2-2 AGRICULTURAL CONDITIONS

2-2-1 General Conditions

(1) Outline of agriculture

Zambia has enough arable land for agricultural production for both domestic consumption and export. However, only about 17% of the arable land is cultivated. The arable land accounts for about 40% of the country's total area.

Major crops are maize, cassava, millet, sorghum, wheat, rice soy beans, groundnuts, sunflower seeds, raw cotton, etc. The livestock industry is also flourishing. Among the above major crops, maize is grown on more than half of the farm land and its production is overwhelmingly large in comparison with other cereal grains. Maize is the major domestic food crop as well as the major cash crop, accounting for about 80% of Zambia's grain consumption. It is also important as feed for livestock.

There are large commercial farms along the railway between Livingstone and Copperbelt. At locations far from major traffic routes, however, the land is only sparsely cultivated and the agricultural level is not above that of self-sufficiency. Agriculture has been sluggish in the past due to the low pricing policy which was taken by the government as a countermeasure against the rapid increase in urban population and due to insufficient investment in agricultural materials, such as chemical fertilizers, caused by the shortage in foreign currency.

The maize crop has been poor since 1980 due to the drought. As a result, Zambia became an importing country. However, because of the increased production in recent years, dependency on imports has become smaller and the nation is on its way to achieving self-sufficiency. As mentioned earlier, however, vast areas of land remain uncultivated. Therefore, there is a large latent

agricultural production capacity awaiting the development of infrastructure such as transportation routes, irrigation, etc.

(2) Agricultural policies

The major development plans after the nation's independence in 1964 have been five-year plans, from the First to the Third Plans. Emphasis was placed on agriculture in each plan, and the nation was self-sufficient in its main food while other food was imported using foreign currency gained from exporting copper until the Second Plan (1972 - 1976). However, since 1975, when the price of copper slumped, the importance of agricultural development increased, making agriculture the most important policy focus in the Third National Development Plan (1979 - 1983). In particular, a target was set to increase the production of food, and Operation Food Production (1980 - 1990) is a strategy to reach the target. Operation Food Production includes various programs such as placing importance on the production of small-scale farmers, activation of cooperative unions, raising the contributions of commercial farmers, and construction of state farms. In the Third National Development Plan, the Integrated Rural Development Program (IRDP) was introduced, with which differences in areas are to be reduced through integrated development of underdeveloped areas.

A new five-year plan has not been announced for the period following the Third National Development Plan, although a "Reformation Plan Under the Crisis" was announced in 1984. Priority was given to agriculture-related items, and "emphasis on small-scale farmers", "a pricing system to give incentives to producers", "a free competition marketing system", "R&D and dissemination activities", "necessity of increasing the yield of existing commercial farms", and "easier access to consumables in farming areas" are designated as major factors. Furthermore, the Interim National Development Plan (1987 - 1988) was announced in July, 1987, which aims to increase self-sufficiency in staple crops, exports of agricultural products, alternatives for

importation such as agricultural products and materials, and income of farmers.

(3) Production of food grains

1) Production

The production of major agricultural products is shown in Table 3: Planted Area, Yield, and Production of Major Agricultural Products (According to FAO Agricultural Products Annual and Monthly Reports)

Maize accounted for an overwhelming portion of the production of food grain in 1985 with 1.122 million tons, followed by, sorghum (19,000 t), millet (19,000 t), wheat (14,000 t), and rice (7,000 t). Other than food grain, 210,000 tons of cassava, 40,000 tons of sunflower seeds and 20,000 tons of groundnuts were produced.

The yield of maize per hectare, which differs slightly from one province to another, was about 1.7 tons on the average, much higher than the roughly 1 ton for neighboring African countries, largely because of the introduction of hybrids. However, this yield is far below the world's average of 3.7 tons. The yield per hectare is expected to increase depending on future increases in agricultural inputs such as fertilizers, agricultural chemicals, etc.

According to the trend of production and importation of major agricultural products in the past ten years (See Table 4), increased production of maize caused imports to fall while exports started in 1986. Although their share of total production is small, production of the traditional Zambian grains of sorghum and millet decreased, due to changes in eating habits and the effects of official purchasing prices, while the production of wheat and rice increased.

Table 3 Planted Area, Yield, and Production of Major Agricultural Products

(Source: 1985 FAO Agricultural Annual and Monthly Reports)

	Planted Area (1000 ha)				Yield (kg/ha)				Production (1000 metric tons)			
	1979-81	83	84	85	1979-81	83	84	85	1979-81	83	84	85
Maize	523	537	500*	530*	1,799	1,677	1,620	1,660	941	900	872	1,122
Cassava	56	60F	61F	61F	3,252	3,500	3,443	3,443	183	210F	210F	210F
Millet	53	21	16	18F	875	614	800	722	47	13	13	19
Sorghum	39	16	21	26F	549	556	672	769	21	9	14	19
Wheat	3	5	4F	4F	3,473	4,500	3,250	3,500	9	20	13*	14*
Rice (unhulled)	5	7	9	9F	497	838	708	778	2	6	6	7F
Soy beans	4	7	9	10F	621	1,069	1,015	1,031	2	7	10	10F
Goundnuts (with shells)	28	21F	23	25F	637	876	810	800	18	18	19	20F
Sunflower seeds	35	47	58	60F	577	668	604	673	20	31	35	40F
Raw cotton	-	-	-	-	-	-	-	-	6	12	15	18F

* : Unofficial figures
F : Estimation by FAO

Table 4 Production and Importation of Major Agricultural Products

(Source: FAO Agricultural Monthly Report)

		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Maize	Production	980,000F	950,000	700,000F	800,000F	1,007,000	810,000	900,000	872,000	1,122,000	1,215,000
	Imports	400	1,800	1,158,000*	315,000*	116,700	68,800	115,900	143,700	130,000	65,000*
	Exports	257,000	61,000	0	0	0	0	0	0	0	35,000*
Wheat	Production	5,000	6,000	7,000	10,000	12,000	-	20,000	13,000*	14,000*	-
	Imports	96,600	90,000*	102,000	170,000*	128,700	130,400	85,300	81,800	75,000*	75,000F
Cassava	Production	170,000F	173,000F	175,000F	175,000F	175,000F	-	210,000F	210,000F	210,000F	-
Millet	Production	86,000F	80,000F	60,000*	60,000F	60,000F	13,000	13,000	14,000	19,000	12,000
Sorghum	Production	51,000F	40,000F	30,000F	35,000F	35,000F	13,000	9,000	14,000	19,000	45,000
Rice	Production	2,000	3,000*	2,000	2,000	6,000	-	6,000	6,000	7,000F	-

* : Unofficial figure
F : Estimation by FAO

2) Production areas

Maize is produced in areas where the annual rainfall is within the range of 800 - 1,200 mm. The major producing areas lie in Central, Eastern and Southern Provinces. In particular, the areas along the main road from Livingstone to Copperbelt via Lusaka and along the main road from Kapiri Mposhi to Mkushi, in both of which the soil is comparatively fertile and the transportation conditions are good, have well-developed commercial farms and are major production areas of maize. Also in areas along main roads in the Petauke and Chipata Districts in Eastern Province, where most of the farms are small, maize production has recently been increasing. Meanwhile maize production in Southern Province, which had greatly decreased because of the drought, has recovered remarkably in recent years.

In areas where the amount of rainfall is small or where transportation conditions are poor and distances from main roads are great, agriculture is still at the subsistence level. In these areas, small farms raise minor cereal grains, cassava, etc., and sell the surplus, if any.

Rice is raised in northern areas where the annual rainfall is within the range of 1,200 - 1,300 mm. It is also raised, although in small quantities, in Eastern and Western Provinces.

3) Farm management scales

Farms are classified as follows according to the management scale.

. Traditional peasant farmer		76.20%
. Commercial farmer	Small-scale (1-10 ha)	20.16%
	Medium-scale (10-40 ha)	3.52%
	Large-scale (more than 40 ha)	0.12%

Although the difference between the traditional peasant farmers and the commercial farmers is not clearly defined, the number of traditional peasant farmers is overwhelmingly large (estimated at 460,000) and they are at the traditional subsistence level of agriculture. Meanwhile, small to large-scale commercial farmers are those who have expanded their scale of operation to become producers of large amounts of farm products for cash, mainly maize, cassava, groundnuts, sorghum, etc. Large farms produce agricultural products on a commercial basis. In particular, the number of very large farms having 40 ha or more land, such as state farms and the Zambia Anglo-American Corporation (Zam-Anglo), reaches about 730. (See Table 5.) All of these state and private farms are located near railways or main roads and account for about 50% of the total agricultural production in Zambia. Large farms carry out capital-intensive production using modern techniques. They produce cereal grains, beef, pork and eggs for urban areas, and tobacco for export. Under the National Development Plans, the government is striving to establish state farms. The state farms thus established have achieved significant results in the development of each locality during the past several years. Furthermore, they are expected to flourish as service centers for nearby farms in the future.

Table 5 The Number of Farms and Farmers by Management Scale (1980)

Level Province	Large-Scale Commercial (>40 ha)		Medium-Scale Commercial (10 - 40 ha)		Small-Scale Commercial (1 - 10 ha)		Traditional Farming Sector		Total	
	Farms	Pop	Farms	Pop	Farms	Pop	Farms	Pop	Farms	Pop
Southern	320	16 000	8 000	76 000	49 900	374 100	7 500	33 900	65 720	500 000
Central	300	15 200	7 630	72 500	21 400	160 599	18 400	82 800	47 730	331 000
Lusaka	90	4 300	1 910	18 100	4 300	32 300	13 400	60 300	19 700	115 000
Copperbelt	-	-	490	4 700	2 000	14 900	17 900	80 400	20 390	100 000
Eastern	20	1 000	3 100	29 500	27 000	202 700	80 900	363 800	111 020	597 000
Western	-	-	-	-	5 450	40 800	85 400	384 200	90 850	425 000
N/Western	-	-	80	800	2 900	21 900	53 600	241 300	56 580	264 000
Luapula	-	-	50	500	2 050	15 300	73 600	331 200	75 700	347 000
Northern	-	-	90	800	7 400	55 500	111 900	503 700	119 390	560 000
Total	730	36 500	21 350	202 900	122 400	981 000	462 600	2 081 600	607 080	3 239 000

Source: Food Strategy Study, 1981, MAWD.

4) Cultivation, harvesting and cleaning of maize

Sowing of maize begins about the middle of November in Western and Northwestern Provinces, and about the end of November in other provinces, coinciding with the start of the rainy season. Meanwhile, the farmers are encouraged to deeply plow the field beforehand, from March to April, when it still rains from time to time. As seeds, such high-yield hybrids as S.R. 52, S.R. 11, Zambia Hybrid 1, etc. are widely used. In particular, S.R. 11 is recommended for areas with a small quantity of rainfall, such as the southern part of the country.

At the small-scale farms, around March when the rainy season nears its end, only the ripened ears are broken while the stalks are left standing and twisted off after they dry somewhat. In some cases, maize are harvested with stalks, dried for about four weeks, and then ears are twisted off. Threshing is done mostly by hand with the use of a simple tool. Foreign materials are removed by sieving or winnowing and maize is shipped after it is dry. Traditionally, farmers store maize on the cob in cribs with good ventilation. Since maize stored in this manner is prone to damage by pests or rats, however, the agricultural extension organization encouraged the farmers to store threshed maize in brick silo bins with cement mortar.

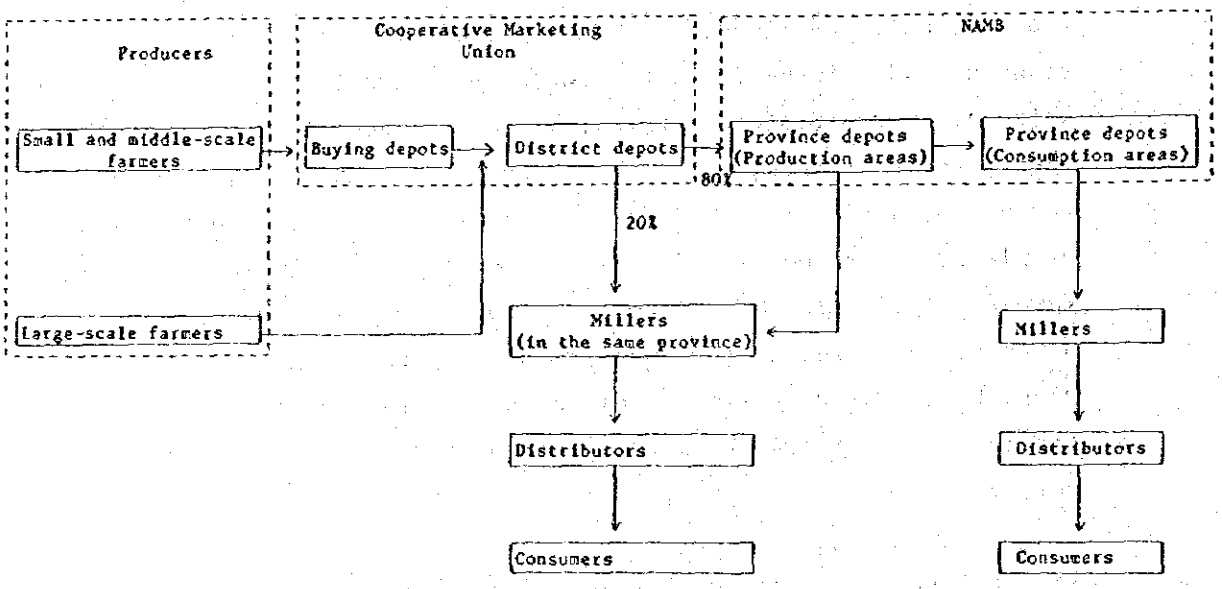
At the large-scale farms, farming work has been mechanized, i.e. automatic harvesters and threshing machines are used and thrashing is done by tractors. However, grain is dried naturally rather than artificially because maize is harvested in the dry season.

2-2-2 Distribution of Food Grains

(1) Grain distribution system

Major food grains distributed in Zambia include maize, wheat, sorghum, millet and rice. Maize accounts for 95% or more (excluding imported grain) of such grain. Grain had been

monopolistically handled by the NAMB under the Ministry of Agriculture and Water Development since its establishment on September 1, 1969. As a result of the revision of the NAMB's functions which was carried out to further close cooperation with the Cooperative Marketing Unions which had handled similar duties, the Cooperative Marketing Unions in each province took over the distributing function within each province from the NAMB in March 1982 and have been carrying out the duties since then. From November 28, 1986, the authority of the NAMB was transferred from the Ministry of Agricultural Water Resource to the Ministry of Cooperatives. The diagram below shows the maize distribution system from the producer to the customer.



1) Purchase from farmers

The Cooperative Marketing Unions in each province collect all the harvested maize from the farmer, except that needed for the farmer's own consumption, via buying (satellite) depots for the NAMB.

Each buying depot, which covers about 10 farmers or about 1,000 bags, is in such a location that the distance from the furthest farmer does not exceed 4 miles (6.3 km). At the buying depot, an inspector dispatched by the Cooperative Marketing Unions inspects the quality and weight of the maize. At present, the quality is checked visually, while the weight is measured using platform scales or spring scales. If the quality turns out to be unacceptable, the inspector instructs the farmer to dry and clean the maize again.

Since Zambia has no allocation system for delivery, each farmer decides by himself on the amount to be sold. However, the customer is limited to a branch of the Cooperative Marketing Unions.

2) Shipping between provinces

Grain gathered at buying depots is temporarily stored at the district depots provided in each district (a lower provincial administrative unit) together with grain collected from large-scale farms before finally being collected at the provincial depot of each production province.

The depots of the production provinces are supervised by the NAMB and actually run by the Cooperative Marketing Unions, and grain is sold to the NAMB at the time of each shipment. Generally, the NAMB is in charge of shipping between provinces, and the grain is shipped to the depots in the consumption provinces and sold to flour mills from the depots there. In some cases, however, the grain is transported to flour mills in other districts within the same province.

Domestically produced maize, which is bought by the NAMB through the Cooperative Marketing Unions, accounts for about 80% of the total distribution amount. The remaining about 20% is sold within the province by the Cooperative Marketing Unions.

(2) Prices of marketed food grains

For agricultural development, the policies of the Government of Zambia are, firstly, to achieve self-sufficiency in major farm products and, secondly, to produce grain for export. To achieve the above goals, for the past several years the government's policy has been to increase investment in agriculture, the production of farm products, and their distribution amount by giving farmers incentives to increase production by raising the official purchase prices of farm products, which had hitherto been kept low.

This tendency is apparent in Table 6, Producer Price of Maize (Official purchase price) which shows fluctuations in the maize price from 1979 onwards. Furthermore, the prices of agricultural materials, etc. were increased drastically by the foreign currency auction in October, 1985, and the prices of agricultural products were increased as well.

On the other hand, it is essential for the welfare of the public to supply low-priced food to low-income consumers in urban areas, who are increasing in number. As shown in Table 7, Producer Price and Consumer Price of Major Agricultural Products, however, although the consumer price of maize was kept fairly low, the consumer price has risen considerably, as a result of introducing the foreign currency auction system.

The Ministry of Agriculture and Water Development draws up the draft for the producer's price. Then the Cabinet approves and announces it. Normally this is done in April before the harvesting year so that it is reflected in that year's crop. The Cooperative Marketing Unions buy maize from farmers at this purchase price.

Table 6 Producer Price of Maize (Official purchase price)

Unit: Kwacha/90kg bag

YEAR	A	B	C	D	E	AGRICULTURAL PRICE INDEX	REAL MAIZE PRICE	REAL MAIZE PRICE INDEX
1969	3.20	3.15	3.05					
1970	3.50	3.45	3.35					
1971	4.00	3.95	3.85			75.1	5.33	100.0
1972	4.30	4.25	4.15			78.9	5.45	102.3
1973	4.30	4.25	4.15			84.0	5.12	96.1
1974	4.30	4.25	4.15	3.50	2.80	90.8	4.74	88.9
1975	5.00	4.95	4.85	4.60	3.85	100.0	5.00	93.8
1976	6.30	6.20	6.05	2.50	2.00	118.8	5.30	99.4
1977	6.30	6.20	6.05	2.50	2.00	142.3	4.43	83.1
1978	6.80	6.75	6.70	3.00	2.75	165.6	4.11	77.1
1979	9.20	9.10	8.95			181.6	5.07	95.1
1980	11.70	11.60	11.40			202.9	5.77	108.3
1981	13.50	13.45	13.25			233.3	5.79	108.6
1982	16.00	15.90	15.85			268.3	5.96	111.8
1983	18.30	18.20	18.15					
1984	28.32							
1985	33.00							
1986	55.00	53.00	51.00	30.00	22.00			

Source: NAMB

Table 7 Producer Price and Consumer Price of Major Agricultural Products

Unit : Kwacha/bag

PP = Producer Price
F : PP Paid to farmers

SP = Selling price
M : SP to millers

% SP = Selling price as % of producer price
U : PP or SP for Unions

COMMODITY	UNIT	1977	1978	1979	1980	1981	1982 F/M	1982 U	1983 F/M	1983 U	1984	1985
Maize	90 PP	6.30	6.80	9.20	11.70	12.50	16.00	17.00(1)	18.30	22.00	28.32	33.0
	SP	4.82	6.25	10.21	12.91	13.50	17.00	16.00	22.48	21.00		
	%SP	77	92	111	110	108	106	94	124	105		
Sunflower	50 PP	10.00	10.00	12.50	16.40	17.60	20.75		21.50		21.50	
	SP	12.50	12.50	19.35	23.70	19.30	27.25(2)		27.25(3)			
	%SP	125	125	155	145	110	131		127			
Wheat	90 PP	20.00	20.00	20.00	24.00	26.00	32.00		35.75		42.50	
	SP	24.60	24.60	24.60	25.90	26.30	40.95(2)		40.95(3)		62.00	86.4
	%SP	123	123	123	108	101	128		114		146	
Soy Beans	90 PP	17.00	17.00	21.50	32.00	36.20	42.31		45.30		52.50	
	SP	28.51	31.70	29.20	33.20	40.60	51.91(2)		51.91(3)		60.90	112.1
	%SP	168	186	136	104	112	123		115		116	
Paddy Rice	80 PP	14.40	14.40	14.40	16.00	18.60	28.00		40.00		40.00	
	SP	19.66	25.25	22.45	24.30	24.80	36.00(2)		36.00(3)		40.00	55.5
	%SP	137	175	156	152	133	129		90		100	
S/G/Nuts	80 PP	25.00	25.00	28.60	32.00	42.70	48.00		52.00			
	SP	30.15	32.60	38.95	43.00	43.80	57.60(2)		57.60(3)			
	%SP	121	130	136	134	103	120		111			

Source: NAMB

(3) Quality of food grains and inspections

The National Agricultural Marketing Act stipulates the inspection standards and methods for food grain. The inspection items for maize include moisture, extraneous matter, discolored grain, insect-damaged grain, diseased grain and so on. According to the inspection results, maize is ranked into 5 grades, i.e. A, B, C, D and E. Maize ranked A, B, or C is used as food, while that ranked D or E is used as brewing and feed materials. There is an official purchase price margin, which is considerable between each of these grades. (See Table 6-Producer Price of Maize (Official purchase price))

The quality and weight of maize are inspected each time the Cooperative Marketing Union buys it from the producer, the NAMB buys it from the Cooperative Marketing Union and millers buy it from the Cooperative Marketing Union or the NAMB.

For weight, sampling inspections are carried out using platform scales or truck scales installed at some of the NAMB depots. For quality, meanwhile, the inspector decides on whether the maize is acceptable or not, in most cases by his own intuition because of the lack of test apparatuses. As a result, quality is prone to be widely disparate. It is therefore desirable to install more test apparatuses.

(4) Transportation of grain

1) Traffic and transportation conditions

At present in Zambia, the total length of roads is 37,000 km, of which 5,700 km accounting for 15.4%, is paved with coal tar. A total 1,252 km was paved from 1974 to 1983, an increase of 28%. (See Table 8)

Vehicles numbered 167,000 in 1975, of which 150,000 (approximately 90%) belonged to private firms or individuals (See Table 9). Since then, the number of vehicles owned by private firms or individuals

has decreased, partially because of restrictions on the importation of foreign vehicles, resulting from the strict control of foreign currency by the government, as well as because of the increased domestic assembly costs of vehicles. As a result, the number of vehicles fell by approximately 42,000 between 1975 and 1983.

Table 8 Actual Record of Paving Work

Unit: km

Type of Road	1974	1976	1978	1980	1982	1983
Bitumen	4,456	4,968	5,297	5,565	5,583	5,708
Gravel	7,513	7,715	7,778	8,374	8,691	8,645
Other (Unclassified)	23,422	23,169	23,069	22,706	22,793	22,720
TOTAL	35,391	36,852	36,144	36,645	37,067	37,073

Source: Central Statistical Office, Lusaka.

Table 9 Total Number of Vehicles

Year	Government	Private	TOTAL
1974	15,306	142,224	157,530
1975	16,316	150,843	167,159
1976	14,913	144,374	159,187
1977	14,016	134,826	148,842
1978	12,589	125,264	137,853
1979	11,872	117,278	129,150
1980	11,383	113,849	125,232
1981	13,119	111,516	124,635
1982	14,241	112,972	127,213
1983	14,282	110,507	124,789

Source: Central Statistical Office, Lusaka.

The railway business is run by two organizations: Zambian Railways (1,260 km) and Tanzam Railway (1,860 km).

Tanzam Railway started operations in 1973, opening an important transportation route to Dar Es Salaam on the coast facing the Indian Ocean in Tanzania.

2) Transportation of maize

Normally, trucks are used to transport food grain within one province (buying depot - district depot - province depot). In rural areas, transportation is not smooth because of bad roads in addition to the shortage of trucks. This tendency is particularly apparent in the rainy season.

For transportation of grain from production areas in Southern and Central Provinces to consumption areas in Copperbelt Province, railways are used in most cases. Trucks are used to transport grain from Eastern Province to Lusaka, because these provinces are not connected by railway.

Maize is normally transported in jute bags (net 90 kg and gross 91 kg). When silos owned by the NAMB are used, maize is delivered in bags, fed into the silos, and directly transported in bulk to flour mills nearby. To transport to distant flour mills, however, the bulk maize in the sito is put into bags again. Table 13 shows the actual record of transportation of domestic maize between provinces from 1984 to 1986.

2-3 PRESENT CONDITIONS OF EXISTING STOREHOUSES

2-3-1 Present Conditions of Existing Storehouses

(1) Food storage facilities

Grain storage: Store in/out operation and bag stacking
Food storage facilities in Zambia are roughly classified into the following three forms:

1) Storehouses : Bag storage
2) Silos : Bulk storage
3) Open-air storage : Bag storage, which is further classified into the following forms:

a) Open hard-standing

b) Wooden rack

Store in/out operations, bag stacking, and other storage methods mainly include the following items:

1) Store in/out operation and bag stacking in the storehouses

Generally, bags of maize are unloaded by a portable conveyor from a trailer truck alongside the front door of a storehouse. Bags are then brought inside the storehouse and piled by portable conveyors. Usually, it is specified that each truck should deliver 340 maize bags (30.6 tons). However, in some cases, trucks loaded with 500 bags (45 tons) were observed.

① Workers: Store in/out operation is usually handled by a team of 48 workers as a rule. A team is divided into three groups of 16 workers and each group is positioned on the truck, in front of the storehouse, and inside the storehouse, respectively. Workers on the truck unload bags onto a conveyor which carries the bags at the entrance door, then the bags are carried into the storehouse by another conveyor. The workers must carry the bags that have to be taken to areas in the storehouse where the conveyor doesn't reach, but hooks cannot be used. Undamaged bags unloaded in front of the entrance door are directly brought into the storehouse while broken bags are weighed to confirm whether or not each bag contains the specified 90 kg before being stacked. The method of mending broken bags including stitching of the bag mouth is almost the same as that done in Japan.

Maize from broken bags is normally classified grades D and E and it is reported to be mixed with maize shipped in normal bags, but the method of mixing is not clear.

② Stacking Method: Normally, the floor of a storehouse is not covered by wooden dunnage, tarpaulins, etc. Therefore, stored

maize bags are placed directly on the concrete floor and stacked. Some storehouses use the Tsugaru 5-bag stacking method following the guidance of the Japanese while others use the Tsugaru 5-bag stacking method only in the four corners and the irregular stacking method for other stacking.

24 to 28 bags are stacked. The conveyor is therefore capable of carrying at least 28 bags. The aisles between the pile and the side walls is only 1 meter in some cases, which is considered to be too narrow. Furthermore, in some storehouses, bags are simply piled up without providing any aisles in either direction. If bags are stacked in several blocks, bags stored longer can be shipped first, but if bags are stacked without leaving space for aisles, problems in storage control result.

③ Shipping operation: Bags are moved out of storage either by a conveyor, after maize bags are dropped on the concrete floor from the top of a pile, or by direct loading onto a trailer truck, exactly reversing the store-in operation. In this case also, a team consists of 48 workers, and workers who live around the storehouse carry out the shipping operation under the supervision of the NAMB.

2) Silos

In Zambia, the number of trailer trucks which can directly load bulk maize into silos is very small. The method used is that bagged maize is loaded into the silos using conveyors and chutes attached to the existing silos. The Study Team drove about 5,000 km in the Eastern, Western, and Southern Provinces during the survey conducted this time, but did not encounter any trailer trucks for bulk maize.

3) Open-air stacking

In Zambia, a large portion of maize is stored outdoors. Two methods are traditionally used: bags are stacked on a concrete floor raised 30 ~ 50 cm above the ground, called open hard-standing, and bags are

stacked on water-proofed canvas sheets placed on two or three levels of logs, each having a diameter of 12 - 30 cm and a length of 4 m, called wooden racks.

In both cases, bags are piled in the hipped-roof building method, the pile height reaching 10 m with 15 - 20 bags vertically and 20 - 25 bags sloped in some cases. The piles are then covered with waterproof tarpaulins to protect bags from rain and sunlight.

(2) Forms of storage and condition of facilities

Food storage facilities are roughly classified into three stages: facilities used in the farmers' stage, in the distribution stage (production and consumption areas), and the processing stage. Storage facilities such as silos, storehouses, and concrete slabs for open-air storage (open hard-standing) in the distribution stage are owned by the public organizations for grain, namely the Cooperative Marketing Union and the NAMB, according to their roles. As for facilities in the processing stage, flour mills own warehouses and silos for storage of raw materials and products. Among these facilities, storage facilities in the distribution stage are the subject covered in this Study.

1) Buying depots

Buying depots are places where food grain purchased from farmers is gathered to be transported to the district depots. They belong to the Cooperative Marketing Union. Usually, grain bags are stacked on wooden racks while open hard-standings having a storage capacity of 200 - 400 t are used partially.

Generally, the buying depots are located at places where transportation by tractors and small/medium trucks is possible. However, such transportation becomes difficult during the rainy season when road conditions are bad.

2) District depots

The district depots store food grains collected from the buying depots of a district and prepare it for sale within a province and purchase by the NAMB. They belong to the Cooperative Marketing Union. Although the conditions of the facilities vary at each depot, in many cases stacking on an open hard-standing (capacity of approximately 2,000 - 5,000 t) and on wooden racks is employed. Food grain is rarely stored in warehouses.

3) Province depots

Province depots belong to twelve NAMB branch offices around the nation and are located at key points along the main roads and railways connecting the production and consumption areas. Their locations are classified into those located at connecting points between the production and consumption areas and those located in the consumption areas. The former are found in places that are convenient for transportation between provinces such as at points where grain is transferred from trucks to freight cars. Although the latter are mainly for receiving and storing grain to supply raw materials to the flour mills, since a large quantity of inventory is required to maintain a stable supply, storage facilities are of a large scale.

Unlike district depots, most of the province depots use open hard-standings rather than stacking directly on wooden racks outdoors. While, the province depots located along railway have sidetracks for long distance transportation. The province depots include three silos (Monze, Lusaka, Kitwe) that were constructed by Britain before independence, and also the three silos (Ndola, Kabwe, Chisamba) that were constructed by Yugoslavia in 1973. These are not fully utilized, however, due to their antiquated mechanical equipment, cracks in the silos, etc.

(3) Storage period

In the districts where the proposed construction sites are located, shipment of maize begins around April and May and ends around

February and March of the following year with approximately 10% of inventory remaining. Although there is a slight difference between depots, the rule that grains stored longer are shipped first is not necessarily kept. Because the inventory level at each storehouse is at its peak in the rainy season, maize piled outdoors is damaged by rainfall. The Study conducted this time revealed that approximately 23,400 tons of maize were piled outdoors at Kalomo depot in Southern Province, and that at Kapiri-Mposhi depot in Central Province approximately 56,750 tons of maize purchased since July of 1987 would have to be stored for ten months until April of 1988 due to lack of transportation. Under such conditions, it seems that a large amount of such grain is damaged and lost due to rain.

(4) Loss of grain during storage

The main causes for qualitative loss during storage are insufficient drying and penetration of external moisture during outdoor piling.

When bagged maize is stacked on wooden racks, the quality of the grain changes because of micro organisms such as mold caused by the higher level of moisture from the bottom to the 5th level or so of the stack, although tarpaulins are provided.

During the rainy season, maize was damaged by extensive penetration of rainwater through rips in the tarpaulins. According to the Survey conducted this time, there was a report that about 50% of stored maize was damaged by this kind of accident in Kalomo District, Southern Province in 1968.

Also, direct damage from overly high temperatures caused by exposure to direct sunlight, insects, rats, and birds has occurred in open-air stacks.

As described above, the method of grain storage is very simple in Zambia, and a large portion of grain is stored outdoors covered by

tarpaulins. Thus, quality losses due to rainwater, direct sunlight, or moisture from the ground, problems of broken bags caused by reduced strength of jute bags, and quantitative losses due to pests are extensive, resulting in large losses of the amount for annual consumption.

These losses can be greatly reduced by storing grain in storehouses and providing proper quality control. Therefore, the effect of investment in the construction of storehouses is expected to be great.

(5) Storage and fumigation of grain

Maize which is being stored is fumigated using methyl bromide. Piles of maize are covered with vinyl sheets which are fixed on the floor with sand bags. Then methyl bromide gas is injected under the cover, which is tightly closed for 24 hours. The chemical is used in the following standard quantities which are stipulated by the TPI of Britain.

Temperature	Chemical quantity
10 - 20°C	54 g/ton or 36 g/m^3
20°C and over	36 g/ton or 24 g/m^3

Fumigation is done about twice a year for the maize which is stored for about one year and about three times a year when there are many insects. Actellic solvent is sprayed on the surface of piles after fumigation to prevent insects from entering. Three NAMB pest control offices, Lusaka, Ndola, and Monze, implement the fumigation: Lusaka, Ndola, and Monze.

A fumigation team is formed at each pest control office, and the team patrols depots (including depots of the Cooperative Marketing Union) in the following areas:

① Lusaka Pest Control Office:
Central, Eastern, and Lusaka Provinces.

② Ndola Pest Control Office:
Copperbelt, Northern, North-western, and Luapula Provinces

③ Monze Pest Control Office:
Southern and Western Provinces

It is difficult to fumigate sufficiently, since each team covers too large an area. As a countermeasure against rats, the rodenticide "FINALE" is used under the guidance of the pest control offices.

2-3-2 Assistance Programs of Foreign Countries to Construct Food Grain Storehouses

Canada and Japan have provided financial assistance for the food grain storage facilities of Zambia. Of these, the financial assistance of Canada is divided into three phases for a storehouse construction plan for grains. Storehouses with a total capacity of 275,000 tons were completed in 1986. (See Table 10)

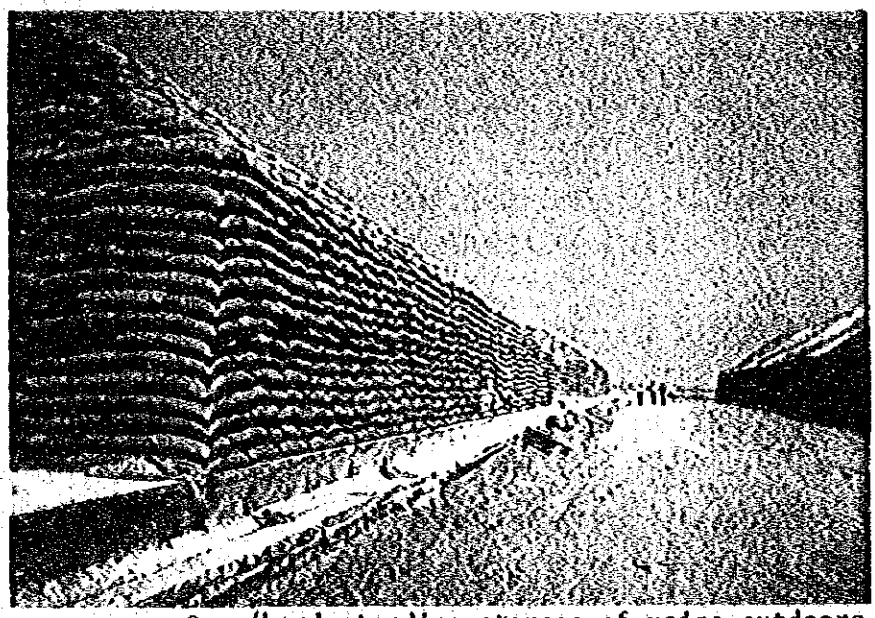
A silo with the capacity of 22,750 tons is scheduled for construction by the Government of Italy for Chipata district in Eastern Province. This project has been approved and is now in the final planning stage. The Italian Government is presently allocating the funds for the financial assistance.

Although these facilities have been completed or are scheduled, the number of indoor storage facilities is quite low. Thus the wish of the Government of Zambia for assistance from the Government of Japan is great.

Table 10 Grain Storage Facilities Owned by the NAMB and Their Capacity

Province	Location	Open hard-standing	Silo	Storehouse by CIDA	Storehouse by Japan
		ton	ton	ton	ton
Southern	Livingstone	55,800			
	Choma			40,000	
	Monze	32,400	14,400	20,000	
	Kalomo	14,400			
	Kaleya			20,000	
Lusaka	Lusaka	61,200	14,400	50,000	
Central	Chisamba	45,000	22,500		
	Mumbwa			10,000	
	Natuseko	31,500	22,500		
	Kapiri-Mposhi	28,800			
	Mkushi			25,000	
	Masansa				5,000
Copper Belt	Bwana Mkubwa	50,400	22,500		
	Kitwe		14,400		
	Chambeshi	54,000			10,000
	Chingola				10,000
Western	Mongu	16,200		10,000	
	Kalabo			5,000	
Eastern	Chipata	18,000		20,000	
	Katete			5,000	
	Lundazi			15,000	
	Petauke			5,000	
	Sinda			10,000	
	Chadiza			5,000	
	Mtirizi				4,000
Northern	Mwenzo			10,000	
	Isoka			5,000	
	Kasama	9,000		10,000	
North Western	Solwezi	3,600		5,000	
Luapula	Mansa	14,580		5,000	
Total		434,880	110,700	275,000	19,000

SOURCE: NAMB
CIDA : Canadian International Development Agency



Open/hard-standing storage of maize outdoors
(Capacity: 4-5000t)

Wooden rack storage of maize outdoors
(Capacity: 500t)

Foundtion of wooden rack

2-3-3 Present Condition of Storehouses Constructed with the Financial Assistance of the Government of Japan

The Government of Japan constructed grain storehouses with a total capacity of 19,000 tons in 1985 at three locations: Chambishi in Copperbelt Province (consumption area), Masansa in Central Province (production area), and Mtirizi in Eastern Province (production area), and furthermore constructed a grain storehouse with a capacity of 10,000 tons in Chingola in Copperbelt Province (consumption area) in 1986.

These storehouses were designed with thorough consideration given to the grain distribution system, handling method, natural conditions, and construction conditions in Zambia, and are evaluated highly by the Government of Zambia. The Basic Design Concepts were established as described below:

1) The floors of the storehouse are elevated about 1 m from the ground to increase the handling efficiency as well as to provide protection against moisture.

2) For efficiency of grain handling by conveyors, grain bags are piled in two rows in the transverse direction, and the large span structure has no columns in the building.

3) Simple gable roofs offer excellent economy and prevent rainwater leaks.

4) A continuous bird screen under the eaves provides sufficient natural ventilation inside the storehouses.

5) Entrances are at both sides of the storehouses so that grain can be handled efficiently.

6) Since natural light cannot enter via the walls because of piled-up grain bags, skylights on the roof provide natural lighting.

7) The external walls are of locally manufactured facing bricks for moisture-proofing, heat insulation, and prevention of rainwater leakage.

8) The roof is of locally manufactured corrugated asbestos cement sheets to facilitate future repair.

The storehouses thus designed reduce quantitative and qualitative loss of maize during storage and help enable flexible transportation plans and efficient handling. Thus, such storehouses will be the model for similar projects, not only in Zambia but also in other African nations.

CHAPTER 3. OUTLINE OF PROJECT

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3-1 OBJECTIVES OF PROJECT

In recent years in Zambia, agriculture promotion measures have been effected with a primary emphasis on the supply of grain, an increased output of maize as an export grain in particular, to meet an increase in the population of Zambia. Efforts have been made to increase grain output through cultivation improvements including the introduction of hybrid seeds. As a considerable proportion of grain storage facilities in Zambia are of outdoor storage, it is true that a significant share of its crop is damaged both quantitatively and qualitatively after the harvest. According to a survey taken in 1983 by the Government of Zambia and the FAO (Nation-Wide Study of Zambia's Storage Requirements for both Products and Inputs), roughly a month's volume of annual consumption is lost in the distribution stage and a sizeable proportion of the loss stems from inadequate handling facilities. It is essential to minimize the loss of grain during storage and to improve grain distribution system in order to eventually realize self-sufficiency in food and achieve the targets of agricultural policies as well.

This project is designed to help achieve these goals by the construction of roofed grain storehouses that match the conditions of Zambia and that are equipped with the necessary equipment for efficient cargo handling and quality control.

3-2 REVIEW OF REQUESTED DETAILS

Prospective sites suggested by Zambia were Mumbwa, Masansa, Katete, Thendere, Muyombe, Lundazi, Mansa, Kaoma, Kalomo and Kabwe-East. In the stage of survey planning, however, Thendere, Muyombe, Mansa and Lundazi were judged to be too problematical as construction sites and were not surveyed further. Reasons are as follows:

- Thendere, Muyombe, Mansa

  In Northern and Luapula Province, the productivity of maize farming remains low and, in view of the current conditins of grain storehouses, the need for storehouse construction does not appear critical. Also, these proposed sites are located in remote areas, making an on-site survey extremely difficult in view of the survey schedule, survey distance, etc. proposed this time. Also considered were the difficulties construction work would face.

- Lundazi

  This site is situated in Eastern Province, where maize productivity was judged outstanding. According to the layout map of the site, however, it was found that 5 CIDA-built storehouses were on the site and ground level differences of the site were also considerable. Therefore, a new storehouse is neither efficient nor necessary.

3-2-1 Summary of Each Province in Which Construction is Scheduled

(1) Southern Province

In Southern Province, average annual rainfall is 800 to 900 mm, with about 700 mm in part of its southern section. As maize grows well in such a climate, its latent output is considered sizable. Because of its warm and mildly tropical climate, the annual average temperature ranges from 17.5°C to 22.5°C, but at the foot of mountains the average temperature rises above 22.5°C because of the geographical nature of valleys.

The average growing season is 130 days in the northeastern part and the central plain, with 80 to 90 rainy days. In the valleys, the growing season is slightly shorter at 110 to 120 days and the average number of rainy days is 50 to 60. Droughts that hit the south coincide with the growing season above and damage both the north and the south. They are more severe on the uplands than in the valleys.

The soil in the Southern Province is extremely varied and changeable, with more fertile soil in the valleys than on the uplands. On the other hand, the soil in the vicinity of such southern regions as Kalomo and Choma consists of loam interspersed with gravel and sand, and is acidic. Also, the soil of the Kafue plain is slow to drain but fertile, making the plain ideal for meadows. Southern Province abounds in rivers; the Kafue river in particular flows from north to south and frequently floods.

The Zambezi river flows through the southern region and Lake Kariba serves as the eastern border of the province. Seen as a whole, however, the province is not blessed with surface water. Consequently, wells, small dams, etc. are the water sources for households and agricultural purposes.

Livingstone in Southern Province is connected to Lusaka by means of a railway and a highway. The total length of so-called inter-provincial highways including paved roads in the province, reaches roughly 430 km and they connect with the main trunk roads of the country. The province has unpaved roads with a total length of 1,600 km (as of 1984). As the quality of these roads is poor, they cannot be used during the rainy season. As a result, they pose a big obstacle to grain and fertilizer distribution in the rural districts.

(2) Western Province

Western Province is one of the driest provinces in Zambia and its annual average rainfall is 600 to 1,000 mm. In the southern part in particular, the volume of rainfall is smaller still. As daily temperature differences are wide, this part is occasionally hit by frosts in winter. All the regions except Kaoma District are consumption area and so they are dependent on maize shipped from other provinces. As a huge part of the province is arable, however, the rural districts could support themselves with agriculture.

In the rural districts, cassava is also grown relatively widely and a few villages live on it. On the other hand, they also grow wet rice in the basin of the Zambezi River and on its flood plain and in Kalabo and Mongu projects to grow wet rice are under way. There is said to be interest in both the production of maize in place of cassava and the expansion of cattle-breeding to insure the future. As described above, Western Province has a large potential for production of food crops in the future, however, presently, it remains as a food consumption province including maize.

(3) Central Province

While the annual rainfall in Central Province is over 1,100 mm in its northeastern part, it hovers around 800 mm in the south. The rains start in November and last till April.

Central Province consists of the Selenje district, which constitutes part of the northern uplands and has a considerable volume of rainfall, and a belt along the Tanzam Railway. As seen, Central Province is blessed with good geography and transportation and also with a good deal of fertile farmland.

The volume of maize purchased by NAMB in 1986 from Central Province was the biggest of all provinces in Zambia. The top suppliers were large-scale farms (about 200~300 workers) followed by medium and small-scale farms. Large-scale farms are often found in Kabwe and Mkushi District.

(4) Eastern Province

Eastern Province covers 31,080 km^2 and consists of uplands and valleys. The soil quality of the uplands varies, ranging from pure sand to loam. It has been developed for more than 70 years to grow grain. As the production of maize has been promoted in recent years, its future looks good.

Though the climate on the uplands remains stable, that of the galleys is unstable and features relatively high temperatures. The volume of rainfall is 800 to 1,000 mm and the rainy season starts in November and lasts until April, with January and February being the rainiest months.

Historically, Eastern Province produced cotton and peanuts, but lately the production of maize as a cash crop has become the norm. The main reason is said to be the small volume of labor required to produce maize compared with that for the production of cotton or peanuts. The maize suppliers in this province are mainly medium and small-scale farms distributed throughout the province.

3-2-2 Current Grain Distribution at Proposed Sites

(1) Productivity in Each Province

Production trends in each province are shown in Table 11, which also shows that the levels of productivity in Central, Southern and Eastern Provinces are much higher than those of other provinces.

The total output of Central, Southern and Eastern Provinces when compared with the total output of the country is as follows:

Crop Year	National Total (A)	3-Provinces Total (B)	Ratio to National Total (C)
1984	871,740	691,650 t	79%
1985	1,123,263	893,412 t	80%
1986	1,111,559	982,753 t	88%
		Average	82%

In short, roughly 80% of the national output is produced by these 3 provinces according to the averages of the last 3 years, demonstrating the importance in terms of output of these provinces for the sites proposed this time. These producer provinces supply maize to low-productivity provinces, demonstrating their importance again in terms of distribution in addition to output. The output of these 3 provinces was calculated from the 1984-89 production plan for maize; for 1984 through 1986, the total output was in rough agreement with actual production figures released by FAO and, as this plan was announced in July 1987, it was concluded that the total output figures were equivalent to actual production.

Table 11 Maize Production Plan (1984 to 1989)

Unit: A: planting area, ha, P: No. of 90 kg bags, ( ) shows tonnage.

Province/Year	1984	1985	1986	1987	1988	1989
Central:						
A ha	101,000	118,700	130,570	143,627	157,900	165,880
P bags	2,759,000	3,172,000	3,489,200	3,838,120	4,221,932	433,029
	(248,310)	(285,480)	(314,028)	(345,431)	(379,974)	(398,973)
Copperbelt:						
A ha	10,400	15,500	17,050	18,755	21,006	22,056
P bags	183,000	321,500	353,650	389,015	435,667	457,482
	(16,470)	(28,935)	(31,829)	(35,011)	(39,212)	(41,173)
Eastern:						
A ha	214,000	206,000	226,600	219,260	274,186	287,895
P bags	3,319,000	3,668,600	4,035,460	4,439,006	4,882,906	5,127,051
	(298,710)	(330,174)	(363,191)	(399,510)	(439,462)	(461,435)
Luapula:						
A ha	4,500	5,400	5,940	6,534	7,187	7,546
P bags	95,000	109,300	120,230	132,253	145,478	152,752
	(8,550)	(9,837)	(10,821)	(11,903)	(13,093)	(13,748)
Lusaka:						
A ha	25,000	30,400	34,048	37,453	41,947	44,044
P bags	460,000	730,000	817,600	899,360	1,007,283	1,057,647
	(41,400)	(65,700)	(73,584)	(80,942)	(90,655)	(95,188)
Northern:						
A ha	42,400	46,800	46,552	51,207	56,328	59,144
P bags	1,000,000	1,073,900	1,181,290	1,298,419	1,429,360	1,500,828
	(90,000)	(96,651)	(106,316)	(116,858)	(128,642)	(135,075)
North-Western:						
A ha	4,200	5,300	5,830	1,413	7,054	7,407
P bags	93,000	111,900	139,948	153,942	169,336	177,803
	(8,370)	(10,071)	(12,595)	(13,854)	(15,240)	(16,002)
Southern:						
A ha	90,000	134,000	147,400	167,140	178,354	177,272
P bags	1,607,000	3,086,200	3,394,820	3,734,302	4,107,732	4,313,119
	(144,630)	(277,758)	(305,534)	(336,087)	(369,696)	(388,181)
Western:						
A ha	15,000	17,900	17,499	19,249	21,174	22,233
P bags	170,000	207,400	258,647	284,512	312,953	328,611
	(15,300)	(18,666)	(23,278)	(25,606)	(28,166)	(29,575)
Total:						
A ha	5,065,000	566,900	588,490	630,880	693,969	728,667
P bags	9,686,000	12,480,700	12,350,660	13,776,244	15,153,869	15,911,562
	(871,740)	(1,123,263)	(1,111,559)	(1,239,861)	(1,363,848)	(1,432,041)

Source: Interim National Development Plan

(2) Grain Transfers between Provinces

The volume of maize purchased from each province by NAMB and the actual movement of maize among provinces between 1984 and 1986 are shown in Table 12, Table 13 and Figs. 1 to 4.

According to actual data of 1986 in particular, Central Province is both a maize producer and supplier to other provinces. First, while 293,000 t of maize were purchased by NAMB in this province, 178,000 t were shipped outside. The supply to Copperbelt Province in particular was as much as 137,000 t, 77% of its total supply of 178,000 t. Other destinations include Luapula (22,000 t), Western (16,000 t) and Lusaka (2,000 t). Favorable conditions such as its convenient railway and highway networks and its central location give this maize supplier an important position in the distribution of grain.

Next, Southern Province purchased 271,000 t of maize in 1986 and supplied roughly 1/3 thereof of 89,000 t to various markets including Western (1,000 t), North-Western (2,000 t), Copperbelt (63,000 t) and Lusaka (20,000 t), establishing itself as another important supplying province.

Table 12 Volume of NAMB Maize Purchases by Province

Unit: No. of 90 kg bags, ( ) shows tonnage

	1984		1985		1986	
CENTRAL	2,117,778	(190,600)	2,232,632	(200,937)	3,254,540	(292,909)
SOUTHERN	1,075,813	(96,823)	1,583,880	(142,549)	3,010,253	(270,923)
EASTERN	1,849,239	(166,431)	1,780,627	(160,256)	2,372,971	(213,567)
NORTHERN	750,552	(67,549)	739,575	(66,562)	673,860	(60,648)
LUAPULA	71,091	(6,398)	58,720	(5,285)	103,872	(9,348)
LUSAKA	193,155	(17,384)	267,384	(24,065)	557,329	(50,159)
WESTERN	89,444	(8,050)	91,578	(8,242)	163,564	(14,720)
COPPERBELT	113,424	(10,208)	241,721	(21,755)	389,829	(35,084)
NORTH WESTERN	67,141	(6,042)	74,644	(6,718)	83,287	(7,495)
TOTAL	6,327,637 Bags	(569,487^{t})	7,070,761 Bags	(636,368^{t})	10,609,505 Bags	(954,855^{t})

Source: NAMB

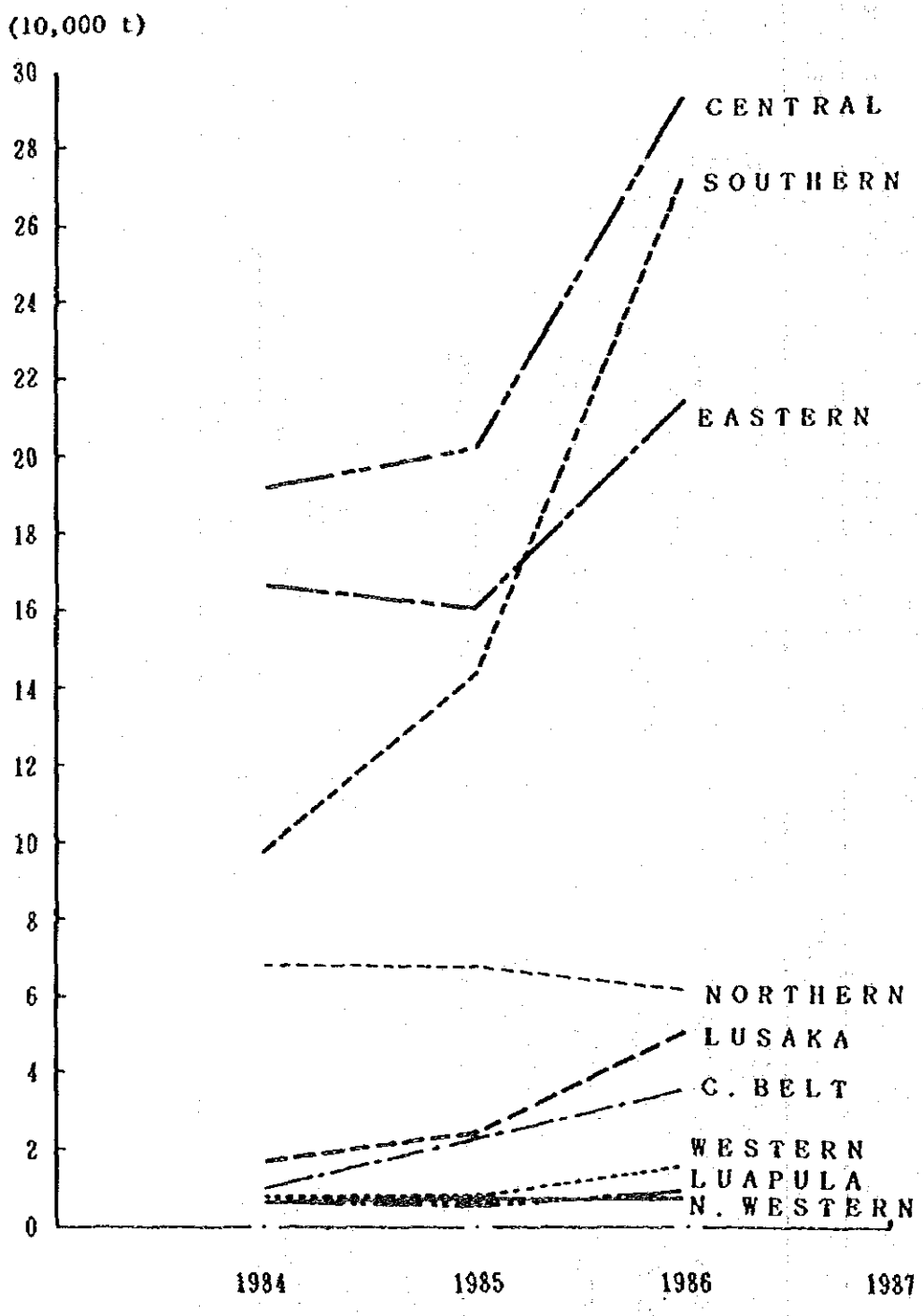


Fig. 1 Volume of NAMB Maize Purchases by Province

Table 13 Actual Maize Transfers between Provinces

Unit: No. of 90 kg bags, ( ) shows tonnage

From \ To	Southern	Western	N/Western	Copperbelt	Central	Lusaka	Luapula	Total
1984								
Central	1,414 (127.26)	69,170 (6,225.3)	-	1,201,567 (108,141.03)	-	-	33,900 (3,051)	1,306,051 (117,544.59)
Copperbelt	-	-	34,837 (3,135.33)	-	-	-	-	34,837 (3,135.33)
Eastern	3,270 (294.3)	-	-	284,743 (25,626.87)	-	1,445,936 (130,134.24)	-	1,765,584 (158,902.56)
Northern	-	31,635 (2,847.15)	-	397,602 (35,784.18)	-	-	44,253 (3,982.77)	441,855 (39,766.95)
Lusaka	39,085 (3,517.65)	124,395 (11,195.55)	-	569,509 (51,255.81)	33,862 (3,047.58)	-	-	766,851 (69,016.59)
Southern	-	-	-	78,631 (7,076.79)		7,230 (650.7)	-	85,861 (7,727.49)
TOTAL	43,769 (3,939.21)	225,200 (20,268)	34,837 (3,135.33)	2,532,052 (227,884.68)	33,862 (3,047.58)	1,453,166 (130,784.94)	78,153 (7,033.77)	4,401,039 (396,093.51)
1985								
Central	-	100,174 (9,015.66)	-	1,699,019 (152,911.71)	-	22,955 (2,065.95)	3,060 (275.4)	1,825,208 (164,268.72)
Copperbelt	-	-	72,486 (6,523.74)	-	-	-	-	72,486 (6,523.74)
Eastern	-	-	-	957,101 (86,139.09)	97,221 (8,749.89)	661,058 (59,495.22)	-	1,715,380 (154,384.2)
Northern	-	-	-	402,470 (36,222.3)	-	1,752 (157.68)	13,744 (1,236.96)	417,966 (37,616.94)
Lusaka	-	7,760 (698.4)	-	236,617 (21,295.53)	-	-	-	244,377 (21,993.93)
Southern	-	-	-	438,870 (39,498.3)	-	51,055 (4,594.95)	-	489,925 (44,093.25)
TOTAL	-	107,934 (9,714.06)	72,486 (6,523.74)	3,734,077 (336,066.93)	97,221 (8,749.89)	736,820 (66,313.8)	16,804 (1,512.36)	4,765,342 (428,880.78)
1986								
Central	-	182,515 (16,426.35)	-	1,525,679 (137,311.11)	-	21,864 (1,967.76)	245,645 (22,108.05)	1,975,703 (177,813.27)
Copperbelt	-	-	36,949 (3,325.41)	-	-	-	-	36,949 (3,325.41)
Eastern	-	-	-	784,464 (70,601.76)	71,007 (6,390.63)	1,418,695 (127,682.55)	-	2,274,166 (204,674.94)
Northern	-	-	-	352,919 (31,762.71)	-	-	73,721 (6,634.89)	426,640 (38,397.6)
Lusaka	-	-	-	269,790 (24,281.1)	-	-	2,116 (190.44)	271,906 (24,471.54)
Southern	-	11,395 (1,025.55)	19,780 (1,780.2)	701,379 (63,124.11)	27,818 (2,503.62)	226,671 (20,400.39)	-	987,043 (88,833.87)
TOTAL	-	193,910 (17,451.9)	56,729 (5,105.61)	3,634,231 (327,080.79)	98,825 (8,894.25)	1,667,230 (150,050.7)	321,482 (28,933.38)	5,972.407 (537,516.63)

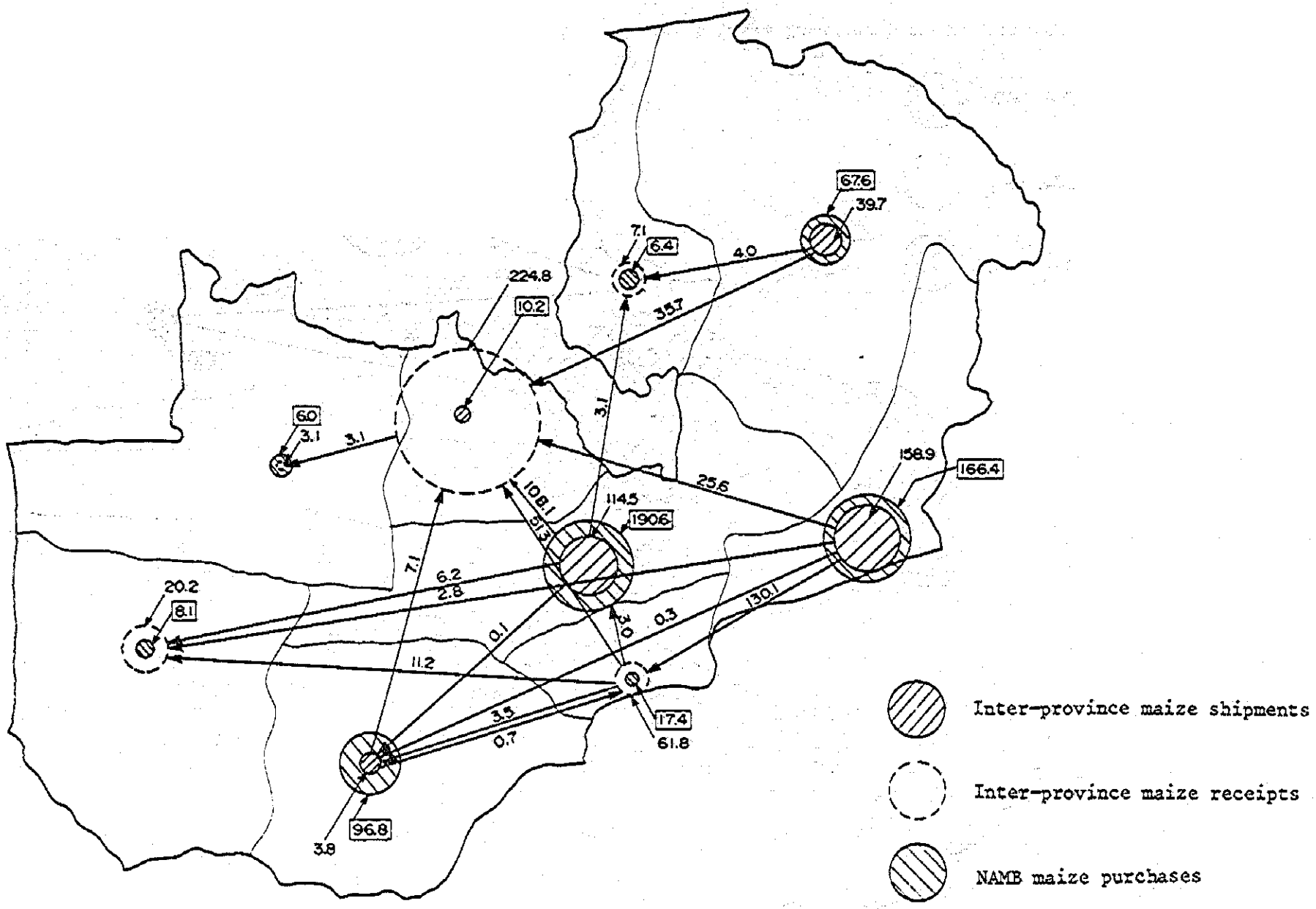
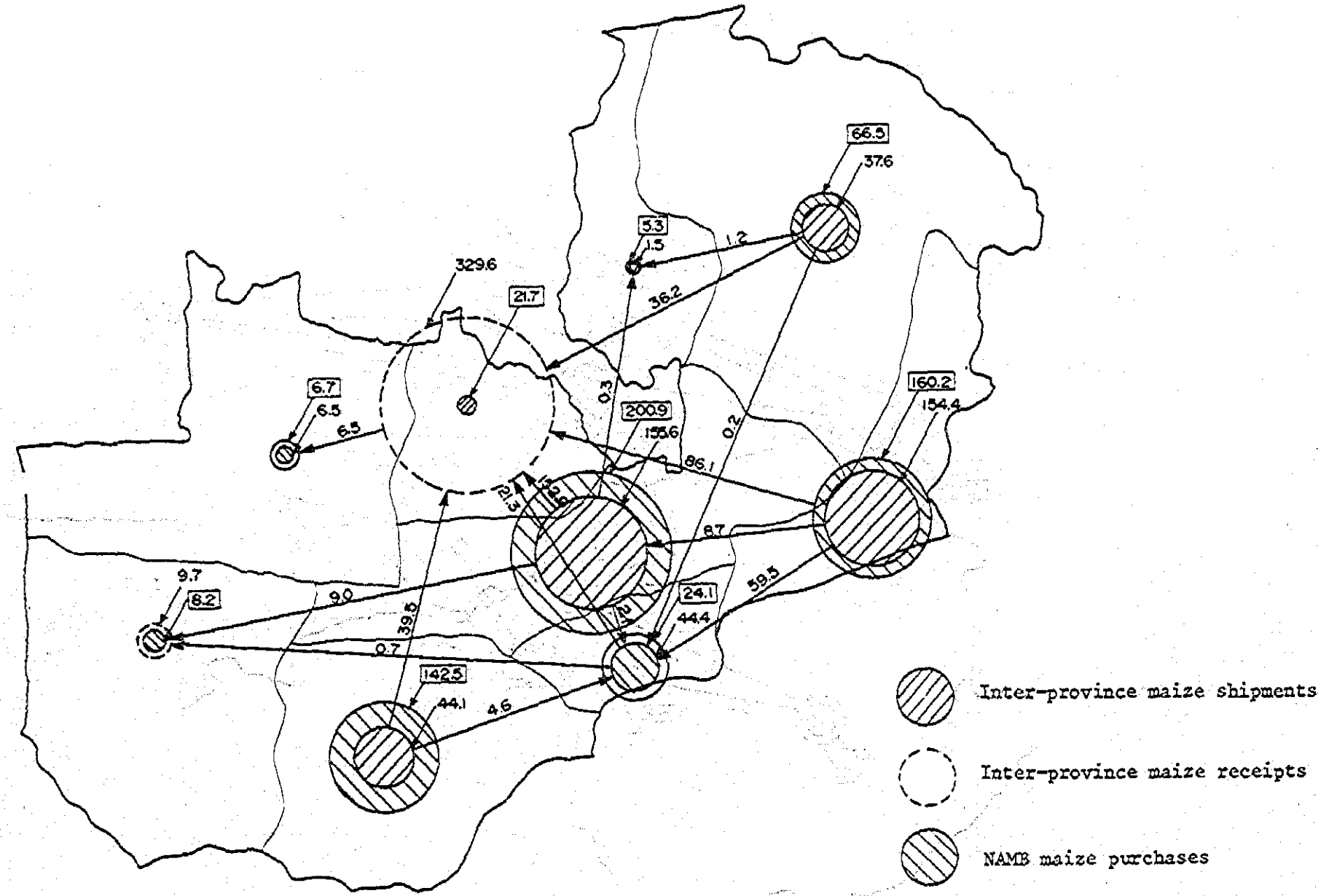


Fig. 2 Actual Maize Transfer between Provinces Unit: 1,000 t (1984)



Unit: 1,000 t

Fig. 3 Actual Maize Transfer between Provinces (1985)

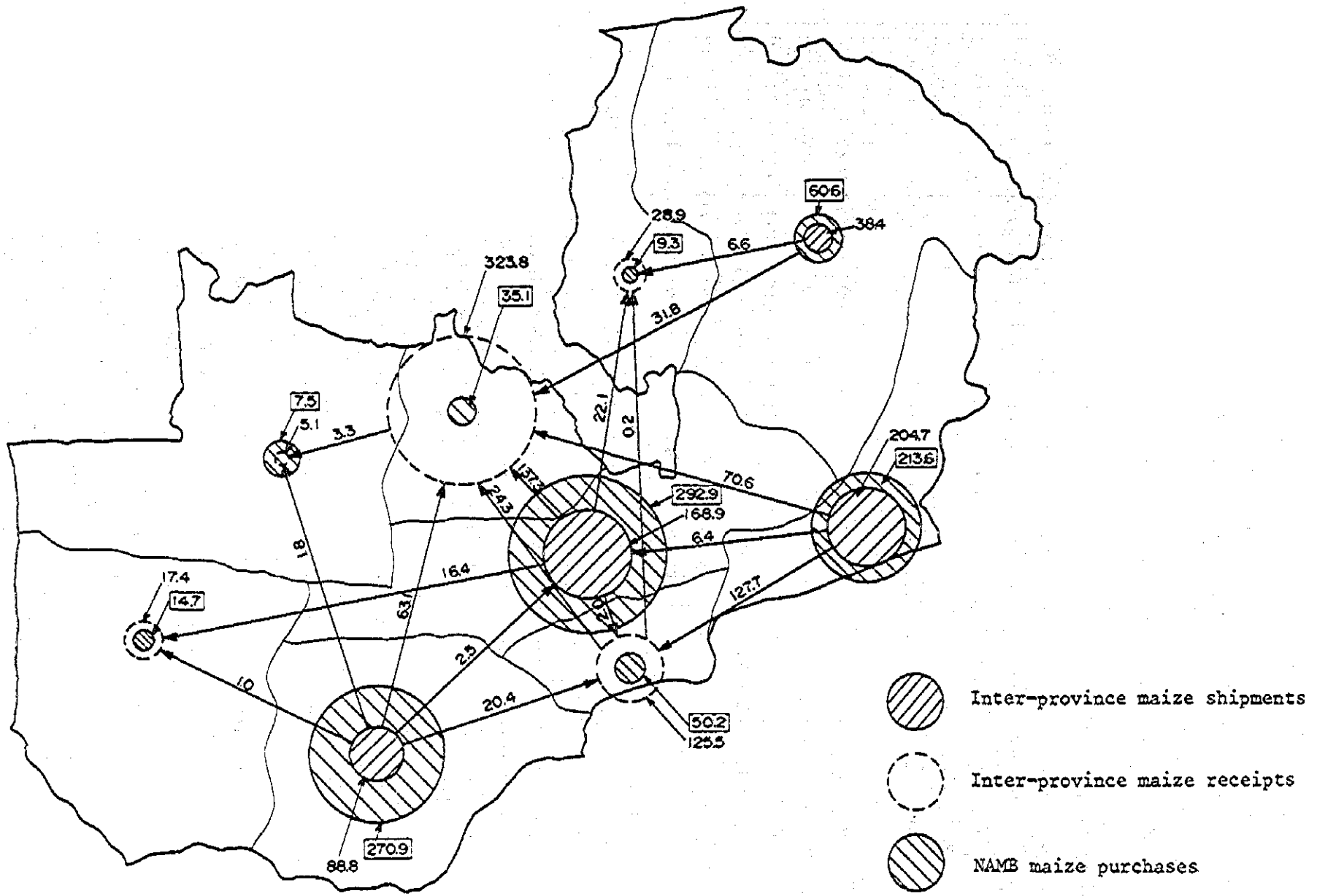


Fig. 4 Actual Maize Transfer between Provinces (1986)

Unit: 1,000 t

In addition, Eastern Province purchased roughly 213,000 t of maize in 1986 and supplied roughly 96% thereof or 205,000 t to the three markets of Copperbelt (71,000 t), Lusaka (128,000 t) and Central (6,000 t), thus ranking extremely high as a supplying province.

Incidentally, the volume of maize purchased from farmers in Western Province is smaller than others (15,000 t), and it buys over 17,000 t of maize from two other provinces, Central (16,000 t) and Southern (1,000 t). Thus, Western Province is a consuming province.

(3) Grain Storehouse Conditions in Each Province

NAMB oversees a grain storage capacity of 850,000 t as of 1987 as shown in Table 14. Roughly 51%, or 430,000 t, out of the above storage capacity is of open hard-standings, while the storehouses and silos have 304,000 t and 111,000 t of storage capacity, respectively. Wooden racks are also used to a great extent under the control of the Cooperative Marketing Union and are used in village and district depots.

The Table below shows the storage capacity of each province compared with the volume of maize purchased by NAMB (purchased from the Cooperative Marketing Union in each province), the volume shipped to other provinces and the volume received from other provinces.

Table 14 Maize Handling Volume and Grain Storage Capacity of NAMB

	NAMB's maize purchase volume	Volume received	Volume shipped	Silo	Storehouse	Open hard-standing
Central province	292,900	8,900	177,800	45,000	40,000	105,300
Southern province	270,900	-	88,800	14,400	80,000	102,600
Eastern province	213,600	-	204,600	-	64,000	18,000
Western province	14,700	17,400	-	-	15,000	16,200
Lusaka province	50,100	150,000	24,400	14,400	50,000	61,200
Copperbelt province	35,100	327,000	3,300	36,900	20,000	104,400
Northern province	60,600	-	38,400	-	25,000	9,000
North-Western province	7,500	5,100	-	-	5,000	3,600
Luapula province	9,300	28,900	-	-	5,000	14,580
Total	954,800	537,300	537,300	110,700	304,000	434,880

* Storehouse ... One-storied storehouse

3-2-3 Review of Proposed Sites

After analyzing grain output in each province, trends of grain transfer between provinces in the past 3 years (1984 to 1986), current conditions of grain storehouses, etc., a survey was taken either to confirm the following or, on the premises of the following, to review each construction site proposed. In Southern, Central and Eastern provinces, maize productivity levels are high and they serve as maize supplying provinces as well. Therefore, the necessity of grain storehouse construction at proposed sites in these provinces (Kalomo, Mumbwa, Kabwe-East, Masansa and Katete) is considered urgent. In addition, though maize productivity in Kaoma in Western Province at present remains low and the province is still a net consumer, dependent on maize supplied from other provinces, its latent agricultural productivity is sufficiently high.

(1) Kalomo (Southern Province)

Kalomo District, one of the nine districts in Southern Province, processes 36,450 t of maize which accounts for roughly 13.5% of the 270,000 t purchased by NAMB in 1986 in Southern Province.

Farms are located between Kalomo and Livingstone and the most maize is produced in the Zimba area situated on the uplands. The fertile soil in limited areas and near the rivers that run into Victoria Falls and Lake Kariba is also good for growing maize.

The Kalomo depot on the proposed construction site is located along the Zambian Railway that connects Livingstone to Lusaka. It is linked by a rail siding to the rail trunkline and is a strategic point of production and handling. Maize is shipped from here to the consuming provinces of Copperbelt and Lusaka and also to Livingstone, the biggest consumer market in Southern Province.

At present, this depot has no storehouse. When the survey was taken, about 23,000 t of maize produced in 1986 were stored outdoors. The shipment of this stored maize to other provinces remains extremely difficult because of the shortage of trailer-trucks, freight cars, etc. As a result, leakage frequently occurs during the rainy season and, in 1986, roughly 40 to 50% of the stock was reportedly damaged.

The construction of maize storehouses is therefore urgently necessary.

(2) Kaoma (Western Province)

In 1986, NAMB purchased 15,000 t of maize in Western Province. 17,000 t were shipped in from other provinces, giving the province a distributed total of 32,000 t. The Kaoma District shipped 7,000 t of the 15,000 t purchased by NAMB to other areas.

The existing Kaoma depot is under the control of the Cooperative Marketing Union and consists of a 2,000 t fertilizer storehouse built with EC assistance and two 2,500 t open hard-standings. In addition, some 500 m away from the depot are 4 open storage yards stocking 2,000 t each and a 2,000 t warehouse with galvanized iron sheet side walls that stores sundries and chemical fertilizers.

The New Kaoma depot will be newly built next to this Cooperative Marketing Union's depot and is designed to handle maize produced in the entire district of Kaoma. As its use as a receiving depot of Western Province and the establishment of a NAMB branch in it are also under consideration, the necessity of constructing this grain storehouse is considered pressing.

(3) Mumbwa (Central Province)

In 1986, Mumbwa District handled 41,000 t of maize, roughly 14% of the 293,000 t of maize purchased by NAMB. A majority of the maize produced in this area is shipped to Copperbelt and Western Provinces.

The Mumbwa depot on the proposed construction site has two 5,000 t CIDA storehouses (10,000 t) built with Canadian aid and a 2,000 t fertilizer warehouse built by the EC.

In addition to its role as the collection depot for areas within a 110 km radius, this proposed site is particularly important for Western Province as it is situated along the trunkroad to Western Province. In 1986, some 16,000 t of maize was supplied from Central to Western via Mumbwa.

In view of its position in the transportation network, the necessity of maize storehouse construction on this proposed site is sufficiently high.

(4) Masansa (Central Province)

Masansa is an important point in Mkushi District, a leading maize producer in Central Province. As it is located 70 km inland on a gravel-paved road that leads to the national trunkroad connecting Kapiri-Mposhi with the national border with Tanzania, it is positioned as a depot directly connected to farms. The volume of maize handling by Masansa depot is roughly 40% of the Mkushi District total, the annual handling volume in 1983 was 36,000 t, and the predicted growth of handling volume is outstanding.

This depot already has a 5,000 t storehouse built with a grant from the Government of Japan. However, open storage on wooden racks is still employed, causing considerable losses both quantitatively and qualitatively.

Hence, the construction of more storehouses is considered necessary.

(5) Kabwe-East (Central Province)

In Central Province, Kabwe District is the biggest maize producer in Zambia, rivalling Mkushi District.

This proposed depot in Kabwe-East, however, is a production-point depot under the control of the Cooperative Marketing Union of Kabwe District and the maize produced and distributed in this district is stored temporarily in this depot and then shipped chiefly to Copperbelt.

This proposed site in Kabwe-East was to be considered in combination with depots in Chikonkomene and Idwambula close by but, as shown in Table 15, even the expected total volume of maize stored in these 3 depots before the starting of rainy season does not reach 5,000 t.

Table 15 Handling Volume by Each Depot

Unit: No. of 90 kg bags, ( ) shows tonnage

Name of depot	Distance from Kabwe	1983/84 Handling volune	1984/85 Handling volume	1985/86 Handling volume
Chikonkomene	34 km	33,706 (3,034)	31,424 (2,828)	35,452 (3,191)
Idwambula	45 km	43,185 (3,887)	51,345 (4,621)	56,116 (5,050)
Kabwe-East	28 km	33,852 (3,047)	24,604 (2,213)	26,403 (2,376)

Also, the routes from Kabwe, a junction with the trunkroad, to Chikonkomene, Idwambula and Kabwe-East remain unpaved and it was predicted that maize transportation during the rainy season would be extremely difficult.

As mentioned above, building a storehouse at the Kabwe-East depot, as proposed this time by the Government of Zambia, was judged unnecessary on account of its handling volume, etc. Kabwe District in Central Province, in which the proposed site of Kabwe-East is located, rivals Mkushi District as the biggest maize producing county in Zambia. Though Central is the biggest maize producing province with a larger output than that of Southern or Eastern, its storehouse ownership ratio remains low.

Therefore, the Study Team recommends Kapiri-Mposhi in Kabwe District in place of Kabwe East, especially because of its position in the distribution network. Background summaries are as follows:

* Kapiri-Mposhi

  The proposed site of Kapiri-Mposhi is located on the border between Kabwe and Mkushi District and at the junction point

of the Zambian Railway that links Lusaka to Copperbelt and the Tanzam Railway. It is also a strategic point on the national trunkroad network.

This depot has no storehouses and, at the time of survey, some 20,000 t of maize was stored on open hardstandings. In 1986, 57,000 t was brought in and reshipped chiefly to Chingola, Copperbelt Province. 20,500 t of the above maize currently under possession is scheduled to be shipped out by April, 1988. However, as it has to be stored and managed for more than 10 months from its delivery in July this year, quality problems are anticipated.

Maize storehouses should therefore be built on this site.

(6) Katete (Eastern Province)

Katete District is one of the production areas in Eastern Province, accounting for about 30% of the total production of the province.

Katete depot handled about 20,000 t of maize in 1986. Maize purchased in this area is temporarily stored in the Katete depot before being shipped mainly to Lusaka and Copperbelt Provinces.

The site is located about 3 km south from the main road connected with Lusaka, and as existing facilities, there are one one-story storehouse (5,000 ton x 1 building) a fertilizer storehouse (2,000 ton x 2 buildings), and an office constructed with a grant aid from Canada on the proposed site. During the survey, it was observed that about 14,000 t of maize was stored outside some 2 km away from the proposed site.

This depot collects maize from areas about 100 km around the depot. When considering the fact that maize production in the province is increasing every year, its role as a production depot to Lusaka, etc., is deemed to be more important in the future.

3-2-4 Location Conditions of Proposed Construction Sites

[List of proposed construction sites]

Western Province	Southern Province	Central Province	Eastern Province
Kaoma	Kalomo	Mumbwa Kabwe-East Masansa Kapiri-Mposhi	Katete Lundazi

The depots proposed this time are all for production points and the details of each on-site survey are listed in summary tables that follows:

Of the proposed construction sites, all sites except Kabwe-East are located by paved trunkroads or in similar road conditions and car traffic is possible even during the rainy season. It is necessary to use an unpaved road some 30 km away from downtown Kabwe to reach Kabwe-East, which makes it difficult to reach by car during the rainy season.

Also, of the above, the construction of a new storehouse in Lundazi was judged inefficient and its on-site survey was eliminated since a check revealed that the site already had 5 CIDA storehouses including a fertilizer warehouse, and since the slope of the site was steep.

Except for the completely new Kaoma depot, to be built in Western Province, details of existing buildings on each site, surrounding infrastructure conditions, etc. will be covered in combination with layouts to follow. Next summaries of each site are provided.

(1) Kalomo (Southern Province)

The proposed depot will be constructed as an extension of the existing depot of Kalomo station and, as shown in the layout that follows, an additional rail siding is also under consideration. Kalomo station is some 2 km away from the trunkroad and some unpaved sections are in between. As they are passable even during

the rainy season, no specific problems are anticipated for approach to the site. Storage at the existing depot is either of an open hard-standing type or of a wooden-rack type and its storage capacity reaches as high as 23,000 t.

NAMB requested that the entrance to the site be on the road on the east so that the premises need not be traversed. Also, there are at present several houses of NAMB employees on the proposed construction site, but it was confirmed that they could be removed. As for the water drainage gutter that runs through the site from north to south, it was suggested that a necessary section be reinforced with concrete.

The layout of the railway siding referred to above requires the final confirmation of Zambia Railways but the location proposed by NAMB was confirmed so that planning for the site may not be disturbed. According to their proposal, the siding consists of two tracks, one connected to the existing depot and the other to the proposed construction site.

As power lines exist at present along the front road in the east and telephone lines and water supply piping are to be placed along this road, planning of construction will be made in full consideration of these utilities.

(2) Kaoma (Western Province)

The site is located some 3 km from the trunkroad leading to the city of Kaoma and, as the front road is paved, no transportation problems are anticipated. As the depot will be new, facilities like existing buildings are not on the site. The site is a generally flat grassland with no specific obstacles. Also, as the site is located close to the entrance to downtown Kaoma, infrastructure facilities can be supplied from the town, making the lead-in of electricity, telephone circuits, water supply, etc. possible.

The shape of the site currently proposed by NAMB has a 200 m side along the road. However, it is possible to extend the site southward in the future. Therefore, it is necessary to consider a future plan as well.

(3) Mumbwa (Central Province)

The site faces the paved trunkroad and no transportation problems are presented even during the rainy season.

Existing facilities on the site consist of CIDA maize storehouses (5,000 t x 2), an EC fertilizer warehouse (2,000 t x 1), 2 offices and a toilet, which are all surrounded by a fence. These facilities attached to the storehouses are all weather-beaten and small in scale and do not appear to have sufficient rooms for operation and control of the depot. Also, the site has a well and a diesel pump to supply water to an existing elevated water tank (capacity: 2,000 litres, H = 4 m). However, the pump is just covered with a tent and there is no real pump room. Although a sufficient volume of water can be obtained, as the pump head is up to a height of 7 m, facility planning in full consideration of a ground level difference of about 6.0 m for the entire site has to be made.

In addition to the above facilities, two houses surrounded by a fence are on the northwestern part of the site and are at present occupied by NAMB officials. As these houses and the fence belong to NAMB, they can be removed.

Though there is a height gap on the site in the north-south direction, it is surrounded by grasslands and no obstacles to construction were found. The toilet is equipped with a septic tank.

(4) Kabwe-East (Central Province)

As the depot is one of the maize handling points of the district and belongs to the Cooperative Marketing Union, the site area is smaller than that of other proposed sites. The width of the front road is 6 m but it is still unpaved. Therefore, it is difficult to approach during the rainy season by car from Kabwe. On the site, an office and workers' facilities are scattered close to the entrance. At present, maize is stored on wooden racks.

The site has a well but the volume of its water supply is not sufficient for construction work, etc. Plans to lead in telephone circuits and electricity are not existent either. A river runs some 3 km away.

Chikonkomene and Idwambula, two other depots of the Cooperative Marketing Union of which site survey was made this time, have similar site scales to that of Kabwe-East. They are 35 to 45 km apart from downtown Kabwe and since all roads from downtown to the sites remain unpaved, the transportation is difficult in the rainy season.

(5) Masansa (Central Province)

No on-site survey of Masansa was made but confirmation by drawings with NAMB was made as it was surveyed in 1984 and a 5,000 t storehouse was completed in 1986 by Japan's grant aid. According to NAMB, the site could be extended southward. They also said that no expansion was made after 1986 and the introduction of electricity and telephone circuits was not specifically scheduled. If the volume of water supplied by a well on the site proves insufficient, they said they would investigate and drill another well on their own.

(6) Kapiri-Mposhi (Central Province)

Though a survey of Kapiri-Mposhi was not included among requests from the Government of Zambia, its summary is introduced below as the study team collected information from the viewpoint of grain distribution when it visited the depot.

The site is located at the relay point between Copperbelt Province and Central Province and is next to the premises of Kapiri-Mposhi Station positioned importantly in the grain distribution network. Though the premises of Kapiri-Mposhi Station adjoin the trunkroad to the east, the site suggested by NAMB does not face this trunkroad directly. The entrance to the site is at present located in the north. If this entrance is to be used, it will be necessary to traverse the existing depot on the premises. Therefore, another entrance is to be located south of the site so that it may be approached directly from the road. As two siding tracks are to be built to the site and the site area of 9.0 hr (300 m x 300 m) is spacious enough, the use of these siding tracks will be taken into consideration as well as future extension in the facility layout planning.

As the existing depot is already in possession of electric and telephone facilities, it is possible to extend them to this site. As for water supply, no well is at present available, but NAMB pledged to make the necessary investigation for drilling and confirm the results.

Maize, fertilizer, etc. in the existing depot were all stored on open hard-standings and nearly all piles were only covered with tarpaulins when surveyed.

Although the existing depot has an office, a toilet etc., they are located close to the north entrance, away from the proposed site. Therefore, these facilities will not be used in the project.

(7) Katete (Eastern Province)

The site is located some 3 km south of the trunkroad and its 7 m wide front road is paved, alleviating any transportation problems during the rainy season.

The existing facilities include a CIDA maize storehouse (5,000 t), two fertilizer storehouses (2,000 t each), an office and a toilet.

The site is situated on a slope from the road and the highest point of the site rises some 9 m above the road. Therefore, it is necessary to plan the approach to the storehouse in full consideration of relations with existing buildings. As the site area is as large as 8.55 ha and its height gap sizable, future use of the site including the existing buildings will have to be considered. Although, there are several houses of NAMB laborers on the site, according to NAMB, they can be demolished and removed.

As for infrastructure, electric and telephone lines run along the front road. Electric power is already led in through a substation on the site and, as for telephone service, one circuit serves the office at present. As for water supply, a well with a pump is behind the existing buildings and an elevated water tank is also equipped to supply water to the toilet and facilities on the site. The toilet also has a treatment tank.

3-2-5 Conditions of Areas Around the Proposed Construction Sites and Their Infrastructure

	Southern Province	Western Province	Central Province				Eastern Province
	Kalomo	Kaoma	Mumbwa	Kabwe East	Masansa	Kapiri-Mposhi	Katete
Area	4.79 ha 428 m x 112 m	3.0 ha 200 m x 150 m	8.10 ha (Area occupied by the existing CIDA store houses: about 1.77 ha) 365.82 m x 221.3m	0.5 ha 100 m x 50 m	5.61 ha 170 m x 330 m (The site will be extended 20 m southward.)	9.0 ha 300 m x 300 m	8.55 ha (334 m x approx. 220 m)
Front Road	7.0 m wide unpaved road	7.0 m paved road and unpaved road on the north side	A 7.0 m major paved road connects with the site, which is approximately 65 m from the road. The connecting road is 6.0 m and unpaved.	6 m unpaved road	7.0 m road (unpaved)	The proposed site is adjacent to the premises of Kapiri-Mposhi Station. There is no front road; however, access to the site will be provided at the place to be designated by the NAMB.	7 m paved road. The site is accessible by a 6 m road.
Configuration and Topography	Many small undulations, but generally flat with minor differences in elevation	The site is almost flat with some bushes.	There is a difference of 6 m in elevation from west to east. Generally, the proposed site is covered by low grass with some bushes.	Generally, the proposed site is flat with some undulations and trees.	The land slopes toward the road from the site, but is generally flat.	Generally flat without major difference in elevation. The site is square; 300 m x 300 m.	Gently sloped over the entire site area. 1 m contour lines can be drawn at intervals of 30 - 40 m from east to west. The difference in elevation between the highest points on the road and the site is approx. 9 m.
Location	The distance between Lusaka and Kalomo is about 400 km (paved road). The proposed site is located on the premises of Kalomo station, approximately 2 km from the main road via unpaved road.	The distance between Mumbwa and Kaoma is about 250 km (paved road). The site is located about 3 km from a 7 m road which connects the main road and Kaoma City and faces the 3 m road.	The distance between Lusaka and Mumbwa is about 150 km (paved road). The site faces the main road and is visible from the main road.	The distance between Lusaka and Kabwe is about 150 km (paved road). The site is about 30 km from Kabwe City to the east of the unpaved road.	The distance between Lusaka and Kabwe is about 150 km and between Kabwe and Tanemeka about 100 km (paved road). The site is about 70 km from Tanemeka along an unpaved road.	The distance between Lusaka and Kapiro-Mposhi is about 200 km (paved road). The site is at the junction of the Tanzan and Zambia Railways for Copperbelt and Central Provinces.	The distance between Lusaka and Katete is about 400 km (paved road). The site is about 3 km from the main road to the south of the paved road.
Current Conditions	The proposed site will be an extension of the existing depots (all open hard-standings). There are some residential houses for the workers of the NAMB. Electric lines supplying electricity for the railway run across the site.	Since the depot is to be newly constructed, there are no existing structures. The site is adjacent to a depot of the W.P.C.U. on the north. Authority for this depot has been transferred from the NAMB. *U.P.C.U. - Western Province Cooperative Union	CIDA .... Maize storehouse (5,000 t x 2) E.C. .... Fertilizer storehouse (2,000 t x 1) Apart from the storehouses, there are two houses (for the NAMB) which are surrounded by fences. The rest of the area around the site is open land without any obstacles.	Since the depot is located in a rural grain collection district, it is very small. A simple office building and facilities for workers are the only structures seen around the proposed site in addition to open hard-standings at two locations and a small wooden-rack.	Japan ..... Maize storehouse (5,000 t x 1) Australia .... Fertilizer storehouse (1,000 t x 3) NAMB ..... Material storehouse (1) Others ..... Wooden rack	The proposed site is adjacent to a station, and there are no existing buildings worth mentioning. On the premises of the station, there are open hard-standings, an office, etc.	CIDA ... Maize storehouse (5,000 t x 1) ... Fertilizer storehouse (5,000 t x 2) Others . Simple office and wooden-rack Several houses for NAMB workers on the proposed site can be removed.
Electricity	There is a power line along the front road on the east of the proposed site.	Electricy can be supplied from the northwest corner of the site.	Electricity is scheduled to be supplied from the road to the east side of the site.	None	None	Electricity can be supplied from northeast of the site.	There is a power line along the front road. Electric power can be supplied through the existing sub-station.
Telephone	Telephone lines will be led in from the northeast of the site	Same as above	None	None	None	Telephone lines can be led in from southeast of the site.	Telephone lines have been installed across the front road.
Water Supply	There is a plan to install a water supply facility along the road on the east side.	Same as above	There is a well with a pump near the CIDA storehouse. Currently, the pump supplies water to the existing elevated water tank (4 m) (2,000 ℓ).	None (There is a river about 3 km from the site.)	There is a well on the site. (Capacity is very small.)	No water facilities such as wells, etc.	A well and an elevated water tank are available on the site. At present, water is supplied from the tank to the toilets of the existing buildings, etc.
Drainage	A drainage culvert, 1.5 m wide and 1.5 m deep, runs from the south to the north.	None. However, the adjacent depot has an open drainage culvert between the road and the site.	One existing septic tank. Wastewater from the site is collected through a drainage ditch before being discharged outside the site.	None	None	No drainage facilities are available at the proposed site. However there is a drainage ditch on the east of the site within the premises.	None
Railroad	A siding track is scheduled to be laid to the site.	None	None	None	None	Siding tracks are planned to be extended from the existing lines.	None
Others	The site belongs to Zambia Railways and the Kalomo District Council. However, the NAMB has been offered the use of the site. There is a river within 1 km of the site.	Maps show the road mentioned above. However, at present, no such road exists. As for structures, there is a gasoline stand on the site.	Although there is an existing office building, it has become obsolete and is small. The houses situated within the site can be removed. There is a river within 1 km of the site.	The C.P.C.U. owns the land. *C.P.C.U. - Central Province Cooperative Union	A survey was not conducted this time. Information will be collected from the survey of 1984 and the local contractors.	NAMB will confirm by drilling whether or not water can be supplied from a well. Since the site is large enough, a plan for future extension will be considered.	Although there is an existing office building, it is small and has become obsolete. A depot is located about 1 km from the present site and handles the flow of maize using open hard-standings.

3-2-6 Proposed Site and Setting of Storehouse Scale

Originally, storehouse scale is set after analyzing various factors related directly and indirectly with delivery to and shipment from the storehouse. For example, such details as supply, demand, and distribution as production to transportation, storage and consumption, actual capabilities of the executing organization to control distribution and operate storehouses, agricultural situations including future programs, population trends, eating habits, trade conditions, weather, etc. prove to be relevant.

Ideally, the scale of a storehouse has to be established after review and analysis of these various factors and their future likely development.

This project is designed to follow up the construction of storehoues already finished in two phases and is not supposed to formulate an improvement program for all aspects of grain production and distribution in Zambia. Rather, it will help improve storage facilities through bettering outdoor storage, etc.

In establishing storehouse scale, it was judged most practical to establish the scale necessary to eliminate open storage during the rainy season after analyzing actual conditions of distribution at a proposed site.

The objectives of a production-point storehouse include, after the harvest of food grain produced in its vicinity, as quick a collection of crops as possible, their storage under optimum conditions and without detriment to quality, and their preparation for shipment to consumer markets. Therefore, the conditions of selection of a production-point storehouse construction site are affected by area grain output, storage capacity, transportation conditions, etc.

On the other hand, a consumption-point storehouse is designed to secure a stable supply of food to neighboring consumer markets and, to this end, it becomes necessary that grain delivered from production points be stored without deterioration in its quality.

Therefore, its storage capacity, the volume of consumption in the neighboring areas, transportation conditions, etc., are relevant. As all construction sites proposed this time are located at existing depots or adjoining thereto, the key point in the establishment of scale is to determine how much of the outdoor storage facilities of each depot can be converted into covered storage facilities in consideration of the location conditions of the depot.

To this end, it is most desirable to build storehouses capable of storing an estimated yearly maximum volume derived from monthly surveys of delivery to and shipment from the storehouse in order to ascertain the highs and lows of the estimated volume of inventory. If cargo is handled properly, outdoor storage can be eliminated almost entirely, but the effect of investment is considered maximized if the total volume can be stored indoors during the annual rainy season after December.

The amount of storage capacity for each proposed site was determined by calculating the monthly receiving and shipping volumes using the following conditions and methods to achieve ideal control over distribution and based on the data obtained from each district and at each depot.

Calculation conditions

① Total volume received = Total volume shipped (Standard handling volume)

② Beginning inventory = Ending inventory

③ Inventory of the lowest inventory level month = 0

Calculation methods

① Standard handling volume = Average handling volume at a proposed site in the past three years + (Maximum handling volume - Average handling volume)/2

② Monthly receiving and shipping volume:
The standard handling volume of each proposed site is calculated based on the monthly distribution volume of each district in the past three years.

Generally, however, the level of inventory of the lowest inventory level month is assumed to be approximately 10% of the total handling volume. The survey conducted this time found that problems in distribution control cause inventory to increase as production increases and that changes in the volume handled tend to be affected by the ending inventory of the previous year. Therefore, when the larger volume for distribution and handling resulting from the remarkably increased maize production in recent years is taken into consideration, the monthly receiving and shipping volumes calculated here seem to be the smallest figures required.

Determined storage capacity of each proposed building is described as follows:

(1) Kalomo (Southern Province)

The actual annual volumes of the last 3 years handled by this proposed site located some 340 km to the southwest of Lusaka and along the Zambia Railway and the national highway that connect Livinstone to Lusaka are as follows:

1984	12,308 t
1985	24,129 t
1986	6,950 t
Average	14,462 t

In the last 3 years, handling was limited to receiving purchases and, in this connection, it can be classified as a typical point of cargo collection, dependent chiefly on transfers in a production area. Standard handling volume and monthly receiving and shipping volumes are calculated based on the preceding conditions (Table 16).

Table 16 Kalomo's In and Out Shipments by Month

(t)

	Volume shipped in	Volume shipped out	Volume of inventory
			At start of period: 6,746
Jan.	-	1,252	5,494
Feb.	-	1,684	3,810
Mar.	-	1,648	2,162
Apr.	145	1,501	806
May	424	1,230	0
Jun.	1,338	1,044	294
Jul.	2,280	340	2,234
Aug.	4,857	3,312	3,779
Sep.	5,318	1,580	7,517
Oct.	4,620	2,915	9,222
Nov.	314	1,694	7,842
Dec.	-	1,096	6,746
Total	19,296	19,296	

According to this Table, the maximum volume of inventory throughout the year is roughly 9,000 t and the volume required for the rainy season is 8,000 to 8,500 t.

However, a record volume of over 20,000 t of maize has been open-stored since 1986 when the on-site survey was made and, for the last two years in a row, the end-of-term inventory reached over 15,000 t and exceeded the existing open hard-standing storage capacity of 16,000 t. However, it is judged that this will have to be solved by an improvement in the abilities of NAMB or the Cooperative Marketing Union to manage the storage facilities

systematically and in the ability to procure transportation vehicles, including trucks which are operated by the private sector.

Therefore, 10,000 t is considered an optimum storage capacity for the storehouse to be built on this proposed site.

(2) Kaoma (Western Province)

The actual handling volume at the proposed construction site in Kaoma over the past three years is as follows. As done for other proposed sites, the volume of monthly distribution in Kaoma is shown in Table 17 below.

1984	14,400 t
1985	15,100 t
1986	15,300 t
3-year average	14,933 t

Table 17 Kaoma's In and Out Shipments by Month

(t)

	Volume shipped in	Volume shipped out	Volume of inventory
			At start of period: 3,160
Jan.		808	2,352
Feb.		476	1,876
Mar.		497	1,379
Apr.		426	953
May	16	625	344
Jun.	63	407	0
Jul.	2,873	747	2,126
Aug.	3,494	3,050	2,570
Sep.	4,875	3,037	4,408
Oct.	3,544	2,049	5,903
Nov.	252	1,845	4,310
Dec.		1,150	3,160
Total	15,117	15,117	

According to the table, the maximum vlume of inventory during the year is approximately 6,000 t and the required volume toward the rainy season approximately 4,000 t. The NAMB has expressed its desire to increase the storage capacity as a new base upon completion of a storehouse in Kaoma. Although the requested capacity is 10,000 t, construction of a storehouse with a capacity of 5,000 t is deemed reasonable.

(3) Mumbwa (Central Province)

Handling achievements in the past 3 years of the proposed site in Mumbwa, which serves the big consumer markets of Lusaka and Copperbelt, are as follows:

1984	6,225 t
1985	34,452 t
1986	18,224 t
3-year average	19,630 t

However, the volumes handled at the site in the last 3 years fluctuate widely. The volume for 1985 is more than 5 times greater than that of 1984, for example.

Standard handling volume and monthly receiving and shipping volume are calculated based on the preceding conditions, of which results are shown in Table 18.

Table 18 Mumbwa's In and Out Shipments by Month

(t)

	Volume shipped in	Volume shipped out	Volume of inventory
			At start of period: 9,349
Jan.	59	5,872	3,536
Feb.	-	1,786	1,750
Mar.	-	1,168	582
Apr.	-	250	332
May	392	724	0
Jun.	515	165	350
Jul.	2,412	-	2,764
Aug.	5,569	481	7,852
Sep.	8,880	3,825	12,907
Oct.	7,585	3,068	17,424
Nov.	1,629	4,634	14,419
Dec.	-	5,070	9,349
Total	27,043	27,043	

The maximum volume of inventory during the year is 17,000 t and the volume of inventory before the rainy season is about 15,000 t. As the site already has a 10,000 t storage capacity built with aid from the Government of Canada, 5,000 t is judged appropriate for the capacity of the storehouse required to be built.

(4) Masansa (Central Province)

This proposed site, an important center in the Mkushi District, already has a storehouse with a capacity of 5,000 t that was built in 1984 in accordance with a Basic Design Study of 1983 with aid from the Government of Japan.

Therefore, an on-site survey of this depot was not made this time but the formulation of the necessary capacity for its new storehouse was based on the contents of the Basic Design Study of 1983.

According to tentative calculations made in 1983, the annual volume of handling at Masansa was 36,000 t. The subsequent growth of maize output in Central Province as a whole including the Mkushi District in the 3-year period between 1984 and 1986 was roughly 25% and the handling volume of NAMB grew by about 50% during the same period.

Although it has been 4 years since the previous survey, a similar growth rate of 50% or so is likely for Masansa as well, pushing up the annual volume of handling to about 54,000 t. Table 19 shows the calculation results of monthly shipments in and out based on this information.

Table 19 Masansa's In and Out Shipments by Month

(t)

	Volume shipped in	Volume shipped out	Volume of inventory
			At start of period: 23,669
Jan.		4,355	19,314
Feb.		4,337	14,977
Mar.		4,819	10,158
Apr.	15	5,050	5,123
May	211	4,433	901
Jun.	536	1,437	0
Jul.	4,547	2,574	1,973
Aug.	11,256	3,183	10,046
Sep.	13,745	4,605	19,186
Oct.	15,988	5,779	29,395
Nov.	7,554	6,267	30,682
Dec.	148	7,161	23,669
Total	54,000	54,000	

Judging from this, a storehouse capacity of about 30,000 t is required for the time being. This proposed site has a 5,000 t storehouse built with aid from the Government of Japan. In addition, nearby Mkushi has 25,000 t storage facilities built with aid from the Government of Canada and the ownership rate of storehouses in Mkushi District is sufficiently high. Because of the above, it is possible to adjust shipments between depots in the district and, even after allowing for an increase in the volume of distribution caused by a recent increase in output, 10,000 t is judged suitable as the capacity for the storehouse to be built.

(5) Kapiri-Mposhi (Central Province)

As mentioned, this site is to replace another proposed site in Kabwe-East and is an important distribution center as it is positioned at the junction point of the Zambia and Tanzam Railways and adjoins a national trunkroad.

This Kapiri-Mposhi depot is under the control of NAMB and its annual handling volumes in the last 3 years confirmed at the time of its on-site study were as follows:

Year	Handling volume (ton)
1984/85	26,150
1985/86	56,751
1986/87	40,948
3-year average	41,283

Table 20 below shows the results of calculated monthly in and out shipments.

Table 20 Kapiri-Mposhi's In and Out Shipments by Month

(t)

	Volume shipped in	Volume shipped out	Volume of inventory
			At start of period: 10,181
Jan.	1,927	3,670	8,438
Feb.	871	3,231	6,078
Mar.	389	2,651	3,816
Apr.	707	3,476	1,047
May	654	1,701	0
Jun.	2,895	2,010	885
Jul.	6,672	7,228	329
Aug.	8,586	6,534	2,381
Sep.	9,797	5,058	7,120
Oct.	10,569	6,804	10,885
Nov.	4,411	3,810	11,485
Dec.	1,539	2,844	10,181
Total	49,017	49,017	

Open hard-standings alone are available in this depot and to prevent losses due to outdoor storage and losses, during the rainy season in particular, the construction of a 10,000 t storehouse is deemed necessary for the time being.

(6) Katete (Eastern Province)

Volumes actually handled by this proposed site in the last 3 years are as listed below. Table 21 shows the monthly distribution volume of Katete for each month calculated in the same manner as for the other proposed sites.

1984	17,372 t
1985	21,711 t
1986	20,574 t
3-year average	19,886 t

Table 21 Katete's In and Out Shipments by Month

(t)

	Volume shipped in	Volume shipped out	Volume of inventory
			At start of period: 3,904
Jan.	431	1,467	2,868
Feb.	1,265	1,744	2,389
Mar.	2,002	3,567	824
Apr.	72	723	173
May	94	267	0
Jun.	102	66	36
Jul.	3,519	2,372	1,183
Aug.	3,180	2,326	2,037
Sep.	4,393	2,348	4,082
Oct.	4,228	2,350	5,960
Nov.	1,513	2,012	5,461
Dec.		1,557	3,904
Total	20,799	20,779	

According to this Table, its required capacity before the rainy season is about 5,000 t and, if properly operated, the existing 5,000 t storehouse built with aid from the Government of Canada should be sufficient. However, as Eastern Province is a maize production province and its production is increasing each year, this is a very important province which ships most of its purchases

to other provinces (about 96%), and is considered a major base for maize distribution in the district. Therefore, depots located in the province are required to play the role of appropriately shipping purchased maize to consumption areas and distribution bases. It was observed during the survey that approximately 14,000 t of maize was piled up near the existing storehouse.

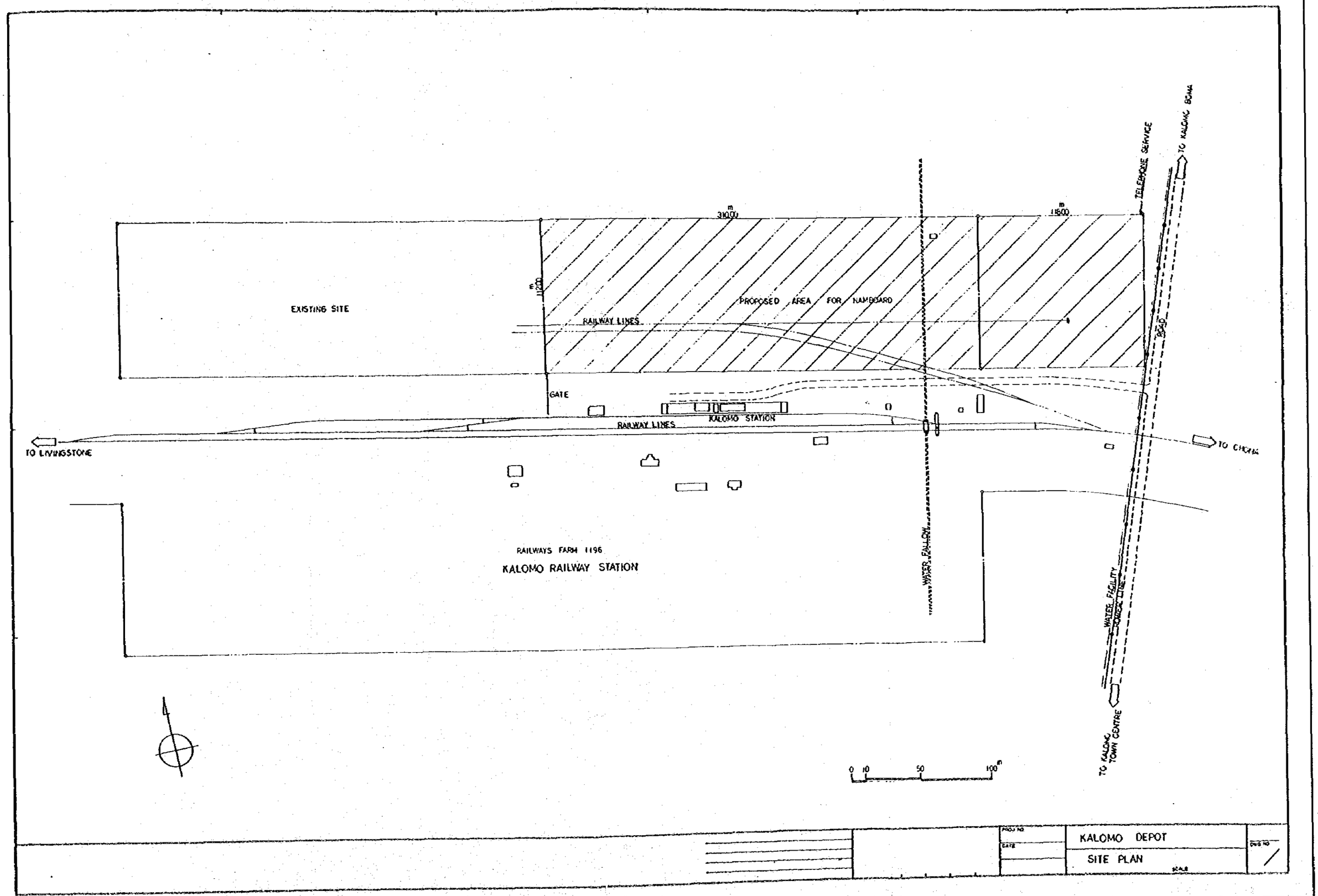
Although the storage period is limited, storehouse capacity is insufficient. Accordingly, a storehouse with a capacity of 5,000 tons is deemed necessary as requested.

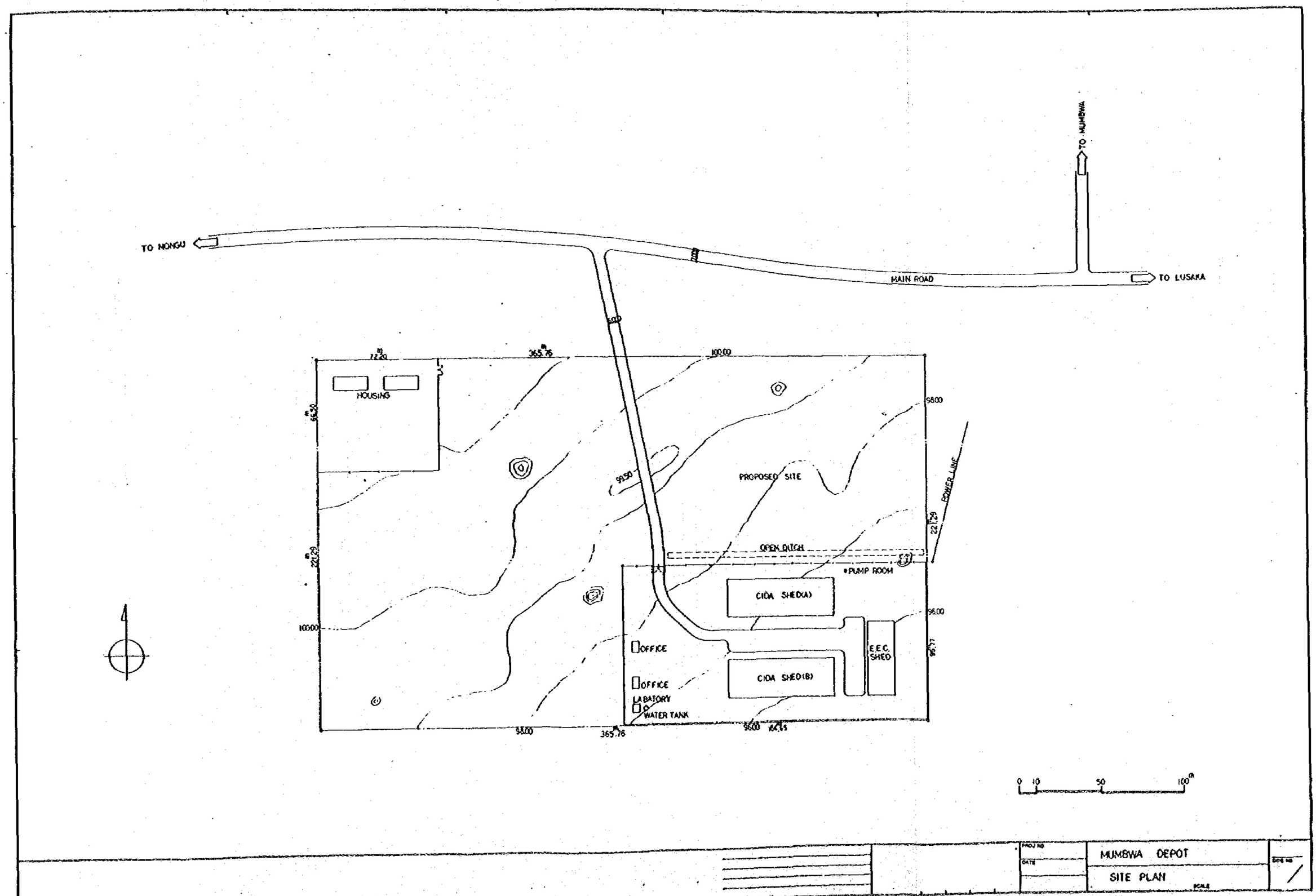
3-2-7 Selection of Construction Sites

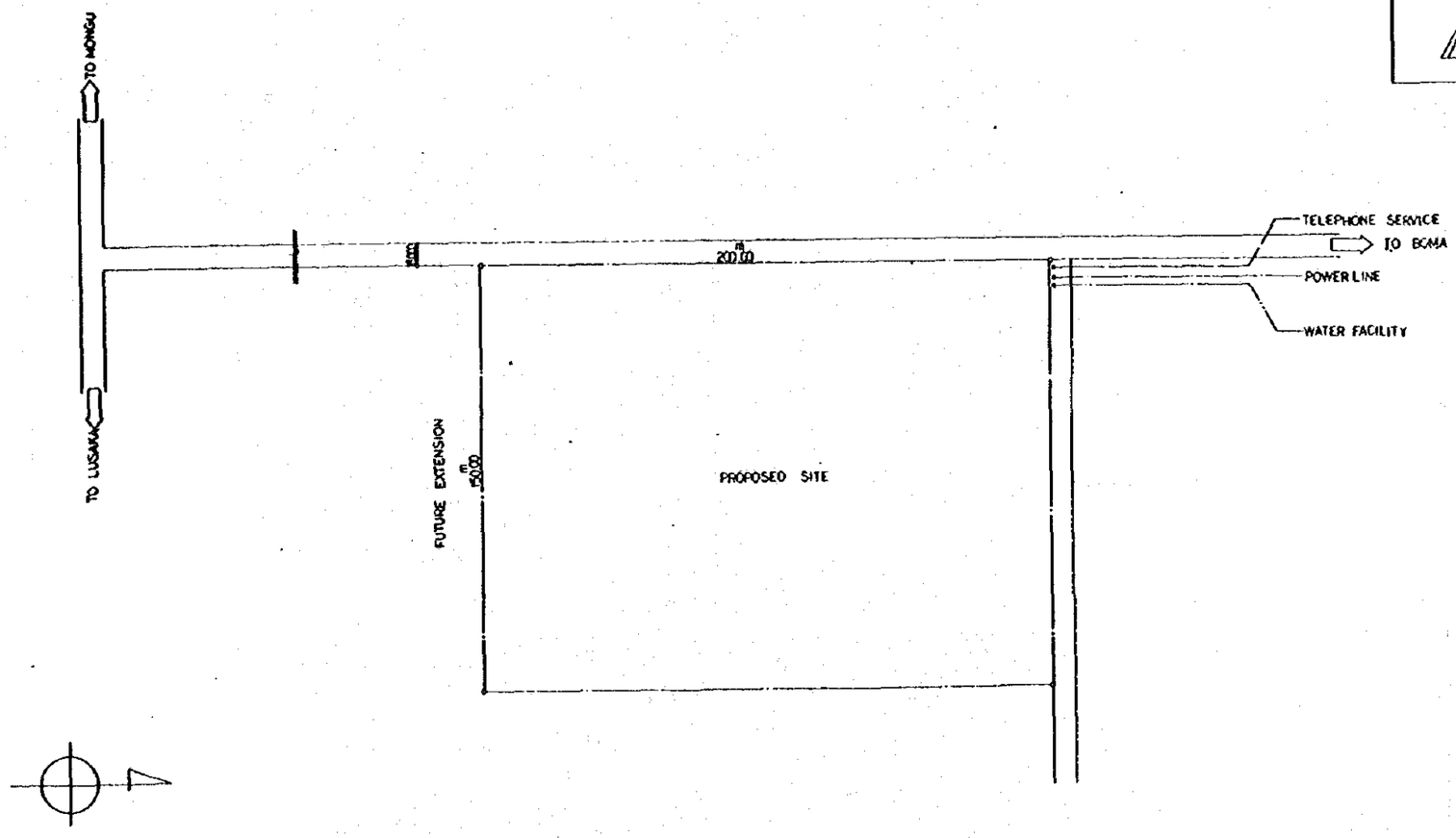
Based on various studies described previously, the proposed construction sites have been ranked in order of the urgency. The ranking and storage capacity of each proposed site are shown below:

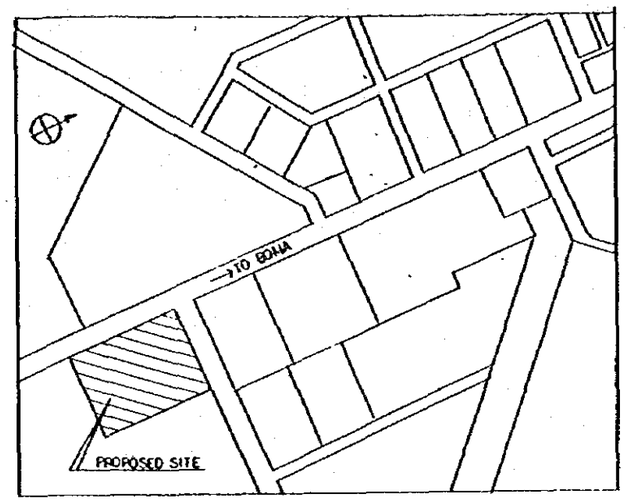
Urgency	Proposed Site	Requested capacity	Decided capacity
1	Kalomo	10,000 t	10,000 t
2	Mumbwa	10,000	5,000
3	Kapiri-Mposhi	-	10,000
4	Kaoma	10,000	5,000
5	Masansa	10,000	10,000
6	Katete	5,000	5,000

3-2-8 Drawings of the Proposed Construction Sites


EXISTING SITE
PROPOSED AREA FOR NAMBOARD
RAILWAY LINES
GATE
KALOMO STATION
RAILWAY LINES
TO LIVINGSTONE
TO CHOMA
TELEPHONE SERVICE
TO KALOMO BOMA
ROAD
WATER FALLOW
WATER FACILITY
TO KALOMO TOWN CENTRE
RAILWAYS FARM 1196
KALOMO RAILWAY STATION
0 10 50 100m
KALOMO DEPOT
SITE PLAN

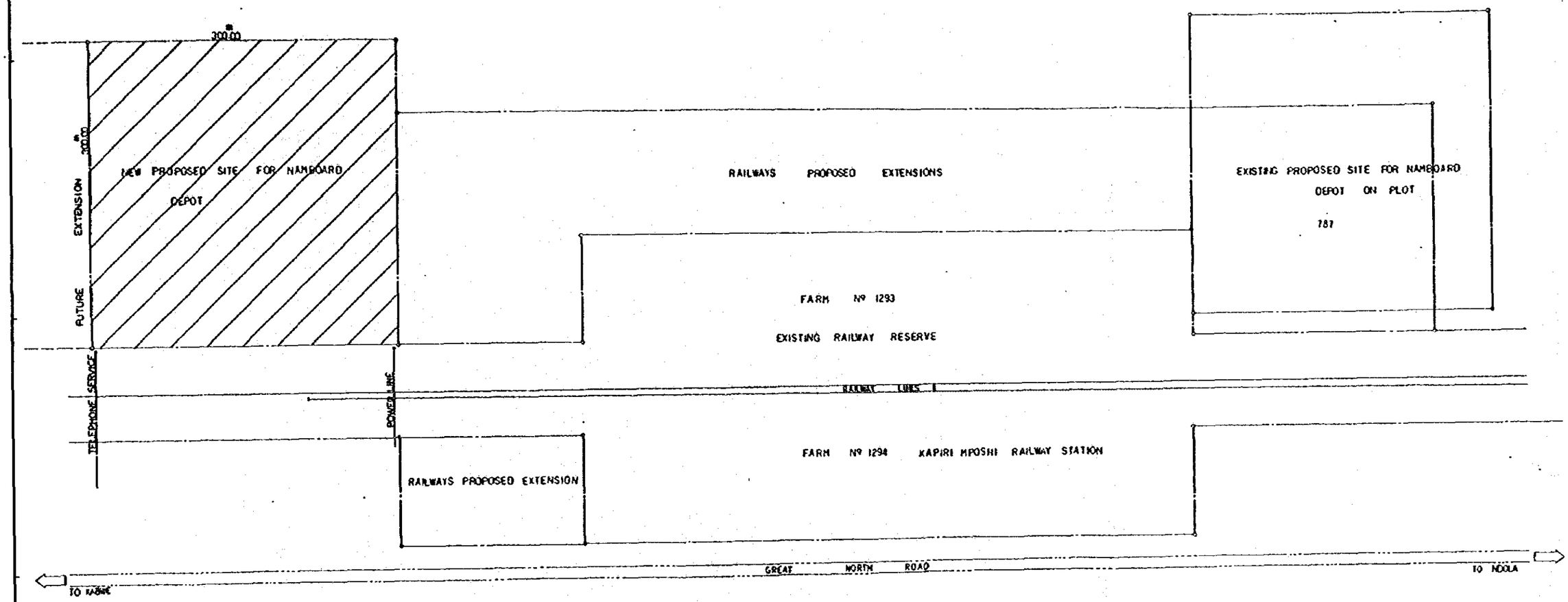

TO NONGU
TO MUMBWA
MAIN ROAD
TO LUSAKA
HOUSING
PROPOSED SITE
POWER LINE
OPEN DITCH
PUMP ROOM
CIDA SHED(A)
CIDA SHED(B)
E.E.C. SHED
OFFICE
OFFICE
LABATORY
WATER TANK
0 10 50 100
MUMBWA DEPOT
SITE PLAN



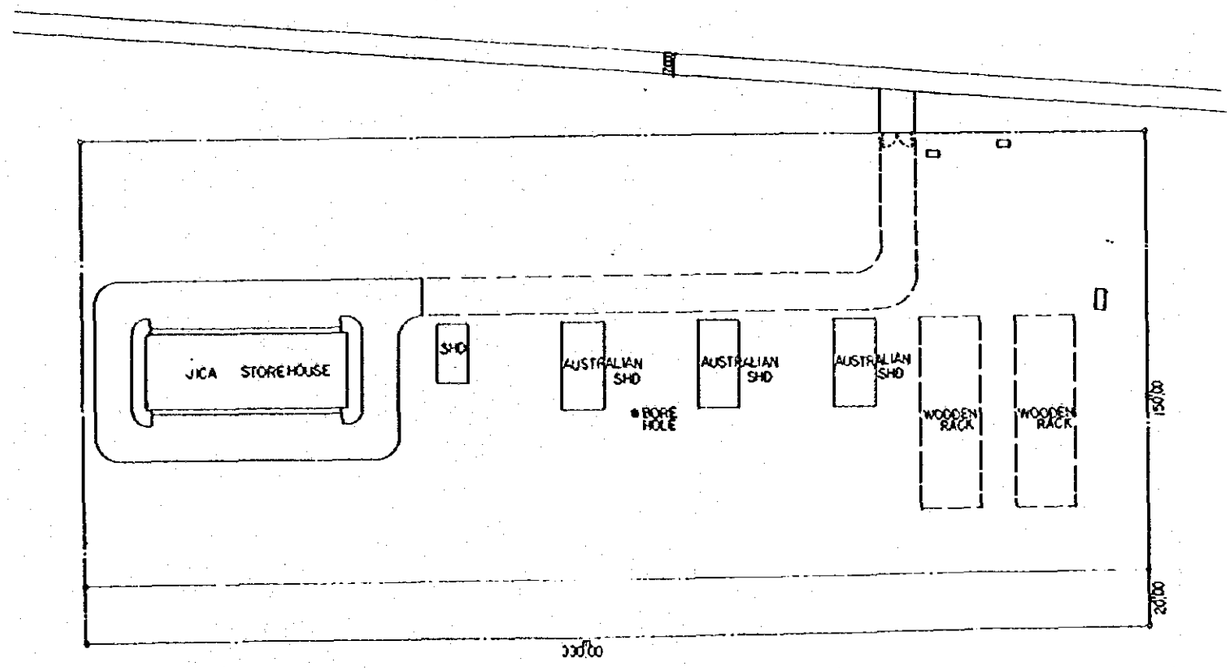


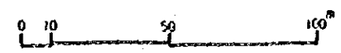
0 10 50 100 m

PROJ NO	KAOMA DEPOT	DWG NO
DATE	SITE PLAN	
	SCALE	

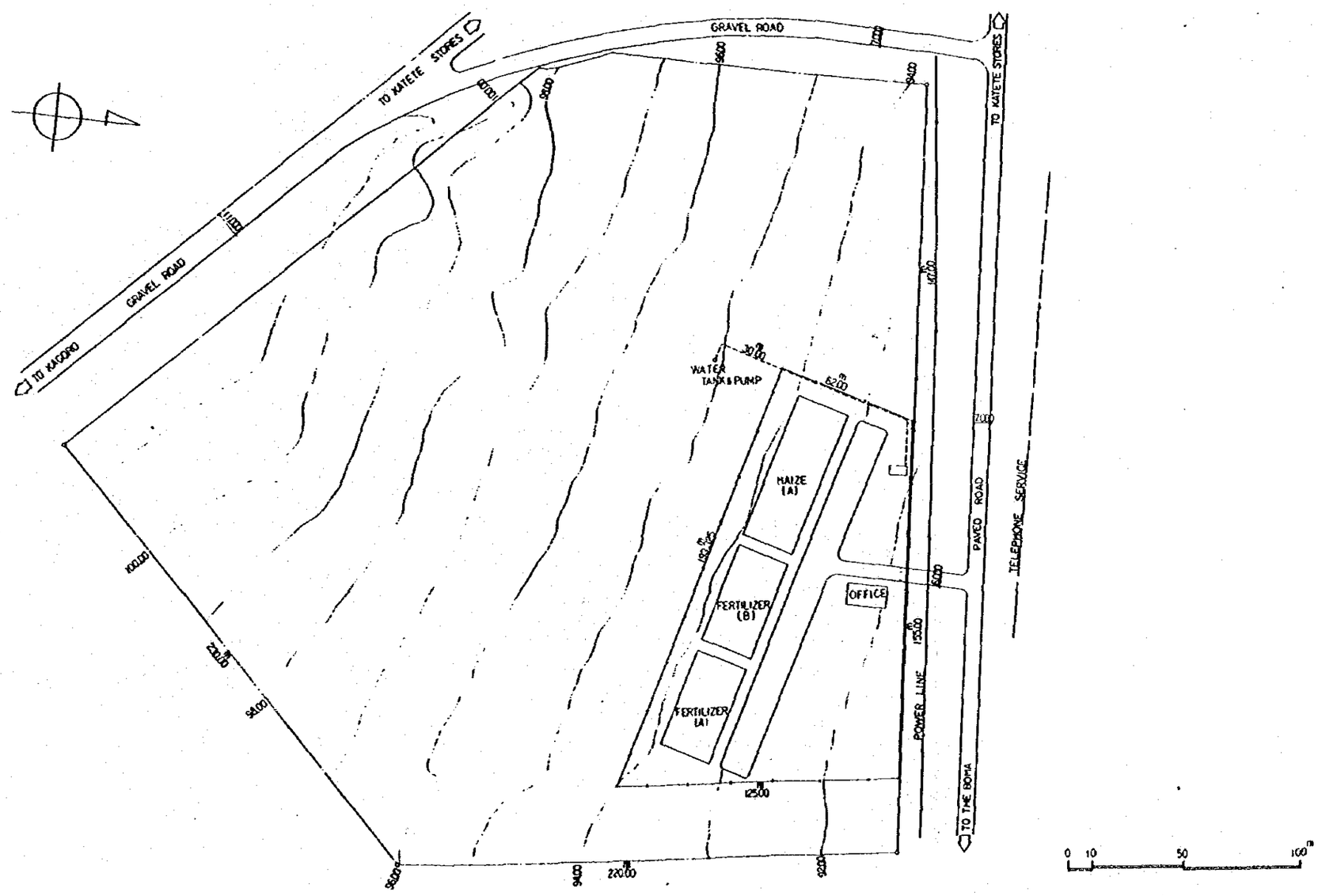


PROJ NO	KAPIRI-MPOSHI DEPOT	DWG NO
DATE	SITE PLAN	
	SCALE	

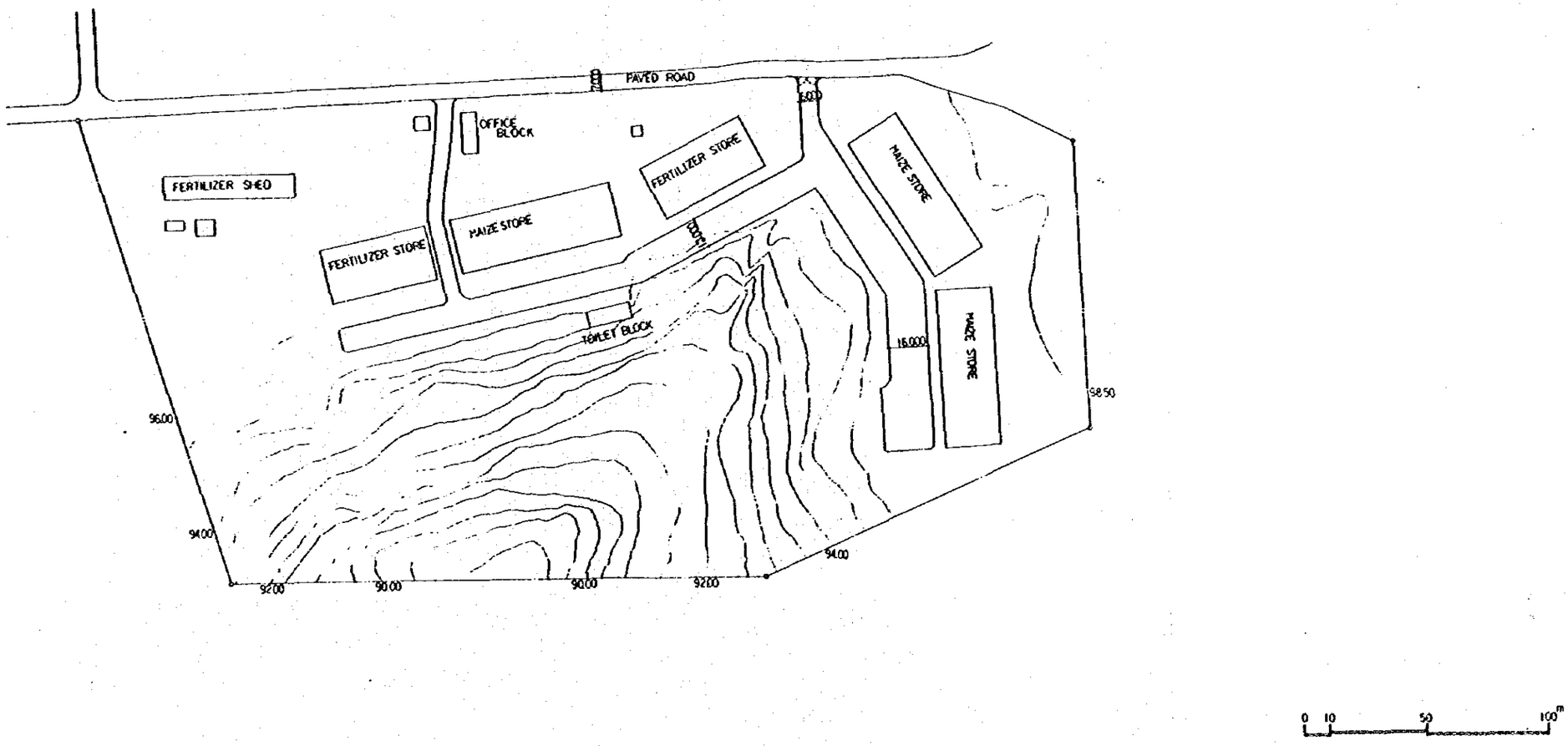




PROJ NO. / DATE	MASANSA DEPOT SITE PLAN SCALE	DWG NO.



PROJ NO	KATETE DEPOT	DWG NO
DATE	SITE PLAN	
	SCALE	



		PROJ NO / DATE	LUNDAZI DEPOT SITE PLAN SCALE

CHAPTER 4. BASIC DESIGN

CHAPTER 4. BASIC DESIGN

4-1 BASIC DESIGN POLICIES

As mentioned in the previous chapter, the objective of this project is to construct grain storehouses for maize having a capacity of 10,000t or 5,000t and buildings for administration purposes on each of the six sites below.

(Construction sites and maize storage capacities)

Southern Province	Kalomo	10,000t
Western Province	Kaoma	5,000t
Central Province	Mumbwa	5,000t
	Kapiri-Mposhi	10,000t
	Masansa	10,000t
Eastern Province	Katete	5,000t

As the grain storehouses that were built in Phase I and Phase II are well-accepted by the personnel concerned of the Government of Zambia and present no construction difficulties, a storehouse with a capacity of 5,000t will be used in this project again as the standard. Except for certain aspects (referred to later) pointed out by NAMB this time, the same structure and specifications as the existing buildings will basically apply in instituting this project.

4-2 REVIEW OF BASIC DESIGN CONDITIONS

4-2-1 Facility Design Conditions

In connection with maize storehouses, consideration will be given to the following in the execution of the project as in Phase I and Phase II.

(1) An elevated floor system will be employed to raise the storehouse floor by about 1m from the ground level to protect against

moisture. Each storehouse will also have platforms equipped to facilitate cargo handling.

(2) Bird screens will be placed continuously under the eaves to provide sufficient natural ventilation for the storehouse interior.

(3) Each side of the storehouse will have an entrance to make cargo handling efficient.

(4) Locally available materials will be used. The exterior walls will be of face bricks and the roofs of asbestos cement sheets.

(5) Skylights will be placed on the roofs for natural lighting.

In addition to the basic specifications above, comments made by NAMB counterparts, local managers, etc. will be examined in depth so that facilities will be designed to be the most suitable for the Zambian situation. Comments made by the Zambian side are as follows:

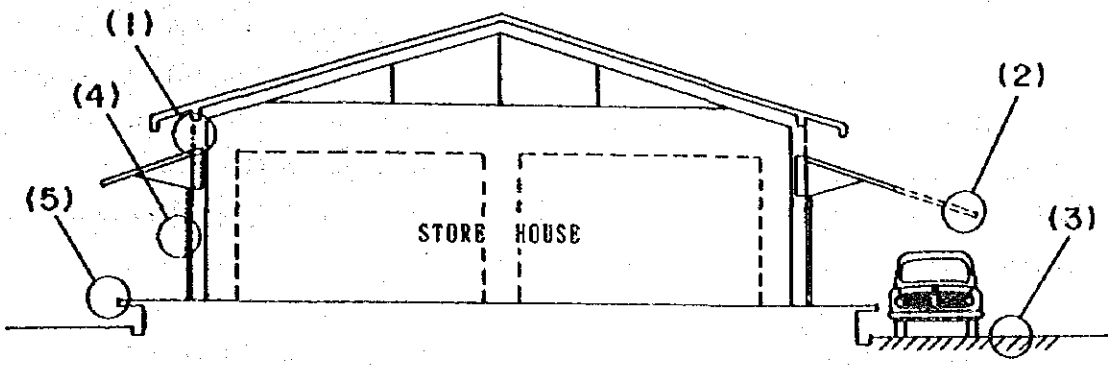
(1) During the rainy season, in heavy rainstorms in particular, rain tends to enter through part of the bird screens under the eaves of the storehouse. This has to be prevented.

(2) The platform canopies will be extended so that bags on the truck will not become wet during cargo handling.

(3) If a bag is ripped during handling, allowing maize to spill from the truck onto the ground, the maize cannot be recovered without contamination by mud and sand. To avoid this, the concrete floors around the platforms will be expanded to exclude any mud and sand.

(4) The hangar door of the main entrance should open and close more smoothly.

(5) The hardwood piece used at the edge of the platform as a buffer is occasionally broken partially during grain handling. It has to be reinforced.



Though rats were not actually sighted, holes, etc. suggested their existence. To further reinforce rat-preventive measures, a gutter will be excavated in front of the slope to better prevent the intrusion of rats into the storehouses.

Basically, the same structure and specifications used at Chingola built during Phase II will apply to the office buildings and ancillary buildings.

Details are as prescribed in "4-3-2: Construction Plan" that follows.

As truck scales will be included this time, truck traffic line planning will be an important point in planning facilities and their layout. Trucks laden with grain will be weighed by the truck scale as the truck enters the depot and again when it leaves. The difference in weights represents the volume shipped in and vice versa. Therefore, some 18m is required before and after the truck scale for trucks to change lanes and a straight 54m-long section is also needed. An overall facility plan should be made precisely in full consideration of this feature.

4-2-2 Storage and Cargo Handling Plan

Maize, an important grain product of Zambia, is placed in 90kg jute bags for distribution and maize transactions are based on this weight. In depots with a truck scale, the arriving maize bags on a truck and the truck itself are weighed altogether when the truck enters and the emptied truck is weighed again when it leaves and vice versa. The difference between these weights is considered the weight of grain

shipped in or out. In a depot without a truck scale, however, the transaction volume is necessarily determined by weighing random samples on a platform scale, a method of weighing which necessarily invites disputes over transaction volumes. Therefore, as in the case of Chingola, the addition of a truck scale to help facilitate maize transactions is considered a proper approach.

As for the type of truck scale, a mechanical type of the same specifications as used before is recommended in view of its convenience of maintenance and repair.

As for in-house cargo handling, a conveyor system is recommended as in the case of Phase I and Phase II and conveyors of the same specifications as before are to be furnished to each site in the same number of units.

4-2-3 Conditions of Equipment Selection

The equipment necessary for a grain storehouse consists of cargo handling machines, scales, control equipment, fumigating equipment, inspection equipment, etc. In the case of projects done previously at Chambishi, Masansa, Mtirizi and Chingola, equipment was planned in accordance with Zambian requests and the storehouse scale at each site. Although fumigating equipment was also reviewed this time, as mentioned in 2-3-1 (5), fumigation is done by the Pest Control Office of NAMB and is not under the jurisdiction of each depot. As conditions of roving fumigation teams cannot be grasped precisely, no fumigation equipment will be furnished in this project.

As for the selection of equipment and machines, preference will be given to the types of equipment furnished so far as they will be used in a severe natural environment featuring alternating dry and wet spells and at heights from sea level to 1,000-1,500m. The equipment and machinery must also suit the technical level of grain control in Zambia. Basically, therefore, equipment that is durable, simply structured and easy to handle will be selected as before.

4-3 BASIC PLAN OF FACILITIES

4-3-1 Layout Plan

(1) Kalomo (Southern Province)

The construction site is located adjoining the east of the existing depot of Kalomo station. It is shaped like a rectangle measuring 428m x 112m and its eastern side faces a 7m road. As a siding track will be laid on the premises for NAMB, 2 storehouses will be built abreast along this siding track. As the premises are equally split by an existing water drain gutter running north to south, buildings will be laid out so as not to interfere with it. The entrance to the site is designed to face the road on the east and is positioned in the northeastern section of the site so that existing telephone poles will not impede access and in consideration of the approach of trucks to the storehouses after entry.

The truck scale will be provided just between the gate and the storehouses to facilitate control of grain, i.e. receiving and shipping, and will be laid out so that sufficient operating space may be secured. The dead end of the in-site road will be designed to have a paved area to turn trucks around.

The administration office, gate house, etc. are planned close to the entrance to facilitate site control as in the case of Chingola depot constructed in Phase II.

(2) Kaoma (Western Province)

The site faces a road on the west and is a rectangle measuring 200m x 150m. As extension of the site southward in the future is scheduled, the entrance will be placed in its northwestern section to cater to future plans. The gate is designed to position 10m away from road inward to secure the space for the access of trucks. As supply of electric power, water, etc., from downtown can be led

in around the gate, ancillary buildings related with building facilities will be laid out in the vicinity of the gate.

A loop road is planned around the storehouse which is in the southern part of the site so that sufficient spaces for truck lane changes will be secured before and after the truck scale positioned between the gate and the storehouse.

As the Kaoma depot is newly built, it is in need of an administration office, gate house, etc. Therefore, they are laid out, as in the case of Kalomo, as close to the entrance as possible for easy control of facilities.

(3) Mumbwa (Central Province)

As the site already has 3 storehouses granted by CIDA and the EC, the proposed storehouse will be laid out abreast of them. The truck scale will be parallel to the existing access road and consideration will be given to securing sufficient space for stand-by trucks, etc. As this truck scale will also be used by trucks serving the existing storehouses, two entrances will be scheduled in accordance with traffic line planning.

An administrative office alone is planned for this site and workers' rooms will be furnished in existing buildings.

(4) Kapiri-Mposhi (Central Province)

The site adjoins the premises of Kapiri-Mposhi station to the southwest. The shape of the proposed site is a square, 300m x 300m. As it is extendable both southward and westward, future extension will be taken into consideration in the layout planning. As the introduction of two siding tracks is scheduled, two storehouses will be laid out along the siding. A trunk road to the east runs along the station premises. In consideration of the approach to this road, the entrance to the depot is planned in the southeastern part of the site as suggested by NAMB. The truck

scale will be positioned between the entrance and the storehouses, and the office building and ancillary buildings close to the entrance.

(5) Masansa (Central Province)

The site will be extended southward by 20m to place two storehouses abreast of the existing storehouse and a loop road is planned around the buildings to secure truck traffic lines. As no truck scale will be used, the entrance will remain as it is. The office building, etc. will be laid out close to the entrance to facilitate control.

(6) Katete (Eastern Province)

The existing facilities, 3 CIDA storehouses, face the front road and the site slopes upward from north to south. Therefore, the truck scale will be laid out parallel to the road. The storehouse is planned on the western part of the site so that it may be seen from the front road and its level is such that trucks can approach easily from the road and the height gap may be minimized. Also, as for clearing the site for building the storehouse, the volume of soil cutting must be minimized and +95m is established as the site level. As the site has sufficient area to the south, positioning relative to existing storehouses will also be considered so as to cater to future plans.

As for ancillary buildings, an office building is planned close to the entrance in view of the shared use of the existing buildings.

4-3-2 Building Plan

1) Storehouse

Storehouses of basically the same specifications that were applied to the storehouses built in Phase I and Phase II will be constructed. As mentioned in "4-2-1: Facility Design Conditions",

however, items pointed out by the Zambian side will be taken into consideration. That is, the platform canopies will be extended by 5m and the height of the bird screen will be changed to 1m. As for the hangar doors, more heavy-duty hinges, metal, etc. will be used.

The following storehouse standards will apply and one storehouse or two will be built on each site.

Storage capacity: 5,000t x 1 or 5,000t x 2 = 10,000t

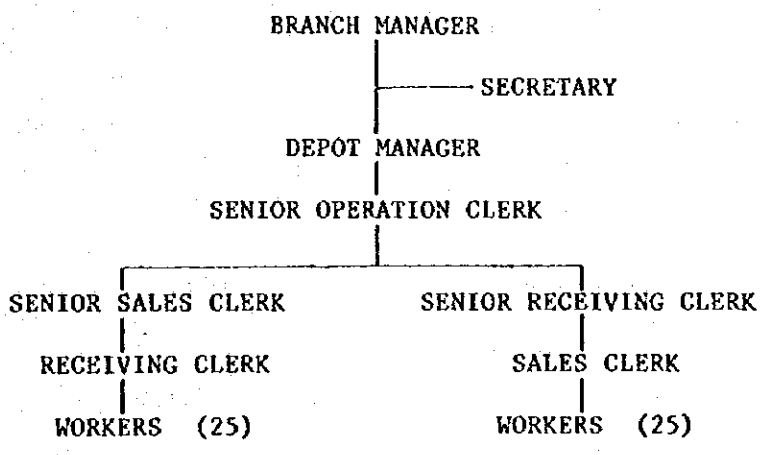
Area	: 24.5 x 66.5 x 1 = 1,629.25m^2 or 24.5 x 66.5 x 2 = 3,258.50m^2
Roof	: Covered with locally-made, corrugated asbestos cement sheets. Sky-lights made of corrugated FRP sheets will be situated for interior lighting.
Exterior wall	: Built with locally-made face bricks.
Floor	: Made of RC, with an anti-dust finish to facilitate cleaning and dust prevention. To prevent expansion due to heat and cracks due to uneven settlement, expansion joints will be placed at proper locations.
Entrance	: Steel hangar door, 4,000H x 5,000W
Opening	: Continuous openings will run under the eaves for storehouse ventilation. Opening will be covered with steel bird screens to keep out birds and rats.
Foundation	: Direct foundation of RC.

As for the architectural design, structural design, design standards, material standards, etc., refer to the Basic Design Study Report (Phase I) submitted in September, 1984.

2) Office building and ancillary buildings

i) Kalomo (Southern), Kaoma (Western), Mumbwa (Central), Kapiri-Mposhi (Central)

Though each of the above sites adjoins the existing depot, each of them will almost be a new depot. Therefore, the office and ancillary buildings will be constructed in the same manner as those built for Chingola in Phase II. The organization chart below was proposed by the Zambian side as a personnel schedule for each depot.



(Organization Chart)

Necessary facilities include an office to control in and out shipments, inventory and workers, a gate house, a scale room for the truck scale, a pump room for water supply to the office, and a shower room/waiting area/toilet for workers. The building specifications remain the same as before. The summary of each building is as follows:

Office Building + Shower Room Building

Floor Area : $184.80m^2 + 77.44m^2 = 262.24m^2$

Roof : Covered with locally-made corrugated asbestos cement sheets, steel frame roof truss.

Exterior wall: Built with locally-made face bricks.

Floor : Of RC.

Foundation : Of RC, strip footing.

Interior : Floor : Mortar, colorcrete

Wall : Mortar, metal trowel finish, VP

Ceiling : Plasterboard

Outer fittings: Locally-made steel fittings

Inner fittings: Wooden fittings

Ancillary Buildings (gate house, scale room, pump room)

Floor area : Gate house : $8.75m^2$

Scale room : $35.88m^2$

Pump room : $9.00m^2$

Roof : Covered with locally-made corrugated asbestos cement sheets, steel frame.

Exterior wall: Built of locally-made face bricks.

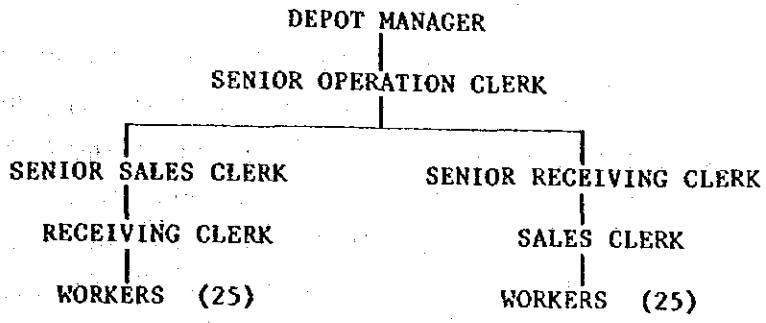
Floor : Of RC.

Foundation : Of RC, strip footing.

Entrance/ Window : Locally-made steel fittings.

ii) Masansa (Central), Katete (Eastern)

The personnel schedule proposed by the Zambian side for the above depots is as follows:



(Organization Chart)

Necessary facilities consist of an office building and a toilet. The specifications of each building are the same as in i). The floor area is 63.28m^2 for the office and 11.00m^2 for the toilet.

4-3-3 Equipment Plan

1) Electrical equipment

i) Kalomo (Southern), Kaoma (Western), Mumbwa (Central), Kapiri-Mposhi (Central)

As in Phase II, the Zambian side is responsible for supplying the primary electric power to the substation. Therefore, each site is required to have a substation at the point of the supplied power source for distribution of power to each building. The electrical equipment after the transformer is included in the scope of the Japanese side and its major specifications and necessary equipment are as follows.

Secondary power: Power-use ... 380V, 50c/s, 3-phases 4-wires
Lamp/water heater for shower and kitchenette/etc. ...
220V, 50c/s, single-phase 3-wires

Necessary equipment:

Storehouse : Conveyor-use outlets: An outlet that operates 3 conveyors simultaneously will be located at each entrance (power-use, 380V).

Outlets for bag-sealing sewing machines: Placed necessary locations (general-use, 220V).
Indoor lighting: Florescent lamp. Illumination intensity on the floor: 50 Lux.
Outdoor lighting: 12 units of 40W x 2 FL per building will be fixed on the outer wall.

Office : Indoor lighting with FLs: Power supply to outlets, shower and water-boiling heater.

Gate house : Indoor lighting alone.

Scale room : Indoor lighting and power supply to outlets and water pump.

Pump room : Indoor lighting and pump-use power.

ii) Masansa (Central)

As no power supply to the site is available, one diesel generator for each storehouse will be furnished for conveyor operation.

iii) Katete (Eastern)

As a receiving panel is already in use, power supply will be extended by the Zambian side to the site. Power supply to the storehouse, office and scale room will be made by the Japanese side using a transformer. The types and specifications of power supplied to facilities are the same as in i).

2) Telephone equipment

i) Kalomo (Southern), Kaoma (Western), Kapiri-Mposhi (Central)

Telephone circuits are connected to the office alone. A 3-circuit telephone exchange will be put to use and each room will have a handset. An extension line will be extended to the detached laborers' building.

ii) Mumbwa (Central), Masansa (Central)

As no telephone circuits are available in the neighborhood of the site, telephone equipment is not included.

iii) Katete (Western)

A telephone exchange for 3 circuits will be placed in the office and each room will have a handset.

3) Plumbing and sanitary equipment

i) Kalomo (Southern)

As public water works will be installed along the road to the east of the site, water supply will be branched therefrom. A ground type water-receiving tank will be placed on the site and a pump will be used to pressurize water for supply to the facilities. Water will be supplied to the toilet, kitchenette and shower room of the office building. Soil water will be treated, as in the case of the work at Chingola done in Phase II, by a septic tank made of in-situ reinforced concrete in accordance with local specifications and discharged into the ground through a seepage pit. Miscellaneous waste water will be trapped by collecting pits and led to this seepage pit via drain pipes for discharging.

ii) Kaoma (Western)

As the public water works from downtown run along the road to the west of the site, water will be supplied therefrom. A water-receiving tank will be placed on the site and a pump will be used to pressurize water to supply facilities. Water will be supplied to the toilet, kitchenette and shower room of the office building. Soil water and miscellaneous waste water will be treated, as in the case of i) Kalomo above, by a septic tank and seepage pit.

iii) Mumbwa (Central)

Presently, water is supplied by a well on the site to an elevated water tank from which the existing toilet is supplied by a gravity system. Water supply is designed to cover the toilet and the kitchenette of the office building. As the height difference between the well and the office building is considerable and as the capacity of the pump head is insufficient, a separate water tank will be constructed. A water pump will be used to supply pressurized water to the facilities. Soil water and miscellaneous waste water will be processed by a septic treatment tank and seepage pit.

iv) Kapiri-Mposhi (Central)

At present, there is no water supply on the site but the Zambian side will provide a water supply by drilling a well. Therefore, the scope of the Japanese side is limited to the water supply pump for pumping up and thereafter. First, water will be supplied to the receiving tank and then to the toilet, kitchenette and shower room of the office building by a pressure pump. The pump room for well-water supply will be a building having an area of about 6.0m^2.

Soil water and miscellaneous waste water will be processed by a septic treatment tank and a seepage pit.

v) Masansa (Central)

Though the site has a well, its volume of water supply is not sufficient and the Zambian side will drill another to supply water. Therefore, as in the case of iv) Kapiri-Mposhi, a water supply pump room will be required. An elevated water tank will be installed and water will be supplied by a gravity system to the toilet and shower room of the office building and the laborers's building.

Soil water and miscellaneous waste water will be processed by a septic treatment tank and a seepage pit.

vi) Katete (Western)

The water supply piping from the existing elevated water tank is branched halfway and water is first received by a water tank. Then, pressurized water is supplied by a water pump to the toilet of the office building.

Soil water and miscellaneous waste water will be processed by a septic treatment tank and a seepage pit.

4-3-4 Exterior Plan

Security and peace have been threatened to a great extent in Zambia in recent years, resulting in a number of thefts, and the prevention of crimes has become an important subject. According to the grant aid system of Japan, the cost of gate/fence work ought to be borne by the recipient but Zambia's ability to bear the cost is limited. Therefore, the gate/fence work will be included in the scope and the cost will be borne by the Japanese side. The construction cost of the approach road will also be assumed by the Japanese side.

As mentioned in the paragraph on the layout plan, a in-site road for truck passage will be built. As the ground is strong enough, random paving need only be provided and special shoulder processing, including curbing and side ditches, will not be provided. Also, the floor of the cargo loading/offloading area of the storehouse building requested by the Zambian side will be paved with concrete.

The rain water trapped around the storehouse building will be led to the open ditch in the neighborhood of the site by drain pipes and left for natural discharge by filtration.

4-3-5 Material Plan

As the Republic of Zambia is a landlocked nation in the southern part of Africa, the supply of construction materials from Japan will require marine transportation to the port of Dar es Salaam, Tanzania, and ground transportation from Dar es Salaam of nearly 2,000km via the Tanzam Railway and the Zambia Railway. It will take at least 2 months and the period of transportation remains changeable.

Therefore, reinforcement bars, etc. required in the initial stage of construction have to be procured locally. As for steel frames, the procurement and fabrication of materials will take at least 3 to 4 months and an additional 6 months before they reach the site after order placement. In addition, some time has to be allowed for the general contractor and fabricators to conclude order contracts, etc., making the progress of work slower still. Therefore, steel frames will be procured locally.

It is not wise to procure such heavy and low value-added materials in Japan as gravel, sand, cement, bricks, asbestos cement sheets, lumber, etc. Therefore, these materials will also be procured locally. Though it is possible to procure these materials locally, the foreign currency reserve position of Zambia is tight and foreign-made materials are in short supply and hard to get. It is necessary to secure materials, even if they will be used in the latter half of the schedule, well in advance, as the production of such materials as bricks was actually suspended because of a shortage of heavy oil.

In view of the above situation, material procurement is classified as follows: