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**HYDRAULIC CHARACTERISTICS OF
IRRIGATION CHANNELS IN THE
MALIK SUB-DIVISION,
SADIQIA DIVISION,
FORDWAH EASTERN SADIQIA
IRRIGATION AND DRAINAGE PROJECT**

by

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ABBREVIATIONS

CCA	Culturable Command Area
GCA	Gross Command Area
FSL	Full Supply Level
OF	Open Flume
OFRB	Open Flume with Roof Block
APM	Adjustable Proportional Module
OCAPM	Orifice cum Adjustable Proportional Module
OCOFRB	Orifice cum Open Flume with Roof Block
OIL	Outlet
RD	Reduced Distance
SDO	Sub Divisional Officer
SE	Superintending Engineer
XEN	Executive Engineer
cfs	Cubic feet per second
ft	Feet
Q	Discharge
Rs.	Rupees .
msf	Million square feet
H_u	Depth of Water Upstream
H_d	Depth of Water Downstream

FOREWORD

This is the second of a series of reports describing the hydraulic **characteristics** of various Irrigation Department subdivisions in the command area of the Fordwah and Eastern Sadiqia canals.

This is a collaborative field research program with the **Punjab** Department of Irrigation and Power. The headworks for Malik Sub-division is located at the tail of Eastern Sadiqia Canal. The program in this sub-division began in mid-1995.

The author, Khalid Mahmood, was given the assignment in November 1995 to prepare this report. He has been supervised by the Bahawalnagar Field Station Manager, Mushtaq **Ahmad** Khan. Also, other field staff have participated in the field data collection.

This is a significant contribution by the author. He has professionally grown during this exercise. Also, he has demonstrated to other field staff that he can prepare a major report.

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CHAPTER 1

INTRODUCTION

The Eastern Sadiqia Division is a perennial system in Bahawalnagar Canal Circle, which consists of Eastern Sadiqia Canal, Malik Branch Canal, Hakra Branch Canal and other small distributaries and minors. The Eastern Sadiqia Canal **offtakes** from the left bank of Suleimanki Headworks, which lies in the southeast of **Punjab** Province and is a component of the **Sutlej** Valley Project. **Three** canals **offtake** from Suleimanki; **the** two canals offtaking from the left bank are Fordwah Canal and Eastern Sadiqia Canal. Fordwah Canal is designed with a maximum discharge capacity of 3366 **cusces** and Eastern Sadiqia Canal is designed for 4917 **cusces** but are actually running at 3400 and 6000 **cusces**, respectively. Fordwah Canal is non-perennial¹ whereas Eastern Sadiqia Canal is perennial. The Eastern Sadiqia Canal is trifurcated at RD 245 + 000 into Hakra Branch Canal, Malik Branch Canal and **Sirajwah** Distributary.

The Eastern Sadiqia Division is headed by an Executive Engineer stationed at Bahawalnagar. He is assisted in technical, operation, maintenance and revenue matters by **3** Canal and one Drainage Sub-divisional Officers (**SDO**) and **14** sub-engineers. Additionally, one Deputy Collector, **10** Zilladars and 109 **Patwars** are also working in this division assisting in revenue matters.

The Eastern Sadiqia Division has four sub-divisions:

1. Jalwala Sub-division;
2. Malik Sub-division;
3. Daharanwala Sub-division; and
4. Drainage Sub-division.

The command area for the Drainage Sub-division consists of the total command area of Eastern Sadiqia Division.

MALIK SUB-DIVISION

Malik Sub-Division falls in the Bahawalnagar and Chishtian **tehsils** and is a middle part of Sadiqia Division, starting from the tail of Eastern Sadiqia Canal (see layout in Figure 1). Upstream of Malik Sub-division, **there** is Jalwala Sub-division and downstream Dahranwala Sub-division. The head regulators of Malik Branch Canal and Sirajwah Distributary are under the control of SDO Jalwala (**RD 0 to 01 + 000**).

¹ A non-perennial canal takes water only during the kharif season from 15 April to 15 October.

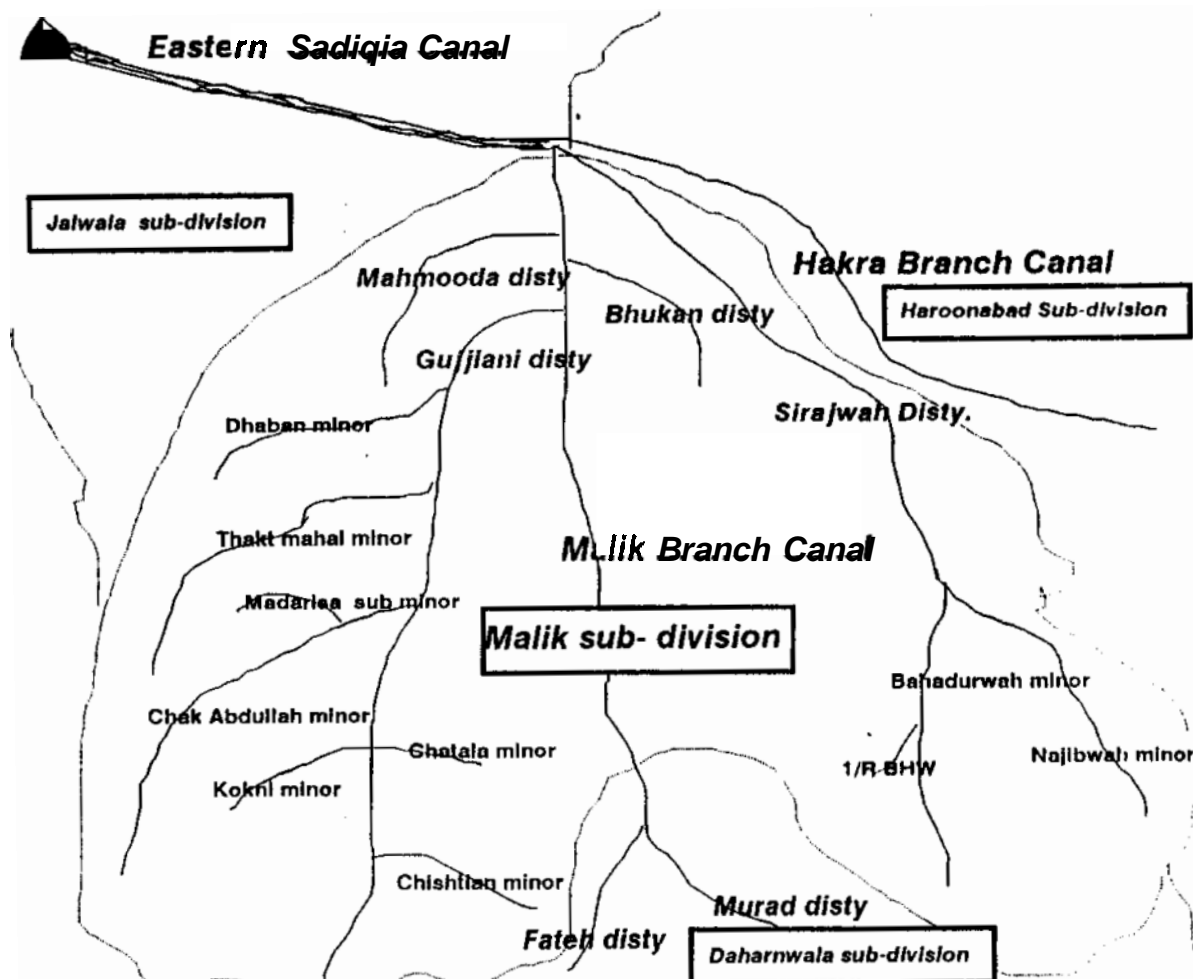


Figure 1. Physical layout of Malik Sub-division.

The Malik Sub-division is headed by a Sub-divisional Officer (SDO) who is stationed at Bahawalnagar. The three Sub-engineers and three Zilladars help the Sub-divisional Officer in technical and revenue matters.

Malik Sub-division is divided into three sections:

- 1) Sirajwah Section;
- 2) Kot Sher Muhammad Section; and
- 3) Gujjiani Section.

The total gross command area (GCA) of Malik Sub-division is 174,171 acres and the culturable command area (CCA) is 149,394 acres. There are 380 outlets and their total design discharge is 548.3 cfs. Details about the total number of outlets, their design discharge, gross command area and culturable command area are given in Table 1.

Each section is controlled by a Sub-engineer. The details for each section are given below.

Siraiwah Section

This section consists of the following distributary and minors:

- | | | |
|----|-----------------------|--------------------------------------|
| a) | Sirajwah Distributary | RD 1+000 to RD 67+700 (tail); |
| b) | Bahadurwah Minor | Head to tail (RD 0 to RD 60+135); |
| c) | 1/R Bahadurwah Minor | Head to tail (RD 0 to RD 5+500); and |
| d) | Najibwah Minor | Head to tail (RD 0 to RD 56+315). |

The headquarters of this section is located at the Dunga Bunga Rest House.

Water level data at the Sirajwah Head Regulator is collected every three hours and conveyed to Bahawalnagar twice a day, whereas water level data at the head and tail of other channels are collected and conveyed once a day to Bahawalnagar. The monthly compiled data is collected by a Sub-engineer of this section. A Signaller is also stationed at the Dunga Bunga Rest House.

Kot Sher Muhammad Section

This section consists of the following irrigation channels:

- | | | |
|----|-----------------------|--|
| a) | Malik Branch Canal | RD 1+000 to RD 95+900 (tail RD 116+900); |
| b) | Gujjiani Distributary | Head to Fall RD 53+200; |
| c) | Mahmooda Distributary | Head to tail (RD 0 to RD 13+400); |

Table 1. Details of GCA, CCA and outlets of Malik Sub-division.

Name of Channel	Total No. of outlets	Total design discharge of outlets (cfs)	GCA (acres)	CCA (acres)
Malik Branch Canal	45	68.6	25052	18654
Sirajwah Distributary	36	57.5	18169	16010
Bahadurwah Minor	50	70.7	22084	20076
Najibwah Minor	27	34.0	10204	9842
Mahmooda Distributary	8	12.8	4252	3877
Bhukan Distributary	8	11.0	4517	3043
Gujjani Distributary	102	146.6	45700	38438
Dhaban Minor	15	16.9	4888	4635
Takhat Mahal Minor	23	33.4	9868	9169
Chak Abdullah Minor	28	36.3	11200	9197
Madrassa Minor	10	17.0	4710	4659
Kokni Minor	7	12.3	3767	3431
Chatala Minor	7	9.8	3227	2698
Chishtian Minor	14	21.4	6533	5665
Total	380	548.3	174171	149394

- d) Bhukan Distributary Head to tail (RD 0 to RD 23 + 040);
e) Dhaban Minor Head to tail (RD 0 to RD 25 + 4701; and
f) Takhat Mahal Minor Head to tail (RD 0 to RD 41 + 100).

Water level data at the head regulators of Malik Branch Canal and Gujjani Distributary are collected every three hours and conveyed to Bahawalnagar twice a day, whereas water level data at the head and tail of other channels are collected and conveyed daily under the personal supervision of the Sub-engineer incharge, whose sanctioned headquarters is Kot Shcr Muhammad Rest House, where the Signaller is also stationed.

Gujjiani Section

This section consists of the following channels:

- a) Gujjiani Distributary RD 53+ 200 to tail RD 139+905;
- b) Chak Abdullah Minor Head to tail (RD 0 to RD 65 + 000);
- c) Kokni Minor Head to tail (RD 0 to RD 12+ 750);
- d) Chatala Minor Head to tail (RD 0 to RD 10 + 250);
- e) Chishtian Minor Head to tail (RD 0 to RD 33 + 500); and
- f) Madrassa Sub-minor Head to tail (RD 0 to RD 17+ 590).

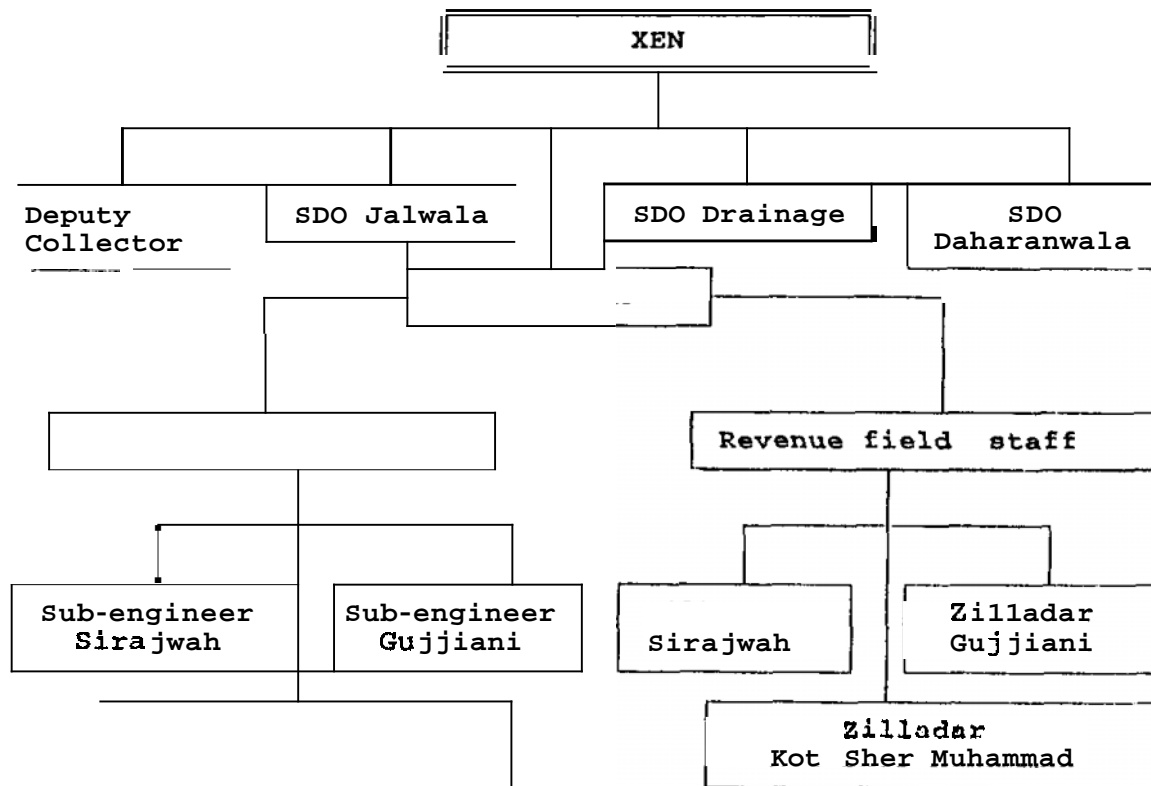
The headquarters for this section is at Gujjiani Rest House near RD 92 + 000 of Gujjiani Distributary.

Water level data of the head and tail of Gujjiani Distributary and all minors are collected and conveyed to Bahawalnagar daily. The Signaller headquarters is also at Gujjiani Rest House, but data is conveyed through the Chak Abdullah telegraphic station because the Gujjiani Rest House telegraphic station is not functioning.

CHAPTER 2

ORGANIZATIONAL ARRANGEMENTS

The Eastern Sadiqia Division is headed by an Executive Engineer. The administrative and organizational flow chart for this division is shown in Figure 2.



Legend:

XEN: Executive Engineer
SDO: Sub-divisional Officer

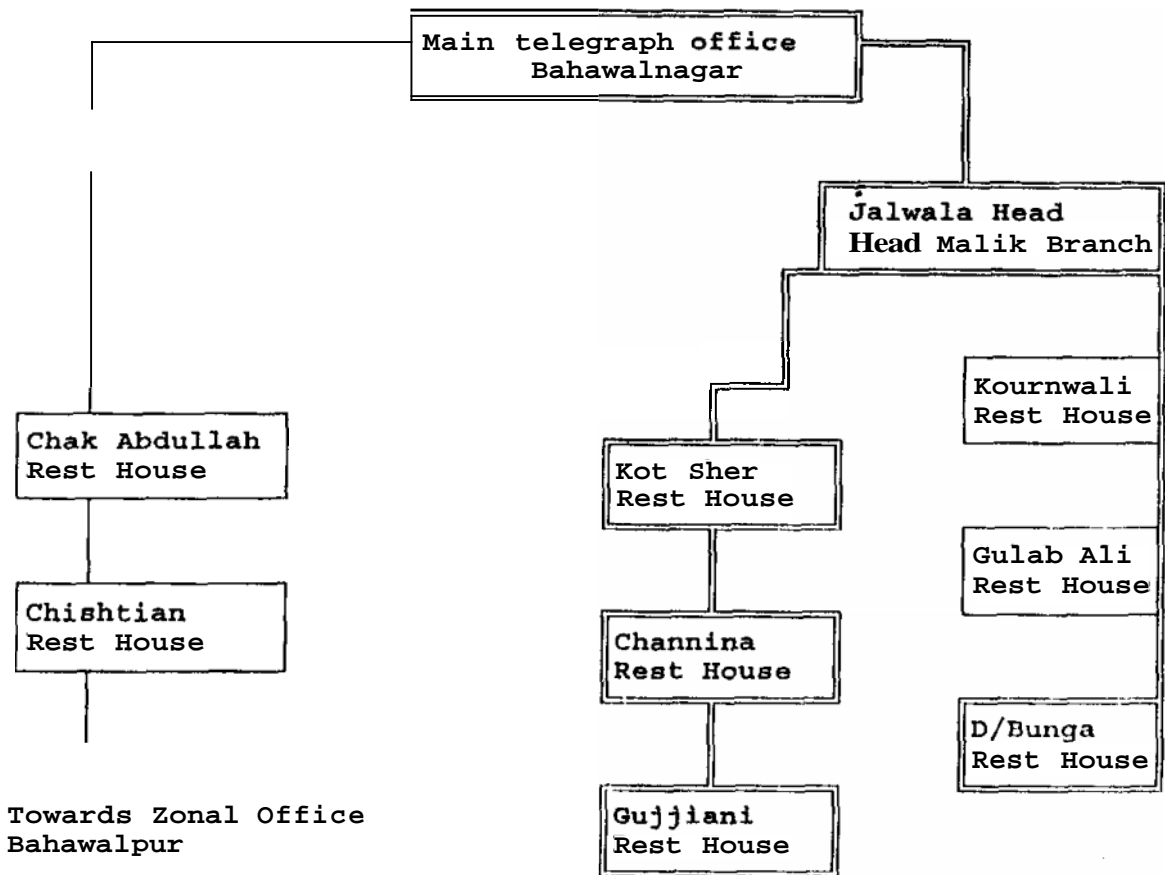
Figure 2. Organizational Chart of Eastern Sadiqia Division.

The section for a Sub-engineer and a Zilladar are the same. The Sub-engineer deals with engineering matters and the Zilladar deals with revenue matters.

The communication system being used by the Irrigation Department is very old. Most of the stations are out of order. The data collection is very difficult. Sometimes, when any channel mishap occurs, it is very difficult to convey this information to higher authorities. For example, if any mishap occurs in Gujjiani section, they cannot use their communication system because the communication system of Gujjiani Rest House is out of order.

The main office of this communication system is at Bahawalnagar. All of the communication network links with this office. The daily gauges of all control points are received here. The times are fixed for relaying information between two stations. At that time, all of the signalers convey the gauges by Canal Wire to the main office while the main office passes the Canal Wire to the appropriated stations. The Signal offices used to be open 24 hours a day because the Signal offices were a portion of the Signaler quarters being provided as free accommodation. Nowadays, the Signalers quarters are not maintained properly and most of the Signalers do not stay in their quarters. Instead they live in private residences away from the Signal offices: thus they fixed the times in the morning as well as evening, for communicating.

The communication and sectional set up of the sub division is shown in Figure 3. This old communication network needs to be replaced by a more modern system.



legend:

Communication system of Malik Sub-division. =====
 Communication system of other Sub-divisions. =====

Figure 3. Communication network for the command area of Malik Branch Canal.

Malik Sub-division is under the control of a Sub-divisional Officer, who is helped by three Sub engineers for technical and three **Zilladars** for revenue matters. A **Sub-divisional** and one Assistant Sub-divisional Reader help the Sub-divisional Officer in revenue cases.

The field Patwari collects information about crops, which is recorded on their register. The Assistant Vernacular Clerk and **Zilladar** check the data. After **completion** of this work, they send this information to the Sub-divisional Officer.

The Gauge Readers read the various gauges and record this on their register, which is also conveyed to the Signaller. All Signalers convey these gauge reading to the SDO office. Also, the SDO is responsible for account work (salaries, repair works, new works, **etc.**)

In every section, a Sub-engineer is responsible for all of the **work**. He looks after the system and also keeps a check on outlets, etc. For this work, **Mates** and **Baldars** help him.

In Malik Sub-division, there are three sections; namely Sirajwah, Kot Sher Muhammad, and Gujjiani sections, but these section are not equal in length and manpower.

There is a need for more manpower for this Branch Canal as compared with other channels. Malik Branch Canal falls in the Kot Sher Muhammad Section, so this section needs more manpower as compared to the other sections like Sirajwah and Gujjiani Sections.

The distribution of **maintenance** staff for the three sections is given in Table 2. The total length of Malik Sub division is 665,555 feet and there is 56 maintenance staff working in this sub-division. Out of 56 maintenance staff, 28 are working in Kot Sher Muhammad Section and 28 maintenance staff are working in the other two section.

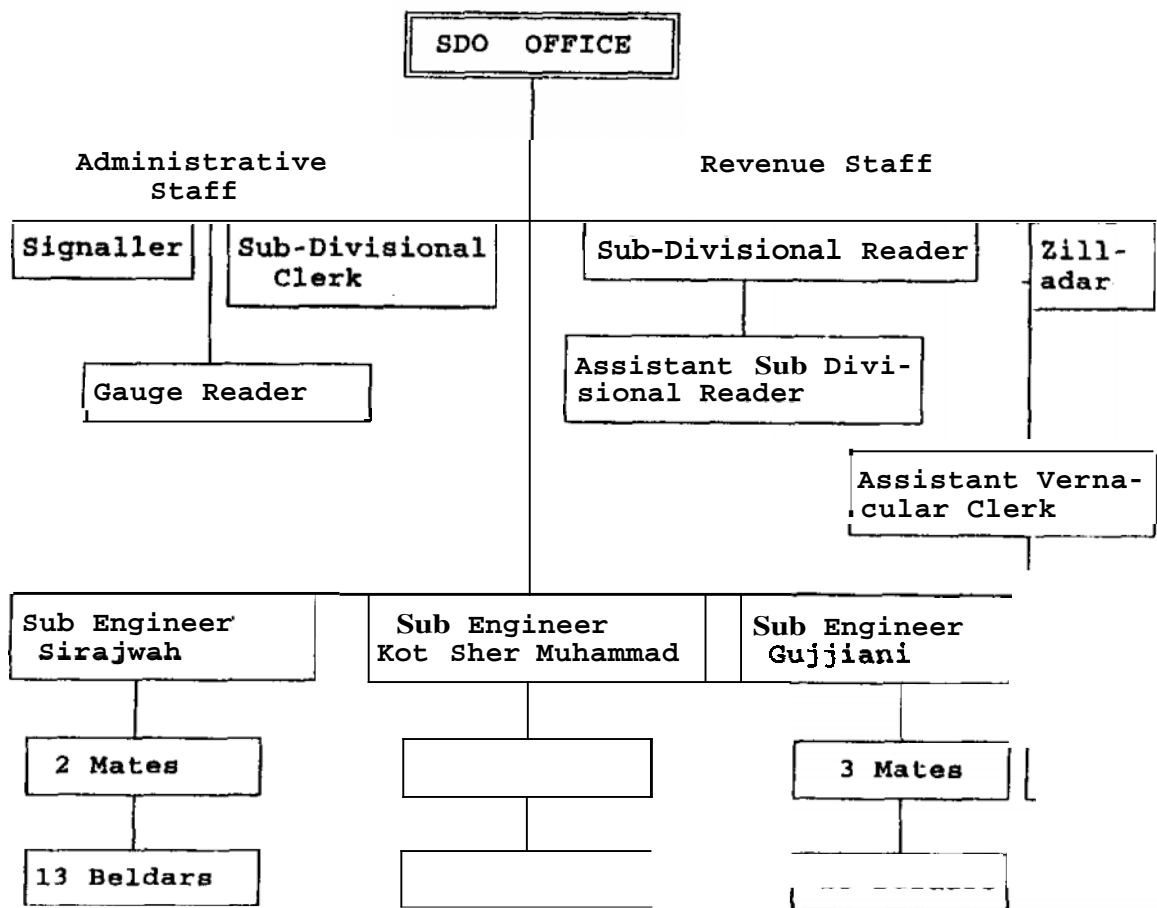


Figure 4. Organizational chart for Malik Sub-division.

Table 2. Distribution of maintenance staff.

Name of Section	Length of Section (feet)	Length (feet)/ Beldar
Sirajwah	188.650	14.500
Kot Sher Muhammad	251,110	9,000
Gujjiani	225.795	15,000

Type of structure	RD	Flow condition	Design Discharge
Weir (Fall)	22 + 900	Free Flow	1154 cfs
Gated orifice (2)	38 + 900	Free Orifice Flow	
Gated orifice (7)	86 + 000	Submerged Orifice Flow	1042 cfs
Weir (Fall)	95 + 900	Free Flow	
Gated orifice (4)	116 + 900	Free Orifice Flow	1031 cfs

Table 5. Off-taking distributaries from Malik Branch Canal

Name of Channel	Off-taking RD	Design Discharge
Mahmooda Distributary	15 + 000	13.5 cfs
Bhukan Distributary	22 + 800	13.0 cfs
Gujjiani Distributary	38 + 900	319.0 cfs
Murad Distributary	116 + 900	596.0 cfs
Fateh Distributary	116 + 900	435.0 cfs

The design and existing longitudinal bed profile (L-section) is shown in Figure 5. The existing bed level was determined by conducting a longitudinal survey of Malik Branch Canal during January 1996 by the IIMI Bahawalnagar Field Station staff.

Malik Branch Canal is usually operated at a higher discharge than its design, which has caused this channel to be mostly in scouring as shown in Figure 5. At some reaches, the bed width has changed because the channel sides have also been scoured.

For example, from RD 1+000 to 5+000, 39+500 to 50+000 and 60+000 to 96+000 there is bed scour that ranges from 0.50 ft to 3.00 ft, while the sides of this channel are also scoured from RD 5+000 to 60+000 ranging between 5.0 ft to 25.0 ft. A few reaches have some sediment deposition ranging from 0.5 ft to 1.0 ft (e.g. the Canal banks are scoured from RD 23+000 to 25+000). For details, see Figures A.1 to A.23, where the cross-sections for every five RDs are shown.

The design discharge of Malik Branch Canal is 1538 cfs, but its average monthly discharge is more than this design discharge. Mostly it was running at a maximum of 1905 cfs during the month of November 1995 (from the gauge register of the Irrigation department). The monthly average discharge for Malik Branch Canal is given in Table 4. At the head of Malik Branch Canal, there is excellent working head while off-taking from the parent channel. There are three gates at the head regulator and the flow condition is free orifice flow. The discharge at the head is most of the time higher than the design discharge, which is quite helpful to the farmers. The side walls of the head structure for Malik Branch Canal need some repair and some reaches need killa bushing to prevent bank erosion.

3.1.1 Fall and Bridge at RD 22+900

This fall structure has sufficient working head and its flow condition is free flow. This fall is without a gate. The width of the overflow crest is 44.96 feet.

Upstream from this fall, there are two distributary offtakes named Mahmooda (RD 15+000) and Bhukan (RD 22+800). When Malik Branch Canal is in low supply days, it is difficult to feed these distributaries without gates. Lift irrigation outlets also exist upstream from this fall structure. The head regulators for Mahmooda and Bhukan distributaries need repair.

3.1.2 Fall and Bridge at RD 38+900

Gujjani Distributary offtakes just upstream from the fall and bridge structure at RD 38+900. This is the major distributary of Malik Sub-division. This is an important regulation point with a gated structure. The water supply/indent of Daharanwala Sub-division is also met at this point. After this point, there are no more control points in Malik Sub-division on Malik Branch Canal. The flow condition of this structure is free orifice flow. Nowadays, the gates are not working so they control the supply with the Gujjani Distributary gate and there is adequate working head. The head regulators for Gujjani Distributary and Malik Branch Canal are not in very good condition.