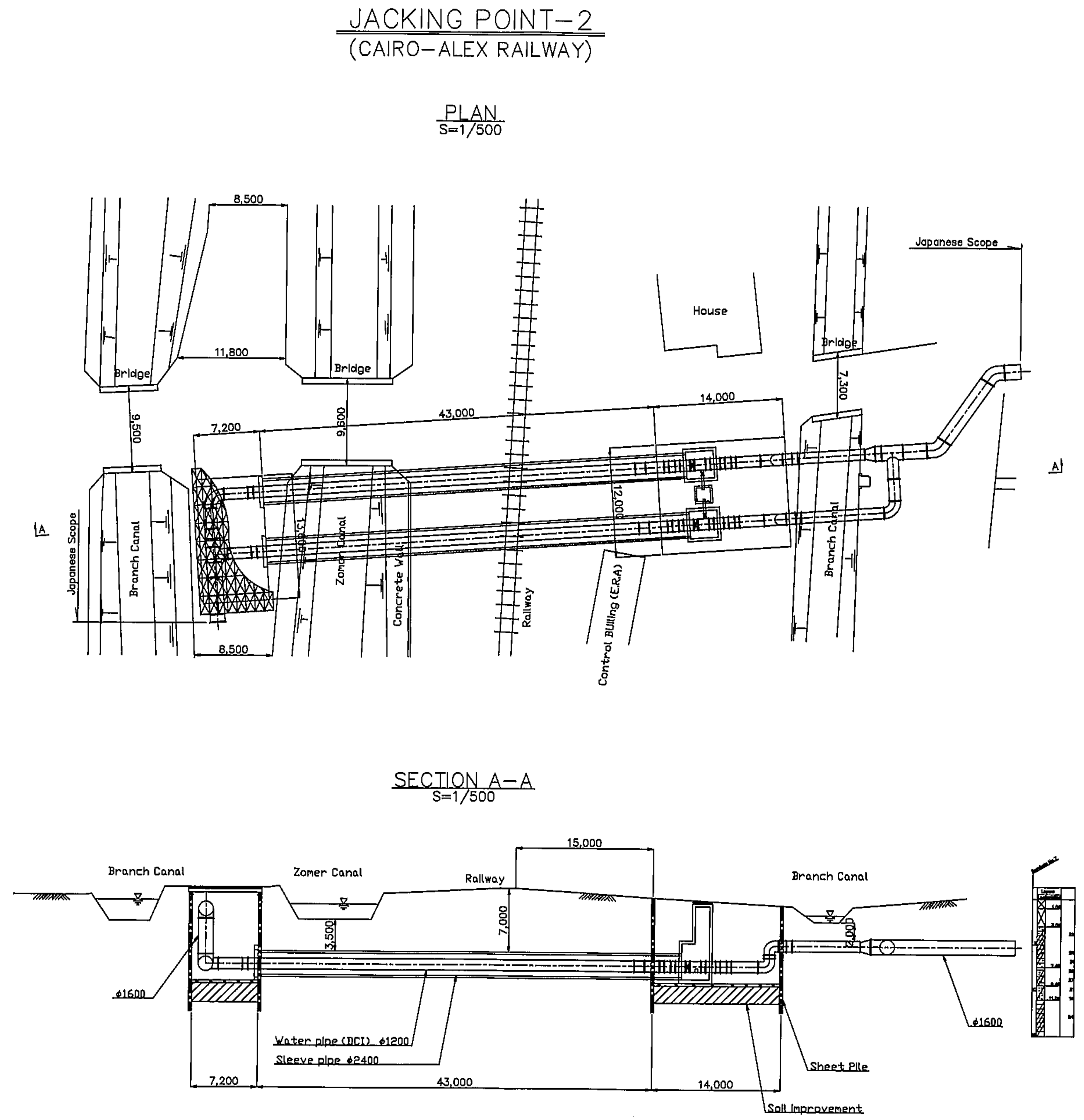
PLAN
S=1/500



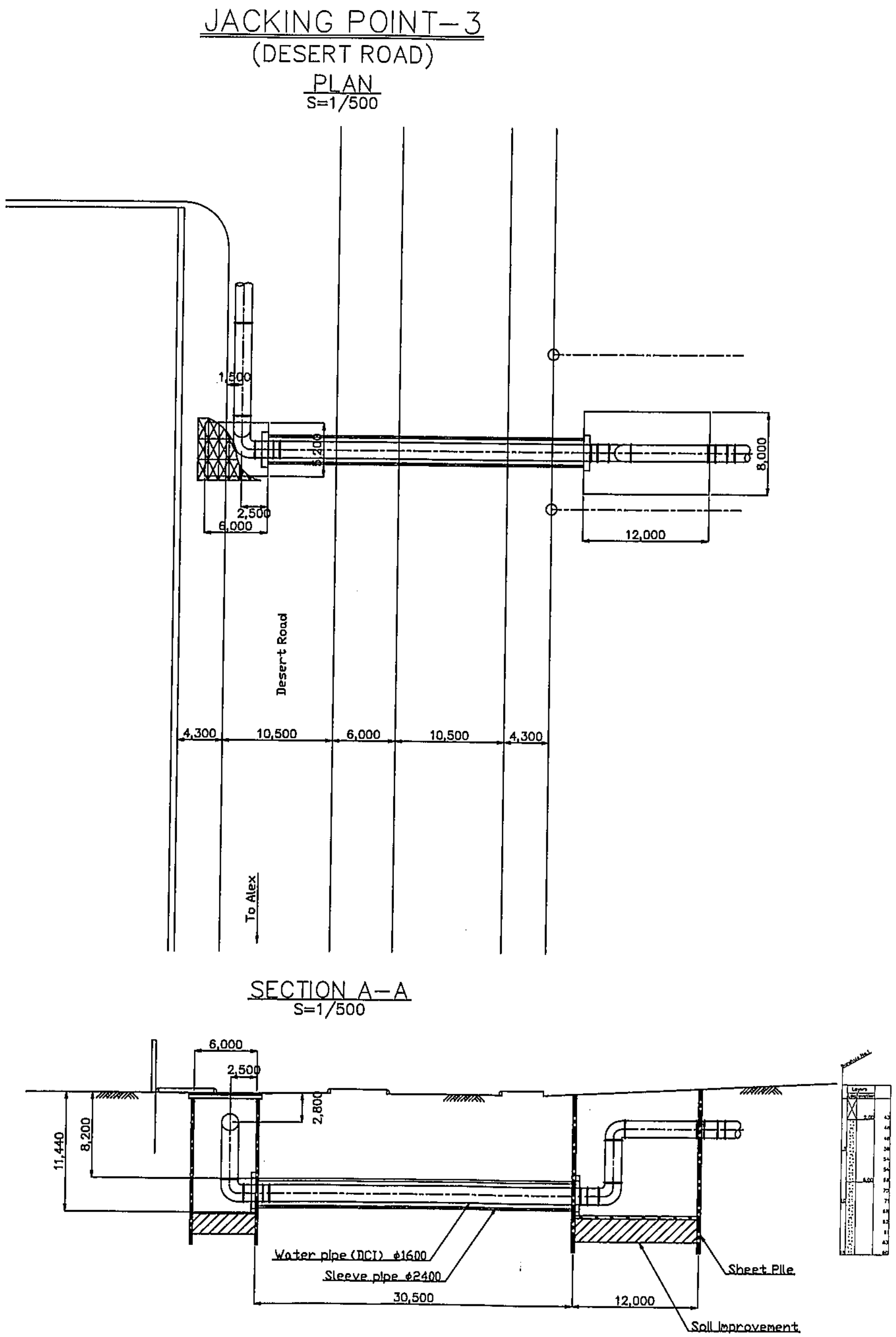
SECTION A−A
S=1/500



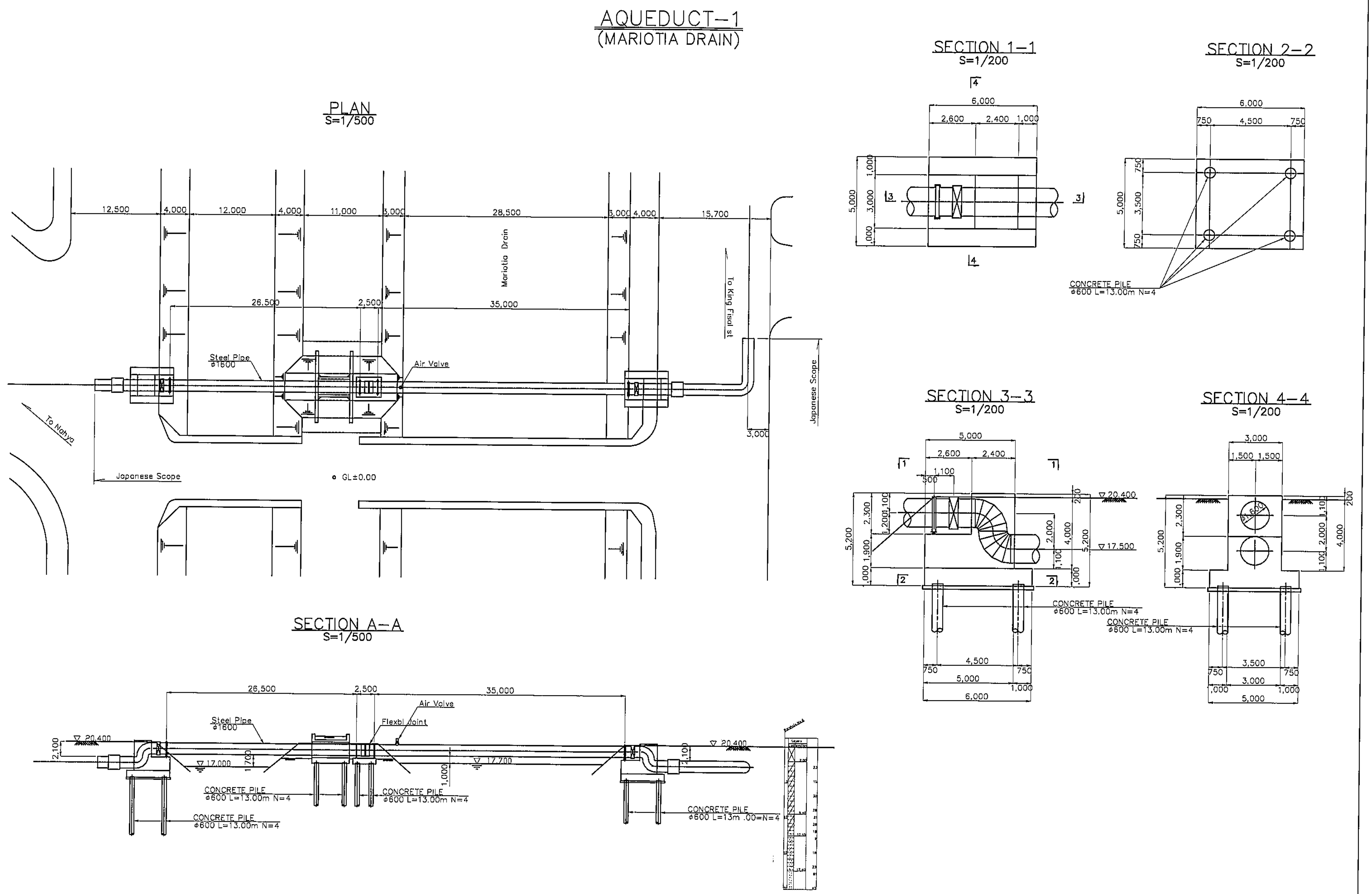
GPN-TM-03 Plan and Section of Jacking Method (1/3)



GPN-TM-04 Plan and Section of Jacking Method (2/3)

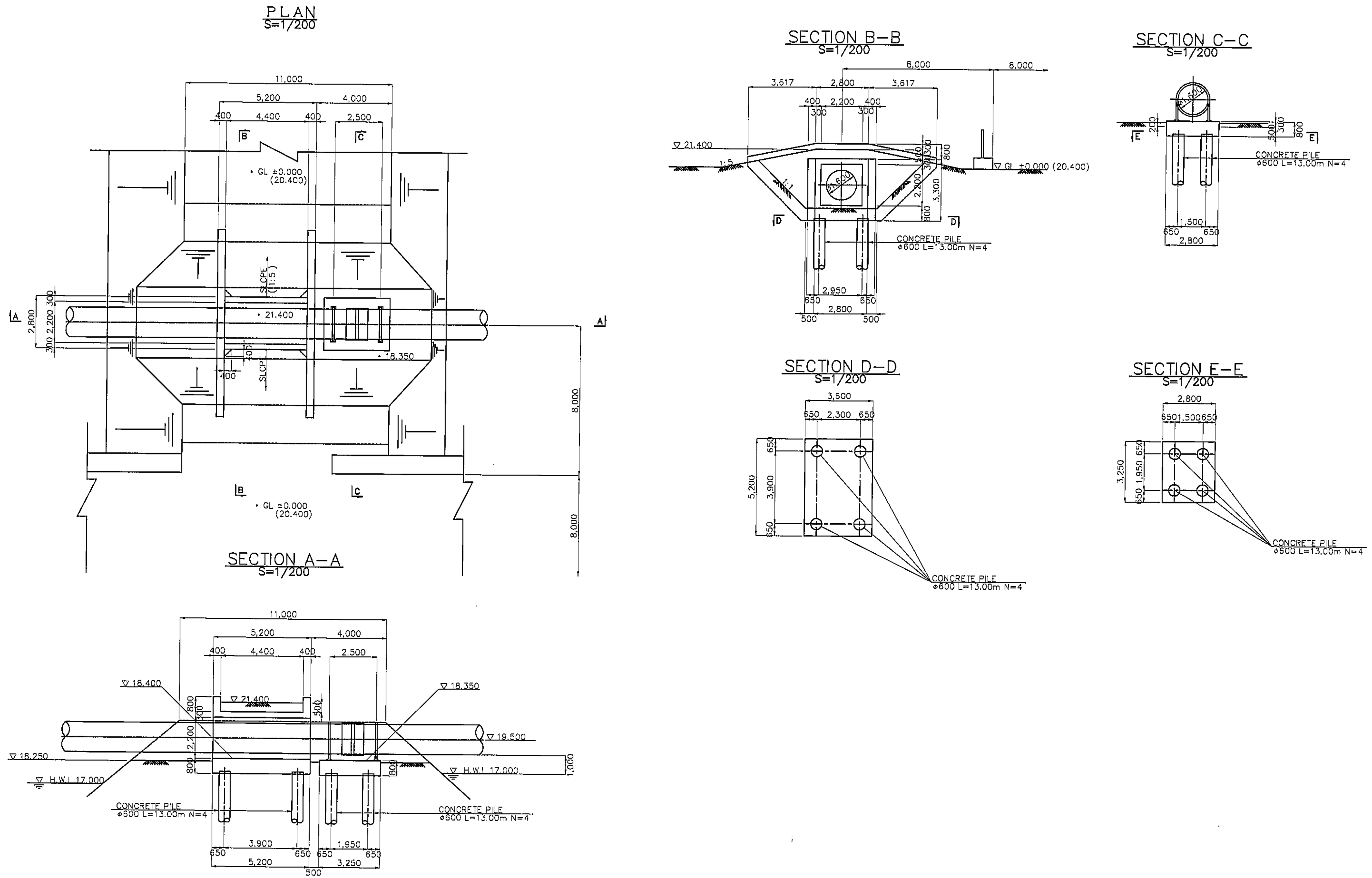


GPN-TM-05 Plan and Section of Jacking Method (3/3)

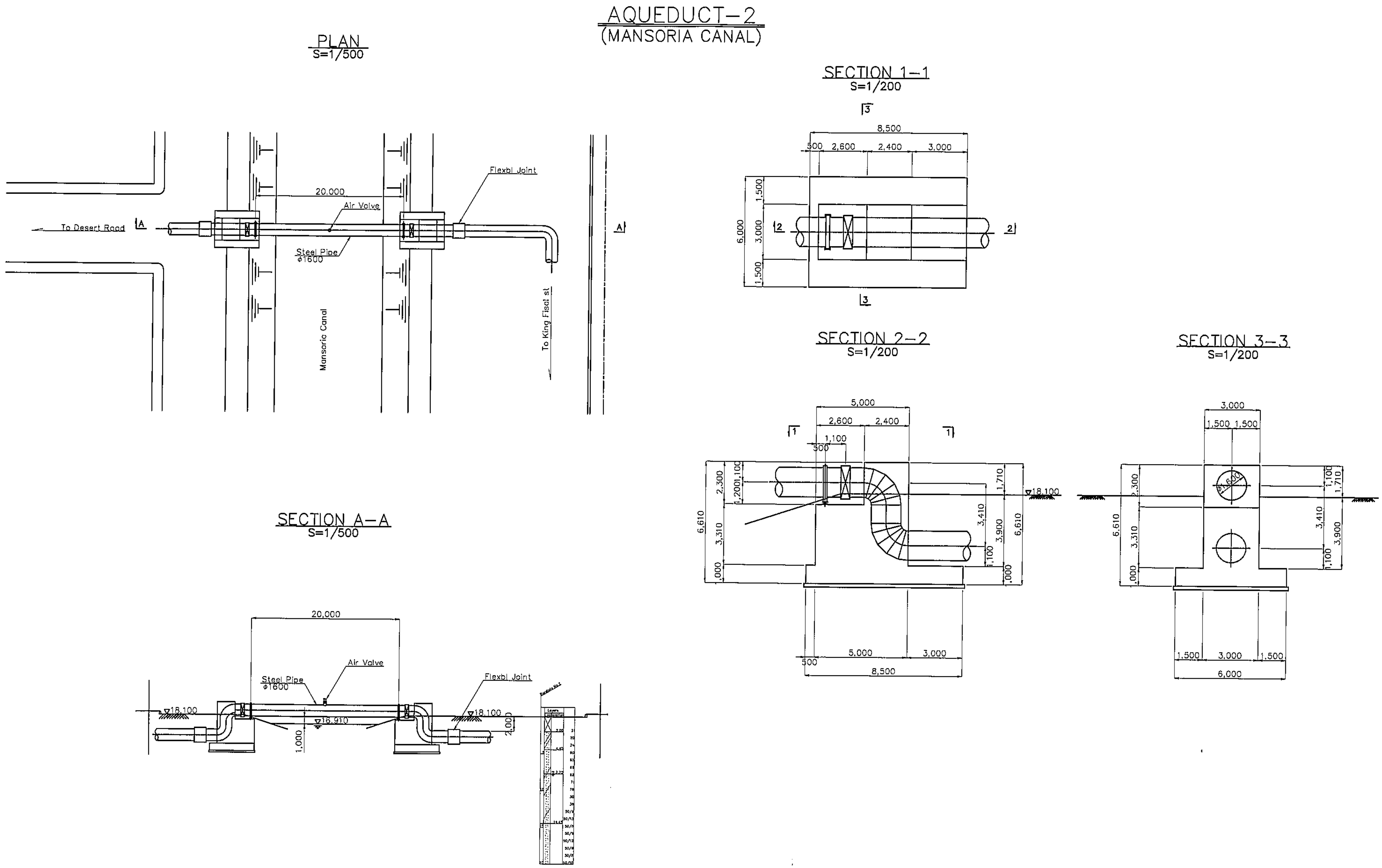


GPN-TM-06 Plan and Section of Aqueduct (1/3)

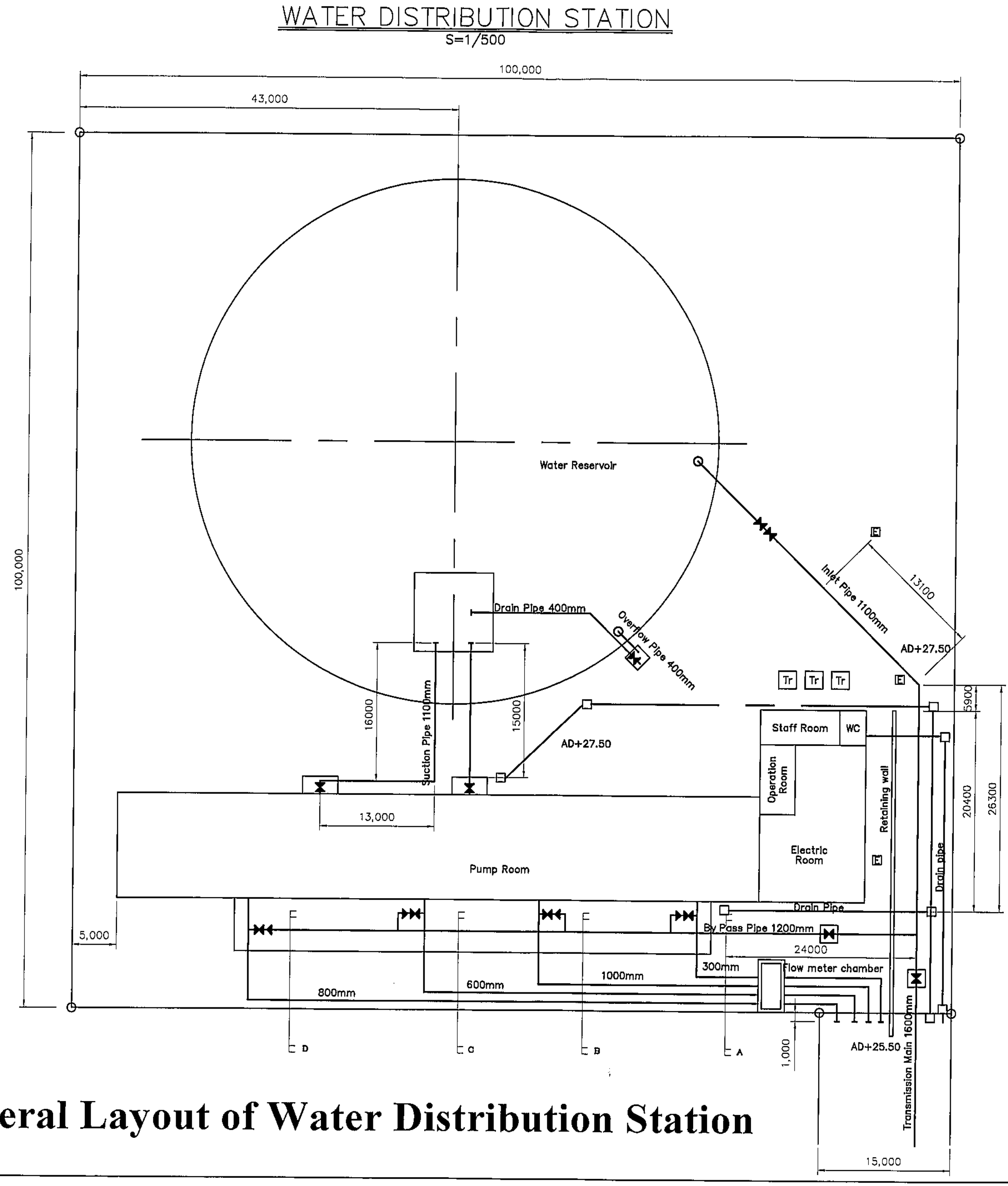
PROTECTION FOR AQUEDUCT-1
(MARIOTIA DRAIN)



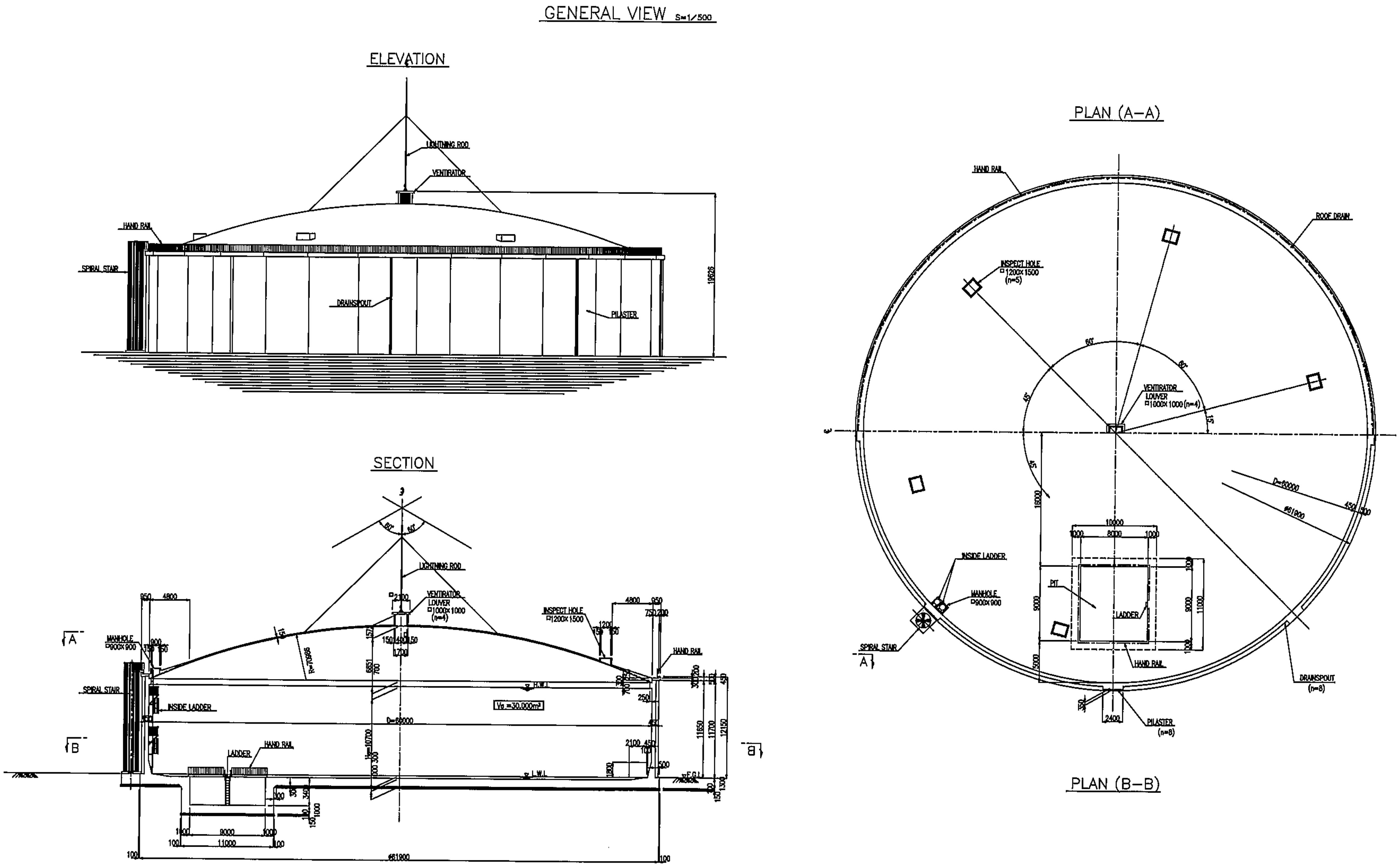
GPN-TM-07 Plan and Section of Aqueduct (2/3)



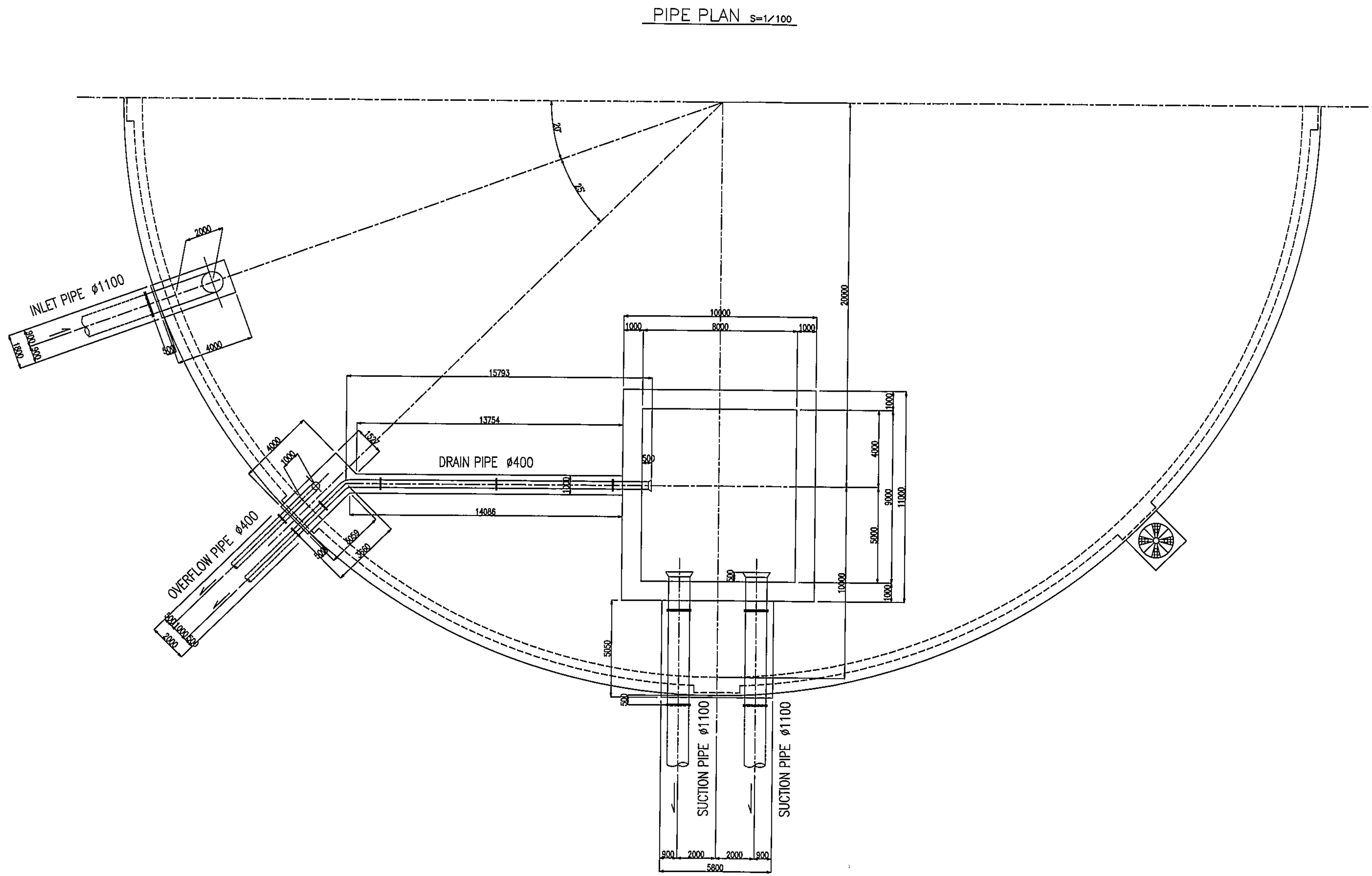
GPN-TM-08 Plan and Section of Aqueduct (3/3)



GPN-WD-01 General Layout of Water Distribution Station

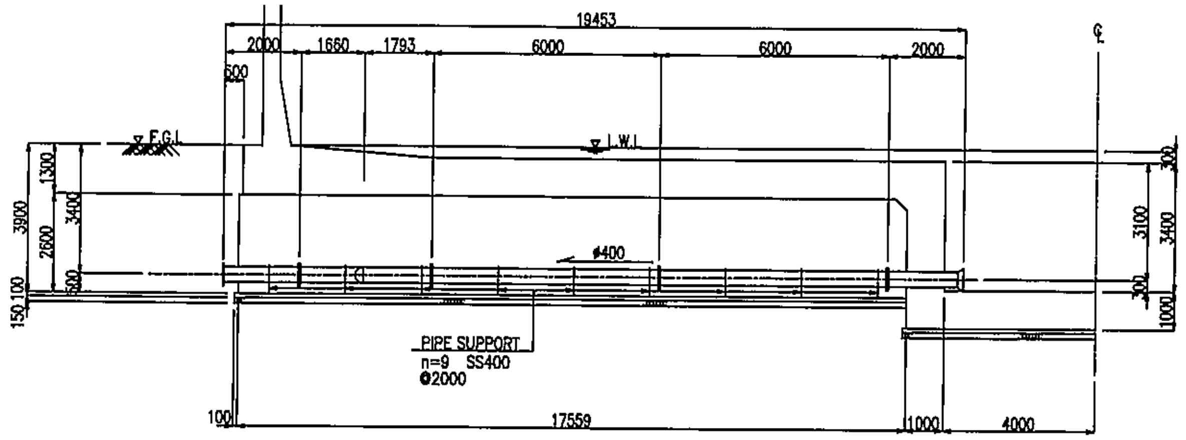


GPN-WD-02 Water Reservoir - Plan and Section

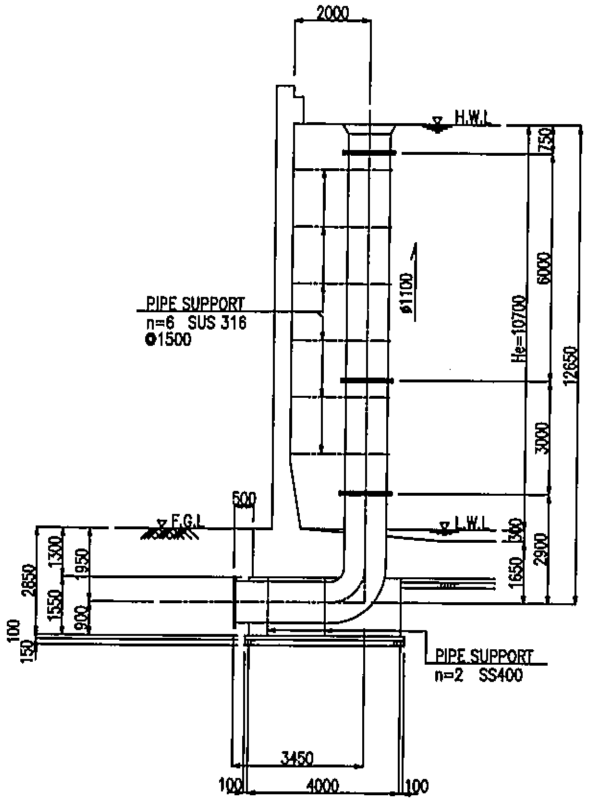


GPN-WD-03 Water Reservoir - Piping System (1/2)

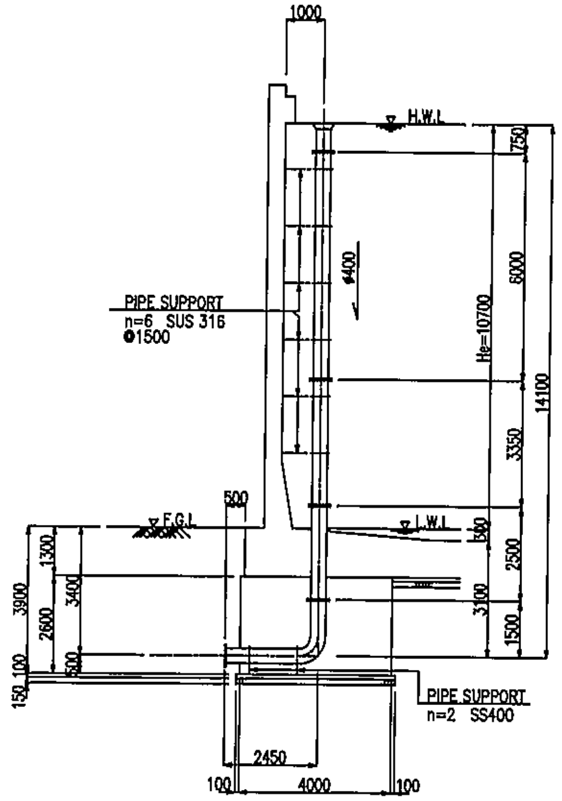
SECTION OF DRAIN PIPE ø400
S=1/100



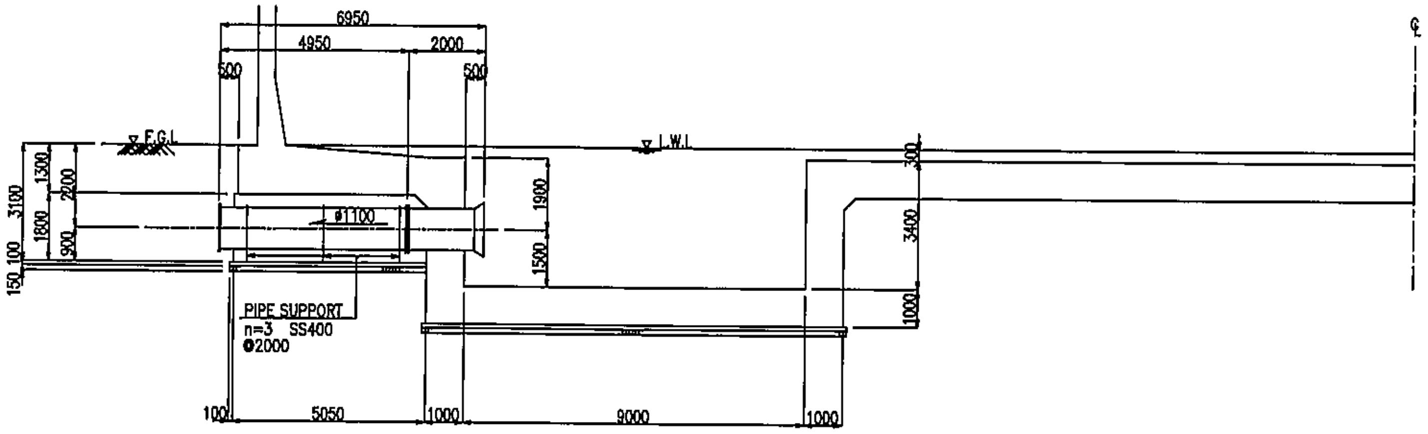
SECTION OF INLET PIPE ø1100
S=1/100



SECTION OF OVERFLOW PIPE ø400
S=1/100

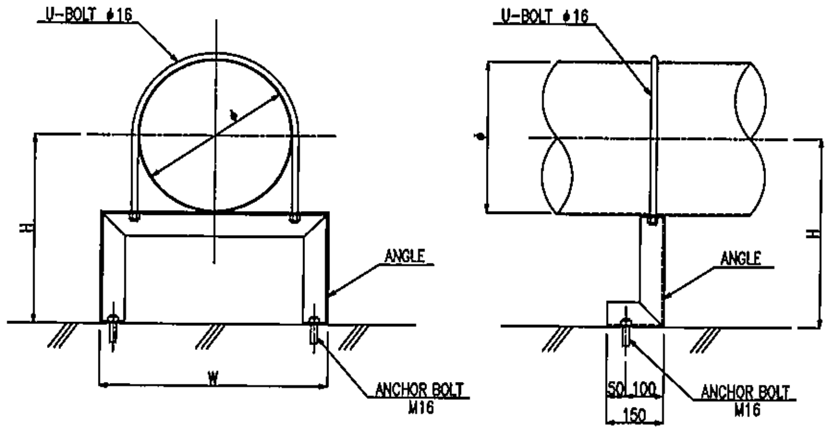


SECTION OF SUCTION PIPE ø1100
S=1/100



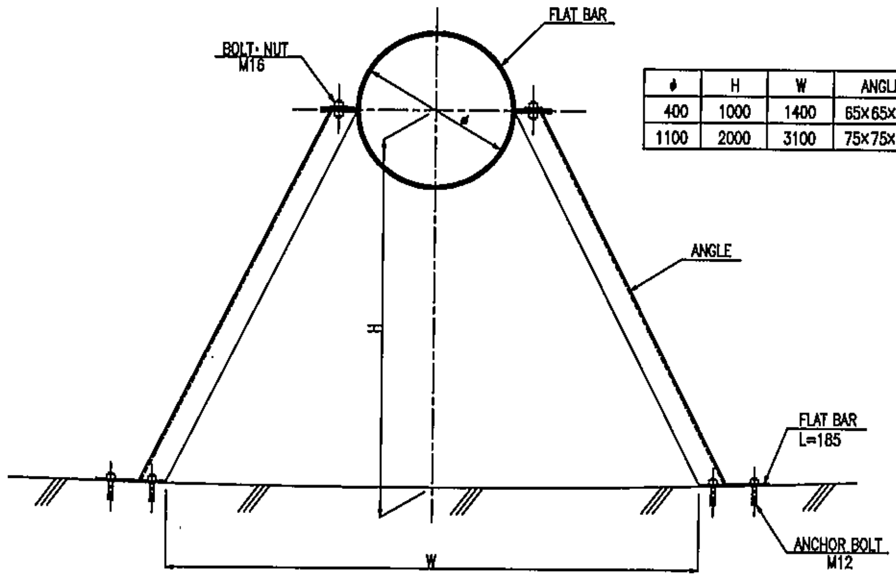
PIPE SUPPORT DETAILED DESIGN
S=1/10

(SS400)



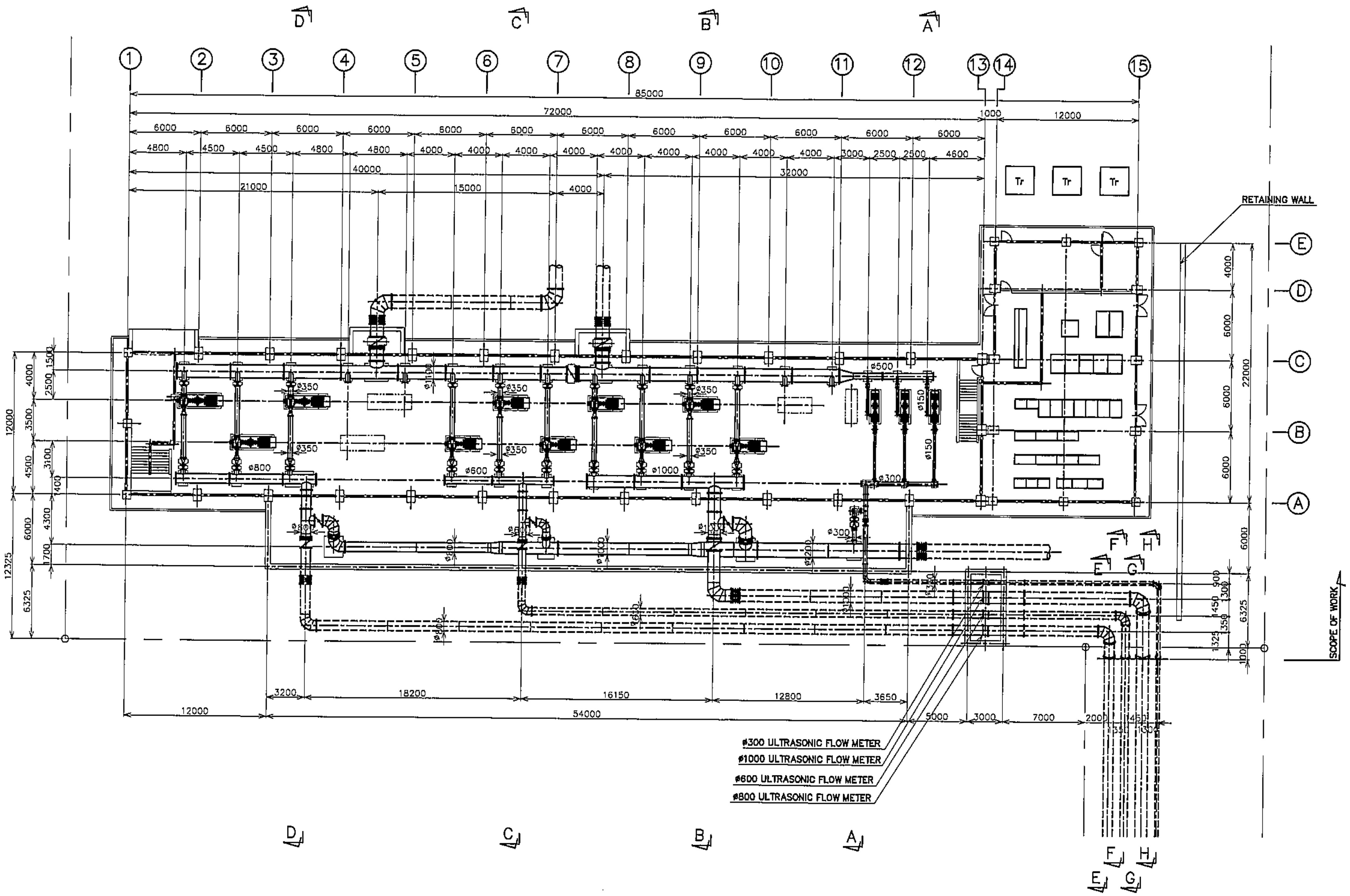
ø	H	W	ANGLE
400	500	600	65×65×6.0
1100	900	1100	75×75×6.0

(SUS316)



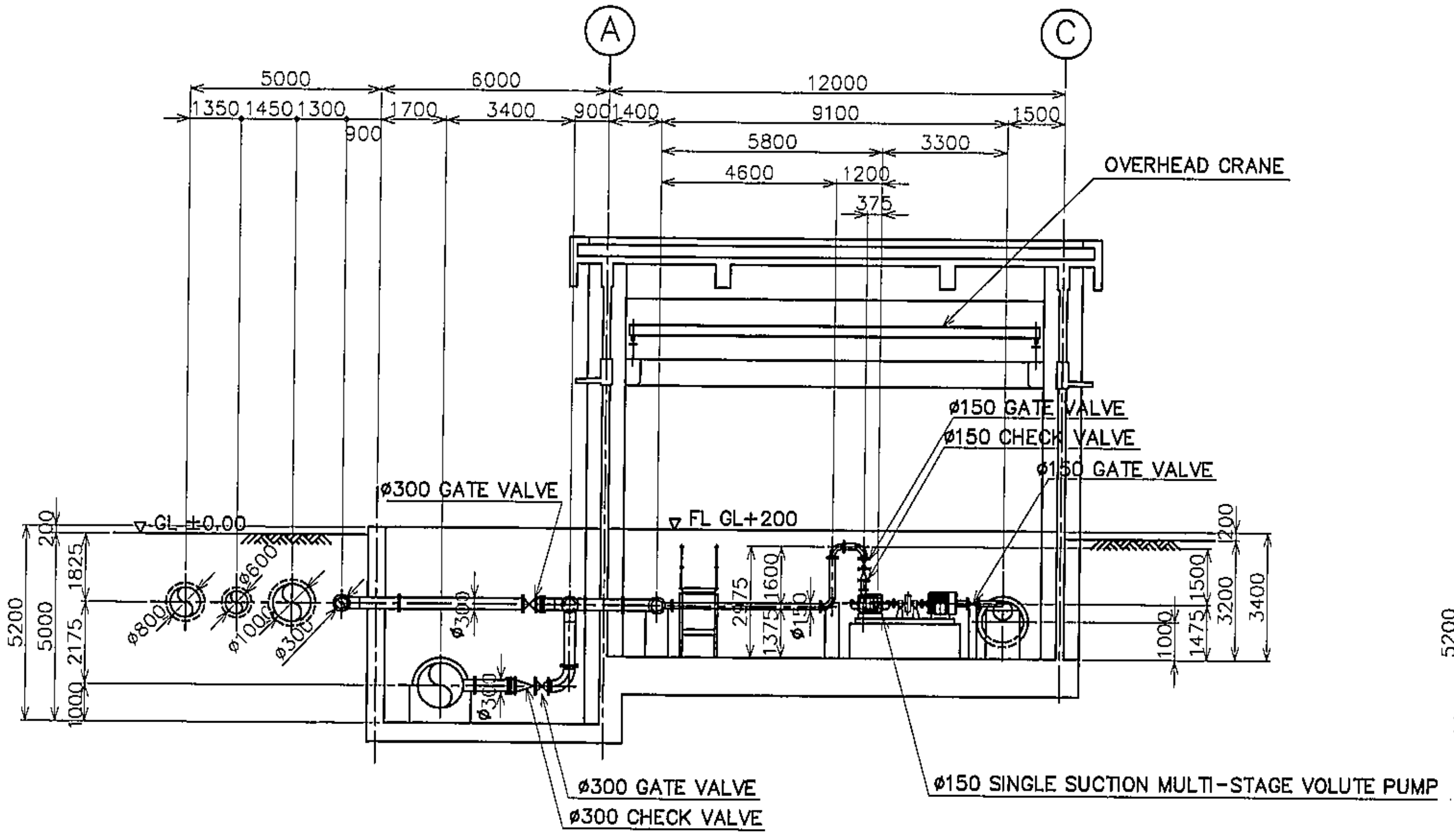
ø	H	W	ANGLE	FLAT BAR
400	1000	1400	65×65×6.0	75×6.0
1100	2000	3100	75×75×6.0	90×6.0

GPN-WD-04 Water Reservoir - Piping System (2/2)

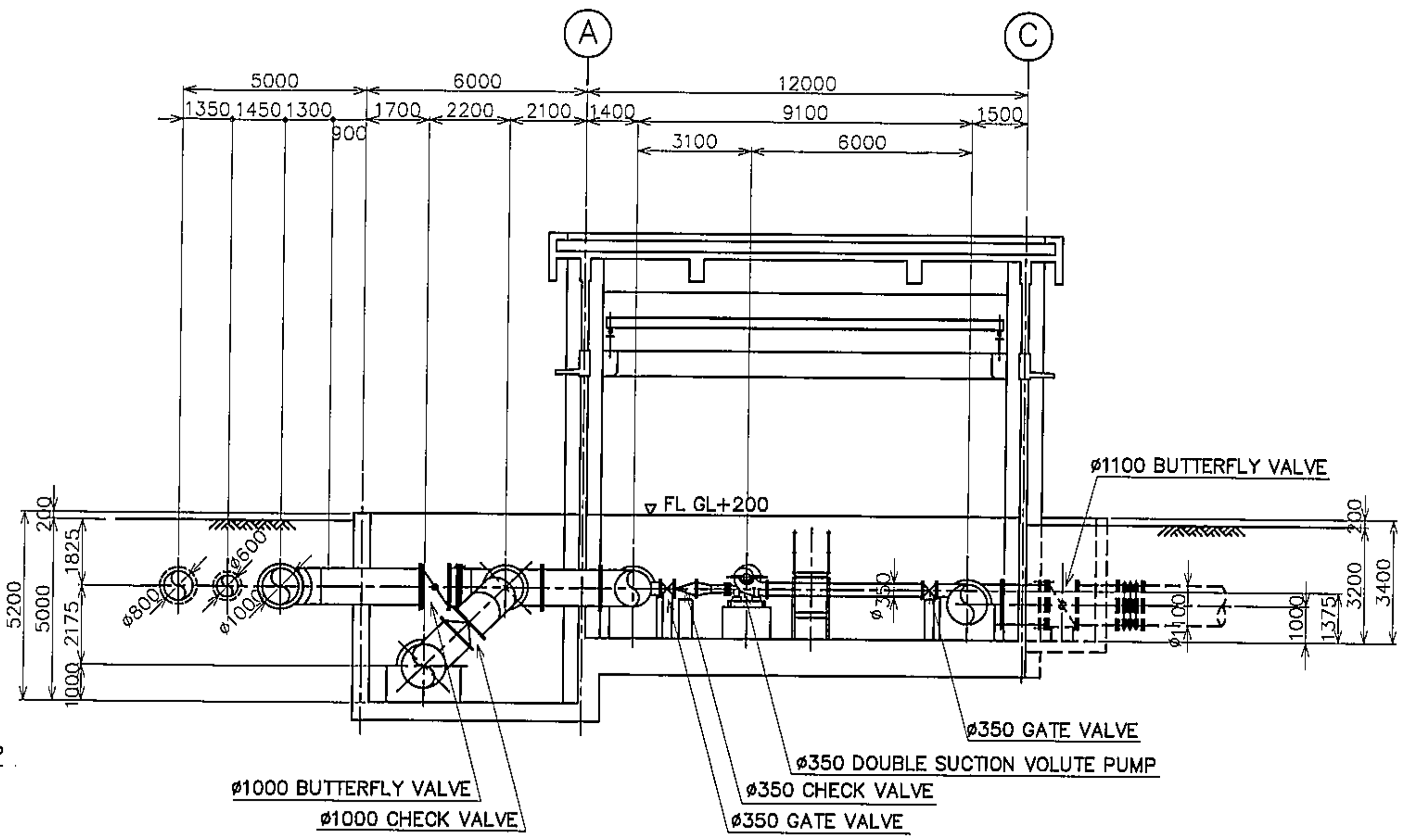


PUMP ROOM PLAN S=1/200

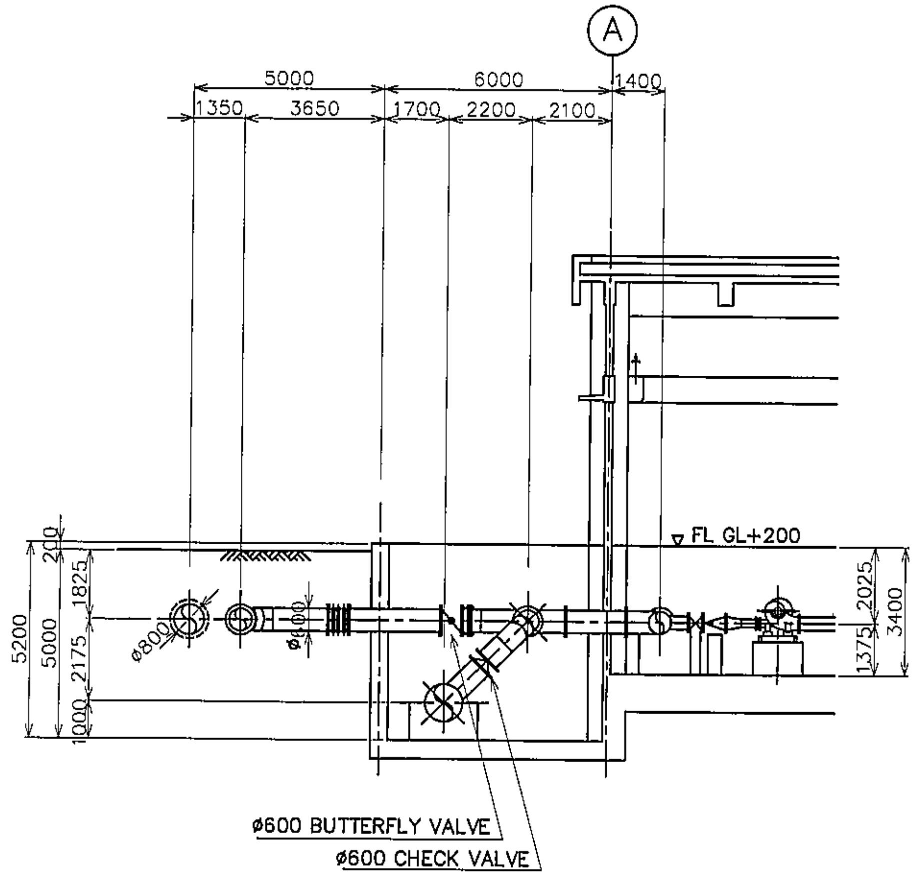
GPN-WD-05 Distribution Pump Facilities - Plan



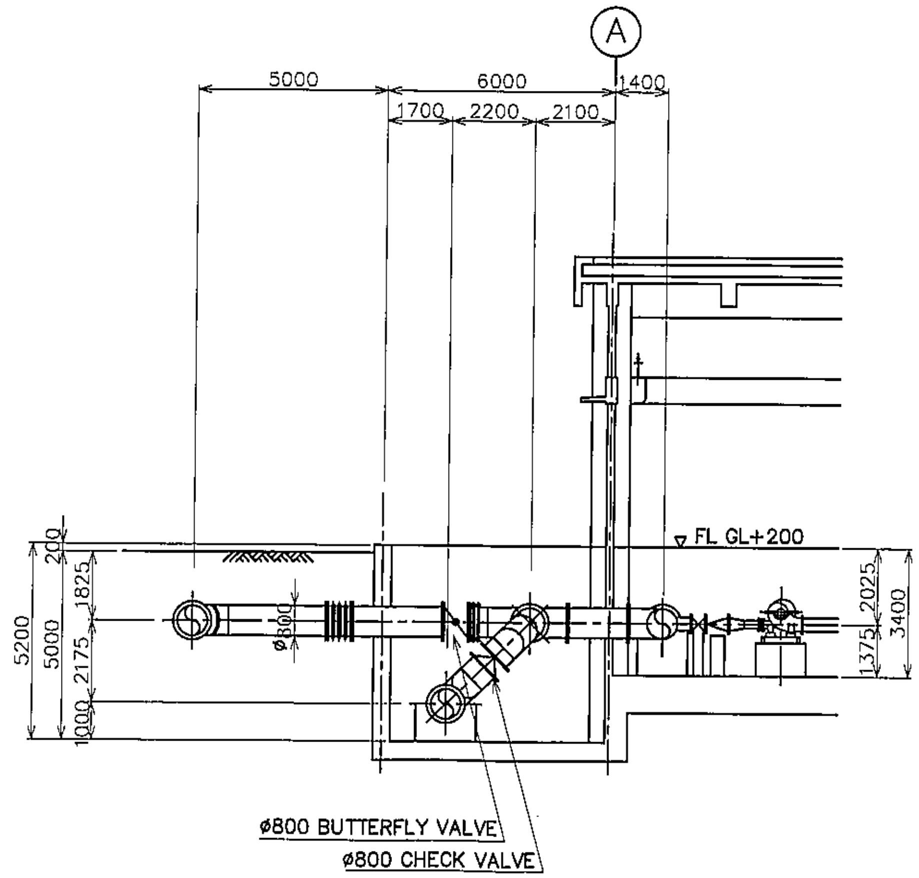
SECTION A – A S=1/200



SECTION B – B S=1/200



SECTION C – C S=1/200

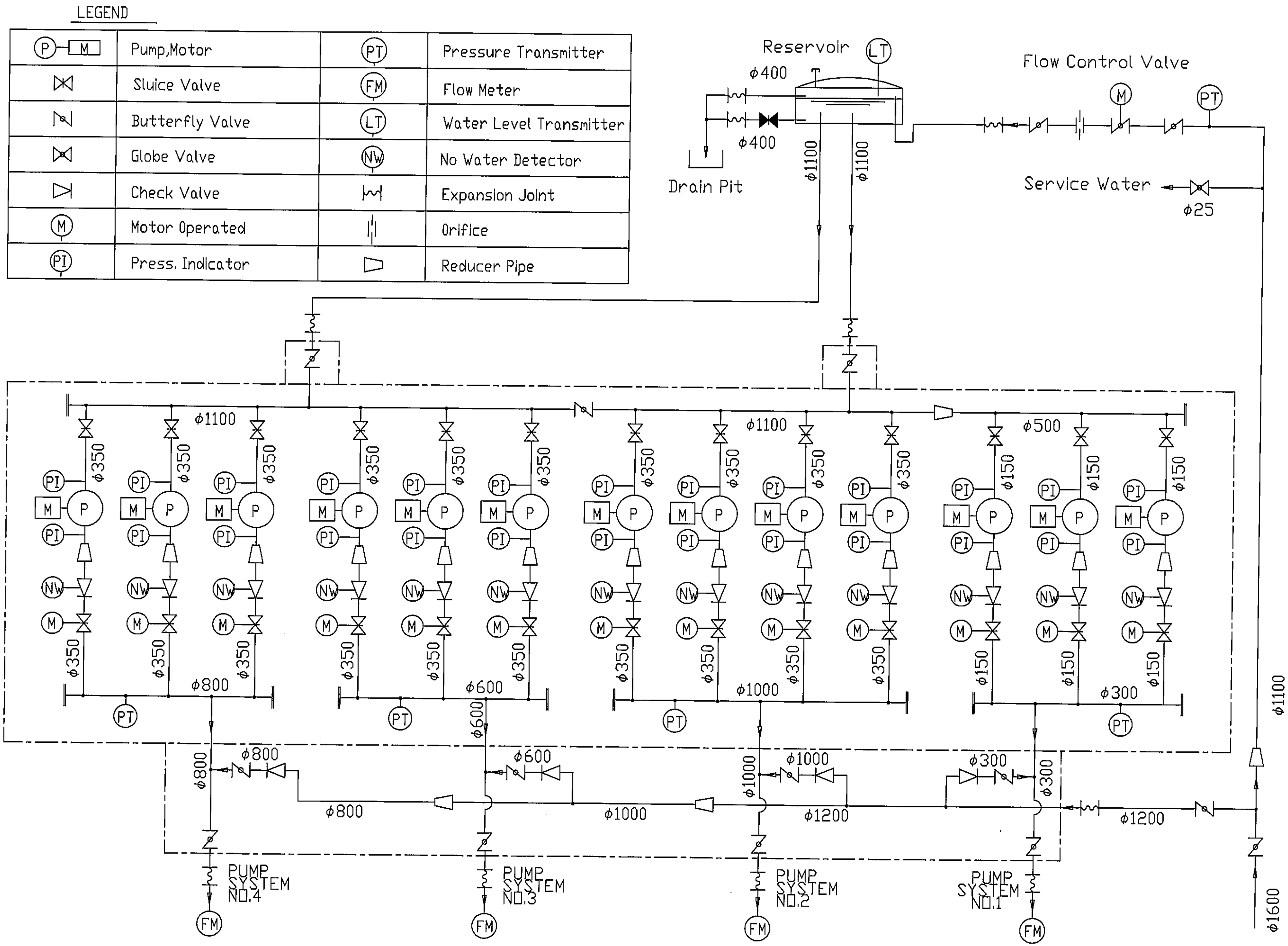


SECTION D – D S=1/200

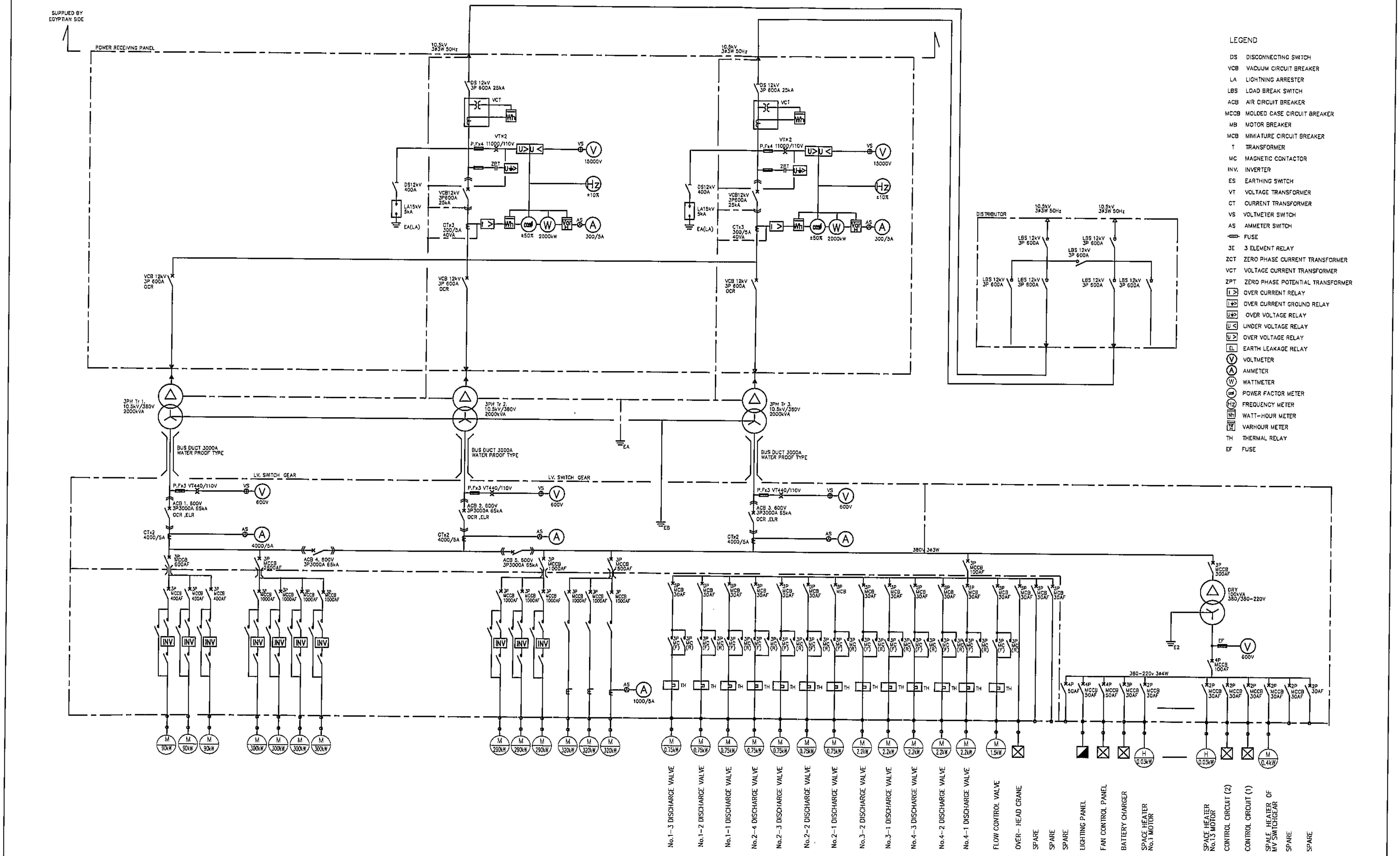
GPN-WD-06

Distribution Pump Facilities

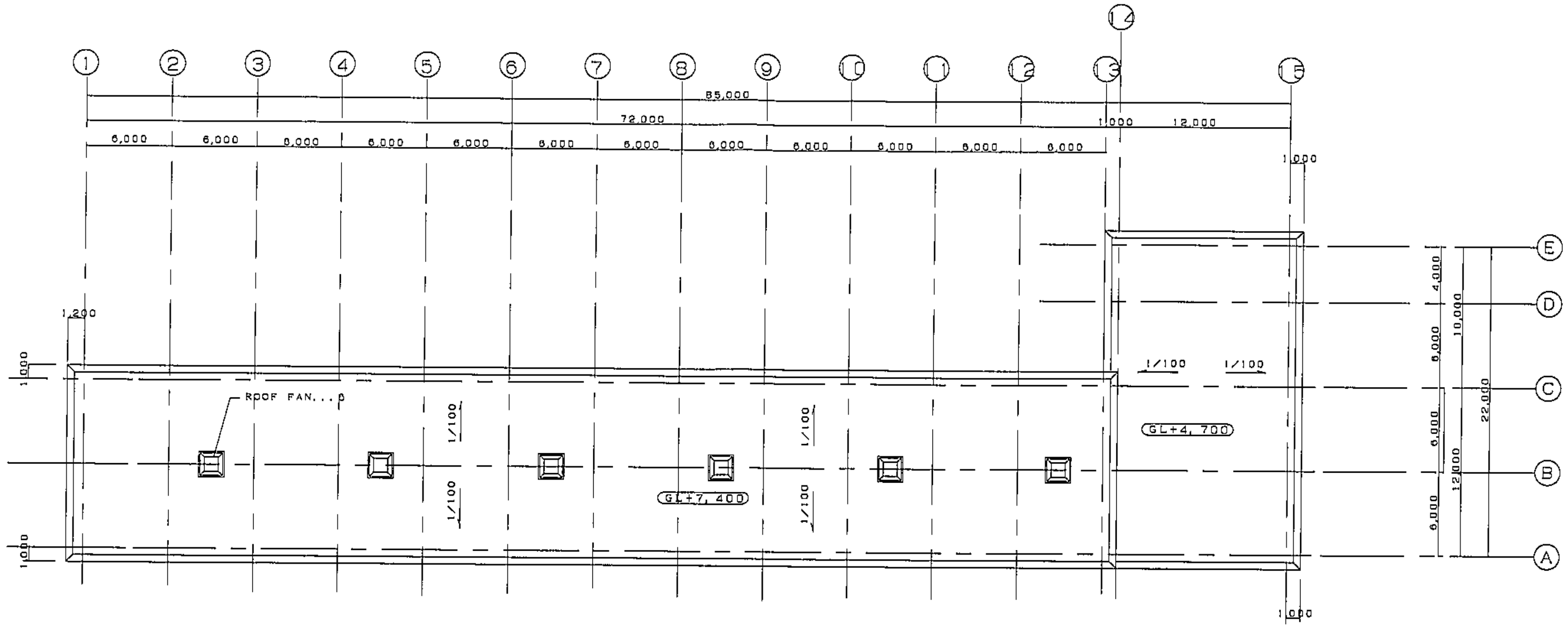
- Section



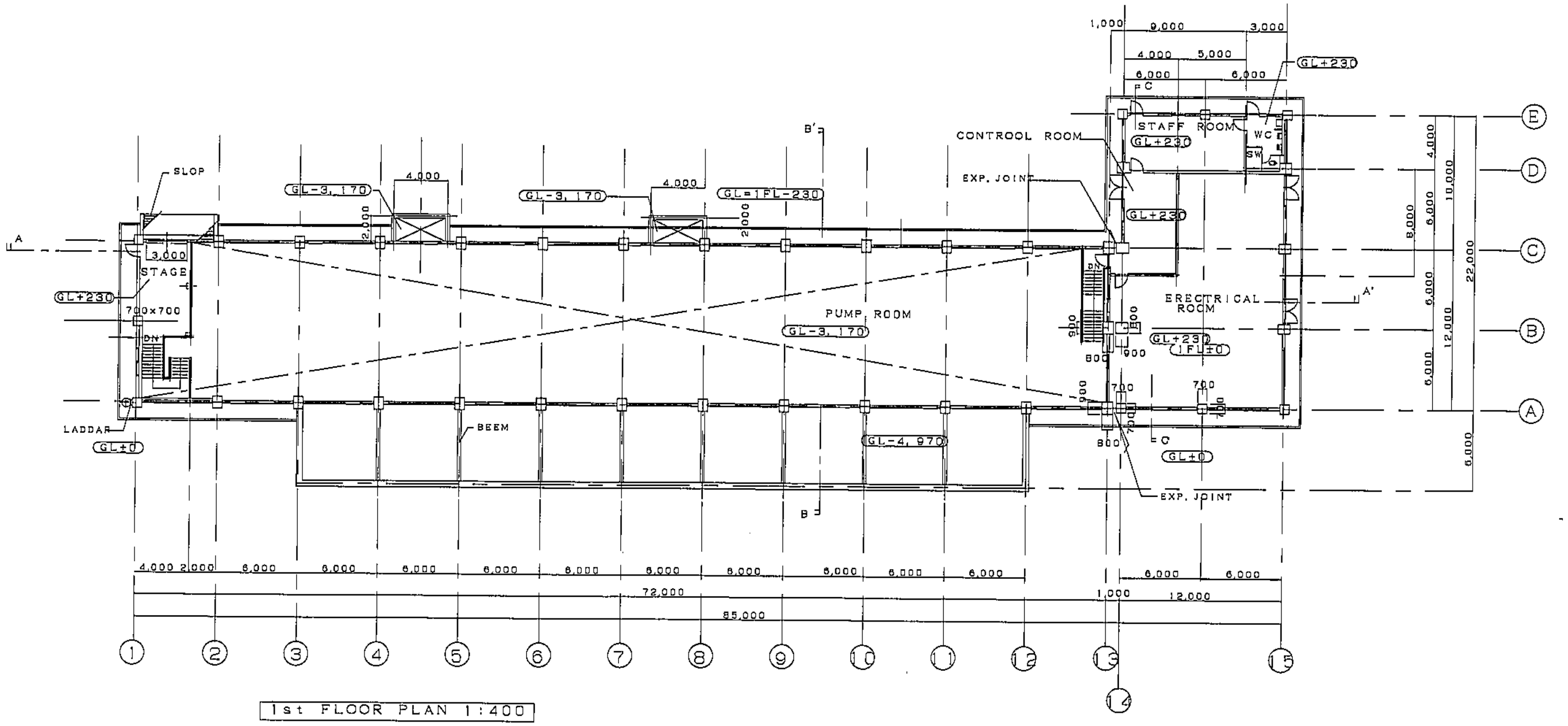
GPN-WD-07 Flow Chart of Distribution Pump Facilities



GPN-WD-08 Single Line Diagram of Distribution Pump Facilities

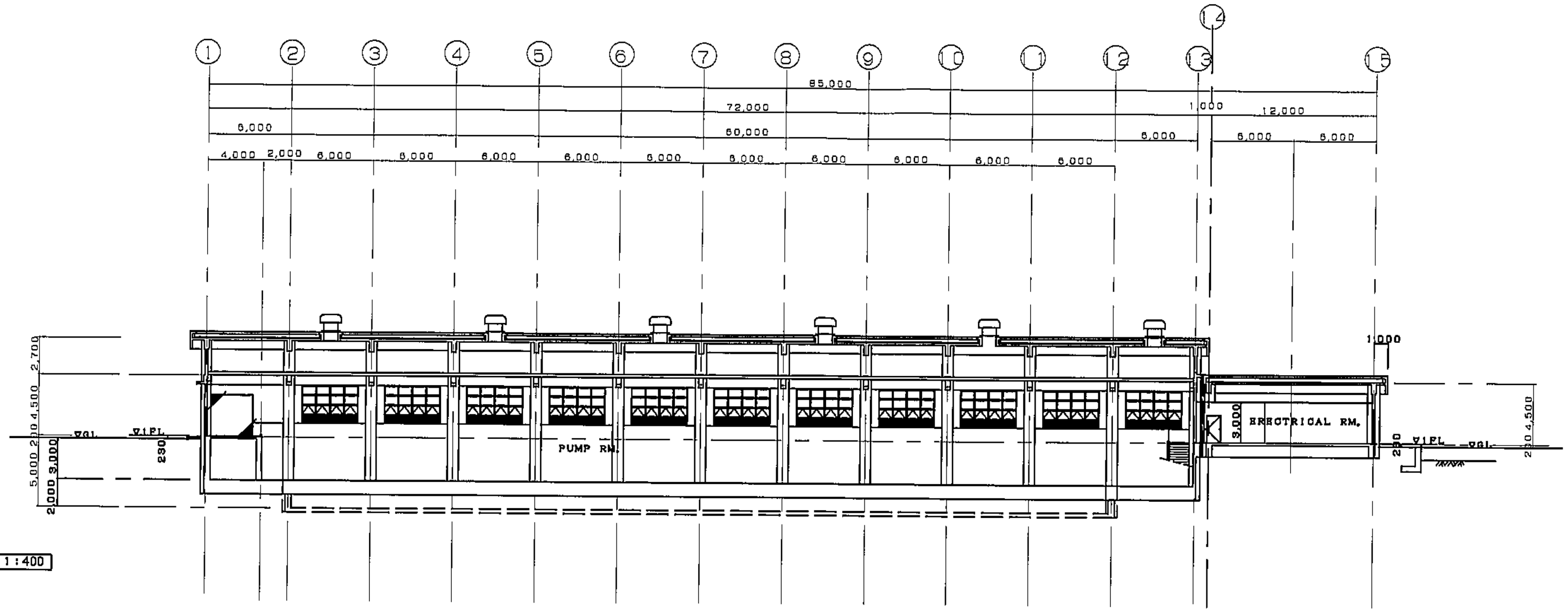


ROOF PLAN 1:400

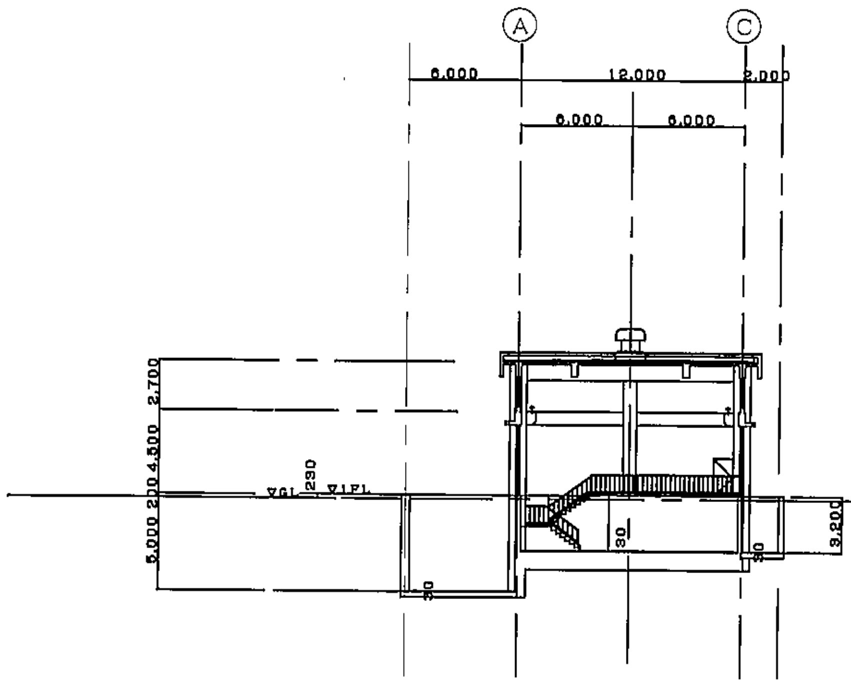


1st FLOOR PLAN 1:400

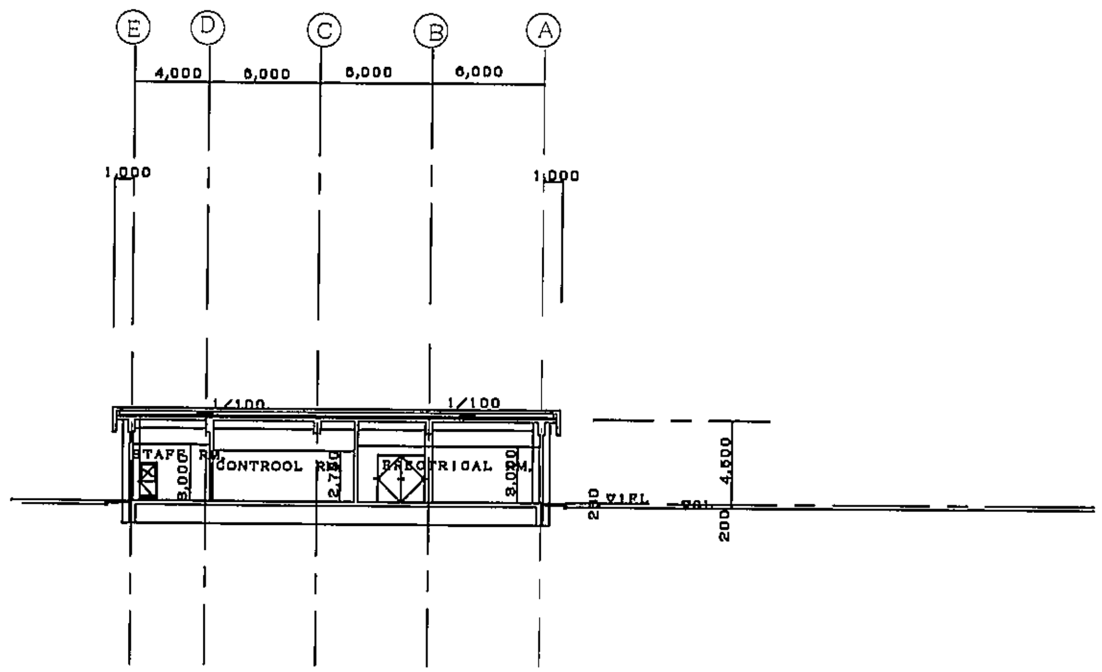
GPN-WD-09 Pump House - Plan



A-A' SECTION 1:400

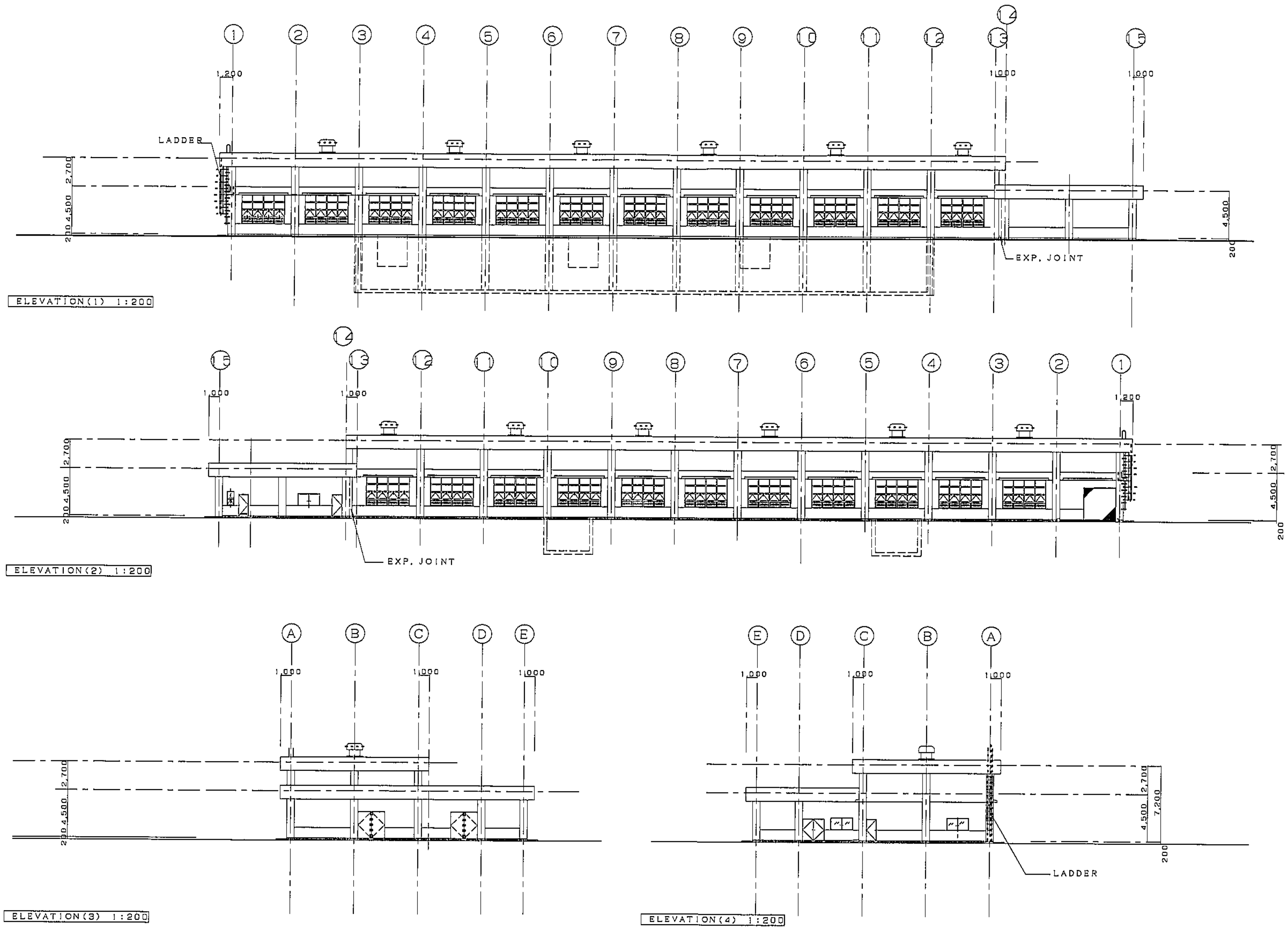


B-B' SECTION 1:400



B-B' SECTION 1:400

GPN-WD-10 Pump House - Section



GPN-WD-11 Pump House - Elevation

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The Project will be implemented in accordance with the framework of Japan's grant aid system. Following approval by the Government of Egypt and the Government of Japan, the Exchange of Notes (E/N) regarding the detailed design will be signed to commence the actual implementation process of the Project. The Government of Egypt will then select the Consultant, a Japanese firm, to begin the detailed design work. As the Project is incorporated in Egyptian National Five Year Plan, the signing of the E/N for the actual construction work will be reported to the People Assembly of Egypt after the signing. The Contractor, a Japanese firm, selected through open tendering, will then conduct the construction of facilities and procurement of equipment. The basic issues and points to note regarding the implementation of the Project are described next.

(1) Project Implementing Agency

Giza Governorate will have overall responsibility for the Project while Giza City and the GOGCWS will act as the project implementing agencies. Giza City will be responsible for the construction of the water transmission main and water distribution station to be conducted by the Japanese side and water distribution network while the GOGCWS will be responsible for the provision of technical information related to the Project and for the construction of the water transmission main from Embaba WTP to the Northern Pyramids Area to be conducted by the Egyptian side. Giza City will establish the project implementation system regarding the work to be conducted by the Japanese side where the administration, civil engineering, architectural and public relations staff members will perform their assigned work under the leadership of the Technical Advisor.

The E/N signed by Egypt and Japan will become immediately effective. As the E/N must be reported to the People Assembly of Egypt, the project implementing agencies in Egypt will swiftly report the E/N to the People Assembly of Egypt with a view to smoothly implementing the Project. As in the case of the previous project, the said agencies will ensure close cooperation with the Japanese Consultant and Contractor and will select a person responsible for the Project and establish the Project Promotion Committee as in the case of the previous project.

(2) Consultant

For the construction of the planned facilities under the Project, the Japanese Consultant will conclude a design and supervision agreement with Giza City to conduct the detailed design for the facilities and work supervision. The Consultant will also prepare the tender documents and will conduct the tender on behalf of Giza City as well as providing necessary advice regarding the tender and the implementation of the Project for Giza City.

(3) Contractor

The Japanese Contractor selected through open tendering by the Egyptian side in accordance with the framework of Japan's grant aid system will conduct the construction of the facilities and procurement of the equipment, etc. planned under the Project. As the Contractor is expected to provide after-service, including the supply of spare parts and arrangement of repair work, etc., after the completion of the Project, it must carefully consider the post-Project liaison arrangements with Giza City. Given the use of locally procured construction materials and others and the planned construction work in areas with heavy traffic and also in densely populated areas, the Contractor must have a sound understanding of the local natural and socioeconomic conditions, construction market, labor situation and labor laws, etc.

(4) Necessity to Dispatch Japanese Engineers

For the successful completion of the planned construction work under the Project, it will be necessary to dispatch Japanese engineers specialized in construction of water distribution station and large diameter water transmission main laying work using the jacking method and aqueduct. As it appears difficult to secure the services of such specialized engineers in Egypt, it will be necessary for the Japanese specialized work companies and equipment manufacturer(s) to dispatch engineers to Egypt in view of the proper construction of the planned facilities.

Apart from the above specialist engineers, it will not be difficult to locally secure engineers, technicians and site workers, etc. in Egypt.

2.2.4.2 Implementation Conditions

The following points must be noted in consideration of the facts that the planned construction work will be conducted in densely populated areas, along trunk roads and across a railway line, canals and drains and that the Project will be implemented with grant aid provided by the Government of Japan.

(1) Local residents should be encouraged to understand the objectives and contents of the work in view of obtaining their cooperation and particular attention should be paid to preventing accidents involving local residents due to the work.

(2) Careful attention should be paid to the selection of the construction method(s) and construction machinery to minimize/prevent harm to local residents and their homes, etc., including noise, vibration and building damage.

(3) Careful attention should be paid to avoiding any damage to the existing bridges and other structures crossing canals and drains.

(4) Given the existence of many underground structures (sewer lines, water supply lines and electric and telephone cables) along the planned route, careful attention should be paid to preserving their functions and to avoiding any damage to these structures.

(5) Careful attention should be paid to ensuring the safe passage of pedestrians and road traffic through the work sections.

(6) Because of the use of a crane and other heavy machinery for the water reservoir construction work which also involves work high above the ground, careful attention should be paid to preventing accidents involving engineers and workers.

2.2.4.3 Scope of Works

The division of the construction work between the Egyptian side and the Japanese side is shown in Table 2-2-30.

Table 2-2-30 Division of Construction Work Between Japanese and Egyptian Sides (1/2)

Item	Japan	Egypt		Remarks
		Giza	GOGCWS	
1. Construction of Water Distribution Station				
1) Land acquisition		○		
2) Existing Facilities Removal			○	
3) Land Preparation Work		○		
4) Electric power receiving facilities				
- Conducting local 10.5 kV power distribution line		○		
- Integrating watt-hour meter		○		
5) Construction of water reservoir	○			
6) Construction of water distribution pump station				
- Construction of pump house	○			
- Supply and installation of pumps	○			
7) Construction of paved inside roads	○			
8) Outdoor lighting of the site	○			
9) Fence and gate		○		
10) Landscaping		○		
11) Drainage system for miscellaneous waste water from pumping station	○			
12) Connection of water reservoir overflow and drainage from the drain pit to public sewer line		○		
13) Acquisition of access road site and construction of access road		○		
- Fittings and valves for connecting mains (300 – 1,000 mm in diameter; approx. 1,24 km) from water distribution station to existing water main	○			
- Straight pipe for above mains		○		
2. Distribution Pipe Laying System				
1) Procurement of pipes				
- Fittings and valves for water distribution main (200 - 400 mm in diameter; approx. 12.5 km)	○			
- Straight pipes for above main		○		
- Water distribution branch pipes (100 - 150 mm in diameter; approx. 25.6 km)		○		
2) Laying of above pipes and household service pipe connection work		○		

Table 2-2-30 Division of Construction Work Between Japanese and Egyptian Sides (2/2)

Item	Japan	Egypt		Remarks
		Giza	GOGCWS	
3) Design approval for distribution pipes designed and laid by Giza City and work supervision			○	
3. Construction of Water Transmission Main				
1) Pipe laying (1600mm x approx. 27.72km) by open cut method				
- General Section (approx. 25km)			○	
- King Faisal St. and Desert Road (approx. 2.72km)	○			
2) 3 points of railway and road crossing by jacking method	○			
5) 2 points of canal/drain crossing by aqueduct	○			
4. Distribution Main Connection between Southern and Northern Pyramids Areas (600 x approx. 600m)			○	

2.2.4.4 Work Supervision Plan

In accordance with the grant aid system of the Government of Japan and based on the basic design, the Consultant will organize a project team which will work through the detailed design and work supervision stages of the Project for the smooth implementation of the Project. At the work supervision stage, the Consultant will dispatch the following site engineers in accordance with the construction schedule, for the purposes of schedule, quality and safety control.

Water Distribution Station work supervisor : one (full-time)
Piping work supervisor : one (full-time)
Mechanical work supervisor : one (spot)
Electrical work supervisor : one (spot)
Civil engineering work supervisor : one(spot)
Building work supervisor : one (spot)

In addition, Japanese specialized staff member of the Consultant will attend the factory inspection and pre-delivery inspection of the equipment to be manufactured in Japan or a third country to preclude any problems with such equipment following its delivery to Egypt.

(1) Basic Principles of Work Supervision

The Consultant will supervise the work progress to ensure the completion of the work envisaged under the Project within the predetermined time limit and will also supervise and guide the Contractor in order to safely and fully achieve the work quality stipulated in the contract. The key points of this supervision are described below.

1) Schedule Control

The Consultant will compare the planned work schedule submitted by the Contractor at the time of signing the contract with the actual progress on a weekly and monthly basis. If the Consultant sees that a delay is likely to occur, he will issue a warning to the Contractor, requesting the submission of improvement measures so that the work in question can be completed on schedule.

① Confirmation of the work progress

② Confirmation of the delivery of equipment and materials

③ Confirmation of the actual number of engineers, technicians and workers, etc. and their productivity

2) Quality Control

The Consultant will conduct the following actions to check whether or not the Contractor is achieving the quality standards of the facilities and equipment stipulated in the contract documents (technical specifications and detailed design drawings, etc.). If the Consultant finds that the required quality may be compromised, he will ask the Contractor to change, modify or alter the quality of the facilities or equipment to meet the originally agreed standard.

① Checking of the shop drawings and equipment specifications

② Checking of the equipment factory inspection results or attendance at the factory inspection

③ Checking of the equipment installation manuals, on-site trial operation, adjustment and inspection manuals and as built drawings

④ Supervision of the site installation work of the equipment and attendance at the trial operation, adjustment and inspection

⑤ Checking of the work plan drawings for the facilities

⑥ Checking of the site work progress and its comparison with the working drawings for the facilities

3) Safety Control

The Consultant will consult and cooperate with the responsible person of the Contractor with a view to supervising the construction work in order to avoid any accidents or disasters. The key points of the on-site safety control are listed below.

① Establishment of safety control rules and selection of a safety manager

② Prevention of disasters through regular inspection of the construction machinery and other equipment

③ Confirmation of the travel route(s) for work-related vehicles and construction machinery and the thorough enforcement of slow driving

④ Introduction of worker welfare measures and the strict enforcement of days off

(2) Project Implementation System

The project implementation system, incorporating all parties of the Project, is shown in Fig. 2-2-16.

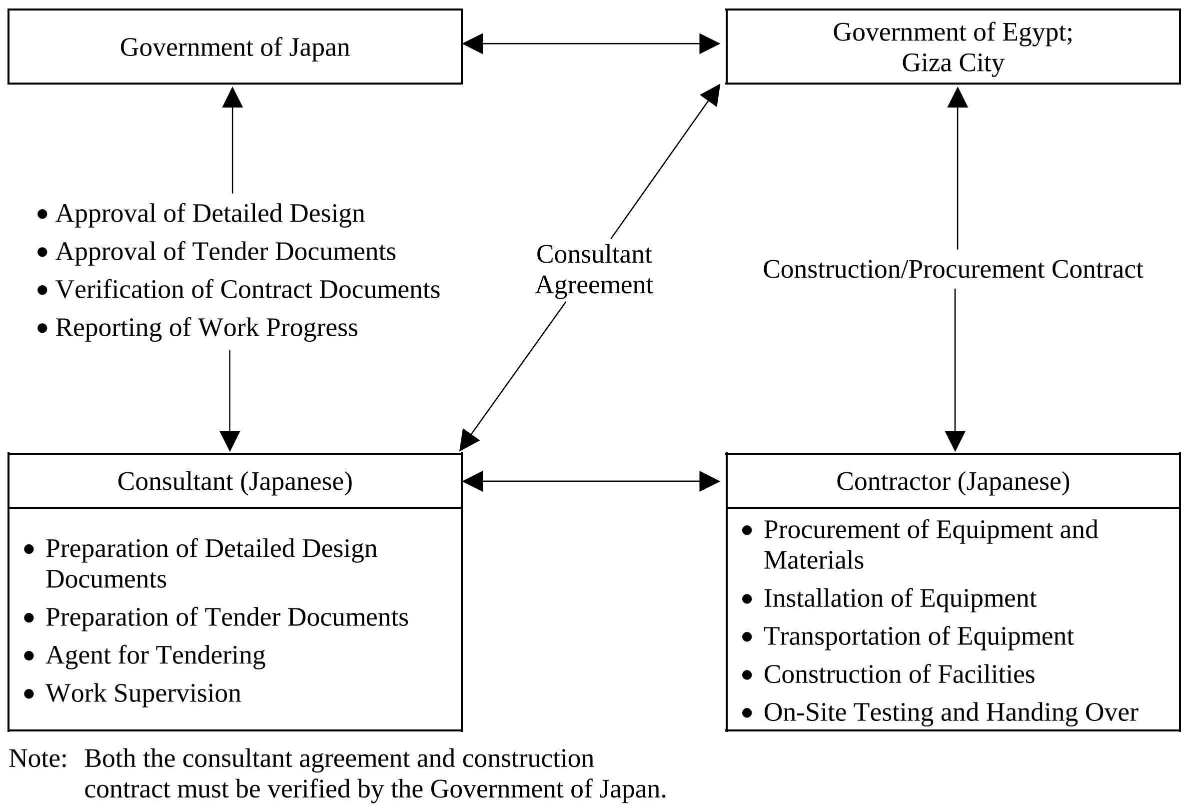


Fig. 2-2-16 Project Implementation System

(3) Work Supervisors

The Contractor will employ local engineers and technicians by means of either direct contract or subcontracting to a local construction company to complete the equipment procurement and construction work within the time limit set forth in the construction contract. It will be necessary for the Contractor to dispatch engineers with overseas experience of work similar to the expected work under the Project to Egypt to ensure strict schedule control, quality control and safety control with the local engineers and technicians employed directly or by the subcontractor.

Given the scope of the Project, the Contractor will be required to dispatch the following work supervisors on either a full-time or spot basis.

- Site representative (full-time) (one) : consultation and coordination with Project-related organizations; acquisition of the necessary approval, etc.
- Chief administrator (full-time) (one) : labor control; procurement
- Senior supervisor (full-time) (one) : guidance and control of the entire work
- Piping engineer (full-time) (one) : guidance and control of the water transmission main construction work
- Civil engineering work engineer (spot) (one) : guidance and control of the work under railway and road crossing by Jacking method and construction of the aqueduct
- Building engineer (spot) (one) : guidance and control of the pump house building work
- Mechanical and electrical engineer (spot) (one) : guidance and control of the pump system installation work
- Assistant engineer (spot) (one) : assistance for work supervision

2.2.4.5 Procurement Plan

(1) Procurement Sources of Equipment and Materials

The equipment and materials for the Project will be procured in Egypt where possible provided that they meet the set specifications, quality, delivery period and price, etc. Those which cannot be procured in Egypt will be procured in Japan or a third country. The following points must be noted when selecting the place for procurement.

1) General construction materials are readily available in Egypt, except equipment for the jacking method and the PC water reservoir and mechanical and electrical equipment for water distribution pump system.

2) Ductile cast iron pipes whose diameter exceeds 1,000 mm, fittings, valves and steel pipes for the aqueducts, etc. cannot be procured in Egypt. While small diameter ductile cast iron fittings and valves, ranging from 100 mm to some 600 mm, can be procured in Egypt, there is only one local manufacturer with a small production capacity, causing concern in regard to punctual delivery. The production of fittings and valves only started a short while ago and it is deemed difficult for this manufacturer to provide fittings and valves in sufficient quantity and with the required quality in a short period of time.

The division of the procurement of the main equipment and materials for the Project between the two sides is shown in Table 2-2-31 and this division takes the procurement principles described in 2.2.1 and the above-mentioned points into consideration.

Table 2-2-31 Division of Procurement of Main Equipment and Materials

Equipment/Material	Egypt	Japan/ Third Country	Remarks
Concrete Aggregate (Sand and Gravel)	○		
Cement	○		
Reinforcing Bars	○		
Forms	○		
Bricks and Concrete Blocks	○		
Concrete Pipes for Jacking Work	○		
Ductile Cast Iron Pipes (Straight: up to Ø1,000 mm)	○		for water distribution main and branch lines
Ductile Cast Iron Pipes (Straight: over Ø 1,000 mm)		○	for water transmission main
Ductile Cast Iron Fittings and Valves		○	for water transmission main and distribution lines
Steel Pipes (Straight)		○	for aqueducts
Steel Fittings and Valves		○	
Water Distribution Pumps (Mechanical and Electrical)		○	
PC Steel Wire and Bars		○	for distribution reservoirs

(2) Transportation

For the transportation of construction equipment, etc. from Japan or a third country, the packaging must be strong enough to sufficiently withstand long maritime transportation, loading and unloading, land transportation to the Project Site from the port of landing and storage thereafter.

Port Alexandria appears to be the most appropriate port of landing as it is a free port where frequent calls are regularly made by ships from Japan, the US and Europe and where adequate landing facilities are provided.

Regular shipping services will be used for maritime transportation between Japan and/or a third country and Port Alexandria while trucks, the main means of freight transportation in Egypt, will be used for land transportation (some 200 km) between Port Alexandria and the Project Site. The so-called Desert Road will be best suited for land transportation because of its wide width and good paved surface conditions.

2.2.4.6 Quality Control Plan

The planned work under the Project mainly consists of the construction of a reservoir and other large-scale concrete structures and the laying of large diameter water main transmission pipes. The main items for quality control, testing method and testing frequency are shown in Table 2-2-32

Table 2-2-32 Quality Control Items

Type of Work	Items	Method	Testing Frequency
Excavation	Work volume completed; height	Levelling	For each structure
	Bearing strength	Loading test	PC tank x 1; pump house x 1; aqueduct x 1
Reinforcing Work	Diameter	Tape measurement	For each concrete placing section or every 40 m of the aggregate length or every 100 m^2
	Covering	“	
	Pitch	“	
	Wrapping method and height	“	
Concrete Work	Reference height	“	For each concrete placing section or every 40 m of the aggregate length or every 100 m^2
	Thickness	“	
	Width	“	
	Height	“	
	Aggregate length	“	
	Compressive strength after 28 days	Compression test	Reservoir: each concrete placing section
			Pump house: each concrete placing section Valve pit: each section; protective concrete: twice
Form Work	Location	Tape measurement	For each concrete placing section
	Width		
	Height		
PC Steel Work	Location	Tape measurement	For each concrete placing section
	Covering		
PC Tension Work	Tension; elongation; setting loss	Reading of gauge/scale	At each site for tension work
	Checking of damage at each anchorage position	Visual checking	
Waterproofing Work	Lining thickness	Lining thickness test	Two sites at the reservoir
Piping Work	Inspection of joints	Feeder gauge	At each joint
	Fastening torque	Torque wrench	At each joint
	Water leakage	Water pressure test	Along the entire pipe routes
	Disinfection	Chlorine disinfection	Along the entire pipe routes
Painting Work	Colour and finish	Visual checking	Pump house and entire reservoir
Pump Installation	In accordance with the special specifications	Performance test	Once when installation is completed
		Test operation	Once when installation is completed
Power Receiving and Distribution Equipment Installation	In accordance with the special specifications	Performance test	Once when installation is completed
		Test operation	Once when installation is completed

2.2.4.7 Implementation Schedule

Following approval of the implementation of the Project by the Government of Japan, the E/N will be exchanged between the two countries to commence the construction work phase of the Project. This construction work phase will mainly consist of three stages, i.e. ① detailed design and preparation of the tender documents, ② tender and signing of the construction agreement and ③ construction of facilities and procurement of equipment. The components of the Project are the construction of a water transmission main, construction of a water distribution station and provision of water distribution pipes, etc. As the water transmission main can only perform its function with the completion of its construction work by both the Egyptian and Japanese sides, the construction schedule for the work to be conducted by the Japanese side must take the work schedule for the Egyptian side into proper consideration.

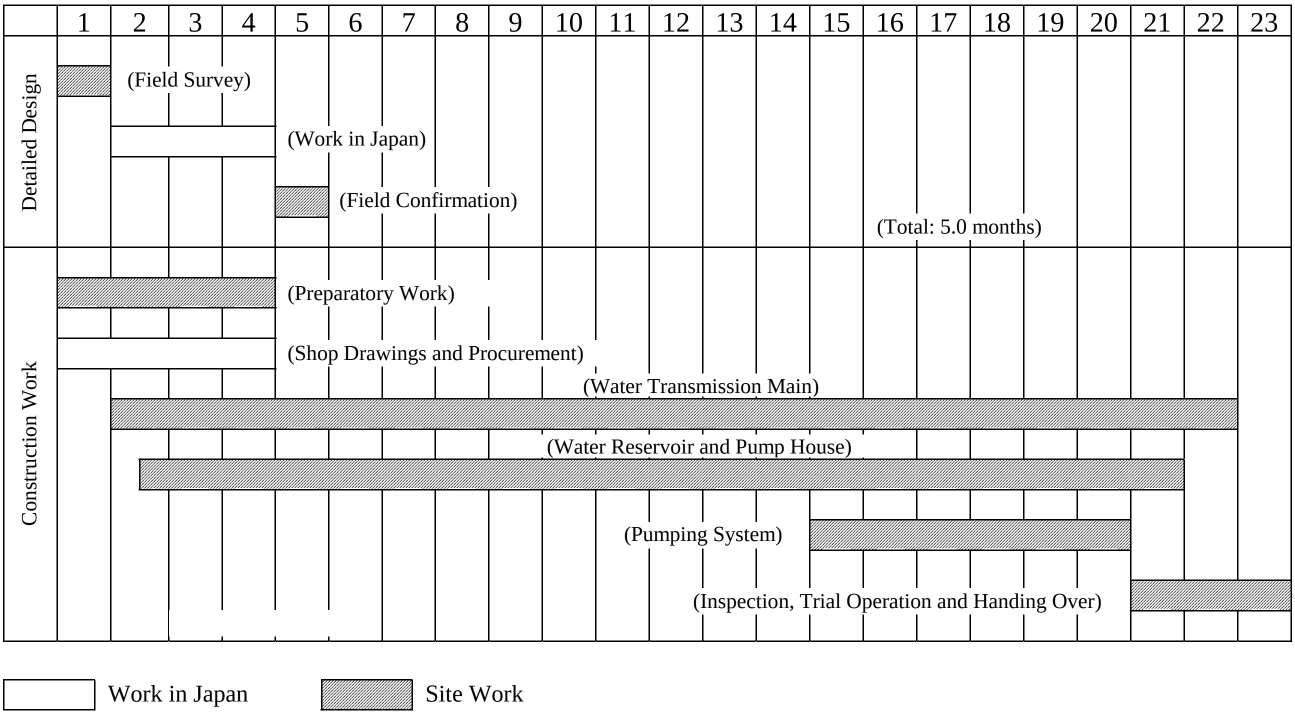


Fig. 2-2-17 Work Implementation Schedule of the Project

2.3 Obligation of Recipient Country

2.3.1 Work to be Undertaken by Egyptian Side

As part of the implementation process of the Project, the Egyptian side will be responsible for the following work.

(1) Acquisition and preparation of the land required for the water distribution pumping station

(2) Land preparation work at the planned water distribution station construction site

(3) Acquisition of an access road site for the water distribution station and construction of an access road

(4) Construction of the water transmission main to the Project Site

(5) Connecting work between the water distribution station and the existing distribution main

(6) Free provision of land to be used for a stockyard and temporary structures during the construction period

(7) Provision of information and data required for the detailed design for the Project

(8) Acquisition of permission for test excavation to confirm the existence of underground structures at the detailed design stage

(9) Facilitation of the acquisition of permits and approvals required for the implementation of the Project

(10) Acquisition of permits regarding all types of work, including manhole investigation, entry into the canal/drain zone and surveying and boring work on roads, associated with the Project

(11) Arrangements for witnessing and confirmation by the competent organizations for preliminary excavation and protective work for underground structures

(12) Introduction of necessary measures and arrangements for traffic control and obtaining of the cooperation of local residents

(13) Adoption of necessary measures and arrangements in the case of any ancient remains being found during the construction work

(14) Provision of disposal sites for surplus soil and wastewater during the construction period

(15) Establishment of the Giza City Project Promotion Committee to facilitate the implementation of the Project

(16) Promotion of the work to lay the water distribution pipes provided under the Project in accordance with the project implementation schedule

(17) Implementation of auxiliary work, including landscaping, erection of fencing and gates and installation of outdoor lighting at the water distribution pumping station

(18) Construction/extension of power receiving facilities (extension of the local 10.5 kV power distribution line, installation of a 10.5 kV connection box and installation of an integrating watt-hour meter), water supply system, telephone line and drainage system to the water distribution pumping station site

(19) Swift unloading, customs clearance and tax exemption of the equipment, etc. required for the Project at the Egyptian port of landing

(20) Exemption of the equipment procured and services provided by Japanese corporations and nationals from customs duties and any other taxes imposed in Egypt

(21) Provision of all facilities required by Japanese nationals to enter and stay in Egypt to perform their assigned work in Egypt in regard to equipment procurement and provision of services

(22) Appropriate use and maintenance of the facilities and equipment which are either constructed or installed by Japanese grant aid under the Project

(23) Payment of all costs necessary for the implementation of the Project which are not included in the scope of the Japanese grant aid for the Project.

2.3.2 Cost Estimation of Egyptian Side's Obligation

(1) Giza City

Works to be done by Giza City related to the implementation of the Project are listed and estimated as follows.

No.	Works to be done by Giza City	Cost (LE)
①	Preparation of access road to Water Distribution Station	170,000
②	Land reclamation for the site of Water Distribution Station	1,270,000
③	Landscaping and construction of fence and gates	70,000
④	Procurement of piping materials other than those supplied by the Japanese side	7,000,000
⑤	Construction of distribution pipes	3,400,000
⑥	Execution of house connection	1,370,000
	Total	13,280,000

(2) GOGCWS

Works to be done by GOGCWS related to the implementation of the Project are listed and estimated as follows.

No.	Works to be done by GOGCWS	Cost (LE)
①	Supply and Construction of Water Transmission Main other than the scope of work of the Japanese side (1,600mm diameter x 24 km length)	125,000,000
②	Connection between the Project Area and Pyramids South District (600mm diameter x 0.6 km length)	540,000
	Total	125,540,000

2.4 Project Operation Plan

2.4.1 Operation and Maintenance Plan

(1) Basic Principles

The proper operation and maintenance of the facilities as well as the equipment and the preservation of a good environment for the facilities are essential for the effective use of the planned facilities and equipment under the Project over a long period of time and also for the stable and continued supply of clean water in response to general fluctuations of the water demand.

The Egyptian side is required to enforce adequate preventive maintenance and repair work aimed at improving the reliability, safety and efficiency of each facility or equipment in order to maintain the necessary performance and functions of the facilities and equipment to achieve a stable supply of clean water.

The basic maintenance concept for the planned facilities is shown in Fig. 2-4-1. The Egyptian side is required to employ the following measures to achieve proper maintenance.

① Securing of the necessary personnel with appropriate knowledge and skills and budgetary appropriation for the proper operation and maintenance of the facilities and equipment

② Securing of the necessary funding to pay all expenses regarding the operation and maintenance of the water distribution pumping station for the effective use of the facilities

③ Securing of the necessary funding for the future renewal of the facilities and equipment

With continual reference to the operational and maintenance requirements referred to in Fig. 2-4-1, the Egyptian side should conduct the operation and maintenance of the facilities and equipment following the Project's completion using the operation and maintenance technologies and techniques transferred to the Egyptian side during the project period through the OJT organized by the Contractor and in accordance with the operation and maintenance manuals.

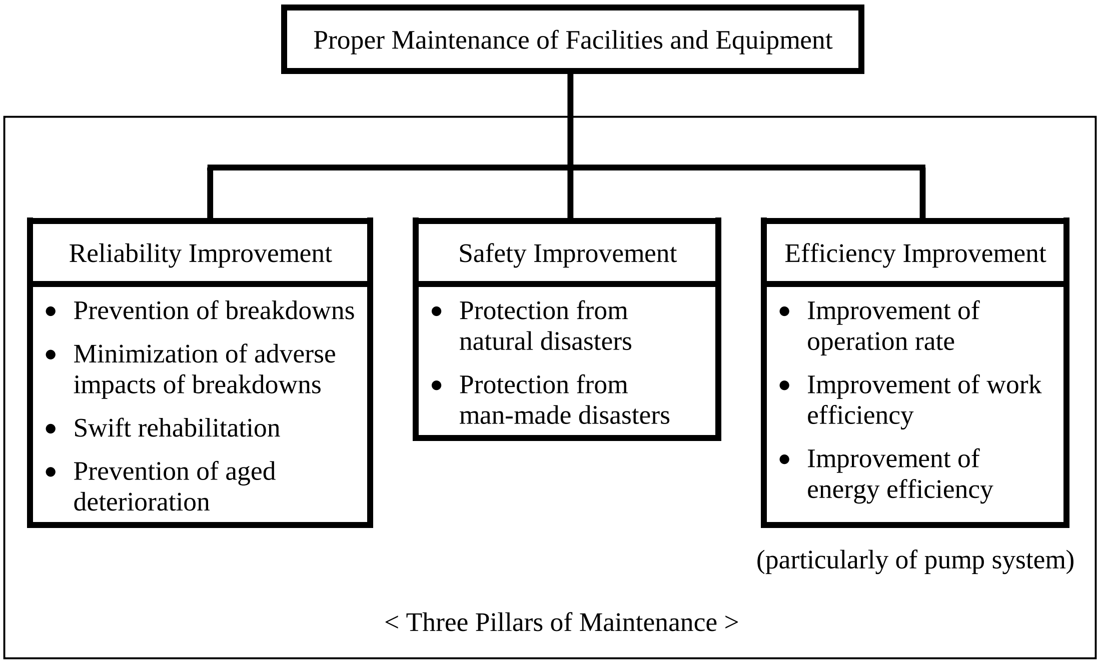


Fig. 2-4-1 Basic Concept of Operation and Maintenance System

(2) Regular Check Items

The standard check items regarding the pump system, distribution reservoir, water transmission main and water distribution pipes are shown in Tables 2-4-1 through 2-4-3. The GOGCWS in Egypt should prepare an operation and maintenance plan for the facilities and equipment based on the maintenance manuals submitted by the manufacturers of the equipment/facilities and the said tables and should uphold the plan as an essential part of the overall operation plan for the water supply facilities in Giza City.

Table 2-4-1 Standard Regular Check Items for Water Distribution Pump System

Equipment	Frequency	Check Item
Pump	Daily (in operation)	• Daily operation record ① Recording of water supply volume ② Visual check of various sections ③ Check of abnormal sound ④ Check of axial temperature rise ⑤ Check of water leakage ⑥ Recording of suction and discharge pressures
	Monthly	• Check of bearing oil deterioration • Check of bearing oil and oil level • Measuring of bearing oil temperature
	Three Monthly	• Change of bearing oil • Measuring of shaft center accuracy • Measuring of vibration and noise levels • Replenishment of bearing grease
	Six Monthly	• Change of bearing grease • Change of gland packing
	Annually	• Overhaul ① State of abrasion of rotating section ② State of gap at sliding section ③ State of internal corrosion ④ State of clogging by foreign matters ⑤ Repair of exfoliated paint • Check of accessories and auxiliary machine
Motor	Daily (in operation)	• Daily operation record ① Measuring of current value ② Visual check of various sections ③ Check of abnormal sound ④ Check of axial temperature rise
	Six Monthly	• Replenishment of bearing grease • Measuring of vibration and noise levels • Measuring of axial temperature
	Annually	• Check of bearing • Measuring of insulation resistance value

Table 2-4-2 Regular Check Items for Water Reservoir

Check Item	Check Interval	
	Monthly	Annually
① State of water leakage, if any		○
② Damage due to uneven subsidence, etc.		○

Table 2-4-3 Regular Check Items for Water Transmission Main and Water Distribution Network

Check Item	Check Interval	
	Monthly	Annually
① State of water leakage, if any	○	
② State of ground subsidence, if any		○
③ Conditions of valves, plugs and lids, etc.	○	
④ State of damage, if any	○	
- Damage by underground structure work, road work, building work and/or vehicle traffic		
- Damage by uneven subsidence, etc.		
- Damage by cleaning tools		
- Damage due to aging		
⑤ Availability of emergency equipment/tools	○	
⑥ Functioning of fire plugs		○
⑦ Functioning of blow-off valve		○
⑧ State of manhole covers (damage, abrasion, gap between iron frame and road surface due to uneven height and state of soil deposit, etc.)	○	
⑨ State of interior of manholes (uneven subsidence, cracks on side walls, corrosion of metal steps and state of soil deposit, etc.)	○	
⑩ State of damage to aqueduct painting, if any		○

(3) Spare Parts Procurement Plan

The spare parts for the water distribution pump system are classified as standard accessories for regular replacement and emergency replacement parts required at the time of a breakdown, etc. It will be necessary for the Egyptian side to procure both types of spare parts in accordance with the regular check cycles shown in Table 2-4-1.

It is planned to provide two years supply of spare parts under the Project as listed in Table 2-4-4. Consequently, it will be necessary for the Egyptian side to secure the necessary funding for the standard accessories and emergency replacement parts within two years of the completion of the Project.

Table 2-4-4 Spare Parts and Maintenance Tools to be Procured Under the Project

I. Spare Parts (to be stored at the water distribution pumping station)

No.	Item	Quantity	Remarks
1	Water distribution pump		
	- Gland packing set	4 sets x number of pumps	for 2 replacements in 1 yr
	- Shaft sleeve set	1 set x number of pumps	for replacement in 2 yrs
	- O ring	1 set x number of pumps	for replacement in 2 yrs
	- Linear ring	1 set x number of pumps	for replacement in 2 yrs
	- Bearing metal set	1 set x number of pumps	for replacement in 2 yrs
	- Ball bearing	1 set x number of pumps	for replacement in 2 yrs
	- Casing gasket	1 set x number of pumps	for replacement in 2 yrs
2	Gate valve (including motor-operated valve)		
	- Gland packing	1 set x number of valves	for replacement in 2 yrs
3	Butterfly valve (including motor-operated valve)		
	- Seat	1 set x various sizes/models	emergency parts
4	Flow control valve (motor-operated)		
	- Complete product	1 set x various sizes/models	emergency parts
5	Pressure gauge		
	- Suction side	1 set x number of pumps	emergency parts
	- Discharge side	1 set x number of pumps	emergency parts
6	Pump control panel and power receiving and transformation panel		
	- Frequency conversion unit	1 set	emergency parts
	- Display lamp/fuse	100%	
	- Circuit breaker	1 set x various sizes/models	emergency parts
	- Protective relay	1 set x various sizes/models	emergency parts
	- Display instruments	1 set x various sizes/models	emergency parts

II. Maintenance Tools (for each water distribution works)

No.	Item	Quantity	Remarks
1	Tool set for mechanical equipment (with tool box)	1 set	
2	Tool set for electrical equipment (with tool box)	1 set	
3	Multi-tester (AC 600 V; 12 A)	1 set	
4	Bar thermometer (mercury; 0 - 100°C)	10	
5	Insulation resistance tester (1,000 V)	1 set	
6	Pump centering tester		
	- Dial gauge (2 mm)	1 set	
	- Dial gauge (lever system)	1 set	
	- Magnet base	2 sets	
	- Shim (0.1, 0.2 and 0.5 mm)	1 reel each	
7	Revolution counter (optical; remote)	1 set	
8	Vibration tester	1	
9	Noise tester	1	
10	Pressure gauge calibrator		
	- Weight balance type	1	

(4) Operation and Maintenance Improvement Plan

1) Particulars of the Water Supply Operation in the Greater Cairo

Particulars of the Greater Cairo water supply operation under the supervision of GOGCWS are as indicated in Table 2-4-5.

Table 2-4-5 Particulars of the Water Supply Operation of GOGCWS

Item	Particulars
Design supply population	16,000,000 (2000)
Water supply rate	75% (2000) 85% (2010 target) 90% (2015 target)
Daily distribution capacity Annual water supply paid Annual gross water supply Daily average water supply Daily maximum water supply	5,200,000 m^3 (2000) 7,300,000 m^3 (2010 target) 8,000,000 m^3 (2015 target) 1,281,000,000 m^3 2,086,200,000 m^3 5,700,000 m^3 6,400,000 m^3
Leakage rate	15% (2000) 12% (2010 target) 10% (2015 target)
Number of employees	14,200 (2000)

Based on the aforementioned particulars of the water supply operation, various ratios regarding the facilities, work outline and profit and loss balance of the water operation in 2000 can be sought as shown in Table 2-4-6. The key points of this table are described below.

① While the operation rate is high at almost 110% due to the lack of water supply capacity, the water charge collection rate of 61% is similar to that of other developing countries (where the relevant ratio ranges from 40% to 60%).

② As the unit income of water supply is lower than the unit cost of water supply, the operational deficit increases in proportion to the volume of water sold.

③ As both the service population and volume of water supply per staff member are small, whether or not the current number of staff are appropriate must be examined.

Table 2-4-6 Ratio Analysis of Water Supply Operation of GOGCWS

Item	Ratio	Calculation Formula
Water Charge Collection Ratio	61%	$\frac{1,281,000,000\ m^3 \text{ (annual water supply paid)}}{2,086,200,000\ m^3 \text{ (annual gross water supply)}} \times 100$
Load Ratio	89%	$\frac{5,700,000\ m^3 \text{ (average daily water supply)}}{6,400,000\ m^3 \text{ (maximum daily water supply)}} \times 100$
Facility Utilization Ratio	110%	$\frac{5,700,000\ m^3 \text{ (average daily water supply)}}{5,200,000\ m^3 \text{ (daily water supply capacity)}} \times 100$
Maximum Operation Ratio	123%	$\frac{6,400,000\ m^3 \text{ (maximum daily water supply)}}{5,200,000\ m^3 \text{ (daily water supply capacity)}} \times 100$
Unit Income of Water Supply	0.200LE/m^3	$\frac{255,577,000 \text{ LE (water supply income)}}{1,281,000,000\ m^3 \text{ (annual water supply paid)}}$
Unit Cost of Water Supply	0.527LE/m^3	$\frac{675,086,000 \text{ LE (operation cost)}}{1,281,000,000\ m^3 \text{ (annual water supply paid)}}$
Service Population per Staff	1,127 people	$\frac{16,000,000 \text{ people (service population)}}{14,200 \text{ people (total number of staff)}}$
Water Supply Volume per Staff	90,211m^3	$\frac{1,281,000,000\ m^3 \text{ (annual water supply paid)}}{14,200 \text{ people (total number of staff)}}$

2) Operation and Maintenance Improvement Items

In view of the aforementioned factors, GOGCWS should strive to make sure that operation and maintenance can be carried out following completion of the Project by implementing the following items and improving the business operating situation by 2003.

① Revise the water supply tariff so that income from water supply is equivalent to the operating cost.

② Implement the planned renewal of deteriorated sewers and asbestos pipes at supply network terminals to ensure that the 2010 target leakage rate of 12% can be achieved.

③ In order to raise the tariff collection rate, prepare and implement a plan of countermeasures such as elimination of unlawful connections, and inspection and renewal of water gages in all households and business establishments.

④ In accordance with the business operating improvement and human resources development plan of USAID and the Project for Improvement of Water Supply

Technical Training in Egypt (project technical cooperation of the Government of Japan) scheduled for implementation from June 1997 to May 2002, strive to acquire and improve operation and maintenance technology.

⑤ Through implementing the above items, aim to achieve operation and maintenance of a sustainable water supply operation.

2.4.2 Estimation of Operation and Maintenance Cost

The operation and maintenance cost to be borne by the GOGCWS following the implementation of the Project is estimated below.

(1) Income from Water Charge

The income from the water charge is calculated based on the following conditions.

1) The service population in the target (year 2010) is 684,800.

2) The increase of the water supply volume is 160 litres/person/day, i.e. the target volume of (240 litres/person/day) minus the average water supply volume at present (50 – 100 litres/person/day or an average of 80 litres/person/day).

3) The service population ratio (2010) is 85%, i.e. the target value adopted by the GOGCWS.

4) The water charge is 0.15 LE/m^3, i.e. the average value for the user category of “ordinary household”.

The calculated income from the water charge in 2010 based on the above conditions is shown below.

(Unit: LE)

	Water Supply from New Facilities Constructed Under the Project (2010)
Income from Water Charge	5,100,000

(2) Maintenance Cost

The maintenance cost, consisting of the electricity charge for pumping operation, personnel cost and spare parts procurement cost, is calculated based on the following conditions.

1) Electricity charge : annual power consumption x average electricity cost

2) Personnel cost : average annual wage for operation and maintenance staff at the water distribution (pumping) station

The operation and maintenance of the planned water distribution station under the Project will be conducted by one station chief, two operators (for each of three shifts) and six workers (for each of three shifts).

3) Spare parts cost : 3% of the equipment cost

Cost Item	Maintenance Cost (LE/year)
1) Electricity charge	37,600
2) Personnel cost	8,400
3) Spare parts procurement cost	22,800
Total	68,800

(3) Estimated Annual Balance for Water Supply Service

Comparison between the estimated annual balance for the water supply service by the GOGCWS following the implementation of the Project and the present balance (FY 1998/99) is shown in the table below.

(Unit: 1,000 LE)

	Entire Service (FY 1998/99)	Estimate After Implementation of the Project (FY 2010/11)	
		Facilities Constructed Under the Project	Entire Service
Income (%)	255,577 (100.0)	5,100 (2.0)	260,677 (102.0)
Expenditure	675,086	2,179	677,265
Balance (%)	-419,509 (100.0)	+2,921 (0.7)	-416,588 (99.3)

As shown in the above table, the total balance of the water supply service by the GOGCWS will remain in the red after the implementation of the Project. However, an increase of the income by 2% following the implementation of the Project will reduce the overall deficit by 0.7%, improving the operating balance of the GOGCWS.

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effects

The current situation and problems at the Project Site, improvement measures to be implemented under the Project and the expected positive effects of the Project's implementation are compiled in Table 3-1-1.

Table 3-1-1 Present Situation, Problems, Improvement Measures and Positive Effects Associated with the Project

Current Situation and Problems	Improvement with the Project (Scope of Cooperation)	Positive Effects and Improvement with Project Implementation
1. Insufficient Water Supply Volume and Pressure The water supply volume and pressure to the Project Site are insufficient because of water consumption in the upstream areas (50 – 100 litres/person/day; 0.5 – 1.0 kg/cm^2).	Construction of a new water transmission main which will not branch out to the Project Site to supply more water	A daily water supply volume of 240 litres/person/day for the design population of some 685,000 will be achieved at the Project Site. The connection of the new main to the main serving the Southern Pyramids Area will create a trunk water transmission loop, contributing to a stable water supply for entire Giza City.
	Construction of a water distribution station with a pumping facility at the end of the new transmission main to supply water to the Project Site	Achievement of water supply to the Project Site with a target water supply pressure of 2.0 kg/cm^2
2. Use of Low Quality Well Water Low quality well water which is unsuitable for drinking purposes is supplied to the distribution network to supplement the insufficient water supply volume and pressure.	Construction of the above-mentioned transmission main and water distribution station to eliminate the need to use well water	Availability of a stable supply of safe, clean water, enabling termination of the use of unsuitable wells
3. Partial Absence of Water Distribution Network Parts of the Project Site lack water distribution facilities, creating the burden on women and children of fetching water and on local residents of purchasing water.	Procurement of fittings and valves, good quality products of which are difficult to procure in Egypt, for the water distribution main, i.e. the backbone of the distribution system, in areas currently without a distribution system to facilitate the construction of the distribution network	Elimination of areas without a distribution system (approx. 2.4 km^2 with an estimated population of 72,000 in 2010), allowing local residents to receive the supply of clean water
4. Insufficient Reservoir Capacity The total reservoir capacity in Giza City is approximately 26% of the target value, causing (i) a heavy burden on the water supply pumps at the water treatment plant and (ii) a decline of the water supply volume during peak hours in some areas.	Construction of a reservoir of a suitable size (30,000 m^2) at the water distribution station to meet the demand at the Project Site	Stable water supply to the Project Site at all times, including peak hours; reduction of the burden on the WTP to supply water during peak hours, enabling increased water supply to other areas; improvement of the reservoir capacity in Giza City to some 38% of the target value

3.2 Pending Tasks and Recommendations

The pending tasks in need of further improvement and related recommendations for the successful implementation of the Project and the sustainable operation and maintenance of the new facilities after the completion of the Project are described below.

(1) Implementation of the Work by the Egyptian Side

For the smooth implementation of the Project and the achievement of its targets, the Giza Municipal Authority and the GOGCWS will properly fund the assigned work, including the construction of the new water transmission main, connection of the new main to the transmission main in the Southern Pyramids Area and construction of a new water distribution network, all of which constitute external risk factors for the Project, so that the work is conducted without any delay.

(2) Improvement of Business Management

The financial situation of the GOGCWS is currently difficult as its water supply business incurs a loss every year. The following matters have been pointed out by the management improvement programme of the USAID.

① Revision of the water charge to a level capable of financing the operation and maintenance cost of the facilities to secure the prospect of self-reliant finance

② Improvement of the water charge collection rate

③ Effective use of facilities and improvement of the charged water supply ratio through improvement of the maintenance skills of staff members

④ Appropriate assignment of staff members and reduction of the personnel cost through a review of the water supply facilities and required staff strength

The GOGCWS should implement these improvements without fail to ensure integrated operation and maintenance following the completion of the Project and to achieve a healthy financial situation as soon as possible.

(3) Connection of Service Pipes

As part of the Project, the Giza Municipal Authority will construct a new water distribution network in some parts of the city. Any delay of this work and the work to connect the service pipes to each household will prevent the achievement of the expected effects of the Project. It will, therefore, be necessary for the Giza Municipal Authority to establish the Project Promotion Committee using its experience of previous projects and to formulate a schedule plan, detailed design plan, personnel plan, equipment and materials procurement and work order placement plan, etc. accompanied by the relevant budgetary measures for completion in line with the completion of the Project.

(4) Learning of New Skills for Pump Operation

While the maintenance staff of the existing pumping stations of the GOGCWS possess certain pump operation skills, it will be necessary for them to undergo further training in regard to flow control, the effective use of the residual head of the water transmission main, the efficient use of the reservoir capacity and adjustment of the water distribution pressure with variable speed pumps, etc. to operate the new pumps to be installed under the Project. Accordingly, the GOGCWS should appoint operation and maintenance staff to operate the planned water distribution facilities under the Project so that they can participate in the OJT to be provided under the Project.