

CHAPTER 10

INITIAL ENVIRONMENTAL EXAMINATION

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The principal objective of an Initial Environmental Examination (IEE) is to reach a decision on whether a full-scale examination of environmental impacts concerning, i.e., an Environmental Impact Assessment (EIA) would be required or not. The purpose of performing the IEE for the project for improvement of water supply system in Yangon city is to identify various environmental factors affected by a priority project implementation for the proposed Pre-Feasibility Study that selected by the Study. The impact on these environmental factors for selected suitable water supply facilities will be reviewed and carefully examined in the next stage of the EIA.

10.1 ENVIRONMENTAL PROTECTION

10.1.1 Institutions and Jurisdictions

(1) Environmental Agencies

1) Ministry of Environment (An imaginary organization)

Presently, there is no responsible agency for environmental protection administration. However, The National Environmental Policy of Myanmar was adopted in December 1994, and the National Commission for Environmental Affairs (refer to the following section) is finally drafting the National Framework Environmental Law and the Environmental Impact Assessment (EIA) Law with the aim to integrate environment and development effectively.

Under the existing circumstances, environmental management is directly carried out by the respective ministries. For example, the Ministry of Forest is responsible for sustainable forests management including wildlife conservation, forest reserves etc., while the Ministry of Industry (1) controls and regulates industrial activities and pollution control. There is no institution responsible for comprehensive environmental policymaking, coordination and legislation.

In the near future, the Ministry of Environment will be founded and would be the main central agency for the protection of the environment in Myanmar.

2) National Commission for Environmental Affairs

The National Commission for Environmental Affairs (NCEA) has been established in February 1990 under direct authority of the Minister of Foreign Affairs in order to carry out, follow-up and evaluate the national level of environmental policy and decision making for sustainable development in accordance with Myanmar AGENDA 21. The Commission acts as the national focal point for environmental matters vis-à-vis other countries and international organizations, co-ordinates the work of various line ministries and departments and reports directly to the Cabinet.

The NCEA was established with the following mandates:

- To develop sound environment policies in the utilization of forests, aquatic, land, mineral resources, marine resources and other natural resources in order to safeguard the environment and prevent its degradation;
- To set environmental standards and lay down rules and regulations to control pollution including water pollution, air pollution, noise pollution, disposal of hazardous wastes and toxic substances;
- To provide short, medium and long term environmental plans, policies and strategies that take into account both environmental needs and developmental requirements; and
- To promote environmental awareness through information and education so as to foster public participation in environmental protection endeavours.

The Commission is chaired by the Ministry of Foreign Affairs and its members include a Secretary, a Joint Secretary and heads of various department of respective line ministries.

(2) Other Agencies Strongly Involved in Environment Management

Several central agencies have environment-oriented tasks but only those having strong implication in the management side are considered.

1) Ministry of Health

The Office of Environmental Hygiene, and the Office of Protection against Diseases Vectors, both belonging to the Division of Public Hygiene under the Direction of Public Hygiene and Education for Health of Ministry of Public Health are major managing agencies for dealing with the urban environmental issues of Yangon. The Office of Environmental Hygiene is involved with domestic sewage, excreta, and disposal of waste. The office is also in charge of housing and living environment hygiene.

2) Ministry of Forestry

Community Forestry Instructions, stated by the Director General of the Forest Department, the Ministry of Forestry in December 1995 calls for decentralization and development in forest management with the primary purposes of both satisfying the basic needs of local communities and protecting the forests against undue causes. So far, some 7,500 ha of community-owned forest plantations have been established and the exercise of community forestry is gaining momentum.

3) Ministry of Industry (1)

The Ministry of Industry (1) prescribed the Standing Order No.3/95 for factories, mills and enterprises under the Ministry of Industry (1) in order to adopt uniform preparatory measures beforehand for the prevention of pollution and destruction of the entire natural environment enveloping the water, land and atmosphere by which are being discharged by

the factories.

(3) Outline of Jurisdictions and Competence

Beside the decentralised local responsibilities in the field of environmental management is basically the competence of state representative agencies, which are considered in this review of jurisdictions and competence.

1) Industrial Environment

In the field of industrial environment, the Ministry of Industry (1) has a duty to control polluting establishments, in coordination with other concerned agencies in the task of controlling pollution and nuisance sources. For the time being, the NCEA may also shoulder a major piece of the control of pollution and nuisances in its task of supervising the adoption of measures in conformity with environmental plan proposed in the EIA.

Actually, jurisdictions in the field of industrial environment are overlapping, which contrasts with the obvious absence of proper management in this field. The absence of effective supervision is justified by the lack of definite duties on respective agencies and the lack of environmental standards.

2) Living Urban Environment

In the field of quality of the living urban environment, the main agencies responsible are the Ministry of Health for hygiene and sanitation and the Ministry of Forest for living amenities, especially greenery.

3) Natural Resources

Natural resources relevant in Yangon are mainly fresh water and fishery. The protection of ambient surface water quality will involve the Ministry of Environment for nature protection purpose, and the Ministry of Health for hygiene and sanitation purpose.

Monitoring of surface water and groundwater is only performed in Yangon city and superb areas. Surface water monitoring will in principle be shared by the Ministry of Science and Technology. With the increase of population and enhanced need for water for economic activities, there is an increasing pressure on extraction of groundwater. The conditions of control, sampling and analysis of wastewater effluents will be set on a case-by-case basis according to a joint order of the Minister in charge of public health and the Minister in charge of industry. However, data on sources of inland water pollution remain quite limited.

4) Natural Habitats and Species

The Ministry of Forestry makes conservation of natural habitats and species through management of natural resources. There is however no institution specifically dealing with the protection and conservation of nature that manages the national parks and rules of the

international conventions for the protection of nature signed or ratified by Myanmar.

The EIA procedure is the main tool available for preventing negative effects on natural environment.

5) Information System

There is no regular collection of environmental data in Yangon, excepting health data and drinking water quality data. Groundwater and surface water quality are known through isolated studies only. The National Framework Environmental Law has required for the preparation of annual statement of environmental quality. The responsible agency of environmental protection has the duty to submit each year to the government an annual state of environment and sustainable development.

10.1.2 Legislative and Regulatory Framework

The National Environmental Policy of Myanmar 1994 provides that everybody has a right to live in a healthy environment.

(1) Living Environment

The National Framework Environmental Law would stipulate that discharge and disposal of liquid and solid waste by individuals or industries are forbidden. The law explicitly provides that waste deposits in public places as well as throwing away domestic waste and other waste like gravel and stones in public places, streets, rivers, or ponds are forbidden. Table 10.2 below is a summary of the main stipulations according to environmental issues.

Application decrees of the sanitation and environment management related laws are almost not yet published excepting those relating to a modernised institutional organisation.

(2) Natural Environment

1) Biodiversity

Myanmar scores as one of the richest biological reservoirs in Asia. Wide varieties of flora and fauna exist in the country. 285 families of flora, consisting of about 7,000 species of trees, shrubs, herbs, bamboos, principal climbers, etc, have been recorded. About 1,000 are identified as endemic. A high proportion of these plants are used for food, medicines, animal fodder, wood or other purposes.

Myanmar also has a rich diversity of wild fauna. About 300 mammal species, 360 reptiles and 1,000 bird species have been recorded. Presently, 580 species of fish and 65 species of corals have been identified in Myanmar.

Wild plants and wildlife in Myanmar are being threatened and endangered as a result of habitat loss, hunting, poaching and lack of sound conservation and management. So far, 11 reptile species, 4 bird species, 19 mammal species and 29 flowering plants and ferns species

are recorded as endangered species. According to the new law for the protection of wildlife and wild plants, 39 mammals, 50 birds and 9 reptile species have been declared as completely protected; 12 mammals, 43 birds and 6 reptile species have been declared as normally protected; and 2 mammals and 13 bird species have been declared as seasonally protected.

In 1994, the Government enacted the new Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, replacing the old Burma Wildlife Protection Act, 1936. Modern concept of biodiversity conservation was introduced in the law.

2) Forest Resources

Myanmar is well endowed with rich natural forests. Forests cover about 340,000 km² constituting over 50 percent of the total area of the country. This is due to the fact that Myanmar forests have been prudently managed over the decades, and sustainable exploitation of timber carried out under the Myanmar Selection System. Depending on precipitation, temperature and soil condition, forest types vary widely throughout the country.

However, deforestation occurs in Myanmar at an annual rate of 220,000 ha or 0.64% of the actual forested area during the period 1975 to 1989. Thoughtless exploitation for fuelwood is one of the major causes of deforestation. Woodfuel accounts for about 80% of the total energy needs of Myanmar and the demand for fuelwood is growing at a rate of 1.1% annually. Shifting cultivation is another reason for deforestation in Myanmar.

The Government is currently making efforts to prevent deforestation in Myanmar. The Forest Policy was adopted in 1995 to ensure sustainable development of forest resources while conserving wildlife and wild plants, and enhancing the ways of living of indigenous people. Fuelwood substitution schemes are also being introduced extensively to protect and conserve the forests.

(3) Landscape and Cultural Patrimony

The preservation of cultural patrimony is managed under the Protection and Preservation of Cultural Heritage Region Law, 1998. According to the law, it can be launched in order to preserve historical, archaeological and scientific sites, as well as specific sites with landscape value. Furthermore, the law provides the rules that the Minister in charge of culture must establish the national inventory of goods, monuments and sites of cultural value. Presently, the agency in charge is the Ministry of Culture.

(4) Natural and Technological Risks

The management of natural and technological risks, especially the risks related to flooding, landslide, drought and fires, is the duty of the State Peace & Development Council. This

agency is basically in charge of preventing and managing crisis situations of socio-economic nature related to food supply, sanitary conditions, disease epidemics and others. There is no measure taken as regards to the risk of industrial disasters.

(5) Public Participation

The involvement of the public is one of the most crucial aspects of the EIA process. The provision for public participation is contained in the National Framework Environmental Law. The notice of availability of the IEE/EIA report for public review must be inserted in one newspaper each in the Myanmarese and English languages and in the gazette. 30 days are allowed of public review. Once the public comment period is over the NCEA must decide whether the case warrants a public hearing. The public comments received during the 30 days period must be sent back to the project proponent for review and response. The project proponent must respond to comments by making every effort to modify alternatives including the proposed action, develop and evaluate alternatives not provided, give serious consideration to providing supplementary information in the document and make factual corrections. All substantive comments received on the draft should be attached to the final statement.

10.1.3 Environmental Policies

(1) Local Environment Policy

There is no local environmental policy. The YCDC has launched a program of environmental protection around 1990's, with the objectives of protecting ecosystems and living conditions of people. However actions have been limited to specific aspects like preservation of green belt, rehabilitation of soils and vegetal cover in peripheral rural housing areas, awareness heightening.

The YCDC has also carried out in 1997 a Diagnostic of Environmental Issues and Identification of Priority Programs for Sustainable Development.

(2) National Environment Policy

The National Commission for Environmental Affairs (NCEA) drafted the National Environmental Policy, which was adopted in December 1994. The Policy calls for harmony and balance between environmental developments through the integration of environmental considerations into the development process. National Environment Policy forms the basis for developing environmental strategies, environmental programmes and plans.

With a view to implement the National Environment Policy of Myanmar, the NCEA initiated the drafting of the Myanmar Agenda 21 in 1995 based on the Agenda 21 laid down by the United Nations Environment and Development Conference in 1992 for achieving sustainable development. The drafting of Myanmar Agenda 21 was carried out with the participation of all government departments concerned. Workshops were held to seek

suggestions and proposals from various departments. The Agenda was published in June 1997 and distributed to the United Nations and UN agencies and the domestic and abroad government departments.

The formulation of the Myanmar Agenda 21 is part of the country's effort to fulfil its commitment to the Rio de Janeiro Earth Summit in 1992. This document is the expression of the political commitment of the Government to sustainable development.

The Agenda 21 seeks to achieve four main objectives:

- To provide a forum and context for the debate on sustainable development and the articulation of collective vision for the futures;
- To provide a framework for negotiation, mediation and consensus-building in the country to achieve development with due regard to the environment, to focus the entire country on a common a set of priority issues;
- To provide a strategy and implementation plans for the changing and strengthening of values, knowledge, technologies and institution with respect to environmental protection and development; and
- To provide the impetus and the framework for the development of organizational capacities and institutions required for sustainable development.

10.1.4 Environmental Conventions and Criteria

(1) International Conventions

The government of Union of Myanmar has signed or ratified several international conventions pertaining to environmental protection. The follow-up of conventions initiated by the Rio Conference of 1992 is the duty of the NCEA, which has been designated as the focus point, in charge of coordinating technical commissions composed of concerned ministers. They are:

- Convention on Biological Diversity (ratified in 1994)
- Convention on Climate Change (ratified in 1994)
- Convention on Combat Desertification (accession in 1997)
- Convention on International Trade in Endangered Species of Wild Flora & Fauna (accession in 1997)
- Bonn (Washington) Convention (accession in 1997).

The Ministry of Forestry has presidency of the technical commission set up for the Convention on Biological Diversity. Technical commissions established for the Convention on Climate Change are presided by the Department of Meteorology and Hydrology.

Other important environmental conventions about the Ozone Layer signed or ratified by the Myanmar government are the Vienna convention (ratified in 1993) and the Montreal

protocol (ratified in 1993).

(2) Environmental Standards

There are no ambient quality standards for environment in Myanmar. Emission standards for water and air pollutions are those only generated from industrial activities, established by Ministerial Standing Order No.3/95 of Ministry of Industry (1). A project of law about water quality standards is presently studied by the Ministry of Science and Technology.

Table 10.1 below shows significant parameters are extracted from the allowable waste effluent standards.

Table 10.1 Allowable Waste Effluent Standards

Parameters	Standard Value
Suspended Solids	Max. 30 mg/L
BOD ₅	Max. 20~60 mg/L
COD _{Mn}	Max. 60 mg/L
pH Value	5~9
Sulphide	Max. 1 mg/L
Arsenic	Max. 0.25 mg/L
Mercury	Max. 0.005 mg/L

10.2 EXAMINATION OF ENVIRONMENTAL EFFECTS

10.2.1 Scope of Environmental Evaluation

(1) EIA Requirement

The national framework environmental law and the decree establishing an EIA both require an EIA for activities, projects and programs of development. These requirements are discussed below in order to better define the expected scopes and pertinence of an EIA for the Master Plan. According to the types of activities subject to an EIA, there are 2 or 3 categories of projects that require attention particularly:

- Construction or expansion of water supply system over 20 km length and water treatment plant (WTP) designed for the treatment of more than 100,000 m³/day. In the Master Plan, the smallest WTP is designed for 467,500 m³/day.
- Siting, construction and extension of distribution systems of treated water.
- There is finally the third case of little explicit but relevant case of any installation or program set up in the public and fluvial domain.

It is reasonable to consider that EIA should be performed in this case, because international rules, including those of JICA do require such EIA for construction of large-scale WTP and reservoir.

The EIA legal requirement as established in Myanmar concerns activities, projects and programmes all together. This means that the Master Plan itself should in principle be the object of an EIA, besides the projects that are proposed within the scope of the Master Plan. However, this last requirement is very subject to interpretation because:

- The list of activities, projects and plans subject to an EIA as defined clearly focuses on projects only.
- There is no any specification about the study process in case of plans and programmes.

It is reasonable to consider that the EIA is firstly required for identifying the impacts of the designed projects but must as well take into account the general evaluation of the cumulated and synergetic effects of the Master Plan. Within the scope of the Master Plan, such approach is fully recommended.

Finally, the decree specifies that YCDC will have ability to decide if a project is subject to EIA or not. The preparation of TOR of EIA in coordination with the YCDC is a prerequisite for getting consensus on the scope of the EIA study.

As a result, the following scopes of evaluation seems properly in order to meet with the international standards:

- EIA of water resource development and water supply project
- Consideration and global evaluation of the effects at the level of the entirety Pre-Feasibility Study

The EIA procedure requires that positive and negative impacts are both considered and specified mentioned in the study. The objectives of the Master Plan, which are construction of water treatment plant, transmission main, service reservoir and pumping station, are all positive environmental objectives. The role of an EIA in such project is then to:

- Make sure that the project objectives are not realised through pollution and nuisances transfer from urban area to natural area, or from one community to the other, but through the full integration of environmental requirements and priorities.
- Make sure that objectives are realised according to sustainability and acceptability concepts.
- Prepare an environmental plan with measures able to increase the positive effects and mitigations able to reduce or eliminate the non-desirable effects.

(2) Purpose of IEE

The Initial Environmental Examination (IEE) is useful in order to find out the possible negative effects of the Master Plan project on the social and natural environment. This IEE is a procedure which is recommended by JICA's guidelines and which follows checklists established for the water supply sector. The purpose of IEE is to clarify the needs and targets for further environmental assessment within the scope of EIA.

The full IEE process includes the evaluation of the initial state of environment conditions and of the institutional organisation for the protection of environment. The output of the IEE is an evaluation of the main expected orientations and issues to be focused on in the forward EIA study. The IEE is performed below through the review of the project components and potential impact sources, and the screening and ranking of possible negative effects.

10.2.2 Project Components and Sources of Environmental Impacts

Implementation of the Master Plan is based on the installation of indispensable water supply facilities, which will meet the future water demand and improve the sanitation conditions of Yangon City. Construction and operation of these units are however potential sources of undesirable impacts, which need consideration in order to avoid negative feedback effects on social or natural environment.

The main components of the priority implementation until 2010 and the corresponding impact sources are overviewed in Table 10.2 below. The main potential sources of impacts can be summarised here:

- Failure in the treatment process and lack of maintenance
- Conditions of installation and maintenance of facilities in the on-site treatment area
- Construction work
- Land acquisition
- Others (pollution and nuisances)

As a rule, it is expected that a large part of potentially positive or negative effects of the projects will be related to the capacity of authorities to manage and maintain facilities on the one hand, and to manage and implement the set of environmental measures made necessary, on the other hand.

10.2.3 Screening of Potential Effects

The analysis of the present conditions of environment in Yangon and its outskirts that there is no critical issues both in terms of urban and natural environment. The sanitary conditions of Yangon have important impacts on the health aspect of resident, their quality of life and quality of the natural environment. A summary of the environmental conditions in Yangon area is presented in Table 10.3 and Table 10.4.

The initial screening of the possible effects both at construction and operation & maintenance phases of the priority projects on environment is done in Table 10.5. The screening checklist has been fulfilled according to the JICA guidelines applying to water supply sector (Vol. IX, 1994). The relevance of each item is considered according to the following ranks, regardless of the positive or negative character of these effects:

Table 10.2 Checklists of Potential Sources of Impacts of Priority Projects Components

Project components	Potential sources of environmental impacts	Conditions of implementation & management	Factors (strengthening the effects or reducing them)
Water Treatment Plants			
Hlaing WTP	Land acquisition of the site	Target year 2010 Total required area: 16.5 ha	Conditions of natural and land resources dependence of local communities, conditions of land use rights and settlements, etc.

	Temporary installation of access road for construction	About 3 km x 10 m-width of access road is required for construction to reach the site	Reclamation of the site by cutting down the trees. Possibilities of noise and vibration by large-size and heavy-duty vehicles transportation
	Operation / maintenance failure	Final selection of the treatment technology	Institutional / technical capacity for long term maintenance, motivation of employed staff
	Change the hydrological situation causing by intake of large volume of water	Target in 2010, required intake quantity: 170 million m ³ /year	Nearly half quantity of river flow is required for water supply during the dry season.
	Generation of sludge	Total quantity generated: approx. 82,300 m ³ /year (Assumption of 60% water content)	Disposal at Sludge Lagoon and possibility of reuse sludge for agriculture
	Generation of wastewater by back-washing of filter ponds	Quantity expected is about 894,000 m ³ /year in total;	Solid waste is also made disposal at Sludge Lagoon and Clear layer of water returns to the receiving well.

Transmission Pipes

Hlaing Transmission Pipe	Land acquisition of the site	Laying single 36 km length of f 2,000 mm transmission pipes from Hlaing WTP to Terminal Reservoir	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
Ngamoeyeik Transmission Pipe	Land acquisition of the site	Laying 31 km length of f 1,800 mm transmission pipe and dual 13 km length of f 1,400 mm pipes from Ngamoeyeik reservoir to Hlawga Reservoir.	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
Other Transmission pipe	Land acquisition of the site	Laying about 60 km length of transmission pipes connected from WTP to each service reservoir and reservoir to other reservoir	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.

Groundwater Development

Right Bank of Hlaing River	Subsidence by excessive pumping	Target in 2010, required intake quantity: 35.4 million	Reasonable quantity of intake from the wells
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		m ³ /year	correspondence with cultivation volume.
Service Reservoirs			
Terminal Reservoir + 2 pumping stations	Land acquisition of the site	Total capacity: 80,000 m ³ Minimum required area: 2 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
Central Block West Reservoir	Land acquisition of the site	Total capacity: 100,000 m ³ Minimum required area: 1.7 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
Central Block Downtown East Reservoir	Land acquisition of the site	Total capacity: 100,000 m ³ Minimum required area: 1.7 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
Central Block Hlawga Reservoir	Land acquisition of the site	Total capacity: 100,000 m ³ Minimum required area: 1.7 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
Central Block North Reservoir	Land acquisition of the site	Total capacity: 10,000 m ³ Minimum required area: 0.2 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
East Block North Reservoir	Land acquisition of the site	Total capacity: 20,000 m ³ Minimum required area: 0.3 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
East Block South Reservoir	Land acquisition of the site	Total capacity: 50,000 m ³ Minimum required area: 0.8 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.
West Block South Reservoir (Dala)	Land acquisition of the site	Total capacity: 10,000 m ³ Minimum required area: 0.2 ha	Legal requirements of the YCDC and others. Conditions of land use rights and settlements, etc.

Independent Pumping Stations

Ngamoeyeik Pumping Station	Land acquisition of the site	Target year 2010 Total required area: 0.2 ha	Conditions of natural and land resources dependence of local communities, conditions of land use rights and settlements, etc.
	Temporary installation of access road for construction	About 3 km x 10 m-width of access road is required for construction to reach the site	Reclamation of the site by cutting down the trees. Possibilities of noise and vibration by large-size or heavy-duty vehicles transportation

Other Component of the Project

New Distribution Network	Excavation work	Target year 2010 Total length of 207 km for Distribution Mains and 857 km of Secondary Distribution Pipes	In the houses clustered area, construction work is expected difficultly in consideration of impacts alleviation
Replacement of Deteriorated Pipe	Excavation work	Target year 2010 Total length of 207 km for Distribution Mains and 857 km of Secondary Distribution Pipes	In the houses clustered area, construction work is expected difficultly in consideration of impacts alleviation

This checklist shows that the projects could have major effects on the environment, in principle positively oriented, and several side effects that need consideration for the good integration of environmental requirements in the implementation of the priority project. All the relevant items are reviewed and discussed in Table 10.6.

Table 10.6 indicates that the scope of possible effects considered in the EIA study is quite large. However, there are 2 major global issues for initial evaluation. They are:

- Natural conditions, livelihood and living environment conditions of communities in projects sites
- Land acquisition and resettlement of population

The Table also shows that the conditions of operation and maintenance of facilities are the main factors of environmental sustainability of the projects and determine the nature and importance of the potential effects. Institutional capacity to manage and follow up environmental measures is also an important factor of good integration of environment in the project and Master Plan.

Finally, the awareness heightening of residents for their water consumption behavior and for the good acceptance of sanitation facilities should be given much attention because of its close links with maintenance conditions of facilities, directly through ecological behavior, and indirectly through sanitation policy legitimization.

Table 10.3 Summary of the Initial State of Social Environment in Yangon

Items	State of environment and sensitive issues
Public health	Good health care system is insufficiency. Dramatic incidence levels of water-borne diseases with strongest effects on children in Yangon.
Women, children, young	67% of Yangon population under 25 years old. Primary role of women and children in health, hygiene, sanitation
Poverty	Worsening the effects of exposure to contaminated water. Few pocket areas with temporary but severe exposure to contaminated water: dug-well water and pond water consumers. Unemployment perceived as the first cause of degradation of living conditions and poverty
Cultural patrimony	In the pre-Buddhist religion such as animism, tree worship was widespread among indigenous races of Myanmar. Due to Buddhist teaching, love and respect for natural environment was ingrained in Myanmar culture.
Natural disasters	Chronic incidence of flooding and landslide in rainy season, with degradation and loss of human settlements (houses, fields, roads).

Table 10.4 Summary of the Initial State of Natural Environment in Yangon

Items	State of environment and sensitive issues
Natural habitats	Hlaing river and Hlawga lake are protective natural areas with aquatic habitats and waterfowl. This environmental resource is however strongly degraded by effluents, sanding, and past agricultural development.
Water resources	Surface water sources like river and artificial reservoirs are largely used for intensive farming, cattle breeding and laundry.
Flooding and erosion	Ecological effects of flooding and erosion are sanding of riverbed, degradation of watercourses and riverbanks.
Biodiversity	There is no recent investigation. Natural vegetation: Almost isolated tree species.
River water	No follow-up of river water quality, but JICA survey has shown bacteriologic and organic pollution. All watercourses in Yangon are used as urban drainage.
Groundwater	Very sensitive to surface pollution and strongly contaminated by infiltration of urban wastewater. Groundwater consumed by 54% of population served of all townships. However, most of groundwater user has privately owned facilities.

Table 10.5 Checklist of Possible Effects of Priority Projects

Item of impact	Construction phase	O&M phase
Social environment		
Resettlement of population	B	D
Loss of the resource base (livelihood)	B	B
Degradation of living environment	B	B
Change in life style, behaviour	C	A+
Social conflicts	B	D
Indigenes, minorities, ethnics	C	C
Economic activity, unemployment	B+	C
Social group, women, children	B	A+
Health / sanitation	C	A+
Remains and assets	B	C
Landscape, amenities, aesthetic values	B	B
Water rights	C	C
Disaster	B	C
Natural Environment		
Soil erosion and sanding	C	C
Loss of land / desertification	D	D
Land subsidence	B	B
Groundwater	B	B
Waterside areas	B	A
Fauna and flora	B	C
Pollution		
Waste	B	B
Offensive odour	C	B
Air pollution	D	C
Traffic	B	D
Water quality	B	D
Proliferation of harmful species	C	B
Noise	A	B

A- Possibly important effect expected; B- possible effect expected; C- unknown; D- No effect or no relevance.

“+” , it means that the effects are basically and prominently positive in good management figure;

No indication means that the effects if any are positive or negative or both.

Table 10.6(a) Review and Description of Potential Effects / Social Environment (a)

Items	Rank	Specific issues and observations
Social life		
Resettlement of population	+	Possibility of involuntary resettlement must be considered with the construction of water treatment plants and service reservoirs or installation of distribution pipe on the situation.
Loss of the resource base / livelihood	++	Siting of facilities has strong potential to affect the resource base of local communities. Need to understand land use patterns and land use rights, as well as contribution to household income
Degradation of the living environment	++	Siting and construction of proposed water supply facilities have potential to contribute to the degradation or the disparity of the living environment of local communities.
Change in life style	-	Change will be necessary to increase citizens' responsibility about water conservation. (role of environmental awareness)
Social conflicts	+	Small scale conflicts slightly liable to occur in the scope of land rights if not properly managed when expropriation or acquisition is made for siting of facilities
Indigenes, minorities, ethnics	-	Not known
Change in economic activity, unemployment	-	It increases employment opportunities, for instance, temporary civil and allied works of the construction.
Sensitive social groups, women, children	+	Population of spontaneous settlements, women and children have special sensitivity to the effects of the project
Health		
Outbreak of endemic disease, communicable disease	-	The improvement of water supply system may favour sanitary conditions of controlling for endemic diseases. Moreover, waterborne diseases, such as diarrhoea may be prevented due to accessible safe water.
Cultural patrimony		
Destruction of remains and assets	+	Religious sites (Pagoda, etc.) widely located in every township are concerned by the planned location of water supply facilities, but some designed routes of transmission pipe must be gone across on / in the religious facilities. It should be confirmed during advancement of the study.
Loss of valuable landscape,	+	There are potential landscape effects due to location of facilities, including service reservoir sites and transmission pipeline layout. But the general benefit of

amenities, aesthetic values		the project is obvious for increasing urban amenities.
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++ Primary issues for negative effects, needing special attention; + Secondary issues for negative effects, needing consideration; - Other issues for negative effects, that are not relevant, or unknown, or improbable, or negligible.

Table 10.6(b) Review and Description of Potential Effects / Social Environment (b)

Items	Rank	Specific issues and observations
Soil and groundwater		
Soil erosion and sanding	-	Not known because closely related to local conditions.
Loss of land / desertification	-	Loss of land will be limited to sporadic places for facilities and is not significant.
Land subsidence	+	Pumping up groundwater excessively causes land subsidence phenomena.
Contamination of groundwater	+	With providing proposed water distribution, it will be a potential source of contamination of groundwater because of the effluent increase expected in served area.
Ecological issues		
Degradation of waterside areas	+	Basically related to the siting of Hlaing water treatment plant. Project is not in principal a factor of degradation of the natural vegetation. The possible effects on bird and fish habitats should be considered in the siting of facilities.
Aquatic habitats, fauna and flora species	+	Flora and fauna seem to be degraded in the present natural conditions of the Hlaing River. There are possible time limited effects on water quality that have to be considered, as described below, and which could affect natural aquatic habitats at local level.
Pollution / Nuisances		
Waste	+	Activities for sorting out wastes present potential health risk to workers who are exposed in permanence. Generation of useless waste and rubbish during the construction works is also expected.
Offensive odour	+	Potential source of unpleasant smells is at sludge lagoon in the water treatment plant. Sludge disposal operation should also be considered.
Air pollution	-	It is expected emission gas is generated by construction and transportation vehicles, but there is no harm pollution.
Traffic	+	Transportation of the construction sites is a factor of increased traffic, with all the potential nuisances that can be induced (air pollution, traffic jam, noise, vibration and traffic accidents).
Surface water pollution	+	Water treatment plant will also generate wastewater through the treatment process, which is a factor of water pollution risk in case of critical conditions like failure of operation. Flow rate reduction of the Hlaing river would be conditions increasing pollution load of the river.

		The risk of failure in operation and maintenance increases when technology involves regular supplies (electricity, water) and qualified human resources.
Proliferation of harmful species	+	Increased proliferation of birds, rodents and insects is to be expected in treatment plants (sludge lagoon) and locations for screening of solid waste before intake.
Noise	++	Sensitive issue during engineering works for construction of facilities.

++ Primary issues for negative effects, needing special attention; + Secondary issues for negative effects, needing consideration; - Other issues for negative effects, that are not relevant, or unknown, or improbable, or negligible.

10.2.4 Terms of Reference of EIA

(1) Purpose of the EIA Study

The Master Plan of water supply system in Yangon will permit to achieve better public health performances and to upgrade the quality of the living environment. Citizens of Yangon will be blessed with the direct beneficiaries of this plan. The full achievement of such objectives is, however, related to the favourable selection of sites for water supply facilities, their technical design and their suitable operation and maintenance.

The purpose of the environmental impact assessment study (EIA) is to make sure that sanitation improvement will not result into transferring pollution and nuisances from the urban area to the natural area, or from one community to the other, according to the new conditions of construction / operation of water supply facilities. From the environmental point of view, the project must achieve objectives like the following:

- Social environment: Improvement of living conditions and health; sustainable and fair distribution of the benefits of the project; participation of public and women; creation of durable / productive employment; development of amenity potentials.
- Natural environment: Restoration of natural habitats; preservation of water resources; protection of the natural resources base and livelihood; protection of valuable natural assets.
- Institutional side: Capacity to manage the impacts through measures to be undertaken, and capacity to follow-up environmental conditions during implementation of the project.

The output of the EIA study will be the evaluation of the expected impacts of the Pre-Feasibility Study projects and the definition of an environmental management plan intended to define a frame for taking into account environment and sustainability factors in the project.

(2) Study Areas and Projects

The EIA will be done within the scope of the Pre-Feasibility Study and cover the study area of the Master Plan. The frame of the assessment is then double:

- Priority projects ranked for the Pre-Feasibility Study (short term projects)
- All the projects planned within the Master Plan and considered on a case by case basis for the assessment of impacts (mean and long terms)

The projects defined within the scope of the Master Plan are the following:

- 2 water treatment plants with incidental facilities
- Total 257 km of transmission pipes with various diameters
- 3 gravity supplying service reservoirs
- 8 service reservoirs with pumping station
- Installation of 1 planned pumping station and supplement / replacement of 3 existing pumping stations
- Groundwater development with 3 receiving reservoirs and pumping stations
- New distribution mains & secondary pipes
- Replacement of deteriorated pipe

The projects defined within the scope of the priority projects by 2010 are follows:

- Half scale of proposed Hlaing water treatment plant (467,500 m³/day) with incidental facilities
- Total 153 km of transmission pipes with various diameters
- 3 gravity supplying service reservoirs
- 4 service reservoirs with pumping station
- Installation of 1 planned pumping station and supplement / replacement of 3 existing pumping stations
- Groundwater development and construction of Hlaingthaya receiving reservoir and pumping station
- Total 1,000 km of new distribution network mains & secondary pipes
- Replacement of deteriorated pipe

(3) Scope and Objectives of the EIA

It is assumed that the scope of this EIA is basically determined by the global figure of the Master Plan more than the individual project packages induced by the Master Plan, which will be subject to alternative choices. Then, it is also assumed that future technical studies to design each of the facilities will be accompanied with individual full EIA studies.

It is assumed that within the scope of the Pre-Feasibility Study, environmental assessment will almost be limited to the construction sites of water supply facilities, especially WTP and service reservoir, and some attention given to the possible nuisances generated from WTP and pumping station after operation its facility.

The evaluation of the positive and negative impacts expected from the projects within the scope of the Pre-Feasibility Study constitutes the core of the study. It will be based on a good knowledge of the present conditions in the project areas and the impact sources of planned facilities. Environmental assessment will be based on analysis of each project site with the objective of providing an overview of the impacts at the level of the Master Plan. The proposition of the environment management plan will be the major conclusion of the EIA study.

The EIA investigation report will provide a clear presentation of the expected effects of the projects taken individually and throughout the Master Plan. Special attention will be given to the presentation of environmental impacts as to cover all the following interfaces for full interpretation of results:

- Short / long term impacts
- Direct / indirect impacts
- Individual projects / Master Plan impacts
- Construction phase / operation phase impacts
- Social / natural environmental impacts
- Impacts according to alternatives and according to project deadlines

In addition, effects will be characterised and evaluated as much as possible taking into account their importance and acceptability levels through the following approaches:

- Ranking/levelling of importance
- Acceptability levels (global environment, local regional environment, local communities)
- Effects with / without environmental measures
- Effects within a scenario of operation / management failure of facilities
- Weighting overall negative / positive effects of the Master Plan.

(4) Major Potential Sources of Impacts and Main Issues of Study

The major potential sources of impacts of the projects have been identified in 10.2.2 and are summarised again:

- Failure in the treatment process and lack of maintenance
- Conditions of installation and maintenance of facilities in the on-site treatment area
- Construction works
- Land acquisition
- Others (pollution and nuisances)

Results of the IEE have stressed the need to consider 2 broad issues in the evaluation of the possible environmental negative impacts, within the EIA. The assessment should, however, not be limited to these 2 issues, since screening of effects has identified several isolated issues needing attention, and possibly intertwining with the broader ones. The 2 priority evaluation issues are recalled here:

- Natural conditions, livelihood and living environment conditions of communities in projects sites
- Generation of noise pollution near the urban construction sites

Isolated issues are those that environmental impacts are not known or seem to be more limited than the precedent in their extent, if they do occur. It is, however, possible to find out that some are important on local scale, based on the results of investigations of the EIA. These effects have been given in Table 10.6 (a)/(b) and are summarised here:

- Resettlement of population
- Sensitive social groups (women, children)
- Destruction of remains and assets
- Loss of landscape, amenities, aesthetic values
- Contamination of groundwater
- Degradation of waterside areas, aquatic habitats and fauna & flora species
- Waste, traffic nuisances, offensive odour and surface water pollution

(5) Field Surveys

The environmental assessment will be based on a set of investigations and field surveys, which will be conducted by the local consultant in coordination with JICA study team and YCDC, and based on the Terms of Reference (TOR). TOR is prepared by the JICA study team in coordination with YCDC for finalisation.

1) Ecological Survey

The questions raised by the impact of the project on the Hlaing River environment are:

- Does the proposed water supply system achieve the water quality objectives retained for the project?
- What are the expected benefits in terms of environmental quality, natural resources savings, public health and amenities? The evaluation should be based on the 2010 figures of achieving water supply system

The ecological survey of the Hlaing River will provide data for a better evaluation of the effects of raw water intake and wastewater discharge and for future follow-up of environmental improvement with implementation of the Master Plan. There is no

classification of rivers according to their intended use but fishery and preservation of ecosystems are the basic objectives to be considered.

The survey should focus on the aquatic habitats existing at the location of the planned raw water intake and wastewater discharging outlets. Data will deal with main aquatic species (mainly plants, fish), with description of their ecological characteristics, their quantitative / qualitative importance, and the environmental and resource values.

2) Environmental Surveys

Physical natural conditions of the planned main facilities sites will be surveyed, focusing on surface water and soil conditions. In the case of the other planned facilities, the check of natural conditions will be normally limited to field observation.

3) Social Surveys

The social questions raised by the project sites issue are:

- To which extent does the implementation of facilities impair the livelihood resource base of local communities and their living environment?
- To which extent do these facilities after operation and during construction works induce nuisances to the neighbourhood residents?
- Does the project directly or indirectly fit with the social objectives of current policies (poverty, employment, public health) and how do local communities accept it?
- Are the project sites free of valuable natural and cultural assets or environmentally valuable assets?

As regards to the social aspects, there are several questions that are particularly relevant at the level of the Master Plan itself:

- Does the project improve livelihood and sanitation for all?
- Is there confirmation that population already spoiled by environmental degradation (loss of resources, exposure to health risks) will at least take benefit of the sanitation project?
- Are there communities where benefits of the project will be impaired by other factors (land acquisition, resettlement, operational noise)?

The social surveys of facilities implantation areas will provide all the necessary data for a better understanding of possible effects on the human communities. All the areas with planned location of facilities are concerned with social surveys. The surveys will cover several key tasks that need to be identified after observation of sites on case-by-case basis. Basically, they could include aspects like:

- Land property and land use rights

- Land use patterns (livelihood)
- Settlements and social groups
- Sanitation and health conditions
- Social and economic conditions
- Landscape and amenity values

(6) Analytic studies

Investigations will be based on the analysis of existing data and on field observation, as well as from discussion with experts as possible. These investigations deal with 2 categories of objectives:

- Evaluating the possible importance of expected impacts for specific issues, according to the projects design and management conditions.
- Evaluating the mitigations / measures to be undertaken as regards to all the identified impacts of the project on the environment.

Specific issues are expected:

- Risk and extent of hydrological regime fluctuation of Hlaing River.
- Importance of pollution and nuisances during construction works

(7) Reporting

The full EIA report will include all the chapters required by the draft on Environmental Impact Study Law in Myanmar, based on the environment related chapters included in the Final Report of the JICA study. The relevant chapters distributed in the JICA study will fit with those of the EIA report required by the Myanmar side as shown in Table 10.7 of the following page. All the reports constituting the EIA study will be edited in a special separate volume (6 copies) at the intention of the YCDC and NCEA, without significant modification of contents. This report will be entitled in agreement with the YCDC.

Table 10.7 Distribution and Connection of Chapters in the EIA

Study outline required by Law	Environmental evaluation in the JICA study
Summary of the study	Chapter on EIA in the pre-feasibility report
Introduction with outline of the report	Chapter on EIA in the pre-feasibility report
Description of project	Master Plan area level: Chapter 4 and 5 of this report Individual projects level: Chapter on EIA in the pre-feasibility report
Analysis of the initial state of environment	Master Plan area level: Chapter 10 of this report Individual projects level: Chapter on EIA in the pre-feasibility report
Legal framework of EIA	Chapter 10 of this report
Evaluation of expected positive and negative effects	Chapter 10 of this report for screening impacts Chapter on EIA in the pre-feasibility report for analysis and conclusions
Description of project alternatives	Chapter on EIA in the pre-feasibility report
Identification of measures / Plan of supervision and follow-up of environment	Environmental management plan: Chapter on EIA in the pre-feasibility report
General conclusion	Chapter on EIA in the pre-feasibility report
Appendices	Appendix of the feasibility report: Documentation consisting in: a) Appendices L b) New appendices constituted by the reports of surveys made by the executive consultant within the scope of EIA study.

PART 2
PRE-FEASIBILITY STUDY

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LIST OF ABBREVIATIONS

ACE	Assistant Chief Engineer
AE	Assistant Engineer
CAPEX	Capital Expenditure
CBD	Central Business District
CE	Chief Engineer
CI	Cast Iron
DEO	District Executive Officer (of YCDC)
DHSHD	Department of Human Settlement and Housing Development
DPDC	Divisional Peace and Development Council
DYCE	Deputy Chief Engineer
EE	Executive Engineer
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EO	Executive Officer of township
FIRR	Financial Internal Rate of Return
GA	General Account
GAD	General Administration Department
GDP	Gross Domestic Product
GI	Galvanized Iron (Pipe)
GOJ	Government of Japan
GOM	Government of Myanmar
GW	Groundwater
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
Ks.	Kyats
MC	Municipal Committee
MCM	Million Cubic Meter per Year
MGD	Million Gallon per Day
MS	Mild Steel (Pipe)
MST	Myanmar Standard Time
NCEA	National Commission of Environmental Affairs
NGOs	Non Governmental Organizations
NIHL	National Health Laboratory
NPL	Non Physical Losses
NPV	Net Present Value
NTU	Nephelometric Turbidity Unit
O&M	Operations & Maintenance
OPEX	Operating Expenditure
P/S	Pumping Station

PDC	Peace and Development Council
PL	Physical Losses
PLC	Passive Leakage Control
PVC	Unplasticized Polyvynyl Chloride (Pipe)
RC	Reinforced Concrete (Pipe)
RCDC	Rangoon City Development Committee
RMC	Rangoon Municipal Corporation
SAE	Sub Assistant Engineer
SLORC	State Law and Order Restoration Council
SP	Steel Pipe
SPDC	State Peace and Development Council
SW	Surface Water
TCU	True Colour Unit
T/S	Township
TE	Township Engineer for Water Supply & Sanitation
TPDC	Township Peace and Development Council
UFW	Unaccounted for Water
US \$	United States Dollar
WA	Works Authority
WHO	World Health Organization
WIS	Water into Supply
WSS	Water Supply & Sanitation (Engineering) Department
WTP	Water Treatment Plant
YCDC	Yangon City Development Committee
YMC	Yangon Municipal Corporation
$\mu S/cm$	Micro Siemens per Centi Meter

Note) Abbreviations are listed in alphabetical order.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 FUNDAMENTALS

A part of work components (Phase-1) proposed in the Master Plan was selected as “priority project”. The object of this feasibility study is the priority project. Fundamentals for the planning of the priority project are as follows:

1.1.1 Target Year

The target year for the feasibility study was set at 2010, which is the intermediate year to the year 2020, the target year of the Master Plan.

1.1.2 Water Demand

Table 1.1 shows the projected service population, service ratio and water demand up to the target year. Target service ratio was set by 60 % in daily maximum base. At the time of daily maximum consumption, water shortage will occur but its degree will be negligible. People can obtain water even in these days for long hours.

Table 1.1 Water Demand

Items	Year	2010
Total Population	Persons	4,955,000
Service Ratio	%	60
Served Population	Persons	2,973,000
Daily Average Use	m ³ /day	733,012
Leakage (Ratio)	%	40
(Amount)	m ³ /day	488,675
Daily Average Demand	m ³ /day	1,221,687
Daily Maximum Demand	m ³ /day	1,466,024

1.1.3 Planned Water Supply Amount

Table 1.2 shows the planned water supply amount generated by the existing and proposed facilities. Total water supply amount is 1,449,900 m³/day corresponding to 99% of water demand in 2010.

Table 1.2 Planned Water Supply Amount

Items	Year	2010
Reservoirs		
Gyobyu	m ³ /day	118,200
Phugyi	m ³ /day	245,400
Hlawga	m ³ /day	75,000
Ngamoeyeik	m ³ /day	409,000
Groundwater	m ³ /day	132,300
Hlawga WTP	m ³ /day	470,000
Total of Available Water	m ³ /day	1,449,900

1.2 PROPOSED FACILITIES

The facilities proposed as the subjects of to be reviewed in the Feasibility Study are as follows;

(1) Raw Water Transmission Facilities

- 1) Raw water transmission pipeline conveying water from Ngamoeycik Reservoir to Hlawga Reservoir

Diameter 1,800 mm x 30.75 km, Diameter 1,100 mm x 13.28 km (Dual pipe with the existing pipeline)

- 2) Pumping Station

Design Capacity = 409,050 m³/day = 90 MGD

(2) Water Treatment Plant

Hlaing Water Treatment Plant with capacity of 470,000 m³/day

(3) Clear Water Transmission Facilities

As stated in Master Plan Study, the whole service area was divided into 3 Distribution Blocks and 11 Distribution Zones shown as follows;

Table 1.3 Service Reservoir by Distribution Block

Distribution Block	Zone	Service Reservoir included
Central Block (CB)	Zone 1	Kokine, Shwedagon and Central Service Reservoir
	Zone 2	CB Downtown East Service Reservoir
	Zone 3	CB West Service Reservoir
	Zone 4	CB Hlawga Service Reservoir
	Zone 5	CB North Service Reservoir (Phase-2)
East Block (EB)	Zone 6	EB South Service Reservoir
	Zone 7	EB Central Service Reservoir (Phase-2)
	Zone 8	EB North Service Reservoir (Phase-2)
West Block (WB)	Zone 9	WB South Service Reservoir (Phase-2)
	Zone 10	WB Central Service Reservoir (Phase-2)
	Zone 11	WB North Service Reservoir

Note) (Phase-2) : will be implemented in Phase-2 works

In Phase-1 work, the following clear water transmission facilities will be implemented.

Table 1.4 Proposed Clear Water Transmission Facilities

From	To	Pump/Gravity	Pipeline Dia. and Length
Hlaing WTP	Terminal Reservoir	Pump	Dia. 2,000 mm x 33.3 km
Terminal Reservoir	Kokine SR	Pump	Connect to the existing pipe
Terminal Reservoir	CB West SR	Pump	Dia. 2,700 mm x 7.5 km
Terminal Reservoir	CB Hlawga SR	Pump	Dia. 2,200 mm x 3.9 km
CB West SR	CB DT East SR	Gravity	Dia. 1,800 mm x 12.2 km
CB DT East SR	EB South SR	Gravity	Dia. 1,200 mm x 7.6 km

Note) SR = Service Reservoir

(4) Service Reservoirs

The following service reservoirs will be constructed in Phase-1.

Table 1.5 Proposed Service Reservoirs

Name of Service Reservoir	Necessary Capacity in 2010	Distribution Method
Terminal Reservoir	60,000 m ³	Pump
CB West SR	50,000 m ³	Gravity
CB Hlawga SR	50,000 m ³	Gravity
CB DT East SR	50,000 m ³	Pump
EB South SR	25,000 m ³	Pump
WB North SP	30,000 m ³	Pump

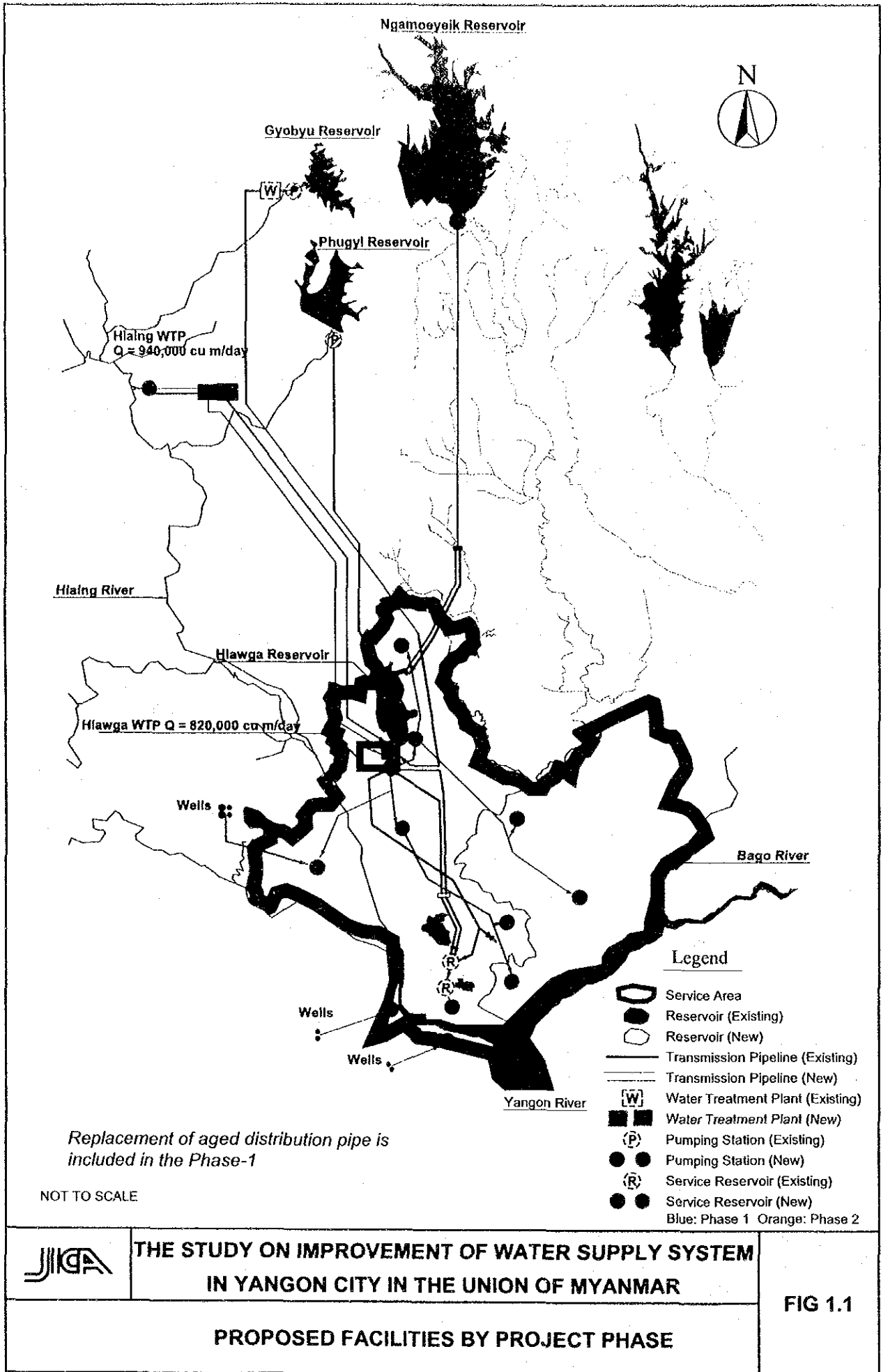
(5) Distribution Pipelines

- 1) Rehabilitation of Aged Pipelines (Dia. 75 to 450 mm) L = 348,900 m
- 2) Installation of New Pipeline
 - a) Primary Mains (Dia. 300 mm to 1,500 mm) L = 87,600 m
 - b) Secondary Mains (Dia. 75 mm to 250 mm) L = 291,700 m

(6) Groundwater Development

- 1) Rehabilitation of pipeline network wells and independent wells
- 2) Well construction in Hlaingthaya System

Figure 1.1 indicates the location of these major water supply facilities.



CHAPTER 2

DESIGN OF FACILITIES

CHAPTER 2 DESIGN OF FACILITIES

Improvement of the existing water supply facilities shall be examined from viewpoint of 1) Water Amount and 2) Water Quality. These issues will be mitigated through the following Phase-1 works;

- Water Amount : Construction of Ngamoeyeik Reservoir Transmission Pipeline,
Service Reservoirs and Transmission/Distribution Pipelines
- Water Quality : Construction of Hlaing Water Treatment Plant

The details of the water supply facilities proposed in Phase-1 will be described in this chapter. Facilities were classified into several categories according to their functions.

2.1 INTAKE FACILITIES

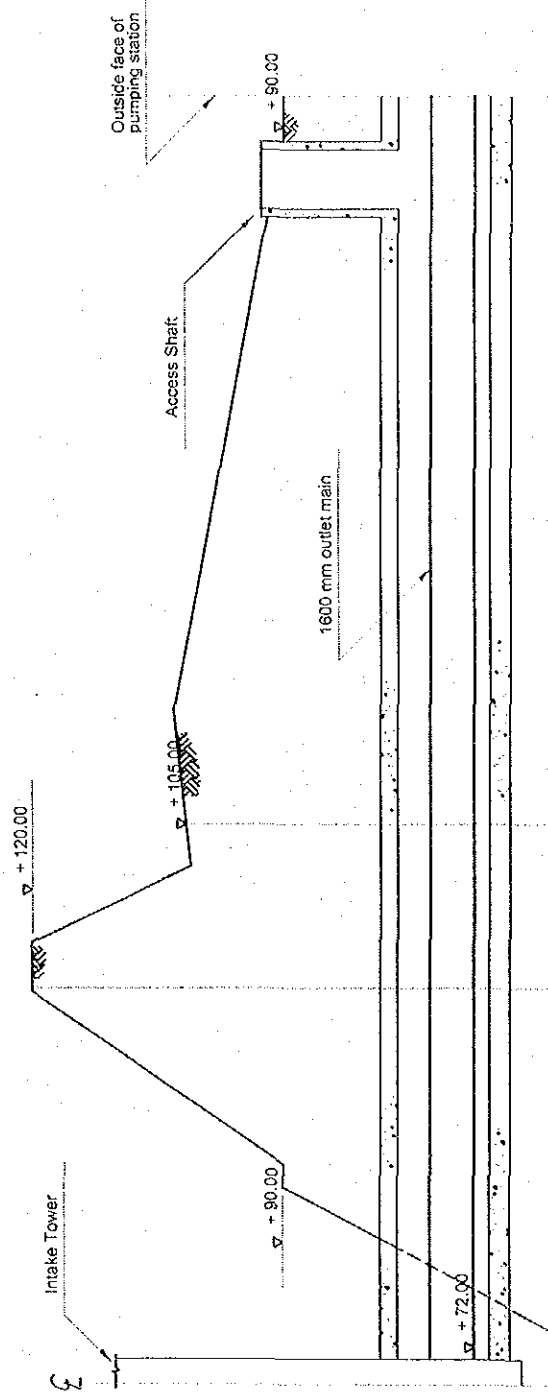
Intake facilities were also divided into several groups by their water sources.

As to Ngamoeyeik reservoir, the existing intake tower will be utilized for exclusively water supply use and river intake gate will be constructed for the proposed Hlaing Water Treatment Plant.

Further, groundwater intake facility, the tube wells, will be improved. The existing tube wells in left bank of Hlaing River will be rehabilitated and new tube wells will be constructed in the left bank of Hlaing River, namely in Hlaingthaya T/S.

2.1.1 Reservoir Water Intake Facilities

Ngamoeyeik Reservoir was included in the scope of work in Phase-1. There are two existing intake towers in the reservoir one is for irrigation use and another is for water supply use. Intake tower for water supply use was completed in 1995 and outlet main with diameter of 1,600 mm was also implemented up to the culvert access shaft. Proposed pumping station to convey reservoir water to Hlawga reservoir will be constructed next to this culvert access shaft. Figure 2.1 and 2.2 shows the outline of these facilities.



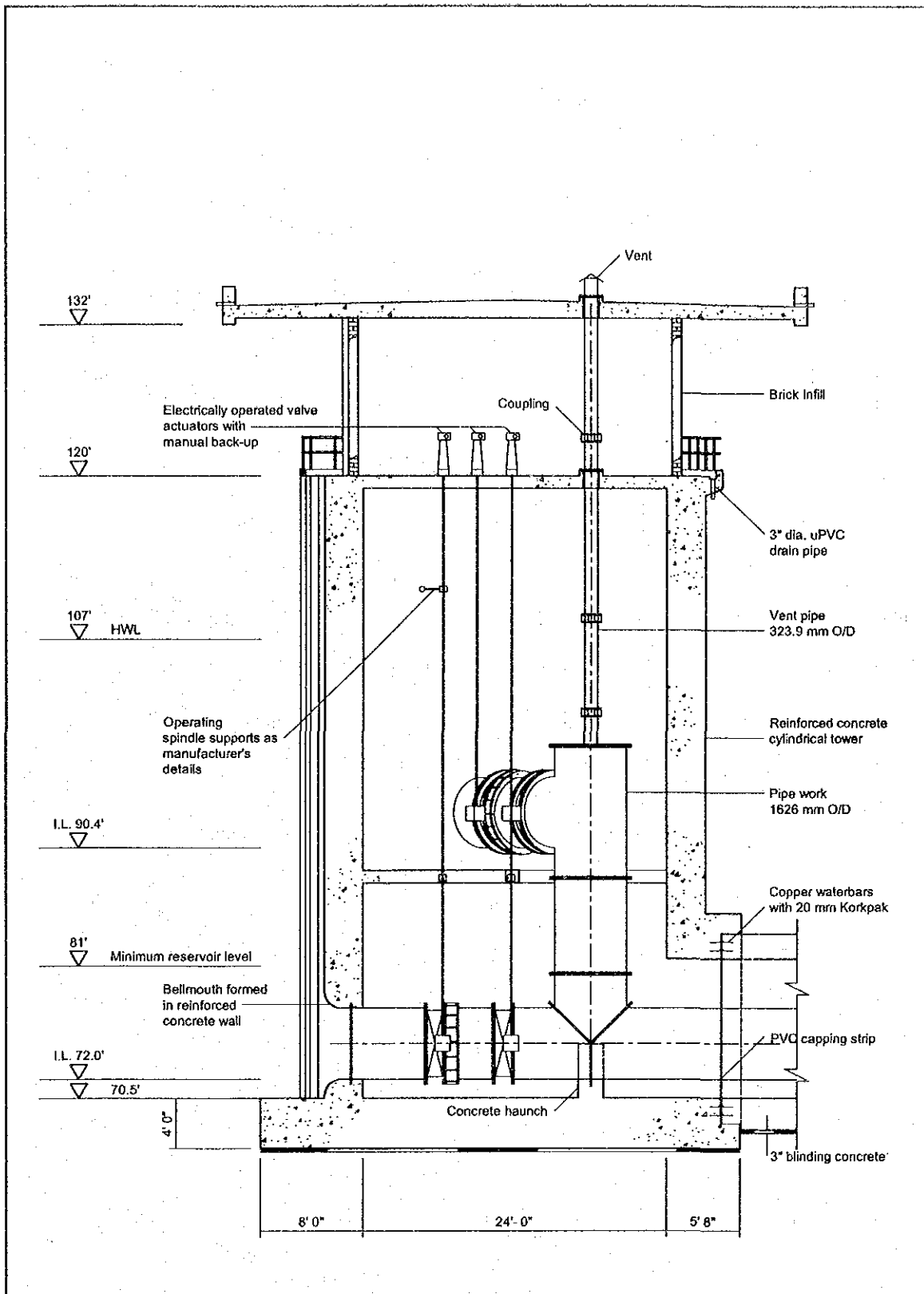
Original GL	90.77	120.00	105.00	72.00
Design GL		120.00	105.00	90.00
Invert Level of Main				




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Section of Ngamoeyeik Reservoir Intake Outlet Main

FIG 2.1



	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 2.2
Section of Ngamoeyek Water Intake Tower		

2.1.2 River Water Intake Facilities

River water intake facility for Hlaing WTP was selected to be included in the scope of work in Phase-1. For selection of construction site, the following conditions were taken into account;

- No effect of saline water
- Less sand/soil sedimentation and bank erosion

Based on the saline water intrusion survey composed of EC value measurement and interview to the villagers living nearby and field survey on topographic status of Hlaing River, Gwedanshe was selected as site for intake facility. Figure 2.3 shows the location.

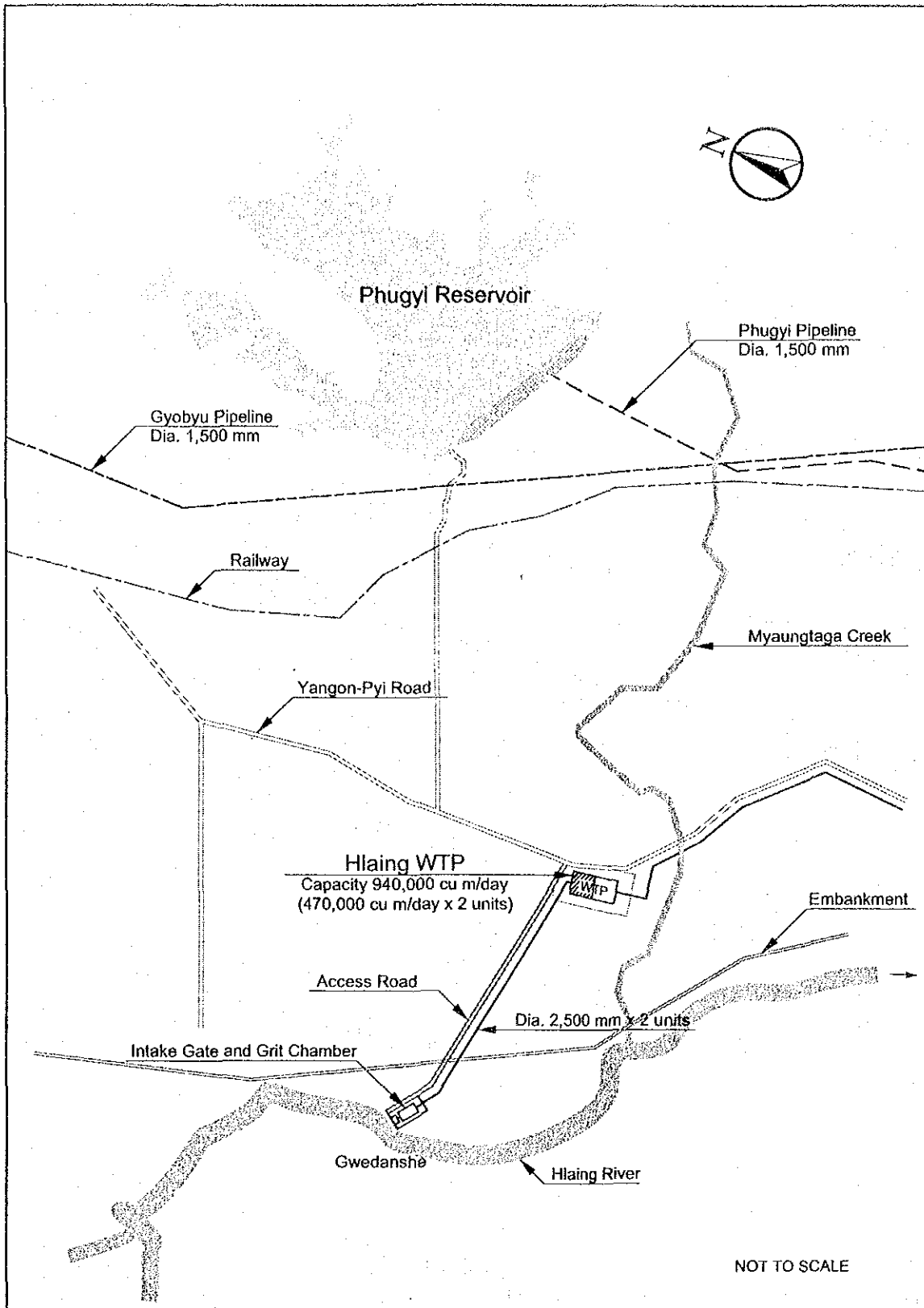
Type of intake facility was examined in the following table based on the following criteria;

- Construction condition
- Possible intake water amount
- Necessary O&M activities
- Construction cost

Table 2.1 Comparison of Intake Facilities

Items	Intake Weir	Intake Tower	Intake Gate
Construction Condition	<ul style="list-style-type: none"> • Weir must be installed in straight portion of river bank and its length shall be two times of river width. • It is not applicable where boat is used as transportation method. 	<ul style="list-style-type: none"> • Not applicable where water depth in draught season is less than 2 m. • Tower must be settled in the flow center of river. 	<ul style="list-style-type: none"> • River bed must be stable.
Intake Condition	<ul style="list-style-type: none"> • Water intake amount is stable since intake water level is secured by weir. • Saline water intrusion can be prevented. 	<ul style="list-style-type: none"> • Intake water amount is affected by river flow fluctuation. • Intake is not available in case of saline water intrusion. 	<ul style="list-style-type: none"> • Intake water amount is affected by river flow fluctuation. • Intake is not available in case of saline water intrusion.
Operation and Maintenance	<ul style="list-style-type: none"> • Sand discharge device shall be installed and be properly operated to prevent sand sedimentation at intake mouth. 	<ul style="list-style-type: none"> • Sand inflow must be accounted but it can be controlled by gate operation. 	<ul style="list-style-type: none"> • Sand inflow must be taken into account.
Construction Cost	<ul style="list-style-type: none"> • Cost is large since large scaled work is required 	<ul style="list-style-type: none"> • Large but less than Intake Weir. 	<ul style="list-style-type: none"> • Generally economical.
Evaluation	×	△	○

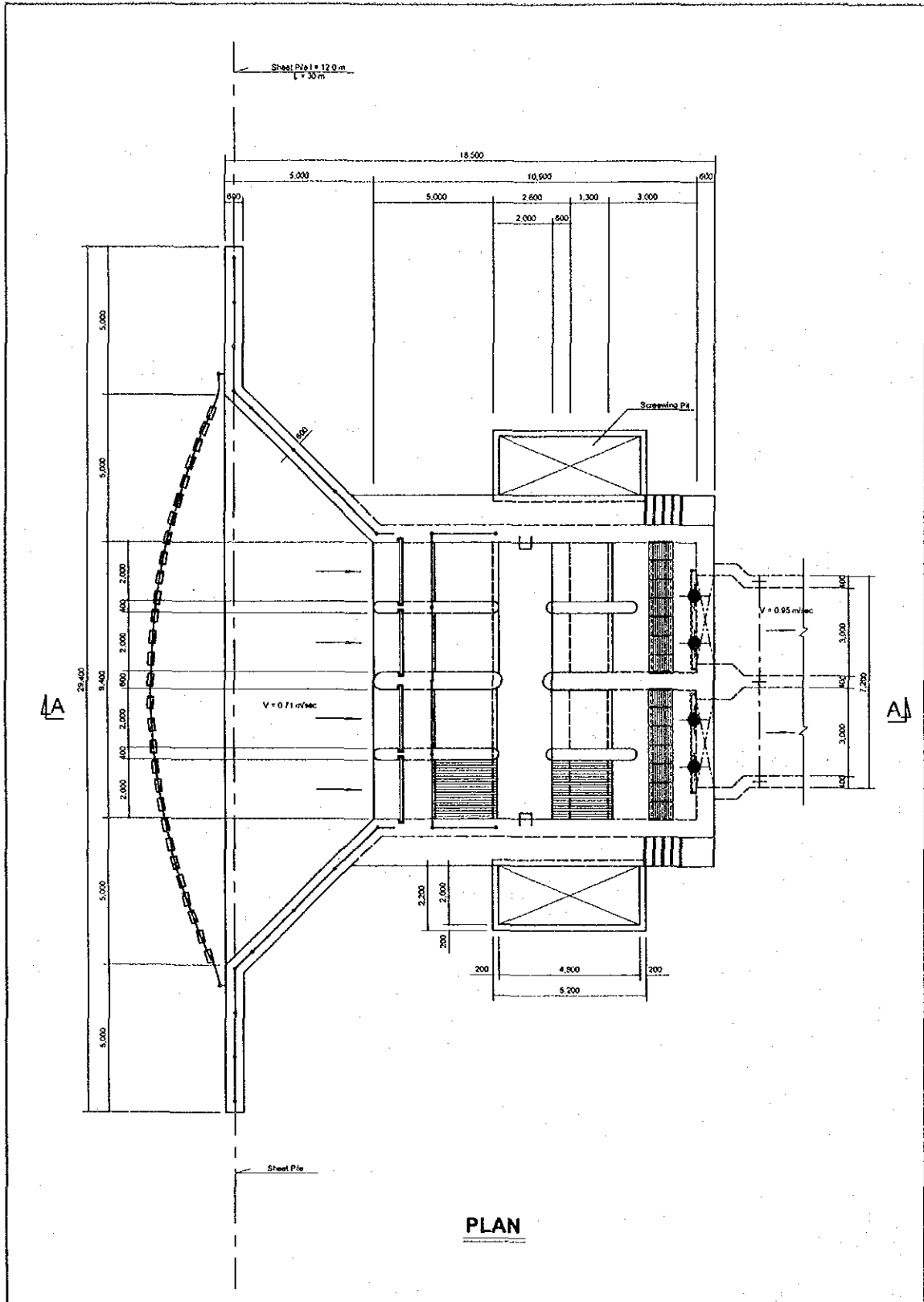
Legend : ○ = Good, △ = Fair, × = Poor



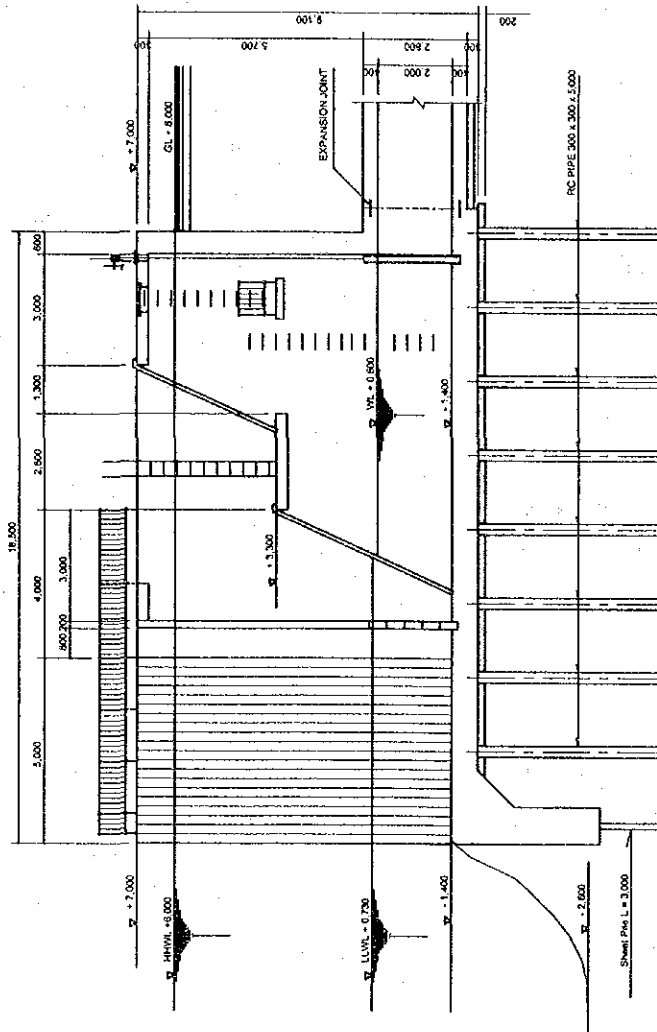
**THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM
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FIG 2.3

Location of Hlaing River Water Intake Facility and Water Treatment Plant



	<p>THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR</p>	<p>FIG 2.4</p>
<p>Plan of Hlaing River Intake Gate (1/2)</p>		



A - A SECTION



**THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM
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Section of Hlaing River Gate (2/2)

FIG 2.4

As presented in Table 2.1, the Intake Gate type was selected as the optimum type of intake facility.

Figure 2.4 shows the plan and section of proposed intake gate.

To mitigate sand intrusion, design intake velocity at the intake gate was set at lower than 0.8 m/sec for planned intake amount of 982,000 m³/day. River water will be sent to the grit chamber by gravity through transmission box culvert (3,000 x 3,000 mm x 2 culverts) with flow velocity at nearly 1.0 m/sec to prevent sand sedimentation in the culverts.

2.1.3 Groundwater Intake Facilities

In total, there are 217 units of existing tube wells belonging to YCDC. Although 207 units are located in the left bank of Hlaing River but 3 units are used as hydrant. Therefore, 204 units are operated as production wells. The remaining 10 units are situated in the T/Ss in the right bank of Hlaing River. To simplify, water supply system comprised of wells in the left bank of the river is called as "Main System", while system composed of wells in the right bank is called as "Satellite System" hereinafter.

In Phase-1, wells in the Main System will be rehabilitated and water supply network including new wells will be constructed in Hlaingthaya T/S, belonging to the Satellite System.

(1) Main System

There are 204 YCDC owned tube wells on the left bank of Hlaing River. These wells were divided into two groups, namely;

- Pipeline Network Wells (104 wells): Wells connected to the existing network
- Independent Wells (100 wells): Wells having their own independent pipelines

1) Pipeline Network Wells

Out of 104 existing wells, 75 wells were selected as "Regular Wells" to be operated through the future. The remaining 29 wells will be abandoned. Evaluation items for grouping of tube wells are existence of problems in terms of water quality as "safety", well structure as "sustainability" and yield as "cost effectiveness". Following criteria were assumed for each parameter.

- (a) Water Quality: low Cl ion < 200mg/l and low Fe concentration < 1.0mg/l
- (b) Structure: tube well diameter > 100A (4") for pump replacement
- (c) Yield: discharge > 300l/min. (annual discharge > 0.1MCM/Y)

The following rehabilitation work will be implemented on regular wells;

- Procurement of submersible pump (20 units) for replacement of deteriorated pumps
- Replacement of Air-lift Pump by Submersible Pump (they can be replaced by adequate submersible pump installed in wells to be abandoned or can be replaced by new one.)

- Replacement of inadequate low water head submersible pump (Since 15 m was adopted as design water head of distribution pipe network, pumps to be used through the future must have a head larger than 15 m.)
- Installation of direct connection pipe to the distribution pipe network
- Installation of well cap and concrete basement

In preparation of pump replacement plan, the following conditions were taken into account;

- ✓ Pumps within the same T/S shall be utilized (replace deteriorated pumps by available existing pumps in the same T/S)
- ✓ If there are several available pumps, pump with less motor output shall be selected to save operational expense.

Table 2.2 indicates the pump replacement plan.

Table 2.2 Well Replacement Plan

	Submergible pumps to be replaced			Transferred from	
	Well No.	T/S	Evaluation	Well No.	T/S
Pipeline Network Wells	79	Kamayut	Head<15m	85	Kamayut
	99	Kyauktada	No pump	11	Botataung
	100	Kyauktada	No pump	14	Botataung
	110	Kyeemyindaing	AL pump	114	Lanmadaw
	111	Kyeemyindaing	No pump	124	Mingalartaungnyunt
	128	North Okkalapa	AL pump	86	Kamayut
	167	Sanchaung	No pump	205	Thingangyun
	180	South Okkalapa	AL pump	209	Thingangyun
	182	South Okkalapa	AL pump	212	Thingangyun
	183	South Okkalapa	AL pump	214	Thingangyun
ID Wells	208	Thingangyun	No pump	215	Thingangyun
	24	Dagon	No pump	18	Dagon
	61	Dawbon	AL pump	190	Thaketa
	181	South Okkalapa	AL pump	216	Thingangyun

Note) ID Wells: Independent wells

Excluding “procurement of submergible pumps”, other works will be implemented by T/S-wise upon introduction of surface water with a target completion year of 2010.

2) Independent Wells

Out of 100 existing wells, 10 wells were selected as “Regular Wells” which will be utilized as stand by source in case of emergency, and the remaining 90 wells will be abandoned. Same to the pipeline network wells, the following rehabilitation work will be implemented for stand by wells;

- Replacement of air-lift pump by submergible pump
- Replacement of inadequate low water head submersible pump
- Installation of direct connection pipe to the distribution pipe
- Installation of well cap and concrete basement

Pump replacement plan is also shown in Table 2.2, and detailed data on the existing submersible pumps are shown in Appendix P.

(2) Hlaingthaya System

1) Outline of Hlaingthaya System

New well construction work will be carried out in Hlaingthaya T/S during Phase-1 period. Figure 2.5 shows the location of wells and in phase-1, 59 wells will be drilled. As shown in Figure 2.5 and 2.6, five or six wells are forming "well group" and each group has one intake reservoir and one stand by pump. Groundwater pumped by submergible pumps will be poured into intake reservoir and then pumped to proposed West Block North Service Reservoir. The followings are the outline of the system;

Table 2.3 Outline of Hlaingthaya System

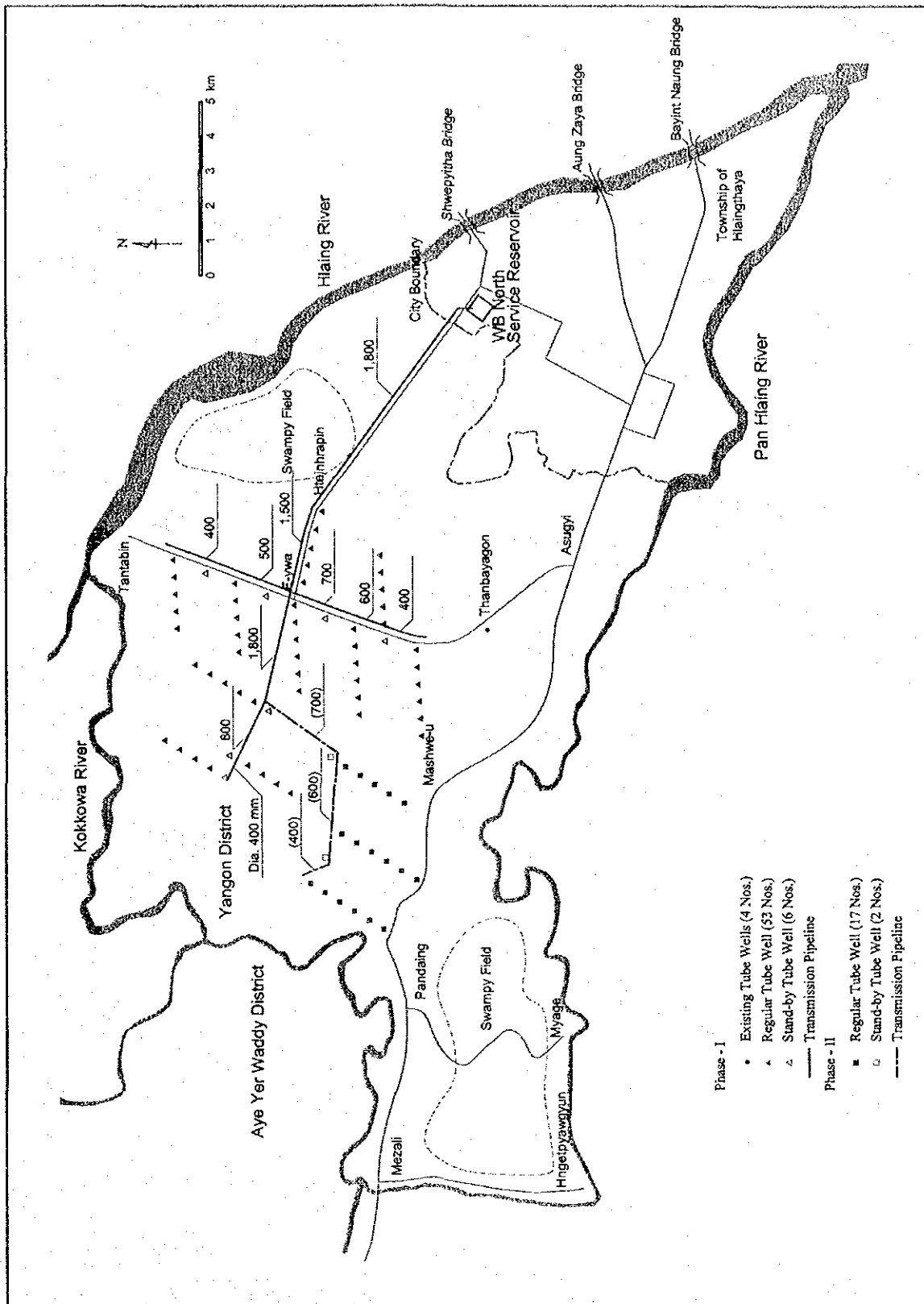
Tube Well	59 units (53 units = Regular, 6 units = Stand by) 10 well groups	
Intake Reservoir	10 units (W 10 m x L 13.5 m x D 3.5 m) Supply Pump: 30 units (20 units = Regular, 10 units = Stand by) 4.5 m ³ /min x 20 m x 22 kW	
Transmission Pipeline	Dia. 400 mm x 3,400 m Dia. 500 mm x 1,700m Dia. 600 mm x 850 m Dia. 700 mm x 1,700 m Dia. 800 mm x 1,700 m Dia. 1,200 mm x 3,300 m Dia. 1,500 mm x 2,950 m Dia. 1,800 mm x 7,130 m	

2) Disinfection System

There are two alternatives in groundwater disinfection scheme. One is 1) individual disinfection at intake reservoir by well group, and the other is 2) integrated disinfection at service reservoir. Outline of these two alternative schemes are shown in Figure 2.7. O&M issues of two alternatives were examined as follows;

Table 2.4 Comparison of Disinfection System

	Individual disinfection system	Integrated disinfection system
O&M issues	<ul style="list-style-type: none"> Chlorinator must be installed at every intake reservoir and they must be properly operated and maintained. More O&M cost and complicated activity is needed 	<ul style="list-style-type: none"> Only one chlorinator is installed at WB North service reservoir. Less O&M cost and manpower is needed.
Evaluation	Not Applicable	Suitable



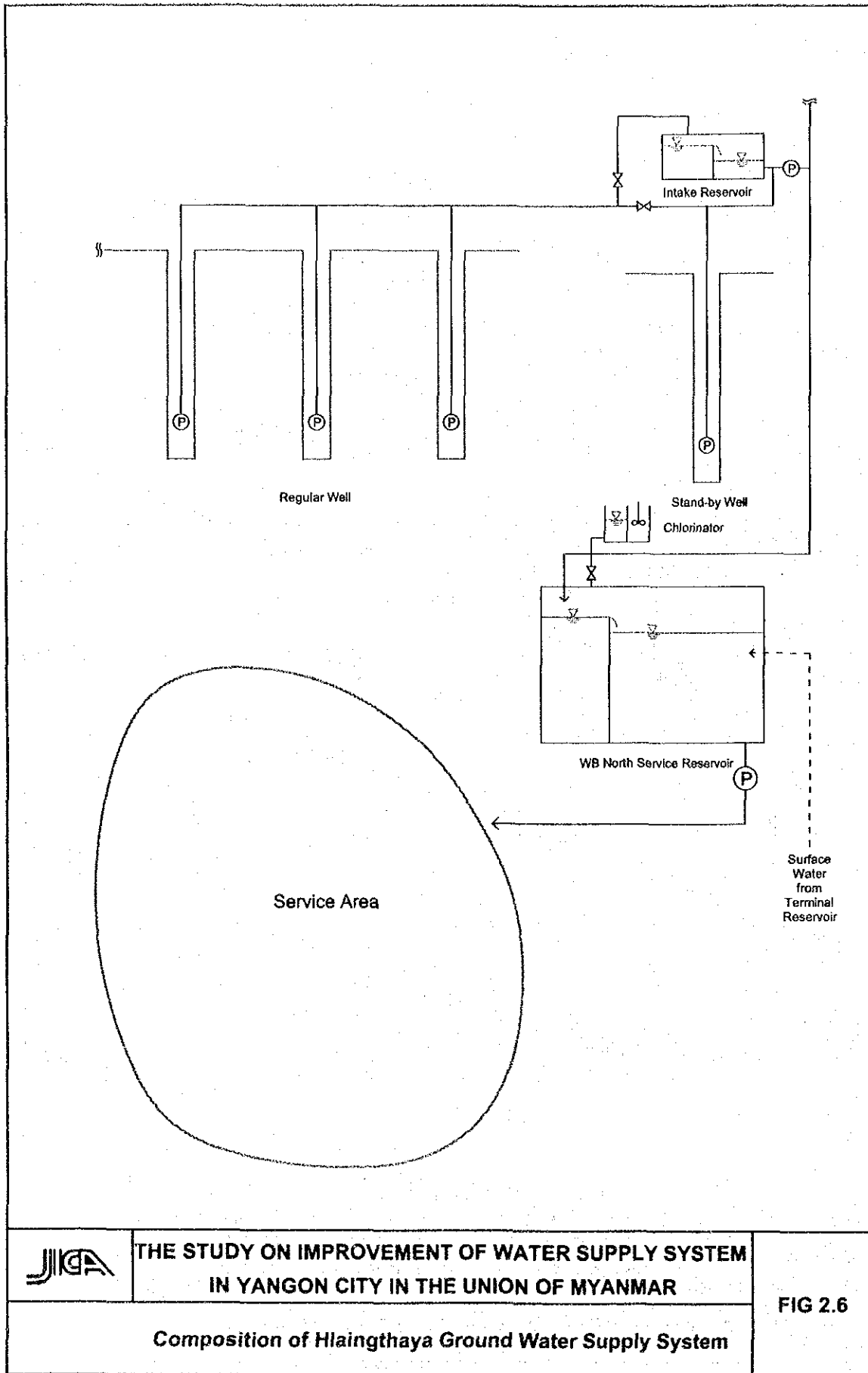
- Phase - I**
- Existing Tube Wells (4 Nos.)
 - ▲ Regular Tube Well (53 Nos.)
 - △ Stand-by Tube Well (6 Nos.)
 - Transmission Pipeline
- Phase - II**
- Regular Tube Well (17 Nos.)
 - Stand-by Tube Well (2 Nos.)
 - Transmission Pipeline



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FIG 2.5

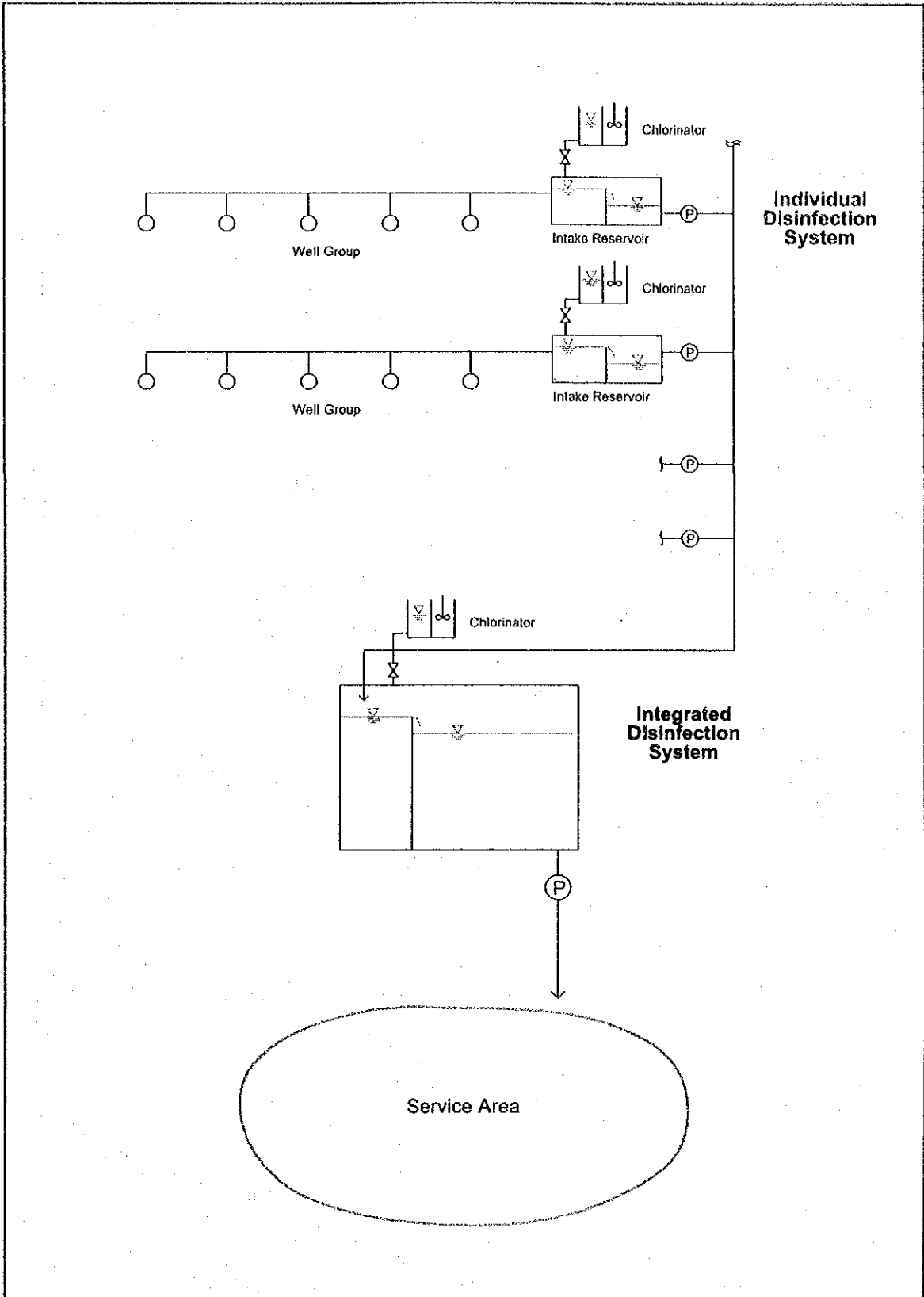
Plan of Hlaingthaya Ground Water Supply System




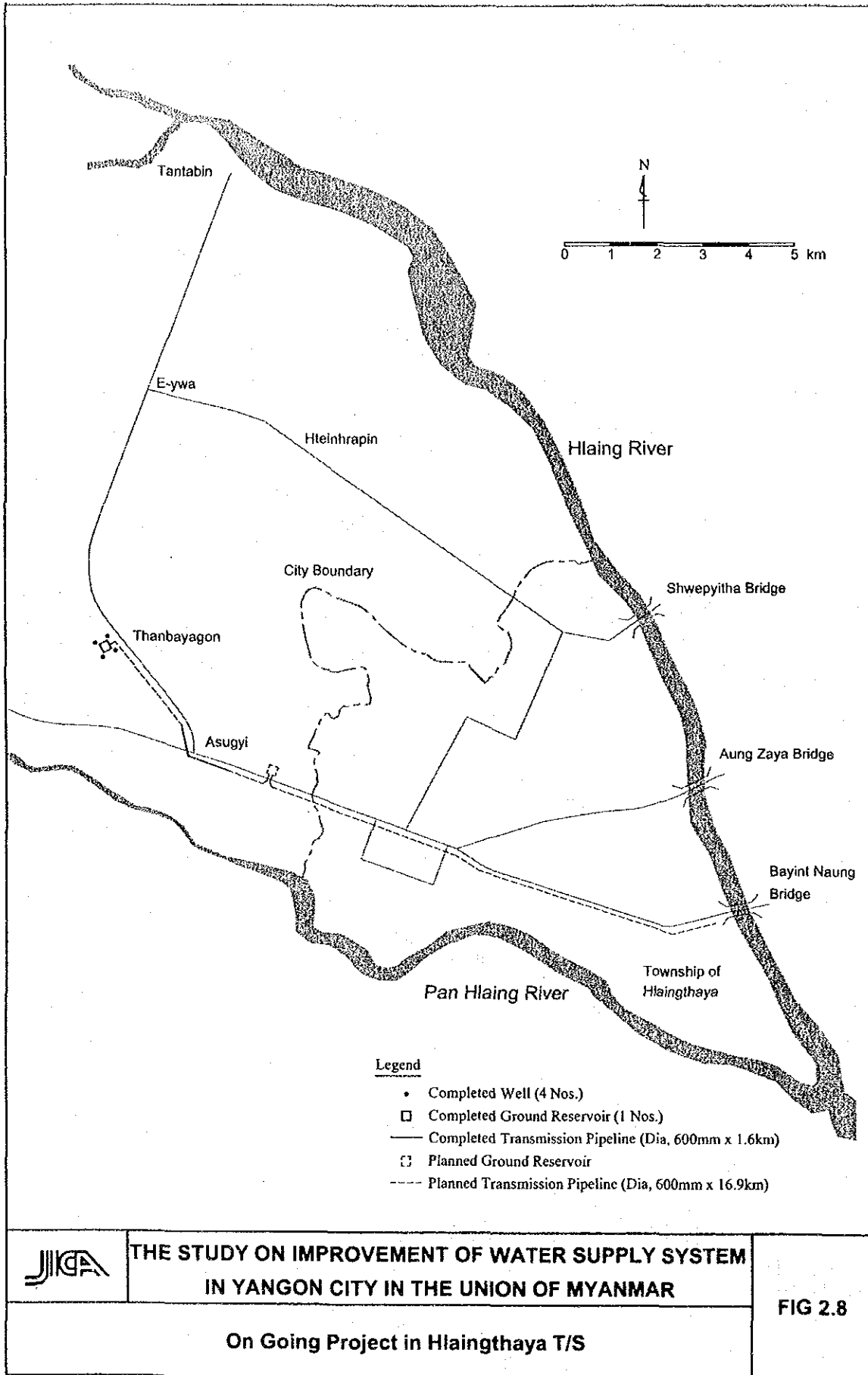
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FIG 2.6

Composition of Hlaingthaya Ground Water Supply System



	<p align="center">THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR</p>	<p align="center">FIG 2.7</p>
<p align="center">Disinfection Alternatives</p>		



It was judged that the integrated disinfection system is suitable for the Satellite Systems, not only for Hlaingthaya System but also for Seikkyi Kanaungto + Kyeemyindaing and Dala System which will be implemented in Phase-2.

3) Relation with on-going project

There are four existing wells in Thanbayagon located in North West outside of T/S boundary. These wells were drilled by YCDC to serve the densely populated area located in south east of the T/S. However, due to the budgetary constraints, construction work was suspended in halfway. As shown in Figure 2.8, completed facilities are four wells, one reservoir with capacity of 455 m³ and 1.6 km of transmission pipeline with diameter of 600 mm out of proposed total length of 18.5 km.

Since no concrete work plan has been prepared by YCDC so far, the well construction plan for Hlaingthaya T/S was formulated disregarding this on-going project.

2.2 RAW WATER TRANSMISSION FACILITIES

2.2.1 Gyobyu Pumping Station

There are three units of transmission pumps in Gyobyu Pumping Station. At present, reservoir water is mainly sent by gravity. Pumps are seldom operated. Pumps have been operated only when reservoir water level was lower than gravity supply level. Pumps were manufactured in 1962 and are already deteriorated.

Based on the hydrological examination, possible intake amount from Gyobyu reservoir was calculated as 26.0 MGD, which is larger than the present amount of 20.5 MGD. To cope with this intake amount and to secure stable raw water transmission to the City Center and to the proposed Terminal Reservoir, existing three pumps and electric panels shall be replaced. Pump specification is as follows;

3,310 m³/hr x 184 kW x 13.7 m x 3 units (1 unit stand by)

2.2.2 Phugyi Pumping Station

According to the hydrological examination, possible intake amount from Phugyi reservoir was calculated as 54.0 MGD, which is larger than the present amount of 50.0 MGD. To cope with this amount and to secure stable raw water transmission to Hlawga reservoir, one additional pump shall be installed. Specification of an additional pump must be equivalent to the existing ones;

5,160 m³/hr x 450 kW x 24 m x 3 units (Existing)

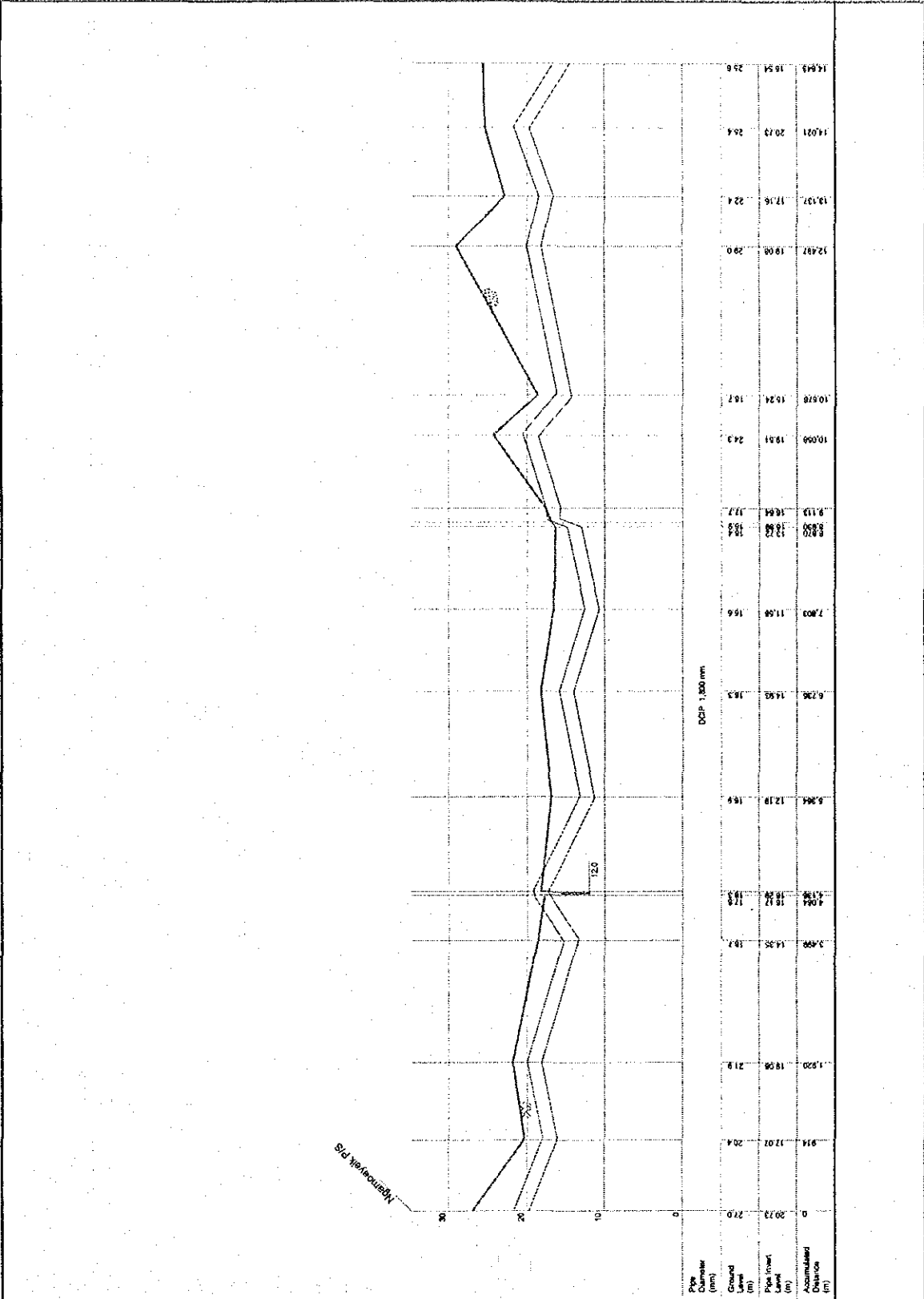
Adding one more pump, total pump number will be four, including one unit of stand by;


5,160 m³/hr x 450 kW x 24 m x 4 units (1 unit stand by)

2.2.3 Ngamoeyeik Pumping Station

To convey Ngamoeyeik reservoir water to Hlawga reservoir, pumping station shall be constructed at the downstream of the existing culvert access shaft. The following is the outline of Ngamoeyeik P/S:

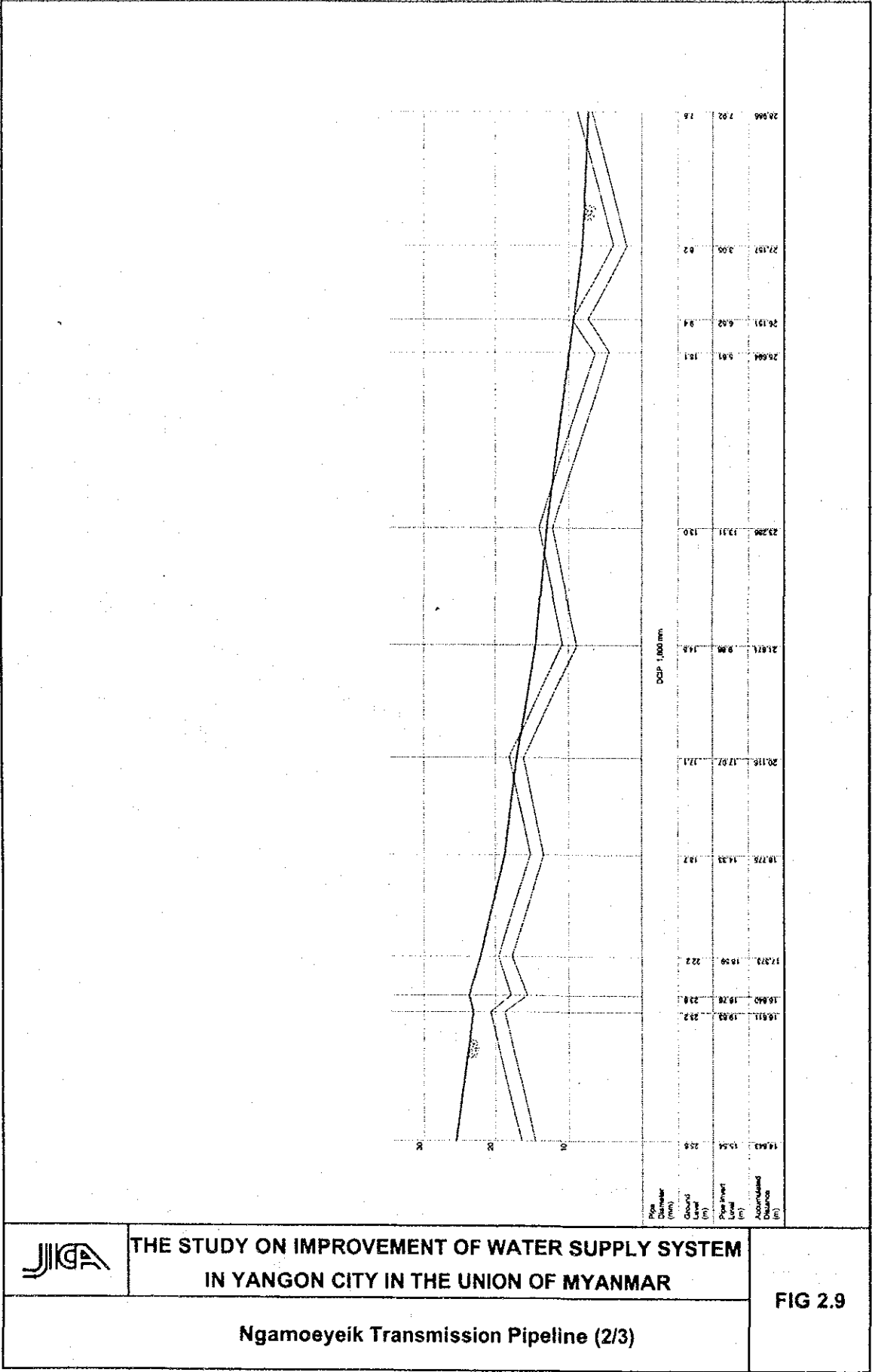
Pump House	: RC made, 1 story
Pump Specification	: 71.0 m ³ /min x 1,200 kW x 78 m x 5 units (1 unit stand by)




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Ngamoeyek Transmission Pipeline (1/3)

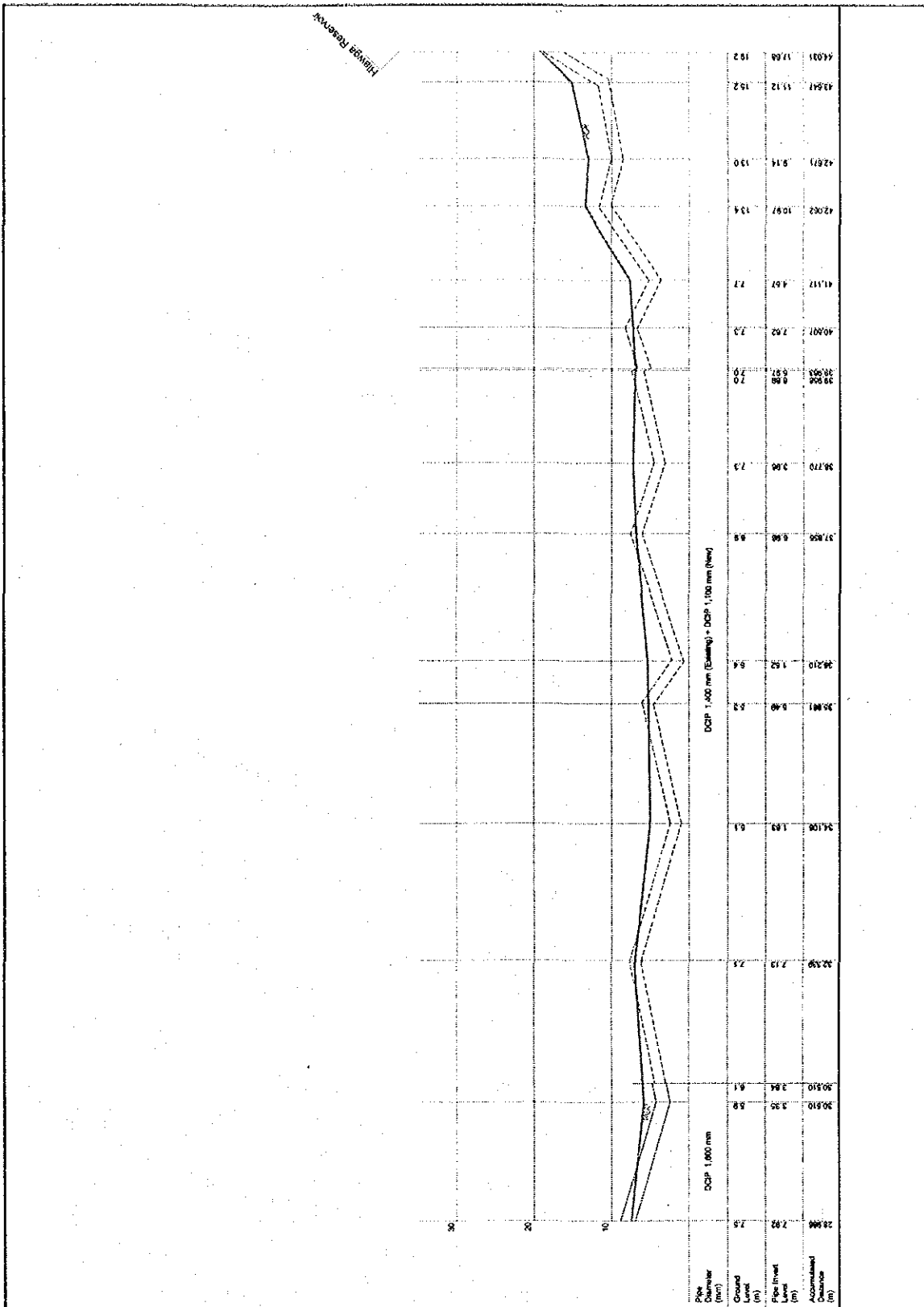
FIG 2.9



**THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM
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Ngamoeyeik Transmission Pipeline (2/3)

FIG 2.9



JICA THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR

Ngamoeyeik Transmission Pipeline (3/3)

FIG 2.9