MINISTRY OF EDUCATION
REPUBLIC OF ZAMBIA

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF BASIC SCHOOLS IN LUSAKA DISTRICT IN THE REPUBLIC OF ZAMBIA

JULY 1998

JAPAN INTERNATIONAL COOPERATION AGENCY

DAIKEN SEKKEI, INC.

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PREFACE

In response to a request from the Government of the Republic of Zambia the Government of Japan decided to conduct a basic design study on the Project for Construction of Basic Schools in Lusaka District and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Zambia a study team from February 1 to March 2, 1998.

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

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

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

July, 1998

Kimio Fujita
President
Japan International Cooperation Agency

July, 1998

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Construction of Basic Schools in Lusaka District in the Republic of Zambia.

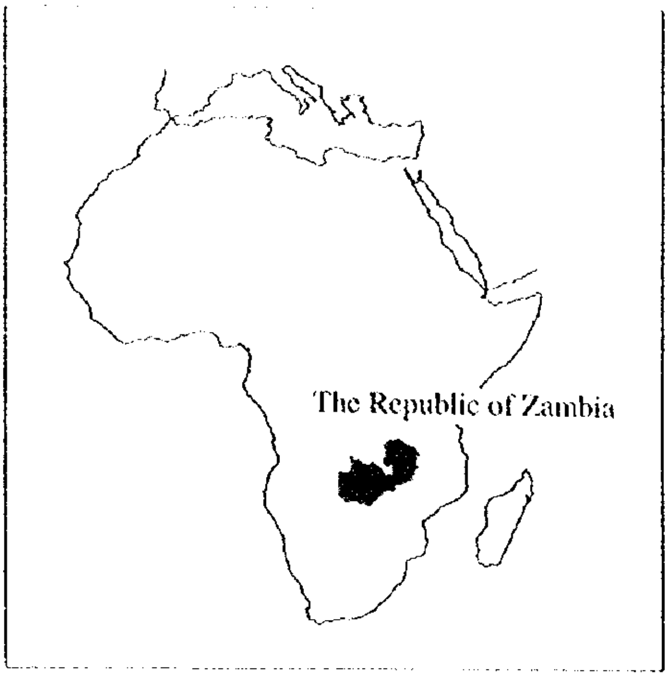
This study was conducted by DAIKEN SEKKEI, INC., under a contract to JICA, during the period from January 20, 1998 to July 31, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Zambia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

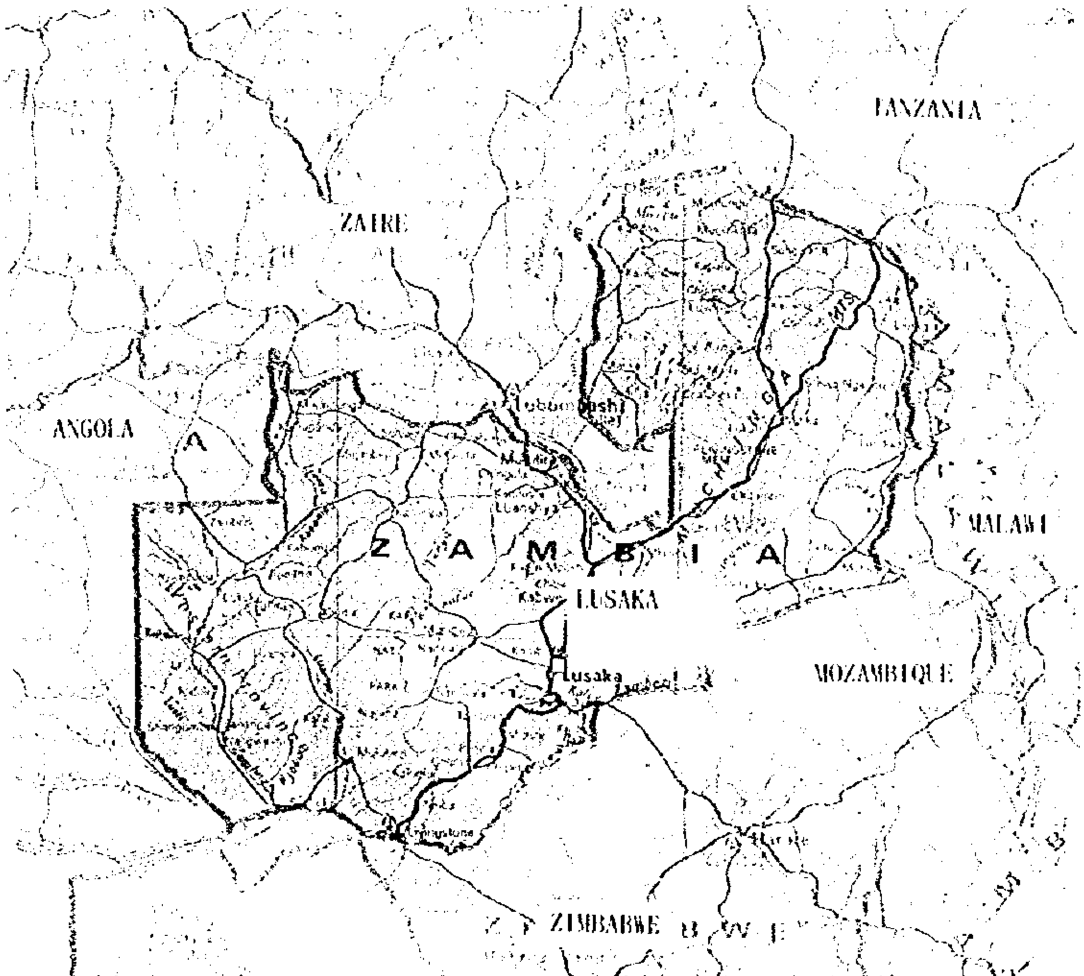
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Yoshiyasu Takase
Project Manager
Basic design study team on
the Project for Construction of
Basic Schools in Lusaka District
DAIKEN SEKKEI, INC.

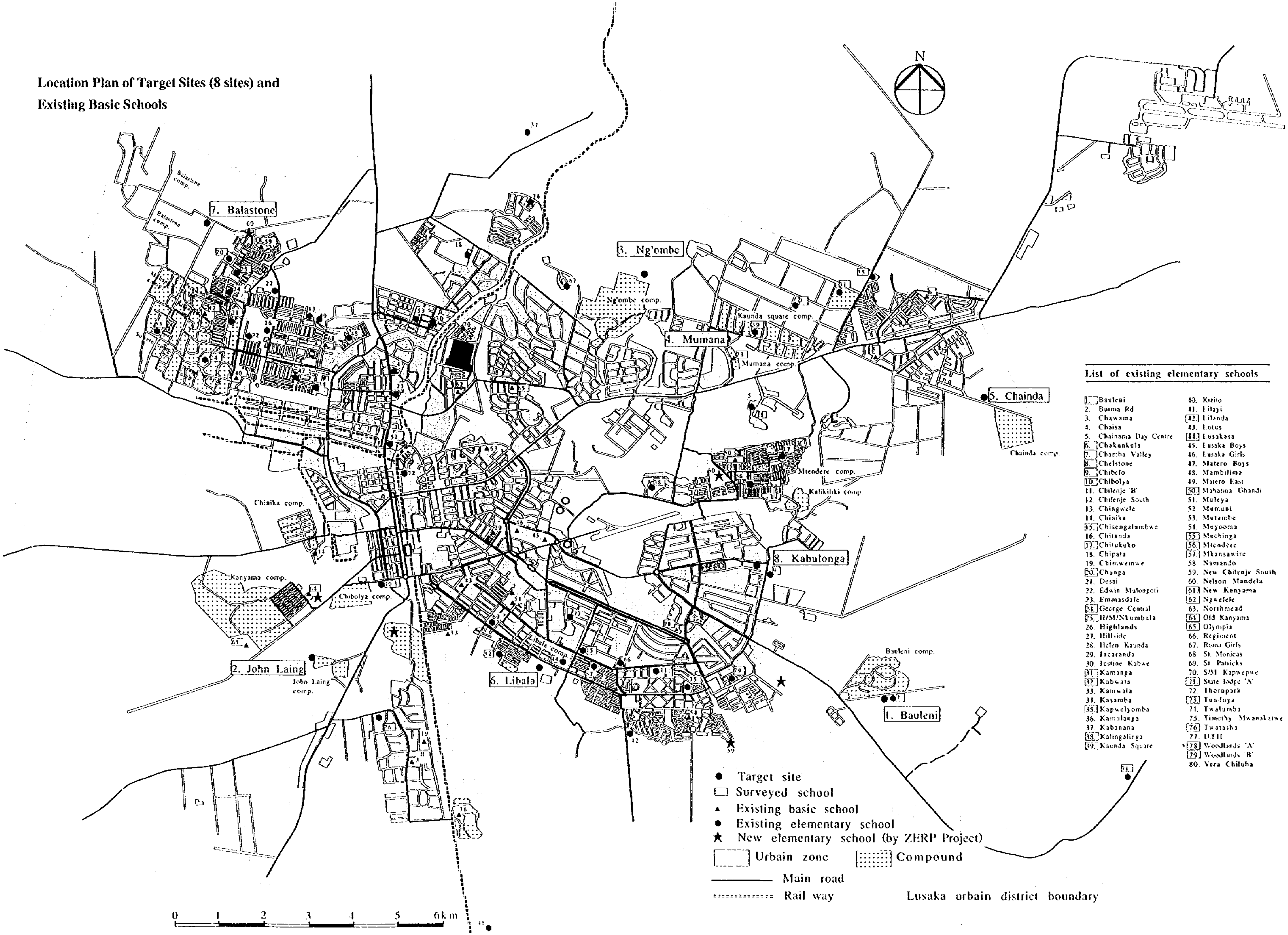
Project Site Map

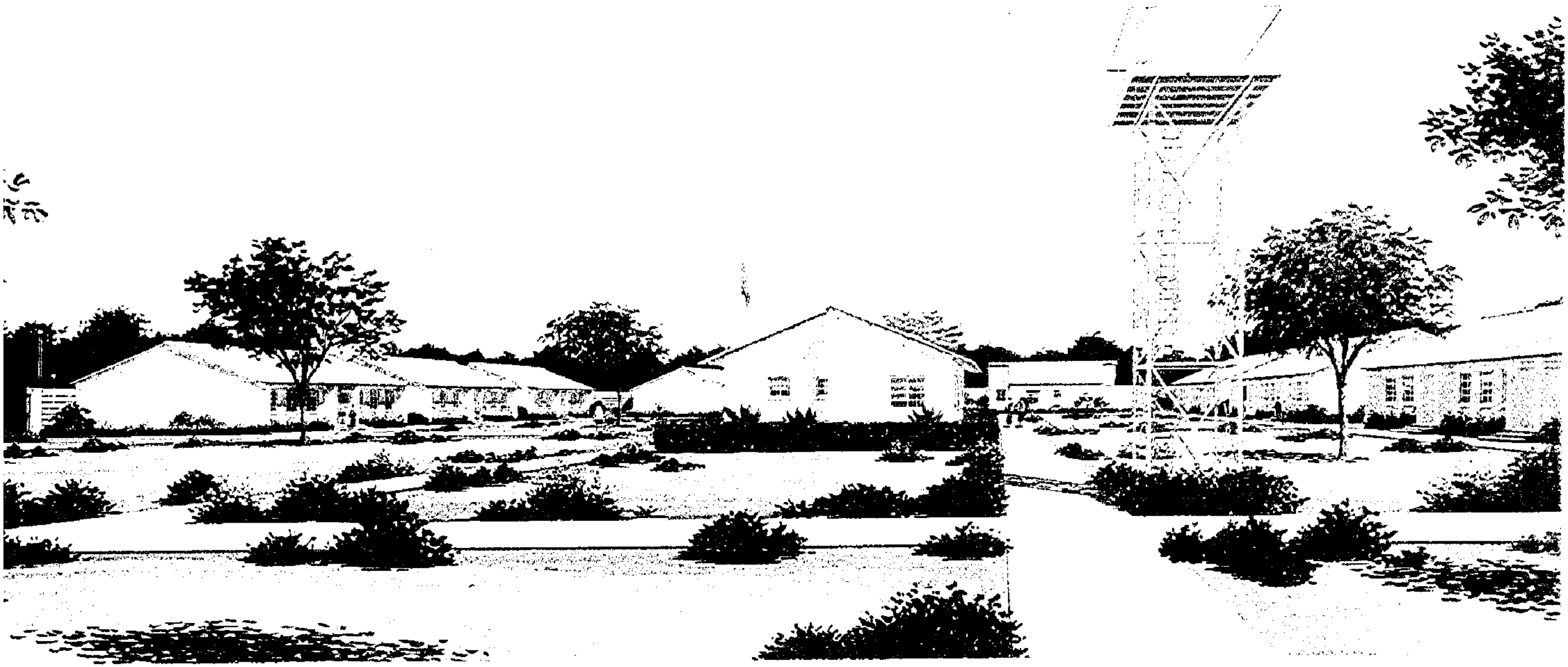




The Republic of Zambia

Location Plan of Target Sites (8 sites) and Existing Basic Schools





Perspective

Abbreviations

AfDB	African Development Bank
BESIP	Basic Education Subsector Investment Programme
CIDA	Canadian International Development Agency
ESIP	Integrated Education Sector Investment Programme
ESSP	Education Sector Support Programme
FINNIDA	Finish International Development Agency
IDA	International Development Association of the World Bank
MCDSS	Ministry of Community Development and Social Services
MFED	Ministry of Finance and Economic Development
MOE	Ministry of Education
MPU	Micro Project Unit
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development
OPEC	Organization of Petroleum Exporting Countries
PIP	Public Investment Programme
SIDA	Swedish International Development Unit
SRP	Social Recovery Project
UNICEF	United Nation Children's Found
UNDP	United Nations Development Programme
ZEPIU	Zambia Education Project Implementation Unit
ZERP	Zambia Education Rehabilitation Project

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CHAPTER 1 BACKGROUND OF THE PROJECT

Chapter 1. Background of the Project

1-1 Background of the Request

After gaining independence in 1964 from Great Britain, the financial condition of the Republic of Zambia had been sound by basing their economy on copper exports. Thereafter, international copper prices fell and an outbreak of droughts brought the national government's finances to a sharp turn for the worse. Since the 1989 agreement with the International Monetary Fund and the World Bank, the country accepted their economical structure adjustment program. From the social development viewpoint, the country is now faced with numerous problems: for instance, increased foreign debt, recession, inflation, severe unemployment, public order taking a turn for the worse, health and sanitation issues such as high infant mortality, spread of AIDS. As a long-term solution to these problems, the government stressed the importance of educational development.

As emphasized in the 6th Public Works Investment Program starting from 1995 to 1997, in recognition of the importance of education, the government is giving high priority to social and welfare sectors, taking active steps toward providing elementary education, resolving the shortage of school facilities and teaching materials such as textbooks, and improving schoolteachers' housing. As stated in Education Our Future (Education Policy 1996), the government is striving to change its education policy of placing importance on advanced education to making the 9-year basic education more widespread.

The government has set the following targets on extending the basic education: make widely available the lower/middle (first-fourth/fifth-seventh grade) basic education by the year 2005; and make widely available the upper (eight and ninth grades) basic education and the establishment of a full (9-year) basic education by 2015. It is estimated that the number of schoolchildren who will receive basic education based on this policy will increase by 50,000-60,000 a year to 2,117,000 in 2005 and 2,841,000 in 2015 from 1,637,000 in 1994.

To realize this education policy, the government is aggressively tackling these problems by receiving aids from many donors. The Integrated Education Sector Investment Program (ESIP), launched mainly by the World Bank in 1996, focusses a step-up in basic education quality, an improvement in schoolteachers' abilities, and fulfillment of vocational training. The program included the construction of classrooms, improvement of educational equipment, an increase in schoolteachers' pay and re-education of schoolteachers. In August 1997, it proposed to draw up Basic Education Subsector Investment Program

(BESIP) that would cover only the basic education sector. In addition to the World Bank, many bilateral aid-giving and international institutions participated in this program. The Directorate of Planning Unit of the Ministry of Education now is preparing a plan mainly for the following approaches: establishment of a framework of educational administration, improvement of school facilities, training of schoolteachers, distribution of textbooks, improvement of sanitation conditions at schools, and an increase in educational opportunities.

Because of rapid increase in population and lower investments in education due to deteriorated financial conditions, school attendance rate for basic education in this country fell and is now hovering at a low level: 82% for primary school and 14.2% for secondary school. (The 1995 Education Statistics) In Lusaka, particularly, the primary school attendance rate is 54.4%, which is below the national average. Primary schools admit only about 27% of seven-year-old applicants; that is, about 47,000 children lose the opportunity to enter schools every year. Particularly in the compound in a suburb of Lusaka where the project sites are located, population influx is severe. Although the existing schools are operating on two and three shift systems, there just is not enough classrooms to accommodate the increasing population.

Attaching the greatest importance to solving the shortage of educational facilities and equipment in Lusaka, the government is attempting to improve school facilities by obtaining financial aids from the World Bank and other institutions. In the compound in a suburb of Lusaka where urban infrastructures are not improved, school facilities sufficient enough to absorb the population inflow cannot be constructed. To give an increasing number of preschool children the opportunity to enter schools, construction of new primary and secondary schools is mandatory.

Against this backdrop, the Government of the Republic of Zambia requested a grant-in-aid from the Government of Japan for the construction of basic schools in Lusaka District.

In response to the request from the Government of Zambia, the Government of Japan decided to conduct an investigation, and the Japan International Cooperation Agency (JICA) dispatched a preliminary survey team in August, 1997. Based on the results of the survey, the Agency despatched a basic design study team on the construction project for basic schools in Lusaka from February 1 to March 2, 1998.

The team consulted with the parties concerned in the government and other aid-giving institutions to confirm the background of the request, to obtain details of the project and the implementation systems in the country, surveyed the eight sites listed in the request to check them for validity as project sites, and subsequently concluded that all the sites were suitable for the project. Furthermore, by surveying all the sites, the well water supply potential has been determined.

After returning to Japan and making subsequent studies on the validation of the project, determining the project scale, implementation organs and administration systems and evaluating the effects of the project, the team drew up a draft basic design with optimum project scale and contents. The results of these studies were compiled into draft basic design documents, and a basic design overview explanation team was dispatched to give a brief explanation of the basic design to the parties concerned in the country from June 2 to 13, 1998.

1-2 Objective and Contents of the Request

1-2-1 Objective of the Request

Setting the principal goals of thorough diffusion of lower/middle (first-seventh grade) basic education by 2005, and make extensively available, upper (eight and ninth grades) basic education and the establishment of a 9-year basic education by 2015 as described in the government's education policy, the project aims at giving the children who have been shut out of schools to receive basic education by constructing 9-year basic schools. The government's request is a grant-in-aid from the Japanese government for the improvement of 9-year basic schools and educational equipment particularly at eight sites in Lusaka where the shortage of educational facilities for basic education is critical. The contents of the request are as follows.

1-2-2 Contents of the Request

(1) Subject sites (in the order of precedence as set by the government of Zambia)

Schools applicable for the grant-in-aid are at the following eight schools in the compound.

- (i) Bauleni
- (ii) John Laing
- (iii) Ng'ombe
- (iv) Mumana
- (v) Chainda
- (vii) Libala
- (vii) Balastone
- (viii) Kabulonga

(2) Educational facilities to be constructed

Classrooms, administration office, caretaker's houses, sanitation services (lavatories), blackboards, and water supply facilities

(3) Educational equipment to be improved

Classroom furniture (desks and chairs), furniture for administration use, and educational equipment

CHAPTER 2 CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Objectives of the Project

Setting the principal goals of thorough availability of lower/middle (first-seventh grade) basic education by 2005, and complete availability of upper (eight and ninth grades) basic education and establishment of 9-year basic education by 2015 as described in the government's education policy, the project aims at providing children, who were not given the chance of attending a school due to shortage of educational facilities for basic education, with the opportunity to receive basic education particularly at eight sites in Lusaka where the shortage is critical.

2-2 Basic Concept of the Project

2-2-1 Site selection

(1) Site selection standards

Survey of site conditions including nearby primary schools was conducted with regard to the eight sites where construction of primary/basic schools was requested under the Project. Using the survey data, the validity of site selection was re-evaluated. The following eight items were used as criteria for re-confirmation of the validity of the sites under the Project.

1) The new schools should be in areas where school enrollment is lower than elsewhere, where there are no basic schools, and where the nearest out-of-area school has no spare capacity.
2) There should be local community involvement in the administration, management, and maintenance of nearby schools.
3) There should be no similar programs operated by other donors.
4) There should be no safety nor security problems in the neighborhood of the site.
5) The site should be accessible by public road.
6) Land ownership must be served for school construction at the chosen site.
7) There should be no geographical limitations imposed by topography, elevation, area, or geology that could prevent the construction of a school at or near each chosen site.
8) An appropriate infrastructure (water, sewage, and power) must be available at the site.

Table 2-1 Site Selection Standards

Standard	Judgment	Criteria
1) Nearby primary school	×	Compound has primary school with adequate capacity.
	△	Compound has primary school but capacity is inadequate.
	○	Compound has no existing primary school.
2) Participation of residents in management and maintenance (survey of nearby schools)	*	Poor participation by residents
	△	Poor participation by residents, but some activity exists.
	○	Considerable participation by residents in school management and maintenance (such as construction of fencing, maintenance of school facilities, reduced vandalism, etc.)
3) Interference with other donors	×	Other project proposed by other donor or the World Bank, and coordination with the requesting organization failed. Or a local residents' organization has initiated its own project
	○	No request for assistance has been proposed by any other organization
4) Safety in site area	×	The local government indicates the site is in an off-limits area. Our survey of the local community indicated a possible danger.
	○	No danger has been indicated by any party concerned.
5) Accessibility by public road	×	No access to the site possible during survey
	△	Accessible by vehicle during the dry season
	○	Accessible by vehicle
6) Availability of site	×	Non-public land and thus cannot be used.
	△	Permission to use the site will definitely be forthcoming by the time basic design is implemented.
	○	Ownership has already been obtained for use by Ministry of Education.
7) Surrounding geography	×	Site or its surroundings is steeply sloping, so school construction is not possible.
	△	Surrounding geography or site plan poses problems as regards school construction, but some action has already been taken. Or site area is not sufficient.
	○	Site is suitable as regards area and shape.
8) Infrastructure	×	No possibility of water and power supplies
	△	Water and power supplies may be secured if action taken
	○	Water and power supplies currently available nearby

○: Appropriate
△: May be suitable under certain conditions
×: Discounted.
*: Difficult

(2) Site survey results

Data collected during site surveys were reviewed according to the site selection criteria, resulting in the evaluation given below.

Table 2-2 Site Selection Results

Item	Bauleni	John Laing	Ng'ombe	Mumana	Chainda	Libala	Balastone	Kabulonga	Remarks
1) Need for school expansion to increase attendance opportunities (lack of capacity)	△	○*1	○*2	△	○*2	△	○*1	○*2	*1: Many children unenrolled *2: No school nearby.
2) Status of school management and maintenance (nearby school survey)	○	○	○	○	○	○	○	○	
3) Interference with other donors	○*1	○	○	○	○	○	○	○	*1: World Bank abandoned plan (lack of budget)
4) Site safety	○	○	○	○	○	○	○	○	
5) Access by public road	○	○	○	○	○	○	○	○	
6) Availability of site (land ownership)	○	△	△	○	△	○	○	○	○: Land owned by Ministry of Education △: Ownership transfer under way
7) Geography of site and its surroundings									
Site area	○	△*1	○	○	○	○	○	○	*1: Site is small.
Natural disasters	○	○	○	○	○	○	○	○	
8) Infrastructure									
Power	○	○	○*1	○	○	○	○	○	△: No water supply/water supply inadequate
Water	△	△	△	△	△	△	△	△	△: No public sewage system
Drainage	△	△	△	△	△	△	△	△	
Well (potential)	○	○	△*1	○	○	○	○	○	*1: Lower potential than other sites
9) Others									
Distance from compound in question	○	○	△	○	○	○	○	○	△: Difficult to excavate
Exposed rock	△	△	○	○	△	△	○	△	
General evaluation of site judgment	○	○	○	○	○	○	○	○	
Priority determined by Education Ministry	1	2	3	4	5	6	7	8	

Notes[1]: ○: Appropriate
△: May be suitable under certain conditions
×: Discounted.
*: Difficult

Notes[2]: The site selection standards given above are an edited version of those proposed in the Minutes.

(3) Outline of Proposed Sites

Proposed site (location)	Geography	Area (m^2)	Status of site Site/surroundings	Water supply	Drainage	Power	Access road	Land ownership	Availability of well
1 Bauleni (southwestern suburbs)	Trapezoid, Flat	37,100	Adjacent to existing school Flat/playing field (exposed boulders)	Not available	Not available	Available	6m wide (paved)	Ministry of Education	Possible
2 John Laing (southern suburbs)	Rectangular Flat 70 x 101 m	7,070	Scattered fields/residential area No land preparation (exposed rock) Power available, but no water	Not available	Not available	Available	6m wide (not paved)	City Hall	Possible
3 Ng'ombe (Northern edge of city)	Rectangular Sloping 120 x 155 m	18,600	Meadow/residential area Sloping/laterite	Not available	Not available	Available	4m wide (not paved)	Ministry of Education	Possible
4 Mumana (Northeastern area of city)	Square Sloping 200 x 200 m	40,000	Farm land/meadow No land preparation Power available, but no water	City water available (inadequate flow)	Not available	Available	4m wide (not paved)	Ministry of Education	Possible
5 Chainda (Eastern suburbs)	Rectangular Flat	38,700	Farm land No land preparation (exposed rock) Power available, no water	Not available	Not available	Available	6m wide	Ministry of Education	Possible
6 Libala (Northeastern area of city)	Trapezoid Flat	24,900	Farm land/meadow Scattered abandoned vehicles (exposed rock) Power available, water available in basic middle schools	City water available (inadequate flow)	Not available	Available	8m wide (not paved)	Ministry of Education	Possible
7 Balastone (Northwestern suburbs)	Rectangular Flat 100 x 200 m	20,000	Farm land No land preparation (exposed rock) Power available, no water	Not available	Not available	Available	6m wide (not paved)	Ministry of Education	Possible
8 Kabulonga (Northeastern area of city)	Square Flat	24,000	Farm land/meadow No land preparation (exposed pebbles) Power and water available	Not available	Not available	Available	4m wide (not paved)	Ministry of Education	Possible

2-2-2 Review of facility and equipment

A survey was carried out on nearby primary schools, primary schools built under the ZERP Project, and similar facilities. This disclosed that primary schools in Lusaka generally consist of regular classroom buildings, an administration building (housing the head teacher's office), a lavatory building, a caretaker's residence, special-purpose classrooms, lavatory stalls, plus various other facilities including a library, a staff room, a kiosk, and storage facilities.

Prior to determining the facility and equipment requirements for this Project, similar facilities were investigated in Lusaka. These were facilities picked up during surveys of proposed sites and nearby basic schools. Details of facilities requested by Zambia were evaluated from a comprehensive perspective.

Of the facilities and equipment requested, the major items are listed below along with the reasoning for them and their purpose.

Table 2-3 Facilities requested, review of need and usage

Item	Request	Necessity	Review of need and usage
[Facility]			
• Regular classrooms	○	○	- Essential at a school
• Special-purpose classrooms	×	○	- Not mentioned in the request, but necessary for the practical parts of basic school education. Intended for homemaking classes and industrial arts classes
• Administration office	○	○	- Required for functioning of a school
• Caretaker's house	×	○	- Necessary to help protect against vandalism
• Sanitation facilities (lavatories)	○	○	- Essential in a school
• Blackboards, etc.	○	○	- Blackboards and bulletin boards are basic equipment for classrooms and administration offices
[Equipment]			
• Classroom equipment	○	○	- Desks and chairs for students (MOE specification: integrated design) and desks and chairs for teachers
• Administration office fittings	○	○	- Fittings necessary for administration-related rooms
• Educational equipment	○	○	- Equipment generally required in regular classrooms and also that for practical education - General educational equipment, homemaking equipment (cooking and sewing), and industrial arts equipment
[Others]			
• External work	○	○	- Facilities made necessary by the natural conditions of the Lusaka area (storm drains, enclosed corridors, sewers)
• Underground water storage tank	○	× △	- Not necessary where well water is used - Required where city water is relied upon
• Water supply facility (well + pump room)	-	○	- Necessary if well water is used
• Elevated water tank	○	○	- Necessary to obtain sufficient water pressure if piped water supply is used
• Gate and fence	-	○	- Essential to protect against local vandalism
• Water purification tank + drainage	-	○	- Necessary if public sewage facilities are not available

2-2-3 Determination of facility size

The Ministry of Education is using updated working drawings, originally prepared for its ZERP Project, for standard designs of primary/basic schools. Specifically, the sizes of schools in this project were developed in consideration of nearby schools covered by the ZERP Project, and their reference employee counts and management standards have also been adopted.

Table 2-4 Determination of facility size

Facility	Size	Ground
1) Regular classrooms		MOE standard: 40-student capacity Room size: 6.70 m x 8.60 m = 57.62 m^2
Two-classroom (+ one storage room) bldg.	137.2 m^2/bldg.	[Classroom types] There should be only one classroom design. Classroom buildings should be of two types: two-room bldg. (+ 1 storage room) type and three-room bldg. (+ 2 storage rooms)
Three-classroom (+ two storage rooms) bldg.	215.9 m^2/bldg.	
2) Special-purpose classrooms Two-classroom (+ one storage room) bldg.	137.2 m^2/bldg.	MOE standard: 40-student capacity [Uses] Homemaking classes (cooking/needlework), woodwork classes, etc. Various uses
3) Administration office	68.63 m^2/bldg.	MOE reference design [Components] head teacher's office, assistant head teacher's office, office, conference rooms (library, staff room, etc.), and storage room
4) Caretaker's house	75.39 m^2/bldg.	MOE reference design
5) Lavatories	Number according to student count	MOE reference design
Lavatory (male/flush)	59.40 m^2/bldg.	Lavatory size should be determined to suit the number of children users by using as reference criteria the sanitation service standard of Zambia and the size and specifications of MOE ZERP Project's lavatories. Each lavatory building should include separate facilities for teachers.
Lavatory (female/flush)	50.16 m^2/bldg.	
Lavatory (male/seepage)	31.28 m^2/bldg.	
Lavatory (female/seepage)	31.28 m^2/bldg.	

(1) Regular classroom

In conformance with the standards of the Ministry of Education, 40-student classrooms are planned. Where the first-fourth, fifth-seventh, and eighth-ninth grades are operated on the three, two and one systems, 46-class and 39-class schools require 21 and 18 classrooms, respectively. In compliance with the requirements for the floor area and specifications of classrooms under the standards, a combination of the following two types is planned: three-classroom and two-classrooms school buildings.

As shown in Table 3-1, at the eight schools selected under the request within the school area of the compound, the school age population is estimated, from which the number of children who can be admitted into existing schools is deducted to obtain the number of children who are unable to attend schools. Calculations of demands for school facilities and classrooms verify that the schools will serve the objective of the project. In addition, the scale of classes per school is determined under the following conditions to calculate the required number of classrooms.

1) The total number of schoolchildren, which will be increased after the construction of the projected schools, should not exceed the number of children unable to attend schools.
2) The number of classes for each grade at existing schools is three for first-seventh grades and one for eighth-ninth grades. The Ministry of Education sets, from a standpoint of school administration, the upper limit number of classes per school to be 47. Based on these figures, it is decided that the maximum number of classes and schoolchildren per school are 46 (6 classes for first-seventh grades and 2 classes for eight-ninth grades) and 1,840, respectively.
3) From Item 2) above, because the number of children who cannot attend schools exceeds the maximum number of schoolchildren, i.e. 1,840, at seven sites in Bauleni, John Laing, Ng'ombe, Mumana, Chainda, Libala and Balastone, 46 classes and 1,840 schoolchildren per school are planned.
4) At Kabulonga site in the compound, because the number of children who cannot attend schools is 1,629, 39 classes (5 classes for first-seventh grades and 2 classes for eight-ninth grades) and 1,560 schoolchildren per school are planned based on Item 1).
5) Assuming that the first-fourth, fifth-seventh, and eighth-ninth grades will be operated on the three, two and one systems, respectively, with the current state at existing schools in view, the required number of regular classrooms is calculated. As a result, 21 and 18 classrooms at respectively 46-class and 39-class schools are planned.

The design of facilities and equipment is in compliance with the standard design for primary and secondary school facilities in the third stage of the ZERP Project financed by the World Bank in 1997. With the number of class shifts, school age children, administration and management conditions in view, the required number of classrooms and educational equipment is validated as given below.
The results of the study are summarized in the table below.

Table 2-5 Results of study on the required number of classrooms

	Balastone, Chainda, Ng'ombe, John Laing, Mumana, Libala and Bauleni	Kabulonga
No. of regular classrooms	21	18
No. of special-purpose classrooms	2	2
No. of classes	46	39
G1-G7	6 each	5 each
G8 and G9	2 each	2 each
Enrollment	1,840	1,560

The review results for each site are given in the pages that follows.

Table 2-6 Review of number of classrooms required per site

Site	1. Bauleni	2. John Laing	3. Ng'ombe	4. Mumana	5. Chainda	6. Libala	7. Balastone	8. Kabulonga	Total
Requirements									
Compound									
• Selected by MOE	Bauleni Cd.	John Laing New Kanyama	Ng'ombe Cd. Roma	Kaunda Square Munali	Chainda Cd. Avonddale	Libala Cd. Ghawama	Balaston George	Kabulonga Kalikiliki Cs.	
Population									
• Zambia Central Statistics Agency data (1996)	15,180	48,206	12,585	25,971	14,872	87,733	78,866	16,617	300,030
Number of school-age children (7 to 15 years of age)	3,613	11,473	2,995	6,181	3,540	20,880	18,770	3,955	71,407
• MOE school age student ratio data (1994)									
• (total population x 0.309 x 0.77 = total population x 0.238)									
Enrollment									
• Net enrollment in Lusaka	(55.4%)	(55.4%)	(55.4%)	(55.4%)	(55.4%)	(55.4%)	(55.4%)	(55.4%)	
• Enrollment according to interviews	30%	15%	5%	30%	5%	30%	15%	15%	
Number of classrooms and schools in compound									
• Total number of schools	1	2	0	2	0	2	3	1	11
• Total number of classrooms	13	33	0	35	0	22	50	24	177
• Total enrollment	1,715	3,462	0	4,085	0	3,000	6,117	2,326	20,705
Survey of neighboring schools									
• Number of schools surveyed (7-year school + 9-year school)	(3+0)	(2+2)	(0+2)	(3+1)	(2+2)	(4+1)	(4+1)	(3+1)	(21+10)
- Number of classes per school	26.6	38.8	38.0	41.8	37.8	49.0	36.4	42.8	39.6
- Number of students per class	44.1	49.8	44.4	47.2	47.9	41.2	47.5	50.2	46.6
- Number of classrooms per school	10.3	17.2	17.9	17.3	17.0	21.2	14.4	16.3	16.6
- Current shift index per school (class/classroom)	2.60	2.37	2.13	2.46	2.35	2.22	2.51	2.59	2.41
- Standard shift index per school (class/classroom)	1.83	1.56	1.97	2.10	2.20	2.18	2.07	1.88	1.99
Review									
Number of children unable to attend classes in the compound									
• Number of school-age children minus those accommodated by classrooms in the compound	1,898	8,011	2,995	2,096	3,540	17,880	12,653	1,629	50,702
Determination of facility size									
Determination of number of schools and classrooms									
• Number of schools	1	1	1	1	1	1	1	1	8
• Number of regular classrooms	21	21	21	21	21	21	21	18	165
• Number special classrooms	2	2	2	2	2	2	2	2	16
Number of children scheduled to be enrolled									
• Number of classes	46	46	46	46	46	46	46	39	361
• Total enrollment	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,560	14,440

(2) Special-purpose classroom

To provide a curriculum for eighth-ninth grades, special-purpose classrooms are planned to practice home economics and industrial arts. Calculations from a timetable, two special-purpose classrooms are planned. The floor area and specifications of special-purpose classrooms are in conformance with the standard design of MOE, and two-classroom buildings are planned. Each special-purpose classroom is provided with a sink, cooking table, blackboard and bulletin board. In each special-purpose classroom, a dual-purpose storage and preparatory room is laid out to store fixtures and make preparations.

(3) Administration office

Because the projected school facilities are large enough to accommodate 39 or 46 classes, it is necessary to plan many administration rooms, including rooms for head teacher, and deputy head teacher and administration staff, storage and meeting room. With these functions integrated into a single administration building, one administration building per school is planned. The building consists of head teacher's room, deputy head teacher's room, administration office, meeting room, teaching staff room, library and storage.

(4) Caretaker's house

As a protection against frequently occurring crimes such as burglary at the project sites, it is very effective from a viewpoint of crime prevention to station a caretaker regularly on the premises. Following the ZERP project financed by the World Bank, one caretaker's house per school is planned to protect school facilities from vandalism. The scale and specifications of the house conform to the standard design of MOE.

(5) Lavatory

In compliance with the standard design of MOE, lavatories of flush and seepage types are planned separately for men, women, students and teachers. In conformance with Zambian sanitation standards and by reference to the lavatory size used for the MOE's ZERP Project, the lavatory is sized and the number of toilet stalls calculated.

Table 2-7 Conditions for sizing lavatories, Number of users:
40 x No. of classrooms (21) = 840
(Breakdown: 420 for male and 420 for female)

		Basis of calculation	Calculation result	Plan	Reference data: ZERP Project
Toilet stalls	Male	One per 30	420/30=14	Flush toilets: 8 Seepage toilets: 5	13 stalls/25 classrooms
	Female	One per 25	420/25=17	Flush toilets: 8 Seepage toilets: 5	17 stalls/25 classrooms
Washbasins	Male	3 per 100	420 x 3 / 100 = 13	Flush toilets: 8 Seepage toilets: water tank	Flush toilets: 8 per 25 classrooms
	Female	3 per 100	420 x 3 / 100 = 13	Flush toilets: 8 Seepage toilets: water tank	Flush toilets: 8 per 25 classrooms
Urinals	Male	One per 20	420 / 20 = 21	Flush toilets: 16 Seepage toilets: water tank	16 per 25 classrooms

(6) Water supply and sewerage facilities

Due to unstable water supply in Lusaka, even in the areas where city water is available , many schools have wells. Because of city water supply difficulties at the project sites which are beyond the city water service area from Lusaka, wells at depths of about 80 m are included in the plan. Sewerage treatment facilities of seepage type are also planned at the sites that are beyond the sewerage service area.

2-2-4 Determination of amount of equipment

The MOE has no standards by which to specify which equipment or how much of it should be provided in schools, except in the case of student's desks and chairs. Quantities of equipment to be supplied under the project should thus be established by looking at nearby schools, schools recently built with ZERP Project, the standard number of students, and school management policy.

Table 2-8 Quantities of equipment

Equipment	Quantity	Reason
1) Desks & chairs for classroom		
Regular classroom		
Student desk + chair (integrated)	20/room	Two-seat integrated units according to the standard specifications of the MOE
Teacher desk + chair (separate)	1/room	Capacity: 40 students per room
Special classroom		
Bench (for practical work)	10 + 1/room	Capacity: 40 students per room at four-seat benches
Chair (for practical work)	40+3/room	One bench and chair for the teacher
2) Furniture for administration office		Nearby schools and World Bank ZERP Project schools should be surveyed and furnishings, furniture, or equipment judged necessary for the school's management as a result should be specified for the project before making a final determination of minimum requirements.
Desk (for administrator)	2	
Chair (for administrator)	2	
Chair (for guest)	3	
Desk (for office)	1	
Chair (for office)	1	
Chair (for guest)	3	
Filing cabinet	3	Administrator (2), secretary (1)
Locker	3	Administrator (2), secretary (1)
Bulletin board	4	
Desk (for meetings)	6	
Chair (for meetings)	24 (4 per desk)	
3) Teaching material		
General educational equipment	Set/classroom	Minimum blackboard-related needs include triangles, straight edges, compasses, and protractors.
Equipment for practical classes (homemaking)	Set/special-purpose classroom	No MOE standard is available for practical study equipment, thus it was set based on equipment specified in ZERP Project
Breakdown of set		
• Sewing machine	(2)	
• Cooker with oven	(2)	
• Refrigerator	(1/school)	
Equipment for practical classes (industrial arts)	Set/special-purpose classroom	
Breakdown of set		
• Hand tool	Set/special-purpose classroom	Set: Plane (1), Saw (1), Chisel (1), Hammer (1), Set square (1), Tape (1), Engineer (1)
• Equipment	Set/2 special-purpose classrooms	Set: Drilling machine (1), Bench grinder (1), Vice (1), Welding machine (1), Drill bits (2), Grinding disk (2), Welding rod (1 box)

The scale and details of school facilities and equipment as planned above are summarized in the following table.

Table 2-9 Scale of school facilities and equipment

	School name	Bauleni, John Laing, Ng'ombe, Mumana, Chainda, Libala and Balastone	Kabulonga	Specifications and standards on which to base calculations
Facilities	No. of regular classrooms	21	18	As per MOE standard: No. of students per classroom = 40 Floor area per classroom = approx. 58 m^2
	No. of special-purpose classrooms	2	2	As per MOE standard: No. of students per classroom = 40 To be used as multi-purpose, home economics and industrial arts rooms
	Administration office	1 bldg.	1 bldg.	As per MOE standard: Including head teacher's, deputy head teacher's, administration, meeting rooms and storage
	Caretaker's house	1 bldg.	1 bldg.	As per MOE standard
	Lavatories	Flush type: 4 bldgs. Seepage type: 2 bldgs.	Flush type: 4 bldgs. Seepage type: 2 bldgs.	Flush type: For male students: stalls/urinals: 8/16 For female students: 12 For male and female teachers: 2 each Seepage type: For male student s: 5 For female students: 5 For male and female teachers: 1 each Washbasins: For male and female: 8 each
	Water supply and sewerage facilities	Well, pump room, elevated water tank, sewerage treatment facility	Well, pump room, elevated water tank, sewerage treatment facility	Required pumping rate: as per MOE standard For students and teaching staff: 20 lit./head For caretaker's residence: 120 lit./head
	Total floor area per school (m^2)	2,052.78	1,836.86	Total 8 schools: 16,206.32 m^2
Equipment	Furniture in regular classrooms	Desk and chair (student): 420 Desk (teacher): 21 Chair (teacher): 21	Desk and chair (student): 360 Desk (teacher): 18 Chair (teacher): 18	Desks and chairs for students: two-seater type: 20/classroom Desk and chair for teachers: 1 each /classroom
	Furniture in special-purpose classrooms	Table for practice: 22 Chair for practice: 82	Table for practice: 22 Chair for practice: 82	1 table per 4 students plus 1 table for teacher Table: 11/classroom Chair: 41/classroom
	Furniture in administration office	Desk and chair: 3 Cabinet: 3 Locker: 3 Chair for guest: 6 Bulletin board: 4 Desk for meeting: 6 Chair for meeting: 24	Desk and chair: 3 Cabinet: 3 Locker: 3 Chair for guest: 6 Bulletin board: 4 Desk for meeting: 6 Chair for meeting: 24	Desk, chair, cabinet, locker: Head teacher, deputy head teacher, and administrator: 1 each
	Educational equipment	For general education: 21 sets For home economics practice: 2 sets For industrial arts practice: 2 sets	For general education: 18 sets For home economics practice: 2 sets For industrial arts practice: 2 sets	For general education: Triangle, straight edge, compass and protractor for blackboard; 1 set/classroom For home economics practice: Sewing machine and cooker table with oven; 1 set each/classroom Refrigerator; 1 set/school For industrial arts practice: Tools; 4 sets/classroom

2-2-5 Consideration on borehole drilling

(1) Design Concept of the Water Supply Facility (including the flush toilet)

Most existing schools in Lusaka are provided with water supply facilities. In many cases, however, water supply facilities are out of service as a result of dilapidation of the facilities and/or lack of water supply pressure of existing water supply system in the city, or lack of borehole yield. Both local residents and the school administrators are aware of the need for water supplies, as well as flush toilets, at basic schools. Thus, in building new schools, it is essential to plan for sufficient supplies of water for flush toilets in addition to hand washing and drinking facilities. Flush toilets require a particularly large supply of water.

Early in the discussions, it was suggested that flush toilets should not be provided and that water supply facilities should be specified according to the particular area. This was because there were fears that the use of 15 liters of water per flush might have a serious impact on local people, and particularly on children who often have to fetch water in places where there is no supply system. However, as it turned out, a major problem in these areas is the widening gulf in living standards between the compounds of low-income residents and those with higher incomes. If the facilities provided at schools were to reflect the wealth of the area in which they are situated, it was thought that this could stir up even greater problems rather than helping to solve them. In particular, differences among the facilities supplied at different compounds would very likely lead to greater vandalism and negative feelings toward projects carried out by Japan. Consequently, it was decided that the water supplies at all schools to be built would be of the same specification.

Based on the policy formulated by the Lusaka Water and Sewage Company (LWSC) that water to be supplied to public facilities should be sterilized even if its water source is a deep well, it was decided to install a sterilizer.

(2) Basic Concept

1) Water source (Comparison of water supply from existing pipe line network and borehole)

As a part of the Project policy, it was decided that independent water supplies should be established. This decision to establish an independent supply was based on the assessment that management of such utilities would be relatively low in cost and that suitable boreholes provide an stable and safe water. The relative advantages and disadvantages of using the existing water piping of LWSC, as compared with boreholes, are shown in the table below.

Table 2-10 Comparison of water sources

Water source	LWSC piped water supply	Boreholes
Required facilities	Underground water storage tank Storage pump (horizontal)	Boreholes Storage pump (submersible) Sterilizer
Advantages	1.Smaller pump	1.Running costs lower than LWSC rates 2.Dependable, independent supply less prone to external interruptions and pressure problems 3.Reduced danger of pollution that with underground storage tank
Disadvantages	1.Higher running costs 2.Supply interruptions a constant possibility 3.Might cause reduced water pressure in neighboring areas 4.Underground water tank may develop cracks allowing the entry of pollutants	1.More powerful submersible pump required 2.Sterilizer required 3.Discharge depends on local hydrogeological conditions 4.Water supply depends on a power supply; power failure halts the flow 5.Requires regular maintenance and periodic renewal of submersible pump, etc. in the well (8 year life).
Running costs (projected) See attachment for breakdown.	Approx. 870,000 kwacha per month	Approx. 210,000 kwacha per month
Reference Renewal costs for pump (estimation based on the present price)	Approx. US $1,000 Maintenance costs for grand reservoir tank and distribution transmission line are required.	Approx. US $4,000 The cost will be minimized if it can be settled with exchange of drive parts such as motor.

2) Selection of Site

Field survey, geophysical survey, and analysis of existing borehole data had been undertaken in 8 sites under the Basic Design Study. Borehole drilling points shall be selected from the candidates which seems to satisfy the design criteria to assure the yield of 402m^3/day. Hours of pump operation shall be limited to 5 to 10 hours.

3) Concept on required amount of water supply

For the estimation of required amount of water supply, 20 liter/day/capita is taken as a unit of supply amount referring to the criterion of Ministry of Education. Also, target population is estimated as 1,840 pupils and 40 teachers and staff.

Given those figure, estimated amount of water supply shall be:

(1,840 pupils + 40 Teachers and Staff + 5 Guards and their family) × 120 liter = approx. 40m^3/day

Estimation of maximum supply amount in a day will be presented in Utilities.

2-3 Basic Design

2-3-1 Design concept

In planning facilities and equipment to be provided in the Project, the following principles have been established by considering natural conditions, social conditions, the situation of construction industry, and the characteristics of the Project.

(1) Aspects of design related to natural conditions

1) Ventilation

The Lusaka area experiences great temperature differences, ranging from a minimum of 3.9°C to a maximum of 38.3°C. Considering this range of temperatures, it is desirable to achieve free ventilation by allowing the classrooms to be opened up to the outside air. Thus, opening windows should be specified.

2) Lighting

The existing basic schools in Lusaka are equipped with light fittings. Likewise, the schools proposed here should also be furnished with lighting.

3) Heat insulation

Appropriate measures to reduce solar heating should be incorporated into the layout and facility plans. No mechanical air-conditioning will be installed. Ceiling heights should be 3m or more to alleviate the effect of direct radiation from the roof.

4) Rain

The rainy season in Zambia lasts from November to March. Civil engineering work and foundation work should not be planned for this period, since delays are more than likely and the work schedule as a whole will suffer. This must be carefully considered when developing a construction schedule. The drainage plan must also provide adequate infrastructure to deal with frequent torrential rain during the wet season.

5) Hydrology

Water source for planned water supplying systems should be deep wells designed to stably provide safe water. Specifications of such deep wells should be determined by assessing hydrological data.

(2) Aspects of design related to social conditions

It is common for schools and their facilities in Lusaka to be damaged and rendered unusable. Schools without adequate theft-prevention are prone to vandalism such as smashed windows and loss of desks, chairs, and other furniture items and light fixtures, electrical outlets, and other interior fittings to theft. The design must incorporate effective means to protect against vandalism.
The following anti-vandalism measures will be employed, which were revealed to be effective by field surveys carried out at existing primary schools and basic schools in the Lusaka district.

1) Demarcate the school compound with a fence around the boundary.
Fencing-in the school compound has a number of beneficial effects: it helps to maintain a favorable educational environment, enhances feelings of ownership among local residents, fends off theft, and discourages vandals.

2) Install crime-prevention equipment and anti-vandalism fixtures at all routes of entry.
Such fixtures should be locally designed and made using local methods; this means they will be easily replaceable once broken. For example, gratings may be fitted over windows and other exposed openings, or slit-shaped windows may be used.

3) Install crime-prevention lighting in the compound.

4) Provide a caretaker's house within the compound.
A resident caretaker-cum-guard within the school compound is able to pay especially close attention to the compound and thus discourage vandalism.

(3) Aspects of design related to the local construction industry

1) Planning for the participation of local contractors
Many local construction companies participated in basic school construction under the ZERP Project. Construction of schools under this project was in compliance with the standard design of MOE and solely carried out by local constructors. Construction of schools under this Project should also comply with the ministry's standard design. Such buildings should also be designed to allow local construction firms to use their own expertise.

2) Planning for the use of local construction equipment and materials

A local-content approach should be used, with emphasis on locally manufactured products or those imported by local firms. This approach should make construction easier and also eventually allow for improved maintenance. The use of local builders and locally available equipment and materials is also an effective way to vitalize local industry.

3) Planning for compliance with Zambian standards

Although no building permit is required for school construction, the schools to be built under this project should be designed in accordance with Zambian building standards.

(4) Aspects of design related to available management and maintenance skills

When the need arises for repairs, the MOE in principle supplies the materials required while parents of students supply the needed labor. However, there are more and more cases where the MOE is turning to PTAs and the local community to supply materials as well, because the ministry is short of funds. The MOE's principle is also to delegate responsibility for daily maintenance to PTAs. Consequently, it is necessary to develop facility plans that allow for easy maintenance by local residents both in terms of skill requirements and finance.

(5) Aspects of design related to scope and quality of facilities and fixtures

The project covers the construction of educational facilities and the supply of fixtures and materials required to operate them. The specifications and quality of the facilities should follow those specified by existing MOE standard designs (originally developed for the ZERP Project) so as to allow local builders to carry out construction and local residents to implement maintenance.

(6) Aspects of design related to construction term

In order to complete the project within the period prescribed for a grant-aided project of the Japanese government, an appropriate construction schedule should be developed. This must take full account of every factor that may affect the time required for construction. An appropriate construction team should be formed to deal with the sites, both individually or as a whole as circumstances demand, for efficient fulfillment of the work.

The project is expected to take 12 months to reach completion for the following reasons:

1) Project sites are scattered throughout the Lusaka district.
2) The number of buildings to be constructed per school is 17 on average (covering an area of about 2,000 m^2).
3) The November to March rainy season is quite long.

2-3-2 Basic design

(1) Site and layout plans

The project entails the construction of new basic schools on the proposed eight sites. Each school is to comprise regular classroom buildings, a special-purpose classroom building, an administration building, a caretaker's residence, and a lavatory building (with flush and seepage toilets).

Site area, level changes, and existing structures differ from site to site, so it is not possible to develop a common layout plan. Thus, individual layout plans should be developed for each school according to the following basic principles, taking full account of the characteristics and siting requirements of each school.

1) Buildings should be laid out to suit the basic site shape as well as to make effective use of the terrain.
2) Variations in ground level, if any, should be taken into consideration to ensure that the required number of classrooms can be fitted on the site.
3) The layout should allow for future increases in the number of classrooms.
4) The layout should provide for as spacious a playground as possible.
5) Where there are variations in ground level, areas prone to poor drainage or flooding during the rainy season should be eliminated if possible and buildings should be placed as far as possible on flat ground.
6) Ground leveling, grading, and improvement work, which are all within the scope of the Zambian government's work, should be kept to a minimum so as to reduce the burden.

(2) Building plan

1) Planning

The MOE has designated as standard design drawings used in basic school construction under the ZERP Project. Facility design has been given appropriate improvement by the ZERP Project. This standard design is the reference on which this project should be based.

Table 2-11 Scale of school facilities

Facility	Scale	Reason
i) Regular classrooms		
2-classroom bldg. (+ 1 warehouse)	137.2 m^2/bldg.	MOE standard; capacity: 40 students
3-classroom bldg. (+2 warehouses)	215.9 m^2/bldg.	Classroom size: 6.70 m x 8.60 m = 57.62 m^2
ii) Special-purpose classrooms		MOE standard - capacity: 40 students
2-classroom bldg. (+ 1 storage room)	137.2 m^2/bldg.	(Use) Multiple uses, including homemaking classes (cooking/sewing), carpentry, etc.
iii) Administration office	68.63 m^2/bldg.	MOE standard design (ZERP) (Composition) head teacher's office, administration office, general office, meeting room (library, staff room, others), storage room
iv) Caretaker's house	75.39 m^2/bldg.	MOE standard design
v) Lavatories	According to the number of students	MOE standard design (ZERP)
Lavatory (male/flush)	59/40 m^2/bldg.	The number and size of lavatories should reflect the needs of students based on the specifications for lavatory buildings used at new MOE schools and on the findings of local surveys.
Lavatory (female/flush)	50.16 m^2/bldg.	
Lavatory (male/pit latrine)	31.28 m^2/bldg.	
Lavatory (female/ pit latrine)	31.28 m^2/bldg.	Each building should also have lavatories for teachers.
vi) Others Pump room		Pump rooms are needed to house pumps for moving water up to elevated water tanks.

2) Structural plan

Local situations involving building materials and methods should be considered in determining a structural method for use in the Project in terms of economic efficiency and durability. Concrete block structure, a typical structural method in Zambia, should therefore be employed. Strip footing to use the ground for support of a building should be used. Reinforced concrete slab should be employed for floor.

i) Foundation plan

All buildings planned under the Project are one-storied and can be fully supported by direct foundation. Effective bearing capacity should be 5.0 T/m^2 or greater.

ii) Structural plan

Buildings should be constructed by using reinforced concrete strip footing and concrete block structure, both of which are commonly used for schools in

Zambia. Floor should be concrete slab and, reinforced truss (spider truss) and cement sheeting (corrugated) for the roof.

iii) Structural materials

Reinforcement: Locally procured products complying with BS 4449.

Round bars: fy = 250 N/mm^2

Deformed bars: fy = 410 N/mm^2

Concrete: Ordinary concrete complying with Fc = 20 N/mm^2 (4-week strength)

Cement: Ordinary Portland cement (Zambian standard ZS001)

iv) Design load

This should satisfy the Zambian Standard for Building Loading.

v) Earthquake load

No past earthquakes are recorded in Zambia. No standard for earthquake load is specified, either. Thus, seismic force need not be considered, except for the design of elevated water tanks.

vi) Wind load

Meteorological data issued by Zambia's Meteorological Agency for the building industry gives an average wind velocity of about 5.0 m/s in the project area. No wind loading should be considered since the planned buildings are all of flat masonry structure.

3) Utilities plan

Supplies of utilities should be planned to allow most efficient use of the buildings while ensuring durability, ease-of-maintenance, and minimal running costs.

The utilities supplied to buildings in the project should be as follows.

Table 2-12 Utilities plan

	Plumbing		Electricity	
	Plumbing	Sanitary services	Lighting	Electrical outlets
1. Regular classrooms	×	×	O	O
2. Special-purpose classrooms	O	×	O	O
3. Administration office	×	×	O	O
4. Caretaker's house	O	O	O	O
5-1. Lavatory (flush)	O	O	O	×
5-2. Lavatory (pit latrine)	×	O	O	×

i) Plumbing and sanitary services plan

a) Water supply

Water needs to be supplied to certain locations (lavatories, washrooms, drinking fountains). Some sites are in areas with no water mains. Therefore, wells should be excavated at these sites as water sources.

b) Water drainage

[Sewage]

Two types of drains are required: sewers for lavatory waste and wastewater drains for other water. All waste water should be treated in septic tanks. The septic tanks must be planned in compliance with the standards, which are documented in the MOE standard drawings (ZERP Project standards) for use in schools. Soil of each toilet should be treated in the septic tank and the treated waste will be lead to the seepage tank for absorption into the ground.

[Rainwater waste]

Rainwater from the facilities and the compound should be lead to trenches excavated without timbering around lowlands in the compound for natural discharge.

c) Sanitary equipment

Lavatory bowls should be of the low-profile unitary tank type (with the flush tank in a single unit with the bowl). Urinals should consist of mortar-finished trenches, not ceramic units. Washbasins should be concrete sinks.

d) Calculation of water supply (common for all sites)

Caretaker's residence (1 unit): Planned water consumption = 1 house x 6 persons /house x 120 L/person/day = 720 L/day

Day students (1,840): Planned water consumption = 1,840 x 20 L/day = 36,800 L/day

Total: 38,960 L/day

e) Calculation of elevated water tank capacity (common to tanks at all the sites)

The capacity of the elevated water tank is calculated as follows. Each such tank should have excess capacity, since daytime power outages are common in Lusaka and electricity is required to pump water from the deep wells.

Number of toilets for male students, female students, and teachers

① 24 x 15 L = 360 L

Amount of water used when all toilets are simultaneously flushed

360 L x 6 = 2,160 L

Amount of water required per one hour (one flush every 10 minutes)

② 40 x 2 L classrooms = 840

Greatest number of students per shift

5 L x 840 = 4,200 L

Amount of water used by the above students for drinking and hand washing.

③ 6,300 L (1) + (2) = maximum water usage per unit time

④ 6,360 L x 1.5 = about 10 m^3

Elevated water tanks are generally designed with a capacity equal to twice the maximum water consumption per unit time. However, considering the nature of expected usage (water consumption decreases during class times) the capacity is to be 1.5 times the maximum consumption.

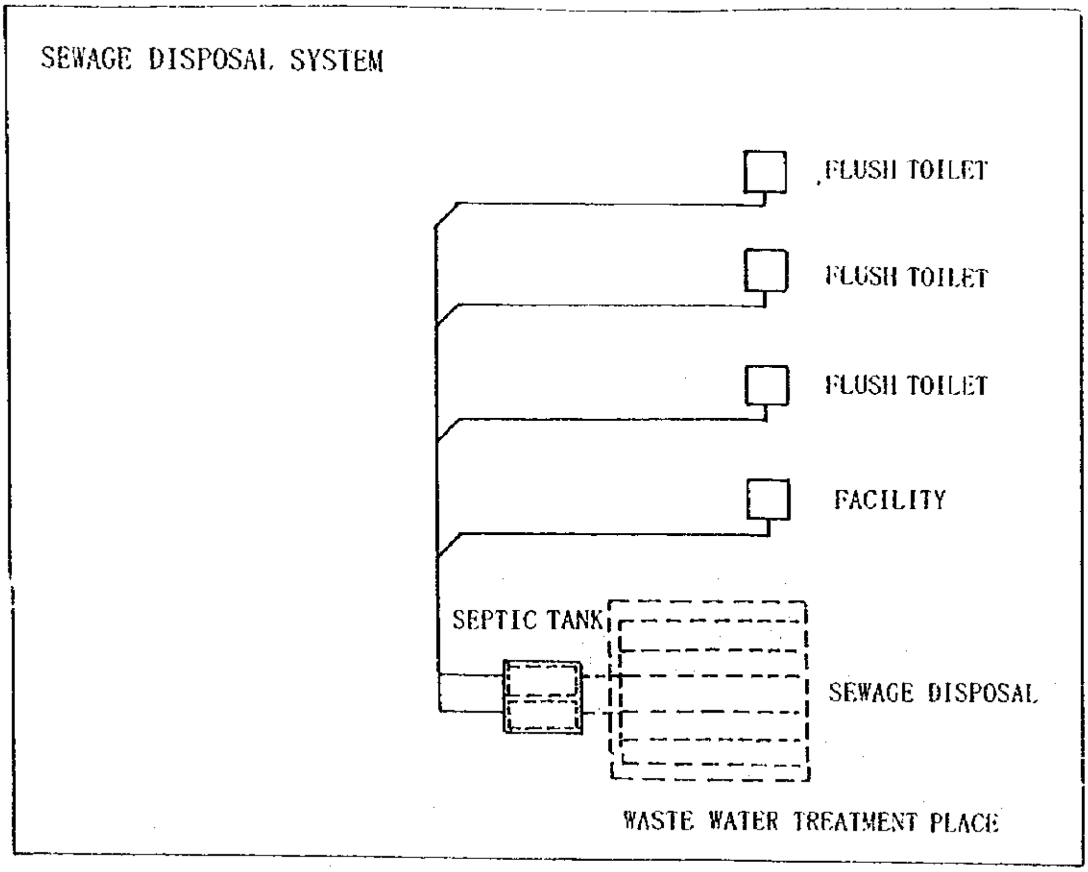


Figure 2-1 Sewage Disposal System

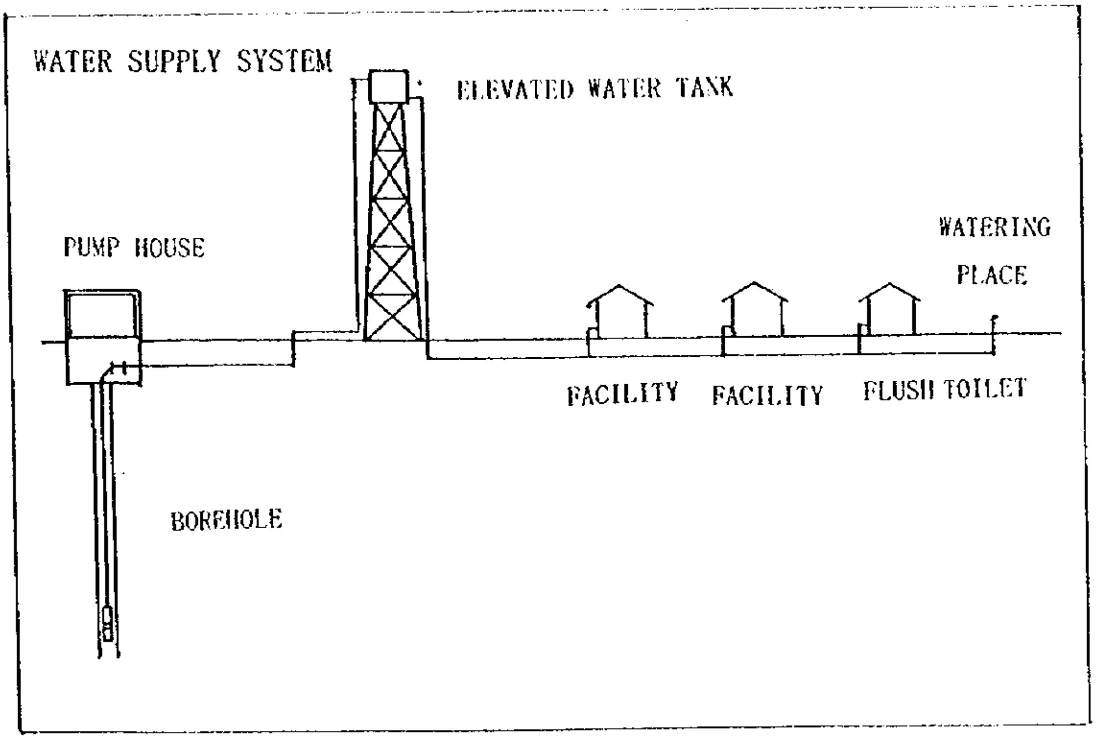


Figure 2-2 Water Supply System

ii) Electricity plan

a) Supply

Eectricity supply is required at each site. The provision of power lines is within the scope of work to be carried out by Zambia.

It is understood that a local power company will provide a supply at 11,000V reducing to 3 phase, 4W 380V and 220V from a distribution cable (overhead, 3 phase, 3W 11,000V). Within the compound, power will then be distributed to each building via distribution panels.

b) Lighting equipment

The lighting plan should specify fluorescent lamps for ease of maintenance and economic efficiency. Luminosity should be as follows.

Classrooms:	150 - 180 Lx
Administration offices:	150 - 180 Lx
Caretaker's houses:	150 - 180 Lx
Lavatories:	50 - 70 Lx

c) Power outlets

Power outlets should be installed as necessary in the various offices and classrooms. The voltage should be either 220V single phase, or 380V 3 phase depending on need.

Outlets should be installed as follows.

Classroom buildings:	classrooms and storage rooms
Administration offices:	head teacher's office, staff room, administrator's office, storage room, meeting room, and all other rooms
Caretaker's houses:	all rooms

These outlets should be fitted wherever required for ordinary electrical appliances. In special-purpose classrooms, outlets should be positioned as appropriate to facilitate practical lessons.

4) Building materials planning

The materials to be used in construction of this project are listed in the table below. Both materials and methods used should be carefully selected after a comprehensive review of factors including siting conditions, meteorological conditions, affordability, maintainability, and post-completion running costs. Locally produced or procured materials are to be recommended wherever possible since they are generally accepted as satisfying the MOE's classroom specifications, which emphasize economic efficiency and durability. Local contractors will be familiar with such materials, and if locally practiced methods are also adopted, a standard quality of workmanship should be ensured while the construction period will be minimized.

i) Major structural components

Foundation:	reinforced concrete
Floor:	reinforced concrete
Wall:	concrete block
Beam:	reinforced concrete
Roof:	reinforced roof truss or wooden roof truss

ii) Exterior finish

Roof:	cement sheet (corrugated) (in compliance with locally practiced finish)
Wall:	mortar finished with painting (in compliance with locally practiced finish)
Exterior floor:	mortar finished with trowel (in compliance with locally practiced finish)
Door:	wooden door + steel grid door

iii) Interior finish

Wall:	mortar finished with painting (in compliance with locally practiced finish)

Floor: mortar finished with trowel and painting for floor (in compliance with locally practiced finish)

Ceiling: roofing materials or particle board

(3) Equipment plan

The table below lists the standard equipment to be supplied for school operation.

Table 2-13 Equipment plan

Description	Quantity	Dimensions	Specifications
1) Desks and chairs for classroom			
Regular classrooms			
Student desks and chairs (integrated type)	20/classroom	MOE standard	MOE standard two-seater integrated design
Teacher's desk	1/classroom	1500 x 750 x H750	Hardboard top + pipe frame
Teacher's chair	1/classroom	•	Plywood seat and back + pipe frame
Special-purpose classrooms			
Benches	11/classroom	1400 x 700 x H700	Hardboard top and back + pipe frame
Stools	43/classroom	•	Plywood seat and back + pipe frame
2) Furniture for administration office			
Desks for administrators	2	1500 x 750 x H750	Hardboard top and back + pipe frame, with drawers
Chairs for administrators	2	•	Office chair (with armrest)
Chairs for guests	3	•	Plywood seat and back + pipe frame
Office desks	1	1500 x 750 x H750	Hardboard top and back + pipe frame, with drawers
Office chairs	1	•	Office chair (with no armrest)
Chairs for guests	3	•	Plywood seat and back + pipe frame
Filing cabinet	3	380 x 1200 x D600	Steel (for administrator + office)
Lockers	3	900 x 2000 x D450	Steel (for administrator + office)
Bulletin board	4	•	Wooden
Desk for meetings	6	1400 x 700 x H700	Hardboard top and back + pipe frame, with drawers
Chair for meeting	24	•	Plywood seat and back + pipe frame
3) Teaching materials			
General educational equipment	One set/classroom	For blackboard	Plastic triangle, straight edge, compass, protractor
Special equipment (homemaking)	One set/special-purpose classroom		
Sewing machine	2		
Cooker with oven	2		
Refrigerators	1/school		
Special equipment (industrial arts)	4 set/special-purpose classroom		Breakdown:
Hand tools			• Plane (1), Saw (1), Chisel (1), Hammer (1) Set square (1), Tape (1)
Other equipment			• Drilling Machine (1), Bench Grinder (1) Vise (1), Welding Machine (1) Drill Bit (1), Grinding Disk (1), Welding Rod (2)

Note[1]: MOE has no standards for equipment other than student desks and chairs.
Note[2]: The specifications for special equipment were determined on the basis of that provided under the SERP Project (third phase).

(4) Drilling Plan

1) Hydrogeology of Lusaka

In and around the city, Lusaka Water and Sewage Company (LWSC) has 70 boreholes, 49 of which are currently operating. Further, there are large numbers of private boreholes. The total number of boreholes is thought to be around 300. Based on this information, the groundwater characteristics of the area could be categorized as follows.

a) Unconfined groundwater forming aquifers in the rough particle layers of the alluvium and laterite

This type of groundwater is characterized by variable flow under strong influence of meteorological conditions; water levels exhibit a marked drop during the dry season. It is not recommended as a source of public water supplies since pollution due to human activity is suspected. In addition, there are a number of shallow wells, of which depth is 1 to 10 m.

b) Confined groundwater in the Lusaka group (limestone)

About 90% of active wells in Lusaka tap into the Lusaka group as a source of water. This group of layers mainly comprises non-crystalline and crystalline limestone and marl, with occasional shale in limited areas. These layers have undergone fierce crustal movement, resulting in the highly developed folds and faults seen today. Of these faults, those oriented northwest to southeast are of greatest magnitude; these are associated with many cracks in parallel and diagonal orientations. The groundwater is recharged by rainfall and surface rivers (about 20% of surface water in and around Lusaka is thought to end up as groundwater) and flows along fissures in the limestone. The flowing water dissolves the limestone and erodes lateral limestone caves. At the same time, rainwater seeps directly downward from depressions in the ground, forming vertical caves over time. Ultimately, these wells come together to form a complex of underground caverns through which the groundwater flows. The limestone caves and highly porous fissures have to be avoided when developing new boreholes, so experienced well drilling engineers are necessary. According to interviews with personnel of the water supply bureau and local well digging companies, only about one well in a few dozen is successful. In Chipata District north of Lusaka, a further 24 wells were drilled to locate one successful well for water supply (at a flow rate of 70 m^3/h).

c) Confined groundwater in the Cheta and Churanga groups (schist)

The Cheta and Churanga groups consist of schist and quartzite. They are highly consolidated, so no water seep into their strata. However, there are many folds and faults together with fissures in these strata, and water is known to exist at these faults.

d) Target aquifer

Given those condition described above, target aquifer to be developed under the Project is determined on lime stone and its fissures in Lusaka group and/or fissures in Cheta and Churanga groups.

2) Survey Method

Each of the planned eight sites was surveyed by field reconnaissance, geophysical survey (geoelectircal and electromagnetic survey), and water quality testing.

3) Results of the Survey and Review

1. Review on the drilling points (Situation at each site)

a) Bauleni

This area is characterized by exposed limestone. An excavation of a few meters can be expected to reach the bedrock. A schist boundary is also found nearby. Geoelectrical and electromagnetic surveys predict the existence of fissures in the limestone near the middle of the site.

A deep well is presently under construction about 100 m east of the site. It is reported that sufficient water has been obtained at a depth of 60 m. There is also a deep well owned by the Water and Sewage Works Bureau in the same compound. This well is incapable of providing water to the site using a direct feed method.

b) John Laing

Limestone underlies this site, and an excavation of about 1m is expected to reach the bedrock. This limestone is part of the Lusaka group, as at Balastone, so it is expected to have many fissure zones. Since the site offers minimal possibilities as excavation sites, careful selection is necessary as early as possible in the execution stage. A deep well managed by the bureau is located about 1.5 km northeast of the site.

c) Ng'ombe

Limestone underlies the area. Relatively well weathered, it is almost certain to yield water from the proposed deep well, although the discharge is expected to be small. The site is far distant from the bureau's piping system and there is no other potential source of water. Thus a deep well is essential.

Although the area has no piped water supply, there are four deep wells equipped with hand pumps under the management of a committee of compound residents. These wells, however, fail to meet the water demands of the residents.

The area is characterized by a weathered layer 10 to 30 m deep, with younger layers of schist further below. Four points were selected as promising excavation sites, but two of these are expected to have fissure zones 80 to 100 m deep.

d) Mumana

Considerably weathered schist lies under this area. This means a certain supply of water, though the discharge is likely to be low. A piped water supply is available nearby, but the pressure is low because of the higher elevation. This enhances the need for a deep well.

About 200 m north of the site is a social economic research center run by Zambia University. This facility has a deep well that was excavated because insufficient pressure was available from the bureau's piping. Their deep well is 60 m deep and supplies water to the building and its neighbors.

e) Chainda

Limestone is reached a few meters below ground, according to our survey. The site is in a valley, suggesting good groundwater potential as a result of an anticipated fissure zone.

The Bureau has a deep well elsewhere in the compound.

f) Libala

Limestone underlies the area, and can probably be reached less than 1m below the surface. Belonging to the Lusaka group, as at Balastone, this limestone is expected to contain fissure zones. Electromagnetic survey indicate the likelihood of many fissure zones in the southwestern part of the site.

g) Balastone

Limestone lies less than 1m below the surface. Geophysical survey indicate that the limestone here is harder than elsewhere. ρ-a graphs prepared based on the geoelectrical survey results suggest fewer fissure zones than in other areas.

Four areas were identified as promising excavation sites. Since this proposed construction site is relatively large, these well excavation points should be fixed with more precision as the project enters the execution stage. The area has no existing wells; the closest one is at Chunga, more than 1km away.

The quality of limestone, which belongs to the Lusaka group, and the geographic conditions indicate that a deep well, if appropriately sited, will provide the required amount of water.

The alternative suggestion of bringing water in from an existing facility in the George Complex (built under Japanese grant aid as part of the Water Supply Project in Satellite Area) poses the following questions:

- The basic aim of the Project is to supply water to the communities through communal faucets and laundry areas. It does not include piping to individual households or buildings, including schools.
- This program envisages an independent water supply for each school, with management by the school and the MOE.
- The distance to the present elevated water tank is 3 km (but if another elevated tank is completed next year as planned, this would be less than 2km away). No decision has been made as to which organization would manage the piping.
- If water is to be supplied from the existing facility in the George Complex, it becomes necessary to pay water charges to the LWSC, as is the case with the water supply from a city water main.

h) Kabulonga

The site is an area sloped from west to east, with a hill on the north side.

Limestone lies in the site, with the shallowest depth of limestone layer judged to be less than 1 m from the surface, although the depth differs from point to point.

Geoelectrical survey indicates the existence of a fissure zone perpendicularly crossing the river that runs in the southwestern part of the site.

There is a deep well operated by the Bureau about 200 m east-southeast. Groundwater is a sure potential.

2. Analysis of data on Existing Borehole and Hydrogeology

a) Actual Condition of Existing Borehole

There are, as described below, existing boreholes in the vicinity of Project sites for the construction of basic schools, which are managed by LWSC. Data of the existing boreholes necessary for the analysis for the construction of new boreholes are limited.

Table 2-14 Actual condition of existing borehole

No.	Well	Year of excavation	Diameter (mm)	Depth (m)	Pumping test data: Water storage (m^3/hr)	Static water level (m)	Dynamic water level (m)	Pump position (m)
1	Chainda	1974	200	58	100	6.0	15.6	31
2	Ng'ombe	1991	200	73	6.8	10	21.5	
3	Bauleni (Kabulonga district)	1974	150	45.7	36			24
4	John Laing	1991	150	72	5.5	5	6	72
5	Ibex Hill	1985	200	68.6	13		7.9	40

Note: Water storage data are taken from the literature of Lusaka Water and Sewage Company (LWSC) and are based on measurements with ultrasonic flow meters. These flow meters generally give instantaneous readings only. Thus, the data cannot be regarded as proper storage figures.

b) Water quality

The table below shows the results of water quality analysis on samples taken from existing boreholes drawing from the same aquifers as expected to be used in this project. These wells are close to the proposed well sites. The analysis indicates that the water is clean enough to be potable, so the planned wells are judged to be appropriate water sources.

Table 2-15 Water quality analysis

Site	Cl- (mg/l)	T-Fe (mg/l)	NH4-N (mg/l)	NO2-N (mg/l)	Total hardness (mg/l)	pH	Conductivity (μ s/m)	Colibacillus	Ordinary bacteria
Ng'ombe - 1 (hand pump)	15	<0.2	0.1	0.006	205	6.5	182	Not detected	Not detected
Ng'ombe - 2 (hand pump)	15	<0.2	0.2	<0.006	210	6.5	163	Not detected	Not detected
Bauleni (LWSC)	50	<0.2	0.1	<0.006	820	8.0	1018	Not detected	Not detected
Mamuna (UNZA)	35	<0.2	0	0.3	310	7.5	405	Not detected	Not detected

c) Analysis of data on Existing Borehole

The depth required depends on local hydrogeological conditions. Since there are so few existing boreholes in the vicinity of each site, there is inadequate information to make a judgment of expected maximum discharge. Consequently, data on deep wells in and around Lusaka, including the proposed sites, were examined in conjunction with the results of the field surveys and geophysical survey. The depth of these existing boreholes, the aquifer depth, the nature of the rock, the static water level, and positions of fractured and weathered zones are summarized in the table below.

Table 2-16 Hydrogeology of Lusaka

Well depth	38 – 128 m
Aquifer	Limestone, Schist, Dolomite,
Pump discharge	5.5 - 440 m^3/h
Static water level	1.5 - 26 m
Storage level	3 - 30 m
Draw down	1 - 12 m
Screen position (below surface) Main aquifer	14 - 105 m 30 – 100 m
Thickness of laterite layer	1 - 20 m

Aquifers developed in the compounds of Lusaka city are, in the Lusaka and Cheta groups. Our hydrogeological and geoelectrical survey demonstrated that aquifers qualified to supply drinking water lie in depths between 40 and 100 m. The limestone fissures and caves as well as weathered and cracked schist are at various depths depending on the hydrogeological conditions of each locality. According to data on existing boreholes, pumping equipment (screen or slit casing) is installed at average depths of 30 to 40 m. This means that water is taken from various aquifers even in a single borehole. Thus, this project should allow for electrical well logging to be carried out after drilling to locate appropriate aquifers. The length and position of the water extraction screen should then be determined on the analysis of the geoelectrical survey at each proposed drilling point, the thickness of the aquifer thought to be present, and the relationship between screen penetration and specific water output.

d) Result of Geophysical Prospecting

From the geophysical survey and result of analysis, we admit fracture zone near 85 – 100 m in whole sites. The main aquifer depth of each site is listed as follows:

Table 2-17 Result of Geophysical Prospecting

Site	Expecting depth of main aquifer
Balastone	65 – 100 m
Chainda	80 – 100 m
Ng'ombe	55 – 95 m
John Laing	70 – 100 m
Mumana	60 – 100 m
Libala	65 – 100 m
Bauleni	65 – 100 m
Kabulonga	65 – 100 m

c) Review

The geology of the Lusaka district is characterized by an abundance of limestone, so there are high potential of groundwater yield. However, the yield varies greatly with location, so careful study will be necessary before actual drilling points can be chosen. Where there is a layer of schist below the ground, the potential for groundwater yield is usually low, but it is still possible to develop groundwater if there are thick layers of weathered or fissured rock.

There are boreholes, in 2 Project sites, which is located within the distance of 300 m from the Project sites. However, it can be concluded that the interference among the boreholes caused by construction of new borehole will not occur unless excessive pumping is continued, because of the distance of 300 m from the Project site from the existing borehole.

Table 2-18 Hydrogeological conditions of the sites

Site	Geology	Existing wells shallower than 300m	Groundwater availability	
			Success rate	Quantity available
Balastone	Limestone	None	△	○
Chainda	Limestone	None	○	○
Ng'ombe	Schist	None	○	△
John Laing	Limestone	None	△	○
Mumana	Schist	Some	○	○
Libala	Limestone	None	○	○
Bauleni	Limestone	None	○	○
Kabulonga	Limestone	Some	○	○

The groundwater potential of each site has been confirmed using ρ-a graphs produced by geoelectrical survey and from existing borehole data. Given these results, it is decided to construct borehole at all eight sites.

4) Design of Borehole

1. Borehole

The boreholes should be constructed to an average depth of 80 m, as confirmed by the hydrogeological conditions and through geoelectircal survey. Diameter of boreholes has been set at 6" (150 mm) to suit the pumping rate of submersible pumps. The well screen should be an all-welded design with a continuous V-slot winding. The diameter of the well screen should also be 6" (150 mm).

The groundwater of the area is known to have a pH of 6.9 to 7.3. Given this, the steel casings and stainless steel screens should be those generally used by the Lusaka Water Supply and Sewage Company. The unit length of both screens and casings should be 6 m, and the lower 20% of the well depth (18 m) should consist of screen, with casing down to a depth of 62 m. This specification is indicated by local hydrogeological analysis.

Each well opening should be housed in a machine room. Contamination must be avoided by grouting each borehole down to a depth of about 20 m with cement. Aquifers and screens should be separated by packing the borehole as appropriate with gravel of a suitable size. Centralizers should be used to ensure that screens and casings are accurately centered in the wells.

The submersible pumps should be driven by 3-phase AC 380V–50Hz motors. They should be equipped with low-level alarms to prevent motor burn-out. Pumping equipment should be mounted on robust steel frames supported on concrete foundations.

Proposed excavation sites are shown in the layout plan.

2. Related Facilities

a) Pumping equipment and pump room

Water will be pumped up from the boreholes via submersible pumps and fed directly into the elevated water tanks. Thus, the submersible pump to be selected has to have enough capacity to transmit water, without any transmission facilities, from the borehole to the elevated tank. Since there is no knowing in advance exactly where each completed well will be, since such decisions depend on a hydrogeological survey, it is possible that some wells may have to be excavated outside the school compound. Allowing for such a possibility, a concrete pit should be constructed around each well-head, separately from the control room foundations, and the control room should be connected to the school by underground water piping and power cables.

The control room should consist of an operator's booth, containing an electricity incoming panel, the pump control panel, and the chlorine sterilizer (see the sections on dosing pump and tank in the following section), and a storage room in which bleaching powder is kept.

b) Chlorine sterilization

The essence of the water supply system discussed above is water quality. Water extracted from the deep wells must be free of dirt, pathogens, and toxic bacteria. The water must be strerilized if aquatic infectious diseases are to be prevented; indeed, human aspects are part of the background to the project. The well water must be treated with chlorine, particularly during the rainy season when contamination is most likely and whenever quality inspections determine that it is necessary. In addition, installed chlorinator should correspond to the policy of Lusaka Water and Sewerage Company. To achieve this, a method of sterilization using an powerful bleaching agent (calcium hypochlorite) should be provided since, of the toxic chlorinating agents, this powder is considered particularly easy to use and store, is easily available as a commercial product, and offers excellent handling and safety characteristics. The sterilization process should consist of first dissolving this powder in a little water, and then adding it to the pumped water with a dosing pump. Backup equipment should always be on hand. The chlorinating agent is highly alkali and corrosive, so all equipment and materials that come into contact with it should be corrosion-resistant. The feed point should be immediately before the water outlet to the elevated tank.

5) Tolerance and Expecting Pumping Rate

1. Tolerance

Where deep wells are excavated in areas with special hydrogeological conditions (fissures are targeted), such as the sites proposed in this project, the possibility of failure to tap an appropriate aquifer must be taken into account. This can occur as a result of locally inhibited amounts of water or reduced water quality even in areas where favorable aquifers are the norm.

2. Success rate

According to an estimate based on data from Lusaka-area wells held by the LWSC, there is an approximately 80% chance of reaching a useful aquifer. One way to reduce the risk is to excavate a well with a smaller diameter and carry out aquifer tests, including pumping and flow tests, to verify that the bored hole reaches into a suitable aquifer.

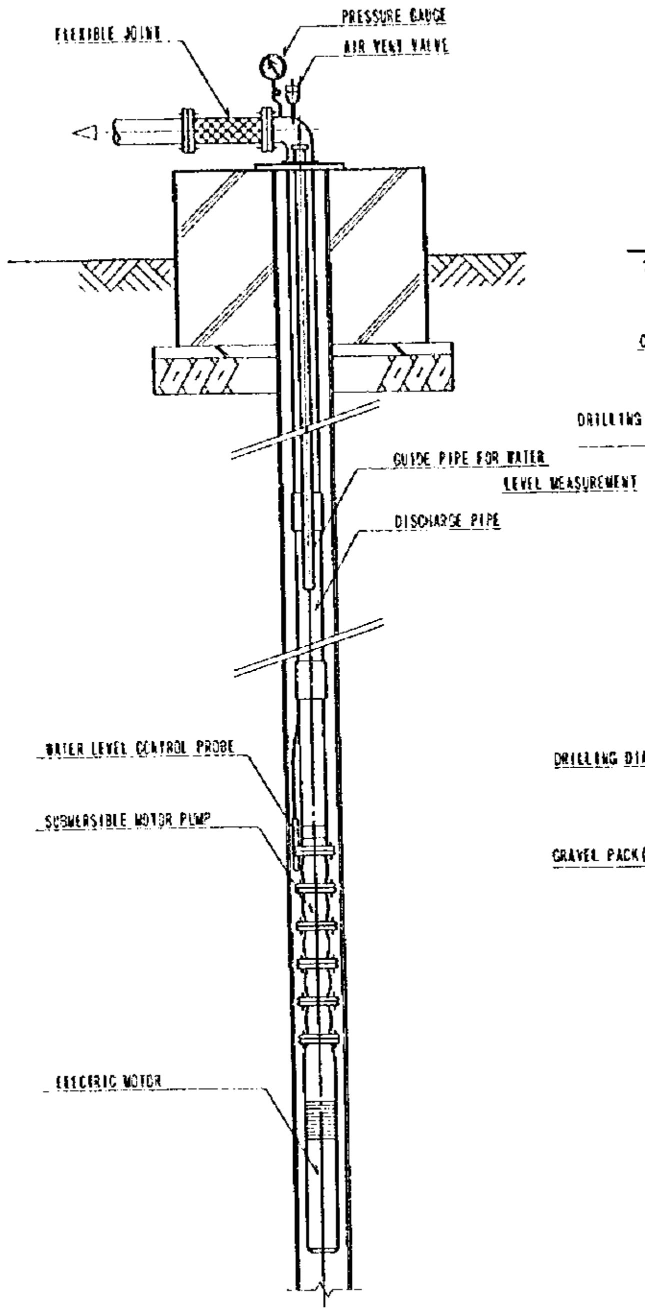
3. Judgment on expected pump discharge

   There are about 70 deep wells for the supply of drinking water to local residents in Lusaka. The majority of them, over 80%, rely on aquifers in the Lusaka group. At the project sites, six wells will penetrate limestone of the Lusaka group and two its schist layer. The groundwater potential is generally known to be higher in limestone than in schist.

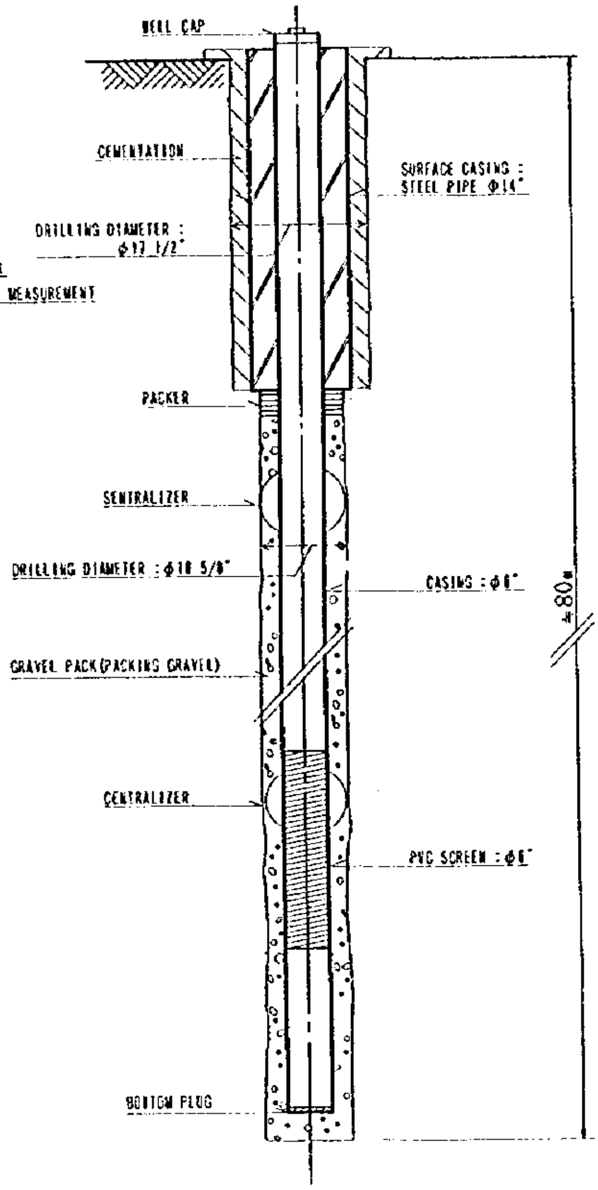
   Field reconnaissance and geoelectrical and electromagnetic survey were conducted to identify aquifers and select promising well excavation sites. Despite these surveys, the actual discharge from each well can only be estimated based on existing wells. Judging from the limited literature on existing wells, about 6 to 20 m^3/hr can be expected from each borehole.

4. Pump discharge and pumping duration

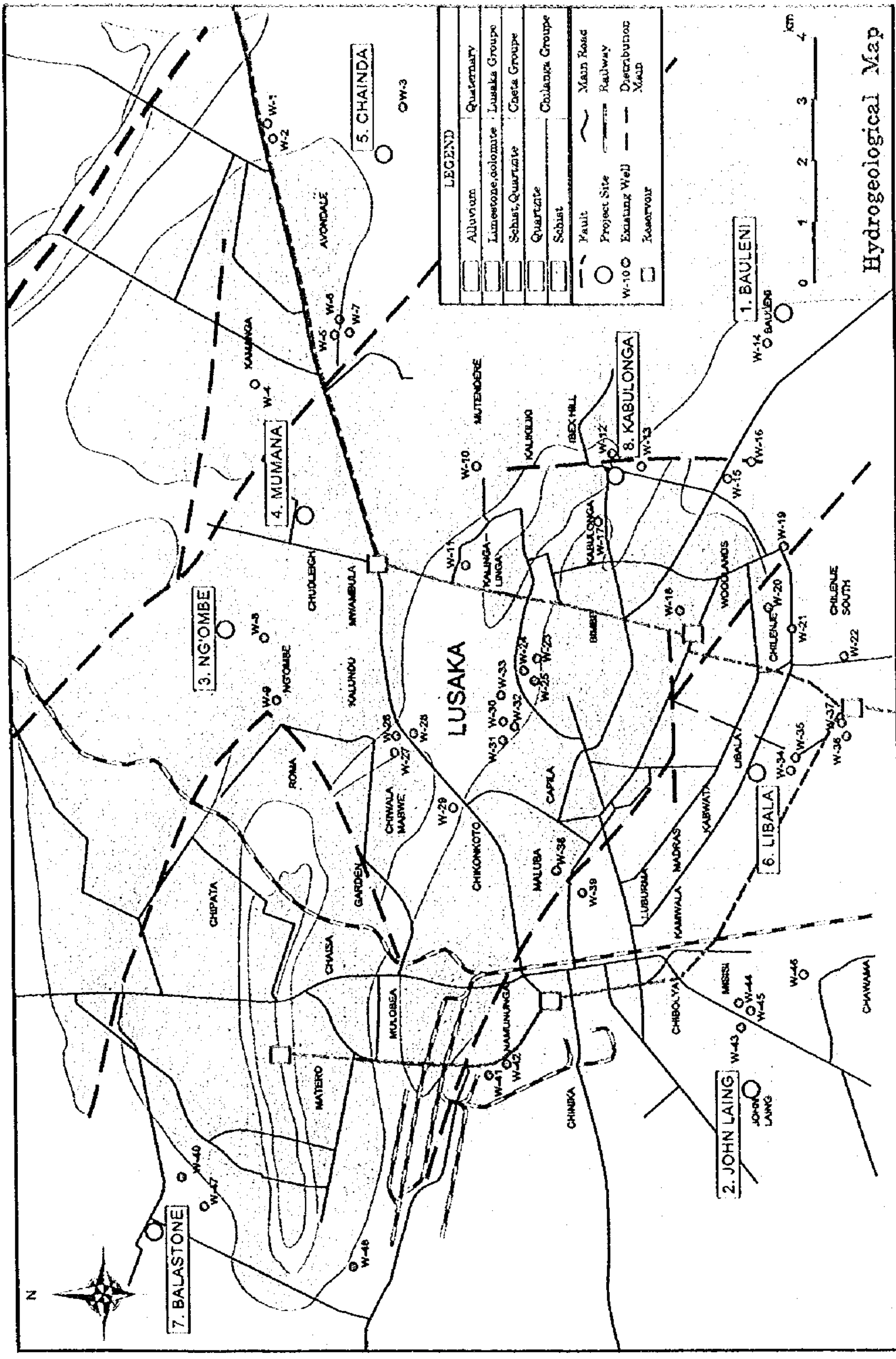
   Aquifers in limestone or schist layers should be the target of well excavation, and consideration should be given to preventing leakage from upper aquifers (in the laterite and conglomerate layers). Actual pump discharge will probably vary with the site. A suitable discharge rate for every well should be calculated after carrying out a pumping test. To allow for well recovery, and also for reasons of pump life and maintenance, pumping should be limited to six to ten hours per day; running costs are calculated on this basis. Thus, minimum pumping amount can be estimated at 4 m^3/hour.



SUBMERSIBLE MOTOR PUMP INSTALLATION



STANDARD BOREHOLE STRUCTURE

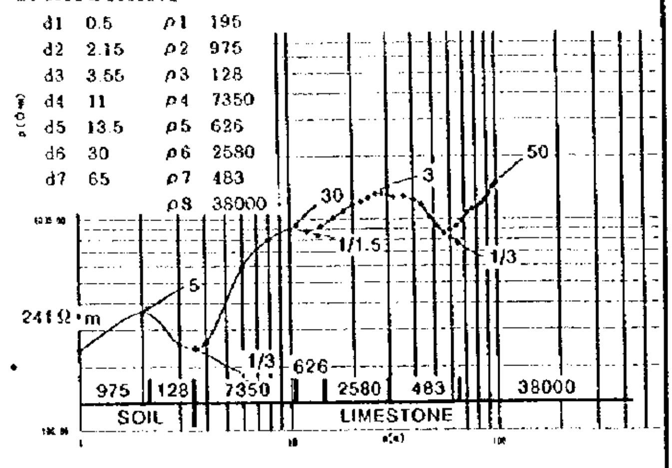

Hydrogeological Map
LEGEND
Alluvium
Quaternary
Limestone,dolomite
Lusaka Groupe
Schist,Quartzite
Cheta Groupe
Quartzite
Chilanga Groupe
Schist
Fault
Main Road
Project Site
Railway
Existing Well
Distribution Main
Reservoir
0 1 2 3 4 km
N
LUSAKA
1. BAULENI
2. JOHN LAING
3. NG'OMBE
4. MUMANA
5. CHAINDA
6. LIBALA
7. BALASTONE
8. KABULONGA
AVONDALE
KAMANGA
MUTENDERE
KALIKILIKI
IBEX HILL
CHUDLEIGH
MWAMBULA
KALUNDU
NG'OMBE
ROMA
CHIPATA
GARDEN
CHAISA
MATERO
MULOBEA
CHAWAMA
WOODLANDS
CHILENJE
CHILENJE SOUTH
KABULONGA
KALINGA-LINGA
CAPILA
MALUBA
CHIKONKOTO
LIBALA
KABWATA
MADRAS
LUBURMA
KANWALA
CHIBOLYA
MISISI
CHINIKA
JOHN LAING
BAULENI

LWSC Borehole Inventory

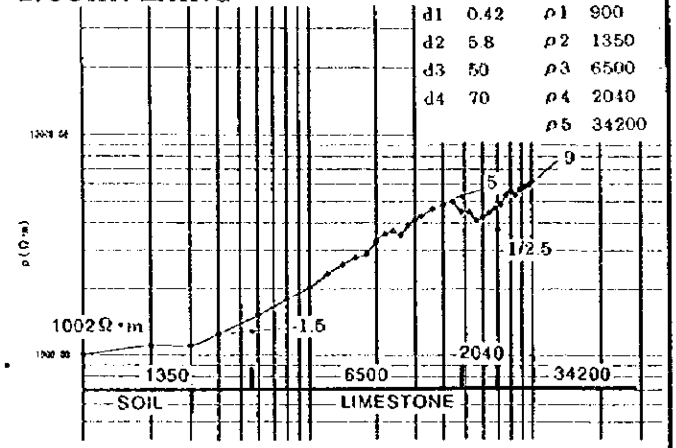
No.	Borehole No.	Borehole Name	In Use	Working Hour	Discharge (m^3/h)	Pump Capacity (m^3/h)	Pump Depth (m)	Water Level DWL (m)	Water Level SWL (m)
1	W-14	BAULRENI	O	15	36	36	27	8.20	
2		BUCKLEY 2	O	12	12	20	51	15.45	
3	W-3	CHAINDA	O	24	24	24	30	12.66	
4	W-46	CHAWAMA 1	O	20	51	50	34	6.26	
5		CHAWAMA 2	O	24	64	50	0	14.00	
6	W-7	CHELSTON 2	O	8	45	50	50	35.55	
7	W-5	CHELSTON 3	O	24	88	150		35.55	
8	W-22	CHILENJE SOUTH	O	24	64	50	30	14.60	
9	W-40	CHUNGA 1	O	12	35	24	39	16.40	
10	W-47	CHUNGA 2	O	8	7	8			
11	W-31	FREEDOM	O	24	6	7	36	22.10	
12	W-48	GEORGE SOUTH	O	12	15	8	30	2.50	
13	W-12	IBEX HILL	O	24	16			7.90	
14		INTERNATIONAL SCHOOL 8A	O	24	108			17.50	
15		INTERNATIONAL SCHOOL 8B	O	24	60	75	38	17.00	
16	W-32	INTERNATIONAL SCHOOL 6C	O	24	21	21	28	18.96	
17		INTERNATIONAL SCHOOL 6D	O	24	132	150	45		
18		INTERNATIONAL SCHOOL 6E	O	24	60			19.65	
19		JOHN HOWARD	O	24	15			9.50	
20	W-43	JOHN LAING	O	17	7	9			
21	W-13	LAKE ROAD	O	24	25		54	15.00	
22		LEOPARD'S HILL 1	O	24	100	200	45	17.70	
23	W-15	LEOPARD'S HILL 2	O	12	113			16.65	
24		LILAYI ROAD 1	O	24	80	100		18.65	
25		LILAYI ROAD 2	×	24	132				14.27
26		LUMUMBA ROAD 4A	O	24	0	100	43	18.20	
27	W-1	MALO FARM-1	O	15	174	255	30	19.70	
28	W-2	MALO FARM-2	O	5	66			19.70	
29	W-23	MASS MEDIA-1	O	24	128	150		14.70	
30	W-24	MASS MEDIA-2	O	24	40	60	45	14.70	
31	W-25	MASS MEDIA-3	O	24	72			16.65	
32	W-26	MULUNGUSHI 6A	O	24	8	15		21.00	
33	W-27	MULUNGUSHI 6B	O	24	43	40	38	22.00	
34	W-39	NIPA*	O	24	52	50	45	8.20	
35	W-29	NORTHMEAD 1	O	24	63	75	40	9.00	
36		NORTHMEAD 2	O	24	48			10.33	
37	W-8	N'GOMBE	O	15	12			17.70	
38	W-34	OLD P/STATION	O	0	64	70	40	12.80	
39	W-38	PARIRENYATWA	O	24	6	7	51	18.00	
40	W-18	PARKS NURSERY	O	24	10	7	54		
41		ROADSIDE 1	O	24	50			9.05	
42		ROADSIDE 2	O	24	100			9.15	
43		ROADSIDE 4	O	24	54	100	48	9.25	
44		ROADSIDE 5	O	24	102	100	42	8.00	
45		ROADSIDE 6	O	24	142	150	36	9.35	
46		SHAFT 5 NO.1	O	24	375	500	44	24.63	
47		SHAFT 5 NO.2	O	24	375	500	44	24.63	
48	W-28	SHOW GROUNDS	O	24	64	75	48	25.20	
49	W-33	TWIKATANE	O	10	13	10	36		
50		U.T.H	×	0	24				
51	W-36	WATERWORKS 1	O	24	140	350	38	17.00	

Geophysical Prospecting Data and Analysis (ρ − a curve)

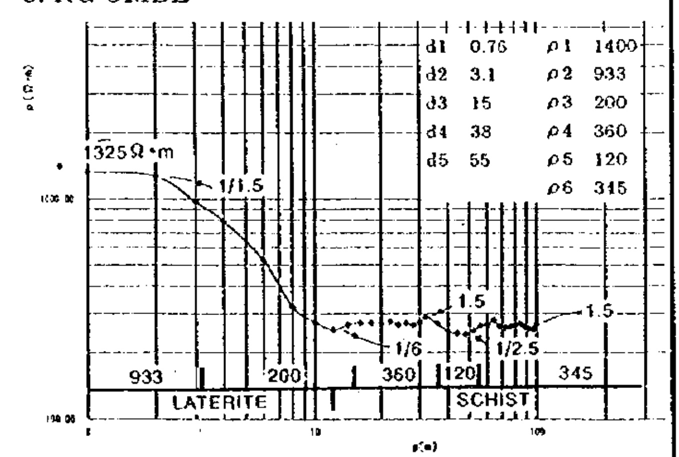
1. BAULENI



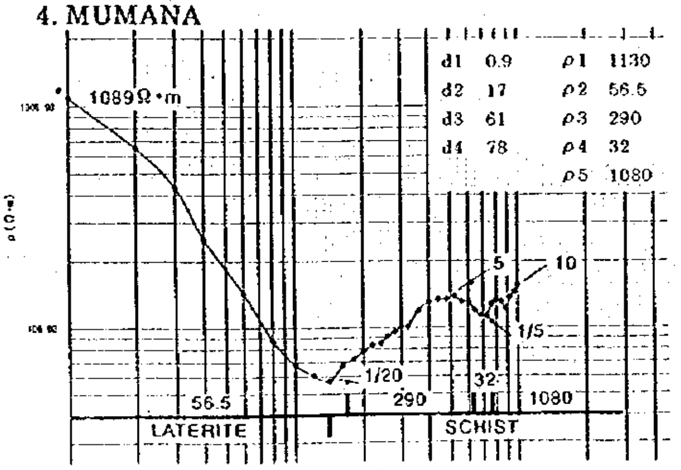
2. JOHN LAING



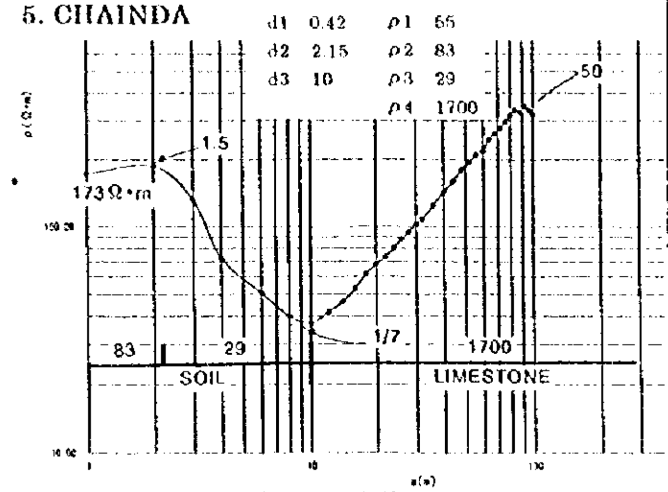
3. NG'OMBE



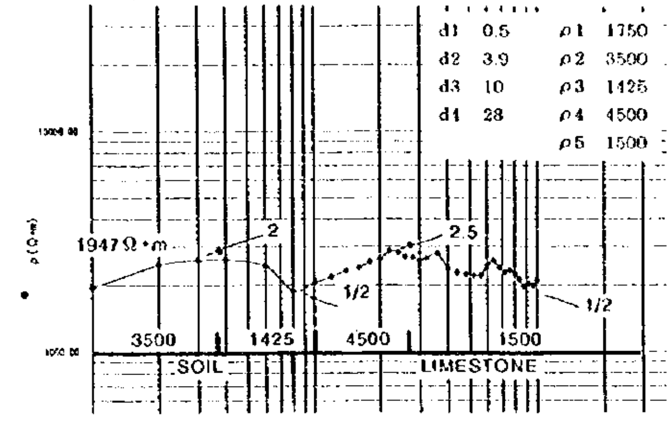
4. MUMANA



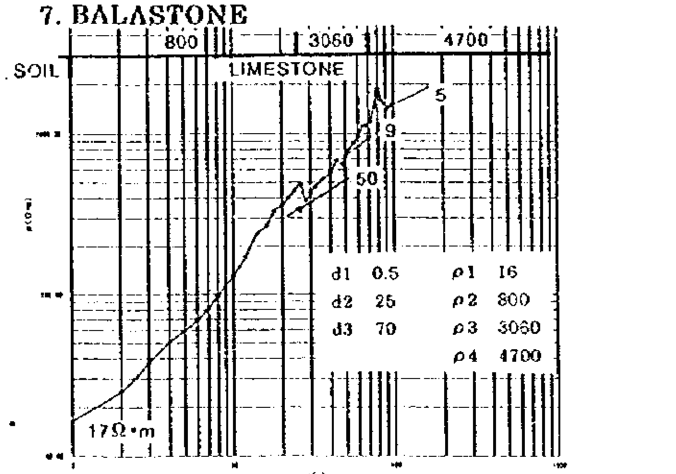
5. CHAINDA



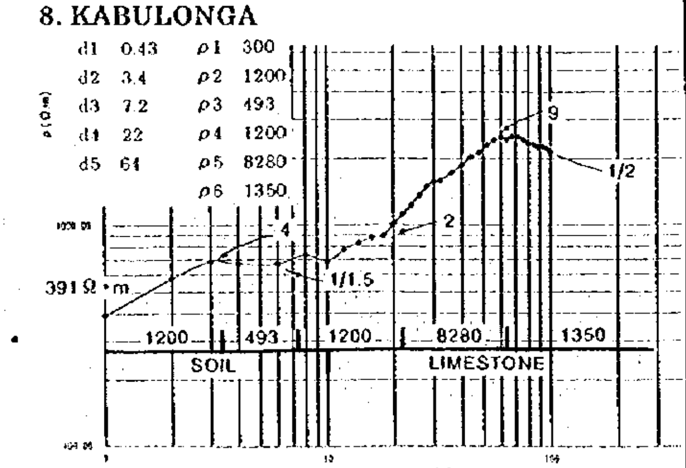
6. LIBALA



7. BALASTONE

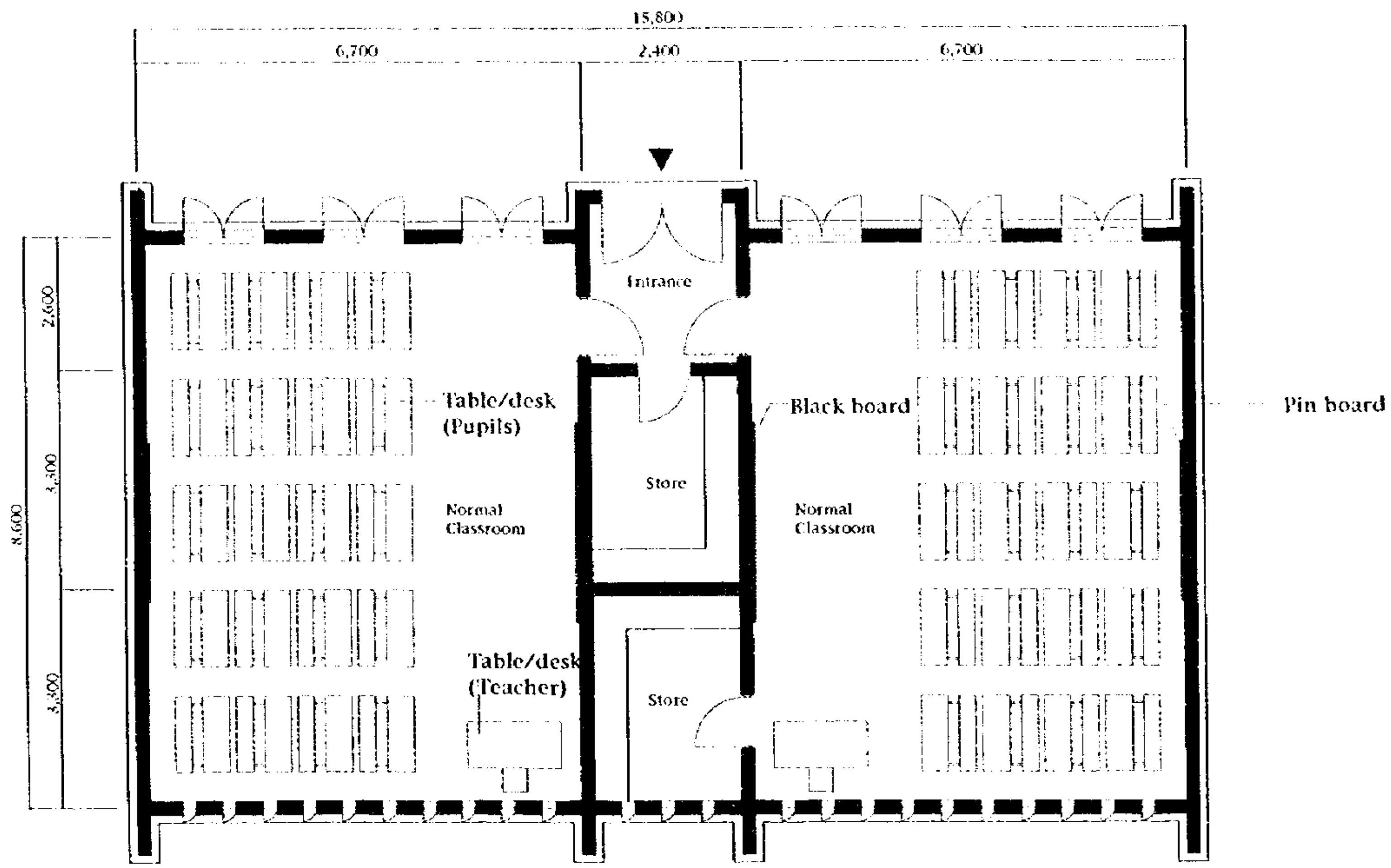


8. KABULONGA

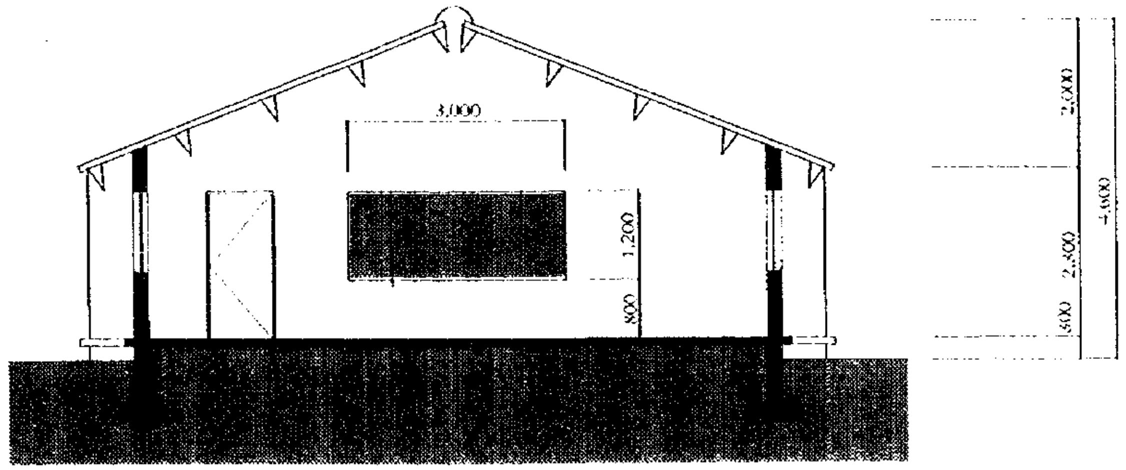


(4) Basic Design Drawings

1. Design drawings of regular classroom building
2. Design drawings of special-purpose classroom building
3. Design drawings of classroom building
4. Design drawings of administration office and caretaker's house
5. Design drawings of lavatory building (toilets of flush and seepage types)
6. Design drawings of elevated water tank support structure and pump control room
7. Building exterior finish schedule, building interior finish schedule



Plan



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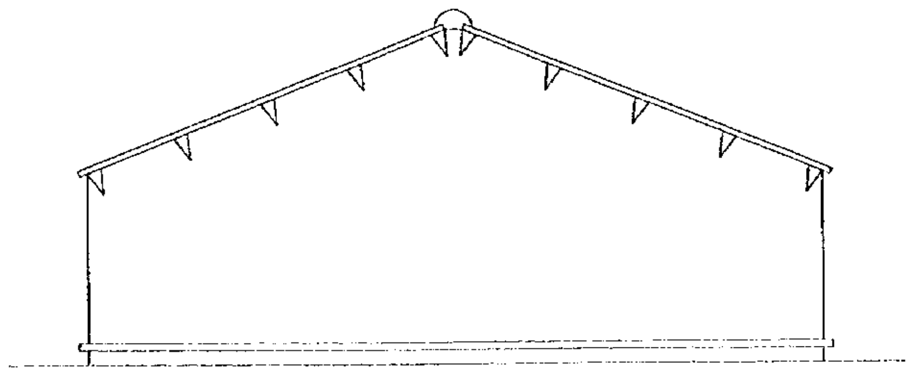
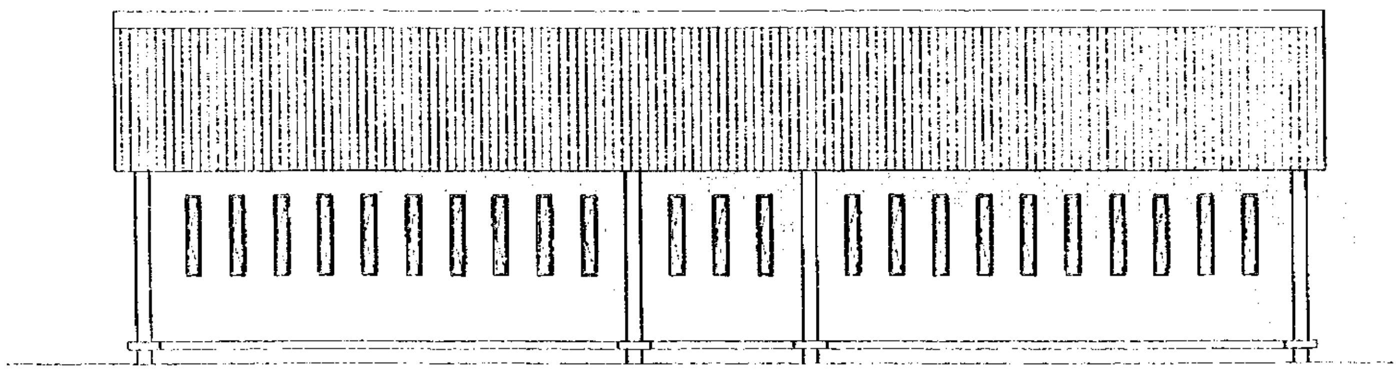
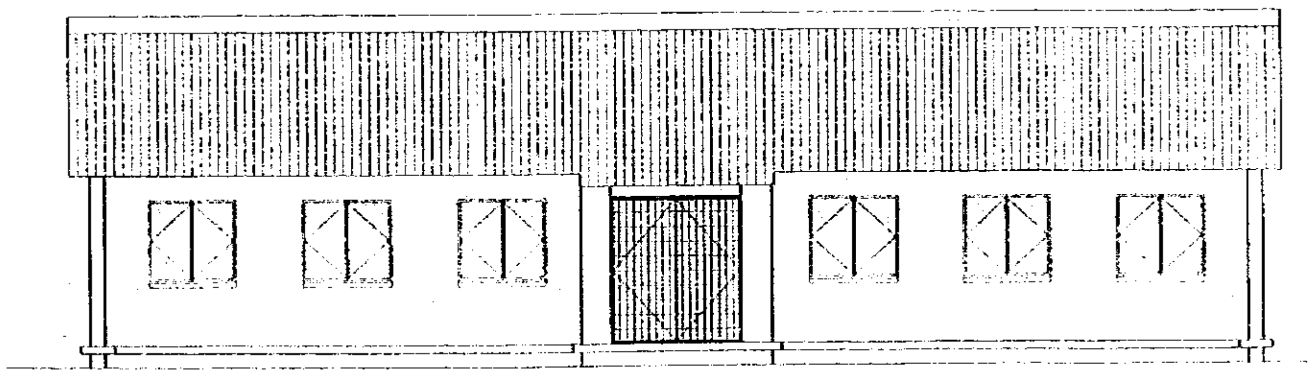


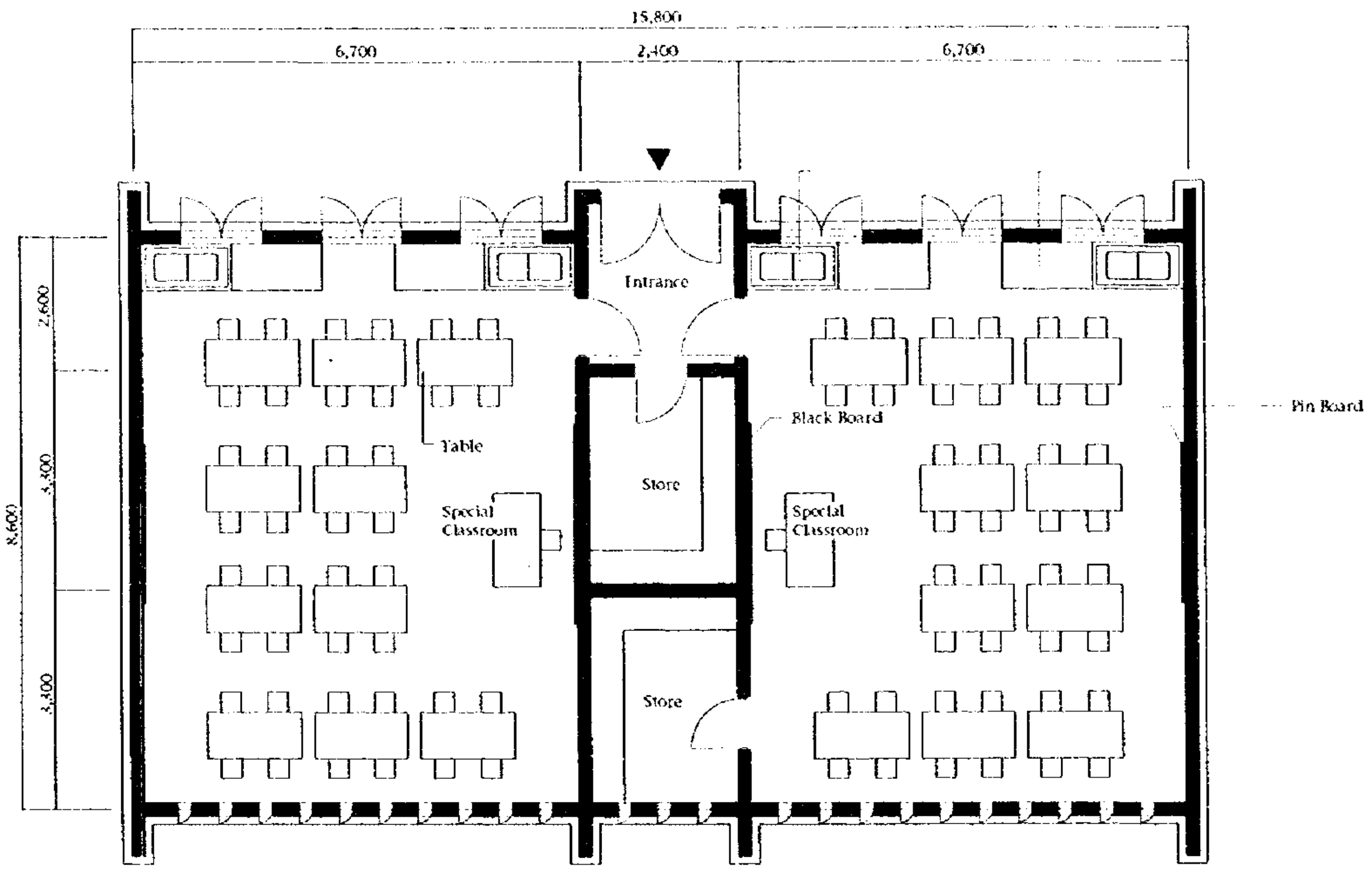
Side Elevation



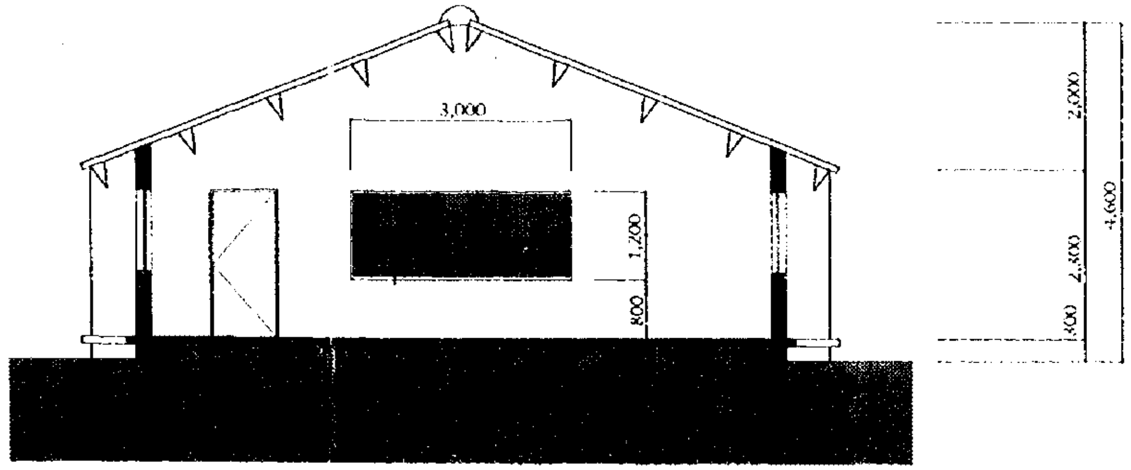
Rear Elevation



Front Elevation



Plan



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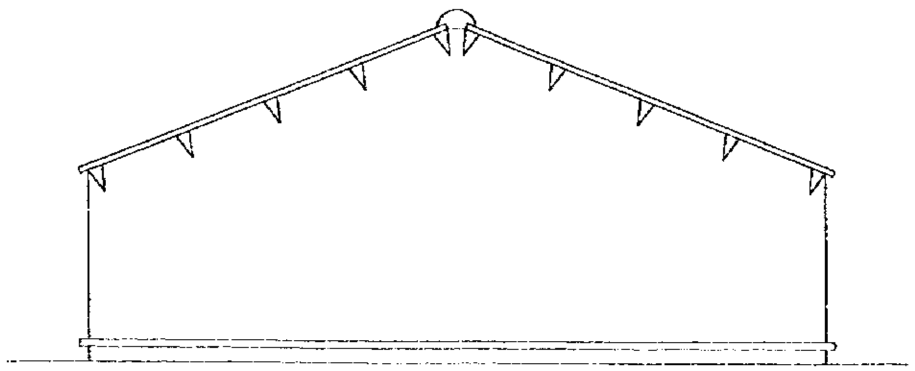
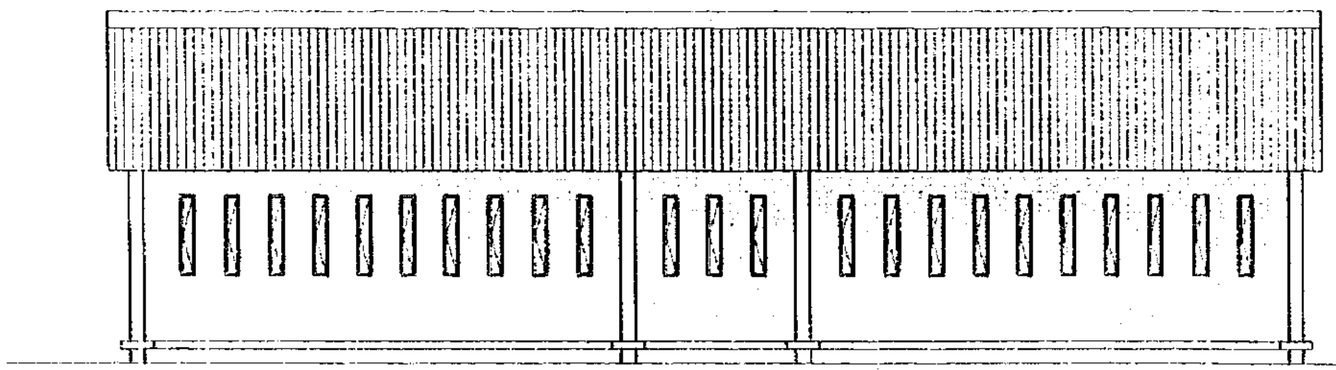
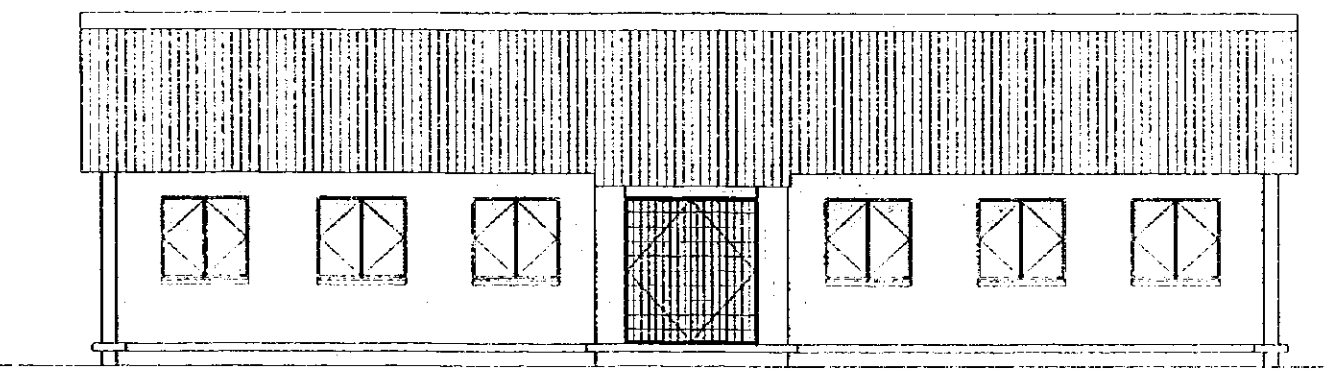


Side Elevation

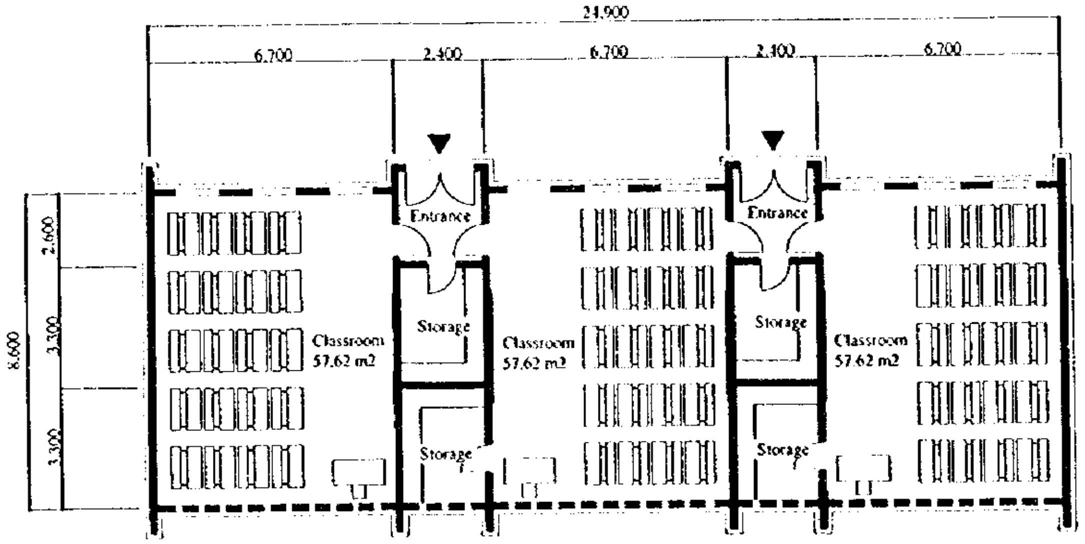


Rear Elevation



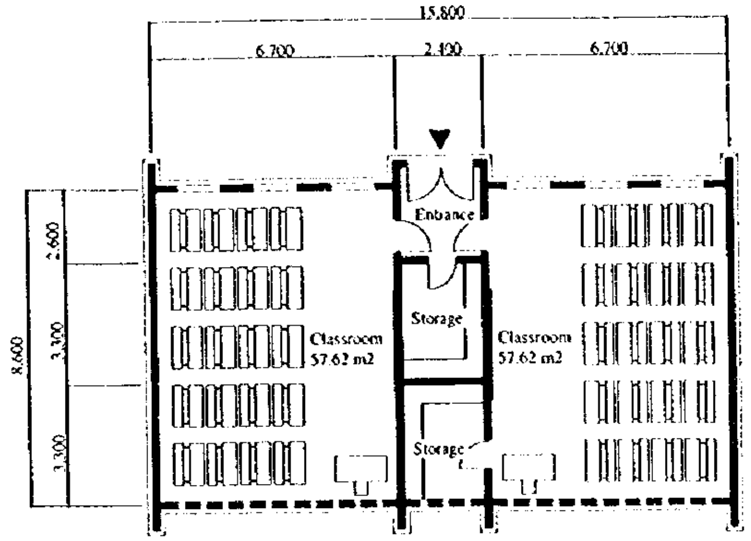
Front Elevation

TRIPLE CLASSROOM BLOCK



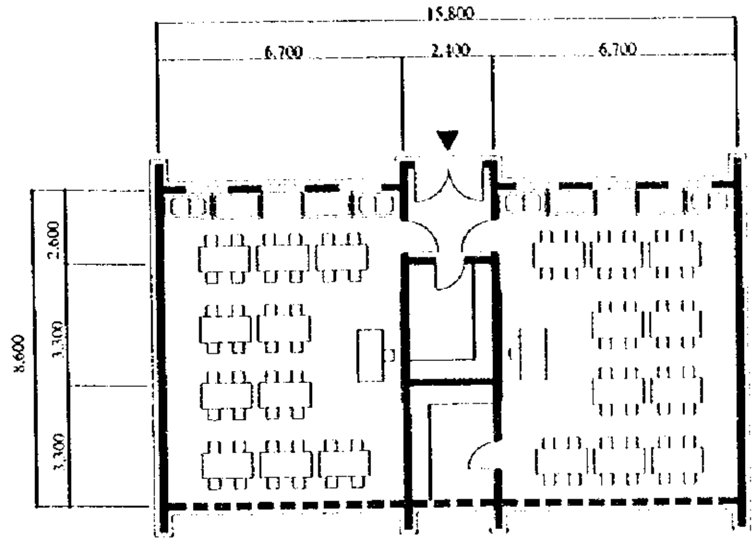
Plan 1/200

DOUBLE CLASSROOM BLOCK

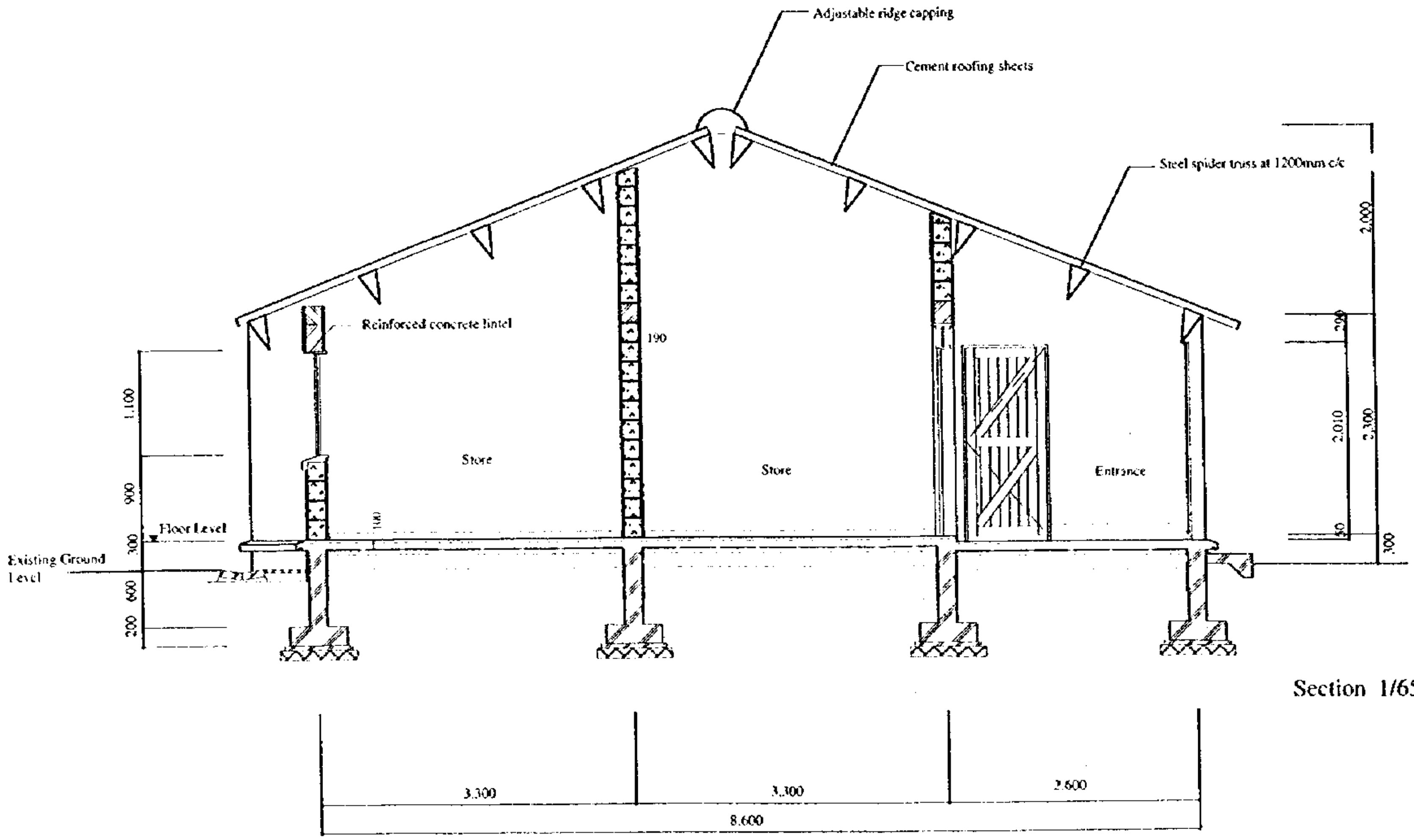


Plan 1/200

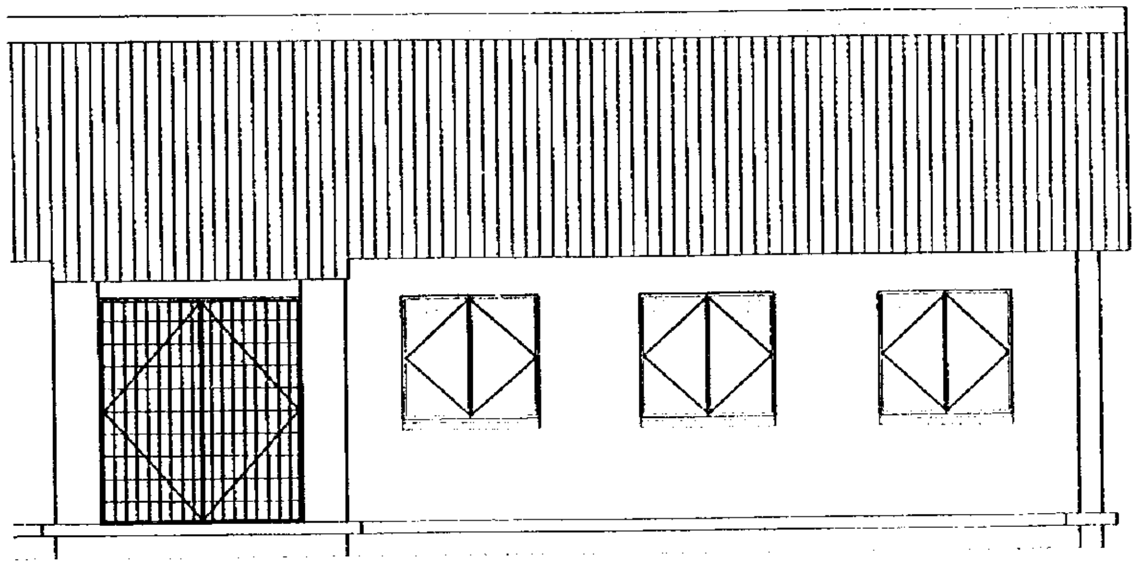
SPECIAL CLASSROOM BLOCK



Plan 1/200

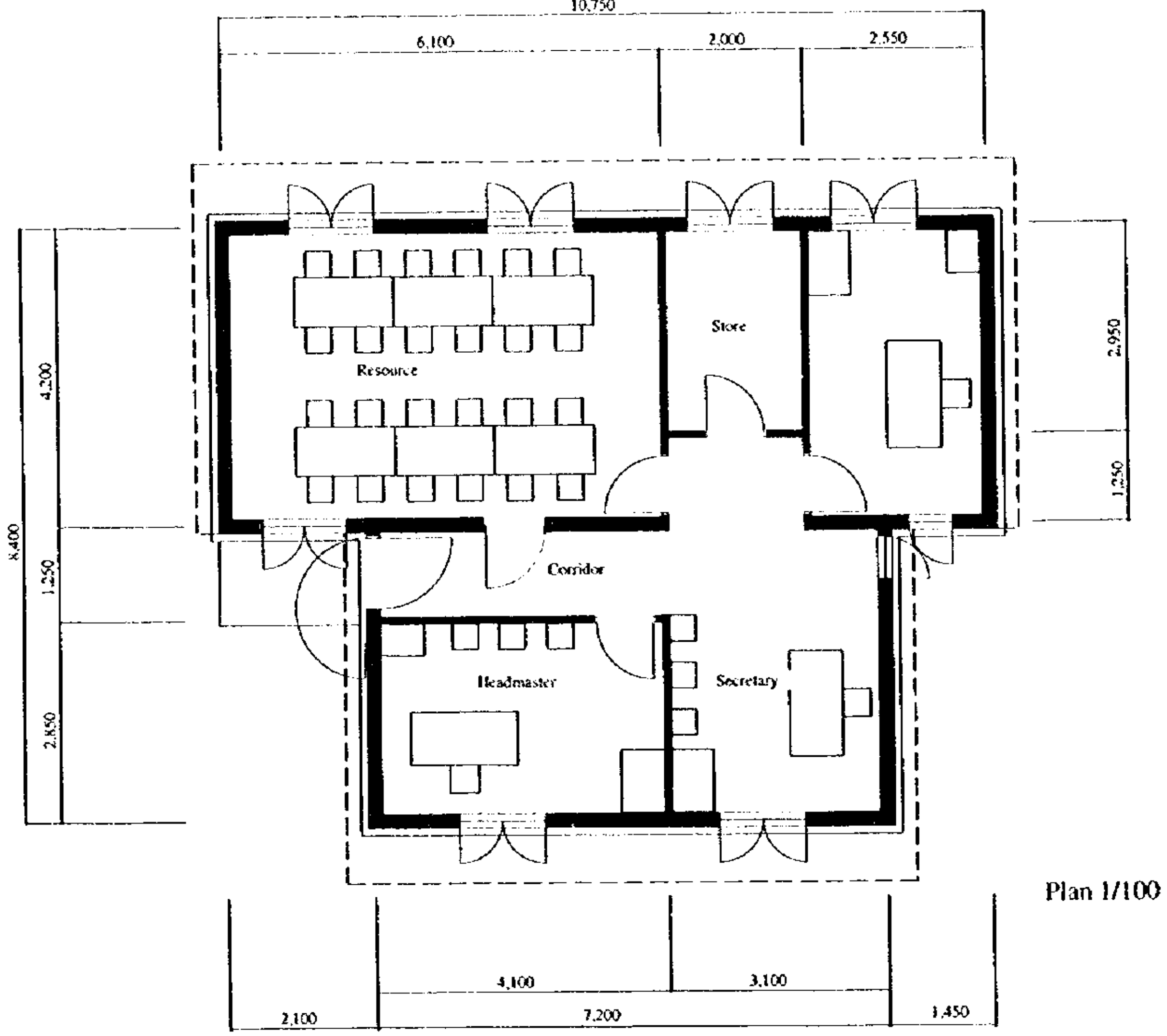


Section 1/65



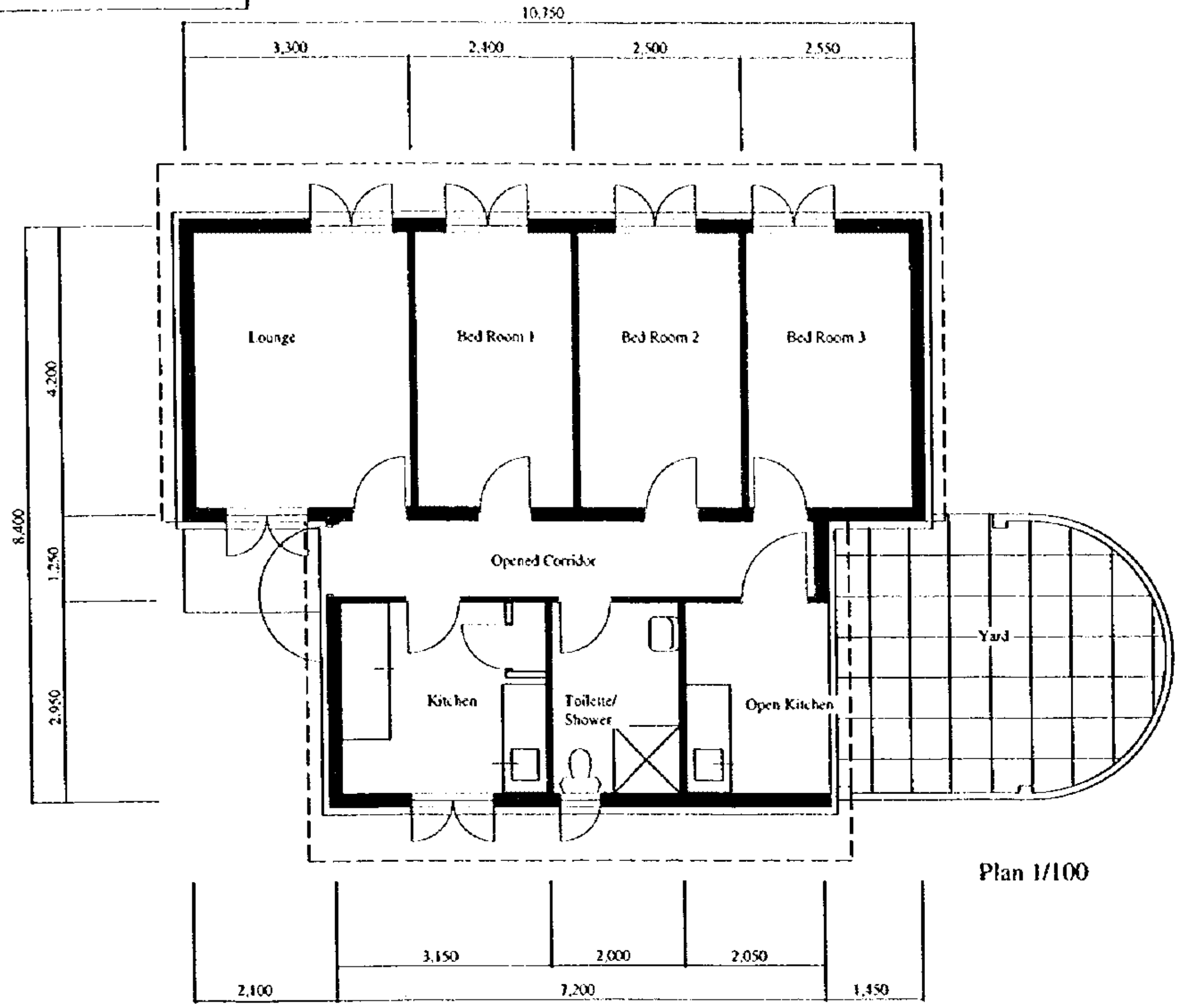
Front Elevation 1/65

Administration office

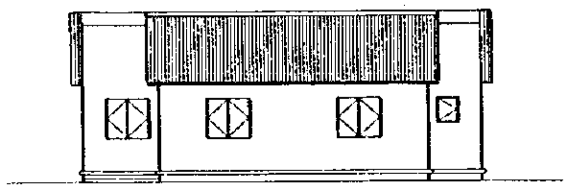


Plan 1/100

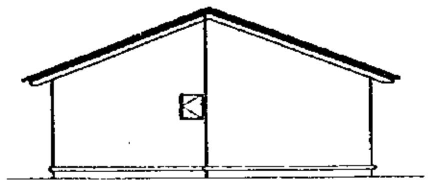
Caretaker's House



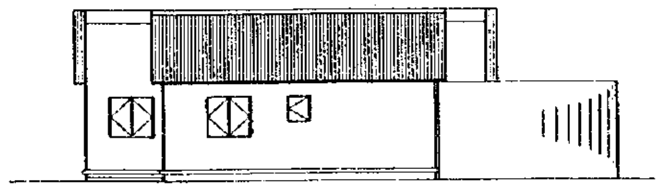
Plan 1/100



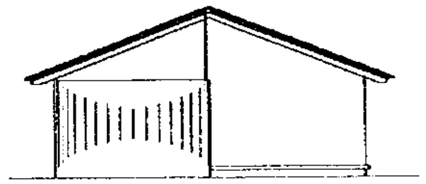
Front Elevation 1/200



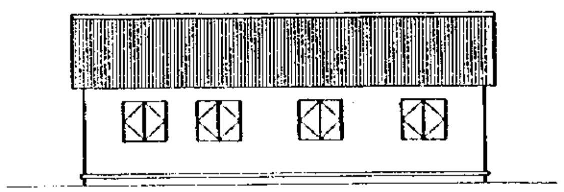
Side Elevation 1/200



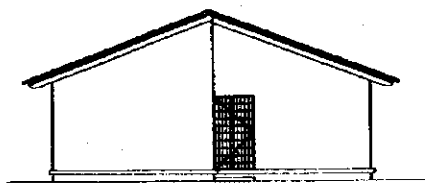
Front Elevation 1/200



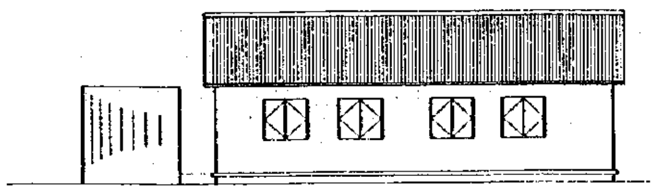
Side Elevation 1/200



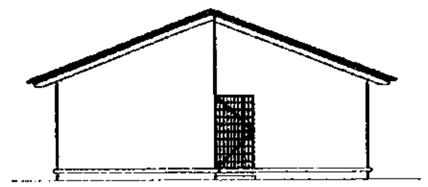
Rear Elevation 1/200



Side Elevation 1/200

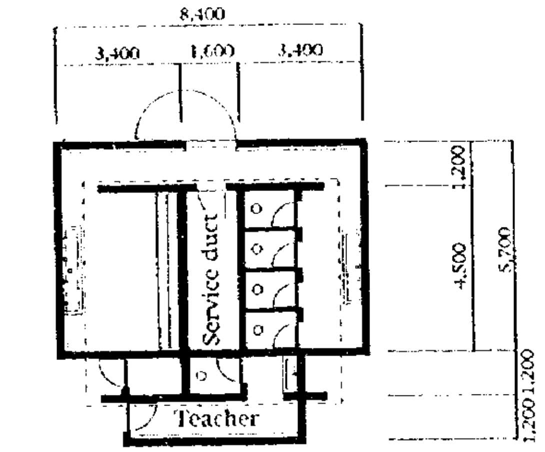


Rear Elevation 1/200

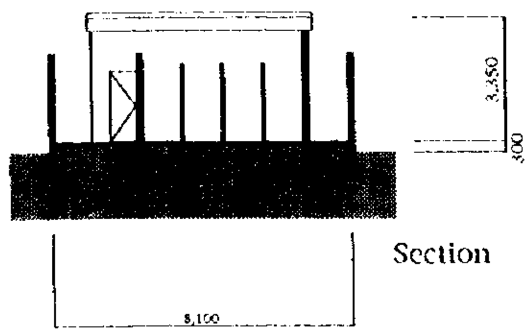


Side Elevation 1/200

Water flush toilet Boys/Girls



Boys



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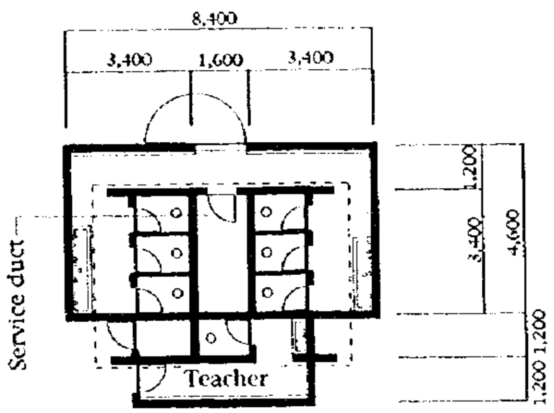
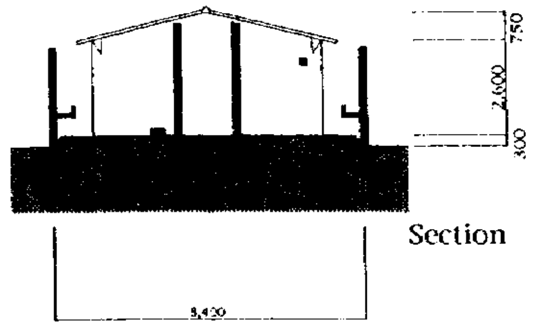


Girls



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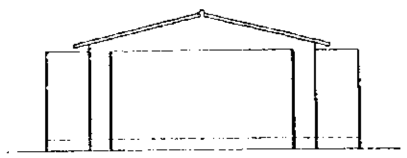
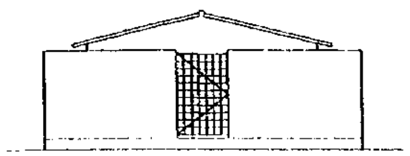
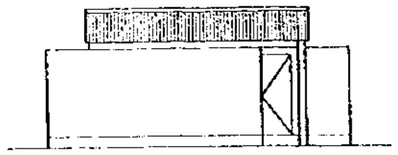


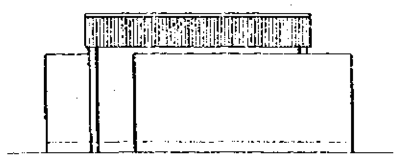
Front Elevation Boys/Girls



Rear Elevation Boys/Girls

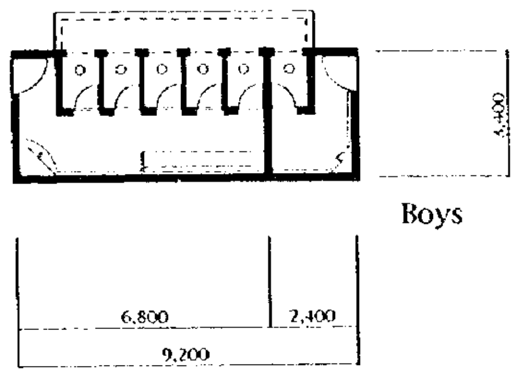


Side Elevation Boys

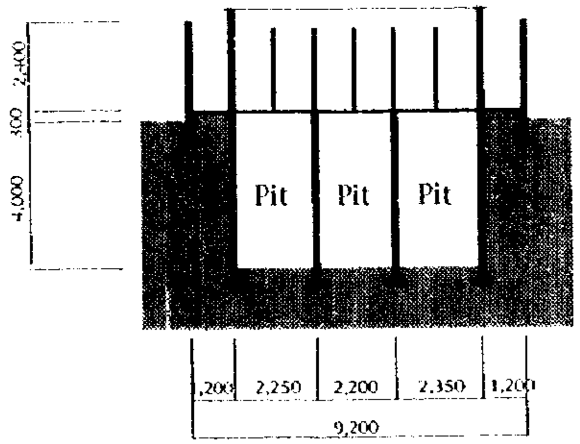


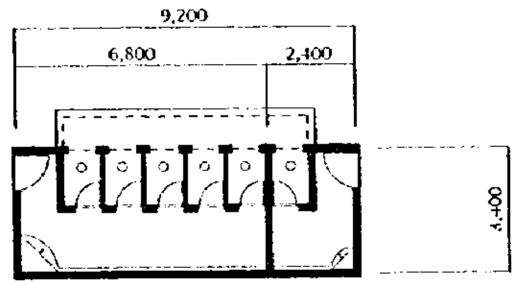
Side Elevation Girls

Pitlatrine

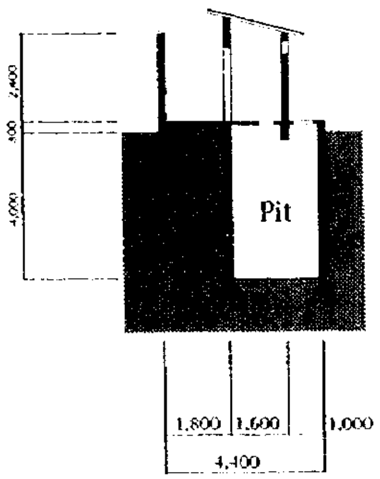


Boys



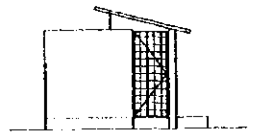


Girls

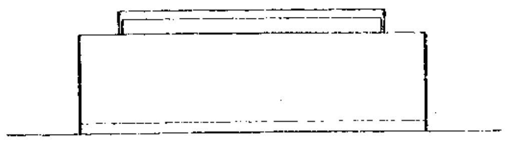


Section

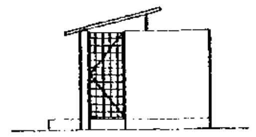
Side Elevation Boys/Girls



Front Elevation Boys/Girls

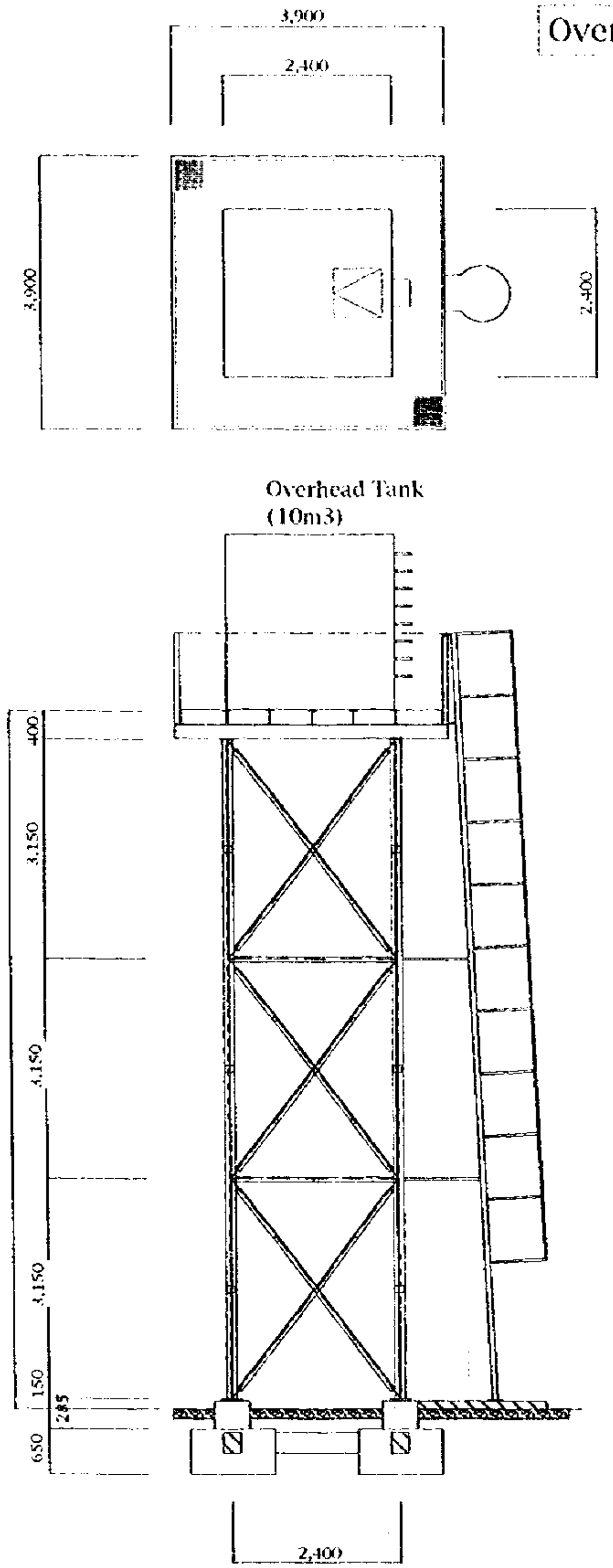


Side Elevation Boys/Girls

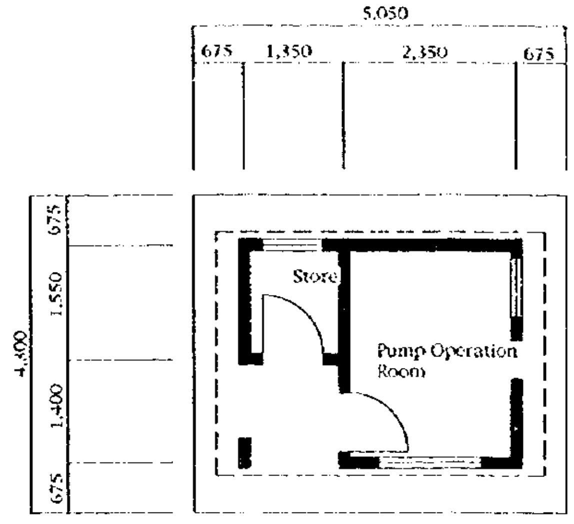


Rear Elevation Boys/Girls

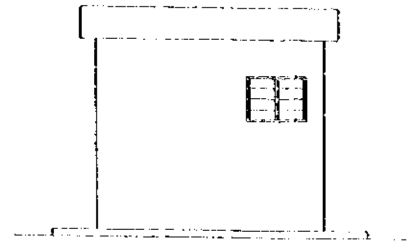
Overhead Water Tank



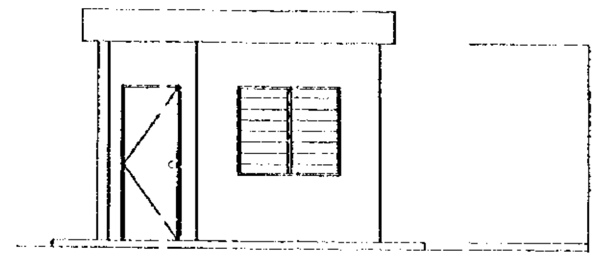
Pump Operation House



Plan

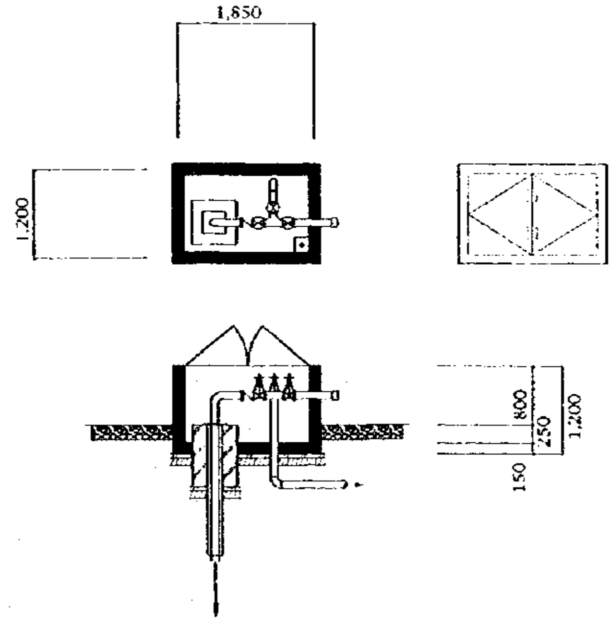


Side Elevation



Front Elevation

Bore Hole Pit



Immerged Pump

Building exterior finish schedule

	Floor	Wall	Ceiling/roof
Regular classroom bldg.	Trowel-finished mortar Spread foundation (RC)	CB + mortar + paint	Corrugated cement sheet + wooden roof truss
Special-purpose classroom bldg.	Trowel-finished mortar Spread foundation (RC)	CB + mortar + paint	Corrugated cement sheet + reinforcing bar truss
Administration office	Trowel-finished mortar Spread foundation (RC)	CB + mortar + paint	Corrugated cement sheet + reinforcing bar truss
Caretaker's house	Trowel-finished mortar Spread foundation (RC)	CB + mortar + paint	Corrugated cement sheet + wooden roof truss
Lavatory (pit latrine)	Trowel-finished mortar	CB + mortar + paint	Corrugated cement sheet + wooden roof truss
Lavatory (flush)	Trowel-finished mortar Spread foundation (RC)	CB + mortar + paint	Corrugated cement sheet + reinforcing bar truss

Building interior finish schedule

	Floor	Wall	Ceiling/roof
Regular classroom bldg.			
Classroom	Trowel-finished mortar + floor paint	CB + mortar + paint	Roofing material exposed
Store (1) (2)	Trowel-finished mortar + floor paint	CB + mortar + paint	Roofing material exposed
Special-purpose classroom bldg.			
Classroom Home economics + industrial arts	Trowel-finished mortar + floor paint	CB + mortar + paint	Roofing material exposed
Store (1) (2)	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Administration office			
Head teacher's office	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Office	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Meeting room	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Administration office	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Administrator's office	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Caretaker's house			
Bedroom (1)(2)(3)	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Kitchen	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Living room	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Dining room	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Bathroom	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Corridor + store room	Trowel-finished mortar + floor paint	CB + mortar + paint	Particle board + paint
Lavatory (seepage)			
Stall	Trowel-finished mortar + floor pain	CB + mortar + paint	Corrugated cement sheet + wooden roof truss
Urinal	Trowel-finished mortar + floor paint	CB + mortar + paint Washstand: trowel-finished mortar	Corrugated cement sheet + wooden roof truss
Lavatory (flush)			
Booth	Trowel-finished mortar + floor paint	CB + mortar + paint	Corrugated cement sheet + reinforcing bar truss
Urinal	Trowel-finished mortar + floor paint	CB + mortar + paint	Corrugated cement sheet + reinforcing bar truss
Piping space	Mortar	CB exposed	Corrugated cement sheet + reinforcing bar truss