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WATER DISTRIBUTION AT THE SECONDARY LEVEL IN THE CHISHTIAN SUB-DIVISION

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FOREWORD

This report represents an enormous amount of field work and analysis. Rarely would you find such a detailed hydraulic report covering such a large area as Chishtian Sub-division, which contains 67000 hectares of cultivated land.

This reports reflects a new approach in IIMI's field work. After calibrating all of the outlets along a distributary or minor, an inflow-outflow test is conducted to measure the seepage rate for various reaches in the channel. This test also provides insights regarding the accuracy of the hydraulic calibration of the outlet structures serving the tertiary watercourses. In other words, the inflow-outflow test provides the sensitivity analysis regarding the field calibration of outlet structures.

There is some analysis of the hydraulic performance for the Fordwah Branch Canal and the 14 distributaries within Chishtian Sub-division. However, the real value of this report is the rich source of data for future analysis. This report provides some of the necessary documentation for the integrated approach presently underway within IIMI for the Chishtian Sub-division. At the same time, this report will serve as a data base for many future studies.

The field staff of the Bahawalnagar Field Station should be commended for such a tremendous piece of work. This also reflects on the Leader Mr. Mushtaq Ahmad Khan and the Supervisor or Team Leader, Marcel Kuper, for this research effort. Most of all, this report demonstrates the dedication and long days of meticulous work by the field staff.

Gaylord V. Skogerboe, Director
Pakistan National Program
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ACKNOWLEDGEMENTS

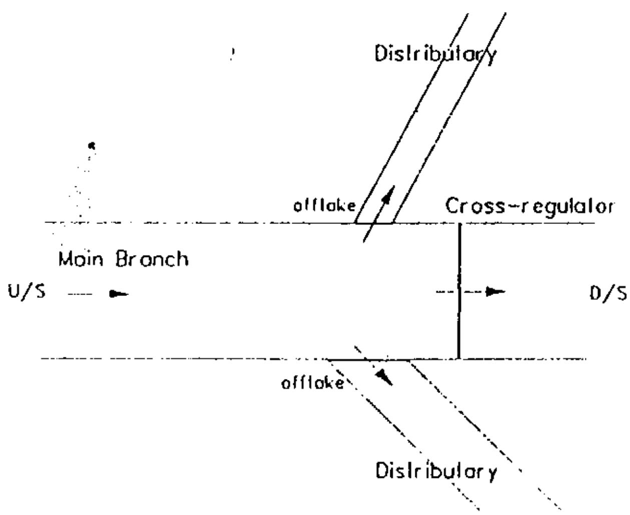
We would like to acknowledge the assistance received from Mr. Hafeez Nafees and the Hasilpur Field Station in carrying out the calibration of outlets of Fordwah Distributary. Their help in the execution of experiments in Fordwah and Daulat Distributaries was also of great value. Finally we would like to thank Mr. Muhammad Manshah for formatting the report and Prof. Gaylord V. Skogerboe for reviewing the manuscript.

CHAPTER 1. INTRODUCTION

1.1 Context

Irrigation in Pakistan's Punjab has been practiced along the rivers for centuries. The present irrigation system, which absorbed the lands that were already irrigated, was constructed during the British colonization period from the late 19th century onwards.

The main system, consisting of main, branch and secondary canals, including all structures located on these canals, is operated and maintained by the Punjab Irrigation Department. Most irrigation outlets, which are serving groups of farmers, are located along the secondary canals (distributaries), but some outlets off-take directly from the main or branch canals. Within the tertiary units, the farmers are responsible for further water distribution and maintenance of the tertiary canals (watercourses).



Recently, policy makers, managers, donors and researchers have emphasized the fact that water distribution in Pakistan's large-scale irrigation systems leaves much to be desired with inequity in water distribution, tail shortages, etc. (World Bank, 1993, Punjab Provincial Assembly, 1992, Bhutta and Vander Velde, 1992, Kuper and Kijne, 1993). To substantiate the inequity in water distribution a study was started in the Chishtian Sub-division, located in the south-east of Punjab Prvince. This 67,000 ha hydraulic unit is located at the tail of the Fordwah Division and has 14 distributaries, which were all studied. There are many factors influencing the water distribution in secondary canals, such as siltation, change in longitudinal slope of the channel, change in the dimensions of outlets, weed growth in the channel, increase in the

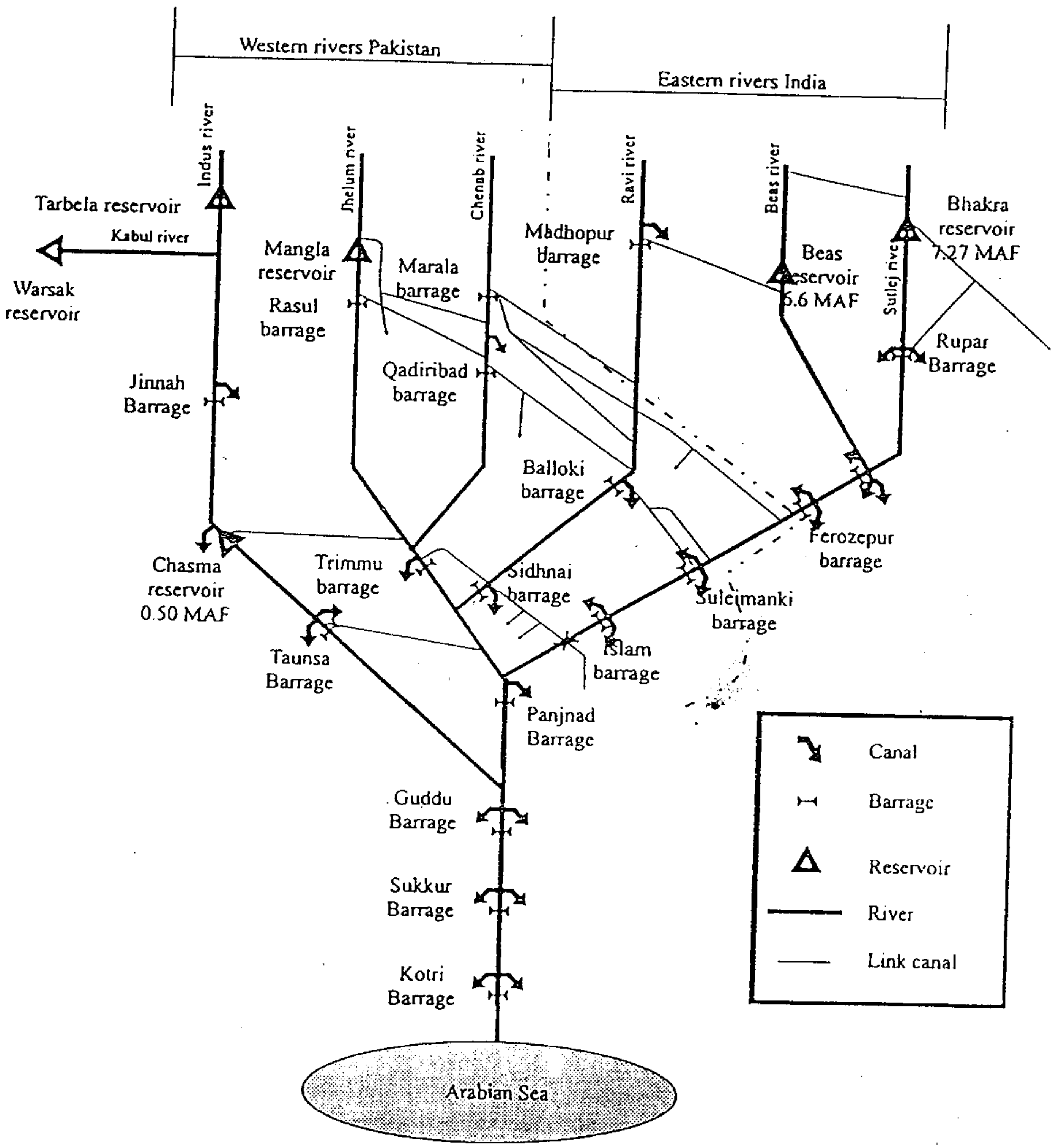
number of outlets, illegal tampering, etc. The marginal impact of these factors are studied in parallel studies (Hart, 1996, Visser, 1996) and will not be analyzed here. The events that have led to the present situation (increased water demand, political situation, reduction in O&M funds, etc.) have been treated in other studies (Kuper and Kijne, 1993, Strosser and Kuper, 1994) and are not further detailed either. This study is a status report of the water distribution for the 14 distributaries in the Chishtian Sub-division, which will substantiate some of the claims that have been made about water distribution in the Punjab. In addition to that, the study contributes to a larger research project in the Chishtian Sub-division, where a research methodology is being developed to evaluate the economic and environmental impact of interventions in irrigation management. For this evaluation, it is necessary to quantify the water delivery to watercourses, to which this study will contribute.

The research question that is being asked: what is the present water distribution in distributaries and how does it compare with official and actual operational targets ? The objectives of the paper are:

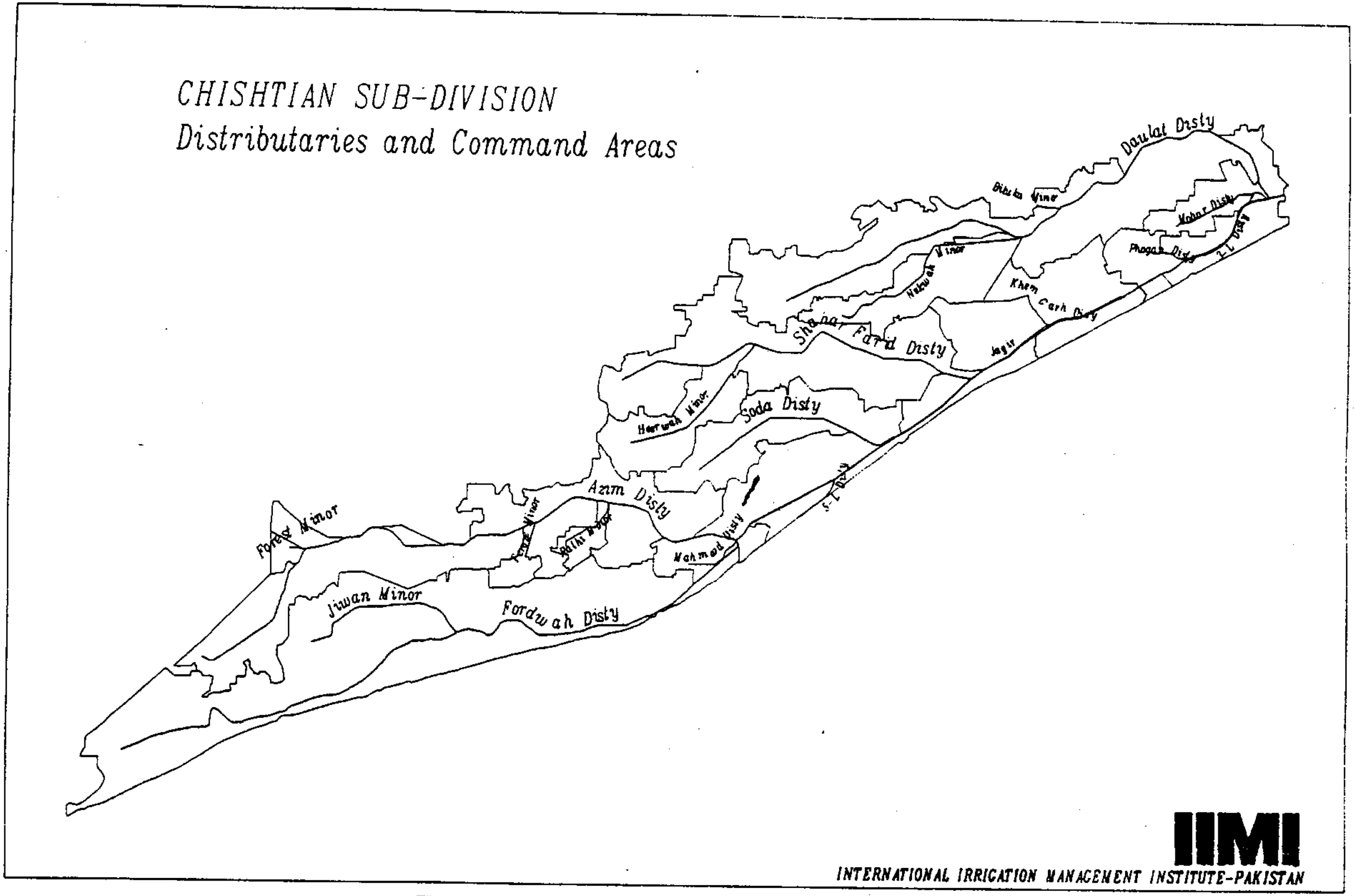
- To review the overall water distribution in the 14 distributaries of the Chishtian Sub-division;
- To examine the physical conditions of the distributaries that are likely to affect the water distribution;
- To calibrate and evaluate the hydraulic performance of outlet structures in the Chishtian Sub-division; and
- To determine the seepage losses for all distributaries.

1.2 Description of the research area

The Chishtian Sub-division is one of three sub-divisions of the Fordwah Canal Division, located on the left bank of the Sutlej river in former Bahawalpur State. The Fordwah Main Canal is supplied through Suleimanki Headworks, which takes its water in summer from the Chenab river and in winter from Mangla reservoir (see Map 1). This canal serves the Chishtian Sub-division through the Fordwah Branch. Fourteen distributaries and eighteen direct outlets off-take from the Fordwah Branch in this sub-division (see Map 2). Since supplies are not sufficient in winter to feed all secondary canals, it was decided at the design stage to give certain distributaries perennial (year round) supplies, while most others receive non-perennial (seasonal) supplies. Only five distributaries in the Chishtian Sub-division are perennial canals, while the nine others are non-perennial. The water allocation to these distributaries varies from 3.2 to 8 cusecs per 1000 acres. Non-perennial supplies receive on average a double amount of water over a shorter period. The distributaries in the Chishtian Sub-division vary substantially in length, discharge and the amount of land they are servicing. Some of the physical characteristics of the 14 distributaries in the Chishtian Sub-division are given in Table 1.1.



Map 1. Schematic of Reservoirs, Barrages and Link canals in the Indus Basin Irrigation.
Source: Hart (1996).



Map 2. Distributaries and their Command Areas in the Chishtian Sub-division.

Table 1.1. Physical characteristics of distributaries in the Chishtian Sub-division.

Distributary	Status	Design discharge (cusecs)	Length (feet)	CCA (acres)	Number of outlets
3-L	NP	18	23100	2970	6
Mohar	NP	38	20240	4447	12
Hussainabad minor		11	8840	738	3
Daulat	NP	209	115150	32690	72
Biluka minor		9	12700	1320	7
Nakewah minor		43	43800	6910	29
Phogan	NP	17.5	8750	2211	9
4-L	NP	14	17350	2053	7
Khemgarh	NP	24	15500	5053	9
Jagir	P	28	13830	4704	9
Shahar Farid	NP	153	74880	24892	47
Heerwah minor		40	32180	6658	27
Masood	P	35	52300	8099	16
Soda	NP	77	43700	10113	33
5-L	P	4	11300	884	3
Fordwah	P	158	139780	36679	87
Jiwan minor		27	34520	7089	22
Mehmud	P	8.25	11860	20066	7
Azim	NP	244	118000	30459	80
Rathi minor		10	10000	1395	10
Feroze minor		9	8000	1226	4
Forest minor		9	3300	730	4

NP: Non-Perennial
P : Perennial

CHAPTER 2. RESEARCH METHODOLOGY AND PROCEDURES

2.1 Hydraulic principles of water distribution in distributaries

2.1.1 Flow control in distributaries

In the irrigation systems of the Punjab, no regulating structures are provided downstream of the inlet structure (head regulator) of the distributary. The water distribution in a secondary canal is, therefore, a function of the inflow, the physical state of the canal (roughness coefficient, longitudinal slope, cross-sections, etc.) and the outlet characteristics (dimensions, crest levels, outlet geometry). In the Punjab, two principles have governed the design, operation and maintenance of distributaries. Firstly, when a distributary is running at around its Full Supply Level (FSL), all watercourses should run at their calculated allowances (equity principle). Secondly, if there is an increase or a decrease in the water supply to a distributary, this change should be distributed proportionally to all watercourses (proportionality principle). Of course, hydraulically it is not possible to have proportionality over the full range of discharges and the irrigation agency tries generally to supply a distributary at more than 70 % of its design discharge. The proportionality principle was tested in a parallel study, where it was demonstrated in one distributary that proportionality indeed existed for design conditions (Visser, 1996).

2.1.2 Canal Outlets

Outlets on distributary canals in the Punjab have traditionally not been provided with gates in order to minimize human interventions in the distribution of water.

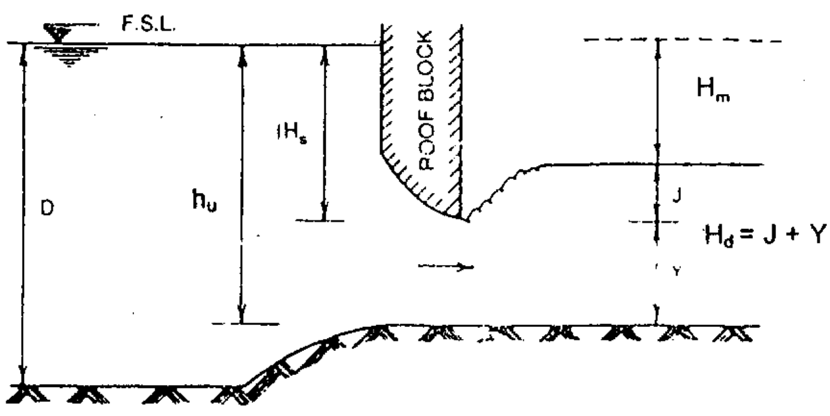


Fig: 2.1. Definition sketch of hydraulic heads for a Fixed Orifice Outlet. Adopted from Ali (1993).

The discharge through a given outlet is, therefore, a function of dimensions and crest level. If free flow exists, difference in water surface elevation in the canal and the crest elevation of the outlet structure, termed h_u, is used to calculate the discharge rate, whereas the discharge rate is a function of the difference in water surface elevation between the canal and tertiary channel, h_u-h_d, for submerged flow (see Figure 2.1). The following types of outlets are found in the Chishtian Sub-division:

1- Open Flume outlets (OF)
2- Fixed-Orifice outlets
   a. Open Flume with Roof Block (OFRB)
   b. Adjustable Orifice Semi-Module (AOSM)
3- Pipe outlets

Open Flume

An open flume outlet is a smooth weir with a constricted section (throat) that operates under either free flow or submerged-flow conditions. The outlet is shown in Figure 2.2. The discharge ratings for free flow and submerged flow are given in Table 2.1.

An important consideration in using flume outlets is that the discharge is theoretically a function of h_u-h_d with an exponent of around 3/2 (see Table 2.1). Thus, the discharge increases rapidly with increasing flow depths in the canal. Consequently, this type of outlet is best used towards the downstream end of the canal, so that if the canal discharge increases, the discharge through the flume outlets will rapidly increase, avoiding canal breaches. The width of the flume is limited to a minimum of 0.2 ft and the flume has to be placed close to the bed level in order to draw its fair share of sediment. This constrains its use in the upstream parts of the distributary. Another limitation of a flume is its super-proportionality, which makes it sensitive to the rises in water levels that have occurred as a result of siltation. The irrigation agency has, therefore, placed roof blocks on most open flumes that existed in the Chishtian Sub-division.

Fixed orifice outlets

There are two types of fixed orifice outlets in the Chishtian Sub-division - - the adjustable orifice semi-module (AOSM) and the open flume with roof block (OFRB). They are depicted in Figures 2.3 and 2.4. The principal difference between the two is the face of the outlet, which is rounded for the AOSM and straight for the OFRB.

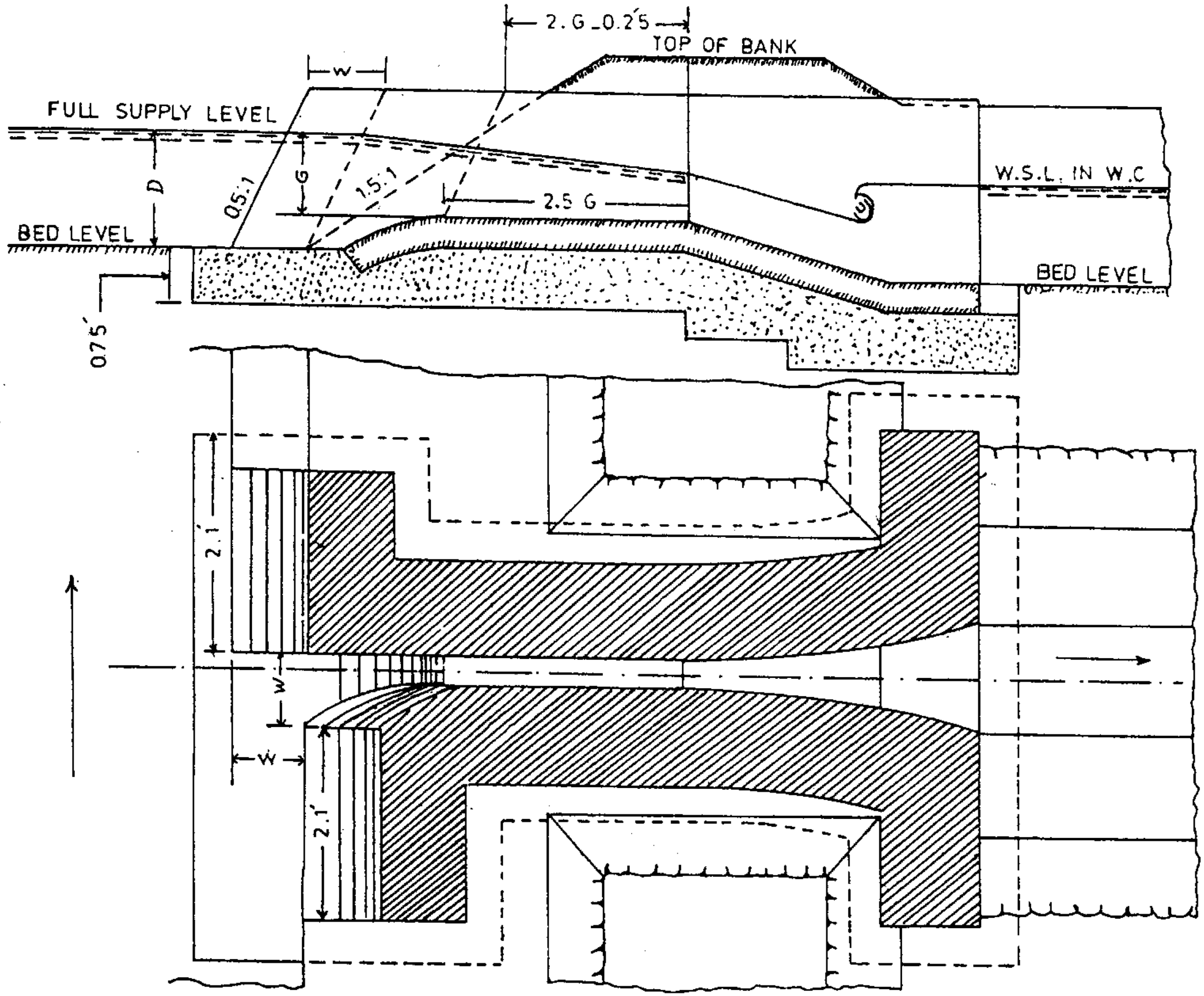


Fig: 2.2. Crump's Open Flume Outlet.

Table: 2.1 The formulae used in the calibration of outlets.

Flow Condition	Coefficient of discharge
Free open channel flow (F.F)	$C_d = \frac{Q}{B*\sqrt{2g}*h_u^{\frac{3}{2}}}$
Submerged open channel flow (F.S)	$C_d = \frac{Q*(-\log S)^{n_s}}{B*(h_u-h_d)^{n_f}}$
Free orifice flow or orifice modular flow (OM)	$C_d = \frac{Q}{A*\sqrt{2g*h_u}}$ where A = B * Y
Submerged orifice flow or non modular flow (ON)	$C_d = \frac{Q}{A*\sqrt{2g*(h_u-h_d)}}$

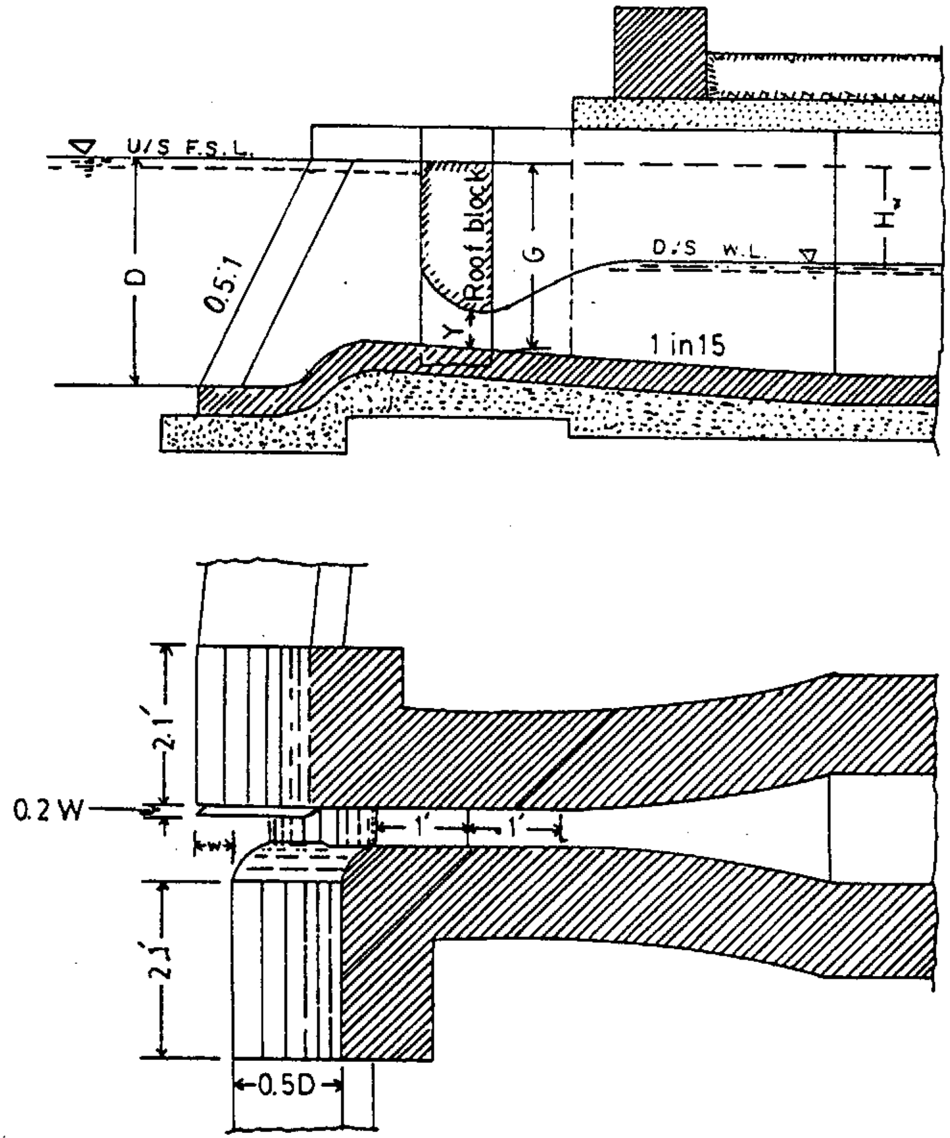


Fig: 2.3. Standard design of A.O.S.M. as used in Punjab.

The AOSM outlet was originally introduced by E.S. Crump in 1922 as the Adjustable Proportional Module (APM). Later, when the sill level was lowered from 0.6 depth[1] for the APM to 0.9 depth, in order to convey more sediment load through the outlet, the name of the outlet structure was changed to Adjustable Orifice Semi-Module (AOSM).

The OFRB was originally designed as an open flume and was later provided with a straight roof block. The primary advantage of a fixed orifice outlet compared with a flume outlet is that the discharge is a function of the canal water level with an exponent of 1/2 (rather than 3/2). Thus, the discharge increases with increasing water levels in the canal, but not nearly as rapidly as in the case of flume outlets. Most outlets in the Chishtian Sub-division are fixed orifices. The discharge equations for free and submerged flow are given in Table 2.1.

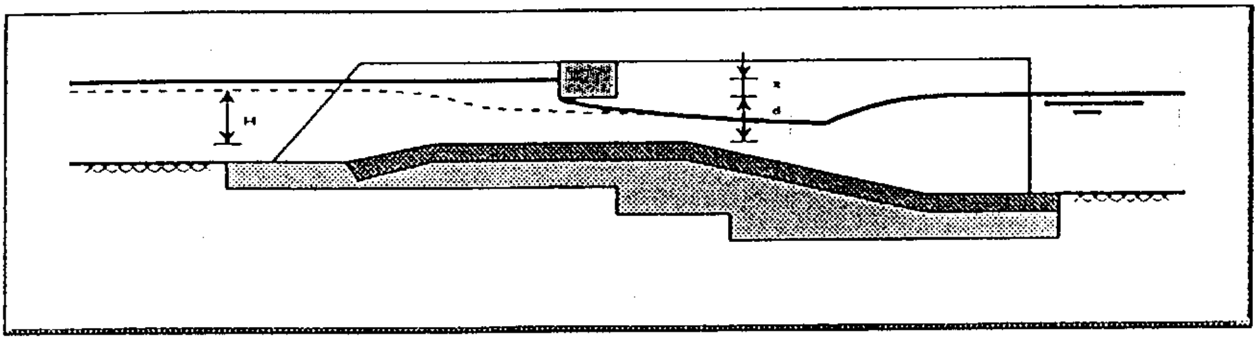


Fig: 2.4. Standard design of O.F.R.B.

Pipe outlets

A pipe outlet is the simplest of all outlet structures in terms of fabrication and installation, but the most complex hydraulically. Some typical examples are shown in Figure 2.5. The discharge will, in most cases, be a function of the upstream head in the parent canal, h_u, to the exponent 1/2 (free flow), or (more often) the square root of the difference in the water surface elevation between the secondary canal and tertiary channel (submerged flow). The formulae which were used in the calibration are given in Table 2.1.

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[1] *It can be calculated that the bottom of the roof block should be at 0.7 D above the bed level, in order to ensure proportionality (Hart, 1996). However, at this level the silt drawing capacity of an outlet is very low.*

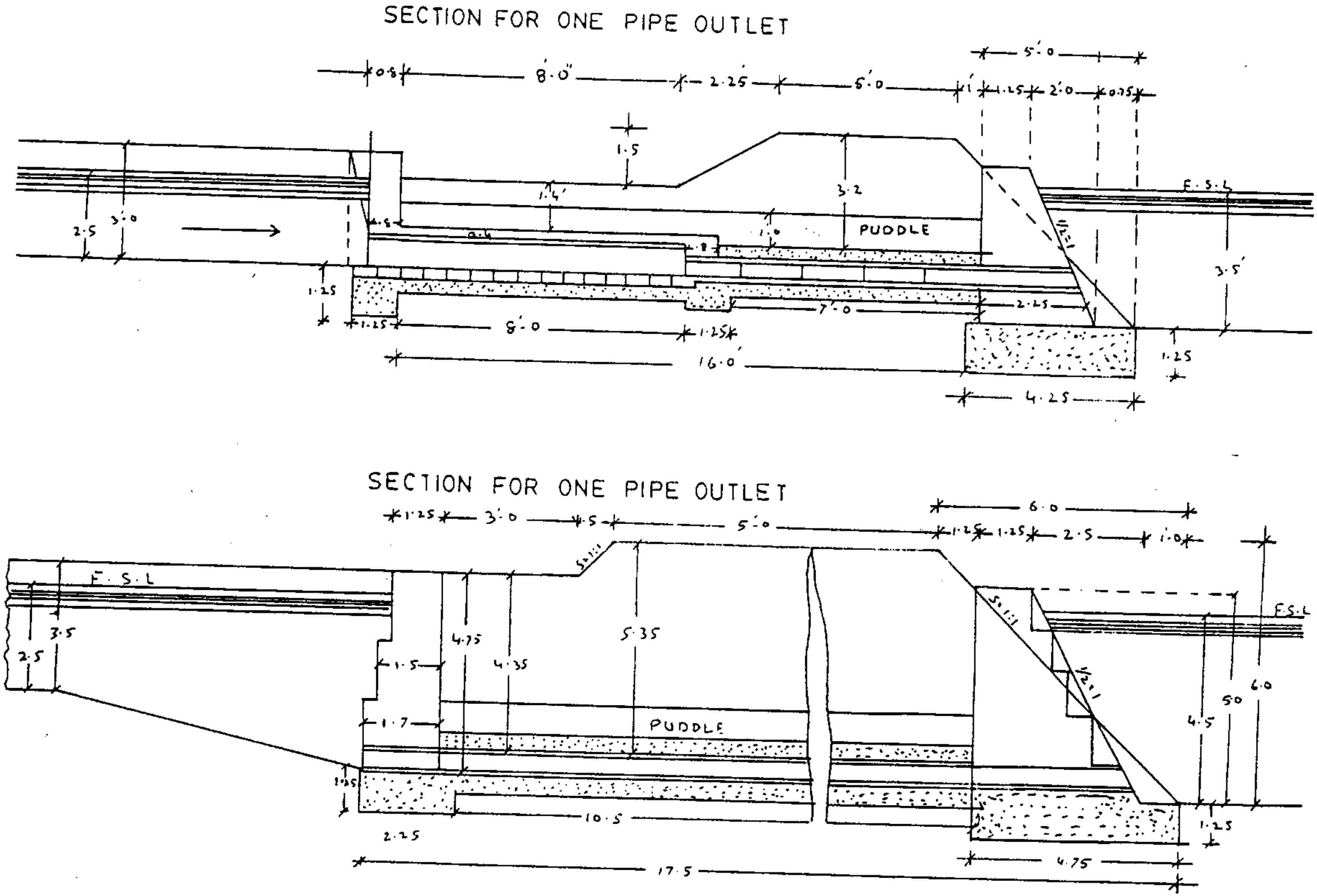

Fig: 2.5. Some typical examples of a pipe outlet.

2.2 Procedure to determine the water distribution of distributaries

In order to study the water distribution in distributaries, deliveries to all watercourses in a distributary were measured. The easiest way to do this is to ensure a stable supply to a distributary and measure the discharges to all watercourses within a specific amount of time. This time period is dependent on the time that is required for water to flow from the head to the tail of a distributary (as a function of hydraulic characteristics such as slope, roughness coefficient, discharge, etc.). In case of large distributaries, outlets were calibrated prior to the experiment, so that on the day of the experiment, only water levels had to be measured. The distributary is divided into reaches and the inflow/outflow is measured for each reach during the experiment. This serves as a cross-check for the measured outlet discharges. Also, seepage losses can then be determined reach-wise. In Figure 2.6, the sequence of the different steps that were taken are given.

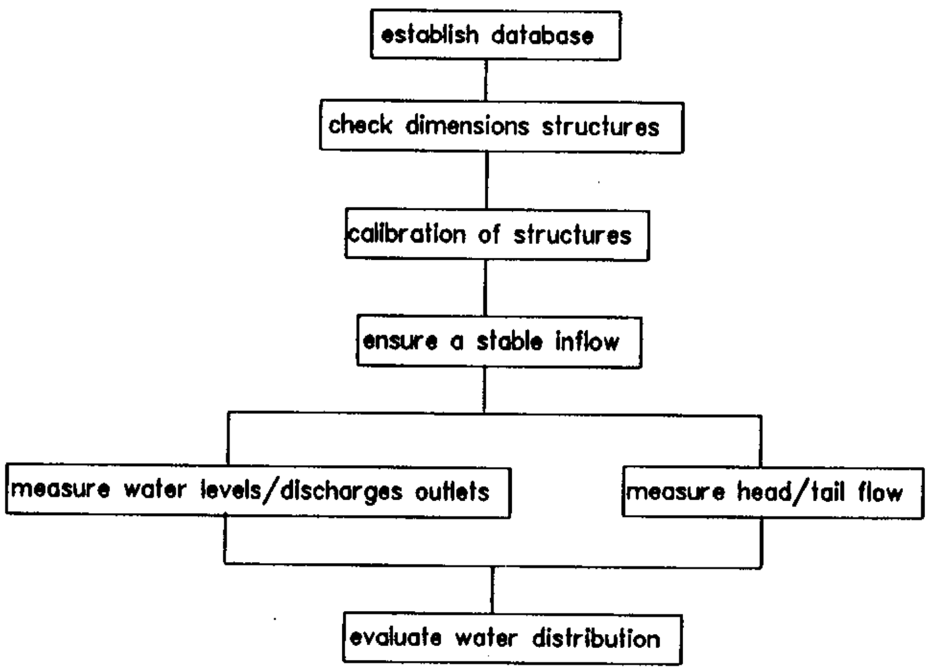

Fig: 2.6. Sequence of steps for determination of seepage losses.

Establish database

The following data was collected from the Irrigation Department:

- location of outlets;
- outlet dimensions (the breadth (B) and height (Y));
- working head; and
- location and dimensions of drops..

This information can be found in the outlet register, which is maintained at the Sub-Divisional, Divisional and Circle offices, and in the longitudinal plans (Divisional office).

Field survey

The actual dimensions of structures (outlets, drops) were checked in the field, which included the crest level and dimensions (height and width). Also, the location of outlets were verified. In addition to that, white marks (bench marks) were painted on the structures, cross-referenced to the outlet crest, to facilitate measuring water levels (see Figure 2.7.).

The outlet register was found to be outdated, as changes that have taken place have not been incorporated in the records. The Circle office data were found to be the most complete.

Calibration of structures

Prior to the start of the water distribution exercise, outlets and structures of a distributary were calibrated. White mark readings were taken upstream and downstream of an outlet, after which the discharge (Q) was measured downstream of the outlet. Flow conditions were determined in order to establish the formula that needs to be used to calculate the coeeficient of discharge, C_d. The common flow conditions that were observed are:

- Free open channel flow (F.F);
- Submerged open channel flow (F.S);
- Free orifice flow or orifice (semi-) modular flow (OM); and
- Submerged orifice flow or non modular flow (ON).

In earthen watercourses, a portable flow measuring flume was temporarily installed downstream of the canal outlet structure. A Cutthroat Flume (Skogerboe et al., 1993) was used, as it does not require much head. These devices increase the water surface elevation upstream of the flow measuring device (and thus the downstream water level of the outlet structure). This does not affect the accuracy of the discharge rating

(which generally to be estimated at +/- 5%), however, as long as the flow conditions of the outlet do not change (e.f., from free flow in the outlet to submerged flow).

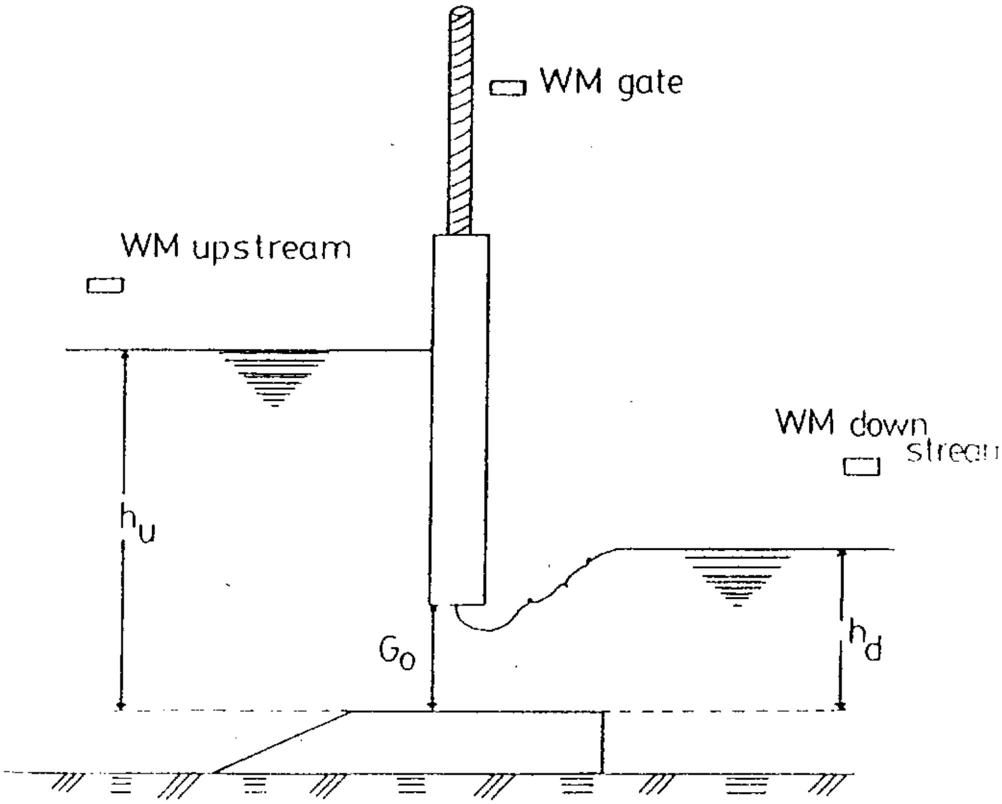

Fig: 2.7. White Marks on Structures.

In lined watercourses, a pygmy current meter mounted on a wading rod was used. By taking a sufficient number of readings (verticals) and by using well maintained equipment, a good accurate measurement was obtained (+/- 5%).

Ensure a stable inflow

On the day of the test, the discharge at the head of the distributary should be constant. A stable inflow should be ensured for the duration of the experiment (which depends, as indicated before, on the travel time of the water from the head to the tail of a distributary). Water level readings were taken at hourly or half-hourly intervals. To check the discharge rating, the discharge at the head was measured during the experiment using a current meter.

Divide channel into reaches and measure head/tail flows

For the experiments, the distributaries were divided into a number of reaches. This was done in order to be able to cross-check the measurements that were done on outlets and to estimate the seepage reach-wise. Reaches were selected preferably between two drop structures, as it facilitates the discharge measurements. Also, a proportionate number of outlets were used in each reach. Also a reach was generally not longer than 20,000 feet. In each reach, the discharge rate was measured at both the head and tail during the experiment.

Measure water levels and discharges of outlets

On the day of the inflow-outflow exercise, the white mark elevations (upstream and downstream) of all outlets were taken, and the flow condition recorded. If the flow condition was the same as during the time of calibration, the white mark readings were accepted. If there was a change, then the discharge was measured using either a Cutthroat Flume or a current meter. In order to evaluate the physical state of the distributary, the average water depth in the distributary (H disty.) was also measured (see Figure 2.8).

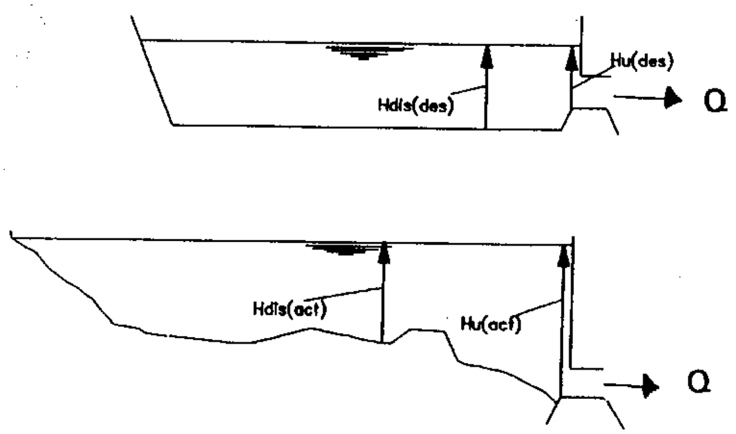

Fig: 2.8. Schematic diagram of design and actual conditions in distributaries.

Evaluate water distribution

After calculating the discharge of each outlet, as well as the discharge in the distributary at various points, the water distribution in the distributary can be verified. First, the discharges are referenced to the authorized discharges, after which the equity in distribution can be verified using performance indicators.

Seepage

There are various methods to determine seepage in irrigation channels (e.g. Ponding Method, Inflow-Outflow Method, etc.). For this study, the Inflow-Outflow Method for estimating seepage is evaluated under normal operating conditions for the irrigation channels. However, the seepage rate must be larger than the error in the discharge ratings in order to have sufficient accuracy.

The Inflow-Outflow Method is basically a water balance methodology, whereby a distributary is subdivided into reaches with a water balance conducted for each reach. When undertaking an Inflow-Outflow test, a steady state flow period is required in order to minimize problems of storage and drainage in channel reaches. Then, the seepage can be calculated for each reach:

Seepage = Inflow - Outflow - Supplies to Watercourses

Often, seepage is calculated as a discharge for a given wetted area. In Pakistan, it is usually expressed in cusecs per million square feet (cusecs/msf). The wetted area is calculated by the following procedure (Litrico, 1995). As canals in the area are generally very wide and flat, a trapezoidal section can be assumed in which the bed width B > > a. The side slope is assumed to be 45° in Figure 2.9.

If

$$D = \frac{a}{\sqrt{2}}$$

The wetted perimeter,

$$P = B + 2*a$$

Then

$$P = B + 2\sqrt{2} * D = B + 2.83 D$$

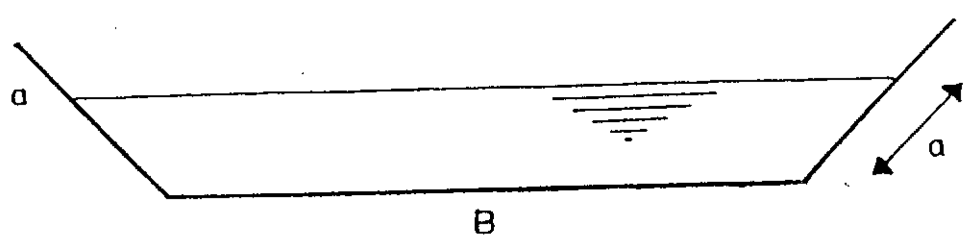

Figure 2.9. Schematic of a wide canal cross-section.

CHAPTER 3. WATER DISTRIBUTION IN SECONDARY CANALS: RESULTS

In this chapter the results of the experiments on the 14 distributaries are presented.

3.1 3-L Distributary

General

The exercise was carried out on 08-10-1995 (8 October 1995) from 6.00 a.m. to 6.00 p.m. It was a sunny day with temperatures ranging from 35° to 42° C. The discharge at the head was 20.12 cusecs, which is higher than its design discharge of 18 cusecs. Normally, this distributary runs at a discharge lower than its design discharge. The bank conditions were comparatively good from RD-0 to RD-2900, but from RD-2900 to RD-3500, the left bank was damaged by cattle.

The entire distributary is in filling except near RD-3400 (for about 400 ft) which is partially cut/fill. The area from RD-2900 to RD-10300 is waterlogged along 3-L Distributary.

Characteristics of outlets

Prior to the exercise, the characteristics of the outlets were determined at site. The measured values of "B" and "Y" of the outlets of 3-L Distributary are given in Annex 1. Dimensions that were observed in the field differ substantially only in some cases from the original data (Figures 3.1.1 and 3.1.2). This is the case for all the outlets except outlet 23100-T. The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets are given in Annex 2. The type of outlet at RD-6400-L was a OFRB in the record book, but at site it turned out to be a pipe outlet.

Calibration of canal structures and outlets

During the day of the exercise, the head structure and the outlets of 3-L Distributary were calibrated, thereby determining the C_d of the head and these outlets. All the outlets were calibrated during the day of the exercise. The C_d of the head structure of 3-L Distributary (FS) was determined to be 0.52.

The complete list of C_d values is given in Annex 2. On the day of the exercise, three outlets had free flow conditions (OM), while two outlets had submerged flow conditions (ON), and one outlet with flow condition FF.

Water Distribution

The discharge at the head of the 3-L Distributary was constant during the exercise (Figure 3.1.3). Similarly, the discharge at the outflow point was constant except in the beginning of the exercise (Figure 3.1.4).

In Annex 3, the observed water levels and corresponding discharges of the outlets of 3-L Distributary are presented. The observed water levels are, in almost all cases, higher than the original target (design) water levels, which results in higher discharges for most outlets. One of the reasons for these high water levels is the fact that the bed level of the distributary is higher than the design level. This is depicted in Figure 3.1.5, which shows that on average the actual bed level of the distributary is higher than the crest level of the off-taking outlets except for Outlet RD-10-L. However, the main reason for the higher water levels seems to be the fact that this distributary is receiving 17% more discharge than design at the head.

The resulting water levels above the crests of the outlets and the corresponding discharges are shown in Figure 3.1.6 and Figure 3.1.7. The discharge of the second outlet in 3-L Distributary is below target due to the fact that this outlet has a submerged flow condition caused by high water levels downstream, where the watercourse is choked with silt. An overall picture of the water flow in the distributary is presented in Figure 3.1.8.

Inflow-Outflow

Seepage losses were determined for different reaches of the 3-L Distributary. The results are presented in Table 3.1.1. The seepage from this distributary is negative for the largest part of the distributary as it runs parallel to the Fordwah Branch Canal. Only in the last part of the distributary, where it no longer runs parallel to Fordwah Branch, does seepage occur.

Table 3.1.1. Seepage from 3-L Distributary for each reach.

Reach (RD) (ft)	No. of outlets	Total Q of O/L' (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage (cfs/msf)
o to 4960	2	6.00	20.12	14.19	-0.07	0.049	-1.42
4960 to 10300	1	3.80	14.19	10.47	-0.08	0.049	-1.62
10300 to 16400	2	5.70	10.47	4.92	-0.15	0.044	-3.37
16400 to 23100	0	0.00	4.92	4.10	0.82	0.035	23.52

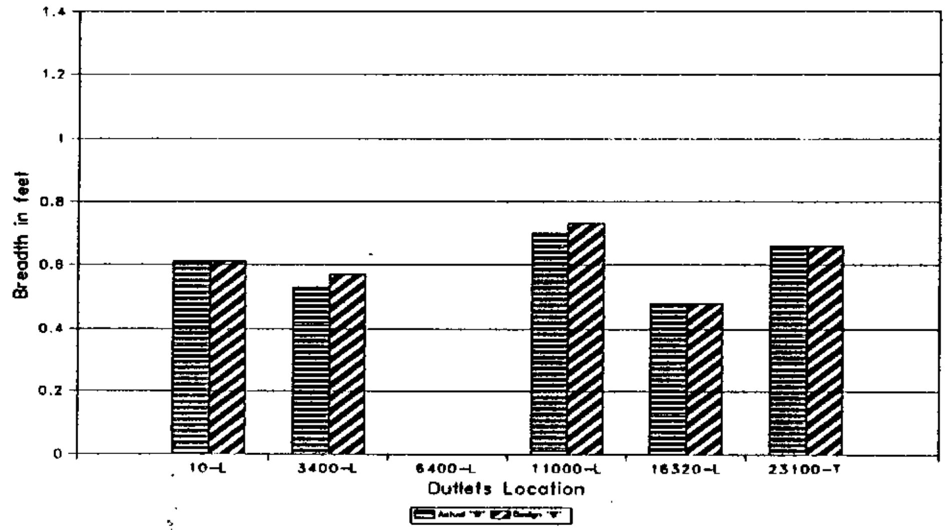

Fig: 3.1.1. Comparison of breadth "B" of outlets in 3-L Distributary,observed versus records.

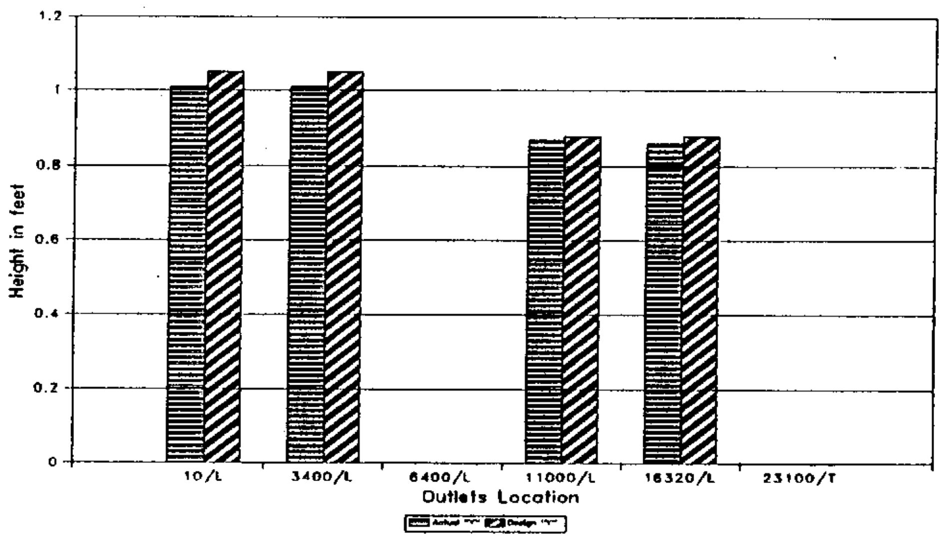

Fig: 3.1.2. Comparison of height "Y" of outlets in 3-L Distributary,observed versus records.

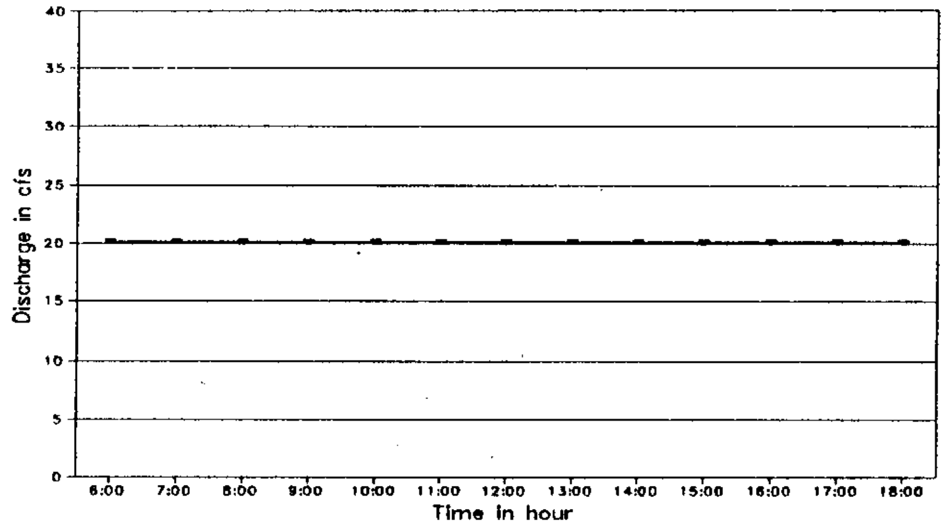

Fig: 3.1.3. Discharge at the head of the 3-L Distributary during the inflow-outflow exercise.

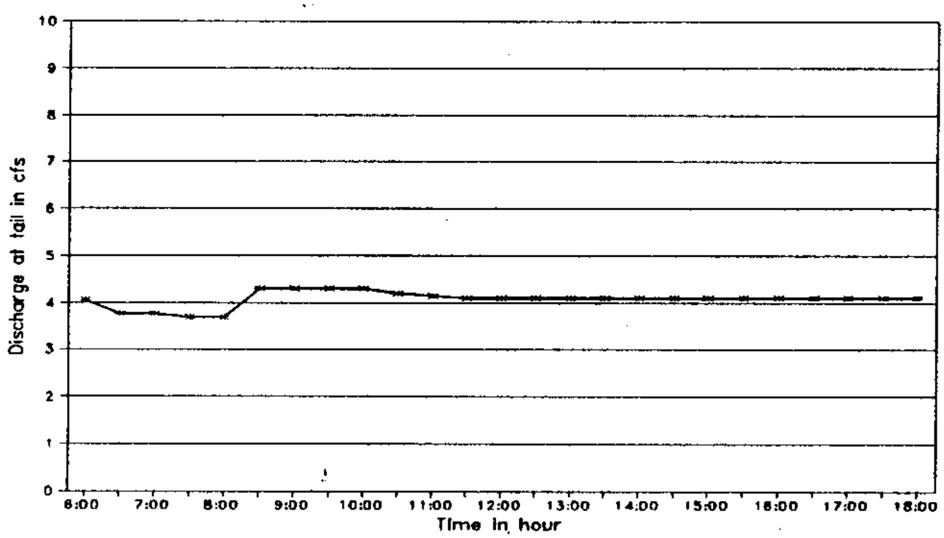

Fig: 3.1.4. Discharge at the tail of the 3-L Distributary during the inflow-outflow exercise.

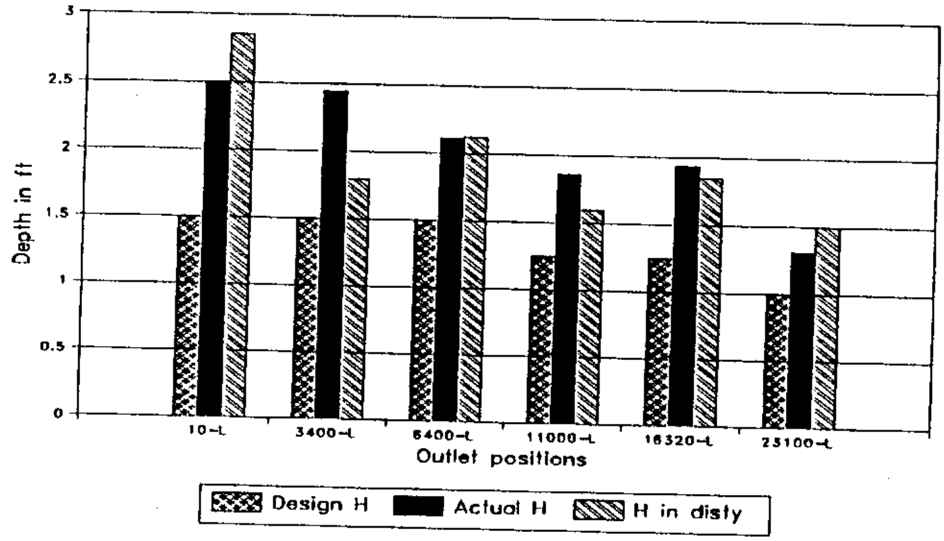

Fig:3.1.5. Comparison between water levels at outlets (observed versus records) versus water level in the 3-L Distributary.

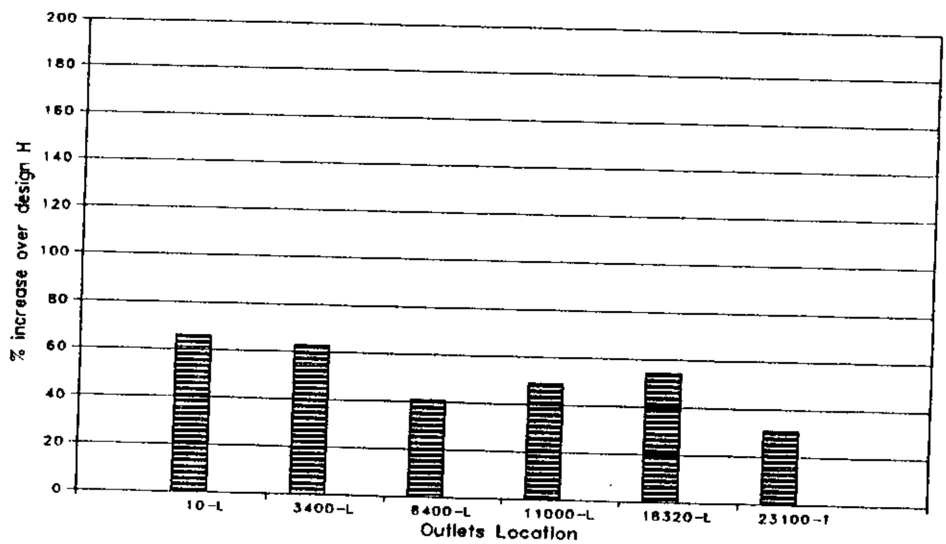

Fig: 3.1.6. Percentage change in actual upstream water levels for outlets with reference to the design water levels in 3-L Distributary.

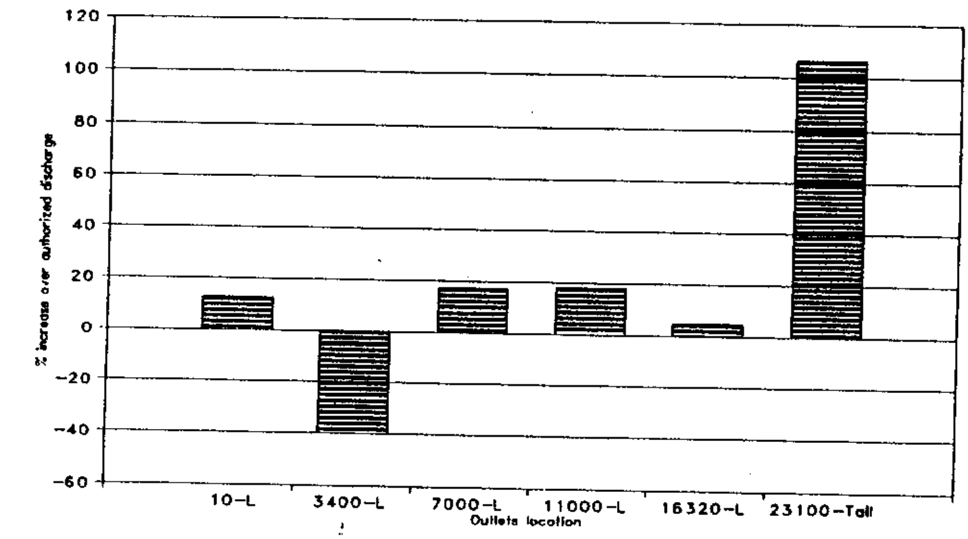

Fig: 3.1.7. Percentage change in actual discharge for outlets with reference to the authorized discharge in 3-L Distributary.

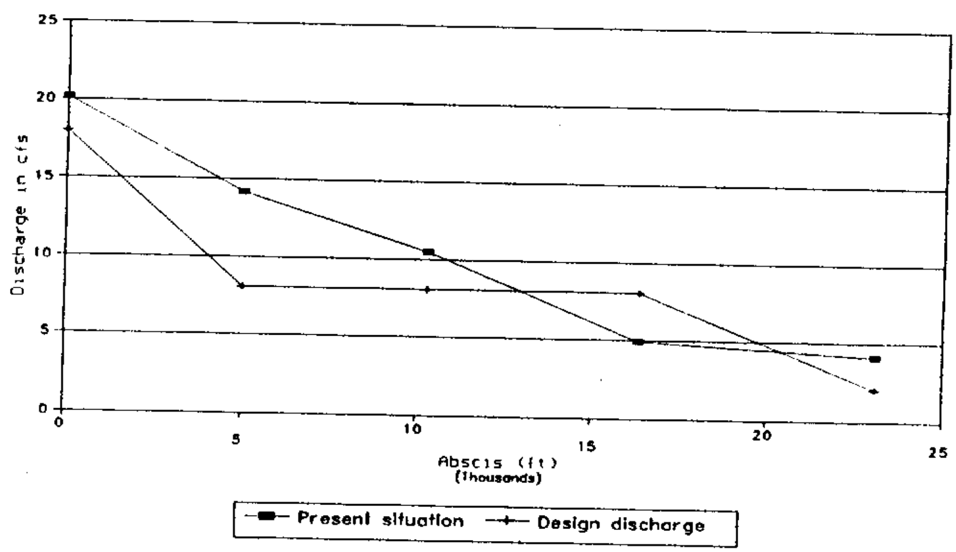

Fig: 3.1.8. Comparison between discharges in 3-L Distributary, observed versus design.

3.2 Mohar Distributary

General

The exercise was conducted in Mohar Distributary on the Fordwah Branch Canal at RD-245000 on 23-09-1995 from 6 a.m. to 6 p.m.

The discharge at the head during the exercise was 33.71 cfs, but the design discharge is 38 cfs. This distributary normally runs under its design discharge (Fig. 3.2.8)

There are thirteen outlets and one minor (Hussain Abad at RD-3300) in which eight are OFRB, one APM outlet, two pipe outlets and two open flumes. Three outlets were broken at the time of the exercise and one cut was observed in this distributary.

This was a sunny day and the temperature ranged between 35 C° and 42 C°. The banks were very weak and were badly damaged by cattle. Particularly between RD 3300 to RD 13700, banks are very weak and even a very small fluctuation in water could breach the distributary.

Most outlets have actual dimensions that are quite close to the authorized values. Only in a few cases was a considerable difference found to exist.

Limitation

The tail was assumed at RD-18000 because the farmers did not allow to take reading to be taken at the actual tail.

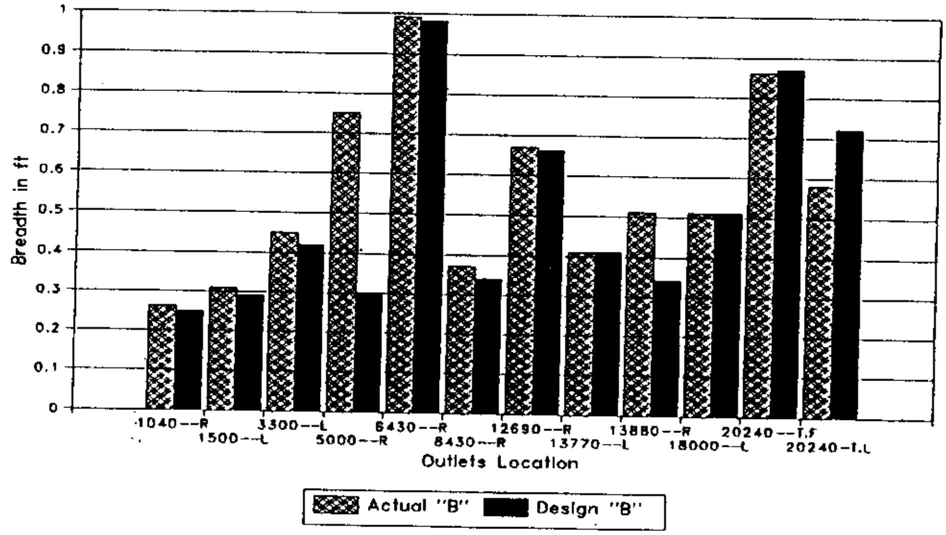

Fig: 3.2.1. Comparison of breadth "B" of outlets in Mohar Distributary, observed versus records.

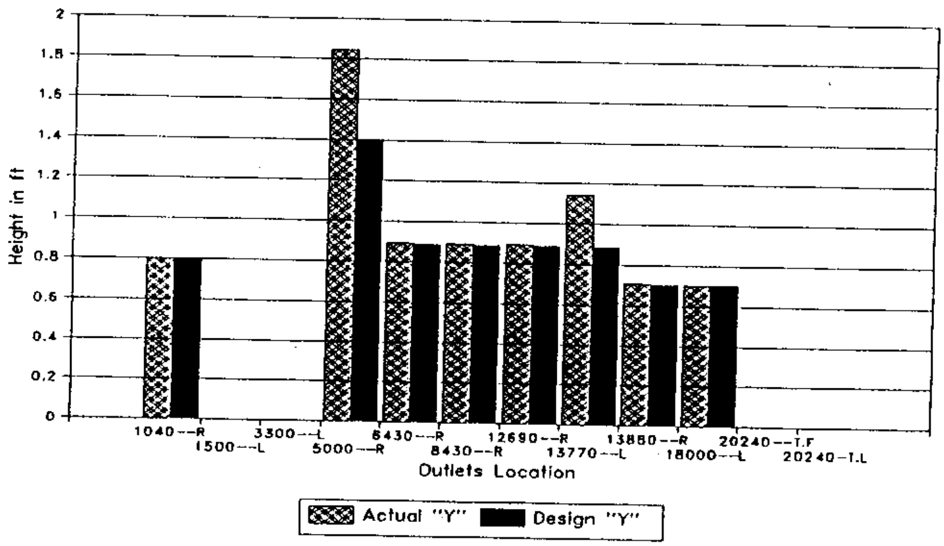

Fig: 3.2.2. Comparison of height "Y" of outlets in Mohar Distributary, observed versus record.

Calibration of canal structure and outlets

The gated orifice at the head of the distributary had submerged flow conditions and the C_d was calculated as 0.70. A list of Cd coefficients established during the experiment is given in Annex 2.

During the exercise, five outlets were running as orifice modular flow (O.M), five were running as orifice non-modular flow (O.N) and two were running as submerged flow (F.S). In this distributary, there are two falls, which were running as free flow (Annex 2).

Inflow-outflow

The discharge at the head of the Mohar Distributary was constant (Fig. 3.2.3), which was also the case at the tail of the distributary (Fig. 3.2.4).

Most of the outlets were drawing more water than their authorized discharge (Fig.3.2.7). The actual depth of water above the crest was more than design (Fig 3.2.5 and Fig 3.2.6). The seepage in this distributary is very small except at the last reach (Table 3.2.1.).

Table: 3.2.1. Seepage from Mohar Distributary for each reach.

Reach RD	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage (cfs/msf)
0-6430	4 + Minor*	12.42	33.71	21.29	0.00	0.13	0.02
6400-14000	5	14.67	21.29	6.6	0.02	0.10	0.19
14000-18000	1	1.54	6.6	4.78	0.28	0.043	6.58
18020-20240	ONE CUT	1.7	4.78	2.56	0.52	0.20	26.21

* The discharge of the minor was 6.72 cfs

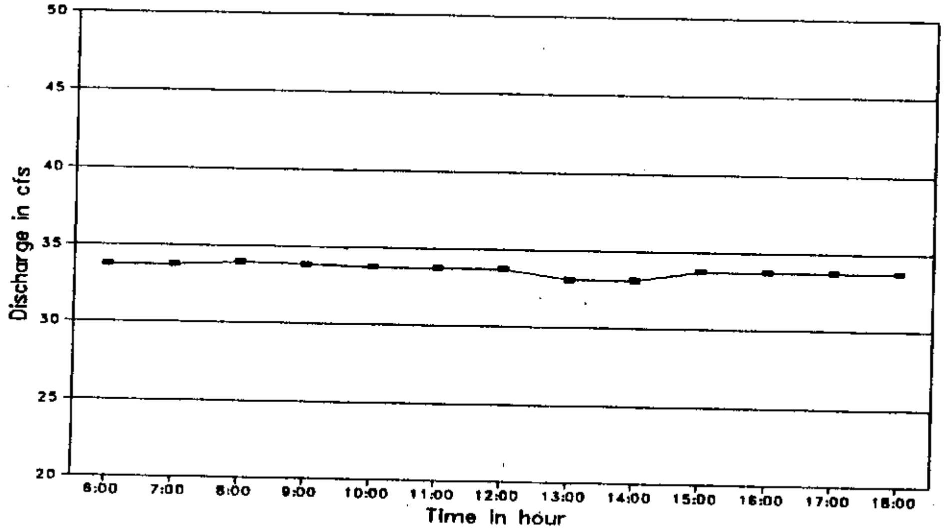

Fig: 3.2.3. Discharge at the head of Mohar Distributary during the inflow-outflow exercise

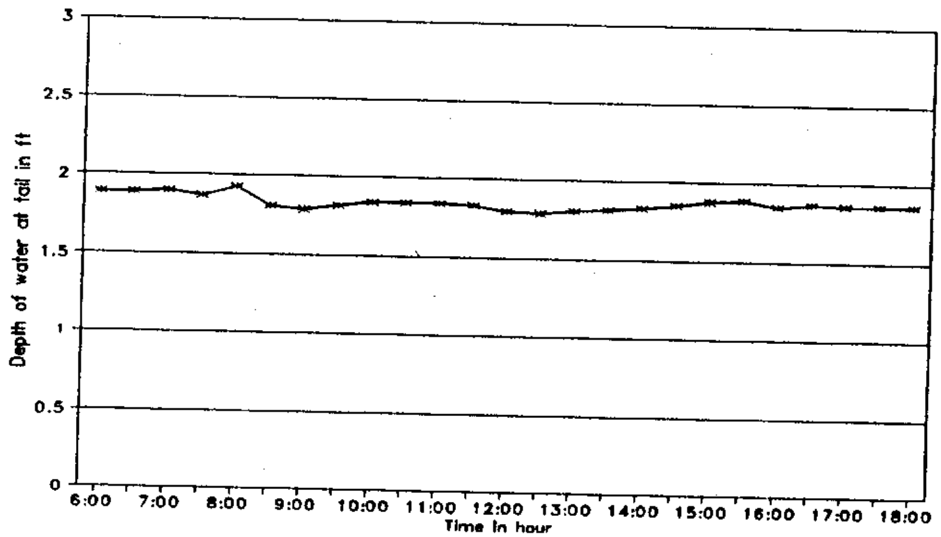

Fig: 3.2.4. Depth of water at the tail of the Mohar Distributary during the inflow-outflow exercise.

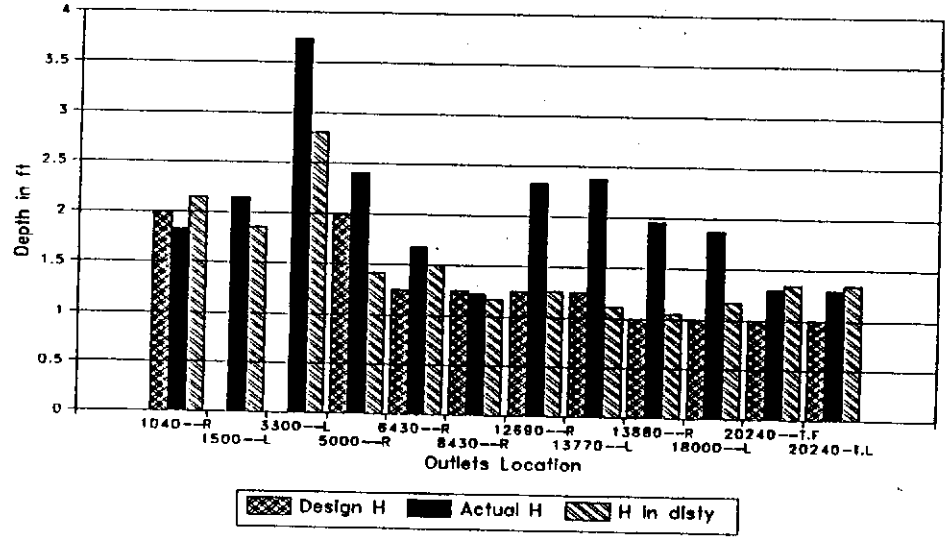

Fig: 3.2.5. Comparison between water levels at outlets (observed versus records) versus water level in the Mohar Distributary.

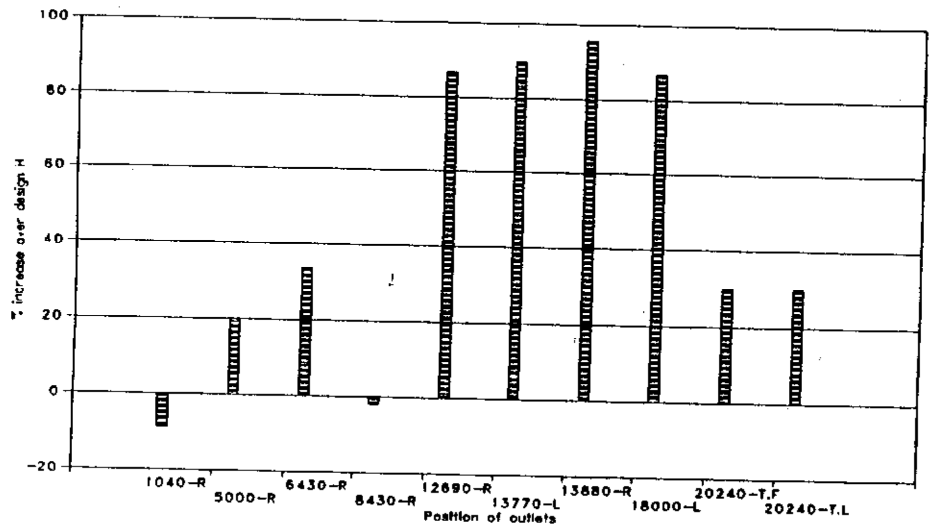

Fig: 3.2.6. Percentage change in actual upstream water levels for outlets with reference to the design water levels for Mohar Distributary.

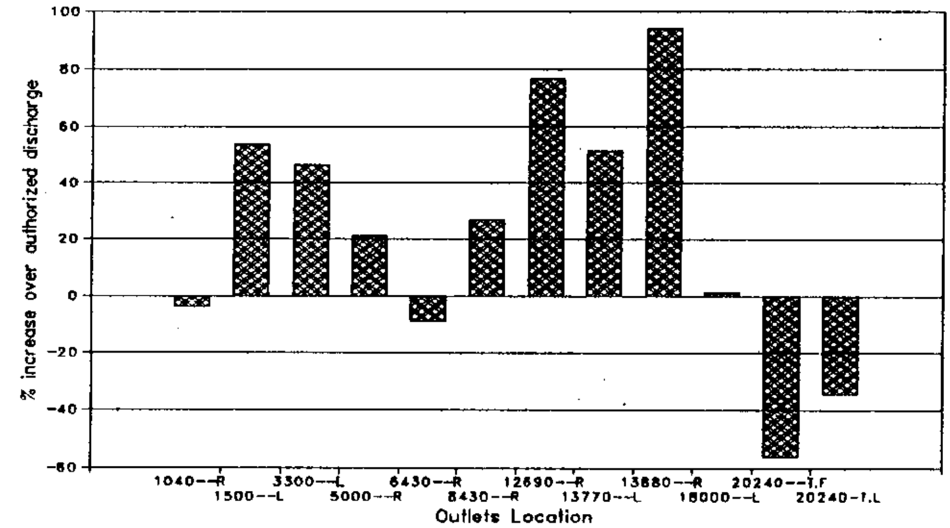

Fig: 3.2.7. Percentage change in actual discharge of outlets with reference to the authorized discharge for Mohar Distributary.

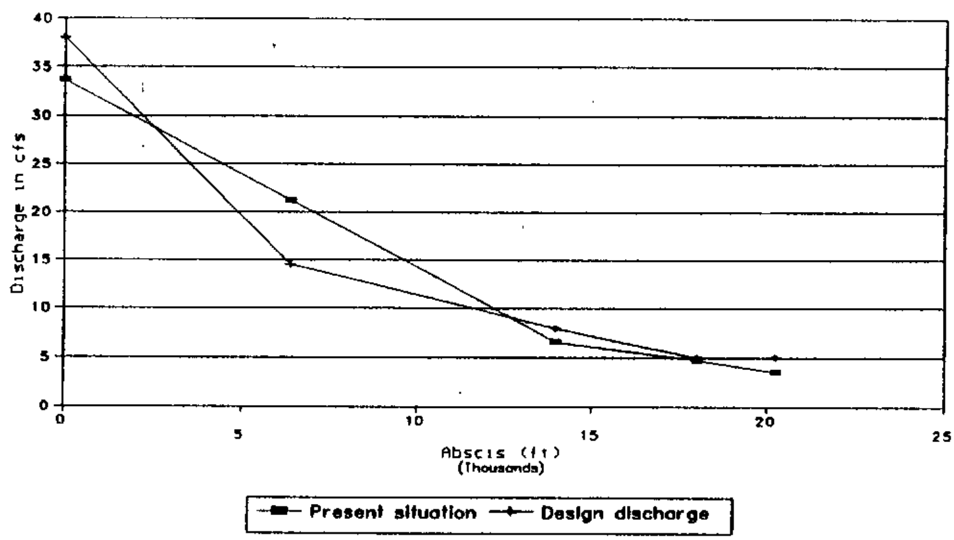

Fig: 3.2.8. Comparison between discharge in distributary, observed versus design, for Mohar Distributary.

3.3 Daulat Distributary

General

The inflow-outflow exercise was carried out from 06:00 a.m. of May 12 to 06:00 p.m of May 13. The climate was sunny, with temperatures ranging from 34° to 38° C. The discharge at the head was 153.83 cusecs, which is lower than its design discharge of 209 cusecs. Usually, this distributary runs at a discharge less than its design discharge. Most of the time, the tail is short of water due to illegal pipes and cuts in upstream reaches and farmers blocking the water in the distributary.

Characteristics of outlets

Prior to the exercise, the characteristics of outlets were determined at site. The measured values of "B" and "Y" of the outlets of Daulat are given in Annex 1 and in Figures 3.3.1, 3.3.2, 3.3.3 and 3.3.4. Dimensions of these parameters are often different from authorized, and a lot of outlets are tampered, including roof blocks or base and check plates. This is the case for outlets 38800-R, 41030-R, 49000-L, 49730-R, 57880-R, 61790-R, 71200-R, 80730-R, 108100-R, 109900-L, 110320-R, 112880-R, 112900-L and 114860-L.

The existing outlet types were found to differ from the records: 41030-R (OCOFRB), 47500-L (OCOFRB), 97560-L (OFRB).

There are four pipes at different locations (22100-L, 23200-L, 24800-L 29000-L) installed in the distributary but in the record there is no outlet at these locations. However, all these pipes were closed on the day of the experiment. The Outlets 3990-L and 89860-R were also closed during the experiment. The Outlet 95600-R was closed but leakage (0.25 cfs) occurred.

Some of outlets which were broken were repaired by ID, before experiment but still some outlets were found broken during the experiment. The outlets which were repaired were: 3990-L, 16100-L, 40000-L, 52500-L, 62090-L, 63470-L, 63490-R, 73000-R, 76480-R, 80979-L, 85750-L, 90070-L,91190-R, 95530-L, 95600-R, 95820-L, 97560-L, 98140-R and 99440-L.

White mark elevations, used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

During the day of the inflow-outflow exercise, the head structure and some of the outlets of Daulat Distributary were calibrated[2], thereby determining the C_d of these structures. The C_d of the head structure of Daulat (OM) was determined at a value of 0.63. For Billuka Minor (FS), Nakewah Minor (FS) and Gated Structure at RD 64 (ON), the values of C_d were found to be 1.03, 1.60 and 0.81, respectively. The C_d for the OFRB outlets ranged from 0.27 to 0.59 for OM flow conditions, while for ON flow conditions the value ranged from 0.49 to 0.98 and for FF flow conditions the value ranged from 0.29 to 0.46. C_d for the OCOFRB outlets were from 0.52 for OM and 0.67 for ON flow conditions, while for FF flow conditions the value ranged from 0.34 to 0.57. C_d for the APM and OCAPM outlets ranged from 0.56 to 0.94 for OM flow conditions. C_d for pipe outlets ranged from 0.40 to 1.14 for ON flow conditions. C_d for OF outlets ranged from 0.33 to 0.43 for FF flow conditions. The fall at RD-21273 was 100 % submerged and the crest of the fall at RD-99800 was broken.

[2] *The best outlets were calibrated prior to the experiment.*

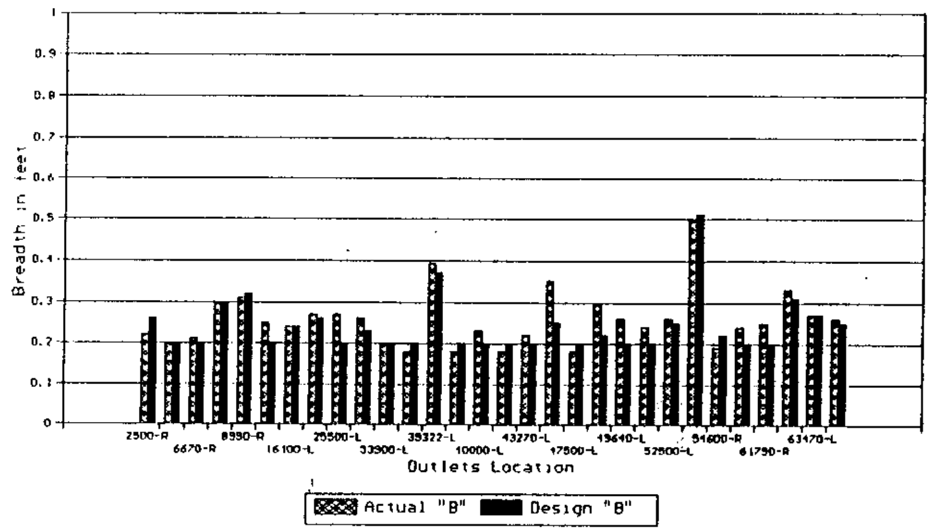

Figure 3.3.1. Comparison of breadth "B" of outlets in Daulat Distributary, observed versus records, RD 2.5 to 64.

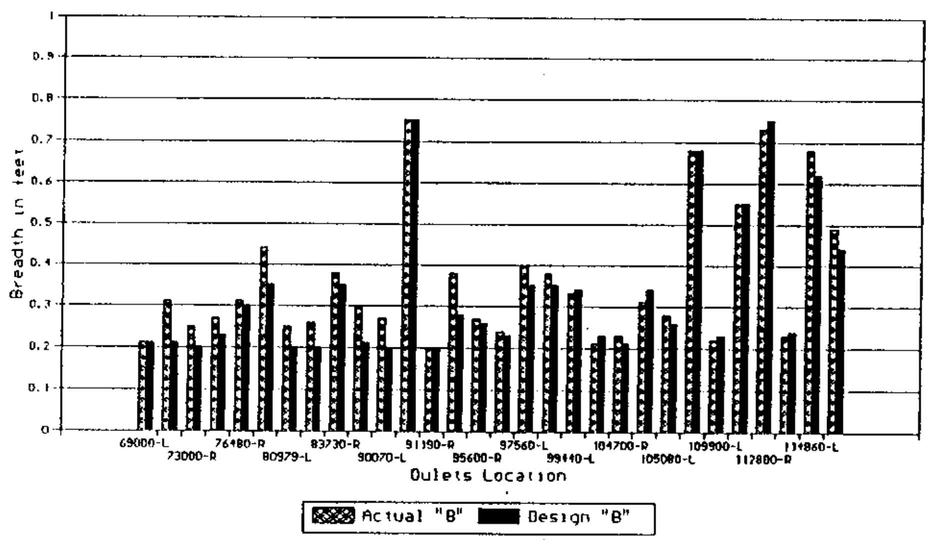

Figure 3.3.2. Comparison of breadth "B" of outlets in Daulat Distributary, observed versus records, RD to tail.

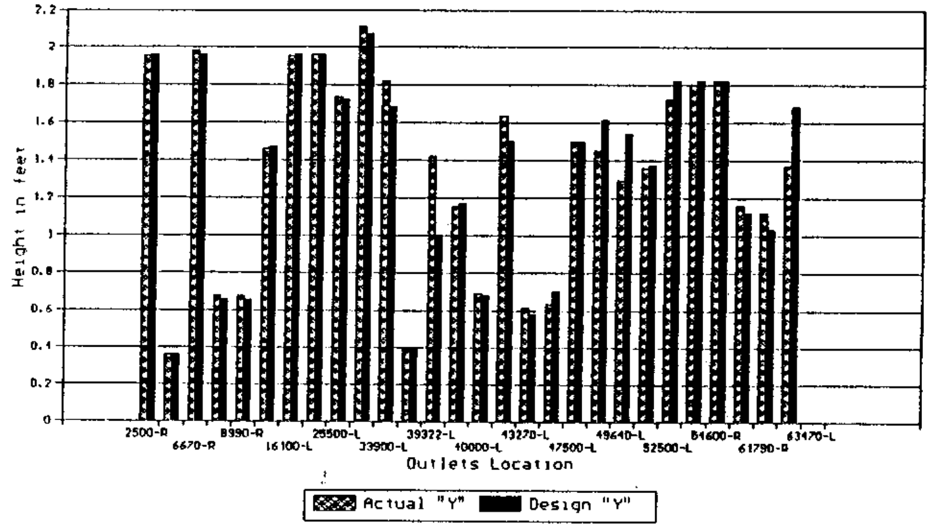

Figure 3.3.3. Comparison of height "Y" of outlets in Daulat Distributary, observed versus records, RD 2.5 to 64.

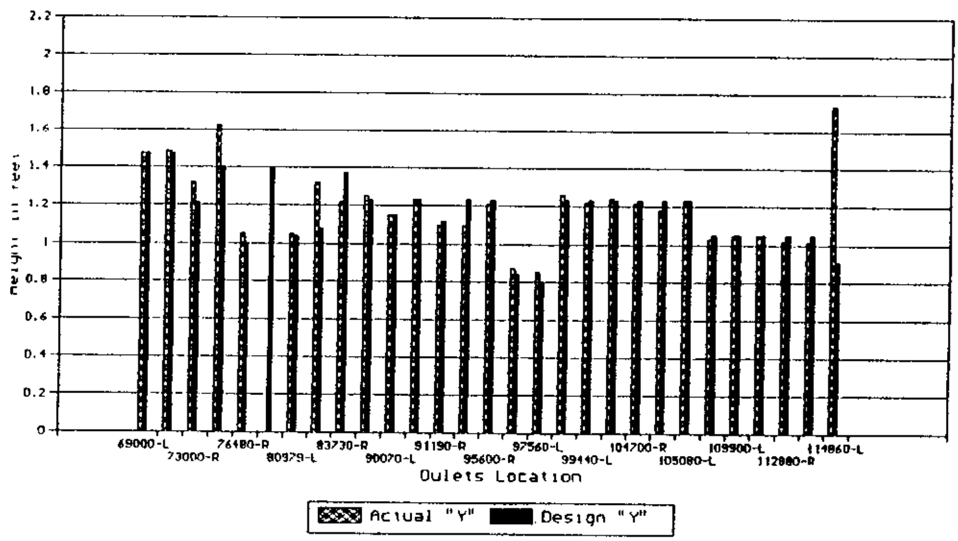

Figure 3.3.4. Comparison of height "Y" of outlets in Daulat Distributary, observed versus records, RD 64 to tail.

The complete list of C_d values is given in Annex 2. On the day of the exercise, the majority of the outlets (22) had free orifice flow conditions (OM), while 14 outlets had submerged orifice flow conditions (ON). Twenty outlets had a free flow condition (FF) and one had submerged flow (FS).

Water distribution

The discharge at the head of Daulat Distributary was almost constant during the exercise (Figure 3.3.5) and the depth of water at the outflow point (which was considered to be RD-108100, because water was blocked at RD-110000) are given in Figures 3.3.5 and 3.3.6.

In Annex 3, the observed water levels and corresponding discharges for the outlets of Daulat Distributary are presented. The observed water levels in a few reaches were higher than the target water levels, which results in higher discharges for some outlets. But observed water levels at the tail reach are lower than the target water levels, which results in less discharge for some outlets. One of the reasons for these high water levels in the upper position of the distributary is the fact that the bed level of the distributary is much higher than the design level. This is depicted in Figures 3.7.7 and 3.7.8. The resulting water levels above the crests of the outlets and the corresponding discharges are shown in Figures 3.3.9, 3.3.10, 3.3.11 and 3.3.12. An overall picture of the water flow in the distributary is presented in Figure 3.3.13.

Inflow-outflow

Seepage rates were determined for different reaches of the distributary. The results are presented in Table 3.3.1. Clearly, seepage losses are fairly low in the first two reaches. The banks of the distributary are not in good condition. They are damaged due to the frequent presence of cattle in the distributary.

Table 3.3.1. Seepage losses for Daulat Distributary.

Reach (RD)	No. of outlets	Total Q of outlet (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage cfs/msf
0-32100	18	30.52	153.83	120.83	2.48	1.24	2.00
32100-64000	21 + 2 Minors*	72.95	120.83	47.02	0.86	0.87	0.99
64000-86000	10	16.12	47.02	28.66	2.24	0.39	5.74
86000-109900	16	23.74	28.66	3.35	1.57	0.23	6.83

* Discharge of Billuka Minor measured as 9.11 cfs and Nakewah Minor as 24.05 cfs.

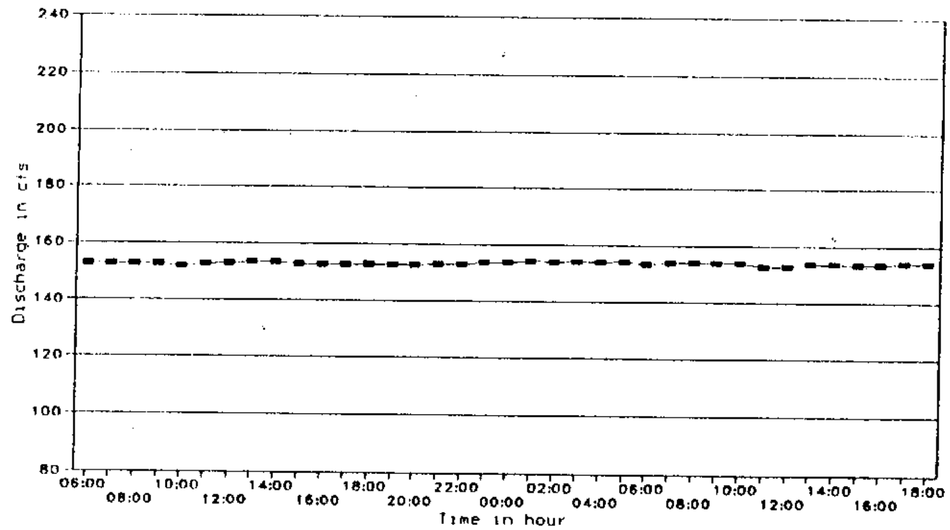

Fig: 3.3.5. Discharge at the head of the Daulat Distributary during the inflow-outflow exercise.

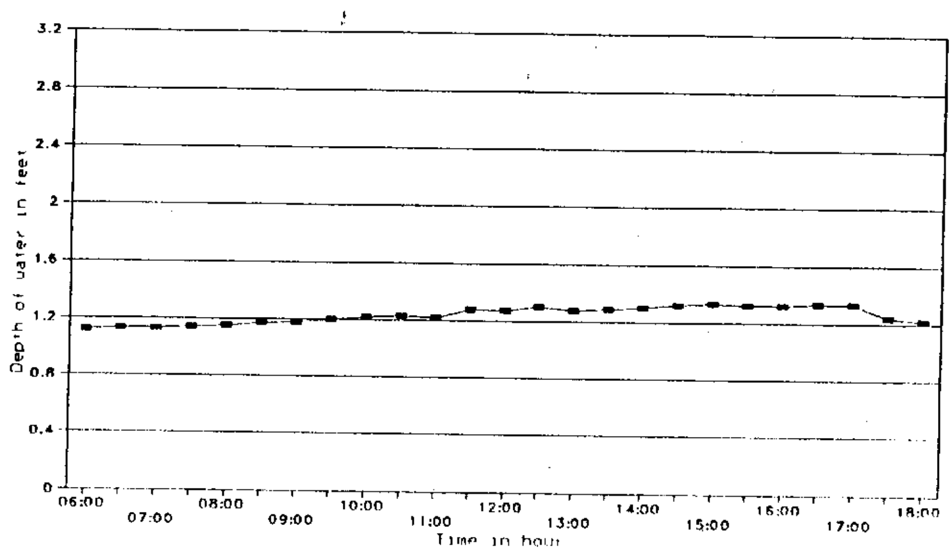

Fig: 3.3.6. Depth of water at the working tail of Daulat Distributary during the exercise.

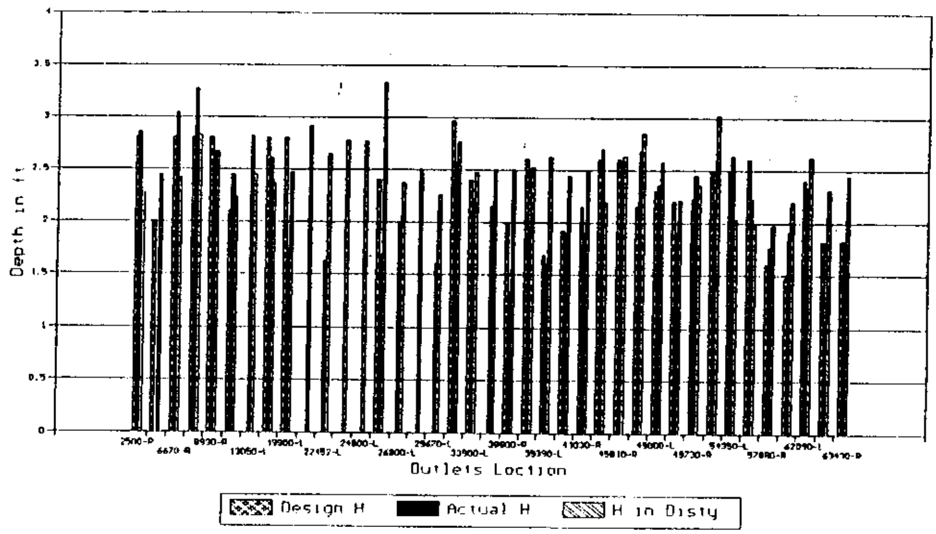

Fig: 3.3.7 Comparison between water levels at outlets (observed versus records) versus water level in the distributary at RD 2 to 64.

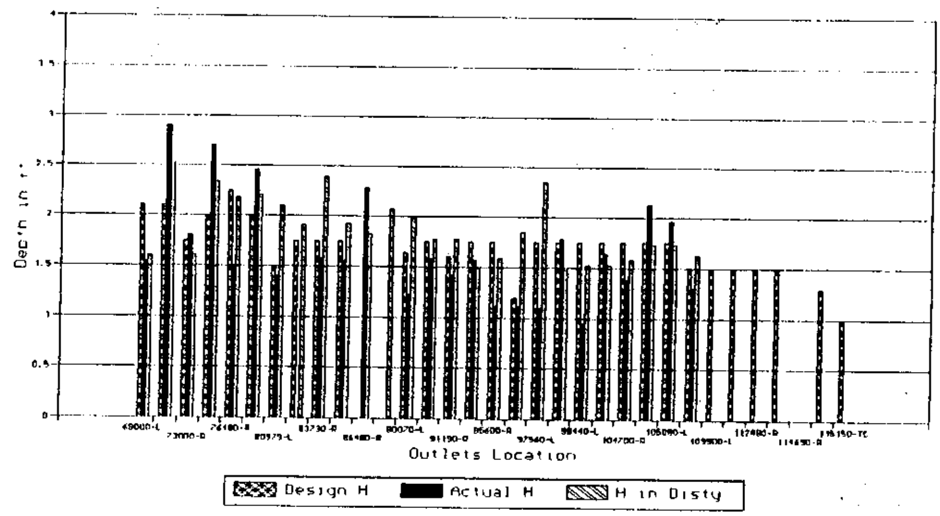

Fig: 3.3.8. Comparison between water levels at outlets (observed versus records) versus water level in the distributary, RD 64 to tail.

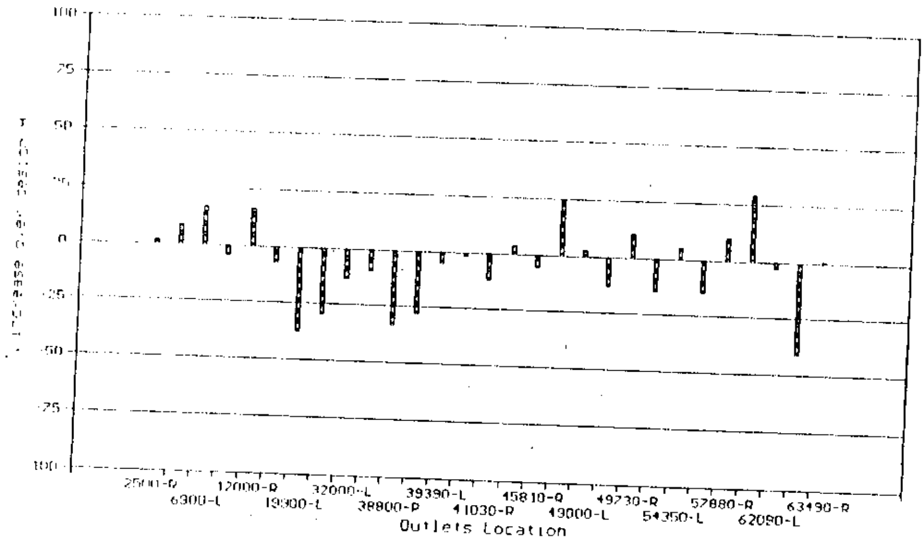

Fig: 3.3.9. Percentage change in actual upstream water levels of outlets with reference to the design water levels for Daulat Distributary, RD 2 to 64.

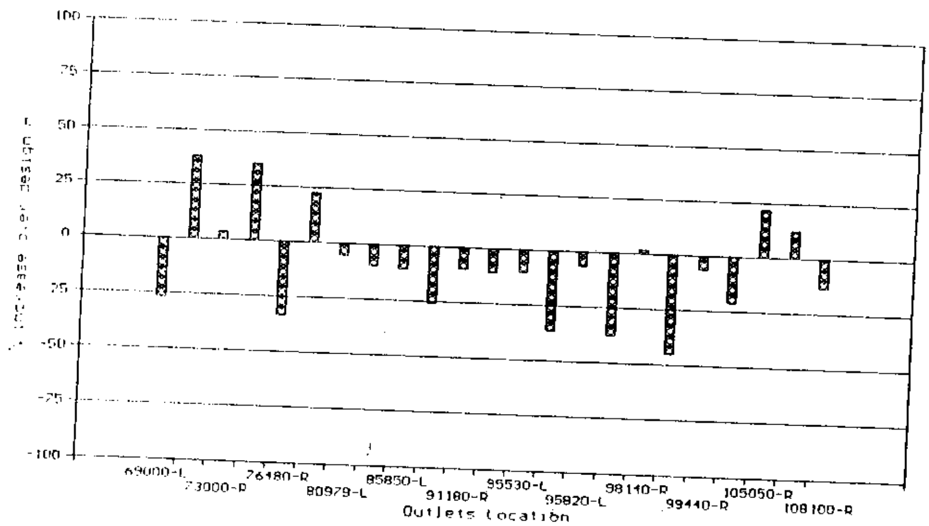

Fig: 3.3.10. Percentage change in actual upstream water levels of outlets with reference to the design water levels for Daulat Distributary, RD 64 to tail.

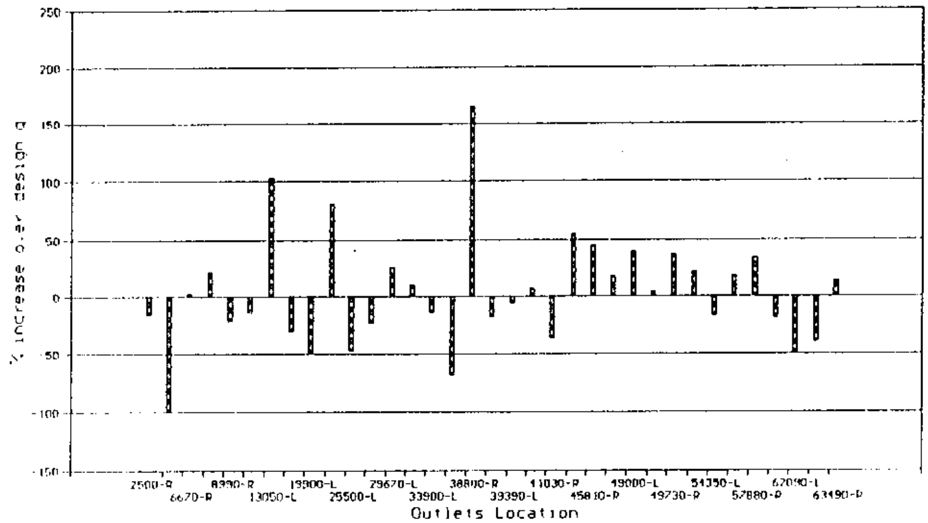

Figure 3.3.11. Percentage change in actual discharge of outlets with reference to the authorized discharge for Daulat Distributary, RD 2 to 64.

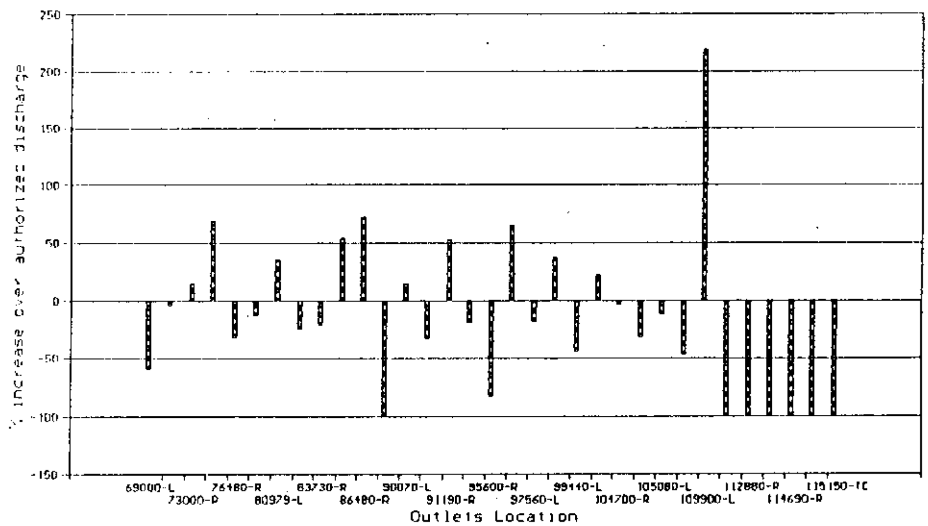

Figure 3.3.12. Percentage change in actual discharge of outlets with reference to the authorized discharge for Daulat Distributary, RD 64 to tail.

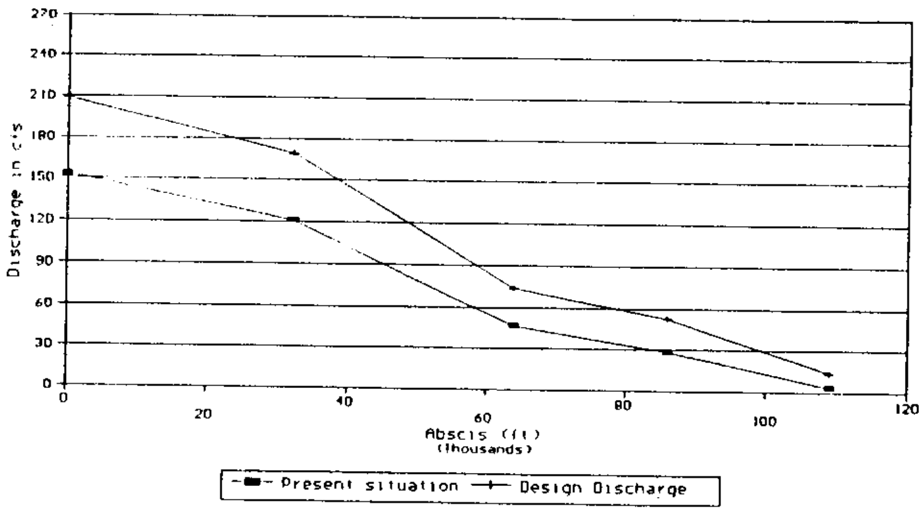

Figure 3.3.13. Comparison between discharges in Daulat Distributary, observed versus record.

3.4 Phogan Distributary

General

The inflow-outflow exercise was carried out on 11-06-1995 from 6.00 a.m. to 6.00 p.m. It was a warm day with temperatures ranging from 40° to 46° C. The discharge at the head was 28.50 cusecs, which is higher than its design discharge of 17.50 cusecs. Usually, this distributary runs at a discharge much higher than its design discharge. During the experiment, a cut was also running at RD-300 (right side) with 1.45 cusec discharge, which was made by an influential farmer. This distributary is constructed partially in cut/fill from head to tail.

Characteristics of outlets

Prior to the exercise, the characteristics of the outlets were determined at site. The measured values of "B" and "Y" of the outlets of Phogan are given in Annex 1. In most cases the dimensions, observed in the field differ substantially from the original data (Figures 3.4.1 and 3.4.2). The elevations of the white marks, which were used during the exercise to determine h_u and h_d, for all outlets are given in Annex 2.

Calibration of canal structures and outlets

During the day of the inflow-outflow exercise the head structure and the outlets of Phogan Distributary were calibrated, thereby determining the C_d values. Four outlets of Phogan Distributary were not calibrated. At the Outlet 7840-R, water was over-topping. Outlet 8750-TL was closed this day, while Outlets 8750-TR and 8750-TF were under water due to the high discharge. The C_d of the head structure (open flume) of Phogan (FF) was determined at a value of 0.33. The C_d OFRB outlets ranged from 0.49 to 0.61 for OM flow conditions, while for ON flow condition from 0.31 to 0.87. The complete list of C_d values is given in Annex 2. On the day of exercise, two outlets had free flow conditions (OM), while three outlets had submerged flow conditions (ON), and two outlets with flow condition FF, and one with flow condition FS.

Water Distribution

The discharge at the head of the Phogan Distributary was constant during the exercise (Figure 3.4.3). Similarly, the depth of water at the outflow point was constant (Figure 3.4.4).

In Annex 3, the observed water levels and corresponding discharges for the outlets of Phogan Distributary are presented. The observed water levels are in almost all cases higher than the original target or design water levels, which results in higher discharges for most outlets. One of the reasons for these high water levels is the fact

that the bed level of the distributary is higher than the design level. This is depicted in Figure 3.4.5, which shows that on average the bed level of the distributary is higher than the crest level of the off-taking outlets. However, the main reason for the higher water levels seems to be the fact that this distributary is taking a discharge more than 60% higher than design at the head.

The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.4.6 and Figure 3.4.7. The discharge of the first outlet in Phogan Distributary is below target due to the fact that this outlet has a submerged flow condition caused by high water levels downstream, where the watercourse is choked with silt. An overall picture of the water flow in the distributary is presented in Figure 3.4.8.

Inflow-Outflow

Seepage losses were determined for different reaches of the distributary. The results are presented in Table 3.4.1. The seepage that was determined in the field (around 8 cusecs per msf), conforms with the general expectations of the Irrigation Department.

Table 3.4.1. Seepage from Phogan Distributary reach wise.

Reach (RD) (ft)	No. of Outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage cfs/msf
0 to 5900	5 + 1(cut)	9.85	28.50	18.04	0.61	0.068	8.97
5900 to 8750	1	4.52	18.04	13.35	0.17	0.022	7.62

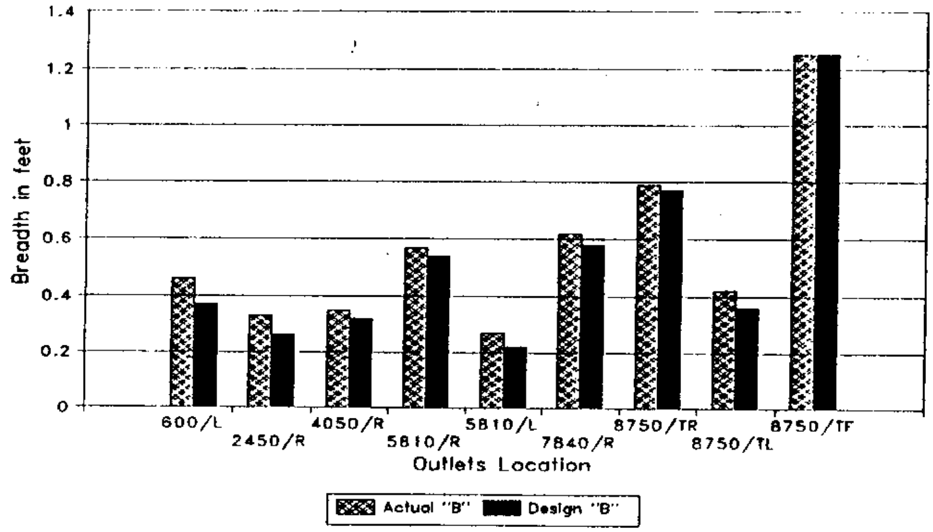

Fig: 3.4.1. Comparison of breadth "B" of outlets in Phogan Distributary, observed versus records.

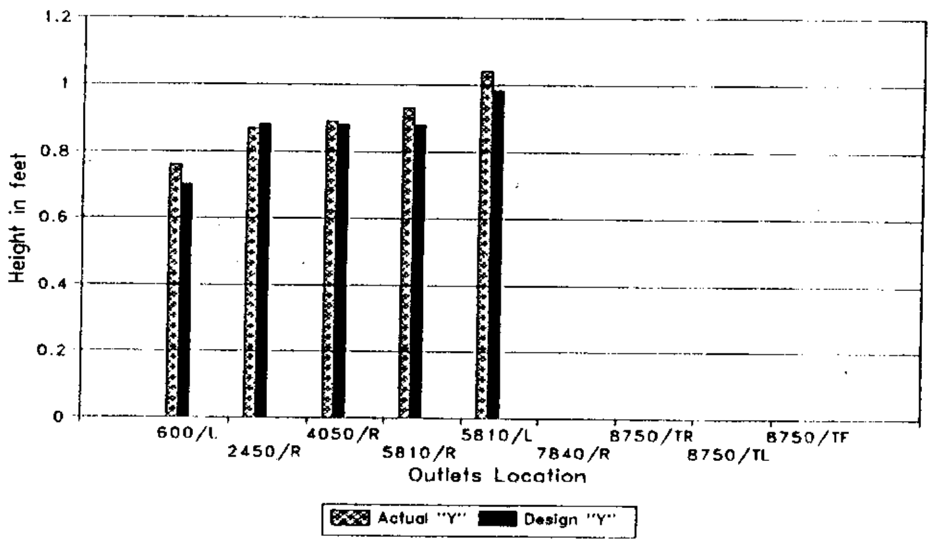

Fig: 3.4.2. Comparison of height "Y" of outlets in Phogan Distributary, observed versus records.

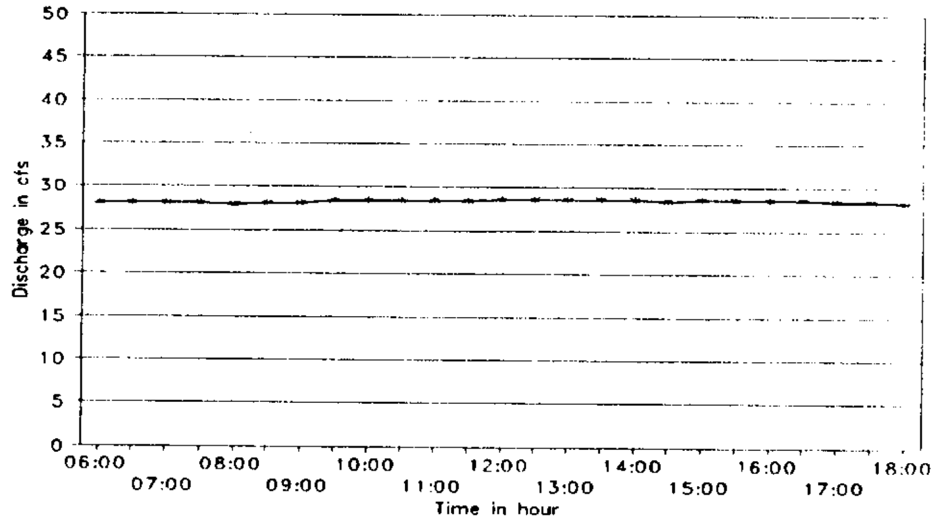

Fig: 3.4.3. Discharge at the head of the Phogan Distributary during the inflow-outflow exercise.

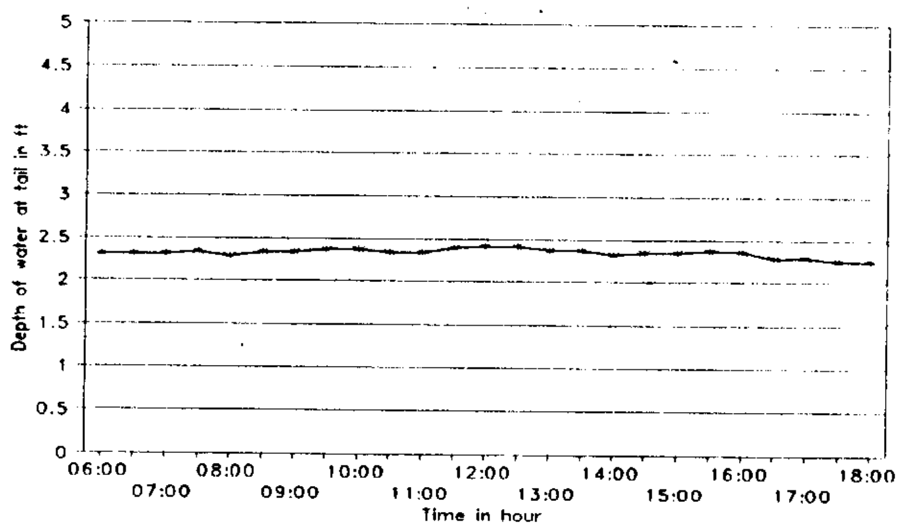

Fig: 3.4.4. Depth of water at the tail of the Phogan Distributary during the inflow-outflow exercise.

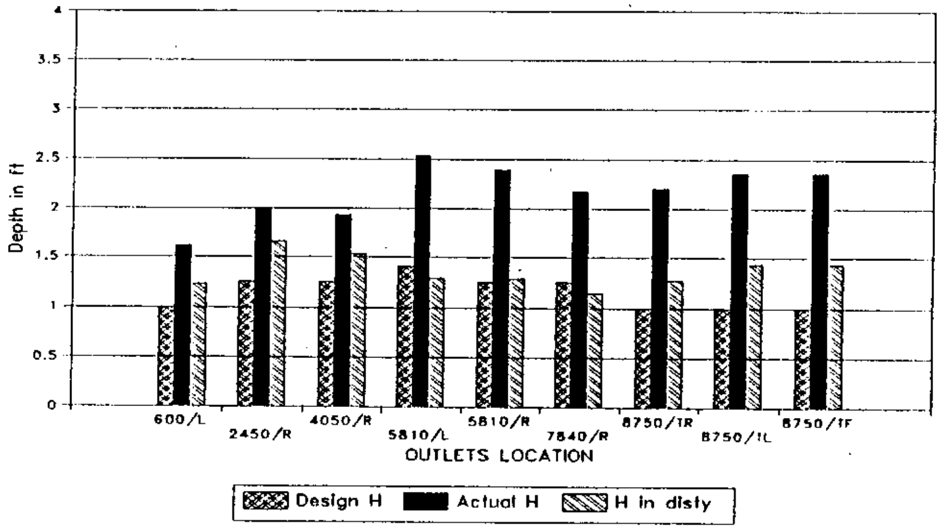

Fig: 3.4.5. Comparison between water levels at outlets (observed versus records) versus water level in the Phogan Distributary.

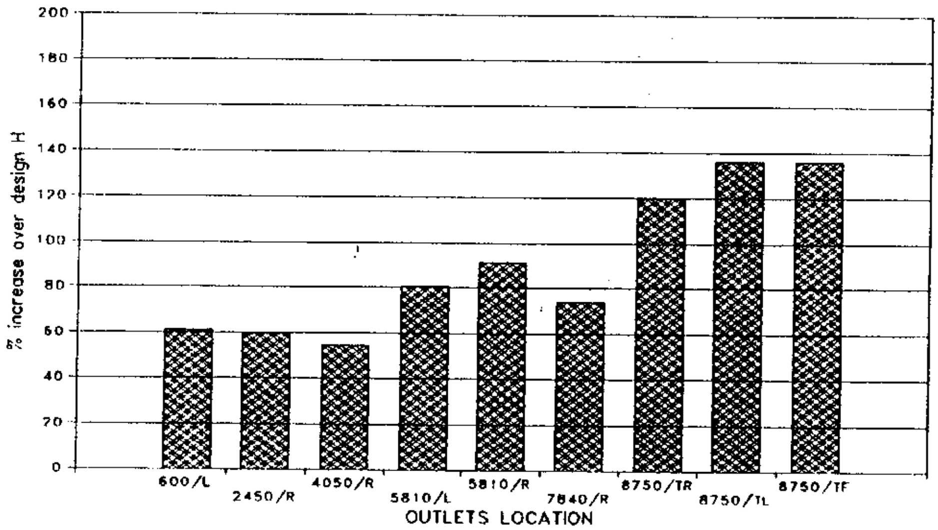

Fig: 3.4.6. Percentage change in actual upstream water levels for outlets with reference to the design water level in Phogan distributary..

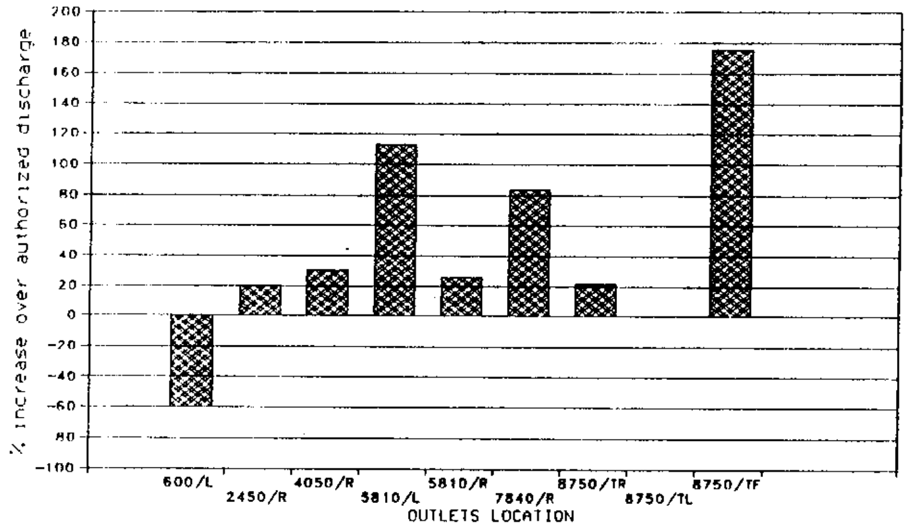

Fig: 3.4.7. Percentage change of actual discharges for outlets with reference to the authorized discharge in Phogan Distributary.

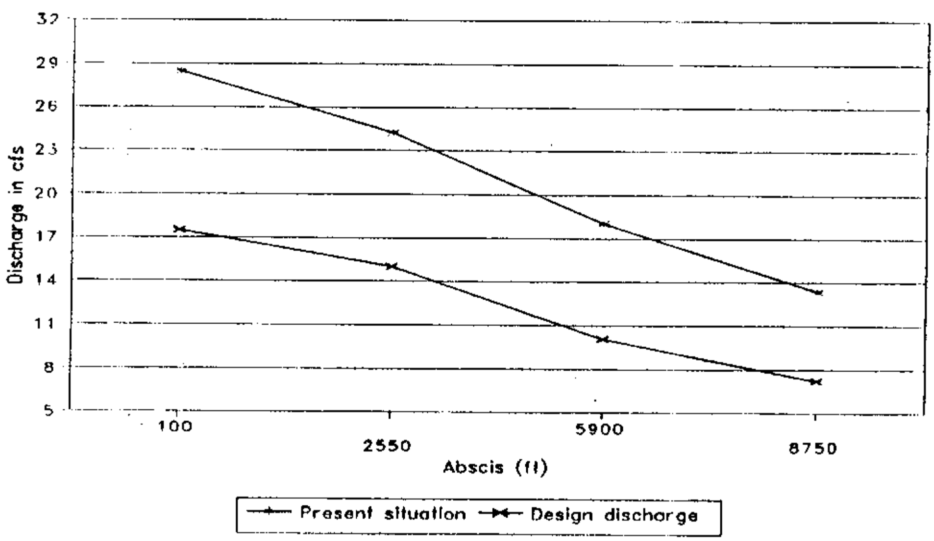

Fig:3.4.8. Comparison between discharge at outlets, observed versus design, in Phogan Distributary.

3.5 4-L Distributary

General

The inflow-outflow exercise was carried out on 14-06-1995 from 6.00 a.m. to 6.00 p.m. It was a hot day, with temperatures ranging from 40° to 46° C. The discharge at the head was 16.99 cusecs, which is higher than its design discharge of 14.00 cusecs. Usually, this distributary runs at a discharge higher than its design discharge.

Characteristics of outlets

Prior to the exercise, the characteristics of outlets were determined at site. The measured values of "B" and "Y" for the outlets of 4-L Distributary are given in Annex 1. The dimensions observed were almost equal to official data (Figures 3.5.1 and 3.5.2). The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

During the day of the exercise, the canal inlet and the outlets of 4-L Distributary were calibrated, thereby determining the C_d of the outlet structures. Also, the C_d of the inlet structure of 4-L, which had been established previously (IIMI, 1995) was verified on the day of the experiment.

The C_d of the head structure of 4-L (FS) was determined at a value of 0.54. The C_d values that were determined are given in Annex 2. One outlet was closed but there was some leakage (0.10 cfs) and the tail outlet had a cut. On the day of the exercise, the majority of the outlets (4) had free flow conditions (OM), while two outlets had submerged flow conditions (ON).

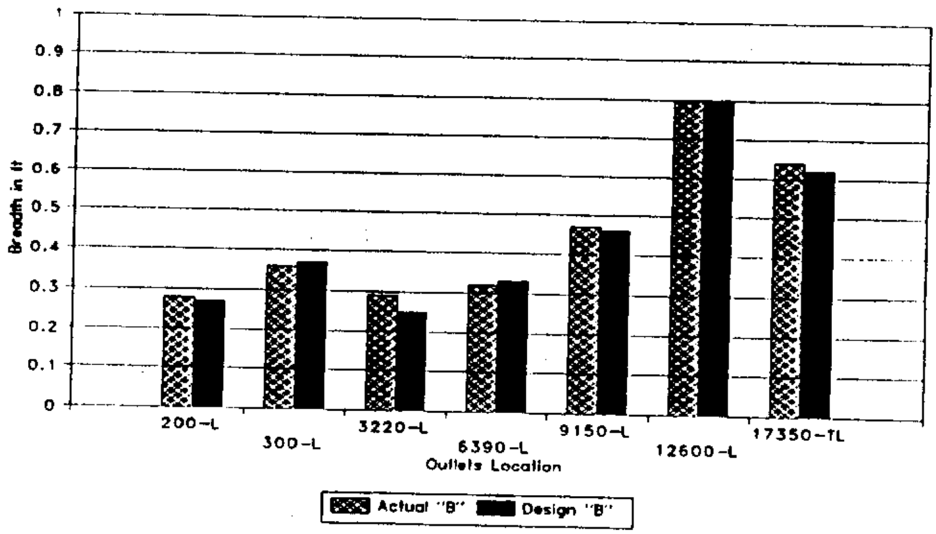

Figure 3.5.1. Comparison of breadth "B" of outlets in 4-L Distributary, observed versus records.

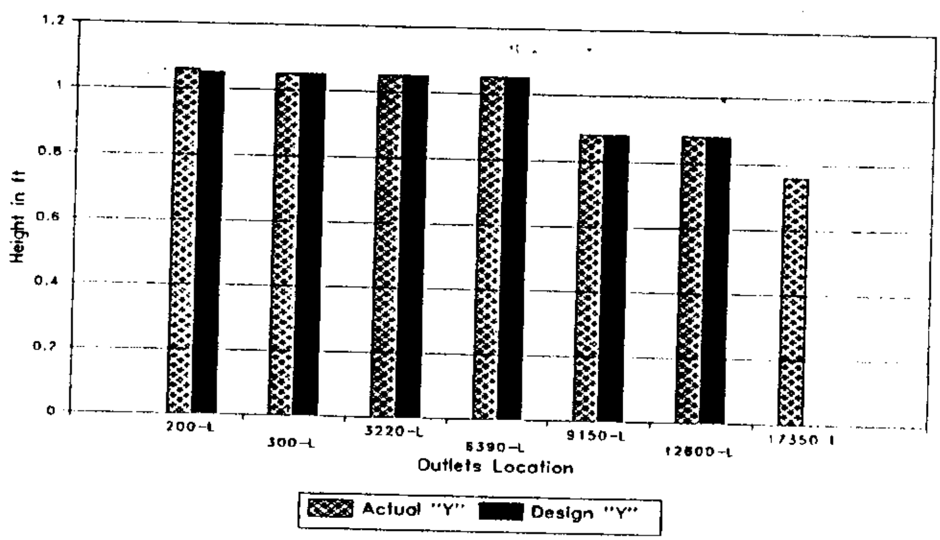

Figure 3.5.2. Comparison of height "Y" of outlets in 4-L Distributary, observed versus records.

Water distribution

The discharge at the head of 4-L Distributary was constant during the inflow-outflow exercise (Figure 3.5.3). Similarly, the discharge at the outflow point was constant after 10:00 am (Figure 3.5.4). In Annex 3, the observed water levels and corresponding discharges during the experiments on the outlets of 4-L are presented. The observed water levels are in almost all cases higher than the original target or design water levels, which results in higher discharges for most outlets. One of the reasons for these high water levels is the fact that the bed level of the distributary at the head has considerable sediment deposition. However, as depicted in Figure 3.5.5, on average the bed level of the distributary is lower than the crest level of the off-taking outlets. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.5.6 and Figure 3.5.7. An overall picture of the water flow in the distributary is presented in Figure 3.5.8.

Inflow-outflow

Seepage losses were determined for different reaches of the distributary. The results are presented in Table 3.5.1. Clearly the seepage losses are very low and in two reaches even negative (the reach is gaining water), which can be attributed to the fact that the distributary runs very close to the Fordwah Branch Canal.

Table 3.5.1. Seepage losses for 4-L Distributary.

Reach (RD)	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	See-page cfs/msf
0-3200	2	5.51	16.99	11.69	-0.21	0.035	-5.98
3200-9120	2	1.93+0.20 *	11.69	9.56	0.00	0.053	0.00
9120-17350 T	2	6.57	9.56	3.04	-0.05	0.0495	-1.01

* 0.10 cfs leakage of O/L 3220/L and 0.10 cfs leakage by holes.

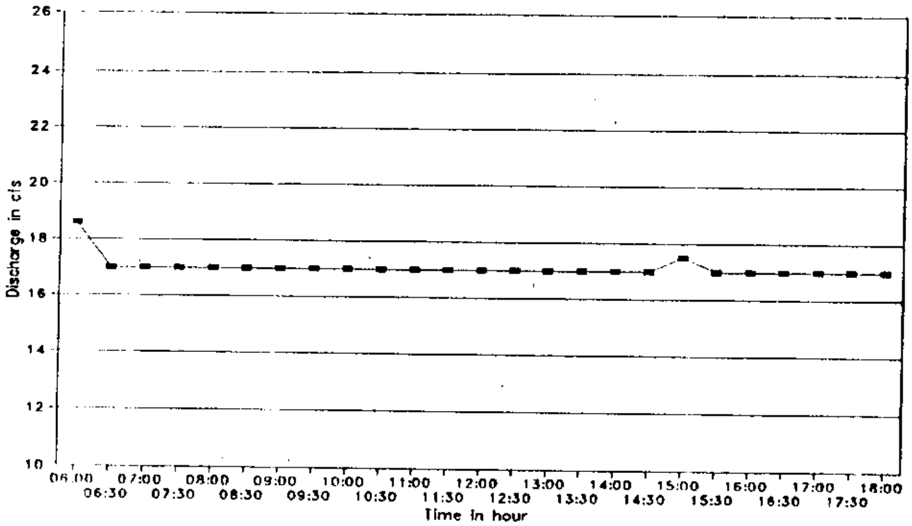

Fig: 3.5.3. Depth of water at the head of the 4-L Distributary during the inflow-outflow exercise.

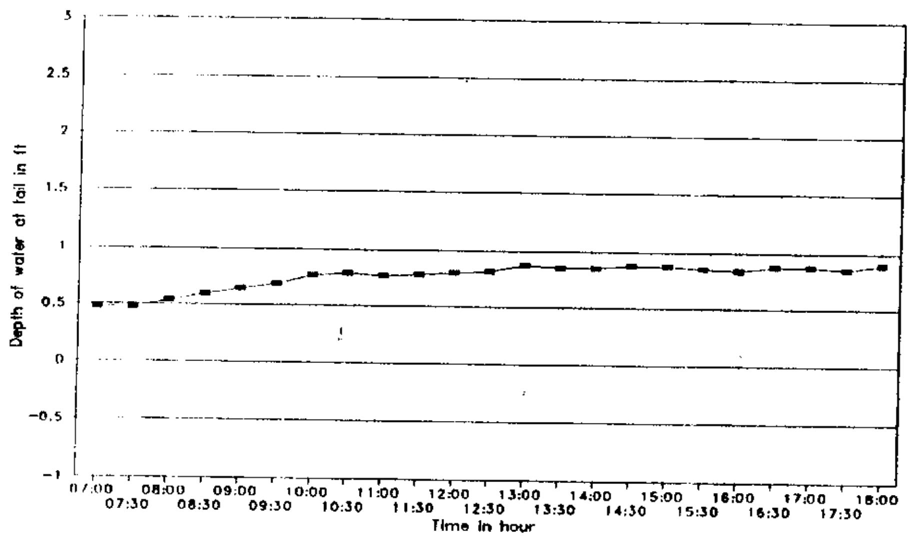

Fig: 3.5.4. Discharge at the tail of 4-L Distributary during inflow-outflow the exercise.

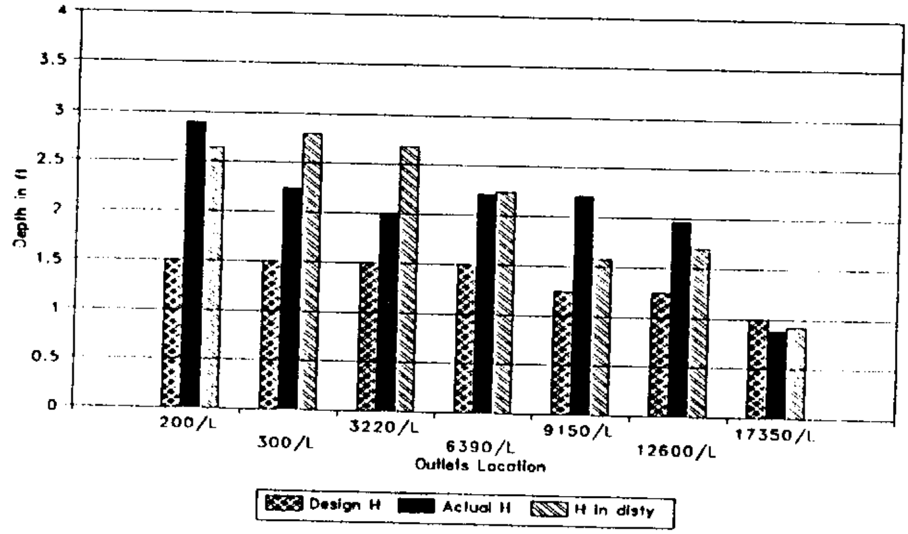

Fig: 3.5.5. Comparison between water levels at outlets (observed versus records) versus water level in the 4-L Distributary.

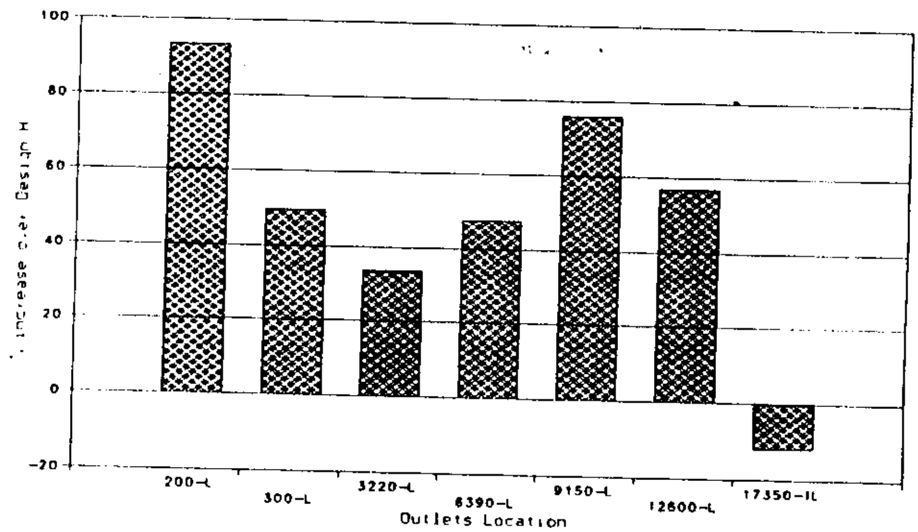

Fig: 3.5.6. Percentage change in actual upstream water level for outlets with reference to the design water levels in 4-L Distributary.

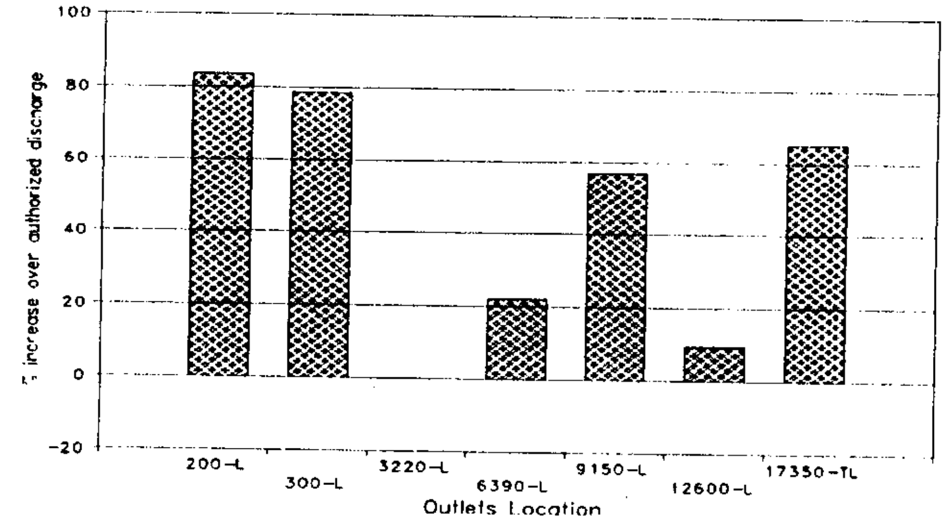

Fig: 3.5.7. Percentage change of actual discharges for outlets with reference to the authorized design in 4-L Distributary.

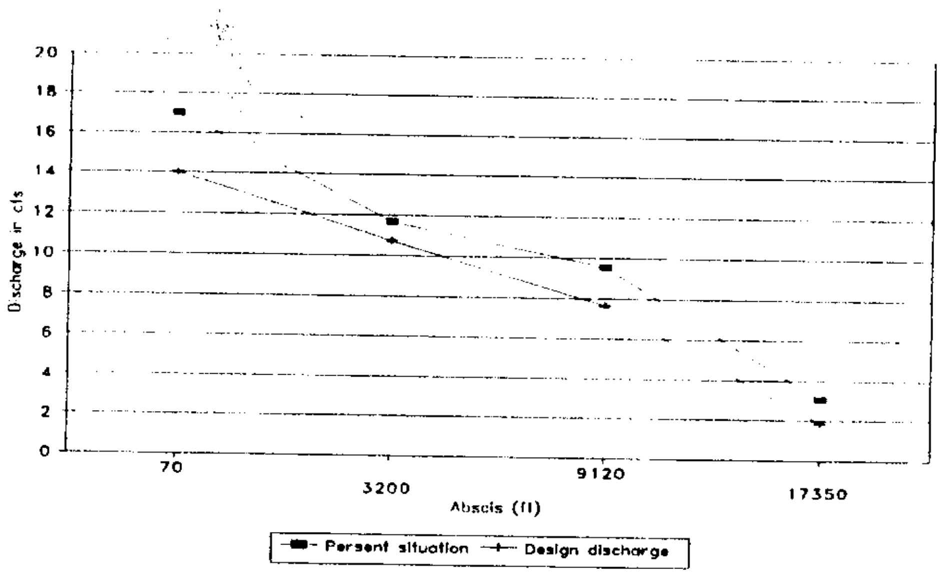

Fig: 3.5.8. Comparison between discharge at outlets, observed versus design, in 4-L Distributary.

3.6 Khemgarh Distributary

General

The inflow-outflow exercise was conducted on 24-09-1995 from 6.00 a.m. to 6.00 p.m. It was a warm, sweating day, with temperatures ranging from 35° to 42° C. The discharge at the head was 42.70 cusecs, which is higher than its design discharge of 24.00 cusecs. Usually, this distributary runs at a discharge higher than its design discharge.

Characteristics of outlets

Prior to the exercise, the characteristics of the outlets were determined at site. The measured values of "B" and "Y" for the outlets of Khemgarh are given in Annex 1. Only in a few cases outlets dimensions that were observed in the field differ substantially from the original design data (Figures 3.6.1 and 3.6.2). This is the case for Outlets 200-R and 1130-R. The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

During the day of the exercise, the outlets of Khemgarh Distributary were calibrated, thereby determining the C_d of these structures. Also, the C_d of the inlet structure of Khemgarh, which had been established previously (IIMI, 1995) was verified on the day of the experiment.

The C_d of the head (gated orifice) structure of Khemgarh (ON) was determined at a value of 1.63. The complete list of C_d values is given in Annex 2.

This distributary has 9 outlets in which eight are OFRB, and one open flume (OF). Two outlets were broken (3850/R , 8730/R) and two cuts (at RD 3650/R , 4900/R) were observed in this distributary during the inflow-outflow exercise (Annex 1).

At the left bank, the contractors had damaged the banks and there were many pits, especially from RD-0 to RD-9000. After the experiment, the contractors have further damaged the left bank from RD-0 to RD-13000 and also damaged the bed of the distributary.

On the day of the exercise, the majority of the outlets (8) had free flow conditions (OM), while one outlet had a submerged flow condition (FS).

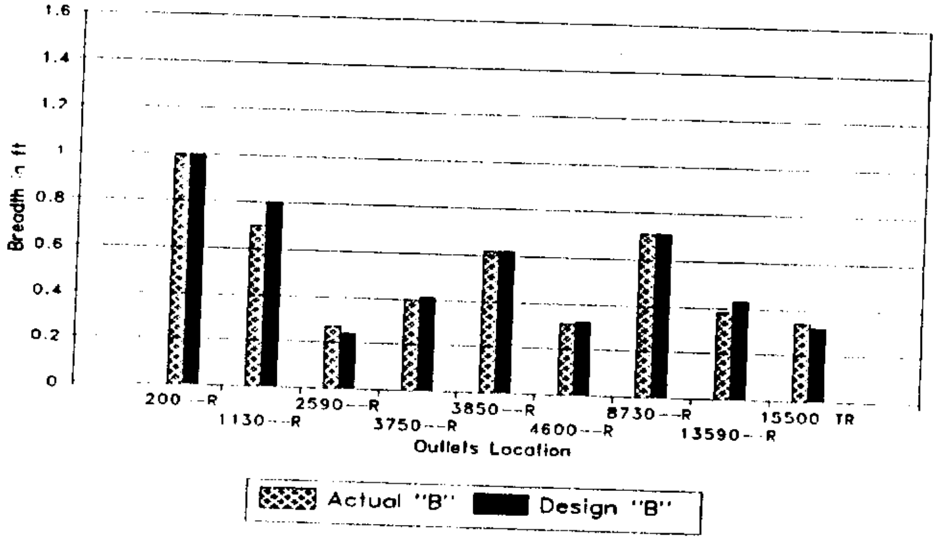

Fig: 3.6.1. Comparison of breadth "B" of outlets in Khemgarh Distributary, observed versus records.

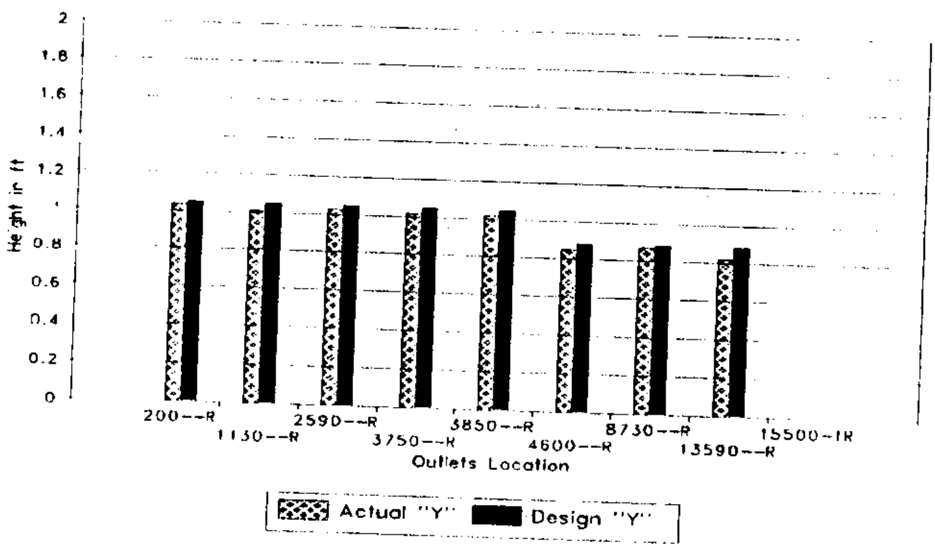

Fig: 3.6.2. Comparison of height "Y" of outlets in Khemgarh Distributary, observed versus records.

Water distribution

The discharge at the head of Khemgarh Distributary was almost constant during the exercise, except from 10:30 am to 12:00 am, when the discharge increased by about 5 to 6 cusecs (Figure 3.6.3). Similarly, the discharge at the outflow point was constant (Figure 3.6.4).

In Annex 3, the observed water levels and corresponding discharges for the outlets of Khemgarh are presented. The observed water levels are in almost all cases higher than the original target or design water level, which results in higher discharges for most outlets. One of the reasons for these high water levels is the fact that the bed level of the distributary is much higher than the design level. This is depicted in Figure 3.6.5, which shows that on average the bed level of the distributary is higher than the crest level of the off-taking outlets. Originally, these outlets were placed slightly above the bed level (at around 0.1 of the water depth) of the distributary. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.6.6 and Figure 3.6.7. The main reason for an increased water level and discharges of the outlets, however, seems to be the excessive discharge at the head. An overall picture of the water flow in the distributary is presented in Figure 3.6.8.

Inflow-outflow

Seepage losses were determined for different reaches of the distributary. The results are presented in Table 3.6.1. In the first reach, the seepage was high (55.9 cfs/msf) because there were many pits along the distributary. The other two reaches have a more normal seepage rate.

Table 3.6.1. Seepage losses for Khemgarh Distributary.

Reach (RD)	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage cfs/msf
0-2700	3	14.13	42.7	26.23	2.34	0.04188	55.87
2700-4700	3 + cut	14.9	26.23	11.02	0.31	0.02104	14.73
4700-15500	2 + cut	7.67	11.02	2.99	0.36	0.08035	4.48

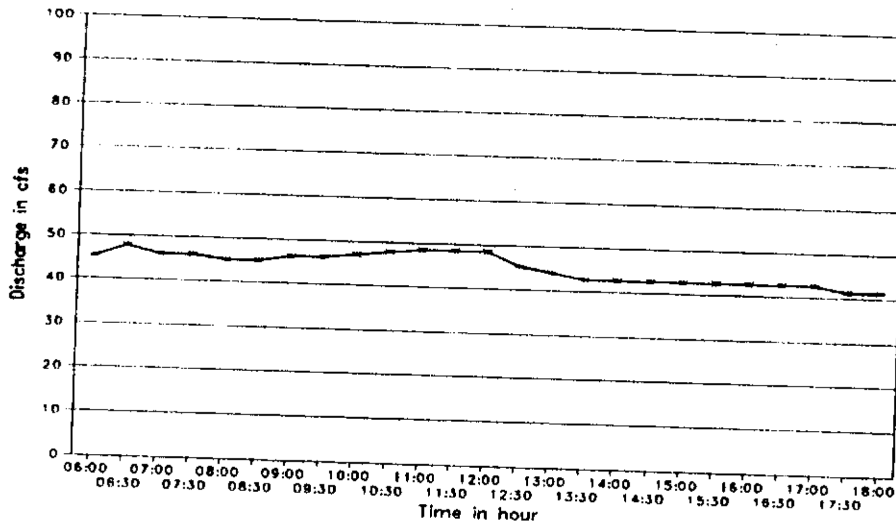

Fig: 3.6.3. Discharge at the head of the Khemgarh Distributary during the inflow-outflow exercise.

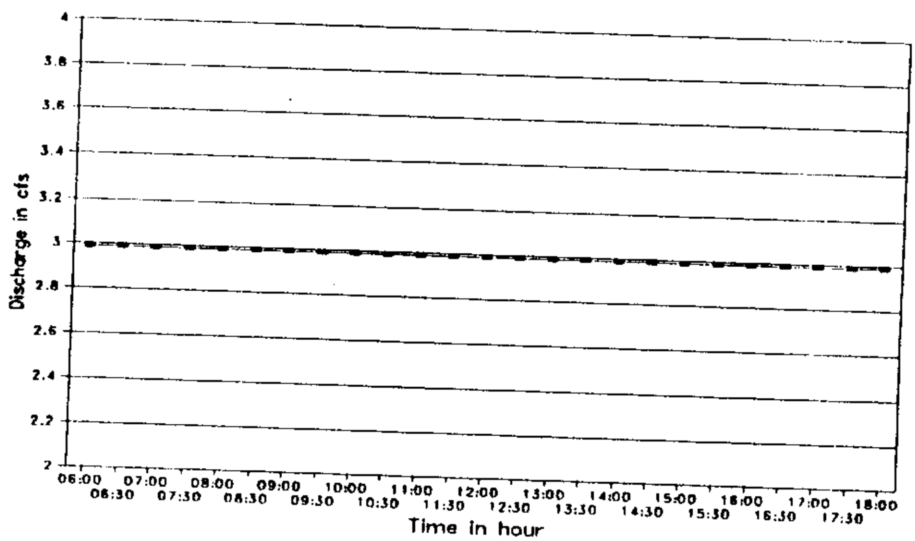

Fig: 3.6.4. Discharge at the tail of Khemgarh Distributary during the inflow-outflow exercise.

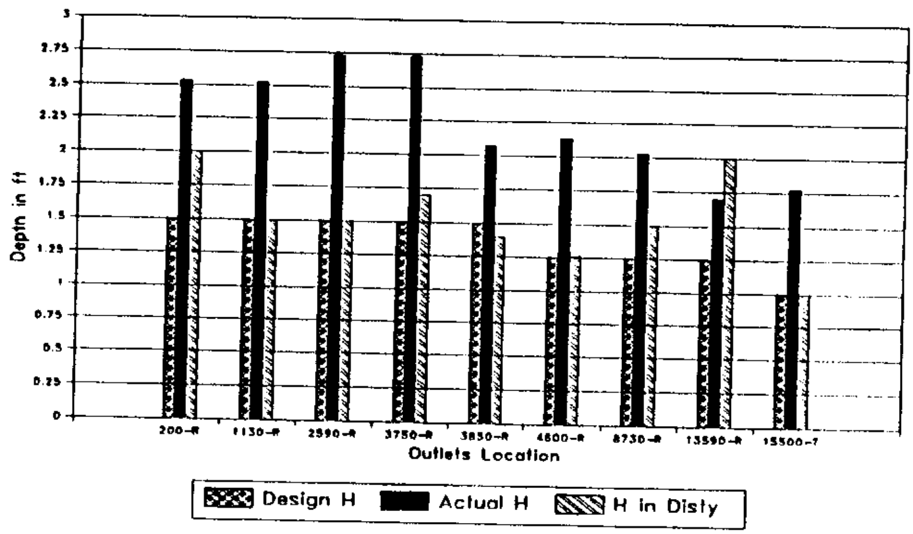

Fig: 3.6.5. Comparison between water levels at outlets (observed versus records) versus water level in the Khemgarh Distributary.

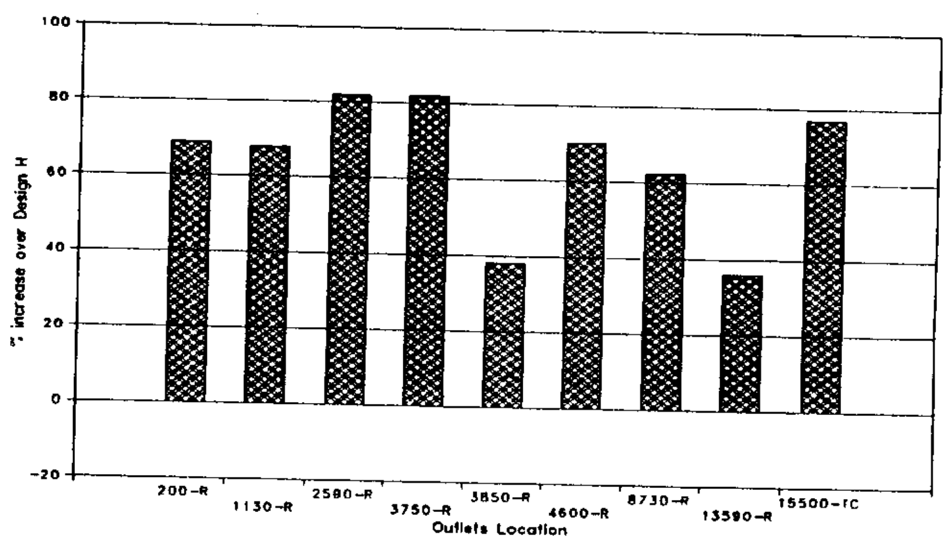

Fig: 3.6.6. Percentage change in actual upstream water level for outlets with reference to the design water levels in Khemgarh Distributary.

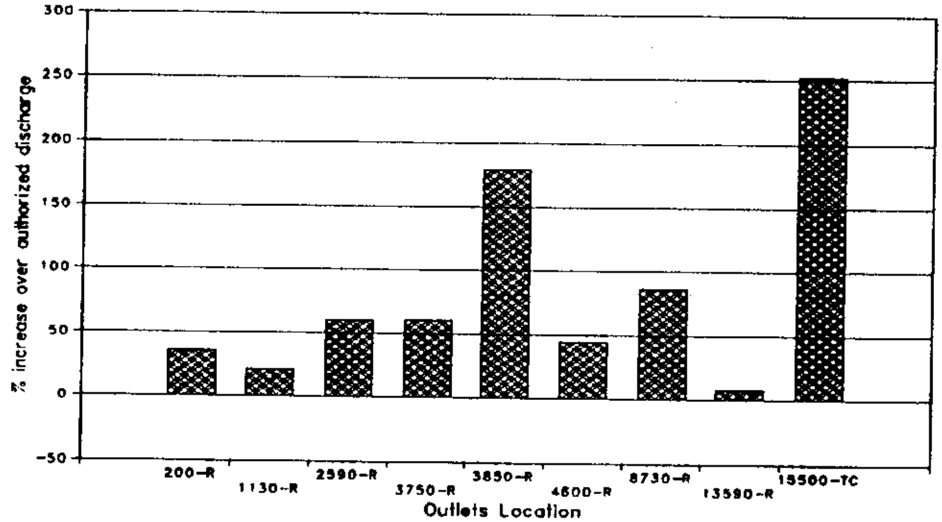

Fig: 3.6.7. Percentage change in actual discharge for outlets with reference to the authorized discharge in Khemgarh Distributary.

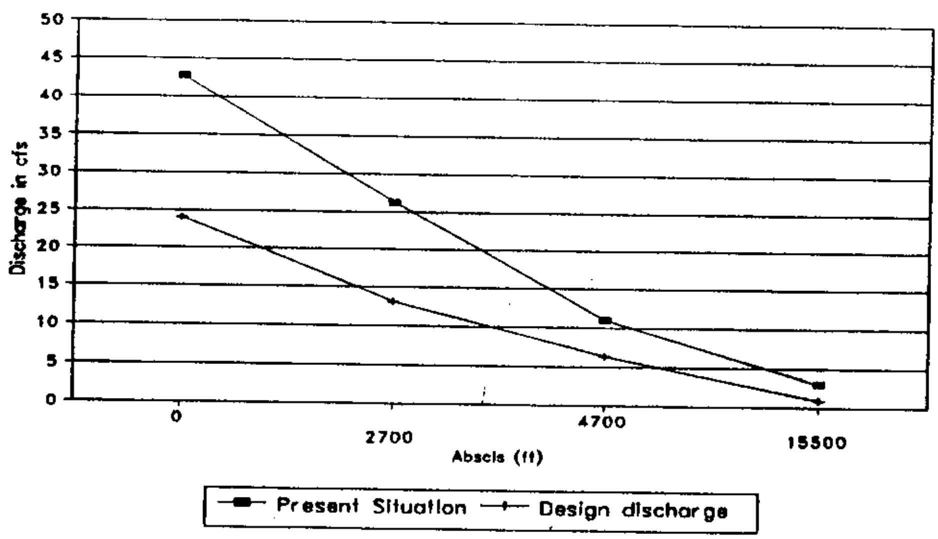

Fig: 3.6.8. Comparison between discharge at outlets, observed versus design, in Khemgarh Distributary.

3.7 Jagir Distributary

General

The inflow-outflow exercise was carried out on 03-03-1996 from 11.00 a.m. to 6.30 p.m. It was a pleasant sunny day with temperatures ranging from 18° to 26° C. The discharge at the head regulator was 26.53 cusecs, which is lower than the design discharge of 28 cusecs. Actually, this distributary runs more than its design discharge during Kharif season due to high water level, in the Fordwah Branch Canal, but in Rabi season, it runs less than design discharge due to lower water level in the branch canal.

The banks conditions were comparatively good from RD-0 to RD-3900, but from RD-3900 to RD-9100, the left bank and bed of the distributary was damaged by a contractor during the closure period of January, 1996. There were many pits on the left side of the distributary.

This distributary is partially in cut/fill except from RD-3900 to RD-9100, which is in cutting. This distributary runs parallel to the Fordwah Branch Canal from head to tail.

Characteristics of outlets

Prior to the exercise, the characteristics of outlets were determined at site. The measured values of "D" (diameter) for the pipe outlets of Jagir Distributary are given in Annex 1. Only in a few cases do the dimensions that were observed in the field differ substantially from the original design data (Figure 3.7.1), which is the case for Outlets 990-R, 1000-R and 13830-TR.

Calibration of canal structures and outlets

During the day of the inflow-outflow exercise, the head structure and the outlets of Jagir Distributary were calibrated, except the outlets at RD-200-R, 990-R, and 1000-R, which were calibrated one day before the exercise. Thus, the C_d was determined for these outletst, as well as for the inlet structure of Jagir, which had been established previously (IIMI, 1995).

The C_d of the head structure[3] (gated orifice) of Jagir Distributary (ON) was determined at a value of 1.46. The complete list of C_d values is given in Annex 2.

On the day of the exercise, three outlets had orifice free flow condition (OM), five outlets had orifice non modular flow conditions (ON), while the tail outlet had free flow condition FF.

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[3] *The gate is in very bad shape with large holes due to rusting.*

Water Distribution

The discharge at the head of the Jagir Distributary was almost constant during the exercise (Figure 3.7.2). Similarly, the discharge at the outflow point was constant except in the beginning of the exercise (Figure 3.7.3).

In Annex 3, the observed water levels and corresponding discharges for the outlets of Jagir Distributary are presented. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figures 3.7.4 and 3.7.5. The discharge of Outlets 7210-R, 9090-R, 11880-R and 13830-R in Jagir Distributary are below target due to a damaged bed from RD-4000 to RD-9500 and because outlets upstream are overdrawing. An overall picture of the water flow in the distributary is presented in Figure 3.7.6.

Inflow-Outflow

Seepage losses were determined for different reaches of Jagir Distributary. The results are presented in Table 3.7.1. The seepage from this distributary is very low, except in the last reach.In the first reach, the seepage was even negative; in other words, reach is intercepting seepage from Fordwah Branch Canal.

Table 3.7.1. Seepage from Jagir Distributary reach wise.

Reach (RD) (ft)	No. of outlets	Discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	See-page (cfs)	Wetted area (msf)	See-page cfs/msf
0 to 3500	4	17.04	26.53	9.56	-0.07	0.054	-1.31
3500 to 9500	3	5.81	9.56	3.63	0.12	0.042	2.83
9500 to 13880	1	1.31	3.63	2.14	0.18	0.023	7.92

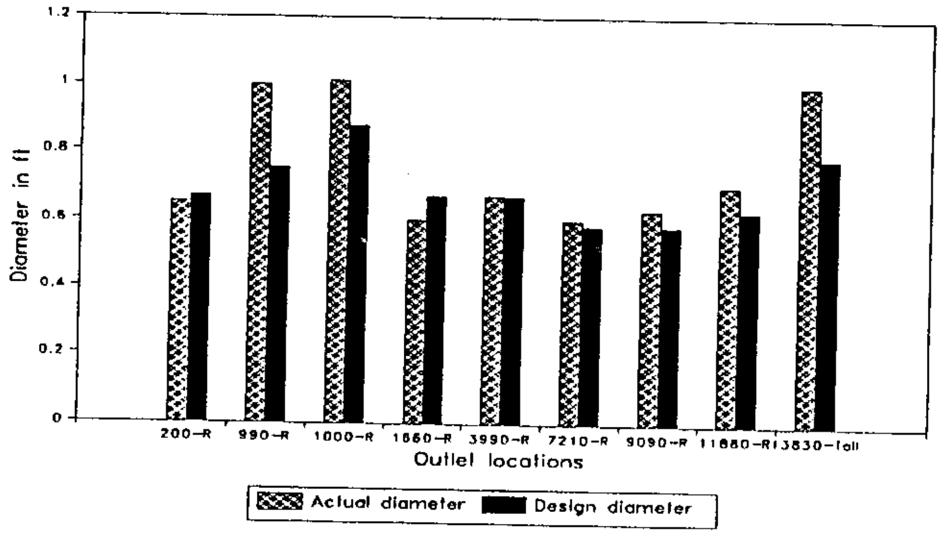

Fig: 3.7.1. Comparison of Diameter "D" of outlets in Jagir Distributary versus records.

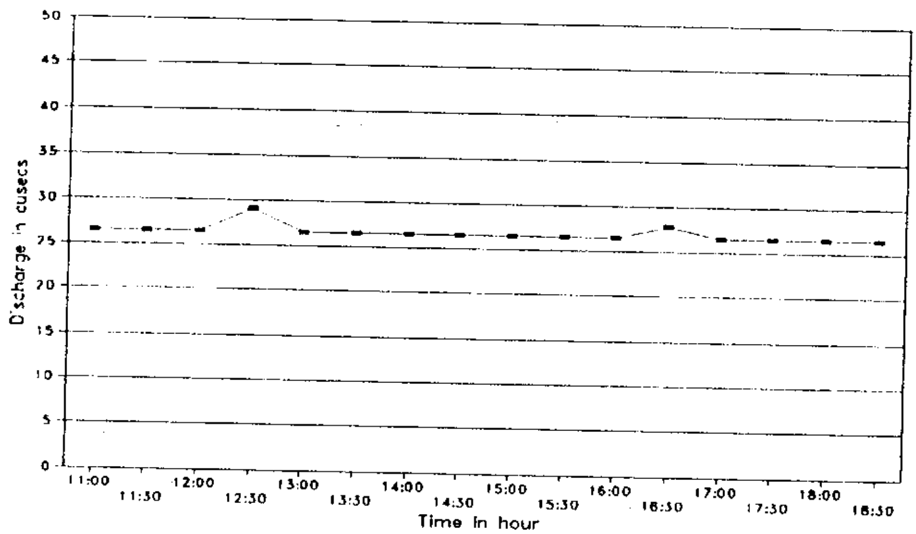

Fig: 3.7.2. Discharge at the head of the Jagir Distributary during the inflow-outflow exercise.

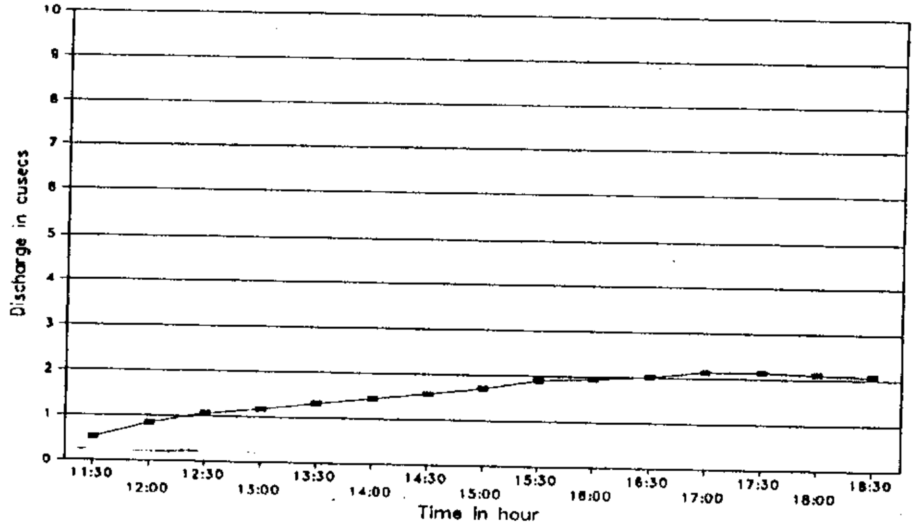

Fig: 3.7.3. Discharge at the tail of the Jagir Distributary during the inflow-outflow exercise.

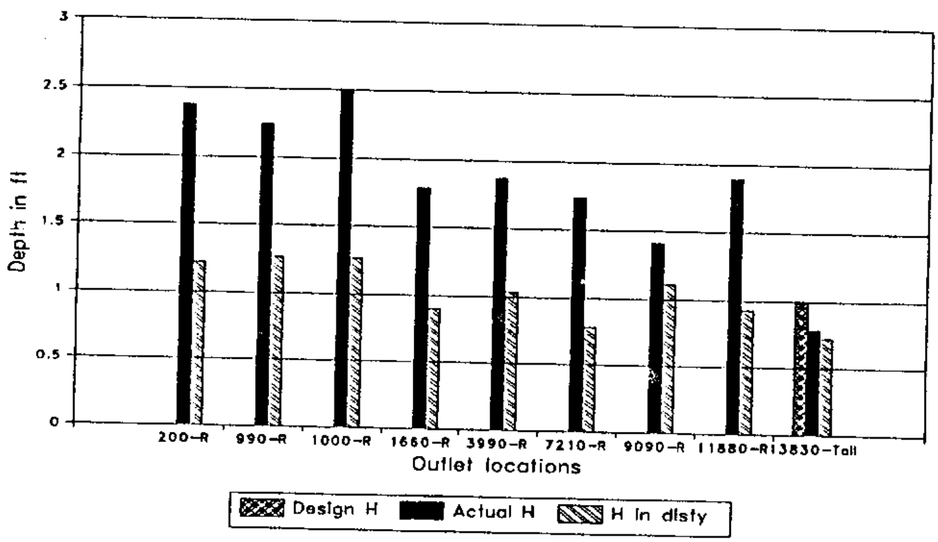

Fig: 3.7.4. Comparison between water levels at outlets (observed versus records) versus water level in the Jagir Distributary.

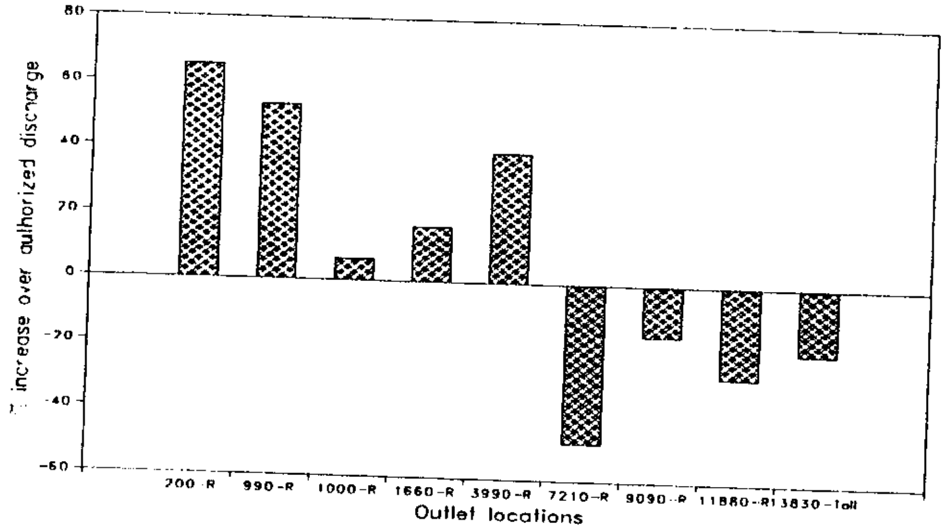

Fig: 3.7.5. Percentage change in actual discharge for outlets with reference to the authorized discharge in Jagir Distributary.

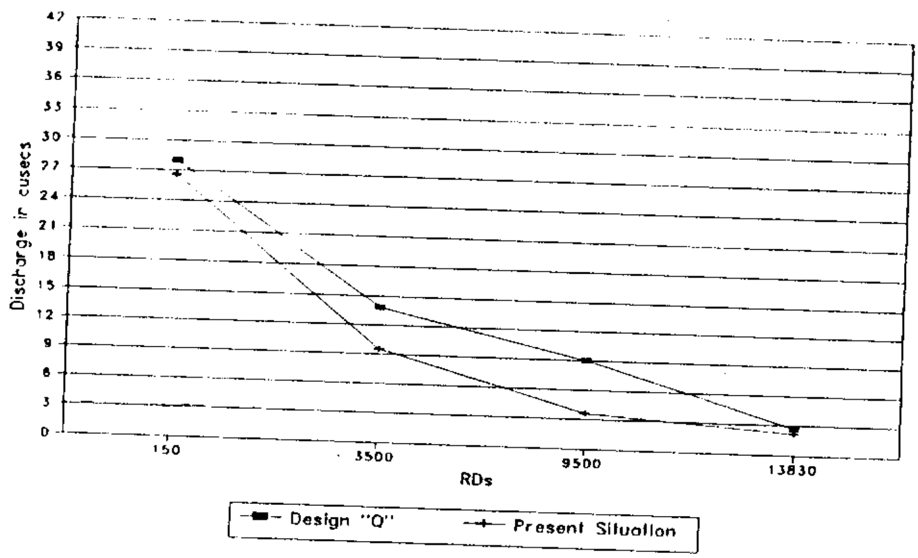

Fig: 3.7.6. Comparison between discharge in Jagir Distributary, observed versus design.

3.8 Shahar Farid Distributary

General

The inflow-outflow exercise was carried out on 10-10-1995 from 2.00 a.m. to 6.00 p.m. It was a sunny day, with temperatures ranging from 35° to 40° C. The discharge at the head was 134 cusecs, which is lower than its design discharge of 153 cusecs. Usually, this distributary runs at a discharge lower than its design discharge. The official tail of the distributary is at RD-74800, but the functional tail of the distributary is at RD-67000 since 15 years. During the experiment, water reached hardly at RD-61637.

Characteristics of outlets

Prior to the exercise, the characteristics of outlets were determined at site. The measured values of "B" and "Y" of the outlets of Shahar Farid Distributary are given in Annex 1. Only in a few cases outlets dimensions that were observed in the field differ substantially from the original design data (Figures 3.8.1 and 3.8.2). This is the case for Outlets 5320-R, 53300-R, 16750-L, 19840-R, 21895-R, 49460-L and 60360-R. The Outlets 16943-R, 18011-L, 20539-L, 22636-L, 23500-R, 24000-L, 32913-L,33075-R, 37000-L, 40900-L,40910-L, 40950-L,46000-R, 46025-R, 59812, 61637-R were broken. The Outlet 49160-R was closed. The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

During the day of the exercise, the canal structures (drops) and the outlets of Shahar Farid Distributary were calibrated, thereby determining the C_d of these structures.

The C_d of the head structure of Shahar Farid (OM) was determined at a value of 1.75. For the diversion structures of Shahar Farid (FS) and Hairwah (FF) at RD-46500, the values of C_d were found to be 1.09 and 0.36, respectively. The C_d values that were determined are listed in Annex 2.

The value for the OCOFRB outlet (OM) was found to be 0.49 and for ON flow condition was 0.95. The C_d for APM outlets ranged from 0.20 to 1.03 for the OM flow condition, while the value ranged from 0.20 to 0.99 for the ON flow condition. The C_d for OF outlets ranged from 0.19 to 0.56. The complete list of C_d values is given in Annex 2. On the day of the exercise, the majority of the outlets (26) had orifice free flow conditions (OM), while eleven outlets had submerged flow conditions (ON). Six outlets had free flow condition (FF) and three had submerged flow (FS). Only nine orifices functioned as a flume.

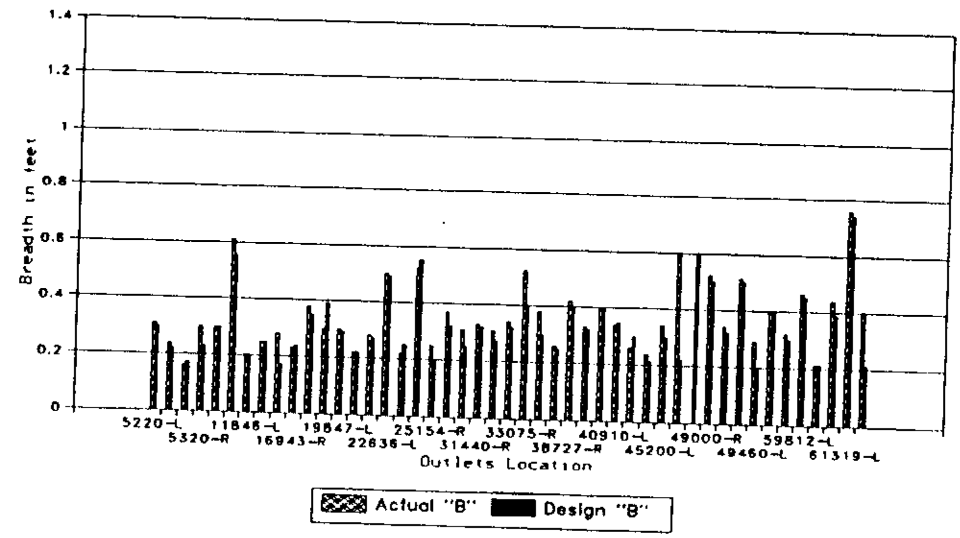

Fig: 3.8.1. Comparison of breadth "B" of outlets in Shahar Farid Distributary, observed versus records.

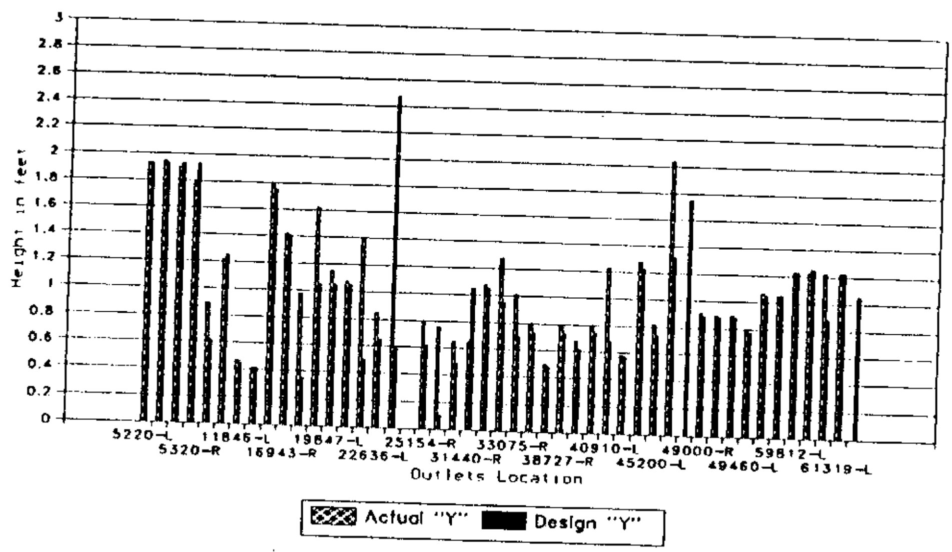

Fig: 3.8.2. Comparison of height "Y" of outlets in Shahar Farid Distributary, observed versus records.

Water distribution

The discharge at the head of Shahar Farid Distributary was constant during the inflow-outflow exercise (Figure 3.8.4). The water did not reach the tail and no tail gauge reading could be taken.

In Annex 3, the observed water levels, and corresponding discharges, for the outlets of Shahar Farid are presented. The observed water levels during the experiment at the head and middle reaches were in almost all cases higher than the target water levels, which results in higher discharges for most outlets. Another reason for high discharge of outlets in the head and middle reaches is that a lot of outlets were tampered. But observed water levels at the tail reach were lower than the original target or design water levels, which results in lower discharges for most outlets. One of the reasons for these high water levels in the upper position of the distributary is the fact that the bed level of the distributary is much higher than the design level. This is depicted in Figure 3.8.3, which shows that on average the bed level of the distributary is higher than the crest level of the off-taking outlets. Originally, these outlets were placed slightly above the bed level (at around 0.1 of the water depth) of the distributary. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.8.5 and Figure 3.8.6. An overall picture of the water flow in the distributary is presented in Figure 3.8.7.

Inflow-outflow

Seepage losses were determined for different reaches of the distributary. The results are presented in Table 3.8.1. Clearly the seepage losses are quite high. The banks of the distributary are in poor condition resulting in some losses.

Table 3.8.1. Seepage losses for Shahar Farid Distributary.

Reach (RD)	No. of outlets	Total discharge of outlet (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage cfs/msf
0-16300	8	21.18	134.3	108.07	5.05	0.551	9.2
16300-22150	8	20.75	108.07	86.91	0.41	0.180	2.3
22150-30700	6	16.42	86.91	66.42	4.07	0.228	17.8
30700-37100	6	20	66.42	45.68	0.74	0.151	4.9
37100-53500	16	38.7	45.68	4.5	2.48	0.222	11.12
53500-61637	5	3.1	4.5	0.1	1.3	0.049	26.6

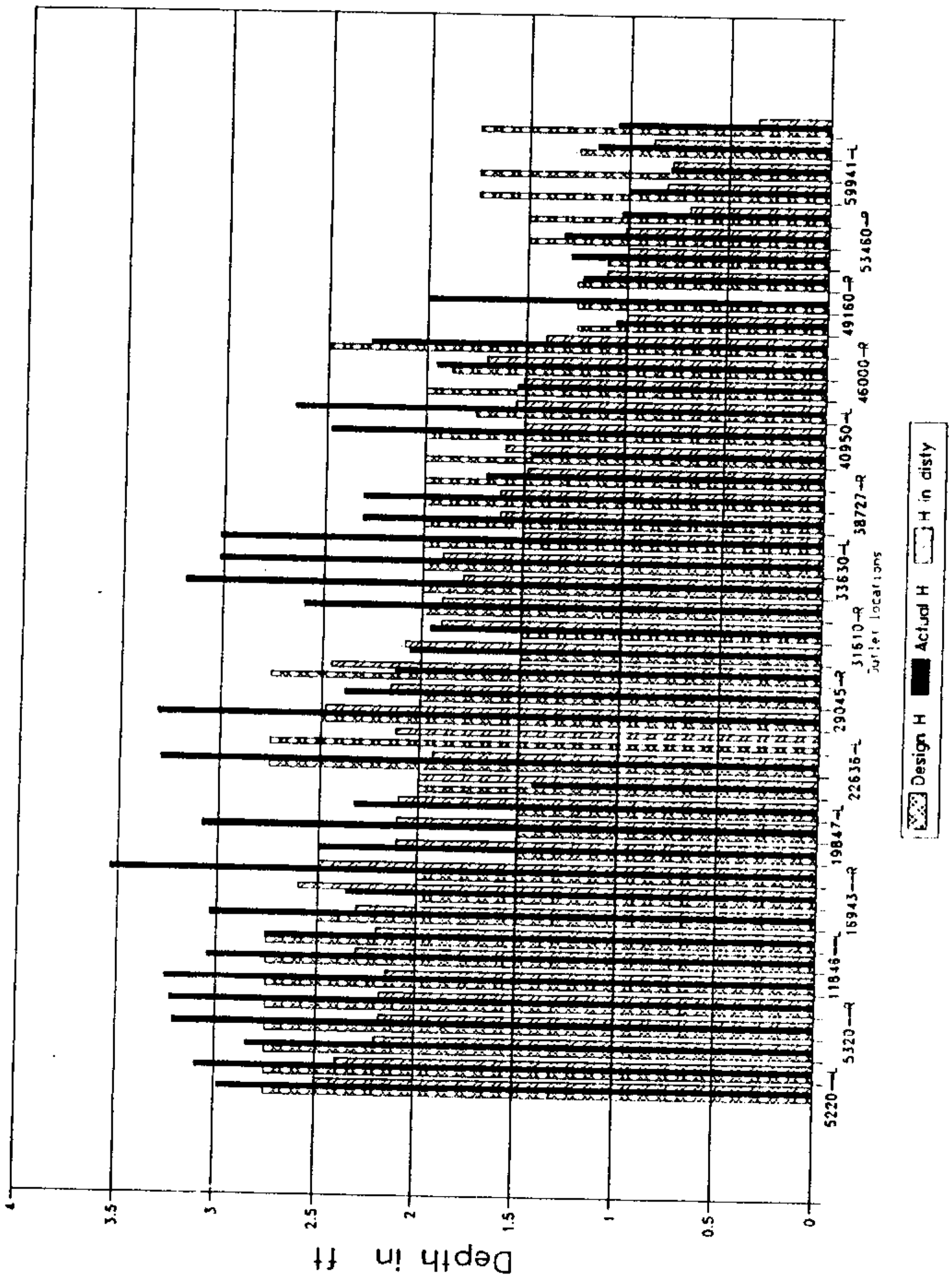

Fig: 3.8.3. Comparison between water levels at outlets (observed versus records) versus water level in the Shahar Farid Distributary.

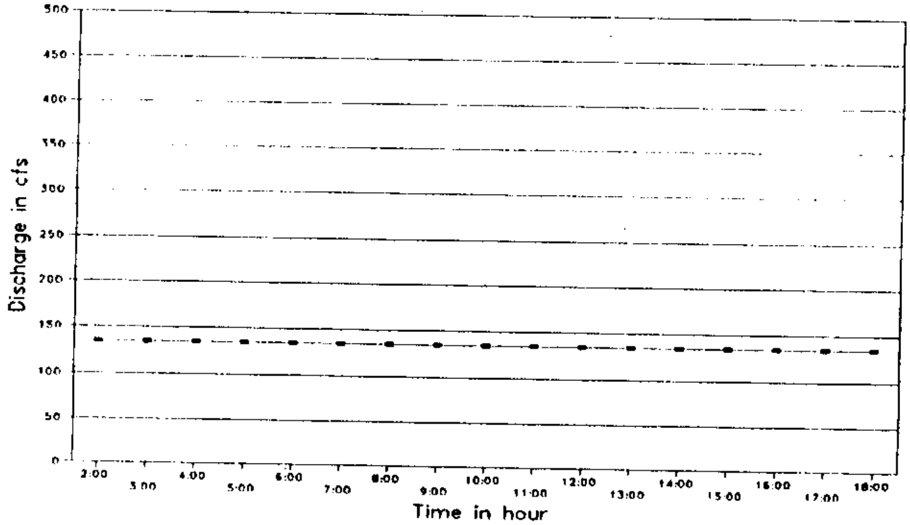

Fig: 3.8.4. Discharge at the head of the Shahar Farid Distributary during the inflow-outflow exercise.

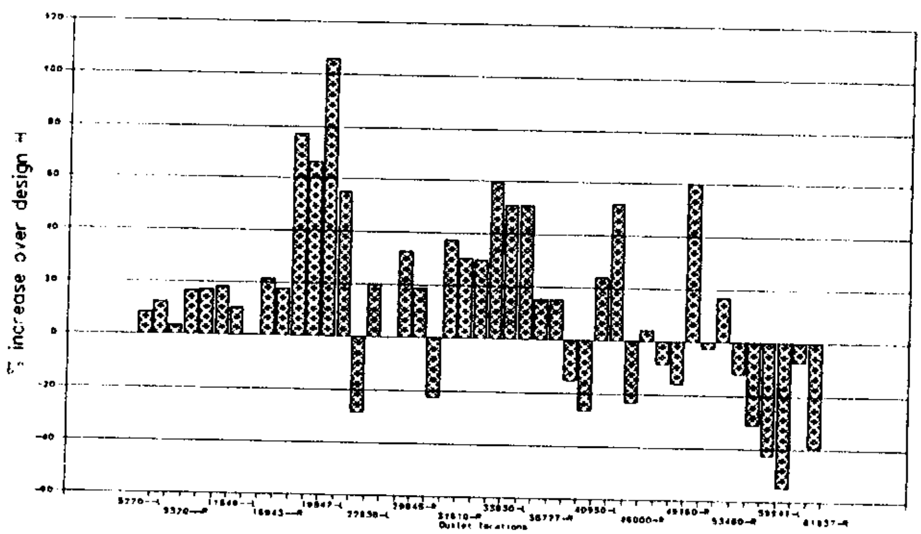

Fig: 3.8.5. Percentage change in actual upstream water level for outlets with reference to the design water levels in Shahar Farid Distributary.

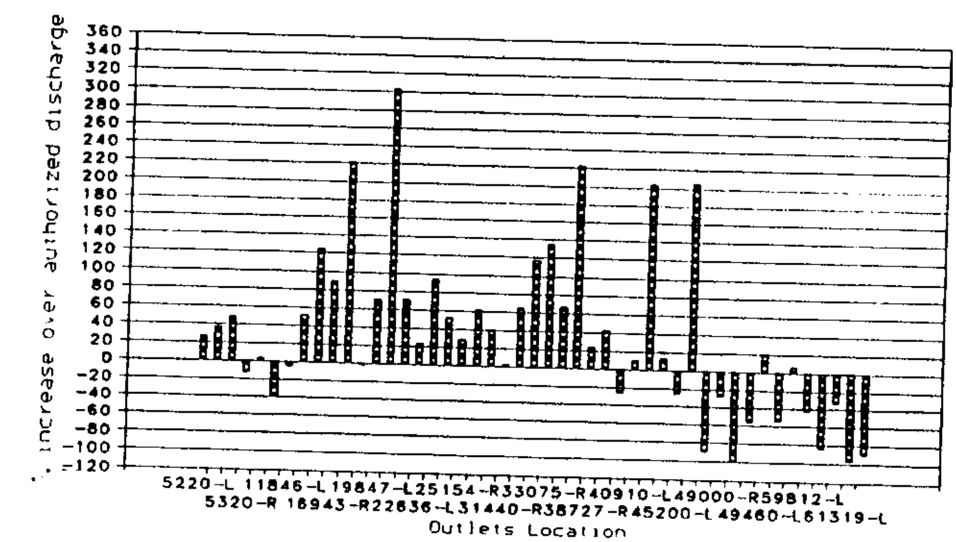

Fig: 3.8.6. Percentage change in actual discharges for outlets with reference to the authorized discharge in Shahar Farid Distributary.

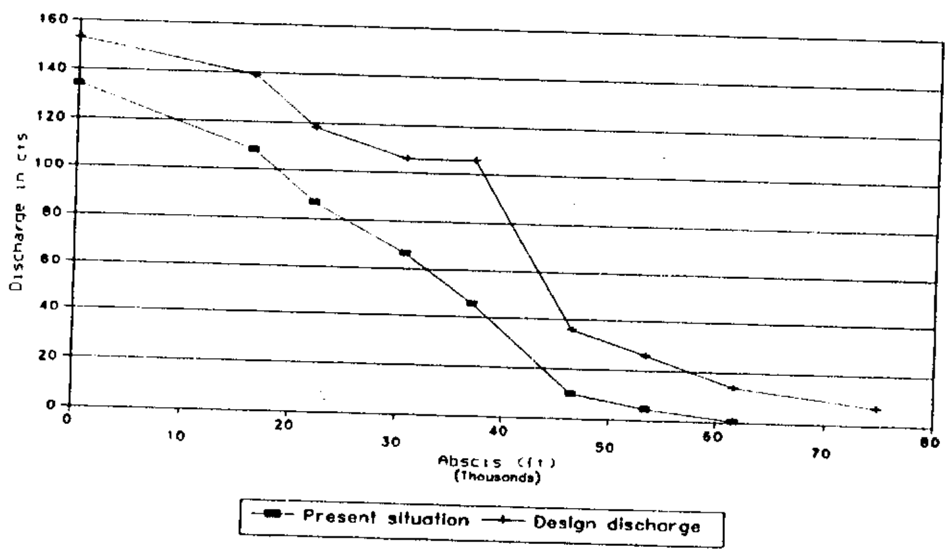

Fig: 3.8.7. Comparison between discharges in Shahar Farid Distributary, observed versus design.

3.9 Masood Distributary

General

The inflow-outflow exercise was carried out on 14-11-1995 from 6 a.m. to 6 p.m.

The discharge at the head during the exercise was 23.1 cfs, which is much lower than its design discharge of 35 cfs. However, the authorized discharge was taken to be 31.65 cfs because at the tail of the distributary, the Irrigation Department has transferred tail outlets to the Fordwah Branch Canal (direct outlets). Therefore, the sanctioned design discharge of these outlets was subtracted from the design discharge. This distributary normally runs less than its design discharge.

Masood Distributary has fifteen outlets in which twelve are OFRB, two pipe outlets and one open flume (OF). Two outlets were broken and no cut was observed in this distributary during the exercise. The fall at RD-18000 is totally submerged and the other two falls at RD-24050 and RD-37500 were operating free flow.

It was a pleasant sunny day and the temperature ranged between 20 C^0 to 32 C^0.

Masood Distributary runs parallel to the Fordwah Branch Canal along the right side. The right bank at some places was weak and damaged by cattle. At the left bank, there is Fordwah Branch Canal; therefore, its condition is better. From RD-18000 to RD-21000, the Masood Distributary runs between Fordwah Branch Canal and Soda Distributary. The main problem in this distributary is the weeds which are growing along the whole distributary length particularly from the RD-13500 to the tail.

The comparative difference between actual and authorized width (B) of outlets varied between -86% to 40.4% but normally between -6.2% to 13%, with a few outlets with much higher values (see Figure 3.9.1).

The comparative difference between actual and design height (Y) of outlets varied mostly from -9.7% to 5% (Figure 3.9.2).

From RD-0 to RD-10000, and RD-23500 to 29000, Masood is partially in cut/fill. From RD-10000 to RD-13000, RD-14000 to RD-23500, and RD-29000 to tail it is in fill. Mostly breaches occur at RD-3800 and RD-42000. The freeboard is very little along the entire length of the distributary.

Calibration of canal structure and outlets

The flow condition at the head of the distributary was submerged and C_d was calculated as 1.27. The tail was assumed at RD-45950 (because in the past water only reached at this point) and its C_d was calculated as 0.44 (Annex 2).

During inflow-outflow the exercise, eight outlets were running as orifice modular flow (O.M), four as orifice non-modular flow (O.N) and one as free flow (F.F) (Annex 2). In this distributary, there are four falls (drop structures). The two falls at RD-24050 and RD-37500 were flowing as free flow and the fall at RD-18000 was flowing as orifice non-modular.

<u>Inflow-outflow</u>

The discharge at the head of the Masood Distributary was constant (Figure 3.9.3). The discharge at the outflow point (tail) was constant during the exercise (Fig. 3.9.4).

The comparative difference between actual and design water levels varied between -6.8% to 40.2% Most of the outlets were drawing more water than the design values (Figure 3.9.7). An overall picture of the water flow in the distributary is presented in Figure 3.9.8.

The seepage in this distributary is very low, the seepage in two reaches had a gain (see Table 3.9.1).

Table: 3.9.1. Seepage from the Masood Distributary for each reach.

Reach RD	No. of outlets	Total Q of outlets cfs	Inflow cfs	Outflow cfs	Seepage cfs	Wetted area msf	Seepage cfs/msf
0-14500	4	6.4	23.1	16.4	0.3	0.21	1.43
14500-25000	1	0.7	16.4	16	-0.3	0.11	-2.72
25000-37250	7	12.48	16	4.7	-1.18	0.11	-10.7
30700-45950	2	2.22	4.7	1.90	0.57	0.06	9.58

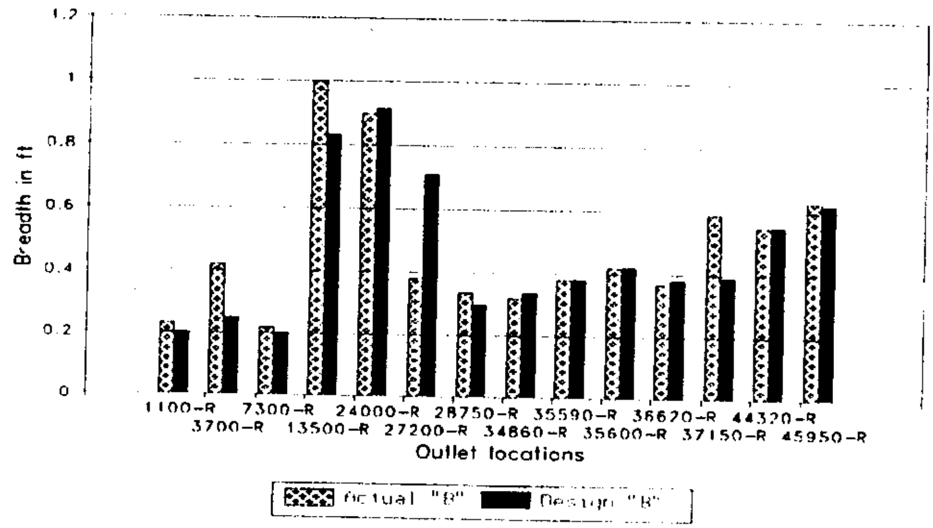

Fig: 3.9.1. Comparison of breadth "B" of outlets in Masood Distributary, observed versus record.

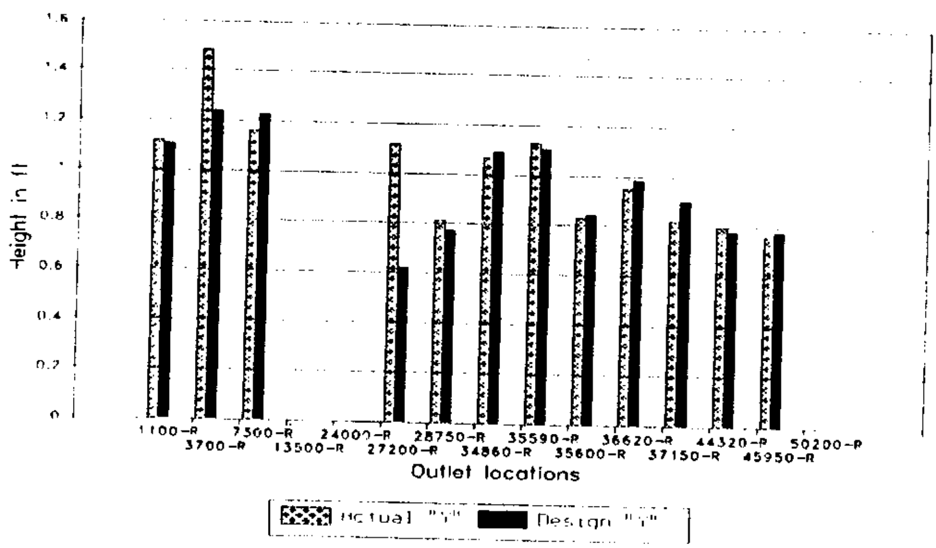

Fig: 3.9.2. Comparison of height of outlets in Masood Distributary, observed versus records.

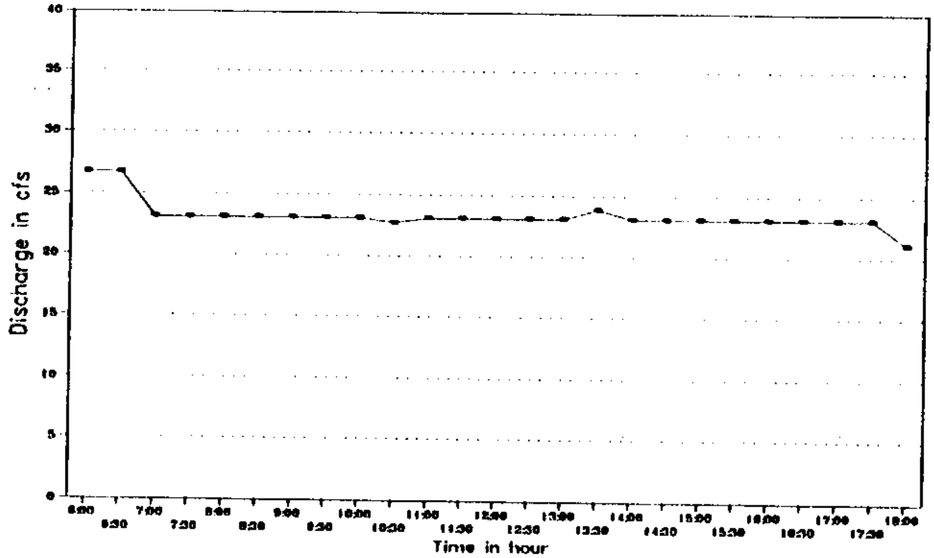

Fig: 3.9.3. Discharge at the head of the Masood Distributary during the inflow-outflow exercise.

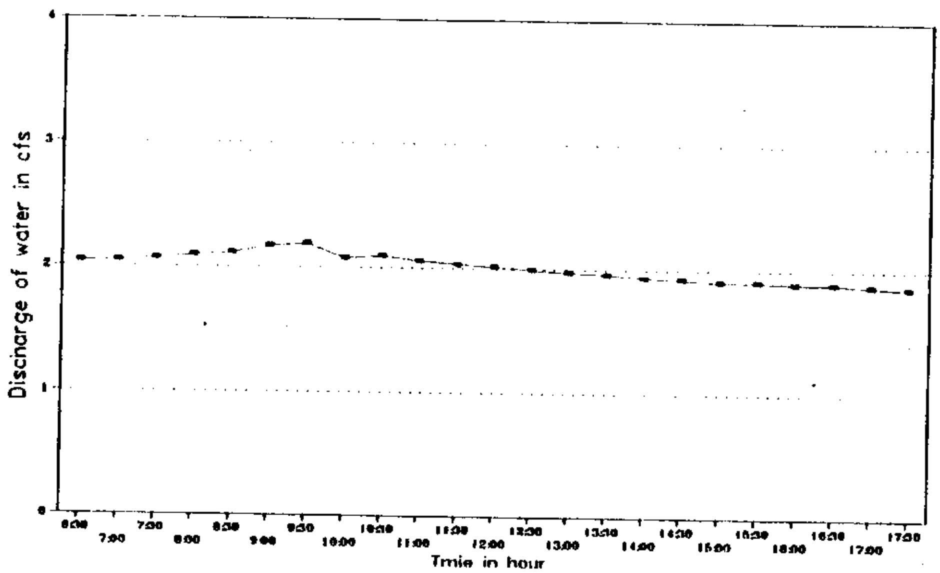

Fig: 3.9.4. Discharge at the tail of the Masood Distributary during the inflow-outflow exercise.

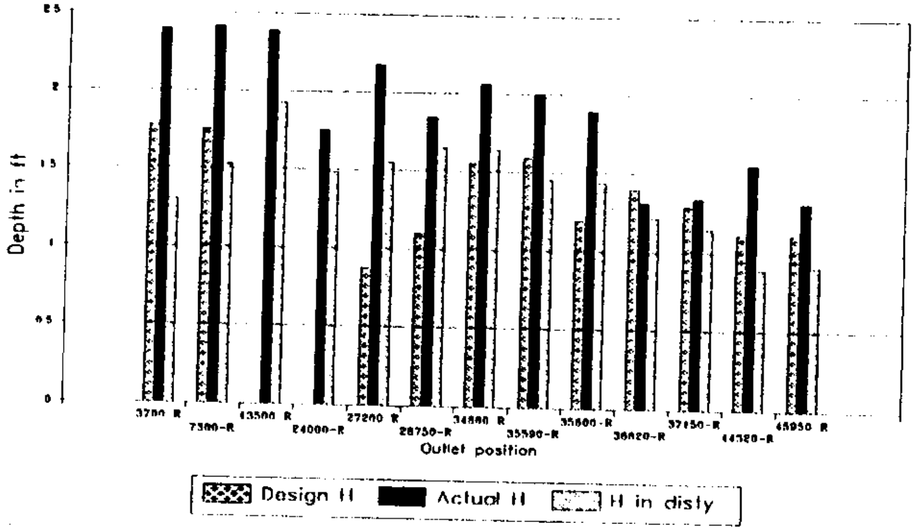

Fig: 3.9.5. Comparison between water levels at outlets (observed versus records) versus water level in the Masood Distributary.

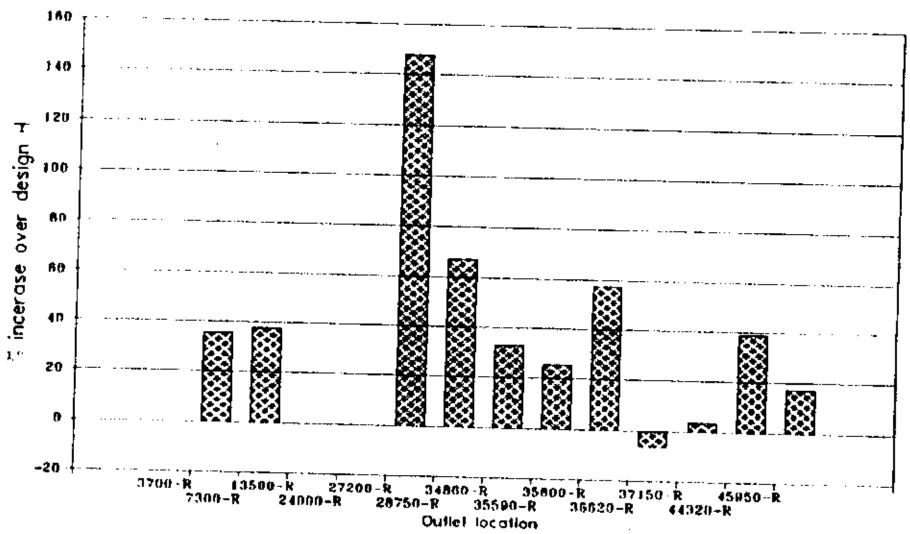

Fig: 3.9.6. Percentage change in upstream water level for outlets, actual over design, in Masood Distributary.

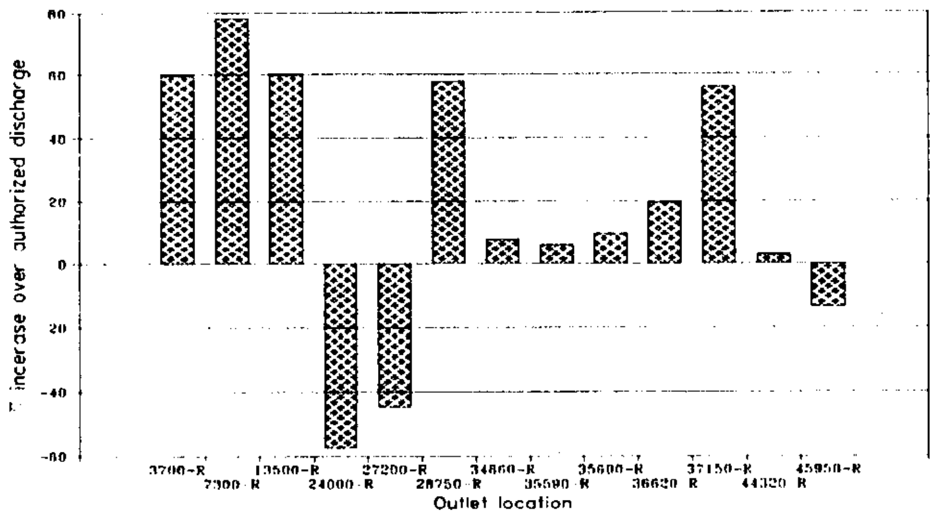

Fig: 3.9.7. Percentage change in actual discharge for outlets with reference to the authorized discharge in Masood Distributary.

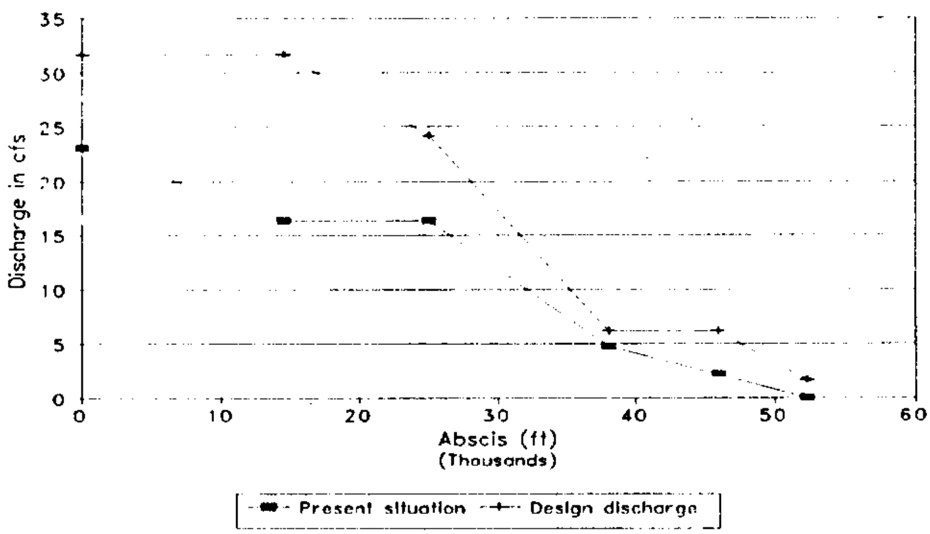

Fig: 3.9.8. Comparison between discharges at outlets, observed versus design, in Masood Distributary.

3.10 Soda Distributary

General

The inflow-outflow exercise was carried out from 06:00 p.m. on 25-8-1995 to 06:00 p.m on 26-8-1995. It was a warm, sweating day, with temperatures ranging from 35° to 43° C. The discharge at the head was 77.76 cusecs, which is equal to its design discharge of 77.00 cusecs. Generally, this distributary runs as per its design discharge.

Characteristics of outlets

Prior to the exercise, the characteristics of outlets were determined at site. The measured values of "B" and "Y" of the outlets of Soda Distributary are given in Annex 1. Only in a few cases outlets dimensions that were observed in the field differ substantially from the original design data (Figures 3.10.1 and 3.10.2). This is the case for Outlets 9320-R, 9300-R, 18080-R 20030-R, 20040-R, 22690-L and 28280-L. The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

Before the day of the inflow-outflow exercise, most of the outlets of Soda Distributary were calibrated, but during the exercise some outlets and canal structure were calibrated also, thereby determining the coefficient of discharge (C_d) for each structure. Also, the C_d of the inlet structure of Soda, which had been established previously (IIMI, 1995) was verified on the day of the experiment. The C_d of the head structure of Soda (FF) was determined at a value of 0.25. The complete list of C_d values is given in Annex 2. On the day of the exercise, the majority of the outlets (15) had OM flow condition, while ten outlets had submerged flow conditions (ON), seven outlets had free flow conditions (FF). Only one orifice functioned as a flume (FS).

Water distribution

The discharge at the head of Soda Distributary was constant during the exercise, except from 09:00 pm to 03:00 am, when the discharge increased approximately 4 to 5 cusecs (Figure 3.10.3). Similarly, the gauge at the outflow point was almost constant (Figure 3.10.4).

In Annex 3, the observed water levels and corresponding discharges for the outlets of Soda are presented. The observed water levels in the head and middle reach of Soda are almost, in all cases, higher than the target water levels, which results in higher discharges for most outlets. In the tail reaches the observed water levels are generally lower than design.

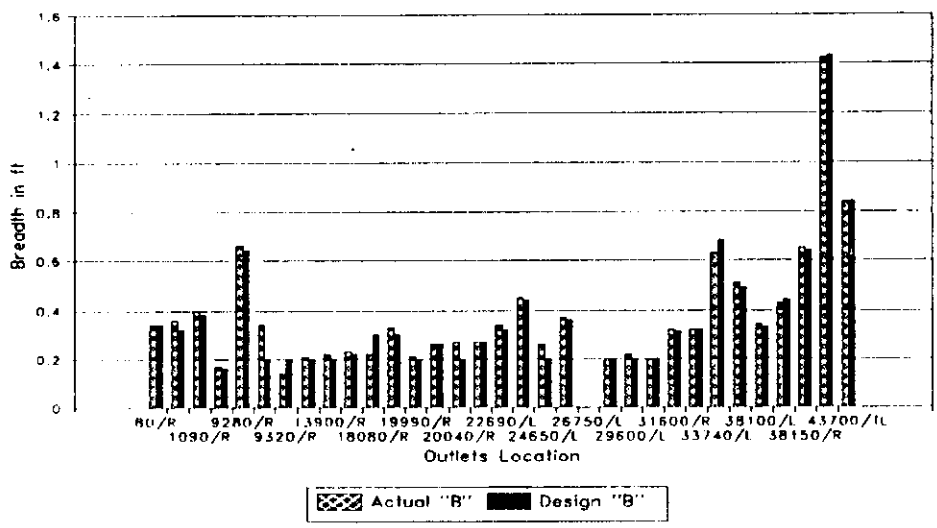

Fig: 3.10.1. Comparison of breadth "B" of outlets in Soda Distributary, observed versus records.

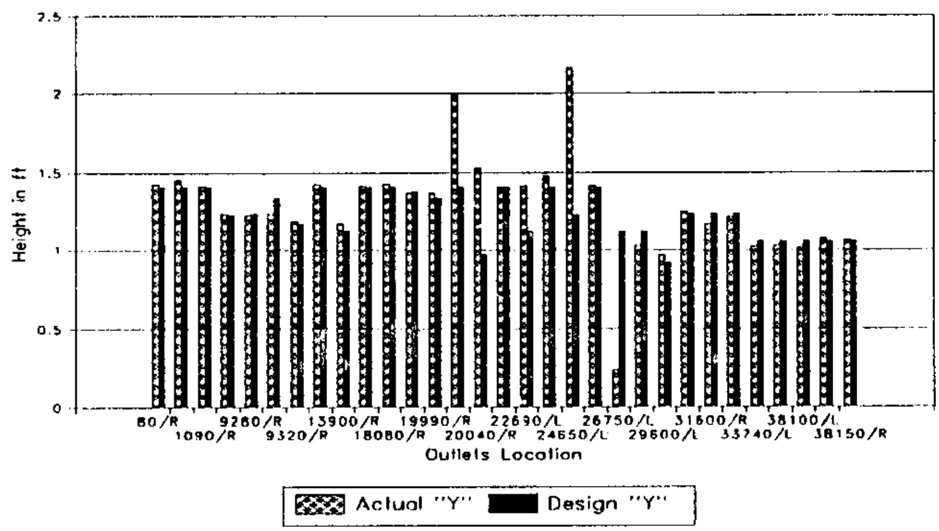

Fig: 3.10.2. Comparison of height "Y" of outlets in Soda Distributary, observed versus records.

One of the reasons for these high water levels in the upper reaches of Soda Distributary is the fact that the bed level of the distributary is much higher in those reaches than the design level. Figure 3.10.5, which shows that, on average, the bed level of the distributary is higher than the crest level of the off-taking outlets. Originally, these outlets were placed slightly above the bed level (at around 0.1 of the water depth) of the distributary. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.10.6 and Figure 3.10.7. An overall picture of the water flow in the distributary is presented in Figure 3.10.8. At the head of Soda Distributary, the discharge was as per design, but in middle and tail reaches, the discharge was less than design (see Figure 3.10.8).

Inflow-outflow

Seepage losses were determined for different reaches of the distributary. In the first reach, the seepage was normal; in the second reach very low, but in the last reach, the seepage was high because there are two villages near the distributary, which results in damaged banks (cattle trespassing). The results are presented in Table 3.10.1.

Table 3.10.1. Seepage losses for Soda Distributary.

Reach (RD)	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	See-page (cfs)	Wetted area (msf)	Seepage cfs/msf
0-20050	15	38.53	77.76	35.49	3.74	0.46	8.10
20050-38150	16	30.37	35.49	4.61	0.51	0.23	2.23
38160-43700 Tail	2	3.59	4.61	3.59	1.02	0.04	28.33

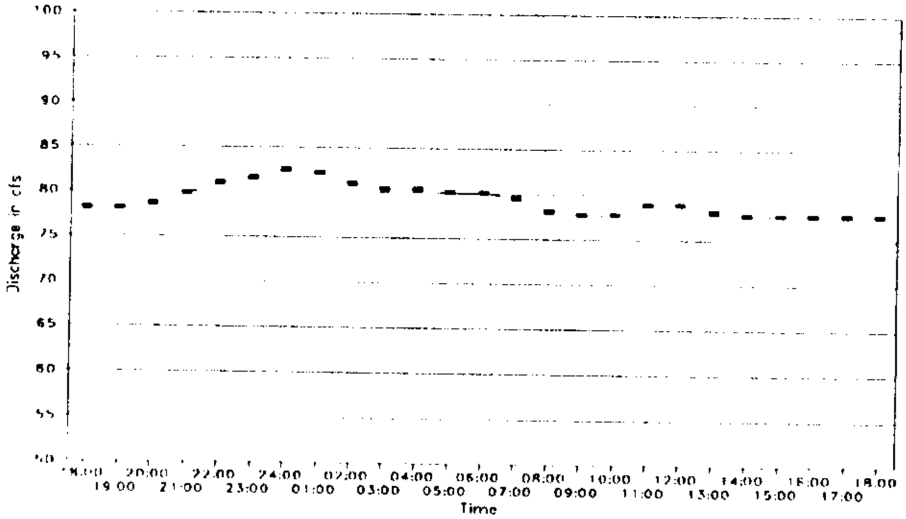

Fig: 3.10.3. Discharge at the head of the Soda Distributary during the inflow-outflow exercise.

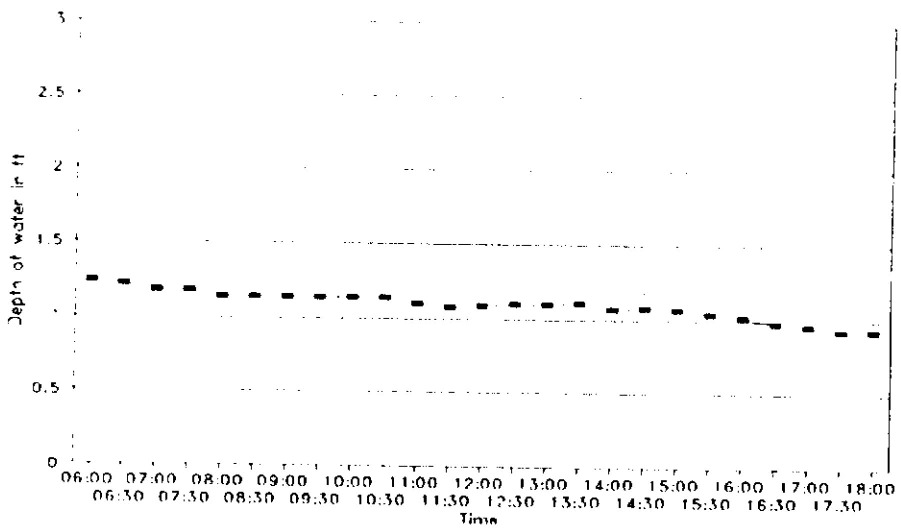

Fig: 3.10.4. Depth of water at the tail of Soda Distributary during the inflow-outflow exercise.

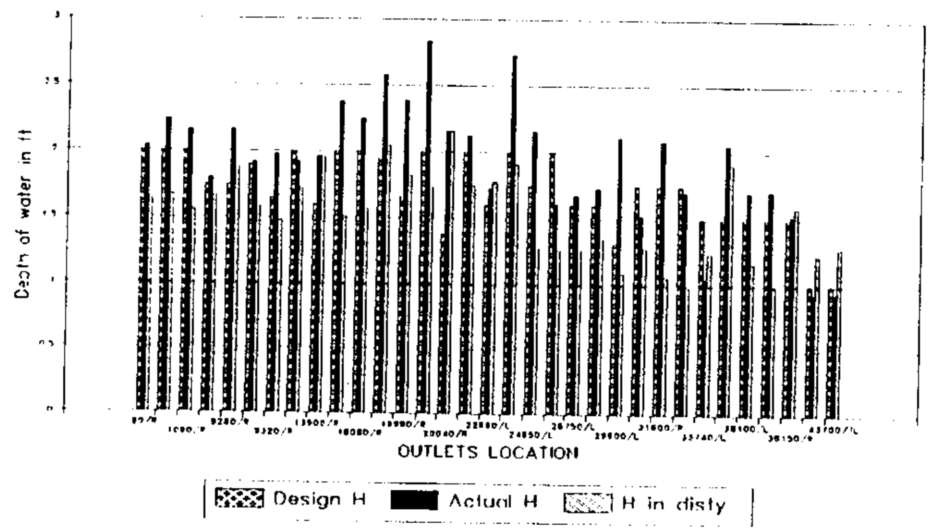

Fig: 3.10.5. Comparison between water levels at outlets (observed versus records) versus water level in the Soda Distributary.

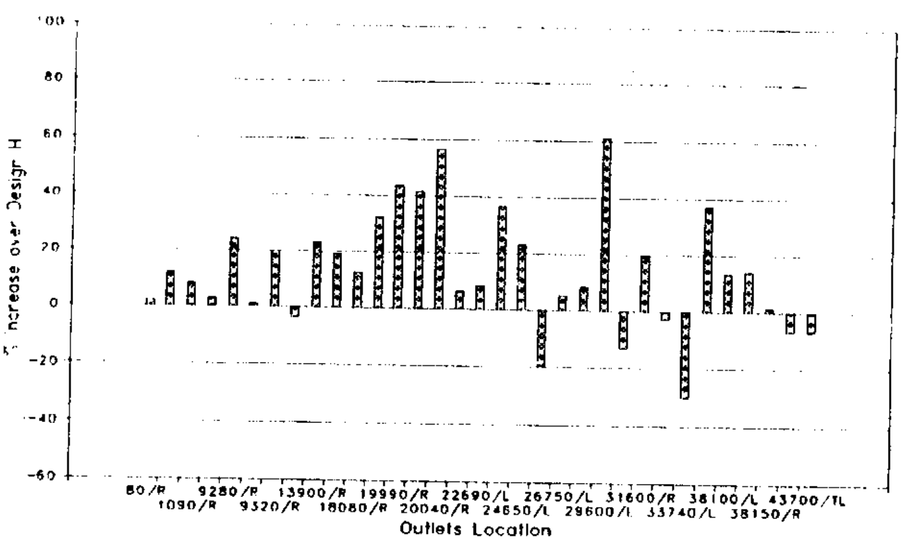

Fig: 3.10.6. Percentage change of actual upstream water level for outlets with reference to the design water levels in Soda Distributary.

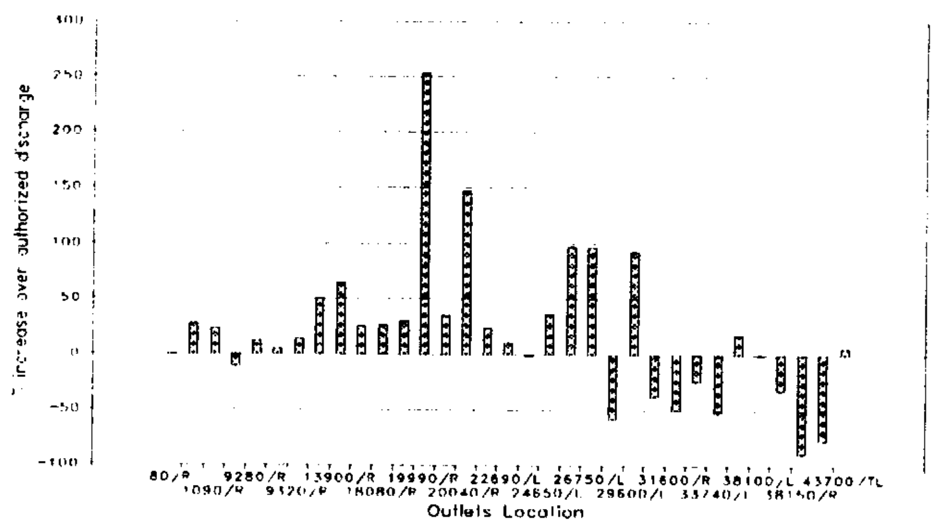

Fig: 3.10.7. Percentage change of actual discharges for outlets with reference to the authorized discharge in Soda Distributary.

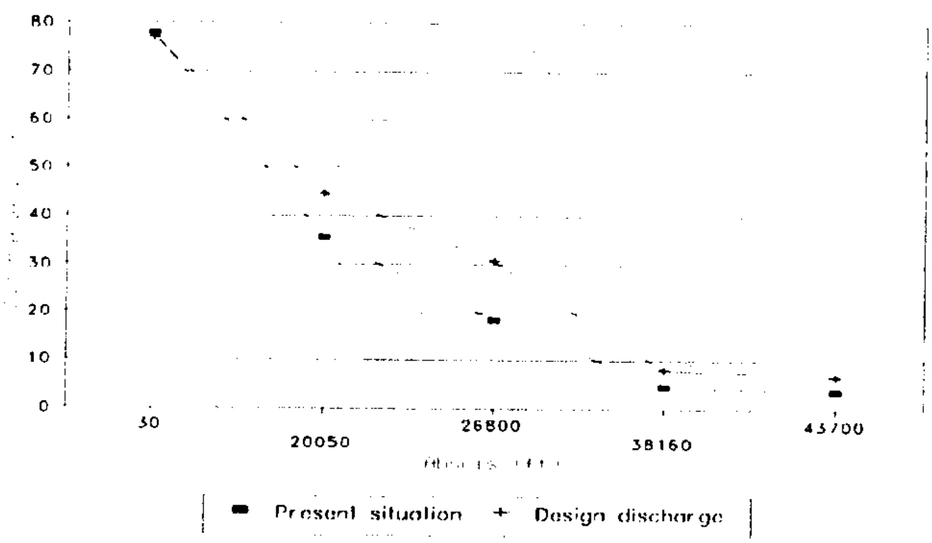

Fig: 3.10.8. Comparison between discharges in Soda Distributary, observed versus design.

3.11 5-L Distributary

General

The inflow-outflow exercise for 5-L Distributary, which offtakes from the Fordwah Branch Canal at RD-348000, was conducted on 16-11-1995 from 6 a.m. to 2 p.m. This was a pleasant sunny day and the temperature ranged between 25 C° to 32 C°.

The discharge at the head during the exercise was 3.83 cfs, but the design discharge is 4 cfs. This distributary normally runs equal to its design discharge. Also its discharge depends upon the level of water in the Fordwah Branch Canal, since there is no gate to control the inflow (Figure 3.11.1).

The 5-L Distributary has four outlets in which two are OFRB and two open flume (OF). Two outlets were broken. No cut was observed in this distributary during the exercise. The command area of Outlet 11300 T.F. is now occupied by houses, but this outlet was not taken out by the Irrigation Department.

The embarkment conditions for 5-L Distributary are not good. The left bank, especially between RD-0 to RD-3000, are very weak and many breaches occur in that reach. Another site which is weak occurs from RD-7500 to RD-9000. Almost the entire distributary is in fill. The freeboard in some places is very little.

The comparative difference between actual and design width (B) of outlets varies between -3.7% to 10.8%. The comparative difference between actual and design height (Y) varies between -16.6% to -1.6% (see Table 3.11.1 and Figure 3.11.2).

Calibration of canal structure and outlets

The flow condition at the head structure of the 5-L Distributary was submerged and C_d was calculated as 0.47. The tail bifurcates in two, but Outlet 11300 T.C. is damaged because the command area is populated (see Annex 2).

During the inflow-outflow exercise, two outlets were running as orifice modular flow (O.M), and one was running as free flow (FF) (see Annex 2). In this distributary, there is one drop structure at RD-5000, which was submerged and its C_d was calculated as 0.36.

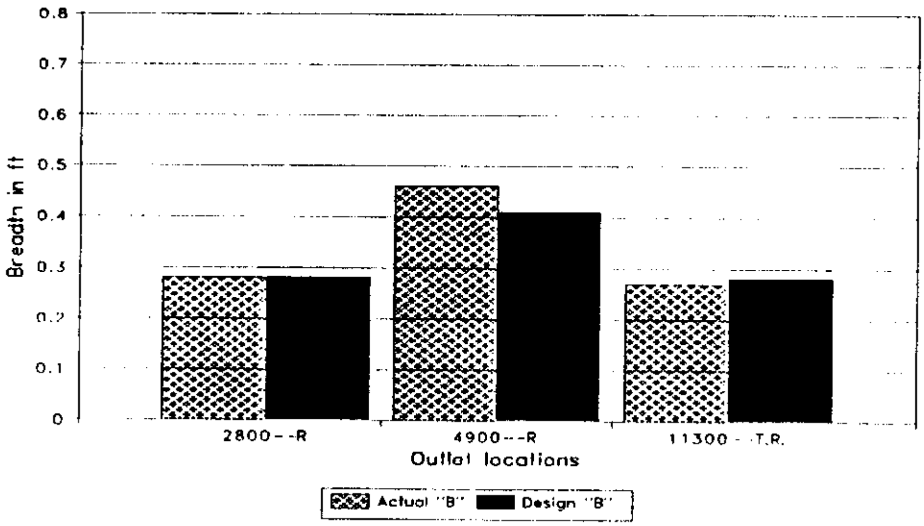

Fig: 3.11.1. Comparison of breadth "B" of outlets in 5-L Distributary, observed versus records.

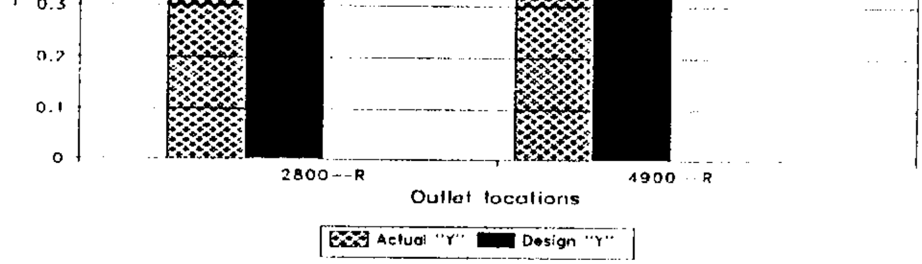

Fig: 3.11.2. Comparison of height "Y" of outlets in 5-L Distributary, observed versus records.

Inflow-outflow

The discharge at the head of the 5-L Distributary was constant (Figure 3.11.3). The discharge at the tail of the 5-L Distributary was also constant (Figure 3.11.4).

The comparative difference between actual and design hydraulic head (H) varies between -5.2% to 47% (Figure 3.11.5 and Figure 3.11.6). The comparative difference between actual and design discharge (q) varies between -2.6% to 48.7%. Most of the outlets were drawing more water than their design discharge (Figure 3.11.7). An overall picture of water flow in the distributary is presented in Figure 3.11.8.

The seepage in the first reach from RD-0 to RD-5000 is comparatively higher than in the second reach from RD-5000 to 11300-Tail (Table 3.11.2).

Table: 3.11.2. Seepage from the 5-L Distributary for two reaches.

Reach (RD)	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Out-flow (cfs)	Seep-age (cfs)	Wetted area msf	Seepage (cfs/msf)
0-5000	2	2.32	3.88	0.98	0.58	0.03	22.21
5000-11300	0	0	0.98	0.98	0.00	0.02	0.08

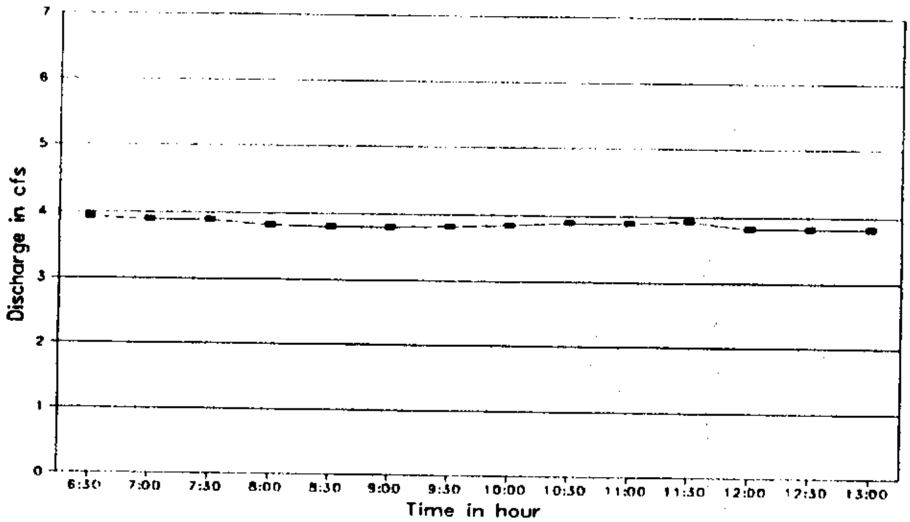

Fig: 3.11.3. Discharge at the head of the 5-L Distributary during the inflow-outflow exercise.

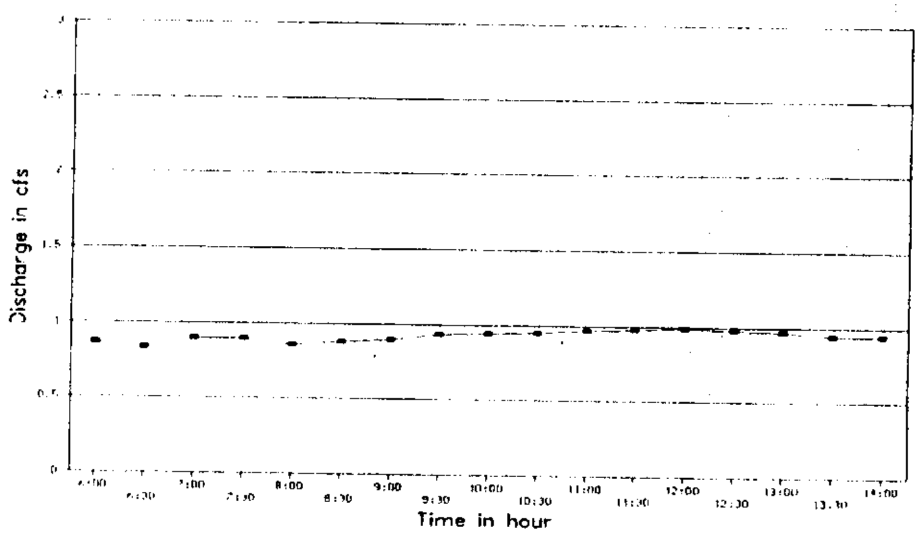

Fig: 3.11.4. Discharge at the tail of the 5-L Distributary during the inflow-outflow exercise.

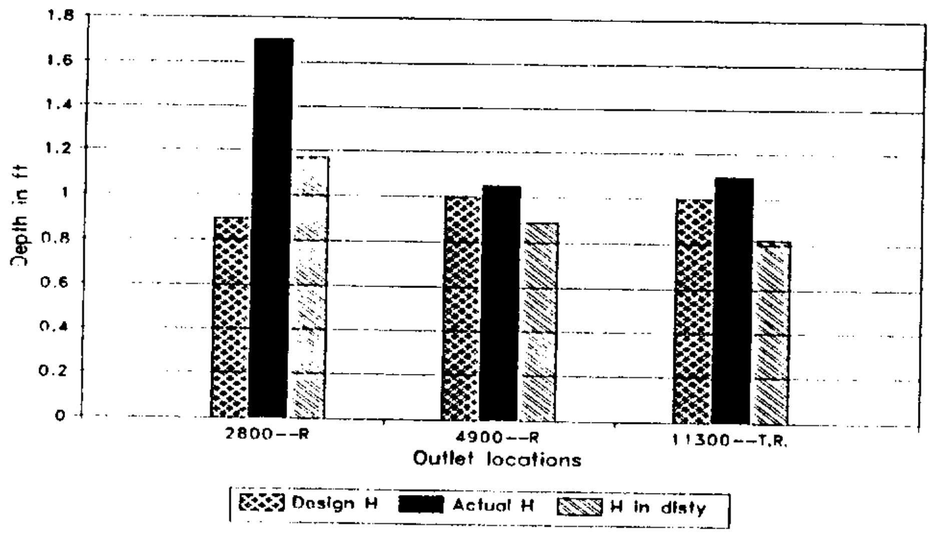

Fig: 3.11.5 Comparison between water levels at outlets (observed versus records) versus bed water level in the 5-L Distributary.

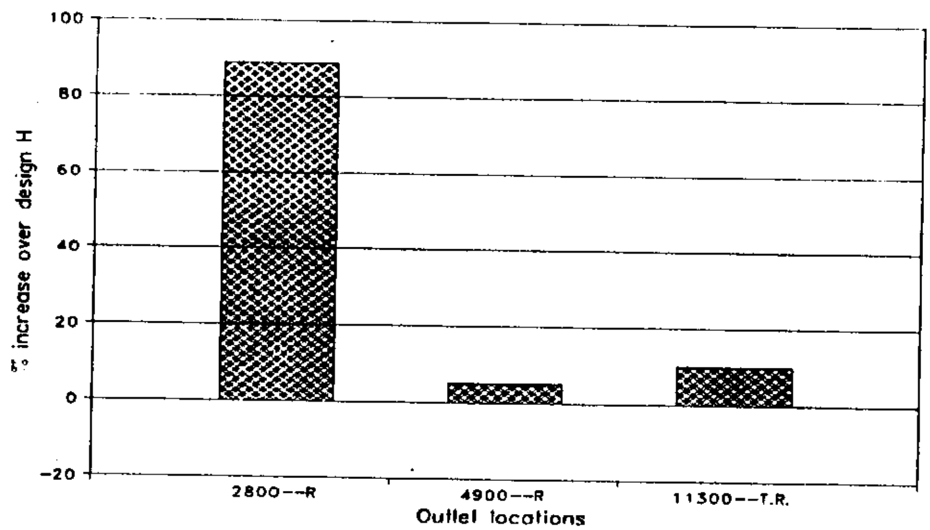

Fig: 3.11.6. Percentage change of actual upstream water levels for outlets with reference to the design water levels in 5-L Distributary.

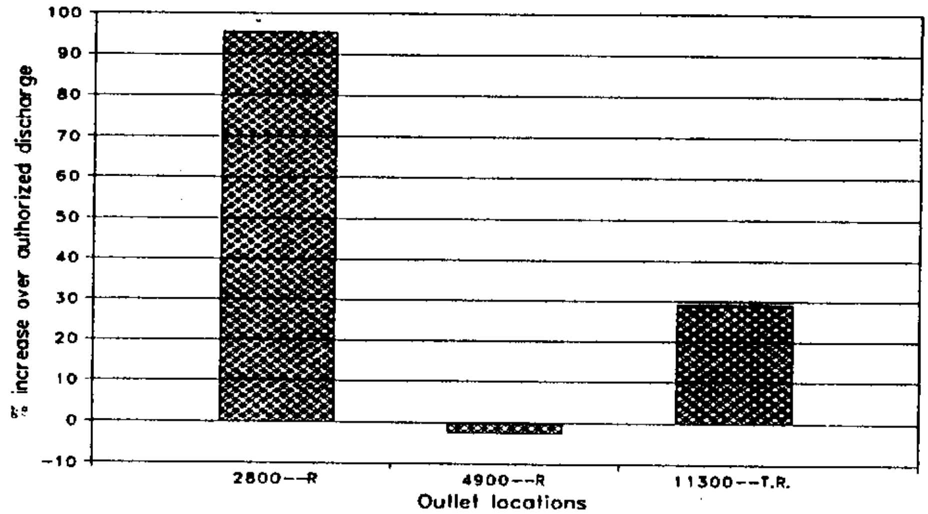

Fig: 3.11.7. Percentage change of actual discharge for outlets with reference to the authorized discharge in 5-L Distributary.

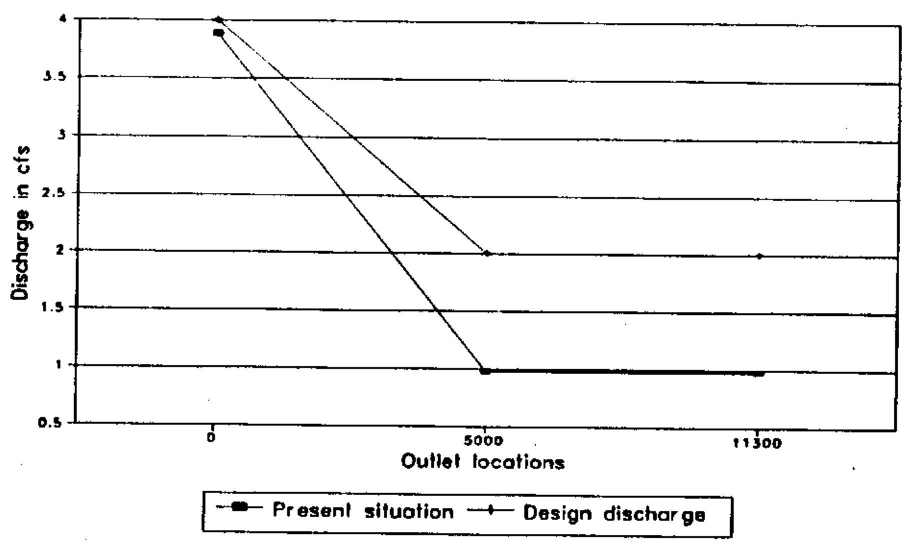

Fig: 3.11.8. Comparison between discharges at outlets, observed versus design, in 5-L Distributary.

3.12 Fordwah Distributary

General

The inflow-outflow exercise was conducted from 06:00 a.m. of April 8 to 06:00 p.m of April 9, 1996. There were sunny days, with temperatures ranging from 30° to 35° C. The discharge at the head was 167.30 cusecs, which is higher than its design discharge of 158 cusecs. Usually, this distributary runs at a discharge more than its design discharge. Most of the time water is available at the tail, specially in winter. During the wheat harvesting season (usually April) the tail has more discharge than its design discharge.

Characteristics of outlets

Prior to the inflow-outflow exercise, the characteristics of outlets were determined at site. The measured values of "B" and "Y" of the outlets of Fordwah Distributary are given in Annex 1. Dimensions of these parameters are very similar to the authorized values in the tail reach, but in the head reach (RD 0 to RD 65000) a lot of disturbances have been created either by disturbing roof blocks or base/check plates. This is the case for Outlets 1556-L, 6100-L, 14320-R, 14910-R, 24800-R, 27050-L, 54060-R, 60410-L, 62085-R, 68260-L, 70530-R, 71200-R, 76640-L, 114700-R and 118250-R.

The existing types of some outlets that were found different from the authorized register are: 33160-R (OCAPM), 42560-R (OF), 42600-R (OCAPM), 54080-R (APM), 55160-R (OCOFRB),71200-R (OFRB) and 116630-L (OF).

There are two illegal pipes in the distributary. Both pipes are installed at outlet 33160-R, one is very close to the outlet (dia = 0.61 foot) and the other is at RD 37 (dia = 0.48 foot). Both pipes were closed on the day of the inflow-outflow experiment.

In the month of April, the harvesting of wheat starts, so most of the fields are not in need of excess water. Due to this reason, some outlets were partially closed, out of which some were also tampered. Those outlets were located at 33120-R, 51500-L, 53380-R, 53920-R and 76640-L

Outlet 33200-L was closed due to a canal breach at the end of February 1996, which had flooded the command area. This outlet is a special case because in design it is a pipe outlet, but until February 1996 there was an OCOFRB. In March 1996, a new pipe outlet was placed very close to OCOFRB. But the situation is not clear yet, because both of the outlets are closed nowadays.

The diameter of Pipe Outlet 32940-R is difficult to establish as there is concrete placed at the upstream side of the pipe. Outlet 117700-R (pipe outlet) was closed on the experiment day because lining of the watercourse was in progress.

"B" & "Y" differ substantially from the original design data for a certain number of outlets, as shown in Figures 3.12.1, 3.12.2, 3.12.3 and 3.12.4. This is the case for Outlets 11450-L, 27050-L, 29660-R, 42580-R, 42600-R, 55160-R, 71200-R, 107820-R.

Elevations of white marks, which were used during the inflow-outflow exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

During the days of the inflow-outflow exercise, the canal structures (falls) and the outlets of Fordwah Distributary were calibrated, thereby determining the C_d of these structures. The C_d of the head structure of Fordwah Distributary (ON) for discharge measurement was used as 0.87 (IIMI-1995). For discharge measurements of structures, the C_d for RD-15 (FF) and Jiwan Minor (FF) was used as 0.38 (IIMI-1996). The canal structure at RD-33 has collapsed. The crest is disturbed, so the C_d value established by IIMI (1996) was not used. The canal structure at RD-65 has a submerged flow condition and the head loss is only 1 cm (IIMI-1996), so, C_d was not calculated.

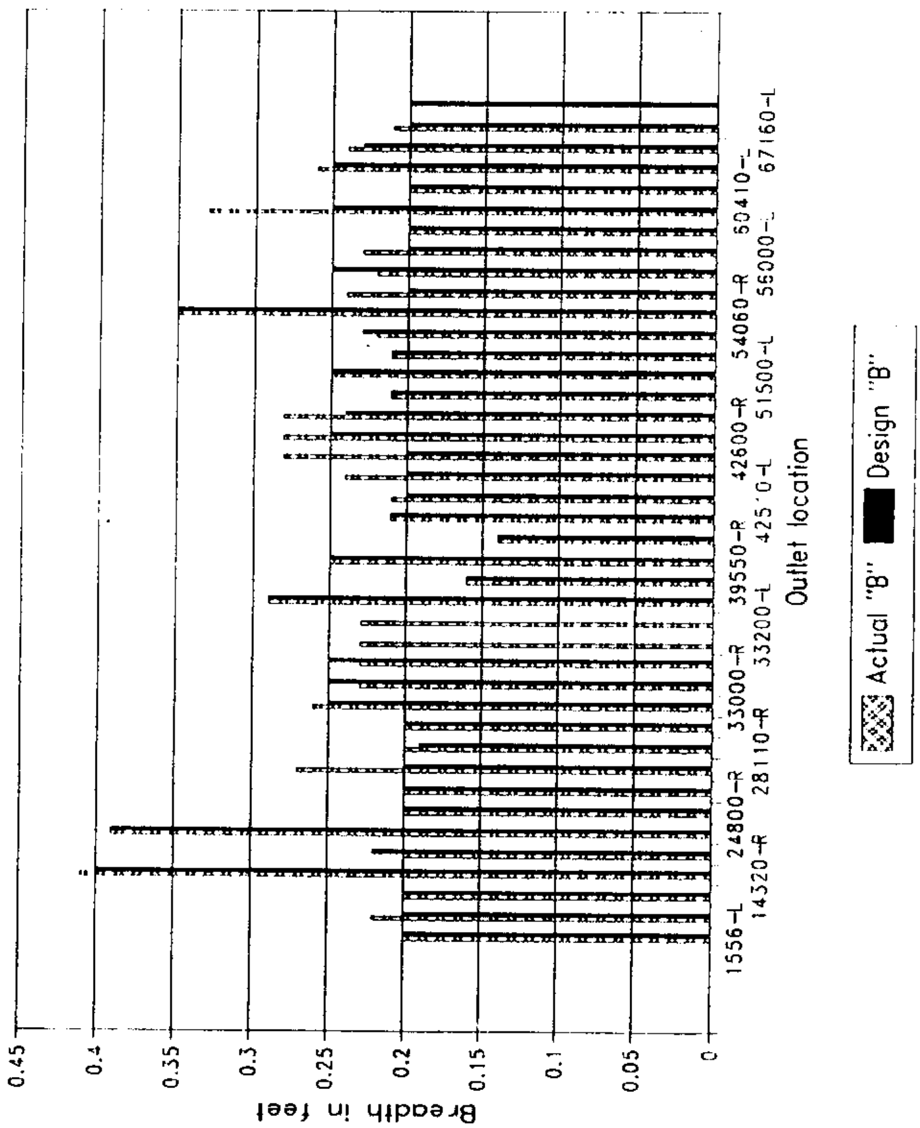

Fig: 3.12.1. Comparison of breadth "B" of outlets in Fordwah Distributary, observed versus records, from RD 0 to RD 70.

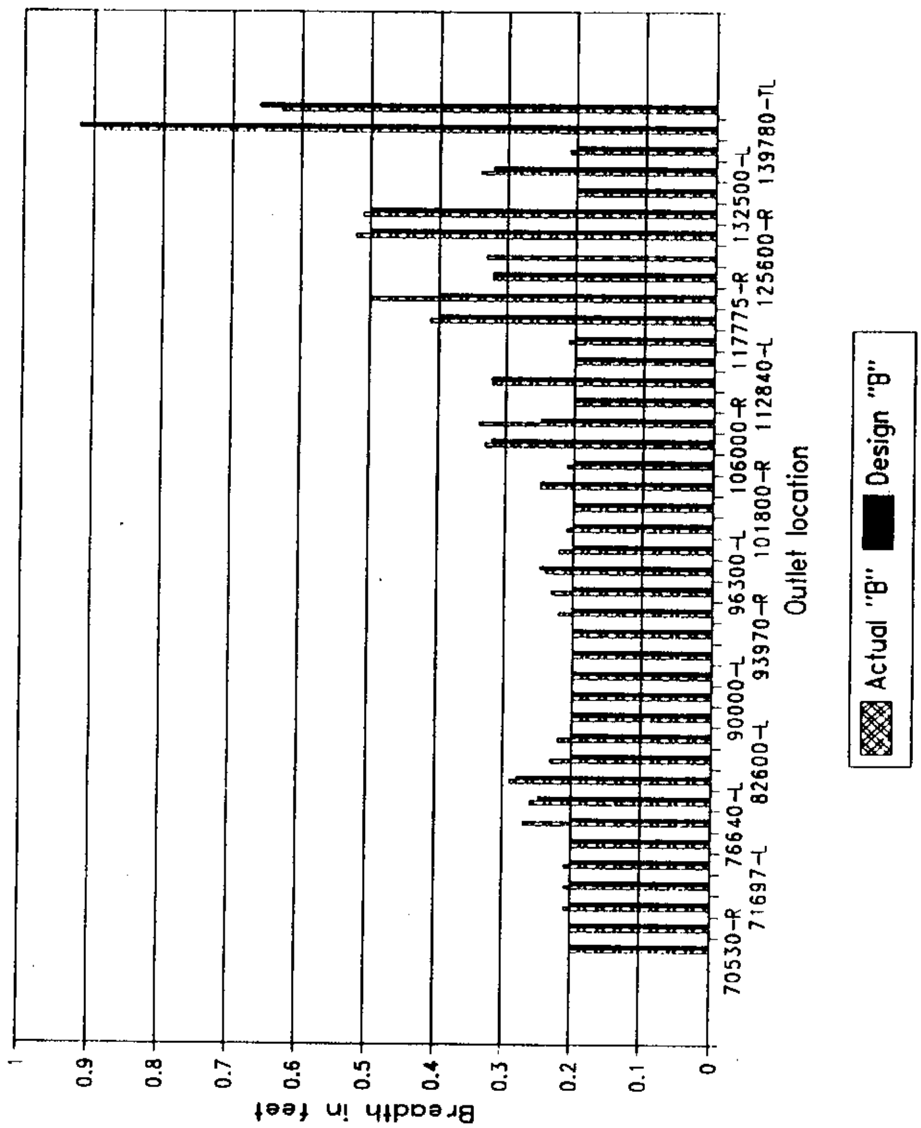

Fig: 3.12.2. Comparison of breadth "B" of outlets in Fordwah Distributary, observed versus records, from RD 70 to tail.

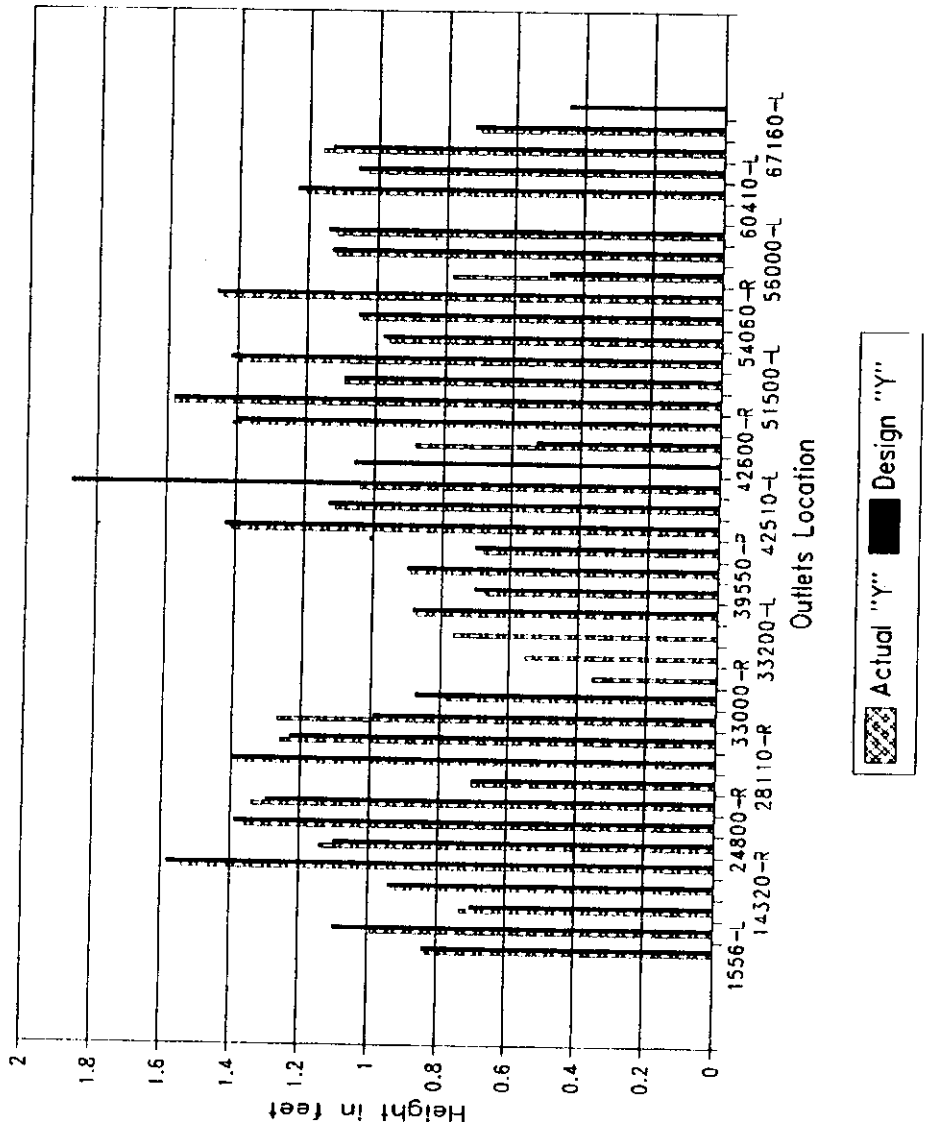

Fig: 3.12.3. Comparison of height "Y" of outlets in Fordwah Distributary, observed versus records, from 0 to RD 70.

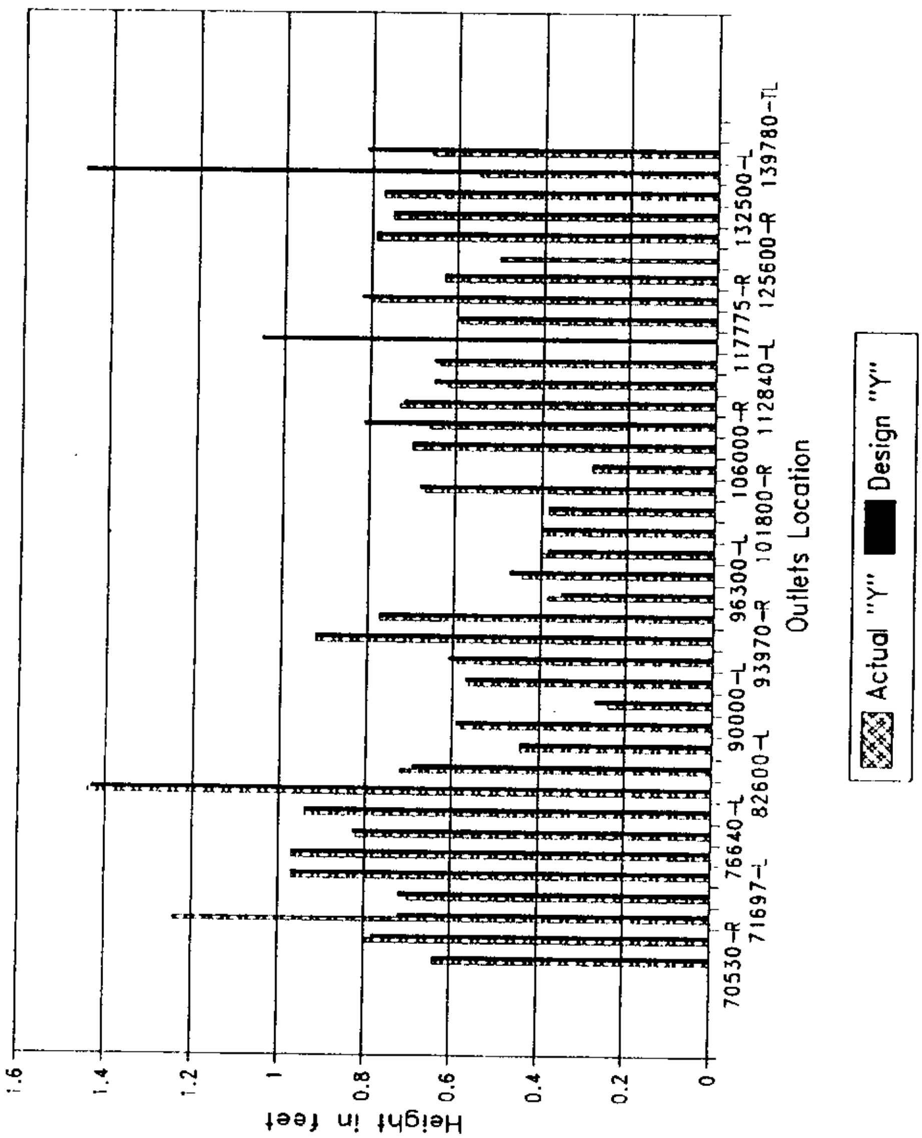

Fig: 3.12.4. Comparison of height "Y" of outlets in Fordwah Distributary, observed versus records, from RD 70 to tail.

The complete list of C_d values is given in Annex 2. On the day of the inflow-outflow exercise, the majority of the outlets (59) had orifice free flow conditions (OM), while 17 outlets had orifice submerged flow conditions (ON). Nine outlets had free flow condition (FF) and one had submerged flow (FS).

Water distribution

The discharge at the head of the Fordwah Distributary was almost constant during the exercise (Figure 3.12.5) and the gauges at the outflow point are given in Figure 3.12.6.

In Annex 3, the observed water levels and corresponding discharges for the outlets of Fordwah Distributary are presented. The observed water levels at the head and middle reaches are in almost all cases higher than the original target or design water levels, which results in higher discharges for most outlets. But observed water levels at the tail reach are lower than the original target or design water levels, which results in less discharge for most outlets. One of the reasons for these high water levels in the upper portion of the distributary is the fact that the bed level of the distributary is much higher than the design level. This is depicted in Figures 3.12.7 and 3.12.8, which shows that, on average, the bed level of the distributary is higher than the crest level of the off-taking outlets. Originally, these outlets were placed slightly above the bed level (at around 0.1 of the water depth) of the distributary. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figures 3.12.9, 3.12.10, 3.12.11 and 3.12.12. An overall picture of the water flow in the distributary is presented in Figure 3.12.13. Because most outlets in the head, as well as Jiwan Minor, are overdrawing water, outlets in the tail reach (beyond RD 65) receive less water.

Inflow-outflow

Seepage losses were determined for different reaches of the Fordwah Distributary. The results are presented in Table 3.12.1. Clearly the seepage losses are very low. The banks of the distributary are in a normal condition.

Table 3.12.1. Seepage losses for Fordwah Distributary.

Reach (RD)	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage cfs/msf
0-50000	28	41.15	167.30	123.30	2.85	1.89	1.51
50000-94500	33	86.55	123.30	33.11	3.64	0.96	3.79
94500-139780	25	30.26	33.11	2.36	0.49	0.47	1.04

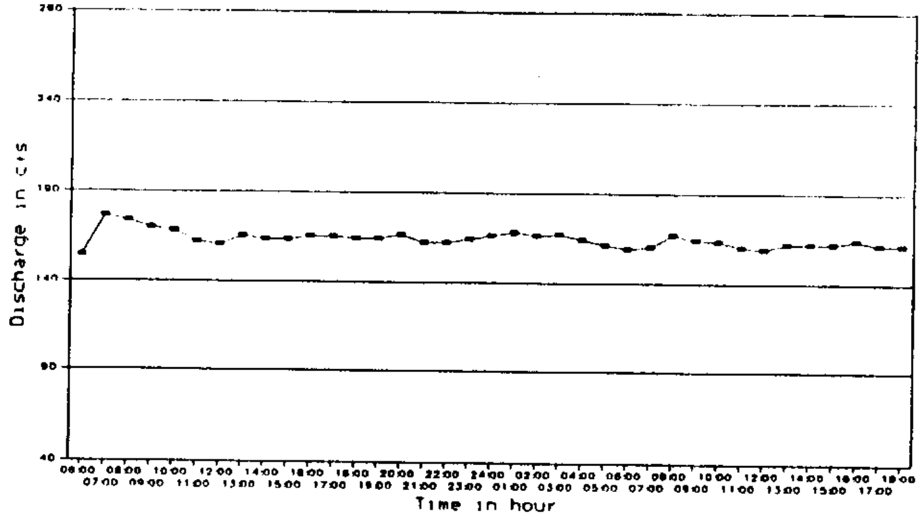

Fig: 3.12.5. Discharge at the head of the Fordwah Distributary during the inflow-outflow exercise.

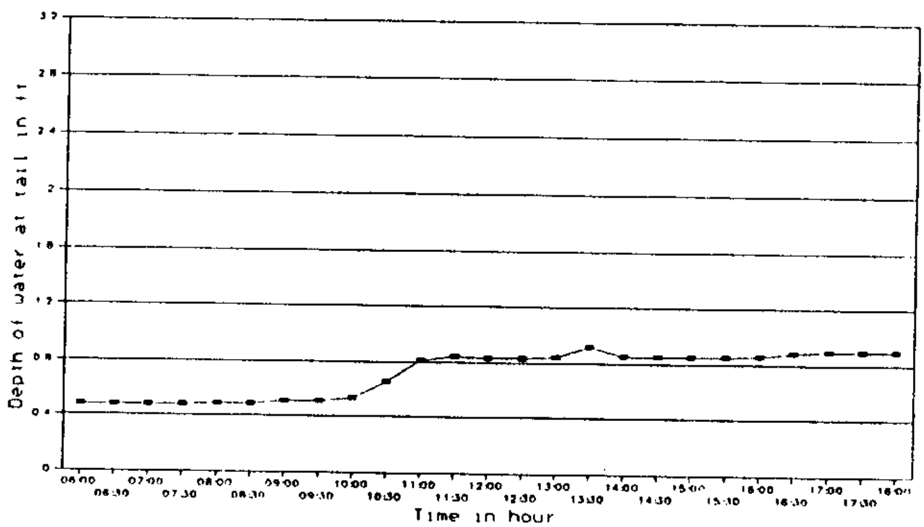

Fig: 3.12.6. Discharge at the tail of the Fordwah Distributary during the inflow-outflow exercise.

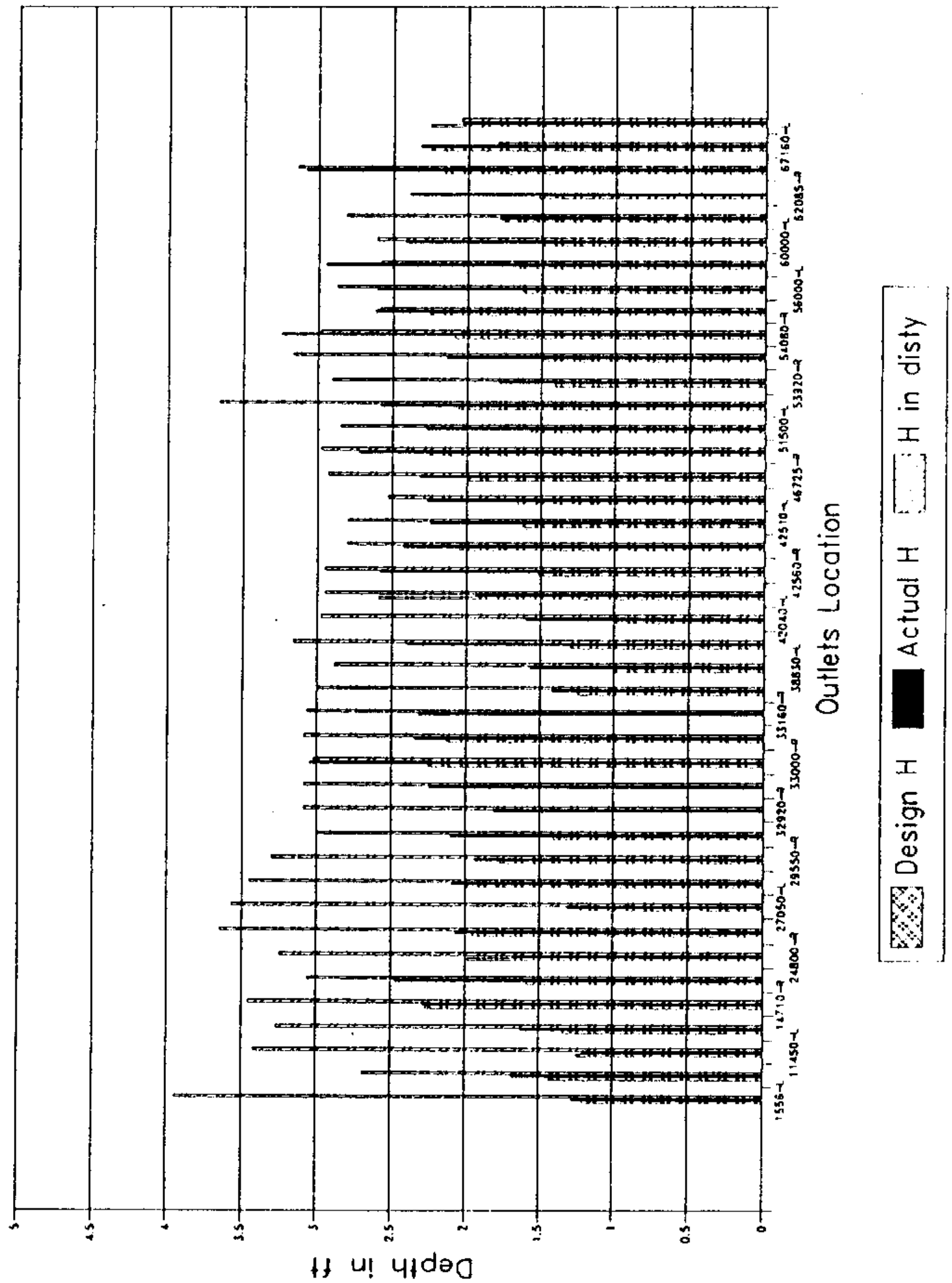

Fig: 3.12.7. Comparison between water levels at outlets (observed versus records) versus water level in the Fordwah Distributary from RD 0 to RD 70.

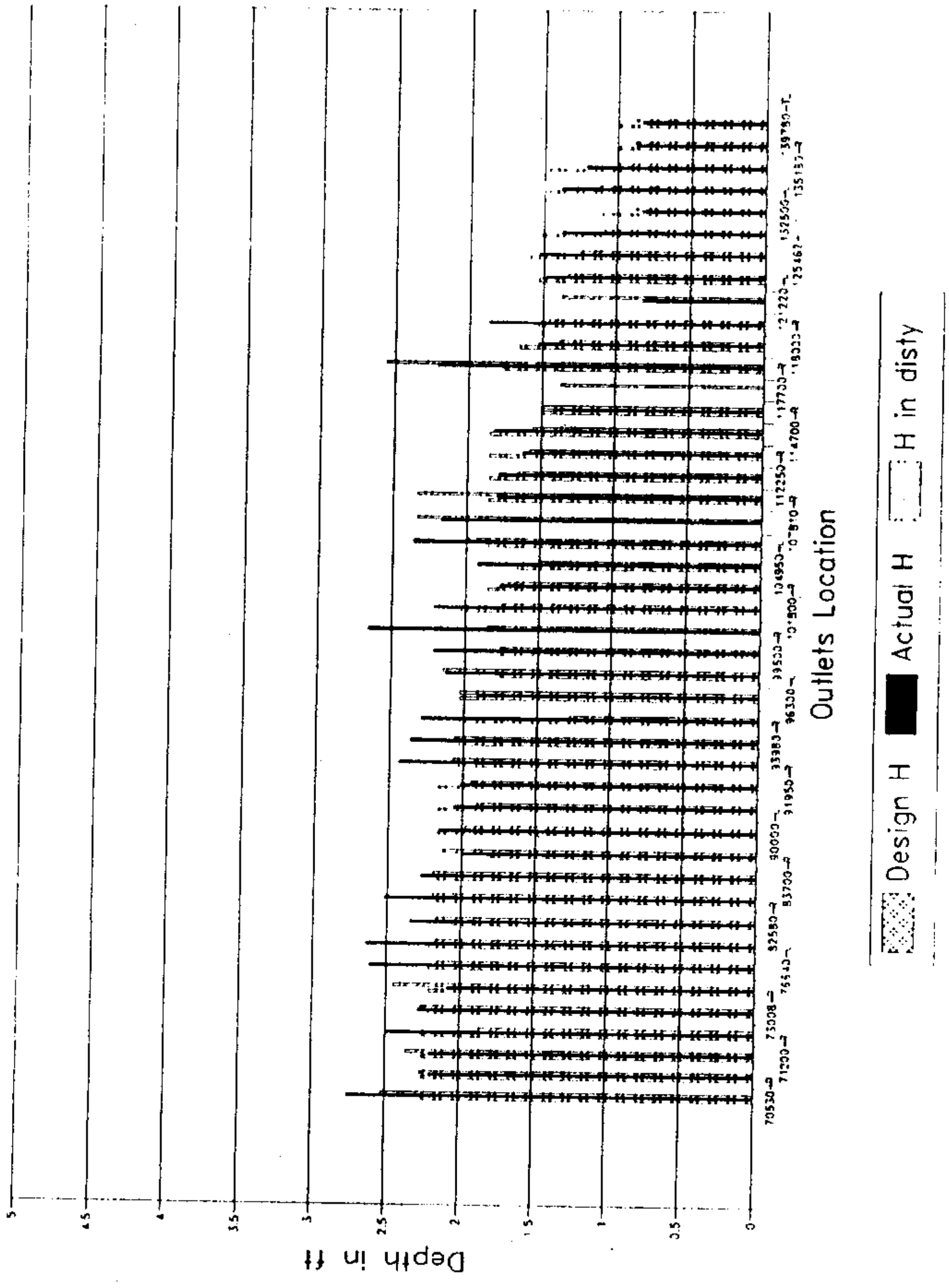

Fig: 3.12.8. Comparison between water levels at outlets (observed versus records) versus water level in the Fordwah Distributary from RD 70 to tail.

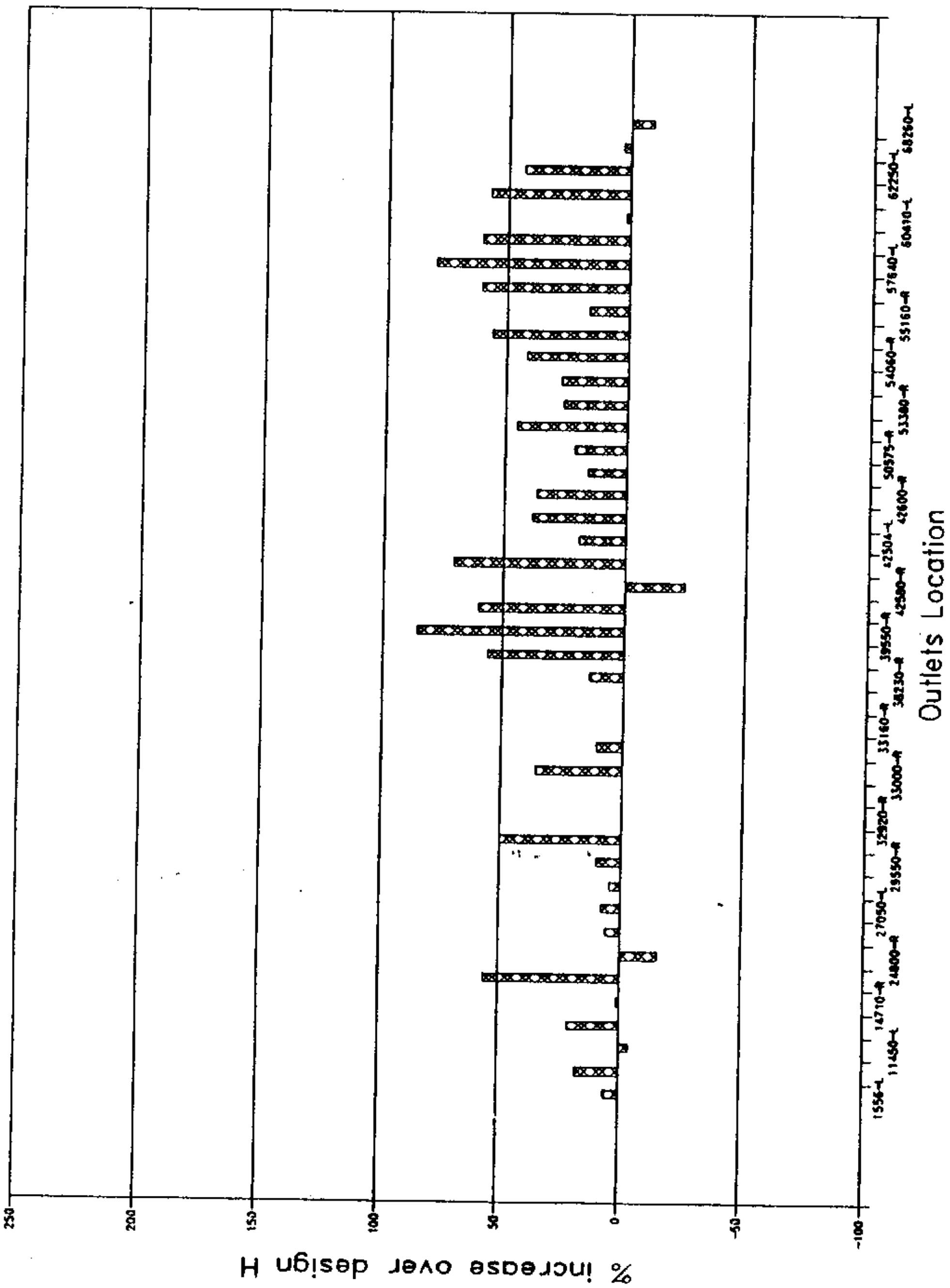

Fig: 3.12.9. Percentage change of actual upstream water levels for outlets with reference to the design water levels in Fordwah Distributary from RD 0 to RD 70.

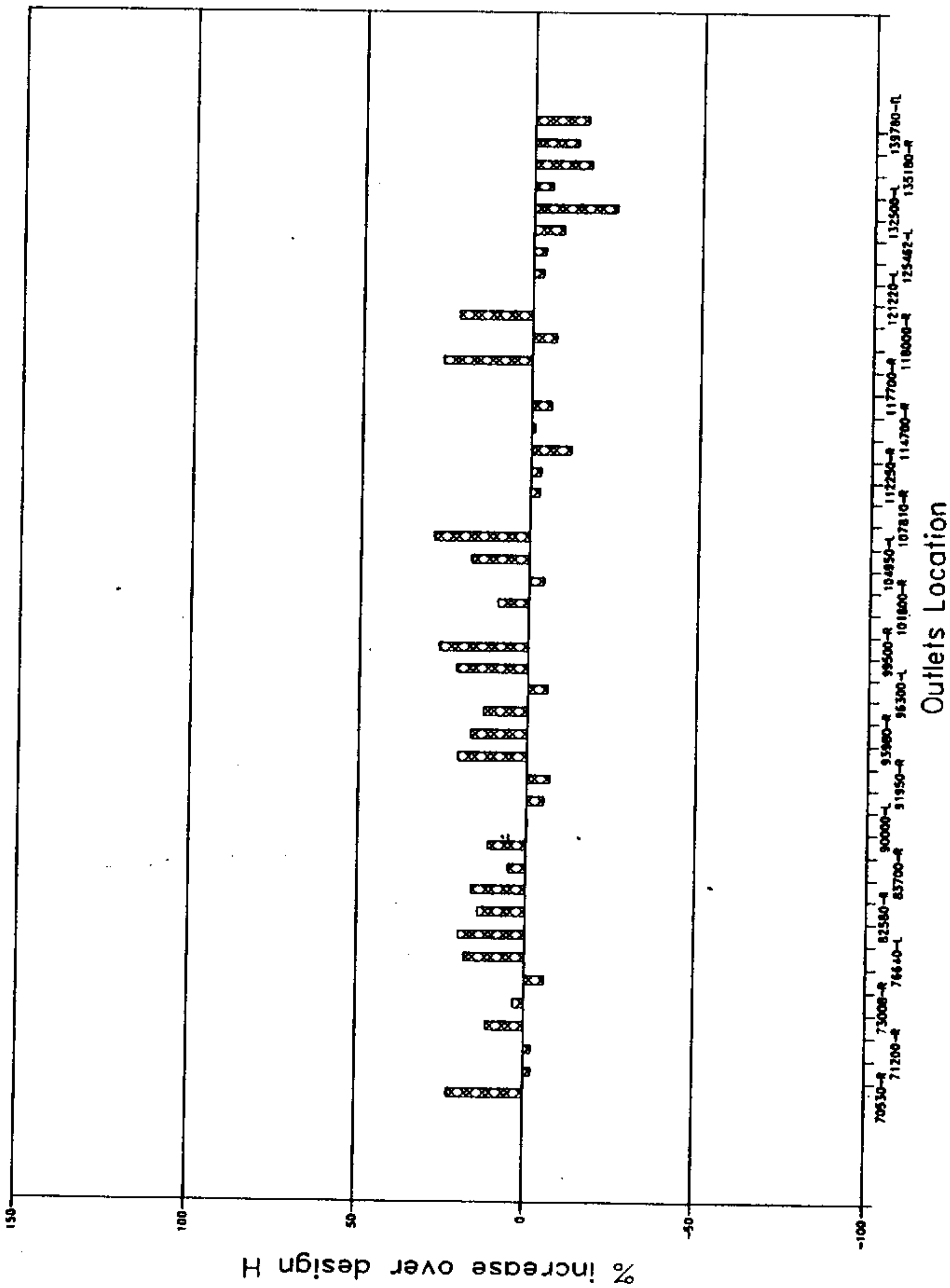

Fig: 3.12.10. Percentage change of actual upstream water levels for outlets with reference to the design water levels in Fordwah Distributary from RD 70 to tail.

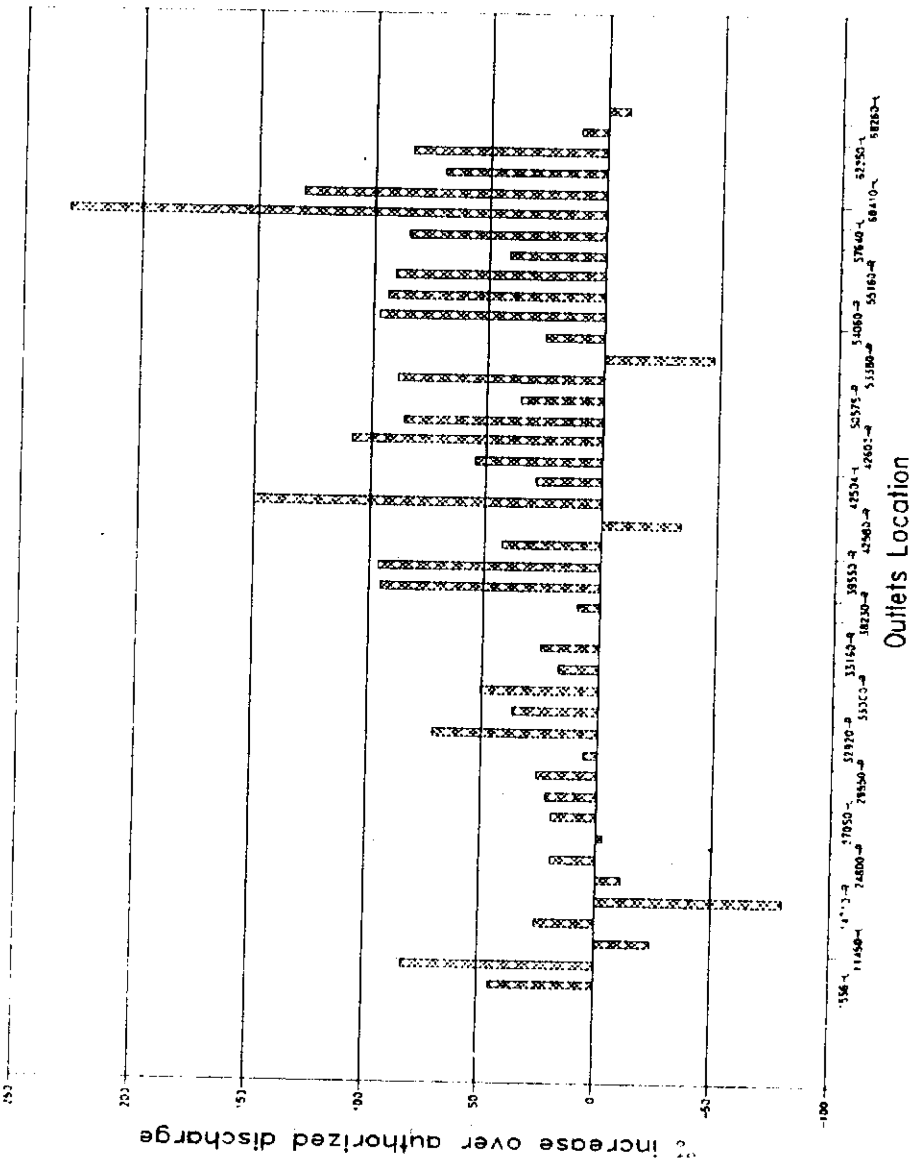

Fig: 3.12.11. Percentage change of actual discharges for outlets with reference to the authorized discharge in Fordwah Distributary from RD 0 to RD 70.

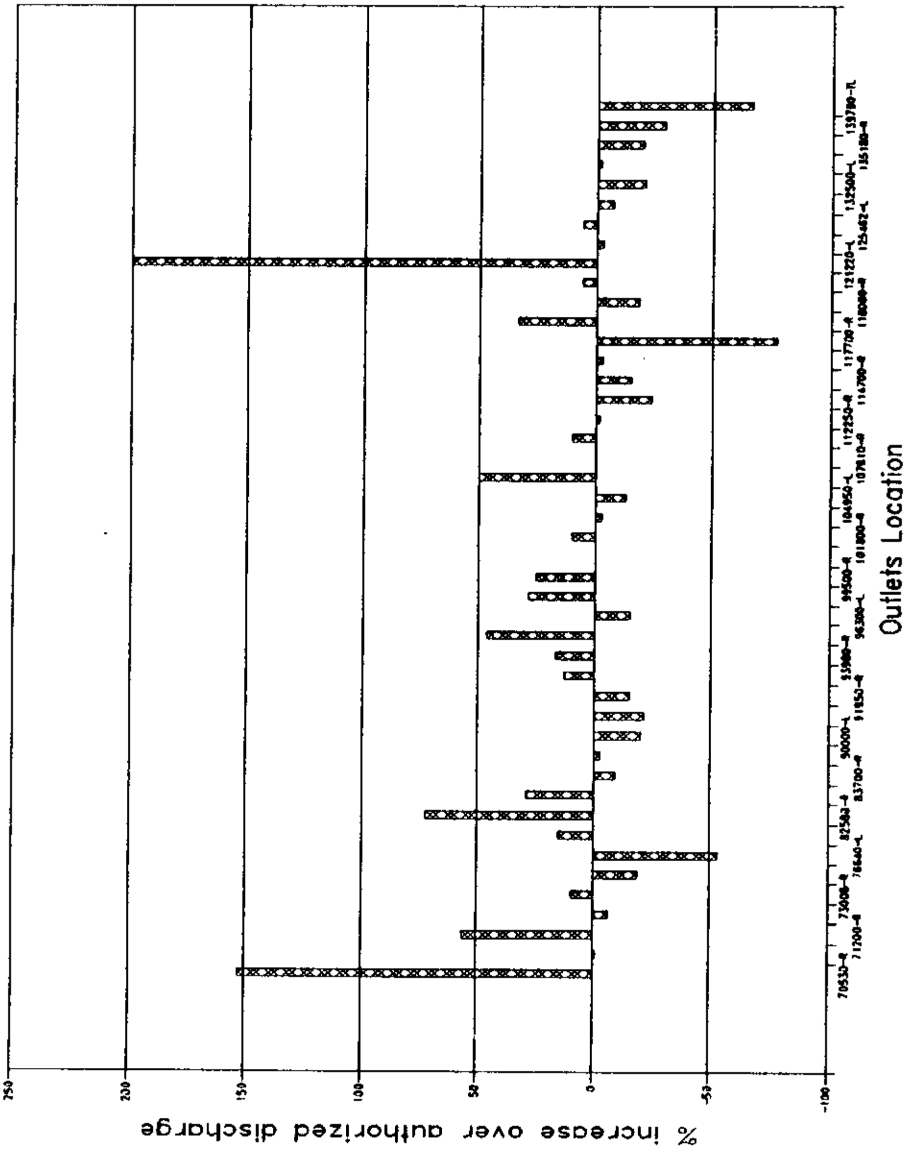

Fig: 3.12.12. Percentage change of actual discharges for outlets with reference to the authorized discharge in Fordwah Distributary from RD 70 to tail.

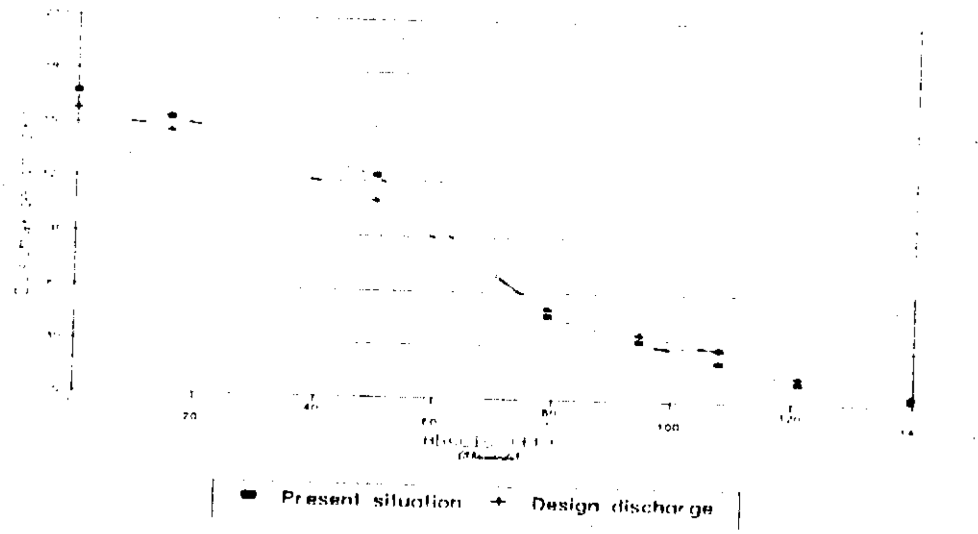

Fig: 3.12.13. Comparison between discharges at outlets, observed versus design, in Fordwah Distributry.

3.13 Mehmood Distributary

General

The inflow-outflow exercise was carried out on 13-11-1995 from 6.00 a.m. to 6.00 p.m. It was a pleasant sunny day, with temperatures ranging from 20° to 35°C. The discharge at the head was 18.8 cusecs, which is higher than its design discharge of 9 cusecs. Usually, this distributary runs at a discharge much higher than its design discharge.

Characteristics of outlets

Prior to the exercise, the characteristics of outlets were determined at site. The measured values of "B" and "Y" of the outlets of Mehmood Distributary are given in Annex 1. Only in a few cases outlets dimensions that were observed in the field differ substantially from the original design data (Figures 3.13.1 and 3.13.2). This is the case for Outlets 1030-R, 5200-R and 13770-L (only Y of the outlets). The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

Calibration of canal structures and outlets

During the day of the inflow-outflow exercise, the canal structures (drops) and the outlets of Mehmood Distributary were calibrated, thereby determining the C_d of these structures. Also, the C_d of the inlet structure of Mehmood, which had been established previously (IIMI, 1995) was verified on the day of the experiment.

The C_d of the head structure of Mehmood (ON) was determined at a value of 0.47. The tail trifurcates had water overtopping the division structure (OF), so it was not possible to calibrate these outlets. The complete list of C_d values is given in Annex 2.

On the day of the in flow-outflow exercise, five outlets had free flow conditions (OM), while five outlets had submerged flow conditions (ON). Two outlets (OF) were running as FS.

Water distribution

The discharge at the head of Mehmood Distributary was constant during the exercise (Figure 3.13.3). Similarly, the water level at the outflow point (tail) was constant (see Figure 3.13.4).

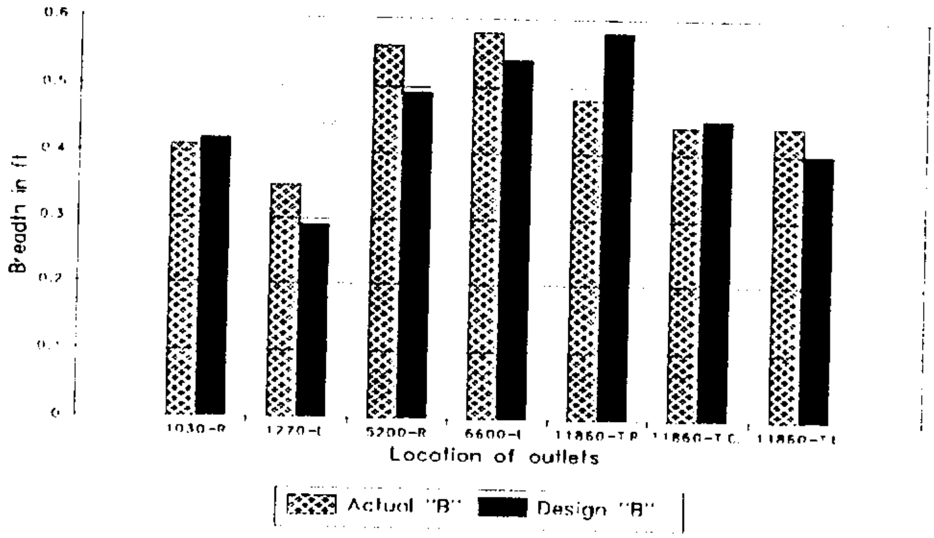

Fig: 3.13.1. Comparison of breadth "B" of outlets in Mehmood Distributary, observed versus records.

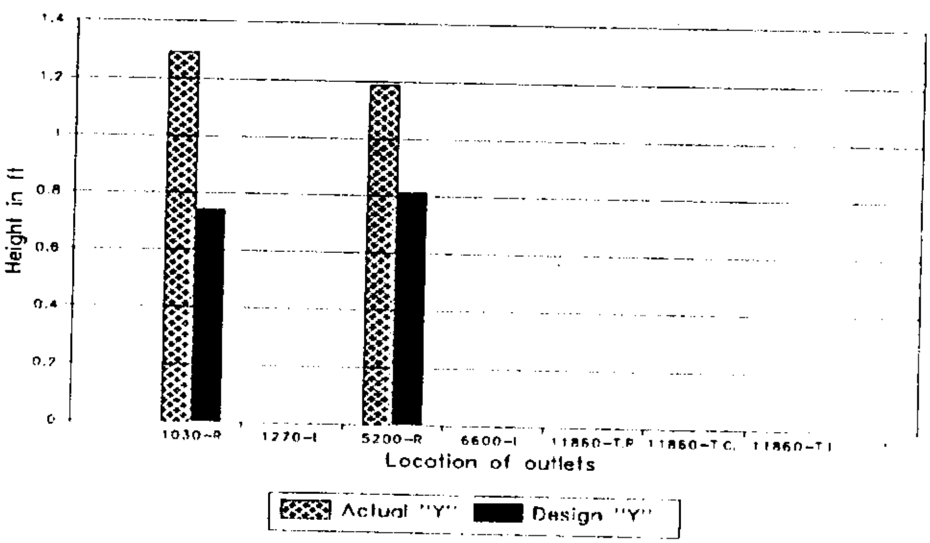

Fig: 3.13.2. Comparison of height "Y" of outlets in Mehmood Distributary, observed versus records.

In Annex 3, the observed water levels and corresponding discharges for the outlets of Mehmood Distributary are presented. The observed water levels are, in all cases, higher than the original target or design water levels, which results in higher discharges for all outlets. One of the reasons for these high water levels is the fact that the bed level of the distributary is higher than the design level. This is depicted in Figure 3.13.5, which shows that, on average, the bed level of the distributary is higher than the crest level of the off-taking outlets. Originally, these outlets were placed slightly above the bed level (at around 0.1 of the water depth) of the distributary. However, the main reason for the higher water levels is the fact that this distributary is taking more than 100% more discharge than design at the head. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.13.6 and Figure 3.13.7. An overall picture of the water flow in the distributary is presented in Figure 3.13.8.

Inflow-outflow

Seepage losses were determined for different reaches of the distributary. The results are presented in Table 3.13.1. The seepage losses are very low in this distributary. The banks of the distributary are in poor condition, resulting in some losses.

Table 3.13.1. Seepage losses for Mehmood Distributary.

Reach (RD)	No. of outlets	Total discharge of outlets (cfs)	Inflow (cfs)	Outflow (cfs)	Seepage (cfs)	Wetted area (msf)	Seepage * cfs/msf
0-5100	2	3.32	18.80	15.45	0.03	0.073	0.43
5100-8000	2	5.28	15.45	10.15	0.02	0.051	0.39
8000-11860		**	10.15	10.09	0.06	0.048	1.26

* This is seepage and excessive withdrawal of outlets.

** It was not possible to measure the discharge of each outlet, seepage is calculated on the inflow-outflow bases for each reach.

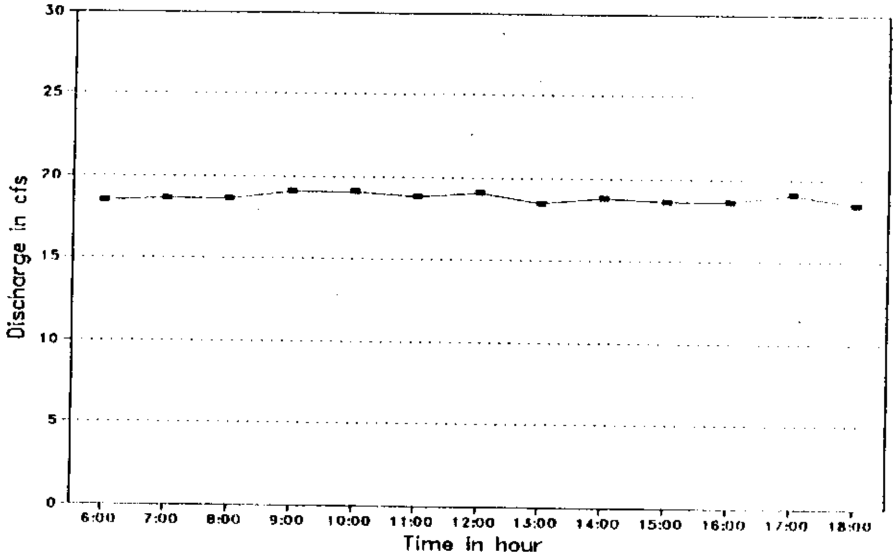

Fig: 3.13.3. Discharge at the head of the Mehmood Distributary during the inflow-outflow exercise.

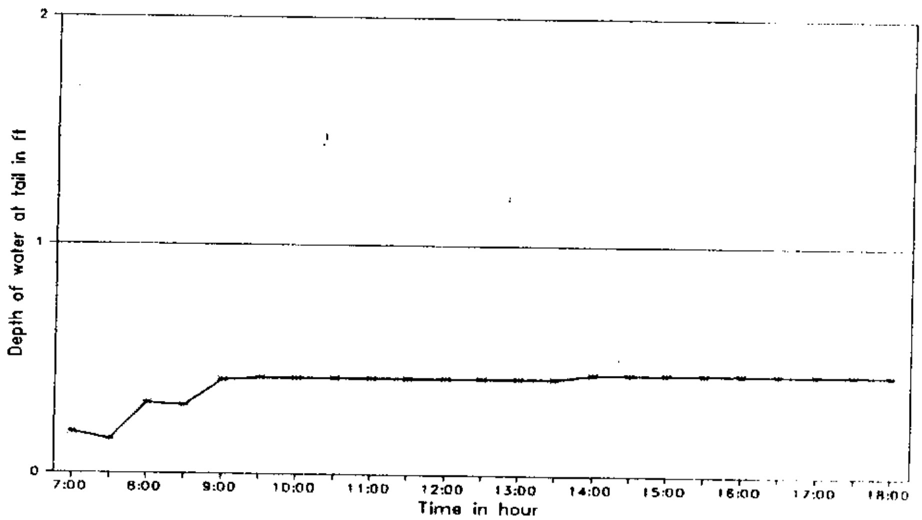

Fig: 3.13.4. Discharge at the tail of the Mehmood Distributary during the inflow-outflow exercise.

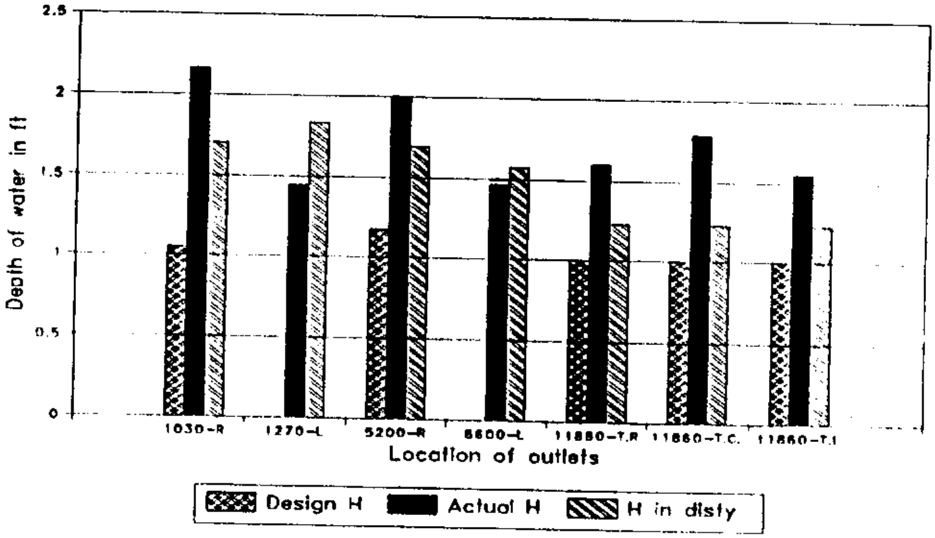

Fig: 3.13.5. Comparison between water levels at outlets (observed versus records) versus water level in the Mehmood Distributary.

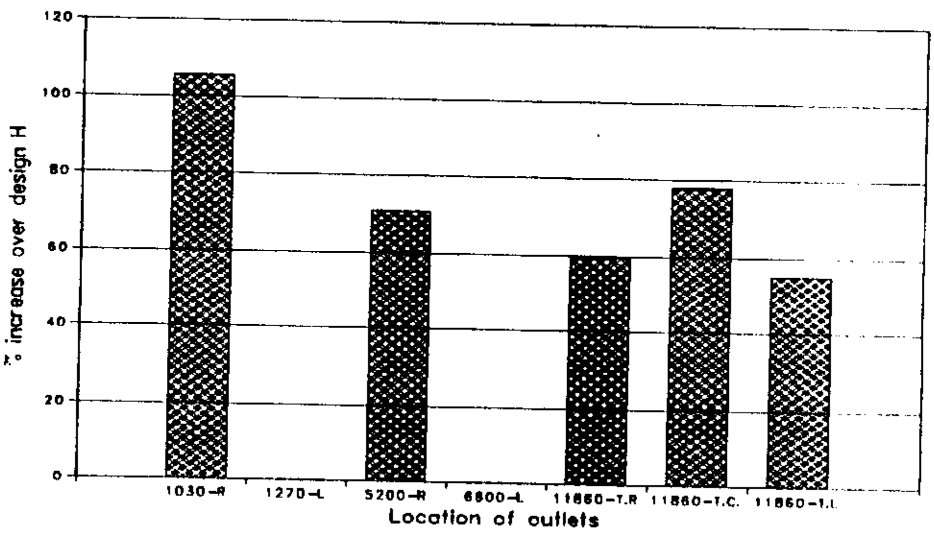

Fig: 3.13.6. Percentage change of actual upstream water levels for outlets with reference to the design water levels in Mehmood Distributary.

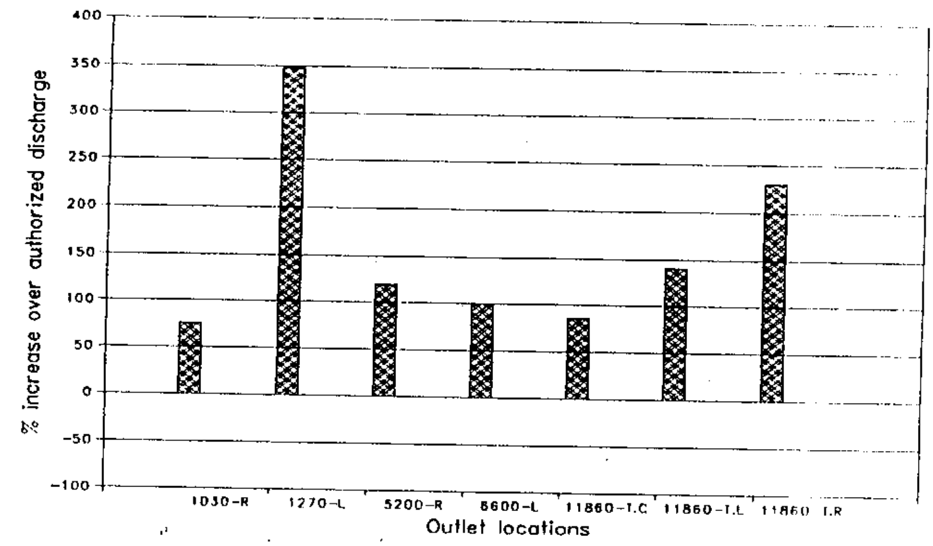

Fig: 3.13.7. Percentage change of actual discharges for outlets with reference to the authorized discharge in Mehmood Distributary.

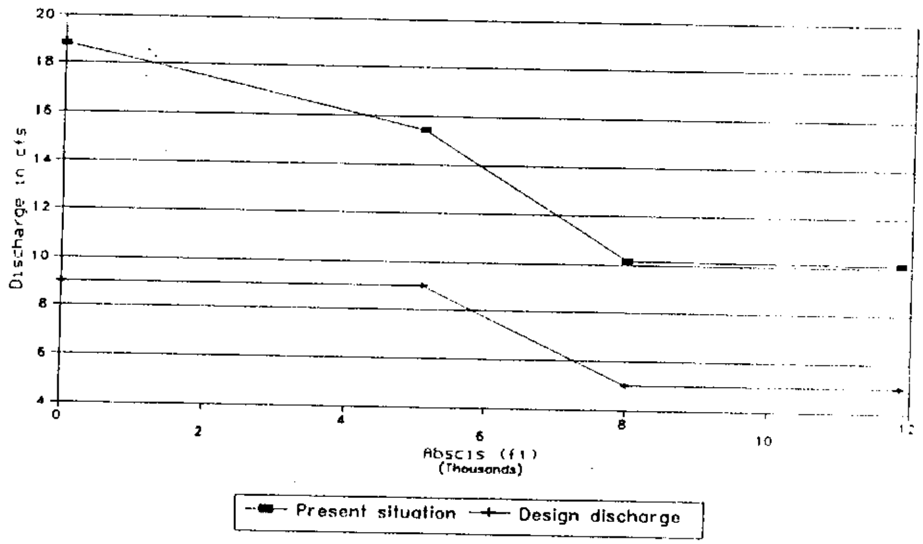

Fig: 3.13.8. Comparison between discharge in Mehmood Distributary, observed versus design.

3.14 Azim Distributary

General

The inflow-outflow exercise was carried out on 13 and 14 of October 1995 from 05.00 p.m. to 05.00 p.m. It was a pleasant sunny day, with temperatures ranging from 30° to 35° C. The discharge at the head was 198 cusecs, which is lower than its design discharge of 244 cusecs. Usually, this distributary runs at a discharge less than its design discharge. For the experiment, the tail of the distributary was assumed to be at RD 74000, which is generally the functional tail of this distributary. Farmers at this point made a bund in the distributary to draw all the water through a direct cut.

This distributary is used as an escape for the Fordwah Branch Canal by the Irrigation Department because the escape which was constructed at the tail of this branch was closed approximately 16 years ago.

This distributary has three minors, namely Rathi Minor at RD-28300 (10 outlets), Feroze Minor at RD-44200 (4 outlets) and Forest Minor at RD 92000 (4 outlets). There are 76 outlets out of which 10 are OCOFRB, 4 OCAPM, 40 OFRB, 18 APM, 1 OF, and 2 CTF.

On this distributary there are seven falls at RD 11500, RD 44500, RD 52500, RD 84500, RD 92000, RD 98000 and RD 114000.

Characteristics of outlets

Prior to the inflow-outflow exercise, the characteristics of the outlets were determined at site. The measured values of "B" and "Y" of the outlets of Azim are given in Annex 1. Only in a few cases outlets dimensions that were observed in the field differ substantially from the original design data (Figures 3.14.1 and 3.14.2). This is the case for Outlets 5100-R, 10710-R, 17580-R, 20610-L, 28460-R, 36250-R, 52220-R, 87500-R, 111940-R and 118980-TL. The elevations of the white marks, which were used during the exercise to determine h_u and h_d for all outlets, are given in Annex 2.

During the inflow-outflow exercise, seven outlets (from the head to the working tail) were found to be broken, three (illegal) pipes were found installed with outlets and 19 cuts were observed. This was the reason why the inflow-outflow exercise that was carried out in other distributaries could not be undertaken in Azim. Instead, losses and delivered discharges were measured (combined) reach-wise.

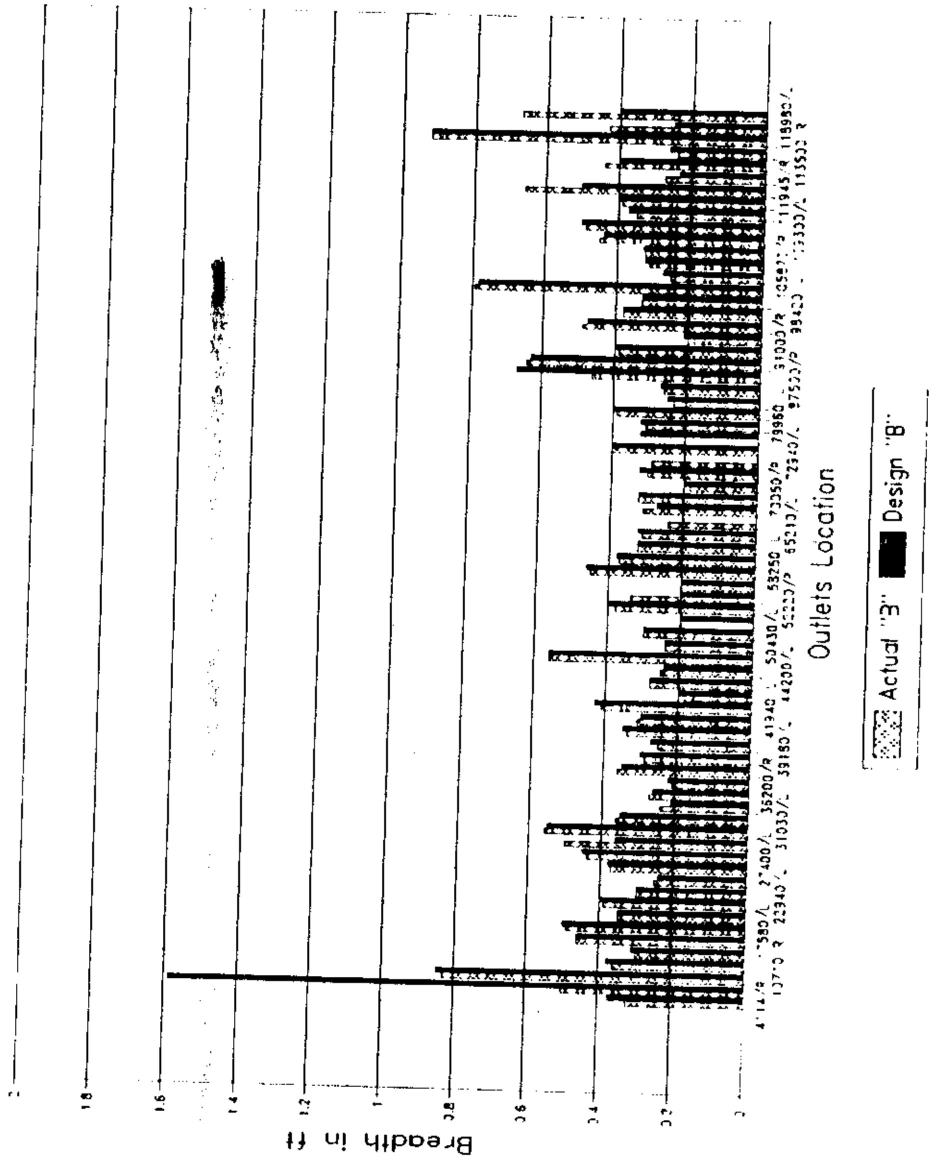

Fig: 3.14.1. Comparison of breadth "B" of outlets in Azim Distributary, observed versus records.

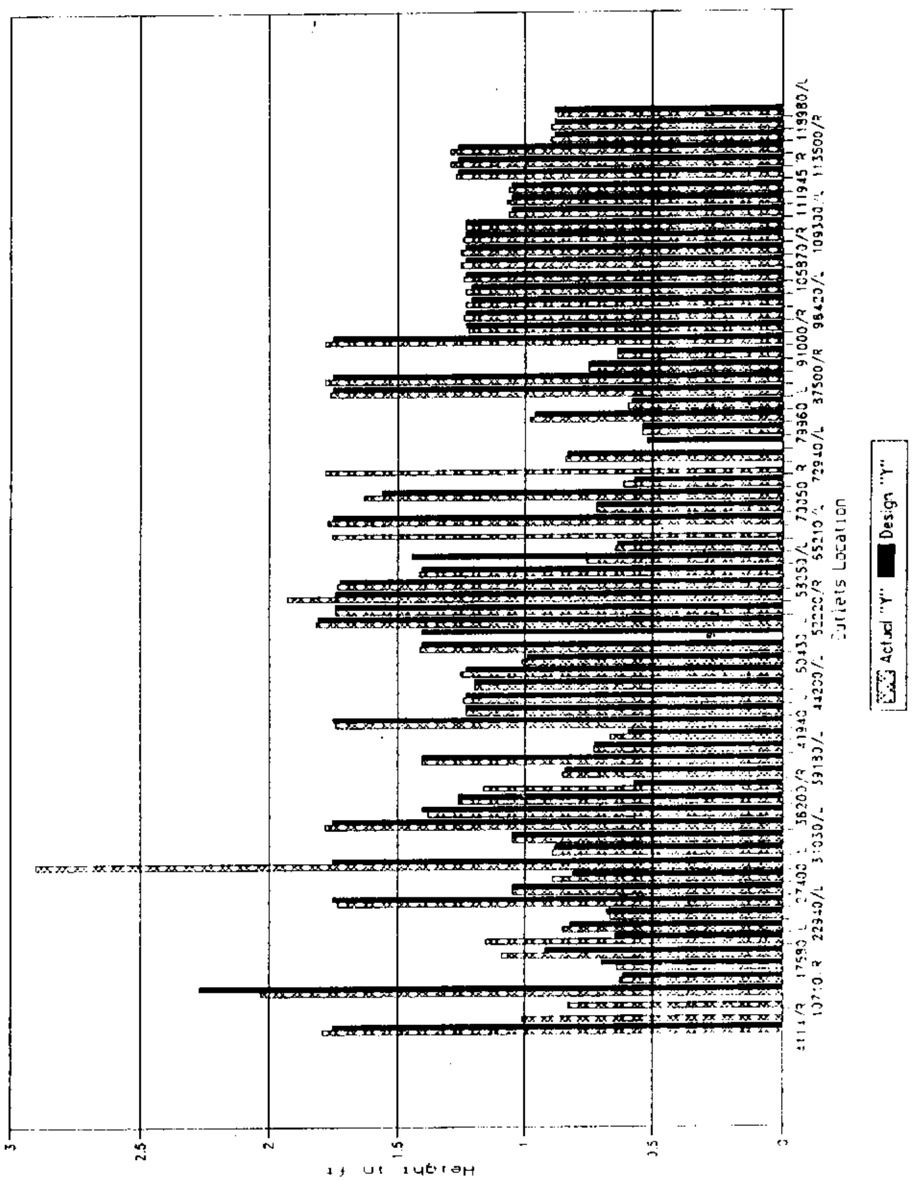

Fig: 3.14.2. Comparison of height "Y" of outlets in Azim Distributary, observed versus records.

Calibration of canal structures and outlets

During the day of the inflow-outflow exercise, the canal structures (falls) and the outlets of Azim Distributary were calibrated, thereby determining the C_d of these structures. Also, the C_d of the inlet structure of Azim, which had been established previously (IIMI, 1995) was verified on the day of the experiment. The C_d of the head structure of Azim (OM) was determined at a value of 0.59. For the drops, RD-11500 and RD-44500, the values of C_d were found to be 11.6 and 0.17, respectively.

The discharge coefficients of outlets were not calculated, because mostly outlets were broken, or there were cuts with the outlets (Annex 1).

Water distribution

The discharge at the head of Azim Distributary was constant during the exercise, except from 20:00 to 21:00 on 13-10-1995, when the discharge decreased approximately 5 cfs, and after 13:00 on 14-10-1995, when the discharge decreased but this did not affect the exercise (Figure 3.14.3). Similarly, the discharge at RD 11500, RD 44500,RD 52500 and the gauge at the outflow point were constant (Figures 3.14.3a, 3b, 3c and 4).

In Annex 3, the observed water levels and corresponding discharges for the outlets of Azim are presented. The observed water levels are, in almost all cases, higher than the original target or design water levels, One of the reasons for these high water levels is the fact that the bed level of the distributary is much higher than the design level. This is depicted in Figure 3.14.5, which shows that, on average, the bed level of the distributary is higher than the crest level of the off-taking outlets. Originally, these outlets were placed slightly above the bed level (at around 0.1 of the water depth) of the distributary. The discharge of different outlets were much higher than design, due to the fact that outlets are broken and the presence of cuts. The resulting water levels above the crests of the outlets, and the corresponding discharges, are shown in Figure 3.14.6. An overall picture of the water flow in the distributary is presented in Figure 3.14.7.

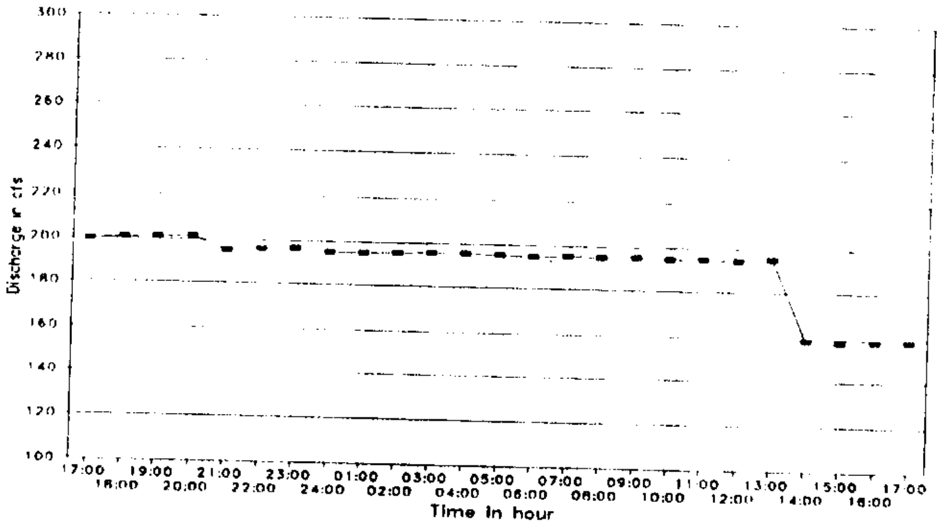

Fig: 3.14.3. Discharge at the head of the Azim Distributary during the inflow-outflow exercise.

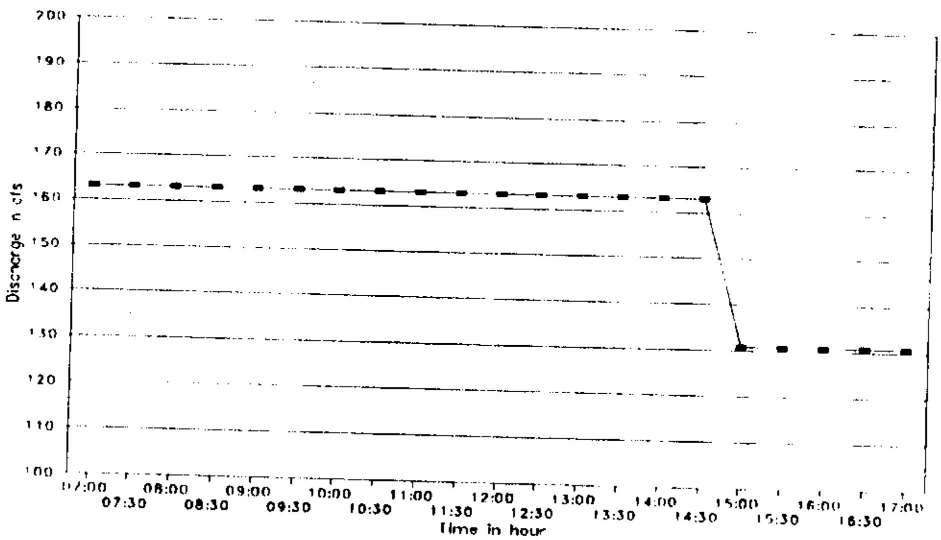

Fig: 3.14.3a. Discharge at RD 11500 of the Azim Distributary during the inflow-outflow exercise.

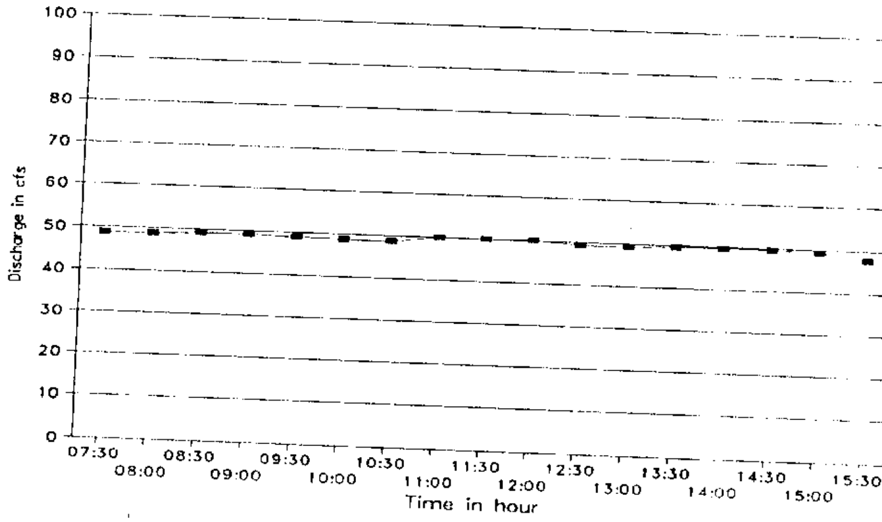

Fig: 3.14.3b. Discharge at RD 44500 of the Azim Distributary during the inflow-outflow exercise.

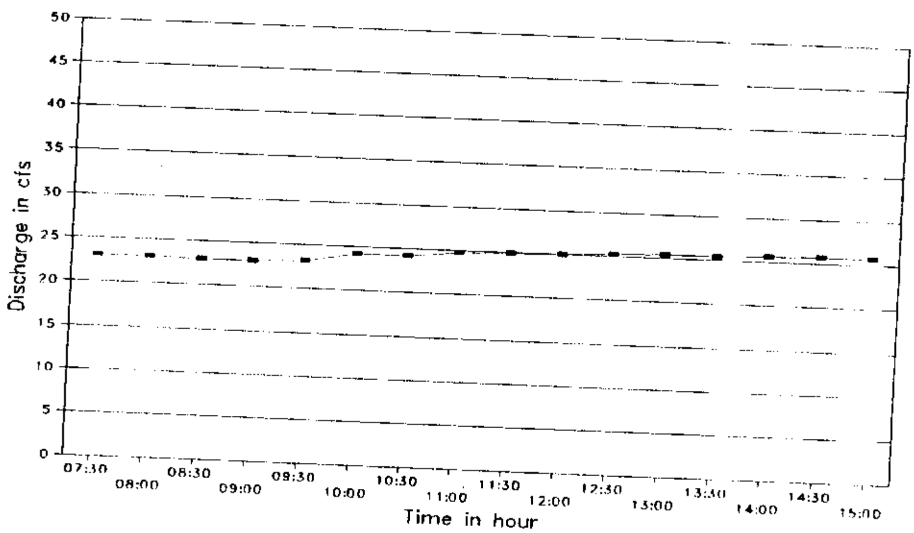

Fig: 3.14.3c. Discharge at RD 52500 of the Azim Distributary during the inflow-outflow exercise.

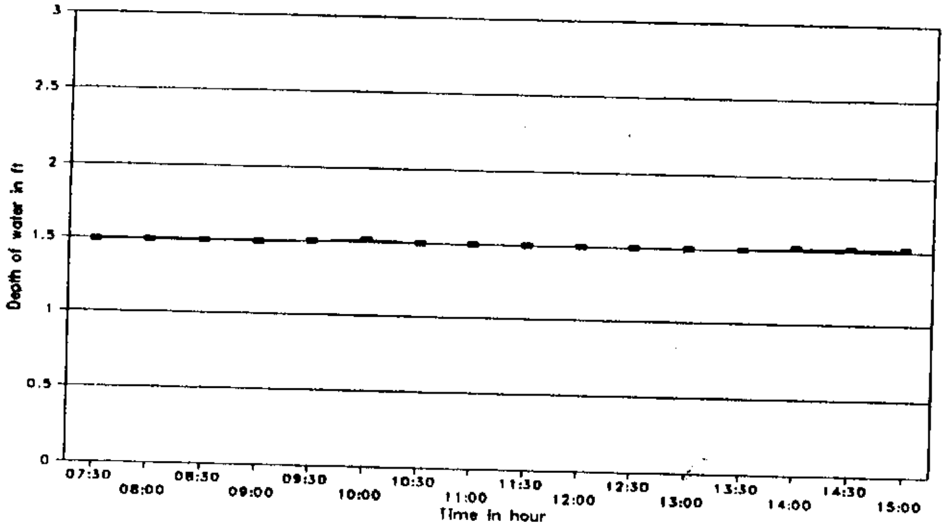

Fig: 3.14.4. **Depth of water at the working tail of the Azim Distributary during the inflow-outflow exercise.**

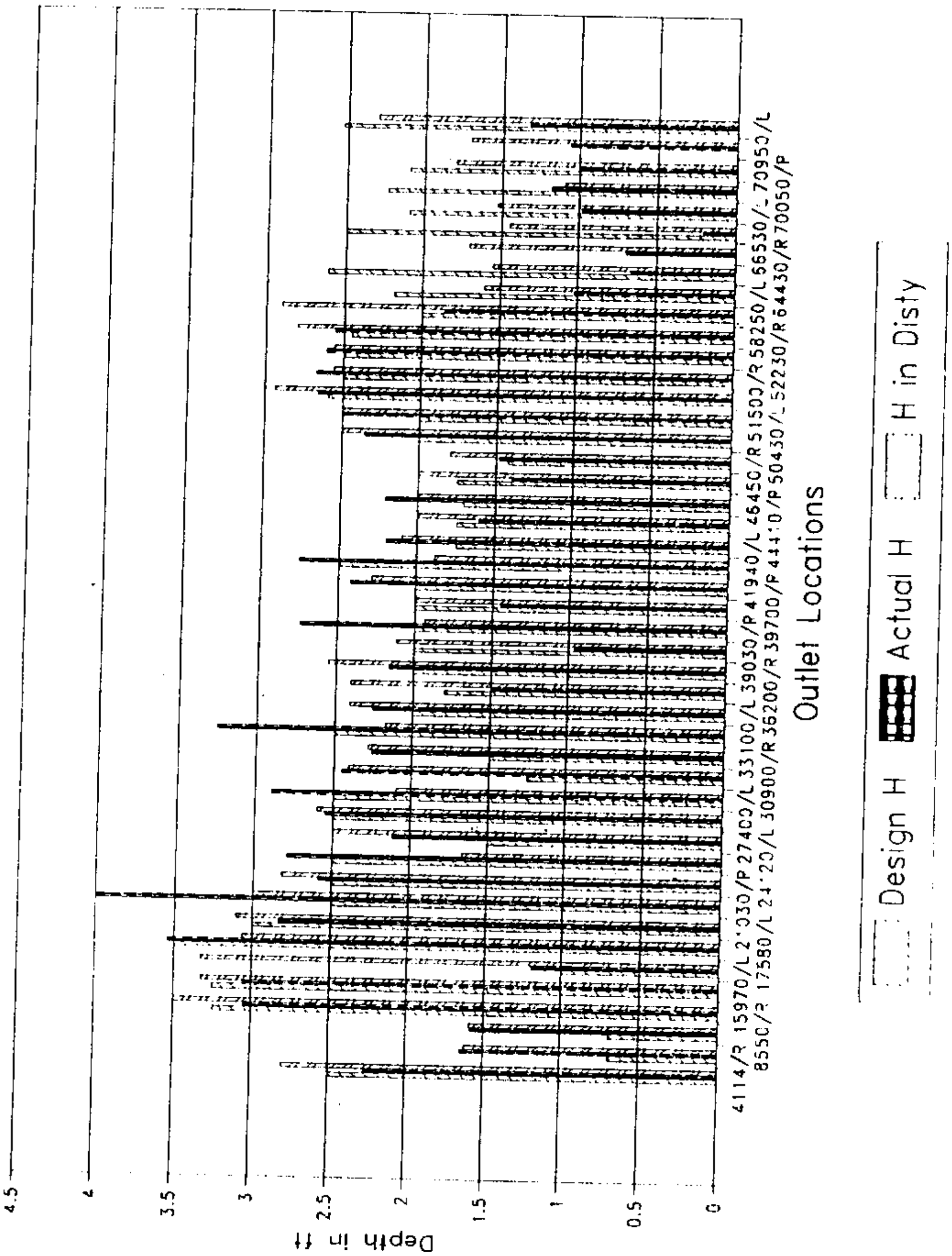

Fig: 3.14.5. Comparison between water levels at outlets (observed versus records) versus water level in the Azim Distributary.

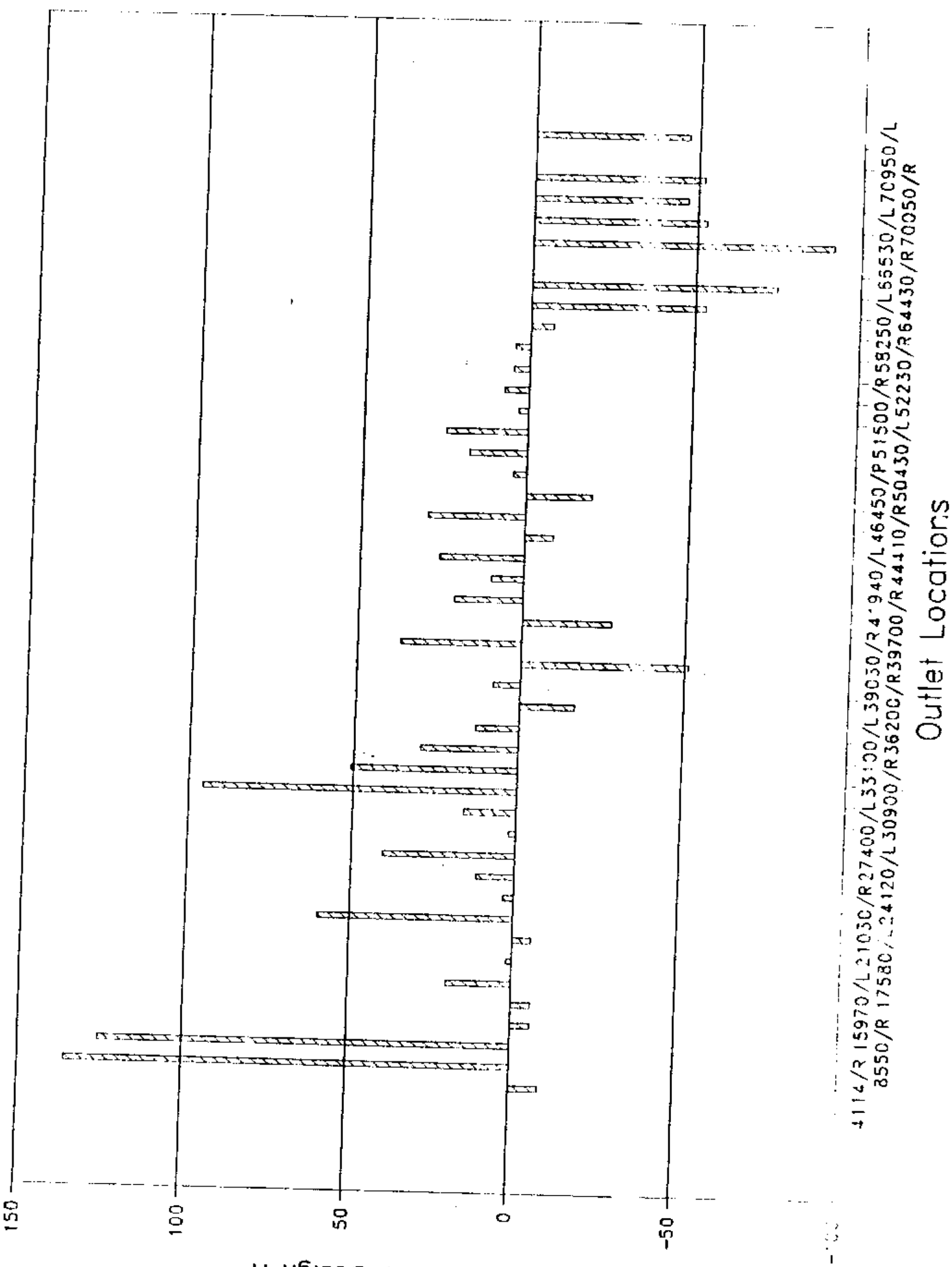

Fig: 3.14.6. Percentage change of actual upstream water levels for outlets with reference to the designed water levels in Azim Distributary.

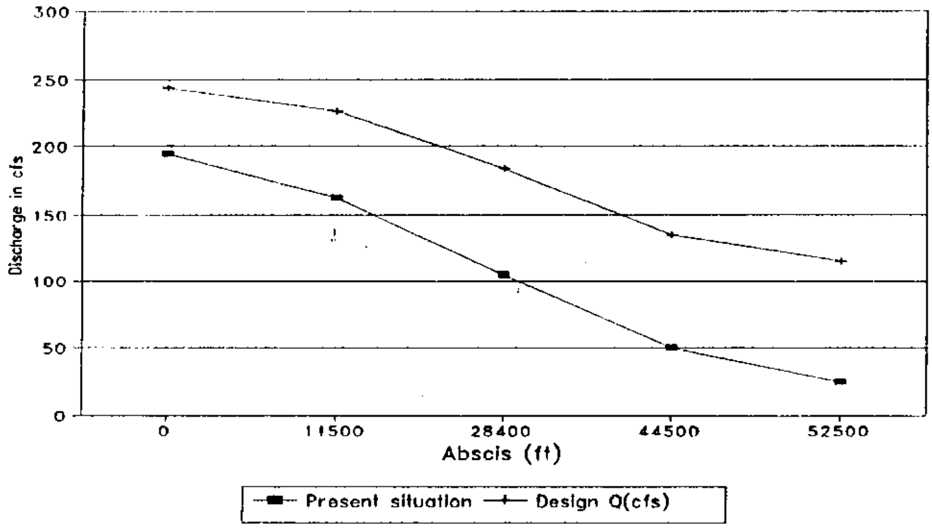

Fig: 3.14.7. Comparison between discharge at outlets, observed versus design, in Azim Distributary.

Inflow-outflow

Outflow were determined for different reaches of the Azim Distributary. The results are presented in Table 3.14.1. Clearly, much water is drawn by the different outlets in the head reach of Azim, resulting in a functional tail at RD 74000 instead of 118000. Since the classical inflow-outflow test was not possible in this distributary, the outflow to the command area comprises of both water delivered through outlets as well as through cuts. Also, seepage is included in here.

Table 3.14.1. Outlets for Azim Distributary.

Reach (Rds)	Inflow (cfs)	Outflow by disty/ minor (cfs)	Outflow to command area (cuts + outlets) (cfs)	Design discharge of outlets (cfs)	Difference (cfs)
0 to 11800	194.81	162.38	32.43	13.93	18.50
11500 to 28400	162.38	124.04	38.34	22.69	15.65
28400 to 44500	104.74	55.60	49.14	27.85	21.29
44500 to 52500	49.87	25.40	24.47	17.94	6.53
52500 to 74000	25.40	working tail	25.40	20.63	4.77

3.15 Summary of results

In this section the results of the inflow-outflow experiments are summarized in order to permit an overall view of: (1) the discharge delivered to outlets; (2) the discharge coefficients of outlets; and (3) the seepage that has been measured for the distributaries.

<u>Water delivery</u>

In Table 3.15.1, the deliveries to outlets are summarized with reference to the authorized discharge. The deviation from the authorized discharge is established using the following formula:

$$\Delta = \frac{Q_{act} - Q_{des}}{Q_{des}} \times 100$$

Table 3.15.1. Deviation of actual deliveries from authorized deliveries $\frac{(q_{act} - q_{auth})}{q_{auth}}$ for outlets in Chishtian Sub-division.

Distributary	Deviation <20% (No. of outlets)	Deviation <50% (No. of outlets)	Deviation >50% (No. od outlets)
3-L	4	5	1
Mohar	3	9	5
Daulat	20	47	19
Phogan	0	4	5
4-L	1	2	5
Khemgarh	1	3	6
Jagir	3	7	2
Shahar Farid	9	22	44
Masood	6	7	7
Soda	11	21	12
5-L	1	2	2
Fordwah	34	59	30
Mehmud	0	0	7
Azim[4]	22	48	32
Total	115	236	177

The validity of the authorized discharge as a reference can be questioned when about 40 % of the outlets in the Chishtian Sub-division are drawing a discharge, which is more than 50 % in excess of the design discharge.

[4] *As detailed in the specific section on Azim (3.14), discharges to outlets are estimated by dividing the total delivered discharge in a reach proportionately over all outlets. A 5 % seepage rate is taken into account and minors are assumed to take the design discharge.*

Conveyance losses

The experiments provided good measurement regarding seepage rates in distributaries in the Chishtian Sub-division. The results are summarized in Table 3.15.2.

Table 3.15.2. Seepage from the secondary channels (distributaries) of Chishtian Sub-division.

Distributary	Inflow (cfs)	Total discharge of outlets (cfs)	Actual seepage (cfs)	Wetted area (msf)	Seepage (cfs/msf)
3-L	20.1	19.6	0.5	0.2	3.0
Daulat	153.8	146.7	7.2	2.7	2.6
Mohar	33.7	32.9	0.8	0.3	2.8
Phogan	28.5	27.7	0.8	0.1	8.7
4-L	17.0	17.2	-0.3	0.1	-1.9
Khemgarh	42.7	39.8	2.9	0.1	20.9
Jagir	26.5	26.3	0.2	0.1	1.9
Shahar Farid	134.3	120.3	14.1	1.4	10.2
Masood	23.1	23.7	-0.6	0.5	-1.2
Soda	77.8	72.5	5.3	0.7	7.2
5-L	3.9	3.3	0.6	0.1	11.6
Fordwah	167.3	160.4	7.0	3.3	2.1
Mahmood	18.8	18.7	0.1	0.2	0.7
Azim	194.8				

The seepage for those distributaries running close to the Fordwah Branch Canal (3-L, Mohar, 4-L, Khemgarh, Jagir and Masood) is much lower than for the other distributaries. Only in the case of Khemgarh, whose banks had recently been destroyed by contractors was a much higher loss rate found to exist.

Discharge coefficients

The C_d values that were obtained while calibrating outlets in the Chishtian Sub-division are given in Table 3.15.3.

Table 3.15.3. Coefficients of discharge (C_d) for outlets in the Chishtian Sub-division.

Outlet type	Flow condition	Total number	Average C_d	CV
OFRB	OM	90	0.51	0.27
APM	OM	51	0.68	0.26
OFRB/APM	ON	36	0.76	0.32
PIPE	ON	20	0.83	0.32
OF	FF	26	0.38	0.23
OF	FS	4	0.91	0.14

The coefficients of variation (CV) are fairly low for the various combinations of outlet structures and flow conditions. This is depicted also in Figure 3.15.1.

In the 14 distributaries of the Chishtian Sub-division (minors not included), there are a total of 413 outlets, out of which 227 outlets were calibrated. A total of 86 outlets were found broken, while 2 outlets were either closed or water was overtopping, which prevented them from being calibrated. A total of 26 outlets in the tail end of Azim Distributary did not get any water, since farmers put a bund at RD 72490. Also, 19 outlets at the tail of Shahar Farid Distributary were without any water, as was the case for the last 6 outlets of Daulat Distributary.

CHAPTER 4. WATER DISTRIBUTION IN THE CHISHTIAN SUB-DIVISION: A DISCUSSION

4.1 Equity in distribution

As stated before, water distribution at the secondary level in the Punjab is governed by the principles of equity and proportionality. In this study, the water distribution in distributaries in the Chishtian Sub-division will be evaluated in terms of equity of deliveries to watercourses based on their current water allowance. The data are not sufficient to evaluate the proportionality principle.

To evaluate the equity principle, two performance indicators are proposed:

(1) Molden and Gates (1990) have proposed an equity indicator (P_E), which defines the equity of water distribution, irrespective of the average level of supply, by dividing the standard deviation of the water delivery of a sample (i.e. watercourses) by the mean. The deliveries are corrected for the intended discharges by dividing the actual discharge by the authorized discharge.

$$P_E \equiv \frac{1}{T} \sum_T CV_R \frac{Q_{act}}{Q_{auth}}$$

Molden and Gates take a value of 0 to 0.1 for P_E to represent good performance, while a value from 0.1 to 0.2 is considered 'fair'. Any score above 0.2 indicates a poor performance (i.e. inequitable distribution).

(2) The Modified Inter Quartile Ratio (MIQR) was proposed by Abernethy (1986), who defined it as the ratio of average depth of water received by all lands in the highest quarter of the command area and the average depth of water supplied to the poorest quarter. In the case of the distributaries of the Chishtian Sub-division, the target would be ratio of unit for actual discharge over authorized discharge.

$$MIQR \equiv \frac{(averageDPR_1)}{(averageDPR_4)}$$

in which

$$DPR = \frac{Q_{act}}{Q_{auth}}$$

Since both indicators do not reflect the level of supplies to distributaries, an extra supply indicator is added, which will help evaluate the results of the application of the two equity indicators:

(3) The Delivery Performance Ratio (DPR) is often defined as the ration of actually delivered discharge divided by the water demand, or by the target. Since the authorized discharge serves as the target in this system, the DPR is defined as:

$$DPR = \frac{Q_{act}}{Q_{auth}}$$

The results of applying these indicators to the water distribution in the Chishtian Sub-division are summarized in Table 4.1.1.

Table 4.1.1. Equity indicators of water distribution at the secondary level in the Chishtian Sub-division .

Distributary	DPR_{avg}	CV (DPR)	MIQR
3-L	0.95	0.37	-
Daulat	0.95	0.64	7.29
Mohar	1.22	0.35	2.62
Phogan	1.35	0.58	3.05
4-L	1.31	0.45	3.31
Khemgarh	1.84	0.41	2.75
Jagir	1.08	0.34	2.59
Shahar Farid	1.26	0.65	7.56
Masood	1.08	0.34	5.10
Soda	1.20	0.54	4.37
5-L	1.40	0.29	-
Fordwah	1.26	0.45	3.13
Mehmood	2.56	0.34	2.07
Azim	0.90	0.76	-

The determination of the MIQR for 3-L and 5-L is not meaningful, since the number of outlets in these distributaries is too small. MIQR cannot be calculated for Azim, because the average discharge for the poorest quartile is 0, which would result in a 0 in the denominator.

In general, equity is not attained in distributaries in the Chishtian Sub-division, when CV(DPR) ranges from 0.29 to 0.76, a score Molden and Gates (1990) would award with "poor". The MIQR also gives sufficient evidence of the existing inequity with values superior to 2 for all distributaries.

The values of the indicators seem to be related to the length of the distributary, as depicted in Figure 4.1.1. There is a general trend of an increase in CV with the length of the distributary and the number of outlets. There are two exceptions to the trend. Fordwah Distributary, a long secondary canal, has a surprisingly low CV value, whereas Phogan has a CV, which seems very high for its length. In Phogan, there is an outlet at the tail that was closed by farmers during the experiment, thereby explaining the high value of CV. Fordwah Distributary attains a remarkable equity in water distribution, given its length.

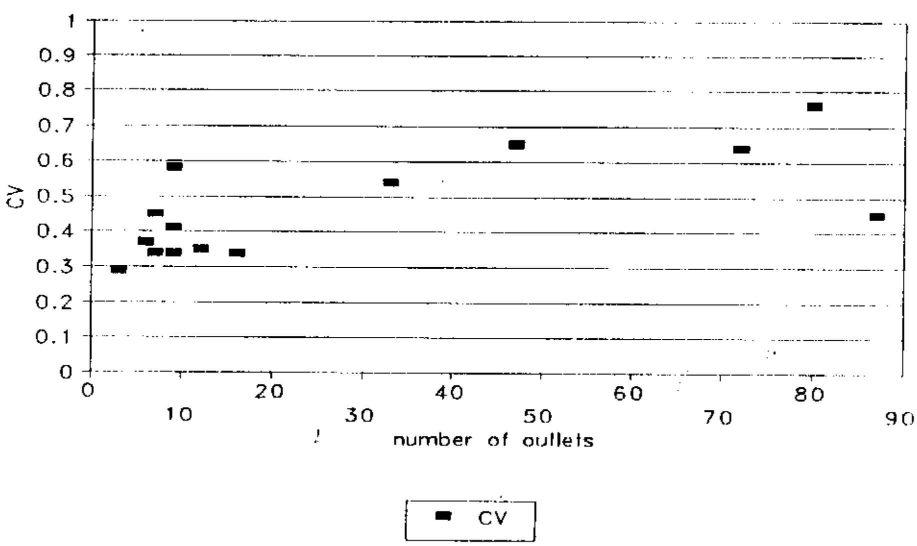

Fig: 4.1.1. Equity of distribution in secondary canals as a function of the number of outlets along the channel.

One of the possible causes for the inequity of water distribution is the sediment deposition (siltation). To estimate actual versus design cross-sections, the actual water depth above the outlet ($H_{u(act)}$) was compared with the design depth ($H_{u(des)}$) and with the actual water depth in the distributary (H_{dis}). If $H_{u(act)}$ is larger than $H_{u(des)}$, this may be an indication of siltation, particularly if it is also greater than $H_{dis(act)}$ (see Figure 2.7). The siltation is then estimated by the following formula:

$$Siltation = (H_{u(act)} - H_{dis(act)}) - (H_{u(des)} - H_{dis(des)})$$

In Table 4.1.2, the average values of the water depths above outlets and in the distributaries are presented, along with the estimated siltation. The siltation varies considerably between distributaries.

Table 4.1.2. Siltation in distributaries of the Chishtian Sub-division.

Distributary	Estimated siltation (feet)
3-L	0.24
Daulat	0.88
Mohar	0.61
Phogan	0.94
4-L	0.20
Khemgarh	0.93
Jagir	0.74
Shahar Farid	1.29
Masood	0.68
Soda	0.97
5-L	0.49
Fordwah	0.61
Mehmud	0.59
Azim	1.01

Even within distributaries, there is a considerable variation in siltation. An example is given in Figure 4.1.3, where the siltation along the length of the distributary is presented for Azim.

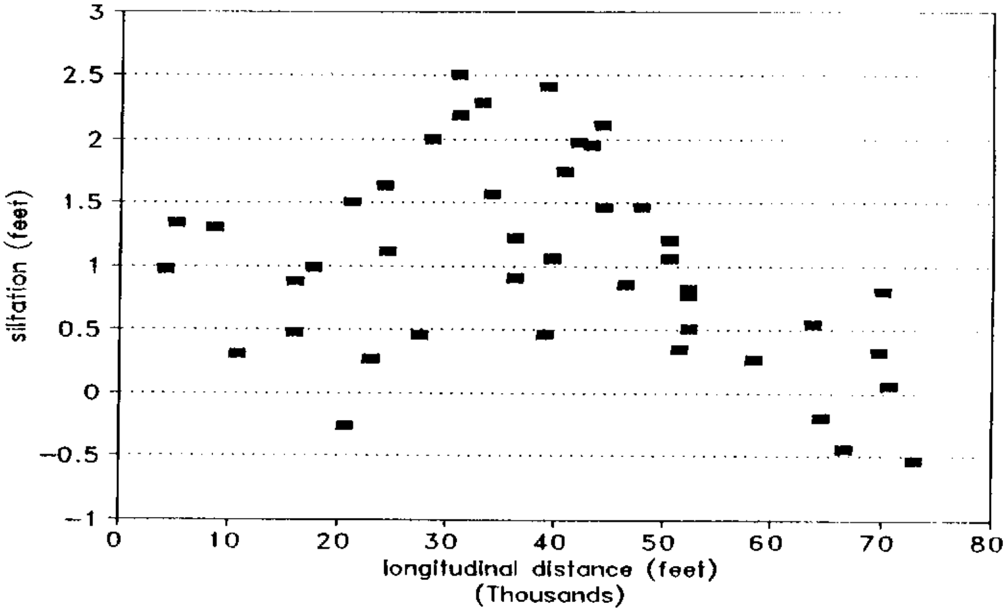

Fig: 4.1.3. Siltation depth along Azim Distributary.

4.2 Conveyance losses

The conveyance losses that were established in the field were compared with the expected losses of the Irrigation Department. These losses are calculated using the following formula[5] (Ali, 1993):

$$Q_L = 0.0133 \times l \times Q^{0.5625}$$

in which Q_L represents the conveyance losses and l is the length of the canal reach. The total conveyance losses are obtained by adding the losses for all reaches. The results are given in Table 4.2.1.

Table 4.2.1. Conveyance losses for distributaries in the Chishtian Sub-division: actual versus theoretical losses

Distributary	Inflow (cfs)	Actual seepage (cfs)	Theoretical seepage (cfs)
3-L	20.1	0.5	1.2
Mohar	33.7	0.8	1.4
Daulat	153.8	7.2	18.2
Phogan	28.5	0.8	0.7
4-L	17.0	-0.3	0.9
Khemgarh	42.7	2.9	1.0
Jagir	26.5	0.2	0.7
Shahar Farid	134.3	14.1	8.5
Masood	23.1	-0.6	2.9
Soda	77.8	5.3	5.1
5-L	3.9	0.6	0.3
Fordwah	167.3	7.0	25.0
Mahmood	18.8	0.1	0.7
Azim	194.8	2.08*	12.6

[5] *To verify the formula of Ali, the value obtained for Fordwah Distributary was cross-checked with a value deducted from the design drawings of Fordwah Distributary. A value of 23.8 cusecs is obtained, which is very close to the value calculated with Ali's formula (25.0).*

Losses for distributaries running parallel to the Fordwah Branch Branch are much below the expectations used in design, effectively delivering more water to the outlets. In some cases there is even a net gain[6]. Losses for the distributaries that are not parallel to Fordwah Branch Canal are much more in accordance with ID design expectations. Exceptions are Shahar Farid and Fordwah distributaries, where seepage is higher and lower respectively than expected. These distributaries would be interesting cases for further study on conveyance losses. The poor condition of the banks of Shahar Farid Distributary would seem to be one part of the explanation.

4.3 Calibration of outlets

Generally, the C_d coefficient for OFRB is assumed to be around 0.5 to 0.6 for free flow conditions (OM), while C_d is thought to be 0.36 for flumes with free flow conditions (FF) (Ali, 1993, Visser, 1996). For submerged flow conditions, no references are available. For pipe outlets, a range of 0.63 to 0.74 is given, the latter value associated with "drowned" flow conditions.

The results presented in Table 3.15.3 show a clear distinction between C_d coefficients of OFRB and AOSM. This is probably due to the difference in the upstream face of the orifice. The APM has a rounded face to prevent the jet from contracting, while the OFRB has a straight face, since it was originally designed as an open flume. The consequence is that the AOSM will draw comparatively more water than an OFRB. The average value of C_d for the OFRB compares very well with the value given by Visser (ibid).

The reference C_d given in the literature for the AOSM is 7.3 using the following formula (Ali, 1993):

$$q = 7.3 \times B_t \times Y \times \sqrt{H_s}$$

where

$$H_s = H_u - Y$$

---

6 *During the course of the experiments, a net gain was determined for Masood Distributary. When the experiment was repeated during a time when the water level in Fordwah Branch Canal was much lower, a (small) loss was recorded.*

When calculating the C_d coefficients using field data in this formula, it appears that the results match very well this theoretical value, with an average C_d of 7.24[7] for a total of 34 free flow AOSM outlets.

The values of C_d for the flumes (FF) match very well with the value predicted by Ali (1993), while for the pipe outlet the C_d is slightly higher.

[7] The coefficient of variation is fairly low at 0.1

CHAPTER 5. CONCLUSIONS

1. A performance evaluation of actual discharges referenced to authorized discharges shows inequity in the water distribution among secondary canals in the study area. At the same time, the use of the authorized discharge as a reference seems questionable, given the large deviations in actual discharges. In general, there seems to be a trend in over supplying distributaries, impacting on supplies to outlets.

2. The physical conditions of distributaries were found to be poor with weak banks, irregular cross-sections and siltation, impacting on the water distribution. Seepage losses, however, are remarkably low for the majority of the distributaries, totalling about 5 % of the inflow distributaries.

3. The condition of outlets is not good, with about 20 % of all outlets broken. Nevertheless, calibration of the remainder of the outlets proved successful and C_d coefficients came close to design values. The results of the experiments indicate that for outlets (OFRB, APM, OF) functioning under free flow conditions, Cd can be assumed to be equal to design values. This will save time in future experiments.

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Outlet data of 3-L Distributary.

W/C (RD)	Type	Design q (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	"H" (ID) (ft)	"B" (ID) (ft)	"Y" (ID) (ft)	CRL* (ID) (ft)	"B" Actual (ft)	"Y" Actual (ft)
10-L	OFRB	3.64	3/8/1988	540	520	1.5	0.61	1.05	502.47	0.61	[illegible]
3400-L	OFRB	3.17	29/6/1944	463	453	1.5	0.57	1.05	501.53	0.53	[illegible]
6400-L	PIPE	3.24	18/12/1993	504	463	1.5	---	---	500.70	0.82	
11000-L	OFRB	3.05	29/6/1944	455	436	1.25	0.73	0.88	499.69	0.7	[illegible]
16320-L	OFRB	2.00	29/6/1944	328	285	1.25	0.48	0.88	498.23	0.48	[illegible]
23100-L	OF	1.99	29/7/1989	300	284	1.0	0.66	---	496.62	0.66	

* CRL is the crest level (elevation) of the outlet structure.

Outlet data of Mohar Distributary.

WC (RD)	Type	Authorised Discharge (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID)	B (ft)	[illegible]
1040-R	APM	1.54	4/7/1992	228	220	2	0.25	0.8	501.56	0.26	[illegible]
1500-L	PIPE	0.41	10/10/1953	67	58	2.44	0.29	-	501.03	0.31 dia	
3300-L	PIPE	0.67	27/4/1953	115	96	2.50	0.42	-	500.60	0.45 dia	
5000-R	OFRB	2.2	4/7/1992	330	315	2	0.3	1.4	498.82	0.75	[illegible]
6430-R	OFRB	4.11	15/1/1946	602	591	1.25	0.98	0.88	499.22	0.99	[illegible]
8430-R	OFRB	1.27	15/1/1946	186	181	1.25	0.34	0.88	496.46	0.37	[illegible]
12690-R	OFRB	2.79	10/7/1944	419	398	1.25	0.66	0.88	495.39	0.67	[illegible]
13770-L	OFRB	1.6	10/7/1944	238	229	1.25	0.41	0.88	495.12	0.41	[illegible]
13880-R	OFRB	1	21/8/1995	184	182	1	0.34	0.7	495.34	0.51	[illegible]
18000-L	OFRB	1.52	10/7/1944	222	217	1	0.51	0.7	494.31	0.51	[illegible]
20240-T.F	OF	2.62	8/7/1976	375	374	1	0.87	-	493.75	0.86	
20240T.L	OF	2.17	21/8/1995	323	311	1	0.72	-	493.75	0.58	

Annex 1

Outlet data of Daulat Distributary.

W/C RD	Type	Authorised Discharge (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B Actual (ft)	Y Actual (ft)
2500-R	OFRB	2.83	07/07/1988	533	515	2.80	0.26	1.96	501.69	0.22	1.95
3990-L	APM	0.57	04/07/1992	130	103	2.00	0.20	0.36	502.24	0.20	0.36
6670-R	OFRB	2.38	07/07/1988	440	432	2.80	0.20	1.96	500.99	0.21	1.98
6900-L	APM	1.85	04/07/1992	337	337	2.80	0.30	0.65	500.90	0.30	0.67
8990-R	APM	1.93	15/06/1964	352	350	2.80	0.32	0.65	500.59	0.31	0.67
12000-R	OCOFRB	1.44	15/06/1964	269	261	2.10	0.2[illegible]	1.47	500.58	0.25	1.46
13050-L	PIPE	1.75	27/08/1973	338	318	3.50	0.7[illegible] =	Dia	499.46	0.75 =	Dia
16100-L	OFRB	2.71	15/06/1964	623	493	2.80	0.24	1.96	499.38	0.24	1.95
19900-L	OFRB	3.00	15/06/1964	585	545	2.80	0.26	1.96	498.77	0.27	1.96
21273-Fall	Weir	186.00	----	----	----	----	15.00	----	----	15.00	----
22100-L	PIPE	----	----	----	----	----	----	----	----	1.36 =	Dia
22452-L	PIPE	2.74	04/05/1995	530	498	3.30	0.92 =	Dia	---- 498.63	1.35 =	Dia
23200-L	PIPE	----	----	----	----	----	----	----	----	0.95 =	Dia
24800-L	PIPE	----	----	----	----	----	----	----	----	1.50 =	Dia
25500-L	OFRB	3.32	15/08/1995	613	613	2.40	0.20	1.72	496.42	0.27	1.73
26800-L	PIPE	2.18	23/02/1995	397	397	3.30	0.875 =	Dia	496.94	0.875 =	Dia
29000-L	PIPE	----	----	----	----	----	----	----	----	1.22 =	Dia
29670-L	PIPE	1.69	15/08/1995	360	307	3.30	0.875 =	Dia	496.10	0.875 =	Dia
32000-L	OFRB	2.88	21/08/1995	651	523	2.96	0.23	2.07	497.21	0.26	2.11
33900-L	OFRB	1.70	15/08/1995	398	309	2.40	0.20	1.68	496.76	0.20	1.82
38800-L	PIPE	4.86	06/04/1995	958	885	3.30	1.25 =	Dia	495.12	1.47 =	Dia
38800-R	OCAPM	0.63	15/06/1964	132	114	2.00	0.20	0.40	496.17	0.18	0.39
39322-L	APM	3.15	28/09/1991	572	572	260	0.37	1.00	495.64	0.39	1.42
39390-L	OCOFRB	1.04	15/06/1964	258	190	1.68	0.2	1.17	496.29	0.18	1.15
40000-L	APM	1.15	08/08/1992	232	209	1.92	0.2	0.68	495.52	0.23	0.69
41030-R	OFRB	1.55	25/04/1993	345	282	2.14	0.20	1.50	495.59	0.18	1.63
43270-L	APM	1.01	08/08/1992	195	185	2.60	0.20	0.58	494.96	0.22	0.61
45810-R	APM	1.45	15/06/1964	287	264	2.60	0.25	0.70	494.53	0.35	0.63
47500-L	OFRB	1.56	20/09/1991	284	284	2.15	0.20	1.50	494.48	0.18	1.50
49000-L	OCOFRB	1.84	19/11/1983	350	335	2.30	0.22	1.61	494.11	0.30	1.45

Annex 1

Outlet data of Daulat Distributary (continued).

From previous page

W/C RD	Type	Authorised Discharge (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B Actual (ft)	Y Actual (ft)
49640-L	OFRB	1.90	20/07/1994	365	347	2.20	0.20	1.54	494.28	0.26	1.29
49730-R	OCOFRB	1.58	15/06/1964	292	287	2.22	0.20	1.37	494.02	0.24	1.36
52500-L	OFRB	2.45	19/04/1989	435	435	2.50	0.25	1.82	493.49	0.26	1.72
54350-L	OFRB	6.04	19/04/1989	1193	1099	2.50	0.51	1.82	493.18	0.50	1.80
54600-R	OFRB	2.49	07/12/1994	490	453	2.60	0.22	1.82	493.04	0.19	1.82
54800-R Billuka	OF (Minor)	9.00	----	1448	1320	2.20	1.84	----	491.40	1.67	----
57880-R	OCOFRB	0.95	15/06/1964	183	172	1.60	0.20	1.12	493.28	0.24	1.16
61790-R	OCOFRB	0.85	15/06/1964	202	154	1.48	0.20	1.03	492.87	0.25	1.12
62090-L	OFRB	2.97	15/06/1964	558	540	2.40	0.31	1.68	491.76	0.33	1.37
63470-L	OF	1.70	15/06/1964	325	310	1.82	0.27	----	492.31	0.27	----
63490-R	OF	1.50	15/06/1964	304	272	1.82	0.25	----	492.31	0.26	----
* 63630-L Nakewah	Gated (Minor)	43.00	----	7861	6910	2.68	3.10	----	489.85	3.10	----
* 63630 Structure	Gated Orifice	74.00	----	----	----	----	----	----	----	----	----
69000-L	OFRB	1.50	15/06/1964	278	273	2.10	0.21	1.47	489.16	0.21	1.47
71200-R	OFRB	1.56	15/06/1964	302	284	2.10	0.21	1.47	488.77	0.31	1.48
73000-R	OFRB	1.57	24/01/1970	210	202	1.75	0.20	1.21	488.79	0.25	1.32
75860-L	OFRB	1.57	15/02/1996	307	286	2.00	0.23	1.40	488.00	0.27	0.62
76480-R	OFRB	2.13	24/01/1970	664	589	2.25	0.30	1.00	487.63	0.31	1.05
80730-R	OFRB	2.64	15/06/1964	507	480	2.00	0.35	1.40	487.08	0.44	broken
80979-L	OCOFRB	0.87	15/06/1964	169	159	1.49	0.20	1.04	487.37	0.25	1.05
81500-L	OCOFRB	1.10	15/06/1964	209	200	1.75	0.20	1.08	487.00	0.26	1.32
83730-R	OFRB	2.55	15/06/1964	468	464	1.75	0.35	1.37	486.55	0.38	1.22
85850-L	OFRB	1.16	15/06/1964	216	211	1.75	0.21	1.23	486.32	0.30	1.25
86480-R	PIPE	0.92	02/10/1975	195	168	2.30	0.58 =	Dia	485.40	0.71 =	Dia
89860-R	PIPE	1.67	12/10/1975	309	303	2.30	0.75 =	Dia	484.66	0.70 =	Dia
90070-L	OCOFRB	0.98	09/10/1984	309	178	1.64	0.20	1.15	485.42	0.27	1.15
91180-R	OFRB	5.20	02/10/1975	986	946	1.75	0.75	1.23	485.31	0.75	1.23
91190-R	OCOFRB	0.98	15/06/1964	205	179	1.60	0.20	1.12	485.23	0.20	1.10
95530-L	OFRB	1.67	15/06/1964	332	303	1.75	0.28	1.23	484.42	0.38	1.10

* Note: The width = 3.10 ft, Height = 4.50 ft of Nakewah's Gate
and The width = 5.11 ft and Height = 4.25 ft of both two Gates of Structure of Daulat Distributary

Annex 1

Outlet data of Daulat Distributary (complete).

From previus page

W/C RD	Type	Authorised Discharge (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B Actual (ft)	Y Actual (ft)
95600-R	OFRB	1.51	15/06/1964	336	274	1.75	0.26	1.23	484.41	0.27	1.21
95820-L	OCOFRB	0.79	07/05/1984	189	144	1.20	0.23	0.84	484.77	0.24	0.87
97560-L	APM	1.88	15/06/1964	363	341	1.75	0.35	0.80	484.02	0.40	0.85
98140-R	OFRB	2.16	15/06/1964	409	393	1.75	0.35	1.23	483.90	0.38	1.26
99440-L	OFRB	2.07	15/06/1964	405	377	1.75	0.34	1.23	483.64	0.33	1.22
99440-R	OFRB	1.29	15/06/1964	238	235	1.75	0.23	1.23	483.64	0.21	1.24
99800- Fall	----	----	----	----	----	----	6.00	---	----	5.92	....
104700-R	OFRB	1.20	15/06/1964	218	218	1.75	0.21	1.23	481.02	0.23	1.22
105050-R	OFRB	2.08	15/06/1964	444	379	1.75	0.34	1.23	480.94	0.31	1.18
105080-L	OFRB	1.53	15/06/1964	302	278	1.75	0.26	1.23	480.94	0.28	1.23
108100-R	OFRB	3.70	15/06/1964	697	673	1.50	0.68	1.05	479.74	0.68	1.03
109900-L	OFRB	1.05	15/06/1964	203	191	1.50	0.23	1.05	479.31	0.22	1.05
110320-R	OFRB	2.99	15/06/1964	575	545	1.50	0.55	1.05	479.21	0.55	1.05
112880-R	OFRB	4.15	15/06/1964	777	754	1.50	0.75	1.05	478.60	0.73	1.02
112900-L	OFRB	1.04	15/06/1964	200	199	1.50	0.24	1.05	478.59	0.23	1.01
114690-R	PIPE	0.25	15/06/1964	46	46	1.60	0.29 =	Dia	478.00	0.68 =	Dia
114860-L	OFRB	2.73	15/06/1964	549	497	1.30	0.62	0.91	478.20	0.68	1.73
115150-TC	OF	1.31	29/11/1981	301	238	1.00	0.44	----	478.46	0.49	....

Outlet data of Phogan Distributary.

W/C RD	Type	Design q (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	"H" (ID) (ft)	"B" (ID)(ft)	"Y" (ID)(ft)	CRL (ID) (ft)	"B" Actual (ft)	"Y" Actual (ft)
600/L	OFRB	1.10	23/08/1989	213	185	1.0	0.37	0.70	496.38	0.46	0.76
2450/R	OFRB	1.04	23/08/1989	320	306	1.25	0.26	0.88	493.27	0.33	0.87
4050-R	OFRB	1.30	23/08/1989	199	185	1.25	0/32	0.88	492.91	0.35	0.89
5810-L	OFRB	1.03	16/01/1984	155	147	1.40	0.22	0.98	492.36	0.27	1.04
5810-R	OFRB	2.25	10/01/1979	324	322	1.25	0.54	0.88	492.51	0.57	0.93
7840/R	OF	2.47	10/11/1961	356	353	1.25	0.58	0.88	492.05	0.62	...
8750/TR	OF	2.37	10/11/1961	353	339	1.0	0.77	---	492.10	0.79	
8750/TL	OF	1.09	24/03/1953	170	156	1.0	0.36	---	492.10	0.42	
8750/TF	OF	3.76	24/03/1953	555	537	1.0	1.25	---	492.10	1.25	

Annex 1

Outlet data of 4-L Distributary.

W/C RD	Type	Authorized Q (cfs)	Date of last alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B actual (ft)	Y actual (ft)
200-L	OFRB	1.23	21/04/1984	186	177	1.50	0.27	1.05	494.23	0.28	1.06
300-L	OFRB	1.82	21/04/1984	296	260	1.50	0.37	1.05	494.21	0.36	1.04
3220-L	OFRB	1.12	24/06/1944	163	160	1.50	0.25	1.05	493.63	0.29	1.05
6390-L	OFRB	1.58	24/06/1944	230	226	1.50	0.33	1.05	492.99	0.32	1.05
9150-L	OFRB	1.76	30/09/1966	257	251	1.25	0.46	0.88	492.69	0.47	0.88
12600-L	OFRB	3.48	30/09/1966	515	497	1.25	0.80	0.88	492.00	0.80	0.88
17350-TL	OFRD	1.84	25/01/1992	272	263	1.00	0.62	---	491.18	0.64	0.76

Outlet data of Khemgarh Distributary.

W/C (RD)	Type	Authorized Q (cfs)	Date of last alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	"B" actual (ft)	"Y" actual (ft)
200/R	OFRB	5.20	19/4/1989	976	936	1.50	0.99	1.05	493.93	0.99	1.04
1130/R	OFRB	4.38	19/4/1989	805	797	1.50	0.80	1.05	493.97	0.70	1.01
2590/R	OFRB	1.10	27/6/1944	207	200	1.50	0.24	1.05	493.13	0.27	1.03
3750/R	OFRB	2.10	19/4/1939	397	390	1.50	0.41	1.05	492.73	0.40	1.02
3850/R	OFRB	3.36	25/3/1971	669	611	1.50	0.62	1.05	492.69	0.62	1.02
4600/R	OFRB	1.15	25/3/1971	224	210	1.25	0.32	0.88	492.68	0.31	0.85
8730/R	OFRB	2.98	27/6/1944	602	542	1.25	0.71	0.88	491.23	0.71	0.87
13590/R	OFRB	1.73	27/6/1944	320	315	1.25	0.43	0.88	489.53	0.38	0.82
15500/T	OF	0.85	24/4/1988	272	154	1.00	0.32	----	489.11	0.34	----

Annex 1

Outlet data of Jagir Distributary.

W/C (RD)	Type	Design Discharge (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	"H" (ID) (ft)	"D" (ID) (ft)	CRL (ID) (ft)	"D" Actual (ft)
200-R	PIPE	2.58	1/6/1985	447	431	---	0.67	490.12	0.65
990-R	PIPE	3.71	1/6/1985	635	618	---	0.75	491.05	1.00
1000-R	PIPE	4.45	5/5/1982	768	741	---	0.88	490.85	1.01
1660-R	PIPE	2.01	10/5/1984	335	335	---	0.67	491.06	0.60
3990-R	PIPE	1.63	16/4/1949	274	271	---	0.67	489.84	0.67
7210-R	PIPE	1.99	29/9/1984	335	332	---	0.58	489.23	0.60
9090-R	PIPE	2.99	14/9/1986	485	482	---	0.58	488.18	0.63
11880-R	PIPE	1.83	14/9/1986	305	305	---	0.63	487.14	0.70
13830-TR	OF	2.69	14/9/1986	464	449	1.0	0.78	486.91	1.00

Annex 1

Outlet date of Shahar Farid Distributary.

W/C (RD)	Type	Authorized discharge (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID)	B (actual) (ft)	Y (actual) (ft)
5200-L	OFRB	3.59	31/8/1965	658	653	2.75	0.3	1.93	484.51	0.31	1.93
5240-L	OFRB	2.56	31/8/1965	495	465	2.75	0.22	1.93	484.5	0.24	1.95
5300-L	OFRB	1.84	31/8/1965	352	335	2.75	0.17	1.93	484.49	0.16	1.9
5320-R	OFRB	2.9	13/12/1984	590	527	2.75	0.23	1.93	484.49	0.3	1.78
5330-R	APM	1.79	31/8/1965	352	325	2.75	0.3	0.62	484.48	0.3	0.89
5500-Fall										13.00	
10700-R	APM	6.15	5/1/1994	1122	1118	2.75	0.55	1.25	482.41	0.61	1.22
11846-L	APM	0.86	31/8/1965	173	157	2.75	0.2	0.45	482.18	0.2	0.47
11960-R	APM	0.93	31/8/1965	173	169	2.75	0.25	0.41	482.16	0.25	0.41
16750-L	OFRB	1.47	31/8/1965	271	268	2.5	0.17	1.75	481.45	0.28	1.79
16943-R	OCOFRB	1.75	8/7/1990	316	311	2	0.24	1.4	481.68	0.23	1.42
18011-L	OFRB	1.04	31/8/1965	210	189	2	0.35	0.35	481.7	0.38	0.97
19840-R	OCOFRB	2.13	5/1/1994	388	388	1.5	0.39	1.05	481.64	0.3	1.62
19847-L	OCOFRB	1.38	31/8/1965	255	255	1.5	0.29	1.05	481.57	0.3	1.15
20539-L	OCOFRB	1.07	20/6/1991	194	194	1.5	0.22	1.05	481.53	0.22	1.07
21895-R	OFRB	1.2	9/5/1992	219	219	2	0.27	0.5	480.92	0.28	1.39
22636-L	OFRB	3.35	8/6/1988	836	610	2.75	0.49	0.65	480.02	0.5	0.85
23500-R	OFRB	1.37	31/8/1965	249	249	2.75	0.25	0.59	479.85	0.22	2.47
24000-L	PIPE	2.1	12/6/1995	681	381	1.75	0.55	-	479.85	0.52	-
25154-R	APM	1.03	5/11/1983	202	188	2.5	0.2	0.62	479.77	0.25	0.8
29045-R	APM	1.68	5/11/1983	308	306	2	0.32	0.71	479.77	0.37	0.76
29700-L	APM	1.16	31/8/1965	313	211	2.75	0.25	0.49	478.61	0.31	0.65
31440-R	APM	1.53	20/10/1986	291	279	1.5	0.32	1.05	479.50	0.33	0.66
31610-R	OFRB	1.24	25/1/1972	253	226	1.5	0.27	1.05	479.48	0.31	1.08
32913-L	OFRB	2.28	13/6/1988	543	415	2	0.32	0.95	478.72	0.34	1.28
33075-R	OFRB	2.2	31/8/1965	403	400	2	0.4	0.7	478.68	0.52	1.01

Annex 1

Outlet data of Shahar Farid Distributary (complete)

From previous page

W/C (RD)	Type	Athorised discharge (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID)	B (actu) (ft)	Y (actu) (ft)
33630-L	OFRB	1.55	30/1/1994	285	282	2	0.3	0.73	478.57	0.38	0.8
37000-L	APM	1.14	30/1/1994	213	208	2	0.25	0.48	477.9	0.26	0.5
38980-L	APM	1.7	6/11/1984	312	309	2	0.32	0.62	477.5	0.33	0.68
38727-R	APM	2.26	31/8/1965	419	411	2	0.4	0.73	477.55	0.42	0.79
40900-L	OFRB	2.29	31/8/1965	433	417	2	0.4	0.74	477.12	0.4	0.8
40910-L	OFRB	1.83	31/8/1965	344	333	2	0.35	0.68	477.12	0.34	1.23
40950-L	OFRB	1.28	17/7/1988	232	232	2	0.3	0.57	477.11	0.26	0.58
41800-R	OFRB	1.19	31/8/1965	218	217	1.75	0.21	1.23	477.19	0.24	1.28
45200-L	APM	1.65	17/7/1988	321	299	2	0.3	0.73	476.26	0.34	0.82
46020-R	OFRB	1.4	14/4/1968	265	256	1.87	0.22	1.32	476.23	0.6	2.04
46025-R	OFRB	7.34	29/11/1989	1452	1335	2.5	0.6	1.75	475.6	Broken	
S.FARID										6.33	
HAIRWAH										7.00	
49000-R	OFRB	2.05	31/8/1965	386	373	1.25	0.5	0.88	475.35	0.52	0.91
49160-R	OFRB	1.16	21/2/1978	211	211	1.25	0.32	0.88	475.33	0.34	0.9
49360-R	OFRB	2.05	31/8/1965	387	373	1.25	0.5	0.88	475.28	0.51	0.9
49460-L	OFRB	0.65	30/7/1994	122	118	1.1	0.2	0.77	475.41	0.29	0.8
53460-R	OFRB	2.04	31/8/1965	421	371	1.5	0.4	1.05	474.12	0.4	1.06
53470-R	OFRB	1.43	31/8/1965	336	261	1.5	0.3	1.05	474.12	0.32	1.05
59812-L	OFRB	2.89	12/6/1995	202	526	1.75	0.45	1.23	471.33	0.46	1.23
59941-L	OFRB	1.24	31/8/1965	228	225	1.75	0.21	1.25	471.3	0.21	1.23
60360-R	OFRB	1.52	31/8/1965	311	276	1.25	0.39	0.88	471.7	0.44	1.23
61319-L	OFRB	5.17	31/8/1965	959	940	1.75	0.74	1.23	470.98	0.76	1.23
61637-R	OFRB	0.95	31/8/1965	201	173	1.50	0.21	1.05	471.16	0.76	1.23

Annex 1

Outlet data of Masood Distributary.

W/C (RD)	Type	Authorized discharge (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID)	B (actu) (ft)	Y (actu) (ft)
1100-R	OFRB	0.96	15/4/1950	268	268	1.59	0.2	1.11	488.47	0.23	1.12
3700-R	OFRB	1.47	15/4/1950	408	408	1.77	0.25	1.24	487.9	0.42	1.48
7300-R	OFRB	1.05	23/9/1976	318	292	1.75	0.2	1.23	487.26	0.22	1.16
13500-R	PIPE	1.36	26/6/1986	394	379	2.72	0.83	-	485.49	1.0	-
24000-R	PIPE	1.67	31/7/1961	474	464	2.36	0.92	-	482.93	0.9	-
27200-R	OFRB	1.76	6/7/1976	493	489	0.88	0.71	0.62	484.41	0.38	1.12
28750-R	OFRB	0.9	15/4/1950	260	250	1.1	0.3	0.77	482.32	0.34	0.81
34860-R	OFRB	1.82	6/2/1985	454	447	1.55	0.34	1.09	480.49	0.32	1.07
35590-R	OFRB	2.04	29/1/1985	573	567	1.59	0.38	1.11	480.8	0.38	1.13
35600-R	OFRB	1.67	14/7/1975	441	440	1.2	0.42	0.84	480.69	0.42	0.83
36620-R	OFRB	1.81	7/9/1982	494	494	1.4	0.38	0.98	480.25	0.37	0.95
37150-R	OFRB	1.59	29/4/1992	462	443	1.29	0.39	0.9	480.02	0.59	0.82
44320-R	OFRB	1.96	1/3/1979	615	444	1.12	0.55	0.78	475.32	0.55	0.8
45950-R	OFRB	2.2	21/4/1956	615	612	1.12	0.62	0.78	474.99	0.63	0.76
50200-T.R	O.F.	1.76	8/4/1995	512	490	1	0.59		473.07	0.5	

Annex 1

Outlet data of Soda Distributary.

W/C No	TYPE	Authorised discharge (cfs)	Date of last alteration	GCA (ID) (ft)	CCA (ID) (ft)	"H" (ID) (ft)	"B" (ID) (ft)	"Y" (ID) (ft)	CRL (ID) (ft)	"B" Actual (ft)	"Y" Actual (ft)
80/R	OFRB	2.6	3/3/1983	391	384	2	0.34	1.4	483.10	0.34	1.42
980/R	OFRB	2.44	3/3/1983	356	348	2	0.32	1.4	482.90	0.36	1.45
1090/R	OFRB	2.81	20/12/1973	435	402	2	0.38	1.4	482.90	0.4	1.41
3000/R	OFRB	0.91	6/7/1968	138	130	1.75	0.16	1.22	482.60	0.17	1.23
9280/R	OFRB	4.45	6/7/1968	645	635	1.75	0.64	1.23	480.40	0.66	1.22
9300/R	OFRB	1.27	17/6/1995	198	182	1.9	0.2	1.33	480.40	0.34	1.23
9320/R	OFRB	1.23	6/10/1987	176	174	1.65	0.2	1.16	480.40	0.14	1.18
12500/L	OFRB	1.4	6/7/1968	201	200	2	0.2	1.4	478.20	0.21	1.42
13900/R	OFRB	1.16	6/10/1987	170	167	1.6	0.2	1.2	478.20	0.22	1.17
18020/L	OFRB	1.49	31/1/1991	217	213	2	0.22	1.4	476.70	0.23	1.41
18080/R	OFRB	2.46	17/7/1995	363	352	2	0.3	1.4	476.60	0.22	1.42
19970/R	OFRB	2.23	13/6/1995	326	319	1.95	0.3	1.37	476.20	0.33	1.36
19990/R	OFRB	1.24	25/6/1992	188	177	1.66	0.2	1.33	476.40	0.21	1.36
20030/R	OFRB	1.89	30/7/1984	283	266	2	0.26	1.4	476.10	0.26	1.99
20040/R	OFRB	0.78	6/7/1968	129	111	1.38	0.2	0.97	476.70	0.27	1.53
21300/L	OFRB	1.94	31/1/1991	279	277	2	0.27	1.4	475.70	0.27	1.4
22690/L	OFRB	1.6	26/6/1991	254	228	1.6	0.32	1.12	475.80	0.34	1.41
23550/R	OFRB	3.55	6/7/1968	517	507	2	0.44	1.4	475.10	0.45	1.47
24650/L	OFRB	1.16	6/7/1968	167	165	1.75	0.2	1.22	475.00	0.26	2.16
26680/R	OFRB	2.81	6/7/1968	455	402	2	0.36	1.4	474.10	0.37	1.41
326750/L	OFRB	1.13	26/6/1991	165	161	0.6	0.23	1.12	474.50	0.78 Dia	
28280/L	OFRB	0.95	26/6/1991	135	135	1.6	0.2	1.12	474.40	0.19	1.03
29600/L	OFRB	0.72	6/7/1968	104	103	1.31	0.2	0.92	473.90	0.22	0.97
31460/R	OFRB	1.13	6/7/1968	162	161	1.75	0.2	1.23	472.90	0.2	1.24
31600/R	OFRB	1.89	6/7/1968	271	270	1.75	0.31	1.23	472.90	0.32	1.16
31960/R	OFRB	1.9	6/7/1968	281	272	1.75	0.32	1.23	472.80	0.32	1.21
33740/L	OFRB	3.8	30/3/1986	617	533	1.5	0.68	1.05	472.50	0.63	1.02
37240/L	OFRB	2.7	29/5/1944	394	387	1.5	0.49	1.05	471.50	0.51	1.03
38100/L	OFRB	1.6	9/7/1981	250	229	1.5	0.33	1.05	471.20	0.34	1.01
38100/R	OFRB	2.3	9/7/1981	330	329	1.5	0.44	1.05	471.20	0.43	1.07
38150/R	OFRB	3.5	6/7/1968	527	501	1.5	0.64	1.05	471.20	0.65	1.06
43700/TR	OF	4.3	9/7/1981	635	615	1	1.43	-	468.50	1.42	----
43700/TL	OF	2.5	9/7/1981	390	357	1	0.84	-	468.50	0.84	-----

Annex 1

Outlet data of 5-L Distributary.

W/C (RD)	Type	Athorised Q (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID)	B (ft)	Y (ft)
2800-R	OFRB	0.61	7/2/1950	169	169	0.9	0.28	0.63	480.87	0.28	0.62
4900-R	OFRB	1.16	28/9/1994	357	283	1	0.41	0.7	480.3	0.46	0.6
11300-TC	OF	0.9	26/7/1975	380	250	1	0.34	-	477.47	0.44	
11300-TR	OF	0.76	5/4/1987	202	195	1	0.28	-	477.47	0.27	

Annex 1

Outlet data of Fordwah Distributary.

W/C RD	Type	Authorised Discharge (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B Actual (ft)	Y Actual (ft)
1556-L	OFRB	0.6	29/08/1983	220	167	1.2	0.2	0.84	474.55	0.2	0.83
6100-L	OFRB	0.89	29/08/1983	282	248	1.43	0.2	1.1	473.5	0.22	0.99
11450-L	OFRB	0.79	29/09/1984	456	220	1.25	0.2	0.88	472.75	0.2	0.73
14320-R	OFRB	1.76	11/08/1993	490	490	1.34	0.4	0.94	472.15	0.41	0.92
14710-R	OFRB	1.84	06/07/1968	522	512	2.26	0.22	1.58	471.17	0.2	1.54
14910-R	OFRB	2.1	11/08/1993	592	592	1.58	0.39	1.1	471.81	0.39	1.14
24800-R	OCOFRB	1.35	08/04/1981	399	375	1.98	0.2	1.39	468.23	0.2	1.36
25950-R	OCOFRB	1.35	08/04/1981	413	374	1.94	0.2	1.3	468.02	0.2	1.34
27050-L	OFRB	0.78	28/04/1973	290	217	1.22	0.2	0.85	468.79	0.27	0.7
28110-R	OCOFRB	1.26	08/04/1981	410	350	2	0.19	1.4	467.57	0.2	1.38
29550-R	OCOFRB	1.07	20/09/1977	298	298	1.76	0.2	1.23	467.58	0.2	1.26
29690-R	OCOFRB	1.04	06/07/1968	290	290	1.4	0.25	0.99	467.88	0.26	1.27
32920-R	PIPE	1.81	21/07/1976	512	502	3.18	DIA =	0.88	465.26	DIA = 0.88	
32940-R	PIPE	1.18	17/07/1979	350	327	3.18	DIA =	0.58	465.41	DIA = 0.62	
33000-R	OCAPM	1.56	06/07/1968	434	432	2.25	0.25	0.81	466.45	0.23	0.78
33120-R	OCAPM	0.83	06/07/1968	233	231	2.12	0.25	0.4	466.58	0.23	0.36
33160-R	PIPE	0.92	01/08/1995	270	256	-	-	0.63 = dia	465.38	0.23	0.55
33200-L	PIPE	0.77	01/08/1995	240	215	-		0.63 = dia	465.38	0.23	0.76
38230-R	OCOFRB	1.06	06/07/1968	311	295	1.25	0.29	0.88	465.62	0.29	0.87
38830-L	OFRB	0.38	06/07/1968	169	105	1	0.16	0.7	466.01	0.16	0.67
39550-R	OCOFRB	0.93	06/07/1968	270	257	1.29	0.25	0.9	465.35	0.25	0.89
42040-L	OCOFRB	0.33	06/07/1968	155	91	1	0.14	0.7	465.23	0.14	0.68
42580-R	OFRB	2	06/07/1968	562	556	2.59	0.2	1.81	463.75	0.24	1.04
42560-R	OCOFRB	1.17	06/07/1968	331	326	1.51	0.2	1.06	464.59	0.28	
42504-L	OCOFRB	1.48	06/07/1968	553	411	2.04	0.21	1.43	464.07	0.21	1.41
42510-L	OCOFRB	0.92	06/07/1968	270	256	1.62	0.2	1.13	464.54	0.21	1.11
42600-R	APM	0.83	24/10/1982	249	231	1.65	0.25	0.53	464.5	0.28	0.88
46725-R	OFRB	1.68	04/04/1994	445	445	2	0.24	1.4	463.59	0.28	1.41
50575-R	OCOFRB	1.71	04/04/1994	476	476	2.25	0.21	1.58	462.42	0.21	1.58
51500-L	OCOFRB	1.25	11/04/1981	348	340	1.56	0.25	1.09	462.96	0.25	1.09

Outlet data of Fordwah Distributary (continued).

From previous page

W/C RD	Type	Authorised Discharge (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B Actual (ft)	Y Actual (ft)
53380-R	OCOFRB	1.53	05/05/1982	434	426	2.05	0.21	1.42	462.16	0.21	1.4
53920-R	OCOFRB	0.93	10/10/1983	240	237	1.4	0.23	0.98	462.67	0.22	0.96
54060-R	OCOFRB	1.79	06/07/1968	574	498	1.5	0.35	1.05	462.57	0.35	1.04
54080-R	OFRB	1.45	03/06/1992	403	403	2.08	0.2	1.46	462.19	0.24	1.44
55160-R	OCAPM	1.07	06/07/1968	298	296	2.25	0.25	0.5	461.57	0.22	0.78
56000-L	OCOFRB	1.1	06/07/1968	305	305	1.62	0.2	1.13	462.04	0.23	1.12
57640-L	OCOFRB	1	12/05/1984	319	278	1.64	0.2	1.14	461.75	0.2	1.12
60000-L	OF	1.14	04/10/1990	350	316	1.5	0.25		461.7	0.33	
60410-L	OCOFRB	1.02	06/07/1968	300	283	1.75	0.2	1.23	461.18	0.2	1.21
62085-R	OCOFRB	1.18	06/07/1968	342	328	1.52	0.25	1.06	461.08	0.26	1.03
62250-L	OCAPM	1.57	09/05/1975	460	437	2.15	0.23	1.13	460.4	0.24	1.16
67160-L	APM	1.38	14/10/1986	401	385	2.25	0.2	0.72	459.03	0.21	0.7
68260-L	APM	0.84	20/07/1894	231,	217	2.25	0.2	0.45	458.87	Broken	
70530-R	APM	1.25	03/06/1987	335	335	2.25	0.2	0.64	458.35	0.2	0.64
70600-L	APM	1.41	20/07/1994	453	391	2.25	0.2	0.78	458.34	0.2	0.8
71200-R	APM	1.3	06/12/1973	361	360	2.25	0.2	0.72	458.22	0.21	1.24
71697-L	APM	1.3	21/08/1972	381	364	2.25	0.2	0.72	458.12	0.21	0.7
73008-R	APM	1.57	11/08/1993	445	430	2.21	0.2	0.97	457.9	0.21	0.97
75140-R	APM	1.53	16/03/1988	426	324	2.21	0.2	0.97	457.47	0.2	0.97
76640-L	APM	1.47	20/10/1980	409	391	2.21	0.2	0.83	457.16	0.27	0.82
78850-R	APM	1.87	18/01/1988	533	520	2.21	0.25	0.94	456.73	0.26	0.94
82580-R	OFRB	2.09	20/05/1976	445	444	2.05	0.28	1.43	456.15	0.29	1.44
82600-L	APM	1.22	21/08/1972	380	340	2.16	0.2	0.69	455.97	0.23	0.72
83700-R	APM	0.85	27/10/1979	226	225	2.16	0.2	0.44	455.87	0.22	0.44
84140-L	APM	0.95	21/08/1972	317	264	1.8	0.2	0.59	456.08	0.2	0.58
90000-L	APM	0.54	20/10/1983	207	149	2.16	0.2	0.27	454.55	0.2	0.24
90000-R	APM	1.06	04/10/1993	291	291	2.16	0.2	0.57	454.55	0.2	0.56
91950-R	APM	1.12	04/10/1993	306	306	2.16	0.2	0.61	454.17	0.2	0.59
93970-R	APM	1.43	04/12/1986	392	391	2.02	0.2	0.92	453.91	0.2	0.92
93980-R	APM	1.28	10/01/1984	361	351	2.02	0.2	0.77	453.9	0.22	0.77

Annex 1

Outlet data of Fordwah Distributary (complete).

From previous page

W/C RD	Type	Authorised Discharge (cfs)	Date of Last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID) (ft)	B Actual (ft)	Y Actual (ft)
94186-R	APM	0.71	10/12/1984	184	184	2.02	0.2	0.35	453.86	0.23	0.38
96300-L	APM	1.06	11/03/1985	288	227	2.02	0.25	0.47	453.44	0.24	0.44
96692-R	APM	0.64	12/05/1985	174	170	1.75	0.2	0.38	453.63	0.22	0.4
99500-R	APM	0.68	12/10/1983	193	188	1.75	0.2	0.4	453.07	0.21	0.4
100700-L	PIPE	0.33	-	140	118	-	-	-	452.53	DIA =	0.27
101800-R	APM	0.7	25/02/1976	234	194	2.02	0.2	0.38	452.34	0.2	0.38
102820-R	APM	1.31	17/07/1982	398	365	1.84	0.25	0.68	452.32	0.25	0.67
104950-L	APM	0.46	29/09/1984	272	127	1.64	0.2	0.28	451.99	0.21	0.28
106000-R	APM	1.71	10/01/1987	488	483	1.84	0.32	0.7	451.33	0.33	0.7
107810-R	PIPE	0.04	-	-	-	-	-	-	450.93	DIA =	0.73
107820-R	APM	1.51	17/07/1982	452	422	1.84	0.25	0.81	451.11	0.34	0.66
112250-R	APM	1.11	21/08/1972	320	309	1.84	0.2	0.72	450.04	0.2	0.73
112840-L	APM	1.7	29/09/1984	558	474	1.84	0.32	0.65	449.9	0.32	0.62
114700-R	APM	1.03	21/08/1972	288	287	1.84	0.2	0.65	449.46	0.2	0.64
116630-L	OFRB	1.00	12/01/1995	591	277	1.5	0.2	1.05	449.35	0.21	
117700-R	PIPE	0.22	16/03/1988	63	62	2.00	DIA =	0.21	448.39	DIA =	0.23
117775-R	APM	1.83	19/07/1984	460	460	1.75	0.4	0.6	448.83	0.41	0.59
118000-R	APM	2.67	11/07/1995	860	743	1.65	0.4	0.82	448.84	0.5	0.8
118250-R	APM	1.4	21/08/1972	424	400	1.53	0.32	0.63	448.89	0.32	0.63
121220-L	PIPE	0.03	07/05/1992	10	8	1.70	DIA =	0.17	447.78	DIA =	0.22
125600-R	APM	1.27	22/04/1985	737	354	1.53	0.32	0.54	446.83	0.33	0.5
125462-L	APM	2.57	09/08/1995	1337	719	1.59	0.5	0.79	446.81	0.52	0.79
130100-R	APM	2.4	16/05/1981	675	663	1.51	0.5	0.75	445.59	0.51	
132500-L	OFRB	0.52	09/08/1995	147	144	1.1	0.2	0.77	445.13	0.2	0.77
134100-R	APM	1.21	01/02/1979	624	335	1.46	0.32	0.53	444.52	0.34	0.55
135180-R	APM	0.81	21/08/1972	252	237	1.46	0.2	0.65	444.23	0.21	0.66
139780-TR	OF	1.99	21/08/1972	666	554	1	0.66	-	443.4	0.63	
139780-TL	OF	2.78	29/09/94	1908	772	1	0.92	-	443.4	0.89	

Annex 1

Outlet data of Mehmood Distributary.

W.C. (RD)	Type	Authorized discharge (cfs)	Date of last Alteration	GCA (ID) (acre)	CCA (ID) (acre)	H (ID) (ft)	B (ID) (ft)	Y (ID) (ft)	CRL (ID)	B (ft)	Y (ft)
1030-R	OFRB	1.49	10/7/1940	355	350	1.05	0.42	0.74	475.07	0.41	1.29
1270-L	PIPE	0.16	8/1/1980	46	45	1.44	0.29	-	474.64	0.35	-
5200-R	OFRB	1.85	12/6/1946	437	437	1.17	0.49	0.81	474.24	0.56	1.19
6600-L	PIPE	0.62	3/12/1975	173	172	1.47	0.54	-	473.55	0.58	-
11860-T.C	OF	1.75	10/7/1940	435	412	1	0.58	-	472.83	0.48	-
11860-T.L	OF	1.3	8/2/1977	423	360	1	0.45	-	472.83	0.44	-
11860-T.R	OF	1.12	10/7/1940	271	263	1	0.4	-	472.83	0.44	-

Annex 1

Outlet data for Azim Distributary.

W/C No	TYPE	Authorised Discharge (cfs)	Date of Last Alteration	GCA (I D) (acre)	CCA (I D) (acre)	H (I D) (ft)	B (I D) (ft)	Y (I D) (ft)	CRL (I D) (ft)	B Actual (ft)	Y Actual (ft)	Ha Elev. (ft)	Hb Elev. (ft)	Remarks
4114-R	OFRB	3.94	6/3/1967	563	394	2.50	0.37	1.76	471.7	0.32	1.79	3.40	2.85	
5100-R	CTF	2.93	5/1/1991	426	418	0.70	1.69	-	472.8	0.60	1.01	3.33	1.29	
8650-R	CFT	1.37	15/4/1975	199	196	0.70	0.85	-	469.8	0.83	0.83	2.68	2.67	
10710-R	OFRB	5.69	6/6/1941	850	813	3.24	0.38	2.27	467.8	0.36	2.03	4.15	2.20	
15970-L	APM	2.04	11/6/1944	323	281	3.25	0.31	0.62	466.5	0.30	0.63	3.61	2.58	
15980-R	OCOFRB	1.32	11/6/1944	188	188	1.00	0.46	0.70	469.5	0.46	0.64	2.39	2.00	Outlet was broken
17580-L	APM	5.48	9/3/1982	824	783	3.50	0.60	0.92	468.2	0.49	1.09	4.56	2.00	
18000-R	OFRB	2.59	20/12/1944	504	471	3.00	0.26	2.10	466.5	....	....	....		Damaged
20610-L	APM	2.06	20/12/1944	306	294	2.50	0.35	0.65	466.7	0.35	1.15	3.61	1.88	
21030-R	//	2.81	23/12/1953	474	415	2.50	0.40	0.82	466.6	0.39	0.85	4.50	2.61	
22840-L	//	1.8	20/12/1944	262	259	2.50	0.30	0.68	466.4	0.30	0.67	3.45	1.19	
24120-L	OFRB	2.39	20/12/1944	357	341	2.50	0.24	1.75	466.2	0.25	1.73	3.56	1.29	
24380-R	OCOFRB	1.95	20/12/1944	281	279	1.50	0.38	1.05	467.1	0.37	1.05	2.68	1.58	Two illegal pipe with Outlet
27400-L	APM	3.25	20/12/1944	481	479	2.50	0.45	0.81	465.8	0.44	0.89	3.36	1.35	
28340-L										1.42	......	3.70	1.74	Rathi Minar Crest is broken
28460-R	OFRB	3.97	17/6/1977	579	567	2.50	0.36	1.75	465.7	0.50	2.90	......		Broken
30900-R	OCOFRB	2.3	3/6/1947	340	328	1.25	0.55	0.88	466.5	0.56	0.89	2.81	1.82	Outlet was broken
31030-L	OCOFRB	1.75	20/12/1944	260	251	1.50	0.35	1.05	466.3	0.36	1.05	3.02	0.86	
33100-L	OFRB	2.04	20/12/1944	304	281	2.50	0.21	1.75	466.1	0.24	1.78	3.96	1.32	
34000-R	OCOFRB	1.83	20/12/1944	283	261	2.00	0.26	1.40	466.3	0.27	1.38	2.91	2.82	Outlet was broken
36200-R	OCOFRB	1.29	18/4/1954	202	184	1.80	0.22	1.28	465.2	0.21	1.26	2.59	1.98	Outlet was broken
36250-L	OCAPM	0.6	20/12/1944	232	229	2.00	0.35	0.57	465.1	0.36	1.16	2.86	3.30	
38030-R	OCAPM	0.76	18/4/1954	267	252	2.00	0.30	0.84	464.7	0.29	0.85	2.74	1.71	Outlet was broken
39180-L	OCOFRB	1.97	20/12/1944	291	281	2.00	0.27	1.40	464.7	0.25	1.40	3.14	3.18	
39670-R	APM	0.97	29/9/1994	141	139	2.00	0.25	0.50	466.3	....	....	....	....	Broken & 3 ft cut with outlet
39700-R	OCAPM	1.93	20/12/1944	280	275	2.00	0.35	0.73	464.6	0.34	0.73	2.30	1.34	1.5 ft cut with outlet
40780-L	OCAPM	1.08	20/12/1944	204	197	2.00	0.30	0.60	464.5	0.31	0.67	3.29	2.76	

Outlet data for Azim Distributary (continued).

W/C No	TYPE	Authorised Discharge (cfs)	Date of Last Alteration	GCA (I D) (acre)	CCA (I D) (acre)	H (I D) (ft)	B (I D) (ft)	Y (I D) (ft)	CRL (I D) (ft)	B Actual (ft)	Y Actual (ft)	Ha Elev. (ft)	Hb Elev. (ft)	Remarks
41940-I	OCOFRB	4.82	12/9/1984	665	654	2.50	0.43	1.75	464.1	0.41	1.74	3.77	2.56	2 cuts near outlet
43260-L	OCOFRB	1.65	12/9/1944	170	164	1.75	0.20	1.23	464.5	0.18	1.23	2.82	2.67	2 cuts near outlet
44410-R	OFRB	1.66	11/11/1987	279	237	1.75	0.28	1.23	464.7	0.28	1.24	2.00	1.16	2.5 ft cut with outlet
44200-L	OFRB	1.37	6/6/1944	184	181	1.70	0.24	1.20	464.5	0.25	1.20	3.18	4.24	4 ft cut with outlet
44220-L	OF	-	-	-	-	-	-	-	-	1.48	......	3.34	3.61	Feroze Minor
46460-R	OFRB	3.86	28/2/1974	551	551	1.75	0.56	1.23	463.7	0.56	1.26	2.15	1.76	
47830-L	OCOFRB	1.01	23/1/1965	147	144	1.42	0.24	0.89	462.3	0.24	1.01	2.45	2.34	3 ft cut with outlet
50430-L	OFRB	2.18	20/12/1944	329	312	2.00	0.30	1.40	461.6	0.30	1.41	2.83	....	
50430-R	OFRB	1.41	20/12/1944	217	201	2.00	0.20	1.40	461.6	....	....	3.16	1.78	Difficult To Measure
51500-R	OFRB	4.61	6/6/1941	788	658	2.59	0.40	1.81	460.9	0.38	1.82	2.40	2.36	
52220-R	OFRB	1.68	6/6/1941	244	240	2.49	0.20	1.74	460.9	0.34	1.74	3.15	2.88	
52230-R	OFRB	1.62	6/6/1941	235	232	2.49	0.20	1.74	460.9	0.18	1.83	2.76	1.32	
52360-L	OFRB	5.16	13/1/1991	788	731	2.45	0.46	1.72	460.8	0.45	1.73	2.54	2.06	
58250-L	OFRB	2.99	20/12/1944	428	428	2.00	0.38	1.40	456.9	0.37	1.41	3.10	1.92	
63620-L	APM	2.09	18/4/1981	305	298	2.18	0.32	1.44	459.5	0.32	0.76	2.57	1.89	Outlet was broken, 3 ft cut with outlet
64430-R	OFRB	2.09	18/4/1981	324	298	2.61	0.32	0.64	458.9	0.31	0.65	2.44	1.25	
65210-L	OFRB	2.2	22/5/1944	327	315		.88 dia			0.24	1.75	2.44	....	Two cuts with outlet
66530-L	OFRB	2.77	9/3/1982	424	396	2.50	0.27	1.76	458.6	0.31	1.77	2.54	....	Two cuts with outlet
69720-L	APM	1.97	9/3/1982	304	281	2.10	0.32	0.72	458.3	0.32	0.72	2.59	....	2 ft cut with outlet
70060-R	OFRB	1.6	3/12/1958	239	229	2.23	0.20	1.56	457	0.18	1.63	2.06	1.76	2 ft cut with outlet
70600-L	APM	1.64	22/5/1944	244	234	2.10	0.32	0.57	458.2	0.30	0.62	....	2.98	2 ft cut with outlet
70950-L	OFRB	3.09	6/6/1944	492	441		0.96 d		456.4	0.29	1.78	2.25	2.48	Illigle pipe and 2 ft cut with outlet
72940-L	APM	3.16	18/4/1981	479	451	2.62	0.40	0.83	457.3	0.40	0.84	2.08	....	
74000-L		1.51	18/4/1981	215	215	2.10	0.32	0.52	457.5	......	....	....	....	No Outlet, Open cut
79920-L	APM	1.55	18/4/1981	224	222	2.10	0.32	0.54	456.3	0.31	0.54	2.30	0.86	
79960-L	APM	3	18/4/1981	437	428	2.10	0.40	0.96	456.3	0.39	0.98	2.65	1.45	

Annex 1

Outlet data for Azim Distributary (complete).

W/C No	TYPE	Authorised Discharge (cfs)	Date of Last Alteration	GCA (I D) (acre)	CCA (I D) (acre)	H (I D) (ft)	B (I D) (ft)	Y (I D) (ft)	CRL (I D) (ft)	B Actual (ft)	Y Actual (ft)	He Elev. (ft)	Hb Elev. (ft)	Remarks
81550-L	APM	1.29	18/4/1981	216	186	2.10	0.25	0.58	456	0.23	0.60	2.09	0.89	
84160-L	OFRB	2.72	4/12/1984	407	389	2.50	0.27	1.75	455.1	0.26	1.76	1.83	1.37	
87500-R	OFRB	5.69	4/2/1976	849	813	2.50	0.67	1.75	454.4	0.46	1.78	2.35	1.94	
88130-L	APM	3.61	12/4/1984	549	515	1.85	0.63	0.75	454.4	0.64	0.75	2.84	2.60	
90540-L	APM	2.5	16/10/1969	274	261	2.52	0.40	0.64	453.3	0.39	0.64	2.24	1.24	
91000-R	OFRB	2.1	10/9/45	338	300	2.50	0.21	1.76	463.2	0.18	1.78	2.74		....
92000-R	OF									2.24	....	1.89	1.29	Minor for forest
94140-L	OFRB	2.99	11/5/70	426	298	1.75	0.48	1.23	452.6	0.48	1.22	2.76		....
96580-R	OFRB	2.35	8/6/44	343	336	1.75	0.38	1.23	452.2	0.39	1.24	1.36		....
98420-L	OFRB	2.02	6/6/41	307	289	1.73	0.33	1.21	451.8	0.33	1.23	1.45	1.48	
98810-R	OFRB	5.31	29/5/46	520	519	1.73	0.78	1.21	451.7	0.79	1.23	1.97		....
104800-L	OFRB	1.61	8/6/44	231	230	1.76	0.27	1.23	449.5	0.25	1.24	1.91	1.88	
105870-R	OFRB	1.91	8/6/44	277	271	1.75	0.32	1.25	449.3	0.31	1.26	2.22		....
106300-L	OFRB	1.98	8/6/44	290	283	1.76	0.33	1.23	449.2	0.32	1.25	1.54	0.88	
106380-R	OFRB	2.93	8/6/44	431	418	1.75	0.44	1.23	448.2	0.46	1.24	1.73	1.23	
109300-L	OFRB	3.48	24/6/74	499	487	1.75	0.60	1.23	448.6	0.49	1.23	....		....
110080-L	OFRB	1.79	24/6/74	268	266	1.60	0.37	1.05	448.7	0.35	1.06	2.13	2.23	
111770-L	OFRB	2.06	11/6/44	300	284	1.50	0.40	1.05	448.3	0.38	1.07	1.63	2.16	
111945-R	OFRB	2.76	28/1/90	514	503	1.50	0.50	1.05	448.7	0.66	1.06	1.79	2.08	
112960-L	OFRB	1.39	28/8/90	204	198	1.80	0.23	1.26	447.8	0.27	1.27	1.88	2.37	
113870-L	OFRB	2.76	28/8/90	406	395	1.81	0.40	1.26	447.9	0.44	1.29	2.37	1.59	
113500-R	OFRB	1.53	13/9/55	230	219	1.80	0.26	1.28	447.7	0.24	1.29	2.06		....
116750-L	OFRB	3.86	4/10/86	569	552	1.25	0.92	0.88	446.7	0.92	0.90	1.90	1.64	
117530-R	OFRB	1.03	28/1/90	198	189	1.25	0.25	0.88	446.6	0.43	0.90	1.73	1.43	
118980-L	OFRB	1.58	28/1/90	295	288	1.20	0.40	0.88	446.5	0.67	0.87	1.13	1.20	TAIL

ANNEX 2 RESULTS OF CALIBRATION OF OUTLETS FOR DISTRIBUTARIES IN THE CHISHTIAN SUB-DIVISION

Results of calibration of outlets of 3-L Distributary.

W/C (RD)	Type	W.M. Elevation (ft)	W.M. Elevation d/s (ft)	Date	H_u (ft)	H_d (ft)	Flow Condition	q (cfs)	C_d
10-L	OFRB	-	-	8/10/1995	2.49	0.66	OM	4.1	0.52
3400-L	OBRB	-	-	8/10/1995	2.44	2.17	ON	1.9	0.85
6400-L	PIPE	-	-	8/10/1995	2.11	1.32	ON	3.8	0.75
11000-L	OFRB	-0.19	0.22	8/10/1995	1.86	1.20	OM	3.6	0.68
16320-L	OFRB	0.14	0.3	8/10/1995	1.93	0.45	OM	2.1	0.46
23100-T	OF	0.26	0.25	8/10/1995	1.31	0.7	FF	4.1	0.52

Results of calibration of canal structures and outlets of Mohar Distributary.

W/C (RD)	Type	W.M. elevation U/S (ft)	W.M. Elevation D/S (ft)	Date	H_u (ft)	H_d (ft)	Flow condition	q (cfs)	C_d
1040-R	APM	2.32	0.64	20/9/1995	1.95		OM	1.54	0.66
1500-L	PIPE	-	-	23/9/1995	2.15	1.15	ON	0.63	1.04
3300-L	PIPE	-	-	23/9/1995	3.73	2.37	ON	0.982	0.62
3300-H.ABAD	OF (Minor)	-	2.52	20/9/1995	3.29	3.28	FS	7.35	0.54
5000-R	OFRB	0.885	-1.52	23/9/1995	2.4	1.26	ON	2.684	Broken
6430-R	OFRB	2.33	0.47	20/9/1995	1.59		OM	3.68	0.41
8430-R	OFRB	1.83	0.69	20/9/1995	1.03	0.58	OM	1.46	0.54
12690-R	OFRB	2.50	2.23	23/9/1995	2.33	1.46	OM	4.2	Broken
13770-L	OFRB	2.66	2.82	23/9/1995	2.37	1.82	ON	2.415	0.86
13880-R	OFRB	2.23	0.56	23/9/1995	1.95	1.12	OM	1.945	0.78
18000-L	OFRB	2.04	1.15	23/9/1995	1.87	1.53	ON	1.54	Broken
20240-T.L.	OF	1.65	0.77	23/9/1995	1.31	1.22	FS	1.42	0.99
20240-T.F.	OF	1.48	1.34	23/9/1995	1.3	1.01	FS	1.143	0.48

Annex 2

Results of calibration of canal structures and outlets of Daulat Distributary.

W/C (RD)	Type	WM Elevation U/S (ft)	WM Elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow Condition	q (cfs)	Cd
2500-R	OFRB	3.86	2.59	10/04/1996	2.50	2.13	ON	2.06	0.98
3990-L	APM	3.96	2.50	09/05/1996	3.13	----	OM	0.66	0.65
6670-R	OFRB	3.41	2.76	17/09/1995	3.23	----	OM	2.51	0.42
6900-L	APM	4.02	1.72	11/05/1996	3.20	----	OM	2.22	0.77
8990-R	APM	3.82	2.13	13/05/1996	2.67	----	OM	1.53	0.56
12000-R	OCOFRB	3.07	2.09	13/05/1996	2.44	2.02	ON	1.27	0.67
13050-L	PIPE	3.23	3.15	10/04/1996	2.62	2.27	ON	2.39	1.14
16100-L	OFRB	2.92	3.22	09/05/1996	2.60	2.22	ON	2.06	0.89
19900-L	OFRB	2.67	1.70	09/05/1996	1.69	----	FF	1.47	0.31
22100-L	PIPE	----	----	----	----	----	----	----	Closed
22452-L	PIPE	1.56	3.17	13/05/1996	1.62	1.41	ON	4.96	0.94
23200-L	PIPE	----	----	----	----	----	----	----	Closed
24800-L	PIPE	----	----	----	----	----	----	----	Closed
25500-L	OFRB	2.19	2.16	09/05/1996	1.62	----	OM	1.52	0.37
26800-L	PIPE	1.03	2.62	10/04/1996	1.97	1.61	ON	3.20	1.10
29000-L	PIPE	----	----	----	----	----	----	----	Closed
29670-L	PIPE	----	----	10/04/1996	1.37	1.15	ON	1.79	0.79
32000-L	OFRB	3.21	3.68	07/05/1996	2.48	----	OM	3.02	0.37
33900-L	OFRB	3.10	2.72	07/05/1996	2.14	----	OM	1.47	0.34
38800-L	PIPE	1.52	2.61	13/05/1996	2.15	2.07	ON	1.53	0.40
38800-R	OCAPM	1.72	----	13/05/1996	1.33	----	OM	1.67	Broken
39322-L	OFRB	2.93	1.76	10/04/1996	1.65	----	OM	2.43	0.43
39390-L	OCOFRB	2.49	1.39	13/05/1996	1.60	----	OM	0.98	0.34
40000-L	APM	2.55	2.19	13/05/1996	1.89	----	OM	1.23	0.70
41030 R	OFRB	2.75	1.15	13/05/1996	1.89	----	OM	0.99	Broken
43270-L	APM	3.47	1.79	08/05/1996	2.54	----	OM	1.51	0.88
45810-R	APM	3.04	0.88	08/05/1996	2.28	----	OM	2.03	0.76
47500-L	OFRB	3.28	2.31	08/05/1996	2.52	----	OM	1.79	0.52
49000-L	OCOFRB	3.02	2.83	13/05/1996	2.36	----	FF	2.56	Broken
49640-L	OFRB	2.80	1.55	25/09/1995	1.92	----	FF	2.02	0.36

Annex 2

Results of calibration of canal structures and outlets of Daulat Distributary (continued).

W/C (RD)	Type	WM Elevation U/S (ft)	WM Elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow Condition	q (cfs)	Cd
49730-R	OCOFRB	2.81	2.45	13/05/1996	2.45	1.55	ON	2.16	Broken
52500-L	OFRB	3.28	2.44	13/05/1996	2.14	----	OM	2.96	Broken
54350-L	OFRB	3.12	0.75	07/05/1996	2.53	----	OM	4.88	0.43
54600-R	OFRB	2.63	2.35	13/05/1996	2.22	0.76	ON	2.93	Cut with O/L
54800-R Billuka	(Minor) Weir	2.50	0.50	13/05/1996	1.78	1.68	FS	9.11	1.03
57880-R	OCOFRB	2.26	1.37	13/05/1996	1.76	1.19	ON	1.27	Broken
61790-R	OCOFRB	2.23	1.30	13/05/1996	1.91	----	OM	0.69	Broken
62090-L	OFRB	3.11	1.31	08/05/1996	2.33	----	OM	1.49	0.27
63470-L	OF	2.10	1.55	08/05/1996	1.14	----	FF	1.13	0.43
63490-R	OF	2.26	1.65	08/05/1996	1.90	----	FF	1.80	0.33
63630-L Nakewah Minor	Gated Orifice	2.35	3.65	08/05/1996	1.76	1.53	FS	24.11	1.60
* 63630 Structure	Gated Orifice	3.24	3.34	08/05/1996	2.50	2.30	ON	36.08	0.81
69000-L	OFRB	2.25	0.60	13/05/1996	1.54	----	FF	0.60	Broken
71200-R	OFRB	3.53	----	13/05/1996	2.89	----	OM	1.50	Broken
73000-R	OFRB	2.79	1.12	13/05/1996	1.81	----	OM	1.81	0.51
75860-L	OFRB	3.48	2.53	11/05/1996	2.38	----	OM	2.47	0.46
76480-R	OFRB	1.86	1.51	11/05/1996	1.50	----	OM	1.46	0.46
80730-R	OFRB	2.81	0.94	13/05/1996	2.45	----	OM	2.30	Broken
80979-L	OCOFRB	1.84	1.05	11/05/1996	1.38	----	OM	1.14	0.35
81500-L	OCOFRB	1.86	1.61	13/05/1996	----	----	----	0.83	Broken
83730-R	OFRB	2.02	----	12/05/1996	1.44	----	FF	1.74	0.33
85850-L	OFRB	1.74	1.86	12/05/1996	1.41	----	FF	1.54	0.38
86480-R	PIPE	----	----	22/08/1995	2.57	1.93	ON	1.67	0.66
89860-R	PIPE	----	----	22/08/1995	2.04	1.38	ON	2.25	0.90
90070-L	OCOFRB	1.69	1.27	13/05/1996	1.22	----	FF	1.13	0.39
91180-R	OFRB	1.48	1.08	12/05/1996	1.50	----	FF	3.25	0.29

* Area was 8.1249 ft on 08/05/1996 for this structure during discharge measurement.

Annex 2

Results of calibration of canal structures and outlets of Daulat Distributary (complete).

W/C (RD)	Type	WM Elevation U/S (ft)	WM Elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow Condition	q (cfs)	Cd
91190-R	OCOFRB	2.10	2.15	12/05/1996	1.34	----	FF	1.37	0.55
95530-L	OFRB	1.64	1.28	13/05/1996	1.57	----	FS	1.36	Cut with O/L
95600-R	OFRB	1.25	1.61	13/05/1996	1.12	----	----	0.25	Half closed
95820-L	OCOFRB	2.03	1.84	12/05/1996	1.07	----	FF	1.22	0.57
97560-L	APM	1.66	0.44	13/05/1996	1.10	----	FF	1.55	0.42
98140-R	OFRB	2.19	2.16	12/05/1996	1.73	----	FF	2.83	0.41
99440-L	OFRB	1.50	----	12/05/1996	0.96	----	FF	1.15	0.46
99440-R	OFRB	1.81	1.56	12/05/1996	1.64	----	OM	1.58	0.59
104700-R	OFRB	1.31	1.18	13/05/1996	1.36	----	FF	1.16	0.40
105050-R	OFRB	2.18	1.22	13/05/1996	2.13	1.14	ON	1.42	0.49
105080-L	OFRB	2.05	1.25	13/05/1996	1.96	1.23	ON	1.35	Broken
108100-R	OFRB	1.32	----	13/05/1996	1.30	----	OM	1.98	Broken
109900-L	OFRB	----	----	13/05/1996	----	-----	ON	3.35	Broken
110320-R	OFRB	1.75	----	13/05/1996	----	----	----	0.00	No Water
112880-R	OFRB	1.59	1.66	13/05/1996	----	----	----	0.00	No Water
112900-L	OFRB	2.48	2.32	13/05/1996	----	----	----	0.00	No Water
114690-R	PIPE	----	----	13/05/1996	----	----	----	0.00	No Water
114860-L	OFRB	1.84	1.56	13/05/1996	----	----	----	0.00	No Water
115150-TC	OF	2.30	----	13/05/1996	----	----	----	0.00	No Water

Results of calibration of outlets of Phogan Distributary.

W/C RD	Type	W.M. Elevation U/S (ft)	W.M. Elevation D/S (ft)	Date	H_u (ft)	H_d (ft)	Flow Condition	q (cfs)	C_d
600/L	OFRB	1.52	1.42	11/06/1995	1.61	1.35	ON	0.44	0.31
2450/R	OFRB	1.98	1.93	11/06/1995	1.99	1.03	ON	1.25	0.55
4050/R	OFRB	2.16	1.54	11/06/1995	1.93	0.17	OM	1.69	0.49
5810/L	OFRB	2.56	2.05	11/06/1995	2.53	0.81	OM	2.19	0.61
5810/R	OFRB	2.18	1.62	11/06/1995	2.39	1.80	ON	2.83	0.87
7840/R	OF	1.43	2.10	11/06/1995	2.17	2.03	FS	4.52	---
8750/TR	OF	2.19	---	11/06/1995	2.20	---	FF	3.00	---
8750/TL	OF	2.35	---	11/06/1995	2.36	---	---	0.00	closed
8750/TF	OF	2.35	---	11/06/1995	2.36	---	FF	10.35	---

Annex 2

Results of calibration of canal structures and outlets of 4-L Distributary.

W/C (RD)	Type	W/M Ele. U/S (ft)	W/M Ele. D/S (ft)	Date	H_u (ft)	H_d (ft)	Flow condition	q (cfs)	Cd
200-L	OFRB	2.90	1.98	14/6/1995	2.90	1.48	ON	2.26	0.80
300-L	OFRB	2.37	1.33	14/6/1995	2.24	0.63	OM	3.25	0.72
3220-L	OFRB	2.27	1.49	14/6/1995	2.00	---		0.10 *	closed
6390-L	OFRB	2.28	0.61	14/6/1995	2.21	0.77	OM	1.93	0.48
9150-L	OFRB	2.65	1.72	14/6/1995	2.20	0.94	OM	2.76	0.56
12600-L	OFRB	2.44	0.73	14/6/1995	1.96	---	OM	3.81	0.48
17350-TL	OFRB	2.23	1.37	14/6/1995	0.88	0.84	ON	3.04	...**

* leakage, ** there was one illegal cut at RD 17350.

Results of calibration of canal structures and outlets of Khemgarh Distributary.

W/C (RD)	Type	W/M Ele U/S (ft)	W/M Ele D/S (ft)	Date	H_u (Ft)	H_d (Ft)	Flow condition	q (cfs)	Cd
200/R	OFRB	2.65	1.72	24/9/1995	2.57	---	OM	7.11	0.54
1180/R	OFRB	2.34	2.04	24/9/1995	2.59	---	OM	5.39	0.59
2590/R	OFRB	2.94	2.24	24/9/1995	2.79	---	OM	1.78	0.48
3750/R	OFRB	3.08	1.29	24/9/1995	2.81	---	OM	3.42	0.62
3850/R	OFRB	2.22	1.98	24/9/1995	2.16	---	OM	9.60	**
4600/R	OFRB	2.33	1.05	24/9/1995	2.23	---	OM	1.71	0.54
8730/R	OFRB	2.34	0.99	24/9/1995	2.10	---	OM	5.64	**
13590/R	OFRB	1.94	0.13	24/9/1995	1.65	---	OM	1.84	0.57
15500/T	OF	2.43	1.66	24/9/1995	1.75	1.74	FS	2.99	0.97

** Outlets were broken

Results of calibration of outlets of Jagir Distributary.

W/C (RD)	Type	W.M. Elevation U/S (ft)	W.M. Elevation D/S (ft)	Date	H_u (ft)	H_d (ft)	Flow Condition	q (cfs)	C_d
200-R	PIPE	---	---	2/3/1996	2.05	1.06	ON	3.77	1.42
990-R	PIPE	---	---	2/3/1996	1.88	1.23	ON	4.80	0.94
1000-R	PIPE	---	---	2/36/1996	2.40	---	OM	4.64	0.47
1660-R	PIPE	---	---	3/3/1996	1.79	---	OM	2.35	0.77
3990-R	PIPE	---	---	3/3/1996	1.89	1.37	ON	2.25	1.10
7210-R	PIPE	---	---	3/3/1996	1.73	1.30	ON	1.02	0.69
9090-R	PIPE	---	---	3/3/1996	1.43	---	OM	2.54	0.85
11880-R	PIPE	---	---	3/3/1996	1.90	1.51	ON	1.31	0.68
13830-TR	OF	2.25	1.49	3/3/1996	0.67	---	FF	1.71	0.39

Annex 2

Results of calibration of canal structures and outlets of Shahar Farid Distributary.

W.C. (RD)	Type	W.M. Elevation U/S (ft)	W.M. Elevation D/S (ft)	Date	H_u (ft)	H_d (ft)	Flow condition	q (cfs)	C_d
5220-L	OFRB	3.25	2.86	8/10/1995	2.935		OM	4.54	0.55
5240-L	OFRB	3.38	2.76	8/10/1995	3.05		OM	3.47	0.53
5300-L	OFRB	3.11	3.39	8/10/1995	2.77		OM	2.7	0.66
5320-R	OFRB	3.73	1.87	8/10/1995	3.13		OM	2.49	0.33
5330-R	APM	3.81	1.50	8/10/1995	3.175		OM	1.82	0.48
5500-Fall		4.75	2.72		4.755				
10700-R	APM	3.46	2.02	9/10/1995	3.22		OM	3.77	0.35
11846-L	APM	3.48	0.91	9/10/1995	2.69		OM	0.76	0.61
11960-R	APM	3.50	1.50	9/10/1995	2.37		OM	1.305	1.03
16750-L	OFRB	3.74		9/10/1995	3.05		OM	3.32	0.47
16943-R	OCOFRB	3.02	2.44	9/10/1995	2.165		OM	3.17	B
18011-L	OFRB	3.76	1.53	9/10/1995	3.135		OM	3.14	B
19840-R	OCOFRB	2.96	2.54	9/10/1995	2.235		OM	1.97	0.49
19847-L	OCOFRB	3.27	1.15	9/10/1995	2.495	3.265	ON	1.83	0.95
20539-L	OCOFRB	3.71		10/10/1995	3.705		OM		B
21895-R	OFRB	1.93	1.93	9/10/1995	1.07		OM	1.77	0.39
22636-L	OFRB	3.62	1.70	9/10/1995	2.9		OM	3.86	B
23500-R	OFRB			10/10/1995	0		OM		B
24000-L	PIPE			10/10/1995	0		ON		B
25154-R	APM	4.12	2.27	9/10/1995	2.89	1.34	ON	1.88	0.20
29045-R	APM	2.79	1.67	9/10/1995	1.86		OM	2.4	0.28
29700-L	APM	2.43		9/10/1995	1.63		OM	1.425	0.20
31440-R	APM	2.68	2.12	10/10/1995	2.06	1.24	ON	1.57	0.22
31610-R	OFRB	2.32	1.80	9/10/1995	2.14	1.25	ON	2.12	0.33
32913-L	OFRB	3.05		9/10/1995	2.82		OM	5.14	B
33075-R	OFRB	4.09		10/10/1995	3.19		OM	5.16	B

Annex 2

Results of calibration of canal structures and outlets of Shaher Farid Distributary (complete).

From previous page

W/C (RD)	Type	W.M. Elevation U/S (ft)	W.M. Elevation D/S (ft)	Date	H_u (ft)	H_d (ft)	Flow condition	q (cfs)	C_d
33630-L	OFRB	3.56	2.03	9/10/1995	3.12	-	OM	2.67	0.61
37000-L	APM	3.77	-	9/10/1995	3.22	-	OM	3.38	B
38980-L	APM	2.95	-	9/10/1995	2.58	-	OM	2.56	0.89
38727-R	APM	2.88	1.90	9/10/1995	2.53	-	OM	2.93	0.69
40900-L	OFRB	2.23	2.04	9/10/1995	1.94	0.96	ON	1.93	B
40910-L	OFRB	1.82	-	9/10/1995	1.72	-	FF	2.54	B
40950-L	OFRB	3.22	2.16	9/10/1995	2.75	-	OM	4.09	B
41800-R	OFRB	1.38	3.19	9/10/1995	2.92	0.62	ON	1.41	0.38
45200-L	APM	2.72	2.45	10/10/1995	1.54	1.24	ON	1.22	0.99
46000-R	OFRB	3.19	2.24	9/10/1995	2.11	-	OM	4.44	B
46025-R	OFRB	2.80	2.32	-	-	-	ON	0.881	B
S.FARID		1.617	-	9/10/1995	1.04	0.99	FS	1.32	1.09
HAIRWAH		1.17	-	9/10/1995	0.93	1.35	FF	17.93	0.36
49000-R	OFRB	2.18	2.28	9/10/1995	1.05	-	FF	1.46	0.33
49160-R	OFRB	2.00	-	-	-	-	Closed		C
49360-R	OFRB	2.01	1.53	9/10/1995	1.41	1.3	ON	1.06	0.87
49460-L	OFRB	1.73	2.32	9/10/1995	1.51	1.05	ON	0.999	0.79
53460-R	OFRB	1.98	1.76	10/10/1995	1.32	-	FF	0.933	0.19
53470-R	OFRB	1.69	-	9/10/1995	1.095	-	FF	1.64	0.56
59812-L	OFRB	1.92	2.23	9/10/1995	1.22	-	FF	2.20	B
59941-L	OFRB	2.01	1.34	10/10/1995	0.79	0.70	FS	0.2*	
60360-R	OFRB	2.34	1.35	10/10/1995	1.16	-	FF	1.009	0.23
61319-L	OFRB	2.56	2.29	10/10/1995	-	-	FS	0.15*	
61637-R	OFRB		-	-	-	-	FS	0.1*	B

* These values are estimated, not measured.

Annex 2

Results of calibration of canal structures and outlets of Masood Distributary.

W.C. (RD)	Type	W.M elevation U/S (ft)	W.M elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow condition	q (cfs)	Cd
1100-R	OFRB	3.00	2.56	14/11/1995	-	-	-	-	Closed
3700-R	OFRB	3.27	2.87	14/11/1995	2.4	-	OM	2.35	Broken
7300-R	OFRB	2.975	1.745	14/11/1995	2.415	-	OM	1.87	0.56
13500-R	PIPE	-	-	14/11/1995	-	-	ON	2.18	Broken
24000-R	PIPE	-	-	14/11/1995	1.75	1.54	ON	0.71	0.26
FALL-24050	Fall	1.31	-	14/11/1995	0.74	-	FF	16	0.31
27200-R	OFRB	2.43	2.56	14/11/1995	2.18	1.83	ON	0.974	0.48
28750-R	OFRB	2.29	1.75	14/11/1995	1.84	1.23	ON	1.42	0.82
34860-R	OFRB	2.11	1.8	14/11/1995	2.06	-	OM	1.96	0.50
35590-R	OFRB	2.12	2.99	23/11/1995	2.05	-	OM	2.13	0.43
35600-R	OFRB	2.27	1.8	14/11/1995	1.89	-	OM	1.83	0.48
36620-R	OFRB	1.8	1.67	23/11/1995	1.36	-	FF	1.73	0.39
37150-R	OFRB	89	2.07	14/11/1995	1.34	-	OM	2.48	0.55
37250 FALL	Fall	485	2.465	14/11/1995	0.925	-	FF	4.71	0.32
44320 R	OFRB	.336	2.24	14/11/1995	1.556	-	OM	2.02	0.46
45950-R	OFRB	345	1.74	14/11/1995	1.315	-	OM	1.9	0.44

Results of calibration of outlets of Soda Distributary.

W/C NO	TYPE	Hu [illegible]/M Ele. (ft)	Hd W/M Ele. (ft)	DATE	Hu (ft)	Hd (ft)	FC	q (cfs)	Cd
80/R	OF[illegible]	2.32	1.8	26/8/1995	2.04	-	OM	2.58	0.47
980/R	O[illegible]	2.91	1.73	26/8/1995	2.24	-	OM	3.11	0.5
1090/R	OF[illegible]B	2.48	1.83	18/5/1995	1.99	-	FF	3.08	0.34
3000/R	OFRB	2.01	2.66	21/7/1995	1.66	-	OM	0.78	0.36
9280/R	OFRB	2.25	3.85	21/7/1995	1.93	-	OM	4.5	0.5
9300/R	OFRB	2.15	3.17	28/5/1995	1.83	-	OM	1.31	0.29
9320/R	OFRB	2.08	3.07	28/5/1995	1.19	-	OM	1.08	0.75
12500/L	OFRB	1.99	-	3/7/1995	1.92		OM	2.1	0.63
13900/R	OFRB	2.11	2	26/6/1995	1.5	-	FF	1.27	0.39

Annex 2 Calibration of outlets of Soda Distributary (complete).

W/C NO	TYPE	Hu W/M Ele. (ft)	Hd W/M Ele. (ft)	DATE	Hu (ft)	Hd (ft)	FC	q (cfs)	Cd
18020/L	OFRB	2.21	-	29/5/1995	2.31	-	OM	1.84	0.47
18080/R	OFRB	2.29	0.72	26/6/1995	1.51	-	OM	2.55	0.83
19970/R	OFRB	3.18	2.26	26/8/1995	2.57		OM	2.56	0.54
19990/R	OFRB	2.41	2.88	26/8/1995	2.42	-	OM	3.07	0.86
20030/R	OFRB	2.79	3.29	26/8/1995	2.87	-	OM	2.58	0.37
20040/R	OFRB	2.47	2.31	26/8/1995	2.19	-	OM	1.94	0.4
21300/L	OFRB	2.06	1.46	29/5/1995	1.98	-	OM	2.33	0.55
22690/L	OFRB	2.44	-	5/7/1995	1.38		FF	1.26	0.28
23550/R	OFRB	2.83	2.51	29/5/1995	2.53	2.11	ON	3.25	0.94
24650/L	OFRB	2.61	1.31	26/8/1995	2.2	**	ON	1.6	-
26680/R	OFRB	2.17	1.86	26/8/1995	1.76	-	FF	4.06	0.42
26750/L	Pipe	-	-	26/8/1995	1.68	1.35	ON	2.23	-
28280/L	OFRB	2.1	0.99	5/7/1995	1.49	1.09	ON	0.55	0.55
29600/L	OFRB	2.04	1.51	26/8/1995	2.18	-	OM	1.41	0.56
31460/R	OFRB	1.49	2.2	3/7/1995	1.57	-	FF	0.73	0.23
31600/R	OFRB	2.33	1.82	29/5/1995	2.23	1.7	ON	1.69	0.8
31960/R	OFRB	1.72	3.72	3/7/1995	1.73	1.69	ON	0.54	0.87
33740/L	OFRB	2.42	2.35	26/8/1995	1.05	-	FF	1.8	0.33
37240/L	OFRB	2.62	2.19	29/5/1995	2.13	1.5	ON	3.28	0.98
38100/L	OFRB	2.2	1.35	15/7/1995	1.07	1.02	ON	0.43	0.7
38100/R	OFRB	1.93	2.15	26/8/1995	1.93	1.4	ON	1.84	0.68
38150/R	OFRB	1.82	2.79	26/8/1995	1.91	1.49	ON	3.5	0.98
43700/TR	OF	1.8	1.09	26/8/1995	1.14	1.1	FS	0.94	0.99
43700/TL	OF	1.8	-	26/8/1995	1.14	-	FF	3.6	0.44

** OFRB was not functioning during the exercise because of rehabilitation of canal at this location. Instead two pipe were used to deliver the supplies.

Results of calibration of outlets of 5-L Distributary.

WC (RD)	Type	W.M elevation U/S (ft)	W.M elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow condition	q (cfs)	Cd
2800-R	OFRB	2.20	1.19	16/11/1995	1.7	-	OM	1.19	Broken
4900-R	OFRB	2.14	1.67	16/11/1995	1.05	0.44	OM	1.13	0.50
4910-Fall	Fall	2.26	2.10	16/11/1995	1.8	1.75	-	0.982	0.28/w
11300-TR	OF	1.96	0.75	16/11/1995	0.95	-	FF	0.98	0.43

Annex 2

Results of calibration of canal structures and outlets of Fordwah Distributary.

W/C (RD)	Type	WM elevation U/S (ft)	WM elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow Condition	q (cfs)	Cd
1556-L	OFRB	2.57	-	09/04/1996	1.27	1.02	ON	0.87	Broken
6100-L	OFRB	2.63	1.65	09/04/1996	1.68	-	OM	1.63	Broken
11450-L	OFRB	2.46	1.62	12/03/1996	1.18	1.01	ON	0.51	1.07
14320-R	OCOFRB	2.42	1.58	09/04/1996	1.62	-	OM	2.21	Broken
14710-R	OCOFRB	2.97	-	20/03/1996	2.44	2.21	ON	0.61	0.51
14910-R	OCOFRB	3.17	2.60	09/04/1996	2.47	-	ON	1.86	Broken
24800-R	OCOFRB	2.24	1.55	09/04/1996	1.67	-	FF	1.61	Broken
25950-R	OCOFRB	2.82	2.08	09/04/1996	2.06	-	OM	1.31	0.42
27050-L	OFRB	2.38	1.78	09/04/1996	1.31	-	ON	0.93	Broken
28110-R	OCOFRB	2.70	2.14	12/03/1996	2.14	-	OM	1.61	0.5
29550-R	OCOFRB	2.72	1.71	13/03/1996	1.99	-	OM	1.38	0.48
29690-R	OCOFRB	2.76	2.32	13/03/1996	2.19	1.31	ON	1.19	0.48
32920-R	PIPE	-	-	20/03/1996	1.89	1.17	ON	3.92	0.95
32940-R	PIPE	-	-	09/04/1996	2.24	1.82	ON	1.61	-
33000-R	OCAPM	3.44	1.75	13/03/1996	3.06	-	OM	2.36	0.94
33120-R	OCAPM	2.73	1.01	09/04/1996	2.34	1.09	ON	0.97	P.closed
33160-R	PIPE	2.48	1.16	09/04/1996	2.31	-	OM	1.15	0.75
33200-L	PIPE	1.46	-	-	-	-	-		Closed
38230-R	OCOFRB	2.24	-	13/03/1996	1.51	-	OM	1.19	0.48
38830-L	OFRB	2.38	-	20/03/1996	0.62	-	ON	0.68	0.99
39550-R	OCOFRB	3.10	-	13/03/1996	2.25	-	OM	1.77	0.66
42040-L	OCOFRB	2.34	-	14/03/1996	1.7	-	OM	0.49	0.49
42504-L	OCOFRB	3.13	-	14/03/1996	2.54	-	OM	1.95	0.51
42510-L	OCOFRB	2.93	2.89	14/03/1996	2.36	-	OM	1.45	0.51
42580-R	OCOFRB	2.77	2.75	14/03/1996	2.06	-	OM	1.35	0.47
42560-R	OF	3.25	2.48	20/03/1996	2.58	-	FF	2.93	0.32
42600-R	OCAPM	2.95	2.26	14/03/1996	2.11	-	OM	1.67	0.58
46725-R	OFRB	3.19	1.60	09/04/1996	2.31	-	OM	3.31	0.65
50575-R	OCOFRB	3.66	2.21	14/03/1996	2.89	-	OM	3.29	0.53
51500-L	OCOFRB	3.19	1.42	09/04/1996	2.27	-	OM	2.36	P.closed

Results of calibration of canal structures and outlets of Fordwah Distributary (continued).

From previous page

W/C (RD)	Type	WM elevation U/S (ft)	WM elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow Condition	q (cfs)	Cd
53380-R	OCOFRB	2.93	2.59	09/04/1996	2.58	-	FF	0.81	p.closed
53920-R	OCOFRB	2.45	-	09/04/1996	1.78	-	OM	1.16	p.closed
54060-R	OCOFRB	3.01	1.26	09/04/1996	2.13	-	FF	3.53	Broken
54080-R	APM	4.16	2.64	16/03/1996	3.38	-	OM	2.87	0.56
55160-R	OCOFRB	3.32	2.13	16/03/1996	2.72	-	OM	2.08	0.92
56000-L	OCOFRB	3.38	2.30	16/03/1996	2.79	-	OM	1.61	0.96
57640-L	OCOFRB	3.85	1.58	16/03/1996	2.98	-	OM	1.86	0.6
60000-L	OF	3.34	1.94	16/03/1996	2.49	-	FF	3.95	0.38
60410 L	OCOFRB	2.49	0.51	09/04/1996	1.78	-	OM	2.35	Broken
62085-R	OCOFRB	3.36	1.13	09/04/1996	2.39	-	OM	2	Broken
62250-L	OCAPM	3.97	1.93	18/03/1996	3.18	-	OM	2.92	0.73
67160-L	APM	2.51	0.62	18/03/1996	2.46	-	OM	1.58	0.86
68260-L	APM	2.64	0.36	09/04/1996	2.03	-	OM	0.76	Broken
70530-R	APM	2.86	0.07	09/04/1996	2.76	-	OM	3.16	Broken
70600-L	APM	2.51		18/03/1996	2.29	-	OM	1.42	0.73
71200-R	OFRB	2.42	1.17	09/04/1996	2.2	-	OM	2.03	Broken
71697-L	APM	2.75	0.71	17/03/1996	2.41	-	OM	1.19	0.65
73008-R	APM	2.49	1.33	17/03/1996	2.19	-	OM	1.69	0.7
75140-R	APM	2.72	0.96	03/03/1996	1.82	-	OM	1.16	0.55
76640-L	APM	2.98	-	09/04/1996	2.61	-	OM	0.79	Broken P.Closed
78850-R	APM	2.64	1.15	03/03/1996	2.37	-	OM	2.03	0.67
82580-R	OFRB	2.66	1.02	03/03/1996	2.04	-	FF	2.95	0.43
82600-L	APM	2.77		03/03/1996	2.26	-	OM	1.49	0.75
83700-R	APM	2.51	1.50	17/03/1996	2.16	-	OM	0.75	0.66
84140-L	APM	2.44		17/03/1996	1.91	-	OM	0.9	0.7
90000-L	APM	2.38	0.50	17/03/1996	2.04	-	OM	0.42	0.76
90000-R	APM	2.16		17/03/1996	1.94	-	OM	0.81	0.65
91950-R	APM	2.17	2.15	24/02/1996	1.91	-	OM	0.93	0.71
93970-R	APM	2.73		24/02/1996	2.31	-	OM	1.57	0.7
93980-R	APM	2.50	1.69	24/02/1996	2.23	-	OM	1.45	0.72

Annex 2

Results of calibration of canal structures and outlets of Fordwah Distributary (complete).

From previous page

W/C (RD)	Type	WM elevation U/S (ft)	WM elevation D/S (ft)	Date	Hu (ft)	Hd (ft)	Flow Condition	q (cfs)	Cd
94186-R	APM	2.52	1.18	19/03/1996	2.22	-	OM	1.03	0.99
96300-L	APM	2.37	0.86	09/04/1996	1.9	-	OM	0.9	0.77
96692-R	APM	2.15	1.56	19/03/1996	2.04	-	OM	0.81	0.8
99500-R	APM	2.52	1.78	17/03/1996	2.13	-	OM	0.84	0.85
100700-L	PIPE	-	-	17/03/1996	2.93	0.55	ON	0.67	0.94
101800-R	APM	2.14	-	17/03/1996	2.09	-	OM	0.75	0.85
102820-R	APM	2.24	0.87	19/03/1996	1.64	-	OM	1.23	0.72
104950-L	APM	2.53	2.55	19/03/1996	1.78	0.78	ON	0.42	0.89
106000-R	APM	2.57	2.67	18/03/1996	2.46	-	OM	2.62	0.9
107810-R	PIPE	-	-	19/03/1996	2.04	1.54	ON	1.41	0.59
107820-R	APM	2.20	1.21	09/04/1996	1.79	0.11	ON	1.66	0.53
112250-R	APM	2.03	0.76	19/03/1996	1.68	-	OM	1.06	0.7
112840-L	APM	1.95	0.85	19/03/1996	1.55	-	OM	1.27	0.64
114700-R	APM	2.40	1.24	09/04/1996	1.82	-	OM	0.87	Broken
116630-L	OF	1.83	1.41	19/03/1996	1.37	-	FF	0.96	0.35
117700-R	PIPE	-	-	20/03/1996	2.44	-	OM	0.64	1.23
117775-R	APM	2.46	1.15	18/03/1996	2.35	-	OM	2.52	0.85
118000-R	APM	1.92	-	19/03/1996	1.51	-	OM	2.16	0.55
118250-R	APM	2.12	0.99	09/04/1996	1.86	-	OM	1.48	Broken
121220-L	PIPE	-	-	20/03/1996	0.81	0.51	ON	0.11	0.67
125600-R	APM	2.17	1.59	19/03/1996	1.47	-	OM	1.23	0.77
125462-L	APM	2.13	1.26	19/03/1996	1.56	-	OM	2.74	0.67
130100-R	APM	2.79	-	09/04/1996	1.37	-	OM	2.24	0.62
132500-L	OFRB	2.02	1.97	19/03/1996	0.85	-	FF	0.42	0.33
134100-R	APM	2.37	1.09	19/03/1996	1.4	-	OM	1.19	0.67
135180-R	APM	1.92	2.95	19/03/1996	1.31	0.98	ON	0.59	0.92
139780-TR	OF	2.34	1.54	09/04/1996	0.87	-	FF	1.41	0.34
139780-TL	OF	2.31	1.63	09/04/1996	0.84	0.71	FS	0.94	0.69

Annex 2

Results of calibration of canal structures and outlets of Mehmood Distributary.

W.C. (RD)	Type	W.M elevation U/S (ft)	W.M elevation U/S (ft)	Date	H_u (ft)	H_d (ft)	q (cfs)	Flow Condition	Cd
1030-R	OFRB	2.07	1.81	13/11/1995	2.16	-	2.61	OM	0.42
1270-L	PIPE	2.77	1.42	13/11/1995	1.44	0.15	0.71	OM	0.77
5200-R	OFRB	2.43	1.53	13/11/1995	2	1.09	4.05	OM	0.54
6600-L	PIPE	1.34	1.49	13/11/1995	1.47	1.18	1.24	ON	1.09
11860-T.C	OF	2.02	2.03	13/11/1995	1.59	1.86	3.26	FS	O.T.
11860-T.L	OF	2.21	2.79	13/11/1995	1.78	2.32	3.13	FS	O.T.
11860-T.R	OF	1.98	1.64	13/11/1995	1.55	0.27	3.7	FS	O.T.*

* over topping the structure

ANNEX 3 INFLOW-OUTFLOW MEASUREMENTS FOR DISTRIBUTARIES IN THE CHISHTIAN SUB-DIVISION

Inflow-outflow test of 3-L Distributary.

W/C (RD)	Design Discharge (cfs)	Measured Discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ (%)	Design "H" (ft)	MMeasured "H" (ft)	$(H_{act}-H_{des})/H_{des}*100$ (%)	H in disty (ft)	Flow Condition
10-L	3.64	4.1	12.6	1.5	2.49	66.0	2.85	OM
3400-L	3.17	1.9	-40.1	1.5	2.44	62.7	1.8	ON
6400-L	3.24	3.8	17.3	1.5	2.11	40.7	2.12	ON
11000-L	3.05	3.6	18.0	1.25	1.86	48.8	1.6	OM
16320-L	2	2.1	5.0	1.25	1.93	54.4	1.85	OM
23100-L	1.99	4.1	106.0	1.0	1.31	31.0	1.5	FF

Inflow-outflow Test of Mohar Distributary.

W/C (RD)	Athorised discharge (cfs)	Masured Discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ (%)	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$ (%)	H in disty (ft)	Flow condition
1040-R	1.54	1.48	-3.89	2	1.82	-9.00	2.15	OM
1500-L	0.41	0.63	53.66	-	2.15	-	1.85	ON
3300-L	0.67	0.98	46.27	-	3.73	-	2.8	ON
5000-R	2.2	2.66	20.91	2	2.4	20.00	1.42	ON
6430-R	4.11	3.76	-8.52	1.25	1.67	33.60	1.5	OM
8430-R	1.27	1.61	26.77	1.25	1.22	-2.00	1.17	OM
12690-R	2.79	4.93	76.70	1.25	2.33	86.56	1.26	OM
13770-L	1.6	2.42	51.25	1.25	2.37	89.60	1.11	ON
13880-R	1.00	1.94	94.00	1	1.95	95.50	1.05	OM
18000-L	1.52	1.54	1.32	1	1.87	87.00	1.17	ON
20240-T.L	2.17	1.42	-56.49	1	1.3	30.00	1.35	FS
20240-T.F	2.62	1.14	-34.56	1	1.3	30.00	1.35	FS

Annex 3

Inflow-outflow Test of Daulat Distributary.

W/C (RD)	Authorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ %	Design H (ft)	Measured H (ft)	$(h_{act}-h_{des})/h_{des}*100$ %	H in disty	Flow conditoin
2500-R	2.83	2.39	-15.55	2.80	2.85	1.79	2.27	ON
3990-L	0.57	--	----	2.00	----	----	2.44	Closed
6670-R	2.38	2.44	2.52	2.80	3.04	8.57	2.41	OM
6900-L	1.85	2.25	21.62	2.80	3.27	16.79	2.83	OM
8990-R	1.93	1.53	-20.73	2.80	2.67	-4.64	2.67	OM
12000-R	1.44	1.25	-13.19	2.10	2.44	16.19	2.23	ON
13050-L	1.75	3.55	102.86	----	2.81	----	2.45	ON
16100-L	2.71	1.89	-30.26	2.80	2.60	-7.14	2.37	ON
19900-L	3.00	1.54	-48.67	2.80	1.74	-37.86	2.46	FF
22100-L	----	--	----	----	----	----	2.91	Closed
22452-L	2.74	4.96	81.02	----	1.62	----	2.65	ON
23200-L	----	--	----	----	----	----	2.77	Closed
24800-L	----	--	----	----	----	----	2.76	Closed
25500-L	3.32	1.75	-47.29	2.40	1.68	-30.00	3.33	FF
26800-L	2.18	1.68	-22.94	----	1.99	----	2.37	ON
29000-L	----	--	----	----	----	----	2.47	Closed
29670-L	1.69	2.12	25.44	----	1.60	----	2.26	ON
32000-L	2.88	3.17	10.07	2.96	2.56	-13.51	2.76	FF
33900-L	1.70	1.46	-14.12	2.40	2.17	-9.58	2.47	OM
38800-L	4.86	1.53	-68.52	----	2.15	----	2.49	ON
38800-R	0.63	1.67	165.08	2.00	1.33	-33.50	2.49	OM
39322-L	3.15	2.61	-17.14	2.60	1.87	28.08	2.52	OM
39390-L	1.04	0.98	-5.77	1.68	1.60	-4.76	2.62	FF
40000-L	1.15	1.23	6.96	1.92	1.89	-1.56	2.44	OM
41030-R	1.55	0.99	-36.13	2.14	1.89	-11.68	2.50	OM
43270-L	1.01	1.56	54.46	2.60	2.70	3.85	2.19	OM
45810-R	1.45	2.10	44.83	2.60	2.45	-5.77	2.63	OM
47500-L	1.56	1.84	17.95	2.15	2.68	24.65	2.85	OM
49000-L	1.84	2.56	39.13	2.30	2.36	2.61	2.58	FF
49640-L	1.90	1.98	4.21	2.20	1.91	-13.18	2.21	FF

Inflow-outflow Test of Daulat Distributary (continued).

From previous page

W/C (RD)	Authorised Discharge (cfs)	Measured Discharge (cfs)	$(q_{act} - q_{des})/q_{des}*100$	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty	FC
49730-R	1.58	2.16	36.71	2.22	2.45	10.36	2.36	ON
52500-L	2.45	2.96	20.82	2.50	2.14	-14.40	3.02	OM
54350-L	6.04	5.04	-16.56	2.50	2.63	5.20	2.03	OM
54600-R	2.49	2.93	17.67	2.60	2.22	-14.62	1.99	ON
57880-R	0.95	1.27	33.68	1.60	1.76	10.00	1.97	ON
61790-R	0.85	0.69	-18.82	1.48	1.91	29.05	2.19	OM
62090-L	2.97	1.50	-49.49	2.40	2.33	-2.92	2.62	OM
63470-L	1.70	1.03	-33.41	1.82	1.07	-41.21	2.31	FF
63490-R	1.50	1.70	13.33	1.82	1.83	0.55	2.44	FF
69000-L	1.50	0.60	-60.00	2.10	1.54	-26.67	1.60	FF
71200-R	1.56	1.50	-3.85	2.10	2.89	37.62	2.52	OM
73000-R	1.57	1.81	15.29	1.75	1.81	3.43	1.61	OM
75860-L	1.57	2.65	68.79	2.00	2.70	35.00	2.34	OM
76480-R	2.13	1.47	-30.99	2.25	1.50	-33.33	2.18	OM
80730-R	2.64	2.30	-12.88	2.00	2.45	22.50	2.21	OM
80979-L	0.87	1.18	35.63	1.49	1.41	-5.37	2.10	FF
81500-L	1.10	0.83	-24.55	1.75	----	----	1.91	Broken
83730-R	2.55	2.00	-21.57	1.75	1.58	-9.71	2.39	FF
85850-L	1.16	1.78	53.45	1.75	1.56	-10.86	1.92	FF
86480-R	0.92	1.58	71.74	----	2.28	----	1.82	ON
89860-R	1.67	--	----	----	----	----	2.07	Closed
90070-L	0.98	1.13	15.31	1.64	1.22	-25.61	1.99	FF
91180-R	5.20	3.47	-33.27	1.75	1.58	-9.71	1.77	FF
91190-R	0.98	1.49	52.04	1.60	1.42	-11.25	1.77	FF
95530-L	1.67	1.36	-18.56	1.75	1.57	-10.29	1.49	FS
95600-R	1.51	0.25	-83.44	1.75	1.12	-36.00	1.59	Half closed
95820-L	0.79	1.30	64.56	1.20	1.12	-6.67	1.84	FF
97560-L	1.88	1.55	-17.55	1.75	1.10	-37.14	2.35	FF
98140-R	2.16	2.97	37.50	1.75	1.78	1.71	1.48	FF
99440-L	2.07	1.15	-44.44	1.75	0.96	-45.14	1.52	FF

Inflow-outflow Test of Daulat Distributary (complete).

From previous page

W/C (RD)	Authorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty (ft)	Flow condition
99440-R	1.29	1.58	22.48	1.75	1.64	-6.29	1.52	OM
104700-R	1.20	1.16	-3.33	1.75	1.38	-21.14	1.58	FF
105050-R	2.08	1.42	-31.73	1.75	2.13	21.71	1.73	ON
105080-L	1.53	1.35	-11.76	1.75	1.96	12.00	1.73	ON
108100-R	3.70	1.98	-46.49	1.50	1.30	-13.33	1.63	OM
109900 L	1.05	3.35	219.05	1.50	....	....	....	Broken
110320-R	2.99	0	....	1.50	....	....	....	.....
112880-R	4.15	0	....	1.50	....	....	....	....
112900-L	1.04	0	....	1.50	....	....	....	....
114690-R	0.25	0	....	....	....	....	....	....
114860-L	2.73	0	....	1.30	....	....	....	....
115150-TC	1.31	0	....	1.00	....	....	....	....

Inflow-outflow Test of Phogan Distributary.

W/C RD	Design Discharge (cfs)	Measured Discharge (cfs)	$(q_{act}-q_{des}/q_{des}*100$ (%)	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des}/H_{des}*100$ (%)	H in disty (ft)	Flow Condition
600/L	1:10	0.44	-0.6	1.00	1.61	61.0	1.22	ON
2450/R	1.04	1.25	20.2	1.25	1.99	59.2	1.66	ON
4050/R	1.30	1.69	30.0	1.25	1.93	54.4	1.53	OM
5810/L	1.03	2.19	112.6	1.40	2.53	80.7	1.29	OM
5810/R	2.25	2.83	25.8	1.25	2.39	91.2	1.28	ON
7840/R	2.47	4.52	83.0	1.25	2.17	73.6	1.14	FS
8750/TR	2.37	3.00	26.6	1.00	2.20	120.0	1.25	FF
8750/TL	1.09	0.00	---	1.00	2.36	136.0	1.43	closed
8750/TF	3.76	10.35	175.3	1.00	2.36	136.0	1.43	Over topping

Annex 3

Inflow-outflow Test of 4-L Distributary.

W.C RD	Athorized discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ %	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$ %	H in disty (ft)	Flow condition
200-L	1.23	2.26	83.7	1.50	2.90	93.3	2.64	ON
300-L	1.82	3.25	78.6	1.50	2.24	49.3	2.80	OM
3220-L	1.12	closed	0.0	1.50	2.00	33.3	2.68	closed
6390-L	1.58	1.93	22.2	1.50	2.21	47.3	2.24	OM
9150-L	1.76	2.76	26.8	1.25	2.20	76.0	1.58	OM
12600-L	3.48	3.81	9.5	1.25	1.96	56.8	1.70	OM
17350-TL	1.84	3.04	65.2	1.00	0.88	-12.0	0.92	ON

Inflow-outflow Test of Khemgarh Distributary.

W/C (RD)	Authorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$	Design H (ft)	Measured H (ft)	$(h_{act}-h_{des})/h_{des}*100$	H in disty (ft)	Flow condition
200/R	5.20	7.05	35.6	1.50	2.53	69.00	2.00	OM
1130/R	4.38	5.32	21.5	1.50	2.52	68.0	1.50	OM
2590/R	1.10	1.76	60.0	1.50	2.73	82.0	1.50	OM
3750/R	2.10	3.37	60.5	1.50	2.73	82.0	1.70	OM
3850/R	3.36	9.40	179.8	1.50	2.07	38.0	1.40	OM
4600/R	1.15	1.76	45.2	1.25	2.13	70.4	1.26	OM
8730/R	2.98	5.55	86.2	1.25	2.03	62.4	1.50	OM
13590/R	1.73	1.87	8.1	1.25	1.70	36.0	2.00	OM
15500/T	0.85	2.99	251.8	1.00	1.77	77.0	1.00	FS

Annex 3

Inflow-outflow Test of Jagir Distributary.

W/C (RD)	Design Discharge (cfs)	Measured Discharge (cfs)	$(q_{act} - q_{des})/q_{des}$ *100 (%)	Design "H" (ft)	Measured "H" (ft)	$(H_{act} - H_{des})/H_{des}$ *100 (%)	H in disty (ft)	Flow Condition
200-R	2.58	4.27	65.50	---	2.38	----	1.22	ON
990-R	3.71	5.68	53.10	---	2.24	----	1.27	ON
1000-R	4.45	4.74	6.52	---	2.50	----	1.27	OM
1660-R	2.01	2.35	16.92	---	1.79	----	0.90	OM
3990-R	1.63	2.27	39.26	---	1.87	----	1.03	ON
7210-R	1.99	1.02	-48.74	---	1.73	----	0.78	ON
9090-R	2.99	2.52	-12.80	---	1.41	----	1.11	OM
11880-R	1.83	1.31	-28.42	---	1.89	----	0.93	ON
13830-TR	2.69	2.14	-20.42	1.00	0.78	-22.00	0.72	FF

Inflow-outflow Test of Shahar Farid Distributary.

W/C (RD)	Athorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ %	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$ %	H in disty (ft)	Flow condition
5220-L	3.59	4.58	27.54	2.75	2.98	8.55	2.50	OM
5240-L	2.56	3.50	36.65	2.75	3.10	12.73	2.40	OM
5300-L	1.84	2.73	48.58	2.75	2.85	3.45	2.20	OM
5320-R	2.90	2.53	-12.91	2.75	3.22	17.09	2.18	OM
5330-R	1.79	1.84	2.63	2.75	3.24	17.64	2.18	OM
10700-R	6.15	3.79	-38.32	2.75	3.26	18.55	2.15	OM
11846-L	0.86	0.81	-5.90	2.75	3.05	10.91	2.30	OM
11960-R	0.93	1.41	51.43	2.75	2.76	0.36	2.20	OM
16750-L	1.47	3.31	125.48	2.50	3.04	21.60	2.30	OM
16943-R	1.75	3.31	88.92	2.00	2.34	17.75	2.60	OM
18011-L	1.04	3.34	220.83	2.00	3.54	77.00	2.50	OM
19840-R	2.13	2.08	-2.28	1.50	2.49	66.33	2.11	OM
19847-L	1.38	2.35	70.58	1.50	3.09	105.67	2.11	ON
20539-L	1.07	4.31	302.80	1.50	2.33	55.00	2.10	OM
21895-R	1.20	2.05	70.52	2.00	1.43	-28.50	2.00	OM
22636-L	3.35	4.12	22.91	2.75	3.30	20.00	1.93	OM
23500-R	1.37	2.66	94.16	2.75	-	-100	2.12	OM
24000-L	2.10	3.19	51.90	-	-	-	2.12	ON
25154-R	1.03	2.11	28.58	2.50	3.32	32.80	2.48	ON
29045-R	1.68	2.71	61.60	2.00	2.38	19.00	2.15	OM
29700-L	1.16	1.63	40.53	2.75	2.13	-22.55	2.45	OM
31440-R	1.53	1.57	2.61	1.50	2.06	37.33	2.08	ON
31610-R	1.24	2.05	65.04	1.50	1.96	30.67	1.90	ON
32913-L	2.28	4.94	116.47	2.00	2.60	30.00	1.90	B
33075-R	2.20	5.16	134.55	2.00	3.19	59.50	1.80	B

Inflow-outflow Test of Shahar Farid Distributary (complete).

From previous page

W/C (RD)	Athorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ %	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$ %	H in disty (ft)	Flow condition
33630-L	1.55	2.59	67.08	2.00	3.02	51.00	1.90	OM
37000-L	1.14	3.68	222.82	2.00	3.02	51.00	1.50	OM
38980-L	1.70	2.42	42.49	2.00	2.31	15.50	1.62	OM
38727-R	2.26	2.80	23.88	2.00	2.31	15.50	1.62	OM
40900-L	2.29	1.70	-25.78	2.00	1.69	-15.50	1.48	ON
40910-L	1.83	2.01	9.66	2.00	1.47	-26.50	1.60	FF
40950-L	1.28	3.88	203.44	2.00	2.48	24.00	1.50	OM
41800-R	1.19	1.34	12.68	1.75	2.66	52.00	1.55	ON
45200-L	1.65	1.22	-26.24	2.00	1.54	-23.00	1.51	ON
46000-R	1.40	4.27	204.88	1.87	1.95	4.28	1.70	OM
46025-R	7.34	0.75	-89.75	2.50	2.28	-8.80	1.40	ON
49000-R	2.05	1.46	-28.78	1.25	1.05	-16.00	1.00	FF
49160-R	1.16	-	-	1.25	2.00	60.00	-	Closed
49360-R	2.05	0.90	-55.90	1.25	1.22	-2.40	1.10	ON
49460-L	0.65	0.78	19.91	1.10	1.29	17.27	1.01	ON
53460-R	2.04	0.93	-54.26	1.50	1.32	-12.00	0.69	FF
53470-R	1.43	1.51	5.39	1.50	1.04	-31.00	0.81	FF
59812-L	2.89	1.64	-43.41	1.75	1.00	-42.86	0.78	FF
59941-L	1.24	0.20	-83.87	1.75	0.79	-54.86	0.86	OM
60360-R	1.52	1.01	-33.62	1.25	1.16	-7.20	0.36	FF
61319-L	5.17	0.15	-97.10	1.75	1.06	-39.43	-	FS
61637-L	-	0.10	-89.47	-	-	-	-	FS
61637-R	0.96	-	-	1.50	-	-	-	FS

Annex 3

Inflow-outflow Test of Masood Distributary.

W.C RD	Athorized discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ %	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$ %	H in disty (ft)	Flow condition
1100-R	0.96	closed	-	1.59	-	-	-	closed
3700-R	1.47	2.35	59.86	1.77	2.4	35.59	1.31	OM
7300-R	1.05	1.87	78.10	1.75	2.415	38.00	1.53	OM
13500-R	1.36	2.18	60.29	-	2.39	-	1.93	ON
24000-R	1.67	0.71	-57.49	-	1.75	-	1.48	ON
27200-R	1.76	0.974	-44.88	0.88	2.18	21.11	1.55	ON
28750-R	0.9	1.42	57.78	1.1	1.84	67.27	1.65	ON
34860-R	1.82	1.96	7.69	1.55	2.06	32.90	1.64	OM
35590-R	2.04	2.16	5.88	1.59	1.99	25.16	1.45	OM
35600-R	1.67	1.83	9.58	1.2	1.89	26.00	1.43	OM
36620-R	1.81	2.16	19.33	1.4	1.31	-6.43	1.22	FF
37150-R	1.59	2.48	55.98	1.29	1.34	3.88	1.15	OM
44320-R	1.96	2.02	3.06	1.12	1.556	38.93	0.90	OM
45950-R	2.2	1.9	-13.64	1.12	1.315	17.41	0.92	OM

Inflow-outflow test of Soda Distributary.

O/L No	Design Discharge (cfs)	Measured Discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$	H design (ft)	H actual (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty (ft)	Flow condition
80/R	2.6	2.58	-0.8	2	2.04	2.0	1.64	OM
980/R	2.44	3.11	27.5	2	2.24	12.0	1.68	OM
1090/R	2.81	3.48	23.8	2	2.16	8.0	1.56	FF
3000/R	0.91	0.81	-11.0	1.75	1.80	2.9	1.66	OM
9280/R	4.45	5.02	12.8	1.75	2.17	24.0	1.88	OM
9300/R	1.27	1.34	5.5	1.9	1.92	1.1	1.59	OM
9320/R	1.23	1.40	13.8	1.65	1.98	20.0	1.48	OM
12500/L	1.4	2.11	50.7	2	1.93	-3.5	1.72	OM
13900/R	1.16	1.91	64.7	1.6	1.97	23.1	1.96	FF
18020/L	1.49	1.87	25.5	2	2.38	19.0	1.51	OM
18080/R	2.46	3.12	26.8	2	2.25	12.5	1.57	OM

Annex 3

Inflow-outflow Test of Soda Distributary (complete).

O/L No	Design Discharge (cfs)	Measured Discharge (cfs)	$(q_{act} - q_{des}) / q_{des} * 100$	H design (ft)	H actual (ft)	$(H_{act} - H_{des}) / H_{des} * 100$	H in disty (ft)	Flow condition
19970/R	2.23	2.91	30.5	1.95	2.58	32.3	2.05	OM
19990/R	1.24	4.38	253.2	1.66	2.39	44.0	1.83	OM
20030/R	1.89	2.56	35.5	2	2.83	41.5	1.74	OM
20040/R	0.78	1.93	147.4	1.38	2.16	56.5	2.17	OM
21300/L	1.94	2.42	24.7	2	2.13	6.5	1.75	OM
22690/L	1.6	1.77	10.6	1.6	1.73	8.1	1.78	FF
23550/R	3.55	3.47	-2.3	2	2.73	36.5	1.92	ON
24650/L	1.16	1.59	37.1	1.75	2.16	23.4	1.27	ON
26680/R	2.81	5.55	97.5	2	1.61	-19.5	1.26	FF
26750/L	1.13	2.23	97.4	1.6	1.68	5.0	1.26	ON
28280/L	0.95	0.40	-57.9	1.6	1.73	8.1	1.35	ON
29600/L	0.72	1.39	93.1	1.31	2.11	61.1	1.09	OM
31460/R	1.13	0.70	-38.1	1.75	1.52	-13.1	1.27	FF
31600/R	1.89	0.94	-50.3	1.75	2.09	19.4	1.06	ON
31960/R	1.9	1.43	-24.7	1.75	1.70	-2.9	0.98	ON
33740/L	3.8	1.79	-52.9	1.5	1.05	-30.0	1.24	FF
37240/L	2.7	3.18	17.8	1.5	2.06	37.3	1.92	ON
38100/L	1.6	1.59	-0.6	1.5	1.70	13.3	1.17	ON
38100/R	2.3	1.54	-33.0	1.5	1.71	14.0	0.99	ON
38150/R	3.5	0.38	-89.1	1.5	1.52	1.3	1.59	ON
43700/TR	4.3	0.94	-78.1	1	0.93	-7.0	1.23	FS
43700/TL	2.5	2.65	6.0	1	0.93	-7.0	1.28	FF

Inflow-outflow Test of 5-L Distributary.

WC (RD)	Athorized discharge (cfs)	Measured discharge (cfs)	$q_{act}-q_{des}/ q_{des}*100$ (%)	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des}/ H_{des}*100$ (%)	H in disty (ft)	Flow condition
2800-R	0.61	1.19	95.1	0.9	1.7	88.9	1.17	OM
4900-R	1.16	1.13	-2.6	1	1.05	4.0	0.89	OM
11300-TR	0.76	0.98	29.2	1	1.1	-5.0	0.82	FF

Annex 3

Inflow-outflow Test of Fordwah Distributary.

W/C (RD)	Authorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ %	Design H (ft)	Measured H (ft)	$(h_{act}-h_{des})/h_{des}*100$ %	H in disty	Flow conditoin
1556-L	0.6	0.87	45.00	1.2	1.27	5.83	3.95	ON
6100-L	0.89	1.63	83.15	1.43	1.68	17.48	2.69	OM
11450-L	0.79	0.6	-24.05	1.25	1.2	-4.00	3.42	ON
14320-R	1.76	2.21	25.57	1.34	1.62	20.90	3.27	OM
14710-R	1.84	0.37	-79.89	2.26	2.28	0.88	3.45	ON
14910-R	2.1	1.86	-11.43	1.58	2.47	56.33	3.06	ON
24800-R	1.35	1.61	19.26	1.98	1.67	-15.66	3.25	FF
25950-R	1.35	1.31	-2.96	1.94	2.06	6.19	3.65	OM
27050-L	0.78	0.93	19.23	1.22	1.31	7.38	3.57	ON
28110-R	1.26	1.53	21.43	2	2.09	4.50	3.45	OM
29550-R	1.07	1.35	26.17	1.76	1.93	9.66	3.30	OM
29690-R	1.04	1.1	5.77	1.4	2.1	50.00	3.00	ON
32920-R	1.81	3.1	71.27	-	1.81	-	3.08	ON
32940-R	1.18	1.61	36.44	-	2.24	-	3.09	ON
33000-R	1.56	2.35	50.64	2.25	3.05	35.56	3.02	OM
33120-R	0.83	0.97	16.87	2.12	2.34	10.38	3.08	ON
33160-R	0.92	1.15	25.00	-	2.31	-	3.07	OM
33200-L	0.77	-	-	-	-	-	3.01	-
38230-R	1.06	1.16	9.43	1.25	1.42	13.60	3.00	OM
38830-L	0.38	0.74	94.74	1	1.56	56.00	2.89	ON
39550-R	0.93	1.82	95.70	1.29	2.4	86.05	3.15	OM
42040-L	0.33	0.47	42.42	1	1.6	60.00	2.98	OM
42580-R	2	1.31	-34.50	2.59	1.93	-25.48	2.95	OM
42560-R	1.17	2.93	150.43	1.51	2.58	70.86	2.95	FF
42504-L	1.48	1.9	28.38	2.04	2.42	18.63	2.79	OM
42510-L	0.92	1.42	54.35	1.62	2.24	38.27	2.79	OM
42600-R	0.83	1.73	108.43	1.65	2.26	36.97	2.53	OM
46725-R	1.68	3.12	85.71	2	2.31	15.50	2.93	OM
50575-R	1.71	2.32	35.67	2.25	2.72	20.89	2.98	OM
51500-L	1.25	2.36	88.80	1.56	2.27	45.51	2.85	OM

Inflow -Outflow Test of Fordwah Distributary (continued).

From previous page

W/C (RD)	Authorised Discharge (cfs)	Measured Discharge (cfs)	$(q_{act} - q_{des})/q_{des}*100$	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty	FC
53380-R	1.53	0.81	-47.06	2.05	2.58	25.85	3.65	FF
53920-R	0.93	1.16	24.73	1.4	1.78	27.14	2.91	OM
54060-R	1.79	3.53	97.21	1.5	2.13	42.00	3.17	FF
54080-R	1.45	2.81	93.79	2.08	3.25	56.25	2.99	OM
55160-R	1.07	2.04	90.65	2.25	2.61	16.00	2.58	OM
56000-L	1.1	1.55	40.91	1.62	2.6	60.49	2.88	OM
57640-L	1	1.85	85.00	1.64	2.95	79.88	2.58	OM
60000-L	1.14	3.77	230.70	1.5	2.41	60.67	2.60	FF
60410-L	1.02	2.35	130.39	1.75	1.78	1.71	2.81	OM
62085-R	1.18	2	69.49	1.52	2.39	57.24	-	OM
62250-L	1.57	2.88	83.44	2.15	3.08	43.26	3.14	OM
67160-L	1.38	1.53	10.87	2.25	2.31	2.67	1.80	OM
68260-L	0.84	0.76	-9.52	2.25	2.03	-9.78	2.05	OM
70530-R	1.25	3.16	152.80	2.25	2.76	22.67	2.52	OM
70600-L	1.41	1.39	-1.42	2.25	2.2	-2.22	2.26	OM
71200-R	1.3	2.03	56.15	2.25	2.2	-2.22	2.36	OM
71697-L	1.3	1.22	-6.15	2.25	2.5	11.11	1.86	OM
73008-R	1.57	1.72	9.55	2.21	2.28	3.17	2.26	OM
75140-R	1.53	1.24	-18.95	2.21	2.08	-5.88	2.45	OM
76640-L	1.47	0.69	-53.06	2.21	2.61	18.10	2.15	OM
78850-R	1.87	2.15	14.97	2.21	2.64	19.46	2.16	OM
82580-R	2.09	3.6	72.25	2.05	2.34	14.15	2.16	FF
82600-L	1.22	1.57	28.69	2.16	2.51	16.20	2.18	OM
83700-R	0.85	0.77	-9.41	2.16	2.27	5.09	2.18	OM
84140-L	0.95	0.92	-3.16	1.8	2	11.11	2.12	OM
90000-L	0.54	0.43	-20.37	2.16	2.15	-0.46	1.97	OM
90000-R	1.06	0.83	-21.70	2.16	2.05	-5.09	1.89	OM
91950-R	1.12	0.95	-15.18	2.16	2.01	-6.94	1.94	OM
93970-R	1.43	1.61	12.59	2.02	2.43	20.30	2.06	OM
93980-R	1.28	1.49	16.41	2.02	2.36	16.83	2.05	OM

Annex 3

Inflow - Outflow Test of Fordwah Distributary (complete).

From previous page

W/C (RD)	Authorised discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty (ft)	Flow condition
94186-R	0.71	1.04	46.48	2.02	2.29	13.37	1.27	OM
96300-L	1.06	0.9	-15.09	2.02	1.9	-5.94	2.02	OM
96692-R	0.64	0.82	28.12	1.75	2.12	21.14	2.14	OM
99500-R	0.68	0.85	25.00	1.75	2.21	26.29	1.75	OM
100700-L	-	0.67	-	-	2.66	-	1.84	ON
101800-R	0.7	0.77	10.00	2.02	2.21	9.41	1.74	OM
102820-R	1.31	1.27	-3.05	1.84	1.76	-4.35	1.71	OM
104950-L	0.46	0.4	-13.04	1.64	1.92	17.07	1.5	ON
106000-R	1.71	2.57	50.29	1.84	2.36	28.26	2	OM
107810-R		2.46			2.17		2.33	ON
107820-R	1.51	1.66	9.93	1.84	1.79	-2.72	2.33	ON
112250-R	1.11	1.09	-1.80	1.84	1.78	-3.26	1.64	OM
112840-L	1.7	1.29	-24.12	1.84	1.62	-11.96	1.57	OM
114700-R	1.03	0.87	-15.53	1.84	1.82	-1.09	1.55	OM
116630-L	1	0.97	-3.00	1.5	1.41	-6.00	1.5	FF
117700-R	0.22	0.05	-77.27				1.37	
117775-R	1.83	2.44	33.33	1.75	2.21	26.29	2.56	OM
118000-R	2.67	2.17	-18.73	1.65	1.53	-7.27	1.38	OM
118250-R	1.4	1.48	5.71	1.53	1.86	21.57	1.45	OM
121220-L	0.03	0.09	200.00		0.82		1.37	ON
125600-R	1.27	1.23	-3.15	1.53	1.48	-3.27	1.33	OM
125462-L	2.57	2.72	5.84	1.59	1.53	-3.77	1.25	OM
130100-R	2.4	2.24	-6.67	1.51	1.37	-9.27	1.08	OM
132500-L	0.52	0.41	-21.15	1.1	0.83	-24.55	0.87	FF
134100-R	1.21	1.19	-1.65	1.46	1.38	-5.48	1.12	OM
135180-R	0.81	0.65	-19.75	1.46	1.21	-17.12	1	ON
139780-TR	1.99	1.41	-29.15	1	0.87	-13.00	0.88	FF
139780-TL	2.78	0.94	-66.18	1	0.84	-16.00	0.88	FS

Annex 3

Inflow-outflow Test of Mehmood Distributary.

W.C (RD)	Athorized discharge (cfs)	Measured discharge (cfs)	$(q_{act}-q_{des})/q_{des}*100$ (%)	Design H (ft)	Measured H (ft)	$(H_{act}-H_{des})/H_{des}*100$ (%)	H in disty (ft)	Flow condition
1030-R	1.49	2.61	75.4	1.05	2.16	51.4	1.7	OM
1270-L	0.16	0.71	347.5		1.44		1.88	OM
5200-R	1.85	4.05	118.9	1.17	2.00	41.5	182	OM
6600-L	0.62	1.24	100.0		1.47		1.76	ON
11860-T.R	1.12	3.26	86.3	1	1.59	37.3	1.19	FS
11860-T.C.	1.75	3.14	141.1	1	1.78	43.8	1.19	FS
11860-T.L	1.3	3.7	230.4	1	1.55	35.5	1.19	FS

Inflow-outflow Test of Azim Distributary.

W.C RD	Athorized discharge (cfs)	Measured H (ft)	Design H (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty (ft)	Remarks
4114/R	3.94	2.27	2.5	-9.20	2.8	
5100/R	2.93	1.65	0.7	135.71	1.62	
8550/R	1.37	1.58	0.7	125.71	1.59	
10710/R	5.69	3.04	3.24	-6.17	3.5	
15970/L	2.04	3.05	3.25	-6.15	3.33	
15980/R	1.32	1.2	1	20.00	3.33	
17580/L	5.48	3.54	3.5	1.42	3.06	
20610/L	2.06	2.83	3	-5.67	3.1	
21030/R	2.91	4	2.5	60.00	3	
22940/L	1.8	2.58	2.5	3.20	2.82	
24120/L	2.39	2.79	2.5	11.60	1.66	
24380/R	1.95	2.11	1.5	40.67	2.5	
27400/L	3.35	2.55	2.5	2.00	2.6	
28460/R	3.97	2.9	2.5	16.00	2.1	
30900/R	2.3	2.45	1.25	96.00	2.4	
31030/L	1.75	2.26	1.5	50.67	2.28	

Inflow-outflow Test of Azim Distributary (complete).

W.C RD	Athorized discharge (cfs)	Measured H (ft)	Design H (ft)	$(H_{act}-H_{des})/H_{des}*100$	H in disty (ft)	Remarks
33100/L	2.04	3.25	2.5	30.00	2.17	
34000/R	1.83	2.26	2	13.00	2.4	
36200/R	1.29	1.5	1.8	-16.67	2.4	
36250/L	1.6	2.16	2	8.00	2.55	
39030/R	1.76	0.97	2	-51.50	2.11	
39180/L	1.97	2.74	2	37.00	1.93	
39700/R	1.93	1.45	2	-27.50	2	
40780/L	1.08	2.42	2	21.00	2.28	
41940/L	4.82	2.75	2.5	10.00	1.88	
43260/L	1.15	2.2	1.75	25.71	2.1	
44410/R	1.66	1.6	1.75	-8.57	2	
44200/L	1.37	2.21	1.7	30.00	2	
46450/R	3.86	1.4	1.75	-20.00	2	
47830/L	1.01	1.48	1.42	4.23	1.8	
50430/L	2.18	2.35	2	17.50	2.5	
50430/R	1.41	2.5	2	25.00	2.5	
51500/R	4.61	2.66	2.59	2.70	2.93	
52220/R	1.68	2.67	2.49	7.23	2.56	
52230/R	1.62	2.61	2.49	4.82	2.56	
52360/L	5.16	2.56	2.45	4.49	2.8	
58250/L	2.99	1.86	2	-7.00	2.9	
63620/L	2.09	1.02	2.18	-53.21	1.6	
64430/R	2.09	0.66	2.61	-74.74	1.55	
65210/L	2.2	0.7		000	1.7	
66530/L	2.77	0.2	2.5	-92.00	1.45	
69720/L	1.97	0.99	2.1	-52.86	1.52	
70050/R	1.6	1.18	2.23	-47.08	1.1	
70600/L	1.64	1	2.1	-52.38	1.8	
70950/L	3.09	1.06		00	1.7	
72940/L	3.15	1.33	2.52	-47.22	2.3	