This form of construction does away with all centring at site and is, in many cases, the last word in speed and economy. At Khanki it has worked to less than half the cost of the steel girder and jack arch bridge as on the left undersluices. The cost per 20 feet clear span of the trough bridge worked out to just under Rs. 1,000 or Rs. 3/9 per square foot of finished roadway.

In Bay 4, the construction of the entire trough bridge of 18 spans and 10 feet clear between wheel guards, took exactly 21 working days from the casting of the first trough to the completion of the wheel guards. These troughs were all cast on the left bank, carried on B. G. trucks downstream of the undersluices, loaded on to boats and boated across and hoisted in position during floods. The cost of carriage and erection worked out to Rs. 6 per trough or Rs. 3-8-0 per ton.

In Bay 8 troughs, over 4 spans, weighing 56 tons were hoisted on to the piers in one day.

Fish Ladder. (Plate V).—A fish ladder has been provided in Bay 8 between the left abutment and the old groyne No. 7. The compartments would give a drop of one foot each under conditions of maximum head. The total number of compartments is 17.

Steel Work.—The entire steel work in the Central and Right undersluices, as well as the new 17′ gates for the Left undersluices were manufactured in the Central Workshops at Amritsar. The gates in the Central and Right Undersluices are 18′ high and are of the plain girder design which is bold and effective in appearance. The 18 counter balance boxes and gears set free from the regulators, as a result of the construction of silt tunnels, have been used in Bays No. 4 and 8.

The grooves in Bay No. 4 are in two parts, one part with the roller face and the other with the staunching face. In Bay No. 8 they have been cast in one piece which is a definite improvement as it simplifies erection and eliminates chances of error.

In Bay 8, the spaces for the grooves were left hollow across the piers—the latter being built in two parts tied across by suitable reinforcement and pieces of rails. When the grooves were erected in position these gaps were concreted from the open spaces left in the cast iron grooves.

The construction of the piers was so arranged that erection of steel work could proceed simultaneously (Photo 8). The last trestle was erected within a few hours of completion of the last pier showing commendable co-operation between the Central Workshop and the Khanki Division. The work of erection of steel-work in each Bay was completed in about 6 weeks' time. The total tonnage was 935 tons.

Painting of Steel Work.—In Bay 4 the superstructure was painted with Waile's Dove bitumastic grey and the under-water work, with bitumastic black. In Bay 8 Aero-lite and Anodite paints were used for superstructure and under-water work, respectively. The latter under-water did not prove successful and had to be replaced by bitumastic black (Waile's Dove). Here, as at Panjnad, experiments have proved that for under-water work the Khanki mixture stands best and is the cheapest.

Ring Bunds.—A description of Ring Bunds, Pumping and Piling should really have come in the earlier pages but it has been purposely kept to the last.

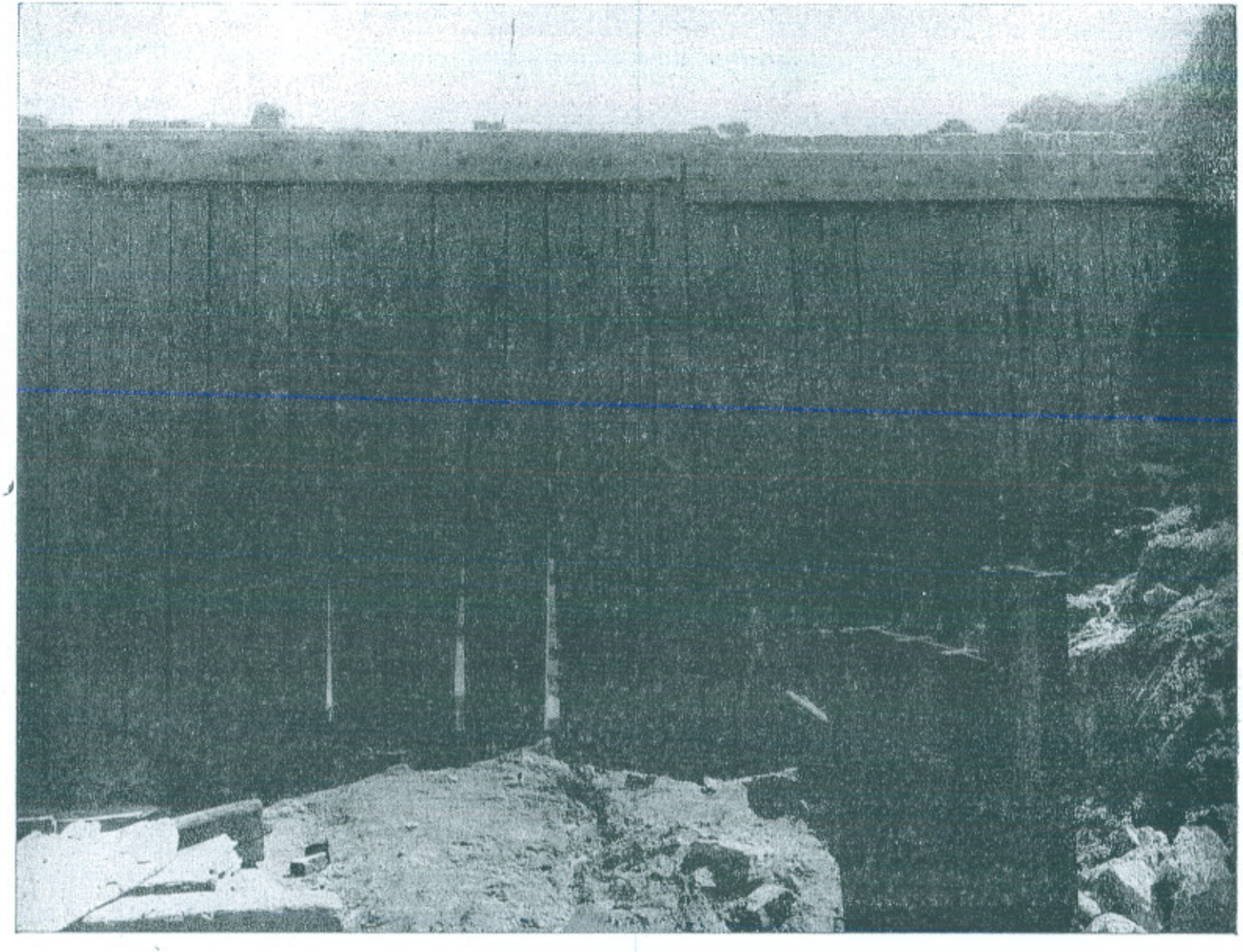
The location of ring bunds during the two winter seasons is shown in Plate I. Bays 1, 2, 3 and 4 were done the first season (1933-34) and Bays 5 to 8 during the second and last season (1934-35).

In 1932-33 when some preliminary work was done and upstream piling driven in Bays 3, 4, 7 and 8, the ring bunds were constructed close to the work and endless trouble was experienced due to the bunds sloughing into the foundations. In the 1933-34 season the bunds upstream and downstream were constructed some 700 to 800 feet away from the weir. In the 1934-35 season the downstream bund was similarly constructed except that, to enclose the Bell's Bund, it had to be further out at the right end. The aprons of the downstream and upstream Bell's Bund had to be lowered by a maximum depth of 14 feet. The upstream bund was located at the head of the right creek. Local accumulations of water were individually dammed. This arrangement of bunds—a good distance away from the foundations—has been most successful.

Pumping.—The entire pumping had to be done with portable pumping sets with 8" to 10" pumps, Petter sets with 6", 4" and 3" pumps and some electric sets. The entire plant was old and had to be locally overhauled to put into working order. Pumping was heavy during both seasons but it was particularly so in 1934-35 as a much larger area had to be pumped and to a lower level, to enable the aprons of the Bells to be lowered to the same level as the floor apron. The aprons round the divide groyne No. 7 were similarly laid at that low level.

The following pumps kept working continuously in Bay No. 8 day and night for almost 7 months and the discharge (a maximum of 35 cusecs) kept at 30 cusecs for a very long period. The pumping head ranged between 18 to 22 feet.

10"—8" Pumps with steam engine	..	8 No.
8" Electric Pumps	..	2 No.
6"—4" Petter and Bernard Sets	..	14 No.
6"—4" Electric sets	..	3 No.
1½" Electric sets	..	8 No.



Note gaps between Wooden piles at the bottom and Universal piles in the foreground.

The cleaning and running overhaul of each pump was done in rotation once every fortnight and, thus, it was possible to carry on without any breakdowns. The above number includes pumping sets for local pumping as well.

In laying foundations a maximum local depression of one foot was allowed. With higher heads the soil was likely to run, resulting in hollows under the foundation. The concreting was always started away from the pumps and finished towards them. In this way subsoil was prevented from being disturbed after the concrete had been laid. This is an important point to bear in mind.

In Bay 8 the pumped level was maintained at R. L. 706 upstream and 703 downstream, to suit the deepest foundation levels. There were frequent freshets and rainfall during the 1934-35 season. These led to considerable increase in pumping, both in volume and head, but the work was kept going without a day's interruption. One battery of pumps consisting of 4 to 5, 8"-10" portable sets and 4 to 5 Petter sets worked continuously at one sump on the upstream. These discharged through the inlet in the upstream Bell's Bund and further down through the newly constructed culvert under the right marginal bund into the downstream river. A similar battery of pumps discharged through a cut in the downstream Bell's Bund into the channel made for the discharge from upstream pumps.

There was the alternative of discharging the water from the upstream pumps into the river upstream. This was ruled out as expensive and unsatisfactory. It would have added 6′ to the pumping head requiring double stage pumping and in case of freshets would have meant stoppage of work.

By this arrangement of concentrated and intensive pumping, the foundations were unwatered to the correct level and the entire floor concrete was laid almost in the dry, thus ensuring really sound construction.

Generating Sets.—For lighting the working area, for electric pumping and for running the workshops, the power house on the left bank consisting of one 40 K. W. and two 10 K. W. sets supplied the necessary power. For Bay 8 a subsidiary power house was temporarily set up with a 40 K. W. Vicker Petter's Set brought from the Chakanwali Farm. The cracked cylinder, liners and piston of this latter were replaced and the set gave excellent service throughout the season. The current generated was D. C. on both banks.

All the pumps mentioned before and the electric pumps run by the power house were just enough to cope with the heavy pumping involved. There were practically no stand-bys and no reserve of power. But the

thorough overhaul of machinery before the commencement of the season's work and regular periodic attention during the working season kept the plant fully effective, so that there were no breakdowns.

Pile Driving.—Two types of piles have been used on this work-the Universal and Ransome Uniform (D). The former are the product of the British Steel Sheet Piling Company and the latter are of Belgian manufacture. The sections of these piles are shown in (Plate III, Figs. 8 and 9). The Universal piles being heavier in section are capable of driving through hard soil and even through stone. These have never been known at Khanki to have lost the interlocks even in very hard driving. The Ransome D. piles will stand driving through hard soil but not through stone. In the latter case they get bent and also have been known to have lost the interlocks. The Ransomes, are, however, more water-tight. Being lighter in section they are cheaper.

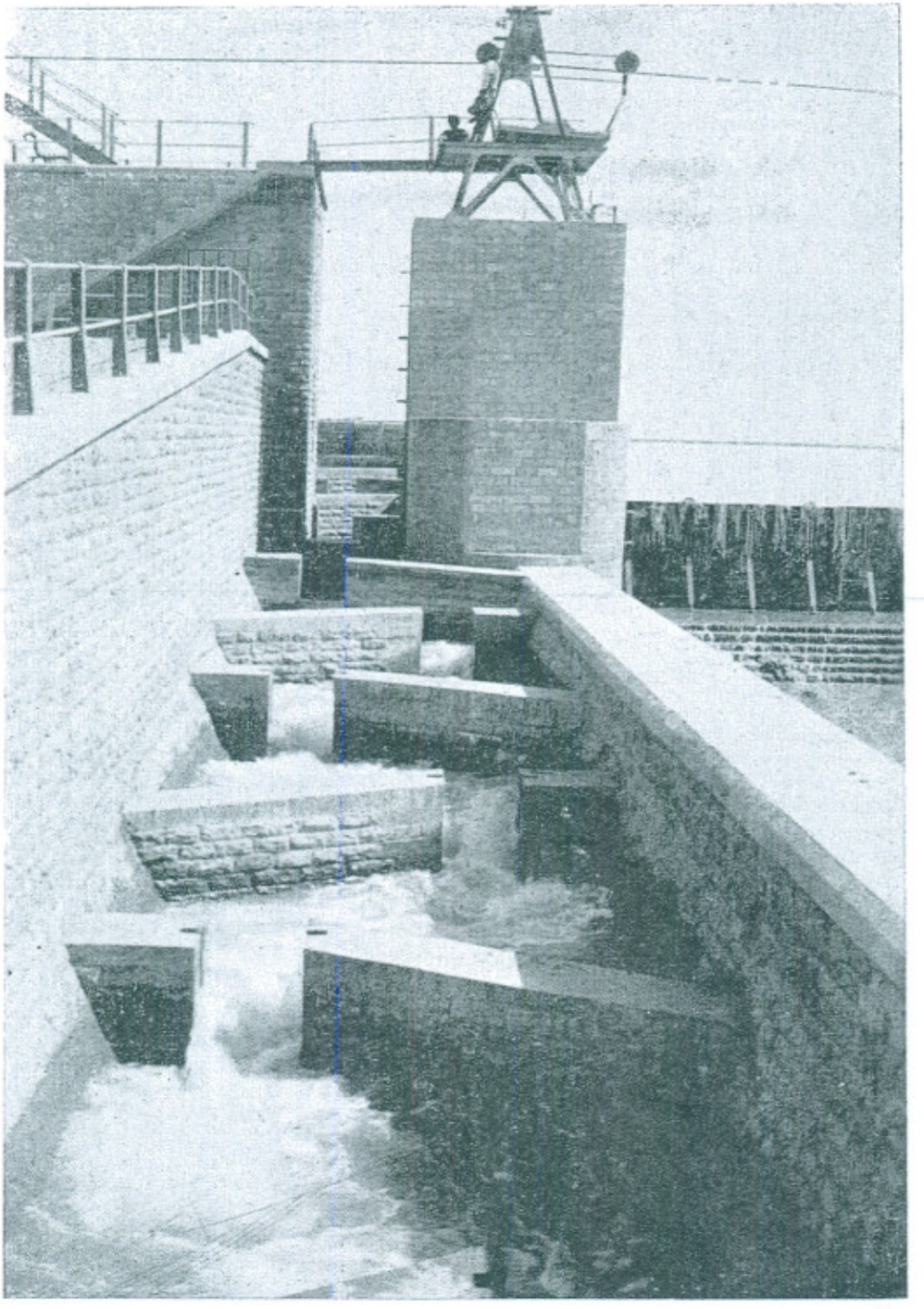
The Ransome piles were obtained through the Indian Stores Department and cost Rs. 203 per ton F. O. R. Mansurwali. Universal piles were obtained from Sukkur (Lloyd Barrage) and also from England.

The cost of the Universals, driven in position, has worked out to Rs. 4-6 per square foot and of the Ransomes Rs. 2-12-0 per square foot. In all 2,800 tons of Universals and 1162 tons (99,200 sft.) of Ransomes have been used on this work. This is the largest quantity of sheet piling that has been used in any of the Punjab weirs. Appendix I gives the details of working costs and progress. The driving of piles should be done with the male end forward. If done otherwise, the sand will get consolidated in groove end resulting in splitting of the interlock.

On this construction there were three pile driving sets, one capable of driving 45 feet piles and the other two, 30 feet piles. The former and one of the latter had a No. 7 ($2\frac{3}{4}$-ton) hammer. The third had a No. 6 ($1\frac{3}{4}$-ton) hammer. In addition there were three spare No. 7 and one No. 6 hammers. A No. 3 hammer was also available for local work away from the pile drivers.

The pile drivers were fed either on oil or coal fuel. They were subsequently all converted to coal fuel as that worked out much cheaper. With oil fuel the cost per shift worked out to Rs. 100 and with coal, to Rs. 50.

During the course of dismantling in Bay 8, the wooden piles driven upstream of the weir, in 1896-97 were exposed (Photo 9). The driving seems to have been extraordinarily well done. But as these had only V-grooves to guide the piles and no mechanical interlocks, the middle or key pile invariably lost the V-groove, so that large gaps remained in the



Fish Ladder.
Right Undersluices Bay 8.

pile line below the top at almost every key pile. Such a pile line cannot therefore be expected to be fully effective, as concentration of flow is possible through these gaps.

On this work the pile lines upstream and downstream and across are all continuously interlocked along the whole length, although they were driven at different times and in different directions. Where piling started from two ends and met in the middle, the junction was secured by special junction piles with sliding slots. Nowhere was such junction secured by a meré overlap of a few piles. The cross lines all took off from T. piles in the main lines and were similarly linked in the middle by these special junction piles.

The pile drivers were all worked on B. G. track. Working on the straight, there was little difficulty but whenever the machine had to be turned at an angle it became extremely slow and tricky. This latter difficulty was removed by a very simple device. B. G. rails were bent to form a circle circumscribing the rectangle formed by the four wheels of the pile driver. The pile driver was lifted, the wheels placed on to this circular track and the machine turned through the required angle. The machine was then moved on to the new track and the simple turntable removed. Ordinarily a turn of the pile driver took a whole day. With this device it took no more than an hour.

Oxy-Acetylene Cutting.—The piles driven along the crest of Bay 4 and Bay 8 in 1932-33 had to be cut to suit the depressed level of crest in 1933-34 and 1934-35 respectively. This cutting was done by the oxy-acetylene flame. The acetylene gas was generated in special cylinders from carbide and the oxygen gas was obtained in steel cylinders containing 200 cft. of oxygen. The mixture of the two gases could be controlled to suit the requisite intensity of flame. On an average 9 piles could be cut per day. A maximum progress of 13 cuts was obtained one day. Each cut took 40 to 50 cft. of oxygen. Only the Universal piles were cut this way. The cost per cut ranged between Rs. 3 and Rs. 5. The cutting of the piles in position offered special difficulty. An opening about 9" to 12" deep and 15" wide had to be cut in the web plate in order to reach the flame to the flanges and the clutches. If it were a simple cut across, the cost would be over a rupee. These straight cuts done by manual labour were paid @ 0-12-0 per cut for the Universal and 0-8-0 per cut for the Ransomes.

Concrete Mixers.—The following mixers were in use:—

One cubic yard	..	..	3 No.
½ ,, ,,	..	..	1 No.
¼ ,, ,,	..	..	3 No.
8 ,, ,,	..	..	1 No.

The cubic yard mixers were installed outside of the work but not further away than 500 feet. The smaller mixers were carried about according to requirements.

The maximum progress on a cubic yard mixer was 300 batches in one shift but an average of 200 batches was maintained over prolonged periods. This is equivalent to about 4,500 cft. per day per mixer. The progress was largely controlled by the working space available and the class of concrete. On a half yard mixer, the maximum progress per day was 180 batches and the average 150 or 1700 cft.; on the quarter yard, the maximum was 200 and average 150 batches.

The maximum progress in any one day was 22,000 cft. of concrete. A progress of 13,000 to 15,000 was maintained over long periods—it being largely a matter of working space and magnitude of work. The quantity of water in the mix was carefully regulated. Spongy concrete was scrupulously avoided even if a little extra water had to be added. High water content reduces compressive strength. A slight reduction in this strength in the case of a floor is of no consequence but if the concrete remain spongy due to the shortage of water, it would be most undesirable. In all such works the fact that the class of labour is unskilled should not be lost sight of. Theoretical assumptions do not work 100 per cent. in practice.

Pressure Pipes.—A series of pressure pipes were erected in the various bays by the late Mr. H. W. Nicholson, C. I. E., prior to the reconstruction. The observations from these were sent to the writer for comments. From a scrutiny of the data, the latter came to the conclusion that the weir must be hollow underneath as the observations showed little resistance under the floor. With this Mr. Nicholson agreed. Speaking on Paper No. 162 (1933 session of the congress) he mentioned this fact. It was the warning given by the pressure pipes coupled with the failures in Bays 3 and 4 in 1932-33 that brought the question of reconstruction to the fore-front. From model tests Dr. Mckenzie Taylor predicted the possibility of failures. (Research Publication Vol. II No. 6.) Pressure pipes have now been erected on a fairly large scale in all the reconstructed weir bays and more particularly in the Central and Right Undersluices. The scheme of location and method of erection are as already described in the Punjab Engineering Congress Paper No. 162 and need not be repeated here.

The pressure under the floor and the clay substratum in Bay 4 have been reproduced on the hydraulic scale model in the Irrigation Research Institute and have been described in Research Publication No. 10 Vol. II 1935.

Pressures under Bay 8 have been reproduced on the Electric model and they agree.

Temperature observations of subsoil and river water have been done at Khanki as at Panjnad.

The analysis of pressure observations and other allied matters will be presented in a subsequent publication, which will also contain a discussion on the thickness of floor required to withstand uplift pressures from seepage flow or from the unbalanced head at the trough of the standing wave.

Protection below Khanki Weir.—Model tests were done on the arrows and blocks and on the length of protection required below the right undersluices. These are described in Research Publication Volume II No. 8 (1934). As a result of these tests the inverted filter was reduced from 50 feet in Bay 4 to 40 feet in Bay 8 and the loose stone protection from 100′×6′ to 80′×6′.

Collection of materials.—All building stone and pitching stone was obtained from the Irrigation Quarry at Baghanwala which is 87 miles along rails to Khanki and most of the ballast from Jammu, sixty miles away, where a special siding was laid for the purpose. At the time of rush, three rakes were at work between the two sources of supply. They were the U. J. C. and L. B. D. C. rakes of 49 trucks each with carrying capacity of 17,000 cft. each and one S. V. C. rake of 49 trucks, obtained on hire from the Panjnad Division with a carrying capacity of 23,000 cft. The hire charges for the U. J. C. and S. V. C. rakes were Rs. 2-2-0 per truck per day and for the L. B. D. C. rakes Re. 1-4-0 per truck per day. As the railway freight is paid on the train mile basis the S. V. C. value with its higher carrying capacity worked out the cheapest. The U. J. C. rake was the most expensive as the same hire charge had to be paid per truck as the S. V. C. ones although the carrying capacity of the latter is 35 % greater. Two B. G. Sentinels were employed to handle the traffic between Mansurwali and the works, as in addition to the stone and ballast, large quantities of cement, steam coal, steel etc., had to be carried.

The analysis of rates for collection of materials is given as Appendix II.

As the hire charges on trucks forms a considerable proportion of the cost of collection of materials, the movement of trucks had to be very carefully controlled. No unnecessary time was allowed either at the quarry or at Khanki during unloading. The prompt handling of traffic and elimination of delays *en route* were the essence of economical working. A regular time table was arranged with the N. W. R. In this way very large economies were possible in the rates of collection.

After the first season's work, the N. W. R. dropped a bombshell in the form of a surcharge of Rs. 53,000. Part of the ballast brought from Jammu was not hand-broken but natural round shingle. The N. W. R. contended that according to the terms of agreement with the Irrigation Department, the shingle was not covered by the concession rate and had, therefore, to be charged at the public rate which is approximately

eleven times the concession rate. After prolonged negotiation the N. W. R. agreed to waive this surcharge of Rs. 53,000 and have further agreed that in future shingle and ballast above ¼" gauge shall be carried at concession rates.

Analysis of Rates.—Appendix III gives the analysis of rates for various items of works such as concrete, masonry etc.

Appendix IV gives the rates for steel work of gates and gearing.

Magnitude of work.—In the design and execution of this work are embodied the latest ideas in headworks construction. The work was one of great complexity, dealing as it did not with the construction of a new weir, but with the rejuvenation of an old one.

Use had to be made, on grounds of economy, of whatever was reasonably sound in the old work and the linking of the new to the old work involved some risk of undermining of the latter. However, with careful planning and supervision this risk was effectively avoided and a sound work secured.

This work of reconstruction costing Rs. 38 lakhs was completed in two working seasons of six months each. The quantities executed are 34,400,000 cubic feet of earthwork, 1,800,000 cubic feet of dismantling, 900,000 cubic feet of stone masonry, 330,000 cubic feet of brick masonry, 2,000,000 cubic feet of cement concrete, 4,600,000 cubic feet of stone filling and 240,000 square feet of interlocked steel sheet piling.

Among other materials used were 350,000 of cement bags, 3,500 tons of steel sheet-piling, 750 tons of reinforcing steel and 935 tons of structural steel for gates.

The entire plant and machinery used on this work was old and no new plant was purchased, thus resulting in large economies.

The programme of construction was complicated owing to the necessity for maintaining an uninterrupted supply in the canal while work was in progress. The upstream river level had in consequence to be maintained at least 10 feet above that necessary for an entirely new construction, and there was also the necessity for keeping the entire weir operative during the flood season. The work had, therefore, to be organised afresh each season and the working area enclosed by new ring-bunds.

During the first season, the appearance of troublesome springs from below the clay substratum in Bay 4 threatened to retard the completion of that season's programme and during the second season the weather was most unfavourable due to many winter freshets and frequent,

unusually heavy and prolonged local rainfall. At times transport was dislocated over prolonged periods and the pumping was unusually heavy.

This work, comprising the reconstruction of 3000 feet of an old weir, the construction of 900 feet of depressed and gated undersluices, three divide walls, a fish ladder, 2000 feet of guide banks with depressed aprons and 1400 feet of silt ejector tunnels, in addition to the entire or partial dismantling of over 4000 feet of the old weir, was an undertaking of considerable complexity and magnitude.

Acknowledgments are due to the late Mr. H. W. Nicholson, C.I.E., who was the originator of the scheme and who saw it to completion as Superintending Engineer and later as Chief Engineer; to Mr. W. G. Dench, I.S.E., Superintending Engineer, (1934 hot weather) and Mr. C. E. Jefferies, I.S.E., Superintending Engineer (working season 1934-35).

The author's thanks are due to the three Sub-Divisional Officers on this work. S. S. Bhai Raghbir Singh (now Sardar Bahadur) did the construction of the weir bays and undersluices except (Bay 8 or) the right undersluices which were completed by Mr. C. L. Handa, I.S.E., who also ably handled the materials and transport throughout the two working seasons. Mr. S. M. Said was in charge of all the Electrical and Mechanical plant which he ran without a breakdown.

Thanks of the author are also due to the officers of the Central Workshops, Messrs. Wheatley and Benson and their assistant Mr. Connolly, for their most valuable cooperation in fabricating and erecting the steel work in good time for each year's floods.

APPENDIX II.

(Rates for manufacture and collection of Materials.)

No.	Name of article with quantity collected.	N.W.R. Freight.	Hire charges of trucks.	Petty charges.	Canal railway freight from Mansurwali to Khanki.	Unloading & stacking.	Cost of collection F.O.R. Quarry.	Cost of Collection at Khanki.	Issue rate.
		Rs. a.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a.	Rs. a.	Rs. a. p.	Rs. a. p.
1	Special Building stone 95,895 cft.	1500	(c) 3120	1115	..	..	12839	18039	19 12%
	Rate .. % cft.	1 11	3 6	1 5	..	..	13 6	19 12	..
2	Ordinary Building stone 10,25,697 cft.	32344	279160	4043	3386	7063	78799	154985	15 4%
	Rate .. % cft.	3 2(a)	2 12 6	0 8 3	0 5 3	0 13	7 11	15 11	..
3	Jammu Ballast 12,11,119 cft.	22745	29914	4603	4957	12022	109049	184671	15 5 6%
	Rate .. % cft.	1 13(b)	2 6	0 8 6	0 6 0	1 3	9 2	15 5 6	
4	Steel 9,358 mds. ..	..	..	..	..	..	63679	63679	6 13 md. or 8 12 per cwt.
	Rate		..	..	..	..	6 13 Md.	6 13 Md.	

No.	Machine crushed ballast ..	Spawl from Baganwala & Jammu.	Contractor's labour.	Engine charges.					
		Rs. a.	Rs. a. p.	Rs. a. p.				Rs. a. p.	Rs. a. p.
5	1,07,423 cft. ..	27996	6086	7564	..	..	..	41641	17 9 0%
	Rate .. % cft.	12 8	2 8 0	7 0 0	..	..	..	17 9 0	
6	Electricity	..	..	..	Total current generated =2,66,460 units.			29,770	0 1 9 per unit.

(a) U. J. C. & L. B. D. C. rakes were mostly used.

(b) S.V.C. rakes were mostly used.

(c) Includes canal railway freight and unloading and stacking.

APPENDIX I.

Particulars.	*Universal.* Upstream piles. Bays 1, 2, 5, & 6.	*Ransome.* Downstream piles. Bays 1, 2, 3, 5, 6, & 7.	Bay No. 4.	Bay No. 8.	Total.	Rate per ft.
1. No. of piles driven	1,575	2,946	2,031	1,980	8,532	
2. Total length of piles driven ..	46,314 ft.	41,341.5 ft.	* 51,178 ft.	* 30,131.5 ft.	149,265 ft.	
3. Do. area of do. ..	or 57,892.5 sft.	or 47,956 sft.	or 37,595 sft.	or 35,961 sft.	1,79,394.5*sft.	
4. No. of working shifts of 9 nours ..	215	138	271	154	778	
5. Average progress per shift ..	268.1 sft.	354.2 sft.	138.7	234.7	231 (average)	
6. *Departmental Labour.*—	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1. Carriage and erection ..	1,074 2 0	1,162 3 0	460 0 0	977 6 0	3,673 11 0	0 0 6
2. Mechanical Staff	2,558 1 0	1,179 8 0	3,045 8 0	1,906 5 0	8,689 6 0	0 0 9
3. Running repairs	2,121 8 0	1,071 2 0	1,375 0 0	1,777 0 0	6,344 10 0	0 0 7
4. Dismantling and carriage ..	612 0 0	631 8 0	339 4 0	566 12 0	2,149 8 0	0 0 2
7. *Payment to Contractors.*—						
1. Driving piles	3,616 15 0	1,950 3 0	1,810 2 0	1,569 6 0	8,946 10 0	0 0 10
2. Lifting and lowering machines	68 0 0	288 0 0	492 0 0	196 0 0	1,344 0 0	0 0 1.5
3. Turning machine and track ..	144 0 0	255 0 0	457 0 0	762 0 0	1,618 0 0	0 0 2
4. Carriage of piles	1,639 0 0	1,960 6 0	363 0 0	1,201 0 0	4,263 6 0	0 0 5
5. Incidental charges ..	1,683 8 0	954 4 0	1,313, 0 0	702 0 0	4,652 12 0	0 0 5
Total labour ..	13,517 2 0	8552 2 0	9,654 14 0	9,957 13 0	41,681 15 0	
Rate for labour ..	0 3 9	0 2 10	0 4 1	0 4 5		0 3 9
Rate for material per sft.						0 3 0
			Total Rate for Driving per square foot ..			0 6 9

*Piles driven under Crest Bays 4, 8, 3, and 7 not included in above analysis.

Note. 1.—The variation in over-all rates are due to the following factors :—

(*a*) Cost of erecting the machine. On some works the machine had to be carried into the work and erected, and on others, machines already erected on an adjoining work were used.

(*b*) Daily progress. This was affected by the nature of the substrata of soil and also by the plan of piling. The greater progress with the same staff was possible on a straight line than on one having several corners and also varying top levels.

(*c*) Number of junction, correction and T Piles used.

(*d*) Cost of dismantling and carriage. On certain works these charges were small as the machine went on to the next adjoining job undismantled.

2. The piling at Khanki during the last two seasons has been of three kinds.

1. Upstream piling, 30 feet piles in a straight line with very few corners but driven through clay and stone.

Bays 1, 2, 5 and 6 upstream come under this category.

2. Downstream piling 15 ft. or under, piles in a straight line.

Bays 1, 2, 3, 5, 6 & 7 downstream.

3. Complicated piling of gated Bays 4 and 8.

APPENDIX III.

STATEMENT OF RATES

I.—Materials (at Khanki).

		Unit.	Rate. Rs. a. p.
1.	Pacca bricks (at kiln) ..	‰ No.	9 12 0
2.	Brick ballast	% cft.	6 12 0
3.	Cement	Bag.	2 6 0
4.	Sand (clean, river)	% cft.	1 0 0
5.	Stone ballast or shingle (mostly from Jammu).	% cft.	15 6 0
6.	Machine crushed ballast	% cft.	17 9 0
7.	Ordinary building stone (Baganwala) ..	% cft.	15 4 0
8.	Pitching stone	% cft.	15 0 0
9.	Spawls (Jammu)	% cft.	12 10 0
10.	Kankar, screened, including 8 miles carriage.	% cft.	11 4 0
11.	Steam Coal	Ton.	18 0 0
12.	Fuel oil	Gall.	0 6 0
13.	Reinforcing steel	Cwt.	8 12 0
14.	Steel sheet piles	Ton.	203 0 0
15.	Steel sheet piles Ransome D at 26·25 lbs. sq. ft. interlocked.	s. ft.	2 6 0
	Steel sheet piles Universal at 43 lbs. per sq. ft. interlocked. ..	s. ft.	3 14 3
16.	Pressure point (3″ × 1½″ strainer)	No.	2 12 0
	1½″ piping (I. S. D. new supply) ..	Rft.	0 6 0
17.	W. I. pipe 4″ dia.	Rft.	0 10 0
18.	Electricity 1933-34/1934-35	per unit	0 1 9
19.	Cement mortar 1 : 3	% cft.	66 2 0

II.—Rates for Labour.

1.	Dismantling R. C. pile cap	% cft.	20 0 0
2.	,, crest skin and cement concrete	% cft.	10 0 0
3.	,, floor masonry in lime mortar	% cft.	5 0 0
4.	,, loose stone in aprons ..	% cft.	1 8 0

		Unit	Rate Rs. a. p.
5.	Precast R. C. work (machine mixed) ..	% cft.	15 0 0
6.	Well sinking	% cft.	125 0 0

Other rates were standard schedule rates, or less

III.—Inclusive Rates for Works.

		Unit	Rate Rs. a. p.
1.	Stone filling (including 5 chains lead) .	% cft.	16 12 0
2.	Stone pitching with loose bajri filling for slopes (including 10 chain lead).	% cft.	23 2 0
3.	Stone pitching set in *kankar* for filters ..	% cft.	23 7 0
4.	Stone filling sand or puddle grouted ..	% cft.	18 8 0
5.	Brick ballast laid on slopes	% cft.	8 6 0
6.	Brick work in 1 : 3 mortar ..	% cft.	40 11 0
7.	Stone masonry 1 : 3 facing ; 1 : 4 hearting	% cft.	52 4 0
8.	Cement concrete machine mixed 1 : 3 : 6	% cft.	56 13 0
	1 : 4 : 8	% cft.	50 8 0
9.	Reinforced concrete 1 : 2 : 4 (of this 8% was precast work).	% cft.	75 12 0
10.	Reinforcement, bent and laid at site	Cwt.	11 4 0
11.	Interlocked steel sheet piles Ransome D. type, driven	sft.	2 12 0
12.	Universal piles, driven	sft.	4 6 0
13.	Pressure pipes (each complete with strainer).	No.	52 0 0
14.	Railing of cast iron standards and G. I. pipes.	Rft.	1 12 0

APPENDIX IV.

STEEL WORK.

		Tons.	Cost. Rs.
1.	Left undersluices new 17 feet gates 12 No., gates 20 feet spans.	105	62,665
2.	Central undersluices (Bay 4) 18 spans, gates 18 feet high, including superstructure and all built in parts and remodelling of the 18 sets of gearing made available from the regulators.	440	228,240
3.	Right undersluices 18 spans gates 18 feet high, including superstructure gearing, built in parts and remodelling of the counter-balance boxes made available from the regulators.	495	2,71,113
	Total ..	1040	5,62,018

The entire steel work was manufactured and erected by the Central Workshops except the grooves, and cill girders which were erected by the Khanki staff.

APPENDIX V.

Statement of Capital expenditure of Reconstruction of Khanki Weir.

Name of estimates.	Expenditure.
	Rs.
(A) *General.*	
1. Incidental estimates	1,27,831
2. Ring Bund and Excavation, 1933-34	80,893
3. Do. do. 1934-35	53,517
Total	1,34,410
4. Pumping Khanki Weir, 1933-34	96,280
5. Do. do. 1934-35	1,34,031
Total ..	2,30,311
(B) *Purchase of Piles.*	
6. Purchase of Piles (Universal) for Bays 1, 2, 5 & 6 ..	2,86,022
7. Cost of piles used on piling Bays 3, 4 & 7, 8 U/S ..	1,69,403
8. Obtaining 30′ Ransome D Type Piles	2,34,966
9. Universal Piles for use in Bay No. 8	32,717
Total ..	7,23,108
(C) *Left Pocket.*	
10. Construction of Silt Ejector (Khanki Regulator)	59,266
11. Strengthening and extending floor in front of Subsidiary Regulator.	24,012
Total ..	83,278

(D) *Weir.*

	Rs.
12. Sheet piling part of Bay No. 1	8,211
13. Reconstructing and strengthening Bays 1 and 2 U/S	79,468
14. Driving piles in Weir Bays 3 and 4 upstream ..	35,291
15. Reconstructing and Strengthening Bays 5 & 6 U/S	77,815
16. Driving piles in Bays 7 and 8 upstream	61,838
17. Reconstructing and strengthening Bays 1 and 2 D/S	1,52,950
18. Reconstructing and strengthening Bay No. 3 D/S ..	49,733
19. Reconstructing and Strengthening 5, 6 and 7 D/S ..	2,77,246
Total ..	7,42,552

(E) *Bays 4 and 8.*

20. Depressing and gating Bay No. 4	7,82,672
21. Do. do. No. 8	7,44,318
Total ..	15,26,990

(F) *Steel work (Gates and Gearing).*

22. New 17 feet gates for Khanki Undersluices ..	62,665
23. Manufacture and erection of steel gates and gearing Bay No. 4 Khanki Weir	2,28,240
24. Manufacture and erection of steel gates and gearing Bay No. 8.	2,71,113
Total ..	5,62,018

Note.—18 sets of lifting gears set free from the remodelling of regulators were used in Bay No. 4 and the 16 counter-balances used in Bay No. 8. These do not form part of the expenditure.

APPENDIX VI.

TRANSPORT OF MATERIALS ON THE NORTH WESTERN RAILWAY.

S. V. C. Rakes.

49 trucks—carrying capacity 23,000 cft. of Baganwala Stone or Ballast and Jammu ballast and 21,500 cft. of Rohri stone and ballast.

L. B. D. C. and U. J. C. rakes.

49 trucks—carrying capacity 17,000 cft.

S. V. C. trucks (type C).

Inside dimensions	..	26′—9′.
Over all length between buffers	..	29′—10″.
Tare	..	11 ton 4 cwt. 1 qr.
Net load	..	20 ton 15 Cwt. 0 qr.
Gross weight	..	31 ton 19 Cwt. 1 qr.

The length of relief sidings on the N. W. R. Section for the Baganwala and Jammu quarries permits of 49 trucks and one brake van. For the Rohri quarry the relief sidings can accommodate 60 trucks and one Brake Van. For train loads of 49 trucks and one Brake Van, the haulage rates are Rs. 6-4 per train mile for the return journey and for 60 trucks and one brake van they are Rs. 7-8 per train mile for the return journey. Prior to June 1933 these rates were Rs, 6-4 and Rs. 9 respectively.

It should be noted that the U. J. C. and L. B. D. C. rakes are uneconomical in running as the N. W. R. will not take more that 49 trucks on the Baganwala or Jammu sections irrespective of the fact whether they are S. V. C. or any other type. The S. V. C. rakes carry 23000 c.ft. for the same cost as the L. B. D. C. and U. J. C. rakes will carry 17000 c.ft. of materials.

Haulage of Irrigation Branch Vehicles.—The following are the rates for the haulage of vehicles (loaded with pitching stone, boulders, *kunkar* unburnt limestone and stone ballast) belonging to the Irrigation Branch, (with effect from 1st June, 1933.)

		Rs.	a.	p.
(*i*)	Individual vehicles hauled by ordinary train.—			
(*a*)	Loaded journey. Per 4 wheeled vehicle per mile	0	3	6
(*b*)	Empty journey. Per 4 wheeled vehicle per mile	0	1	0

(*ii*) Rakes carried in train loads.—

		Rs.	a.	p.
(*a*)	Loaded journey.—			
	(*i*) Trains composed of a maximum gross tonnage of 1,576 tons inclusive of brake vans. Per train mile ..	3	12	0
	(*ii*) Trains composed of a maximum gross tonnage of over 1,576 tons and upto 1900 tons, inclusive of brake vans. Per train mile ..	4	8	0
(*b*)	Empty journey.—			
	(*i*) In the case of item (*a*) (*i*) above. Per train mile ..	2	8	0
	(*ii*) In case of item (*a*) (*ii*) above. Per train mile ..	3	0	0

2. The above quoted gross tonnages refer to section of the line where gradients do not exceed 1/200. Where this is exceeded, the load of trains will vary and the charges for the haulage of such trains will be decided on reference to the Agent, N. W. R., Lahore.

Note 1. The gross load of vebicle is the tare weight plus the marked carrying capacity.

2. N. W. R. vehicles given on hire to the Irrigation Branch are considered as Irrigation Branch vehicles till returned to the railway.

3. These rates apply only when the vehicles loaded with pitching stone, boulders, *kankar*, unburnt limestone and stone ballast are consigned to a responsible official of the Public Works Department. If the vehicles are loaded with other commodities (such as lime permanent way materials, machinery, etc.) or are consigned to private individuals the ordinary tariff rates apply.

4. On certain sections of the line heavy engines cannot be used. Therefore, the loads of stone trains to pass over such sections are arranged to accord with those that can be worked through from the starting to the destination stations.

5. The gross tonnage of a special train must not be allowed to exceed 1,900 tons under any circumstances.

6. These rates for empty journeys apply independently of the charges for the loaded journeys. When however, newly constructed or acquired stock is transferred from one station to another the rate chargeable is Rs. 0-3-6 per 4 wheeled vehicle per mile.

Copy of a letter No. 1807-R-756 dated 17th July 1934 from Lt. Col. W. Macrae, R.E., Agent, North Western Railway, Lahore, to the Secretary to Government Punjab, Public Works Department, Irrigation Branch, Lahore.

Concession rates for carriage of stone ballast etc., in Irrigation Branch and Buildings and Roads Branch vehicles.

Reference correspondence ending with your endorsement No. 10438-Con., dated 30th October, 1933.

I have the honour to state that this Administration has decided that the concession rates for the carriage of pitching stone, boulders, *kanker*, unburnt limestone and stone ballast in Irrigation Branch and Buildings and Roads Branch Vehicles also apply to shingle which cannot pass through a screen of $\frac{1}{4}$" meshes.

2 This will have retrospective effect from 14th September, 1933.

3. I shall be glad if you will please arrange to advise those concerned in your Department in this matter.

APPENDIX VII.

DISCHARGING CAPACITY OF RECONSTRUCTED WEIR.

H. F. L. R. L. 738.0 Upstream.
R. L. 735.0 Downstream.

Afflux =3 feet.

A standing wave forms in a maximum flood.

Underslucies Right, Central, Left } crest at R. L. 715.

Weir Bays crest at R. L. 727

(Bays 1 and 2 have crest at 726.5 but this is ignored in calculations.)

Discharge per foot run through undersluices.

$$q=3.1\ (h+ha)^{\frac{3}{2}}$$

h=738—715 = 23 feet
ha= = 2 feet
} =25 feet.

$=3.1\times25^{\frac{3}{2}}$ =387 cusecs.

Discharge per foot of Weir

$$q=3.1\ (h+ha)^{\frac{3}{2}}$$

h=738-727=11 feet
ha= 2 feet
} =13 feet

$=3.1\times13^{\frac{3}{2}}$ =145 cusecs.

Discharge capacity of Right Undersluices
=18×20×387 =1,39,320

Discharge capacity of Central Undersluices
=18×20×387 =1,39,320

Discharge Capacity left Undersluices
=12×20×387 = 92,880

Total 3,71,520

Discharge capacity 6 Weir bays
=2969×145 = 4,30,505

Total 8,02,025

Say 8,00,000 Cusecs.

Discharging Capacity per foot run of some Weirs.

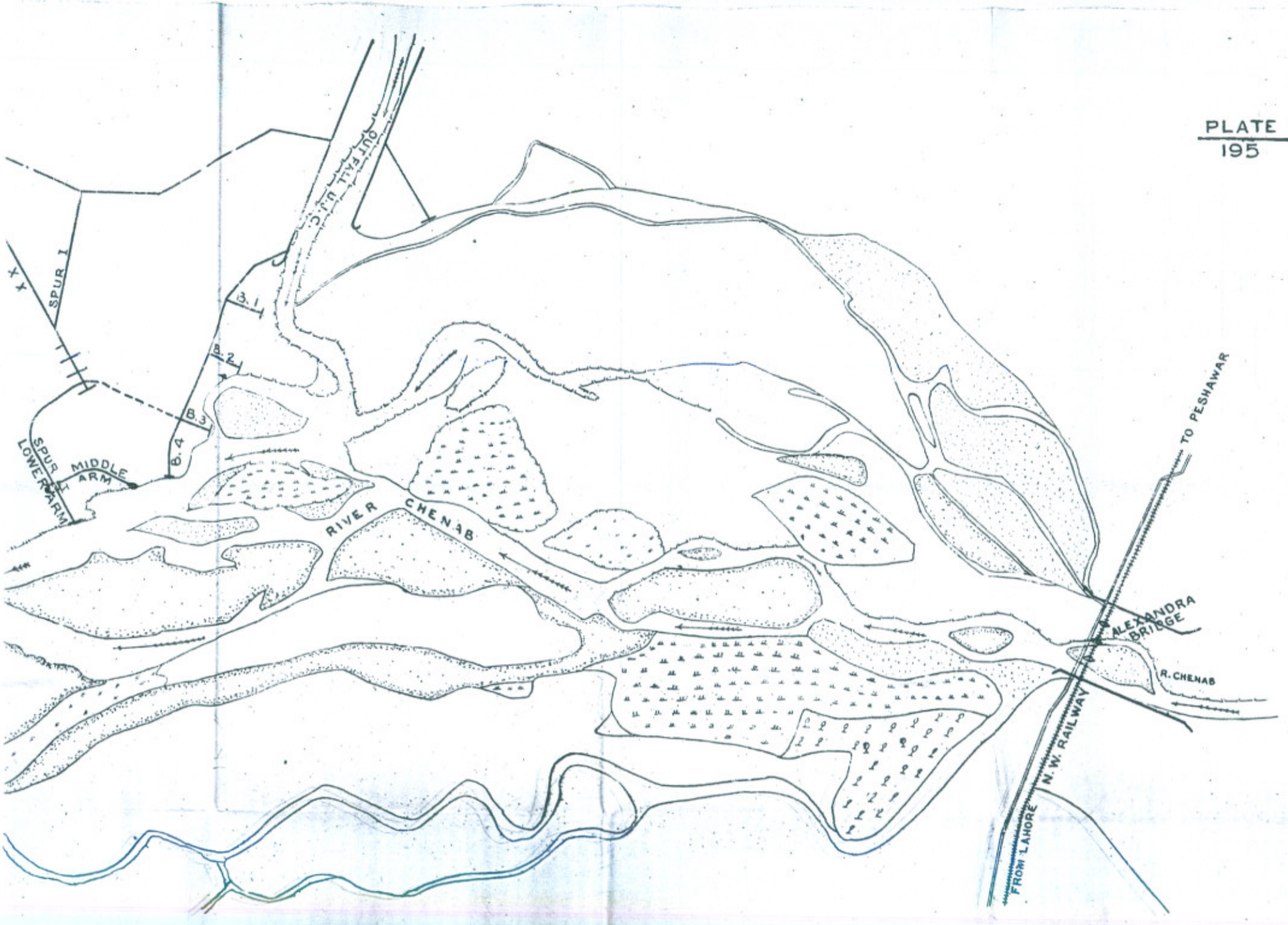
	Weir.	Undersluices.
Marala	160	357
Khanki	145	387
Ferozepore	258	..
Sulemanki	145	240
Islam	208	342
Panjnad	248	..

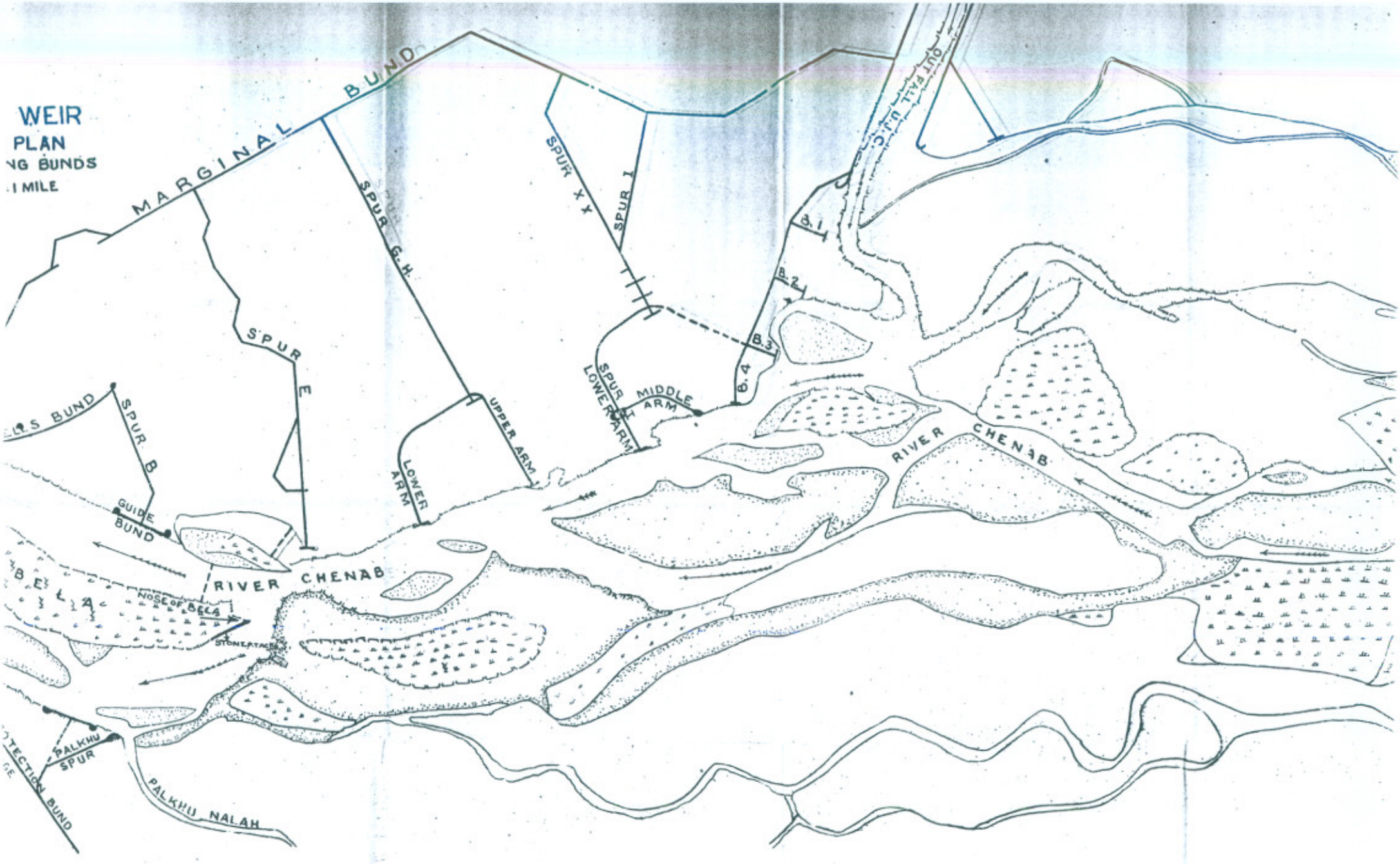
APPENDIX VIII.

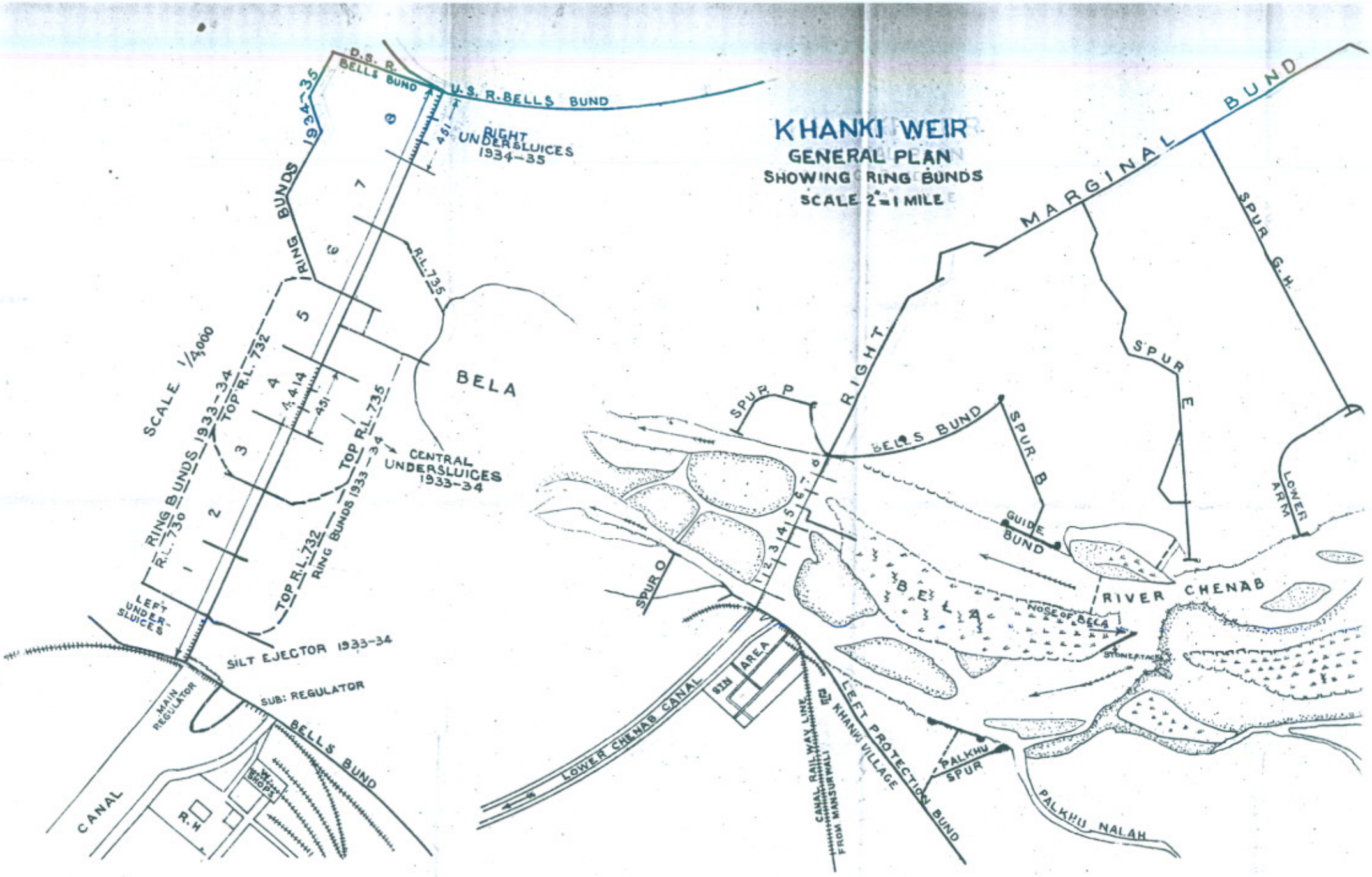
Statement of Quantities.

Nature of work.	Khanki re-construction.	Suleimanki including regulators and guide Banks.	Panjnad including regulators and guide Banks.
1. Earthwork cft. ..	3,44,00,000	(a) 2,45,00,000	(a) 4,41,00,000
2. Dismantling cft. ..	48,00,000	..	..
3. Steel Sheet Piling			
Area sft. ..	2,40,000	93,000	2,56,000
Weight tons ..	3,900	1,100	3,200
4. Stone pitching and filling cft.	46,00,000	31,00,000	56,00,000
5. Cement concrete cft. ..	20,00,000	(b) 33,00,000	33,00,000
6. Stone masonry cft. ..	9,00,000	12,00,000	10,00,000
7. Brick masonry cft. ..	3,30,000	1,70,000	6,50,300
8. Steel work of Gates and Gearing tons ..	1040		4,000

PLATE I
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OUTFALL U.J.C.
X
X
SPUR I
B.1
B.2
B.3
B.4
SPUR II
LOWER ARM
MIDDLE ARM
RIVER CHENAB
TO PESHAWAR
ALEXANDRA BRIDGE
R. CHENAB
FROM LAHORE
N.W. RAILWAY


WEIR
PLAN
NG BUNDS
I MILE
MARGINAL BUND
SPUR G.H
SPUR X X
SPUR I
OUT FALL U.J.C.
B.1
B.2
B.3
B.4
SPUR E
SPUR B
GUIDE BUND
LOWER ARM
UPPER ARM
SPUR I
LOWER ARM
MIDDLE ARM
RIVER CHENAB
NOSE OF BELA
STONE PITCHING
PALKHU SPUR
PALKHU NALAH

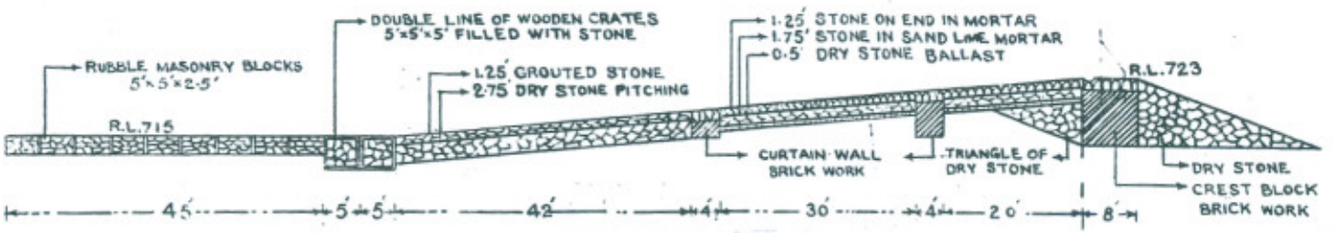

KHANKI WEIR
GENERAL PLAN
SHOWING RING BUNDS
SCALE 2"=1 MILE
SCALE 1/4,000
D.S. R. BELLS BUND
U.S. R. BELLS BUND
RIGHT UNDERSLUICES 1934-35
451
RING BUNDS 1934-35
RING BUNDS 1933-34
TOP R.L. 732
TOP R.L. 735
R.L. 735
414
451
CENTRAL UNDERSLUICES 1933-34
RING BUNDS 1933-34
R.L. 730
TOP R.L. 732
RING BUNDS 1933-34
LEFT UNDER SLUICES
SILT EJECTOR 1933-34
SUB: REGULATOR
MAIN REGULATOR
BELLS BUND
CANAL
W. STOPS
R.H.
BELA
MARGINAL BUND
SPUR G.H.
SPUR E
LOWER ARM
SPUR P
RIGHT
BELLS BUND
SPUR B
GUIDE BUND
SPUR O
RIVER CHENAB
NOSE OF BELA
STONE PITCHING
LOWER CHENAB CANAL
SIN AREA
CANAL RAIL-WAY LINE FROM MANSURWALI
KHANKI VILLAGE
LEFT PROTECTION BUND
PALKHU SPUR
PALKHU NALAH

SECTIONS OF KHANKI WEIR

AS CONSTRUCTED IN 1892

SCALE 1/250

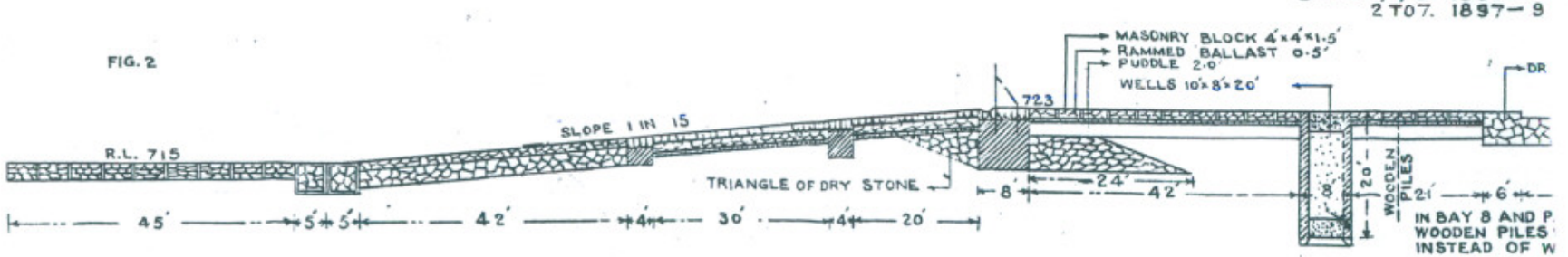
FIG. 1



UPSTREAM PORTION

BAYS 1, 7, 8. 1896–9
2 TO 7. 1897–9

FIG. 2



IN BAY 8 AND P.
WOODEN PILES
INSTEAD OF W

OSE STONE PROTECTION ADDED

BAYS 2, 3, 5 AND 7 IN 1907–08
BAYS 6 AND 8 IN 1909–10
BAY 1 IN 1910–11
BAY 4 IN 1917–18

CROSS SECTION OF WEIR BEFORE RECONSTRUCTION

CREST RAISED FROM 723 TO 725 IN 1910–11 AND 1916–18
FROM 725 TO 727 IN 1920–22

FIG. 3

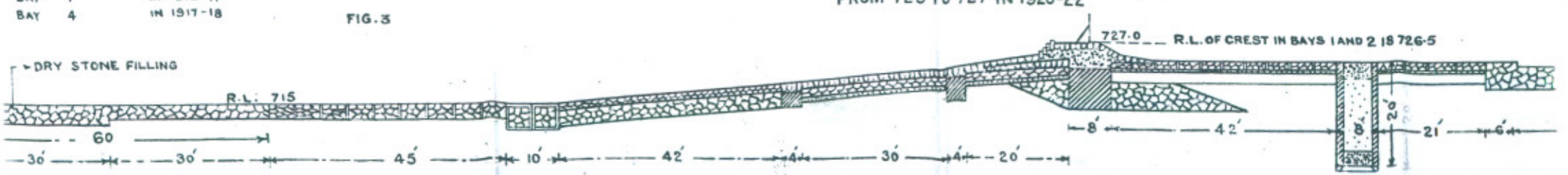


PLATE III

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FIG: 4

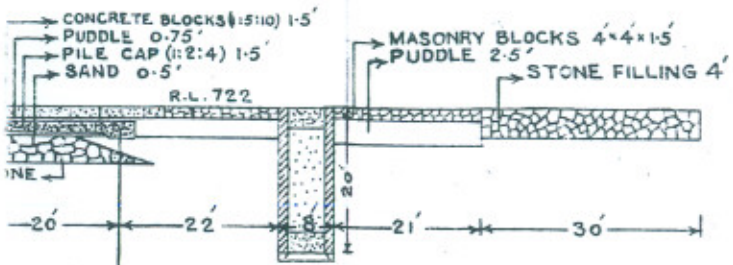


FIG: 5

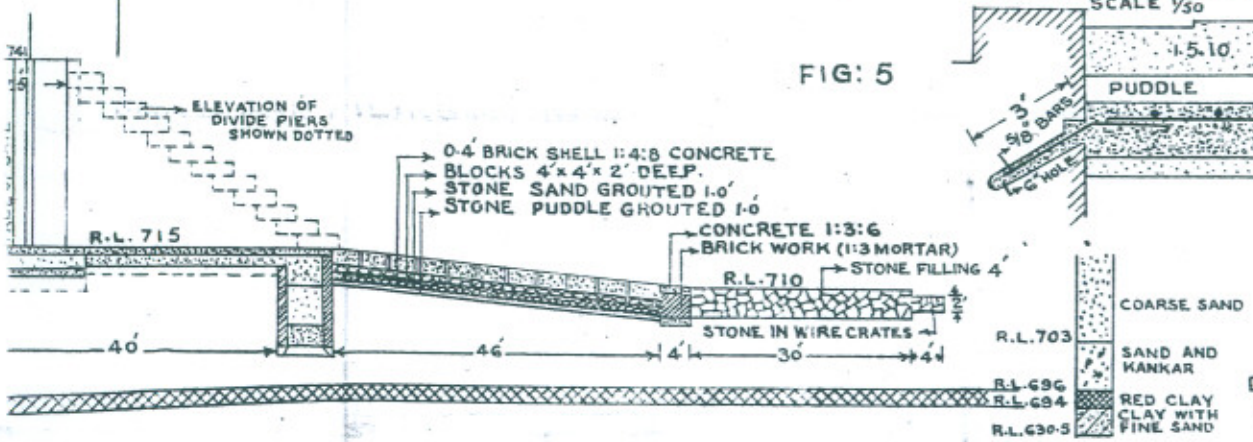
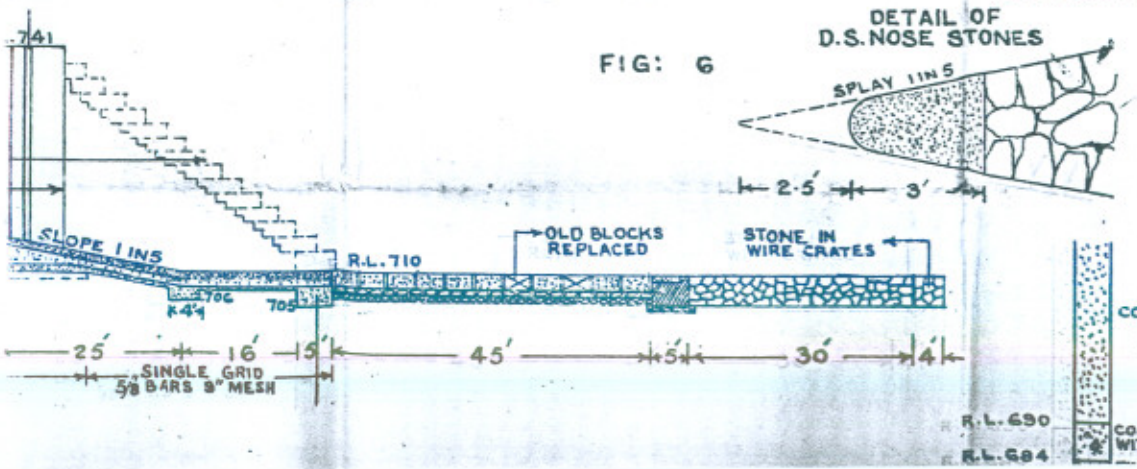
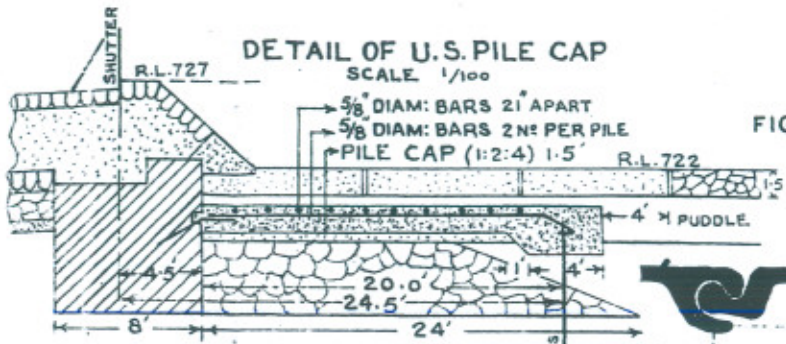


FIG: 6



DETAIL OF U.S. PILE CAP

SCALE 1/100



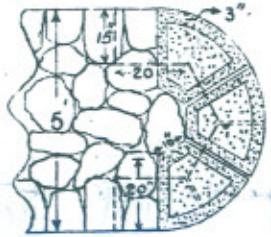
JUNCTION OF PILE CAP WITH CREST BLOCK

SCALE 1/50

DETAIL OF D.S. NOSE STONES

DETAIL OF PRECAST U.S. NOSE BLOCKS

SCALE 1/40



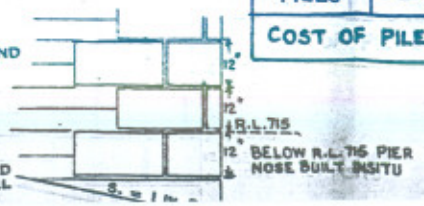


FIG: 8

RANSOME TYPE "D" PILING UNIFORM SECTION

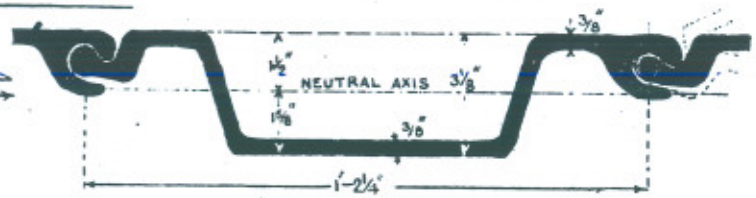
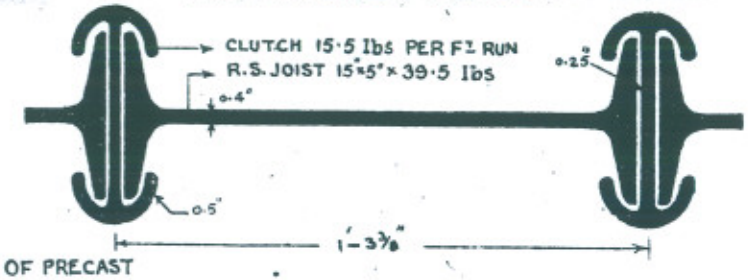


FIG: 9

UNIVERSAL PILING



COMPARATIVE STATEMENT OF PILES

PILES	WEIGHT PER Ft RUN lbs	WEIGHT PER SQ. FT: INTER LOCKED lbs	WIDTH COVERED BY EACH PILE ins	SECTION MODULUS IN^3
RANSOME PILES	31	26.25	14 1/4"	7.32
UNIVERSAL PILES	55	43	15 3/8"	8.3

COST OF PILES F.O.R. MANSUR WALI = Rs 203/TON

WEIR BAYS 1,2,3 AND 5,6,7
AS RE-CONSTRUCTED 1933-35.
SCALE 1/250

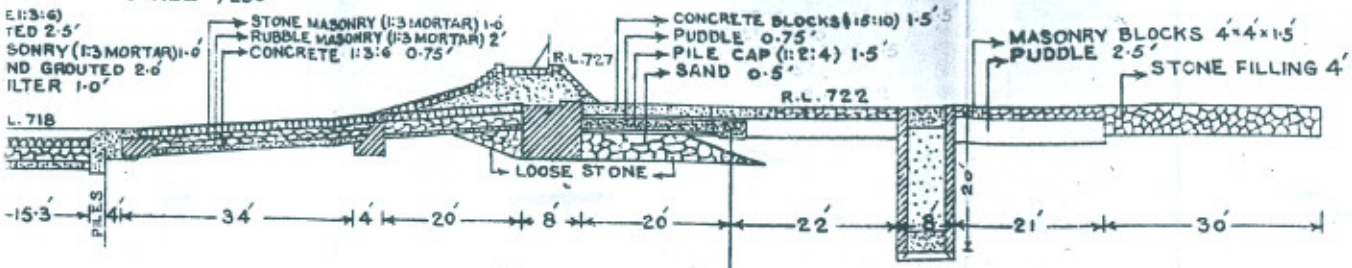
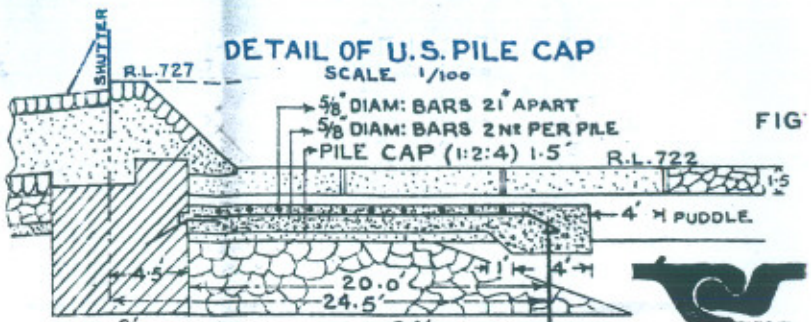


FIG: 4

DETAIL OF U.S. PILE CAP
SCALE 1/100



FIG

JUNCTION OF PILE CAP WITH CREST BLOCK
SCALE 1/50

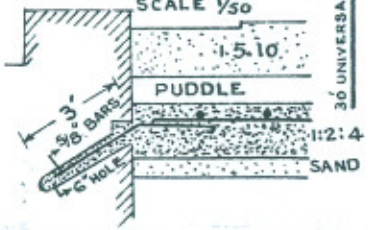


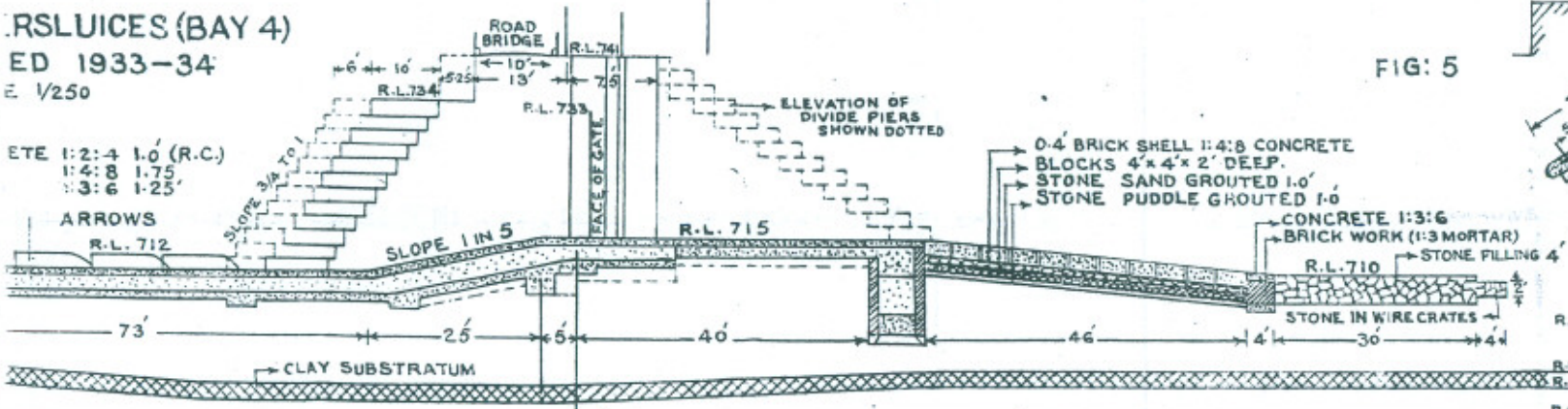
FIG: 5

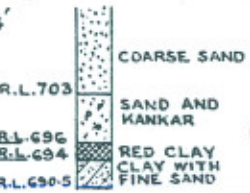
FIG: 9.



DETAIL OF PRECAST U.S. NOSE BLOCKS
SCALE 1/40

ERSLUICES (BAY 4)
ED 1933-34
E 1/250





GHT UNDERSLUICES (BAY 8)
CONSTRUCTED 1934-35
SCALE 1/250

FIG: 3

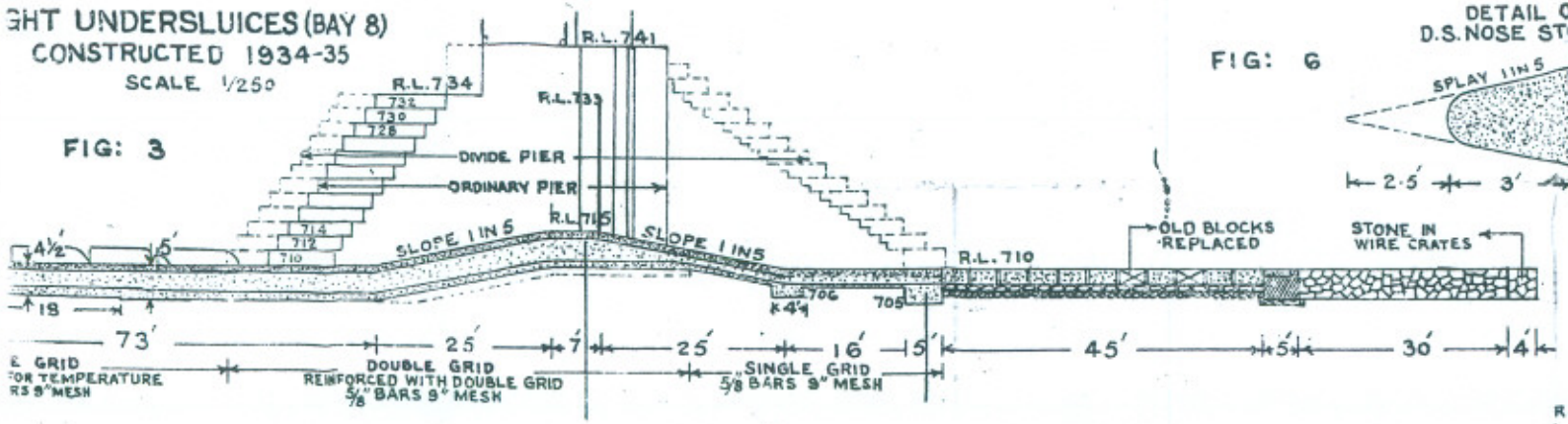
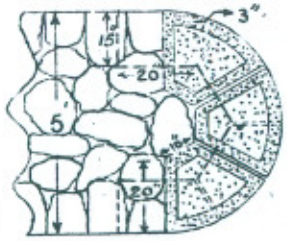
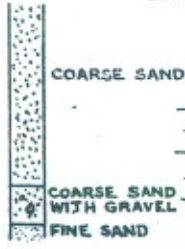


FIG: 6

DETAIL OF D.S. NOSE STONES





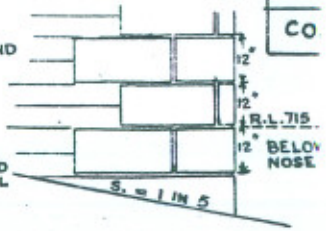
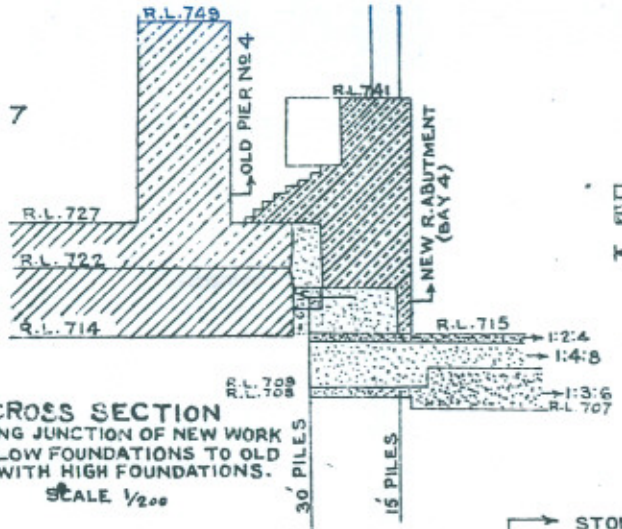
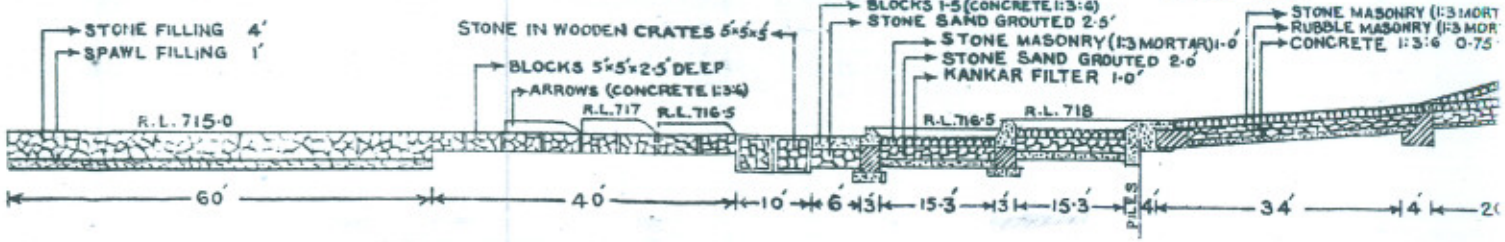


FIG: 7



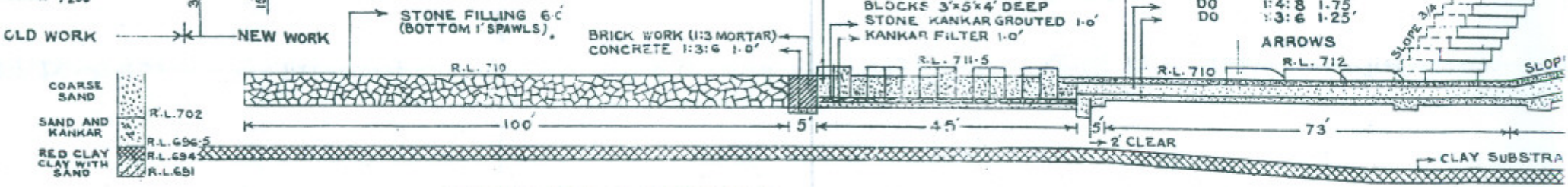
CROSS SECTION
SHOWING JUNCTION OF NEW WORK WITH LOW FOUNDATIONS TO OLD WORK WITH HIGH FOUNDATIONS.
SCALE 1/200

FIG: 1



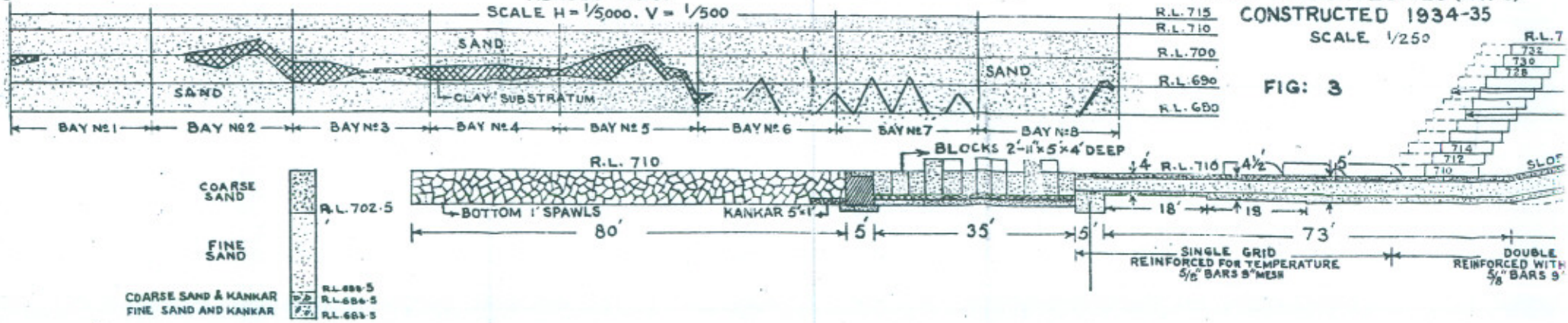
WEIR BAYS 1,2,3 AND 5,6,7
AS RE-CONSTRUCTED 1933-35.
SCALE 1/250

FIG: 2



CENTRAL UNDERSLUICES (BAY 4)
CONSTRUCTED 1933-34
SCALE 1/250

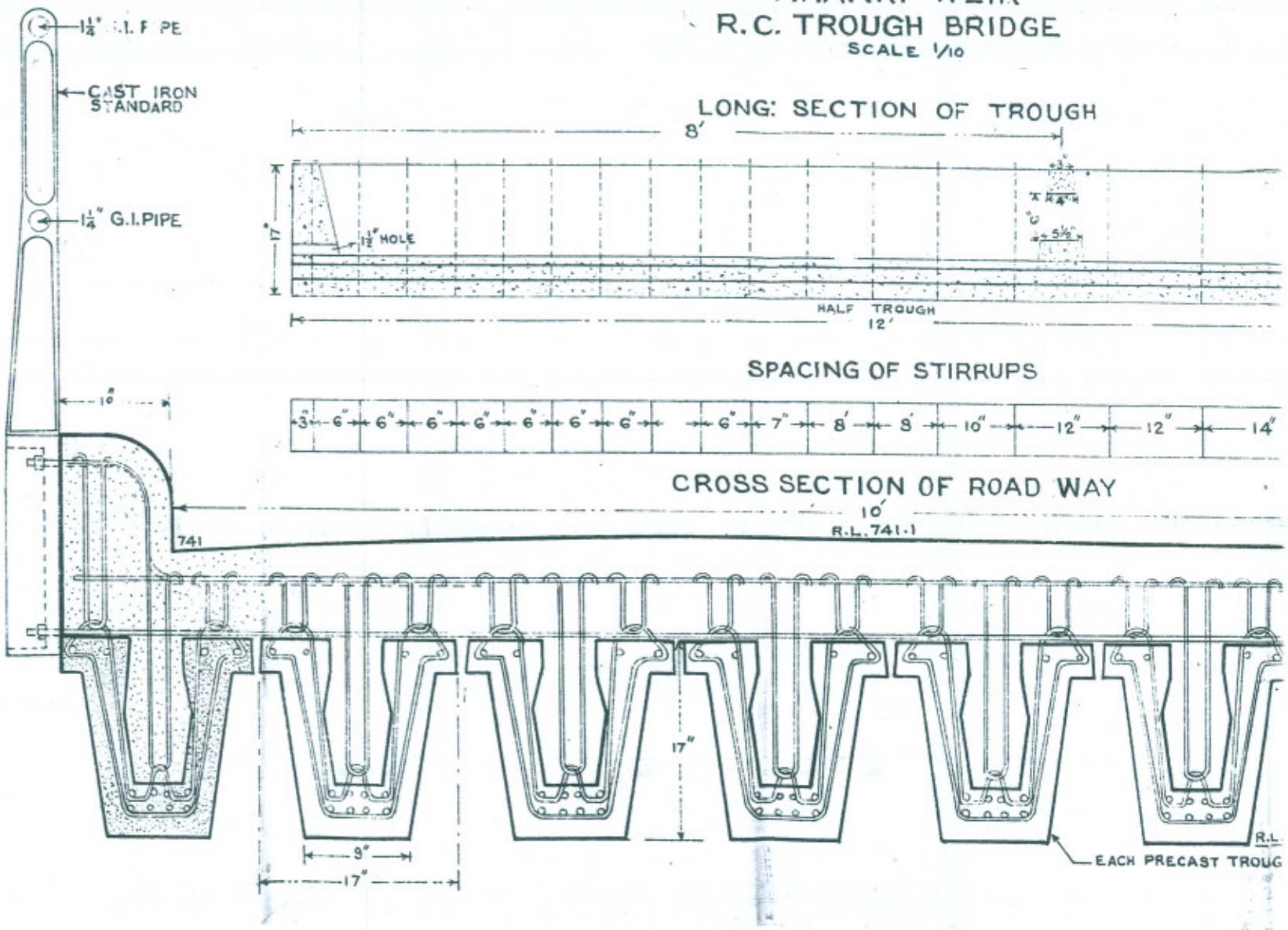
FIG: 10



RIGHT UNDERSLUICES (BAY 8)
CONSTRUCTED 1934-35
SCALE 1/250

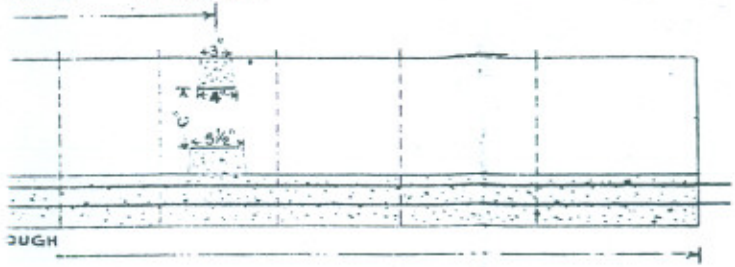
FIG: 3

KHANKI WEIR
R.C. TROUGH BRIDGE
SCALE 1/10

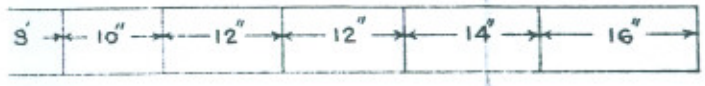


I WEIR
H BRIDGE
E 1/10

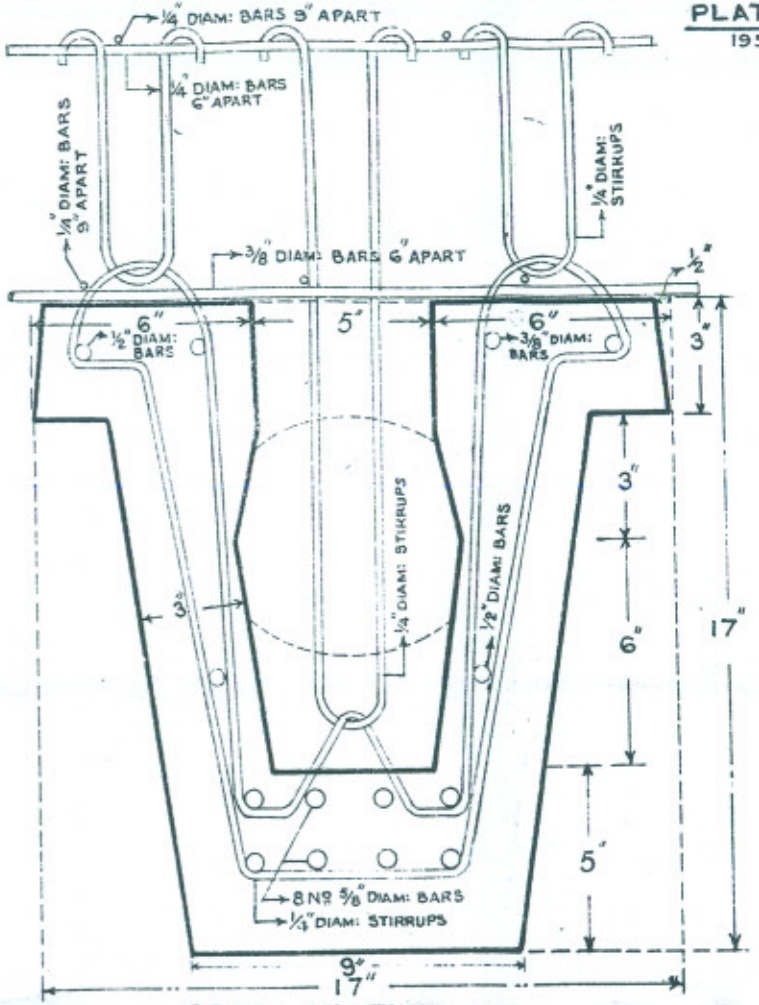
N OF TROUGH



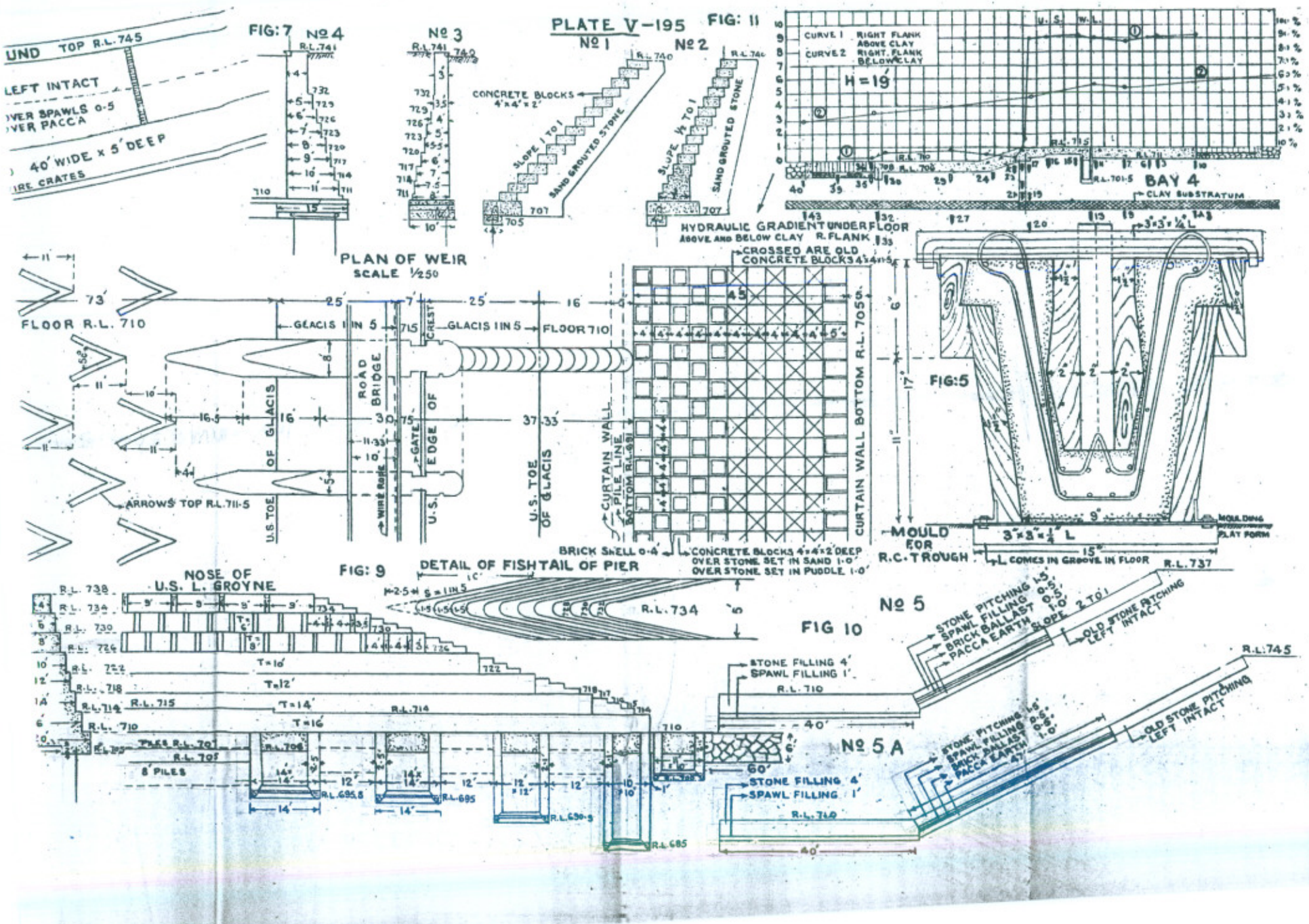
STIRRUPS

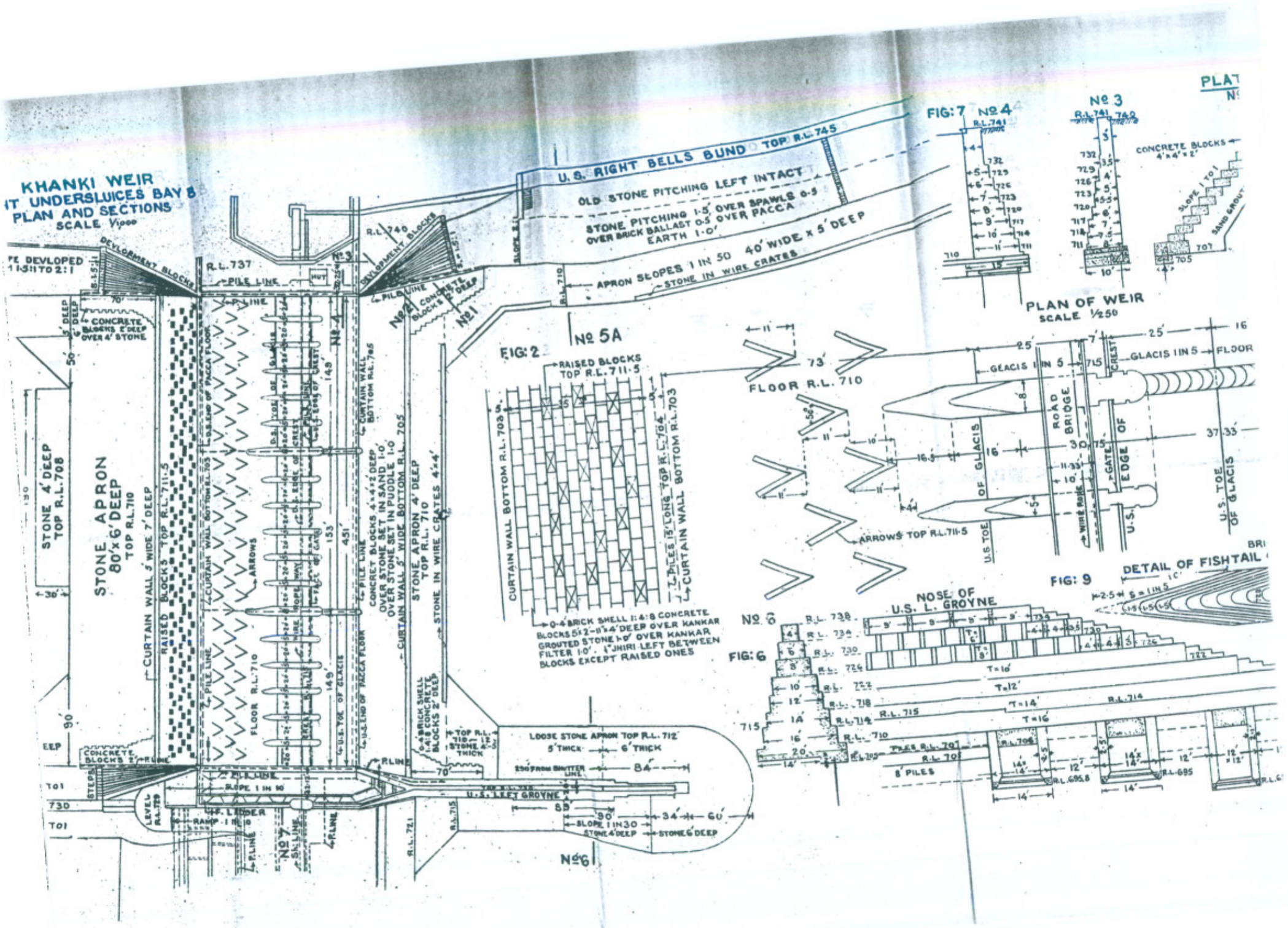


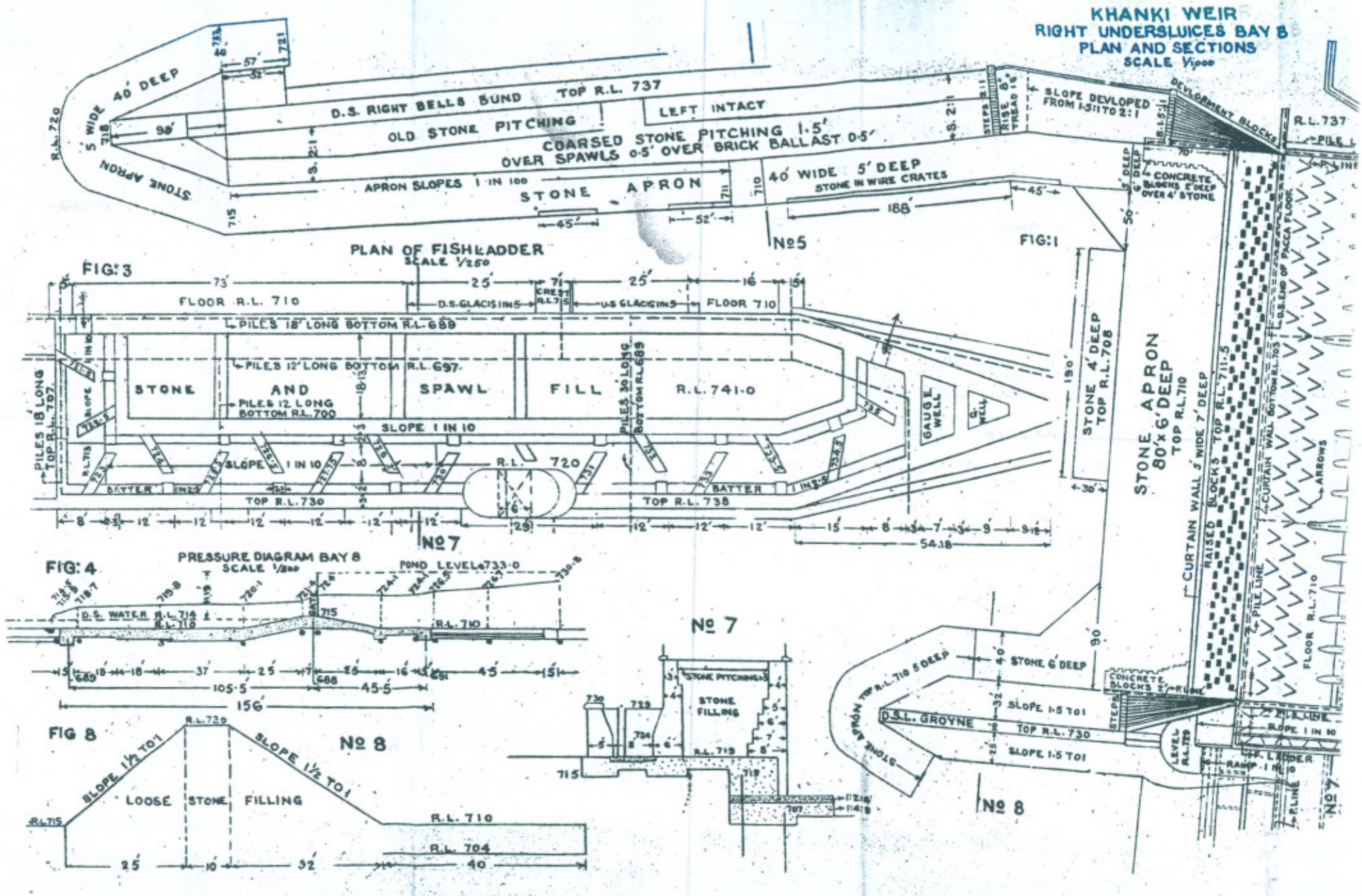
N OF ROAD WAY



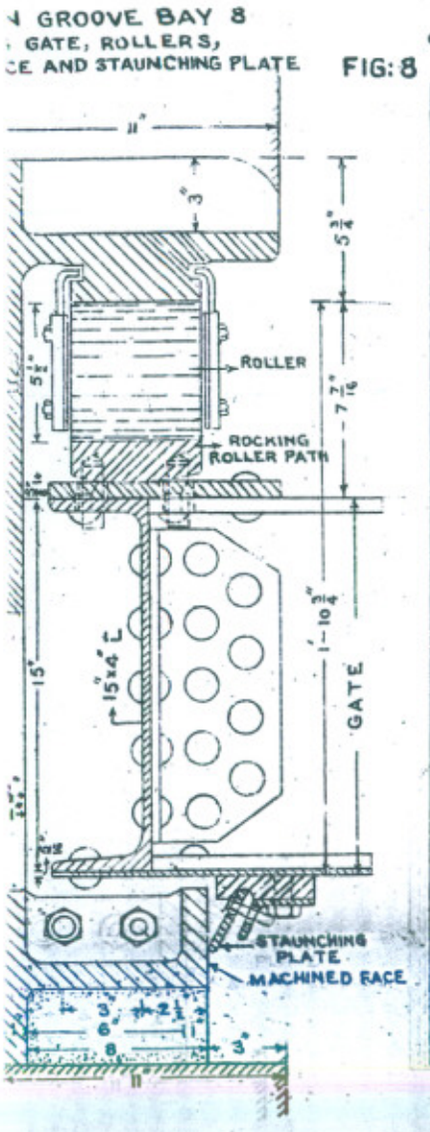
CROSS SECTION OF
R.C. TROUGH

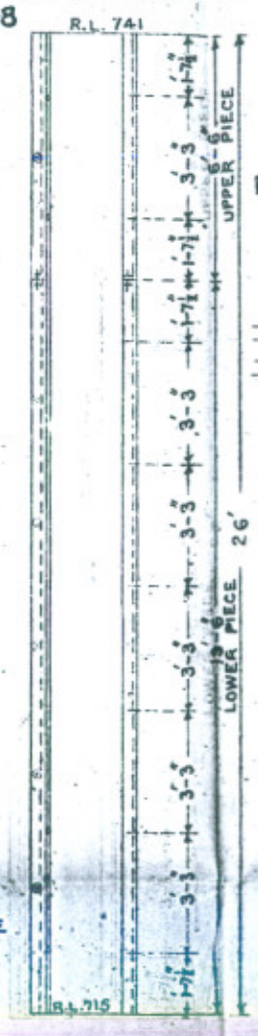

PLATE V–195
FIG: 7 Nº 4
Nº 3
Nº 1
Nº 2
FIG: 11
UND TOP R.L. 745
LEFT INTACT
VER SPAWLS 0·5
VER PACCA
40' WIDE x 5' DEEP
IRE CRATES
CONCRETE BLOCKS 4'x4'x2'
SLOPE 1 TO 1
SAND GROUTED STONE
SLOPE ½ TO 1
CURVE 1 RIGHT FLANK ABOVE CLAY
CURVE 2 RIGHT FLANK BELOW CLAY
H=19'
U.S. W.L.
R.L. 715
R.L. 711
R.L. 701·5
BAY 4
CLAY SUBSTRATUM
HYDRAULIC GRADIENT UNDER FLOOR
ABOVE AND BELOW CLAY R. FLANK
PLAN OF WEIR
SCALE 1/250
FLOOR R.L. 710
GLACIS 1 IN 5
CREST
GLACIS 1 IN 5
FLOOR 710
ROAD BRIDGE
OF GLACIS
EDGE OF
GATE
WIRE ROPE
U.S. TOE
U.S. TOE OF GLACIS
ARROWS TOP R.L. 711·5
CROSSED ARE OLD CONCRETE BLOCKS
CURTAIN WALL
PILE LINE
BOTTOM R.L. 691
CURTAIN WALL BOTTOM R.L. 705
BRICK SHELL 0·4'
CONCRETE BLOCKS 4'x4'x2' DEEP OVER STONE SET IN SAND 1·0' OVER STONE SET IN PUDDLE 1·0'
FIG:5
MOULD FOR R.C. TROUGH
3"x3"x¼" L
MOULDING PLAY FORM
L COMES IN GROOVE IN FLOOR
R.L. 737
FIG: 9
DETAIL OF FISHTAIL OF PIER
R.L. 734
NOSE OF U.S. L. GROYNE
T=10'
T=12'
T=14'
T=16'
PILES R.L. 707
R.L. 705
8' PILES
R.L. 695·8
R.L. 695
R.L. 690·5
R.L. 685
Nº 5
FIG 10
STONE PITCHING 1·5'
SPAWL FILLING 0·5'
BRICK BALLAST 1·0'
PACCA EARTH
SLOPE 2 TO 1
OLD STONE PITCHING LEFT INTACT
R.L. 745
STONE FILLING 4'
SPAWL FILLING 1'
R.L. 710
40'
Nº 5A
60'

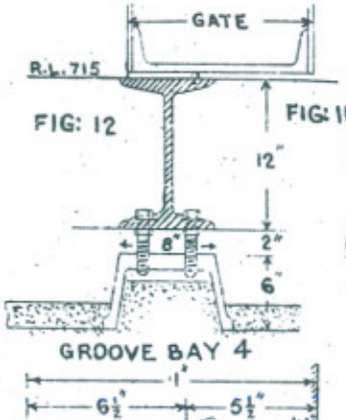

KHANKI WEIR
IT UNDERSLUICES BAY 8
PLAN AND SECTIONS
SCALE 1/200
U.S. RIGHT BELLS BUND TOP R.L. 745
OLD STONE PITCHING LEFT INTACT
STONE PITCHING 1·5' OVER SPAWLS 0·5
OVER BRICK BALLAST 0·5' OVER PACCA
EARTH 1·0'
APRON SLOPES 1 IN 50 40' WIDE x 5' DEEP
STONE IN WIRE CRATES
DEVLOPMENT BLOCKS
R.L. 737
PILE LINE
CONCRETE BLOCKS 2' DEEP
STONE 4' DEEP TOP R.L. 708
STONE APRON 80'x6' DEEP TOP R.L. 710
CURTAIN WALL 5' WIDE 7' DEEP
RAISED BLOCKS TOP R.L. 711·5
CURTAIN WALL BOTTOM R.L. 705
CONCRET BLOCKS 4'x4'x2' DEEP
OVER STONE SET IN SAND 1·0'
OVER STONE SET IN PUDDLE 1·0'
CURTAIN WALL 5' WIDE BOTTOM R.L. 705
STONE APRON 4' DEEP
TOP R.L. 710
STONE IN WIRE CRATES 4'x4'
ARROWS
FLOOR R.L. 710
U.S. TOE OF GLACIS
U.S. END OF PACCA FLOOR
0·4 BRICK SHELL 1:4:8 CONCRETE BLOCKS 2' DEEP
LOOSE STONE APRON TOP R.L. 712
5' THICK
6' THICK
U.S. LEFT GROYNE
SLOPE 1 IN 30
STONE 4' DEEP
STONE 6' DEEP
F. LADDER
RAMP 1 IN 10
STEPS
LEVEL R.L. 729
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FIG: 2
No 5A
RAISED BLOCKS TOP R.L. 711·5
CURTAIN WALL BOTTOM R.L. 703
CURTAIN WALL BOTTOM R.L. 703
0·4 BRICK SHELL 1:4:8 CONCRETE BLOCKS 5'x2'-11"x4' DEEP OVER KANKAR GROUTED STONE 1·0' OVER KANKAR FILTER 1·0'. 1" JHIRI LEFT BETWEEN BLOCKS EXCEPT RAISED ONES
FIG: 7
No 4
No 3
PLAN OF WEIR
SCALE 1/250
FLOOR R.L. 710
GLACIS 1 IN 5
CREST
FLOOR
ROAD BRIDGE
GATE
EDGE OF
U.S. TOE OF GLACIS
ARROWS TOP R.L. 711·5
FIG: 6
No 6
NOSE OF U.S. L. GROYNE
T=10'
T=12'
T=14'
T=16'
8' PILES
FIG: 9
DETAIL OF FISHTAIL

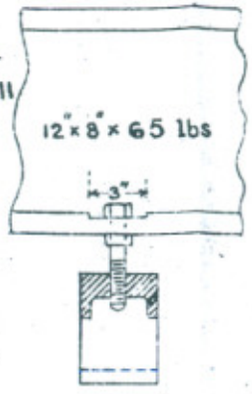

KHANKI WEIR
RIGHT UNDERSLUICES BAY 8
PLAN AND SECTIONS
SCALE 1/250
D.S. RIGHT BELLS BUND TOP R.L. 737
OLD STONE PITCHING LEFT INTACT
COARSED STONE PITCHING 1.5' OVER SPAWLS 0.5' OVER BRICK BALLAST 0.5'
STONE APRON
APRON SLOPES 1 IN 100
40' WIDE 5' DEEP
STONE IN WIRE CRATES
SLOPE DEVLOPED FROM 1.5:1 TO 2:1
DEVLOPMENT BLOCKS
CONCRETE BLOCKS 6' DEEP OVER 4' STONE
R.L. 737
PILE LINE
FIG: 1
PLAN OF FISHLADDER
SCALE 1/250
FIG: 3
FLOOR R.L. 710
D.S. GLACIS 1 IN 5
U.S. GLACIS 1 IN 5
CREST R.L. 715
FLOOR 710
PILES 18' LONG BOTTOM R.L. 689
PILES 12' LONG BOTTOM R.L. 697
PILES 12 LONG BOTTOM R.L. 700
PILES 30 LONG BOTTOM R.L. 689
STONE AND SPAWL FILL
R.L. 741·0
SLOPE 1 IN 10
BATTER 1 IN 2
TOP R.L. 730
TOP R.L. 738
R.L. 720
GAUGE WELL
STONE 4' DEEP TOP R.L. 708
STONE APRON 80'x6' DEEP TOP R.L. 710
CURTAIN WALL 5' WIDE 7' DEEP
RAISED BLOCKS TOP R.L. 711·5
CURTAIN WALL BOTTOM EL. 703
D.S. END OF PACCA FLOOR
ARROWS
FLOOR R.L. 710
No 5
No 7
FIG: 4
PRESSURE DIAGRAM BAY 8
SCALE 1/200
POND LEVEL 733·0
D.S. WATER R.L. 714 & R.L. 710
R.L. 710
105·5
45·5
156'
No 7
STONE PITCHING 1.5'
STONE FILLING
R.L. 719
R.L. 704
FIG 8
No 8
SLOPE 1½ TO 1
LOOSE STONE FILLING
R.L. 715
R.L. 710
R.L. 704
25'
10'
32'
40'
STONE APRON TOP R.L. 710 5' DEEP
STONE 6' DEEP
CONCRETE BLOCKS 2' DEEP
D.S.L. GROYNE
TOP R.L. 730
SLOPE 1·5 TO 1
SLOPE 1 IN 10
LEVEL R.L. 729
F.L. LADDER
No 8

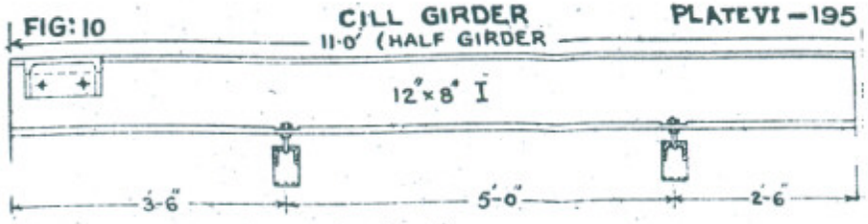
.NKI WEIR
'EEL WORK
YS 4 AND 8

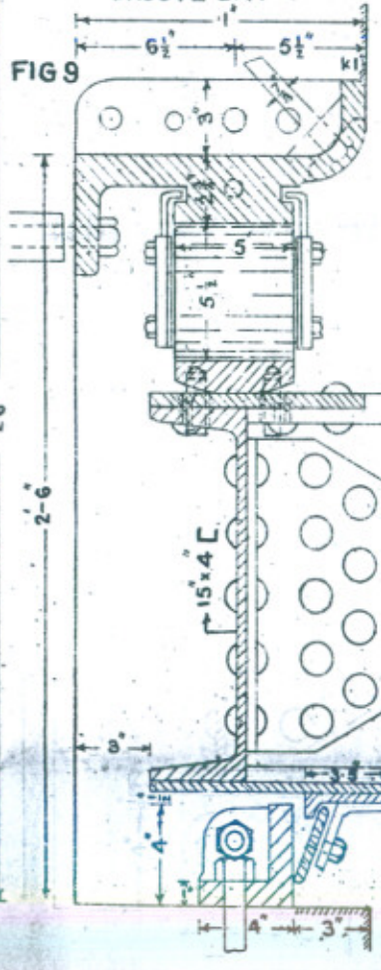


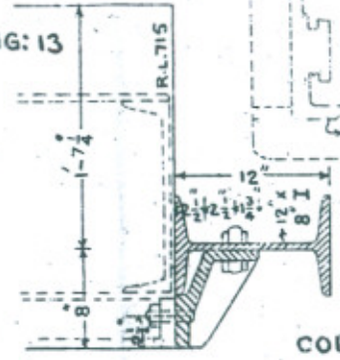


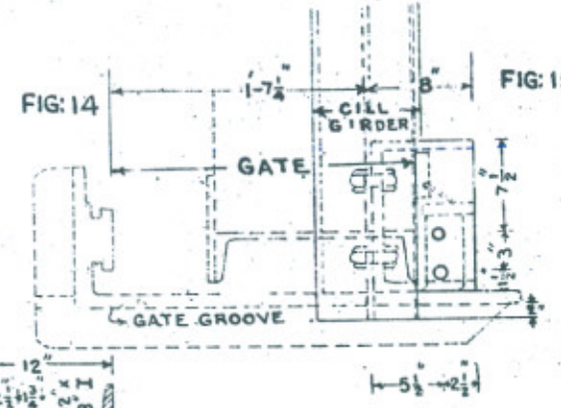


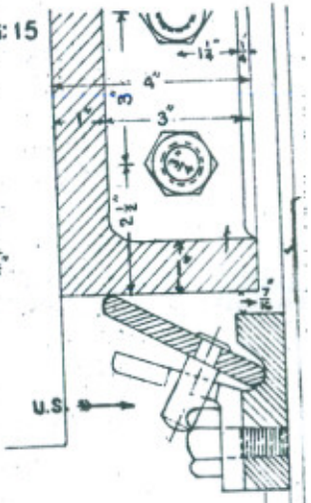


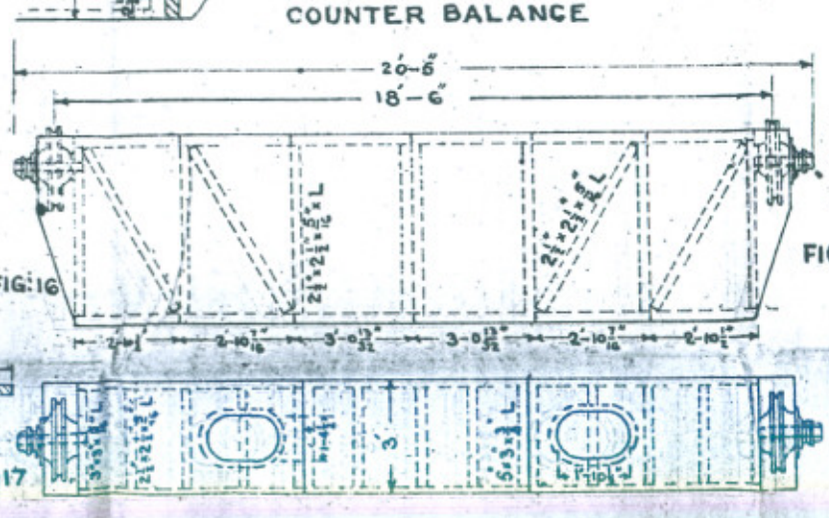


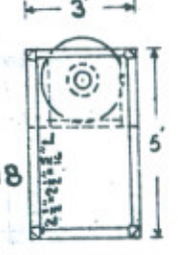








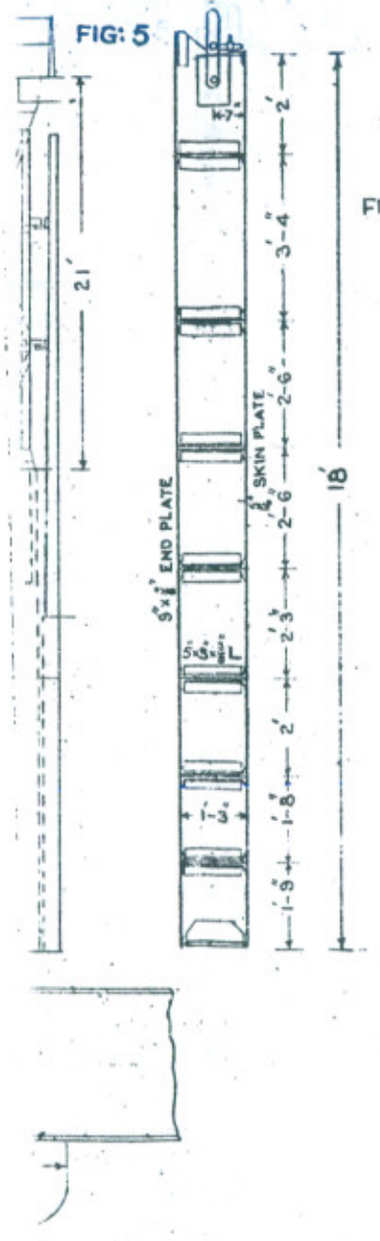




KHANKI WEIR
STEEL WORK
BAYS 4 AND 8

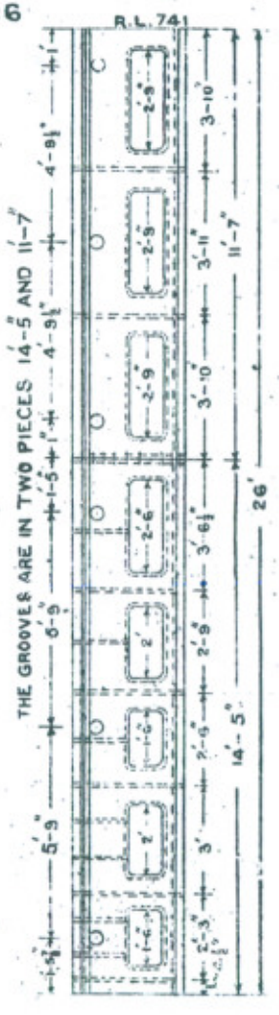
SECTION OF GATE

FIG: 5



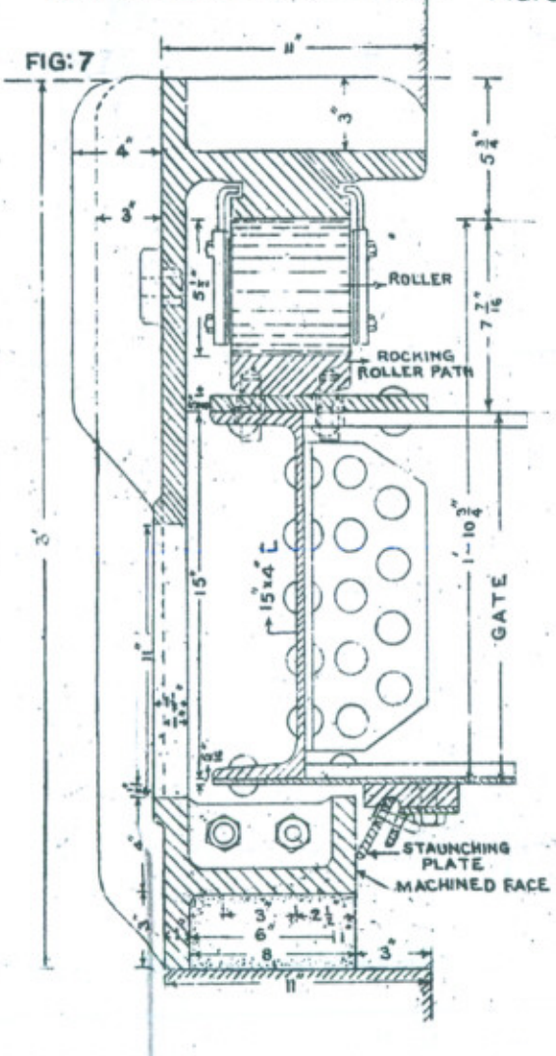
ELEVATION
GROOVE BAY 8

FIG: 6



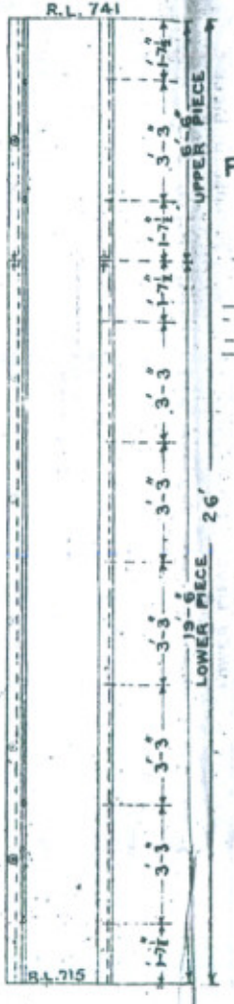
SECTION GROOVE BAY 8
SHOWING GATE, ROLLERS,
ROCKING FACE AND STAUNCHING PLATE

FIG: 7



ELEVATION
GROOVE BAY 4

FIG: 8



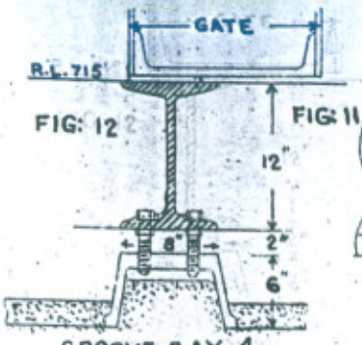
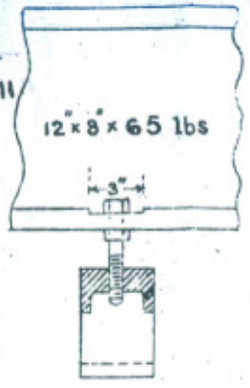


FIG: 12

FIG: 11



GROOVE BAY 4

FIG 9

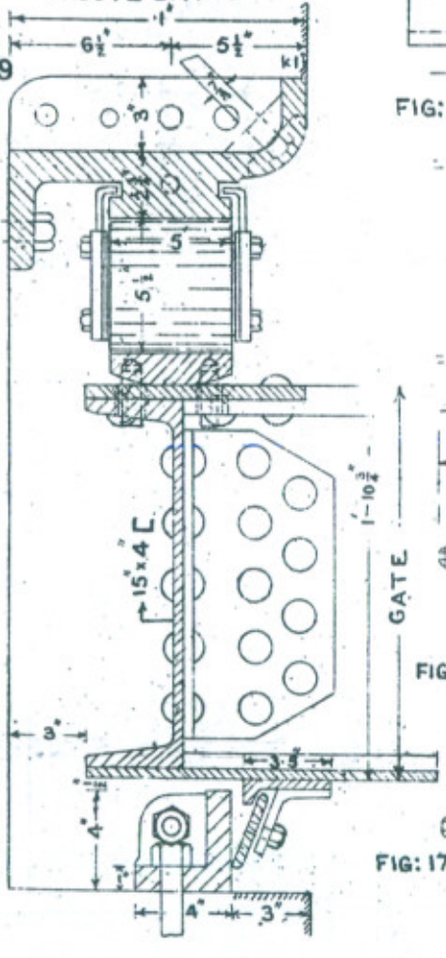


FIG: 13

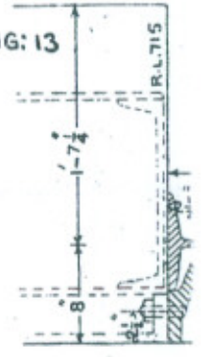


FIG: 16

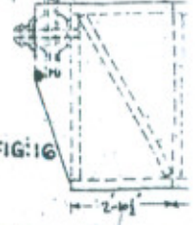
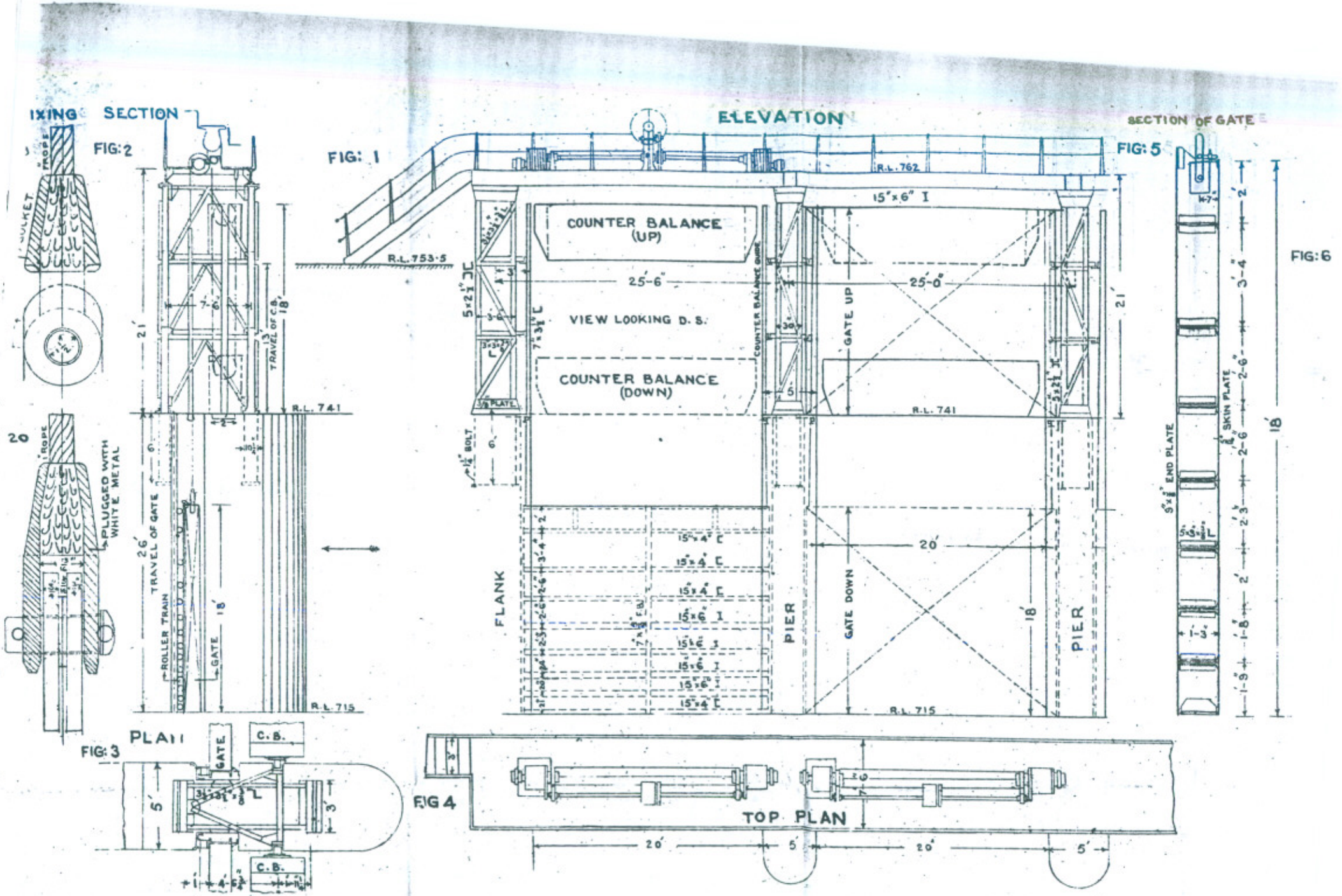


FIG: 17




IXING SECTION
FIG: 2
FIG: 1
ELEVATION
SECTION OF GATE
FIG: 5
FIG: 6
R.L. 762
15"x6" I
COUNTER BALANCE (UP)
25'-6"
VIEW LOOKING D.S.
COUNTER BALANCE (DOWN)
25'-0"
GATE UP
GATE DOWN
R.L. 753·5
R.L. 741
R.L. 715
FLANK
PIER
PIER
20'
18'
21'
TRAVEL OF C.B.
TRAVEL OF GATE
ROLLER TRAIN
GATE
PLUGGED WITH WHITE METAL
SKIN PLATE
END PLATE
PLAN
FIG: 3
C.B.
GATE
FIG 4
TOP PLAN
20'
5'
20'
5'