TABLE XXX

Effect of irrigation and Rainfall in Chaj and Rechna Doabs on the rise of sub-soil Water-table in the two Doabs.

	CHAJ DOAB					RECHNA DOAB					BOTH DOABS					
Year	Contribution by irrigation.	Contribution by rainfall over irrigated area	Contribution by rainfall over whole area below Mangla 116/100 + Col.3.	Total Col. 2 + Col. 4	Rice of sub-soil Water-table	Contribution by irrigation	Contribution by rainfall over irrigated area	Contribution by rainfall over whole area below Marala 112/100 × Col.7	Total Col. 6 + Col. 8	Rise of sub-soil Water-table	Contribution by irrigation	Contribution by rainfall over irrigated area	Contribution by rainfall over whole area below Mangla and Marala, Col.11 + 113.5/100	Total Col.10+12	Rise of sub-soil Water-table	Discharge required to give annual rise
1	2	3	4	5	6	6A	7	8	9	9A	10	11	12	13	14	15
1935-36	525	627	727	125	+.14	1,500	660	740	2,240	0.0065	1,240	655	745	1,985	+ .043	95
1936-37	565	1,140	1,320	1,885	−.018	1,650	2,380	2,665	4,215	0.47	1,360	2,050	2,325	3,685	+ .342	755
1937-38	540	350	405	945	+.13	1,650	75	84	1,734	−0.008	1,360	148	170	1,530	+ .029	63
1938-39	570	290	336	906	−.33	1,480	870	975	2,455	.18	1,240	670	760	2,000	+ .045	99
1939-40	570	242	280	850	−.26	1,670	350	392	1,962	− .12	1,300	322	366	1,666	− .158	-348
1940-41	543	790	917	1,460	.086	1,180	1,055	845	2,025	.17	1,022	765	870	1,892	+ .148	328
1941-42	578	1,600	1,860	2,438	.51	1,390	3,080	3,460	4,850	.66	1,180	2,680	3,040	4,220	+ 610	1,340
1942-43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.55	[illegible]	1,785	1,960	3,240	+ 525	1,160

Distance above water-table.	Moisture percentage before lowering of spring level.	Moisture percentage after lowering.	Difference.
6'0	20·0	20.0	0.1
5'5	20.9	20.0	0.9
4,3	21.0	20.9	0.1
3,8	22.1	21.0	1.1
2'5	22.9	22.1	0.8
1'0	24.8	22.9	1.9
0'	40.0	24.8	15.0
1'	40.0	40.0	0.0
			20.0

When the water-table is lowered by 1′ the percentage of moistur the original water-table will become the same as the percentag moisture at 1′ above the spring level before it is lowered. At 1′ al spring level it will be the same as 2′ above sub-soil water-table befor is lowered and so on. It is further assumed that the field mois capacity is 20.0 Then discharge to be removed with a view to lower water-table by 1.5′ annually is $= \frac{80{,}49{,}000 \times 1.5 \times 20}{2, \times 365} = 3{,}300$ cu

This assumes that :—

(*a*) Seepage from canals does not increase. Actually when water-table is lowered, seepage from canals will increase saturated tracts where the sub-soil water-table is not lower t 3′ below bed. It is also likely that in some rea seepage will increase when the flow changes from saturated unsaturated phase.

(*b*) The efficiency of the method adopted to remove water does fall. For example, if tubewells are used, the discharge tube-well must not decrease.

(*c*) Water removed by infiltration into the river is not redu Actually, as the water-table is lowered, the slope of sub- water-table from the water shed to the river will become fla and the regeneration will, therefore, become less.

(*d*) The cropping scheme is not materially altered. For exam if rice is substituted for cotton on a large scale, contribu from irrigation will increase.

(*e*) The discharge used for irrigation is not materially altered.

(*f*) Discharge of 3,300 cusecs is removed continuously through the year.

(*g*) Loss by evaporation and transpiration by plants does not decrease. Actually there will be a fall in waterlogged tracts as spring level goes down.

Hence in order to ensure that the water-table should fall at the rate of one foot per annum, a discharge much greater than 3,300 cusecs worked out above will have to be removed. It is possible that a discharge one and a half times of this say 5,000 cusecs will require removal. Further, greater and greater discharge will have to be removed, as the water-table falls because infiltration will decrease on account of falling water-table.

The discharge should be removed from as large an area as possible as should removal be concentrated in a small area a steep gradient will be formed from the surrounding area to the place where it has been lowered. This may bring harmful salts to the area whence discharge is being removed.

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CHAPTER VI.

EFFECT OF FACTORS OTHER THAN IRRIGATION AND RAINFALL ON SUB-SOIL WATER-TABLE.

1. Seepage from or to Rivers. Statements VI. 1 to VI. 8 give gains and losses in river Jhelum between Mangla and Trimmu, Che between Marala and Shershah and Ravi between Madhopur and Sidh The results are abstracted in Statement VI. 9. It has been assumed one-half of the seepage from the Jhelum and the Ravi and the whole seep from the Chenab effect the sub-soil water-table in Chaj and Rechna Do There is considerable variation from year to year. This was only to expected. Gains and losses are based only on the morning gauges time lag has been neglected. Further discharge contributed by tributa and taken away by off-takes is not measured and is not taken account. Average loss for the eight-year period is 2,036 cusecs. Of t loss by evaporation from surface of the river is 500 cusecs (see Table VI for details) and net contribution to sub-soil water-table is 1,536 1,500 cusecs.

2. Sub-soil Flow from Upper Regions and to the Lower Regi of the Doabs.

At present no information is available about these two factors.

3. Evaporation from Soil and Transpiration by Canal Irriga Crops.

Effect of these has already been discussed in Chapters III and IV.

4. Transpiration by Barani and Sailab Crops,

Average area under barani and sailab crops in Chaj and Rec Doabs to south of Mangla and Marala is given in Statement VI. 10. statement has been prepared from the information supplied by Dep Commissioners of the various districts. Total average areas under bar and sailab crops is 806,000 acreas. Evapo-transpiration losses for irri ed crops are :

Cotton	20.3″
Wheat	14.0″
Maize	12.5″
Bajra	9.0″
Jawar	16.6″
Gram	4.0″
Average . . .	12.8″

Average loss for barani and sailab crops may be taken as 11″.

Thus total loss $= \frac{806,000}{2 \times 365} \times \frac{11}{12} =$ 1,012 cusecs

say 1000 cusecs

5. Irrigation wells. Number of irrigation wells and the average number of hours for which the wells work in various districts are given in in Statement VI. 10. There are altogether 52,112 wells and they work for 9.3 hours daily. Then discharge removed by wells, taking discharge of one well as 1/10 cusecs

$$= 5{,}2112 \times \frac{9.3}{24} \times \frac{1}{10}$$

$$= 2{,}019 \text{ cusecs, say } 2000 \text{ cusecs.}$$

6. Surface and Seepage Drains. Statistics show (see para 9 of Chapter VII) that the average discharge removed to the river by the above drains is 7 per cent of the maximum discharge ever experienced in these drains and the maximum discharge is given below :—

CHAJ DOAB

P. R. K. Drain	218 cusecs
Machiana	175 cusecs
Phalia	40 cusecs
Budhinalla	905 cusecs
Bahaud Din	45 cusecs
Mona	1,020 cusecs
Wan	192 cusecs
Malakwal	28 cusecs
Lower Raniwah	655 cusecs
	3278 cusecs

RECHNA DOAB

Vagh System	2,499 cusecs
Ahmedpur System	1,175 cusecs
Chiniot	470 cusecs
Rechna Outfall	656 cusecs
Maduana	nil
Chaku	153 cusecs
Niki Deg	619 cusecs
Chichoki Malian	147 cusecs
	5,719 cusecs
Total	8,997 say 9,000 cusecs

Average discharge removed by drains $= 9000 \times \frac{7}{100} = 630$ cusecs.

7. Combined Effect of all Factors.

Inflow into Doabs

(1) Seepage from Canals = 1,248 (Col. 10 bottom Table XXX)

(2) Contribution by rainfall = 1280 (Col. 12 ,, ,, ,,)

(3) Sub-soil flow from upper regions of Doab not known

Total . . . . 2,528 cusecs

Outflow from Doab

(1) Seepage into rivers = 1,500 cusecs (para 1 supra)

(2) Transpiration by Barani and Sailab crops = 1,000 (para supra)

(3) Removed by irrigation wells = 2,000 cusecs (para 5 supra)

(4) Removed by surface and seepage drain = 630 cusecs (para supra)

(5) Flow to lower regions of Doab not known

Total . . . . 2,130 cusecs

Difference between inflow and outflow = 398 cusecs

Discharge required to raise sub-soil water-table = 437 cusecs (Col. 15 bottom of Table XXX).

So inflow and outflow practically balance for the eight-year period. attempt was made to do the balancing for each year, but did not succe principally owing to defective data for gains and losses in rivers.

CHAPTER VII.

ECONOMICS OF DIFFERENT ANTI-WATERLOGGING MEASURES

Anti-waterlogging measures that have been adopted in the past or can be adopted in the future are enumerated below :—

1. Restriction of water supply for irrigation.
2. Lining of channels.
3. Tubewell pumping.
4. Pumping in local areas.
5. Lowering of full supply of irrigation channels.
6. Seepage drains along canals.
7. Seepage drains away from canals.
8. Surface drains.
9. Porous gallery.

2. Restriction of water supply for irrigation Anti-waterlogging closures were introduced as a result of the statistical examination of well records by Wilsdon and Sarathy*, who prepared what are known as regression curves based on the correlation existing between the rise of water-table and the combined value of irrigation and rainfall. As a result of their advice, the closures noted below were introduced on the perennial distributaries of the Upper Chenab Canal :—

November	12 days
December to February	60 days
April	15 to 20 days
May	15 days

During the monsoon months, these channels were to be closed for as many days as possible, having regard to weather conditions and to the requirements of rice cultivation. Minimum closure of five to six days per month was expected. Similar, thoughtless rigorous, closures were ordered on the Lower Chenab and Lower Jhelum Canals. These closures were, however, found to be impracticable owing to their not fitting in with the requirements of irrigation on the Lower Bari Doab Canal and owing to the protest of zemindars on other canals. They could never be enforced strictly and the actual number of days for which the canal was closed was considerably less than originally ordered. They were soon relaxed but have been re-introduced recently on the Lower Jhelum Canal.

It is doubtful if these anti-waterlogging closures are of any appreciable use. It will be seen from Table XXVIII, Chapter V, that of the 6,805 cusecs utilised on the distributaries of Lower Chenab Canal only 366 and

*Irrigation Research Memoirs Volume I, Nos. 1 and 2.

444 cusecs were added to the sub-soil water-table from distributaries water courses ; that is, there was a total addition of 810 cusecs f these two sources. This is only 12 per cent of the supply utilised on distributaries. Even this saving would only occur if the distributa could remain closed throughout the year. This is, of course, imposs The actual saving due to any anti-waterlogging closures that coul enforced, would probably not exceed 2 per cent of the discharge utilise the distributaries.

Restriction of supply is not an unmixed good. According Russell*, salts are produced by the decomposition of rock brought al by natural agents. Thus water and carbon dioxide acting as carb acid very slowly decompose the complex silicates forming clay mine silica, oxides of iron, alluminium and manganese and carbonate calcium, magnesium, potassium and sodium. Oxidation of sulphur l also to the formation of sulphates of the four last named elements. O salts, chlorides, phosphates, etc., are also formed. These salts are b continuously formed and would increase in the soil should sufficient w be not applied to the surface to leach the salts. A restriction of sup would thus interfere with this leaching and the soil would conseque become more saltish. Anti-waterlogging closures are not recommen except where water is being wasted or too much water was given in first instance.

3. Lining of Irrigation Channels. Lining of channels was started about 1911 and a number of materials have been tried. So the only materials that have proved reasonably successful are :—

1. Kankar lining on Gang Canal.
2. Brick lining on Haveli Canal.
3. Thal canal is being lined with cement concrete a this too is expected to prove an efficient means of wat proofing the canal.

It will be seen from Table XXVIII, Chapter V, that of the 3, cusecs added to the sub-soil water-table from the channels of Lo Chenab, Upper Chenab, Lower Jhelum and Upper Jhelum Canals many as 1,937 cusecs seeped from the Main Canals and Branches. most efficient results relative to the money spent are, therefore, likely to achieved by lining the Main Canals and Branches. This was first tr on a large scale on the Gang and Haveli Main Lines. The net cost lining the Haveli Canal amounted to Rs.41,23,000. Tank experim showed that the seepage from this lining would be negligible. It has been so far possible to measure the actual reduction in absorption by use of the lining. Assuming that the absorption from a lined channel is the rate of two cusecs per million square feet, it is computed that

*Soil conditions and plant growth by E. John Russell.

cusecs are being saved by lining of the Main Line. Therefore cost of lining per cusec saved $= \frac{41,23,000}{300} =$ Rs.13,743. The present prices are about double of those ruling in 1938-39 when the lining was executed. Cost per cusec saved at present rate will, therefore be :—

$$13,743 \times 2 = \text{Rs.}27,486' \text{ say Rs.}27,500'.$$

Annual interest charges at 4%=Rs.1,100. Average cost of maintenance per cusec saved $\frac{2,17,755}{=300}$ =Rs.73. Total annual cost=1100+73= Rs.1,173 say Rs.1,200.

This compares very favourably with the annual cost of saving one cusec of water by other means. Some estimates have also been sanctioned for lining distributaries as detailed below :—

Name of Works.	Estimated cost including establishment and T. & P. charge Rs.	Amount of water expected to be saved by lining cusecs.	Cost per cusec of water saved Rs.
1. Lining 9 L. Distributary of L. B. D. C. ...	7,65,972	6·1	1,25,570
2. Lining Lak Distributary L. J. C. with its two Minors. ...	6,53,032	10·5	62,193
3. Lining Rasulpur Distributary ...	1,12,382	1·22	92,116
4. Lining of Nahrianwala Distributary ...	83,748	1·12	74,775
5. Replacing Jhang Branch R. D. 25,000 to 37,000 with a lined channel ...	13,07,587	15·2	86,025
6. Lining Bhangu Distributary ...	1,39,728	2·4	58,220

Average cost per cusec saved=83,800.

Annual interest charges @ 4%=3,352.

Annual charge @ 70% time factor $= \frac{3,352}{0.7} = 4,790$.

This is considerably higher than Rs.1,100, estimated for Haveli Canal. One of the reasons for this big disparity is that, when a lined channel is constructed in the first instance considerable economy can be affected in acquisition of land, earthwork and masonry works. This of course is not possible when an old channel is lined. Lining can only be done where the sub-soil water-table is below the bed of the canal or the weight of the lining is such that it can counter-balance the uplift pressure should the spring level be higher than the bed. In reaches with high water-table, special arrangements have to be made to load the lining to such an extent that the uplift pressure cannot burst the lining. On the Haveli Canal, number of regulators have been used, while humps are being provided o the Thal Canal. Lining of Main Canal and Branches would be ide: for saving seepage but unfortunately spring level is now so high over larg tracts of Upper Chenab, Lower Chenab and other canals that suc reaches cannot be lined without prohibitive expenditure. Moreover, th economy in land, earthwork and masonry works that could have bee effected had these channels been lined in the first instance, is now n longer possible.

It has been shown above that the annual cost of saving one cusec b lining distributaries is Rs.3,352. This is not remunerative but lining ma be useful in reaches where the distributary passes through sandy soil an absorption is heavy or the distributary is in high filling and breaches ar frequent. It can also be useful in tail reaches of distributaries fc extending irrigation in such reaches where it would be very costly t remodel the whole channel in order to bring the extra discharge require for extension of irrigation in the tail reach. All the distributaries (Rechna and Chaj Doabs add only 676 cusecs (see Table XXVIII). S lining of existing distributaries cannot be very effective as an anti-wate logging measure and will be expensive. It is, however, a moot questio whether all new distributaries (at least the major ones) should not b lined. Saving in land, earthwork, masonry works and water may offs the extra cost in such cases.

Considerable economy can be affected by lining main watercourse The average size watercourse on colony canals has a discharge of 1. cusecs and its main watercourse may have a length of 8,000'. On a average, a length of 4,000' is in use. Taking 4' as a wetted perimeter, 1 and 8 cusecs as the loss per million square feet in kharif and rabi respec tively, in an unlined watercourse and two cusecs per million in a line watercourse, saving of water by lining will be :—

$$\text{Kharif} = \frac{4000 \times 4 \times (12\text{-}2)}{10,00,000} = 0.16 \text{ cusecs.}$$

$$\text{Rabi} = \frac{4000 \times 4 \times (8\text{-}2)}{10,00,000} = 0.10 \text{ cusecs.}$$

Average saving = 0.13 cusecs.

This is 8.7 perc ent of the discharge of the watercourse. Cost of linin such a watercourse with flat brick on $\frac{1}{2}''$ cement plaster over compacte earth will be Rs.1-8 per lineal foot. The cost of lining the whole water course will be Rs.11,250. Annual cost at 4% = Rs.450. Cost per cusec c water saved is 4,500-13 = Rs.3,460. Thus the lining of the watercourse i not remunerative if only direct return in the shape of Abiana and Lan Revenue is considered. But it would pay the Zemindar to line his water course as the cost of extra crops that he can raise by the water saved wil pay for the whole lining in four to five years' time. Should the Zeminda provide his own carts for carriage of materials and also unskilled labou free, he could reduce the cost of lining considerably.

4. Tube-wells. Tube-wells were first used as an anti-waterlogging measure at Amritsar where between 1911 and 1917, 15 tube-wells were sunk. Their gross discharge when first opened amounted to 28.5 cusecs. This rapidly fell off and by 1936 only amounted to 9.45 cusecs of which 2.85 cusecs was provided by the two new tube-wells sunk in the interim. The cost of operations rose simultaneously and reached a very high figure. The experiment was finally abandoned in 1936. The tube-wells had no appreciable effect on the water-table.*

Three tube-wells of an average discharge of 1.2, 0.75 and 1.0 cusecs were put in between the Left Retired Embankment of Hussainiwala Headworks and Ferozepore City with a view to prevent the spring level in Ferozepore City rising and damaging the buildings. As expected, the tube-wells utterly failed to achieve this. The discharge was too small to make any appreciable effect on an almost inexhaustible reservoir. After an initial lowering of the spring level in the first week or so, the sub-soil water-table could not be lowered further even though the tube-wells were continuously worked twice for more than six months at a time between June 1928 and February 1930. As a matter of fact, the sub-soil water-table rose whenever there was heavy rainfall and it came to the normal as soon as the pumping ceased.

Five tube wells of an aggregate discharge of 4.4 cusecs were constructed between the Upper Chenab Canal, Main Line, and Gujranwala Town but it was found that the tube-wells had a purely local effect which did not extend beyond half a mile radius and which did not last after the pumping stopped.**

All the three experiments, mentioned above, failed because the discharge pumped was utterly inadequate to affect a large capacity reservoir. An experiment on a large scale is being tried for the first time in the case of Rasul Tube-well Scheme where it is proposed to put in as many as 1,860 tube-wells of two cusecs each on Upper Chenab, Lower Chenab, Upper Jhelum and Lower Jhelum Canals. The capital cost of the Project is :—

Generation	=1,62,56,000
Transmission	=2,28,74,000
Distribution	= 97,32,000
Tube-wells	=3,12,61,000
Total ...	8,01,23,000

This capital cost only includes the cost which would be debitable to the project had it been solely designed for tube-well pumping. A portion of the energy to be produced at Rasul is proposed to be used in the grid for electrifying a number of towns. Cost of transmission lines for this supply

*Report on factors affecting Irrigation in the Punjab from tube-wells by A. M. R Montagu.

**Waterlogging on U. C. C. Its causes and cure by Rai Bahadur B. N. Singh Paper No. 197 Punjab Engineering Congress, 1937.

has been excluded. Annual cost of the project is :—

Generation and transmission at $3\frac{3}{4}$ per cent on Rs.3,91,30,000	Rs.14,67,375
Distribution at $6\frac{1}{4}$ per cent on Rs.97,32,000	6,03,250
Interest charges at 4 per cent on total cost of Rs.8,01,23,000	32,04,920
General supervision per annum	2,00,000
Direct supervision per annum	6,24,000
Maintenance of tube-wells per annum	1,40,323
Maintenance of buildings etc.	1,16,557
Depreciation	12,00,784
Total ...	76,92,304

$$\text{Cost per cusec of maximum capacity} = \frac{76,92,304}{3,720} = 2,067$$

Say . . . . Rs.2,100.

Assuming a time factor of 70 per cent for tube-wells, cost of saving cusec of maximum discharge=2,100/0.7=3,000. Cost of removal of cusec will, however, increase if tube-wells are installed in satura zones. In such cases, seepage from canals will increase as spring leve lowered until connection is broken between the canal and the sub-soil wa table. The net water removed from the sub-soil water-table is thus redu by the amount of extra seepage from canals thereby increasing cost.

Thus the tube-wells are more costly than lining Main Canal a Branches in the first instance but are cheaper, if the channels have to lined afterwards.

What is the best location of the tube-wells; whether they should on the water shed or on the drain for most expeditious lowering of sub-soil water-table; whether they should be sited along the main line branches or well away from them in regions where seepage is likely occur under saturated conditions and what should be the distance betw the tube-well and the main line; should it be found that the wells ou to be located away from the main line, is still far from settled. Exp ments are in progress and it is too early to say anythings about this asp of the matter. What is the optimum size of a tube-well? What sho be the length of the strainer,

(*a*) if there is a continuous pervious water bearing stratum,

and

(*b*) if an impervious layer of clay is situated between two pervi layers,

which is the best type of strainer for Punjab conditions what is maximum distance apart of the tube-wells for greatest efficiency and wh is the minimum distance between them so that they do not und interfere with one another are questions that require further study. Co sideration of these factors is beyond the scope of the present note.

5. Pumping in local areas. Pumping has been done at a number of places on Upper Chenab, Lower Chenab, and Lower Jhelum Canals with a view to affect local lowering of sub-soil water-table. Of these the important pumping stations are :—

1. Kachi Chhapar near Gujranwala,
2. Sheikhupura,
3. Bandoki (Lower Chenab Canal),
4. Wan Pumping Station at the outfall of Wan seepage drain (L. J. C.).
5. Bombanwala (U. C. C.). and
6. Chianwali(U. C. C.).

The last two stations are worked by hydrautomats. These pumping stations have proved useful in lowering the sub-soil water-table in the locality and in disposing of the discharge from seepage drains where gravity outfall is not available, but are costly and cannot be adopted with a view to lower the sub-soil water-table over an extensive area. Cost of working of some of the pumping stations is given in Table XXXI below :—

TABLE XXXI.

Cost of pumping per cusec day October 1943 to June 1944.

Name of pumping station.			*Cost of pumping per cusec day.*	
Lower Chenab Canal.		Rs.	As.	Ps.
Sadkana	... ...	7	2	8
Sukheki	... ...	6	14	3
Bandoki	... ...	4	0	6
Dhilwan	... ...	7	2	3
Ajmanwali	... ...	6	4	11
Upper Chenab Canal.				
Goindke	... ...	4	9	10
Sheikhupura	... ...	4	12	0
	Average=	5	14	0

Cost of pumping one cusec for 365 days $= 365 \times 5/14,$
$= \text{Rs.}2{,}144.$

These pumping stations were constructed many years ago and are not efficient. Machinery is now much more costly but is much more efficient. So the interest and depreciation charges will be heavier but cost of pumping one cusec may not be appreciably greater than Rs.2,144, worked out above. Compare this with Rs.2,067, worked out for tube-wells. Thus individual pumping stations are more costly than tube-wells and being scattered over a large area cannot receive the same amount of attention as a network of tube-wells and so there are greater chances of a break down.

6. Lowering of full supply of irrigation channels. Full suppl main line Upper Chenab Canal was lowered in Gujranwala Divisio few years ago by lowering the crest of some of the falls. In some ca the heads of distributaries had to be shifted to the upper falls so as no lose command. The total cost of the lowering was Rs.6,78,691. It found that this lowering had a purely local effect, which did not ext beyond half a mile. As a means of lowering general water-table, it wa useless measure. As only crests were lowered and no excavation of bed was done anywhere, the lowering has given endless trouble. In so reaches, the bed is so hard that no scour has occurred. The extra ene created by the increased slope has resulted in extensive side erosion a large amounts of money had to be spent to protect the sides. T measure is not recommended.

7. Seepage drains along canals. Thirty-five miles long seepage dra were excavated at a cost of Rs.1,31,876 just on the outer toe of banks of the Upper Chenab Canal, Main Line. Similar drains were a constructed along Lower Chenab Canal. It was found that these dra drew directly from the canal and the seepage loss increased. All of th had consequently to be abandoned. No seepage drain should, therefc be constructed at the toe of the channel. Rechna seepage drain has b constructed at a distance of over 1,000′ from the toe. It has been fou that this drain does not draw from the canal. If any seepage drains to be constructed, they must be placed at a minimum distance of 1,0 from the outer toe of the bank.

8. Seepage drains away from canals. A large number seepage drains have been constructed in Chaj and Rechna Doa Such drains are expensive both in the first cost as well as in subsequ maintenance—sloughing of the sides gives considerable trouble, and wh the slopes is flatter than 1/4,000 *jala* leads to trouble. Where, howev the slope is steeper than 1/2000, a seepage drain can work efficient Its working is fair for slopes between 1/2,000 and 1/4,000. Cost of so of the seepage drains constructed in the Upper Chenab Canal area given in Appendix A of Paper No. 197, Punjab Engineering Congr 1937, Waterlogging on the Upper Chenab Canal—its causes and cu by Rai Bahadur Bawa Natha Singh. Cost of the maintenance of W seepage drain—21.5 miles long—during 1943-44 was Rs.5,948, *i.e.*, c of maintenance per mile was Rs.280.

It has been found that such drains are effective in lowering t sub-soil water-table in their immediate vicinity only. Vaidhianath and Chanan Singh*, Irrigation Research Institute, Lahore, carried c a number of experiments and found that

" When a drain is cut in a waterlogged area the free water standi on the surface of the soil drains away, no capillary forces exist in t soil at this stage and therefore do not affect this drainage. When tl

*Punjab Engineering Congress 1942, Paper No. 255—Effect of capillarity on drain waterlogged areas by Dr. V. I. Vaidhianath and Chanan Singh.

water is drained and surface of the soil is exposed to air, the soil-air-water interfaces develop a negative pressure depending on the grain size of the soil. For instance, in the case of very fine sand, the negative pressure, which can be developed is of the order of 7′. Until the depth of the drain exceed this 7′, the pores in the soil must remain full of water."

The finer the particles of soil the greater the capillarity and lower must the drain be placed in order to drain the soil. Nand Gopal* has found that sub-soil water slope observed by pressure pipes in cross section lines indicated a slope of about 1 in 40 in average loam soil. Thus if a drain were dug 3′ below sub-soil water level, it would drain a width of about 120′ only on either side. Rechna Seepage Drain has been found to have an effect up to 600′ on either side of the drain.

Seepage drains are only useful if they are provided with a net work of branch, subsidiary and field drains. These drains take up so much land and upset the agricultural operations to such a degree that the zemindars do not like them and it has not been found possible to induce them to excavate and maintain even the field drains, what to say of subsidiary drains. Seepage drains have normally to be provided with a pumping station at their outfall as gravity outfall is not as a rule available. This increases the cost still more. Seepage drains are not recommended excepting as a purely local anti-waterlogging measure and this only if the zamindars can be persuaded to excavate and maintain the subsidiary and field drains or near towns or big villages where they may be used to lead water of ponds to a pumping station.

9. **Surface Drains.** Surface drains are useful in expeditiously removing local collection of water. It was shown in paragraph 6, Chapter II, that higher the initial saturation of the soil and greater the quantity of water applied to the surface, the greater will be the chances of the moisture travelling to the water-table. Should the soil be initially at field moisture capacity, the whole of the water applied to the surface will be added to the sub-soil water-table. Hence it is important to ensure that there should be no collection of water, which may bring the soil to field moisture capacity and establish a direct connection between the surface water and sub-soil water-table.

These drains are, however, very expensive in first cost and subsequent maintenance when the total discharge removed by them during the year is taken into consideration. Cost of excavating Faqirian Sillanwali drain with its branch drains is given below :—

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*Punjab Engineering Congress 1942, Paper No. 255—Effect of capillarity on drainage in waterlogged areas by Dr. V. I. Vaidhianathan and Channan Singh—Discussion.

Faqirian Sillawali Main Drain.

Designed capacity at outfall	...	471 cusecs
Total estimated cost	...	Rs.33,84,823
All Branch drains of Faqirian Sillanwali drain.		
Total estimated cost	...	Rs.28,97,833
Grand Total	...	Rs.62,82,656

Capital cost per cusec of designed

capacity at outfall $\frac{6,282,656}{471}$ = Rs.13,340.

Annual cost of 4% = Rs. 534.

Statement VII. 1. shows the data for a number of drains in Rechna Drainage Division. Maximum discharge of drains is 14,274 cusecs. As the total cost of maintenance is Rs.16,677, this gives cost of maintenance per cusec of maximum discharge as Rs.8 Total cost per annum of maximum discharge = 534 + 8 = Rs.542. Mean discharge removed during the year is only a very small percentage of the maximum discharge ever experienced. A flood of a frequency of one per annum is likely to be only 20 to 30 per cent of the maximum discharge. Duration of such a flood will be small. There will be some smaller floods also. On other days, the drain will run with only a small discharge and the total number of days on which a purely surface drain is in flow will probably not exceed 50 per annum. So it can be easily appreciated how small a quantity of water can be removed by such a drain and how expensive a surface drain is as an anti-waterlogging measure. Statement VII.2 shows average monthly discharges of Rechna outfall, Mangoki, Gujranwala and Chichoki Malian drains for 1942-43, 1943-44 and 1944-45. Results are abstracted below in Table XXXII.

TABLE XXXII.

Name of drain	Average discharge	Maximum discharge ever-experienced
Rechna Outfall.	71	656
Mangoki.	18	293
Guranwala	7	235
Chichoki Malian,	12	269
	108	1453

Percentage of water removed = 7%

All these drains are seepage cum surface drains. Discharge removed by purely surface drains will be considerably less than 7 per cent. They are, however, useful, as already pointed out, for a quick removal of local llections of water, which if not removed, are likely to have a serious verse effect on the sub-soil water-table. They should not have too ge a capacity. Normally, collection of water for less than 5 days causes harm to the crop and should the drains be given so much capacity at all water can be removed in five day's time, it will be sufficient. There ay be cases, however, where it may be desirable to effect this removal three days time. Each case will have to be dealt with on its merits.

A serious defect of the surface drains is that part of the water noved from the upper reaches of the drains is absorbed lower down. quantity of the water removed to the river is very small and it is ssible that the water-table may start rising in an area, where it was ble before. So, such drains should outfall into the river as early as ssible.

10. Porous gallery. Porous concrete pipes have been used in nerica and Chianwali Farm in the Punjab to lower sub-soil water-table. iese pipes have to be laid at the depth at which it is desired to stabilise e sub-soil water-table. Thus if it is desired that the spring level should t be higher than 10′ below natural surface, they must be placed not gher than this depth and so on. For normal agricultural operations acing them at 5′ below natural surface is sufficient but, at this depth permanent reclamation of the soil, should it be thur effected, is ssible. Evaporation from the surface is effective at this depth and salts n be brought up. For permanent reclamation, the spring level should t be higher than 10′ below the natural surface. Of course, deeper the pes are placed the higher is the cost. The rate of increase of cost is ite steep as the depth increases.

Distance between the drains will depend upon :--

(*a*) the freedom with which water may flow through the sub-soil towards the drain. The finer the soil grains the closer the spacing of the drains should be.

(*b*) the depth at which the pipes are placed.

(*c*) the interval of time between the rainfall sufficiently heavy to produce considerable percolation.

(*d*) seepage from the surface due to irrigation, if any.

In America*, these drains have been placed 30′ to 100′ apart and some cases even 200′ apart. It is considered that for normal Punjab il it will probably be sufficient to place pipes about one killa or 200′ art.

As regards gradient for the drains, King** recommends that, t fall of 2″ or more in 100′ can be secured, the conditions are favourable good results. If it is not possible to maintain a constant gradient, is best to change from a flatter slope to one which is steeper, because en any sediment which would be carried in the upper part of the drain

*Irrigation and Drainage by King.

** ———do———.

will also be carried when the slope is increased. With reverse condi the flatter slope must have a tendency to cause the drain to bec clogged. Where the slope is changed, it is prudent to place a silt b in which the sediment may deposit and whence it may be removed time to time.

As regards size of the drains, King quotes Elliot who states " drains not more than 500' long, a 2" pipe will drain two acres. Lines r than 500' long should not be laid on 2" pipes. A 3" pipe will drain acres and should not be of greater length than 1,000'. A 4" pipe drain 12 acres, a 5" 20, a 6" 40, and a 7" 60 acres."

Where laterals are connected with the mains, an effort shoul made to introduce the branch above the axis of the main. Great should be taken to secure a clear fall at the outlet of all drains pla if possible where it will always be above water. If gravity ou is not available as would be the case in most cases, pumping will ha be done.

This method is useful for lowering sub-soil water-table in a s area but is very expensive and it is impossible to adopt it on a large s Minimum cost of providing a porous gallery at a depth of 10' b natural surface will be Rs.150 an acre. Should pumping be requir the outfall or the area to be served is large, so that bigger pipes required for the main drain, the cost may easily be Rs.200 or even r per acre. This method is not, therefore, recommended.

CHAPTER VIII.

SUMMARY AND RECOMMENDATIONS

(A) **Summary.** Pellicular zone, zone of field moisture capacity and zone of maximum capillary capacity are defined in paras 4, 4 A and 5 of Chapter II.

2. Soil moisture must be completely built to field capacity befor. appreciable downward movement of water takes place. Water applied to the soil surface moistens the soil to field capacity to a depth for which the water applied is sufficient. Within the pellicular zone, water is removed by transpiration and evaporation. After removal of this water, depleted films must be built up before further downward seepage takes place. Progressive regeneration of films takes place on an even front. Below the pellicular zone, transpiration is inactive and evaporation is very slight. Higher the initial saturation of the soil and greater the quantity of water applied to the surface, the greater will be the chances of the moisture travelling to the water-table. Should the soil be initially at field moisture capacity the whole of the water applied to the surface will be added to the sub-soil water-table (Chapter II, paragraph 6).

3. Soil is completly saturated when the sub-soil water-table is not lower than about 3′ below bed level of the canal. Under these conditions, seepage loss varies direclly as the head, that is, the difference of the water surface level in the canal and the sub-soil water-table. It does not depend upon the depth of the channel. Conditions of partial saturation occur when the spring level is from 5′ to 3′ below bed. Losses rapidly decline from the critical position giving the maximum losses in the saturated phase. Soil is unsaturated when the water-table is more than 5′ below bed. Under these conditions, losses do not depend upon the head or on the depth of the channel but they are a function of the strata (Chapter II, paragraph 7).

4. Normally, evaporation and transpiration by plants are effective for a depth of not more than 10′ below natural surface (Chapter II, paragraph 8).

5. Factors governing evaporation from free water surface have been described in Chaptet II, paragraph 9.

Evaporation loss near Lyallpur is :—

mean daily loss, June to September	= 0.44″
mean daily loss, October to May	=0.27″
Total loss, June to September	=53.68″
Total loss, October to May	=65.61″
Total loss for the year	=119.29″

This loss is on the high side as the size of the evaporimeter used (4′ diameter) was too small. It has been found that evaporation from a

4′ diameter evaporimeter is 1.5 times of the evaporation from a diameter evaporimeter.

6. Evaporation from soil depends upon the factors enumerated Chapter II, paragraph 10. The main factors are initial percentage water, depth of sub-soil water-table below natural surface and meteorological conditions. The wetter the soil is at the surface, t more rapidly is water evaporated from it. The nearer the water-tal is to the surface, the more is the evaporation loss. If the surface saturated, the loss from it is equal to the loss from free water surfa High temperature, more sun-shine, less humidity and high wir increase the evaporation loss from soil. Evaporation from soil unc various conditions is given in the same paragraph.

7. Transpiration by plants is governed by the factors mentioned Chapter II, paragraph 11. The more important factors, are init percentage and distribution of soil moisture, kind of crop and meteoro gical conditions. The salts in the soil and the agricultural operatic have also an important effect. The higher the initial percentage moisture in the soil and wetter the surface, the greater is the transpi tion by plants. Transpiration ratios for different crops have also be given.

8. Effect of irrigation on sub-soil water-table is fully discus: in Chapter III. The results for the 8-year period, 1935-6 to 1942- are given in Statements III.1 to III.4 and are abstracted in Ta XXVIII. For facility of reference, the results are recorded below.

Name of Canal.	Mean discharge utilised at disty: head.	Addition to sub-soil water-table from Main Canal and Branches	% of Col. 2	Distributaries	% of Col. 2	Water courses	% of Col. 2	Total
1	2	3	4	5	6	7	8	9
Lower Chenab ...	6805	1130	16·6	366	5·4	444	6·5	1940
Upper Chenab ...	2324	162	7·0	131	5·6	139	6·0	432
Lower Jhelum ...	2375	340	14·3	126	5·3	154	6·5	620
Upper Jhelum ...	968	305	31·4	53	5·5	71	7·3	429
Total ...	12472	1937	15·5	676	5·4	808	6·5	3421

Thus more than half of the discharge reaching the wate-tal seeps from Main Canal and Branches.

It has been shown in Chapter III, paragraph 7, that in case of crc other than rice, transpiration by plants and evaporation from soil c deal with all the water used for irrigation and no portion of it finds way to the water-table. As a matter of fact, these two factors c dispose of some portion of the rainfall also. In case of rice followed by *wadh wattar* gram, however, some portion of the irrigation water and rainfall does reach the sub-soil water-table. Thus while 50 to 60" of water are used for irrigation of rice during the season and rainfall is in addition, the evapo-transpiration loss in the case of this crop is only 43.3"

9. Evaporation from soil can deal with the following portion of the rainfall.

L.C.C. and L.J.C. areas.		U.C.C. and U.J.C. areas.	
Kharif.	Rabi.	Kharif.	Rabi.
5"	3"	8"	5"

Portion of the rainfall over and above these quantities only finds its way to the water-table (Chapter IV).

10. Relative effect, for the 8-year period 1935-36 to 1942-43, of irrigation and rainfall on sub-soil water-table is given below.

Name of Canal.	Addition to sub-soil water-table from Irrigation channels.	Rainfall.	Total.
Lower Chenab ...	1,940	1,474	3,414
Upper Chenab ...	432	809	1,241
Lower Jhelum ...	620	732	1,352
Upper Jhelum ...	429	680	1,109

It will be seen that the effect of rainfall is more important on Upper Chenab and Upper Jhelum Canals. This is due to the fact that rainfall is heavier and canal irrigation is comparatively less on the upper two canals. The variation in the contribution from rainfall is much more than similar variation in case of irrigation. Hence rainfall appears to be more important in causing the yearly rise and fall of spring level. Actually both irrigation and rainfall are responsible for the rise. It does not matter whether water seeps into the soil from irrigation channels or rainfall. The result is the same. If the total inflow is more than the outflow, the sub-soil water-table will rise. Table XXX compares the absorption from the two sources and rise of sub-soil water-table in Chaj and Rechna Doabs in the same 8-year period. The results are also plotted on Logarithmic paper (Plate II). In spite of scatter, which is unavoidable, a definite correlation can be traced between the absorption from irrigation and rainfall and the annual rise and fall of the water-table.

11. Quantity of water required to be removed in order to lower the sub-soil water-table in Rechna and Chaj Doabs by one foot per annum has been worked out in Chapter V, paragraph 5, and it is computed that at least 3,300 cusecs must be continuously removed in order to achieve this purpose. Taking into consideration the factors enumerated in that

paragraph, it is certain that a quantity considerably in excess of 3,: cusecs will have to be removed. It is possible that 5,000 cusecs may h: to be removed to ensure that the water-table falls steadily at the ab rate.

12. Anti-waterlogging closures have only a very limited utility a interfere seriously with agricultural operations. Further they reduce water available for leaching the salts that are formed as a result of natu weathering of the soil. The soil is likely to become more and m saltish. Such closures are not recommended except where water is be wasted or too much water was given in the first instance.

13. Lining of Main Canal and Branches, at the time of origi construction, is the cheapest anti-waterlogging measure. Annual cos saving one cusecs is only Rs.1,200 at the present prices. Lining of channels is more expensive. Thus this cost works out to Rs.3,352 cusec in the case of Jhang Branch and certain other distributa Lining of channels in waterlogged soil will be still more expens Lining of distributaries (at least the major ones) at the time of orig construction is worth consideration, as it is possible that the saving in cost of land, earthwork, masonry works and water may more than cou balance the extra cost of lining. Considerable economy can be effe by lining main water courses on perennial channels. This saving is li to be of the order of 8·7 per cent of the discharge of the watercou Cost of lining with flat brick and cement laid on ½" cement plaster compacted earth will be Rs.1-8-0 per lineal foot. Lining of the wa course is not remunerative if only direct return in the shape of abi and land revenue is considered but it will pay the zamindar to do lining as the cost of extra crop that he can raise by the water saved pay for the whole lining in four to five years' time. Should the zamin provide his own carts for carriage of materials and also unskilled lab free, the cost would be considerably reduced.

14. Tube-wells are the second cheapest means of lowering the wa table. Isolated tube-wells are, however, useless and to be effective battery of tube-wells is needed. They should be spaced as uniformly possible so that heavy lowering of the water-table in any partic locality does not result in excessive gradient, which may bring harr salts to the area where pumping is in progress. Annual cost of sa one cusec of maximum capacity by means of tube-wells is Rs.2, Should it not be possible to work the tube-well continuously, the cost be correrpondingly increased. Thus with a 70 per cent time factor, annual cost will become Rs.3,000. Should tube-wells be installed i saturated zone, cost of removal of one cusec net from the sub-soil wa table will increase still more.

15. Pumping in local area is useful for early lowering of the wa table in the vicinity of important towns, etc. Cost of pumping cusec for 365 days on the existing pumping stations in the two Doal Rs.2,144. Machinery is now much more costly but more efficient. the interest and depreciation charges will be more but the total cha

for pumping one cusec may not be appreciably greater than Rs.2,144, however, there are, greater chances of a breakdown in case of isolated tube wells.

16. Lowering of full supply of irrigation channels has only a local effect, which does not extend beyond half a mile. It is costly and causes many other troubles. This is not recommended.

17. Seepage drains along canals "draw" directly from the canals and such drains constructed in the past had to be abandoned. If they must be constructed at all, they should be at a distance of not less than 1,000 from the outer toe of the bank.

18. Seepage drains away from canals are expensive in first cost as well as in subsequent maintenance. Due to the effect of capillarity, these drains have only a purely local effect. It has been found that in heavy soil a 3′ deep drain does not effect more than 120′ on either side of the drain. Rechna seepage drain effects an area of 600′ on either side. A system of branch, subsidiary and field drains is needed to effect any lowering of the water-table. This cuts up land and interferes seriously with agricultural operations and it has been found very difficult to induce the zamindars to dig and maintain such drains. Seepage drains are not recommended except near towns, where they may be used to lead water of different ponds to a pumping station.

19. Surface drains are useful in expeditiously removing local collection of water but they are very expensive in first cost as well as in maintenance, considering the small amount of water that such drains remove to the river. Annual cost of removing one cusec of maximum capacity may be only Rs.542 but as the mean discharge for the year may be only 7 per cent of the maximum discharge ever experienced, it can be easily calculated how expensive surface drains can be. Such drains should only be constructed to remove local collection of water so that addition to the sub-soil water-table from such sources is eliminated and ground can be made ready for the crop at the earliest possible opportunity. The drains should not, however, be given an unduly large capacity and should they be given so much capacity that all water can be removed in about five days time, it will be sufficient. There may be cases, however, where it may be desirable to effect this removal in three days' time. Each case will have to be dealt with on its merits. Such drains should outfall into the river as early as possible. So far as possible water should not be allowed to collect anywhere.

20. Placing of porous concrete pipes at the depth at which it is desired to stabilise the sub-soil water-table, can lower spring level but the method is very expensive. Minimum cost per acre will be Rs.150. This may easily go up to Rs.200 or even more should the area to be served is large or no gravity outfall is available. Method is not recommended.

(B) **Recommendations**. As very few experiments were available for Punjab conditions, the note had necessarily to be based on the results of experiments performed elsewhere. There is a large margin of error in pot experiments for determining transpiration and evaporation losses.

For correct results, experiments on field scale by means of large Lysimeters are needed to determine :—

(*a*) Losses from distributaries, lined and unlined.

(*b*) Losses from watercourses, lined and unlined.

(*c*) Evapo-transpiration losses for main crops sown in the Punja

(*d*) Evaporation from bare soil.

In these experiments, different soils will have to be used and water-table will have to be placed at varying depths below na surface. The idea is to determine the amount of water added to sub-soil water-table by irrigation and rainfall.

2. As whenever irrigation is introduced in an area for the first t it must upset the balance between the rainfall and the sub-soil w table, which must consequently rise, so it is desirable that all new Canals and Branches should invariably be lined. The lining of all major distributaries also requires very careful consideration. Linin existing distributaries is likely to be useful in sandy, high filling an reaches. Lining in the tail reaches is needed where it is desire extend irrigation near the tail and it is very costly to remodel the v distributary with a view to bring the discharge required for extensio the tail. Considerable economy can be effected by lining waterco and vigorous propaganda is needed to induce the zamindars to tak this work in hand. Lining is the cheapest way of preventing additic sub-soil water-table in areas where irrigation is introduced for the time.

3. Tube-wells are likely to be the cheapest means of lowering the soil water-table in areas where irrigation is already established but must be adopted on a large scale and should be spread over as larg area as possible. Tube-wells of insufficient capacity are worse useless. There may, however, be cases, where lining of main canal branches may be cheaper, or a combination of lining and tube may be the best. Each case must be decided on its merits.

4. Local pumping stations and seepage drains should onl constructed in the vicinity of towns or large villages.

5. Surface drains should only be constructed for removal of collection of water and they should have only so much capacity that can remove all such water in three to five days' time ; so far as possib water should be allowed to accumulate anywhere.

6. Anti-waterlogging closures are not recommended except water is being wasted or too much water was given in the first instan

7. Lowering of full supply, having only a local effect, is not re mended.

8. Porous concrete pipes are expensive and are not recommenc

9. So far, tube-wells have been considered from the point of vie productivity. It was calculated in Chapter V, paragraph 5, that cusecs may have to be abstracted from Rechna and Chaj Doabs in

to lower the water-table in these two Doabs by one foot per annum. This means that one cusec should be abstracted from an area of $\frac{80,49,000}{5,000} = 1,600$ acres. Annual cost of abstracting one cusec is Rs.2,100, assuming that one cusec is continuously pumped throughout the year. This gives less than Rs.2 per acre. Should it not be possible to work the tube-well continuously or tube-wells are installed in saturated zones, the cost will be correspondingly increased. Part of this cost can be met if the water pumped from the sub-soil water-table is used for irrigation. This may not, however, be possible in all cases. The pumped water may be so saline that it is not possible to dilute it with a sufficient quantity of canal water in order to make it fit for irrigation. Taking the worst case that the water cannot be used for irrigation the annual cost of protecting one acre will be only Rs.2 to Rs.3. This is nothing considering that land worth Rs.400 to 500, per acre will be protected. No businessman would hesitate to spend Rs.2 to 3, per annum, if by doing so he can ensure that he can protect property worth Rs.400 to 500, specially when he knows that should the investment of Rs.2 to 3, per annum be not made, he might lose the whole of his property in a short time. This small amount can either be recovered by levying a surcharge on the Abiana or it can be debited direct to the Revenue Account of the canal. In the former case, it will have to be considered whether the amount should be recovered from the Zamindar whose land is protected or it should be spread over the whole area of the canal. The second alternative appears to be fairer. In many cases, waterlogging has been caused by supplies, which have not been used in the area where waterlogging occurred, but lower down. Thus waterlogging on Upper Chenab Canal is partly due to the supply used on Lower Bari Doab Canal. Similarly, waterlogging in head reach of Lower Chenab Canal is caused by the supply used lower down. So it is fairer to spread the burden over the whole canal. It is, however, a question whether any recovery should be made at all and whether the whole of the cost of anti-waterlogging measures should not be debited to the revenue account of the canal. Government will gain in many indirect ways by the increased prosperity of the Zamindars, which is bound to result should futher deterioration of their lands be stopped and the area already deteriorated reclaimed.

It is, therefore, suggested that the cost of all anti-waterlogging measures should be debited direct to the canal where such measures are needed. In the case of interlinked canals, the cost should be divided *pro rata* in proportion to the amount of water used an each canal.

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UPPER CHENAB CANAL.

Effect of Irrigation and Rainfall on sub-soil Water-table.

Year	Kharif or Rabi	Mean discharge at R.D. 17,000	Passed out of Circle	Utilized in Distys. in the Circle	Absorption & evaporation losses in Main Canal and Branches, Col.3 (Col. 4+5)	Absorption & evaporation losses in Distys. vide Chapter 111 Para 4	Absorption & evaporatio losses in W.Cs vide Chapter III Para 5	Contribution to S.S. Water-table by Canal and Branches, Distys. and W.Cs.=.9 Col.6+.75 Col.7 +.5 Col.8	Weighted average rainfall	Contribution to S. S. Water-table by Rainfall on area within irrigation boundary	Total contribution to S. S. Water-table Col. 9+Col. 11.	Rise of S. S. Water-table June—June	Discharge required to give rise in Col. 13 assuming specific yield as 20%
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1935-36	Kharif	7,871	4,597	3,063	211	245	397	395	13.75	1,004	1,399	−0.29	−122
	Rabi	5,050	3,805	1,113	132	67	93		4.55				
1936-37	Kharif	9,300	5,781	3,474	45	278	452	296	14.52	1,450	1,746	+0.351	148
	Rabi	4,769	3,669	1,074	26	64	93		6.80				
1937-38	Kharif	9,558	5,589	3,597	372	288	404	596	7.35	...	596	−0.47	−198
	Rabi	5,381	3,929	1,107	345	66	96		4.25				
1938-39	Kharif	9,067	5,196	3,481	390	278	457	562	13.13	894	1,456	+0.05	22
	Rabi	4,704	3,356	1,080	268	65	93		4.29				
1939-40	Kharif	9,662	5,573	3,633	456	291	471	532	8.34	54	586	−0.40	−168
	Rabi	4,587	3,318	1,161	108	70	92		3.26				
1940-41	Kharif	9,564	5,718	3,667	179	293	475	397	12.34	750	1,147	+0.10	− 42
	Rabi	4,128	2,920	1,126	22	68	99		3.32				
1941-42	Kharif	9,469	5,705	3,595	169	288	464	402	14.13	1,387	1,789	+0.3	126
	Rabi	5,087	3,873	1,096	118	66	92		6.84				
1942-43	Kharif	8,650	4,946	3,615	89	289	456	295	13.34	935	1,230	+0.56	236
	Rabi	5,163	3,920	1,297	-54	78	108		4.51				
	Kharif	9,143		3,516	239	281	455	809		6,474		0,025	11
	Rabi	4,858		1,132	121	68	97	434		809			

LOWER CHENAB CANAL.

Effect of Irrigation and Rainfall on sub-soil Water-table.

Year	Kharif or Rabi	Mean discharge at Chenanwan	Escapage	Utilized in Distys. in the Circle	Absorption and evaporation losses in Main Canal & Branches Col. 3-(Col. 4+Col 5.)	Absorption and evaporation losses in Distys. vide, Chapter III Para 4	Absorption and evaporation losses in W. Cs. vide Chapter III Para 5	Contribution to S. S. Water-table by Main Canal and Branches Distys. and W. Cs.=.9 Col. 6+0.75 Col. 7+.5 Col. 8	Weighted Average Rainfall	Contribution to S. S. Water-table by rainfall	Total contribution to S. S. Water-table Col. 9+Col. 11	Rise of S. S. Water-table June—June	Discharge required to give rise to Col. 13 assuming 20% specific yield
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1935-36	Kharif	9,223	71	7,264	1,888	581	1,071	1,957	6.27	523	2,480	+0.13	1,308
	Rabi	6,521	38	5,726	757	344	612		2.82				
1936-37	Kharif	9,543	17	7,683	1,943	615	1,129	2,214	9.64	2,777	4,991	+0.53	534
	Rabi	7,325	43	6,013	1,269	371	647		4.97				
1937-38	Kharif	9,517	78	7,731	1,708	618	1,135		5.20	107	2,197	+0.19	192
	Rabi	7,031	128	5,753	1,150	345	633	2,090	1.72				
1938-39	Kharif	8,933	52	7,396	1,485	592	1,092	1,872	6.79	773	2,645	+0.23	232
	Rabi	6,292	38	5,258	996	315	573		2.88				
1939-40	Kharif	9,549	104	7,956	1,489	636	1,180	2,003	6.06	473	2,476	...	...
	Rabi	6,873	18	5,716	1,139	345	628		2.64				
1940-41	Kharif	8,620	42	7,630	948	610	1,133	1,530	6.77	757	2,287	+0.2	202
	Rabi	5,882	4	5,133	745	308	564		2.71				
1941-42	Kharif	9,418	37	8,136	1,245	651	1,208	1,815	11.70	3,800	5,615	+0.8	800
	Rabi	7,394	3	6,525	866	392	688		5.26				
1942-43	Kharif	9,720	42	8,089	1,589	647	1,192	2,037	10.30	2,580	6,417	+0.55	554
	Rabi	7,864	28	6,864	972	412	749		3.80				
	Kharif	9,315		7,736	1,524	619	1,142	15,518		11,790		0.33	
	Rabi	6,898		5,874	987	354	637	1,940		1,474			478

UPPER JHELUM CANAL.

Effect of Irrigation and Rainfall on sub-soil Water-table.

Year	Kharif or Rabi	Mean discharge below Qasba	Discharge passed out of the Circle	Utilized in Distys. in the Circle	Absorption and evaporation losses in Main Canal and Branches Col. 3-Col. 4+5	Absorption and evaporation loses in. Distys. vide Chapter III Para 4	Absorption and evaporation losses in W.Cs vide Chapter III Para 5	Contribution to S. S. Water-table by Canal and Branches, Distys. and water courses=9 Col. 6+75 Col. 7+.5 Col. 8	Weighted Average Rainfall	Contribution to S. S. Water-table by rainfall	Total contribution to S. S. Water-table Col. 9+Col. 11	Rise of S. S. Water-table June—June	Discharge required to give rise to Col. 13
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1935-36	Kharif	4,445	2,997	1,114	334	89	177	443	15.84	628	1,071	14.00	111
	Rabi	5,774	4,731	640	403	38	77		7.41			0.01	...
1936-37	Kharif	6,145	4,226	1,315	604	105	216	559	16.45	659	1,218	−0.21	−31
	Rabi	5,862	4,882	621	359	37	75		7.31				
1937-38	Kharif	5,694	4,237	1,196	261	96	191	371	15.18	437	808	+0.15	22
	Rabi	6,042	5,019	734	289	44	93		4.70				
1938-39	Kharif	5,372	3,912	1,295	165	104	205	309	14.78	545	854	−0.42	−62
	Rabi	4,694	3,825	623	246	37	75		7.22				
1939-40	Kharif	5,237	3,577	1,313	347	105	209	372	11.90	237	609	−0.40	−59
	Rabi	5,529	4,705	625	199	38	80		4.68				
1940-41	Kharif	5,747	4,243	1,292	212	103	207	379	20.87	783	1,162	+0.30	44
	Rabi	5,170	4,199	619	352	37	79		4.11				
1941-42	Kharif	6,232	4,371	1,350	511	108	217	478	21.52	1232	1,710	+0.30	44
	Rabi	6,333	5,472	593	268	36	76		11.67				
1942-43	Kharif	6,189	4,263	1,391	485	111	213	525	19.39	915	1,440	+0.45	66
	Rabi	5,891	4,741	770	380	46	92		8.61				
	Kharif	5,626		1,283	365	103	204	3,436		·680		.022	17
	Rabi	5,662		653	312	39	81	429		5,436			

LOWER JHELUM CANAL.

Effect of Irrigation and rainfall on sub-soil water-table.

Year	Kharif or Rabi.	Mean Discharge below Qasba	Escapage	Utilized in Distys. in the Circle.	Absorption and evaporation losses in Main Canal and Branches) Col. 3 (Col. 4+5	Absorption and evaporation losses in Distys. vide Chapter III Para 4	Absorption and evaporation losses in W.Cs vide Chapter III Para 5	Contribution to S. S. Water-table by Canal and Branches, Dystiy. and W. Cs. vide -9 Col. 6+75 Col. ·7+5 Col. 8.	Weighted average rainfall.	Contribution to S. S. Water-table by rainfall	Total contribution to S. S. Water-table (Col. 9+Col. 11).	Rise of S. S. Water-table June—June	Discharge required to give rise to Col. 13
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1935-36	Kharif	2,646	27	2,282	337	183	341	557	7.53	627	1,184	+.20	74
	Rabi	2,525	17	2,197	311	132	245		4.50				
1936-37	Kharif	2,783	32	2,329	422	186	347	569	9.86	1,340	1,909	+.06	22
	Rabi	2,484	14	2,222	248	133	240		6.91				
1937-38	Kharif	2,879	22	2,488	369	199	372	621	7.07	315	936	+0.12	28
	Rabi	2,703	...	2,320	383	139	249		1.79				
1938-39	Kharif	3,181	21	2,615	545	209	391	678	5.68	185	868	—0.29	—107
	Rabi	2,437	5	2,095	337	126	227		3.49				
1939-40	Kharif	3,121	13	2,685	423	215	401	649	5.91	248	897	—0.2	—74
	Rabi	2,419	5	2,019	395	121	219		3.71				
1940-41	Kharif	3,017	37	2,601	379	208	391	610	10.18	792	1,402	...	...
	Rabi	2,326	2	1,955	369	117	213		2.91				
1941-42	Kharif	2,903	22	2,484	397	199	373	616	14.22	1,740	2,356	+0.6	220
	Rabi	2,519	12	2,146	361	129	233		5.19				
1942-43	Kharif	3,317	64	2,825	428	226	395	660	8.96	605	1,265	+0.46	168
,,	Rabi	3,078	14	2,725	339	164	275		2.94				
Kharif	...	2,981		2,539	413	203	376	4,960		732		0.12	41
Rabi	..	2,850		2,210	343	133	239	620		5,852			

TABLE VI—1.

Statement showing average monthly losses for the year 1935-36.

Name of the months	River Jhelum: Mangla to Rasul	River Jhelum: Rasul to Chela	River Jhelum: Chela to Trimmu	River Jhelum: Mangla to Trimmu	River Chenab: Marala to Alexandra Bridge	River Chenab: At Khanki	River Chenab: Khanki to Rivaz Bridge	River Chenab: Rivaz Bridge to Trimmu	River Chenab: Trimmu to Sher-Shah	River Chenab: Marala to Sher-Shah	River Ravi: Madhopur to Shahdara	River Ravi: Shahdara to Balloki	River Ravi: Balloki to Sidhnai	River Ravi: Madhopur to Sidhnai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October 1935 (16-30)	+ 581	+1,974	− 67	+2,488	+ 109	− 89	+1,731	− 42	+2,525	+4,314	−413	− 258	− 60	+ 95
November 1935	+ 384	931	− 6	+1,309	− 257	− 372	+1,041	− 11	+1,698	+2,099	+ 278	− 80	− 127	+ 71
December 1935	+ 561	+ 160	+ 52	+ 773	− 159	− 85	+ 767	+ 69	+1,053	+1,645	+ 337	− 174	− 130	+ 33
January 1936	+ 424	+ 530	− 15	+ 939	+ 78	− 617	+1,078	− 10	+ 497	+1,026	− 158	− 350	− 157	− 665
February 1936	− 650	−1,641	− 12	−2,303	− 540	− 822	−2,298	+ 20	+ 717	−1,279	+ 471	− 178	− 234	+ 59
March 1936	− 276	−5,279	−1,117	−6,672	− 552	−3,083	+4,010	−1,574	−4,889	−6,488	+1,437	−1,116	−1,365	− 1,044
April (1-15)	−4,777	−1,562	− 574	− 6,913	+ 69	−2,197	+3,407	− 256	−2,880	− 186	+ 970	− 191	− 838	− 59
April (16-30)	−2,566	−7,006	− 435	−10,007	−3.808	− 78	− 316	− 317	−2,460	−6,979	− 934	− 15	− 284	−1,233
May 1936	+9,972	−9,515	−9,871	−9,414	+4,409	−4,122	−1,667	− 7,096	− 1,130	−19,776	−4,660	−1,117	−2,459	−8,236
June 1936	+1,397	+4,355	−8,639	−2,887	−5,658	+5,315	+2,515	− 8,489	−14,289	−20,606	−3,284	−1,011	−1,619	−5,914
July 1936	+3,360	+1,902	−8,072	−2,810	−3,414	+9,261	+5,750	−14,291	−20,602	−23,296	+7,408	−4,145	−3,923	− 660
August 1936	+6,257	−2,495	−2,789	+ 973	+1.441	+3,108	+4,228	−10,502	− 6,582	− 8,307	+2,260	−3,227	−7,414	−8,381
September 1936	+2,830	−1,351	−1,188	+ 291	+1,937	+6,466	+4,433	− 3,515	− 252	+ 9,069	+2,847	+1,450	+6,915	+11,212
October 1936 (1-15)	+ 998	+3,565	+ 229	+4,792	+ 133	+ 729	+5,382	+ 277	+ 4,632	−11,153	+ 956	− 186	+ 789	+1,559
Total ...	+21,377	−13,918	−32,080	−24,621	−4,424	+15,876	+24,959	−45,968	−53,044	−62,601	+7,637	−10,273	−10,710	−13,344
Avarage ...	+ 1,781	− 1,160	− 2,673	−2,052	− 369	+ 1,323	+ 2,080	− 3,831	− 4,420	− 5,217	+ 636	− 856	− 892	− 1,112

Statement showing average monthly losses for the year 1936-37.

Name of the Months	Mangla to Rasul	Rasul to Chela	Chela to Trimmu	Mangla to Trimmu	Marala to Alexandra	At Khanki	Khanki to Rivaz	Rivaz to Trimmu	Trimmu to Shershah	Marala to Shershah	Madhopur to Shahdara	Shahdara to Balloki	Balloki to Sidhnai	Madhopur to Sidhnai
	River Jhelum				River Chenab						River Ravi			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October 1936 (16-31) ...	+ 790	+ 1,104	+ 112	+ 2,006	+ 513	+ 350	+ 1,960	+ 184	+ 2,662	+ 5,669	+ 505	+ 71	+ 330	+ 906
November 1936 ...	+ 746	+ 849	+ 127	+ 1,722	+ 27	– 2	+ 1,233	+ 152	+ 1,486	+ 2,896	+ 498	+ 248	– 409	+ 337
December 1936 ...	– 174	– 701	+ 72	– 803	+ 307	+ 325	+ 474	+ 72	+ 465	+ 1,643	+ 502	+ 113	– 126	+ 489
January 1937 ...	+ 397	+ 734	+ 55	+ 1,186	+ 145	+ 132	+ 394	+ 43	+ 779	+ 1,493	– 334	– 120	– 109	– 563
February 1937 ...	+ 374	– 2,451	– 80	– 2,157	– 971	+ 713	– 2,321	– 48	– 1,079	– 3,706	– 923	+ 261	– 660	– 1,322
March 1937 ...	– 48	– 1,551	+ 440	– 1,159	+ 431	– 12	+ 1,498	+ 312	– 2,533	– 304	+ 809	+ 1,187	– 817	+ 1,179
April 1937 (1-15) ...	– 202	– 5,077	– 3,314	– 8,593	– 946	+ 722	– 5,320	– 1,003	– 4,923	– 11,470	– 1,514	+ 493	– 3,043	– 4,064
April 1937 (16-30) ...	+ 477	– 3,932	– 1,977	– 5,432	+ 448	+ 764	– 250	– 417	– 2,020	– 1,475	– 611	+ 156	– 1,969	– 2,424
May 1937 ...	+ 3,250	– 8,587	– 647	– 5,984	– 3,491	+ 2,472	– 9,547	+ 9	– 4,551	– 15,108	– 2,901	– 62	– 1,968	– 4,931
June 1937 ...	+ 4,263	– 8,619	+ 386	– 3,970	– 117	+ 897	– 18,053	+ 276	+ 4,408	– 12,589	– 4,658	– 133	– 2,495	– 7,2[illegible]
July 1937 ...	+ 7,221	– 1,774	+ 3,196	+ 8,643	– 1,739	+ 1,616	– 12,340	+ 4,169	+ 925	– 7,369	+ 1,566	– 1,318	– 4,917	– 4,[illegible]
August 1937 ...	+ 3,948	– 501	+ 934	+ 4,381	– 6,715	+ 2,890	– 2,677	+ 1,880	– 1,950	– 6,572	+ 1,323	+ 970	– 681	+ [illegible]12
September 1937 ...	+ 1,948	+ 2,607	– 714	+ 3,841	– 2,872	– 587	+ 9,010	– 1,965	+ 1,287	+ 6,047	– 418	+ 847	– 1,214	– 785
October 1937 (1-15) ...	+ 546	+ 1,244	+ 31	+ 1,821	+ 781	– 199	+ 2,815	+ 43	+ 2,959	+ 6,399	+ 1,108	– 164	+ 307	+ 1,251
Total ...	+ 22,731	– 23,325	+ 1,195	+ 601	– 14,597	+ 10,436	– 32,726	+ 4,304	– 1,425	– 34,008	– 4,793	+ 2,272	– 15,[illegible]	– 18,105
Average ...	+ 1,894	– 1,944	+ 100	+ 50	– 1,216	+ 870	– 2,727	+ 359	– 119	– 2,834	– 399	+ 189	– 1,[illegible]9	+ 1,509

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TABLE VI—3.

Statement showing average monthly losses for the year 1937-38.

	River Jhelum					River Chenal					River Ravi			
Name of the months	Mangla to Rasul	Rasul to Chela	Chela to Trimmu	Mangla to Trimmu	Marala to Alexandra	At Khanki	Khanki to Rivaz	Rivaz to Trimmu	Trimmu to Shahadara	Marala to Shershah	Madhopur to Shahdara	Shahdara to Balloki	Balloki to Sidhnai	Madhopur to Sidhnai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October 1937 (15-30) ...	+ 1,037	+ 101	+ 62	+ 1,200	+ 89	+ 304	+ 1,433	+ 101	+ 1,575	+ 3,502	+ 653	+ 17	+ 191	+ 861
November 1937 ...	+ 469	+ 839	+ 33	+ 1,341	+ 252	- 294	+ 1,186	+ 60	+ 882	+ 2,086	+ 398	+ 311	- 38	+ 671
December 1937 ...	+ 339	+ 218	+ 30	+ 587	+ 183	+ 90	+ 404	+ 52	+ 451	+ 1,180	+ 339	+ 69	- 328	+ 80
January 1938 ...	+ 486	+ 147	+ 105	+ 738	- 1,550	+ 95	+ 574	- 141	- 695	- 1,717	+ 1,782	- 677	- 1,790	- 685
February 1938 ...	- 633	- 111	+ 147	- 597	- 10	+ 1,626	- 3,210	+ 479	- 5,818	- 6,933	- 2,141	+ 3,977	- 3,345	- 1,509
March 1938 ...	+ 89	- 6,391	- 423	- 6,725	- 1,689	- 953	+ 121	- 486	- 5,414	- 8,421	- 1,307	+ 1,019	- 920	- 1,208
April, 1938 (1-15) ...	+ 1,507	- 11,665	- 367	- 10,525	+ 892	- 935	+ 6,428	- 223	- 9,374	- 3,212	- 2,024	- 286	- 1,325	- 3,635
April, 1938 (16-30) ...	+ 5,408	- 7,272	- 3,166	- 5,030	- 2,393	- 1,618	+ 1,506	- 1,815	- 11,133	- 15,453	- 4,374	+ 111	- 1,777	- 6,040
May, 1938 ...	+ 4,462	- 10,889	- 477	- 6,904	- 1,458	- 2,521	- 8,184	- 361	- 1,446	- 13,970	- 5,171	- 2,905	- 3,079	- 11,155
June 1938 ...	+ 2,085	- 8,816	+ 1,598	- 5,133	- 2,205	- 28	+ 6,565	+ 1,916	+ 2,714	+ 8,962	- 3,660	- 1,261	- 969	- 5,890
July 1938 ...	- 1,258	- 1,418	+ 4,402	+ 1,726	+ 5,474	- 6,663	- 20,676	+ 6,985	- 11,387	- 26,240	- 705	- 2,402	- 1,462	- 4,569
August 1938 ...	+ 4,859	+ 256	+ 3,352	+ 8,467	+ 1,650	+ 619	- 11,552	+ 6,997	- 14,462	- 16,748	- 1,404	- 3,630	- 1,892	+ 334
September 1938 ...	+ 1,828	+ 3,136	+ 424	+ 5,388	- 977	- 566	+ 6,064	+ 990	+ 2,278	+ 7,789	+ 1,698	+ 65	+ 1,501	+ 3,264
October 1938 (1-15) ...	+ 489	+ 1,278	+ 259	+ 2,026	- 199	- 188	+ 2,715	+ 391	+ 2,054	- 5,171	+ 583	+ 209	+ 137	+ 511
Total ...	+ 16,946	- 31,808	+ 7,585	- 7,276	- 936	- 9,786	- 22,667	+ 15,718	- 41,336	- 59,008	- 12,752	+ 1,643	- 13,709	- 24,818
Average ...	+ 1,412	- 2,651	+ 632	- 606	- 78	- 816	- 1,889	+ 1,310	- 3,445	- 4,915	- 1,063	+ 137	- 1,142	- 2,068

TABLE VI—4.

Statement showing average monthly losses for the year 1938-39.

Name of the months	River Jhelum: Mangla to Rasul	River Jhelum: Rasul to Chela	River Jhelum: Chela to Trimmu	River Chenab: Mangla to Trimmu	River Chenab: Marala to Alexandra Bridge	River Chenab: At Khanki	River Chenab: Khanki to Rivaz Br.	River Chenab: Rivaz Br. to Trimmu	River Chenab: Trimmu to Shershah	River Chenab: Marala to Shershah	River Ravi: Madhopur to Shahdara	River Ravi: Shahdara to Balloki	River Ravi: Balloki to Sidhnai	River Ravi: Madhopur to Sidhnai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October 1938 (16-30)	+ 573	+1,057	+ 106	+1,736	+ 272	+ 172	+1,628	+ 162	+1,515	+3,749	+ 498	− 356	− 69	+ 73
November 1938 ...	+ 453	+ 688	+ 119	+1,260	+ 268	+ 362	+ 921	+ 147	+1,260	+2,958	+ 370	+ 77	+ 203	+ 244
December ,, ...	+ 123	+ 499	+ 51	+ 673	+ 541	+ 65	+ 529	+ 57	+ 793	+1,985	+ 272	+ 186	− 287	− 201
January 1939 ...	+ 241	+ 212	− 15	+ 438	+ 83	+ 319	+ 924	− 17	+ 621	+1,930	+ 227	+ 157	− 60	+ 324
February ,, ...	+1,160	−6,111	+ 228	−4,723	−1,757	+ 423	− 597	+ 171	−1,790	−3,550	+ 430	+ 171	− 535	− 326
March ,, ...	+3,433	−3,461	−4,370	−4,398	+3,371	−1,655	+2,057	−1,399	−1,736	−10,218	+ 831	+ 615	−2,417	− 971
April 1939 (1-15) ...	−2,133	+ 102	+1,379	− 652	+ 708	− 684	−2,679	+ 66	+2,866	+ 277	+ 803	+ 317	− 557	+ 563
April (16-30) ...	− 348	−4,833	+ 371	−4,810	− 650	+ 704	−1,275	− 187	+3,161	− 719	− 196	+ 521	−1,277	− 952
May 1939 ...	− 813	−12,020	+7,104	−5,729	−5,233	+ 483	−4,616	+2,002	−7,625	+14,989	−2,886	− 148	−1,913	−4,651
June ,, ...	+5,160	−11,355	+7,372	+1,177	−6,248	+1,825	−13,028	+3,974	−3,760	−17,237	−3,939	− 62	−1,970	−5,971
July ,, ...	+ 344	−6,216	+1,080	−4,792	−2,349	−3,490	−12,647	+1,606	− 202	−17,082	−6,774	+2,045	−4,732	−9,461
August ,, ...	+1,152	−1,960	+2,523	+1,715	− 870	+2,802	−2,126	+3,914	+3,186	+6,906	+ 157	+1,974	−2,417	− 286
September ,, ...	+1,002	+1,717	+1,098	+3,807	+1,265	+ 345	+2,813	+1,888	− 80	+6,231	+3,773	− 395	−1,418	+1,960
October ,, ...	+ 254	+2,183	+ 56	+2,493	+ 91	− 2	+4,202	+ 46	+3,857	+8,194	−1,129	− 342	+ 203	+ 990
Total ...	+11,428	−38,763	+16,146	−11,189	−16,811	−1,574	−27,671	+12,386	−6,794	−37,316	−6,423	−4,272	−16,852	−19,004
Average ...	+ 952	− 3,230	+ 1,346	− 932	− 1,401	− 131	− 2,306	+ 1,032	− 566	− 3,110	− 535	− 356	−1, 404	− 1,583

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TABLE VI—5.

Statement showing average monthly losses for the year 1939-40.

Name of the months	River Jhelum			River Chenab							River Ravi			
	Mangla to Rasul	Rasul to Chela	Chela to Trimmu	Mangla to Trimmu	Marala to Alexandra	At Khanki	Khanki to Rivaz	Rivaz Br. to Trimmu	Trimmu to Shershah	Marala to Shershah	Madhopur to Shahdara	Shahdara to Balloki	Balloki to Sidhnai	Madhopur to Sidhnai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October 1939 (16-30) ...	+ 550	+ 781	+ 239	+1,570	+ 255	− 243	+1,906	+ 380	+1,444	+3,748	+ 491	− 131	+ 275	+ 635
November 1939 ...	+ 415	+ 834	+ 141	+1,390	+ 126	+ 213	+ 961	+ 168	+ 975	+2,443	+ 302	+ 301	+ 70	+ 673
December 1939 ...	+ 178	+ 562	+ 277	+1,017	+ 240	− 232	+ 649	+ 333	+ 422	+1,412	+ 228	+ 87	− 146	+ 169
January 1940 ..	+ 313	+ 273	+ 14	+ 600	+ 122	+ 16	+ 679	+ 25	+ 847	+1,689	+ 211	+ 32	− 73	+ 170
February 1940 ...	+ 839	+ 422	− 243	+1,018	− 267	− 254	− 244	− 227	+ 616	+ 158	+ 710	+ 57	− 472	+ 296
March 1940 ...	− 39	− 839	− 69	− 947	− 680	− 45	+ 126	+ 122	+ 532	+ 55	+ 384	− 76	− 19	+ 289
April 1940 (1-15) ...	+1,098	−5,735	−2,257	−6,894	+ 656	+ 54	+ 356	− 295	−1,696	− 925	+ 180	− 200	− 47	− 67
April 1940 (16-30) ...	+1,133	−8,705	− 7	−7,579	− 646	+ 333	−5,132	− 301	−3,721	−9,465	− 144	− 379	− 209	+ 26
May 1940 ...	+1,147	−6,556	−2,710	−8,119	−4,116	+1,289	−4,060	− 655	−2,253	−9,795	−2,873	− 474	− 418	−3,765
June 1940 ...	+1,374	+ 813	−6,856	−4,669	−3,421	+1,563	−7,964	−3,527	−4,165	−17,514	−2,225	− 437	− 836	−3,498
July 1940 ...	+7,072	−3,415	+2,016	+5,673	+1,043	+3,143	−9,025	+2,509	− 175	−2,505	−3,995	+1,242	−3,779	−6,[illegible]
August 1940 ...	+9,251	+4,215	−2,780	+10,686	+1,505	− 290	+2,274	−2,124	+14,333	+15,698	+7,140	+2,442	−7,545	+2,037
September 1940 ...	+ 475	+3,493	− 602	+3,371	−1,181	+1,043	+4,175	− 830	+9,385	+12,592	+1,067	+ 467	− 206	+1,328
October 1940 (1-15) ...	+ 644	+2,551	+ 198	+3,393	− 771	− 17	+2,366	+ 247	+2,493	+5,860	+1,004	− 245	+ 246	+1,005
Total	+22,736	−5,747	−11,726	+5,262	−5,576	+6,509	−12,681	−4,188	+19,777	+3,842	+1,714	+3,542	−13,292	−8,034
Average	+1,895	− 479	− 977	+ 439	− 465	+ 542	−1,057	− 349	+1,646	+ 320	+ 143	+ 295	−1,108	− 670 + B 205

Statement showing average monthly losses for the year 1940-41.

Name of the months	River Jhelum: Mangla to Rasul	Rasul to Chela	Chela to Trimmu	Mangla to Trimmu	River Chenab: Marala to Alexandra	At Khanki	Khanki to Rivaz	Rivaz to Trimmu	Trimmu to Shershah	Marala to Shershah	River Ravi: Madhopur to Shahdara	Shahdara to Balloki	Balloki to Sidhnai	Madhopur to Sidhnai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October 1940 (16-31) ...	+ 632	+1,137	+ 92	+1,861	− 15	+ 167	+1,416	+ 116	+1,620	+3,304	+ 490	− 39	+ 28	+ 479
November 1940 ...	+ 561	+ 609	+ 221	+1,451	+ 121	+ 174	+ 897	+ 294	+1,216	+2,702	+ 313	+ 129	− 69	+ 373
December 1940 ...	+ 613	+ 524	+ 101	+1,238	+ 303	+ 92	+ 573	+ 127	+ 973	+2,068	+ 243	+ 91	− 192	+ 142
January 1941 ...	+ 347	+ 270	+ 158	+ 775	− 61	+ 413	+ 627	+ 286	+ 582	+1,847	+ 92	+ ...	− 42	+ 50
February 1941 ...	+1,069	− 30	+ 47	+1,086	+ 197	+ 355	+ 486	+ 68	+ 760	+1,866	+ 418	− 2	− 2	+ 418
March 1941 ...	−1,412	−1,744	− 606	−3,762	+ 316	+ 371	− 96	− 81	+ 432	+ 942	+ 267	+ 510	− 10	+ 767
April 1941 (1-15) ...	− 193	−6,209	+1,191	−5,211	− 153	+ 385	+ 468	+ 66	−3,388	−2,622	+ 139	− 234	− 12	− 107
April 1941 (16-30) ...	− 963	−8,143	+3,379	−5,727	−1,900	+1,120	−2,470	+ 107	−6,111	−9,254	−1,066	− 666	− 19	−1,751
May 1941 ...	−3,075	− 795	−3,437	−7,307	−1,866	+2,778	−3,853	− 670	−6,361	−9,972	− 979	− 746	− 676	−2,401
June 1941 ...	− 68	− 930	+2,111	+1,113	−2,359	+ 859	−11,133	+2,562	+1,209	−8,862	−2,997	− 597	− 803	−4,397
July 1941 ...	−4,033	+1,951	− 34	−2,116	−4,234	−8,478	−9,596	− 476	+1,641	−21,143	−3,963	+ 335	−1,424	−5,052
August 1941 ...	+1,615	+2,140	+ 968	+4,723	−2,129	−5,137	−3,789	+1,318	− 643	−10,380	+1,916	+ 557	−4,481	−2,008
September 1941 ...	+1,062	+ 693	+ 232	+1,987	+1,680	−1,781	+ 642	− 830	−2,672	−2,961	+1,607	− 573	− 599	+1,581
October 1941 (1-15) ..	+ 518	+3,316	+ 859	+4,693	− 507	+ 283	+2,284	+ 563	+5,042	+7,665	+ 788	+ 318	− 153	+ 953
Total	−3,324	−2,202	+2,521	−3,004	−9,319	−9,377	+24,393	+3,024	−4,282	−44,347	−2,908	+ 540	−8,372	−10,740
Average	− 277	− 183	+ 210	− 250	− 777	− 781	+2,033	+ 252	− 357	−3,696	− 242	+ 45	− 698	− 895

TABLE VI—7.

Statement showing average monthly losses for the year 1941-42.

Name of the months.	River Jhelum: Mangla to Rasul	River Jhelum: Rasul to Chela	River Jhelum: Chela to Trimmu	River Jhelum: Mangla to Trimmu	River Chenab: Marala to Alaxandra Bridge	River Chenab: At Khanki	River Chenab: Khanki to Rivaz Br.	River Chenab: Rivaz Bridge to Trimmu	River Chenab: Trimmu to Shershah	River Chenab: Marala to Shershah	River Ravi: Madhopur to Shahdara	River Ravi: Shahdara to Balloki	River Ravi: Balloki to Sidhnai	River Ravi: Madhopur to Sidhnai.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October, 1941 (16-30) ...	+ 850	+ 2,075	+ 455	+ 3,380	+ 489	− 287	+ 2,200	+ 539	+ 2,807	+ 5,748	+ 488	− 14	− 187	+ 287
November, 1941 ...	+ 761	+ 844	+ 216	+ 1,821	+ 138	+ 169	+ 1,070	+ 269	+ 1,431	+ 3,077	+ 333	− 43	− 116	+ 174
December, 1941 ...	+ 368	+ 184	+ 124	+ 676	+ 806	− 382	+ 1,021	− 528	+ 43	+ 960	+ 828	+ 179	− 370	+ 637
January, 1942 ...	+ 1,834	− 1,670	+ 47	+ 211	+ 463	+ 1,355	+ 670	+ 259	− 1,321	+ 1,426	+ 257	− 66	− 418	− 227
February, 1942 ...	+ 4,857	− 5,268	− 1,508	− 1,919	+ 1,435	+ 3,764	− 2,921	− 135	− 3,358	+ 1,215	− 147	+ 921	− 2,658	− 1,884
March, 1942 ...	+ 3,037	− 4,368	− 895	− 2,226	+ 316	+ 1,356	+ 855	− 481	+ 3,238	+ 5,284	+ 197	− 245	− 264	− 312
April, 1942 (1-15) ...	+ 3,340	− 5,441	− 3,444	− 5,545	− 908	+ 1,865	− 1,069	− 1,051	+ 2,068	+ 905	− 814	− 693	− 732	− 2,239
April 1942 (15-30) ...	+ 3,026	− 3,121	− 3,376	− 3,471	+ 1,226	+ 2,921	− 848	− 943	+ 6,056	+ 8,412	− 1,389	+ 85	− 1,429	− 2,733
May, 1942 ...	+ 1,283	+ 8,357	= 11,291	− 1,651	− 2,548	+ 424	+ 728	− 3,058	+ 8,833	+ 4,379	− 925	+ 880	− 773	− 818
June, 1942 ...	+ 1,994	− 3,776	− 1,163	− 2,945	− 5,808	+ 2,378	− 6,566	− 854	− 1,001	− 11,851	− 3,069	− 855	− 928	− 4,852
July, 1942 ...	+ 6,779	+ 2,506	+ 1,382	+ 10,667	− 5,266	+ 4,381	+ 2,786	+ 1,097	+ 18,986	+ 13,222	− 6,738	− 1,755	− 7,646	− 16,139
August, 1942 ...	+ 2,676	− 371	+ 310	+ 2,615	− 5,238	− 2,750	+ 10,711	− 710	+ 12,690	+ 14,703	+ 19,995	− 9,500	− 13,522	− 3,027
September, 1942 ...	+ 3,507	+ 2,215	+ 781	+ 4,941	+ 2,144	+ 4,481	+ 9,669	− 1,792	+ 12,498	+ 27,000	+ 2,839	+ 4,201	+ 4,751	+ 11,791
October, 1942 (1-15) ...	+ 599	+ 4,105	+ 427	+ 5,131	+ 2,006	+ 162	+ 5,321	+ 412	+ 9,352	+ 17,253	+ 2,004	+ 472	+ 1,564	+ 4,040
Total ...	+ 31,004	− 2,538	− 16,528	+ 11,937	− 12,152	+ 8,745	− 20,825	− 6,455	+ 62,180	+ 73,143	+ 13,715	− 6,358	− 22,336	− 14,980
Average ...	+ 2,584	− 212	− 1,377	+ 995	− 1,013	+ 729	− 1,735	− 538	+ 5,182	+ 6,095[illegible]	+ 1,143	− 530	− 1,861	− 1,248 + B 5,969

Statement showing average monthly losses for the year 1942-43.

	River Jhelum				River Chenab						River Ravi			
Name of the months	Mangla to Rasul	Rasul to Chela	Chela to Trimmu	Mangla to Trimmu	Marala to Alexandra Bridge	At Khanki	Khanki to Rivaz Br.	Rivaz Br. to Trimmu	Trimmu to Shershah	Marala to Shershah	Madhopur to Shahdara	Shahdara to Balloki	Balloki to Sidhnai	Madhopur to Sidhnai
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
October, 1942 (16-30)	+1,106	+2,168	− 11	+3,263	+ 406	− 234	+2,319	− 17	+5,220	+7,694	+ 914	+ 367	+ 899	+2,180
November, 1942 ...	+ 657	+1,381	− 19	+2,019	+ 372	+ 212	+1,565	+ 1	+1,637	+3,787	+ 492	+ 288	+ 197	+ 977
December, 1942 ..	+ 705	+ 120	+ 227	+1,052	+ 172	+ 388	+ 856	+ 481	+ 208	+2,105	+ 656	+ 261	+ 72	+ 989
January, 1943 ..	+1,256	−3,306	+ 403	−1,647	−2,703	+1,997	+ 250	+ 379	+2,097	+2,020	+ 979	+2,286	−2,298	+ 967
February, 1943 ...	+ 824	+1,483	+ 185	+2,492	+ 422	+ 982	+2,897	+ 270	+7,958	+12,529	+1,365	+ 495	+ 642	+2,502
March, 1943 ...	+3,226	−5,502	− 849	−3,125	− 66	+1,849	− 987	− 67	−6,247	−5,518	+ 235	+ 133	− 610	− 242
April, 1943 (1-15) ..	+3,305	−1,209	−4,583	−2,487	− 757	− 40	−3,391	− 853	−3,414	−8,455	− 904	− 232	+ 45	−1,091
April, 1943 (16-30)	+2,845	− 600	−3,298	−1,053	− 778	+1,196	+1,486	− 824	− 507	+ 573	− 896	+1,307	−3,542	−3,131
May, 1943 ...	+ 197	−2,207	−2,930	−5,334	− 379	+ 586	− 608	− 585	+1,878	+ 892	−2,712	+ 106	− 508	−3,114
June, 1943 ...	+5,167	−5,690	−1,794	−2,317	− 622	+2,838	−3,672	+ 74	−1,153	−2,535	−3,644	− 88	−2,038	−5,770
July, 1943 ...	+4,496	− 56	−3,112	+1,328	−1,118	+9,741	+15,781	−5,103	−11,493	+7,808	−2,878	− 592	−5,040	−8,510
August, 1943 ...	+5,394	+1,702	− 799	+7,895	−2,414	+3,536	+8,933	+ 44	−27,768	−17,669	+16,643	−5,520	−5,918	−5,205
September, 1943 ...	+3,502	+5,450	− 542	+8,410	−4,785	+1,002	+6,658	−1,313	+15,388	+16,950	+6,488	+1,014	+1,153	+8,655
October, 1943 (1-15)..	+1,127	+3,861	− 242	+4,746	− 365	+ 683	+5,347	− 963	+7,327	+12,029	+1,235	+4,388	− 154	+1,469
Total	+29,222	−4,515	−11,699	+13,008	−11,867	+23,934	+34,553	−7,148	−13,181	+26,290	+17,799	− 701	−15,724	+1,373
Average	+ 2,435	− 376	− 975	+1,084	− 989	+ 1,995	+ 2,879	− 597	− 1,098	+ 2,191	+ 1,483	− 58	− 1,310	+ 114

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TABLE VI—9.

Gains and Losses in Rivers Jhelum, Chenab and Ravi, during the period 1935-36 to 1942-43.

LOSS *MINUS*

GAIN *PLUS*

	RIVER JHELUM	RIVER CHENAB	RIVER RAVI	
Years	Mangla to Trimmu	Mangla to Shershah	Madhopur to Sidhnai	½Col : 2 plus Col : 3 plus ½Col : 4
1	2	3	4	5
1935-36 ...	−2,052	−5,217	−1,112	−6,799
1936-37 ...	+ 50	−2,834	−1,509	−3,564
1937-38	− 606	−4,917	−2,068	−6,254
1938-39 ...	− 932	−3,110	−1,583	−4,368
1939-40 ...	+ 439	+ 320	− 678	+ 205
1940-41 ...	− 250	−3,696	− 895	−4,269
1941-42 ...	+ 995	+6,095	−1,248	+5,969
1942-43 ...	+1,084	+2,191	+ 114	+2,790
Total ...	−1,272	−11,168	−8,971	−16,290
Average ...	− 159	−1,396	−1,121	−2,036

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Gross areas, No. of working wells, average No. of hours for which the wells are worked, and average area under barani, sailab and chahi crops, in Chaj and Rechna Doabs.

CHAJ	GROSS AREA	NO. OF WORKING WELLS		HOURS			BARANI	SAILAB	CHAHI
Gujrat ...	1,95,080	1,922	×	10	=	19,220	50,010	46,631	23,834
Shahpur ...	14,54,739	4,699	×	5.2	=	24,435	33,603	41,277	1,27,460
Jhang ...	5,40,836	4,306	×	14	=	60,284	3,981	37,277	77,111
	21,90,655	10,927				103,939	87,594	12,5,185	2,22,405
	18,78					9.5 hours			
RECHNA									
Gujranwala ...	14,33,548	13,856	×	10	=	13,8,560	1,18,945	47,148	4,11,594
Sheikhupura ...	13,77,709	8,631	×	7.3	=	63.006	1,75,394	30,755	1,50,097
Sialkot ...	53,356	12,142	×	8	=	97,136	1,46,791	26,492	2,43,726
Jhang ...	7,44,407	3,996	×	12	=	47,952	5,886	8,451	1,66,050
Lyallpur ...	22,49,056	2,560	×	13	=	33,280	5,582	27,909	50,649
	58,58,076	41,185				3,79,934	4,52,598	1,40,755	10,22,116
	52.07					9.2 hours			
Grand Total ...	80,48,731	52,112				9.3 hours	5,40,194	2,65,940	12,44,521

TABLE VI—11.

Evaporation from Rivers.

Rate of evaporation at Lyallpur = Kharif 0.46" per day
(from Table IX Chapter. II)

Rabi 0.19" per day
(from Table IX Chapter. II)

Length of Jhelum Mangla to Trimmu = 210 miles

Average discharge = $\frac{\text{Kharif}}{\text{Rabi}}$ $\frac{49{,}595}{14{,}540}$

Wetted perimeter at 8/3-Q = $\frac{\text{Kharif}}{\text{Rabi}} = \frac{594}{322}$

Evaporation $\frac{\text{Kharif}}{\text{Rabi}} = \frac{290}{65}$ cusecs.

Average evaporation = 178 cusecs.

Length of Chenab Marala to opposite Sidhnai = 210 miles.

Average discharge = $\frac{\text{Kharif}}{\text{Rabi}}$ $\frac{72{,}400}{10{,}260}$

Wetted perimeter = $\frac{K}{R} = \frac{717}{274}$

Evaporation = K/R = 350/55

Average = 203 cusecs.

Length Ravi Madhopur to Sidhnai = 260 miles.

Average discharge = K/R = 13,750/3800

Wetted Perimeter = K/R = 314/164

Evaporation = K/R = 190/41

Average evaporation = 116 cusecs.

Total evaporation = $\frac{1}{2}$ Jhelum + Chenab + $\frac{1}{2}$ Ravi = 89 + 203 + 58 = 350 cusecs.

River is not strictly a channel in regime and actual evaporation will be much more. It may be taken as 500 cusecs.

Average Monthly Discharge of Drains.

Name of the months	1942-43			1943-44			1944-45		
	Tail Rechna Outfall Drain	Tail Mangoki Drain	Tail Gujranwala Branch Drain	Tail Rechna Outfall Drain	Tail Mangoki Drain	Tail Gujranwala Br. Drain	Tail Rechna Outfall Drain	Tail Mangoki Drain	Tail Gujranwala Br. Drain
1	2	3	4	5	6	7	8	9	10
April	24	...	2	19	Dry	1	42	9	...
May	...	...	Dry	15	Dry	Dry	18	2	Dry
June	11	Dry	Dry	19	Dry	Dry	16	2	Dry
July	36	12	3	71	3	9 (49)*	109	29	...
August	68	9	15	87 (231)*	9 (51)*	11	377	130	...
September	204 (372)*	38 (79)*	82 (335)*	30	Dry	3	424 (656)*	186 (293)*	78 (188)*
October	52	1	8	24	Dry	1	93	...	...
November	41	1	3	27	Dry	Dry	36	...	...
December	45	1	5	24	Dry	Drv	28	...	...
January	36	2	6	32	1·0	2	162	...	...
February	22	Dry	2	61	...	4	68	4	...
March	29	Dry	..	55	2·0	4	71	3	...
	568	64	124	464	14	35	1,444	361	78
	55	6	11	39	1.0	3.0	120	46	6

*Maximum discharges during the year.

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TABLE VII—1.

Statement showing date in tabular form for Rechna Division for the year 1943-44.

Permanent Data					Maximum discharge of drain with date				
Serial No	Name of Drain	Kind of Drain	Catchment area in sq. miles	Maximum Rain-fall on any one day in inches with date	Date	Discharge	Length of Drain in miles	Average total cost of maintenance per annum for the drain	Designed capacity of drain in cusecs
1	2	3	4	5	6	7	8	9	10
	Sukheki Sub-Division			Lower Chenab West Circle					
1	Wagh Drain	Seepage-cum-storm	448		7-8-44	2499	18·80	4306	930
2	Kaula Tarar Branch Drain	Storm	7·1		1-9-42	72·5	2·00	224	...
3	Akalgarn Branch Drain	Seepage-cum-storm	48		7-8-44	1444	14·60	3059	110
4	Kallianwala Chammb	Storm	9·0		7-8-44	103	1·25	190	10
5	Chak Kaval Branch Drain	Seepage-cum-storm	4·8		6-8-44	84	1·40	263	8
6	Gajar Cola Branch Drain	Seepage-cum-storm	3·2		6-8-44	55	2·36	473	10
7	Shori Cola Branch Drain	Seepage-cum-storm	8·7		17-7-33	444	3·06	1085	85
8	Kallowala Tributary Drain	Seepage-cum-storm	4·5		9-8-40	151	4·30	2292	...
9	Thathanwali Drain	......	1·5	6-8-44, 3·45	17-7-33	75	4·94	1136	9
10	Bucha Tributary Drain Fatehpur F. Drain	Storm	6·5	7-8-44, 4·00	28-8-42	142	9·20	981	52
11	Said Nagar Tributary Drain	Storm		7-8-44, 5·73			1·50	129	...
12	Vanike Tributary Drain	Storm		7-8-44, 4·00			0·75	...	...
13	Dohatta Tributary Drain	Seepage		7-8-44, 2.82			0·10	5	...
14	Ahmadpur Drain to River Creek	Seepage-cum-storm	315		21-8-33	1500	50·45	8703	300
15	Chiniot Road Branch Drain	Storm	4·2		30-8-42	37·3	2·62	284	...
16	Pindi Bhattian Branch Drain	Storm	8·5		21-8-33	113	2·40	455	6
17	Thatta Raika Branch Drain	Seepage-cum-storm	8·2		10-7-34	337	3·44	563	34
18	Rattoki Branch Drain	Storm	19·5		4-8-42	44	9·80	993	78
19	Jangle Branch Drain	Storm	13·6		24-8-44	15·6	4·81	550	28
20	Channi Branch Drain	Storm	9·2		18-8-44	59·0	7·30	1201	78
21	Lakhi Branch Drain	Seepage-cum-storm	9·9		15-8-44	146	3·80	529	14
22	Ramgarh Branch Drain	Storm	4·3		27-7-37	78	3·19	498	5
23	Hafizabad Branch Drain	Seepage-cum-storm	6·8		8-8-44	142	2·40	310	9
24	Sagar Branch Drain	Seepage-cum-storm	5·6		6-8-44	120	2·80	787	9
25	Pir Kot Tributary Drain	Seepage-cum-storm	13·6	7-8-44, 5·73	18-8-44	184	6·60	950	20
26	Sagar Compound F. Drain	Seepage-oum-storm	1·2	4-9-44, 2·00	23-8-33	30	2·08	465	6
27	Chiniot Drain River Creek	Seepage-cum-storm	426		4-9-44	650	37·5	15859	852
28	Budh Nallah	Storm	...		12-9-41	199	1·17	322	500
29	Dobava Branch Drain	Seepage	12		24-8-42	52·6	7·36	1005	48
30	Paran Wali Drain	Seepage	...	4-9-44, 4·40	5-9-44	8·5	0·95	80	...
31	Sadhara Branch Drain	Seepage	11		24-8-42	53·1	4·70	671	44
32	Ratti Branch Drain	Storm	...	4-9-44, 4·40	5-9-44	12·2	1·2	287	...
33	Vanir Branch Drain	Seepage	10		24-8-42	66·8	5·28	850	40
34	Sukheki Branch Drain	Seepage	40		5-9-44	198	12·36	3470	160
35	Sadhana Branch Drain	Seepage	...		...	...	2·73	...	...
36	Chak Anva Tributary Drain	Storm	...		5-9-44	19·5	1·78	221	2
37	Bhabra Tributary Drain	Seepage	...		5-9-44	30	6·47	1108	24
38	Par Ahmad Tributary Drain	Seepage	...		...	..	0·60		...
39	Par Nasiba Tributary Drain	Storm	...		5-9-44	10	1·90	228	44
40	Par Bhondi Tributary Drain	Seepage	...		...	...	1·44	...	...
41	Par Masam Tributary Drain	Seepage	...		...	...	1·40	3519	...
42	Ahmadanagar Tributary Drain	Seepage	...		...		0·30	...	...
43	Par Lakhan Feeder Drain	Seepage	...		...		0·44	...	...
44	Akbar Feeder Drain	Seepage	...		...	...	0·44	...	...
45	Khuda Yar Drain	Seepage	...		...	...	0·44	...	...
46	Delivery Drain of Mark Pump	Seepage	...		...	...	1·00	...	...
47	Sangla Town Drain	Seepage	...		6-9-44	7·4	3·10	1683	60
48	Kubrika Drain	Seepage	...		13-7-44	49·7	7·96	1924	...
49	Danluwala Branch Drain	Seepage	...		...		0·70	...	...
	Feroze Sub-Division								
50	Rechna Outfall Drain	Storm and Seepage	250	4-9-44, 0·15	10-9-44	510	...	...	700
51	Recha Outfall Drain	Storm and Seepage	350	3-9-44, 1·19	11-9-44	656	34·8	7488	300
52	Sacha Sauda Branch Drain	Storm and Seepage	16	19-7-44, 2·15	7-8-39	54·3	12·8	4169	...
53	Dhilwan Village Tributary Drain	Storm and Seepage	...	3-9-44, 1·90	13-9-44	13·0	2·8	898	...
54	Nakkar Tributary Drain	Storm and Seepage	L/Pond	3-9-44, 1·90	3-7-41	24·62	0·89	430	...
55	Chuhar Kana Tributary Drain	Storm and Seepage	L/Pond		8-9-44		2·52	...	...
56	Gujranwala Drain	Storm Water	L/Pond		8-9-44	188		...	175
57	Rechna Tributary Drain	Seepage and Storm	476·76	4-9-44, 4·15	19-7-41	144·6	16·06	2259	70
58	Mark Drain	Seepage and Storm	15·90	7-8-44, 3·15	10-9-44	480	15·96	2130	636
59	Mellowana Branch Drain	Seepage and Storm	67·00	7-8-44, 3·15	10-9-44	180	15·24	2405	268
60	Jalaliana Tributary Drain	Seepage and Storm	14·00	7-8-44, 3·15	28-8-42	27·9	4·80	1146	56
61	Mullay Branch Drain	Seepage and Storm	...	7-8-44, 3·15	2-9-44	9	5·44	179	...
62	Salar Drain	Seepage and Storm	54·46	4-9-44, 4·15	10-9-44	275	11·90	1530	206
63	Mianwali Branch Drain	Seepage and Storm	1·72	7-8-44, 3·15	18-8-40	20·43	6·82	385	6
64	Gajiana Branch Drain	Seepage and Storm	1·54	7-8-44, 3·15	6-3-42	4·9	2·9	411	11
65	Kassoke Branch Drain	Seepage and Storm	23·96	4-9-44, 4·15	6-9-44	78	10·30	1066	152
66	Ajnianwala Branch Drain	Seepage and Storm	2·94	7-8-44, 3·52	6-9-44	15	2 9	851	12
67	Chakhu Reservior Drain	Seepage and Storm	...		18-8-44	153	8·6	410	150
68	Segatan Branch Drain	Storm Water	...		16-8-44	11·0	6·26	50	35
69	Haripur Tributary Drain	Storm Water	...		16-8-44	7·0	2·83	57	15
70	Maduana Drain	Storm Water	...	27-6-44, 2·45	19-8-40	72·0	137·54	4898	72
71	Faqirian Tributary Drain	Storm and Seepage	...		18-8-44	8·0	4·55	62	...
	Mangoki Sub-Division								
72	Nikha Deg Drain	Storm Water and Seepage	...	26-7-44, 6·36	1-9-42	838	29·30	2280	...
73	Khatha Nalla Branch Drain	Storm Water and Seepage	...	26-7-44, 6·36	31-7-44	30	15·40	1994	...
74	Katha Nalla Branch Drain Extension	Storm Water and Seepage	87·62	26-7-44, 4·90	31-7-44	13	11·60	620	...
75	Drajke Tributary Drain	Seepage	9·16	26-7-44, 6·36	15-9-44	30	9·40	1504	...
76	Mari Thakran Tributary Drain	Seepage	1·72	26-7-44, 6·35	29-8-42	6	1·64	160	...
77	Gajrana Branch Drain	Seepage	16·0	26-7-44, 6·36	31-7-44	21·0	5·76	119	16
78	Kharak Feeder Drain	Seepage	...	26-7-44, 6·36	...	...	0·83	400	Not Known
79	Sheikhupura Branch Drain	Seepage	...	26-7-44, 6·36	23-8-42	97·0	30·40	600	400
80	Chichoki Mallian Drain	Seepage	81·0	26-7-44, 4·58	4-8-44	147·0	21·40	449	322
81	Santpura Branch Drain	Seepage	0·9	26-7-44, 4·58	26-7-44	62·0	9·70	777	...
82	Gujranwala Branch Drain	Seepage and Storm	175	26-7-44, 4·90	7-9-44	363·0	33·96	10739	...
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE VII—2. *Continued*

	1942-43	1943-44	1944-45
Name of the months	Chichoki Mallian R.D. 4360	Chichoki Mallian R.D. 4360	Chichoki Mallian R.D. 4360
April	...	Dry	24
May	...	Dry	5
June	Dry	6	2
July	11	38 *(120)	27
August	17	18	97 *(269)
September	29 *(95)	7	48
October	4	3	3
November	3	4	4
December	3	1	7
January	Dry	4	41
February	Dry	11	4
March	Dry	3	Dry
	67	95	262
	7	8	22

*Maximum discharge during the year.