3-3-3 Irrigation, Drainage and Farm Roads

1) Pipeline

Table 3.3.3.1 shows the length and the discharge of the pipelines. Pipe diameters are selected to provide an economical velocity during pump operation, as shown in the following table.

Pipe Diameter (ø)	Velocity
ø 75 ~ ø 150	0.7 ~ 1.0 m/s
ø 200 ~ ø 400	0.9 ~ 1.6 m/s
ø 450 ~	1.2 ~ 1.8 m/s

Table 3.5 Dimension of Pipeline

Pipeline No.	Discharge	Length	Diameter	Remarks
B-P-1	0.307 m^3/s	1,656 m	ø 500 mm	DCI
B-P-2	0.216 m^3/s	769 m	ø 500 mm	PVC
B-P-3	0.170 m^3/s	523 m	ø 400 mm	PVC
B-P-4	0.087 m^3/s	746 m	ø 300 mm	PVC
C-P-1	0.336 m^3/s	1,941 m	ø 500 mm	DCI
C-P-2	0.213 m^3/s	891 m	ø 450 mm	PVC
C-P-3	0.104 m^3/s	930 m	ø 300 mm	PVC

Types of pipe will be determined by the internal pressure and external pressure (e.g., earth pressure, dynamic load, etc.).

For this Project, the planned internal water pressure between the pump station and the farm ponds is relatively high, ranging from 5.0 kg/cm^2 to 7.0 kg/cm^2. Therefore, based on the calculated result, ductile cast-iron pipe with superior durability is adopted because of its easy installation for the head races between the pump stations and the farm ponds. Because the planned interior pressure, between the farm ponds and the main division works, is not so high, PVC pipe (available in Zimbabwe) is adopted for these pipeline sections.

Pipe loss, that will be included in the total pump head, for the pipes chosen above, is calculated using the following Hazen & Williams formula.

$$hf = 10.67 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

Where;

hf:	Coefficient
C:	Coefficient depending on the pipe (DCI pipe: C = 130)
D:	Pipe diameter (m)
Q:	Discharge (m^3/s)
L:	Pipe length (m)

Individual pipe loss is shown in the following table.

Table 3.6 Water-head Loss of Pipeline

Pipeline	Diameter	Length	Pipe Loss
B-P-1	ø 500 mm	1,656 m	11.6 m
C-P-1	ø 500 mm	1,941 m	16.1 m

Air valves will be installed at intervals of 400 to 500 m on the line, and on longitudinal protrusions; blow-off valves will be provided on longitudinal depressions for operation and maintenance.

(2) Farm Ponds

Trouble-free and efficient water management is only possible when a stable volume of irrigation water is supplied. To guarantee such a stable supply, farm ponds serving the additional role of discharge chambers will be constructed.

Locations for the farm ponds will be selected in consideration of the fact that the irrigation water can flow by gravity through pipelines from the farm ponds to the main division works in each small irrigation block. The proposed locations will be adjacent to villages on the boundary between farms and hilly land. These locations will also allow the residents of the villages to use this water.

The capacity of each farm pond is determined in accordance with the pump's allowed shut-down period. An allowed interruption interval is set because when a pump is started

up shortly after being shut off, load is applied to the motor. The pump's allowed shut-down interval will be 0.5 hour, so the volume of water pumped in 0.5 hour will be considered to be the capacity of the farm ponds. The following table shows the proposed capacity of the farm ponds in each block.

Table 3.7 Capacity of Farm Pond

Farm Pond No.	Irrigation Area	Capacity
B-F-P	128 ha	560 m^3
C-F-P	140 ha	620 m^3

T-type reinforced concrete retaining walls will be applied for the structure of the farm ponds, since the acquisition of extensive land for the ponds will be difficult because the proposed sites will be in the narrow and steep residential area of the villages. Moreover, on-site permeability tests have revealed that the site coefficient of permeability is 10^{-2} and is low. The shape of the ponds will be rectangular with an effective water depth of 2.0 m and free board of 1.0 m. A spillway will direct redundant water into existing small rivers.

(3) Main Division Works

Each small irrigation block will be provided with main division works to receive irrigation water from farm ponds and distribute it to the farms through open canals.

The main division works will be made of reinforced concrete. A disk valve installed at the inlet will automatically adjust the water level. The outlet will be constructed so that an attached butterfly valve can adjust the discharge into the open canals.

(4) Irrigation Canals

Irrigation canals will be constructed to distribute the water from the main division works to each farm in the project area.

The irrigation canals will be reinforced concrete trapezoidal sections with side-wall gradients of 60 degrees, in order to control the volume of seepage and to simplify both maintenance and irrigation operations. The irrigation canal sections are designed with the conditions that a longitudinal gradient of I = 1/500 is set and the design velocity is

assumed to range from 0.50 m/s to 1.00 m/s. The following formula by Manning is used for the velocity study.

$V=(1/n) \times R^{2/3} \times I^{1/2}$

V: Mean velocity (m/sec)
I: Hydraulic gradient (canal bed slope)
R: Hydraulic mean depth (m)
n: Coefficient of roughness

As a result of the calculation, four types of irrigation canals are designed. Types A to D are shown in the table below.

Table 3.8 Irrigation Canal Types

Type	Discharge (m^3/s)	Bottom Width (m)	Height (m)
A	0.100~0.140	0.35	0.45
B	0.060~0.100	0.30	0.40
C	0.040~0.060	0.25	0.35
D	0.020~0.040	0.20	0.30

The irrigation canal length for each block is determined as follows.

- Block B: 12,035 m
- Block C: 14,998 m

(5) Appurtenant Works for Irrigation Canals

Along the irrigation canals, work will be carried out at various points as necessary to provide such facilities as division works, drops, road cross siphons, canal cross siphons, canal cross culverts, entrance works, cut throat flumes and chutes.

[Division Works]

Division works will be constructed at junctions of the irrigation canals. Their structure will be made of reinforced concrete and will be fitted with square steel sluice gates manufactured in Zimbabwe. The dimensions of the gates will match the sections of each irrigation canal.

[Drops]

As already stated, the longitudinal gradient of the irrigation canals has been set at I = 500. The topographical gradient of farms is steeper than that of the canals, however, so drops will be constructed. A fall will uniformly be 0.5 m, and locations for the drops will be determined according to topographical conditions. A water-cushion type will be applied. The side walls of the downstream part will be provided with stoplog recesses so that irrigation water will be able to stay while conducting irrigation with hoses.

[Road Cross Siphons]

Road cross siphons will be constructed at the points where roads intersect the irrigation canals. Reinforced concrete pipes will be installed under roads with a reinforced concrete box placed at the ends of the pipe.

All the pipes will have a diameter of 600 mm to simplify maintenance. Where a canal crosses a major district road, burial depth will be 1.2 m, and where it crosses a farm road, the depth will be 1.0 m.

[Canal Cross Siphons]

Canal cross siphons will be constructed at intersections of irrigation canals and small rivers or drainage canals in the project area. Their structure will be identical to that of the road cross siphons, but their depth will be 0.6 m.

[Canal Cross Culverts]

Canal cross culverts will be constructed at intervals of 250 m so that tractors and other equipment can cross the canals. The culverts, which will be 3.0 m wide, will be formed with reinforced concrete pipes.

[Entrance Works]

To allow machinery to enter farms from farm roads, entrance works will be constructed at 250 m intervals. Their structure will be identical to that of the canal cross culverts, but the width will be 5.0 m so that machinery can enter from the roads.

[Cut Throat Flumes]

Cut throat flumes will be installed downstream of division works to monitor the discharge of irrigation canals, so that proper water management can be performed. These flumes are widely used by AGRITEX.

[Chutes]

For drainage of excess water into drainage canals and rivers at the ends of irrigation canals, chutes will be constructed in order to subdue water force and prevent soil erosion. Made of reinforced concrete, these chutes have a stepped configuration. Gabions are installed around the chutes to prevent erosion caused by flow change.

(6) Drainage Canals

Drainage canals will be constructed to drain rain water in the project area. The drainage canals will generally be constructed along low-lying areas which are presently used as natural drainage. The ends of canals will be connected to streams and to the Gairezi River. The drainage canals will be trapezoidal-shaped earth canals, with a side gradient of 1:1.0. To simplify maintenance, the smallest sections will feature a bottom width of 0.5 m and a canal height of 0.8 m. Manning's formula is used to determine this canal section.

The drainage canal length for each block is determined as follows.

- Block B: 14,163 meters
- Block C: 16,336 meters

(7) Appurtenant Works for Drainage Channels

Along the drainage canals, work will be carried out at various points as necessary to provide such facilities as confluent facilities, ground sills, road cross culverts, revetment works, canal cross culverts, entrance works and chutes.

[Confluent Facilities]

Confluent facilities made of gabions will be constructed at confluence points of the drainage canals in order to subdue water force and prevent soil erosion.

[Ground Sills]

Because the gradient of the farms is steep, the drainage canals made of earth are expected to be eroded. Ground sills will be constructed every 100 m to prevent such erosion. The structure is wall-shaped reinforced concrete with gabions around.

[Road Cross Culverts]

Road cross culverts will be constructed at points where roads intersect the drainage canals. The culverts will be formed with reinforced concrete pipes and installed under the roads. Gabions are installed around the culverts to prevent erosion caused by flow change.

[Revetment Works]

Revetment works made of gabions will be constructed at points where the drainage canals bend, in order to subdue water force and prevent soil erosion.

[Canal Cross Culverts]

Canal cross culverts will be constructed at intervals of 250 m so that tractors and other equipment can cross the canals. Their structure will be identical to that of the canal cross culverts, and their width will be 3.0 m.

[Entrance Works]

To allow machinery to enter farms from farm roads, entrance works will be constructed at 250 m intervals. Their structure will be identical to that of the canal cross culverts, but the width will be 5.0 m so that machinery can enter from the roads.

[Chutes]

For drainage of water into small rivers and the Gairezi River at the ends of drainage canals, chutes will be constructed in order to subdue water force and prevent soil erosion. Made of reinforced concrete, these chutes have a stepped configuration. Gabions are installed around the chutes to prevent erosion caused by flow change.

(8) Farm Roads and Appurtenant Works

Trunk farm roads designed for the use of big trucks will link arterial district roads with the pump stations, and will be used to deliver machinery. Farms will be provided with secondary farm roads for use in farming activities and canal inspections. In principle, the secondary farm roads will be constructed on relatively high land.

The farm roads will be embanked, and the trunk farm roads will be 5 m wide while the secondary farm roads will be 3 m wide. Embankments will be 40 cm high for the trunk farm roads while 30 cm high for the secondary farm roads. Their longitudinal gradients will not be greater than 12 %. The road surface gradient will be 2 % and the thickness of the gravel pavement will be 10 centimeters. The effective width of the trunk farm roads will be 4.0 m while that of the secondary farm roads will be 2.5 m.

The farm roads' lengths for each block are determined as follows.

	Trunk Farm Roads	Secondary Farm Roads
- Block B	150 m	3,915 m
- Block C	160 m	4,096 m

[Road Bridge]

Road bridges will be constructed at intersections between the proposed roads and existing small rivers. The road bridges will be of a structure that is widely used for improvement work carried out on the major district road crossing the project area. The bridges will be of box-culvert construction.

(9) Well Facilities

Hand-pumped wells (approximately 50 m deep) will be constructed beside the ponds in order to secure domestic water. Wash stands will be provided beside these wells.

3-3-4 Building Facility Plan

(1) Site and Layout Plan

The site for the Project Management Facilities is located roughly in the centre of Block B and C within the project area, approximately one hundred and twenty meters from the border with Mozambique in the Gairezi River basin. The site is on the east side of the arterial district road (effective width: 8 meters) which connects Nyamaropa in the southwest with Nyakomba in the northeast. The site is trapezoid-shaped beside the church at the northeast side. The buildings are laid out in view of their overall functions.

The following is being noted in the layout plan.

a. The site, permitting effective use, is trapezoid-shaped, jutting to the southeast with an area of approx. 7,000 m^2.

b. The site inclines gently down toward the southwest, therefore the design GL will be set in view of the current condition.

c. The natural environment (wind directions, temperature, humidity, sunshine, soil, etc.) is taken into consideration, and introduction of natural ventilation and air passages is essential.

d. The buildings are laid out in view of the relationship between buildings and traffic lines, as they are given different purposes.

(2) Facilities

Facilities will be designed to satisfy the following conditions, taking into consideration the objectives.

Table 3.9 Contents of Project Management Facilities

Classification	Contents	Rooms
a) Administration	* All work relative to administration, training and personnel planning. * Offices of administrators. * Other common spaces.	Manager's room, office, on-site manager's room, hot water room, toilets, shower room, hallway
b) Training Department	* Maximum 40 * Maximum persons in a small conference room 10 * Other common space	Meeting rooms, small conference room, warehouse, hallway
c) Garage, Workshop Department	* Storage and repair of agricultural machinery, storage space for spare parts * Storage and repair of agricultural machinery, machinery for field maintenance, equipment for management and storage space for spare parts * Management of incoming and outgoing material, products * Other common space	Workshop, preparation room, garage for construction equipment, garage for agricultural equipment, toilets
d) Warehouses	* Intended for storage of agricultural products and material * Intended for supply and storage of fuel	Warehouse, fuel storage
e) Health Department	* Accommodation functions are added given the travel conditions of Zimbabwe in the interest of improving efficiency of training and its results * Lodging for instructors and trainees is separated, designed for ease of management * Kitchen and showers are added to facilitate accommodation	Long-term stay for instructors with dining hall single rooms...3 For trainees double rooms...4

(3) Departmental Functions and Composition of Facilities

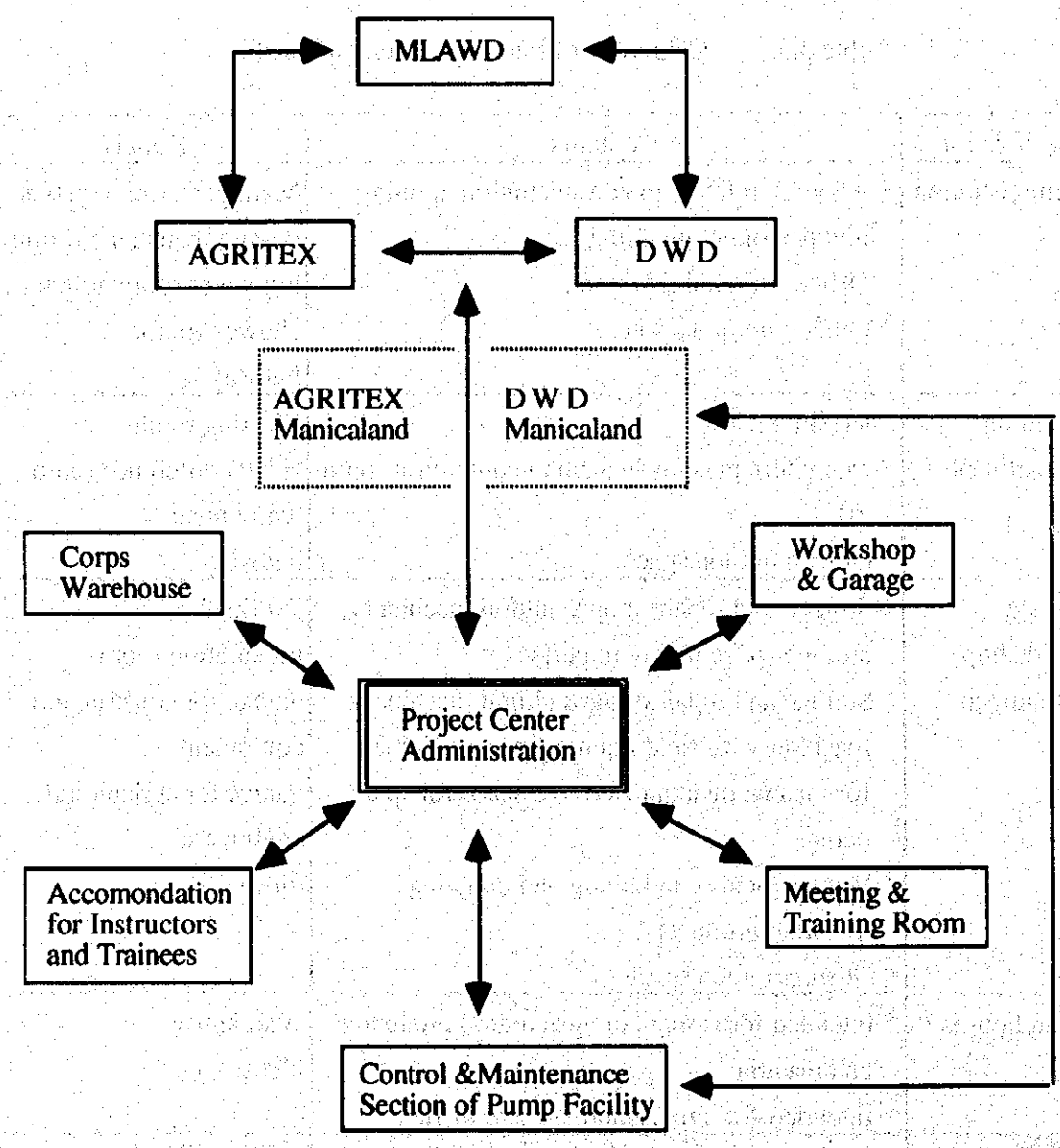


Fig. 3.3 Relations among Facilities and Organizations

Relations among the facilities and organizations will be planned as shown in the above figures in consideration of administration, operating system and contents of training. Additionally, concerning the pump house, coordinating by AGRITEX will be necessary, as the location will be separated from the project management facilities.

(4) Size of Buildings

The required sizes of the rooms in the facilities are calculated based on actual conditions with reference to common practices in Zimbabwe.

1) Project Management Facilities

Project Management Building

Space Designation	Size (m^2/person)	Required Area (m^2)	Design Value (m^2)	Remarks
1. Manager's Room	26 m^2 x 1	36 m^2	26 m^2	Private rooms corresponding to instructors' rooms. Secure space for filing and other cabinets.
2. On-site Manager's Room	18 m^2 x 1 12 m^2 x 3	54 m^2	54 m^2	Room for irrigation managers, single rooms for use by farmers and instructors. Secure space for filing and other cabinets.
3. Office	9 m^2 x 2	18 m^2	18 m^2	Telephone and cable lines to connect with reception and typists.
4. Union Manager's Room	18 m^2 x 1	18 m^2	18 m^2	Union personnel. Single rooms for use of project personnel. Secure space for filing and other cabinets.
5. Managerial Personnel Room	9 m^2 x 3	27 m^2	26 m^2	Assistance management for project and union personnel.
6. Common Space			138.8 m^2 (100.8 m^2)	Hot water room, wash rooms, toilets, open hallway
Total area			280.8 m^2	* In parentheses: area for open hallway

Training Space

Space Designation	Size (m^2/person)	Required Area (m^2)	Design Value (m^2)	Remarks
1. Meeting Room	1.8 m^2 x 40	72 m^2	78 m^2	Maximum persons 40. Multi-purpose use considered.
2. Small Conference Rooms	1.8 m^2 x 15	27 m^2	26 m^2	Maximum persons 15. Movable partition is installed for joint use with meeting room.
3. Common Space			58 m^2 (32 m^2)	Warehouse and hallway
Total area			162 m^2	* In parentheses: area for open hallway

Lodging Facilities

Space Designation	Size (m^2/person)	Required Area (m^2)	Design Value (m^2)	Remarks
1. Instructors	23 m^2 x 3	69 m^2	68 m^2	For long-term instructors, capacity 3. F14/R type standard housing of Zimbabwe is used as a model and improved. Kitchen, dining hall, toilets and showers provided in design.
2. Trainees' Lodging	9 m^2 x 8	72 m^2	68 m^2	For trainees, capacity 8 F14/R type standard housing of Zimbabwe is improved upon for double rooms. Kitchen, dining hall, toilets and showers provided in design.
3. Common Space			(24.5m^2)	Hallway
Total area			160.5 m^2	* In parentheses: area for open hallway

2) Workshop & Garage

Space Designation	Size (m^2/person)	Required Area (m^2)	Design Value (m^2)	Remarks
1. Workshop		170 m^2	170 m^2	Designed adjacent to garage for spare parts cabinet, storage and repair space. Preparation room is also provided to function also as office.
2. Garage Space for Construction Equipment & Agricultural Equipment	32 m^2 x 3	96 m^2	96 m^2	Maintenance and management space of construction equipment & agricultural equipment
3. Common Space		6 m^2	6 m^2	Washroom, toilets
Total area			376 m^2	

3) Warehouse

Space Designation	Size (m^2/person)	Required Area (m^2)	Design Value (m^2)	Remarks
1. Warehouse			162 m^2	Storage of agricultural crops and material, etc.
2. Fuel Station			52 m^2 (26 m^2)	Storage and supply of fuel for construction and agricultural equipment
Total area			214 m^2	* In parentheses: area for open hallway

(5) Architectural Planning

1) Plane Plan

a. Project Administration Office

The building floor plan will be studied in consideration of 1) required room space to adjust the movement of the irrigation officials and clerks, 2) disposal of equipment to fulfill respective purposes and 3) normally economical spans in Zimbabwe. Spans of 6.8 m (inclusive of 1.8 m for hallway) and beams of 3.6 m will be applied based on the grids advantageous for masonry structures. The building will be located in the southern part of the site, where a broad front yard will be obtained, so that proper management will be conducted by means of proper awareness of human passage and material flow. A broad and open hallway will contribute to effective wind passage, air flow and screening of sunlight.

b. Meeting Rooms

A meeting hall and small meeting rooms will be located in the centre adjacent to the administration office across the hallway, in order to concentrate on training and communication purposes inside the project management building. Dividing walls will be movable partitions to permit multipurpose functions, since the room may be used as a meeting hall for the community.

c. Lodgings

The lodgings will be placed to the east of the administration office and meeting rooms considering the natural environment and living conditions. The lodgings for the long-term instructors and trainees will be in separate buildings. Due to the proximity to the Gairezi River, security of the occupants must be considered.

d. Workshop, Garage and Warehouse

The workshop and garage will be located next to each other at the centre of the site. Storage places of equipment and transportation routes need to be considered for the garage, while space must be secured for the storage & supply of repair parts and instruction & service for users in the workshop. The warehouse is planned along the district road in consideration of the site configuration, incoming and outgoing flow of crop transportation and accessibility for the vehicles.

2) Elevation Plan

All buildings will be designed to be one-storied in consideration of the existing project facilities in the vicinity in Zimbabwe and the appearance & volume of the buildings as well as their similarity and relationship.

a. External columns and beams will be painted with architectural concrete finish to secure sufficient concrete cover, while walls will be of burned bricks exposed or mortared, either of which will be water-proofed. Finishing material and coloring will be selected to harmonize with the surroundings.

b. Steel doors will be furnished. Windows will be framed with general-type steel sashes and transparent glass will be fitted, with insect screens on the outside. Steel bars will be furnished, where necessary, for security.

c. Corrugated asbestos slate boards and concrete tiles will be utilized for roofs of the administrative and auxiliary buildings respectively. Hallways with long eaves and pentroofs are installed to deal with strong sunlight, rain and wind.

3) Cross-sectional Plan

a. Appropriate sash openings will be required to prevent humidity in the building and rooms. The openings under beams will be equipped with screened louvers for air passage and ventilation.

b. The following requirements will be imposed as to the height of the ceiling.

- Zimbabwe standard 2.7 m for habitable spaces such as the administration office, the lodgings and the meeting rooms.

- 4.0 - 5.5 m for the workshop and the garage as calculated from material standards and space for repairs and storage.

- 4.5 m for the warehouse for installation of ventilators under beams to facilitate natural ventilation, mainly due to the necessity of crop storage.

c. Height of the floor will be a 0.35 m above the ground level to permit drainage and prevention of humidity in the rainy season.

4) Finishing Plan

a. Main materials for external finish

floor ... reinforced troweled concrete or troweled mortar for grano finish
pillar, beam ... direct reinforced concrete with paint finish for water-proofing
walls ... masonry structure with exposed burned bricks under paint finish for water-proofing
roofs ... wooden truss rafter over colored cement tile finish or steel frame truss angle on the base of corrugated slate plate finish

b. Main materials for interior finish

floors ... offices and meeting rooms: grano finish, lodging: for instructors, parquet wooden floor, for trainees, color grano finish; workshop, garage and warehouse, direct concrete joint seal, troweled concrete
walls ... direct troweled mortar, paint finish
ceiling ... plasterboard only for living quarters, paint finish

5) Structural Plan

a. Basic policy

- Structures and methods will be proper to size, configuration and purpose of building.

- Methods will be decided with reference to general construction methods widely employed in Zimbabwe as well as existing structures in the vicinity. Structures will be reinforced concrete for foundation floor slabs, pillars, beams, wall girders and lintels over windows. External walls are to be raised by piling single-row burned brick directly from the concrete foundation floor slabs.

- Construction materials in principle, will be obtained in Zimbabwe while appropriate levels of technology and quality will be maintained.

b. Structural design conditions

Zimbabwe has "MODEL BUILDING BY-LAWS" for structural design and all buildings are designed in accordance with them. However, government buildings are exempt in general so that Japanese design standards will be applied for design loads, etc.

- Direct foundation is employed. The ground has been cultivated for a long time and the current condition permits an estimated soil bearing capacity over 5t/m^2, so that a foundation requires a depth of approx. 1 m. Since the surroundings of the Gairezi River basin have complicated topography with bedrock and sandy soil, the bearing capacity of the soil must be verified by soil investigation at the detailed design stage.

- Additional filling on the ground will not be required for the floors of the buildings and floor concrete can be placed directly after the foundation work. Concrete slab with wire mesh made in Zimbabwe will be adopted.

- Designs for wind load and seismic force are based on the Japanese standard.

c. Structural materials

* concrete design standard strength : Fc = 210 kg/cm^2 (JIS equivalent)
* cement : normal portland cement (JIS equivalent)
* reinforcement bar: SR 24, or SD 30A (JIS equivalent),
  weld wire mesh by 4.5-6 f standard.
* bricks : locally made bricks (Standard Association Zimbabwe)

6) Facility Plan

a. Basic policy

The following policies are valid for the facilities plan of this Project.

- To reflect the local conditions, analyzing the requirements in regard to usage and functions, in consideration of the natural conditions and living customs in Zimbabwe.

- To consider easy and low cost operation and maintenance by achieving ventilation, heat & cold prevention measures and cleaning at low running cost.

- To avoid unnecessary future replacements, supplies and repairs by means of utilizing quality materials.

b. Water supply

A new well will be dug in the proposed site and water will be directly pumped to an elevated water tank (6-7 m high), then supplied by gravity.

- Calculation of water to be supplied

* supply per day ... 55 (men) x 80 l/man • day = 4400 l/man • day
* supply per hour ... 4400 x 1/8 = 550 l
* maximum supply per hour ... 550 l x 2 (peak load coefficient) = 1,100 l/h
* Capacity of elevated water tank will be set at 9,000 l, 2 days supply per day.

- Elevated water tank

One elevated water tank of 2,500 l will be required. One well pump will be operated automatically depending on water level in the elevated water tank.

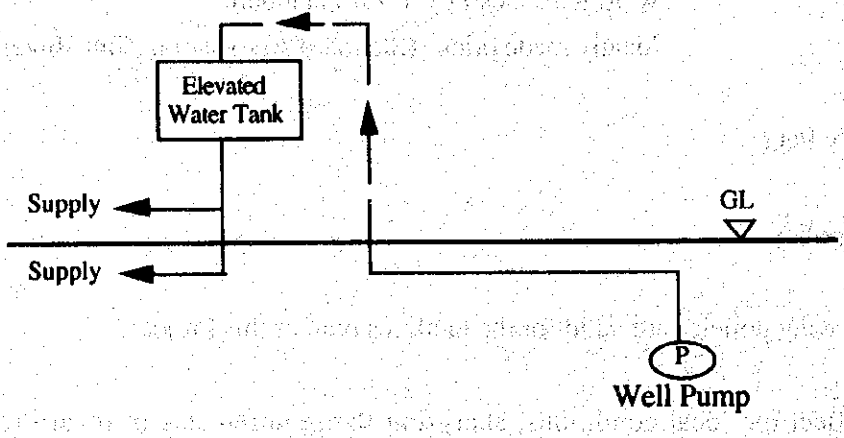


Fig. 3.4 Model of Supply Plan

c. Drainage

Drainage of waste water will be by a combined sewage system utilizing local methods. Waste water will be treated in a purification tank and released into the ground at the site by permeable perforated pipe. Piping in the buildings, with the exception of lodgings, will be exposed piping. External supply piping and catch basins will be installed respectively. The volume of drained water will be set at 80% of supply for calculations.

d. Ventilation

Ventilation register louvers will be furnished aiming at natural ventilation as the main mode for the rooms.

e. Electrical equipment

- Electricity will be drawn by a receiving board in the proposed building in 3-phase, 4-line, 220 v/50 Hz via the leading-in pole.

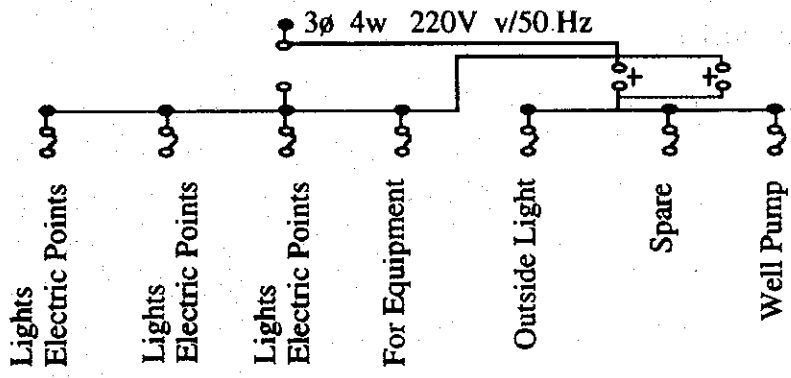


Fig. 3.5 Layout of Electricity

- Electric supply from the receiving board to distribution panels and control panels will be by piped wires and cables.

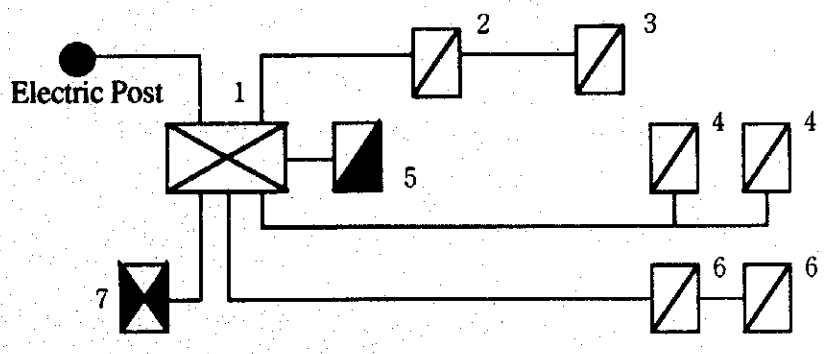


Fig. 3.6 Main Power System

1. Receiving Board 2. Project Managing Building 3. Meeting Room
4. Lodgings 5. Workshop/Garage 6. Other Facilities 7. Control Board

- Lights and outlets

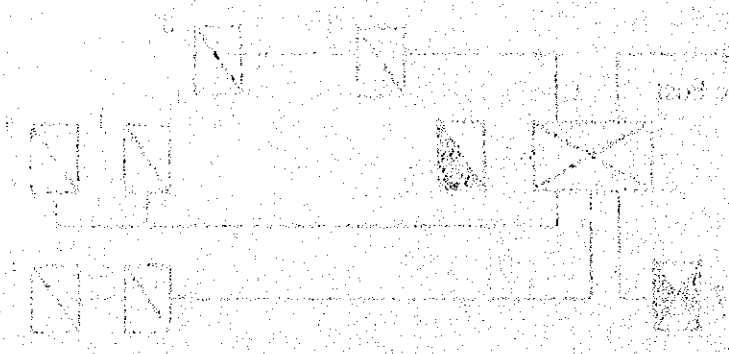
Illumination will be mainly by fluorescent light and the administration office will be illuminated by 300 - 500 LX, meeting rooms by 300 LX, lodgings by 100 LX and other common spaces by 100 - 150 LX. Types of electric points will follow the standard in Zimbabwe, and the voltage will be 220 V in general.

- Facilities for prime mover

Power will be delivered to the workshop and the well pump.

- Lightning conductors

Lightning conductors will be installed at the tops of the buildings as lightning often occurs in the region.



3-3-5 Equipment

Necessary equipment will be planned in order to carry out smooth management of the facilities after the project facilities are transferred to the Government of Zimbabwe.

(1) Irrigation Pump Facilities

Type: Double Suction Volute Pump

Unit: Block B 3 units, Block C 3 units

Bore: ø 250 mm

Power: Block B 132 kw, Block C 150 kw

Other appurtenant facilities: 1 set

(2) Electric Equipment

Control Panel: Receiving Board, Distribution Board, etc.

Other appurtenant facilities: 1 set

(3) Agricultural Machines: 1 unit each

Tractor: 4WD, 75 HP

Attachments: Rotary Harrow, Disc Plow, Ridger, Trailer

The tractor will be used for farmers training of agricultural working system with tractor, and extension activities by demonstrating mechanical agriculture at the farms. In consideration of operation in the dry season, 75 HP class is selected. AGRITEX will carry out the operation and maintenance, and it will be kept together with the attachments in the garage of the Project Management Facilities.

(4) Field Maintenance Machine:

Motor Grader: B = 2.80 m 1 unit

The motor grader will be used for leveling of the farms and maintenance of the farm roads. It will be kept in the garage of the Project Management Facilities.

(5) Other Equipment:

Pickup: 500 kg 1 unit

The pickup will be used for canal inspections and transportation of necessary materials by the staffs of AGRITEX. It will be kept in the garage of the Project Management Facilities.

Truck: 6 ton 1 unit

The truck will be used for transportation of necessary materials for the maintenance of the irrigation facilities and supplement for the delivery of yielded crops. It will be kept in the garage of the Project Management Facilities.

Motorcycle: 90 cc 1 unit

The motorcycle will be used for inspections of the pump stations and the farm ponds by Artisan of DWD.

Bicycles 4 units

The bicycles will be used for communications between the pump stations and farm ponds by the pump operators of DWD.

(6) Equipment for the Workshop 1 set

The following is the equipment for the workshop in order to maintain the above-mentioned machines and equipment, and will be facilitated in the workshop.

- Electric handy-type drill: max. ø13, 1 kW - 2 units
- Drill bit set: ø15~13, 15 pieces - 3 sets
- Grinder with table: 2 disc tap - 1 units
- Electric handy-type grinder: 0.7 kW - 2 units
- Vice: 200 mm - 1 unit
- Workbench: 1.8 m (B) x 0.9 m (L) x 0.7 m (H) - 1 unit
- Electric welding machine: 4 KVA - 1 piece
- Spanner: 6 pcs/set (M10~M23) - 2 sets
- Box spanner: 6 pcs/set (M10~M23) - 2 sets
- Pipe wrench: 60 cm - 2 pieces
- Prier: 20 cm - 2 pieces

(7) Spare Parts

In order to guarantee that the above machinery operates satisfactorily, when the machinery is provided, it will be accompanied by consumable parts and such spare parts as are deemed necessary (a two-year supply).

(8) Handing Over the Equipment and Materials

All equipment and materials will be transported to the construction sites or distribution points. After being installed and the necessary trial runs completed, they will be handed over to the managing body along with the associated spare parts. Operating and inspection manuals will also be provided.

3-3-6 Basic Design Drawing

List of Drawings

1.	BLOCK - B	GENERAL PLAN	
2.	" "	PUMP STATION	PLAN
3.	" "	PUMP STATION	SECTION
4.	" "	PUMP STATION	STRUCTURE (1)
5.	" "	PUMP STATION	STRUCTURE (2)
6.	" "	PUMP STATION	HOUSE
7.	" "	HEAD RACE (1)	LONG SECTION B-P-1
8	" "	HEAD RACE (2)	LONG SECTION B-P-2, B-P-3, B-P-4, B-P-a
9.	" "	FARM POND	PLAN
10.	" "	DETAILS OF FARM POND	
11.	" "	IRRIGATION FACILITIES (1/3)	
12.	" "	IRRIGATION FACILITIES (2/3)	
13.	" "	IRRIGATION FACILITIES (3/3)	
14.	" "	DRAINAGE FACILITIES (1/2)	
15.	" "	DRAINAGE FACILITIES (2/2)	
16.	" "	FARM ROADS	
17.	BLOCK - C	GENERAL PLAN	
18.	" "	PUMP STATION	PLAN
19.	" "	PUMP STATION	SECTION
20.	" "	PUMP STATION	STRUCTURE (1)
21.	" "	PUMP STATION	STRUCTURE (2)
22.	" "	PUMP STATION	HOUSE
23.	" "	HEAD RACE (1)	LONG SECTION C-P-1
24.	" "	HEAD RACE (2)	LONG SECTION C-P-2, C-P-3
25.	" "	FARM POND	PLAN
26.	" "	DETAILS OF FARM POND	
27.	" "	IRRIGATION FACILITIES (1/3)	
28.	" "	IRRIGATION FACILITIES (2/3)	
29.	" "	IRRIGATION FACILITIES (3/3)	
30.	" "	DRAINAGE FACILITIES (1/2)	
31.	" "	DRAINAGE FACILITIES (2/2)	
32.	" "	FARM ROADS	
33.	PROJECT MANAGEMENT FACILITIES		
34.	PROJECT MANAGEMENT BUILDING		PLAN & SECTION
35.	PROJECT MANAGEMENT BUILDING		ELEVATION
36.	WORKSHOP & GARAGE		PLAN & SECTION
37.	WORKSHOP & GARAGE		ELEVATION
38.	WAREHOUSE		
39.	FUEL STATION		

3-4 Implementation Plan

3-4-1 Construction Condition

(1) Project Implementation Organization

In the event that the Project is implemented under Japan's Grant Aid, in accordance with the division of administrative responsibilities established by the Government of Zimbabwe, the executing agencies will be AGRITEX and DWD, both of which are under the Ministry of Lands Agriculture and Water Development. The time of work to be executed by each agency have been divided at a particular structure point in the complete irrigation system: the so called "field edge". The field edge in this Project is the outlet gate of each farm pond. DWD is responsible for the development and supply of all surface water in Zimbabwe. Consequently, it will be in charge of the pump house, head races and the farm ponds. AGRITEX, on the other hand, is in charge of the facilities in the fields; the irrigation canals, drainage canals, and farm roads. It will also handle operation of the project management office.

Both government bodies have considerable experience with irrigation development projects, and have state offices in Mutare in Manicaland. AGRITEX also has a district office in Nyanga, the site of the project area. With the advice of consultants, these two state offices will actually manage and implement the Project.

(2) Use of Local Contractors

Within the region, there are more than ten large contractors with the capacity to perform comprehensive construction work and with specialized technologies. These contractors possess the advanced construction technology needed to execute each stage of the Project. All of them have experience in construction projects conducted by DWD and AGRITEX, and own the machinery needed for this Project. Positive steps will be taken to involve these contractors in it.

3-4-2 Implementation Method

(1) Execution Period

The project area is located in a hilly area in the eastern part of the country, an area of Zimbabwe noted for its heavy rainfall. From December to February, when the rainfall is

particularly heavy, earth work, etc., is expected to progress very slowly. The rising level of the Gairezi River during that period will prevent any work on the lower parts of the pump stations.

The project schedule will be prepared to take into account these restrictions on construction.

(2) Roads

The Nyamaropa - Elim Road which crosses the project area is a major district road, so it will be impossible to disrupt traffic on this road totally while constructing structures intersecting it. Consequently, work must be conducted so that at least one lane is open at all times.

(3) Cofferdam

The contractor who will build the pump stations will have to install a cofferdam on the Gairezi River. It will be necessary to build a steel sheet-pile, double-wall cofferdam for two reasons. First, the excavation work will be very deep; second, the river forms the border with Mozambique, so the work must be confined to the Zimbabwe side of the river.

(4) Construction

Before actual construction work begins, the land must be prepared at the sites of the planned facilities, and electricity must be provided to locations requiring electric power. Both tasks must be completed by Zimbabwe.

3-4-3 Construction and Supervisory Plan

(1) Execution Management Organization

The detailed design and execution management will be conducted by a Japanese consulting firm in accordance with an operation contract to be signed with the Ministry of Land Agriculture and Water Development after the Exchange of Notes (E/N) is signed.

The operations contract will be prepared in accordance with the E/N, and will be issued after it has been approved by the Government of Japan.

Execution will be managed under the jurisdiction of the head offices and the bureaus in charge of design and construction at AGRITEX and DWD, the two departments of the Ministry of Land Agriculture and Water Development.
This organization is shown in Figure 3.7.

(2) Execution Organization

1) Contents of Detailed Design

- Detailed design
- Advice concerning the bidding procedures and the establishment of construction contracts between a Japanese corporation and the two departments of the Ministry of Land Agriculture and Water Development.

2) Contents of the Execution Management Work

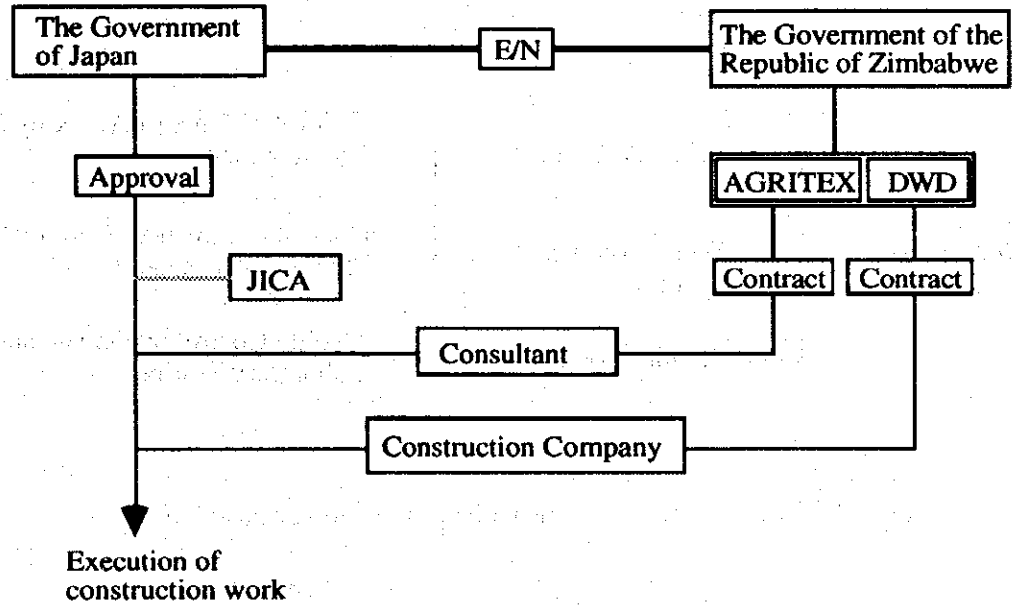
Scheduling and product-quality management will be performed for the following work.

- Earth work, concrete work, pipe-laying work
- Pump-related equipment work
- Building construction work

(3) Execution Management Plan

Execution management will be carried out as the work progresses in accordance with the execution management standards of AGRITEX and DWD. The basic organization of execution management is shown in Fig. 3.8.

(1) Contractual Work



(2) Organization

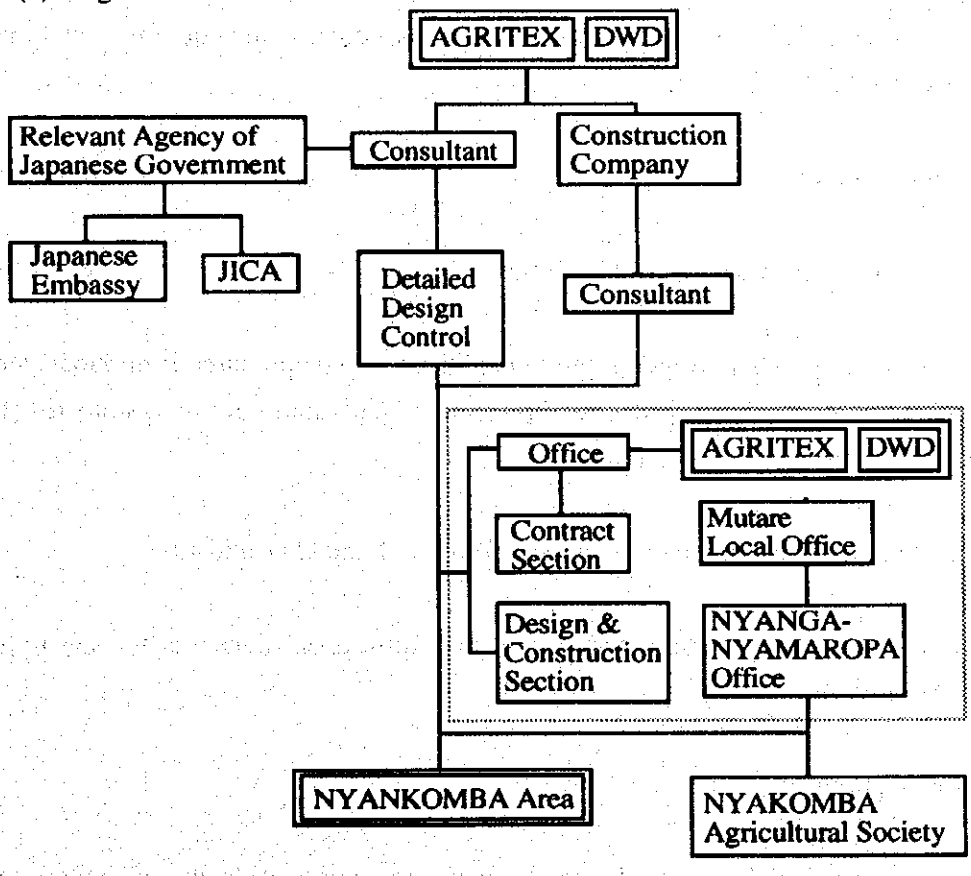


Fig. 3.7 Implementation Organization

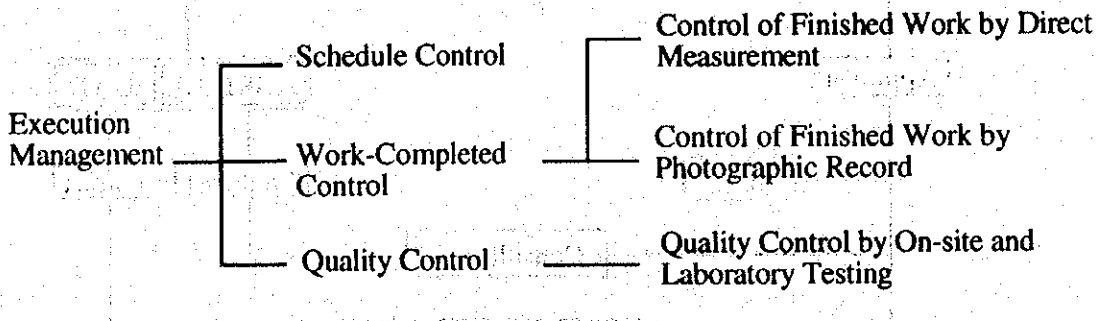


Fig. 3.8 The Basic Organization of Execution Management

3-4-4 Procurement Plan

The procurement plan of the equipment, materials, construction equipment and materials are described below.

(1) Procured Equipment

1) Irrigation Pumps with Electric Facilities

It has been decided that irrigation pump facilities are to be procured from Japan, since the pumps applied in this Project have high pump heads and careful systematic study is needed for prevention of water hammer.

2) Agricultural Machinery and Machinery for Farm Land Consolidation

The tractor and motor grader are to be procured from Japan, since it is not easy to procure them in Zimbabwe.

3) Other equipment

The pickup, truck and motorcycle are also to be procured from Japan, since those made in Japan are popular in Zimbabwe. The bicycles and equipment for the workshop are to be procured in Zimbabwe, since they are easy to procure there.

4) Spare Parts

In order to guarantee that the above machinery operates satisfactorily, when the machinery is provided, it will be accompanied by consumable parts and such spare parts as are deemed necessary (a two-year supply).

5) Handing Over the Equipment and Materials

All equipment and materials will be transported to the construction sites or distribution points. After being installed and the necessary trial runs completed, they will be handed over to the managing body along with the associated spare parts. Operating and inspection manuals will also be provided.

(2) Construction Equipment and Materials

Equipment and materials for the construction are to be procured in Zimbabwe as much as possible, however ductile cast-iron pipes are to be procured from Japan, since they are not available locally. On the other hand, PVC pipe can be procured in Zimbabwe.
Local contractors have the construction equipment needed to execute the construction work required for this Project.

3-4-5 Implementation Schedule

The construction schedule is divided into two phases. The Construction Schedule of this Project is shown in Fig. 3.9.
In the first phase, Block C on which a first priority is put will be implemented, and the Project Management Facilities will be implemented in the first phase as well due to smooth management of the Project.
In the second phase, Block B and the procurement of equipment will be implemented.

(1) Implementation Schedule

The schedule from the E/N to commencement of the construction of each phase is as below;

- Contract for consultant services
- Field Survey in the Detailed Design Stage
- Detailed Design in Japan

} about 3 months

- Preparation of the tender documents
- Tendering and evaluation } about 2 months
- Contract for construction

(2) Construction Period

The construction period of this Project will require about one year for each phase, in consideration of natural conditions, site conditions, working conditions, construction methods, keeping down costs and so on.

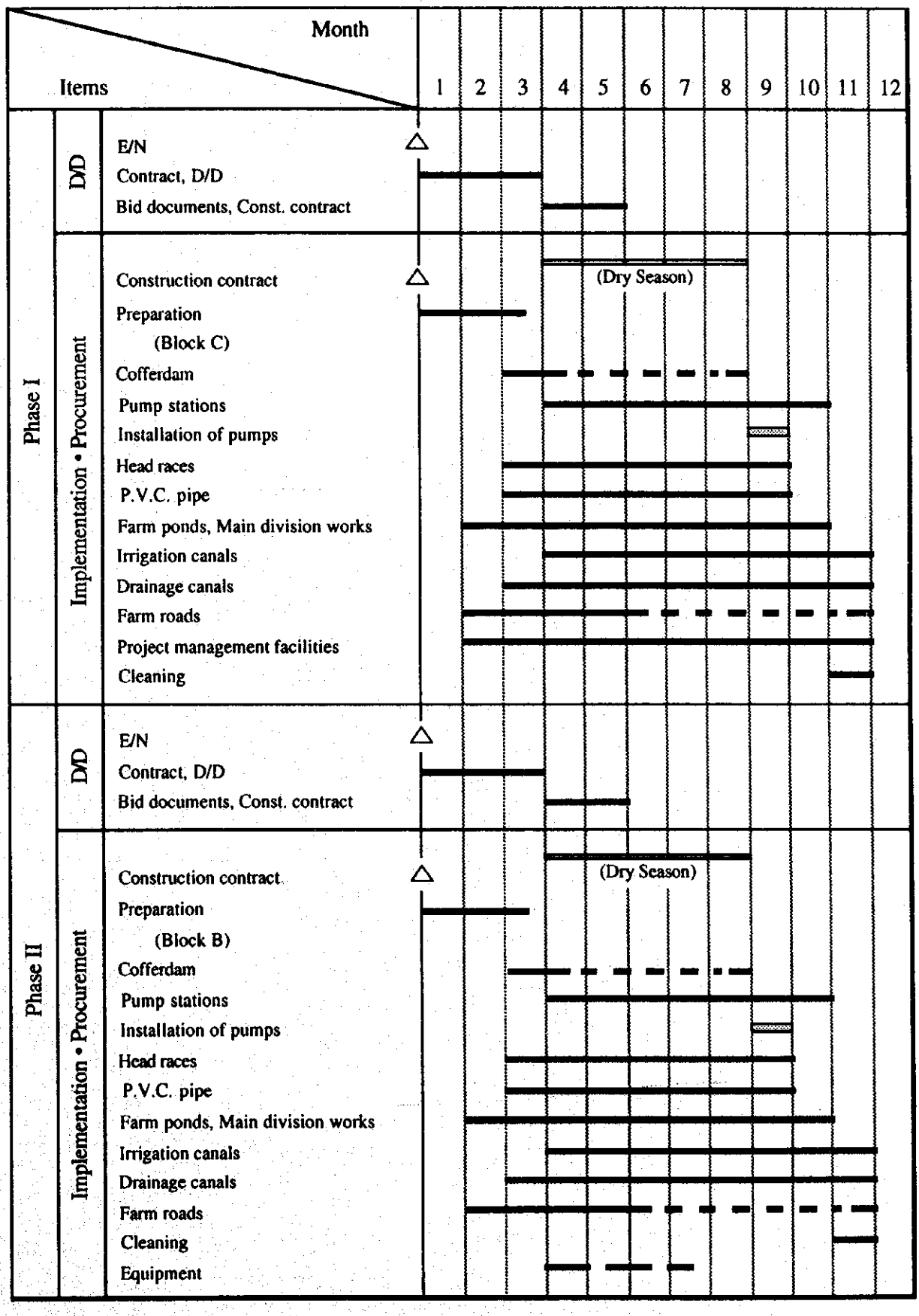
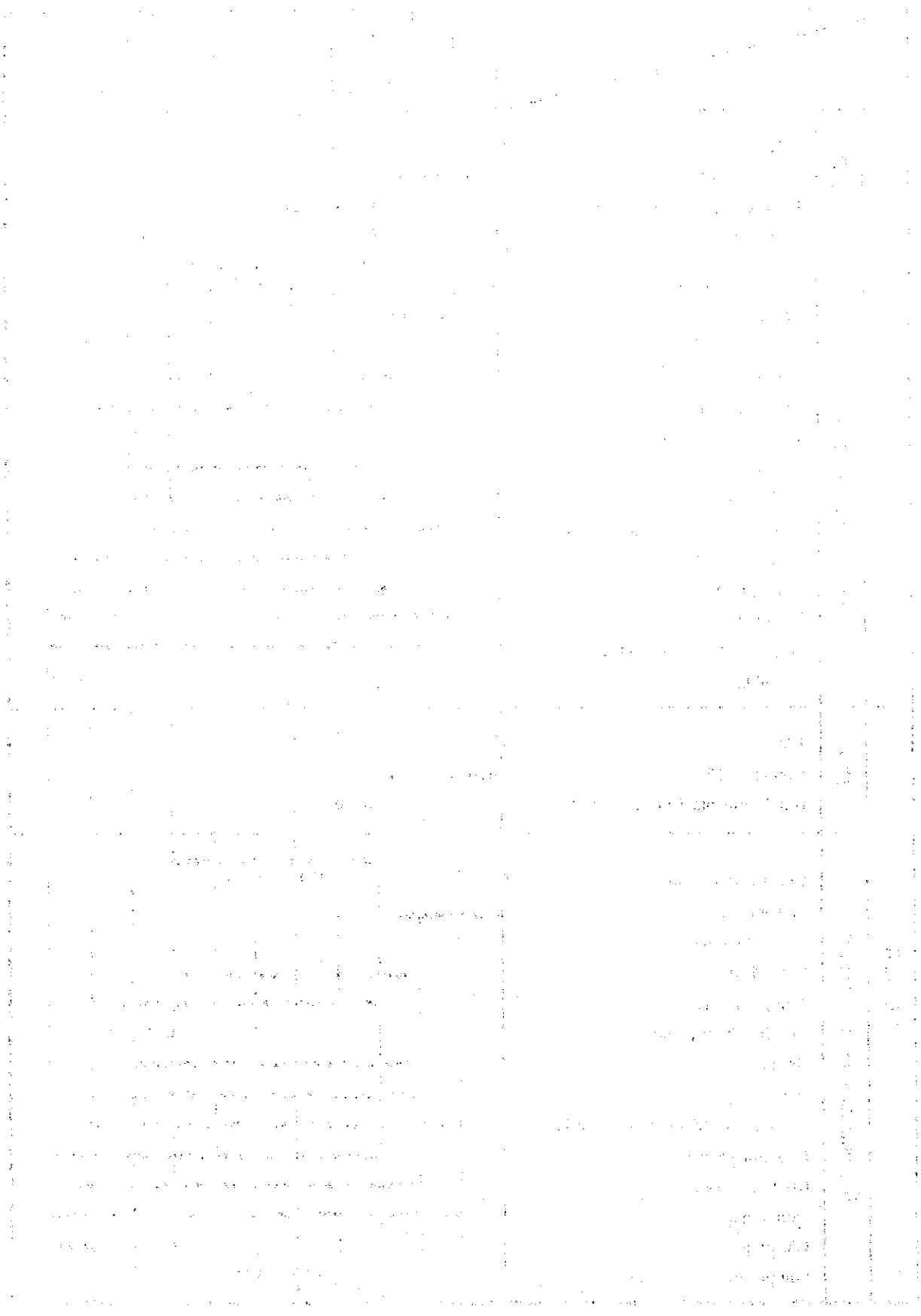


Fig. 3.9 Construction Schedule



CHAPTER 4 PROJECT EVALUATION AND CONCLUSION

CHAPTER 4 Project Evaluation and Conclusion

4-1 Benefit

The tangible benefit expected to be derived from execution of the Project is summarized in the Table 4 - 1.

This Project complies with the Second National Development Plan that aims at development in the Communal Lands, promoted by the Government of Zimbabwe, and improvement of the living standard. In this Second Plan, top priority is especially given to the development in the Communal Lands located at the remote area with bad land conditions.

Agriculture is the trunk industry in the Communal Lands, but improvement of conditions for agriculture including social infrastructure has been delayed. Consequently, the present condition shows that the farmers are forced to carry out agriculture with low productivity in this region.

In order to improve this condition, construction of irrigation facilities and guidance to the farmers are in progress by the government of Zimbabwe. However, its progress is very slow due to budgetary restrictions and so on.

The implementation of the Project is expected to realize the improvement of living standards in the Nyakomba Ward, which is one of the typical Communal Lands, by means of 1) increasing incomes, 2) improvement of employment opportunities, 3) a stable food supply and 4) reduction of the labour burden of women and children by providing a constant water supply that is derived from the construction of the irrigation facilities. Moreover, its implementation is expected to have beneficial effects on the adjacent areas.

4-2 Verification and Evaluation

In consideration of the benefit derived from the implementation of the Project, its nature and practicability of operation and maintenance, it is judged that the Project is appropriate with the Grant Aid of Japan. The details are as follows.

1) The beneficiaries of the Project are the farmers who live in the Communal Lands located in the remote area. The inhabitants of Block B and Block C are about 1,200.