CHAPTER 3

3 WATER SUPPLY ENHANCEMENT IN KOTIKAWATTE AND MULLERIYAWA AREA

3.1 SCOPE OF JBIC LOAN

Scope of JBIC loan for this project component was decided based on World Bank Report 1994 and the scope of work agreed for the purpose of estimating the project cost is as follows:

- "Reservoir (capacity: 2,000 m3), Water tower, and Distribution line (length: 4,710 m, diameter 75 mm –150 mm), Transmission line (length: 2,400 m, diameter 500 mm), etc."

The scope of work was clarified during the visit of the JICA S/W mission in that NWSDB explained that the present water supply enhancement plan had been based on the World Bank Report, and that the review of the plan should be conducted to conform best alternative plan.

3.2 REVIEW OF WATER SUPPLY ENHANCEMENT PLAN

3.2.1 Previous Proposals and Related Plans

(1) World Bank Proposal

In 1993, World Bank Report proposed improvements mainly utilising the existing Gothatuwa Tower to supply part of Gothatuwa Town and to tap Ambatale- Jubilee transmission main to a ground reservoir, a pumping station and a tower at Mulleriyawa Hospital to supply Mulleriyawa area in two phases (Figure 3-1, Figure 3-2 and Figure 3-3).

These were not implemented except for distribution reinforcements in 1995 and ad-hoc distribution extensions.

This World Bank proposal formed the basis for the JBIC loan's scope of work.

(2) NWSDB Proposal

In 1999, NWSDB prepared a revised proposal to directly pump water from Ambatale WTP to Mulleriyawa to supply Mulleriyawa area while utilising Gothatuwa Tower to supply part of Gothatuwa Town (Figure 3-4). NWSDB conducted a street-wise survey to forecast water demand.

(3) NWSDB Proposal for New Kolonnawa Reservoir

NWSDB indicated the study team that it is planning to construct a new ground reservoir at Kolonnawa with its own funds to supply mainly CMC. NWSDB requested to consider pumping to the Kotikawatte-Mulleriyawa area and to the proposed Kolonnawa ground reservoir from a common pumping station and through a common transmission main thereby reducing the number of pumping stations at Ambatale WTP and the number of transmission mains originating from the plant. NWSDB has provided the following details of water transmission to the new reservoir at Kolonnawa. This is to cater for housing development at Sahaspura (20,000 housing units) and Minikelanipura (6,000 housing units).

Rate of water transmission (design demand)	-	29,575 m^3/d (6.5 mgd)
Diameter of transmission main	-	600 mm
TWL of Reservoir	-	25.2 m MSL
BWL of Reservoir	-	15.75 m MSL
Reservoir capacity	-	11,250 m^3

Making provisions for the NWSDB's scheme was agreed in the amended scope of work agreement between NWSDB, JICA and JBIC dated August 4, 2000.

3.2.2 Existing Supply

Number and category of connections in the Kotikawatte and Mulleriyawa area in March 2000 is shown in Table 3-1.

Table 3-1 Number of Water Connections and Billed Consumption

Category of water connection	No. of connections (March 2000)	Billed Consumption, m^3/d
Domestic	9,522	6,775
Standpost	144	1,616
Non-domestic	282	537
Priority consumers	13	2,700
Total	9,961	11,628

Three major hospitals in the area are included in the priority consumers. Assuming that non-revenue water percentage is 35%, estimated supply is 17,900 m^3/d. It is estimated based on the above data that about 70% of the population is served by both house connections and standposts.

Figure 3-5 shows the areas suffering from low pressure. Most of these are high elevation areas as will be discussed in Sub-section 3.2.7.1.

3.2.3 Existing Facilities

Table 3-2 provides the description of existing facilities. Figure 3-6 shows the existing pipe network covering most of the area.

Table 3-2 Existing Water Supply Facilities in Kotikawatte-Mulleriyawa Area

Facility	Description	
1. Ground reservoirs		
Gothatuwa sump	V = 22.7 m^3	TWL = 17.7 m, BWL = 15.2 m
2. Pumping station		
Gothatuwa Pumping Station	2 Pumps	Q =N/A, 7.5 kW
3. Water tower		
Gothatuwa Tower	V = 227 m^3	TWL = 46.1m, BWL = 41.5 m

3.2.4 Existing Water Supply Sources

Following are the existing supply sources for Kotikawatte and Mulleriyawa areas.

① Dehiwela Transmission Main, at the washout along Udumulla Road near Bank Junction
- 160 mm transmission/distribution main to supply along Himbutana Road and to fill the existing sump opposite Fever Hospital (through the facilities shown in sub-section 3.2.3)
- 160 mm distribution main to supply along Himbutana Road up to Maligagodella Road
- 90 mm distribution main to supply along Udumulla Road

② Dehiwela Transmission Main, at the exit of S-tower
- 225 mm distribution main to supply along Old Avissawela Road
- 160 mm distribution main to supply along Low Level Road

③ Kolonnawa Transmission Main, at the junction of Kotikawatte Road and Delgahawatta Road through the tee
- 160 mm distribution main to supply towards south along Kotikawatte Road,

④ Transmission Main from Labugama, at the Kohilawatta Junction through the washout

- 90 mm distribution main to supply along Low Level road and along Kotikawatte Road,

⑤ Transmission Main Kolonnawa Tower to Weragoda Water Tower (250 mm CI) near Wellampitiya Bridge, through a tee

- 160 mm distribution main to supply along Low Level road and along Katupelella Road

⑥ Distribution Main from Moragasmulla Water Tower through Madinnagoda Bridge

- 90 mm distribution main to supply along M.D.H. Jayawardena Mawatha

⑦ Distribution Main from Towns East Project

- through southern part of Udumulla Road
- through Galwalahena Road
- through Angoda Road at Aggona Junction
- along Koswatta Road

⑧ Transmission Main from Labugama near Angoda Junction

- 200 mm CI main to supply Angoda Mental Hospital

⑨ Transmission Main from Kolonnawa Tower to Harbour, through a tee

- 90 mm distribution main to supply parts of Sedawatta area

3.2.5 Water Demand

3.2.5.1 Population and Land Use

Population in each Grama Niladhari (GN) division within Kotikawatte- Mulleriyawa area was obtained from the Divisional Secretariat (Figure 3-7). Population figures from Divisional Secretariat is 12,000 persons higher than that shown in Table 3-3 for the year 2000. Population is adjusted based on the year 2000 population data from the Divisional Secretariat and employing similar annual growth rate.

Table 3-3 shows the revised population of Kotikawatte – Mulleriyawa PS (Pradeshiya Sabha).

Table 3-3 Population Forecast of Kotikawatte – Mulleriyawa PS

Year	1995	2000	2005	2010	2015	2020
Population	92,400	98,500	101,500	104,500	107,400	110,300
Annual growth		1.13%	0.6%	0.58%	0.55%	0.53%
Revised population		110,500	113,900	117,300	120,600	123,900
Total Land Use, ha	1,483	1,515	1,531	1,546	1,552	1,557

Source: Adopted from SAPROF Study

Agricultural land use map (1:10,000) of 1995, which also shows the existing pipe network was provided by NWSDB to the study team and it was used as the base map for planning.

3.2.5.2 Per Capita Consumption

Per capita consumption for domestic use will be as shown in Table 3-4.

Table 3-4 Per Capita Consumption unit : (lpcd)

Year	1995	2000	2005	2010	2015	2020
House Connection	155	168	174	178	179	180
House Connection without in-house plumbing	75	75	75	75	75	75
Stand Post	53	53	53	53	53	53

Source: SAPROF Study

3.2.5.3 Unit Commercial, Industrial and Institutional Demand

Table 3-5 shows land use area for commercial, industrial and institutional uses.

Table 3-5 Commercial, Industrial and Institutional Land Use and Unit Demand

Year	1995	2000	2005	2010	2015	2020
Commercial Area, ha	108	112	114	116	118	120
Industrial Area, ha	133	136	138	140	132	124
Institutional Area, ha	94	96	98	100	102	104
Unit Commercial Demand, l/(ha.d)	686	686	686	686	686	686
Unit Industrial Demand, l/(ha.d)	13,078	13,078	13,078	13,078	13,078	13,078
Unit Institutional Demand, l/(ha.d)	49,968	49,968	49,968	49,968	49,968	49,968

Source: SAPROF Study (M/P Update)

Unit demands for commercial, industrial and institutional uses are those shown in Master Plan Update 1991, which was also adopted in SAPROF Study.

3.2.5.4 Large Consumers and New Developments

Locations of existing large consumers were obtained through the priority billing data of NWSDB for December 1999 and from street-wise survey of NWSDB. The information was used for distributing demand within the distribution network. Other developments were also considered for the demand allocation, including the recent industrial development near the Fever Hospital.

3.2.5.5 Peak Factor

Peak factors for transmission main and distribution main which are utilised in the detailed design of Towns North of Colombo water supply project for areas of this magnitude are adopted.

Peak factor for transmission mains (daily peak) - 1.1

Peak factor for distribution mains (hourly peak) - 1.6

3.2.5.6 Water Demand

Water demand estimates for this project are made for the year 2020.

For Kotikawatte and Mulleriyawa area, water demand estimated by the SAPROF study has been revised reflecting the increase in population, existing water supply and expected time when the improvements under this project actually benefit the customers. As a result, water demand is estimated at 32,108 m^3/day (daily average) for the year 2020. Appendix 3A-1 and Appendix 3A-2 show the details of the SAPROF estimate and revised SAPROF estimate respectively.

In the meantime, NWSDB also estimated water demand in 1998 based on a streetwise survey along most of the roads in which new pipelines will be laid. The estimate covers up to the year 2018. Table 3-6 shows a summary of the estimates whereas the details are provided in Appendix 3A-3. The total demand for the Kotikawatte and Mulleriyawa area is estimated at 16,270 m^3/d (the sum of water demand in Gothatuwa supply area and Mulleriyawa supply area) for the year 2018. Extrapolating this, the total demand for the year 2020 is estimated at 16,670 m^3/d.

Table 3-6 Demand Forecast by NWSDB Streetwise Survey unit: (m^3/d)

Area	Year 2003	Year 2008	Year 2013	Year 2018
Gothatuwa supply area	3,539	3,756	3,987	4,232
Mulleriyawa supply area	10,066	10,685	11,341	12,039
Kolonnawa supply area	4,689	4,977	5,283	5,608
Total	18,294	19,418	20,611	21,878
Gothatuwa and Mulleriyawa Supply Area	13,605	14,441	15,328	16,270

Source : JICA (NWSDB)

Demand estimated by NWSDB is based on the rate of increase in gross supply (including leakage of 25%) at 1.2% from the land use such as number of houses, shops, industries etc. along each road.

The above two estimates are based on two different scenarios for the year 2020. Scenario of NWSDB is development along low growth levels. Revised SAPROF demand includes potential development especially for commercial, industrial and institutional uses.

Due to large difference between the estimates made by SAPROF with revised population and that proposed earlier by the NWSDB streetwise survey, following methodology is adopted for water demand estimation.

1. Existing consumption is obtained from billed meter reading data
2. Existing supply is determined by adding non-revenue water to the billed consumption. Percentage of NRW is assumed as 35% which is applicable outside CMC area in Greater Colombo.
3. Water demand in the year 2020 is determined assuming the same gross average growth rate between year 2000 and Year 2020 obtained in the SAPROF estimates with revised population. Gross average growth rate was 2.28%

Figure 3-8 shows estimated demand for the period of year 2000 until year 2020 and following are the summary of those estimates:

Existing consumption (year 2000)	-	11,628 m^3/d
Existing supply (year 2000)	-	17,900 m^3/d
Average daily water demand (year 2020)	-	28,100 m^3/d
Maximum daily water demand (year 2020)	-	30,900 m^3/d

Table 3-7 shows the 5-yearly variation of water demand for the design of facilities.

Table 3-7 Design Flows

Year	2005	2010	2015	2020
Kotikawatte-Mulleriyawa Area				
Daily Average, m^3/d	20,036	22,426	25,102	28,100
Daily Maximum, m^3/d	22,039	24,669	27,612	30,910
Pumping and Transmission Main Design				
To Kolonnawa New Reservoir				
Daily Average, m^3/d	9,100	16,959	26,886	26,886
Daily Maximum, m^3/d	10,010	18,655	29,575	29,575
Total for Kotikawatte-Mulleriyawa Area and to Kolonnawa New Reservoir				
Daily Average, m^3/d	29,136	39,386	51,989	54,986
Daily Maximum, m^3/d	32,049	43,324	57,188	60,485

3.2.6 Water Source

Water from Labugama, Kalatuwawa and Ambatale WTP's are supplied to Kotikawatte and Mulleriyawa areas through direct tappings from transmission mains serving CMC, Dehiwala and Kolonnawa areas as described in Sub-section 3.2.4 Existing Water Supply Sources. Water source to Kotikawatte and Mulleriyawa areas will be limited to Ambatale WTP.

3.2.7 Land Availability

3.2.7.1 Topography (Ground Elevation)

Most of the land to the north of Avissawella Road is low lying land below 5 m MSL except for a small area between Buthgamuwa Junction and Angoda Junction along Saranankara Mawatha where ground elevation reaches 20 m MSL (Figure 3-9). Ground elevation of southern part of the PS is higher. Highest elevation at 29.0 m above MSL is found around Fever Hospital which is situated to the northeast of existing Gothatuwa Tower. Ground elevation above 20 m above MSL is found around Gothatuwa New Town, around Gotama Tapowanaya, around Kajugahawatta Housing Scheme, around Mulleriyawa Hospital Quarters and closer to Ambatale Water Treatment Plant.

3.2.7.2 Mulleriyawa Site and Gothatuwa Site

During the Stage II work in Sri Lanka, three sites were identified for the facilities. They are Gothatuwa site, Mulleriyawa site where ground reservoir, pumping station and tower have been planned to be sited within the Angoda Mental (Teaching) Hospital premises and Fever Hospital site. At the Mulleriyawa site, wards have already been built in the proposed area while vacant plot where construction of tower was abandoned previously. Preliminary topographic survey of Gothatuwa site and Mulleriyawa site was carried out by NWSDB. Site within Fever Hospital was dropped due to the poor accessibility and health concerns.

At Mulleriyawa site, extent of the available land is approximately 0.1 ha which is not sufficient for the facilities. Ground elevation of this site is around 16 m above MSL. This site requires an access road. Existing Gothatuwa Tower site has vacant land on southwest, south and west sides which are owned by the Fever Hospital. Ground level of this site is around 24 m above MSL, making it possible to supply from this site to the entire service area.

3.2.7.3 Ambatale WTP Site

NWSDB indicated that pumping station for Kotikawatte – Mulleriyawa area can be designed by extending the pumping station to be constructed for Ambatale-Ellie House transmission. The construction of the pumping station has already commenced when this Study was started in January and the pumping station has commenced test operation in October 2000. Details of the pumping station were made available by NWSDB.

3.2.8 Proposed System

Considering the water demand, land availability for facilities within Ambatale WTP and in Kotikawatte and Mulleriyawa area, the following facilities are required for the enhancement of water supply in Kotikawatte and Mulleriyawa Area.

① Gothatuwa-Kolonnawa Pump House - pumping facility at Ambatale WTP

② Gothatuwa Transmission Main - transmission main from Ambatale WTP to Gothatuwa Ground Reservoir

③ Gothatuwa Ground Reservoir and Pump House - Ground reservoir and pumping facility at Gothatuwa site

④ Gothatuwa New Water Tower - new water tower at Gothatuwa site

⑤ Distribution mains - pipelines for strengthening existing network

Drawing KMU/PS/G-02 shows the outline of the proposed system. Table 3-8 shows the design flows used for each of the major facilities.

Table 3-8 Design Flows for each Facilities

Facility	Design Flow	Remarks
1. Inlet piping to Ambatale	Daily maximum	
2. Transmission pumps at Ambatale	Daily maximum	Yearly variation
3. Transmission main	Daily maximum	
4. Ground reservoir	Daily maximum	
5. Pumps at Gothatuwa	Hourly variation	Yearly variation
6. Pumped main at Gothatuwa	Hourly peak	
7. Water tower	Daily maximum	Hourly peak for piping
8. Distribution mains	Hourly maximum	

3.2.8.1 Basis of Facility Development

All civil work required for the above facilities will be designed and constructed in this Project except for distribution mains. Priority distribution mains will be selected and detailed design and installation will be carried out. Installation of pumps and pump-related electrical equipment will be phased and those required for the initial phase will be installed.

3.3 GOTHATUWA-KOLONNAWA PUMP HOUSE

3.3.1 Process Design

The pump house is designed to transmit treated water from Ambatale treatment plant to service reservoirs at Gothatuwa (this project) and in the future to Kolonnawa.

(1) Operating characteristics

Volume of sump	:	100 m^3
High water level	:	+12.38 m MSL
Low Water Level	:	+ 9.28 m MSL
Floor level sump	:	+ 7.30 m MSL
Floor level pump house	:	+ 8.0 m MSL
Ground elevation	:	+ 7.5 m MSL

(2) Design flows

Table 3-9 Design flows for Pumps at Gothatuwa-Kolonnawa Pump House

Year	2005	2010	2015	2020
Kotikawatte-Mulleriyawa Area				
Daily Average, m^3/d	20,036	22,426	25,102	28,100
Daily Maximum, m^3/d	22,039	24,669	27,612	30,910
Pumping and Transmission Main Design				
To Kolonnawa New Reservoir				
Daily Average, m^3/d	9,100	16,959	26,886	26,886
Daily Maximum, m^3/d	10,010	18,655	29,575	29,575
Total for Kotikawatte-Mulleriyawa Area and to Kolonnawa New Reservoir				
Daily Average, m^3/d	29,136	39,386	51,989	54,986
Daily Maximum, m^3/d	32,049	43,324	57,188	60,485

(3) System head curves and pump selection

A detailed analysis of the transmission main for varying flow conditions is provided in the Design Report. Figure 3-10 shows the system head curve developed for pumping to Gothatuwa and Kolonnawa from year 2005 to 2020. When pumping for Gothatuwa and Kolonnawa, flow control will be required at Gothatuwa and at Kolonnawa to release the required quantity of flow to each reservoir. Extra head will be dissipated using a specialized butterfly valve (toothed-vane type). Following conditions are used for the calculations of the system head curves:

Loss of head around the pump is assumed to be 2 m

Hazen-Williams coefficient C = 110 for mortar-lined ductile iron pipe (which includes allowance for friction loss in bends and valves)

R1, R2 and R3 are friction losses in the pipe sections between Ambatale PS to Hospital Junction, Hospital Junction to New Kolonnawa Reservoir and Hospital Junction to Gothatuwa Ground Reservoir.

Pumping is assumed to be continuous throughout the day.

Minimum static head to overcome is assumed as the difference between high water level of Ambatale sump and low water level of Gothatuwa Ground Reservoir plus 0.5 m.

Pump curves are superimposed on the system head curve to select the optimum configuration (size and number) of pumps for existing and future flow conditions. The pumps must be suitable for the wide range of operating conditions. Design of the transmission system is based on requirements for Kotikawatte and Mulleriyawa water supply with provision to extend transmission system to Kolonnawa and expand the pumping capacity in the future. The number and size of pumps at Ambatale is selected in modular units to accommodate a range of operating conditions from year 2005 to year 2020. Pump units are selected with the assumption that Kolonnawa New Reservoir becomes operational in the year 2005 as indicated by NWSDB.

Table 3-10 Pump Characteristics at Gothatuwa-Kolonnawa Pump House

Pump Characteristics	2005	2010	2015	2020
Total design flow Maximum m^3/d	32,049	43,324	57,188	60,485
No. of pumps	2 duty 1 standby	3 duty 1 standby	3 duty 1 standby	3 duty 1 standby
Capacity of each pump (m^3/min)	11.85	11.85	14	14
TDH max (m)	40			50
Motor Output (kW)	120*			165

The use of multiple pump units makes it possible for operators to adjust flow rates as growth occurs. The ultimate number of pumps units is 3 x 14 m^3/min plus 1 stand-by. Initially (year 2005) three pumps will be installed (2 duty + 1 standby). The pumps will have trimmed impellers to give 11.85 m^3/min each thereby matching the range in flow from 2005 to 2010. By 2010 it will be necessary to install one additional pump (3 duty pumps) to meet maximum day flows bringing the total number of pumps to 4. Timing for the installation of a fourth pump will depend on growth and trends in water use. Between the year 2010 and 2015 it will be necessary to change the impellers to 14 m^3/min in all pumps to obtain maximum day flows. The tender documents call for the supply of 14 m^3/min impellers (normal impellers) to be kept in stores by NWSDB for future use. Operating staff at Ambatale WTP can carry out the impeller replacement as they have done it recently. The design has the advantage of simplifying future upgrade in capacity without the need for extensive construction or disruption to existing pumping process.

(4) Transient analysis

A transient analysis for flow conditions in the year 2020 was carried out to determine if water hammer protection is required. Details are presented in the Design Report and a schematic of the transmission scheme is represented in Figure 3-11 and Figure 3-12. The lengths of the transmission main and elevations along the route are based on the surveys carried out for the detailed design.

The ultimate hourly flow of 700 l/s produced a maximum transient pressure of 121.8 m at the outlet of the pump station (position 4) and a negative pressure of –10.1m at positions 4 and 10. The maximum pressure is within the rated pressure of ductile iron pipe however the negative pressure indicates separation of water column, which will lead to cavitation and damage to the pipe. The transient curve without protection is presented in Figure 3-13.

A method for preventing separation of water column is required. One of the simplest methods of controlling water hammer is to use inertial flywheels on the pumps. This method was rejected because it would require too much space for four horizontal pumping units. The method preferred and adopted by NWSDB at a similar installation uses a hydro-pneumatic surge vessel. The vessel is pressurized with compressed air and has an internal bladder filled with water. The vessel releases water into the pipeline to prevent vacuum conditions and cushions the pressure waves. Computer modeling has indicated that 30 m^3 of water is required in the surge tank to eliminate the negative pressures at ultimate flow. The attenuated transient curve is presented in Figure 3-14.

(5) Provisions for future extension

The pumping station is physically designed for the future. Inlet and outlet piping provisions are made to facilitate connection of the fourth pump at a later date. Switchgear is planned for the addition of a fourth motor starting cubicle. Surge vessel is sized for the ultimate flow in the year 2020.

3.3.2 Pump House Layout

(1) Site

The site plan for Gothatuwa-Kolonnawa Pump House is presented in drawing KMU/PS/C-01. The station has been positioned to avoid the transmission mains to Ellie House, and the drainage culvert next to the pumping station that is presently under construction. The new pump house is located as close as possible to the Ellie House Pump Station to save space for future developments. Site access is from the treatment plant side to minimize costs of grading around the station.

(1) Pump intake sump

The pump house will be connected to the 1,200 mm diameter treated water main as shown schematically in Figure 3-15. The supply connection is made by cutting the existing treated water main and installing a 1200 mm diameter tee and isolating valve.

The intake sump at the pump house is fed by gravity from the treatment plant clear well. A baffle wall is provided to distribute the flow evenly to the pump intakes. Levels in the treatment plant clear well fluctuate between 13.9 TWL and 10.8 LWL. Allowing for losses at bends and fittings provides the following operating levels for ultimate flow conditions (year 2020):

Bottom water level	=	+9.28 m MSL
Top water level	=	+12.38 m MSL

In the initial years flow velocities will be lower therefore losses will be much less. Operating levels in the sump will closer to those in the clear well and the sump structure has been designed accordingly. Volume of the intake sump is provided for the pump operation only since storage is provided in the clear water reservoir in the new Ambatale WTP. Hydraulic calculations are shown in Appendix to the Design Report.

(2) Internal arrangement

The general layout plan for the pump house is presented in drawing KMU/PS/C-04 with a sectional view presented in drawing KMU/PS/C-07 and C-08. The upper level (+11.25 m MSL) consists of a staging area at the entrance for removing pumps and a floor area for electrical switchgear and motor controls. The pumps are located at the lower floor level (+ 8.0 m MSL).

The pumps are double suction type with horizontal split casing. The pump centre line is +8.55 m MSL which is below low water level thus providing submerged suction conditions at all times. Each pump has a separate 500 mm suction pipe into the sump. A valve is provided on each suction line to isolate the pump for maintenance.

The pumps are connected in parallel to a common 600 mm diameter discharge header. The discharge header increases to 800 mm ND outside the station where it is connected to the transmission main. A valve is provided at the end of the discharge header to isolate the station from the transmission main in the event of maintenance on the discharge header.

Each pump is connected to the common discharge header through a 500 mm ND discharge pipe with check valve and discharge valve. The discharge valve is normally closed and modulates open when the pump starts. Butterfly valves are used on the discharge side because provide better flow control when throttled. Butterfly valves are also used elsewhere in the station because they are more compact and easier to operate than gate valves.

Steel piping has been selected within the station to simplify fabrication, alignment and field assembly. Piping through the walls into the intake sump is ductile iron.

Pumps are spaced on 4 m centres to provide sufficient space for maintenance. Pumps can be removed using a gantry crane and lifted up to the staging area.

(3) Hydro-pneumatic surge vessels

Two 15 m^3 surge tanks are provided to attenuate the effects of pressure transients in the transmission main. The tanks are physically quite large and have been located outdoors to simplify access for maintenance. These are located in an open chamber at the front of the pump house and connected to the transmission main.

3.3.3 Electrical

(1) Incoming service

Electrical Single line diagram is presented in drawing KMU/PS/E-02. Power supply is provided from an existing substation located in the neighboring Ellie House Pump house. Power is supplied at 415/240 volts therefore a step down transformer is not required. Incoming power cables are connected to a 1250 amp air circuit breaker located in a separate switchgear cubicle inside the pump house. The incoming panel feeds distribution switchgear.

(2) Motors

Pump motors are rated 165 kW, 3 phase 415 volts. All pump motors are totally enclosed fan cooled squirrel cage type. Motor starters are reduced voltage autotransformer type. Special motors such as valve operator motors will be supplied to the manufacturers standard design.

(3) Emergency power supply

Reliability of power supply is very high because the treatment plant is supplied by a bank of diesel generators operated 24 hours a day by CEB. There is therefore no emergency generator for the treatment plant and no need to provide a generator for the pump house since there would be no treated water to pump in the event of a power failure.

(4) Power factor correction

Pump motors are provided with dry type capacitors to correct power factor to a minimum of 0.90 lagging. These capacitors are located in each motor control cubicle of the low voltage switchgear.

(5) Lighting

High bay fixtures with 125 watt mercury vapour lamps are generally used indoors mounted to the underside of the concrete roof beams.

Fluorescent lighting is provided at pump level for additional lighting. Outdoor lighting around the station is provided by wall mounted fluorescents in weatherproof enclosures.

Roadway lighting consists of mercury vapour pole mounted luminaries.

(6) Lightning protection

Lightning protection is provided to protect the building. The system consists of a two "early streamer emission" type air terminal connected to copper grounding electrodes buried 1.5 m below grade.

3.3.4 Control system

(1) Equipment

- 2 duty pumps and 1 standby pump, 165 kW each pump providing 11.85 m^3/min x 42 m TDH
- Pump volute is sized for the ultimate design flow (year 2020) but impellers are sized to meet flow and head requirements for the year 2005. Impellers will be replaced for larger ones when demand exceeds pump capacity around year 2010.
- A third duty pump will be added when demand exceeds pump capacity (around the year 2010). Provision for the future pump is provided in the piping design and floor layout of the pump house
- 3 discharge valves with motorized operator
- 3 low suction pressure switches
- 1 level sensing transmitter
- 1 level sensing electrode
- 1 pressure transmitter on transmission main

(2) Flow Regulation

The transmission pumps are sized to match the projected maximum day demand (Kolonnawa and Gothatuwa) until the year 2010. Pump selection is made with the intention to provide continuous pumping operation with as few stop start cycles as possible.

Flow control at the transmission end (Ambatale) is not possible since the transmission main branches into two sections with different operating requirements and head loss characteristics. Therefore flow control is placed at each reservoir to control the amount of water received.

(3) Pump Control System

The pumps are controlled automatically by a local a programmable logic controller (PLC) or manually by the operator in charge. The control program is resident in the PLC and control set-points can be adjusted at the PLC.

a) Control Modes (pumps):

There are 3 control modes available for the pumps:

- (AUTO) automatic PLC control,
- (LINK-UP) manual control of the pumps linked with the discharge valve
- (INDIVIDUAL) manual control of the pump only without opening the discharge valve.
- Each pump has two control switches located at the motor control panel providing "ON-OFF" and "RUN-STOP" positions
- Each pump has one selector switch located at the Motor Control Panel providing "INDIVIDUAL-LINK UP-AUTO" positions
- When the selector switch is in the "AUTO" position, the pump is controlled automatically by the PLC
- There are two manual control modes: "LINK UP" and "INDIVIDUAL".
- When the selector switch is in the "LINK UP" position manual control of the pump is linked to the operation of the discharge valves. The pump is activated manually by setting the control switch to the "RUN" position and de-activated by selecting "STOP"
- With the selector switch in the "INDIVIDUAL" position the pump can be started with the discharge valve closed. This feature is required for pump maintenance when the operators want to test the correct operation of the pump or motor without having the discharge valve open automatically. The pump is activated manually by setting the control switch to "ON" and deactivated by selecting "OFF".
- The "ON-OFF" switch has a handle that can be removed for safety during maintenance. When in the "OFF" position the pump is deactivated and cannot be turned on by any other means.
- Most interlocks are contained in the PLC software. However, critical interlocks (mainly related to safety) are hardwired into the control circuit.

b) Control mode (discharge valves)

There are 3 control modes available for each discharge valve:

- AUTOMATIC (linked to pump operation),
- REMOTE manual control at the motor control panel (upper station level) and
- LOCAL manual control at the valve (pump level).
- Each discharge valve has a selector switch with "REMOTE-LOCAL" positions and a

control switch with “OPEN-CLOSE” positions located at the valve. A control switch providing “OPEN-CLOSE” positions is also mounted on the motor control panel (upper station level)

- The discharge valve operates automatically (linked to pump operation) when the pump selector switch is in the “AUTO” position or in the “LINK-UP” position.
- The valve can be operated manually at pump level by placing the selector switch at the local control panel in the “LOCAL” position and activating the “OPEN-CLOSE” control switch at the valve.
- The valve can be operated manually from the motor control panel at the upper station level by placing the selector switch at the local control panel to the “REMOTE” position and activating the “OPEN-CLOSE” control switch on the motor control panel.

c) I/O Listing

- level sensing in the suction sump
    - digital level indicator
    - high level alarm
    - low level alarm
- motor protection
    - low voltage, phase failure
    - over current
    - stator coil high temperature
    - motor bearing temperature
    - ground fault
- Pump protection
    - Failed to start
    - Failed to stop
    - Low suction pressure
    - Pump Bearing temperature
    - Low discharge pressure
- Motor operated Valves
    - Position indicator
    - Over torque alarm
    - Failed to open
    - Failed to close
- Flow metering
    - Instantaneous flow
    - Totalized flow
    - Analogue recorder

(4) Control Logic

(a) Starting pumps

- With the control switch in "AUTO" the pumps operate automatically according to a 24-hour schedule that is programmed into the PLC by the operator. The schedule will determine the number of pumps that should be in operation at a given time of day.
- The pumps can also be brought on line manually either at the PLC or by turning the control switch to "LINK UP" position.
- If the PLC fails for any reason, the pumps shut down and the operator must restart the pumps by turning the switch to "LINK UP" position.
- Each pump will start automatically against a closed discharge valve. After an adjustable time delay the PLC will modulate the butterfly valve to open.
- Before starting a pump the following conditions must be maintained:
  - The Motor operated discharge valve must be closed
  - The water level in the clear well must be above LWL
  - No pump or transmission main faults
- The pump starters are interlocked so not more than one pump can be started at the same time

(b) Stopping Pumps

- High pressures will occur in the transmission main when the flow control valve at the ground reservoir(s) is closed or throttled to reduce inlet flows to the reservoir, or when the inlet valve(s) at the ground reservoir are closed.
- When a high-pressure condition occurs the number of pumps in operation at Ambatale will automatically be reduced. A pressure transducer located on the common discharge header will provide a signal to the PLC to shutdown one pump. If two pumps are in operation the second pump will be shutdown after a suitable time delay if high pressures continue.
- The pressure transducer on the discharge header will also signal all pumps to stop if it detects a low operating pressure on the transmission main (typically caused by a transmission main break). This will prevent the pump from reaching run-out conditions
- After pump shutdown the discharge valves will be returned to their normal position i.e. fully closed after a suitable time delay (adjustable automatic slow closure of discharge valves)
- All motor operated discharge valves are equipped with limit switches to indicate fully open and fully closed positions.
- If the level of water on the suction side of the pumps drops below an adjustable set-point (9.28m) the pumps will be shutdown or prevented from starting.
- Should a pump stop for whatever reason while it is energized (including low liquid level), an integral pump relay will send a pump general alarm signal to the PLC.
- The low level switch in the treated water well will provide a low level alarm for the PLC. In

this way the operator will be able to distinguish between a general pump fault and a low liquid level.

- A pressure switch located on the suction side of the pump will shutdown the pump if low suction pressure is detected (e.g. suction valve is accidentally closed). The set-points are independently adjustable at the pressure switch. This switch is wired into the pump control circuit and operates independent of the PLC. The appropriate alarm (low pressure) is activated whenever the switch is activated.

3.3.5 Mechanical

(1) Ventilation

Ventilation of the pump house will provide heat relief to the motors. Supply air is provided by a single 60 m^3/min fan and ducted to the lower level of the pump house. Exhaust air is provided by 2 fans, one located on each roof gable 70 m^3/min each.

(2) Drainage

Gutter drains are provided around the perimeter of the pump room to collect water that may leak or be drained during repairs or maintenance. Generally the floor will be sloped towards the gutter drain. A sump will collect water from the drains and a duplex sump pump arrangement will discharge water to a surface drain outside the station.

The chamber of the surge tank also has a separate sump and duplex pump arrangement to remove water that may accumulate in the pit.

3.3.6 Architectural

Pump building is designed to be similar in appearance to the existing pump house next to it.

The building is reinforced concrete frame. Walls above grade are in filled with 200 mm concrete blocks. The walls are plastered and painted on both sides. Walls below grade are structural concrete and will have fair-faced surfaces. Walls will be finished with a breathable coloured sealer for ease of maintenance and light reflectivity. Concrete floors will receive a clear concrete sealer to prevent dusting.

Roofing is zinc aluminium sheets laid on steel purlins. Doors and windows are anodised aluminium.

3.3.7 Structural Design

(1) Foundation design

A detailed geotechnical report describing soil conditions and recommended foundation design parameters is presented in Supplementary Data to Tender Documents.

The proposed pump house has overall dimension of 15 m x 15 m. The floor level for the wet well will be around +7.3 m MSL. The floor level inside the pump house and surge tank area will be around +8.0 m MSL.

In the area of the wet well and surge tank the foundation level will be set at +7.0 m MSL and will be entirely on cut material. In the area of the pumps foundation levels will be set at +7.7 m MSL and the floor slab will be mostly on cut with a small balance on fill.

The material located at foundation levels is classified as hard laterite, based on the high standard penetration test (SPT) values recorded. The ground water level is at an elevation of +6.03 m MSL.

At borehole No.1 (S/E corner wet well) the allowable safe bearing pressure is 200 kN/m^2. At borehole No.2 (N corner of pump house) the safe bearing pressure is 125 kN/m^2. Since part of the site will need to be filled the structure is designed using a raft foundation with an allowable bearing capacity of 125 kN/m^2. The fill material under the foundation slab should be lateritic gravel, placed in layers and compacted to provide an allowable bearing pressure of 125 kN/m^2.

After construction of the pump house a compacted fill 3 m high will be placed right around the structure to bring ground level outside the station to +11.0 m MSL.

(2) Design methodology

The sump structure is reinforced concrete designed according to BS 8007: 1987 for water retaining structures which requires the design of reinforcement steel to limit maximum crack width to 0.2 mm or less.

The rest of the building is reinforced concrete raft foundation with monolithic reinforced concrete walls to grade level. The foundation is designed using the most unfavourable conditions i.e. dead and live load, and sump full water. The slab (and the whole structure) is also designed against uplift forces and flotation in the event of seasonal high groundwater or localized flooding.

It is necessary to provide a superstructure with clearance and capability for removal of pumps, and valves for maintenance. The superstructure is designed to house an over-head crane and allowance has been made in the design for the impact load. The overhead travelling crane will be provided to the full length of the building.

Walls for the sump have been designed to resist full height of water in the sump (+14.0 m MSL) without the assistance of soil pressure. Under the empty conditions all walls are designed against pressure from earth backfill.

The sump will be lined with a Cementitious mortar to protect against degradation of concrete.

Specific criteria used for design of the structure and design calculations are presented in the Design Report. Details of the structural design are provided in the Design Report and drawings KMU/PS/ST-01 to 08.

3.3.8 Civil Works

(1) Grading and Drainage

After construction of the pump house a compacted fill 3 m high will be placed right around the structure to bring ground level outside the station to +11.0 m MSL. The gully between the existing treatment plant service road and the pump house will be filled to provide access to the station.

A new surface drain will be provided between the two pump houses to channel water from the existing culvert. The drain will be lined with grouted rip-rap to prevent erosion of the fill around the pump house.

3.4 GOTHATUWA TRANSMISSION MAIN

3.4.1 Outline

Gothatuwa Transmission main is to pump water from Gothatuwa-Kolonnawa Pump House located within Ambatale Water Treatment Plant premises to the Gothatuwa Ground Reservoir to be constructed next to the existing Gothatuwa water tower along the Fever Hospital Road.

Gothatuwa Transmission Main (φ800 mm DI) will exit through the gate of New Ambatale Plant taking an anti-clockwise route around the new treatment plant facilities. It will be laid along the same route as existing Dehiwela main (φ1,000 mm CI) and existing Kolonnawa main (φ600 mm DI) for approximately 0.6 km and thereafter up to Petiagoda Lane with the existing Kolonnawa main. At the Hospital Junction (junction of Himbutana Road and Angoda Road), it will branch to Gothatuwa Ground Reservoir site (φ500 mm DI) and to New Kolonnawa Reservoir site (φ600 mm DI). A blank-flanged tee with valve will be provided at this junction for future laying of pipeline to New Kolonnawa Reservoir site. Preliminary analyses showed that the pumping through a common main will involve dissipation of energy at one of the receiving end and present values are compared for the following cases as shown in Appendix 3B.

- Common pump house, common transmission main with branches to Gothatuwa and Kolonnawa
- Separate pump houses and separate transmission mains to Gothatuwa and Kolonnawa

Common pumping station and common transmission main are economical compared to separate pump houses and separate transmission mains based on the present value analysis. The latter also has the following disadvantages.

- Space for laying two transmission mains with standard trenches along Himbutana Road is not available
- Space for separate pump houses is limited
- Operation and maintenance of common pump house is preferred to two pumping stations

Figure 3-11 shows the schematic of Gothatuwa Kolonnawa transmission model based on survey information along the Gothatuwa Transmission Main route and from the information provided by NWSDB on the proposed Kolonnawa Transmission Main route. Major lengths are as follows:

Length of 800 mm transmission main, from Gothatuwa-Kolonnawa
Pump house to Hospital Junction = 2,541 m

Length of 500 mm transmission main, from Hospital Junction to Gothatuwa Ground Reservoir = 1,821 m

Length of 600 mm transmission main, from Hospital Junction to Kolonnawa New reservoir = 6,207 m

Ductile iron pipe with cement-mortar lining will be used which is the economical material for this range of diameters.

Table 3-11 shows the flow rate, velocity and friction gradient in the Gothatuwa and Kolonnawa transmission mains.

Table 3-11 Flow Rate, Velocity and Friction Gradient in the Transmission Mains

Transmission Main	Parameter	2005	2010	2015	2020
800 mm section from Pump House to Hospital Junction	Flow rate, Q, L/s	371.0	501.5	662.3	700.1
	Velocity, V, m/s	0.74	1.00	1.32	1.39
	Friction Gradient, m/km	0.84	1.48	2.47	2.73
500 mm section from Hospital Junction to Gothatuwa GR	Flow rate, Q, L/s	255.0	285.5	320.0	357.8
	Velocity, V, m/s	1.30	1.45	1.63	1.82
	Friction Gradient, m/km	4.16	5.13	6.34	7.79
600 mm section from Hospital Junction to Kolonnawa New Reservoir	Flow rate, Q, L/s	116.0	216.0	342.3	342.3
	Velocity, V, m/s	0.41	0.76	1.21	1.21
	Friction Gradient, m/km	0.40	1.26	2.95	2.95

Note: The above values are when pumping to both Gothatuwa and Kolonnawa simultaneously.

3.4.2 Detailed Design

Detailed Design is described in Section 4.2 of the Design Report and the following are the salient points.

(a) Normal operating pressure is 6.3 bars and the test pressure is 10 bars.

(b) Since distribution main will also be laid along the same route between Ch. 566 and Ch. 4,042, common trench will be used where pipes will be staggered horizontally and vertically while allowing adequate earth cover.

(c) Staggered configuration of air valves and washouts for transmission main and distribution main in common trenches have been provided.

(d) In the low-lying areas soft ground is expected between Ch. 2,700 and Ch. 3,360 and special bedding with geotextile and granular filling will be used.

3.5 GOTHATUWA GROUND RESERVOIR AND PUMP HOUSE

3.5.1 Process Design

The reservoir receives treated water from Ambatale treatment plant. The pump house is designed to lift water from the service reservoir to the elevated water tower. The reservoir and tower combine to provide storage to balance the fluctuation in demands in the Kotikawatte-Mulleriyawa distribution area.

(1) Operating characteristics reservoir

Volume	:	4,400 m^3
High water level	:	+26.25 m MSL
Low Water Level	:	+ 21.0 m MSL
Floor level sump	:	+ 19.15 m MSL
Floor level pump house	:	+ 20.0 m MSL
Ground elevation variable	:	+ 23.0 to 25.0 m MSL

(2) Design flows

Table 3-12 Design flows for Gothatuwa Pump House

Year	2005	2010	2015	2020
Kotikawatte-Mulleriyawa Area				
Daily Average, m^3/d	20,036	22,426	25,102	28,100
Daily Maximum, m^3/d	22,039	24,669	27,612	30,910

The reservoir provides 3.4 hours of storage at maximum day demand in the year 2020.

Table 3-13 Hourly Variation of Water Demand for Peak Factor 1.6

Time, hrs		Ratio of Hourly Flow to Average Hourly Flow
From	To	
0:00	1:00	0.40
1:00	2:00	0.40
2:00	3:00	0.40
3:00	4:00	0.50
4:00	5:00	0.80
5:00	6:00	1.20
6:00	7:00	1.60
7:00	8:00	1.30
8:00	9:00	1.00
9:00	10:00	0.80
10:00	11:00	0.90
11:00	12:00	1.35
12:00	13:00	1.30
13:00	14:00	0.90
14:00	15:00	0.90
15:00	16:00	0.90
16:00	17:00	0.95
17:00	18:00	1.40
18:00	19:00	1.50
19:00	20:00	1.60
20:00	21:00	1.40
21:00	22:00	1.00
22:00	23:00	0.80
23:00	24:00	0.70
24:00	25:00	

(3) Pump selection

Gothatuwa New Pumping Station is to cope with the hourly fluctuations in water demand in the distribution system together with water tower and ground reservoir. Simulation of ground reservoir levels, pumping rates, water tower levels and hourly demand in year 2020 was carried out using computer model. Results of the analysis is shown in Appendix to the Design Report. Hourly demand variation assumed is as shown in Table 3-13. Based on this analysis two options are developed as follows:

Option 1 : Year 2005 to year 2020
Number of pumps : four (3 duty 1 stand-by)
Capacity of pumps : 12 m^3/min, TDH = 30 m

Option 2 : Year 2005 to year 2015
Number of pumps : two (1duty 1 stand-by)
Capacity of pumps : 18 m^3/min, TDH = 30 m

Year 2015 to year 2020
Number of pumps : three (2duty 1 stand-by)
Capacity of pumps : 18 m^3/min, TDH = 30 m

Option 2 was selected to reduce the physical dimensions of the pump house and to reduce the number of units that would need to be maintained by NWSDB.

Table 3-14 Pump Characteristics at Gothatuwa Pump House

Pump Characteristics	2005	2010	2015	2020
Maximum Day, m^3/d	22,039	24,669	27,612	30,910
Average day, m^3/d	20,036	22,426	25,102	28,100
Maximum hourly flow, m^3/hr	1,335	1,495	1,673	1,873
No. of pumps	1 duty 1 standby	1 duty 1 standby	2 duty 1 standby	2 duty 1 standby
Capacity of each pump, m^3/min	18	18	18	18
TDH max, m	30	30	30	30
Motor Output per unit, kW	130	130	130	130

The use of multiple pump units makes it possible for operators to adjust flow rates as growth occurs. The ultimate number of pumps units is 2 x 18 m^3/min plus 1 stand-by. Initially (year 2005) two pumps will be installed (1 duty + 1 standby). By 2010 it will be necessary to install one additional pump (2 duty pumps) to meet maximum day flows bringing the total number of pumps to 3. Timing for the installation of a third pump will depend on growth and trends in water use.

(4) Provisions for future extension

The pumping station is physically designed for the future. Inlet and outlet piping provisions are made to facilitate connection of the fourth pump at a later date. Switchgear is planned for the addition of a fourth motor starting cubicle.

(5) Chlorination

Water is chlorinated at Ambatale. The short travel and residency times make it unnecessary to add additional chlorine at the ground reservoir.

3.5.2 Pump House and Reservoir

(1) Site

The site plan for Gothatuwa Pump House and ground reservoir is presented in drawing KMU/GR/G-01. The site is near the existing water tower in Gothatuwa adjoining the Fever Hospital Boundary. The site is small and physically constrains the maximum plan dimensions of the reservoir.

(2) General arrangement

General arrangement is shown on drawing KMU/GR/C-01. The reservoir is rectangular and has a plan dimension of 26.6 m x 32.6 m with a water height of 5.25 m. The floor of the reservoir is set at +20.0 m MSL. The pump house is built attached to the reservoir and has a plan dimension of 10.7 m x 19.5 m.

The reservoir is divided into two equal cells. A sump common to both cells is provided for pump intakes. Sluice gates are provided between each cell and the common sump to isolate one half of the reservoir for maintenance.

Internal baffle walls are provided to improve circulation within the reservoir.

(3) Reservoir Inlet

The transmission main from Ambatale enters a valve house where the flow is metered and controlled automatically by a motor operated flow control valve that also functions as an energy-dissipating device. The supply is then divided into two to feed each cell independently. The supply lines are brought to the back of the reservoir and provided with a submerged bell mouth outlet.

(4) By-pass

A by-pass line is provided from the inlet main to the discharge header in the pump house. Thus it is possible to completely by-pass the reservoir by pumping directly from Ambatale to the distribution system.

(5) Wash out and overflow

Each cell has a washout line and an overflow that are connected to a common discharge header. A new gravity drain is provided to safely channel overflow and washout to a nearby surface drainage canal. Washout valves have been located inside the station for access and ease of maintenance.

(6) Internal Piping arrangement

The general layout plan for the pump station and reservoir is presented in drawing KMU/GR/C-01 with a sectional view presented in drawing KMU/GR/C-05. The upper level (+ 26.25 m MSL) consists of a staging area at the entrance for removing pumps and a floor area for electrical switchgear and motor controls. The pumps are located at the lower floor level (+ 19.5 m MSL).

The pumps are double suction type with horizontal split casing. The pump centre line is +20.38 m MSL which is below low water level thus providing submerged suction conditions at all times. Each pump has a separate 500 mm suction pipe into the sump. A valve is provided on each suction line to isolate the pump for maintenance.

The pumps are connected in parallel to a common 600 mm diameter discharge header. The discharge header reduces to 450 mm ND outside the station where it is connected to water tower rising main. A valve is provided at the end of the discharge header to isolate the station from the water tower in the event of maintenance on the discharge header.

Each pump is connected to the common discharge header through a 500 mm ND discharge pipe with check valve and discharge valve. The discharge valve is normally closed and modulates open when the pump starts. Butterfly valves are used on the discharge side because provide better flow control when throttled. Butterfly valves are also used elsewhere in the station because they are more compact and easier to operate that gate valves.

Steel piping has been selected within the pump house to simplify fabrication, alignment and field assembly. Piping through the walls into the intake sump is ductile iron.

Pumps are spaced on 4 m centres to provide sufficient space for maintenance. Pumps can be removed using a 3 ton gantry crane and lifted up to the staging area.

3.5.3 Electrical

(7) Incoming service

Electrical Single line diagram is presented in drawing KMU/GR/E-01. Power supply is provided by LECO from a 400 kVA pole mounted transformer located on site. Power is supplied at 3 phase, 415/240 volts therefore a step down transformer is not required. Incoming power cables are connected to a 800 ampere moulded case circuit breaker located in a separate switchgear cubicle inside the pump house. The incoming panel feeds distribution switchgear.

(8) Motors

Pump motors are rated 130 kW, 3 phase 415 volts. All pump motors are totally enclosed fan cooled squirrel cage type. Motor starters are reduced voltage autotransformer type. Special motors such as valve operator motors will be supplied to the manufacturers standard design.

(9) Emergency power supply

A 375 kVA diesel generator is provided to operate 1 duty pumps in the event of a power failure and miscellaneous station loads. The diesel generator is oversized to meet the inrush current when the pump starts. A second pump is prevented from starting by a control circuit interlock. The diesel generator starts automatically and has a fuel supply of 8 hours. Appendix 3D shows the details of the sizing of diesel generator.

(10) Power factor correction

Pump motors are provided with dry type capacitors to correct power factor to a minimum of 0.90 lagging. These capacitors are located in each motor control cubicle of the low voltage switchgear.

(11) Lighting

High bay fixtures with 125 watt mercury vapour lamps are generally used indoors mounted to the underside of the concrete roof beams.

Fluorescent lighting is provided at pump level for additional lighting. Outdoor lighting around the station is provided by wall mounted fluorescents in weatherproof enclosures.

Roadway lighting consists of mercury vapour pole mounted luminaries.

(12) Lightning protection

Lightning protection is provided to protect the building. The system consists of a two “early streamer emission” type air terminal connected to copper grounding electrodes buried 1.5 m below grade.

3.5.4 Control System

(1) Equipment

- 1 duty pump and 1 standby pump, 130 kW each pump providing 18 m^3/min x 30 m TDH
- a second duty pump will be added when demand exceeds pump capacity (around the year 2010)
- discharge valves with motorized operator
- magnetic flow meter inlet to reservoir
- magnetic flow meter outlet to reservoir
- pump low suction pressure switch
- level sensing transmitter
- level sensing electrodes
- motor operated flow control valve

(2) Flow Regulation

General

- pumping from Ambatale will be a continuous operation with as few stop start cycles as possible
- a motor operated flow control valve on the inlet side will be modulated by a flow meter to keep flow into the reservoir constant and match demand as closely as possible

Control mode (flow control valve)

- There are 3 control modes available for each discharge valve:
- AUTOMATIC (linked to pump operation),

- REMOTE manual control from the control panel (inside the pump house) and
- LOCAL manual control at the valve (outside the pump house).
- The flow control valve can be operated remotely from the pump house or locally at the valve
- Control at the valve consists of a selector switch with “REMOTE-LOCAL” positions and a control switch with “OPEN-CLOSE” positions.
- The valve modulates automatically when the selector switch in the pump house is placed in “AUTO” position and the selector switch at the valve is placed in “REMOTE” position.
- The valve can be operated manually from the pump house by selecting “MANUAL” position and activating the “OPEN-CLOSE” control switch on the control panel.
- The valve can be operated manually at the valve by selecting “LOCAL” and activating the “OPEN-CLOSE” control switch at the valve.

List of I/O Points (flow control valve)

- Motor operated Valves
    - Position indicator
    - Overtorque alarm
    - Failed to open
    - Failed to close
- Flow metering
    - Instantaneous flow
    - Totalized flow
    - Analogue recorder

Control logic (flow control valve)

- The valve modulates open or close to match the desired inlet flow set-point
- Flow is monitored continuously by an electro-magnetic flow meter
- The flow meter, located just ahead of the flow control valve, will send a signal to the PLC to modulate the valve to the desired set-point programmed into the PLC
- If the level in the reservoir reaches overflow level and remains there for more than 5 minutes (adjustable) then the motor operated control valve will close and send an alarm signal to the PLC.
- Following an overflow alarm the motor operated flow control valve will remain closed for a suitable period of time (adjustable) then modulate to the fully open position. In this way the station attendant will have sufficient time to investigate the reason for the overflow condition and communicate with operators at Ambatalle to shutdown pumps at Gothatuwa-Kolonnawa Pump House if necessary.

(3) Pump Control System

- the pumps will be controlled automatically by a local programmable logic controller (PLC) or manually by the station attendant
- the control program is resident in the PLC and control set-points can be adjusted at the PLC
- the control panel is located in the pump house.

d) Control Modes (pumps):

- There are 3 control modes available for the pumps:
- (AUTO) automatic PLC control,
- (LINK-UP) manual control that links the pump with the discharge valve
- (INDIVIDUAL) manual control of the pump only without opening the discharge valve.
- Each pump has two control switches providing “ON-OFF” and “RUN-STOP” positions and one selector switch providing “INDIVIDUAL-LINK UP-AUTO” positions located at the Motor Control Panel.
- When the selector switch is in the “AUTO” position, the pump is controlled directly by the PLC and can also be activated manually via the PLC keypad or it can be operated automatically using the control program
- There are two manual control modes: “LINK UP” and “INDIVIDUAL”.
- When the selector switch is in the “LINK UP” position manual control of the pump is linked to the operation of the discharge valves. The pump is activated manually by setting the control switch to the “RUN” position and de-activated by selecting “STOP”
- With the selector switch in the “INDIVIDUAL” position the pump can be started with the discharge valve closed. This feature is required for pump maintenance when the operators want to test the correct operation of the pump or motor without having the discharge valve open automatically. The pump is activated manually by setting the control switch to “ON” and deactivated by selecting “OFF”.
- The “ON-OFF” switch has a handle that can be removed for safety during maintenance. When in the “OFF” position the pump is deactivated and cannot be turned on by any other means.
- Most interlocks are contained in the PLC software. However, critical interlocks (mainly related to safety) are hardwired into the control circuit.

e) Control mode (discharge valves)

- There are 3 control modes available for each discharge valve:
- AUTOMATIC (linked to pump operation),
- REMOTE manual control at the motor control panel (upper station level) and
- LOCAL manual control at the valve (pump level).

- Each discharge valve has a selector switch with "REMOTE-LOCAL" positions and a control switch with "OPEN-CLOSE" positions located at the valve. A control switch providing "OPEN-CLOSE" positions is also mounted on the motor control panel (upper station level)
- The discharge valve operates automatically (linked to pump operation) when the pump selector switch is in the "AUTO" position or in the "LINK-UP" position.
- The valve can be operated manually at pump level by placing the selector switch at the local control panel in the "LOCAL" position and activating the "OPEN-CLOSE" control switch at the valve.
- The valve can be operated manually from the motor control panel at the upper station level by placing the selector switch at the local control panel to the "REMOTE" position and activating the "OPEN-CLOSE" control switch on the motor control panel.

- level sensing in the reservoir
    - o digital level indicator
    - o high level alarm
    - o low level alarm
- level sensing in the 1500 m^3 water tower
    - o digital level indicator
    - o low level alarm
    - o high level alarm
    - o pump start level
- level sensing in the 227 m^3 water tower
    - o digital level indicator
    - o low level alarm
    - o high level alarm
    - o pump stop level
- motor protection
    - o low voltage, phase failure
    - o over current
    - o stator coil high temperature
    - o motor bearing temperature
    - o ground fault
- Pump protection
    - o Failed to start
    - o Failed to stop
    - o Low suction pressure
    - o Pump Bearing temperature

- Low discharge pressure

- Motor operated Valves
  - Position indicator
  - Over torque alarm
  - Failed to open
  - Failed to close

(4) Control Logic

(a) Starting pumps

- With the control switch in "AUTO" the pumps operate automatically according to the level sensors in the elevated tanks.
- The pumps are automatically activated when water levels in the new 1500 m^3 tank drops below an adjustable set-point (+43.0 m MSL)
- If the PLC fails for any reason, the pumps shut down
- Pumps will start against a closed discharge valve. After an adjustable time delay the PLC will modulate the butterfly valve to open.
- Before starting a pump the following conditions must be maintained:
  - The Motor operated discharge valve must be closed
  - The water level in the reservoir must be above LWL (+21.0 m MSL)
  - No motor or pump faults detected
- The pump starters are interlocked so not more than one pump can be started at the same time

(b) Stopping Pumps

- The pump will shutdown when water level in the 227 m^3 tank reach top water level (+46m MSL).
- After pump shutdown the discharge valve will be returned to the normal position i.e. fully closed after a suitable time delay (adjustable automatic slow closure of discharge valves)
- Motor operated discharge valves are equipped with limit switches to indicate fully open and fully closed positions
- If the level of water on the suction side of the pumps drops below an adjustable set-point (19 m) the pump will be shutdown
- Should a pump stop for whatever reason while it is energized (including low liquid level), an integral pump relay will send a pump general alarm signal to the PLC.
- The low level switch in the reservoir will provide a low level alarm for the PLC. In this way the operator will be able to distinguish between a general pump fault and a low liquid level.

- A pressure switch located on the suction side of the pump will protect the pump against low suction pressure if the suction valve is accidentally closed. The set-points are independently adjustable at the pressure switch. This switch is wired into the pump control circuit and operates independent of the PLC. The appropriate alarm (low pressure) is activated whenever the switch is activated.
- A limit switch on the check valve (pump delivery side) will signal the PLC to shutdown the pump if the check valve does not open after a suitable time delay (this is to indicate a broken coupling or a failure of the motor operated discharge valve)
- A limit switch on the check valve (outlet of 227 m^3 elevated tank) will signal the PLC to shutdown the pump if overflow levels are reached and the check valve is not open after a suitable time delay (this is to prevent pumping to a full tank if the check valve fails to open)

f) Operating sequence (automatic control)

- The pump will start automatically verifying the start conditions when the control panel receives a low water signal from the 1500 m^3 elevated tank.
- When the motor is started the control panel will signal the discharge valve to open after a suitable time delay
- The pump will run continuously until receiving a signal from the control panel that top water level has been reached in the 227 m^3 elevated tank.
- If power failure occurs the generator will start after a suitable time delay. The pumps will restart automatically (one at a time) after verifying that power of correct voltage and frequency is available.

3.5.5 Mechanical

(3) Ventilation

Ventilation of the pump house will provide heat relief to the motors. Supply air is provided by a 70 m^3/min fan and ducted to the lower level of the pump house. Exhaust air is provided by two fans, one located on each roof gable 90 m^3/min each.

(4) Drainage

Gutter drains are provided around the perimeter of the pump room to collect water that may leak or be drained during repairs or maintenance. Generally the floor will be sloped towards the gutter drain. A sump will collect water from the drains and a duplex sump pump arrangement will discharge water to a surface drain outside the station.

3.5.6 Architectural

The building is reinforced concrete frame. Walls above grade are in filled with 200 mm concrete blocks. The walls are plastered and painted on both sides. Walls below grade are structural concrete and will have fair-faced surfaces. Walls will be finished with a breathable coloured sealer for ease of maintenance and light reflectivity. Concrete floors will receive a clear concrete sealer to prevent dusting.

Roofing is zinc aluminium sheets laid on steel purlins. Doors and windows are anodised aluminium.

3.5.7 Structural Design

(3) Foundation design

A detailed geotechnical report describing soil conditions and recommended foundation design parameters is enclosed in Supplementary Data to Tender Documents for Civil Works.

Boreholes could not be taken in the location of the proposed ground reservoir since the study team could not obtain permission from the Hospital to access to the site. Geotechnical evaluation for the ground reservoir is based on a single borehole drilled along Halgahadeniya Road, which is not located within the proposed reservoir area. The results of boreholes taken at the water tower site are used for the pump house.

The allowable soil bearing pressure is 250 kN/m^2. Groundwater levels vary between +15.99 m MSL at the S/E side to +19.0 m MSL at the tower site . Foundations for the reservoir are set above GWL at +20.4 m MSL. The sump is just below ground water level at +10.55 m MSL. The foundation for the pump house floor is also below GWL at +10.9 m MSL. A groundwater drainage system is provided under and around the perimeter of the reservoir and pump house to relieve any build up of ground water level

Before proceeding with construction, geotechnical design parameters should be confirmed by additional investigations within the proposed reservoir area. Final design drawings should then be adjusted if necessary. A minimum of 3 additional boreholes located within the reservoir and pump house area should be taken prior to final design and construction.

(4) Design methodology

The reservoir structure is reinforced concrete designed according to BS 8007: 1987 for water retaining structures which requires the design of reinforcement steel to limit maximum crack width to 0.2 mm or less. Walls for the reservoir and pump house have been designed to resist full height of water in the sump (+26.25 m MSL) without the assistance of soil pressure. Under the empty conditions all walls are designed against pressure from earth backfill.

The outside walls are designed as cantilevered retaining walls with 3.5 m base inside and 1.3 m toe. The walls are tapered from 650 mm at the base to 400 mm at the top. The central dividing wall is designed as a cantilevered retaining wall to rests overturning when one side is empty. The base is 3 m wide on each side of the wall. A 1 m deep key is provided to prevent sliding.

The base slab is designed as a raft mat. Water bar is provided between the base of the wall slab and the floor slab. The roof is flat slab supported on 400 mm square columns with a grid spacing of 5.33 m x 5.44 m. a sliding joint is provided where the roof rests on top of the wall.

The pump house building is reinforced concrete raft foundation with monolithic reinforced concrete walls to grade level. The foundation is designed using the most unfavourable conditions i.e. dead and live load, and sump full water. The slab (and the whole structure) is also designed against uplift forces and flotation in the event of seasonal high groundwater or localized flooding.

It is necessary to provide a superstructure with clearance and capability for removal of pumps, and valves for maintenance. The superstructure is designed to house a motor-driven over-head crane and allowance has been made in the design for the impact load. The overhead travelling crane will be provided to the full length of the building.

The proposed roofing material is light weight steel roofing (with Zinc/Aluminium Alloy steel or Colourbond manufactured to recognized international standard) on steel lipped channel purlins supported on steel trusses or on RC beams resting directly on top members of concrete frames.

Specific criteria used for design of the structure and design calculations are presented in the Design Report. Details of the structural design are provided in the Design Report and drawings KMU/PS/ST-01 to ST-12.

3.5.8 Civil Works

(1) Grading and Drainage

Backfill around the perimeter of the structures will be free draining granular material for a width of 500 mm.

(2) Roads

A new 6 m wide asphalt access road s provided n front of the pump house. Two entrances are required since there is insufficient space for truck turning on the site.

(3) Fencing

Chain link fence 2m high is provided around the perimeter of the site. Two double gates accommodate large trucks.

3.6 GOTHATUWA NEW WATER TOWER

3.6.1 Process Design

The water towers provided as additional storage and to maintain pressures in the distribution lines.

(6) Capacity

A size of 1500 m^3 is generally used by NWSDB as standard for water towers. This will provide 1.15 hours of storage at maximum day demand in the year 2020. The existing 227 m^3 water tower increase storage to 1.34 hours.

Characteristics of the new structure:

Volume of clear well	:	1500 m^3
High water level	:	+47.5 m MSL
Low water level	:	+ 41.5 m MSL

Note: low water level is set to match the bottom of the existing 227 m^3 tower.

3.6.2 Piping Arrangement

Piping for the water tower is presented on drawing KMU/WT/YP-01. The inlet, outlet and washout / overflow pipes will be accommodated within the shaft. The inlet riser to the new tank is 450 mm ND and is supplied directly from the pumping main. The inlet is terminated inside the tank with a bell mouth submerged 1 m below the top water level. The water tower can be by-passed by operating valves locate in the piping gallery at the base of the water tower.

The outlet riser is 450 mm ND and a magnetic flow meter is provided to record the flow out of the new tank. The new tank is connected to the old tank bay a 150 mm ND connection. The outlet of the old tank is metered and connected separately to the distribution system.

A 300 mm ND washout and overflow riser is connected to the common wash out header for the reservoir.

Maintenance access is provided by a series of stairs and landings. A concentric tube goes through the tank and provides access to the roof. A 600 x 1000 mm opening above high water level provides access to the inside of the tank for maintenance

3.6.3 Structural Design

(1) Foundation design

A detailed geotechnical report describing soil conditions and recommended foundation design parameters is enclosed in Supplementary Data to Tender Documents for Civil Works.

The water tower has a shallow circular raft foundation with a design bearing pressure limited to within the allowable bearing capacity of 250 kN/m^2. The foundation will be set at +22.25 m MSL.

The material at foundation level is classified as hard laterite. Very high SPT values were recorded in the overburden. Ground water is at an elevation of +19.02 m MSL.

(2) Design methodology

The 1,500 m^3 water tower will be reinforced concrete of the same Intz-type design adopted by NWSDB in other locations. Ground elevations at the site vary from +24.38 m MSL to +23.38 m MSL. The foundation level is set at +22.25 m MSL at same elevation as the existing water tower. The top water level is set at +47.5m MSL and the low water level at +42.5m MSL The cylindrical water tank has a conical bottom that will be supported on a circular reinforced concrete shaft bearing onto a raft foundation. The inlet and outlet piping will be accommodated within the circular shaft. Access stairs and landings will be provided to the bottom of the tank. A thin walled shaft will be provided in the center of the tank for service access.

The structure is designed according to BS 8007: 1987 for water retaining structures which requires the design of reinforcement steel to limit maximum crack width to 0.2 mm or less.

3.6.4 Electrical

(1) Internal Lighting

Internal lighting is provided at each of the platform levels within the cylindrical wall and also inside the shaft up to the lantern level. Inner space of the tank compartment is illuminated by the lamps fixed on to the external surface of the shaft below crown of the spherical dome.

(2) Lightning Protection

Lightning protection is provided for the tower by adopting "Early Streamer Emission" type air terminations (finials). This would provide a reliable and adequate level of protection with the use of one or two finials - as opposed to the use of several finials at roof-top, if the conventional passive finials are adopted. Copper tapes will connect the air terminations to copper plate earth electrodes buried 1.5 M below ground level.

(3) Aircraft obstruction warning light

The aircraft warning light is installed on a mast fixed to the lantern roof conforming to International Aviation Standards.

3.6 DISTRIBUTION MAINS

3.7.1 Outline

Existing distribution network required to be strengthened to supply water throughout Kotikawatte-Mulleriyawa area from the Gothatuwa Water Tower and Gothatuwa New Water Tower. As-built drawings are not available with NWSDB and the existing distribution mains were laid in an ad-hoc manner and mainly to distribute water around respective transmission main tappings. Pipeline routes required to be strengthened to satisfy year 2020 water demand are determined based on a preliminary network analysis. These new pipelines will be connected to existing pipelines through interconnections around the network to boost the pressures. Network Analysis is shown in Appendix 3C.

Approximately 40 km of priority pipeline routes were identified to be constructed under this project. Route and leveling surveys were carried out along these priority pipeline routes for detailed design. Drawing KMU/DM/G-01 shows both existing and priority pipelines while drawing KMU/DM/G-02 shows the locations of the proposed priority distribution to be constructed under this project. Table 3-15 shows the road name, pipe diameter and material, ground level of the priority pipelines. Table 3-16 shows a summary of lengths for each diameter.

Table 3-15 Summary of Priority Pipelines for Strengthening (1/2)

Name of Road	Node No.	Road Authority	Elevation, m MSL	Distance, m	Diameter / Material
1. I. D. H. Road	N98	RDA	22.95		
	N312B		18.42	187	500 mm DI
2. Kotikawatta Road	N312A	RDA	2.82		
	N354		2.75		
	N368		3.95		
	N601		3.60	1,689	400 mm DI
3. Kohilawatta Road	N601	RDA	3.60	75	400 mm DI
	N532		2.67		
	N679		3.70	1,188	300 mm DI
4. Angoda Road /	N888	PRDA	15.00		
	N892		17.50		
Siri Sumana Mawatha	N1137	PRDA	4.35	1,370	300 mm DI
	N1166		3.65		
	N1215		3.65	804	110 mm PVC
5. Meegoda Kolonnawa	N312A	RDA	2.82		
Road /	N265	PRDA	7.10	1,282	300 mm DI
	N86		6.60		
Katupelella Road	N407	PRDA	3.00		
	N397		1.46		
	N500		3.06	2,900	225 mm PVC
6. Delgahawatta Road	N354	PRDA	2.75		
	N931				
	N892		17.50	1,328	300 mm DI
7. Bandaranayakapura Road	N98	PRDA	22.95		
	N177		22.05	135	500 mm DI
	N137		2.57	1,007	300 mm DI
8. Buthgamuwa Road /	N137	RDA	2.57		
Koswatta Road /	N133	PRDA	2.31		
	N834		6.67		
Angoda Road	N837	PRDA	3.58		
	N823		2.57	2,653	300 mm DI
9. Halgahasdeniya Road	N22	PS	21.56		
	N199		3.58	400	160 mm PVC
	N177		3.58	295	225 mm PVC
	N199	PS	3.58		
	N170		2.57	474	225 mm PVC
10. Thapowanaya Road	N834		5.87		
	N846		21.00	213	250 mm DI
11. Sri Perakum Mawatha /	N892	PS	17.50		
Ranabiru Mawatha	N984	PS	5.80	381	300 mm DI
	N1127		5.08	984	225 mm PVC
	N1227		5.54	846	110 mm PVC
12. Old Avissawela Road	N1227	RDA	4.35		
	N679		3.12	2,362	110 mm PVC
	N500		3.06		
	N373		2.38	2,338	225 mm PVC
	N750		1.90	627	160 mm PVC
13. Gothatuwa Road	N265	PRDA	7.10		
	N389		3.15	804	225 mm PVC
SUB-TOTAL				24,342	

Table 3-15 Summary of Priority Pipelines for Strengthening (2/2)

Name of Road	Node No.	Road Authority	Elevation, m MSL	Distance, m	Diameter / Material
14. Brandiyawatta Road	N712	PRDA	3.50		
	N387		2.20	1,424	225 mm PVC
15. Nagahawela Road	N368	PRDA	3.95		
	N1145		4.60		
	N631		4.75	1,061	110 mm PVC
16. Abeysiri Perera Mawatha	N1145	PS	5.46		
	N1151		4.96	426	110 mm PVC
17. Malpura Road	N1313	PS	2.00		
	N1314		19.50	658	110 mm PVC
18. Dahamwila Mawatha	N532	PS	2.67		
	N655		2.42	270	110 mm PVC
19. Buthgamuwa Road	N312A	RDA	16.01		
	N168		4.15	365	160 mm PVC
	N128		2.36	571	110 mm PVC
20. Buthgamuwa Road	N128	RDA	2.36		
	N137		2.57	303	110 mm PVC
21. M. D. H. Jayawardena	N128	PRDA	2.36		
Mawatha &	N130A		2.82		
Elhena Road	N130B		3.57		
	N142		14.20	334	110 mm PVC
22. M. D. H. Jayawardena	N130B	PRDA	3.57		
Mawatha	N153		14.20		
	N63		4.10	1,263	110 mm PVC
23. Moravitiya Road	N168	PS	4.15		
	N130A		2.82	553	110 mm PVC
24. Pethiyagoda Road	N1315	PS	12.65		
	N984		5.80	885	160 mm PVC
25. Shanthi Mawatha	N1071	PS	18.15		
	N768		12.25	569	160 mm PVC
26. Udumulla Road	N1096	PRDA	16.65		
	N1003		15.85		
	N1015		12.54	1,406	300 mm DI
	N1014		7.00	333	225 mm PVC
27. Pansala Road /	N1085	PS	16.50		
Jayanthi Mawatha /	N1080	PS	18.35	352	225 mm PVC
Batahena Road	N1004	PS	16.30		
	N1003		15.30	615	160 mm PVC
28. Galwalahena Road	N1016	PRDA	16.45		
	N1019		21.50	471	160 mm PVC
29. Fever Hospital Road	N98	RDA	22.95		
	N22		6.50		
	N823		8.46	1,520	500 mm DI
30. Angoda Road	N823	PRDA	8.46		
	N888		15.00	282	500 mm DI
31. Himbutana Road	N888	PRDA	15.00		
	N1096		16.65		
	N1071		18.15	1,710	300 mm DI
SUB-TOTAL				15,371	
TOTAL				39,713	

Table 3-16 Summary of Priority Pipeline by Diameter

Diameter and Material	Required Length, m
500 mm DI	2,124
400 mm DI	1,764
300 mm DI	12,290
250 mm DI	213
Sub-total	16,391
225 mm PVC	9,904
160 mm PVC	3,932
110 mm PVC	9,486
Sub-total	23,322
Total	39,713

3.7.2 Network Analysis and Pipe Network Design

(a) Basis of Network Analysis

1. Length and ground elevation from the survey along priority pipeline routes are used together with elevations shown on topographic map for other routes.
2. Hazen-Williams Equation was used with the following C values for pipelines.

For all PVC mains above 110 mm or 4”	- 130
DI pipes with cement mortar lining	- 120
All existing pipes less than 4”	- 90

4. New pipelines along Avissawella Road was avoided as there are four large size transmission mains (36”) and a 110 PVC distribution main existing on that road. Laying another main will be extremely difficult unless road is widened. Network analysis is made considering only the existing distribution main in that road. Distribution main could be laid when road widening is carried out and provisions will be made on the detailed design by installing blank flanges for future pipe laying.

(b) Fire Requirement

Network analysis was carried out to confirm the availability of fire fighting requirements according to that specified in the Chapter 2 General Design Criteria at the proposed locations of fire hydrants in the network.

(c) Waste District

Provisions are made by constructing wastemeter chambers to divide the network into two waste districts where the flow into each district can be measured at both sides of the exits of water towers.

3.7.3 Detailed Design

Detailed Design is described in Section 4.5 of the Design Report and the following are the salient points.

(a) Normal operating pressure is 4.75 bars and the test pressure is 7.5 bars.

(b) Interconnections will be made to the existing pipe network at forty two locations supplying water from the Gothatuwa Water Tower and Gothatuwa New Water Tower. Each interconnection will be through a valve such that control of existing and proposed pipeline network can be controlled independently.

(c) Two canal crossings at Delgahawatta Road Bridge and at Angoda Road Bridge where pipe support structures independent of existing bridges are designed.

(d) Section valves are provided such that sections of proposed pipeline can be isolated for maintenance etc.

(e) Air valves are provided at all humps.

(f) Washouts are provided at troughs generally near existing culverts.

(g) Three types of culvert crossings are used depending on the site conditions. Damage to the existing culvert structure, if any, shall be repaired.

(h) Twelve numbers of fire hydrants will be provided at major junctions and facilities.

(i) Blank flanges are provided at pipes crossing Low Level Road to facilitate pipe laying in the future when the road is widened.

Interconnections to existing distribution system, disconnecting of existing sump and pump and commissioning of new supply are further discussed in the following section.

3.7.4 Interconnection to Existing Distribution System

All interconnection to existing distribution system are identified with the node number of the network. Sketch of the plan view of existing and proposed pipelines are shown and included in the Supplementary Data to Tender Documents for Civil Works. Junction detail showing the required fittings for the interconnections and pipe junctions are shown in the distribution main drawings.

3.7.5 Closure of Existing Transmission Main Tappings

Basic concept of enhancement of Kotikawatte and Mulleriyawa water supply is to limit the water supply to Kotikawatte and Mulleriyawa areas from the water tower and to relieve existing transmission mains to their intended purpose. Therefore, all the existing transmission main tappings shall be closed when the new system is commissioned.

Procedure to be followed when closing the existing tappings are discussed in Sub-section 4.5.3.15 Commissioning of New Supply of the Design Report.

3.7.6 Disconnecting of Existing Sump and Pump House

Existing sump and pump house need to be disconnected and abandoned. Figure 3-16 shows the schematic of existing pipe connection and after disconnection. Existing 160 mm PVC from Dehiwela Transmission Main washout will be connected to 500 mm DI distribution main and to the existing pumped main (110 mm PVC). Existing pumped main shall be encapped prior to existing tower and will be used as distribution main.

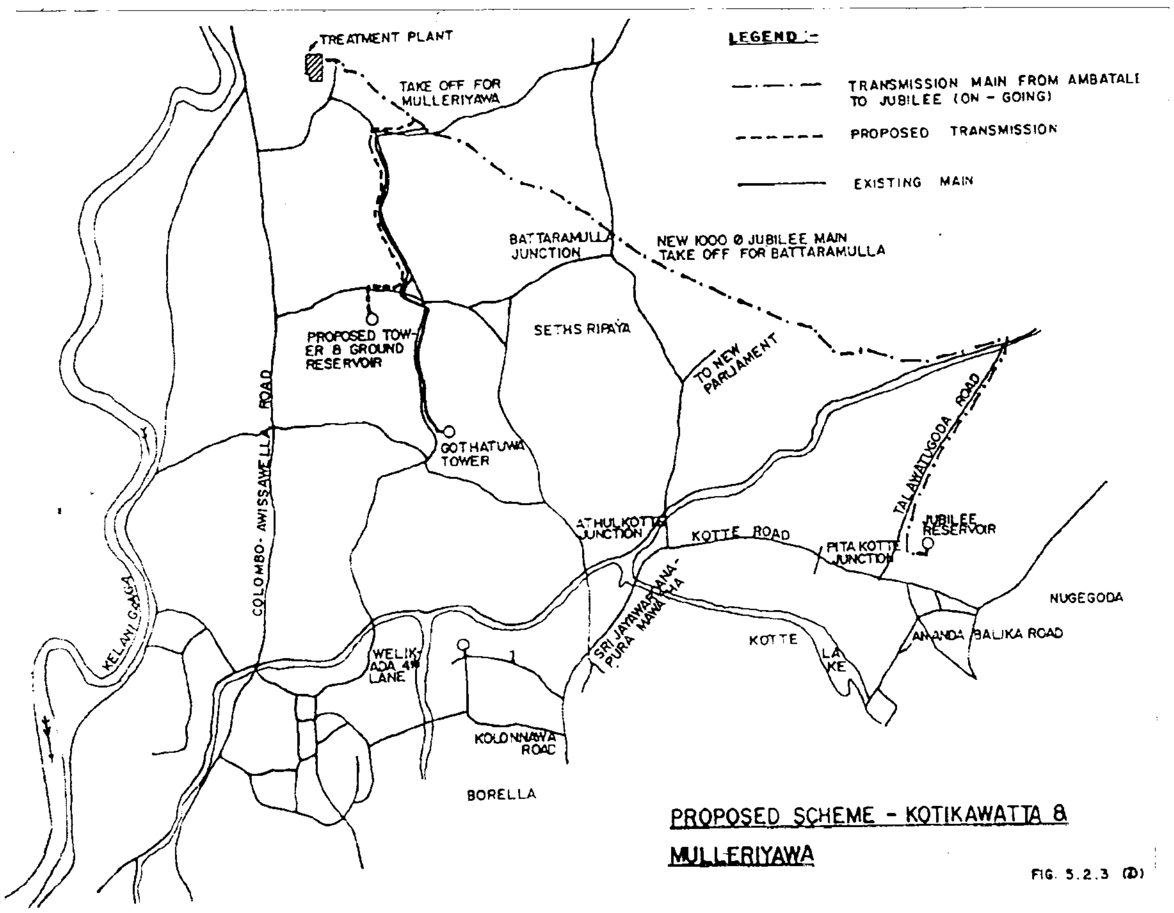
Disconnection of sump can only be made after tapping on Dehiwela Transmission Main and existing Kolonnawa Transmission mains are closed and the new tower is successfully put on service. Time when this can be carried out in the overall program of commissioning is discussed in Sub-section 4.5.3.15 Commissioning of New Supply of the Design Report. Once disconnected, existing tower shall also be isolated to facilitate the alteration of piping and shall be put on service on completion.

3.7.7 Commissioning of New Supply

Commissioning of new supply can be done once the proposed pipe network is completed and tested and Gothatuwa-Kolonnawa Pump House, Gothatuwa Transmission Main, Gothatuwa Ground Reservoir and Pump House and Gothatuwa New Water Tower are ready for commissioning. Closure of the existing transmission tappings shall be done one by one while commissioning the supply from the new system based on the following rule.

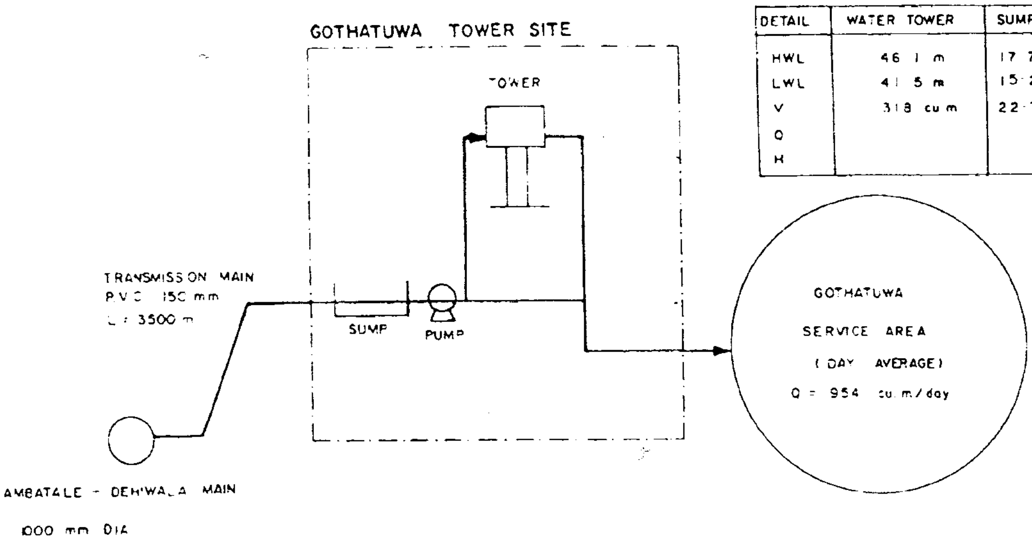
- ***As much as possible current pressures and direction of flow shall be maintained***
  - Interconnection to the existing system shall be opened near the location where the existing transmission tapping is closed.
  - Interconnection around areas where there is insufficient pressure shall be opened to the required pressure.
  - Wherever pressure is insufficient opening of interconnection shall be carried out for example at N297 and at N846
  - Opening of other interconnection shall be carried out in the course of time when increase of pressure is required for a particular area

Major steps to be followed for closing of transmission main tappings and commissioning the new system is outlined in Sub-section 4.5.3.15 Commissioning of New Supply of the Design Report.



Note: Transmission main from Ambatale to Jubilee Reservoir has been completed.

FIG. 3-1	World Bank Study (1993) Proposal for Kotikawatte – Mulleriyawa Area Water Supply
SCALE	Not to scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



DETAIL	WATER TOWER	SUMP	PUMP
HWL	46 1 m	17 7 m	
LWL	41 5 m	15·2 m	
V	318 cu m	22·7 cu.m	
Q			1·46 cu.m
H			27 m

SYSTEM DIAGRAM

GOTHATUWA DISTRIBUTION SYSTEM

FIGURE 5.2.3. (C)

FIG. 3-2	World Bank Study (1993) Proposal for Gothatuwa Distribution System
SCALE	Not to scale

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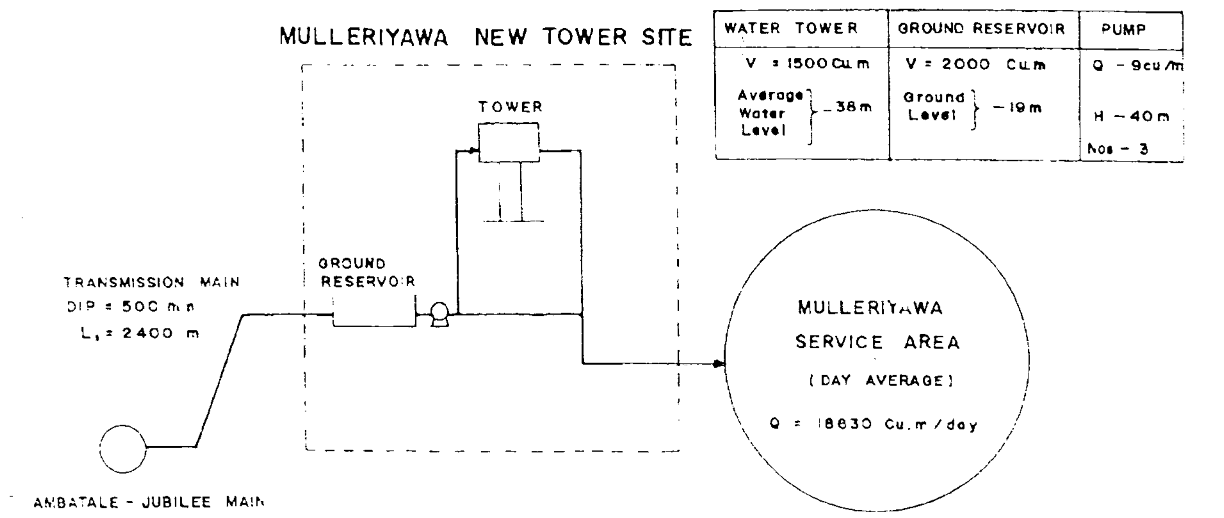

SYSTEM DIAGRAM
MULLERIYAWA DISTRIBUTION SYSTEM

FIGURE 5.2.3 (B)

FIG. 3-3	**World Bank Study (1993) Proposal for Mulleriyawa Distribution System**
SCALE	Not to scale

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THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

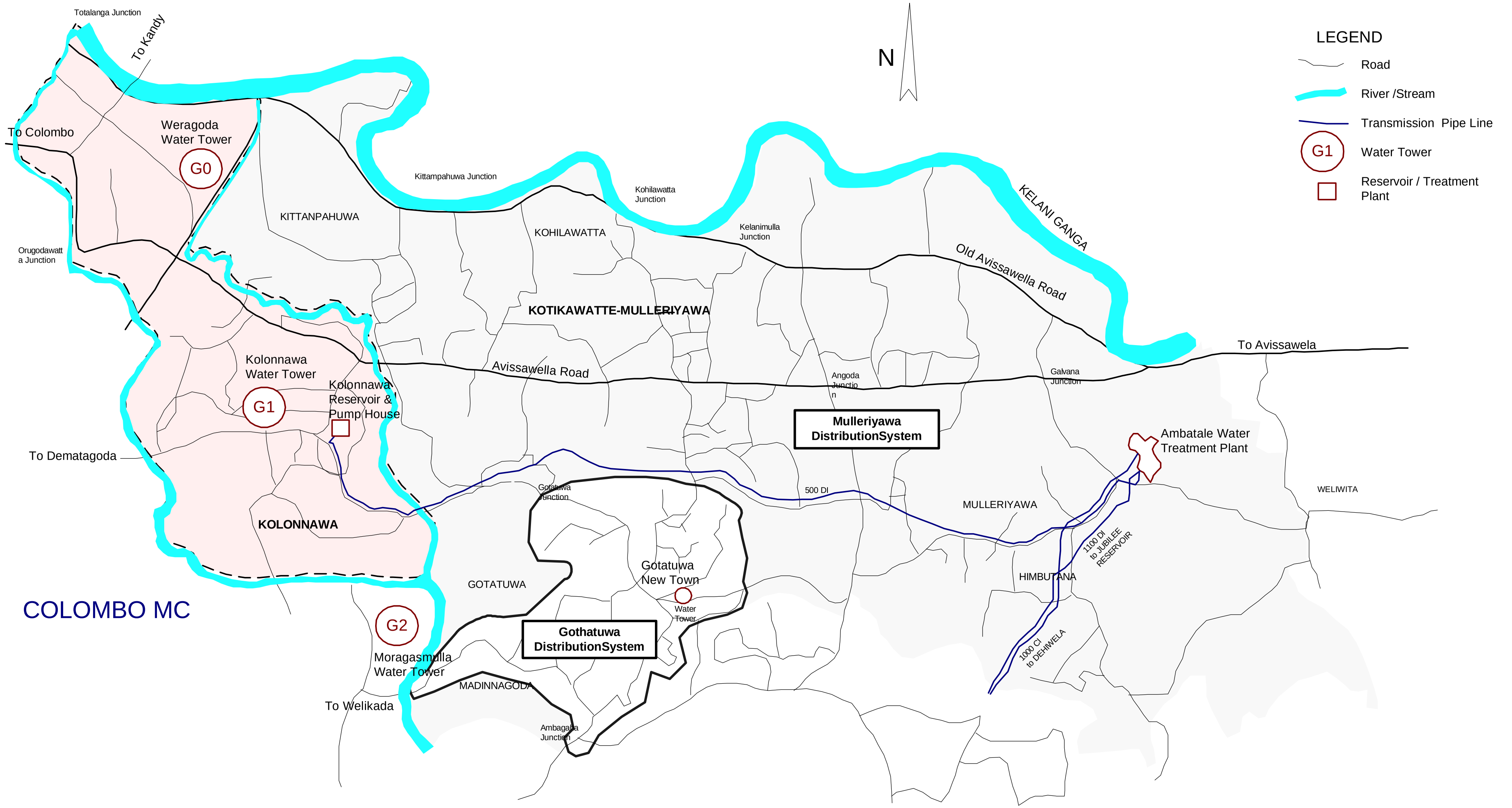

FIG. 3-4	NWSDB Proposal (1999) for Kotikawatte-Mulleriyawa Area Distribution System
SCALE	Not to scale

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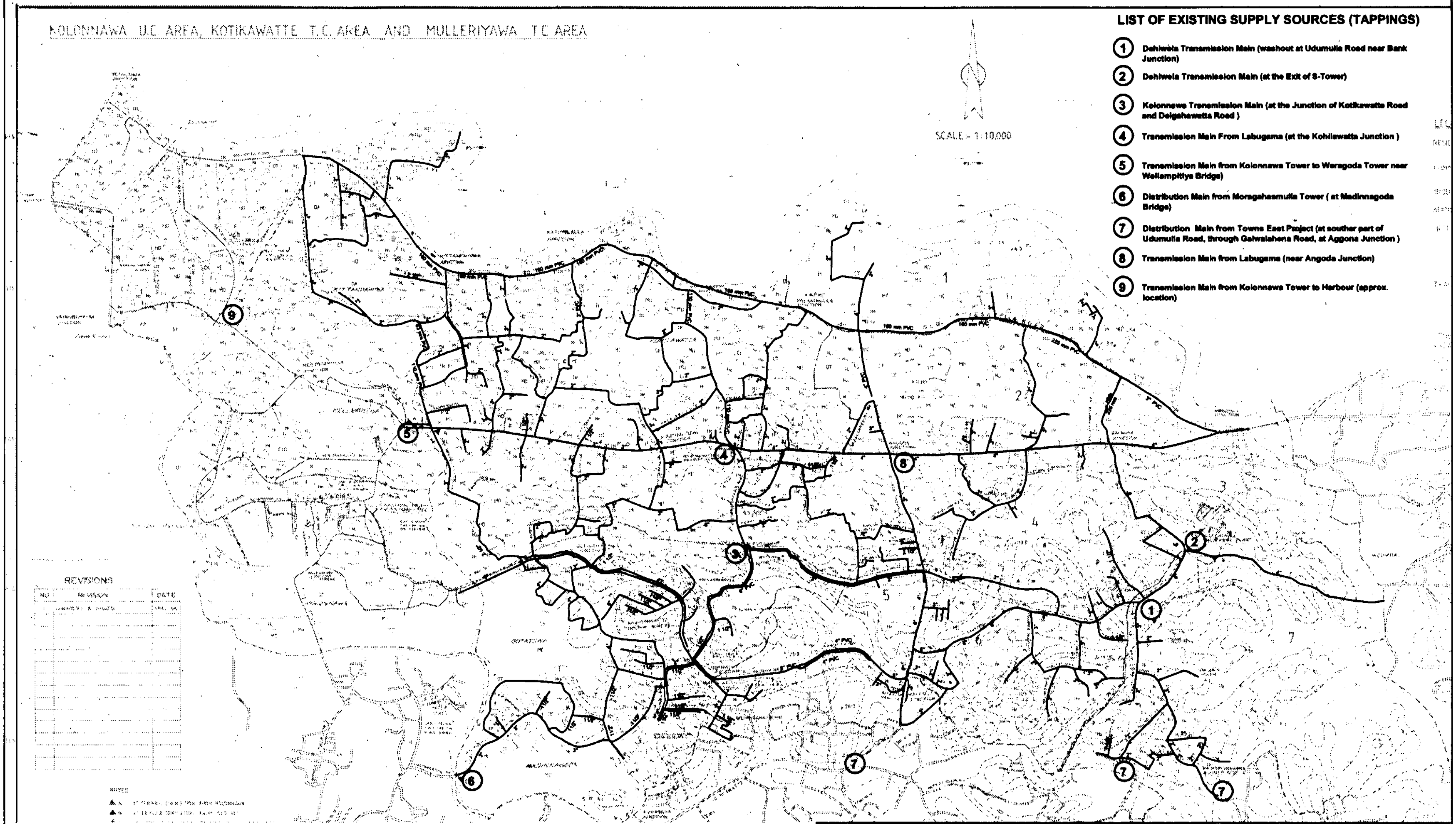

FIG. 3-5	Existing Distribution Pipe Network in Kotikawatte-Mulleriyawa Area
SCALE	NOT TO SCALE

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THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FIG. 3-6	Low Pressure Areas in Kotikawatte-Mulleriyawa Area
SCALE	Not to scale

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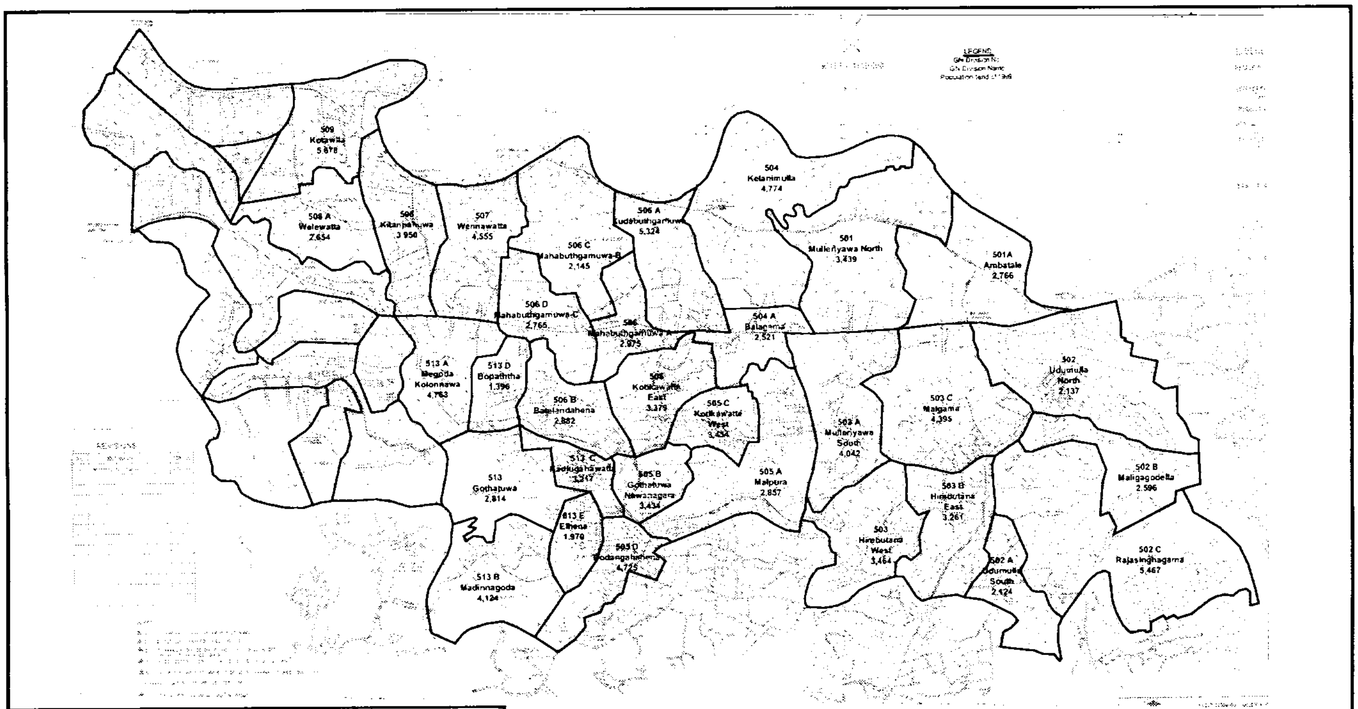
THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

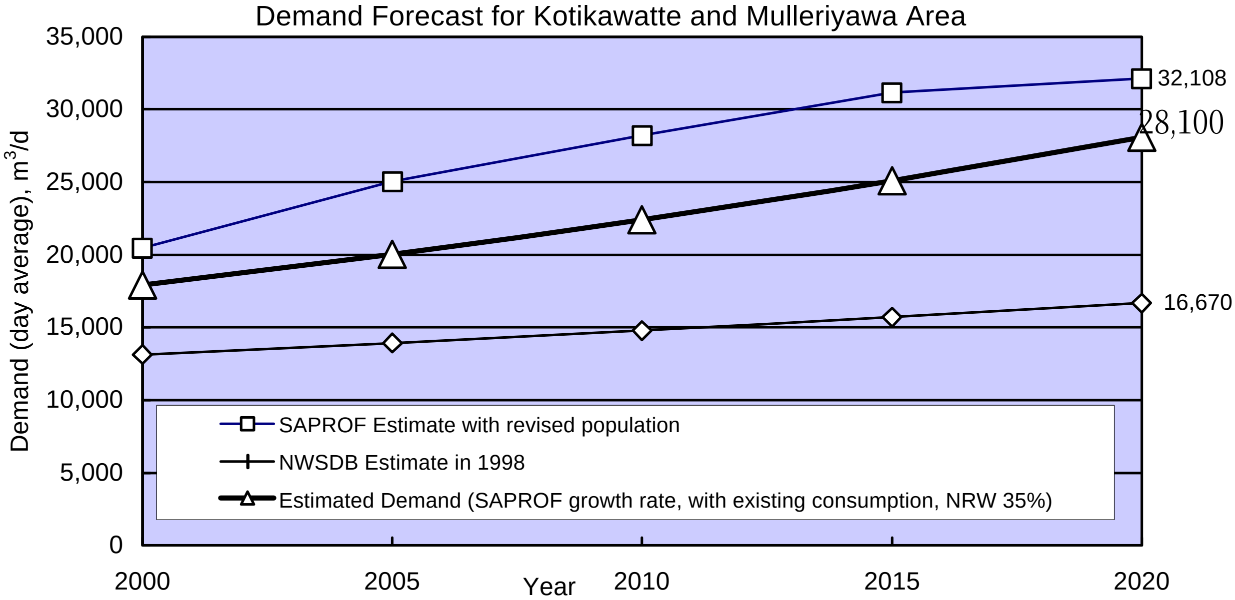


No.	Ref. No.	GN Division	Population (end of 1999)
1	501	Mulleriyawa North	3,439
2	501 A	Ambatale	2,766
3	502	Udumulla North	2,137
4	502 A	Udumulla South	2,124
5	502 B	Maliga Godalla	2,596
6	502 C	Rajasingha Gama	5,467
7	503	Himbutana West	3,464
8	503 A	Mulleriyawa South	4,042
9	503 B	Himbutana East	3,261
10	503 C	Malgama	4,395
11	504	Kelanimulla	4,774
12	504 A	Balagama	2,521
13	505	Kotikawatte East	3,379
14	505 B	Gothatuwa Nawanagara	3,434
15	505 A	Malpura	2,857
16	505 C	Kotikawatte West	3,528
17	505 D	Dodangahahena	4,725
18	506	Mahabuthgamuwa A	2,975
19	506 A	Kuda Buthgamuwa	5,324
20	506 B	Batalanda Heena	2,882
21	506 C	Mahabuthgamuwa B	2,145
22	506 D	Mahabuthgamuwa C	2,765
23	507	Wennawatta	4,555
24	508	Kitanpahuwa	3,950
25	508 A	Welewata	2,654
26	509	Kotuwila	5,768
27	513	Gothatuwa	2,814
28	513 A	Megoda Kolonnawa	4,763
29	513 B	Madinnagoda	4,124
30	513 C	Kajugahawatta	3,217
31	513 D	Bopatha	1,396
32	513 E	Alhena	1,970
		Total	110,211

FIG. 3-7	**Population Distribution of Kotikawatta-Mulleriyawa PS**
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA



Estimated Demand

Year	2000	2005	2010	2015	2020	Average Growth Rate year 2000-2020
SAPROF Estimate with revised population	20,464	25,043	28,199	31,149	32,108	2.28%
NWSDB Estimate in 1998	13,126	13,933	14,790	15,700	16,670	1.20%
Estimated Demand (SAPROF growth rate, with existing consumption, NRW 35%)	**17,900**	20,036	22,426	25,102	**28,100**	2.28%

Estimate of existing consumption for Kotikawate/Mulleriyawa

Connection Category	No. of Connection	Consumption	Consumption
	Kotikawatte / Mulleriyawa	m^3/month/ connection	m^3/day
Domestic	9,522	0.71	6,775
Stand Posts	144	11.2	1,616
Non-domestic	282	1.9	537
Sub-total	9,948		8,928
Priority	13		2,700
Sub-total	9,961		11,628
NRW at 35%			4,475
TOTAL SUPPLY			**17,900**

FIG. 3-8	**Estimated Water Demand for Kotikawatte – Mulleriyawa Areas**
SCALE	Not to scale

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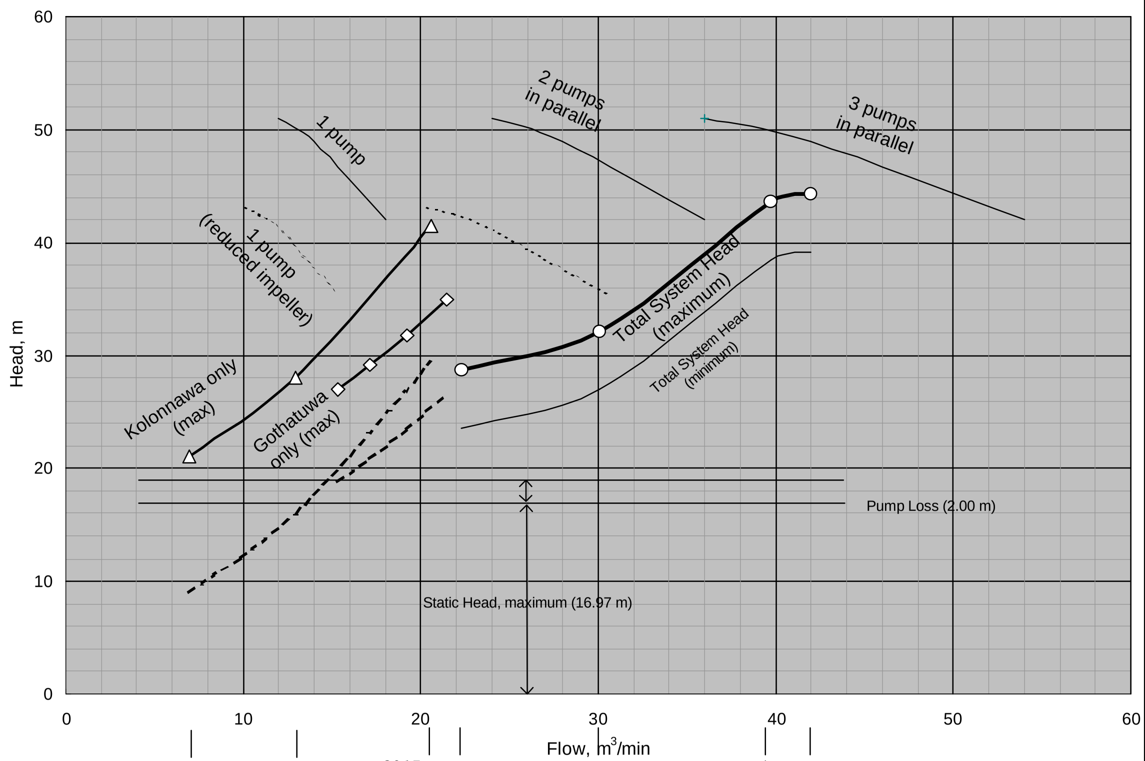
THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FIG. 3-9	High Elevation Areas in Kotikawatte-Mulleriyawa Area
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

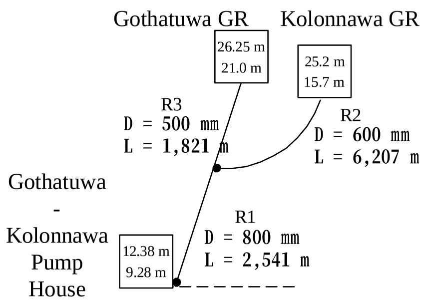
System Head Curves



Kolonnawa	2005	2010	2015 and 2020
Day Max (m^3/d)	10,100	18,655	29,575

Gothatuwa + Kolonnawa	2005	2010	2015	2020
Day Max (m^3/d)	32,050	43,324	57,187	60,485

Gothatuwa	2005	2010	2015	2020
Day Max (m^3/d)	22,040	24,669	27,612	30,910



Pumping to Gothatuwa and Kolonnawa

Item		Unit	2005	2010	2015	2020
Quantity of water transmission						
Flow required at Gothatuwa	Q_{KM}	L/s	255.0	285.5	320.0	357.8
Flow required at Kolonnawa	Q_{Kol}	L/s	116.0	216.0	342.3	342.3
Total flow required	Q_{tot}	L/s	371.0	501.5	662.3	700.1
Friction loss in pipeline						
Gothatuwa-Kolonnawa Pump House - Hospital Juncti	R1	m	2.15	3.75	6.27	6.95
Hospital Junction - Kolonnawa GR	R2	m	2.48	7.82	18.34	18.34
Hospital Junction - Gothatuwa GR	R3	m	7.58	9.35	11.54	14.19
Effective friction loss	If R2>R3, R1+R2	m			24.61	25.29
	If R2<R3, R1+R3	m	9.73	13.10		
Static Head						
Gothatuwa-Kolonnawa Pump House Sump	LWL	m	9.28	9.28	9.28	9.28
	HWL	m	12.38	12.38	12.38	12.38
Gothatuwa GR	HWL	m	26.25	26.25	26.25	26.25
	LWL	m	23.75	23.75	23.75	23.75
New Kolonnawa GR	HWL	m	25.20	25.20	25.20	25.20
	LWL	m	23.75	23.75	23.75	23.75
Maximum Static Head						
Gothatuwa-Kolonnawa Pump House Sump - Gothatuwa GR		m	16.97	16.97	16.97	16.97
Gothatuwa-Kolonnawa Pump House Sump - New Kolonnawa GR		m	15.92	15.92	15.92	15.92
Minimum Static Head						
Gothatuwa-Kolonnaw Pump House Sump - Gothatuwa GR		m	11.37	11.37	11.37	11.37
Gothatuwa-Kolonnawa Pump House Sump - New Kolonnawa GR		m	11.37	11.37	11.37	11.37
Effective static head	maximum	m	16.97	16.97	16.97	16.97
	minimum+ 0.5 m	m	11.87	11.87	11.87	11.87
Other Losses						
Around the pump		m	2.0	2.0	2.0	2.0
Effective friction loss		m	9.73	13.10	24.61	25.29
System Head Characteristics						
Total pumping head required	maximum	m	28.70	32.07	43.58	44.26
	minimum	m	23.60	26.97	38.48	39.16
Total flow		m^3/min	22.26	30.09	39.74	42.01
Flow to Gothatuwa GR		m^3/min	15.30	17.13	19.20	21.47
Total Head Loss from Ambatale to Gothatuwa GR		m	28.70	32.07	36.78	40.11
Flow to New Kolonnawa GR		m^3/min	6.96	12.96	20.54	20.54
Total Head Loss from Ambatale to Kolonnawa GR		m	23.60	30.54	43.58	44.26

Pumping to Gothatuwa only

System Head Characteristics			2005	2010	2015	2020
Total pumping head required	maximum	m	27.62	29.64	32.14	35.17
	minimum	m	22.02	24.04	26.54	29.57
Total flow		m^3/min	15.30	17.13	19.20	21.47

Pumping to Kolonnawa only

System Head Characteristics			2005	2010	2015	2020
Total pumping head required	maximum	m	20.65	26.54	38.11	38.11
	minimum	m	16.60	22.49	34.06	34.06
Total flow		m^3/min	6.96	12.96	20.54	20.54

Note: Pumping head requirements are governed by Kolonnawa facilities which are at planning stage and are based on the data provided by NWSDB.

FIG. 3-10	**System Head Curves for Pumping to Gothatuwa and Kolonnawa**
SCALE	Not to scale

JICA STUDY TEAM
THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

GOTHATUWA - KOLONNAWA TRANSMISSION MODEL

DESIGN FLOWS, L/s

AREA	2005	2010	2015	2020
GOTHATUWA	255.0	285.5	320.0	357.8
KOLONNAWA	116.0	216.0	342.3	342.3
TOTAL	371.0	501.5	662.3	700.1

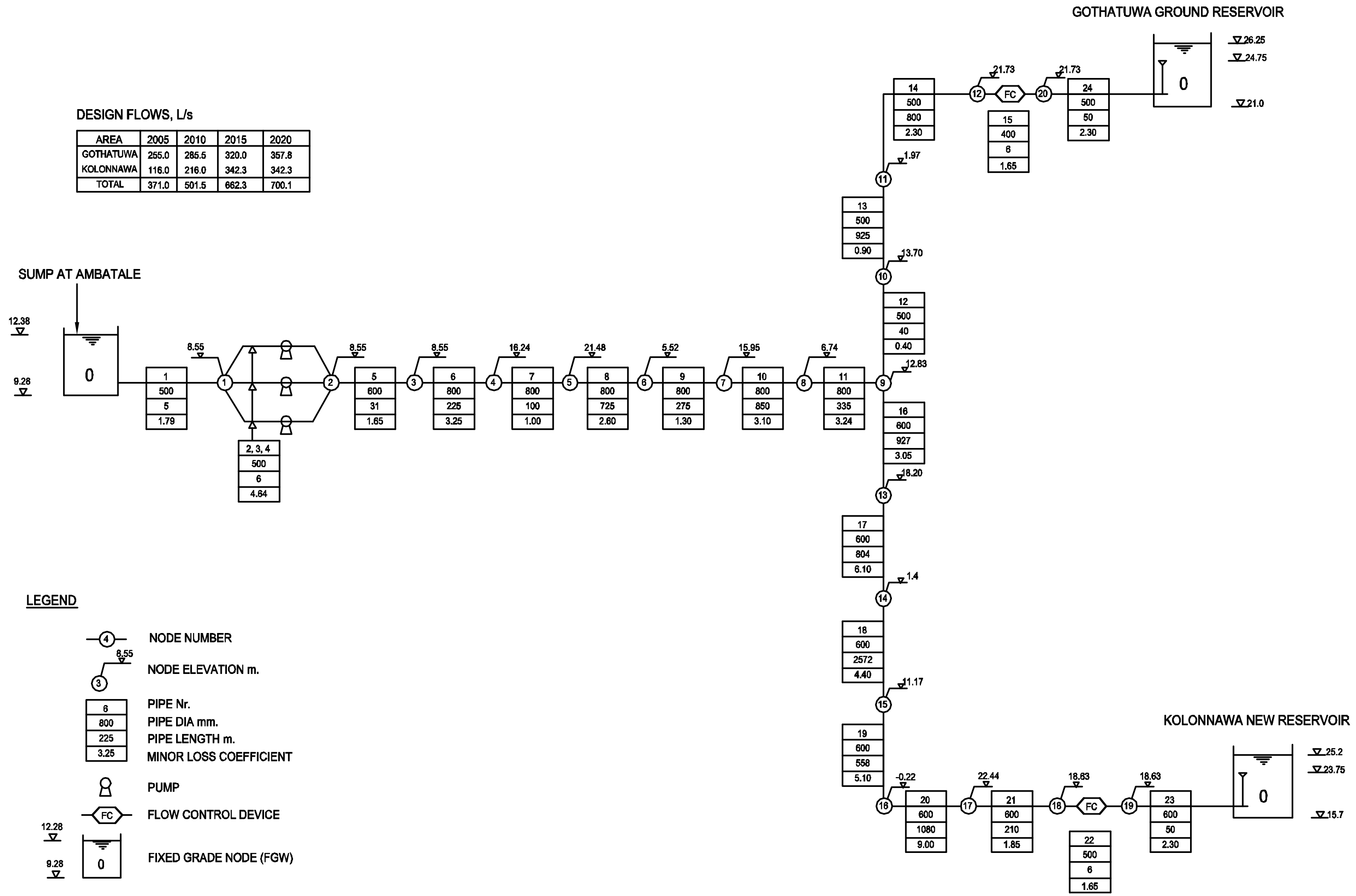


FIG. 3-11	**Gothatuwa - Kolonnawa Transmission Model**
SCALE	Not to Scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

GOTATHUWA - KOLONNAWA TRANSMISSION SYSTEM
MODEL FOR SURGE ANALYSIS
(WITH SURGE TANK AND AIR VALVES IN PLACE)

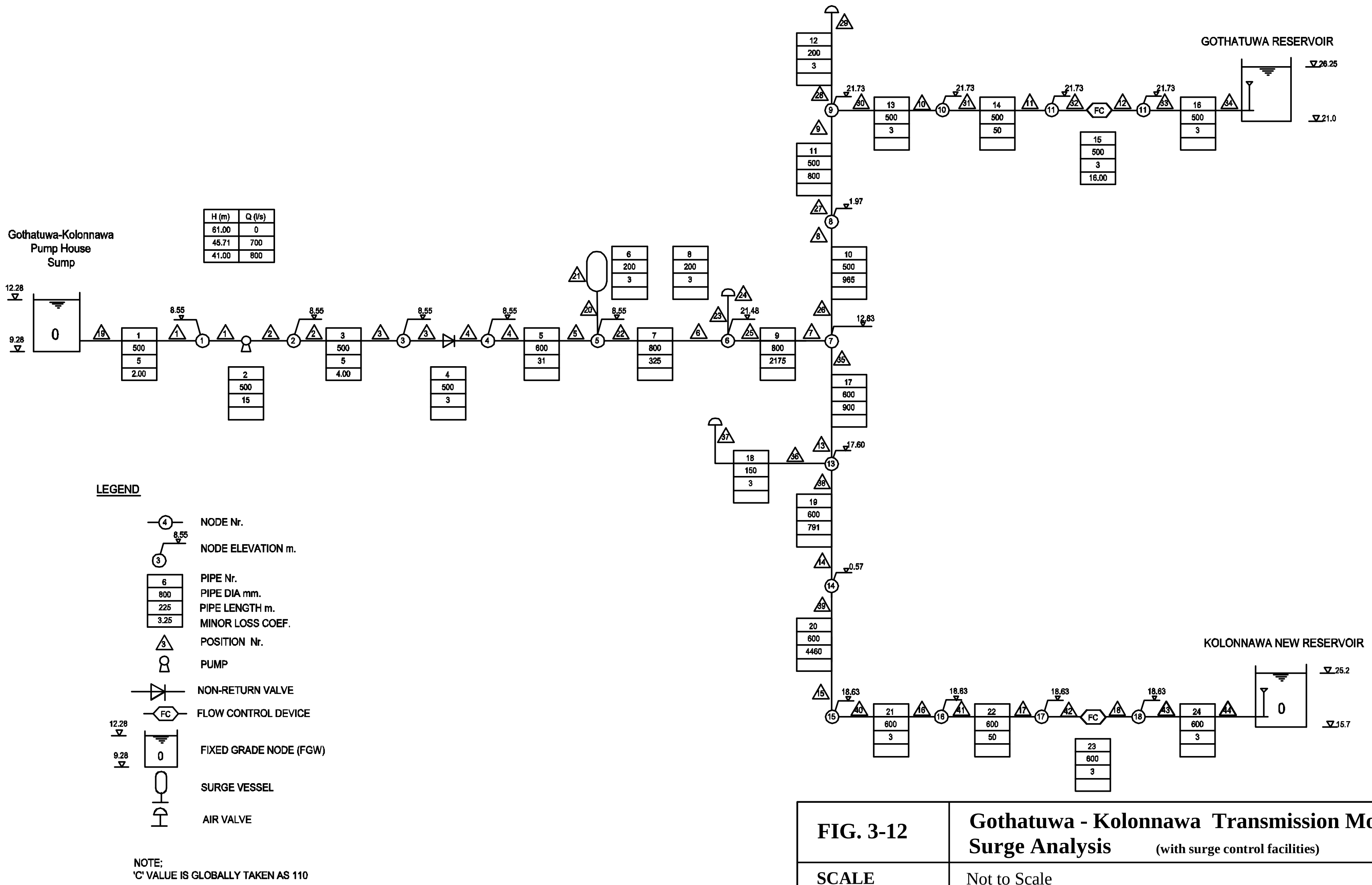


FIG. 3-12	Gothatuwa - Kolonnawa Transmission Model for Surge Analysis (with surge control facilities)
SCALE	Not to Scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

GOTATHUWA KOLONNAWA SURGE ANALYSIS
Run 1 - Simulation of Pump Trip without Surge Tank(pumping to G & K)
Head at Position 4 (Output File: gk_ic1.out)

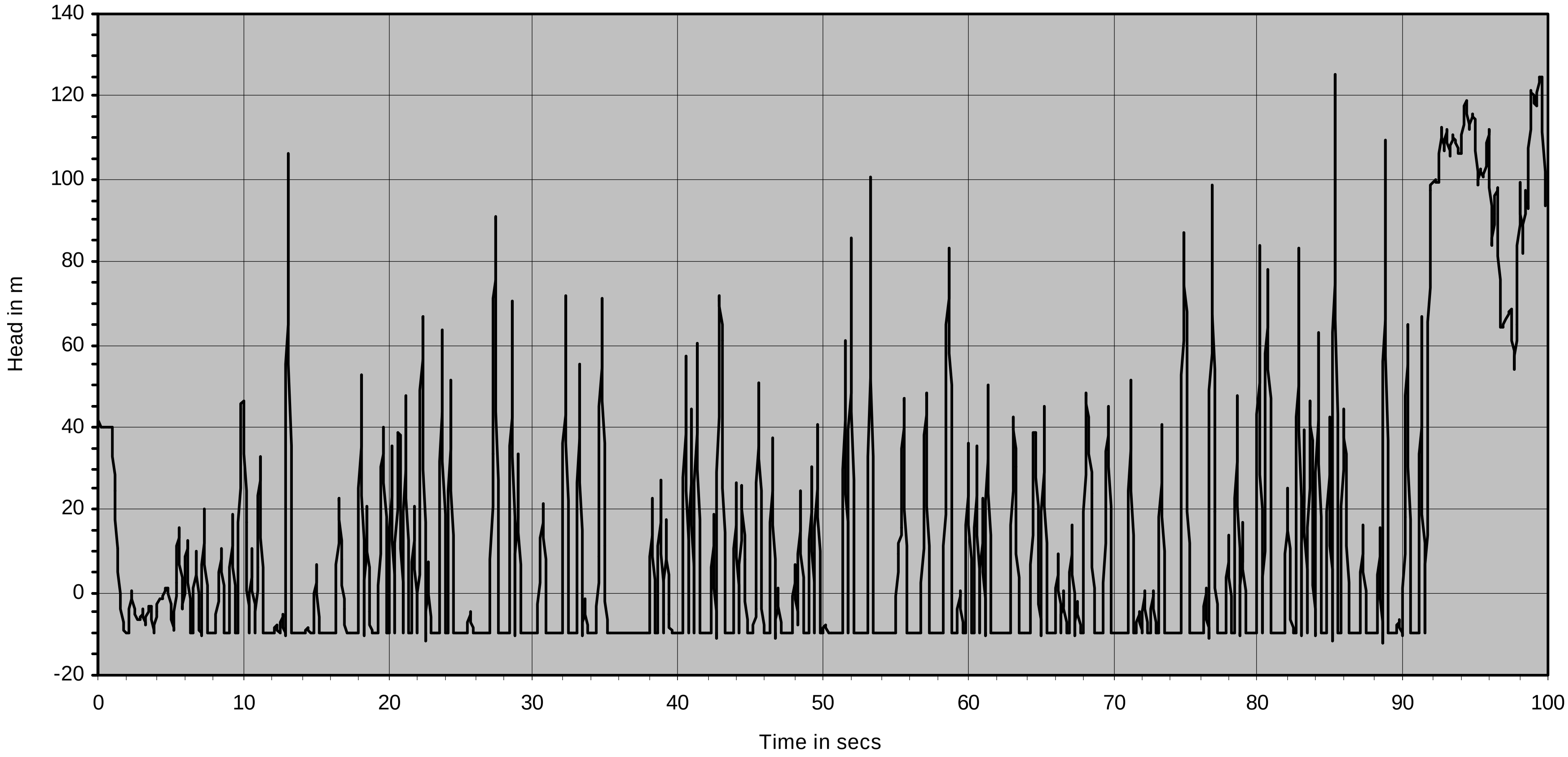


FIG. 3-13	**Transient Curve without Surge Protection**
SCALE	Not to scale

JICA STUDY TEAM
THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

GOTATHUWA KOLONNAWA SURGE ANALYSIS
Run 4 - Simulation of Pump Trip with Surge Tank (Pumping to G & K)
Variation of Surge Tank gas volume with time (Output File: gk_ic4.out)

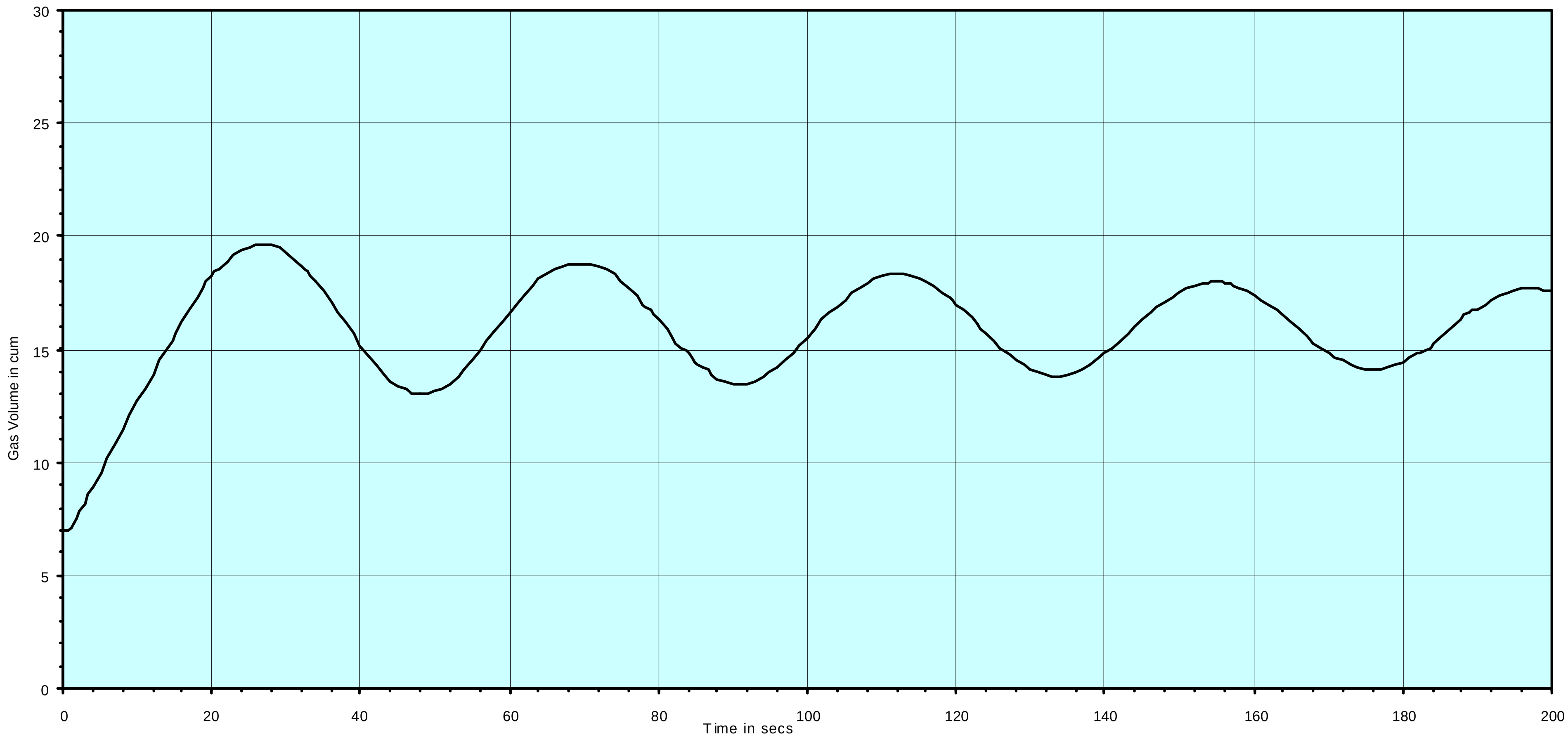
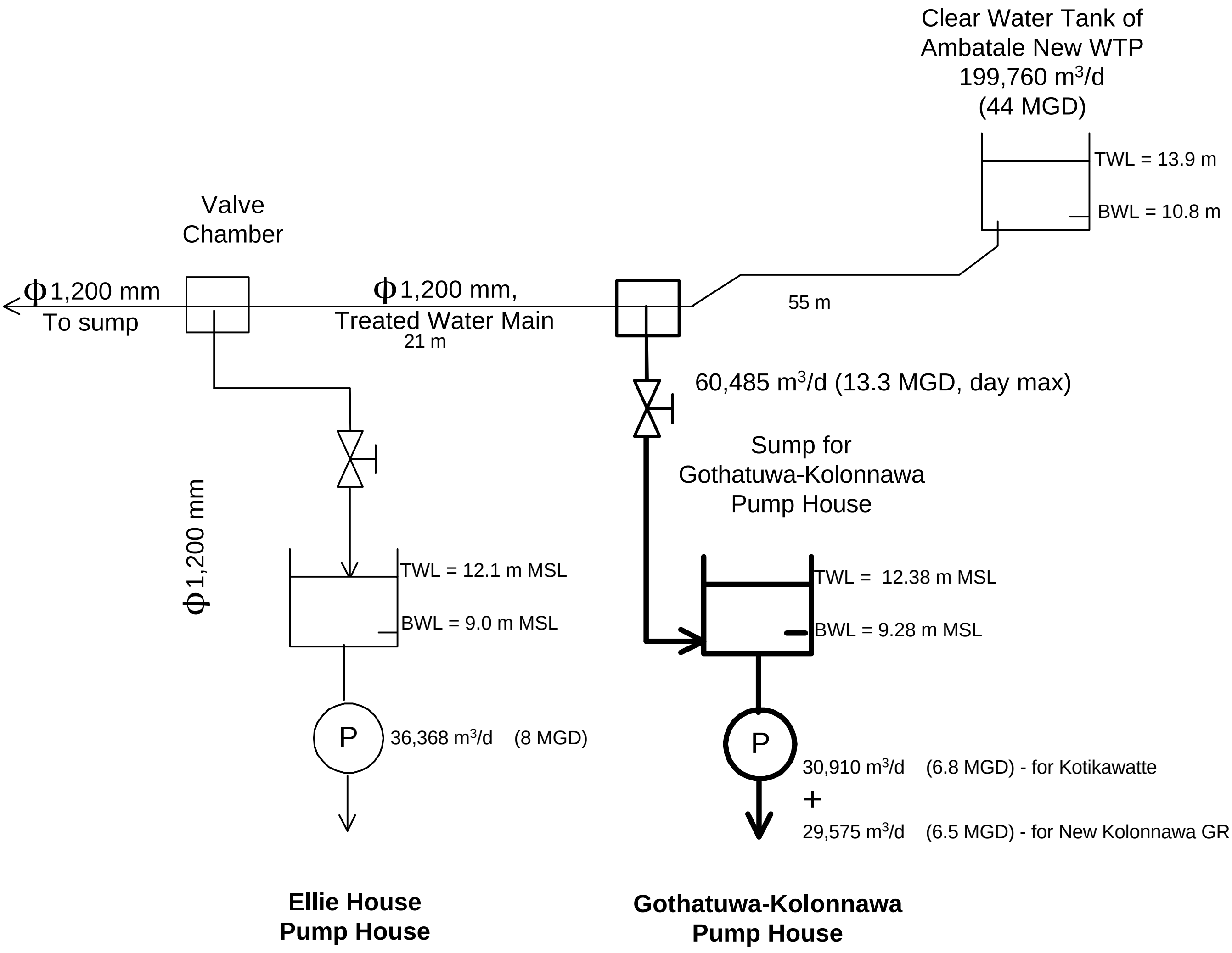


FIG. 3-14	**Transient Curve with Surge Protection**
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA



LEGEND

Existing (thin line)

This Project (thick line)

FIG. 3-15	**Schematic of Intake Connection to Gothatuwa-Kolonnawa Pump House**
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

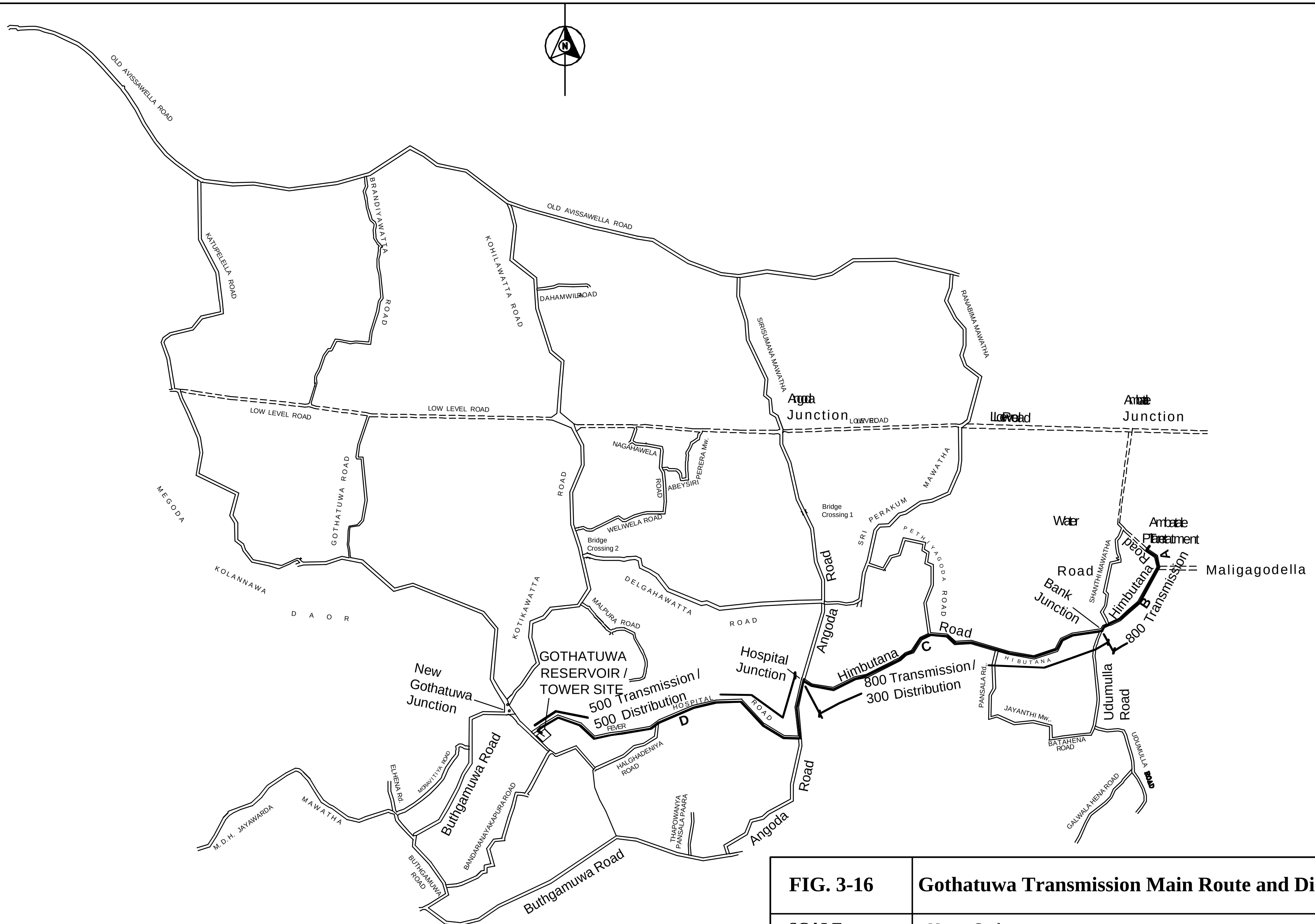
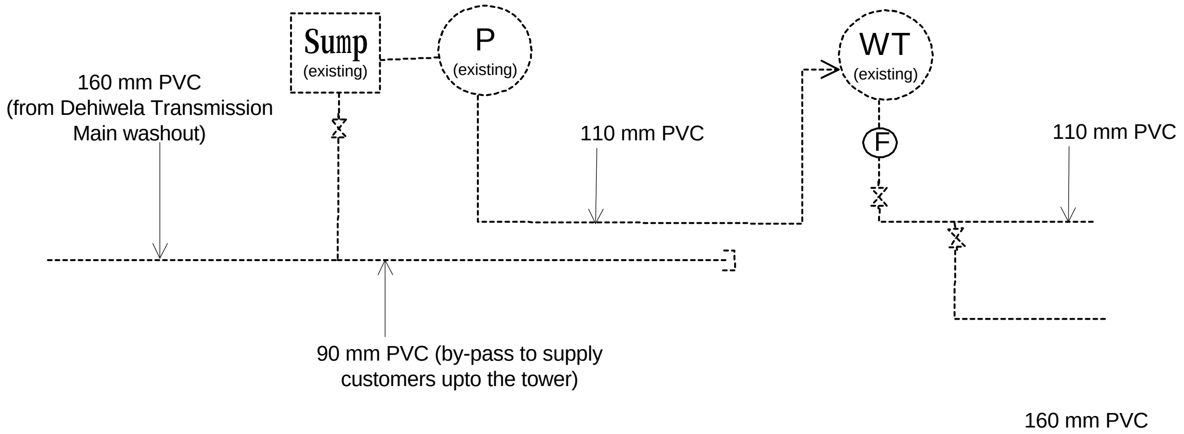


FIG. 3-16	**Gothatuwa Transmission Main Route and Diameter**
SCALE	Not to Scale

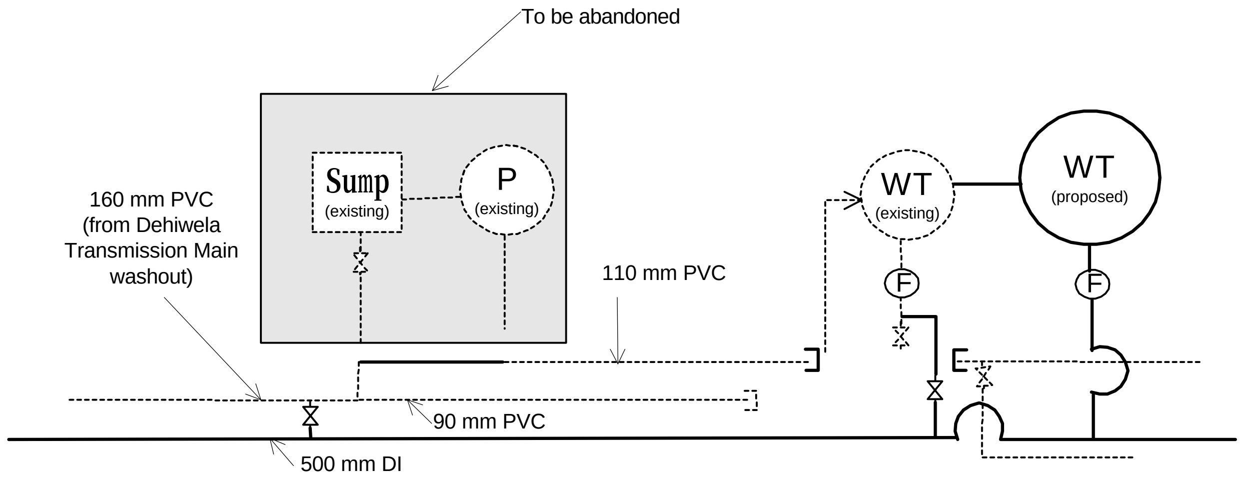
JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Existing



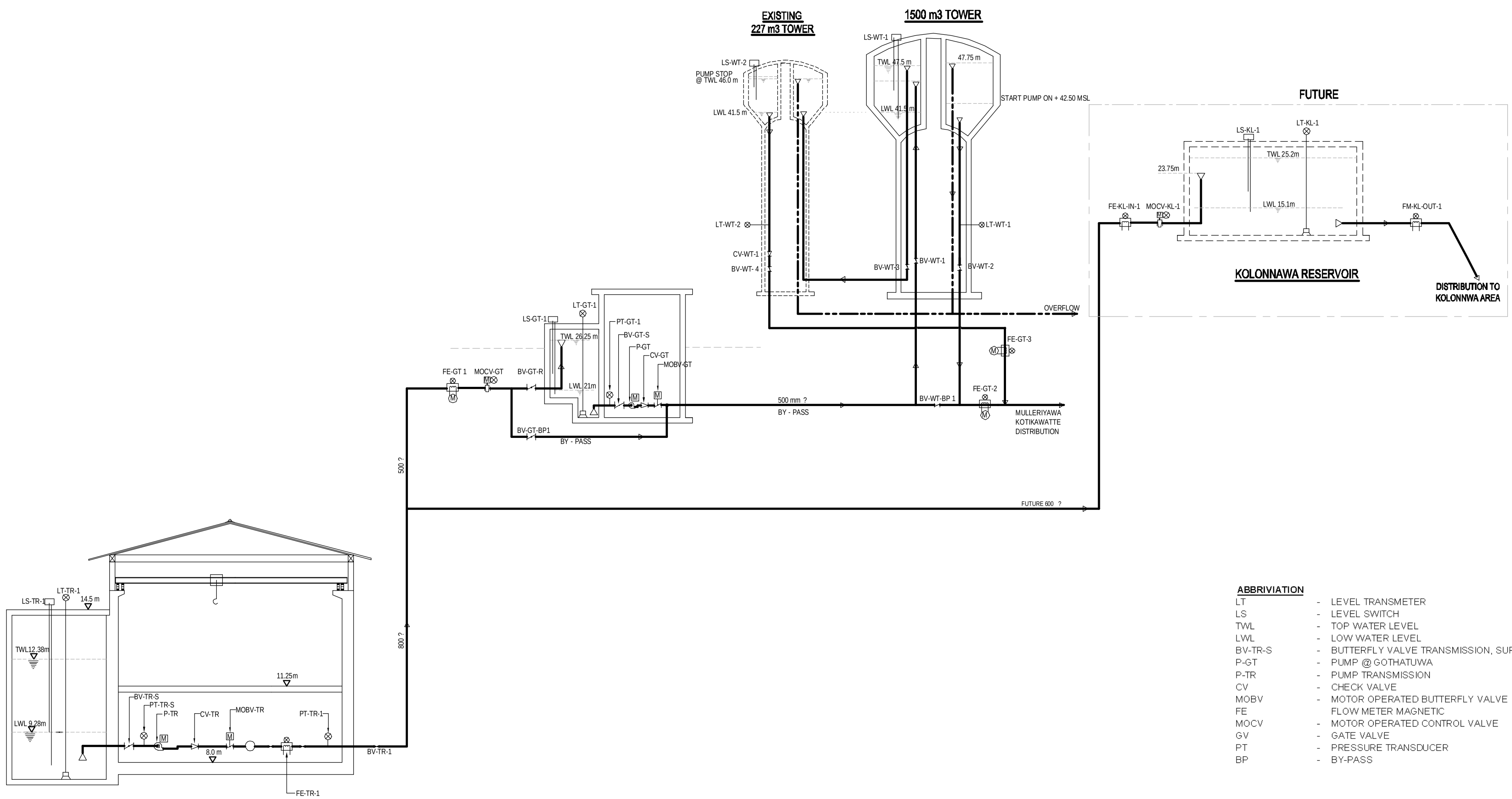
After Disconnection



Note: Illustrative purpose only. Details of valves etc.
around the water tower are not shown for clarity.

LEGEND
- ------- Existing
- ▬▬▬ This Project

FIG. 3-17	**Disconnecting of Existing Sump and Pump House**
SCALE	Not to scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



KOLONNAWA - GOTHATUWA TRANSMISSION
PUMP STATION AT AMBATALE

ABBRIVIATION

LT	-	LEVEL TRANSMETER
LS	-	LEVEL SWITCH
TWL	-	TOP WATER LEVEL
LWL	-	LOW WATER LEVEL
BV-TR-S	-	BUTTERFLY VALVE TRANSMISSION, SUPPLY
P-GT	-	PUMP @ GOTHATUWA
P-TR	-	PUMP TRANSMISSION
CV	-	CHECK VALVE
MOBV	-	MOTOR OPERATED BUTTERFLY VALVE
FE		FLOW METER MAGNETIC
MOCV	-	MOTOR OPERATED CONTROL VALVE
GV	-	GATE VALVE
PT	-	PRESSURE TRANSDUCER
BP	-	BY-PASS

PUMP SPECIFICATION	GOTHATUWA - KOLONNAWA PUMP HOUSE (this contract)	(future)	GOTHATUWA PUMP HOUSE (this contract)	(future)
Total no. of pumps	3	4	2	3
Pump unit in operation	2	3	1	2
Pump unit on stand-by	1	1	1	1
Q (m^3) each	11.85	14	18	18
TDH (m) each	42	50	30	30
Motor Output (kw) each	165	165	130	130
Type of pump	double volute horizontal		double volute horizontal	

DO NOT SCALE

REV. | DESCRIPTION

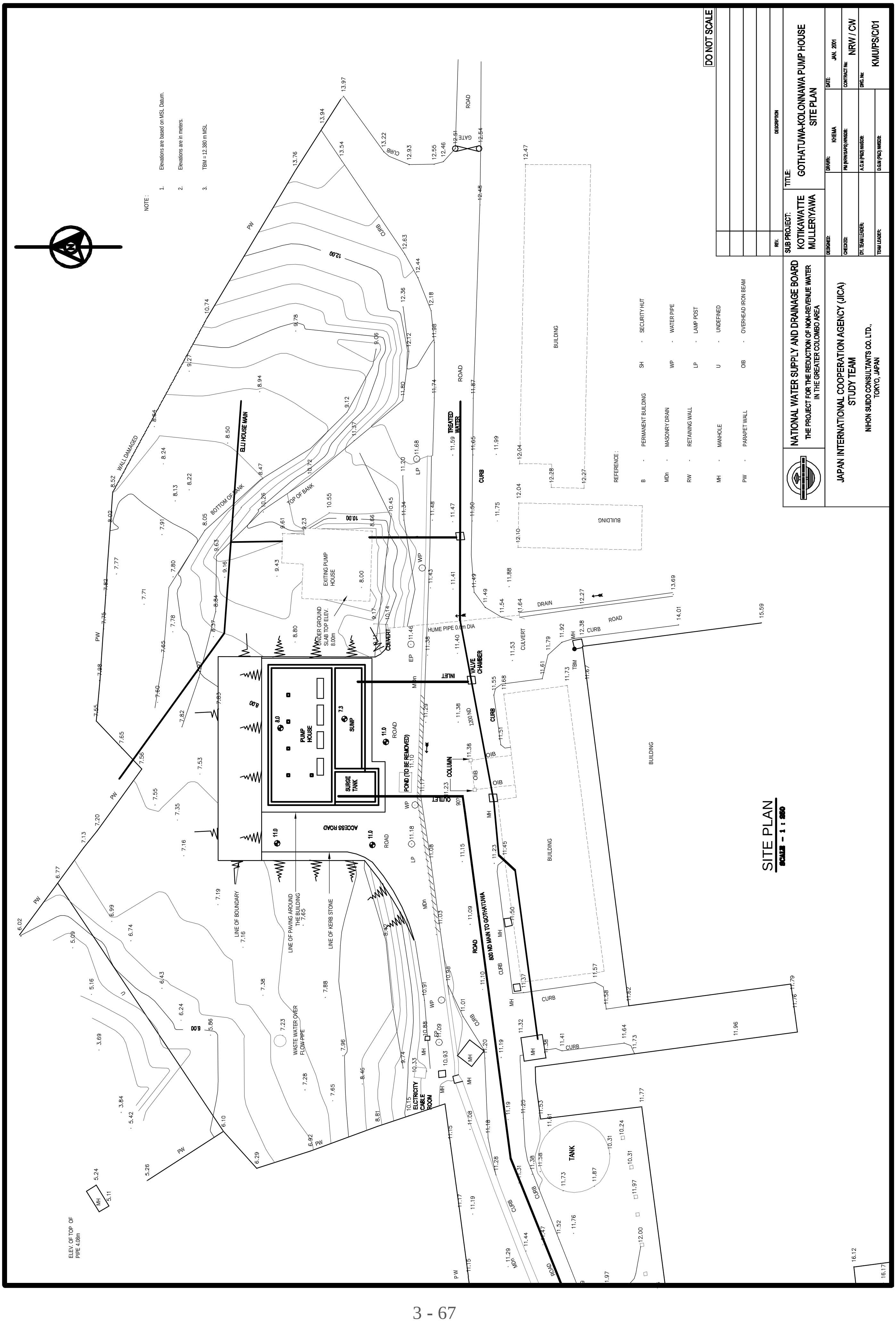
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

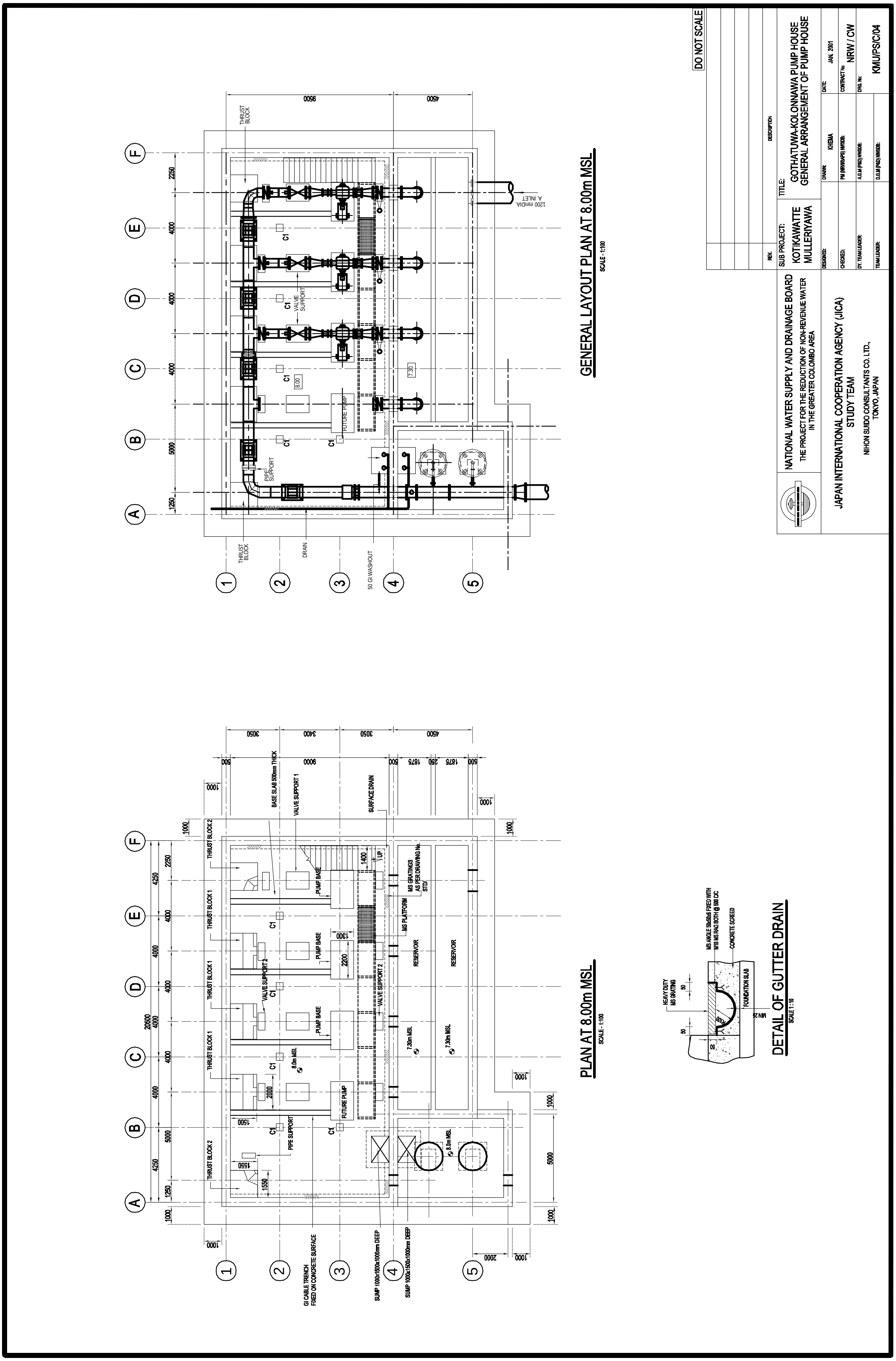
SUB PROJECT: KOTIKAWATTA MULLERIYAWA

TITLE: GOTHATUWA GROUND RESERVOIR & PUMP HOUSE SCHEMATIC FLOW DIAGRAM

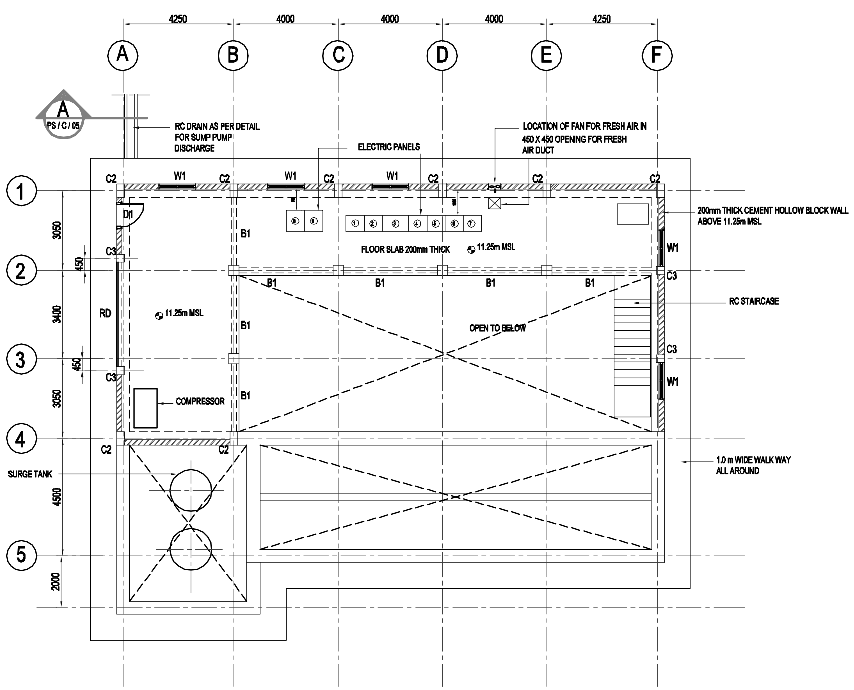
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD.,
TOKYO, JAPAN

DESIGNED:	DRAWN: KHEMA	DATE: JAN. 2001
CHECKED:	PM (NRW/SAPS) NWSDB:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D) NWSDB:	DRG. No:
TEAM LEADER:	D.G.M (P&D) NWSDB:	KMU/PS/G-02


DO NOT SCALE
NOTE :
1. Elevations are based on MSL Datum.
2. Elevations are in meters.
3. TBM = 12.380 m MSL
REFERENCE :
B - PERMANENT BUILDING
SH - SECURITY HUT
MDn - MASONRY DRAIN
WP - WATER PIPE
RW - RETAINING WALL
LP - LAMP POST
MH - MANHOLE
U - UNDEFINED
PW - PARAPET WALL
OIB - OVERHEAD IRON BEAM
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
SUB PROJECT: KOTIKAWATTE MULLERIYAWA
TITLE: GOTHATUWA-KOLONNAWA PUMP HOUSE SITE PLAN
DATE: JAN. 2001
CONTRACT No: NRW / CW
DWG. No: KMU/PS/C/01
SITE PLAN
SCALE - 1 : 250
PUMP HOUSE
SUMP
SURGE TANK
EXITING PUMP HOUSE
VALVE CHAMBER
TREATED WATER
INLET
OUTLET
ELU HOUSE MAIN
600 ND MAIN TO GOTHATUWA
ACCESS ROAD
POND (TO BE REMOVED)
HUME PIPE 0.6m DIA
ELECTRICITY CABLE ROOM
TANK
BUILDING
ROAD
CURB
CULVERT
DRAIN
LINE OF BOUNDARY
LINE OF PAVING AROUND THE BUILDING
LINE OF KERB STONE
WASTE WATER OVER FLOW PIPE
WALL DAMAGED
TOP OF BANK
BOTTOM OF BANK
GATE
ELEV. OF TOP OF PIPE 4.08m

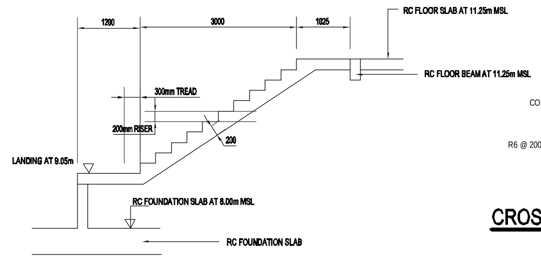


GENERAL LAYOUT PLAN AT 8.00m MSL
SCALE - 1:100
PLAN AT 8.00m MSL
SCALE - 1:100
DETAIL OF GUTTER DRAIN
SCALE 1 : 10
THRUST BLOCK
PIPE SUPPORT
VALVE SUPPORT
FUTURE PUMP
DRAIN
50 GI WASHOUT
1200 mmDIA. INLET
THRUST BLOCK 1
THRUST BLOCK 2
BASE SLAB 500mm THICK
VALVE SUPPORT 1
VALVE SUPPORT 2
SURFACE DRAIN
PUMP BASE
MS PLATFORM
MS GRATINGS AS PER DRAWING No. STD/
RESERVOIR
7.30m MSL
8.0m MSL
GI CABLE TRENCH FIXED ON CONCRETE SURFACE
SUMP 1000x1500x1000mm DEEP
HEAVY DUTY MS GRATING
CONCRETE SCREED
FOUNDATION SLAB
DO NOT SCALE
REV.
DESCRIPTION
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
SUB PROJECT:
KOTIKAWATTE MULLERIYAWA
TITLE:
GOTHATUWA-KOLONNAWA PUMP HOUSE GENERAL ARRANGEMENT OF PUMP HOUSE
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
DESIGNED:
DRAWN: KHEMA
DATE: JAN. 2001
CHECKED:
PM (NRW/SAPS) NWSDB:
CONTRACT No: NRW / CW
DY. TEAM LEADER:
A.G.M (P&D) NWSDB:
DRG. No:
TEAM LEADER:
D.G.M (P&D) NWSDB:
KMU/PS/C/04



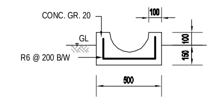
PLAN AT 11.25m LEVEL

SCALE - 1:100

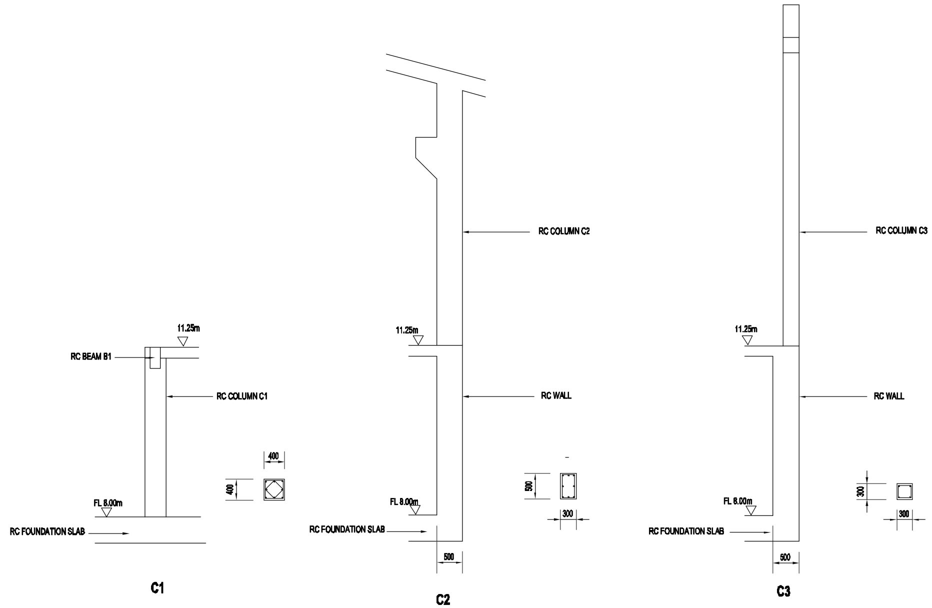


DETAIL OF RC STAIRCASE

SCALE - 1:50



CROSS SECTION 'A' OF DRAIN



DETAIL OF COLUMNS

SCALE - 1:50

SCHEDULE OF DOORS & WINDOWS

TYPE	SIZE IN mm		DESCRIPTION	QUANTITY
	WIDTH	HEIGHT		
D1	1000	2200	BRONZE ANODISED ALUMINUM DOOR WITH GLAZED PANELS	01
W1	1400	1800	BRONZE ANODISED ALUMINUM FRAMES & PANELS WITH GLASS	05
RD	4000	3000	ALUMINUM ROLLER DOOR	01

DO NOT SCALE

REV.	DESCRIPTION

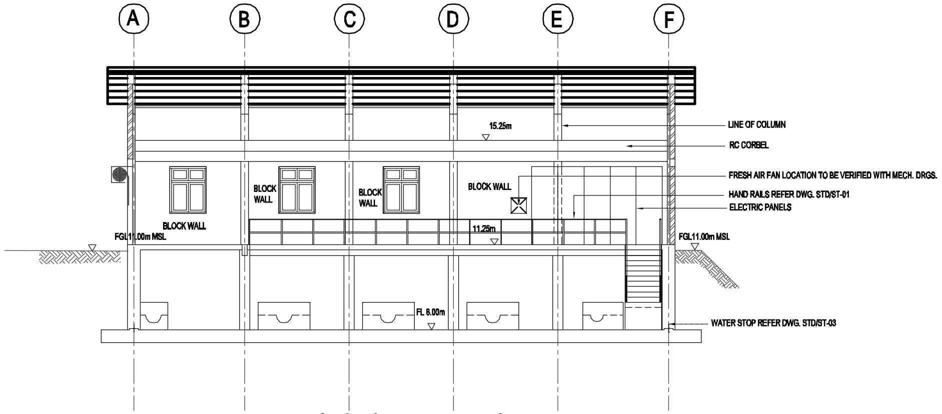
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN

SUB PROJECT: KOTIKAWATTE MULLERIYAWA

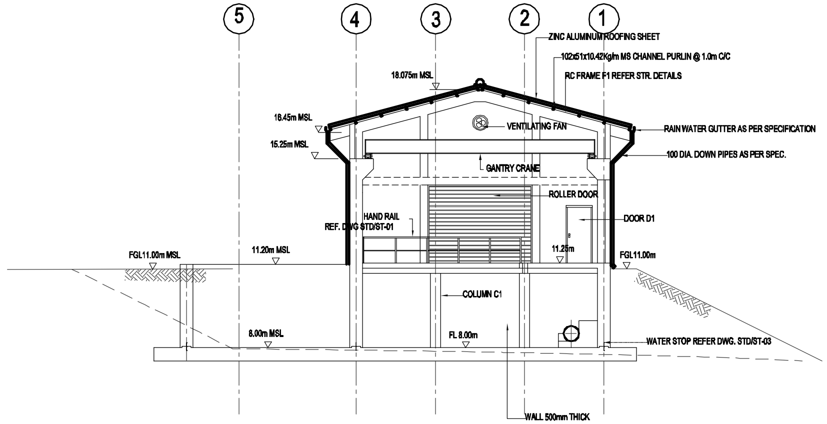
TITLE: GOTHATUWA-KOLONNAWA PUMP HOUSE PLAN AT 11.25 MSL

DESIGNED:	DRAWN: KHEMA	DATE: JAN. 2001
CHECKED:	PM (NRW/SAPS) NWSDB:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D) NWSDB:	DRG. No: KMU/PS/C/05
TEAM LEADER:	D.G.M (P&D) NWSDB:	



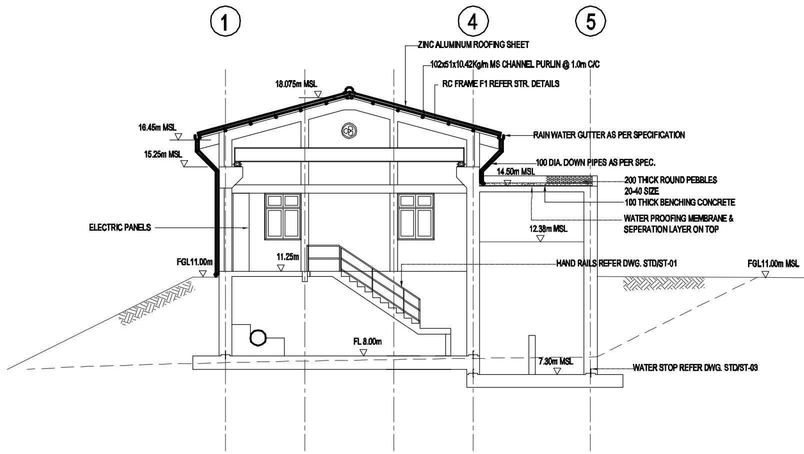
SECTIONAL ELEVATION 1

SCALE - 1:100



SECTIONAL ELEVATION 2

SCALE - 1:100



SECTIONAL ELEVATION 3

SCALE - 1:100

DO NOT SCALE

REV.	DESCRIPTION

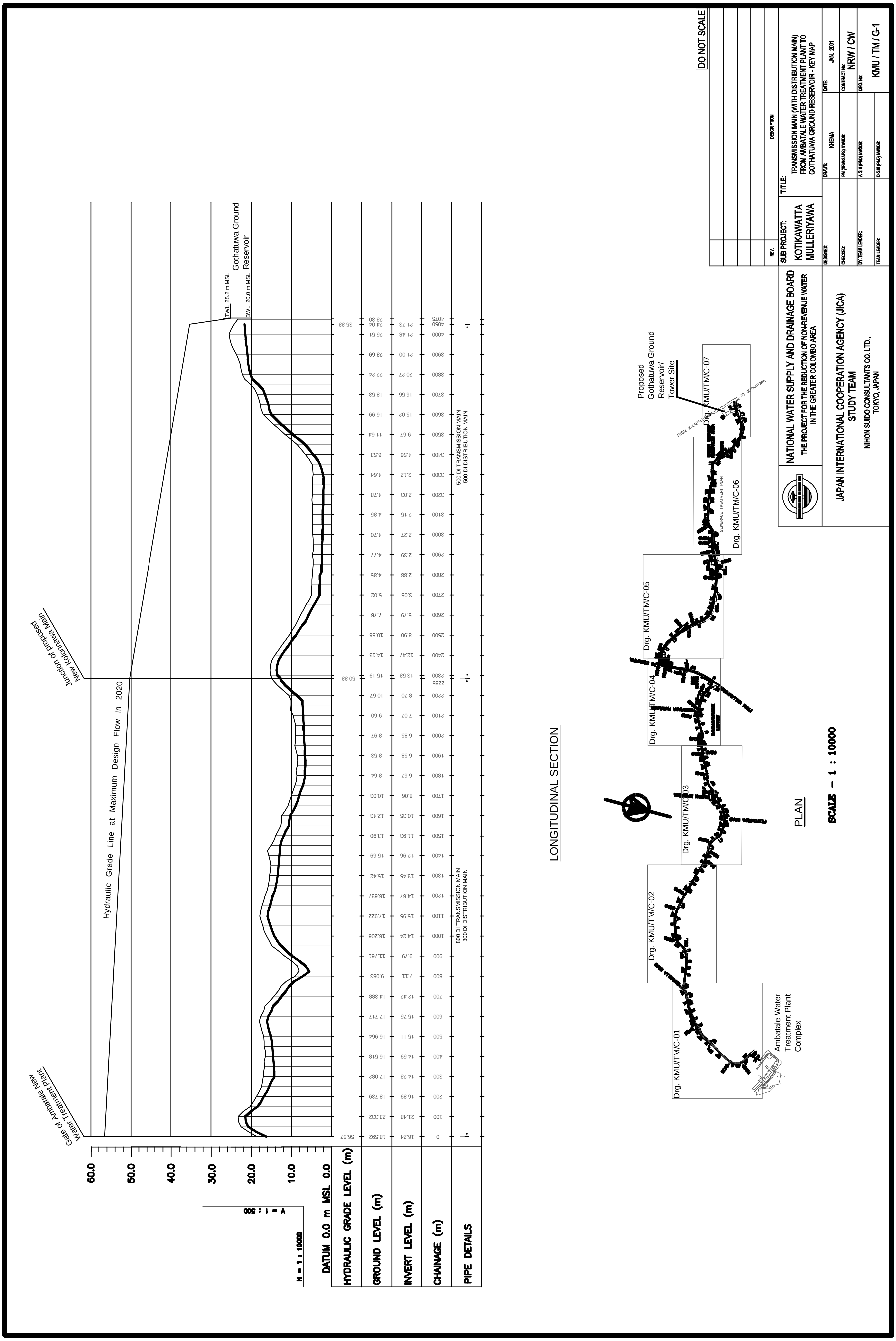
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

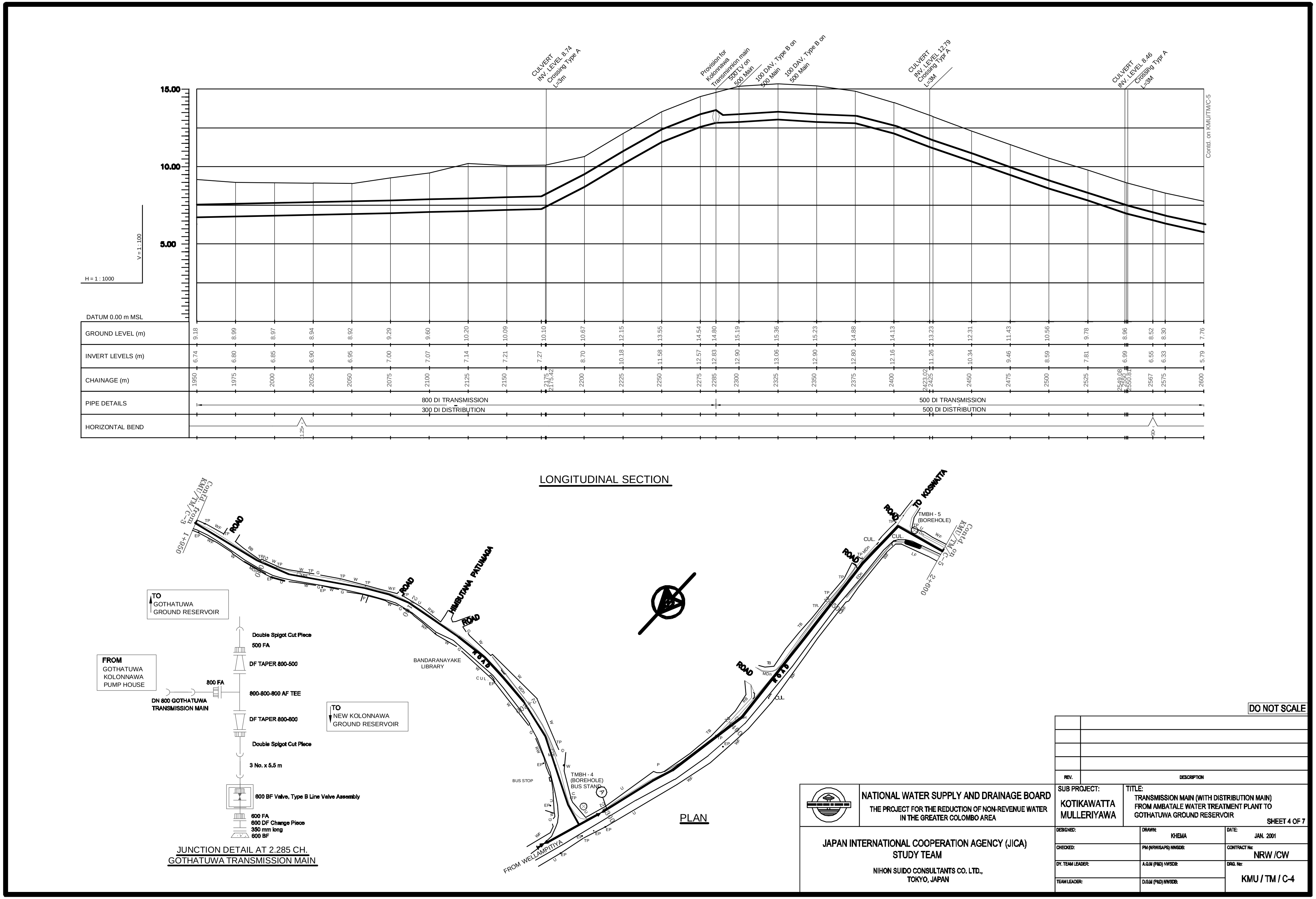
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD.,
TOKYO, JAPAN

SUB PROJECT: KOTIKAWATTE MULLERIYAWA

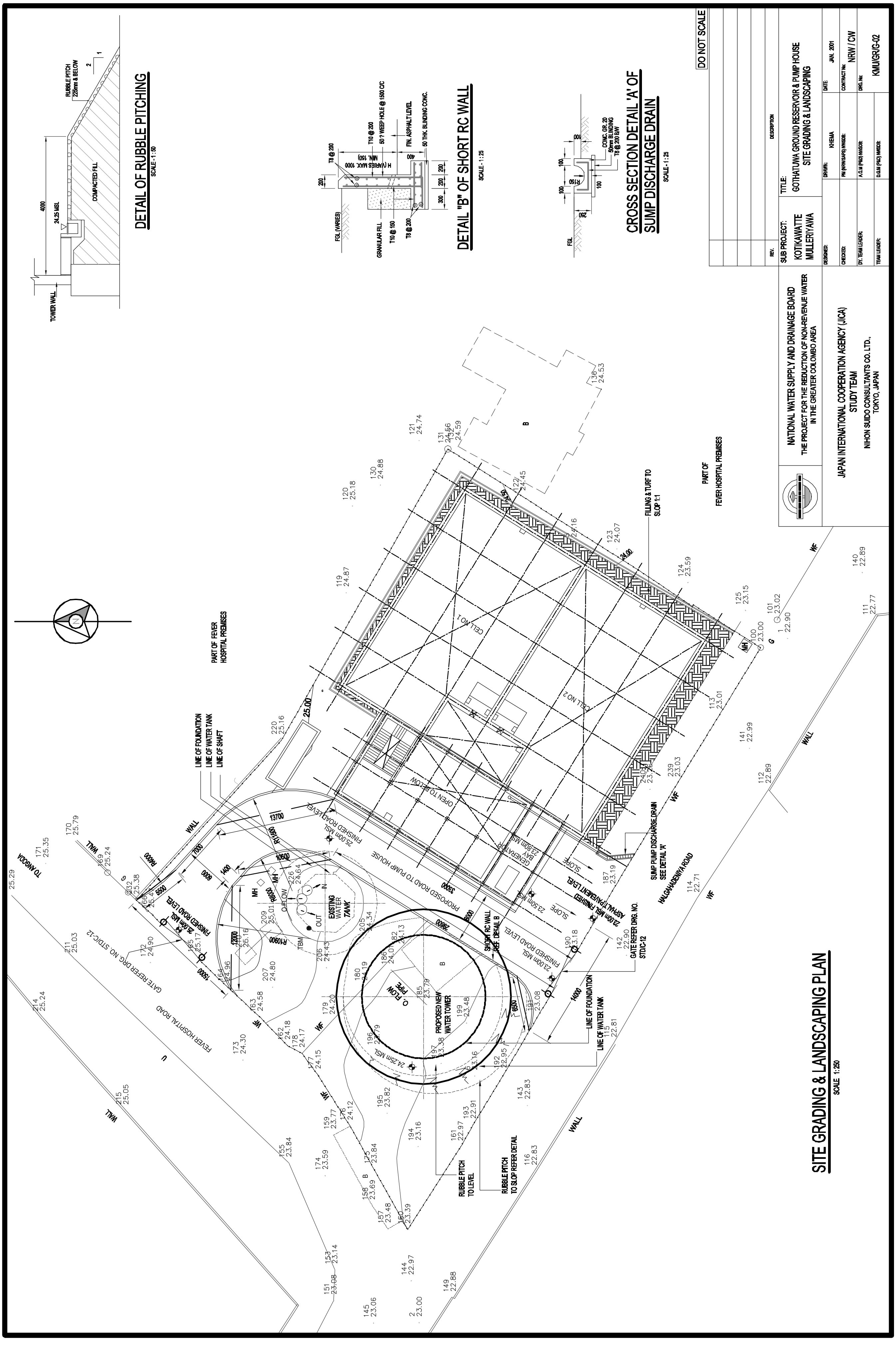
TITLE: GOTHATUWA - KOLONNAWA PUMP HOUSE SECTIONAL ELEVATIONS & DETAILS

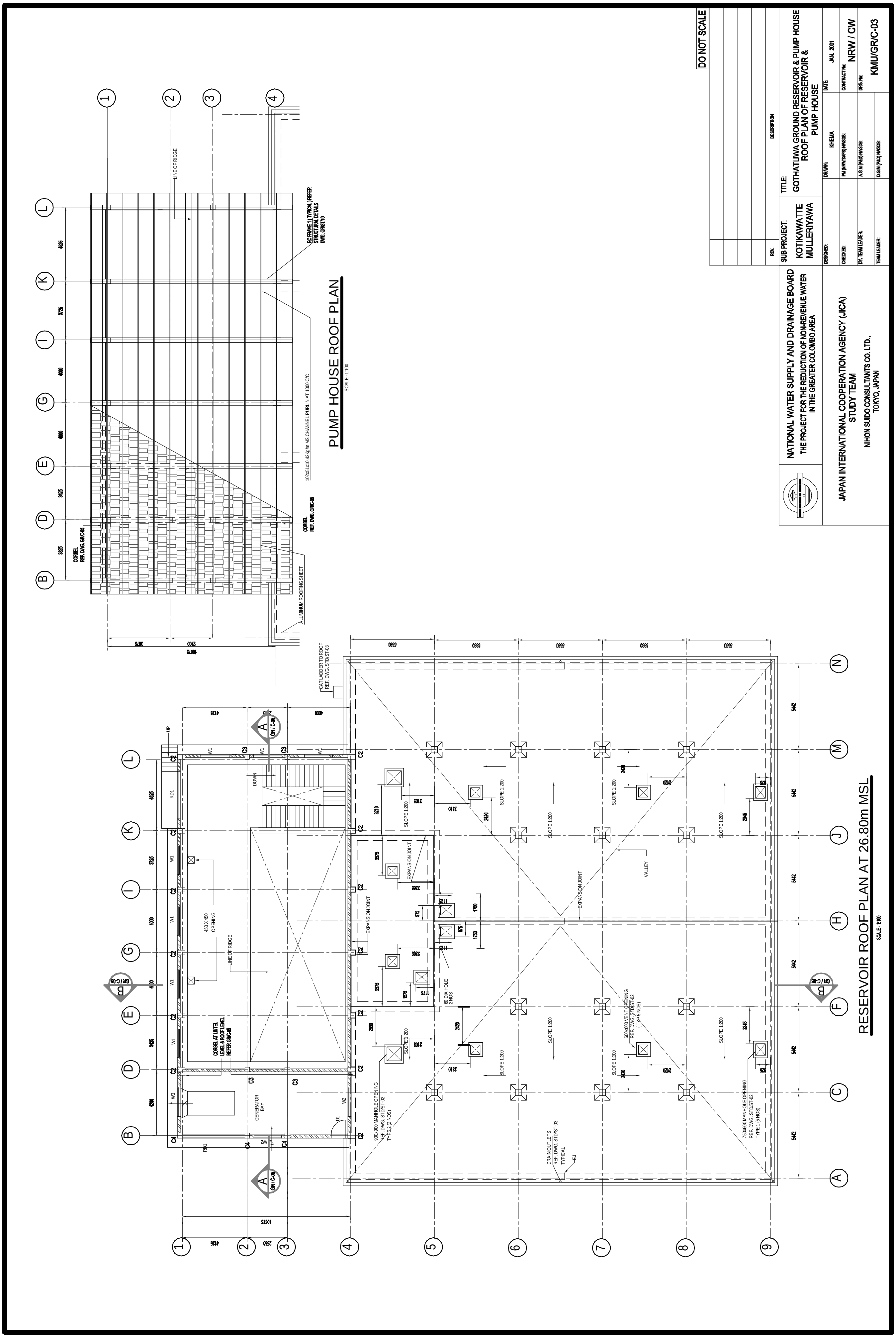
DESIGNED:	DRAWN: KHEMA	DATE: JAN. 2001
CHECKED:	PM (NRW/SAPS) NWSDB:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D) NWSDB:	DRG. No: KMU/PS/C/08
TEAM LEADER:	D.G.M (P&D) NWSDB:	


DO NOT SCALE
LONGITUDINAL SECTION
H = 1 : 10000
V = 1 : 500
DATUM 0.0 m MSL
HYDRAULIC GRADE LEVEL (m)
GROUND LEVEL (m)
INVERT LEVEL (m)
CHAINAGE (m)
PIPE DETAILS
Hydraulic Grade Line at Maximum Design Flow in 2020
Gate of Ambatale New Water Treatment Plant
Junction of proposed New Kolonnawa Main
Gothatuwa Ground Reservoir
TWL 25.2 m MSL
BWL 20.0 m MSL
800 DI TRANSMISSION MAIN
300 DI DISTRIBUTION MAIN
500 DI TRANSMISSION MAIN
500 DI DISTRIBUTION MAIN
PLAN
SCALE - 1 : 10000
Ambatale Water Treatment Plant Complex
Proposed Gothatuwa Ground Reservoir/ Tower Site
Drg. KMU/TM/C-01
Drg. KMU/TM/C-02
Drg. KMU/TM/C-03
Drg. KMU/TM/C-04
Drg. KMU/TM/C-05
Drg. KMU/TM/C-06
Drg. KMU/TM/C-07
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO., LTD.,
TOKYO, JAPAN
SUB PROJECT:
KOTIKAWATTA MULLERIYAWA
TITLE:
TRANSMISSION MAIN (WITH DISTRIBUTION MAIN) FROM AMBATALE WATER TREATMENT PLANT TO GOTHATUWA GROUND RESERVOIR - KEY MAP
DATE: JAN. 2001
CONTRACT No: NRW / CW
DRG. No: KMU / TM / G-1

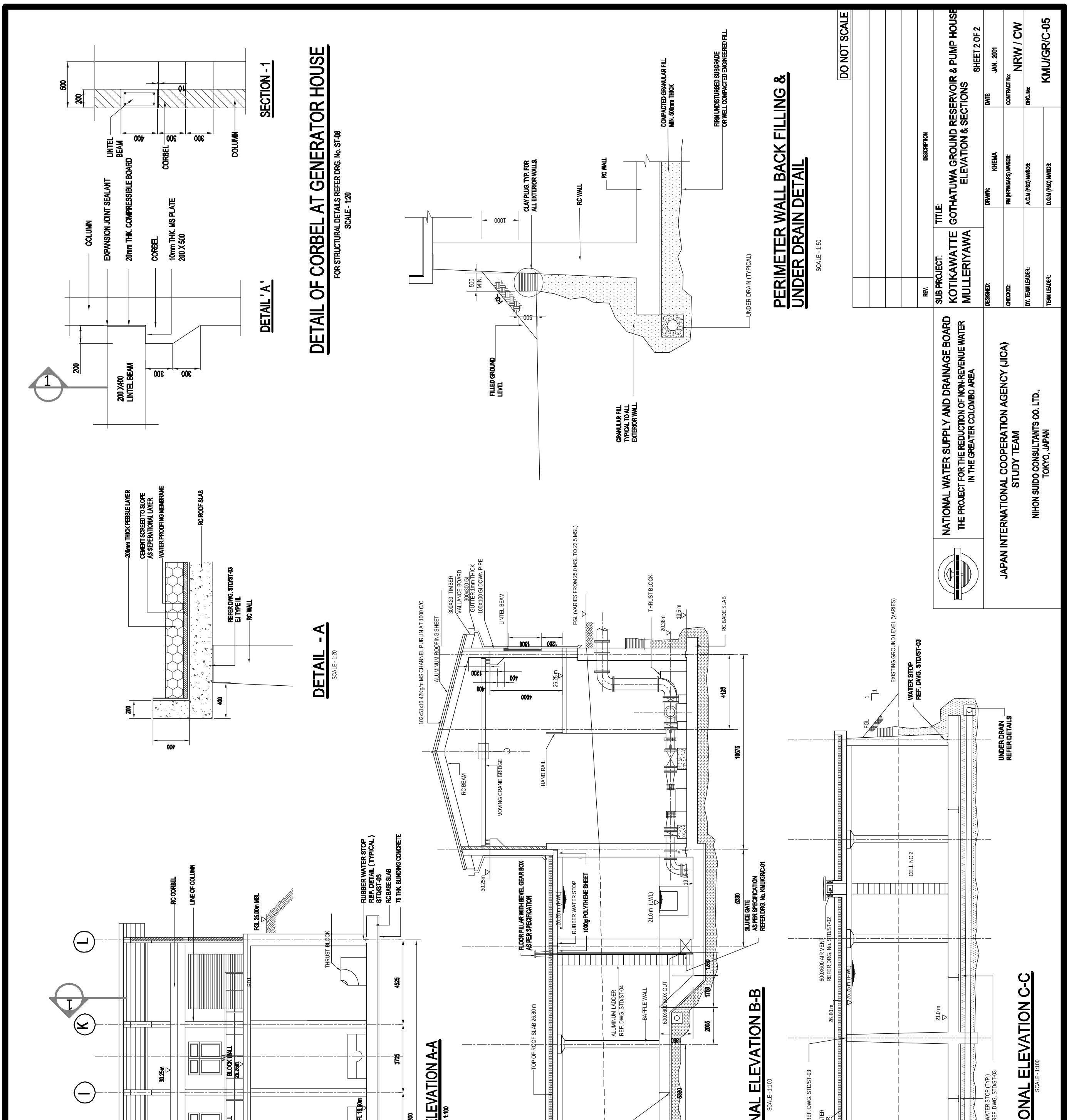


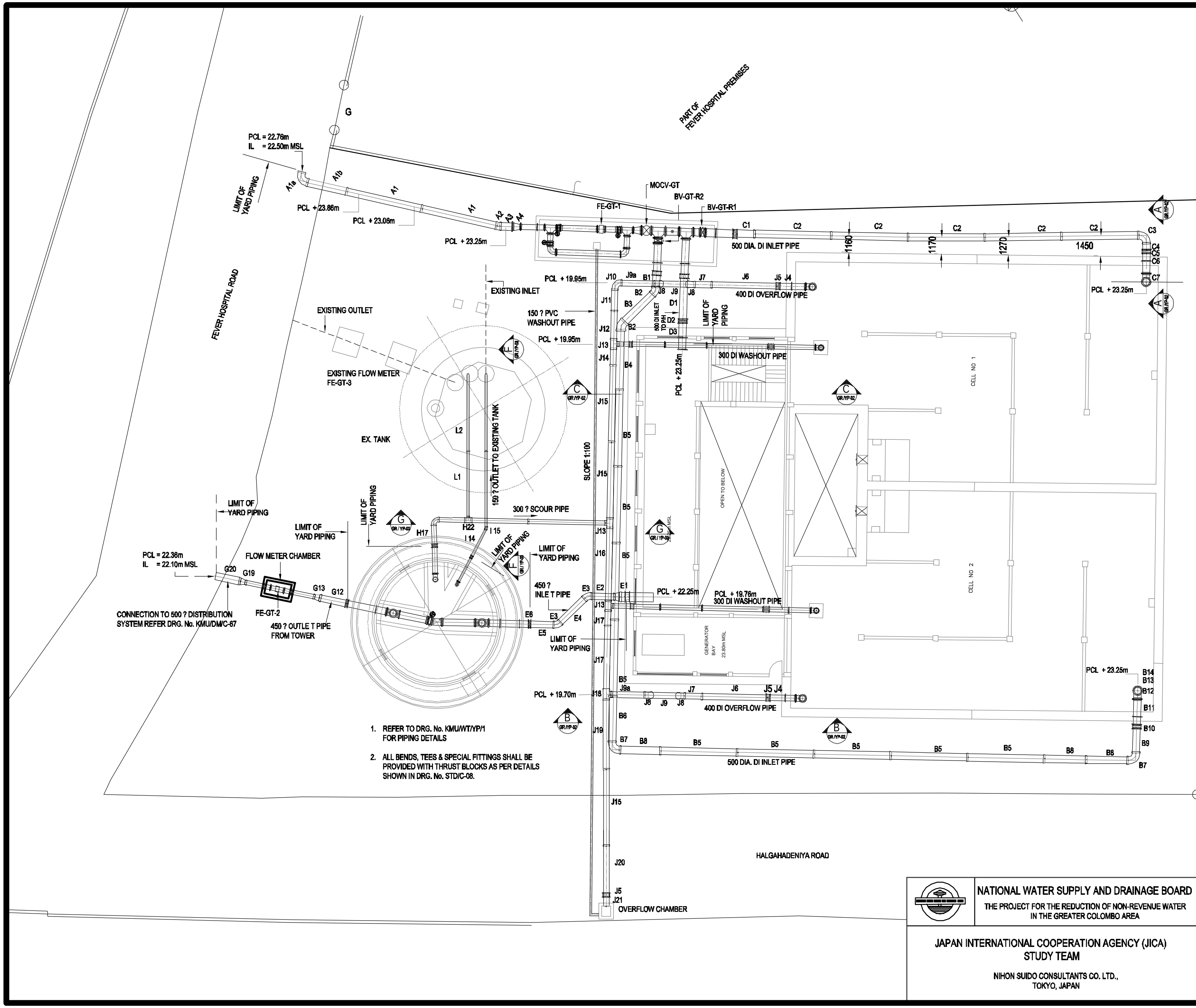
CHAINAGE (m)	GROUND LEVEL (m)	INVERT LEVELS (m)
1950	9.18	6.74
1975	8.99	6.80
2000	8.97	6.85
2025	8.94	6.90
2050	8.92	6.95
2075	9.29	7.00
2100	9.60	7.07
2125	10.20	7.14
2150	10.09	7.21
2175 / 2175.42	10.10	7.27
2200	10.67	8.70
2225	12.15	10.18
2250	13.55	11.58
2275	14.54	12.57
2285	14.80	12.83
2300	15.19	12.90
2325	15.36	13.06
2350	15.23	12.90
2375	14.88	12.80
2400	14.13	12.16
2423.02 / 2425	13.23	11.26
2450	12.31	10.34
2475	11.43	9.46
2500	10.56	8.59
2525	9.78	7.81
2549.08 / 2550 / 2550.81	8.96	6.99
2567	8.52	6.55
2575	8.30	6.33
2600	7.76	5.79


DETAIL OF RUBBLE PITCHING
SCALE - 1 : 50
DETAIL "B" OF SHORT RC WALL
SCALE - 1 : 25
CROSS SECTION DETAIL 'A' OF SUMP DISCHARGE DRAIN
SCALE - 1 : 25
SITE GRADING & LANDSCAPING PLAN
SCALE 1:250
DO NOT SCALE
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO., LTD.,
TOKYO, JAPAN
SUB PROJECT:
KOTIKAWATTE MULLERIYAWA
TITLE:
GOTHATUWA GROUND RESERVOIR & PUMP HOUSE
SITE GRADING & LANDSCAPING
DATE: JAN. 2001
CONTRACT No: NRW / CW
DWG. No: KMU/GR/G-02
PROPOSED NEW WATER TOWER
EXISTING WATER TANK
FEVER HOSPITAL ROAD
PART OF FEVER HOSPITAL PREMISES
PROPOSED ROAD TO PUMP HOUSE
HALGAHADENIYA ROAD
TO ANGODA



PUMP HOUSE ROOF PLAN
SCALE: 1:100
RESERVOIR ROOF PLAN AT 26.80m MSL
SCALE: 1:100
ALUMINIUM ROOFING SHEET
LINE OF RIDGE
RC FRAME 1 (TYPICAL) REFER STRUCTURAL DETAILS
CORBEL REF. DWG. GR/C-05
EXPANSION JOINT
VALLEY
SLOPE 1:200
60 DIA HOLE 2 NOS
DRAIN OUTLETS REF. DWG. STD/ST-03 TYPICAL
900x900 MANHOLE OPENING REF. DWG. STD/ST-02 TYPE 2 (2 NOS)
750x600 MANHOLE OPENING REF. DWG. STD/ST-02 TYPE 1 (5 NOS)
600x600 VENT OPENING REF. DWG. STD/ST-02 (TYPE 5 NOS)
CAT LADDER TO ROOF REF. DWG. STD/ST-03
GENERATOR BAY
450 X 450 OPENING
DOWN
UP
DO NOT SCALE
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO., LTD., TOKYO, JAPAN
SUB PROJECT: KOTIKAWATTE MULLERIYAWA
TITLE: GOTHATUWA GROUND RESERVOIR & PUMP HOUSE ROOF PLAN OF RESERVOIR & PUMP HOUSE
DRAWN: KHEMA
DATE: JAN. 2001
CONTRACT No: NRW / CW
DWG. No: KMU/GR/C-03


DETAIL OF CORBEL AT GENERATOR HOUSE
FOR STRUCTURAL DETAILS REFER DRG. No. ST-08
SCALE - 1:20
DETAIL 'A'
SECTION - 1
COLUMN
EXPANSION JOINT SEALANT
20mm THK. COMPRESSIBLE BOARD
CORBEL
10mm THK. MS PLATE 200 X 500
200 X 600 LINTEL BEAM
LINTEL BEAM
PERIMETER WALL BACK FILLING & UNDER DRAIN DETAIL
SCALE - 1:50
CLAY PLUG, TYP. FOR ALL EXTERIOR WALLS.
RC WALL
COMPACTED GRANULAR FILL MIN. 500mm THICK
FIRM UNDISTURBED SUBGRADE OR WELL COMPACTED ENGINEERED FILL
FILLED GROUND LEVEL
GRANULAR FILL TYPICAL TO ALL EXTERIOR WALL
UNDER DRAIN (TYPICAL)
DETAIL - A
SCALE - 1:20
200mm THICK PEBBLE LAYER
CEMENT SCREED TO SLOPE AS SEPERATIONAL LAYER
WATER PROOFING MEMBRANE
RC ROOF SLAB
RC WALL
SECTIONAL ELEVATION A-A
SCALE - 1:100
SECTIONAL ELEVATION B-B
SCALE - 1:100
SECTIONAL ELEVATION C-C
SCALE - 1:100
RC CORBEL
LINE OF COLUMN
BLOCK WALL
THRUST BLOCK
RUBBER WATER STOP REFER DETAIL (TYPICAL) STD/ST-03
RC BASE SLAB
75 THK. BLINDING CONCRETE
CORBEL
LINTEL BEAM
LOUVERS FOR EXHAUST AIR
200 mm THK. RC SLAB WITH BRC A252 MESH AT TOP
EXPANSION JOINT
WELL COMPACTED EARTH FILL
RC FOOTING
75 mm THK. BLINDING
ALUMINIUM ROOFING SHEET
RC BEAM
MOVING CRANE BRIDGE
HAND RAIL
THRUST BLOCK
RC BASE SLAB
SLUICE GATE AS PER SPECIFICATION
FLOOR PILLAR WITH BEVEL GEAR BOX AS PER SPECIFICATION
RUBBER WATER STOP
1000g POLYTHENE SHEET
TOP OF ROOF SLAB 26.80 m
ALUMINIUM LADDER
BAFFLE WALL
COLUMN CAPITAL
BITUMINOUS WATER PROOFING LAYER
CAT LADDER
200 THICK PEBBLE LAYER
EXISTING GROUND LEVEL (VARIES)
CLAY PLUG REFER DETAIL
GRANULAR FILL
UNDER DRAIN (TYPICAL)
75 THICK BLINDING CONC. (TYP.)
CELL NO 1
CELL NO 2
WATER STOP REF. DWG. STD/ST-03
CAT LADDER AT THE MANHOLE
75 THICK BLINDING
UNDER DRAIN REFER DETAILS
SEE DETAIL - A
DO NOT SCALE
REV.
DESCRIPTION
SUB PROJECT: KOTIKAWATTE MULLERIYAWA
TITLE: GOTHATUWA GROUND RESERVOIR & PUMP HOUSE ELEVATION & SECTIONS
SHEET 2 OF 2
DATE: JAN. 2001
CONTRACT No: NRW / CW
DRG. No: KMU/GR/C-05
DESIGNED:
DRAWN: KHEMA
CHECKED:
DY. TEAM LEADER:
TEAM LEADER:
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO., LTD., TOKYO, JAPAN



1. REFER TO DRG. No. KMU/WT/YP/1 FOR PIPING DETAILS
2. ALL BENDS, TEES & SPECIAL FITTINGS SHALL BE PROVIDED WITH THRUST BLOCKS AS PER DETAILS SHOWN IN DRG. No. STD/C-08.

PIPING SCHEDULE - From Transmission Main

Pipe No.	ND mm	Description	Length mm	Qty.
A1a	500	90⁰ Socketed Bend		1
A1b	500	P/E Pipe piece	2800	1
A1	500	Socket & Spigot Pipe	5500	2
A2	500	111/4⁰ Socketed Bend		1
A3	500	F/PE Pipe Piece	900	1
A4	500-350	Flanged Taper		2
A5	350	F/PE Pipe piece with Puddle Flange	1725	1
A6	350-350	Flanged Tee		2
A7	350	Flange Adaptor		2
A8	350	F/PE Pipe Piece	2500	1
A9	350	F/PE Pipe Piece	1000	1
A10	500-500	Flanged Tee		2
A11	500-100	Air Valve Tee		1
A12	500	D/F Pipe Piece	500	1
A13	500	Flange Adaptor		2
A14	500	P/E Pipe piece with Puddle Flange	2000	1
A15	500	Coupling		3
A16	500	P/E Pipe piece with Puddle Flange	2500	1
A17	500	F/PE Pipe Piece	2000	1
A18	350	D/F Pipe Piece	880	1
A19	350	Flanged Bend		2
A20	350	D/F Pipe Piece	4700	1
A21	350	D/F Pipe Piece	600	1

PIPING SCHEDULE - Inlet to Reservoir

B1	500	P/E Pipe Piece	1200	1
B2	500	45⁰ Socketed Bend		2
B3	500	P/E Pipe Piece	3000	1
B4	500	P/E Pipe Piece	4400	1
B5	500	Socket & Spigot Pipe	5500	9
B6	500	Socket & Spigot Pipe	3225	1
B7	500	90⁰ Socketed Bend		2
B8	500	P/E Pipe Piece	3000	3
B9	500	P/E Pipe Piece	1800	1
B10	500	Coupling		1
B11	500	F/PE Pipe Piece	1900	1
B12	500	90⁰ Duckfoot Bend		1
B13	500	F/ Pipe Piece	620	1
B14	500	Flanged Bell Mouth		1

PIPING SCHEDULE - Inlet to Reservoir

C1	500	P/E Pipe Piece	1400	1
C2	500	Socket & Spigot Pipe	5500	5
C3	500	90⁰ Socketed Bend		1
C4	500	P/E Pipe Piece	575	1
C5	500	Coupling		1
C6	500	F/PE Pipe piece with Puddle Flange	1300	1
C7	500	90⁰ Duckfoot Bend		1
C8	500	F/ Pipe Piece	620	1
C9	500	Flanged Bell Mouth		1

PIPING SCHEDULE - Inlet to Pump House

D1	500	P/E Pipe Piece	3200	1
D2	500	Coupling		1
D3	500	F/PE Pipe piece with Puddle Flange	2000	1

PIPING SCHEDULE - Inlet to Tower

E1	600-450	Socketed Concentric Taper		1
E2	450	P/E Pipe Piece	1750	1
E3	450	45⁰ Socketed Bend		2
E4	450	P/E Pipe Piece	2525	1
E5	450	P/E Pipe Piece	1750	1
E6	450	Coupling		1

FOR REMAINING SCHEDULE REFER DRG. No. KMU/GR/YP-02
* PIPE LENGTH MAY VARY DEPEND ON SITE CONDITION

PIPING SCHEDULE - Scour from ExistingTower

L1	150	S/PE Pipe Piece	4700	1
L2	150	S/PE Pipe	5500	1

DO NOT SCALE

REV.	DESCRIPTION

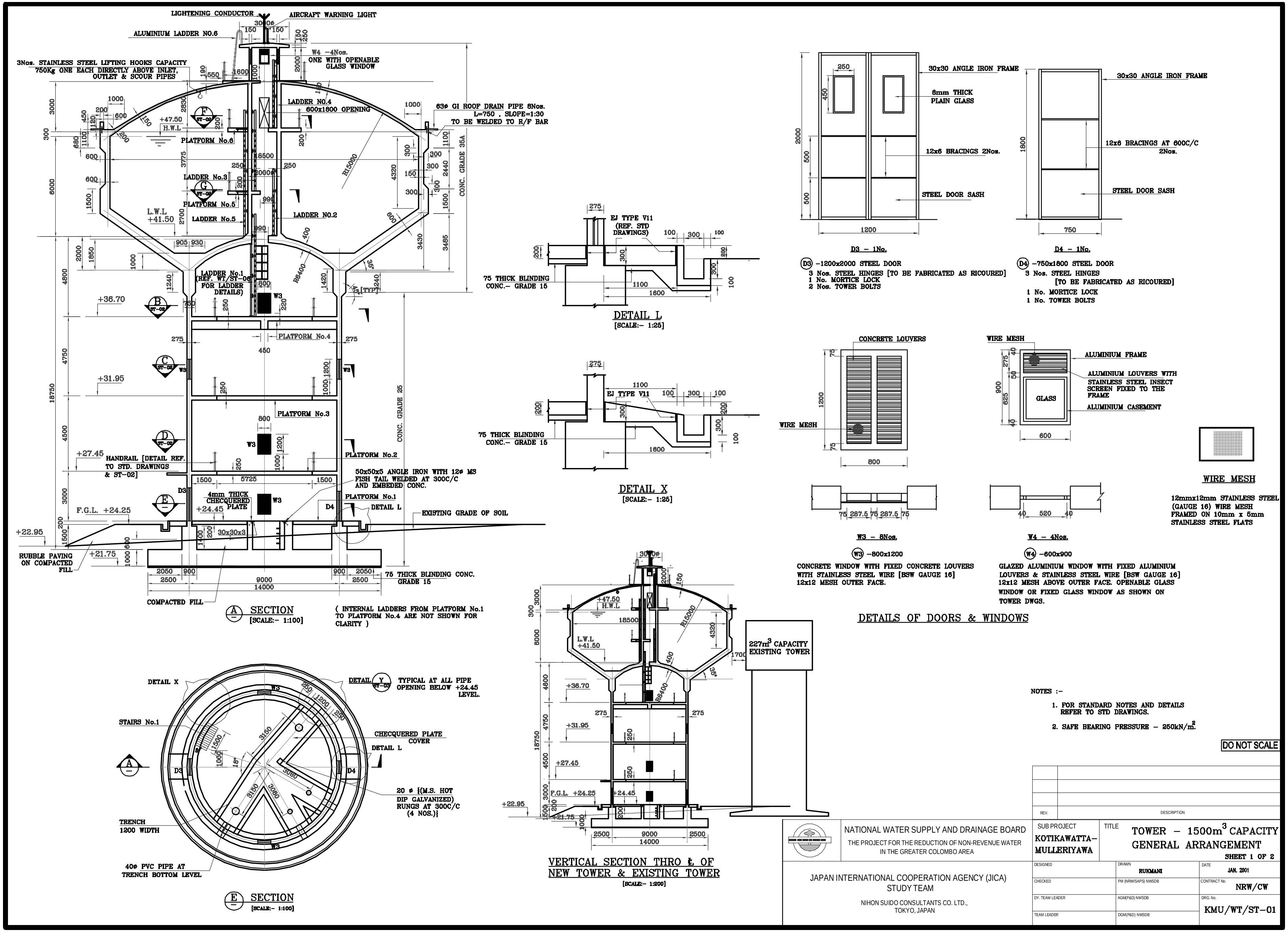
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN

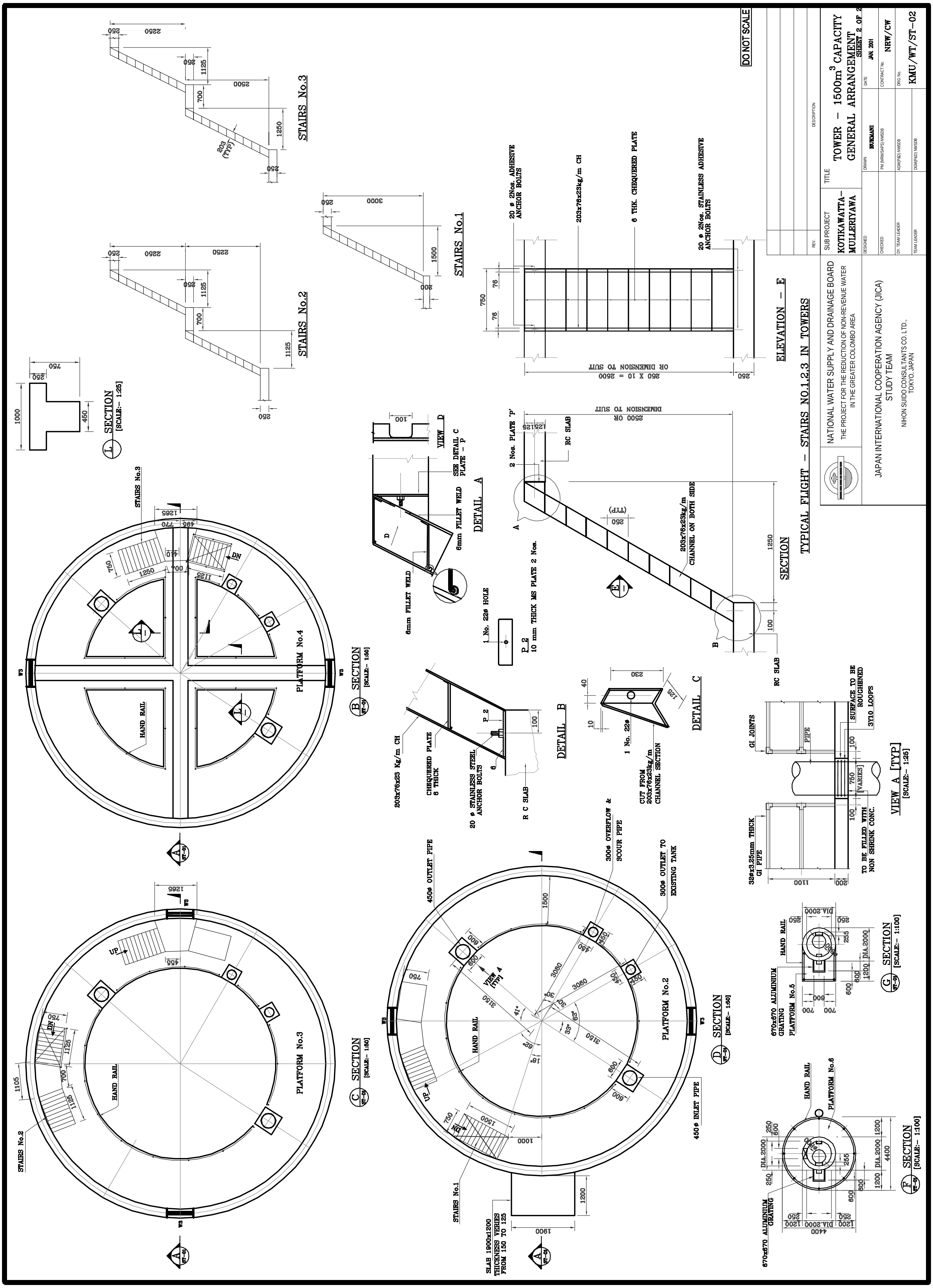
SUB PROJECT: KOTIKAWATTA/ MULLERIYAWA

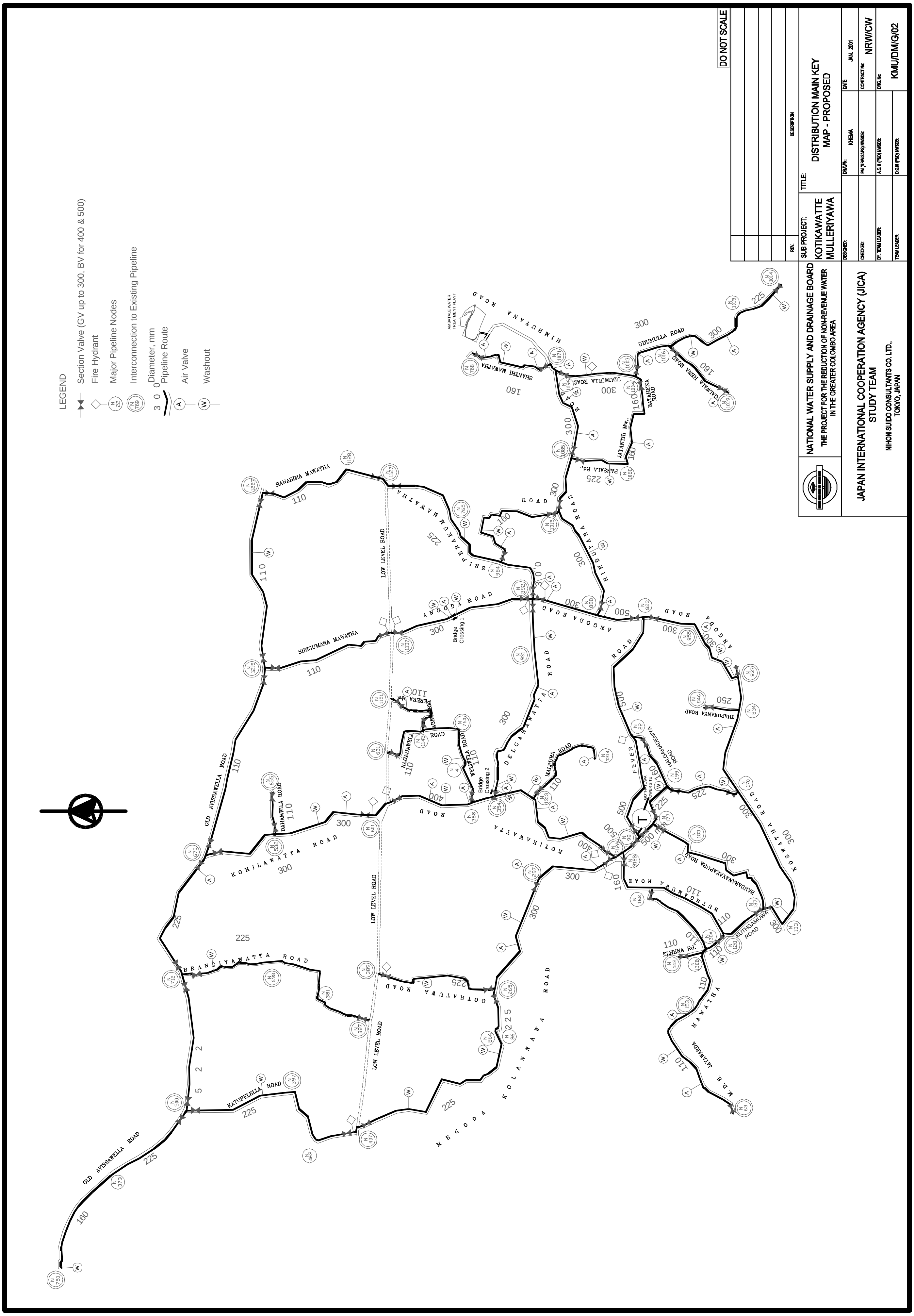
TITLE: GOTHATUWA GROUND RESERVOIR & PUMP HOUSE YARD PIPING - RESERVOIR INLET & OUTLET PLAN

DESIGNED:	DRAWN: KHEMA	DATE: JAN. 2001
CHECKED:	PM (NRW/SAPS) NWSDB:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D) NWSDB:	DRG. No: KMU/GR/YP-01
TEAM LEADER:	D.G.M (P&D) NWSDB:	



LIGHTENING CONDUCTOR
AIRCRAFT WARNING LIGHT
ALUMINIUM LADDER NO.6
3Nos. STAINLESS STEEL LIFTING HOOKS CAPACITY 750Kg ONE EACH DIRECTLY ABOVE INLET, OUTLET & SCOUR PIPES
W4 -4Nos. ONE WITH OPENABLE GLASS WINDOW
LADDER NO.4 600x1800 OPENING
63ø GI ROOF DRAIN PIPE 6Nos. L=750 , SLOPE=1:30 TO BE WELDED TO R/F BAR
PLATFORM No.6
LADDER No.3
PLATFORM No.5
LADDER No.5
LADDER NO.2
CONC. GRADE 35A
L.W.L +41.50
H.W.L +47.50
LADDER No.1 (REF. WT/ST-06 FOR LADDER DETAILS)
PLATFORM No.4
PLATFORM No.3
PLATFORM No.2
PLATFORM No.1
CONC. GRADE 25
HANDRAIL [DETAIL REF. TO STD. DRAWINGS & ST-02]
50x50x5 ANGLE IRON WITH 12ø MS FISH TAIL WELDED AT 300C/C AND EMBEDED CONC.
4mm THICK CHECQUERED PLATE
DETAIL L
EXISTING GRADE OF SOIL
F.G.L. +24.25
RUBBLE PAVING ON COMPACTED FILL
75 THICK BLINDING CONC. GRADE 15
COMPACTED FILL
A SECTION [SCALE:- 1:100]
(INTERNAL LADDERS FROM PLATFORM No.1 TO PLATFORM No.4 ARE NOT SHOWN FOR CLARITY)
EJ TYPE V11 (REF. STD DRAWINGS)
75 THICK BLINDING CONC.- GRADE 15
DETAIL L [SCALE:- 1:25]
DETAIL X [SCALE:- 1:25]
30x30 ANGLE IRON FRAME
6mm THICK PLAIN GLASS
12x6 BRACINGS 2Nos.
STEEL DOOR SASH
12x6 BRACINGS AT 600C/C 2Nos.
D3 - 1No.
D3 -1200x2000 STEEL DOOR
3 Nos. STEEL HINGES [TO BE FABRICATED AS RICOURED]
1 No. MORTICE LOCK
2 Nos. TOWER BOLTS
D4 - 1No.
D4 -750x1800 STEEL DOOR
3 Nos. STEEL HINGES [TO BE FABRICATED AS RICOURED]
1 No. MORTICE LOCK
1 No. TOWER BOLTS
CONCRETE LOUVERS
WIRE MESH
ALUMINIUM FRAME
ALUMINIUM LOUVERS WITH STAINLESS STEEL INSECT SCREEN FIXED TO THE FRAME
GLASS
ALUMINIUM CASEMENT
W3 - 8Nos.
W3 -800x1200
CONCRETE WINDOW WITH FIXED CONCRETE LOUVERS WITH STAINLESS STEEL WIRE [BSW GAUGE 16] 12x12 MESH OUTER FACE.
W4 - 4Nos.
W4 -600x900
GLAZED ALUMINIUM WINDOW WITH FIXED ALUMINIUM LOUVERS & STAINLESS STEEL WIRE [BSW GAUGE 16] 12x12 MESH ABOVE OUTER FACE. OPENABLE GLASS WINDOW OR FIXED GLASS WINDOW AS SHOWN ON TOWER DWGS.
WIRE MESH
12mmx12mm STAINLESS STEEL (GAUGE 16) WIRE MESH FRAMED ON 10mm x 5mm STAINLESS STEEL FLATS
DETAILS OF DOORS & WINDOWS
DETAIL X
DETAIL Y TYPICAL AT ALL PIPE OPENING BELOW +24.45 LEVEL.
STAIRS No.1
CHECQUERED PLATE COVER
20 ø {(M.S. HOT DIP GALVANIZED) RUNGS AT 300C/C (4 NOS.)}
TRENCH 1200 WIDTH
40ø PVC PIPE AT TRENCH BOTTOM LEVEL
E SECTION [SCALE:- 1:100]
227m³ CAPACITY EXISTING TOWER
VERTICAL SECTION THRO ℄ OF NEW TOWER & EXISTING TOWER [SCALE:- 1:200]
NOTES :-
1. FOR STANDARD NOTES AND DETAILS REFER TO STD DRAWINGS.
2. SAFE BEARING PRESSURE - 250kN/m²
DO NOT SCALE
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
SUB PROJECT KOTIKAWATTA-MULLERIYAWA
TITLE TOWER - 1500m³ CAPACITY GENERAL ARRANGEMENT
SHEET 1 OF 2
DRAWN RUKMANI
DATE JAN. 2001
CONTRACT No. NRW/CW
DRG. No. KMU/WT/ST-01


DO NOT SCALE
TOWER - 1500m3 CAPACITY
GENERAL ARRANGEMENT
SHEET 2 OF 2
KOTIKAWATTA-MULLERIYAWA
NRW/CW
KMU/WT/ST-02
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
STAIRS No.1
STAIRS No.2
STAIRS No.3
ELEVATION - E
TYPICAL FLIGHT - STAIRS NO.1,2,3 IN TOWERS
SECTION
DETAIL A
DETAIL B
DETAIL C
VIEW D
VIEW A [TYP] [SCALE:- 1:25]
PLATFORM No.2
PLATFORM No.3
PLATFORM No.4
PLATFORM No.5
PLATFORM No.6
HAND RAIL
450ϕ OUTLET PIPE
450ϕ INLET PIPE
300ϕ OVERFLOW & SCOUR PIPE
300ϕ OUTLET TO EXISTING TANK
SLAB 1900x1200 THICKNESS VERIES FROM 150 TO 125
670x670 ALUMINIUM GRATING
RC SLAB
203x76x23kg/m CHANNEL ON BOTH SIDE
6 THK. CHEQUERED PLATE
20 ϕ 2Nos. STAINLESS ADHESIVE ANCHOR BOLTS
32ϕx3.25mm THICK GI PIPE
GI JOINTS
SURFACE TO BE ROUGHENED
TO BE FILLED WITH NON SHRINK CONC.


DO NOT SCALE
REV.
DESCRIPTION
SUB PROJECT:
KOTIKAWATTE MULLERIYAWA
TITLE:
DISTRIBUTION MAIN KEY MAP - PROPOSED
DESIGNED:
DRAWN: KHEMA
DATE: JAN. 2001
CHECKED:
PM (NRW/SAPS) NWSDB:
CONTRACT No: NRW/CW
DY. TEAM LEADER:
A.G.M (P&D) NWSDB:
DRG. No: KMU/DM/G/02
TEAM LEADER:
D.G.M (P&D) NWSDB:
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
LEGEND
Section Valve (GV up to 300, BV for 400 & 500)
Fire Hydrant
Major Pipeline Nodes
Interconnection to Existing Pipeline
Diameter, mm
Pipeline Route
Air Valve
Washout
HIMBUTANA ROAD
UDUMULLA ROAD
SHANTHI MAWATHA
BATAHENA ROAD
GALWALA HENA ROAD
JAYANTHI Mw.
PANSALA Rd.
SRI PERAKUM MAWATHA
RANABIMA MAWATHA
LOW LEVEL ROAD
ANGODA ROAD
SIRISUMANA MAWATHA
PERERA MW.
NAGAHAWELA ROAD
WELIWELA ROAD
DELGAHAWATTA ROAD
MALPURA ROAD
THAPOWANYA ROAD
HAGAHAMEGEWATTA ROAD
FEVER
KOSWATTA ROAD
OLD AVISSAWELLA ROAD
DAHAMWILA ROAD
KOHILAWATTA ROAD
KOTIKAWATTA ROAD
BANDARANAYAKAPURA ROAD
BUTHGAMUWA ROAD
ELHENA Rd.
M.D.H. JAYAWARDENA MAWATHA
BRANDIYAWATTA ROAD
GOTHATUWA ROAD
MEGODA KOLANNAWA ROAD
KATUPELELLA ROAD
Bridge Crossing 1
Bridge Crossing 2

CHAPTER 4

4 NRW REDUCTION ACTION PLAN

4.1 SCOPE OF JBIC LOAN

In conjunction with the reduction of NRW, the JBIC loan includes the following components.

(a) Implementation of the two contracts: (1) Contract for Leak Repair Works and (2) Contract for Low Income Settlement Environmental Improvement

(b) Procurement of materials and equipment for NRW reduction under the Contract for Civil Works

4.2 TOR OF JICA STUDY

The Terms of Reference (TOR) of JICA study includes the following.

(a) Preparation of tender documents for the above two contracts

(b) Review existing conditions and recommend action plans for each of the following.

- Public standposts
- Illegal connections
- Apartment buildings

(c) Review existing conditions and make recommendations for improvement to each of the following NRW reduction management systems

- Meter Repair Workshop
- Meter Reading and Capacity Development of Meter Readers
- Billing and Collection System
- Inventory and Information Management System

(d) Implementation of pilot projects in three low income settlements in CB1 area

(e) Implementation of a NRW reduction pilot project in CB1 area

(f) Preparation of Water Awareness Mass Media Campaign Program

(g) Make recommendations on the locations and specifications of water meters to be required for NRW monitoring of CB1 area

4.3 CONTRACT FOR LEAK REPAIR WORKS

The contract for leak repair works includes the repairs of 2,340 leaks in distribution mains and 9,000 leaks in service mains. These numbers were estimated by JBIC as being approximately halves the numbers of leaks currently repaired by NWSDB and CMC during a period of one year and a half (18 months).

In conjunction with this contract, the study team prepared the following report and documents, each bound separately from this Main Report.

(a) Design Report on the Contract for Leak Repair Works
(b) Prequalification Documents for the Contract for Leak Repair Works
(c) Tender Documents for the Contract for Leak Repair Works

The design report discusses the approaches and methodologies used for estimating the volumes of work and materials to be required for this contract. Since the kinds of works and materials required for repairing a leak vary from one place to another depending on actual conditions of the leak, one cannot tell them exactly until the leak is finally exposed and visually inspected. The study team therefore collected leak repair records from NWSDB and CMC and sorted leaks into a number of different groups. As a result, 2,340 leaks in distribution mains are classified into the following 5 groups.

i) Leaks from pipe bodies (1,260 locations)
ii) Leaks from pipe joints (660 locations)
iii) Leaks from fire hydrants (120 locations)
iv) Leaks from air valves (30 locations)
v) Leaks from gate valves (270 locations)

These leaks were further divided into 18 different types, each requiring a different repair method and a different set of repair materials.

Leaks in service mains were classified into the following 4 groups.

i) Leaks from saddles/ferrules (600 locations)
ii) Leaks from service connection pipes (4,200 locations)
iii) Leaks from stop cocks (600 locations)
iv) Leaks from water meters (600 locations)

In addition, the study team also included the following works as part of the leak repairs in service mains.

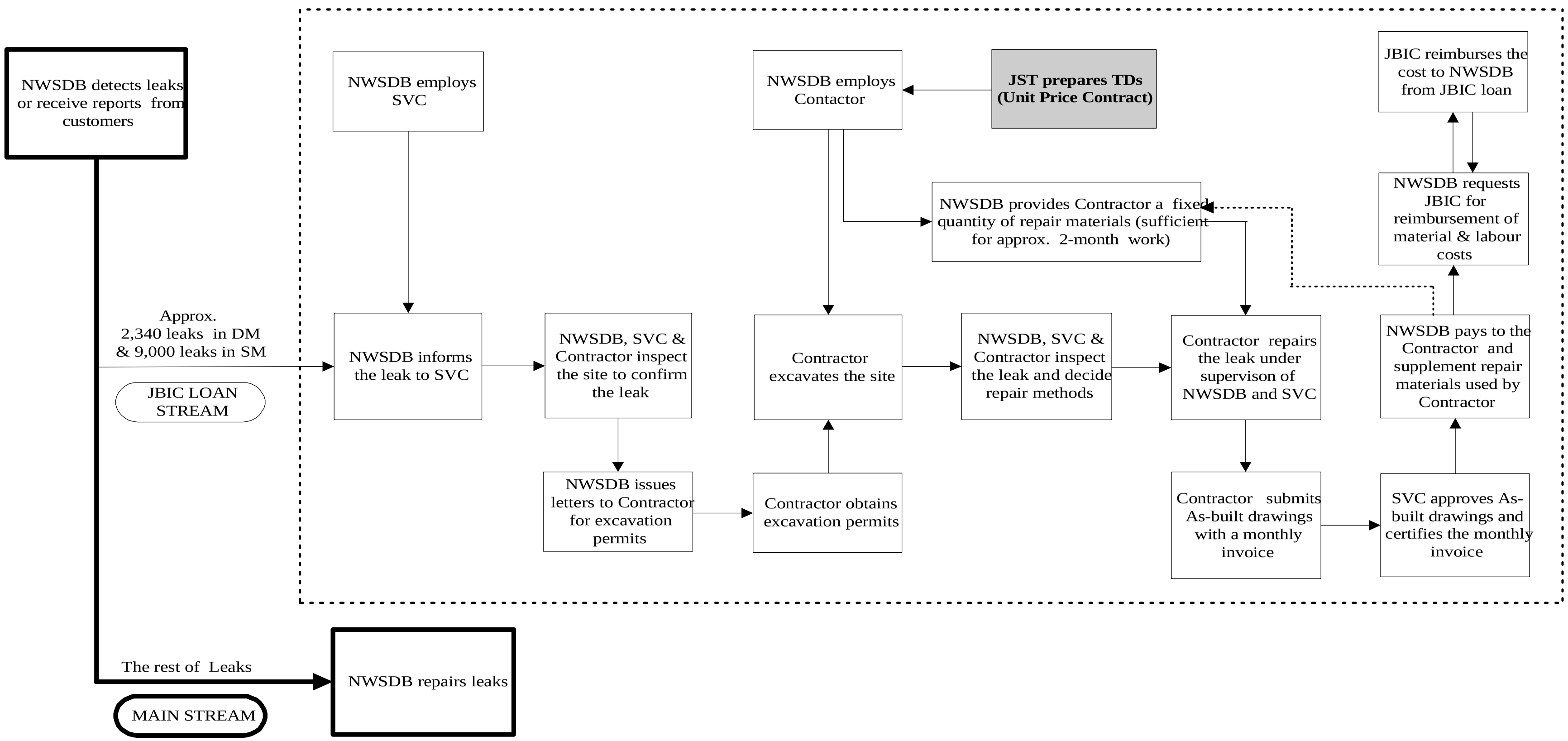
i) Replacement of GI service connections (1,000 locations)
ii) Encasement of exposed PVC service connection pipes (1,000 locations)
iii) Rectification of spaghetti-like service connection pipes (1,000 locations)

The design report also includes a recommended implementation plan for this contract as shown in Figure 4-1. The duration of the contract is estimated to be approximately 2 years. It is recommended that the entire work in this contract be implemented in several contracts each to be awarded to a contractor at an interval of every 6 months or so.

The prequalification documents specify minimum qualification criteria as well as criteria for evaluation of applications. It is recommended that prequalification be conducted only once at the outset, and a contractor be selected each time from a pool of the initially prequalified contractors.

Prototype tender documents have been prepared by the study team for use by NWSDB for selection of contractors. The contract will be a unit-price contract in that the contractor will be paid for actual works performed based on the unit prices quoted by him in his tender. It is recommended that all couplings and other pipe materials required for leak repairs be furnished to the contractor by NWSDB, and the contractor provides only labor and construction equipment.

FIGURE 4-1 RECOMMENDED IMPLEMENTATION PLAN FOR CONTRACT FOR LEAK REPAIR WORKS



Legend
SVC: Construction Supervision Consultant; JST: JICA Study Team;
DM:Distribution Main; SM: Service Main; TD: Tender Documents

4.4 CONTRACT FOR LOW INCOME SETTLEMENT ENVIRONMENTAL IMPROVEMENT

The contract for low income settlement environmental improvement envisages improvement of water supply conditions at approximately 30 low income settlements in CB1 area by providing individual connections and disconnecting standposts. The reason why JBIC estimated the number of low income settlements for improvement as 30 is unknown.

In conjunction with this contract, the study team prepared the following report and documents, each bound separately from this Main Report.

(a) Design Report on the Contract for Low Income Settlement Environmental Improvement
(b) Prequalification Documents for the Contract for Low Income Settlement Environmental Improvement
(c) Tender Documents for the Contract for Low Income Settlement Environmental Improvement

The design report discusses approaches and methodologies used for estimating the volume of work and materials to be required for this contract. The works and materials actually required for water supply improvement in settlements vary from one place to another depending on the actual conditions of the settlement.

It is estimated that about half of the population of CMC live in settlements numbering 1,624, most using free standpost water. The standposts are generally in poor condition, many having been tampered with, particularly in low pressure areas, and leakage of water is both obvious and serious. The residents seem not to care about damage or wastage, a major factor probably being that the supply is free. The NWSDB policy is to provide subsidised individual household connections settlement by settlement, and to remove the standposts. In 1999, NWSDB worked in 45 Tenement Gardens, completing 28. In this operation, communities are required to do all excavation and backfilling work for the connections and they also pay for the cost of the connection to the main and the road reinstatement costs.

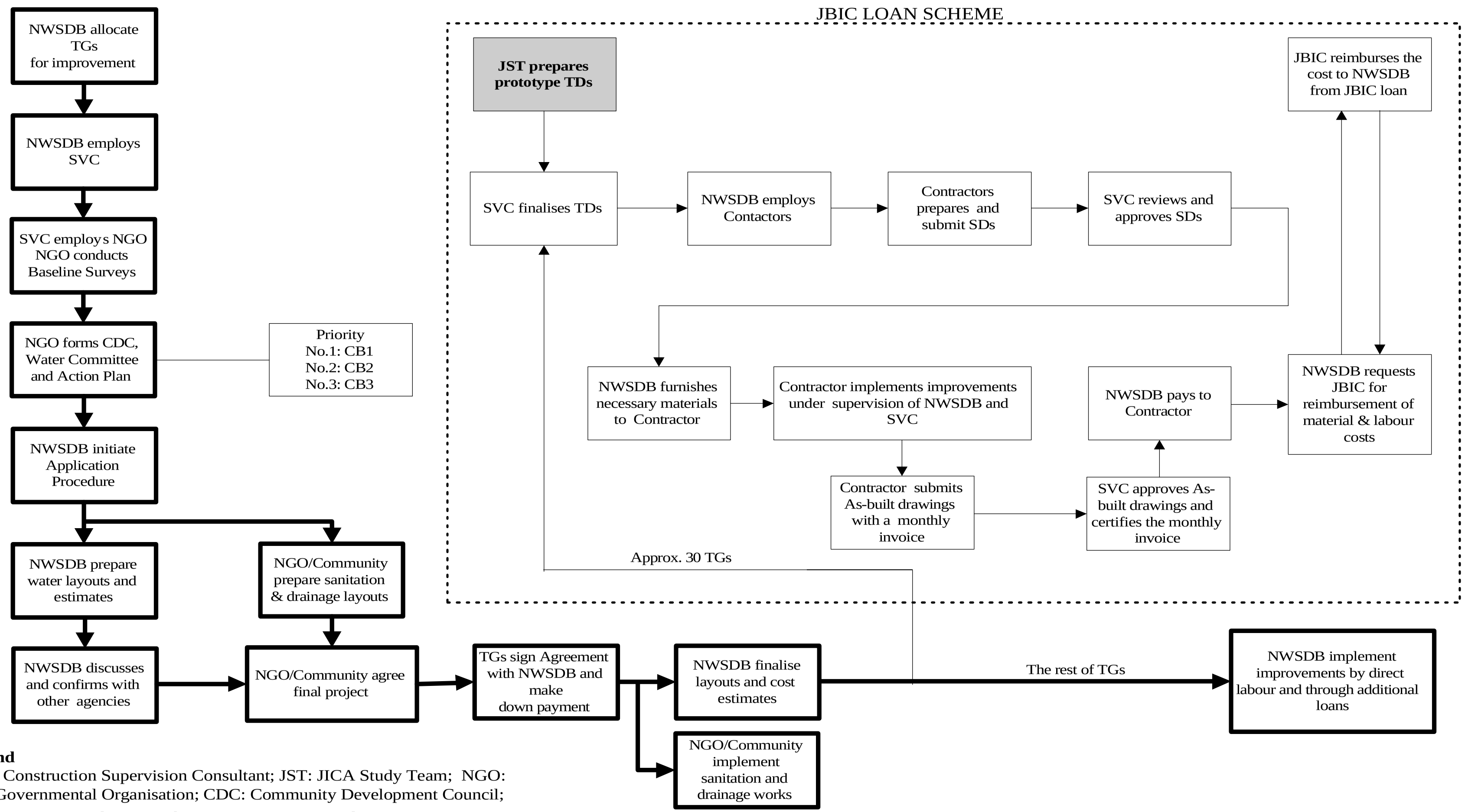
Since the kinds of works and materials required for water supply improvement vary from one settlement to another depending on the actual conditions of the settlement, one cannot tell them exactly until the location of the settlement is determined and the current conditions of the settlement are examined. The study team therefore collected the layouts and other details of 21 tenement gardens in CMC where NWSDB had already completed the provision of individual connections and disconnection of standposts. Having fully analyzed the data obtained, the works and materials to be required for water supply improvements to 30 low income settlements were estimated.

The design report also includes a recommended implementation plan for this contract as shown in Figure 4-2. It is strongly recommended that NWSDB use NGO and the consultant for construction supervision to facilitate the implementation. The duration of the contract is estimated to be approximately 2 years. It is also recommended that the entire work in this contract be implemented in several contracts, each to be awarded to a contractor at an interval of every 6 months or so.

The prequalification documents specify minimum qualification criteria as well as criteria for evaluation of applications. It is recommended that the prequalification be conducted only once at the outset, and a contractor be selected each time from a pool of the initially prequalified contractors.

Prototype tender documents have been prepared by the study team for use by NWSDB for selection of contractors. The contract will be a unit-price contract in that the contractor will be paid for actual works performed based on the unit prices quoted by him in his tender. It is recommended that all pipe materials required for improvement be furnished to the contractor by NWSDB, and the contractor provides only labor and construction equipment.

FIGURE 4-2 RECOMMENDED IMPLEMENTATION PLAN FOR CONTRACT FOR LOW INCOME SETTLEMENT ENVIRONMENTAL IMPROVEMENT



Legend
SVC: Construction Supervision Consultant; JST: JICA Study Team; NGO: Non Governmental Organisation; CDC: Community Development Council; TG: Tenement Garden; SD: Shop Drawings; TD: Tender Documents