CHAPTER 4 PLANNED SITE OVERVIEW

CHAPTER 4

PLANNED SITE OVERVIEW

4-1 Planned Site in Muguga

4-1-1 Planned Site Overview

The planned site in Muguga is owned by the Kenyan Gov. and located within the premises of the Kenya Agriculture Research Institute (KARI) and administered by the Kiambu District, Central Province. The site is about 2 km west of national highway A104 some 25 km northwest of Nairobi. Comprising about 4.2 ha, the rectangular site measures about 500 m (along the road) by about 100 m. It is presently planted mainly with eucalyptus (10-20 cm in diameter and about 10-15 m high). The site, sloped from about 0° to 10°, climbs about 20 m from the lowest to highest points, and is about 12 m below the road at its lowest point.

4-1-2 Natural Conditions

(1) Topography and soil

The site is in a gently sloped hill district connected with the Aberdare Range, which was a fissure volcano in ancient times. On average, it is 2,000 m above sea level. The Rift Valley, which falls sharply to about 1,500 m above sea level, lies about 15 km to the west.

Drilling was conducted to a depth of about 1.5 m at two points on the planned site. Reddish-brown laterite was found in the lower part of a layer 5-10 cm below the surface. Laterite is produced by weathering in tropical climates through the action of soil formation (or laterization) and has a high content of iron oxides and aluminum hydroxide. Exhibiting a high drying strength, laterite can be

formed into something like stone by drying. The laterite layer in Muguga has not weathered very much because it is covered with woods and thus protected against the effects of the tropical climate. It is comparable to the Kanto loam in Japan.

(2) Weather

Notwithstanding its equatorial location (lat. 1°13'S), the annual average temperature at the Muguga site remains virtually constant throughout the year at 13 to 17°C because of its 2,000 m elevation. Relative humidity is 40 to 60%. The site has two rainy seasons each year, March-May and October-December. Annual precipitation varies (1,366 mm in 1977 and 580 mm in 1984), but has averaged about 950 mm for 11 years (1974-1984).

4-1-3 Infrastructure Status

Extending from Nairobi, national highway A104 is a key route to the commercial city Mombasa and neighboring Uganda. The asphalt-paved highway supports public bus service. The Muguga site sits on a road connecting A104 to the KARI headquarters. This road is paved with asphalt and about 7 m wide.

Electric power and telephone services have been established on land across the road from the planned site, and are easily available at the planned site. The existing KARI water supply system, based on deep wells, can be utilized to supply water to the site for living and production of nursery trees.

4-2 Planned Site in Kitui

4-2-1 Planned Site Overview

Kitui City is about 180 km east of Nairobi. The planned site faces the Kalundu River about 2 km north of the center of Kutui and is administered by the Kitui District, Eastern Province, of which Kitui is the district seat. According to 1983 statistics, the district has a population of 555,418 (464,283 in 1979). Passenger planes from Nairobi fly to a simple airfield east of Kitui. The planned site is trapezoidal, measuring about 600 m (along the Kalundu River) by about 130 m at its widest point. Comprising about 7.7 ha, the site varies about 12 m from the lowest to highest points, sloping down to the river from the access road. Nursery trees are currently being produced in pots in a flat area of about 1.5 ha along the river. Other areas are planted with eucalyptus and some maze.

4-2-2 Natural Conditions

(1) Topography and soil

The Kitui site is on the Yatta Plateau that extends south from Mt. Kenya (5,199 m), the second-highest African peak after Mt. Kilimanjaro. On average, the plateau is 1,100 m above sea level. The Mutio Hill is about 20 km east-northeast of Kitui, while a gently sloping low-lying area extends further to the east.

Kitui District is surrounded by three rivers which are full throughout the year: the Tana River to the north; the Athi River to the west and sourthwest; and the Galana River to the south. In addition, there are seasonal rivers, many of which store water in sandy river-bottom layers even in dry seasons.

According to the Kitui District Development Plan 1984/1988, by the Ministry of Finance and Planning, the river at the Kitui site is one of the seasonal rivers available as water reservoirs during dry seasons.

The soil is composed of laterite. Unlike the Muguga site, the surface soil here has little organic content and a high silica content. Laterization is fairly advanced, making the planned site a stable ground from an engineering viewpoint. Drilling was conducted on the site. Digging 90 cm with a pick took about 90 minutes. As noted, laterite is formed into something like stone by drying, and sun-dried bricks are being produced in the vicinity for use as wall material in dwellings.

(2) Weather

Kitui District belongs to a semi-arid region. To the east and south are areas with annual precipitation of 255 mm or less. Annual precipitation in Kitui City during 1962 to 1981 averaged about 800 mm, according to the Kutui District Development Plan 1984/1988. The site has two rainy seasons a year, March-May and October- December. A monthly precipitation of 620 mm was recorded in April 1979 at observatory No. 913800 near the Kitui site. Annual precipitation in 1979 was 1,753 mm, but figures vary widely from year to year, probably due to differences in the measurement methods used.

Annual temperatures average 18 to 22°C, with the monthly average maximum being 26 to 34°C.

Relative humidity is fairly low. Though specific statistics are not available, the Kitui District Development Plan lists little rainfall and high evaporation as meteorological features of this district.

4-2-3 Infrastructure Status

An asphalt-paved road branches off from the middle of national highway A109 (leading from Nairobi to Mombasa) to the Kitui City via Machakos City. This road supports public bus service. All principal roads in Kitui City are asphalt-paved, but those around the site are covered only with rolled laterite. The access road leading from the principal road to the site has many elevation changes which could interfere with transport of construction materials and equipment unless it is maintained by the Kenyan government.

Eelctric power and telephone services are available for existing lines near the access road.

City water is transported to Kitui through a 12-inch pipe from a river in Matuu about 80 km north. City water is available from a water pipe already laid near the access road.

For nursery tree production, water from the river will be utilized by drilling a shallow well on the bank and pumping water from it. Even in the dry season, when there is no running water in the river, a sufficient quantity of water would be available as underground water from the riverbed percolates through the shallow well. Availability of adequate city water has been confirmed even during the most severe dry season if no water were left in the sandy layer of the riverbed.

CHAPTER 5 BASIC DESIGN

CHAPTER 5

BASIC DESIGN

This chapter deals with the layout and construction planning of all facilities, including scale and details, to make them highly efficient and exhibit all functions necessary to meet the project objectives described in Chapter 3.

5-1 Basic Policies

(1) Local climatic conditions will be considered

In the design of all facilities, efforts will be made to take advantage of the relatively good climatic conditions with which both sites are favored. Specifically, natural ventilation will be used for indoor climate adjustment, and all buildings will be located on an east-west axis to ensure the best natural light conditions.

(2) Economic efficiency/justifiability will be secured

Efforts will be made to minimize initial and running costs by utilizing locally produced materials to the maximum extent and by exploiting site topography to reduce cut and fill work. These cost-saving measures will be planned while assuring that all facilities will fully serve necessary functions.

(3) Laws regulations and situation in Kenya will be given due consideration

The basic design will be worked out in strict conformity with all relevant laws and regulations now in force in Kenya. Locally available materials and construction methods generally adopted in Kenya will be given preference over imported materials and construction methods employed in other countries to ensure easier maintenance after building completion. Furthermore, care will

exercised not to make any of the facilities excessively large in scale or grade compared to similar facilities already built in Kenya.

5-2 Layout Plan

The layout plan will be formulated according to basic policies enumerated below.

(1) Each building will be located on an east-west axis as mentioned in 5-1 (1) to reduce the intensity of the afternoon sun.

(2) Ample space will be provided between adjoining building to ensure efficient indoor climate adjustment by natural ventilation.

(3) The layout of each building will be planned to best exploit site topography to minimize the volume of cut and fill work.

(4) Special care will be exercised to ensure ease of maintenance, management, and operation of all facilities.

(5) Attention will be paid to avoid unnecessary cutting of trees within the site.

(6) At the Muguga site, approach will be made from a point in the southwestern section, where the elevation difference between the site and road is smallest, and will proceed northeast in the following order: dormitories → laboratory building → training building → nursery training facilities → nursery.

(7) At the Kitui site, approach will be made from the southeastern section and will proceed west in the following order: dormitories → training building → nursery training facilities → nursery.

5-3 Construction Plan

5-3-1 Outline of Facilities

The following table shows the name and area of each of the facilities to be built under the project.

Muguga site		Kitui site	
Building name	Area (m^2)	Building name	Area (m^2)
1. Training building	1,072.5	1. Training building	1,135.5
2. Research building	1,968.1	2. Garage	341.6
2' Greenhouse	60	3. Nursery training facilities	234
3. Garage	341.6	4. Dormitory	651.5
4. Nursery training facilities	162	5. Dining hall	282.5
5. Dormitory	746.3	6. Pump house	12
6. Dining hall	335	7. Electric house	17.5
7. Pump house	12		

5-3-2 Planning/Section Planning

The scale of facilities to be built under the project was determined after a series of careful discussions between the competent Kenyan authorities and the Japanese team for each of the management/maintenance, clerical service, training, and research departments.

(1) Muguga Site

1) Training Building

The training building will have a large lecture hall equipped with audio-visual facilities; one medium-size and one small-size lecture room; a large multipurpose conference room for exchange of information between Japanese experts and instructors from institutes in various localities as well as

for exchange of opinions between instructors; and other facilities, including those for the management department.

Details of the training building will be as shown in the following table.

Training Building (Muguga)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Deputy Director	1	26	28
Secretary	1	19.5	15
Office	6	81	78
Conference	30	84	75
Lecture (Large)	40	98	98
Lecture (Medium)	20	42	40
Lecture (Small)	10	22	20
Experts, Instructor & Counterpart	18	171.5	151
Information, Documentation	2	54	55
Storage		42	40
Guard, Janitor	2	12.5	17
Hot Water		9.5	5 (10)
W.C.		64.2	44 (80)
Entrance Hall			
Corridor			

Notes: 1. ( ); in case of two location
2. Calculation; from some standard

2) Research Building

The laboratory building will have six laboratories (three will be biological laboratories specializing in Silviculture, Tree Seed and Tree Improvement, and another three will be chemical laboratories specializing in Forest Entomology, Forest Pathology, and Forest Chemistry); a draft chamber room to be used most frequently for forest chemistry studies and other studies; a cultivation room used mostly for forest pathology, where various specimens and equipment like shaking culture apparatuses, autoclaves, and high-pressure sterilizers are available; a cold reserve storage room for storing seeds; a seminar room for meetings of scientists from Japan, Kenya, and other countries for exchange of information; a library for collecting various data and information including reports of research activities in foreign countries.

Besides the research building mentioned above, three greenhouse will be built separately for the silviculture, tree seed, and tree improvement laboratories, respectively, on a north-south axis.

Details of the research buildings will be as shown in the following table.

Research Building (Muguga)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Director	1	28	28
Secretary	1	21	15
Office	6	80	76
Silviculture Lab. & Study	6	105	104
Tree Seed Lab. & Study	5	105	104

Research Building (Muguga) (continued)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Tree Improvement Lab. & Study	6	105	104
Forest Entomology Lab. & Study	6	105	104
Forest Pathology Lab. & Study	7	105	104
Forest Chemistry Lab. & Study	5	105	104
Seed Storage (Cold Room)		21	25
Cultivation		42.4	50
Draft		14	20
Darkroom		21	25
Seminer	20	49	50
Storage		63	60
Library	15	174	178
Information, Documentation	2	38.5	38
Guard, Janitor	2	13.5	17
Hot Water		31.6	5
W.C.		86	44 (80)
Generator		28	30
Entrance Hall			
Corridor			
Greenhouse		60	60 (3 bldgs.)

3) Garage

The garage will be designed for storage of a four-ton truck, a medium-capacity bus, a pickup, a tractor and their attachments and spare parts, and for repair service of these vehicles.

Details of the garage will be as shown in the following table.

Garage (Muguga, Kitui)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Garage		285.6	197
Storage, Fuel Storage		56	50

4) Nursery Training Facilities

The nursery training facilities will be designed specifically for practical training in nursery operations. These facilities will include the management/maintenance office; warehouse for nursery materials and equipment; warehouse for dangerous substances including agrochemicals; compost storage; and observation facilities for measuring and recording meteorological data.

Details of the nursery facilities will be as shown in the following table.

Nursery Training Facilities (Muguga)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Office	1	21.25	22
Covered Workshop	10 + α	30	30
Agro-Chemical Storage		5	4
Compost Storage		51	50
Meteorological Data		3.75	4
Material Storage		51	50

5) Dormitories

The dormitories will accommodate 40 trainees and four instructors.

Two dormitories will be built, each having 10 rooms and accommodating two trainees per room, so as to allow a trainee an accommodation plan suitable to the curriculum and sex. One dormitory for instructors will be built, accommodating one person per room.

Details of the dormitories will be as shown in the following table.

Dormitories (Muguga)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Bedroom for Trainees	40	306	300
W.C., Shower, Hot Water Dressing		132	164
Entrance Hall		15	
Corridor + stair		144	
Bedroom for Lecturer	4	96	88
Hot Water		5	8
Entrance Hall		7.5	
Corridor		24	

6) Dining Hall

The dining hall will be designed not just as a room for providing meals to trainees and staff members, but also as a hall suitable for holding meetings and parties.

Details of the dining hall will be as shown in the following table.

Dining Hall (Muguga)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Dining	150	150	149
Kitchen		46.5	44
W.C.		15	7
W.C. (for Cook)		3	3
Locker (for Cook)	4 to 5	10.5	13
Linen		8.75	9
Laundry		8.75	9
Janitor		8.75	9
Manager Office		8.75	8
Pump		12	12

(2) Kitui Site

1) Training Building

The training building at the Kitui site will have a small lecture room; a medium-capacity lecture room equipped with audio-visual facilities; a training room for providing versatile practical training; a multipurpose conference room for exchange of information between Japanese experts and instructors from various localities, or for conferences on matters related to the management of facilities; and other facilities, including those for the management department.

Details of the training building will be as shown in the following table.

Training Building (Kitui)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Director	1	29.3	28
Secretary	1	22.7	15
Office	7	83	87
Conference	20	59.5	50
Lecture (Medium)	30	77	78
Lecture (Small)	10	28	20
Experts & Instructors	10	91	90
Researcher	3	44.1	40
Training	30	91	93
Library	12	46.9	48
Storage		45.5	40
Guard, Janitor	2	15	17
Information, Documentation	1	28	29
Hot Water		11.6	5
W.C.		83	44 (80)
Entrance Hall			
Corridor			

(3) Nursery Training Facilities

The nursery training facilities will be designed specifically for practical training in nursery operations. These facilities will include the management/maintenance office; warehouse for nursery materials and equipment; warehouse for dangerous substances including agrochemicals; compost storage; observation facilities for measuring and recording meteorological data; and a cold reserve storage area for storing seeds.

Details of the nursery facilities will be as shown in the following table.

Nursery Training Facilities (Kitui)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Office	2	31	30
Covered Workshop	20 + α	60	60
Agro-Chemical Storage		4	4
Compost Storage		60	60
Meteorological Data		4	4
Material Storage		51	50
Low Temperature Storage		24	25

(4) Dormitories

The dormitories will have rooms to accommodate 30 trainees and six instructors.

Two dormitories will be built, each having 10 rooms and accommodating two trainees per room, so as to provide a trainee an accommodation plan suitable to the curriculum and sex. One dormitory for instructors will be built, accommodating one person per room.

Details of the dormitories will be as shown in the following table.

Dormitories (Kitui)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Bedroom for Trainees	30	229.5	225
W.C., Shower, Hot Water Dressing		99	123
Entrance Hall		22.5	
Corridor		108	
Bedroom for Lecturer	6	144	132
Hot Water		5	
Entrance Hall		7.5	
Corridor		36	

(5) Dining Hall

The dining hall will be designed not just as a room for providing meals to trainees and staff members, but also as a hall suitable for holding meetings and parties.

Details of the dining hall will be as shown in the following table.

Dining Hall (Kitui)

Room Name	No. of Person (Capacity)	Planned Area in Drawing (m^2)	Required Area by Calculation (m^2)
Dining	108	105	107
Kitchen		35	32
W.C.		15	7
W.C. (for Cook)		5	3
Locker (for Cook)	4 to 5	12.5	13
Linen		8.75	9
Laundry		8.75	9
Janitor		7.5	9
Manager Office & Night-Duty		25	22
Pump		12	12
Substation		17.5	17.5

5-3-3 Structure and Construction Materials Plan

(1) Design standard

Construction design conforms to Kenyan standards as below, or to Japanese standards where there is no established Kenyan standard.

- Building Code 1968
- Structural Manual 1973
- Code of Practice for Considering Earthquakes in the Design and Construction of Buildings and other Structures 1973
- B.S. CP.3 Wind Load
- B.S. CP.110 Concrete Construction Design Standard

(2) Design outline

1) Live load

Lecture room	310 kg/m^2
Corridor	400 kg/m^2
Bedroom	150 kg/m^2
Roof	25 kg/m^2

2) Seismic load

According to Kenyan standards, Muguga is situated in an earthquake zone classified VIII - IX. In that zone, reinforced concrete construction and masonry structures must conform to the following equation in Usage Classification A, B, C, or D.

$$F = 1.3\ CB.W$$

F: Total lateral load

$$CB: \frac{0.05}{\sqrt[3]{T}} \qquad T = \frac{0.09H}{\sqrt{D}}$$

H: Height of building above base in meters

D: Width of building in direction assessed, in meters

W: Total building load

Kitui is situated in a class V earthquake zone, so quake resisting design is unnecessary.

3) Wind load

$F = Cf.q.Ae$

F: Total lateral load
Cf: Coefficient of wind load
q: Wind pressure q = 25 kg/m^2
Ae: Effective frontal area

4) Bearing capacity of soil

The bearing capacity of soil of 10 t/m^2 at a depth of 1 m below the reference ground level is used for the design.

5) Design strength

a) Reinforced concrete

Class 20 260 kg/cm^2 28 day strength

b) Reinforcement

SD 30 (JIS G3112)
t = 2000 kg/cm^2
or
BS 4461
fy = 425 N/mm^2 (43 kg/mm^2) above 16 mm diameter
fy = 460 N/mm^2 (47 kg/mm^2) 16 mm diameter or less

c) Concrete block

One-story masonry house; quake resisting construction:	Grade B
Minimum average compressive strength:	3.5 N/mm^2 (36 kg/cm^2)
Minimum strength:	2.8 N/mm^2 (26 kg/cm^2)

6) Expansion joint

Minimum of every 40 meters

(3) Structure design

1) Study of structural types

Comparison Table of Structural Types

	Cost	Dura-bility	Appear-ance	Earth-quake Resistance	Work-ability	Availa-vility	Suitable Scale	Total
① R.C.	4	1	2	1	2	2	M - L	12
② Steel	5	2	3	1	3	4	M - L	18
③ Reinforced C.B.	3	2	2	3	2	2	S - M	14
④ Masonry	3	2	1	4	2	2	S	14
⑤ Wood	1	5	3	4	3	3	S	19

Scale	① ② ③ ④ ⑤
Cost	Low ←——→ High
Durability	High ←——→ Low
Appearance	High ←——→ Low
Earthquake Resistance	High ←——→ Low
Workability	High ←——→ Low
Availability	High ←——→ Low

① R.C.: R.C. is the most popular structural type for the size of buildings being constructed in this project, and all the materials needed for these kinds of structures are available in Kenya. Thus, it is expected that workers are already skilled in this type of construction. Taking all the above mentioned factors into consideration, we find that R.C. is the most appropriate structural type for this project.

② Steel: In terms of scale and construction time, steel represents a fair possibility for use in the project. However, having steel for the structure cut to order in Kenya presents some problems. If steel is used, it would have to be pre-cut in Japan and shipped to Kenya, adding greatly to the cost of the project. Thus, it seems more feasible to use R.C. rather than steel.

③ Reinforced Concrete Blocks: This type of structure is common for small to medium-sized buildings. Concrete blocks, which are readily available in Kenya, could be used for one-story or other small-sized buildings in the project.

④ Masonry (Nairobi Stone): Nairobi Stone, which is popular in Kenya, is suitable for one story and small-sized buildings. Because of low labor costs, Nairobi Stone is only slightly more expensive than concrete blocks. Nairobi Stone is currently being used as siding material in R.C. structures and as an alternative to concrete blocks. Nairobi Stone is attractive in appearance and, as a siding material, has the advantage of being maintenance free. Thus, Nairobi Stone is the best material for external walls.

⑤ Wood: Wood could be used for small structures, but is lacks durability. However, the cost of wood is low, so it could be utilized for roof trusses which will not be exposed to the elements.

2) Structure plan

Taking "1) Study of structural types" into consideration, we design each element of each building as follows:

① Frame

Reinforced concrete structure. The greenhouses will be manufactured aluminium structures.

② Foundation

Continuous footing, independent footing

③ Earth floor

Floor waterproofed by polyethylene undersheet bed, reinforced by welded wire mesh and reinforcing bar

④ Partition wall

Concrete block

⑤ Roof truss

Truss of wood

(4) Construction materials

For principle construction materials, use the following:

Cement:	B12 normal Portland Cement
Reinforcement:	JIS G3112. SD30 or BS4461 twisting reinforcement

(5) Finish plan

The outside and inside finish outline is to be the following:

1) Training building, research building, dining hall, and dormitories

a) Outside finish

Roof:	Slate or clay tile roofing
Wall:	Nairobi stone
Fitting:	Aluminium sash, louver, aluminium door, and steel door

b) Inside finish

Floor:	Terrazzo, or concrete with hardener or metal trowel finished
Baseboard:	Terrazzo, or mortar metal trowel finished AEP
Wall:	Plaster AEP
Ceiling:	Rock wool acoustical tile t = 12 mm
Fittings:	Wooden fittings

2) Nursery training facilities

a) Outside finish

Roof:	Slate or clay tile roofing
Wall:	Mortar paint finish
Fittings:	Aluminium sash, louver, aluminium door, and steel door

b) Inside finish

Floor: Terrazzo

Baseboard: Terrazzo

Wall: Plaster AEP

Ceiling: Rock wool acoustical tile t = 12 mm

Fittings: Wooden fittings

3) Garage

a) Outside finish

Roof: Slate or clay tile roofing

Wall: Nairobi stone

Fittings: Aluminium sash, steel door

b) Inside finish

Floor: Concrete with hardener or metal trowel finished

Baseboard: Mortar metal trowel finished AEP

Wall: Plaster AEP

Ceiling: Exposed ceiling

Fittings: Steel door and wooden fittings

4) Greenhouse (Ready made)

a) Outside finish

Roof: Aluminium framed glass

Wall: Aluminium framed glass

Fittings: Aluminium door

5-3-4 Utilities

(1) Water Supply

Muguga Site

The maximum daily supply of drinking water required at the Muguga site is estimated at 22 m^3.

Breakdown:

Trainees	40 persons	x 80 ℓ/day	=	3,200 ℓ/day
Staff members (Research)	77	x 80	=	6,160
Staff members (Training)	25	x 80	=	2,000
Dining hall	60	x 20 x 3 times	=	3,600
Dormitories	46	x 100	=	4,600
Experiments	6 labo.	x 250	=	1,500
Visitors	20	x 70	=	1,400
				22,460 ℓ/day
				(= Approx. 22 m^3/day)

A daily supply of 12 m^3 of water will also be required for nursery operation.

Breakdown:

Assuming that the nursery will be used for planting 200,000 seedlings (100 seedlings per m^2), it will have a total area of 2,000 m^2. If it is to be sprinkled with 5 mm/m^2 of water a day and a loss of 20% is taken into account, the daily amount of water to be supplied for nursery operation turns out to be 12 m^3, as calculated below.

$$2{,}000\ m^2 \times 0.005\ m \times 1.2 = 12\ m^3/day$$

As the project site is within the compound of the Kenya Agricultural Research Institute (KARI), it will be possible to make use of KARI's existing water supply system. At present, KARI has three deep wells with a total yield of about 40 m^3/hour, but it needs only two of

them to fill the water requirements of existing facilities. Accordingly, the remaining well, which was drilled in 1979 and has an yield of 13.63 m^3/hour, can meet the water requirements of the Muguga site. Water pumped from this well will be stored first in KARI's large tank (90 m^3), then piped to the project site and stored in a new reservoir. It will then be pumped up to a new elevated water tank which will supply each building and nursery.

A loop pipeline network will be constructed for water supply to provide for the peak load of each building. The elevated water tank and reservoir will have capacities large enough to insure adequate water supplies in case of suspension of well water supply, service interruption, or equipment failure. Specifically, the reservoir will have a capacity of 70 m^3, a three-day supply for drinking/nursery operation. The elevated water tank will have a capacity of 25 m^3, a one-day supply. The primary service pipeline construction to the site boundary will be undertaken by the Kenyan side, as already agreed upon between the Kenyan authorities and the Japanese team.

Kitui Site

The maximum daily supply of drinking water required at the Kitui site is estimated at 17 m^3.

Breakdown:

Trainees	30 persons	x 80 ℓ/day	=	2,400 ℓ/day
Staff members (Research)	36	x 80	=	2,880
Staff members (Training)	34	x 80	=	2,720
Dining hall	50	x 80 x 3 times	=	3,000
Dormitories	36	x 100	=	3,600
Experiments		lump sum	=	1,000
Visitors, etc.	20	x 70	=	1,400
Total				17,000 ℓ/day
				(= Approx. 17 m^3 ℓ/day)

If 200,000 seedlings are to be planted as in the Muguga site nursery, a daily supply of 12 m^3 of water will also be required for nursery operation.

Drinking water will be obtained from the Kitui City water supply system. Water drawn from the system will be stored in a reservoir, then pumped up to an elevated water tank to supply each building. The elevated water tank and reservoir have capacities large enough to insure adequate water supplies in case of suspension of water supply from the city water supply system, service interruption, or equipment failure. Specifically, the reservoir will have a capacity of 60 m^3, a three-day supply. The elevated water tank will have a capacity of 20 m^3, a one-day supply.

Nursery irrigation water will be obtained from the Kalundu River flowing along the site. A shallow well will be bored about 3 m from the river, with an intake pipe laid between the well bottom and the river. Water stored at the well bottom will be pumped to a water tank for the nursery, and piped to the nursery by gravity flow. The water tank for the nursery will have a storage capacity of 120 m^3, a 10-day supply. This large capacity is necessary to cope with the probable decline in well intake volume during the dry season (past data indicate that the river's lowest water level is recorded in October). In case water intake from the river becomes impossible and the tank's storage capacity cannot be maintained, water from the city water supply system will be used.

As with the Muguga site, it is agreed that the primary service pipeline construction to the site boundary will be undertaken by the Kenyan side.

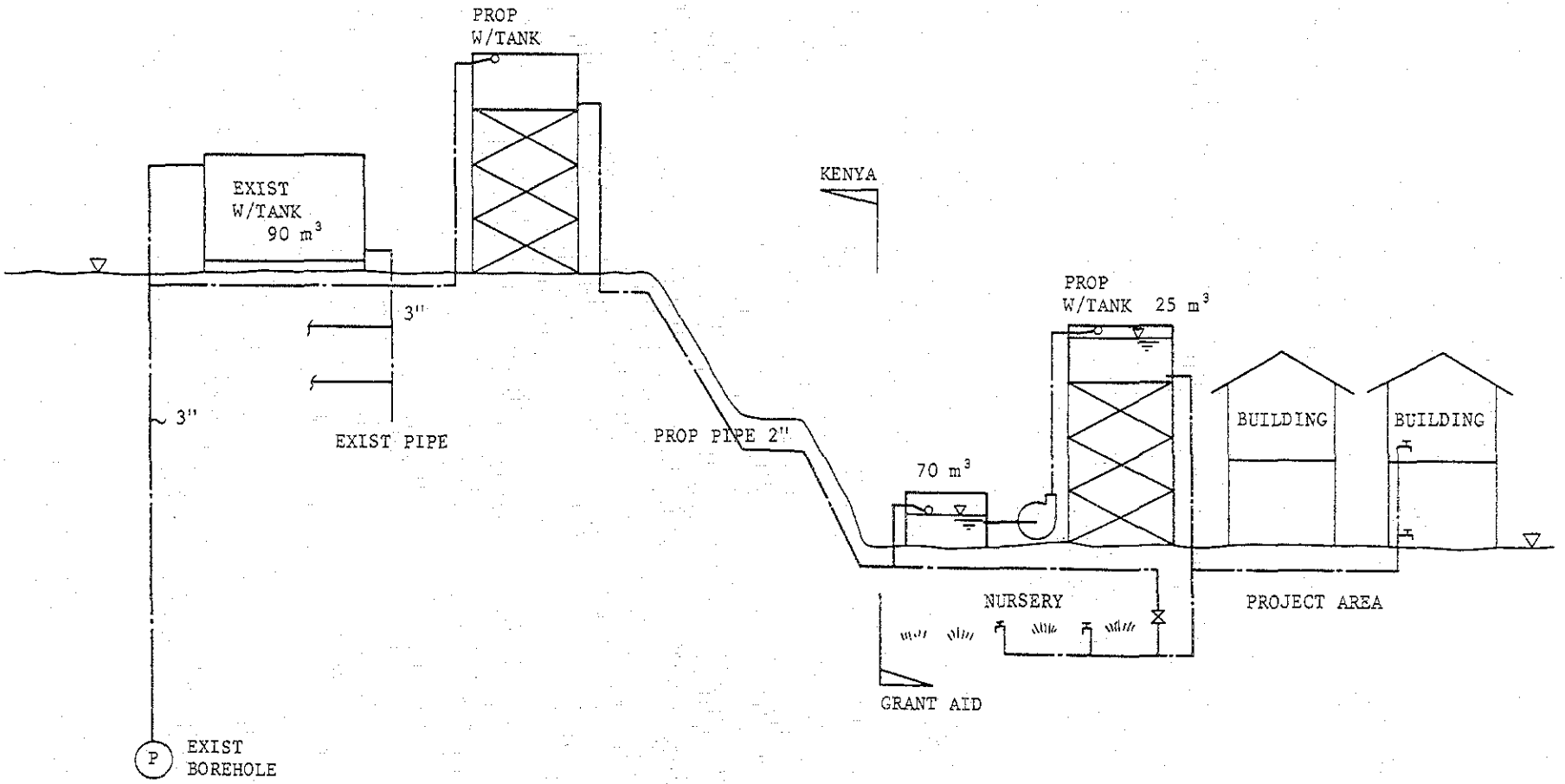


Diagram of Water Supply System: MUGUGA

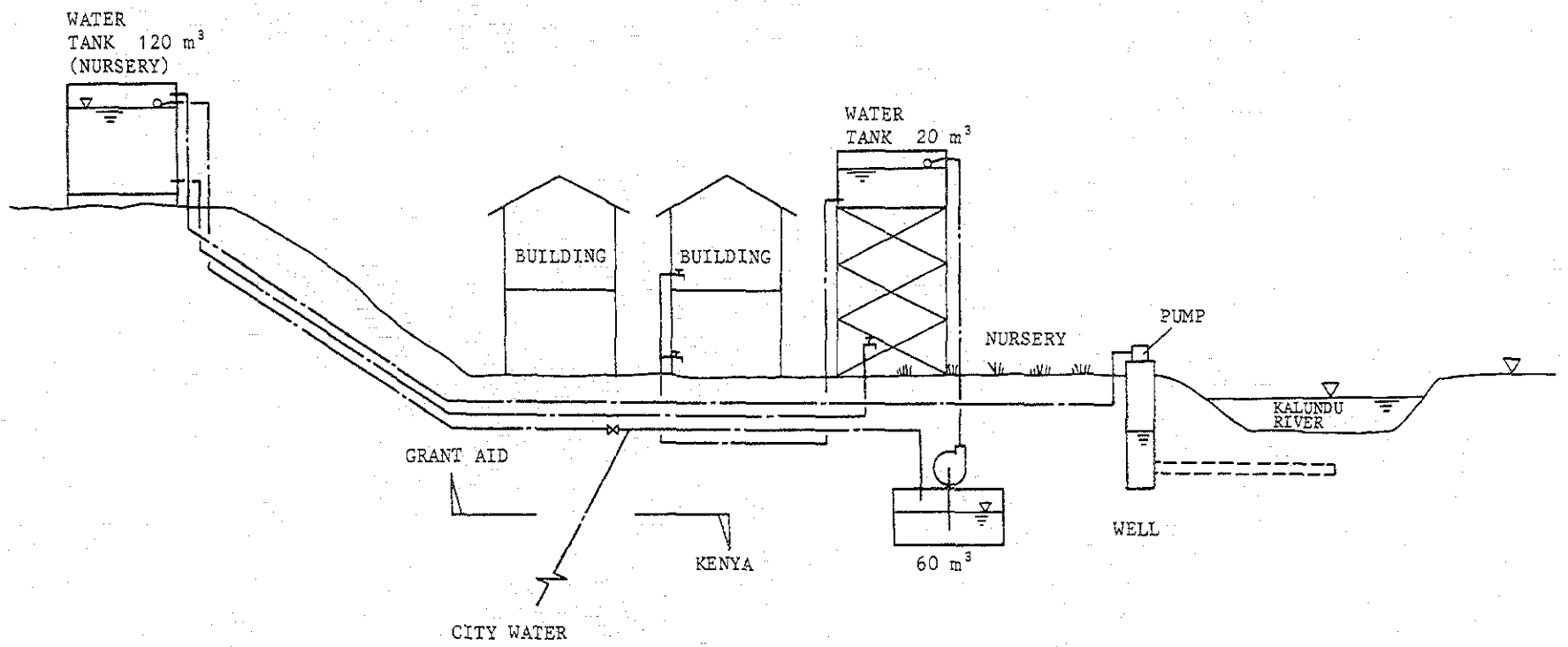
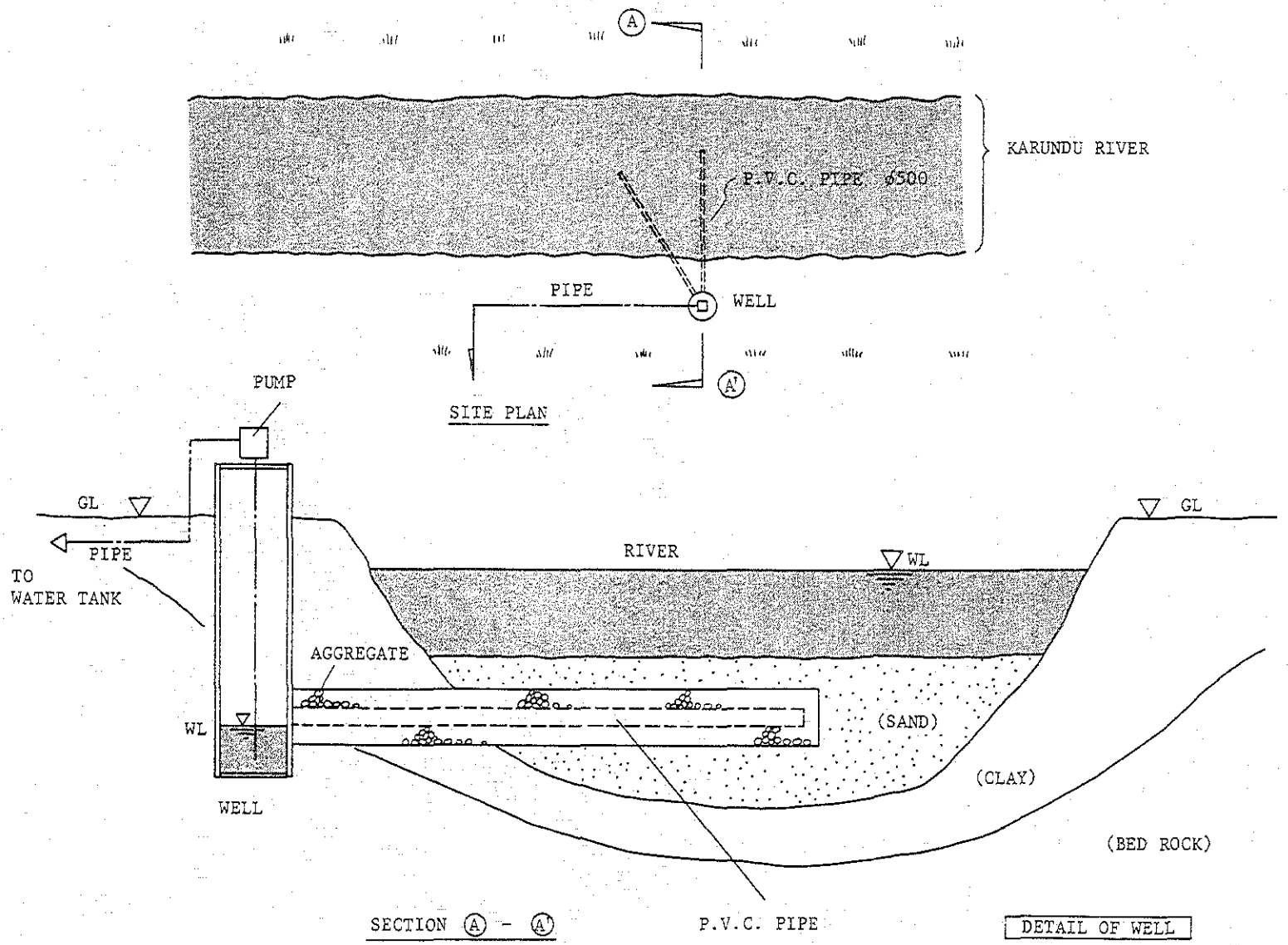


Diagram of Water Suply System: KITUI


A
KARUNDU RIVER
P.V.C. PIPE ϕ500
PIPE
WELL
A'
SITE PLAN
PUMP
GL
PIPE
TO
WATER TANK
WL
WELL
AGGREGATE
RIVER
WL
GL
(SAND)
(CLAY)
(BED ROCK)
SECTION Ⓐ - Ⓐ'
P.V.C. PIPE
DETAIL OF WELL

(2) Well Drilling Plan

Kitui Site

A shallow well yielding 12 m^3/day will be drilled near the Kalundu River to meet irrigation water requirements for nursery operation. To determine riverbed stratification, Kenya Drilling Co. was commissioned to conduct a boring survey using a hand earth auger and an electric logging machine. It was confirmed that the riverbed is composed of three layers: a 2.5-m surface sand layer covering the riverbed; a 1.7-m clay layer; and hard bedrock. Thus it should be possible to obtain a substantial amount of well water even when the river is devoid of flowing water.

The well will be about 5 m deep, with a diameter of about 1.5 m. As noted, it will be bored about 3 m from the river. A ready-made concrete sewer pipe will be used for the sidewall, and a ready-made large-diameter PVC pipe will serve as the intake pipe. The intake pipe will be buried with gravel surrounding its entire surface to prevent sand intrusion.

(3) Sewerage

① Sewage

Sewage from each building will be collected in a cesspool. It will then be pumped to a septic tank for treatment, after which it will be released through a system of drainage pipes into a nearby field. The septic tank and the cesspool will be designed according to the standards of the M.O.W.

② Drainage

Other wastewater from the buildings will also be collected, treated, and released in the same manner. In addition, a grease trap will be installed to filter kitchen wastewater before it enters this system.

③ Rainwater

Rainwater runoff from the buildings and the road will be channeled into culverts.

④ Drainage from Laboratories

Chemical wastes from the Muguga laboratories will be handled in the following way:

Ⓐ Acid-Alkali Wastes

Acid-alkali wastes will be tranasferred into neuturalizing tanks. After neuturalization these wastes will be disposed of through the regular drainage facilities.

Ⓑ Heavy Metal Wastes

Heavy metal wastes from the laboratories will be stored in a separate tank. When sufficient heavy metal wastes have accumulated, they will be transferred to a safe storage place.

⑤ Piping Material

The piping material to be used in this project will be mainly P.V.C. pipes. In places where stronger materials are needed, reinforced concrete pipes will be used.

- o Internal sewage piping: P.V.C. pipes
- o External sewage piping: P.V.C. and R.C. pipes
- o Drainage piping: P.V.C. pipes
- o Rainwater drainage piping: P.V.C. and R.C. pipes
- o Chemical wastes piping: P.V.C. pipes

(4) Hot Water

Electric water heaters will be used to heat water for shower-rooms, kitchens, and kitchenettes. For shower-rooms and kitchens, large water heaters will be installed. For kitchenettes, smaller sized heaters will be installed. Copper pipes will be used for all hot water lines.

(5) Gas

L.P.G. will be used for heating in kitchens and laboratories. Bottled gas cylinder will be situated in places where smaller amounts of gas are needed.

(6) Kitchen

Hot and cold water, drainage, and ventilation equipment will be installed including basic furnishings such as appliances and tables for food preparation. Above each gas range an exhaust hood will be provided. Each kitchen floor will contain a pit to facilitate proper drainage. A grease trap will be provided at the end of this drainage pit to separate oil from the drainage water.

(7) Sanitary

Toilets, basins, sinks, showers, etc. will be provided in each building according to the architectural plan.

(8) Fire Fighting Installations

Fire extinguishers, hoses, and hose reels will be placed at each corridor exit of each building for internal fire fighting installations. Hose boxes containing nozzles and hose will be placed with external hydrants. However, there will be no special pump installed for this system. All equipment used will be in accordance with the Kenyan Regulations and Standards.

(9) Air Conditioning/Ventilation

The Muguga site is at an elevation of 2,000 m and the Kitui site at an elevation of 1,100 m, so that both sites are favored with exceptionally mild climatic conditions, with the highest atmospheric temperature at both sites ranging from 22 to 27°C and the lowest from 10 to 13°C. Accordingly, there is no need for air conditioning in offices or lecture room. Few air conditioning facilities are now found in Kenyan buildings. Since a comfortable indoor environment can be maintained by introducing fresh outside air, even when the temperature rises in the daytime, ventilation system alone will ensure a pleasant indoor environment.

1) Ventilation

To provide an agreeable indoor environment to all laboratories, etc, ventilation fans will be installed according to the volume of air in each room. Special-purpose rooms will be provided with ventilation fans or air inlet/exhaust facilities. Ventilation facilities are planned for the following rooms and equipment.

a.	Rooms:	Laboratories
b.	Special-purpose rooms:	Generator room, laundry, darkroom
c.	Gas/heat generating equipment:	Draft chamber, autoclave
d.	Kitchen utensils:	Cooking ranges, ovens.

2) Cold Room

A large-capacity cold reserve storage room for seeds will be constructed with prefabricated panels within a building at both sites. It will have the same size and specifications at both sites, as shown below.

a.	Floor space:	Approx. 10 m^2
b.	Ceiling height:	2.4 m
c.	Temperature range:	0 - 5°C
d.	Humidity range:	30 - 35% RH
e.	Attachments:	Racks for storing seeds

3) Greenhouse

The greenhouses will be suitable for various research purposes. Greenhouse specifications will be as shown below.

a.	Floor space:	Approx. 20 m^2
b.	Equipment:	* Equipment for controlling sunshine/ambient temperature - two greenhouses * Heating system capable of maintaining a temperature range of 20 - 25°C at all times, and equipment for controlling sunshine/ambient temperature one greenhouse
c.	Faucets:	Three per greenhouse
d.	Number of greenhouses:	Three at Muguga site

(10) Dangerous Substances Storage (Fuel Storage)

The light oil, gasoline, heavy oil, etc, required for the maintenance/operation of nursery equipment will be stored at each site in one storage shed for dangerous substances. Steel drums will be used for safe storage of these substances, and to prevent explosions, fire extinguishers will be installed and all electrical equipment will be explosion-proof.

(11) Irrigation System

A) Muguga Field

Nursery irrigation water will be supplied from the same elevated water tank to be constructed for drinking water from KARI. In the nursery, faucets will be provided at intervals of 10 m to supply water to vinyl hoses or watering pots.

B) Kitui Field

Nursery irrigation water will be obtained from the shallow well drilled near the Kalundu River. Water will be stored in the water tank to supply vinyl hoses or watering pots from faucets provided in the nursery at intervals of 10 m.

(12) Electrical Installation

1) Lead-in Cable Plan

Power supply to the two project sites will be secured by reducing voltage with transformers from the high-tension power cables of the KPLC (Kenya Power and Lighting Co., Ltd.) which near both sites.

It is agreed that the installation of stepdown transformers and the primary lead-in cable connections will be undertaken by the Kenyan side. Accordingly, it will be the responsibility of the Kenya side to determine the branch points and lead-in cable routes. Since KPLS service is reported to be largely influenced by materials availability, it will be necessary to apply for service well in advance to secure the power supply in time.

2) Power Receiving/Transformation

High-voltage current from the 11,000 V power cables will run through stepdown transformers to each building and then through non-fused breakers on a low-voltage power board.

Facilities at the Muguga site will have a power load of about 280 KVA, and those at the Kitui site about 160 KVA. The special 3ϕ-200 V and 1ϕ-100 V current required for experimental equipment will be secured by installing separate transformers.

3) Main Feeder

As regards downstream of power receiving/transformation facilities, 3ϕ-4W-240 V current will be supplied to the distributing and power control boards in each building. All power equipment using water will have a built-in earth leakage breaker for safety assurance. For supply of 3ϕ-415 V current to utility and experimental equipment, an separate power board or control board will be installed. Furthermore, ammeters, voltmeters, control switches, emergency switches, etc, will be installed according to the needs for safety assurance and ease of maintenance/management.

4) Lighting

Locations, number of lamps, type/model, and switches of lighting equipment will be determined for the convenience of users in each room to enable them to perform their duties smoothly in a comfortable environment. All lighting equipment will have an reasonable design worked out in conformity to KPLC standards and the British Standard, with consideration given to safety and economic efficiency.

Intensity of illumination in main rooms will be as shown below.

Office rooms	300 Lx
Conference rooms	300 Lx
Lecture rooms	300 Lx
Halls	100 - 150 Lx
Corridors	100 - 150 Lx
Laboratories	300 Lx

5) Receptacle Outlet

Positions and numbers of all receptacle outlets, including general receptacle and special outlets, will be determined according to the needs of each room. Current will be obtained from the MCB secondary side of the panelboard, but an independent circuit will be provided for large-capacity experimental equipment. Wiring will be done with PVC cables and conduit pipes, following a safe, logical, and economical design conforming to KLPC standards and the British Standard.

6) Emergency Power Generating

Emergency power plant with a capacity of about 50 KVA will be installed only at the Muguga site. It will be designed to start automatically if the power supply from KLPC is interrupted, and to be stopped manually when the power supply is resumed. The plant will supply experimental equipment in the laboratories and main utility equipment for nursery operation.

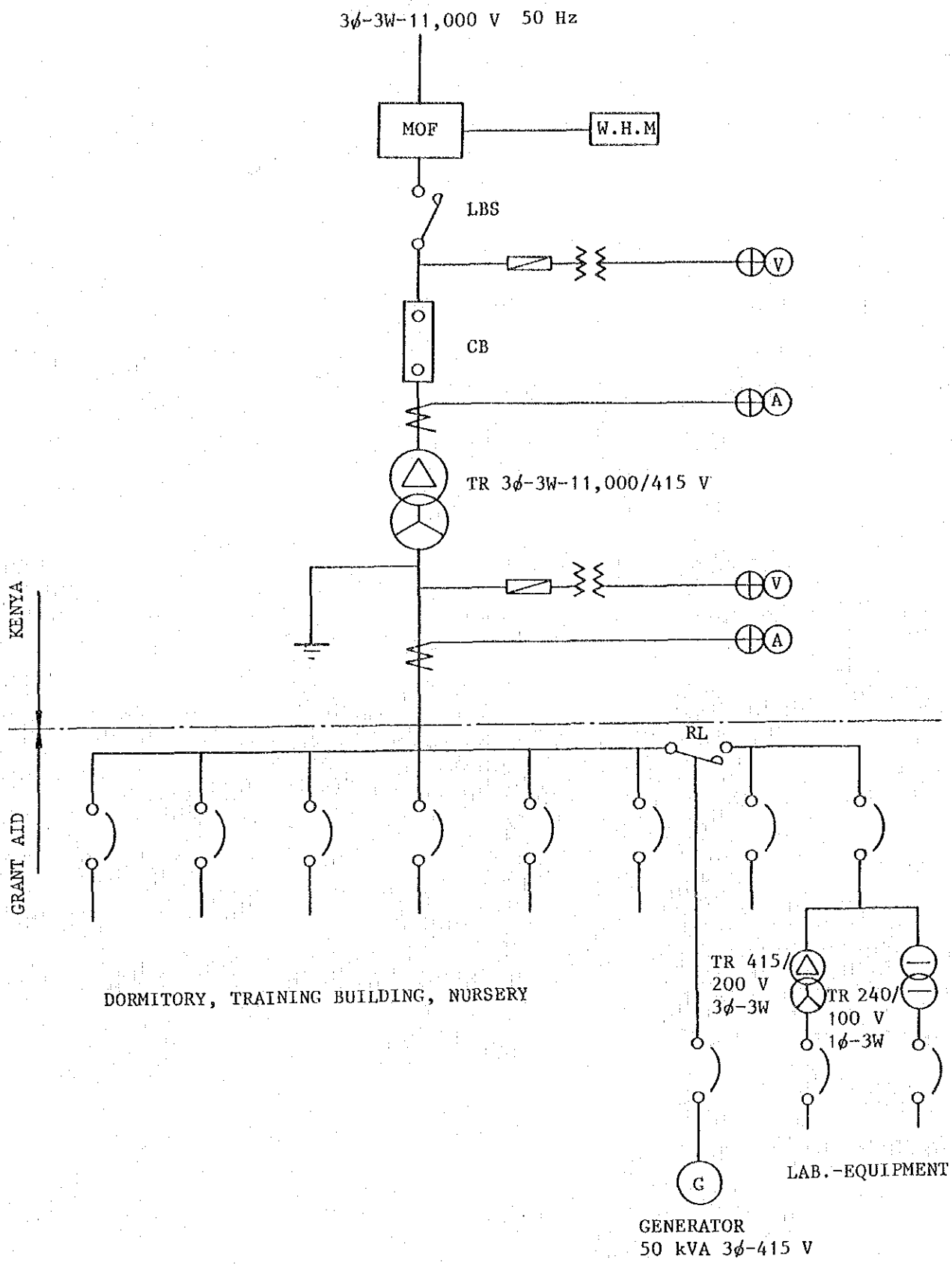
7) Telephone

It is agreed that the primary telephone drops will be undertaken by the Kenyan side. Since existing telephone cables run near the two project sites, the Kenyan side will provide drops

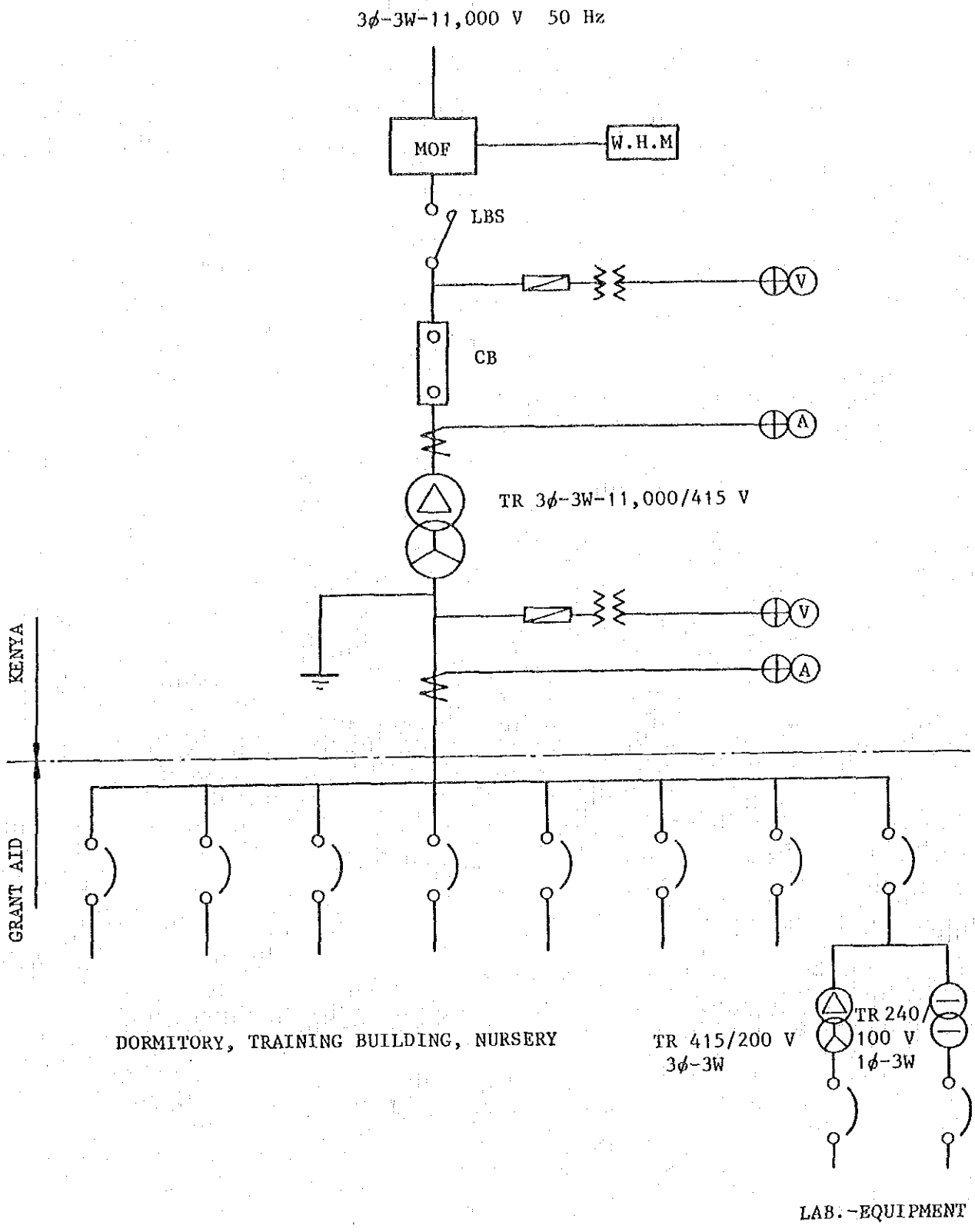
between these cables and the primary terminals of the PBX in the office buildings. About four drops will be required at the Muguga site, and about three at the Kitui site. Wiring from PBX to each outlet box is to be done using conduit pipes. Telephone protector installation and grounding work for PBX will also be conducted. The exchange sets will use key telephones not requiring operator service. About 20 telephone sets will be installed at the Muguga site and about 15 at the Kitui site. Public telephone booths will be provided in the dormitories at both sites.

(13) Lightning Arrester

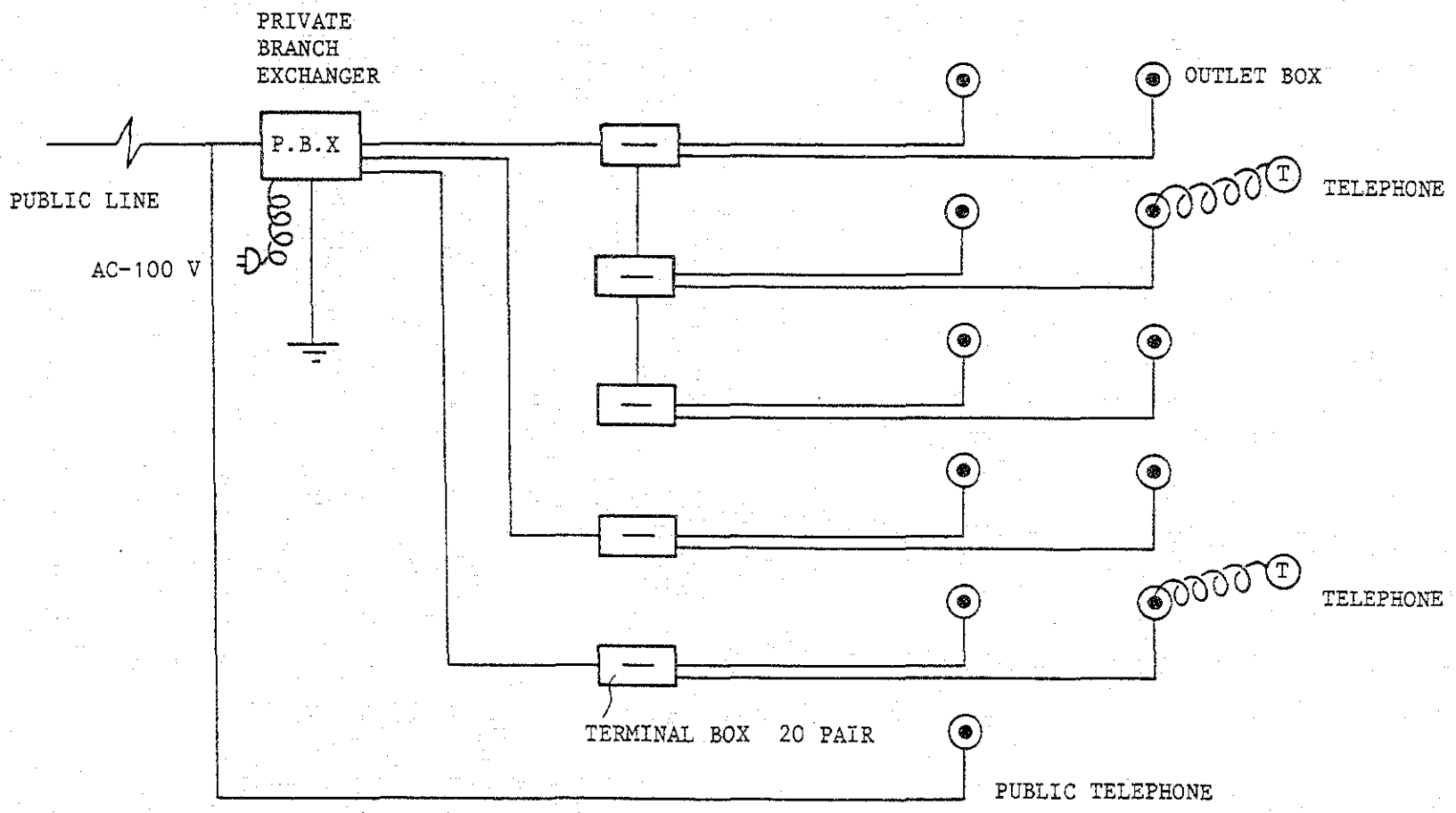
A lightning conductor will be installed at the top of each water tank or building. Each will have a lightning rod, a grounding conductor, and a buried copper earth-plate.



SYSTEM DIAGRAM OF POWER SUPPLY (MUGUGA)



SYSTEM DIAGRAM OF POWER SUPPLY (KITUI)



TELEPHONE DISTRIBUTION DIAGRAM

5-4 Planning on Equipment and Devices

(1) Policy of planning on equipment and devices

Equipment and devices for this project were selected on the basis of local conditions, purposes of research and ease of maintenance. Specifically, the policies of selection are as follows:

1) Equipment and devices which are locally available, and with a well-established service system, will be procured locally.

2) Easy-to-maintain equipment and devices will be used when possible. Experimental equipment and devices which are necessary, and for which spare parts are hard to get locally, will be supplied from Japan along with sufficient spare parts.

3) Equipment and devices which can be easily used by Kenyan counterparts and experts to be sent from Japan as a part of the technical cooperation project will be used.

(2) Educational and training equipment and devices

Equipment and devices to be used in training are as listed below.

List of Educational and Training Equipment and Devices

Name	Muguga	Kitui	Total	Remarks
Complete color video television set	1 set		1 set	
8 mm camera	1 pc	1 pc	2 pcs	
Film editor	1 set	1 set	2 sets	
8 mm projector	1 pc	1 pc	2 pcs	
Slide projector	1 pc	1 pc	2 pcs	
Overhead projector	1 pc	1 pc	2 pcs	
Screen with stand, TP-art kit	1 set	1 set	2 sets	
Typewriter	3 pcs	2 pcs	5 pcs	
Copy machine	1 pc	1 pc	2 pcs	
Printing and book-binding machine	1 set		1 set	Equipment for each process of printing and bookbinding
Measuring instruments and tools (pocket compass surveying)	5 pcs each		5 pcs each	Pocket compass, tripod, pole (2 pcs), tape measure
Measuring instruments and tools (plane table surveying)	5 pcs each		5 pcs each	Plane table, tripod, alidade, tape measure
Distance, area measure-ment utensil	5 pcs each		5 pcs each	Planimeter, curvi-meter
Drafting tools	5 pcs each		5 pcs each	Drawing board, T-square
Forest measurement utensil	5 pcs each		5 pcs each	Hypsometer, relascope, increment borer, caliper, di-ameter tape
Book cabinet	9 pcs	5 pcs	14 pcs	For use in library
Filing cabinet	5 pcs	5 pcs	10 pcs	For use in library

(3) Research equipment and devices

Equipment and devices required for each research laboratories are as listed below.

List of Research Equipment and Devices (1/3)

① Silviculture Laboratory
② Tree Seed Laboratory
③ Tree Improvement Laboratory
④ Forest Entomology Laboratory
⑤ Forest Pathology Laboratory
⑥ Forest Chemistry Laboratory

Name	①	②	③	④	⑤	⑥	Total
Testing bench (biological)	1	1	1				3
Testing bench (chemical)				1	1	1	3
Hot air circulation drying ovens	1	1					2
Drying ovens	1	1	1		1	1	5
Incubator					1		1
Centrifuge (table type)	1						1
Centrifuge (tripod pull-up type)					1		1
Centrifuge (vacuum, high-speed cooling type)						1	1
Pressure chamber	1						1
Germinator		1					1
Germinator (constant low temperature)		1			1		2
Freezer			1				1
Refrigerator	1	1	1	1	1		5
Sterilizer					1		1
Pressure reducing and enriching apparatus						1	1
Draft chamber						1	1
Clean bench					1		1

List of Research Equipment and Devices (2/3)

Name	①	②	③	④	⑤	⑥	Total
Electric furnace						1	1
Shaking incubators					1		1
Autoclave					1		1
Vacuum pump		1			1		2
Compressor	1						1
Freon distillation apparatus	1						1
Atomic absorption analyzer						1	1
Nitrogen analyzer						1	1
Air-screen cleaner		1					1
Soft X-ray apparatus		1					1
Binocular stereomicroscope				1	1		2
System microscope				1	1		2
Microscope preparation apparatus					1		1
Microtome					1		1
Direct-reading even balance	1	1			1	1	4
Chemical balance				1	1		2
Balance bench				1	1		2
Personal computer			1				1
Leaf-area meter	1						1
Illuminometer	2						2
Spectrometer						1	1
Charcoal tester						1	1
pH meter	1	1	1		1	1	5
Recorder	1	1	1			1	4
Book cabinet	1	1	1	1	1	1	6

List of Research Equipment and Devices (3/3)

Name	①	②	③	④	⑤	⑥	Total
Testing side-bench	4	4	4	4	2	2	20
Workbench	1	1	1	1	3*1	3*2	10
Unit sink	1	1	1	1	1	1	6
Chemicals cabinet				1	1	1	3
Ultra-violet spectro photometer						1	1
Flame photometer						1	1
Deioniser						1	1
Shakers (2) glass and plastic bottle shakers					1	1	2
Magnetic hat stirrer						1	1
Heating units for nitrogen digestion					1	1	2
Thin layer chromatography						1	1
Gas chromatographs						1	1

*1: Including 2 for cultivation room
*2: Including 2 for draft room

(4) Meteorological instruments

Instruments required for meteorological observation are as follows:

List of Meteorological Instruments (1/2)

Name	Muguga	Kitui	Total	Remarks
Instrument shelter	1	1	2	
Thermograph	1	1	2	
Hygrograph	1	1	2	
Rain gauge	1	1	2	
Windvane and anemometer	1	1	2	
Jordans sunshine recorder	1	1	2	

List of Meteorological Instruments (2/2)

Name	Muguga	Kitui	Total	Remarks
Recording earth thermometer	1	1	2	
Evaporimeter	1	1	2	
Aneroid barometer	1	1	2	
Maximum and minimum thermometer	1	1	2	
Rain strength gauge	1	1	2	

(5) Equipment for Nursery Work, Vehicles, and Equipment for Repair Shop

Major vehicles and equipment required for nursery work and necessary equipment for the repair shop are as follows (listed separately):

List of Vehicles for Nursery Work

Name	Muguga	Kitui	Total	Remarks
Wheel-type tractor		1 pcs	1 pcs	Middle-size attachment mounting type
Attachment to the above		1 pc each	1 pc each	Bucket, dozer, dumping fork, trailer
Spare parts for the above		1 pc each	1 pc each	
Truck 4 ton		1 pc	1 pc	
Bus		1 pc	1 pc	Kitui: 40-passenger type
Small truck and pickup		1 pc	1 pc	

List of Equipment for Nursery Work

Name	Muguga	Kitui	Total	Remarks
Sprayer (carry-on-back type)	3 pcs	3 pcs	6 pcs	
Plastic case (for carrying nursery trees)	20 pcs	20 pcs	40 pcs	
Agricultural tools	10 pcs each	10 pcs each	20 pcs each	Pick, hoe, shovel

List of Equipment for Repair Shop and Others

Name	Muguga	Kitui	Total	Remarks
Chain block	1 pc	1 pc	2 pcs	
Punctured tire repair kit	1 set	1 set	2 sets	
Crocodile jack	1 pc	1 pc	2 pcs	
Complete set of generator and power distribution installation	1 set		1 set	

(6) Furnitures

Conference Table	17
Conference Chair	50
Lecture Room Desk	110
Lecture Room Chair	110
Training Work Table	10
Training Stool	30
Office Desk Class A	4
Office Desk Class B	37
Office Desk Class C	43
Office Chair Class A	4
Office Chair Class B	37
Office Chair Class C	43
Steel Lockers 90 x 30 cm	74
Steel Cabinet	30
Dining Table	21
Dining Chair	120
Bed/Matress Class A	10
Bed/Matress Class B	70

Relevant Laws and Regulations

The Building Code conforms to the British Standard. The Code lists requirements for electrical equipment. The Fire Services Act conforming to the British Standard Fire Hydrant System is established. Drainage requirements are established by the Drainage Department.

Relevant local standards are listed below:

Structural Planning

- Seismic Design Standard
- BS CP3, Wind Load
- BS CP110, Concrete Structure Design Standard
- BS 449, Steel Structure Design Standard

Electrical Planning

- BS
- Technical Instructions - MOW Electrical Dept.

Construction Work and Materials Planning

- Construction Specification, 1976
- Concrete Work Specification, 1974
- Steel Work Specification, 1973
- Standard Concrete Block Specification, 1972