Somali Democratic Republic
Ministry of Agriculture

Farahaane Irrigation Rehabilitation Project

Water Management Report

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CHAPTER 1

INTRODUCTION

1.1 The Project

The Farahaane Irrigation Rehabilitation Project lies in the Lower Shebelle valley, about 100 km south west of Mogadishu. It is part of a series of rehabilitation projects which the Government is intending to invest in within the Genale-Bulo Marerta area. A feasibility study for the project is contained in the Genale Irrigation Rehabilitation Project feasibility study completed by Tippetts-Abett-McCarthy-Stratton (TAMS) in October 1986.

The aim of the project is the rehabilitation of the Farahaane irrigation area (4/98 ha net) including the installation of a drainage system, and rehabilitation of Qorioley and Falkeerow barrages.

The proposed works are summarised below:

a) Qorioley and Falkeerow Barrages

The existing gates at both barrages will be replaced and the road bridges widened and strengthened. General structural improvements will be carried out together with protective works upstream and downstream.

b) Irrigation System

The irrigation system will be rehabilitated by the remodelling of existing canals, construction of some new canals and the provision of control and regulation structures. The present system of numerous small canals offtaking from the river would be replaced by the remodelled Farahaane primary canal and the new Gayweerow primary canal offtaking from Qorioley and Gayweerow barrages respectively.

The existing canal layout will be maintained as much as possible to avoid disruption to the existing well established system.

c) Drainage System

A surface drainage system will be introduced comprising in-field tertiary and quaternary drains discharging into larger secondary and primary drains. The primary drain will dishcarge into the existing Bokore canal through a drainage pump station of peak capacity 8.1 m^3/s.

1.2 Purpose of this Report

This report has been prepared as a guide for the operation of the Farahaane Project irrigation and drainage systems. It does not include other components of the project, such as buildings, services and maintenance.

This manual therefore covers the following:

(a) Organisation and management;
(b) Irrigation requirements and scheduling;
(c) System operation;
(d) Operating procedures.

The necessary organisation and management to ensure effective operation facilities is discussed in Chapter 2.

Irrigation requirements and scheduling, system operation and operating procedures are described in Chapter 2 and Chapter 3. Chapter 4 briefly describes the operation of the drainage system.

This report should be read in conjunction with the following documents:

(a) Tender Documents (comprising one volume and an Album of Drawings)
(b) Design Report;
(c) Topographical and Cadastral Survey Report.

CHAPTER 2

ORGANISATION AND MANAGEMENT

2.1 Responsible Authorities

The operation of the Farahaane Irrigation Project will be controlled at two levels. The first level; the operation of the river barrages and the main distribution system will be the responsibility of the Ministry of Agriculture. The second level; the operation within a tertiary canal, will be the responsibility of the farmers in the form of Water User Organisations.

To some extent these two levels of control will overlap. The Ministry of Agriculture, for instance, will operate the tertiary canal head regulators. The water user organisations, although not being responsible for the volume of water supplied to the tertiary unit, will have an opinion as to how any rotation of supply should be organised. It is therefore of great importance that the two groups maintain good communications.

The Ministry of Agriculture will be represented in the Project area by two Authorities. The Shebelle Valley Water Authority will be specifically responsible for the operation of the two river barrages and for the allocation of water to the Farahaane Project. The Farahaane Project Authority will be responsible for the operation of the main distribution system down to, and including, tertiary canal head regulators.

The Water User Organisations are basically existing committees representing farmers or water users along a specific canal.

2.1.1 Barrage Operation

The Farahaane Project is commanded by two barrages, the Gayweerow barrage and the Qorioley barrage. The Shebelle Valley Water Authority will be responsible for controlling the water resources of the Shebelle Valley, and will thus be responsible for operating the two barrages to control pond levels and water abstractions.

Under normal operating conditions the Farahaane Project Authority will request a certain allocation of water, on a 10 day basis, from each barrage. The Shebelle Valley Water Authority will then allocate a proportion of the requested volume depending on water availability in the river.

2.1.2 Distributary Canal Operation

The distributary canal system comprises the primary and secondary canals and all associated structures. The Farahaane Project Authority will be responsible for the operation of this system.

2.1.3 Tertiary Unit Operation

The tertiary unit, that is all canals downstream of the tertiary canal head regulator, will be operated by representatives of the various Water User Organisations. These Organisations will be based on the existing farmer groups which presently control supplies from secondary canals down to farm level.

The allocation of water to a secondary canal and the subsequent operation of the tertiary canal head regulators will be carried out by the Farahaane Project Authority, although some consultation will be necessary with the Water User Organisation if, for instance, rotation of supplies during times of water shortage is considered. The Water User Organisation will be responsible for operating the tertiary and quaternary canals to ensure equitable supplies to each farmer within a tertiary unit.

2.2 Staff and Labour Requirements

In this section it is proposed only to consider the staffing of the Farahaane Project Authority. It is assumed that the Shebelle Valley Water Authority will provide sufficient staff for the operation of the Gayweerow and Qorioley barrages. The Water User Organisations will have no permanent staff.

The total operational staff requirements for the Operation Service of the Farahaane Project Authority are presented in Table 2.1. The Chief of Operation Service, who will be an irrigation engineer, will determine the flows required in the distributary canals and communicate the required gate settings to the Water Master who will in turn instruct the Water Guards and Operators.

Table 2.1

Farahaane Project Authority Staff Requirements - Operation Service

Job Title	Total	Location
Chief of Operation Service	1	Project headquarters
Water Master	1	Project headquarters
Water Guards	1	Canal F1
	1	Canals F2 and F3
	1	Farahaane Primary Canal
	1	Gayweerow Primary, G4 and G5 canals
	1	Canal G1
	1	Canal G2
	1	Canal G3
	1	Canals G3 - 1 and G3 - 2
	8	
Operators (Excludes drainage pump station operator)	1	Gayweerow Primary Head Regulator
	1	Farahaane Primary Head Regulator
	1	Gayweerow Primary/G1 Regulator Group
	1	G3/G3 - 1/G3 - 2 Regulator Group
	1	Gayweerow Primary Tail Regulator Group
	1	Farahaane Primary Tail Regulator Group
	6	

2.3 Staff Duties

The duties of the proposed staff employed by the Farahaane Project Authority would be as described below.

(a) Chief of Operation Service

The Chief of Operation Service will be responsible for the operation of the whole Project. His main function will be to issue operational orders to the Water Guards and Operators and to receive from them, and process, field records.

He will calculate irrigation requirements, probably on a 10 day basis, determine the required discharges and durations and instruct his staff accordingly using standard instruction forms.

(b) Water Master

The Water Master will be responsible for the day to day supervision of the Operators and Water Guards. He will provide the channel of communication between the Chief of Operation Service and the Operators and Water Guards. One of his most important duties will be to coordinate the operation of the system, ensuring that Operators and Water Guards liaise with each other to minimise disruption to supplies due to poorly coordinated operation of structures.

This post is an important one requiring the selection of a responsible person with the ability to manage and direct people. Preferably he should have a number of years experience in a similar capacity, if possible on the same or a similar scheme.

(c) Operators

The operation of primary and secondary canal regulator groups require specialised operators. These Operators will have responsibility for their allocated regulator group as well as any other special instructions given to them by the Chief of Operation Service.

They will receive their operating instructions for a period, as discussed in (a) of this section. They will then be responsible for maintaining water levels and discharges at their regulator group until they receive further instructions.

Each operator will be allocated an operator's quarters adjacent to the canal group for which he is responsible.

(d) Water Guards

The Water Guards will be the main communication channel between the scheme management and the farmer. The importance of their relationship with the farmers cannot be overstressed. They must be capable and honest and able to operate their allocation of tertiary head regulators according to their instructions from the Chief of Operation Service without allowing any unauthorised abstractions. On some canals, Water Guards will be responsible for the operation of the secondary canal head regulator as well as the tertiary canal head regulators.

The actual operation of tertiary canal head regulators may be undertaken by the Water User Groups under the supervision of the Water Guards.

2.4 Transport and Communications

Transport for the Operation Service staff has been provided for under the Contract.

The Water Master and Water Guards will be allocated motor cycles whilst the Chief of Operation Service will be allocated a four wheel drive vehicle.

CHAPTER 3

IRRIGATION SYSTEM OPERATION

3.1 Description of the system

The Farahaane Irrigation System is gravity fed from the river Shebelle. Discharges in the system are regulated by upstream control at the head regulators of the two primary canals offtaking from the river barrages at Gayweerow and Qorioley. The distributary system comprises two primary and eight secondary canals. Each distributary canal serves a number of tertiary units varying in size from typically 25 - 60 ha. Distribution within the tertiary unit is by tertiary and quaternary canals. An overall irrigation and drainage layout is shown in Figure 3.1.

3.2 Cropping Pattern

The cropping pattern proposed by the World Bank Appraisal Team (1986) has been adopted and is shown in Table 3.1.

Table 3.1

Proposed Cropping Pattern

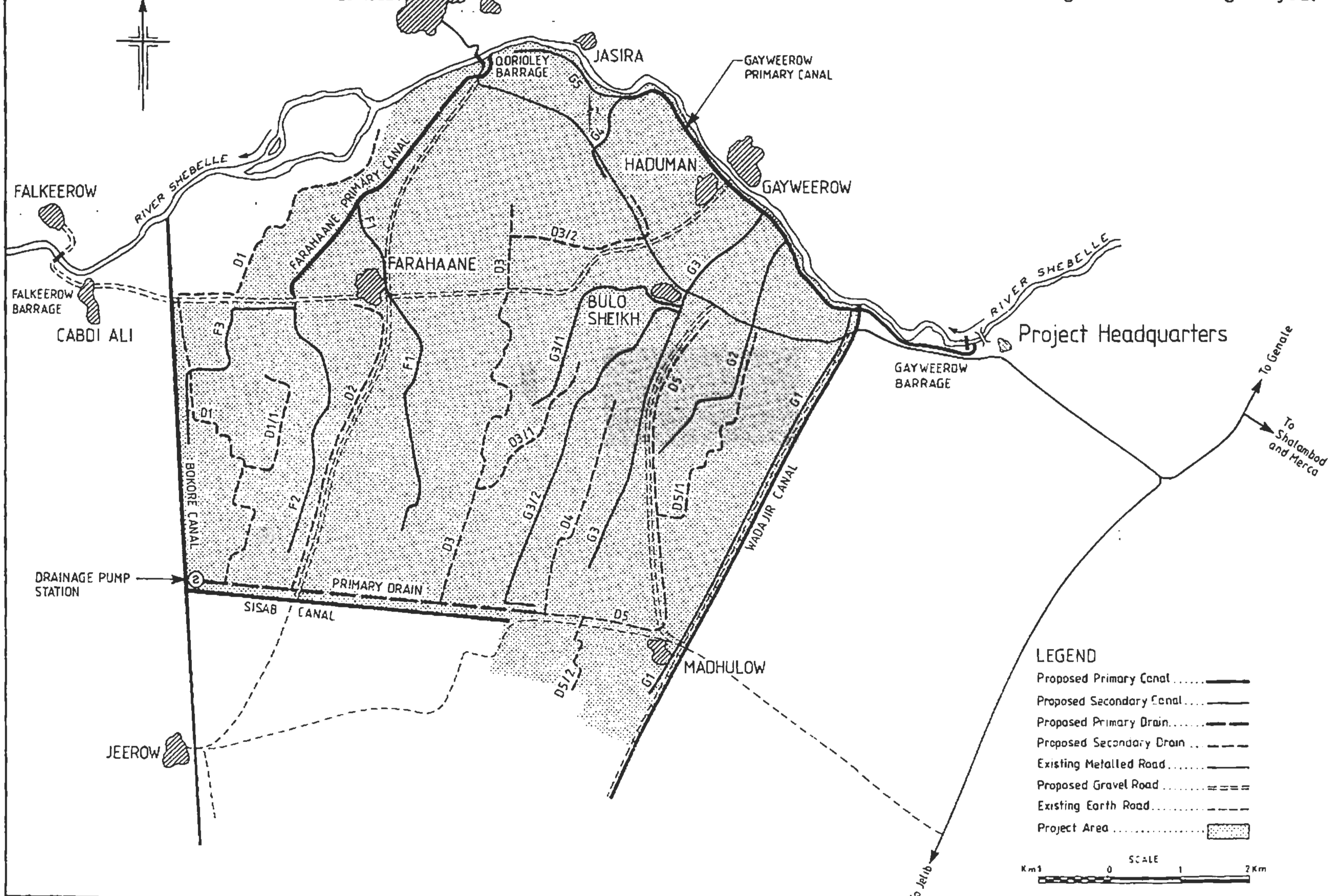
Crop	Gu Season (%)	Der Season (%)
Maize	47	-
Sesame	-	53
Legumes	15	15
Vegetable	-	5
Watermelon	-	5
Rice	5	5
	--	--
Total	67	83

This cropping pattern produces an overall intensity of 150%. This is the same as the overall intensity proposed by TAMS (1987).

3.3 Crop Water Requirements and Irrigation Scheduling

The canal design is based on water requirement calculations presented in the Inception Report (MMP 1987). This assumes a field efficiency of 60%, distribution efficiency of 80% and losses in the primary and secondary canals of 1.5 m^3/million square metres of wetted perimeter. The overall irrigation efficiency from the head of the canal system to the field is estimated to be about 45%.

Figure 3.1
Irrigation and Drainage Layout



To allow for a degree of flexibility and possible future changes in the cropping pattern, the canal design has been based on a 100% cropping intensity of sesame in December giving a gross crop irrigation requirement of 217 mm. Hence the design discharge at tertiary head will be 1.0 l/s/ha, and 1.1 l/s/ha at the head of the irrigation system, assuming 10% primary and secondary canal losses.

Net and gross irrigation requirements based on the proposed cropping pattern, shown in Table 3.1, are presented in Table 3.2.

Table 3.2

Irrigation Requirements

Month	Net (mm)	Gross (mm)
January	62.7	104.5
February	4.0	6.7
March	-	-
April	-	-
May	16.5	27.5
June	40.2	67.0
July	69.3	115.5
August	53.5	89.2
September	23.8	39.7
October	38.8	64.7
November	63.9	106.5
December	112.7	187.8

If the system is operated at full design discharge to supply the irrigation requirements shown in Table 3.2, then the daily duration of supply will be as shown in Table 3.3.

Table 3.3

Irrigation Durations

Month	Hours of Operation (hrs/day)
January	11.7
February	0.8
March	-
April	-
May	3.1
June	7.8
July	12.9
August	10.0
September	4.6
October	7.2
November	12.3
December	21.0

The philosophy of scheduling irrigation supplies will be based on the following criteria:

- tertiary head regulators operate at a fixed discharge of 1.0 l/s/ha;
- the duration of supply differs throughout the season according to estimated crop demand;
- rotation of secondary canals should be used during months of low demand.

During the majority of the year, irrigation will be carried out in daylight hours only, all primary and secondary canals being operated for between five and twelve hours per day. In December night time watering will be necessary but only a small percentage of farmers will be involved in a single day. For the months of February, May and September during which the canal system and hence tertiary head regulators need only be in operation for 0.8, 3.1 and 4.6 hours respectively, a system of rotating the supply to the distribution system, at secondary canal level could be used.

It should be borne in mind that the calculated crop water requirements and hours of watering shown above assume that rainfall corresponding to a 1 in 4 dry year occurs, so rain in itself does not necessarily mean that changes to the schedule are required.

However, if rainfall has filled the root zone there is no point in irrigating immediately, and irrigation should be delayed several days, so long as it is then possible to irrigate all the fields under crop before they reach the allowable depletion level.

The procedure to be followed must be determined in advance. It is recommended that various alternative procedures such as 'half-waterings' should be adopted, based on daily readings of antedecent rainfall.

3.4 Design Flows and Water Levels

3.4.1 Tertiary Canals

Tertiary canals are designed for continuous flow during the daily irrigation period, the length of which has been previously discussed in Section 3.3 of this Report. The design flow at tertiary canal head is 1.0 l/s/ha, typical tertiary head discharges are shown overleaf in Table 3.4.

Table 3.4

Tertiary Head Discharges

Tertiary Unit Area (Ha Net)	Design Flow (l/s)
30	30
40	40
50	50
60	60

Tertiary and quaternary canal capacities have been standardised at a nominal 60 l/s.

3.4.2 Primary and Secondary Canals

The primary and secondary canals have been designed using the Lacey Regime equations. The design flows are based on a discharge of 1.0 l/s/ha at tertiary head with transit losses added at a rate of 1.5 m^3/s per million square metres of wetted perimeter. They are designed to flow at full design discharge throughout the year, except when rotation of secondary canals is necessary and primary canal flows are reduced. Failure to maintain full design discharges will result in a general falling of water levels with a corresponding reduction in command at tertiary level.

Design flows and water levels in the distributary system are shown in Figure 3.2.

3.5 Operating Procedures

3.5.1 General

Discharges and water levels in the primary and secondary canals will be regulated by adjusting the gate settings of head regulators and cross regulators equipped with lifting gates. Duck-bill weir type cross regulators require no operation other than periodic opening of the central gate to scour away silt deposits. The central gate can also be used, if necessary, for fine adjustment of levels over the weir.

Flows in the tertiary canals will be maintained at design values irrespective of crop water requirements and allocation of water within the tertiary unit will be controlled by the relevant Water User Group.

Field irrigation requirements and hence required flows will be determined by the Chief of Operation Service at 10 day intervals. He will request that the required amount of water be allocated to the Project by the Shebelle Valley Water Authority. Depending upon the availability of water in the river, an allocation will be made and the Chief of Operation Service

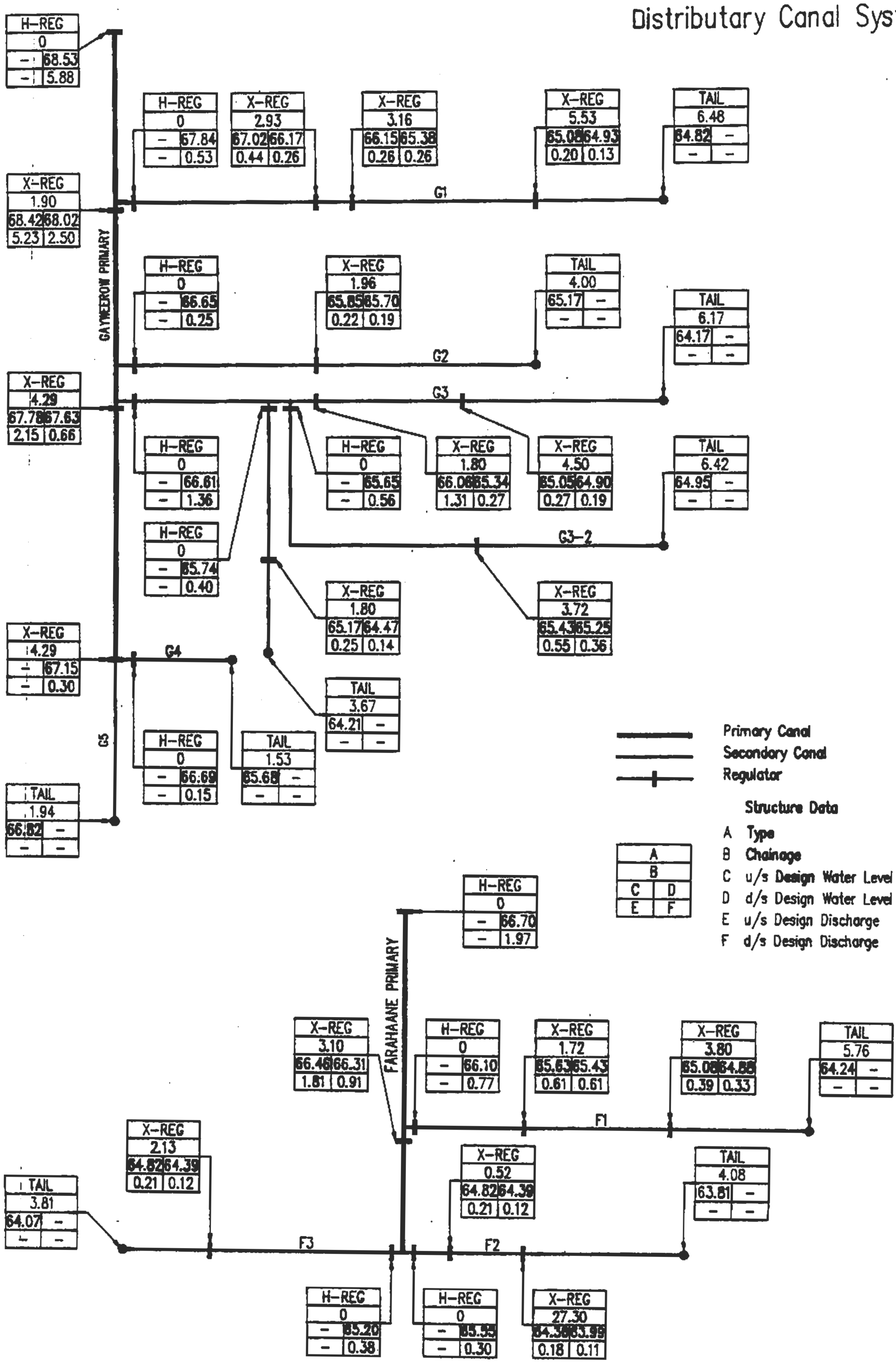


Figure 3.2
Distributary Canal System

will schedule irrigation flows in the system for the following 10 day period. He will then issue operation instructions to the Operators and Water Guards. Once the 10 day flow requirements have been set, the gates should need little adjustment other than daily opening and closing.

3.5.2 Barrages

The operation of the two barrages will be the responsibility of the Shebelle Water Authority. The operation of the barrage gates will be performed by Shebelle Valley Water Authority staff located at the barrages. The aim of the operation will be to maintain pond levels as shown in Table 3.5.

Table 3.5

Barrage	Normal Retention Level (m)
Gayweerow	69.11
Qorioley	67.16

Each barrage has nine vertical lifting gates. During operation it is important to ensure that the gates are opened and closed in small increments. When gates are to be opened, the sequence of opening should be from the centre gates outwards. When gates are to be closed, the sequence should be from the outer gates inwards. In this way the intensity of flow through the barrage will be symmetrical with larger intensities in the centre of the structure.

Due to the importance of barrage operating procedures it is necessary that the operators are experienced in the operation of river barrages. Moreover, it is considered prudent to instigate a monitoring programme to investigate the response of pond levels and downstream flow condition to gate opening and closing.

3.5.3 Primary and Secondary Canals

3.5.3.1 General

In operating the primary and secondary canals, the aim will be to maintain water levels, as far as possible, at their design values. The design water levels upstream and downstream of each regulator should be clearly marked on the structure and the basic aim of gate operation should be maintain the upstream design levels irrespective of flow in the canal.

Downsteam water levels at regulators are less important than those upstream but still should be monitored.

Although maintaining design water levels in the system is the major concern of Operators and Water Guards they are also responsible for observing and recording discharge. Where necessary, especially at regulator groups, gate adjustment will be necessary to ensure the correct discharge through structures. Discharge measurement is possible at all head regulators; at tertiary head regulators by direct measurement from a calibrated weir crest gauge and at primary and secondary canal head regulators by a combination of weir crest gauge and discharge measurement curves. The relevant discharge measurement curves are included in Appendix A together with Table A.1 which shows which curve should be used for each particular regulator.

3.5.3.2 Canal Filling

With all new canal systems, or when refilling canal systems which have been allowed to dry out, it is essential that the filling of the canal is carried out slowly in order that the soil can take up moisture gradually. Close supervision of the canal during the filling operation is required in case excessive seepage occurs at any location, whilst men and materials must be at hand to cater for such an eventuality. Before filling commences the dry canal should be inspected and any animal holes, breaches or gulleys should be repaired.

The canals are mostly in fill and thus particular care is required during initial filling and on refilling from a dry state if the canal has been dewatered. The maximum recommended rate of filling under these circumstances is 0.02 m/hour increase in water level. During normal operation when the soil is already wetted the filling rate should not exceed 0.10 m/hour.

When filling primary or secondary canals after a long closure period for maintenance or repair etc, the recommended method is to pass initially half the design discharge down the system with the cross regulator gates open. When the last reach of a secondary canal is half filled, the last cross regulator gate shuld be closed and the next upstream reach allowed to fill similarly. This procedure continues to the head of the canal. The water in the canal should be allowed to stand for one day after which the canal may be filled to design capacity.

When opening distributary canals each morning from their normal night time ponded condition, the primary canal head regulators should first be opened to the required setting followed by the secondary canal head regulators and finally the tertiary canal head regulators which should be opened starting at the tail of the canal and working back upstream.

3.5.3.3 Canal Closure

The recommended procedure for closing the canal system is as follows:

- close the primary canal head regulators;
- close the tertiary canal head regulators starting at the head of the system and working downstream;
- close the secondary canal head regulators.

The secondary canal cross regulator gates should remain closed to facilitate maintaining the canals at 0.1 m below full supply level during closure.

The last tertiary head regulator in each reach should not be closed until flow over the upstream cross regulator has ceased.

There are tail escapes located at the tail of each secondary canal, but these are provided for emergencies only and not as a routine way of controlling levels in the canal.

3.5.3.4 Response Time

There will be a response time or lag between the operation of primary or secondary canal head regulators and the effects being noticed at tertiary canal head regulators. This will be of importance when commencing irrigation each morning, but if the reaches have been ponded over night in accordance with Section 3.5.3.3 then the response time should not be significant.

3.5.4 Tertiary Unit

Each tertiary unit has a typical area of between 25 ha and 60 ha. The design supply discharge at tertiary head is calculated in Section 3.3 as 1.0 l/s/ha net.

A typical tertiary unit of 40 ha net will receive a supply of 40 l/s. Assuming average farm size within the unit of 1 ha and a required supply at farm level of 10 l/s, based on present practice, then a rotation will be required with four farms receiving supplies at any one time. The irrigation interval in this case will be 10 days.

The responsibility of organising the rotation of supply within a tertiary unit will be given to the Water User Group which will comprise farmers from the represented area.

3.5.5 Operation During Water Shortages

Generally during the flood season there is not a likelihood of water shortage, as supplies from the river Shebelle are plentiful. It is normal practise for farmers to postpone planting until the river is in flood which minimises the chances of delayed floods causing a water shortage.

In the event of water shortage and hence under allocation of water to the Project from the river, the Chief of Operation Service will schedule supplies to limit the long term damage to crops to a minimum. The operation of the canal system will continue as normal with the duration of supply being reduced, due to the water shortage, rather than discharges in the canals. If the duration of supply falls below 5 hours in one day then a system of rotating the distribution system at secondary canal level should be used.

The barrages will be operated to maintain the normal retention level at the barrages in order to supply full design discharges to the primary canals.

CHAPTER 4

DRAINAGE SYSTEM OPERATION

4.1 General

The drainage system comprises quaternary, tertiary, secondary and primary drains. The secondary or collector drains convey drainage water from the tertiary drains into the primary or main collector drain. Disposal of water from the primary drain is by pumping into the Bokore canal.

The drainage system as such requires no operation other than the operation of the pump station. However responsibilities for the system should be allocated to ensure that if problems arise they are located and put right. Recommended divisions of responsibility are shown in Table 4.1.

Table 4.1

Responsibility for Drainage System

Component	Responsible Authority
Tertiary and Quaternary Drains	Water User Groups
Primary and Secondary Drains	Farahaane Project Authority
Drainage Pump Station	Farahaane Project Authority

If, not envisaged that any further staff will be required than those shown in Table 2.1 apart from one operator who will be reponsible for the operation of the drainage pump station.

4.2 Drainage Pump Station

The pump station pumps water from the primary drain into the Bokore canal. Three 2.7 cumec vertical axial or mixed flow pumps have been selected to deliver the design discharge of 8.1 cumecs against a maximum static lift of 8 m. A fourth standby pump has been provided.

The pump station will only be required to operate when levels in the primary drain rise above 62.0. The pumps are activated manually which necessitates the presence of a full time operator. Pump cut out is automatic when levels in the primary drain fall below 59.6.

At present the capacity of the Bokore canal is insufficient to receive the full supply discharge from the pump station. It is expected that the canal will be remodelled to do this but in the meantime the pump station operator will monitor water levels in the canal closely to avoid overtopping of the canal banks.

APPENDIX A

DISCHARGE CURVES

Table A.1
Secondary Canal Head Regulator
Weir Crest Widths

Canal	Weir Width (B) (m)
G1	1.5
G2	1.2
G3	3.3
G3-1	1.35
G3-2	1.5
G4	1.05
G5	1.35
F1	1.65
F2	1.35
F3	1.35

Figure A.1

Discharge Measurement Curves – Sheet 1

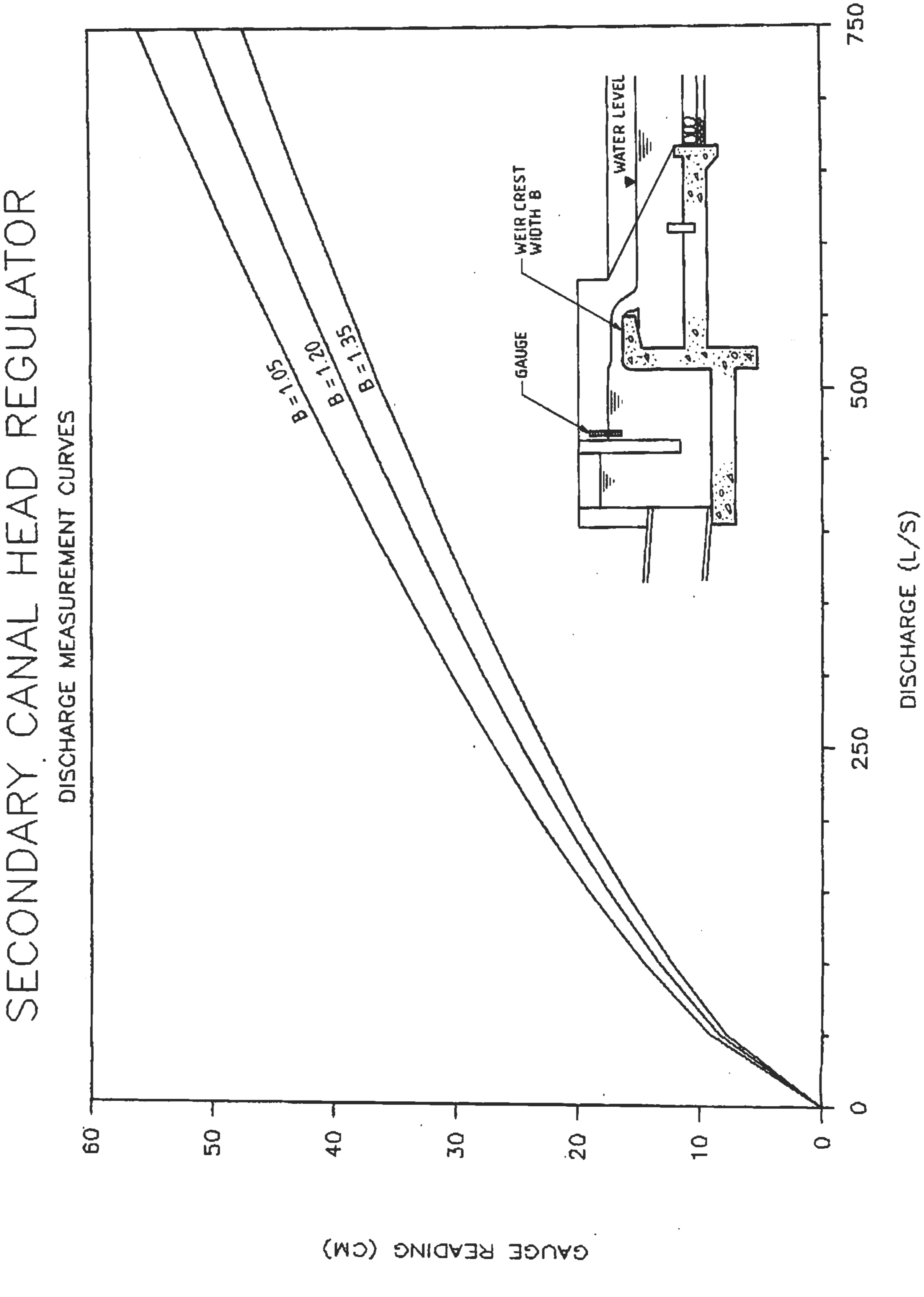


Figure A.2

Discharge Measurement Curves - Sheet 2

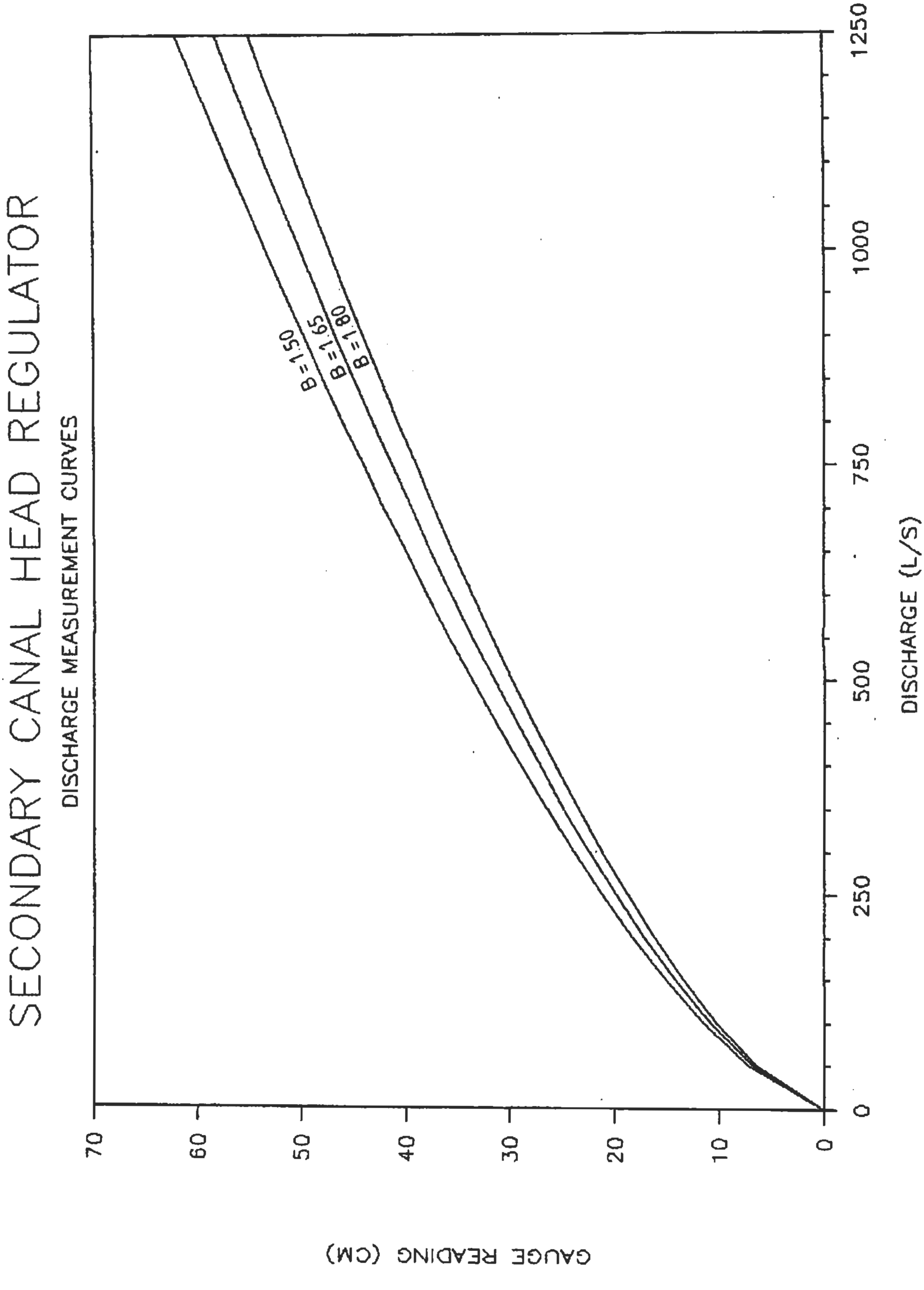


Figure A.3

Discharge Measurement Curves – Sheet 3

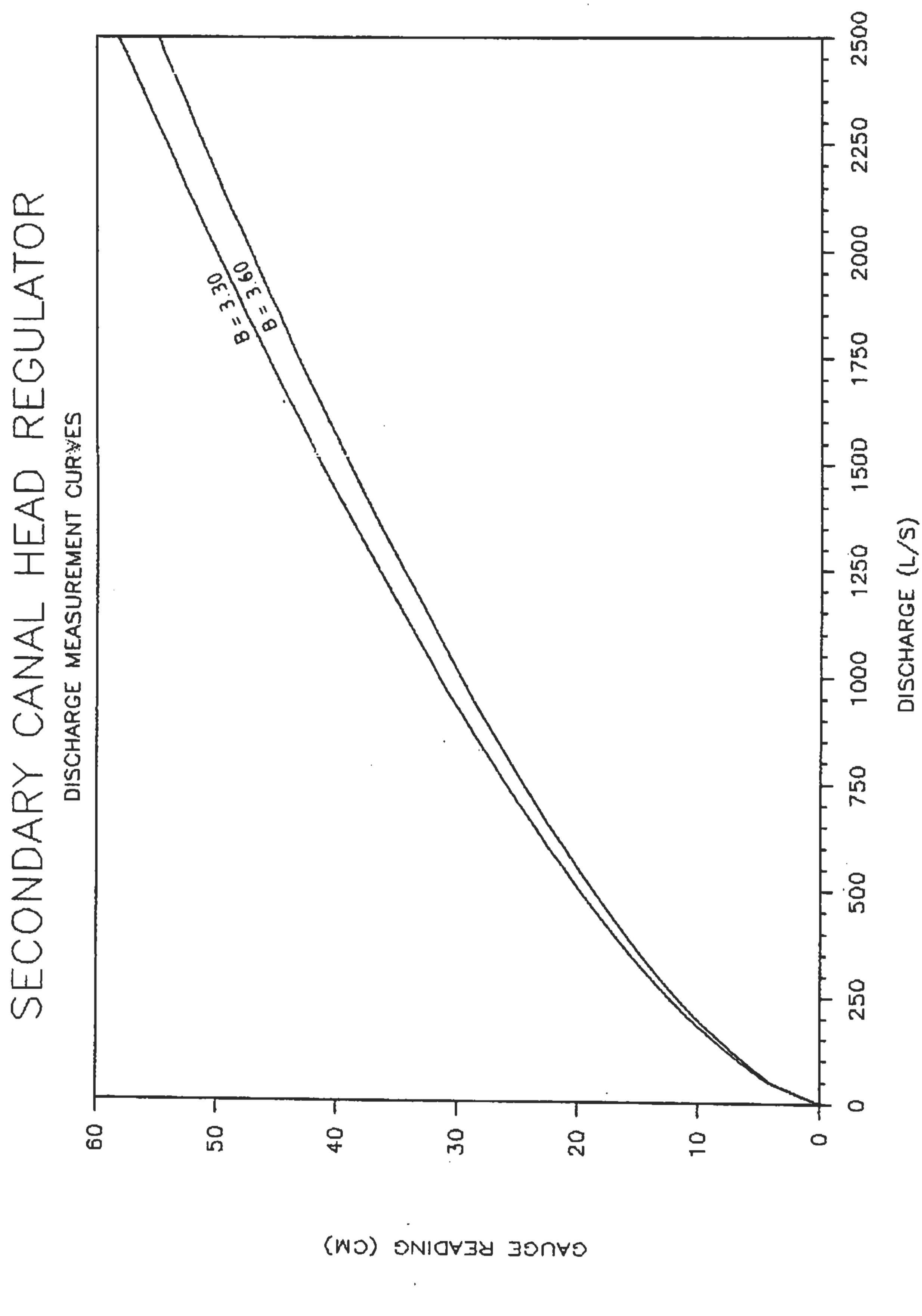
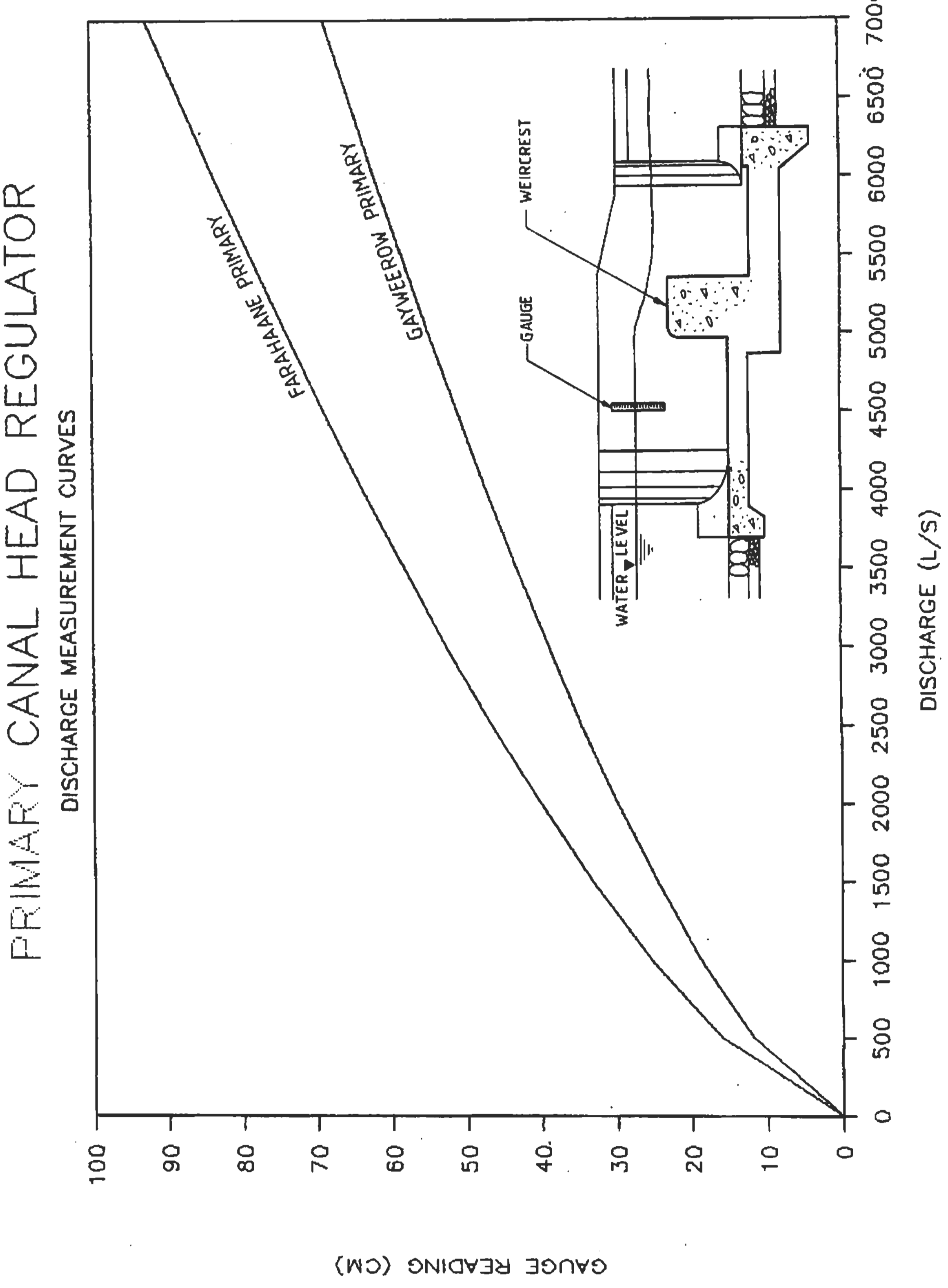


Figure A.4

Discharge Measurement Curves – Sheet 4



APPENDIX B

REFERENCES

APPENDIX B

REFERENCES

Sir M MacDonald & Partners Ltd (MMP)	1987	Farahaane Irrigation Rehabilitation Project Inception Report
Sir M MacDonald & Partners Ltd (MMP)	1988	Farahaane Irrigation Rehabilitation Project Design Report
Sir M MacDonald & Partners Ltd (MMP)	1988	Farahaane Irrigation Rehabilitation Project Contract Documents
Tippetts-Abbett-McCarthy-Stratton (TAMS)	1987	Genale Irrigation Rehabilitation Project Feasibility Study
Food and Agriculture Organisation of the United Nations	1971	Irrigation Practice and Water Management
Food and Agriculture Organisation of the United Nations	1982	Organisation, Operation and Maintenance of Irrigation Schemes