JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
MINISTRY OF URBAN DEVELOPMENT, CONSTRUCTION
AND PUBLIC UTILITIES
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

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

FINAL REPORT

EXECUTIVE SUMMARY

MARCH 2001

NIHON SUIDO CONSULTANTS CO., LTD.

CHAPTER 1

1 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVE OF JICA STUDY

From September 1997 through January 1998, the "Special Assistance for Project Sustainability for Towns East of Colombo Water Project (SAPS)" was conducted by the JBIC at the request of the Government of Sri Lanka (GOSL). The prime objective of the SAPS was to analyze the condition of Non-Revenue Water (NRW) in the Greater Colombo (GC) area with a view to formulating a comprehensive mid-term NRW reduction program and a program specially designed to improve the efficiency of the water distribution system in the Colombo Municipal Council (CMC) area.

The SAPS analyzed the condition of NRW in the Greater Colombo Area and proposed the following two sets of programs for implementation, each comprising several components as shown below.

(1) Rehabilitation Program
   (a) Rehabilitation/Strengthening of Large and Medium Diameter Pipe Network in CMC Area
   (b) Rehabilitation of Small Diameter Pipe Network in CB1 Area
   (c) Rehabilitation of Maligakanda Reservoir and Ellie House Reservoir
   (d) Rehabilitation/Strengthening of Water Transmission and Distribution Facilities in Kotikawatte and Mulleriyawa Area
   (e) Improvement of NWSDB's Meter Workshop

(2) NRW Action Program
   (a) Leakage Reduction
   (b) NRW Reduction in Low Income Settlements
   (c) Abatement of Illegal Connections
   (d) NRW/Wastage Reduction at Wayside Public Standposts
   (e) Abatement of Meter-related Losses
   (f) NRW Reduction in Apartment Buildings

Following the completion of SAPS, GOSL requested the Government of Japan (GOJ) for a Japanese ODA loan for implementation of the above two improvement programs and the "Loan Agreement (SL-P66) for the Project for Reduction of Non-Revenue Water" was signed on August 4, 1999, which subsequently became effective on December 1, 1999.

The loan agreement envisaged that the project would be implemented with one International Competitive Bidding (ICB) and two Local Competitive Bidding (LCB) contract packages as described below.

1) Civil Works (ICB)
- Implementation of all the components of Rehabilitation Program
- Procurement of materials and equipment for NRW reduction

2) Leak Repair Works (LCB)
- Implementation of the component (a) of NRW Action Program

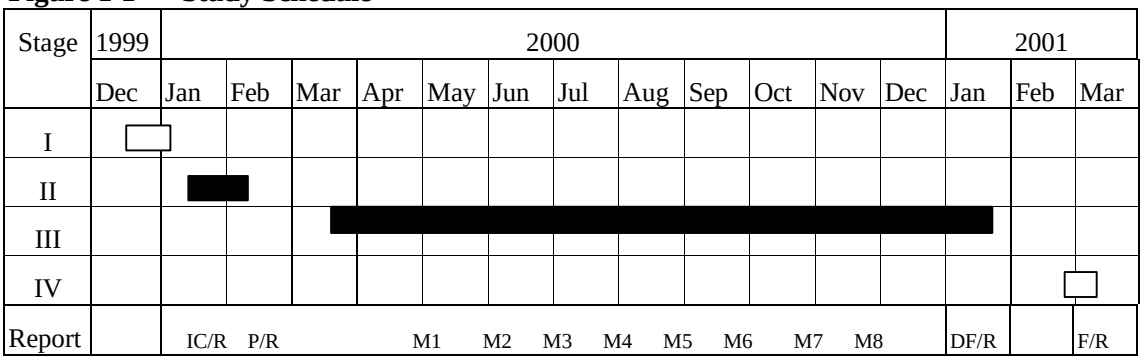
3) Low Income Settlement Environmental Improvement (LCB)
- Implementation of the component (b) of NRW Action Program

In December 1998, GOSL also requested GOJ to conduct a detailed design study on the project. In response, GOJ decided to conduct a JICA (Japan International Cooperation Agency) Study, officially called "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 ".

The JICA detailed design study started in December 1999 and was conducted in four (4) stages as shown in Figure 1-1 below.

Stage I : Preparatory Work in Japan
Stage II : First Work in Sri Lanka
Stage III : Second Work in Sri Lanka
Stage IV : First Work in Japan

Figure 1-1 Study Schedule



Note: □ Work in Japan ■ Work in Sri Lanka IC/R: Inception Report, P/R: Progress Report, M: Monthly Report, DF/R: Draft Final Report, F/R: Final Report

The study included the review of existing conditions and the scope of the project components included in the JBIC loan agreement with the prime objective of preparing detailed designs and

tender documents necessary for the implementation of the Project for Reduction of Non-Revenue Water.

1.2 JBIC LOAN (LOAN AGREEMENT NO. SL-P66)

As mentioned earlier in Section 1.1, the JBIC loan for implementation of this project (Loan Agreement No. SL-P66) was signed on August 4, 1999 between GOSL and JBIC.

Details of the JBIC loan are summarized as follows:

(a) Loan Agreement No: SL-P66
(b) Date of Signing: August 4, 1999
(c) Project Title: The Project for Reduction of Non-revenue Water
(d) Loan Amount: Four Billion Two Hundred Seventeen Million Japanese Yen (¥ 4,217,000,000)
(e) Signed Between: The Japan Bank for International Cooperation ((JBIC) and The Government of Democratic Socialist Republic of Sri Lanka
(f) Executing Agency: National Water Supply and Drainage Board (NWSDB)
(g) Effective Date of Loan Agreement: December 1, 1999
(h) Effective Period of Loan Agreement: 7 years from December 1, 1999 through December 1, 2006 (Final disbursement shall be made not later than December 1, 2006)

1.3 FINAL OUTPUT OF JICA STUDY

The following is a summary of major reports and documents prepared under the JICA detailed design study.

(1) Executive Summary

This document provides an executive summary of the Main Report excerpting important outcome of the JICA detailed design study in a condensed form.

(2) Main Report

This report discusses about the original scope of the JBIC loan for each major project component and important changes made thereto with reasons why they became necessary or were recommended as a result of the JICA study. The report also intends to provide methodologies and approaches used by the study team to determine the final scope of work for

each major project component. In addition, the report also provides construction plans and schedules for each project component, recommendations on project implementation, and project evaluation.

(3) Design Report

This report discusses, general design criteria and standards, design conditions, specific design criteria, design calculations, detailed design considerations, etc. used for the preparation of detailed designs and tender documents.

A separate design report has been prepared for each of the following three contracts.

i) Civil Works
ii) Leak Repair Works
iii) Low Income Settlement Environmental Improvement

(4) Tender Documents

A separate set of tender documents has been prepared for each of the following three contracts.

i) Civil Works
ii) Leak Repair Works
iii) Low Income Settlement Environmental Improvement

Each set of tender documents basically consists of Prequalification Documents, Tender Documents including drawings and Cost Estimates.

CURRENCY EQUIVALENTS

(As of August, 2000)

Currency Unit = Sri Lankan Rupee (Rs.)

US$1.00 = 79.47 Rs.

US$1.00 = 109.288 Yen (Japanese Yen)

1.0 Rs. = 1.37522 Yen (Japanese Yen)

1.0 Yen (Japanese Yen) = 0.727 Rs.

PREFACE

In response to the request of the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a 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 and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Sadanobu Sawara of Nihon Suido Consultants Co., Ltd. to Sri Lanka, two times between January 2000 and January 2001.

The team held discussions with the officials concerned of the Government of Sri Lanka and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Sri Lanka for their close cooperation extended to the Team.

March 2001

Kunihiko Saito
President
Japan International Cooperation Agency

March 15, 2001

Mr. Kunihiko Saito
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We are pleased to submit the Final Report on 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. The report incorporates the views and suggestions of the authorities concerned of the Government of Japan and your Agency. It also includes the comments made by the National Water Supply and Drainage Board on the Draft Final Report dated January 2001.

The Final Report comprises a total of twenty-one volumes as listed below.

1. Executive Summary
2. Main Report
3. Appendices to Main Report
4. Design Report on the Contract for Civil Works
5. Appendices to Design Report on the Contract for Civil Works
6. Design Report on the Contract for Leak Repair Works
7. Design Report on the Contract for Low Income Settlement Environmental Improvement
8. Prequalification of Contractors for Civil Works
9. Prequalification of Contractors for Leak Repair Works
10. Prequalification of Contractors for Low Income Settlement Environmental Improvement
11. Tender Documents for Civil Works (Volume 1)
12. Tender Documents for Civil Works (Volume 2)
13. Tender Documents for Civil Works (Volume 3, A3 size)
14. Tender Documents for Civil Works (Volume 3, A1 size)
15. Tender Documents for Leak Repair Works
16. Tender Documents for Low Income Settlement Environmental Improvement

17. Cost Estimate on Civil Works
18. Cost Estimate on Leak Repair Works
19. Cost Estimate on Low Income Settlement Environmental Work
20. Supplementary Data on Tender Documents for Civil Works
21. Quantity Survey Sheets for Civil Works

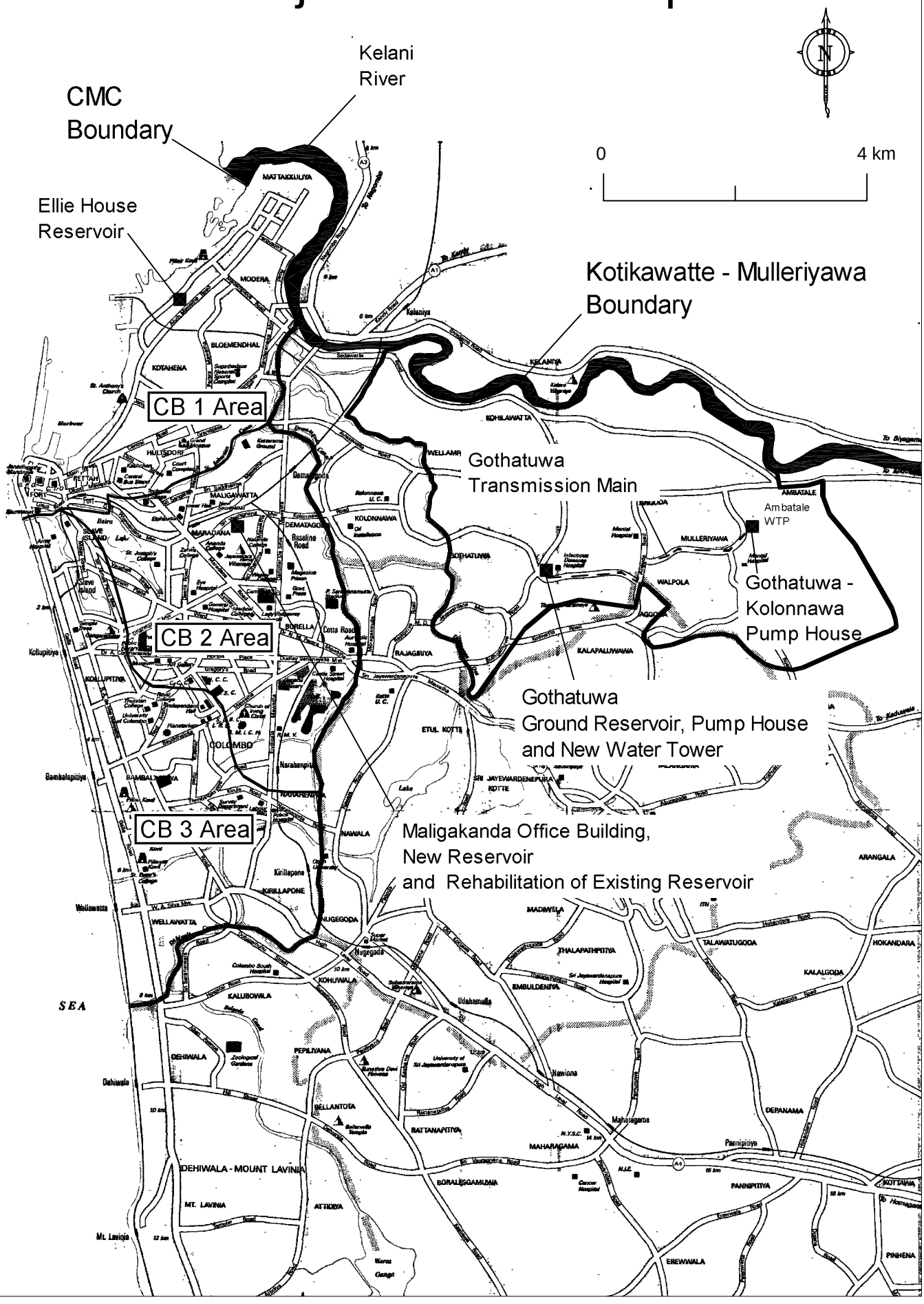
This Executive Summary discusses the findings, conclusions and recommendations derived from the Detailed Design Study.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Ministry of Foreign Affairs for their valuable suggestions and advice. We would also like to express our deep appreciation to the relevant officers of the National Water Supply and Drainage Board, Ministry of Urban Development, Construction and Public Utilities and other related agencies of the Government of the Democratic Socialist Republic of Sri Lanka for their cooperation and assistance extended to us during our study.

Very truly yours,

Sadanobu SAWARA
Team Leader, 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

Project Location Map



SYNOPSIS

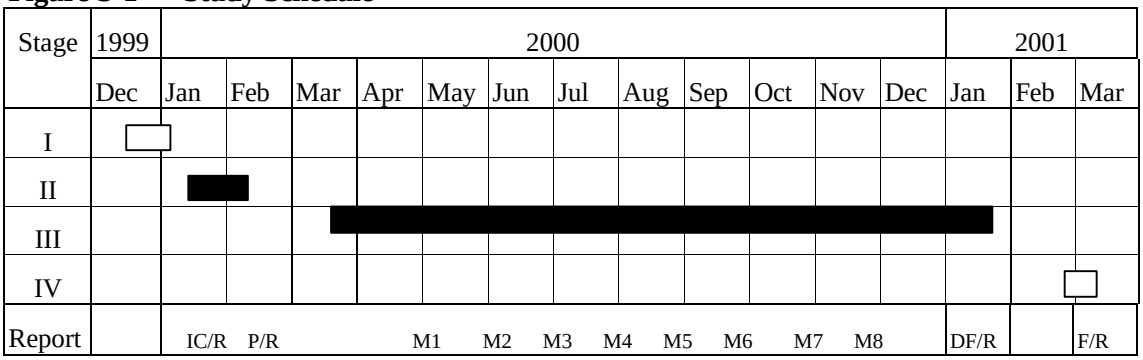
1. Background and Objective of the Study

On August 4, 1999, a Japanese ODA loan was signed between GOSL and JBIC for the implementation of the Project for Reduction of Non-Revenue Water (Loan Agreement No. SL-P66).

The study included the review of existing conditions and the scope of the JBIC loan project components with the prime objective of preparing detailed designs and tender documents for the implementation of the Project for Reduction of Non-Revenue Water.

The study started in December 1999 and was conducted in four (4) stages as shown in Figure S-1 below.

Figure S-1 Study Schedule



Note: ☐ Work in Japan ■ Work in Sri Lanka IC/R: Inception Report, P/R: Progress Report, M: Monthly Report, DF/R: Draft Final Report, F/R: Final Report

2. Scope of the Project

During the course of the JICA detailed design study, several changes have been made to the scope of the JBIC loan project. The original scope of the JBIC loan project and that finally adopted in this JICA detailed design study are summarized in Table S-1

3. Project Cost

The project cost has been estimated as shown in Table S-2.

Table S-2 Project Cost

No.	Item	Cost (Yen)
A	Civil Works Contract	3,573,164,788
A1	Preliminary and General Works	539,584,706
A2	Rehabilitation of Maligakanda Reservoir and Ellie House Reservoir	1,318,680,956
A3	Water Supply Enhancement in Kotikawatte and Mulleriyawa Area	846,292,757
A4	Rehabilitation and Reinforcement of Medium and Large Diameter Pipe Network in CMC Area	470,188,753
A5	Rehabilitation of Small Diameter Distribution Mains in CB1 Area	274,924,852
A6	Supply of Materials and Equipment for Reduction of NRW	123,492,764
B	Leak Repair Works Contract	154,849,512
C	Low Income Settlement Environmental Improvement Contract	20,257,613
	Sub-Total for Three Contracts (A+B+C)	3,748,271,912
D	Consulting Service	389,177,139
E	Interest During Construction and Service Charge	177,049,549
	Sub-Total for JBIC Loan Part	**4,314,498,601**
F	Project Administration Cost	64,717,555
G	Land Acquisition Cost	27,400,358
H	Custom Duties	244,736,783
I	GST (Goods and Services Tax)	446,646,072
	Sub-Total for NWSDB Part	**783,500,767**
	Total Project Cost	**5,097,999,368**

4. Project Implementation Schedule

The project is estimated to be implemented during the five years from early 2002 through late 2006 as shown in Figure S-2.

5. Disbursement of Project Cost

The project cost is estimated to be disbursed as shown in Table S-3.

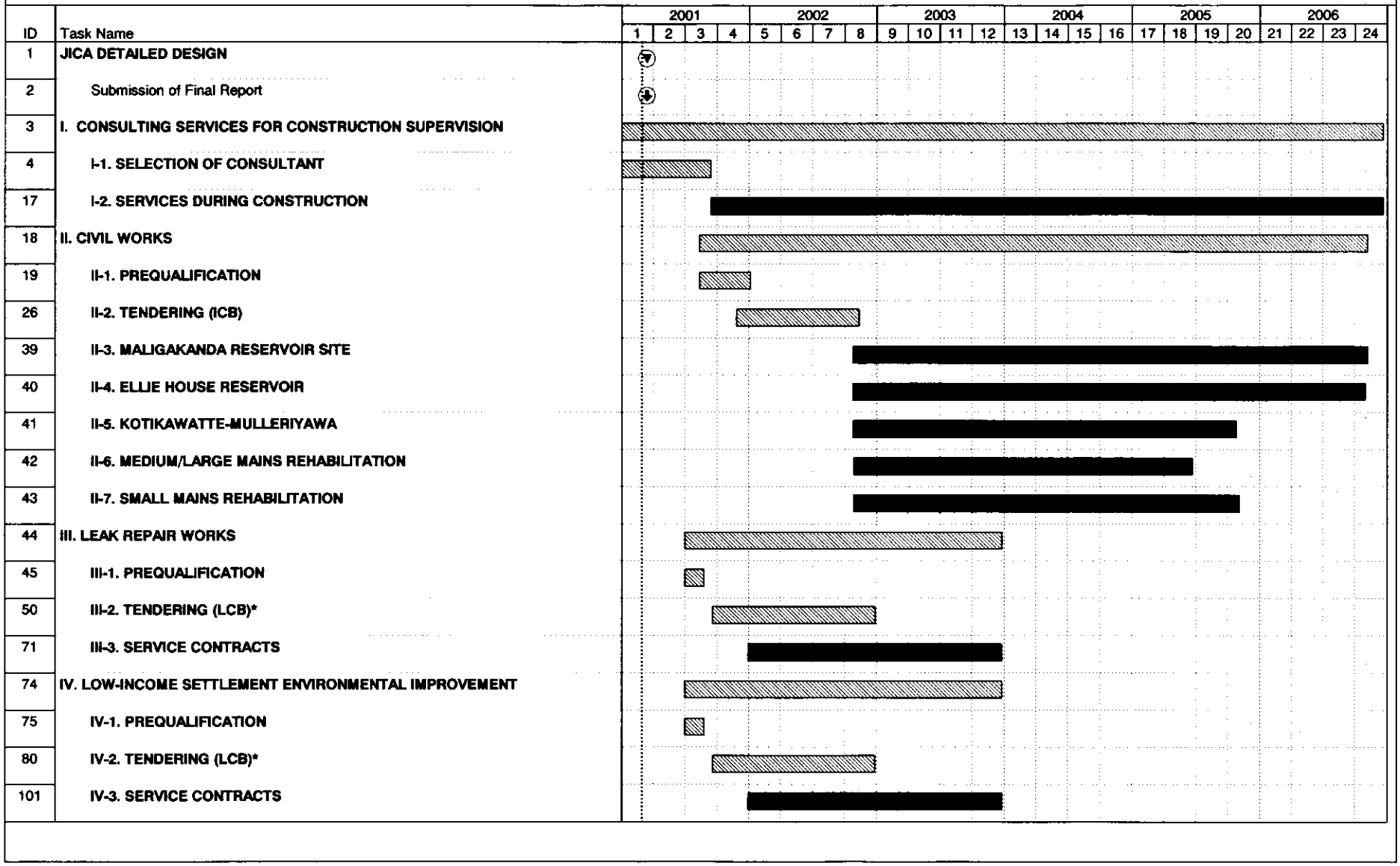
Table S-3 Disbursement of Project Cost (1,000 yen)

Project Cost	2001	2002	2003	2004	2005	2006	Total
JBIC Loan Part	7,850	514,358	1,182,019	1,415,647	724,322	470,303	4,314,499
NWSDB Part	33,872	74,298	198,853	276,100	193,906	6,472	783,501
Total	41,722	588,656	1,380,872	1,691,747	918,228	476,775	5,098,000

Table S-1 Scope of the Project

Project Component		Original Scope (JBIC Loan)	Final Scope (JICA Detailed Design)
A	**Civil Works Contract（ICB）**		
A1	Rehabilitation of Maligakanda Reservoir and Ellie House Reservoir	New Office Building at Battaramulla (3,000 m^2)	New Office Building at Maligakanda (3,100 m^2)
		Maligakanda New Reservoir (28,400 m^3)	Maligakanda New Reservoir (22,000 m^3)
		Rehabilitation of the Roof Structure of the Existing Maligakanda Reservoir	Same as left. (However, the final decision on whether or not the rehabilitation should actually be implemented will be made taking into account the results of the detailed structural assessment of the existing reservoir, which will be conducted by NWSDB after completion and commissioning of the Maligakanda New Reservoir.)
		Rehabilitation of the Roof Structure of the Existing Ellie House Reservoir（36,300 m^3）	Demolition of the Entire Existing Reservoir and Construction of A New Reservoir (36,600 m^3)
A2	Water Supply Enhancement in Kotikawatte and Mulleriyawa Area	Transmission Main 2.4 km（Dia.500 mm）	Transmission Main 4.36 km、(Dia.500 mm～800 mm)
		Distribution Main 4.71 km（Dia.75 mm～150 mm）	Distribution Main 39.7 km（Dia.100 mm～500 mm）
		Mulleriyawa Reservoir（2,000 m^3）	Gothatuwa Reservoir（4,400 m^3）
		Mulleriyawa Water Tower（1,500 m^3）	Gothatuwa Water Tower (1,500 m^3)
		Gothatuwa Pump Station（1.5 m^3/min. x 27 m）	Gothatuwa-Kolonnawa Transmission Pump House（14 m^3/min. x 50 m）
		Mulleriyawa Pump Station（9 m^3/min. x 40 m）	Gothatuwa Pump House（18 m^3/min. x 30 m）
A3	Rehabilitation and Reinforcement of Medium and Large Diameter Pipe Network in CMC	Pipe Rehabilitation 28.45 km (Dia.10”～30”)	Pipe Rehabilitation 27.9 km (Dia.250 mm～450 mm)
		Pipe Reinforcement 8.8 km (Dia.300 mm～500 mm)	Pipe Reinforcement 9.3 km (Dia.300 mm～500 mm)
		Rehabilitation/Replacement of Valves and Installation of Valve Covers	Replacement of Valves and Installation of Valve Covers
A4	Rehabilitation of Small Diameter Distribution Mains in CB1	Pipe Rehabilitation 33 km (Dia.50 mm～150 mm)	Pipe Rehabilitation 7.5 km (Dia.6”)
		Pipe Replacement 5.55 km	Pipe Replacement 32.6 km (Dia.3”～5”)
		Rehabilitation/Replacement of Valves and Installation of Valve Covers	Replacement of Valves and Installation of Valve Covers
		Rehabilitation/Replacement of Service Pipes	Replacement of Service Pipes
B	**Leak Repair Works Contract（LCB）**	Repair of 2,340 Leaks in Distribution Mains and 9,000 Leaks in Service Mains in CMC	Same as left.
C	**Low Income Settlement Environmental Improvement Contract（LCB）**	Provision of Individual Connections at 30 Low Income Settlements in CB1	Same as left.

Figure S-2 Project Implementation Schedule



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

EXECUTIVE SUMMARY

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ABBREVIATIONS AND TERMINOLOGY

AC	-	Asbestos Cement
AGF	-	Above Ground Floor
AGM	-	Additional General Manager
AS	-	Australian Standards
AWWA	-	American Water Works Association
B/C	-	Benefit Cost Ratio
BOQ	-	Bill of Quantity
BS	-	British Standards
BWL	-	Bottom Water Level
CDC	-	Community Development Council
CEB	-	Ceylon Electricity Board
CI	-	Cast Iron
CMC	-	Colombo Municipal Council
CSPU	-	Clean Settlement Program Unit of the Ministry of Urban Development, Construction and Public Utilities
DG	-	Diesel Engine Generator
DGM	-	Deputy General Manager
DI	-	Ductile Iron
dia.	-	Diameter
E/N	-	Exchange Notes
GC	-	Greater Colombo
GI	-	Galvanized Mild Steel Pipe
GM	-	General Manager
GOJ	-	Government of Japan
GOSL	-	Government of Sri Lanka
GR	-	Ground Reservoir
GST	-	Goods and Services Tax
GWL	-	Ground Water Level
HP	-	Horsepower
HWL	-	High Water Level
I/O	-	Input-output
ICB	-	International Competitive Bidding
ICTAD	-	Institute for Construction Training and Development

IDA	-	International Development Agency
IEE	-	Institution of Electrical Engineers
IRR	-	Internal Rate of Return
ISO	-	International Organization for Standardization
JBIC	-	Japan Bank for International Cooperation
JICA	-	Japan International Cooperation Agency
JST	-	JICA Study Team
LCB	-	Local Competitive Bidding
LDB	-	Lighting Distribution Board
LECO	-	Lanka Electricity Corporation
LI	-	Langelier's Saturation Index
LV	-	Low Voltage
LWL	-	Low Water Level
M/D	-	Minutes of Discussion
MCCB	-	Molded Case Circuit Breaker
MDPE	-	Medium Density Polyethylene
MLD	-	Million Litre per Day
MS	-	Mild Steel
MSB	-	Main Switch Board
MSL	-	Mean Sea Level
MUDCP	-	Ministry of Urban Development, Construction and Public Utilities
NCCSL	-	National Construction Contractor Association
ND, DN	-	Nominal Diameter
NGO	-	Non-government Organization
NHDA	-	National Housing Development Authority
NPV	-	Nett Present Value
NRW	-	Non-revenue Water
NWSDB	-	Notional Water Supply and Drainage Board
O&M	-	Operation & Maintenance
ODA	-	Official Development Assistance
OPC	-	Ordinary Portland Cement
PDB	-	Power Distribution Board
PIU	-	Project Implementation Unit
PLC	-	Programmable Logic Controller
PQ	-	Prequalification
PRDA	-	Provincial Road Development Authority
PS	-	Polis Station
PVC, uPVC	-	(Unplasticized) Polyvinyl Chloride

R/C, RC	-	Reinforced Concrete
RDA	-	Road Development Authority
RSC	-	Regional Support Centre of the National Water Supply and Drainage Board
S/W	-	Scope of Work
SAPROF	-	Special Assistance for Project Formation
SAPS	-	Special Assistance for Project Sustainability
SDB	-	Socket Distribution Board
SLLRDC	-	Sri Lankan Land Reclamation and Development Corporation
SLS	-	Serviceability Limit State
SLT	-	Sri Lanka Telecom
SPSS	-	Statistical Package for Social Sciences
STP	-	Sustainable Township Programme of the Ministry of Urban Development, Construction and Public Utilities
TDH	-	Total Dynamic Head
TG	-	Tenement Garden
TM	-	Transmission Main
TOR	-	Terms of Reference
TP&N, TPN	-	Three Pole and Neutral
TWL	-	Top Water Level
UDA	-	Urban Development Authority
UFW	-	Unaccounted-for Water
ULS	-	Ultimate Limit State
UPDB	-	Utilities Power Distribution Board
VH	-	Valve House
WTP	-	Water Treatment Plant
XLPE	-	Cross-linked Polyethylene Insulated Vinyl Sheath

UNITS

A, amp, Amp	-	Ampere
^{o}C	-	Celsius
cm	-	Centimetre
d	-	Day
dB	-	Decibel
h, hr, Hr	-	Hour
ha	-	Hectare
Hz	-	Hertz

kg	-	Kilogram
km	-	kilometre
kN	-	kilonewton
kVA	-	Kilovolt-ampere
kW	-	Kilowatt
L, l, ltr	-	Litre
lpcd, lcd	-	Liter per Capita per Day
m, M	-	Metre, Million
m^2, sqm	-	Square Metre
m^3, cum	-	Cubic Metre
mg	-	Milligram
MG	-	Million Imperial Gallon
min	-	Minutes
mm	-	Millimetre
mm^2, sqmm	-	Square Millimetre
mph	-	Mile per Hour
N	-	Newton
pH	-	Potential of Hydrogen
ppm	-	Parts per Million
psi	-	Pounds per Square Inch
Rs.	-	Sri Lankan Rupee
s, sec	-	Second
V	-	Volt
W	-	Watt

CHAPTER 2

2 CONSTRUCTION AND REHABILITATION OF RESERVOIRS

2.1 SCOPE OF JBIC LOAN

The scope of the JBIC loan for Rehabilitation of Ellie House Reservoir and Maligakanda Reservoir was based on replacement of the roof structure in accordance with previous studies that were commissioned by NWSDB.

The original scope of work has changed as result of feasibility studies carried out by the study team and requests made by NWSDB. The following changes have been agreed:

Items Changed	Original Scope	Revised Scope
Rehabilitation of Ellie House Reservoir	Replacement of roof	New reservoir and valve house, 36,600 m3
Capacity of the new Maligakanda reservoir	28,400 m3	22,000 m3
Location of new office	2 storey building located in Battaramula	4 storey building with lift located at Maligakanda

The change in the scope of work was agreed between NWSDB, JBIC and JICA on August 4, 2000.

2.2 MALIGAKANDA OFFICE BUILDING

2.2.1 Background

The CMC water works and drainage offices located at Maligakanda must be demolished to make space for the new 22,000 m^3 ground reservoir. Therefore the project includes construction of a new office building. The budget allocated in the JBIC loan is based on providing a building equivalent in size and function to the buildings presently used by CMC.

2.2.2 Design Brief

The design of the new office building is based on the criteria stipulated in the “Development

Plan for the Colombo Municipal Council area Planning & building regulations1999". These regulations are considered as a minimum requirement only and have been supplemented to meet specific requirements or concerns expressed by NWSDB.

The main characteristics of the building are summarized as follows:

Site area	3,220 m^2
Structural form	Reinforced concrete frame, slab on beams
Foundations	Strip footing with grade beams
No. of floors	4 (ground + three upper)
Building footprint area	863 m^2
Individual Floor area (gross)	792 m^2
Total floor area (gross)	3168 m^2
Top of roof (AFG)	17.68 m
Third floor slab (AFG)	11.60 m

The new office building will be located on 0.322 ha of land owned by CMC. CMC has agreed to the use of the site for the new office building but NWSDB will need to complete the necessary formalities to change land title before construction starts.

The site is just outside the boundary of the Maligakanda reservoir compound and is located directly East of the old CMC Water Works Office. The site is presently occupied by abandoned Municipal Courts buildings and overgrown by several trees. Some squatters have erected unauthorised housing at the edge of the road along the East boundary. The old buildings will need to be demolished and the trees removed as part of the contract for construction. The squatters will need to be relocated as well in order to reconstruct the boundary wall.

The site has sufficient space to provide vehicle parking on the south side and space for future expansion if required on the North side.

The building is 44 x 18 meters, provides 792 m^2 (gross) per floor and a total area of 3,168 m^2 excluding the machine room, roof slab and emergency staircase. The floor-to-floor height is 4.0 m for the ground floor and 3.8 m for upper floors. The ceiling heights of individual floors is set at 3.0 m for the ground floor and 2.8 m for upper floors conforming with building regulations. The space above the ceiling is provided for ductwork in case a central air-conditioning system is installed in the future.

Occupancy schedules and space requirements were determined in consultation with NWSDB. The building can be occupied by up to 250 persons. The space is planned for NWSDB's requirement of approximately 50 persons per floor. The occupancy requirements are as follows:

Floor	Offices	Floor Space m^2 Required/(Available)	No. of people
Ground floor	NWSDB CB1, CB2 & CB3, metering/commercial Manager (Colombo City) Common Areas	688 / (792)	50
First Floor	CMC Water Works Office	603 / (792)	48
Second Floor	CMC Drainage Operations	615 / (792)	48
Third Floor	NWSDB Greater Colombo Sewerage Section	639 / (792)	50

2.3 MALIGAKANDA NEW RESERVOIR

2.3.1 Background

The Water Supply Master Plan 1972 identified the requirement to increase storage capacity at Maligakanda. The concept drawing from the master plan identified 2 circular pre-stressed above ground structures to be constructed in separate phases to the east of the Old Maligakanda Reservoir.

- Phase 1: 3.0 MG tank (13,600 m^3)
- Phase 2: 6.25 MG tank (28,400 m^3)

The tank identified under Phase 1 was constructed in 1978 on vacant land. The second tank is now required in order to provide sufficient storage capacity for the old Maligakanda reservoir to be taken out of service and rehabilitated.

2.3.2 Design Brief

The proposed site for the new reservoir is located on flat and stable ground to the immediate South/East of the Old Reservoir in space occupied by CMC Waterworks and Drainage Offices. There are no other suitable areas within the existing Maligakanda site for water retaining structures.

There is insufficient space within the existing property boundary for a 28,400 m^3 tank therefore the decision has been taken to design a smaller tank with an internal diameter of 53 m and capacity of 22,000 m^3.

Characteristics of the new reservoir are as follows:

Volume	:	22,000 m3
High water level	:	+29.9 m MSL
Low water level	:	+19.9 m MSL
Depth of water	:	10.0 m

The perimeter wall is 500 mm thick reinforced concrete designed for horizontal segmental post-tensioning. There are four vertical pillars, at 90 degree positions, cast monolithically with the wall to anchor the post-tensioning wires.

The perimeter post tensioned wall rests on a ring beam foundation. The base slab inside the reservoir is a reinforced concrete raft foundation independent from the ring foundation. The roof is a reinforced concrete slab 250mm thick on beams supported on 600 mm diameter concrete columns. Baffle walls are provided in the new tank to improve circulation within the reservoir.

Quality of drinking water in Colombo is considered slightly aggressive towards concrete therefore a Cementitious mortar coating is applied to protect all internal structural concrete surfaces (columns, walls and floor but not baffle walls).

Sectional valves are arranged so the reservoirs can be fed from either source of supply. The reservoirs can also be completely by-passed via the old 27” by-pass main to the west and the new 30” by-pass main to the east.

The existing supply arrangement will be modified by removing the inlet connection from the new 30” supply to the old reservoir to provide more flow to the circular tank and the proposed new reservoir. The new reservoir will be connected to the 30” steel by-pass line.

The outlet system of the two existing reservoirs is already complex and the outlet valves are located over a wide area. The addition of a third reservoir with a conventional outlet system will aggravate this situation. Yard piping at Maligakanda will be modified to simplify operations and provide greater flexibility in control of supply, by-pass and distribution.

The new reservoir will be provided with a 800 mm diameter outlet taken from a bottom sump located on the South side of the reservoir. The outlet of the new reservoir and outlets from the 3MIG tank and the old reservoir will be connected to a common distribution header (1000 mm diameter) making it possible to float all three reservoirs at the same operating level.

The outlet header will be routed to a new valve house that will be constructed to organize and facilitate connection of distribution mains. Distribution mains that are presently connected to the outlets of the two existing reservoirs will be re-connected at the new valve house. The larger outlet capacity will improve pressure and flow conditions in the distribution system. The new valve house will also make it possible to isolate one or any combination of reservoirs without affecting the distribution system.

NWSDB adds chlorine to the service reservoirs at Maligakanda to maintain water quality within the reservoir and boost free residual in the distribution system. The NWSDB presently uses 900 kg containers because they are the cheapest form of chlorine available. However the lack of safe handling and storage practices and the absence of leakage control systems gives rise to serious concerns for public safety.

In order to reduce the risk to the public, the chlorination facilities are designed to use smaller 68 kg chlorine gas cylinders and to store a smaller quantity of chlorine at the reservoir site. The existing chlorination facility in the N/W corner of the old reservoir will be rehabilitated to house chlorine gas cylinders and dosing equipment.

2.4 REHABILITATION OF EXISTING RESERVOIR ROOF

2.4.1 Background

The Maligakanda reservoir has had a recurring history of leakage and failure, which is relevant to the rehabilitation of the reservoir roof. The necessity for roof repairs has long been recognized by NWSDB which has commissioned three separate studies on the status of the Maligakanda Reservoir Roof: Howard Humphreys & Sons in 1972, Watson Hawksley Asia (date unknown but probably 1987-88), and University of Moratuwa in 1989. According to

previous reports and visual inspections, the roof is in a most unsatisfactory condition. Howard Humphreys & Sons have recommended to provide a new roof and the other two consultants have concluded that it was feasible to repair the existing roof.

The scope of work in the JBIC loan, based on previous studies, is to rehabilitate the roof (or replace it if necessary). The JICA study team inspected the roof structure and determined that rehabilitation was no longer worthwhile because of the advanced stage of deterioration.

Characteristics of the existing reservoir are as follows:

Volume	:	36,368 m^3 (8 M.Imp.Gal.)
High water level	:	+28.64 m MSL
Low Water Level	:	+19.9 m MSL
Floor level (avg.)	:	+18.5 m MSL
Depth of water	:	9.36 m
Ground elevation	:	+22.0 m MSL

The reservoir is a single cell with no internal partitions. The reservoir is prone to short-circuiting because of the proximity of the inlet to the outlet. When the new roof is constructed baffle walls will be provided to improve circulation.

The old ground reservoir is 190 x 191 x 36 feet deep and has no dividing walls. The perimeter mass concrete gravity type retaining wall is getting subjected to a maximum water depth of 11.7 m (38'-5"). The top level of the earth embankment, which covers the gravity wall, is slightly higher than the top water level.

The roof consists of 225mm (9") thick un-reinforced multi-span barrel vaults spanning on to steel beams and the perimeter retaining wall. The roof vaults and steel beams run in the direction of north to south. The steel beams are in turn supported by a grid of circular hollow section cast iron stanchions columns of 225mm (9") external dia.

The horizontal reaction of the barrel vault roof is taken by steel tie-rods located at the level of the spring of the barrel vault. Two tie rods each, 1.2m (approx) apart have been provided on either side of the columns. The two end spans of the vaults roof have closer ties.

In the year 1965 to 1967 a set of post-tensioned concrete tie beams 300 mm x 600 mm were constructed to strengthen the perimeter retaining wall. The beams are located at depth of 5.8 m and 7.1 m (approx.) from the level of the roof beam. These tie beams rest on a grid of 300 mm x 300 mm concrete columns.

The study team inspected the reservoir on the 29th January 2000. The inspection of the reservoir roof was carried out from top of the roof and from inside the reservoir. The following general observations were made during the inspection:

a) There are wide longitudinal cracks, in the direction right angles to the span of the vaults. These cracks appear at the crown as well as at the valley of the arch roof and extend from one end of the vault to the other end.

b) A large number of transverse cracks can be seen on the top surface of the roof. These cracks at 1.5 meters (approx) centres are in the direction of the span of the arches and extend to the entire span of barrel vault.

c) Most of the cracks appearing on top of the roof have been repaired but the repair material has failed to bond and is spalling off.

d) The concrete roof slab is not protected from exposure to sun and rain. As a result the cement sand mortar layer has been damaged leaving the coarse aggregate fully exposed.

e) The web and the top flange of the steel beams that support the vault roof are encased in concrete; hence the embedded surface of the steel beams is protected against corrosion. The exposed bottom flange of steel beam is very badly corroded and extensive scaling and de-lamination was observed.

f) Most of the tie-rods have are broken away. The few remaining tie-rods are badly corroded and cannot sustain the horizontal load exerted by the barrel arches. The roof load is at present extended to the perimeter walls.

g) The corrosion on the top 1.5 meters height of the cast iron stanchions columns is more compared to the rest of the height. This is due to less weathering of the immersed section.

2.4.2 Design Brief

On the basis of the above observations, a new roof structure is recommended. Reinforced concrete is selected for long-term durability. The roof to wall connection is designed to prevent wall movement or rotation (if any) from transferring loads to the roof therefore a sliding joint is adopted. The roof to wall connection is also designed to accommodate vertical wall movement.

Before proceeding with the construction of the new roof it will be essential to carry out a thorough structural appraisal of the reservoir to determine if the reservoir can in fact provide another 40 to 50 years of trouble free, water tight service. If the reservoir is deemed unsound

or near the end of its service life then there will be no financial benefit for replacing the roof and the reservoir should be replaced entirely or abandoned.

Under the rehabilitation work the existing roof structure will be completely removed together with the supporting steel beams, mild steel tie rods and steel columns. The old columns are not re-used because cleaning and removing rust will be a costly and it will be difficult to achieve good results (i.e. complete removal of rust). To avoid potential problems with corrosion of steel and spalling of concrete the design provides new reinforced columns.

The new reinforced concrete roof is designed as a flat slab on column capitals. Roof beams are provide at expansion joints only. The roof is supported on 600 mm diameter columns spaced on a 4.83 m x 4.83 m grid. The outer panels of the roof is simply supported on top of the perimeter wall. The level of the new roof is almost same as the existing roof therefore it is necessary to lower the top level of the perimeter mass concrete wall by 1.6 m.

The new floor slab for the reservoir is designed as a raft slab supported on an elastic media. The design is checked for the direct water pressure and for the column loads. Expansion joints are introduced at regular intervals.

The columns are designed to support the roof slab with no intermediate level bracing. The column grid is so chosen to match with the existing column grid so that new construction will not disturb the existing post-tensioned beams. The roof slab is basically a flat slab with column capitals to take care of high shear at the supports.

Movement joints are introduced at regular intervals to look after expansion and any differential settlement that may occur between the walls and the roof. A sliding joint is provided between the roof slab and the perimeter wall.

2.5 ELLIE HOUSE RESERVOIR RECONSTRUCTION

2.5.1 Background

About 20 years after Maligakanda, a second reservoir was constructed at the Ellie House site in 1905. This reservoir has also had a history of leakage and failure. The reservoir is 360 feet by 195 feet by 20 feet deep and is divided across its width by a half wall 10 feet high for the purpose of facilitating maintenance without interrupting service. The necessity for roof repairs has long been recognized by NWSDB which has commissioned three separate studies

on the status of the Ellie House Reservoir Roof: University of Moratuwa in 1989, Watson Hawksley Asia (undated) and Godfrey, Heath & Spearing in 1993. The Godfrey, Heath & Spearing report, the most recent of the three, recommended a new roof. The other two reports have concluded that repairs were feasible.

Visual survey of the reservoir by the study team confirmed previous reports identifying the need to replace the roof but a lack of information on the walls made it impossible to comment on wall performance. In accordance with the original scope of work the study team proposed a preliminary design for a new RC roof structure stipulating that the wall stability and conditions should be thoroughly investigated before proceeding with construction of the new roof. The long-term performance of the walls cannot be predicted with any certainty and the ability of the walls to remain stable and leak free for the life span of a new roof is doubtful.

Subsequent concerns over wall stability and uncertainty over the remaining service life of the 95-year-old walls resulted in a recommendation to reconstruct a new reservoir of the same capacity in the same location as the existing.

2.5.2 Design Brief

NWSDB is in the process of constructing a new 600 mm transmission main from Ambatale to augment the supply to Ellie House reservoir. The new transmission main and pump house has a capacity of 36,320 m^3/day. In the first stage the new transmission main will be connected several kilometres upstream of the reservoir to the old 20" steel TM. It is uncertain how much flow will reach Ellie House Reservoir since the transmission main also supplies several distribution mains before it reaches the reservoir. If supply conditions at Ellie House do not improve sufficiently after the first stage, the NWSDB plans to extend the transmission main directly to Ellie House. Therefore the new reservoir will be provided with blank inlet piping as provision for this future connection.

Characteristics of the existing reservoir are as follows:

Volume	:	36,400 m^3
High water level	:	+28.9 m MSL
Low water level	:	+22.9 m MSL
Depth of water	:	6.0 m
Ground elevation	:	+27.0 m MSL
Volume (1 cell empty)	:	8,800 m^3
High water level	:	+25.8 m MSL

Low water level	:	+22.9 m MSL
Depth of water	:	2.9 m

The new reservoir will provide approximately the same storage capacity and will occupy approximately the same space as the old reservoir. Design criteria for the new reservoir are as follows:

Volume (3 cells) 2 x 13,000 + 1 x 10,600 m^3	:	36,600 m^3
High water level (3 cells in parallel, normal condition):		+28.45 m MSL
High water level (3 cells in series)	:	+28.64 m MSL
Low water level	:	+23.2 m MSL
Depth of water	:	5.25 m

The top water level will be slightly less than existing therefore there will be no additional head required on the transmission mains supplying the reservoir.

Outlet from the existing reservoir consists of a single 20" pipe located between the two inlet structures. The close proximity of inlet and outlet leads to short-circuiting of flow within the reservoir. The outlet is too small to meet the needs of a growing distribution system. Over the years several distribution mains have been connected add-hoc to the 20" outlet, but the outlet capacity remains inadequate. The new reservoir will be provided with a 1,000 mm diameter outlet header located on the west side, at opposite the inlets to improve circulation. Baffle walls are also provided to improve circulation within the reservoir.

The outlet header will be routed to a new valve house that will be constructed to organize and facilitate connection of distribution mains. Mains that are presently connected to the inlet will be re-connected at the new valve house to the outlet of the reservoir. The larger outlet capacity will improve pressure and flow conditions in the distribution system.

The 3 cells will each have an outlet connected to the common discharge header. Each cell can also be connected with a neighbouring cell through penstock gates in the separation wall. Thus the cells can be operated in parallel or series or any combination. There are no check valves on the outlet so all cells will be floating on the system at approximately the same water level.

A new office building (7 x 14 m footprint = 98 m^2) will be constructed over the valve house for storage, the OIC office and maintenance staff rest room.

NWSDB adds chlorine to the service reservoirs at Ellie House and Maligakanda to maintain

water quality within the reservoir and boost free residual in the distribution system.

In order to minimize the risk to the public, the chlorination facility is designed to use smaller 68 kg cylinders and to store a smaller quantity of chlorine at the reservoir site. A new chlorination building approximately 15 m^2 will be located in the southeast corner next to the inlet structure.

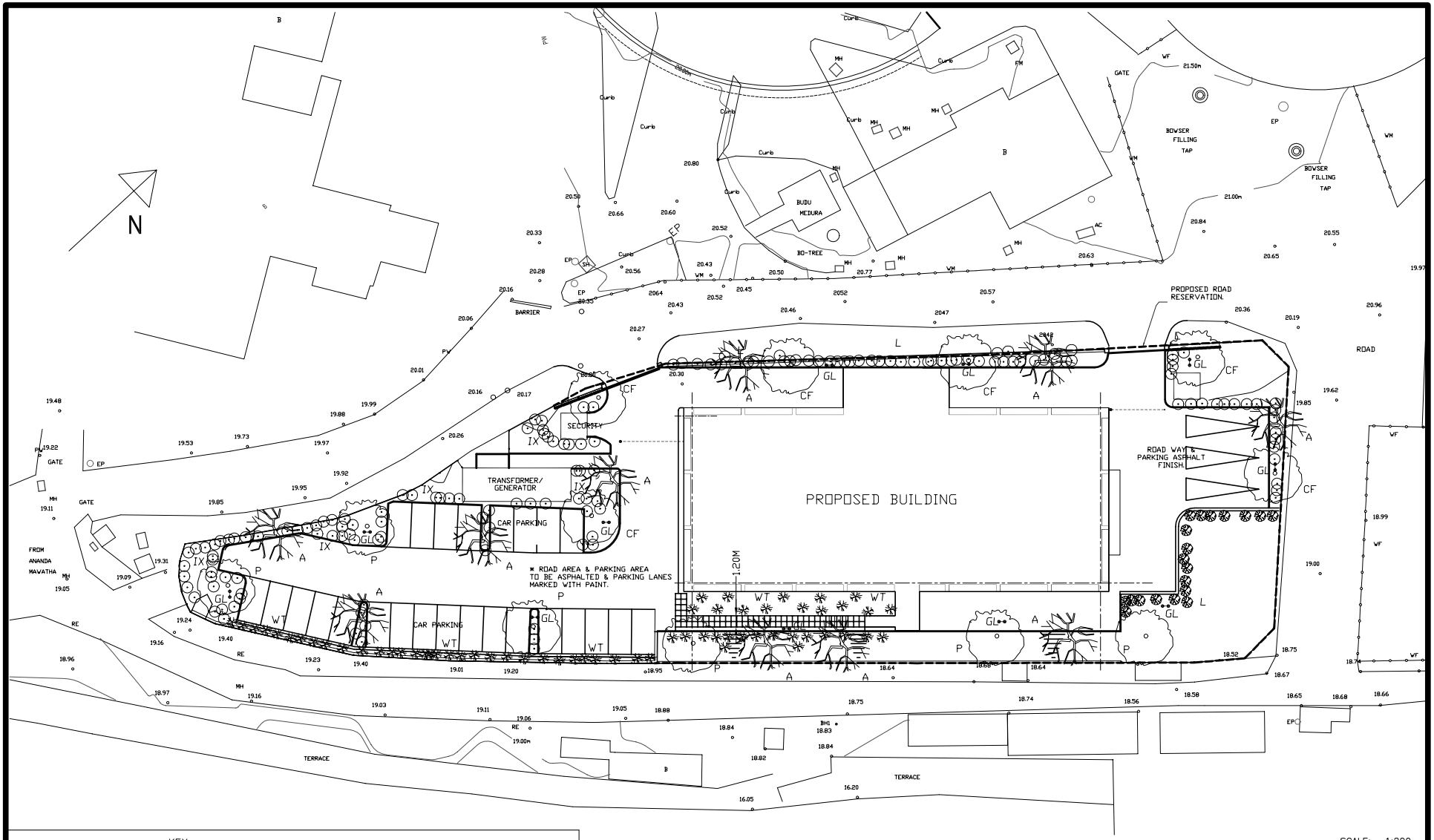
Construction of the new reservoir will be phased to reduce disruption in service. Half the reservoir could be kept in service while building the first of three new cells. Once the first new cell is ready, the other half of the reservoir will be demolished and remaining cells built in sequence.

The reservoir will be constructed with reinforced concrete walls and reinforced concrete beam slab supported on columns for the roof. The walls are 700 mm thick at the base and the footings protrude 750 mm beyond the outside face of the wall. The wall footing is to be constructed with 750 mm thick reinforced concrete base slab after removing the existing 450mm unreinforced concrete base slab. The existing base slab is removed and a new 500mm base slab will act as the foundation for the new circular columns.

The reservoir is designed as a continuous structure with full expansion joints at regular intervals to cater for stresses due to temperature variations and long-term creep and shrinkage of concrete. The roof slab will be properly insulated with a pebble layer and proper drainage will be provided. There will be a sliding joint between the walls and the roof slab.

When demolishing the existing roof slabs there should be adequate support to prevent total collapse of the roof structure. The contractor will be asked to provide a temporary supporting system with props and bracings, which shall be reviewed by the Engineer at the construction stage. The controlled demolition of the roof slab is important and should be carried out by a competent contractor.

The 95-year old inlet and outlet structures have a heritage value and the NWSDB has requested that they be protected during demolition and repaired under the scope of reconstruction. The concrete dome roof of these structures is cracked and these are to be rehabilitated. Wall demolition work to be started from eastern wall 8 m away from the inlet structure by using non vibratory equipment or methods giving special attention to the existing inlet and outlet structures. The method selected to cut the east wall should not cause damage to these existing inlet and outlet structures.



KEY			
TYPE	COMMON NAME	ENGLISH NAME	SCIENTIFIC NAME AND FAMILY
CF	EHELA	PUDDING PIPE.	CASIA ESTULA. (LEGUMINOSAE)
P	PIHIMBIA	FERN TREE	ILICIUM DECIPIENS. (SAPINDACEA)
A	ARALIYA	TEMPLE TREE	PLUMERIA ACUMINATE. (APOCYNACEAE)
L	Lantana camara Variety flava (yellow flower), Variety nivea(white flower)	-	Lantana camara Variety flava(yellow flower), Variety nivea(white flower)
IX	Ixora coccinea (red and yellow varieties)	-	Ixora coccinea
WT	Wedelia trilobata	-	Wedelia trilobata

●● GL GARDEN LAMP (REFER DRAWING No. MK/OB/A-23.

SCALE:- 1:200

REV.	DESCRIPTION

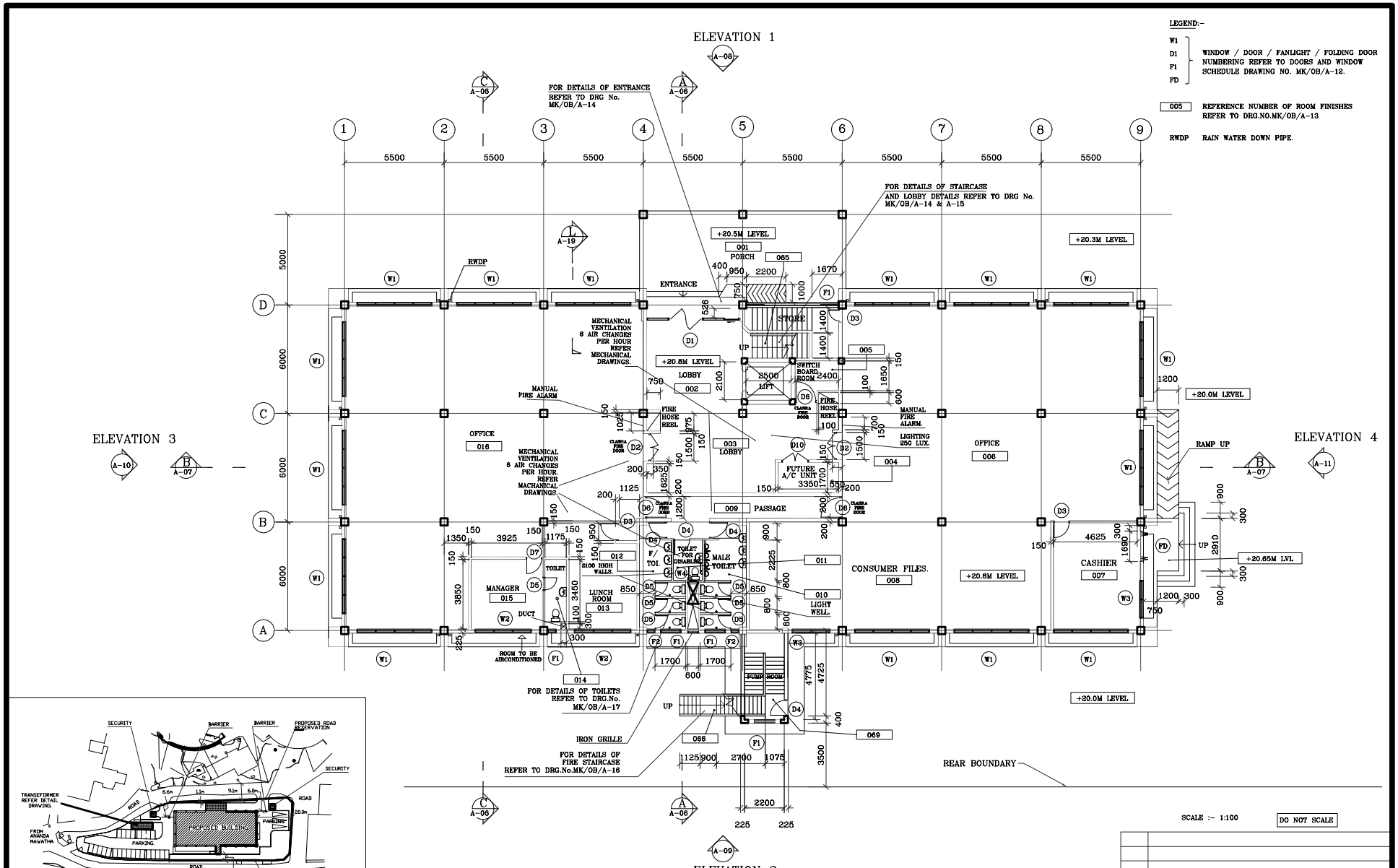
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

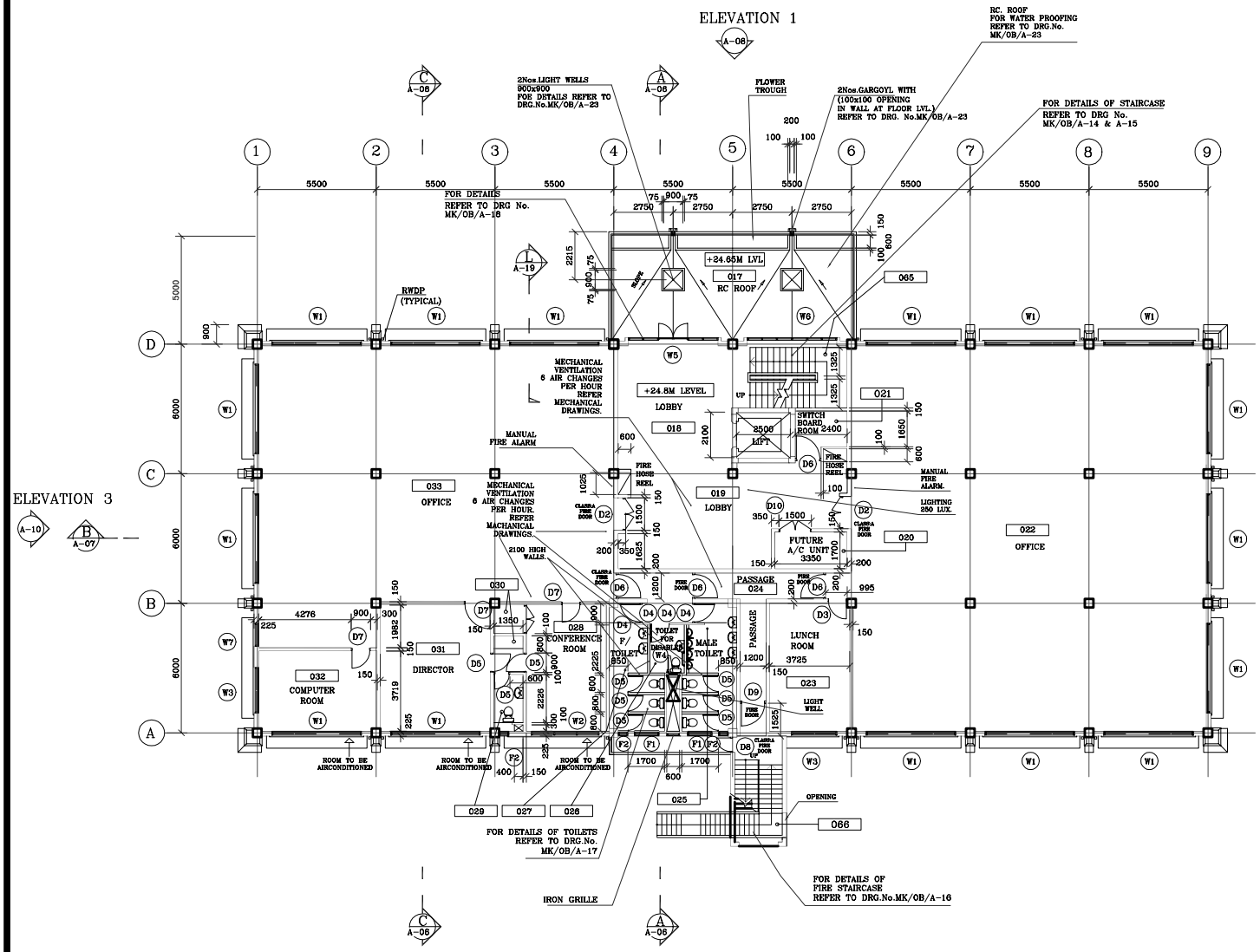
SUB PROJECT: MALIGAKANDA

TITLE: MALIGAKANDA OFFICE BUILDING LANDSCAPING LAYOUT

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

DESIGNED	DRAWN: Rn	DATE	
CHECKED	PM(NRW/SAPS) NWSDB	CONTRACT No. NRW/CW	
DY. TEAM LEADER	AGM(P&D) NWSDB	DRG. No. MK/OB/G-4	
TEAM LEADER	DGM(P&D) NWSDB		


ELEVATION 1
ELEVATION 2
ELEVATION 3
ELEVATION 4
LEGEND:-
W1 D1 F1 FD WINDOW / DOOR / FANLIGHT / FOLDING DOOR NUMBERING REFER TO DOORS AND WINDOW SCHEDULE DRAWING NO. MK/OB/A-12.
005 REFERENCE NUMBER OF ROOM FINISHES REFER TO DRG.NO.MK/OB/A-13
RWDP RAIN WATER DOWN PIPE.
FOR DETAILS OF ENTRANCE REFER TO DRG No. MK/OB/A-14
FOR DETAILS OF STAIRCASE AND LOBBY DETAILS REFER TO DRG No. MK/OB/A-14 & A-15
+20.5M LEVEL
+20.3M LEVEL
+20.8M LEVEL
+20.0M LEVEL
+20.65M LVL
001 PORCH
065 ENTRANCE
RWDP
STORE
UP
005
002 LOBBY
LIFT
SWITCH BOARD ROOM
MECHANICAL VENTILATION 6 AIR CHANGES PER HOUR REFER MECHANICAL DRAWINGS.
MANUAL FIRE ALARM
FIRE HOSE REEL
CLASS A FIRE DOOR
OFFICE 016
003 LOBBY
004
FUTURE A/C UNIT
LIGHTING 250 LUX
OFFICE 006
RAMP UP
009 PASSAGE
012 TOILET 2100 HIGH WALLS.
F/TOL
TOILET FOR DISABLED
MALE TOILET
011
CONSUMER FILES. 008
CASHIER 007
MANAGER 015
LUNCH ROOM 013
DUCT
010 LIGHT WELL.
ROOM TO BE AIRCONDITIONED
014 FOR DETAILS OF TOILETS REFER TO DRG.No. MK/OB/A-17
IRON GRILLE
FOR DETAILS OF FIRE STAIRCASE REFER TO DRG.No.MK/OB/A-16
PUMP ROOM
066
069
REAR BOUNDARY
SECURITY
BARRIER
PROPOSED ROAD RESERVATION
TRANSFORMER REFER DETAIL DRAWING.
ROAD
PARKING
FROM ANANDA MAWATHA
PROPOSED ROAD RESERVATION
PART SITE PLAN
SCALE:- 1:1000
SCALE :- 1:100
DO NOT SCALE
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
SUB PROJECT MALIGAKANDA
TITLE MALIGAKANDA OFFICE BUILDING GROUND FLOOR PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
DESIGNED
DRAWN Rn
DATE JAN. 2001
CHECKED
CONTRACT No. NRW/CW
DRG. No. MK/OB/A-01



LEGEND:-

W1, D1, F1, FD	WINDOW / DOOR / FANLIGHT / FOLDING DOOR NUMBERING REFER TO DOORS AND WINDOW SCHEDULE DRAWING NO. MK/OB/A-12.
005	REFERENCE NUMBER OF ROOM FINISHES REFER TO DRG.NO.MK/OB/A-13
RWDP	RAIN WATER DOWN PIPE.

SCHEDULE OF DOORS & WINDOWS

TYPE	DIMENSIONS WIDTH x HEIGHT	DESCRIPTION
D1	5100 x 2650	ALUMINIUM 1620 WIDE DOOR WITH OPENABLE WINDOW PANEL.
D2	1500 x 2100	CLASS A FIRE DOOR WITH DOOR CLOSERS AND VISION PANEL (TIMBER SOLID CORE 45mm THICK)
D3	900 x 2100	ALUMINUM PANELLED DOOR.
D4	900 x 2100	-DO-
D5	800 x 2100	-DO-
D6	1200 x 2100	CLASS A FIRE DOOR WITH DOOR CLOSERS AND VISION PANEL (TIMBER SOLID CORE 45mm THICK)
D7	900 x 2100	ALUMINUM PANELLED DOOR.
D8	800 x 2100	CLASS A FIRE DOOR WITH DOOR CLOSERS AND VISION PANEL (TIMBER SOLID CORE 45mm THICK)
D9	1200 x 2100	ALUMINUM PANELLED DOOR.
D10	1500 x 2100	ALUMINUM LOUVERED DOOR.
		-DO-
W1	4000 x 1650	GLAZED ALUMINUM WINDOW WITH 100% OPENABLE SASHES.
W1a	4000 x 1650 + 1333 x 1000	GLAZED ALUMINUM WINDOW WITH 100% OPENABLE SASHES.
W2	2667 x 1650	GLAZED ALUMINUM WINDOW WITH 100% OPENABLE SASHES.
W3	2000 x 1650	-DO-
W4	450 x 1750	GLAZED ALUMINUM WINDOW WITH OPENABLE SASH & FIXED VENTILATION PANEL.
W5	4000 x 2650	GLAZED ALUMINUM WINDOW WITH OPENABLE SASHES & FIXED VENTILATION PANELS.
W6	4000 x 2650	-DO-
W7	990 x 1650	GLAZED ALUMINUM WINDOW WITH 100% OPENABLE SASHES.
W8	990 x 975	ALUMINIUM FIXED VENTILATION PANEL.
F1	1400 x 950	GLAZED ALUMINUM FANLIGHT WITH 100% OPEN ABLE SASHES.
F2	450 x 2650	GLAZED ALUMINUM FANLIGHT WITH EXHAUST FAN ON TOP AND OPENABLE SASH IN MIDDLE AND FIXED VENTILATION PANEL IN BOTTOM.
GRILLE	600 x 2650	IRON GRILLE.

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

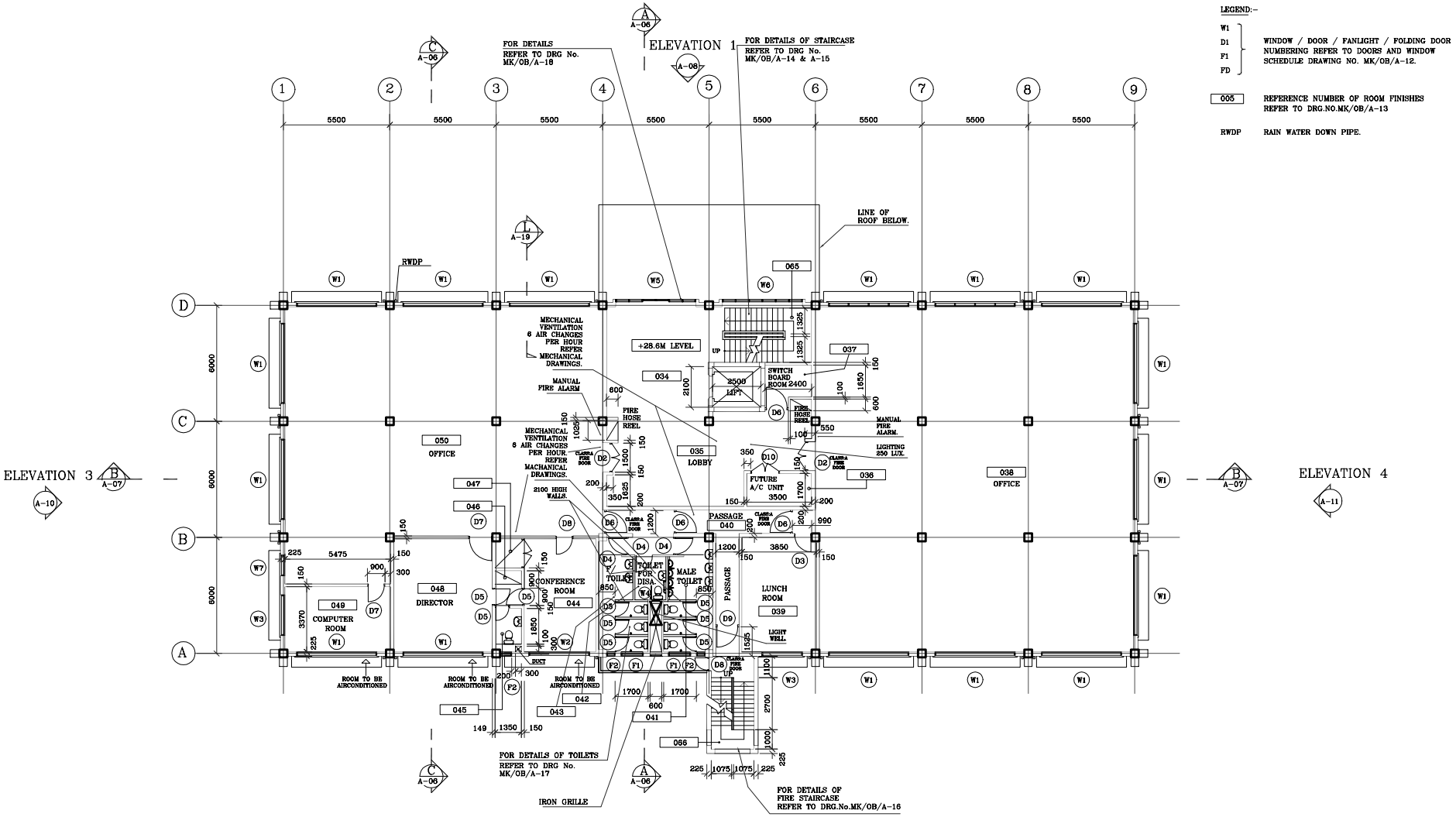
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM

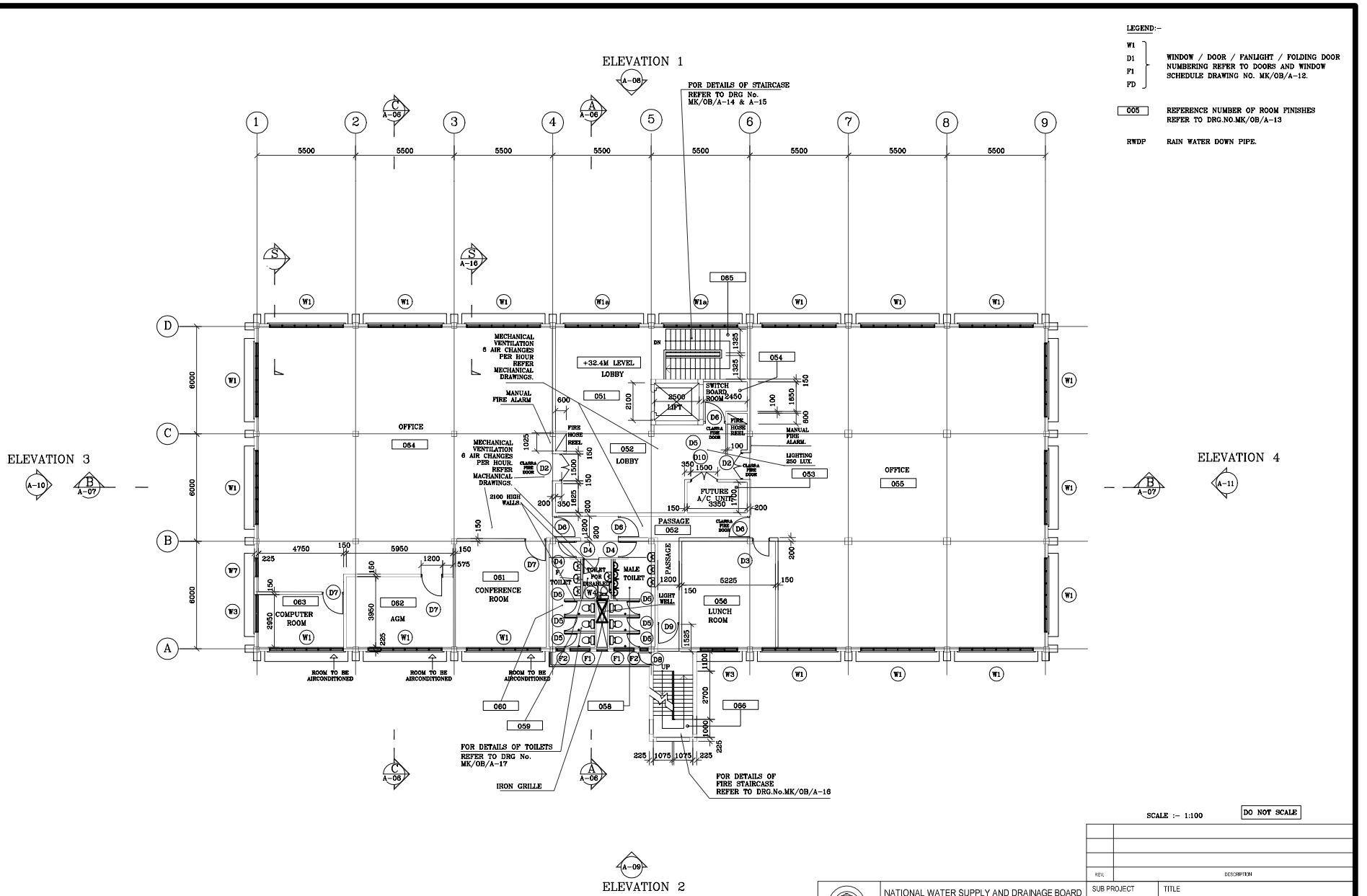
NIHON SUIDO CONSULTANTS CO. LTD.,
TOKYO, JAPAN

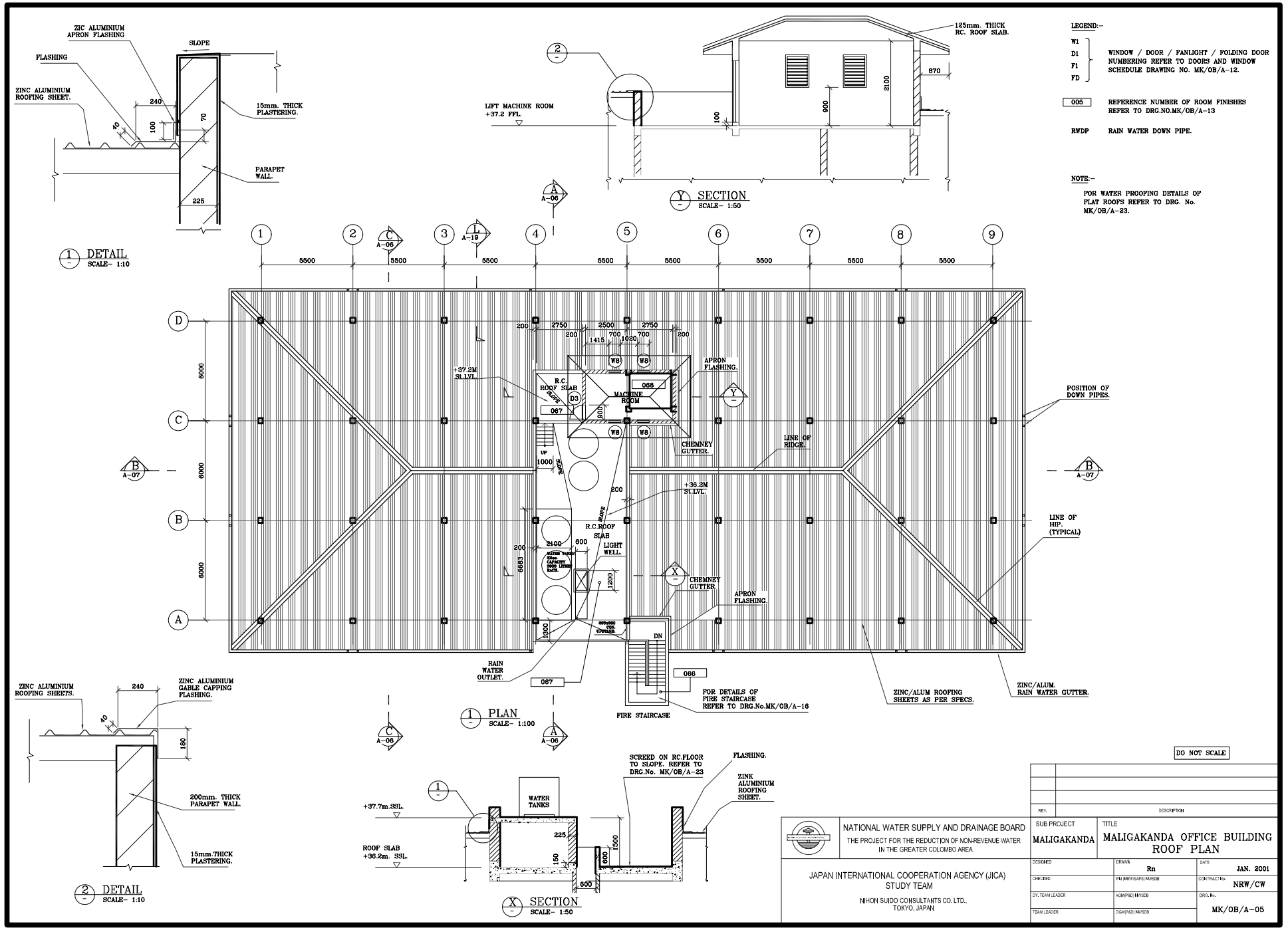
SUB PROJECT: MALIGAKANDA

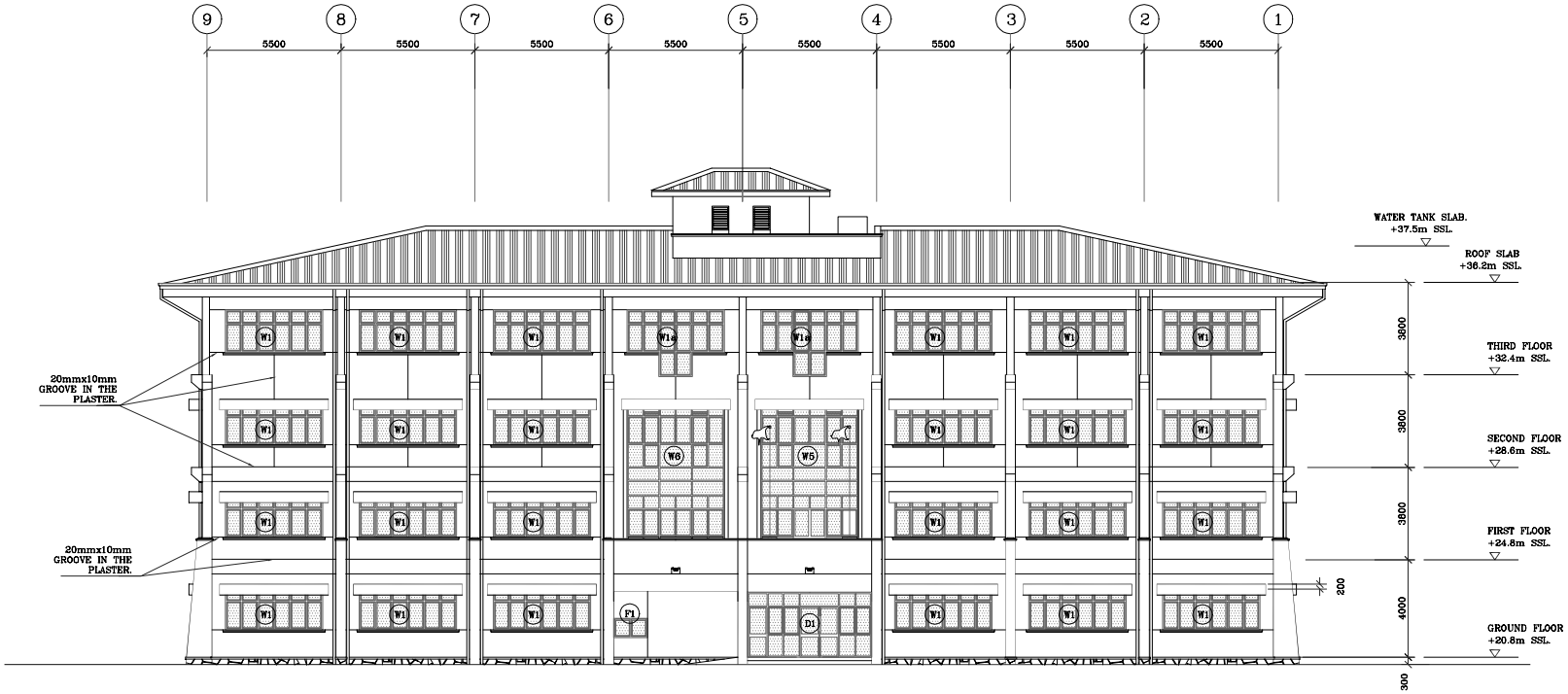
TITLE: MALIGAKANDA OFFICE BUILDING FIRST FLOOR PLAN

DESIGNED		DRAWN: Rn	DATE: JAN. 2001
CHECKED		PM(NRW/SAPS) NWSDB	CONTRACT No.: NRW/CW
DY. TEAMLEADER		AGM(P&D) NWSDB	DRG. No.: MK/OB/A-02
TEAM LEADER		DGM(P&D) NWSDB	


LEGEND:-
W1 D1 F1 FD — WINDOW / DOOR / FANLIGHT / FOLDING DOOR NUMBERING REFER TO DOORS AND WINDOW SCHEDULE DRAWING NO. MK/OB/A-12.
005 — REFERENCE NUMBER OF ROOM FINISHES REFER TO DRG.NO.MK/OB/A-13
RWDP — RAIN WATER DOWN PIPE.
ELEVATION 1
ELEVATION 2
ELEVATION 3
ELEVATION 4
FOR DETAILS REFER TO DRG No. MK/OB/A-18
FOR DETAILS OF STAIRCASE REFER TO DRG No. MK/OB/A-14 & A-15
LINE OF ROOF BELOW.
RWDP
MECHANICAL VENTILATION 6 AIR CHANGES PER HOUR REFER MECHANICAL DRAWINGS.
MANUAL FIRE ALARM
FIRE HOSE REEL
+28.6M LEVEL
SWITCH BOARD ROOM 2400
LIFT
MECHANICAL VENTILATION 6 AIR CHANGES PER HOUR REFER MACHANICAL DRAWINGS.
2100 HIGH WALLS.
OFFICE
LOBBY
FUTURE A/C UNIT
LIGHTING 250 LUX
PASSAGE
TOILET FOR DISA.
MALE TOILET
FEMALE TOILET
LUNCH ROOM
LIGHT WELL
CONFERENCE ROOM
DIRECTOR
COMPUTER ROOM
DUCT
ROOM TO BE AIRCONDITIONED
IRON GRILLE
FOR DETAILS OF TOILETS REFER TO DRG No. MK/OB/A-17
FOR DETAILS OF FIRE STAIRCASE REFER TO DRG.No.MK/OB/A-16
SCALE :- 1:100
DO NOT SCALE
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
SUB PROJECT: MALIGAKANDA
TITLE: MALIGAKANDA OFFICE BUILDING SECOND FLOOR PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
DESIGNED
DRAWN: Rn
DATE: JAN. 2001
CHECKED
CONTRACT No.: NRW/CW
DY. TEAM LEADER
DRG. No.: MK/OB/A-03
TEAM LEADER


ELEVATION 1
ELEVATION 2
ELEVATION 3
ELEVATION 4
LEGEND:-
W1 D1 F1 FD — WINDOW / DOOR / FANLIGHT / FOLDING DOOR NUMBERING REFER TO DOORS AND WINDOW SCHEDULE DRAWING NO. MK/OB/A-12.
005 — REFERENCE NUMBER OF ROOM FINISHES REFER TO DRG.NO.MK/OB/A-13
RWDP — RAIN WATER DOWN PIPE.
FOR DETAILS OF STAIRCASE REFER TO DRG No. MK/OB/A-14 & A-15
MECHANICAL VENTILATION 6 AIR CHANGES PER HOUR REFER MECHANICAL DRAWINGS.
+32.4M LEVEL
LOBBY
MANUAL FIRE ALARM
SWITCH BOARD ROOM
LIFT
FIRE HOSE REEL
MANUAL FIRE ALARM.
LIGHTING 250 LUX.
OFFICE
FUTURE A/C UNIT
PASSAGE
LOBBY
2100 HIGH WALLS.
CONFERENCE ROOM
COMPUTER ROOM
AGM
LUNCH ROOM
MALE TOILET
F/ TOILET
TOILET FOR HANDICAPPED
LIGHT WELL
ROOM TO BE AIRCONDITIONED
IRON GRILLE
FOR DETAILS OF TOILETS REFER TO DRG No. MK/OB/A-17
FOR DETAILS OF FIRE STAIRCASE REFER TO DRG.No.MK/OB/A-16
SCALE :- 1:100
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: MALIGAKANDA
TITLE: MALIGAKANDA OFFICE BUILDING THIRD FLOOR PLAN
DESIGNED
DRAWN: Rn
DATE: JAN. 2001
CHECKED
CONTRACT No.: NRW/CW
DY. TEAM LEADER
DRG.No.: MK/OB/A-04
TEAM LEADER


ZIC ALUMINIUM APRON FLASHING
SLOPE
FLASHING
ZINC ALUMINIUM ROOFING SHEET.
240
40
100
70
15mm. THICK PLASTERING.
PARAPET WALL.
225
1 DETAIL SCALE- 1:10
125mm. THICK RC. ROOF SLAB.
LIFT MACHINE ROOM +37.2 FFL.
870
2100
900
100
Y SECTION SCALE- 1:50
LEGEND:-
W1 D1 F1 FD WINDOW / DOOR / FANLIGHT / FOLDING DOOR NUMBERING REFER TO DOORS AND WINDOW SCHEDULE DRAWING NO. MK/OB/A-12.
005 REFERENCE NUMBER OF ROOM FINISHES REFER TO DRG.NO.MK/OB/A-13
RWDP RAIN WATER DOWN PIPE.
NOTE:-
FOR WATER PROOFING DETAILS OF FLAT ROOFS REFER TO DRG. No. MK/OB/A-23.
1 2 3 4 5 6 7 8 9
5500
A B C D
6000
+37.2M SL.LVL.
R.C. ROOF SLAB SLOPE
MACHINE ROOM
067
068
D3
W8
APRON FLASHING.
POSITION OF DOWN PIPES.
CHEMNEY GUTTER.
LINE OF RIDGE.
LINE OF HIP. (TYPICAL)
+36.2M SL.LVL.
R.C.ROOF SLAB
LIGHT WELL.
CHEMNEY GUTTER.
APRON FLASHING.
RAIN WATER OUTLET.
DN
066
FIRE STAIRCASE
FOR DETAILS OF FIRE STAIRCASE REFER TO DRG.No.MK/OB/A-16
ZINC/ALUM ROOFING SHEETS AS PER SPECS.
ZINC/ALUM. RAIN WATER GUTTER.
1 PLAN SCALE- 1:100
ZINC ALUMINIUM ROOFING SHEETS.
240
ZINC ALUMINIUM GABLE CAPPING FLASHING.
40
180
200mm. THICK PARAPET WALL.
15mm.THICK PLASTERING.
2 DETAIL SCALE- 1:10
SCREED ON RC.FLOOR TO SLOPE. REFER TO DRG.No. MK/OB/A-23
FLASHING.
ZINK ALUMINIUM ROOFING SHEET.
WATER TANKS
+37.7m.SSL.
ROOF SLAB +36.2m. SSL.
225
150
600
1500
X SECTION SCALE- 1:50
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 MALIGAKANDA
TITLE MALIGAKANDA OFFICE BUILDING ROOF PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
DESIGNED
DRAWN Rn
DATE JAN. 2001
CHECKED
CONTRACT No. NRW/CW
DY. TEAM LEADER
DRG. No. MK/OB/A-05
TEAM LEADER



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

SUB PROJECT: MALIGAKANDA

TITLE: MALIGAKANDA OFFICE BUILDING ELEVATION NORTH-WEST

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM

NIHON SUIDO CONSULTANTS CO. LTD.,
TOKYO, JAPAN

DESIGNED	DRAWN: Rn	DATE: JAN. 2001
CHECKED	PM (NRW/GAPS) NWSDB	CONTRACT No.: NRW/CW
DY. TEAM LEADER	AGM(P&D) NWSDB	DRG. No.: MK/OB/A-08
TEAM LEADER	DGM(P&D) NWSDB	

DO NOT SCALE

REV.	DESCRIPTION

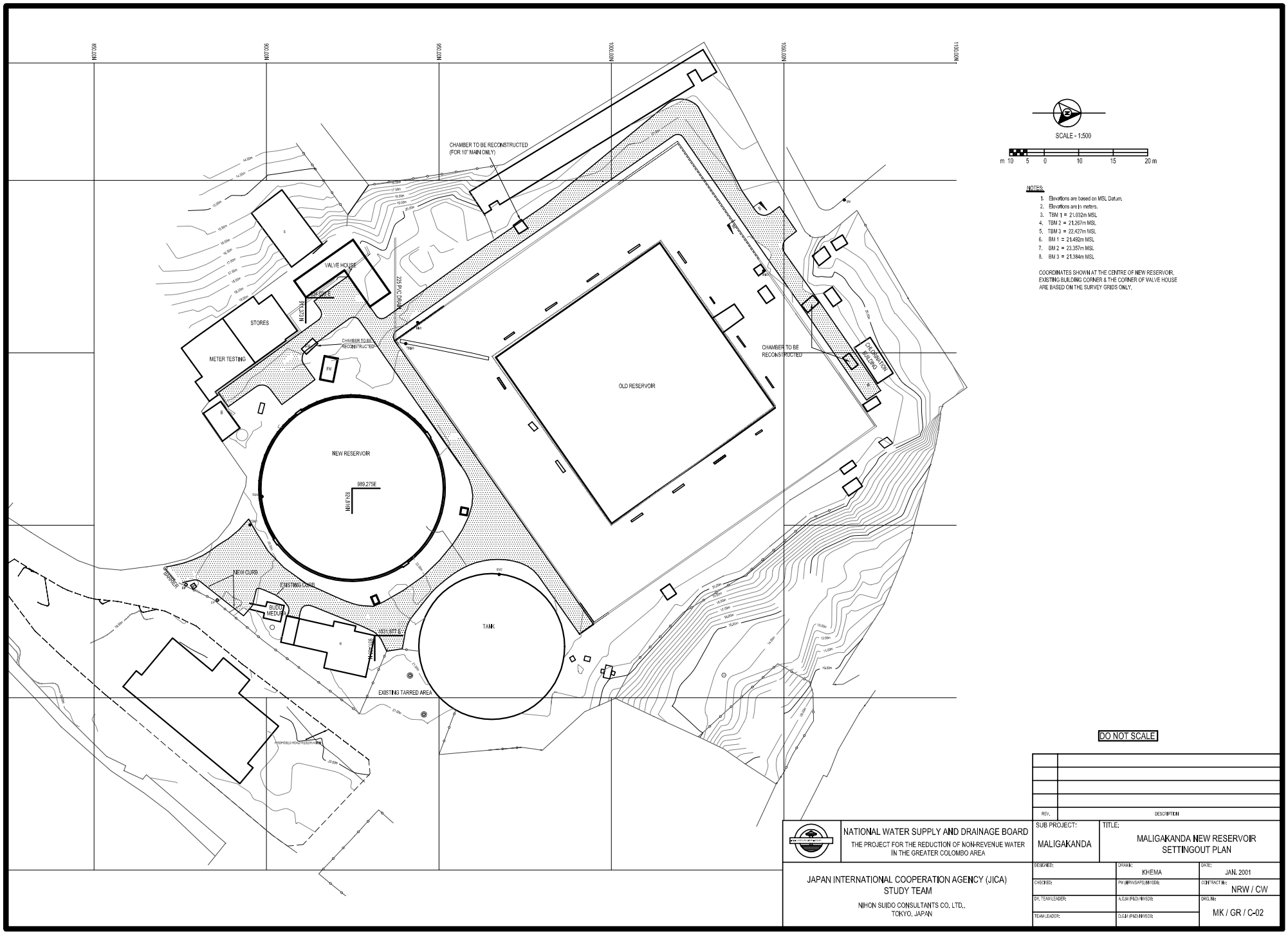
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

SUB PROJECT: MALIGAKANDA

TITLE: MALIGAKANDA OFFICE BUILDING ELEVATION 4 NORTH-EAST

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

DESIGNED	DRAWN: Rn	DATE: JAN. 2001
CHECKED	PM (NRW/S/APS) NWSDB	CONTRACT No.: NRW/CW
DY. TEAM LEADER	AGM(P&D) NWSDB	DRG. No.: MK/OB/A-11
TEAM LEADER	DGM(P&D) NWSDB	



NOTES:

1. Elevations are based on MSL Datum.
2. Elevations are in meters.
3. TBM 1 = 21.032m MSL
4. TBM 2 = 21.267m MSL
5. TBM 3 = 22.427m MSL
6. BM 1 = 21.492m MSL
7. BM 2 = 23.357m MSL
8. BM 3 = 21.384m MSL

COORDINATES SHOWN AT THE CENTRE OF NEW RESERVOIR, EXISTING BUILDING CORNER & THE CORNER OF VALVE HOUSE ARE BASED ON THE SURVEY GRIDS ONLY.

DO NOT SCALE

REV.	DESCRIPTION

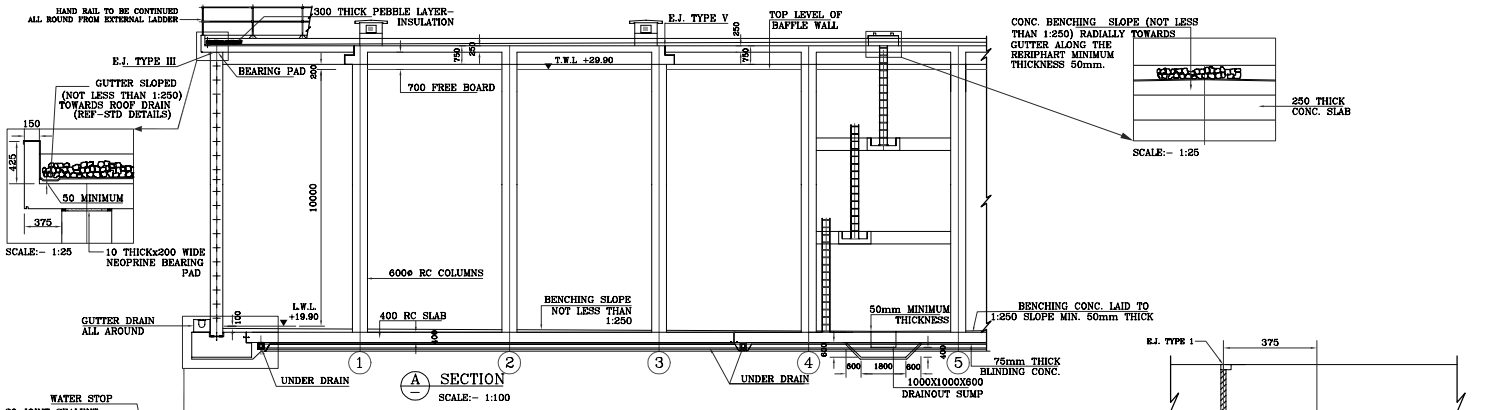
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

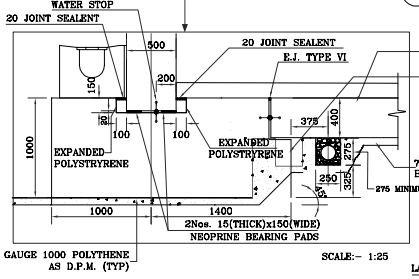
SUB PROJECT: MALIGAKANDA

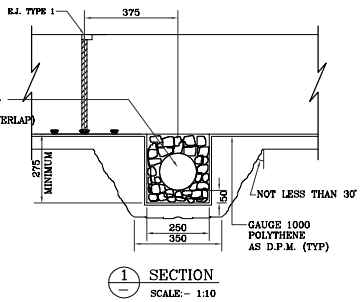
TITLE: MALIGAKANDA NEW RESERVOIR SETTINGOUT PLAN

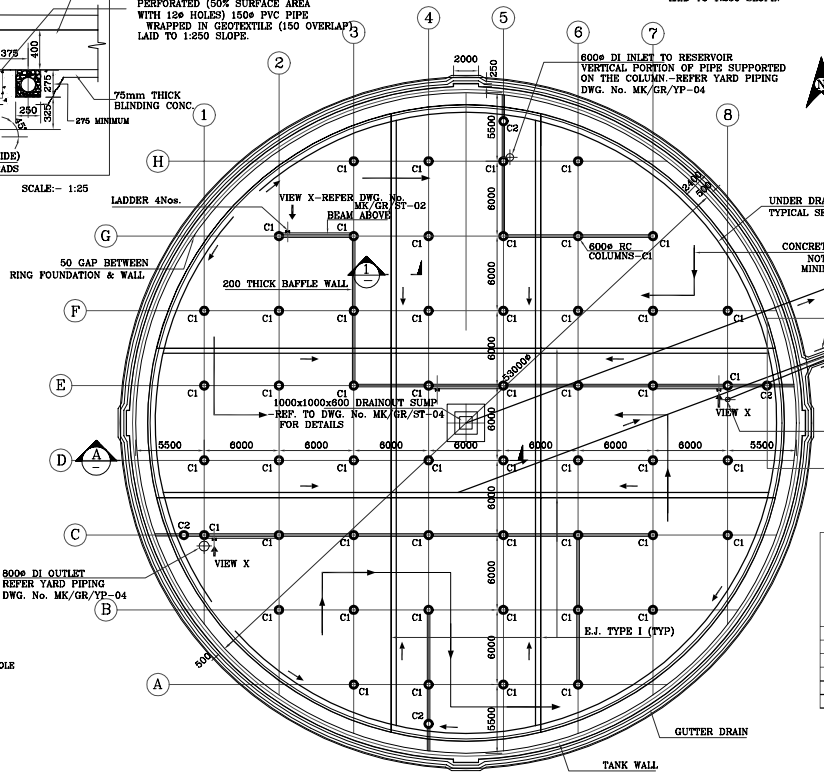
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO, LTD.,
TOKYO, JAPAN

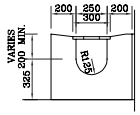
DESIGNED:	DRAWN: KHEMA	DATE: JAN. 2001
CHECKED:	PM (NRW/SAPS)/NWSDB:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D)/NWSDB:	DRG. No: MK / GR / C-02
TEAM LEADER:	D.G.M (P&D)/NWSDB:	

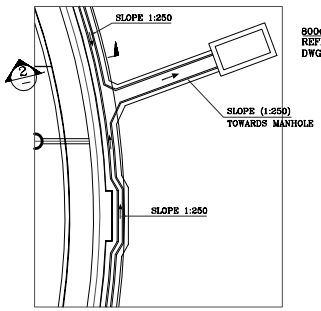












Notes:-

1. The drawings to be read in conjunction with Standard Drawings, Structural and other relevant drawings.
2. All exposed concrete corners shall be chamfered 20 mm unless otherwise stated on the drawings.
3. The blinding concrete shall be grade 15 having Characteristic strength of 15 N/mm^2.
4. The structural concrete of the perimeter post-tensioned circular wall shall be grade 40 having a Characteristic strength of 40. N/mm^2 and for all other structural members the concrete shall be grade 35A having a Characteristic strength of 35. N/mm^2 unless otherwise noted on the drawings.
5. All laps in reinforcing steel (48 x bar diameter) shall be staggered.
6. All reinforcing steel in the perimeter wall shall be arranged so that there is a minimum of 40 mm between any bar and the nearest cable duct and clear cover to reinforcing steel shall be 50. mm.
7. The proprietary post-tensioning wires, ducts and anchorages shall be approved by the Engineer prior to start with construction.
8. The contractor shall provide adequate steel supports for the cable ducts and reinforcing steel in addition to the designed reinforcement shown on drawings and the details shall be approved by the Engineer.
9. Wires shall be placed in the ducts before concreting commences.
10. All cable ducts shall be grouted and grout vents shall be provided at all points necessary at not more than 10.m centres. The grout mix shall be approved by the Engineer and shall contain approved expanding agent.
11. The cables shall be stressed in the order shown. The wires in the cables shall not be cropped until all wires have been stressed.
12. The wires shall not be cropped closer than 25. mm from the grips and cropping of wires shall not commence until the stressing records have been approved by the Engineer.
13. Each pre-stressing wire shall be 7.0 mm dia high tensile low relaxation steel conforming to BS 5896-1980 with ultimate guaranteed tensile strength not less than 1860 N/mm^2 and shall be stressed as shown in Table 1.
14. The pre-stressing wires shall be stressed only after the complete wall is cast and the entire wall concrete attains 28 day strength and after a minimum period of 28 days.
15. Anchorage recesses shall be dimensioned by the contractor to suit type of anchor used and the details shall be approved by the Engineer. All anchor recesses shall be covered with non-shrink cement sand mortar after stressing all wires and grouting the ducts are completed and approved by the Engineer.
16. All exposed concrete surfaces shall be in accordance with the specifications.
17. The wires in the cable ducts shall be stressed in two operations, first with 50% of the force on all cables and second to complete the balance 50% of the forces and in the following order of ducts.

    1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, 34, 37, 40, 43, 46, 49, 52, 55, 58, 61

    2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, 44, 47, 50, 53, 56, 59,

    3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 51, 54, and 57.
18. The notation used in labeling the cable ducts (and wires) is as shown in example table 1 of dwg. No MK/GR/ST-06
19. The cement used to produce concrete for the foundation structure such as the perimeter rc ring foundation and the base slab of the reservoir shall be Portland Cement complying to BS 12 mixed with 25 % pulverized fuel ash (pfa). The cement content of the concrete shall be not less than 380 kg/m^3 and the maximum free water cement ratio shall be 0.45.

Table 1

Height of wall measured from bottom of wall (m)	Force that should be applied by prestressing –after all losses (kN/m height)	No of 7.0 mm Wires in a single cable (nos.)	Cable spacing used (mm c/c)	Jacking force per Cable allowance for slip at anchors is not considered (kN)	Actual stress that should get transferred on to the wall due to pre-stressing (after all losses) (N/mm^2)
10.0-11.4	892.0	12	400	443.0	1.78
8.0-10.0	1177.0	12	300	443.0	2.35
6.0-8.0	1547.0	12	225	443.0	3.09
4.0-6.0	2254.0	12	150	443.0	4.51
2.0-4.0	2756.0	12	120	443.0	5.51
0.0-2.0	3233.0	12	100	443.0	6.47

loads (unfactored)

super imposed load on roof	2.5kN/m^2
250 mm pebble layer on roof	5.0 kN/m^2
benching concrete (250 mm average)g on roof	5.5 kN/m^2
Density of water	10.0 Kn/M^3

Parameters assumed -post tensioning

Coeiff. of friction	0.3
Profile Coeiff.	0.0025 /m

Allowable bearing capacity of founding material = 200 kN/m^2

REV.	DESCRIPTION

NATIONAL WATER SUPPLY AND DRAINAGE BOARD

THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

SUB PROJECT: MALIGAKANDA

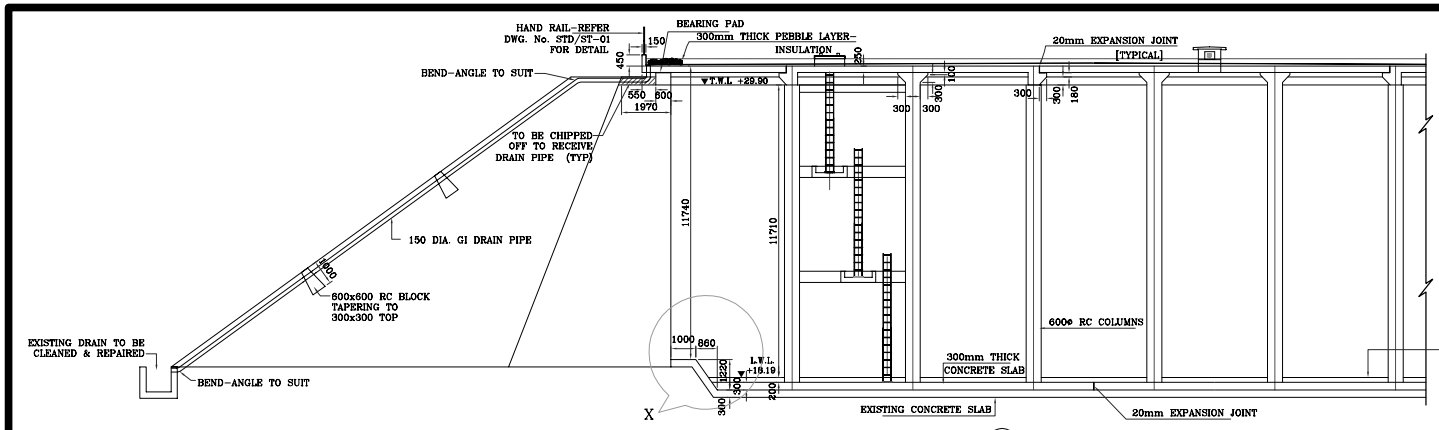
TITLE: NEW RESERVOIR GENERAL ARRANGEMENT

SHEET 1 OF 3

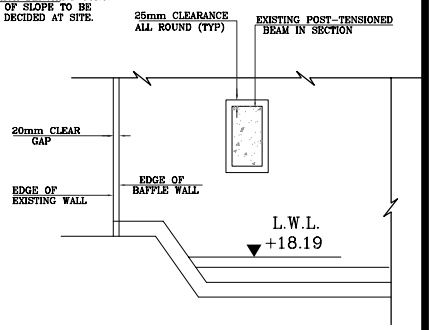
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM

NIHON SUIDO CONSULTANTS CO, LTD., TOKYO, JAPAN

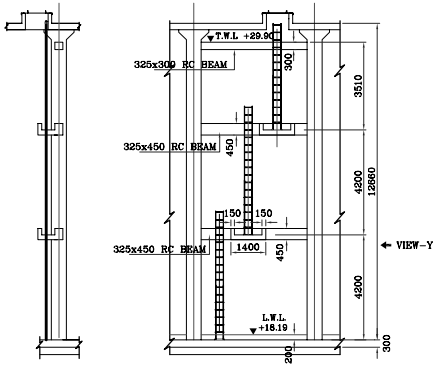
DESIGNED	DRAWN: RUKMANI	DATE	
CHECKED	PM (NRW/SAPS) NWSDB	CONTRACT No.: NRW/CW	
DY.TEAM LEADER	AGM(P&D) NWSDB	DRG. No.: MK/GR/ST-01	
TEAM LEADER	DGM(P&D) NWSDB		



A SECTION
(EXISTING POST-TENSIONED BEAMS & SUPPORTS NOT SHOWN)
SCALE:- 1:100

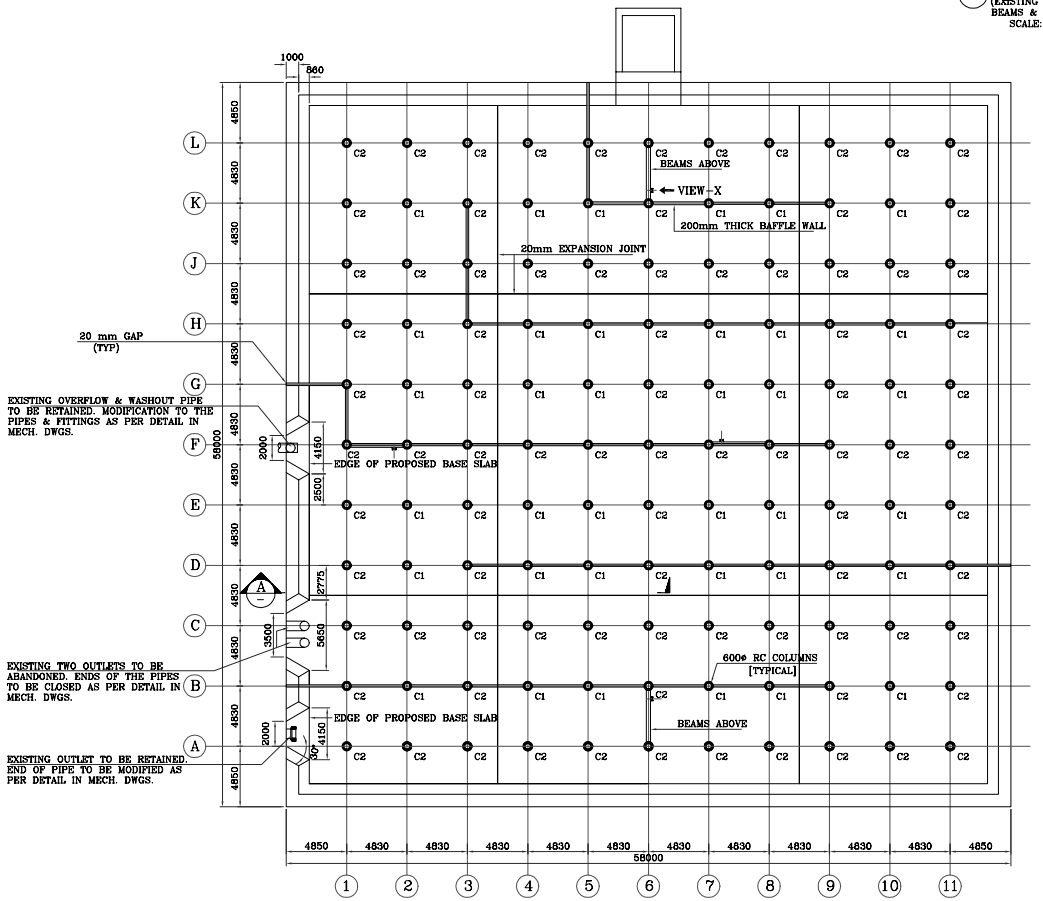


DETAIL - X (NTS)
SCALE :- NTS
BAFFLE WALL -DETAILS AT EDGES AND OPENING AT POST-TENSIONED BEAMS (TYP)



VIEW Y VIEW X

(TYPICAL AT ALL ACCESS MANHOLE - REF. TO STD. DWGS. FOR LADDER DETAILS)
SCALE:- 1:100



BASE PLAN
SCALE:- 1:200

DO NOT SCALE

REV.	DESCRIPTION

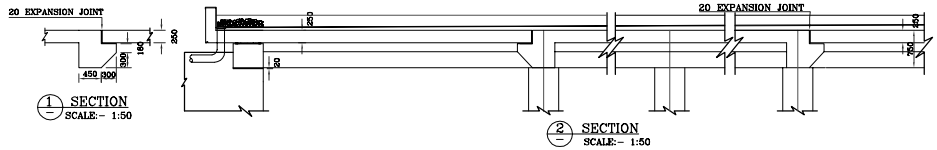
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

SUB PROJECT: MALIGAKANDA

TITLE: REHABILITATION OF EXISTING RESERVOIR ROOF GENERAL ARRANGEMENT
SHEET 1 OF 2

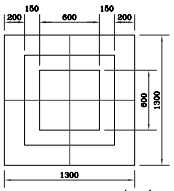
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN

DESIGNED	DRAWN: SUKMANI	DATE: JAN. 2001
CHECKED	PM (NRW/SAPS) NWSDB	CONTRACT No.: NRW/CW
DY. TEAM LEADER	AGM(P&D) NWSDB	DRG. No.: MK/RF/ST-03
TEAM LEADER	DGM(P&D) NWSDB	

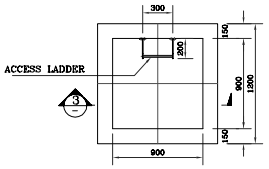


1 SECTION
SCALE:- 1:50

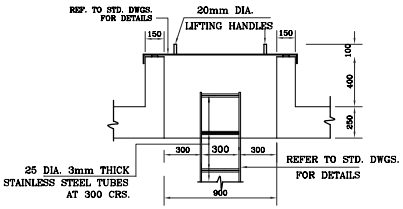
2 SECTION
SCALE:- 1:50



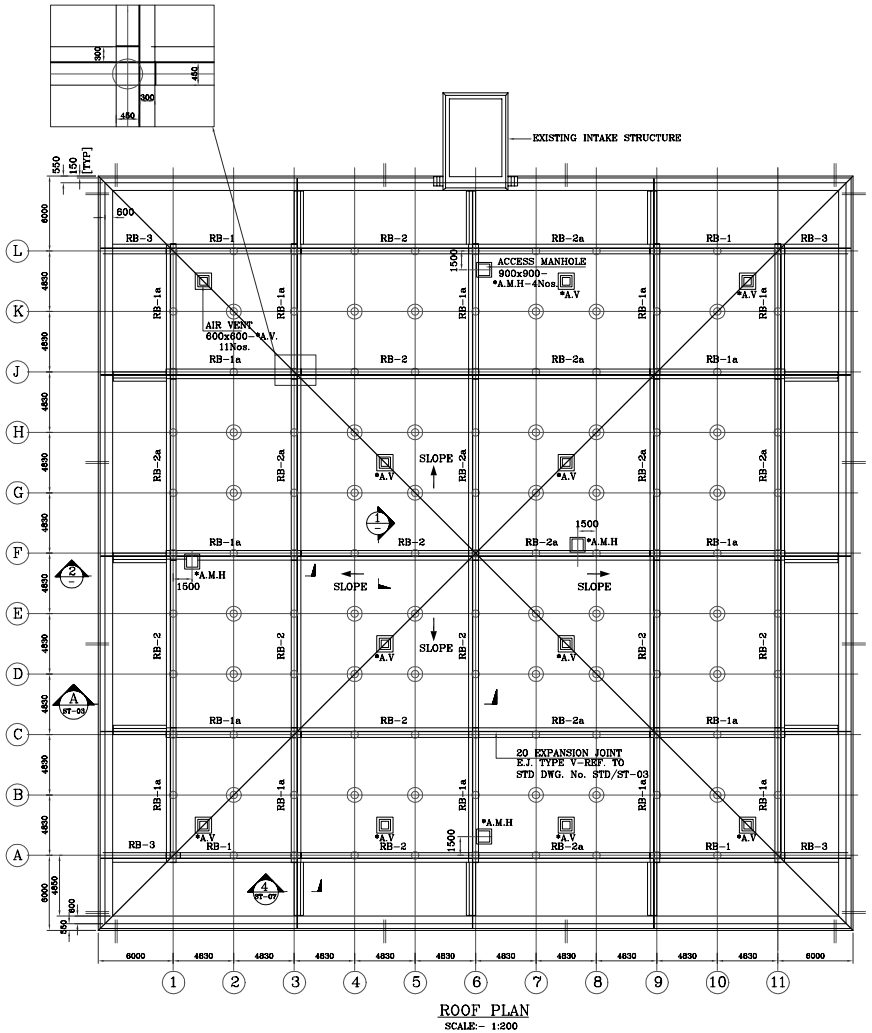
AIR VENT (A.V)
SCALE:- 1:25



ACCESS MANHOLE (A.M.H), LADDER & PLATFORMS
SCALE:- 1:25



3 SECTION
SCALE:- 1:20



ROOF PLAN
SCALE:- 1:200

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: MALIGAKANDA

TITLE: REHABILITATION OF EXISTING RESERVOIR ROOF GENERAL ARRANGEMENT
SHEET 2 OF 2

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

DESIGNED		DRAWN: BUKMANI	DATE: JAN. 2001
CHECKED		PM (NRW&WASH)/NWSDB	CONTRACT No.: NRW/CW
DY. TEAM LEADER		AGM(P&D)/NWSDB	DRG. No.: MK/RF/ST-04
TEAM LEADER		DGM(P&D)/NWSDB	