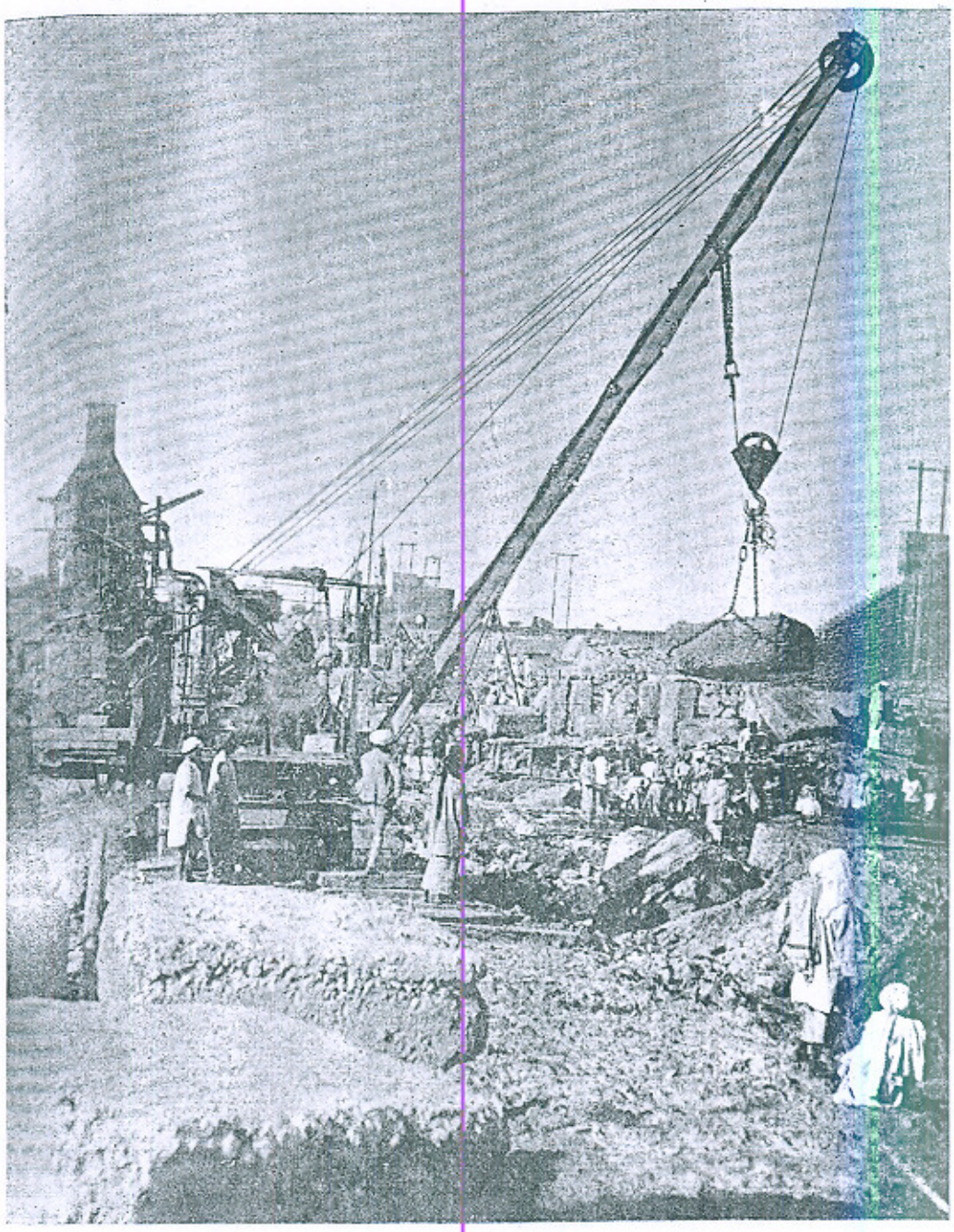
Photo No. 11.



Excavator lifting 3-ton block.—November, 1936 .

blocks in cement concrete at site, the shuttering for the blocks being provided by brick shells, with walls half a brick thick and with a few bricks in alternate layers laid as headers in each shell to give a good key into the concrete. Photo No. 13 gives a good view of these blocks.

An important factor contributing towards the disappearance or subsidence of the old blocks was the wide spacing (one foot) between them and the insufficient stone (9″) below as a result of which sand was sucked out by the high velocity jet in floods. To remedy this a foundation of 9″ of stone sand-grouted lying over a layer of 9″ of spawls was provided under the new blocks. A one-inch layer of sand was also given on top of the stone to prevent the mortar from the concrete getting into the stone below and making the block area impervious. The spacing between the blocks was also reduced to 3″ in the case of masonry blocks and 2″ in the case of brick shells. A filter of fine material was put in in the bottom half of the 3″ spaces and one foot of stone hammered in at the top. The spaces between the brick shells were filled with rammed sand. On account of the reduction of the spacing between the block the number of rows increased from 10 to 11. Plate X shows an arrangement where the blocks in the first eight rows next to the C line were built in stone masonry and those in the remaining three rows in brick shells and concrete. It also shows how the raised and staggered blocks were fitted into the last three rows. The object of the raised blocks in the block area and in the horizontal floor between the B and C lines was to turn up and dissipate the high velocity jet. Model experiments had shown that with a maximum flood discharge of 162·5 cusecs per foot run over the reconditioned weir, whereas a plain floor gave a maximum scour of 12 feet below the block area, this scour was reduced to 5·8 feet with the provision of the raised blocks.

In lowering the stone apron, a layer of spawls 1½ feet deep was provided below the stone which was 3 feet thick.

Reconstruction of the downstream glacis.

As shown in Plate II, the old downstream glacis with a flat slope of 1 in 15 was replaced by a glacis having a slope of 1 in 4 above the B line and a horizontal floor between the latter and the C line, depressed 4 feet below the original level. On Plate VIII is given a cross section which shows details of the junction of new work with old and of reinforcement of the new horizontal floor between B and C lines of wells. At the upstream end the new work was bonded into the old glacis by giving a stepped joint in which reinforcement bars were embedded, the latter being grouted into holes jumped in the old work. Unlike the old section the new glacis has a bottom layer of concrete to give it proper bedding on sand which is impossible with stone masonry. Over this bottom concrete there is 2 feet of rubble masonry in 1 : 4 cement mortar

covered by 1·0 foot of toothed *kharwanja* in 1 : 3 cement mortar. As shown in Photo No. 9 the necessary bond between the different layers was provided by the use of binder stones, also the stones in the lower layer were cleared of all mortar before the upper layer was put on. At the B line the requisite bond has been provided by having a layer of concrete at the top of the wells and in the gaps in between and carrying it above and below the well line in one continuous operation. Short reinforcement bars were provided on either side projecting from the concrete inside the wells into that under the sloping floor upstream and the horizontal floor downstream. The latter consists of a mass concrete section 4 feet thick, the bottom 3 feet being a 1 : 4:7½ mix and the top one foot a 1 : 2 : 3½ mix. Concrete was laid in layers as at Khanki, the bond between the different layers being provided by stone plums obtained from dismantling the old floor and by mild steel vertical stirrups. The top layer is reinforced for temperature stresses by ½ inch bars spaced 9″ centres both longitudinally and transversally to the weir, the latter being tied to the sheet piles by means of triangular stirrups attached to each pile.

The proportions adopted for the concrete were as recommended by the Principal, Government School of Engineering, Rasul on the basis of tests carried out by him with the materials to be used, samples of which were supplied.

Altogether 6 mixers—5 cubic yard and one quarter yard—were available for the work. Plate VI shows the sites where the cubic yard mixers were installed in each bay. In view of the likelihood of high freshets in the period when work in bays 3 to 8 of the weir was in progress, the bottom 3 feet of the concrete between the B and C lines and the 1 foot above the B line was laid first in order to cover the area exposed as quickly as possible so that no damage might be done in case of a high freshet breaching the bunds. With water level lowered and kept well below the foundation level and a cross drain maintained in the centre of each bay as also a longitudinal drain along the C line of wells, it was possible to start concreting from both ends of a bay towards the centre. With these arrangements good progress was obtained in bays 3,4 and left half of 5, the maximum daily output being 18,500 cubic feet with three cubic yard and one quarter yard mixers.

In the right half of bay 5 and bays 6, 7 and 8 which formed the last stage of the work, the quantity of concrete to be laid in the glacis and floor was 4½ lacs cubic feet and in the blocks one lac cubic feet. Concreting was started on the 14th February, 1937 and as it was absolutely essential that it should be finished before the end of March after which floods of over 1.5 lacs of cusecs were likely, all the mixers were utilized. Arrangements were made to start concreting on seven faces. The

Photo No. 9.

Masonry of glacis. Mark binder stones and cleaning of layers.—January, 1937.

position of the cubic yard mixers and the faces and dates on which concreting was started are given in the table below :-

	Position of Mixer	Concreting face	Direction	Date of starting concrete
1.	Down stream of bay 5	Centre of bay 5	Towards right	14-2-37
2.	On right flank of weir	Groyne No. 7	Towards right	16-2-37
3.	Upstream of Groyne No. 7	Groyne No. 7	Towards left	17-2-37
4.	Downstream of bay 5 / Downstream of bay 6	Groyne No. 5	Towards right	25-2-37
5.	Downstream of bay 6 / Upstream of groyne No. 6	Groyne No. 6	Towards left	25-2-37
6.	On right flank of weir	Right flank	Towards left	26-2-37
7.	Upstream of groyne No. 6 / Upstream of groyne No. 7	Groyne No. 6	Towards right	4-3-37

In order to w rk to thi. programme it was first necessary to dismantle and complete the excavation between the B and C lines of wells in all 4 bays simultaneously so as to get the pile line completed as soon as possible. Above the B line the cautious policy was first adopted of dismantling only a chain ahead of the concrete but as this left insufficient face for the men to work and would have greatly delayed the completion of the concrete it was decided to take the risk when the bunds were up to full section and dismantle from end to end. The glacis slope and the horizontal floor were covered with concrete to the reduced section mentioned above by the 10th of March and concreting was completed to full section in the weir floor and in the blocks 10 days later. During the last period from the 2nd to the 12th March the average daily progress was 27,000 cubic feet, the maximum done on any one day being 30,100 cubic feet on 6-3-37. These results constitute a record in the Department and were due to the forethought given to the layout of the mixers and tram lines and other details.

Plates XI to XIV give the plans and sections of all the seven groynes showing how they were reconditioned. The groynes on the right of the weir had failed over and over again owing to cross flow. The surplus *malba* and spawls obtained from dismantling were therefore added to the aprons at the downstream ends of groynes Nos. 5, 6 and 7 so as to give them a diameter of 70 feet round the noses as against 40 feet in the other groynes. The thickness of the apron at the outer edge was also made 6 feet against 4 feet in groynes 1, 2 and 3. As stated above, groyne No. 4 had failed more than once before. It was therefore

decided to give it a stronger foundation by providing a line of sheet piles under it below the C line of wells and to reconstruct it in stone masonry right up to the downstream end. In spite of considerable amounts of stone and debris found under it when it was dismantled, it was found possible to drive this line of piles. As the downstream end of the groyne is subject to heavy action it would have been better to found it on wells and this proposal was considered but had to be rejected due to the presence of stone through which wells could not be sunk. The apron round the nose was however made 7 feet thick throughout its width.

In the original construction a cross line of wells was provided under groyne No. 4 between the B and C lines of wells. The pile foundation now provided under the remaining length of the groyne will enable the weir to be divided into two separate compartments in future.

Groyne No. 7 had failed in the record flood of 1929 and been subsequently rebuilt in stone masonry on a thin slab of concrete with foundation R. L. 792, i.e., two feet above the new depressed floor. As it was in good order it was decided to underpin it by encasing the foundations in concrete carried down to R. L. 784·8. To rebuild this groyne would have cost about Rs. 6000 more, and there was no time to do the work in any case.

Photo No. 13 gives an idea of the pressure under which work in bays 5 to 8 was carried on. Photo No. 14 shows a view of the completed work from the right flank. Groyne No. 7 appears prominently in both the photographs.

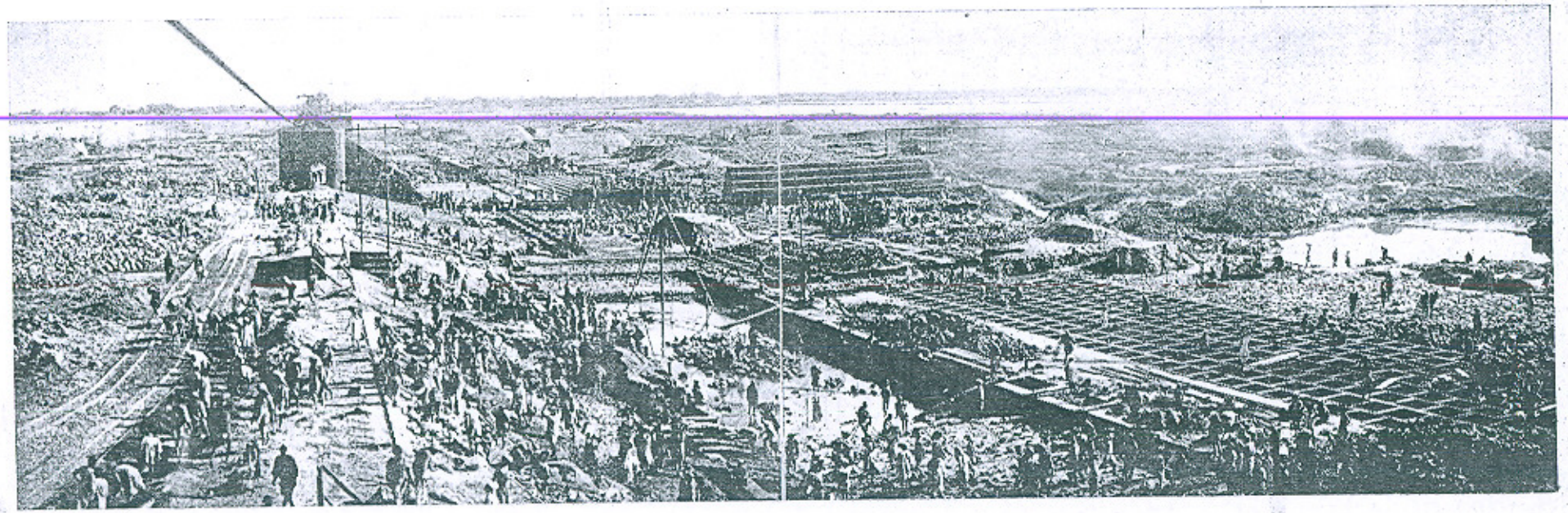
Grouting of upstream glacis.

To improve the watertightness of the upstream floor of the weir between the A line of wells and the weir crest, holes were jumped in the floor up to sand about 30 feet above the shutter line and spaced 20 feet apart parallel to the weir and neat cement slurry was grouted through them either with a hand grouting machine or with stand pipes about 15 feet high. The quantity of cement consumed in each bay varied from 200 to 450 bags, the largest quantity taken by any one hole being 80 bags in centre of bay 1.

Special repairs to the right Downstream Guide Bund.

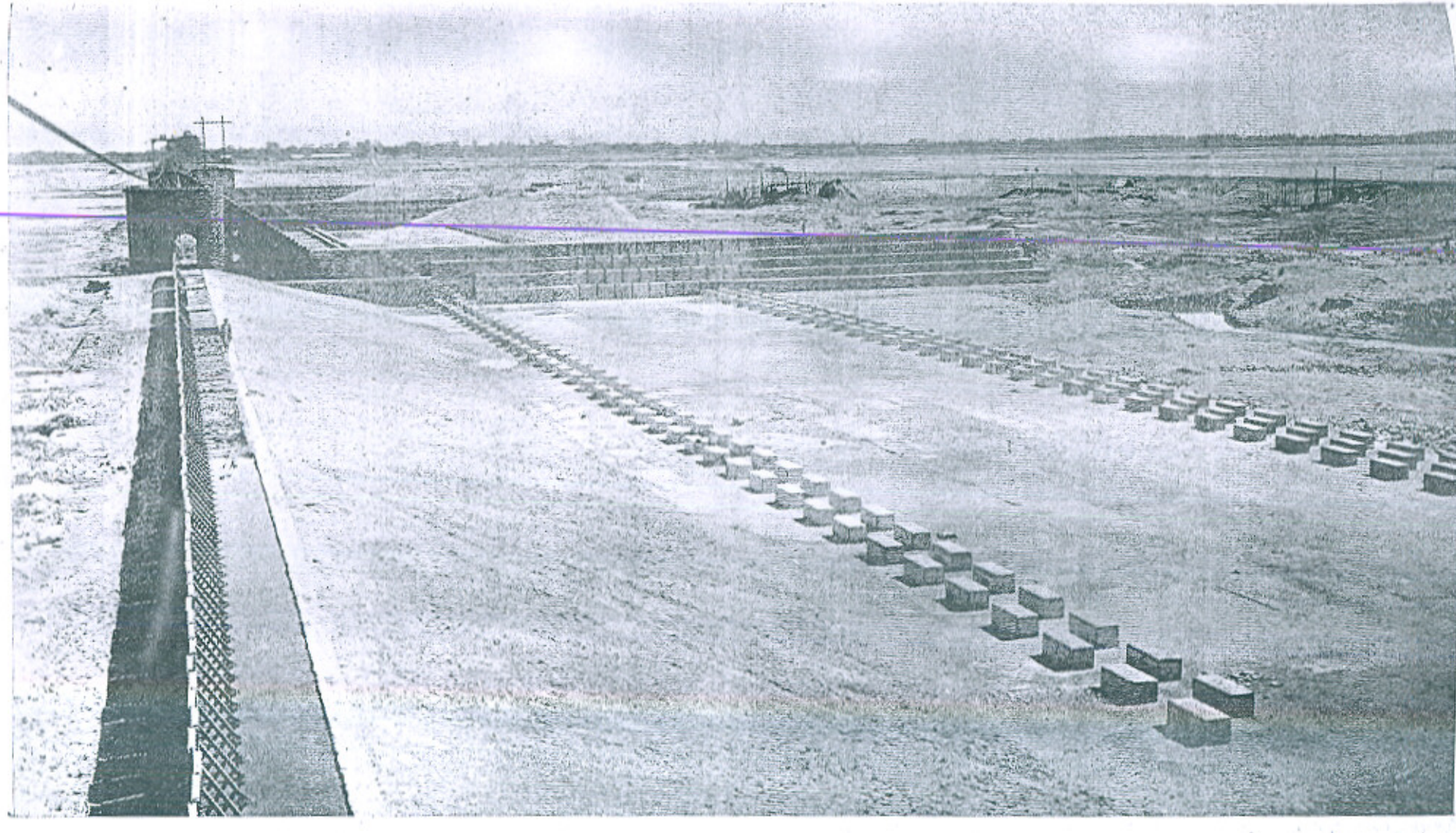
In the rush to complete the weir in the winter of 1910-11, this Guide Bund was never properly constructed. In the sanctioned design it consisted of a straight shank extending to 1500 feet below the shutter line and ending in a rounded nose. The width of the apron was to be 50 feet for the first 5 chains followed by 40 feet for the next 7½ chains, then widened again to 50 feet at the end of the shank and round the nose and tapered to zero at the back. As actually constructed, however, the

Photo No. 13.



Panoramic view of Bays 5 to 8 showing work in progress, Groyne No. 7 in centre being underpinned. The artificial sump prepared in bay No. 8 is clearly visible. Date 5-3-37.

Photo No. 14.



Panoramic view of completed work from right flank.

shank was only 1160 feet long and the width of the apron through the centre of the nose was only 10 feet and the R. L. of its top at this point 802. In the sanctioned design the slope pitching was proposed to be 3 feet thick but it actually consisted of a layer of 9" uncoursed stone on 12" of spawls. Observations made when the apron was unwatered and laid bare showed that most of the stone was non-existant.

In view of the unsatisfactory condition of this bund it was decided to repair it thoroughly although this work did not form a part of the weir reconditioning programme. The repairs were as follows :-

Up to a distance of 4½ chains from the shutter line the top of the apron was kept at R.L. 789·8 i. e., the same as the new downstream floor. Beyond this point it was sloped up to R. L. 796 and continued at this level throughout to the back of the bund. The width of the apron was kept the same as in the original design, *viz.*, 50 feet up to R. D. 510 (the shutter line being at R. D. O)then 40 feet to R. D. 910, gradually widening out to 50 feet at the end of the shank at R. D. 1160 and round the nose and then gradually tapering out to zero at the back of the bund. The new apron was made 5 feet thick on the outside and 4 feet on the inside. The side slopes were dismantled and relaid with 1·5 feet of stone over 1 foot of spawls.

As the bottom of the low apron was at R. L. 784·8, an unwatering channel was led along the Guide Bund and connected to the sump of the main pump in bay 8. This kept the water down and enabled the work to be done without any difficulty.

Collection and carriage of materials.

One of the main items arrangements for collecting which had to be made well in time was stone ballast for concrete. About 9 lacs cubic feet had to be collected from outside as it was anticipated that some could be made available on the work itself by breaking the spawls and stone obtained from dismantling the old work. One alternative was to get the ballast from Jammu as done at Khanki. Local enquiry and reconnaissance, however, had shown that shingle, both coarse and fine, could be had in any quantities required from the bed of the river and its affluents within a distance of about 12 miles above Marala. Samples of the shingle as also those of the sand and cement which were to be used in the concrete were sent to the Principal, Government School of Engineering, Rasul with a view to tests being carried out to determine whether the shingle was fit for use. The tests showed that it was sound in every way but in view of its grading it was found necessary to slightly alter the composition of the mixes, using proportions of 1 : 2 : 3¾ and 1 : 4 : 7½ instead of the usual 1: 2: 4 and 1: 4: 8, respectively. This greatly simplified the problem of collection of materials as an entirely separate organisation could be set up for the collection of shingle, thus relieving the 16 miles long canal railway connecting Marala with Sambrial, a

station on the North Western Railway, of congestion. It also meant a saving of about Rs. 25,000 in cost of collecting this item. The work of collection however had to be started about a year in advance as it could be done economically only during certain periods when the river discharge was moderate and it was possible to take the boats, on which shingle was brought to Marala, near the sites from where it could be had.

The requirements of stone were more than met from the quantity obtained from dismantling the old work. Four rakes were however obtained from the Baghanwala Quarry for the *kharwanja* course of the new downstream glacis.

The other articles, *viz.*, sheet piles, cement, mild steel bars, steam coal, crude oil, and other miscellaneous articles commenced to arrive a little before the work was started and kept on coming while it was in progress. To cope with this traffic, two B. G. Sentinels were employed between Sambrial and Marala.

"*Five Rivers*" Portland cement was used on the work. About the time it was started orders were received from the Chief Engineer to the effect that the cost of the empty cement bags should be charged to the work for which the cement had been obtained, they should then be brought on to stock at no value and any credit subsequently received from the Company on their return or by local sale should be afforded to Revenue. In view of these orders, about 50,000 empty bags were returned to the Company for being refilled with cement, resulting in an economy of Rs. 10,000.

Plant and Machinery.

With the exception of a few minor articles costing not more than Rs. 10,000, the work was carried out with plant collected from within the Department. This plant consisted, principally, of the following items :—

(1) Pile drivers.
(2) Portable steam engines.
(3) Fowler Tractor engines.
(4) Concrete Mixers.
(5) 10 Ton crane.
(6) D. C. Generating Set.
(7) Dragline Excavators.

Two pile drivers were obtained. One might have sufficed but as both were old it was considered necessary to have one spare to provide against a breakdown. Eleven Portables, all that were available, were

obtained and of these two were small (8 N.H.P.) and were used for driving the concrete mixers. The others were of 12, 14 and 16 N. H. P. and were employed for pumping. Two Fowler Tractor Ploughing Engines, 16 N. H. P. mounted on caterpillars, which had been very little used and were in excellent condition, were also obtained from the Chakanwali Farm and were used as Portables. As already stated above, 5 one cubic yard and 1 one quarter cubic yard concrete mixers, lying in different divisions were collected, three of the former being Ransomes, which were driven off Portables, and two Rexs, which are self-driven. A 60 kw. 220 volt D. C. Generating Set was obtained from Amritsar and was used for lighting the work and for running small electric pumping sets, required for local pumping or for supplying water on work. Two dragline excavators, one a Ruston and the other a Bucyrus, were used as travelling cranes for removing and relaying the concrete blocks.

In addition there were a number of Ruston-Hornby engines with pumps, Petter engine and electric pumping sets, Pressure and Hand Grouting Machines, crude oil tanks, crabwinches, pipe lines, tramway plant, workshop machinery, etc.

The plant was overhauled and put into running order before being used on the work. It was kept going almost day and night during a period of four to five months with only one break-down. This was in November 1936 when the 60 kw. D.C. Generator broke down for a couple of days. The generator was 29 years old and on account of this the insulation in the commutator broke down. Luckily a spare armature was available in the Central Workshops, Amritsar and the duration of the breakdown was therefore small.

It should be added, however, that it was only due to the exercise of constant vigilance and care that the breakdowns in the working of the plant were not more frequent or serious. And as might be expected, the running costs were also high. For instance, the Portables which were originally designed to give 12 N. H. P. were actually giving no more than 8 as the working pressure had to be reduced on account of the age of the boilers from 180 to 100 lb. per square inch.

Pressure pipes.

Advantage was taken of the work of reconditioning the weir to put in a number of observation pipes under the floor of the weir with the object of determining the pressures under the floor at different sites. The location of these pipes which is shown in Plate XV was decided on in consultation with Dr. Mckenzie Taylor, Director, Irrigation Research and Rai Bahadur A. N. Khosla. The water levels in these pipes are being read and recorded regularly. The results obtained so far, however, have been vitiated by the fact that a good deal of the silt deposit on the upstream side of the weir caused by the gapping of the upstream ring bunds after the completion of the work is still there, as during the last monsoon

river discharge did not rise sufficiently high for this silt being washed away.

Position of Standing Wave after Reconditioning.

It has been stated above that observations were made during the record flood of August, 1929 of the profile of the standing wave but during tests made subsequently on a model of the weir the field observations could not be reproduced. In view of the great importance of the subject, arrangements were made to determine the position of the standing wave, after the weir had been reconditioned, by photographing an actual wave against Groyne No. 4 on which horizonal and vertical lines at one foot intervals had been painted. Owing to the absence of floods during the last monsoon, however, it has not been possible so far to do more than take a photograph with the supply above the weir headed up to the top of the shutters (R. L. 808). Photo No. 15 shows the wave under such conditions. The intensity of discharge per foot run of weir was then about 50 cusecs and the downstream water level at R. L. 801. It will be seen that the wave formed about half way between the shutter line and the B line of wells. In the old Weir the wave under such conditions used to form over or a little below the B line. The change is due to the downstream glacis having been reconstructed with a slope of 1 in 4 against its previous slope of 1 in 15.

Cost of Work.

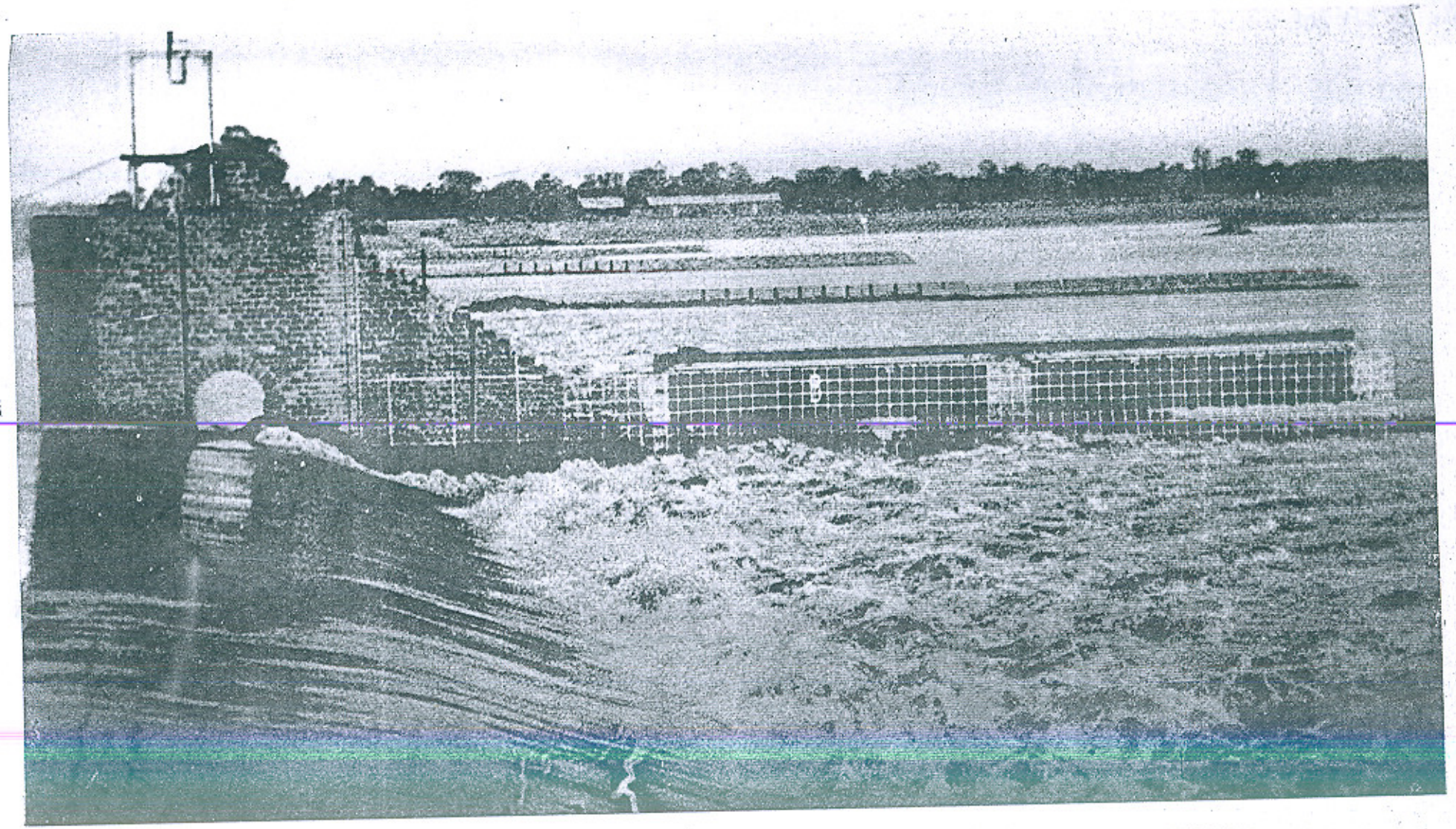
The main work was sanctioned under Capital with a project estimate of Rs. 15·5 lacs. The final figures of expenditure are not yet available but as shown in Appendix I, the working estimates will be closed with a slight saving. Appendix II gives a schedule of labour rates for the work. In preparing it, the rates previously paid for each item at Marala, Khanki and the Deg fall were kept in view and the minimum actually paid at any place, reduced further if necessary in the light of experience gained there and the rate tenders, received for this work, was adopted.

The amount spent on grouting the upstream glacis of the weir and special repairs to the right downstream guide bund was charged to Revenue.

Concluding Remarks.

The work was started in the last week of September, 1936 and was completed on the 27th of March, 1937. The magnitude of the work

Photo No 15.



Standing wave after Reconditioning. Upstream R.L. 808, downstream 801.—Date 15-8-37.

carried out in this short working season can be gauged from the following quantities :-

Earthwork	.. 2·26 Crores	cubic ft.
Dismantling	..35·45 Lacs	do.
Steel sheet piling	..66,000	square ft.
Stone pitching and filling ..	..15·7 Lacs	cubic ft.
Cement concrete	..11·75 Lacs	do.
Stone masonry	.. 6·95 Lacs	do.
Revetment of *pilchi* and spawls	.. 5·0 Lacs	do.
Removing and relaying 3¼-ton concrete blocks.		3800 No.
Constructing new blocks.		4200 No.

The quantities for the work of reconstruction of the Khanki Weir are given on page 134 of the 1936 Proceedings, Vol. XXIV.

Some of the difficulties under which the work had to be carried out have already been touched upon above. Due to the necessity of passing water below the weir to feed the Lower Chenab Canal the downstream water level was high. As a result of this and the coarse grade of sand the daily discharge pumped at Marala was many times as great as at Khanki in the weir bays. The dismantling of the downstream glacis and of the cement concrete in the block area laid to replace the blocks which had been washed away—about 18 lacs cubic feet in quantity—was extremely difficult. The bunds were started in the last week of September and in the middle of October a freshet came down and submerged and washed away a good deal of the bund above bays 1 and 2. In these bays there was also great difficulty in lowering the water level sufficiently to lay the concrete in the dry, particularly close to the left flank which was subject to a head of 18 feet from the water level in the pocket and a good many tube wells had to be used. To keep the labour force (4000 men and 1500 donkeys) continuously employed, it was necessary to start dismantling and removing the whole of the glacis from a point a few feet below the crest a month before the concrete could start and this was a source of great anxiety. Work was in progress over three-quarters of the weir in the freshet period which starts after the middle of December during which flood discharges up to 150,000 cusecs had passed over the weir in the past. If a flood of this magnitude had occurred before the beginning of March when the bunds had not been completed to full section, the latter might have breached and it would have been then impossible to make them up again in time to resume work during the rest of the season. Thus the work had to be carried on in an atmosphere of constant strain and anxiety. The strain became intense on the 20th of February when the weather broke and there was almost daily rainfall at Marala and the foot hills above for the next week. This not only interrupted the work but gave

every promise of a large winter freshet which fortunately did not materialize.

Mention has been made above of a programme (Plate V) framed for the work before it was started. Some of the difficulties met with after work had commenced in bays 1 and 2 have been described above. Another was that the anticipated progress on earthwork by boats was not realised and the number of donkeys had therefore to be increased. Still another was that dismantling was found to be more difficult than expected and this also necessitated an increase in the labour strength. In the light of experience gained in bays 1 and 2 a revised programme was therefore prepared for the remaining work which was further revised when work in bays 3 and 4 was nearing completion. Thus at each of the three stages into which the work was divided there was a programme which was being followed and modified as and when the necessity arose. In addition, a detailed programme for each day's work was chalked out at a meeting held in the field office on the previous evening. At this meeting which was attended by all the officers in charge of the work and the principal subordinates, such items as progress achieved on the work during the day, the water levels outside and inside the ring bunds, the position of the main and subsidiary pumps and other plant and any changes required therein, the materials consumed during the day and the balances available all came under review, followed by the drawing up of a programme for the next day. Copies of this programme were distributed to all concerned *the same night* so that every one knew what he had to do on the following day. Thus every little detail was thought of in time and the element of surprise and the consequent helplessness cut down to the very minimum. It is believed that it was due to this method of working that a work which would have normally taken two seasons to finish was satisfactorily completed in one season within the project estimate, thus resulting in a saving of three to four lacs of rupees.

RECONDITIONING OF MARALA WEIR.

APPENDIX I.

Statement of Actual Expenditure.

Serial No.	Name of Estimate.	Expenditure to end of Oct. 1937.
		Rs.
1	Ring bunds, excavation and *pilchi* revetment ..	2,02,989
2	Pumping	1,34,086
3	Obtaining and driving Ransome D piles ..	1,96,268
4	Obtaining special Tools and Plant	56,031
5	Obtaining M. S. reinforcement bars	53,450
6	Providing electric lighting on work	5,104
7	Reconstruction of the Downstream Glacis and depressing blocks and loose stone apron.	8,80,164
8	Conservancy and Hutting	5,729
	Total ..	15,33,821

Note :—The figures given above, though not final, are very nearly so, as with the exception of a few minor adjustments, they include all expenditure incurred on the work.

RECONDITIONING OF MARALA WEIR.

APPENDIX II.

Schedule of Labour Rates.

No.	Particulars.	Unit.	Rate.
			Rs.A.P.
1	Earthwork in river bed upto 50 feet lead undressed including wet and saturated earthwork.	per%cu. ft.	4-0-0
2	Do. beyond 50 feet lead	,, ,,	0-4-0 per half chain.
3	Earthwork by boats including lead up to 25 chains by boat including dressing.	,, ,,	8-0-0 ,,
4	Extra lead for earthwork by boats beyond one chain by manual labour. ..	,, ,,	0-4-0 ,,
		,, ,,	0-8-0 per chain.
5	Completion and dressing	,, ,,	0-12-0
6	Laying debris in slopes including collection and carriage up to one mile.	per%sq. ft.	1-4-0
7	Laying *pilchi* mattress including 8 miles carriage of *pilchi* and cost of binding materials.	,, ,,	3-0-0
8	*Pilchi* revetment double including 8 miles carriage of *pilchi* and cost of binding materials.	,, ,,	7-0-0
9	Special *pilchi* revetment double including carriage of *pilchi* and cost of binding materials.	,, ,,	9-0-0
10	Laying *kahi* mattress including 2 miles carriage of *kahi* and cost of binding materials.	,, ,,	2-0-0
11	Special *kahi* revetment double including 2 miles carriage of *kahi* and cost of binding materials.	,, ,,	4-0-0
	Concrete.		
1	Cement concrete plain machine mixed laid by baskets.	per %cu. ft.	4-0-0
2	Cement concrete machine mixed reinforced laid by baskets.	,, ,,	5-4-0
3	Preparing foundation for cement concrete	,, sq. ft.	0-8-0

No.	Particulars.	Unit.	Rate.
			Rs.A.P.
4	Timber shuttering for curtain walls ..	per%sq. ft.	2-0-0
5	Depressing concrete blocks 5′×5′×2′ with excavator.	Each	0-12-0
6	Depressing concrete blocks with shear legs.	Each	4-0-0
7	Nicking surface for raised blocks and hand shaping chamfered edges.	,,	0-12-0
8	Mud plastering joints between blocks ..	%sq. ft.	0-8-0
9	Skipping concrete ..	,, cu. ft.	10-0-0
	Stone Work.		
1	Stone masonry coursed rubble and kharwanja or in weir glacis less than 5.0′ thick.	,, cu. ft.	8-8-0
2	Racking out of old masonry for joining new work.	,, sq. ft.	3-0-0
3	Laying dry stone apron	% cu. ft.	1-0-0
4	,, ,, ,, in groyne	,, ,,	1-0-0
5	Grouting stone apron with sand ..	% cu. ft.	1-8-0
6	Coursed stone pitching	,, ,,	3-0-0
7	Collecting spawls and breaking into ballast 1½″ size.	,, ,,	3-8-0
8	Clearing old stones to be used in masonry including removal of old mortar with wire brushes.	,, ,,	1-0-0
9	Packing *jhiries* 1′ wide and 2′ deep with graded material and wedging stone.	Block	0-12-0
10	Packing 3″ wide *jhiries*	,,	0-3-0
11	Hammer dressing stone for face work ..	sq. ft.	0-2-0
12	Chisel dressing stone for face work ..	,,	0-12-0
15	Laying sand grouted stone	% cu. ft.	2-12-0
14	Jumping holes in stone masonry for cement grouting in U/s glacis.	l. ft.	0-12-0

No.	Particulars.	Unit.	Rates.
	Dismantling.		Rs.A.P.
1	Dismantling stone masonry or concrete in in lime mortar.	per cu. % ft.	3-0-0
2	Do. in cement mortar.	,, ,,	5-0-0
3	Dismantling dry stone under weir glacis	,, ,,	1-8-0
4	Dismantling dry stone in apron ..	,, ,,	1-0-0
5	Dismantling cement concrete in cut off walls and glacis.	,, ,,	10-0-0
6	Dismantling cement concrete over block area.	,, ,,	7-8-0
7	Dismantling stone in crates ..	,, ,,	2-0-0
	Sheet Piles.		
1	Driving 15·0′ sheet piles	per sq. % ft.	4-0-0
2	,, 20′—30′ ,, ...	,, ,,	6-0-0
3	Dolleying 15·0′ sheet piles ..	Each	0-6-0
4	Turning track 90° per pile driver ..	,,	8-0-0
5	Turning pile driver 90°	,,	10-0-0
6	,, ,, ,, 180°	,,	15-0-0
7	Raising or lowering machine ..	,,	8-0-0
8	Tracking machine light	Chain	10-0-0
9	Drilling holes in piles	Each	0-1-0
10	Unloading from track 15·0′ Universal piles (5·0′ clear of rail).	,,	0-1-6
11	Removing 15·0′ sheet pile from platform and stacking within one chain.	,,	0-1-2
	Carriage.		
1	Carriage of steam coal average distance one mile.	Ton.	0-11-9
2	Carriage of steam coal average distance within 2 miles.	,,	1-5-0

	Particulars.	Unit.	Rates.
	Unloading.		Rs. A. P.
1	Unloading steam coal and stacking ..	Ton.	0-5-0
2	Unloading building stone	per % cu. ft.	0-4-0
3	Stacking building stone lead within one chain.	,, ,,	0-7-0
	Miscellaneous.		
1	Laying, linking and packing tramway line	per % l.ft.	3-0-0
2	Dismantling tramway line	,, ,,	1-0-0
3	Carriage of tramway track lead within one mile.	,, ,,	1-0-0
4	Filling empty cement bags with sand, sewing and placing them in position for making retaining walls for mixers	Each	0-1-0
5	Fitting well curbs in position ..	,, ,,	1-0-0
6	Well sinking by hand upto 15·0′ depth	% cu. ft.	10-0-0
7	Dismantling retaining walls of sand bags	Bag.	0-0-3

RASUL WEIR
XIMUM FLOOD LEVEL UP STREAM = 724·2 (8,75,000 CUSECS) D/ 29-8-29
" " DOWN STREAM = 723·5 " "

723·5

FERENCES
NS BEFORE RECONDITIONING SHOWN THUS _ _ _ _ _
ONS RECONDITIONED SHOWN THUS ———

STONE PITCHING

100·0

154·50
3
151·50

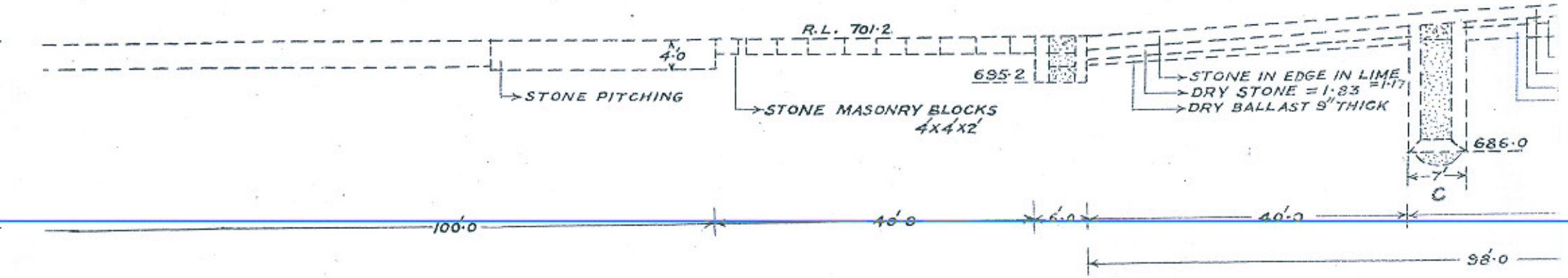
'8,75,000 CUSECS) D/ 29-8-29
" "

CROSS SECTION OF RASU

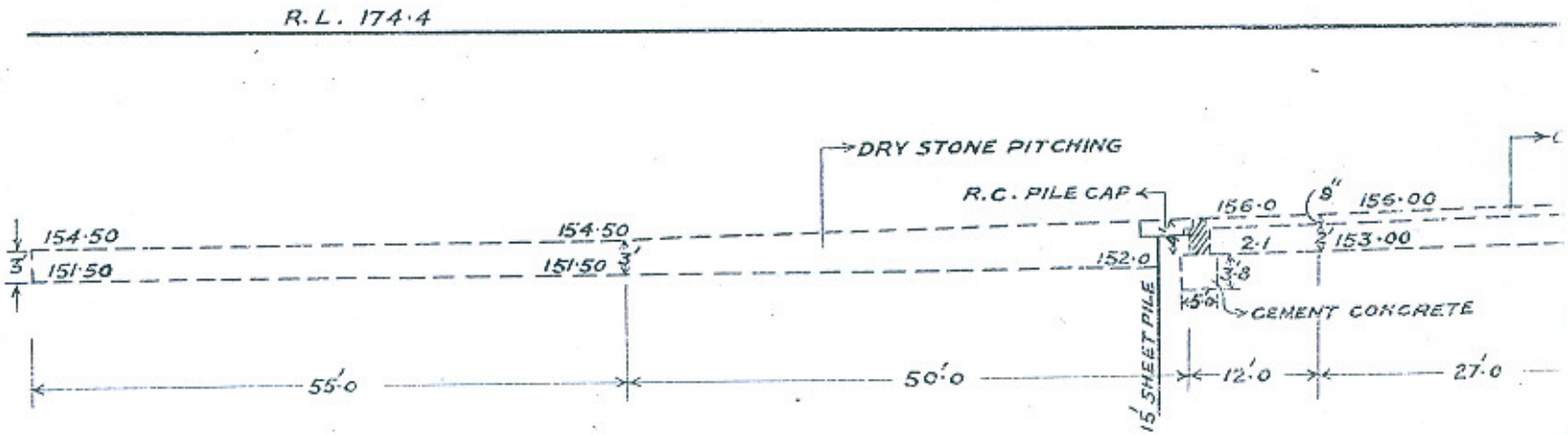
SCALE = 1/200

723·5

'US



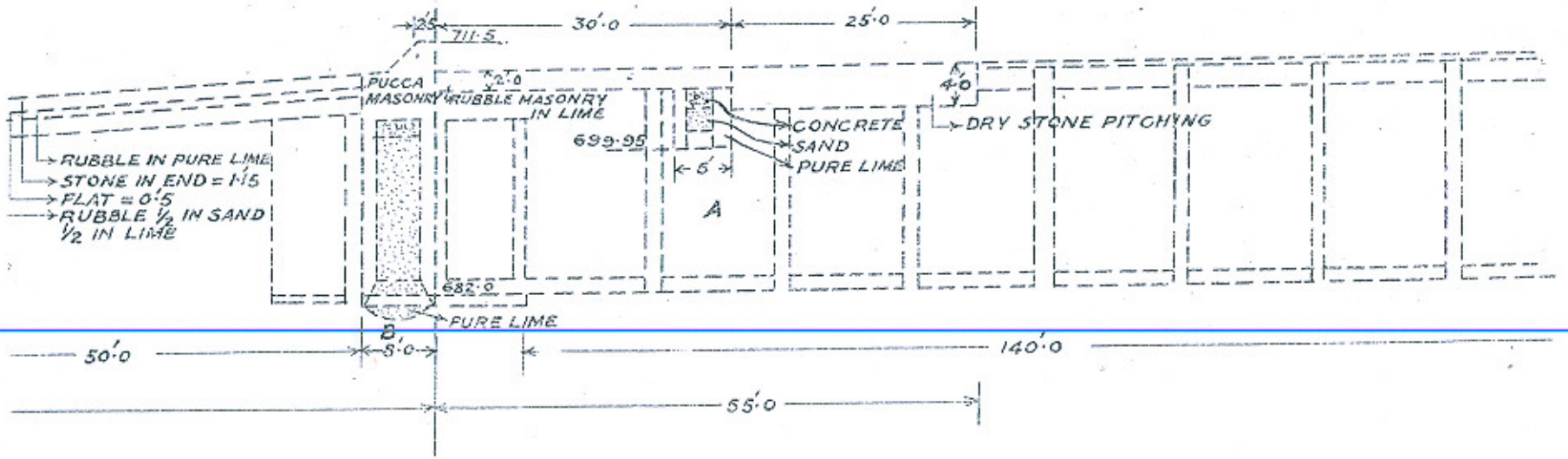
CROSS SECTION OF ANDERS



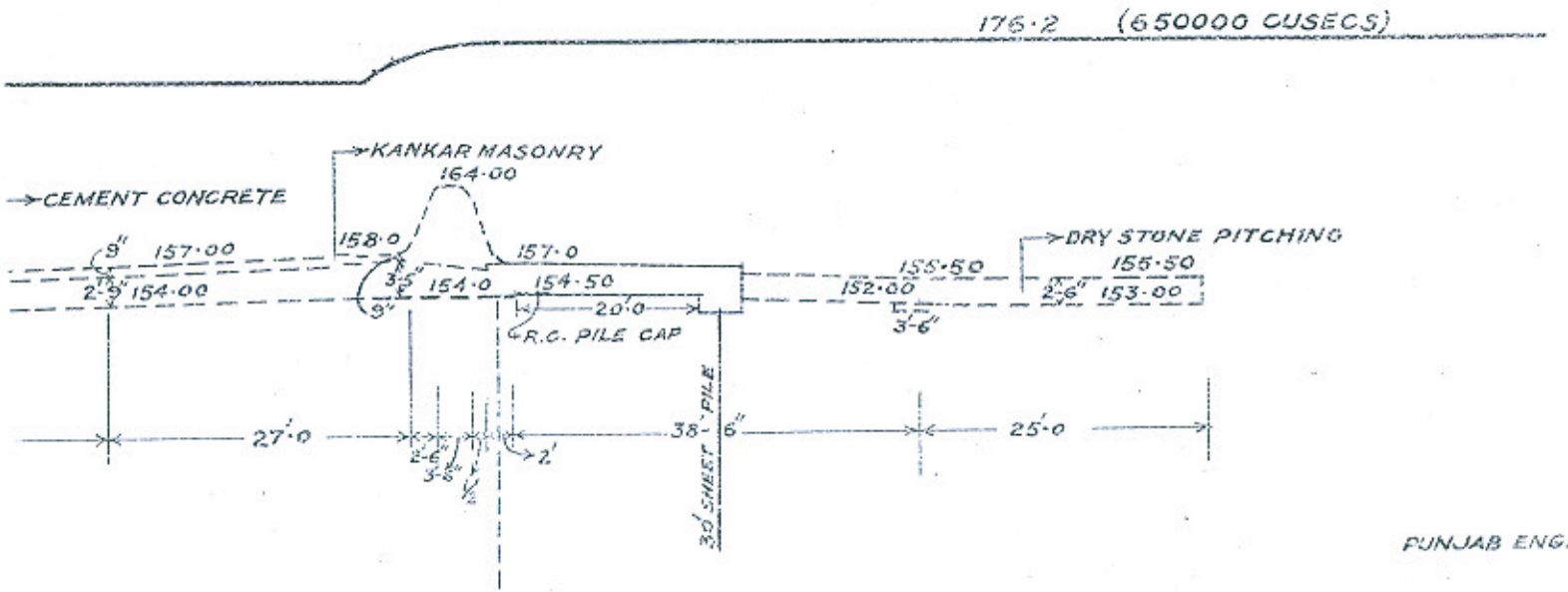
SUL WEIR & GROYNE

PLATE I a

PAPER NO. 215



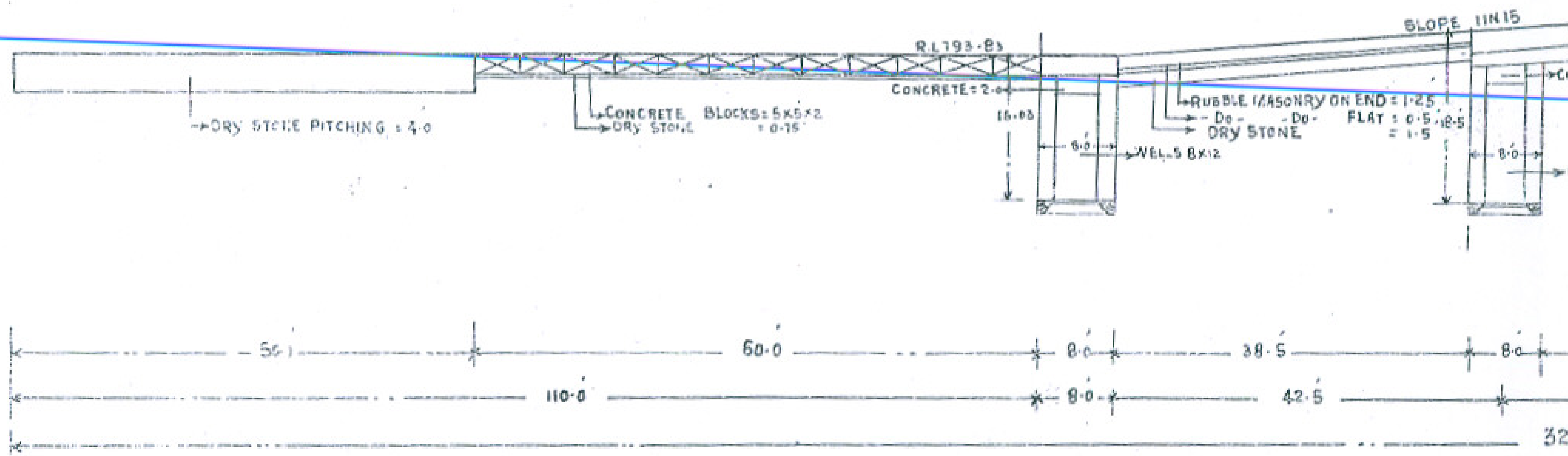
RSON WEIR



PUNJAB ENGINEERING CONGRESS
1938

MARALA WE

CR

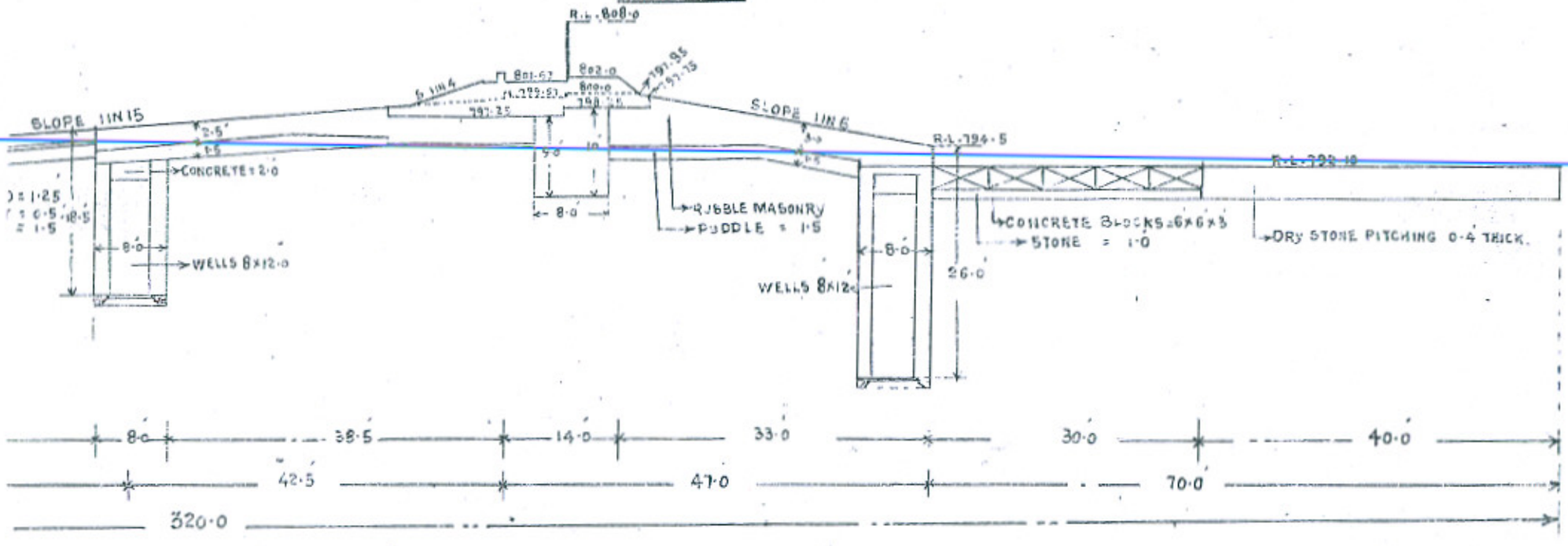


SLOPE 1IN15
R.L793·83
CONCRETE = 2·0
CONCRETE BLOCKS = 5X5X2
DRY STONE = 0·75
DRY STONE PITCHING = 4·0
RUBBLE MASONRY ON END = 1·25
-Do- -Do- FLAT = 0·5
DRY STONE = 1·5
WELLS 8X12
16·08
18·5
8·0
60·0
38·5
110·0
42·5

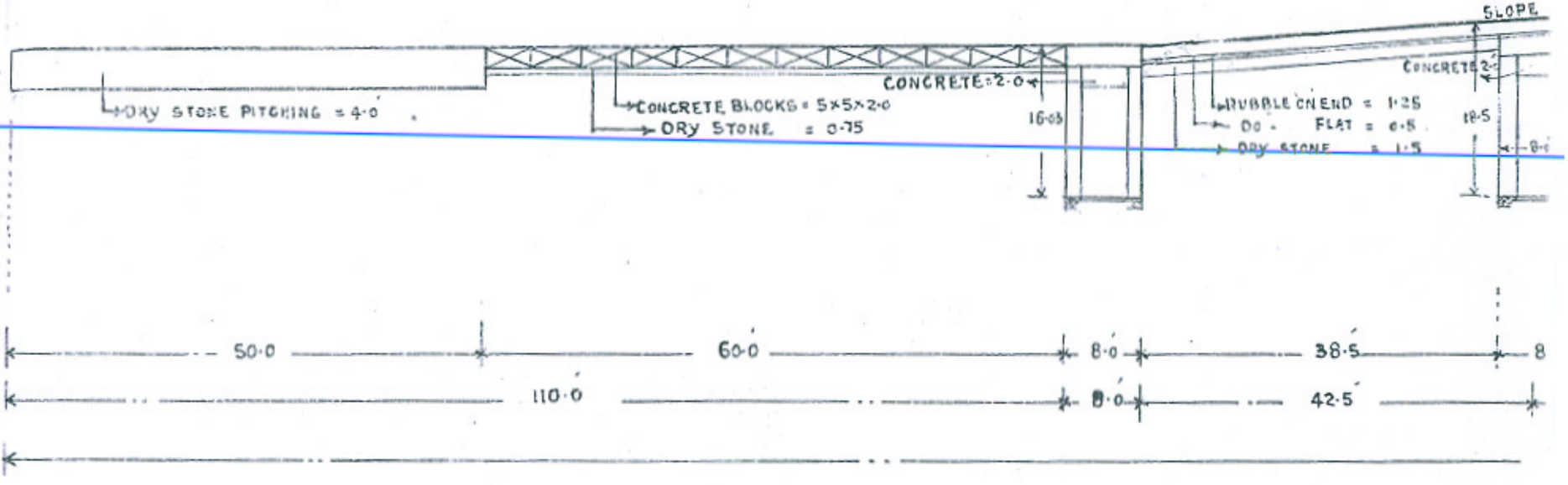
ALA WEIR

CROSS SECTION OF BAYS NO 1 TO 6 BEFORE RECONDITIONING

SCALE = 1/200



MARALA WE

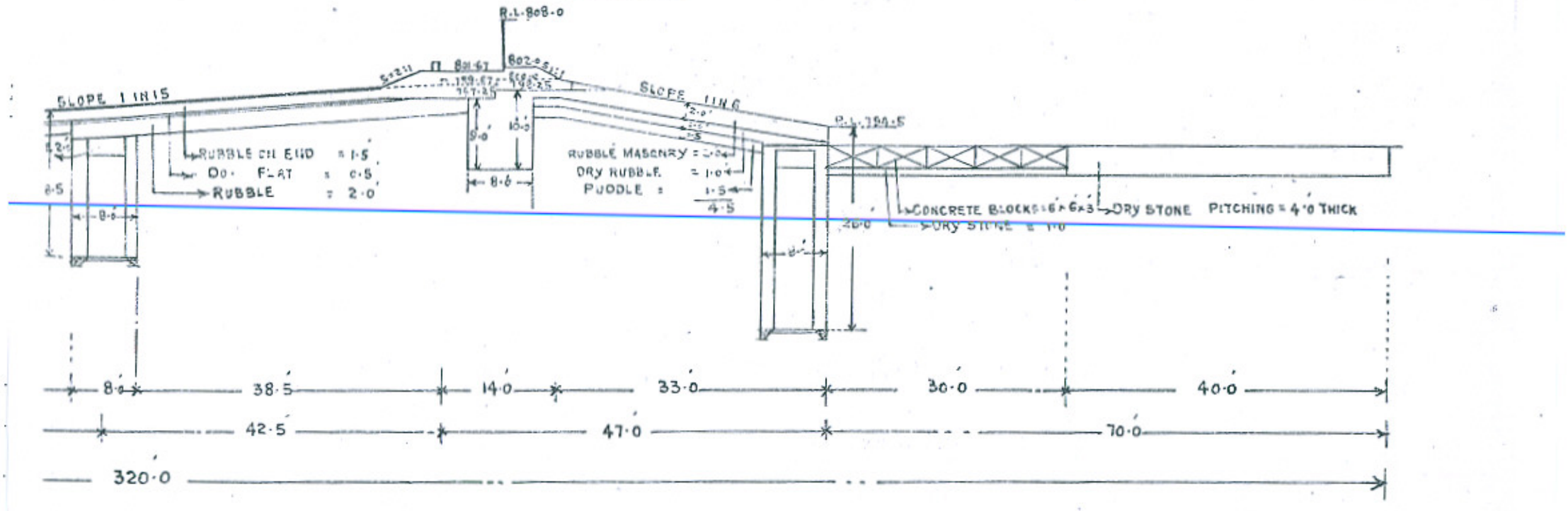

SLOPE
DRY STONE PITCHING = 4·0
CONCRETE BLOCKS = 5×5×2·0
DRY STONE = 0·75
CONCRETE = 2·0
16·0
RUBBLE ON END = 1·25
DO FLAT = 0·5
DRY STONE = 1·5
CONCRETE 2·
18·5
8·0
50·0
60·0
8·0
38·5
8
110·0
8·0
42·5

WEIR

PLATE II a
PAPER NO. 215

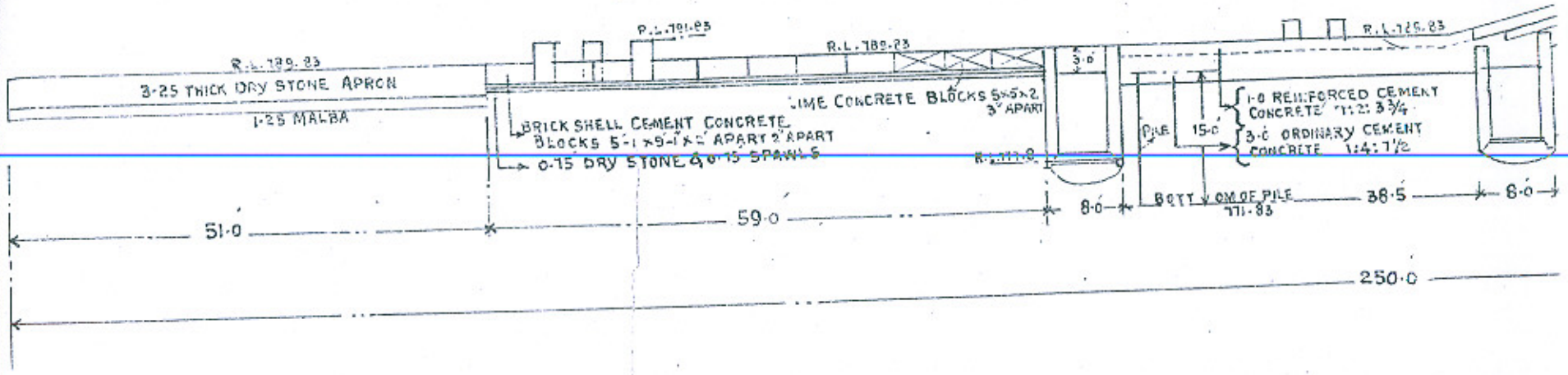
CROSS SECTION OF BAYS NO 7 & 8 BEFORE RECONDITIONING

SCALE = 1/200



PUNJAB ENGINEERING CONGRESS
1938

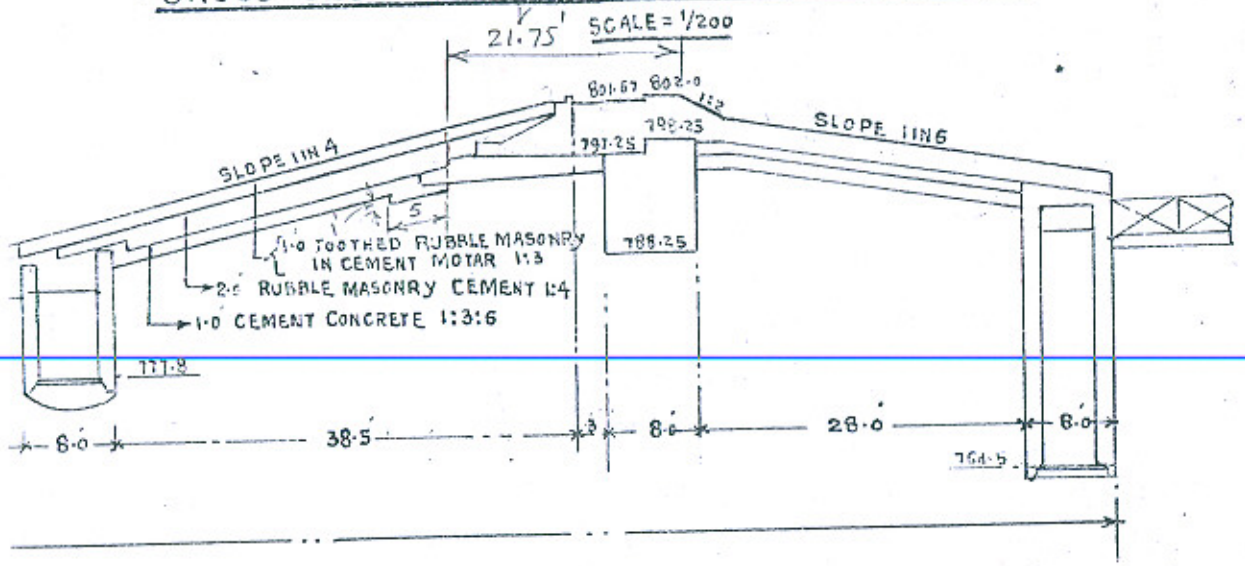
MARALA WEII


R.L. 789.83
3-25 THICK DRY STONE APRON
1-25 MALBA
R.L. 791.83
R.L. 789.83
BRICK SHELL CEMENT CONCRETE BLOCKS 5-1"x9-1"x2" APART 2" APART
0-15 DRY STONE & 0-15 SPANDLS
LIME CONCRETE BLOCKS 5x5x2 3" APART
3-0
R.L. 777.0
8-0
PILE
15-0
BOTTOM OF PILE 771.83
1-0 REINFORCED CEMENT CONCRETE 1:2:3¾
3-0 ORDINARY CEMENT CONCRETE 1:4:7½
R.L. 786.83
38-5
8-0
51-0
59-0
250-0

WEIR

PLATE 11b
PAPER NO. 215

CROSS SECTION OF WEIR AFTER RECONDITIONING



PUNJAB ENGINEERING CONGRESS
1938

MARALA WEIR

CROSS SECTION O

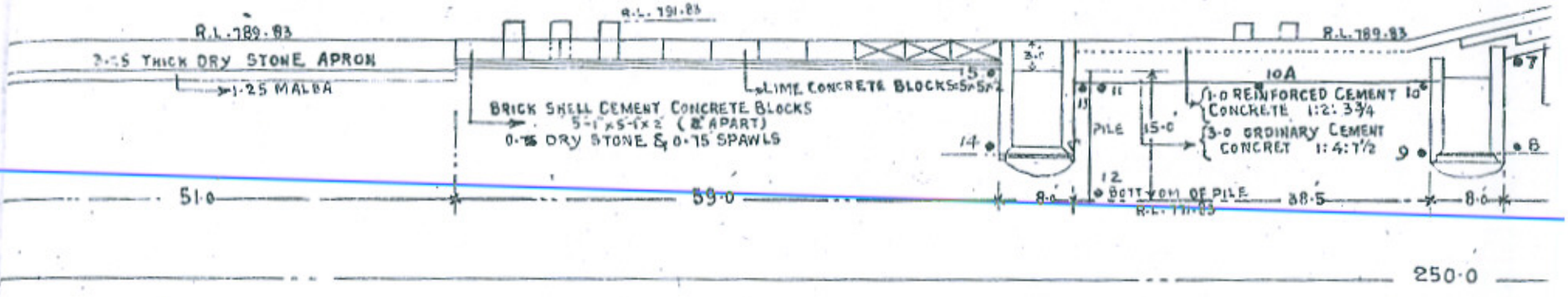
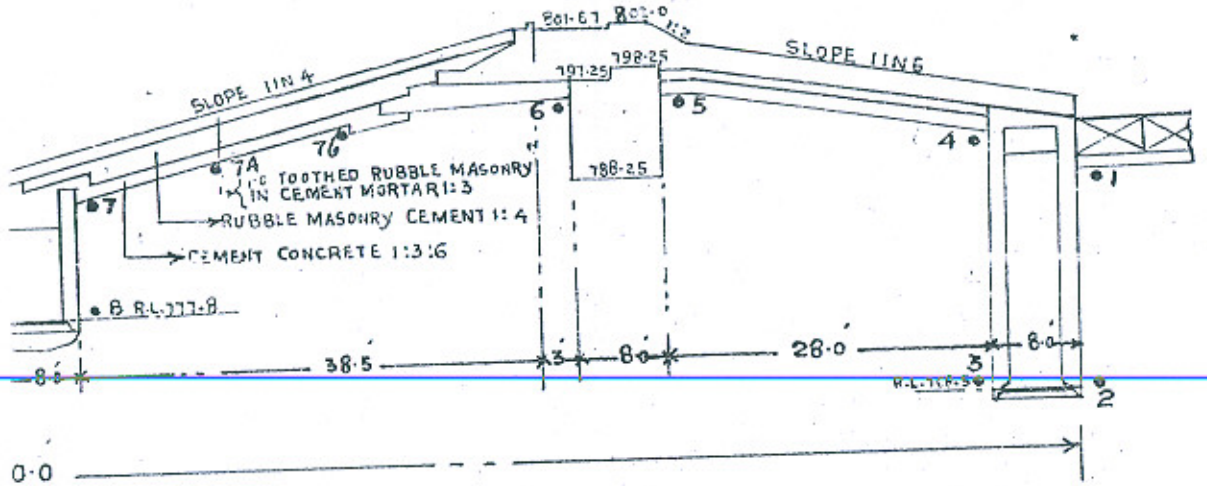


PLATE IIc
PAPER NO. 215.

CTION OF WEIR SHOWING POSITION OF PRESSURE PIPES

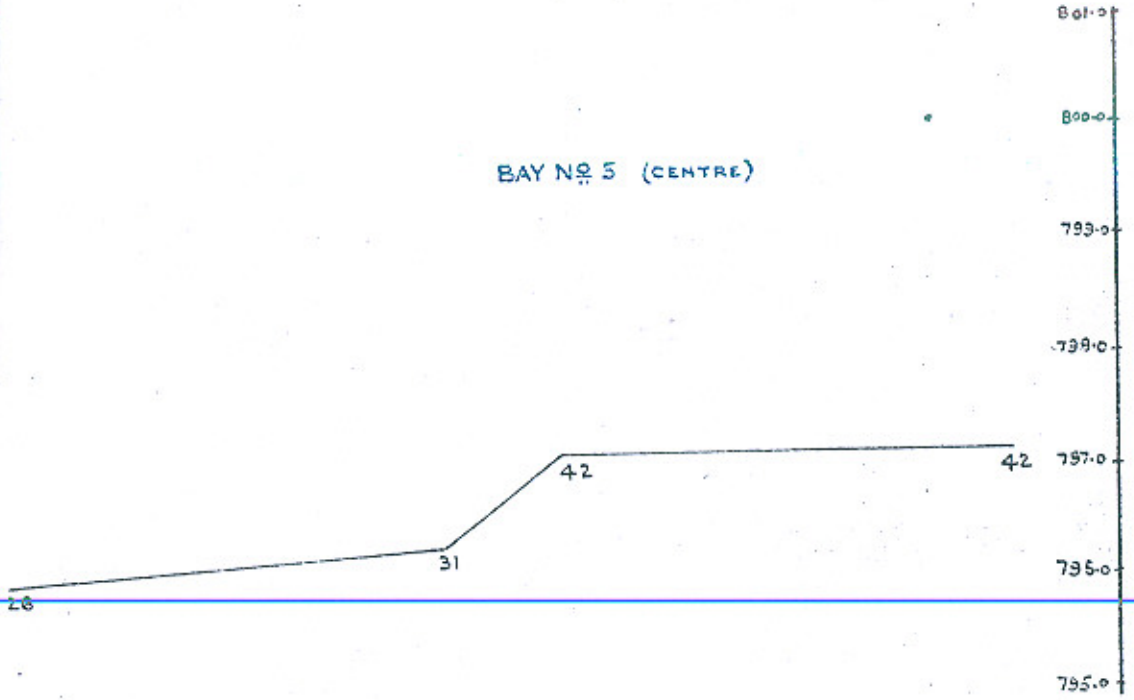
SCALE = 1/200

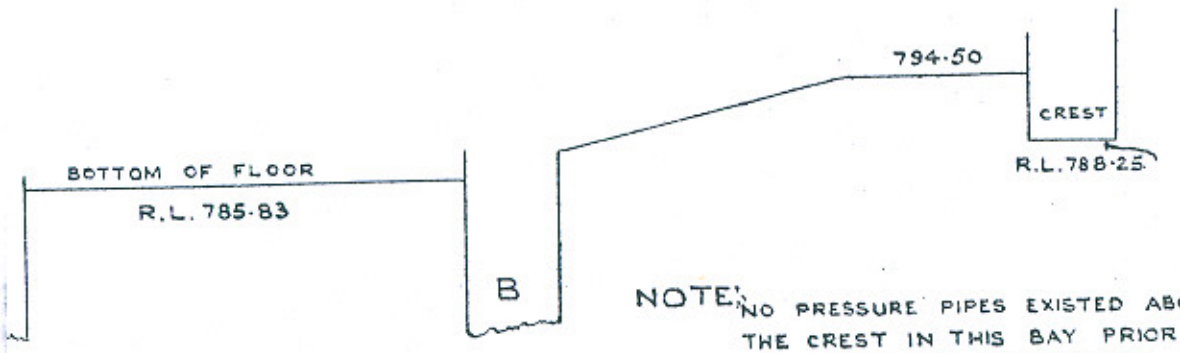


PUNJAB ENGINEERING CONGRESS
1938

BAY No. 5 (CENTRE)

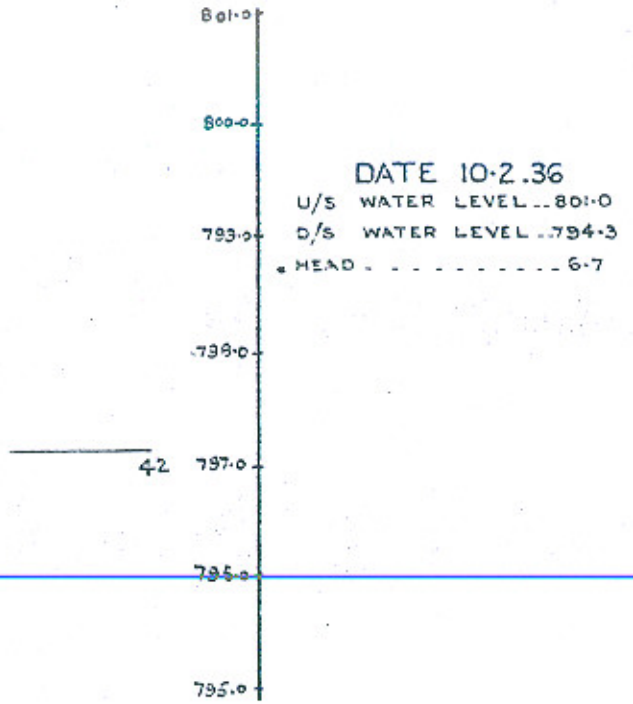
DATE 10.2.36
U/S WATER LEVEL .. 801.0
D/S WATER LEVEL .. 794.3
HEAD 6.7

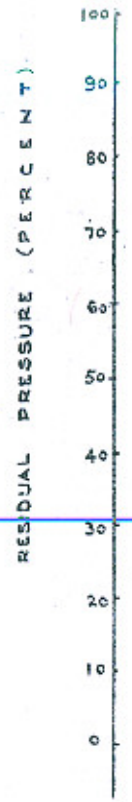


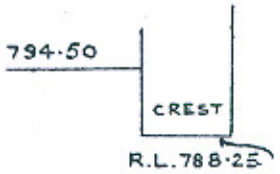


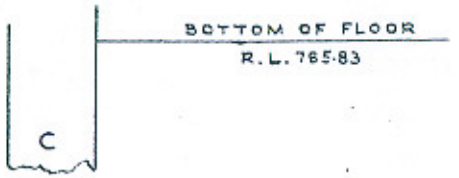
NOTE: NO PRESSURE PIPES EXISTED ABOVE THE CREST IN THIS BAY PRIOR TO RECONDITIONING OF THE WEIR.

DIAGRAMS SH







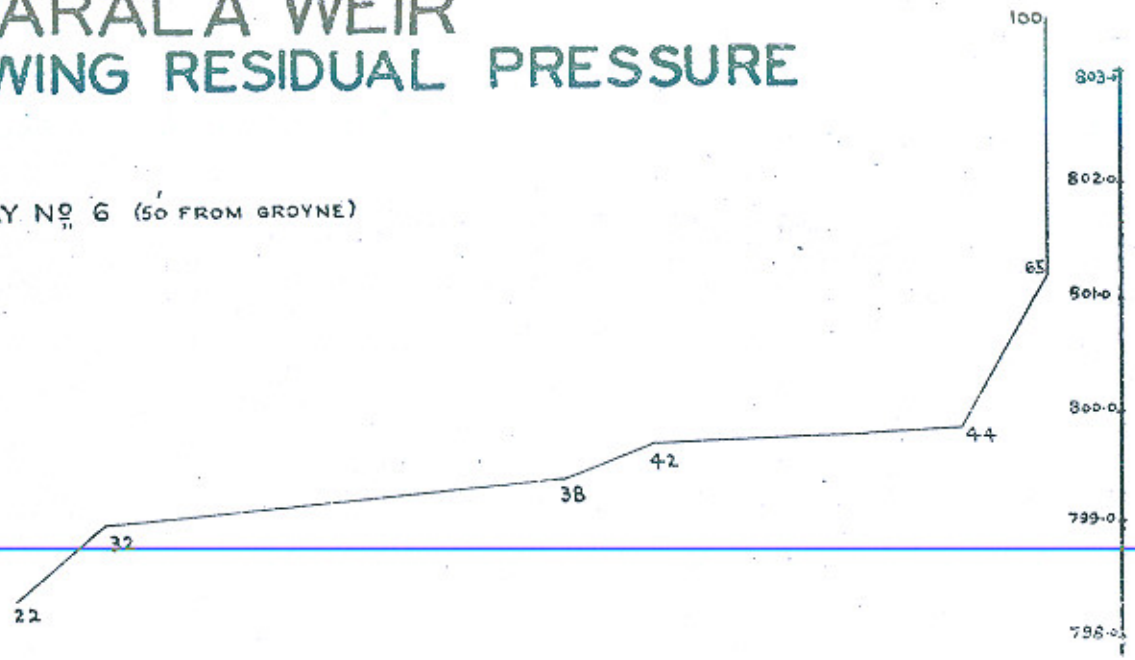


E PIPES EXISTED ABOVE
IN THIS BAY PRIOR TO
NING OF THE WEIR.

PLATE III
PAPER NO. 215

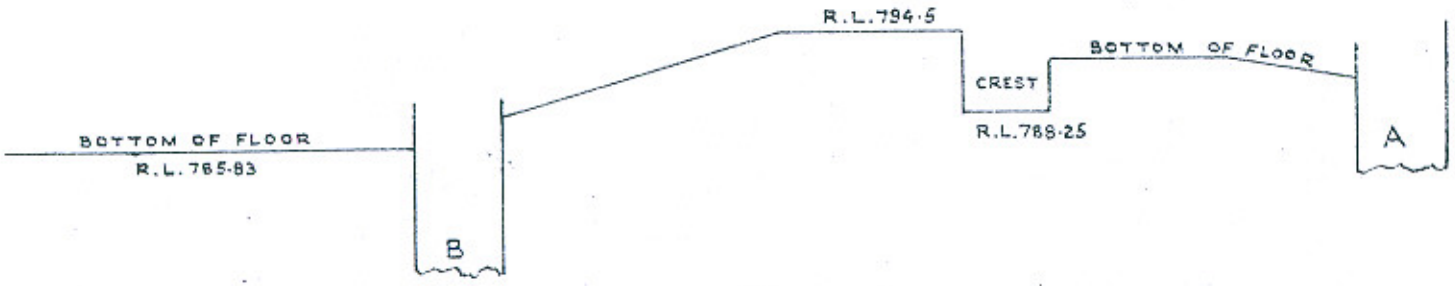
MARALA WEIR
AGRAMS SHOWING RESIDUAL PRESSURE

BAY No 6 (50' FROM GROYNE)



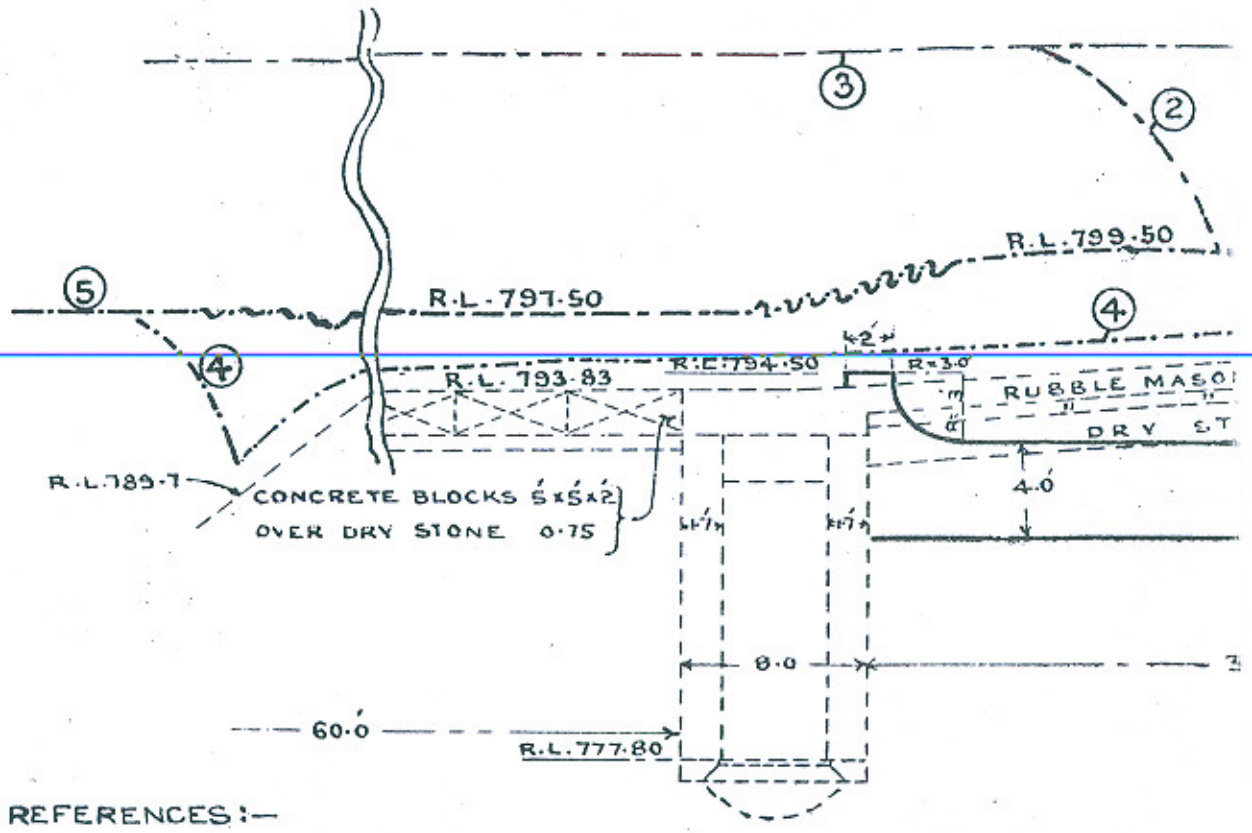
DATE 22·3·36

U/S WATER LEVEL . . . . 803·45
D/S WATER LEVEL . . . . . 797·00
HEAD . . . . . 6·45



PUNJAB ENGINEERING CONGRESS
1938

SUGGESTIC



REFERENCES:—

EXISTING WORK SHOWN THUS - - - - - - - - - - - - - - - - - (DOTTED) — — — — —

PROPOSALS FOR RECONDITIONING THE D/S. GLACIS SHOWN THUS ———————

(1) ACTUAL S.W. FOR 133·5 CUS: ON 8/29

(2) CALCULATED S.W. FOR 133·5 CUS: ON EXISTING WORK

(3) " " " " " WITH THE PROPOSED WORK IN POSITION

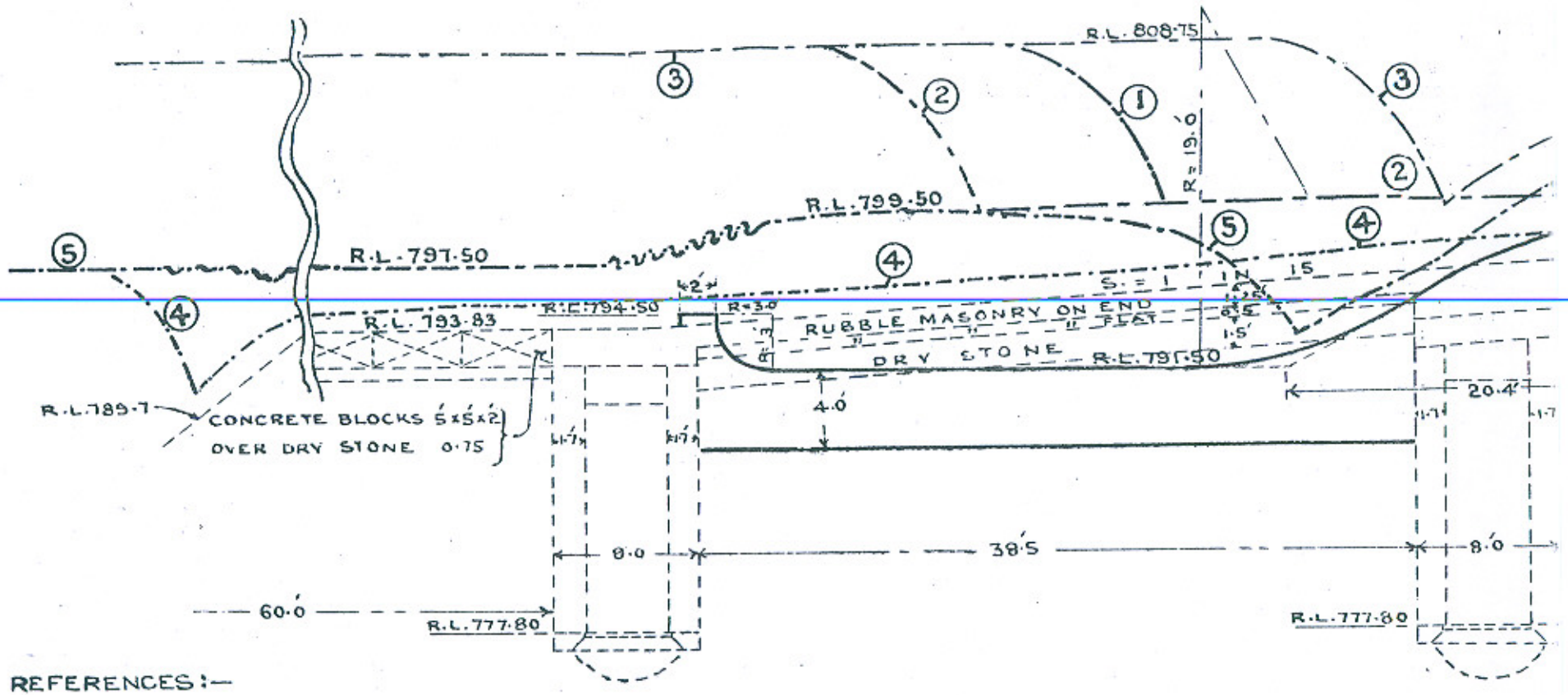
(4) " " " 4·0 " ON EXISTING WORK

(5) " " " " " WITH THE PROPOSED WORK IN POSITION

MARALA WEIR

SUGGESTIONS FOR RECONDITIONING

SCALE = 1/100



REFERENCES :—

EXISTING WORK SHOWN THUS - - - - - - - - - - - - - - - - - - (DOTTED) — — — — —

PROPOSALS FOR RECONDITIONING THE D/S. GLACIS SHOWN THUS ————————

(1) ACTUAL S.W. FOR 133·5 CUS: ON 8/29

(2) CALCULATED S.W. FOR 133·5 CUS: ON EXISTING WORK

(3) " " " " " WITH THE PROPOSED WORK IN POSITION

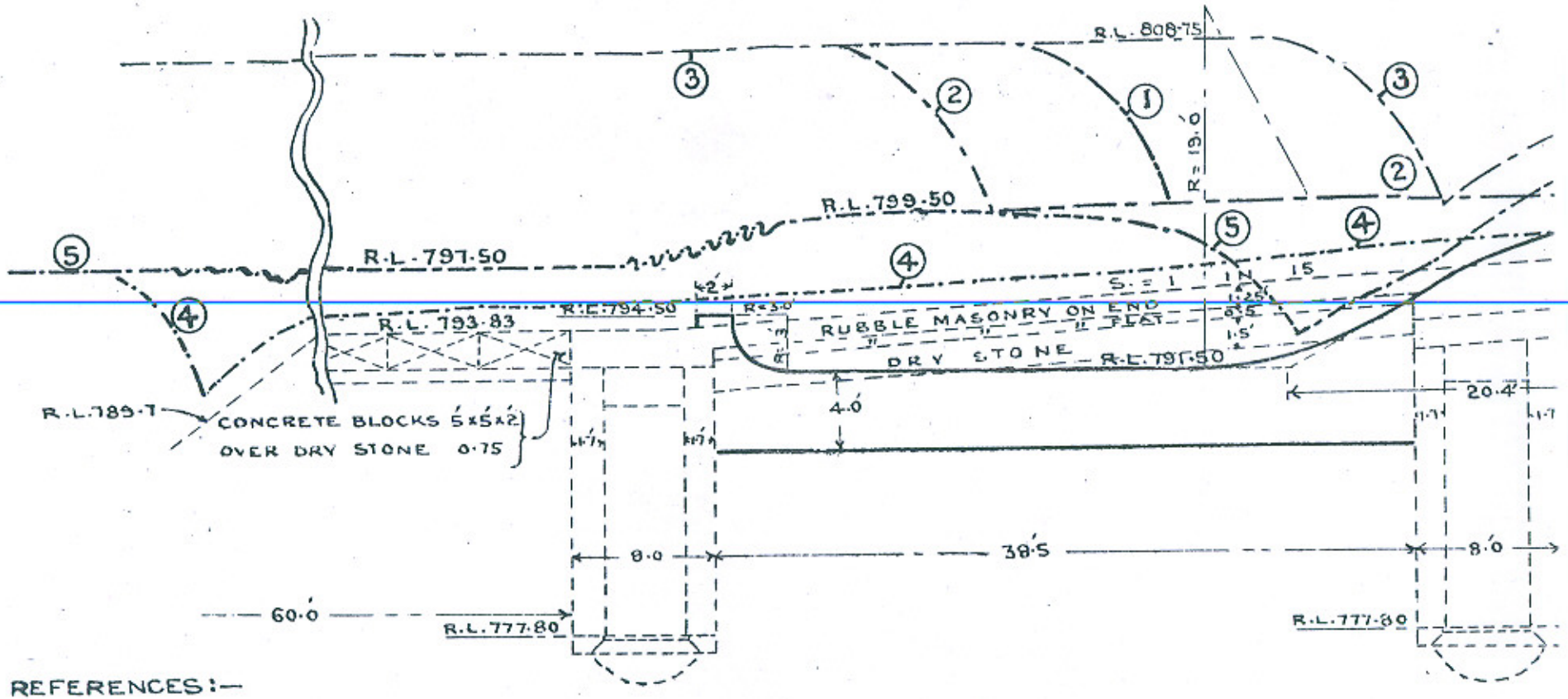
(4) " " " 4·0 " ON EXISTING WORK

(5) " " " " " WITH THE PROPOSED WORK IN POSITION

MARALA WEIR

SUGGESTIONS FOR RECONDITIONI

SCALE = 1/100



REFERENCES:—

EXISTING WORK SHOWN THUS - - - - - - - - - - - - - - - - - - (DOTTED) — — — — —

PROPOSALS FOR RECONDITIONING THE D/S. GLACIS SHOWN THUS ————————

(1) ACTUAL S.W. FOR 133·5 CUS: ON 8/29

(2) CALCULATED S.W. FOR 133·5 CUS: ON EXISTING WORK

(3) " " " " " WITH THE PROPOSED WORK IN POSITION

(4) " " " 4·0 " ON EXISTING WORK

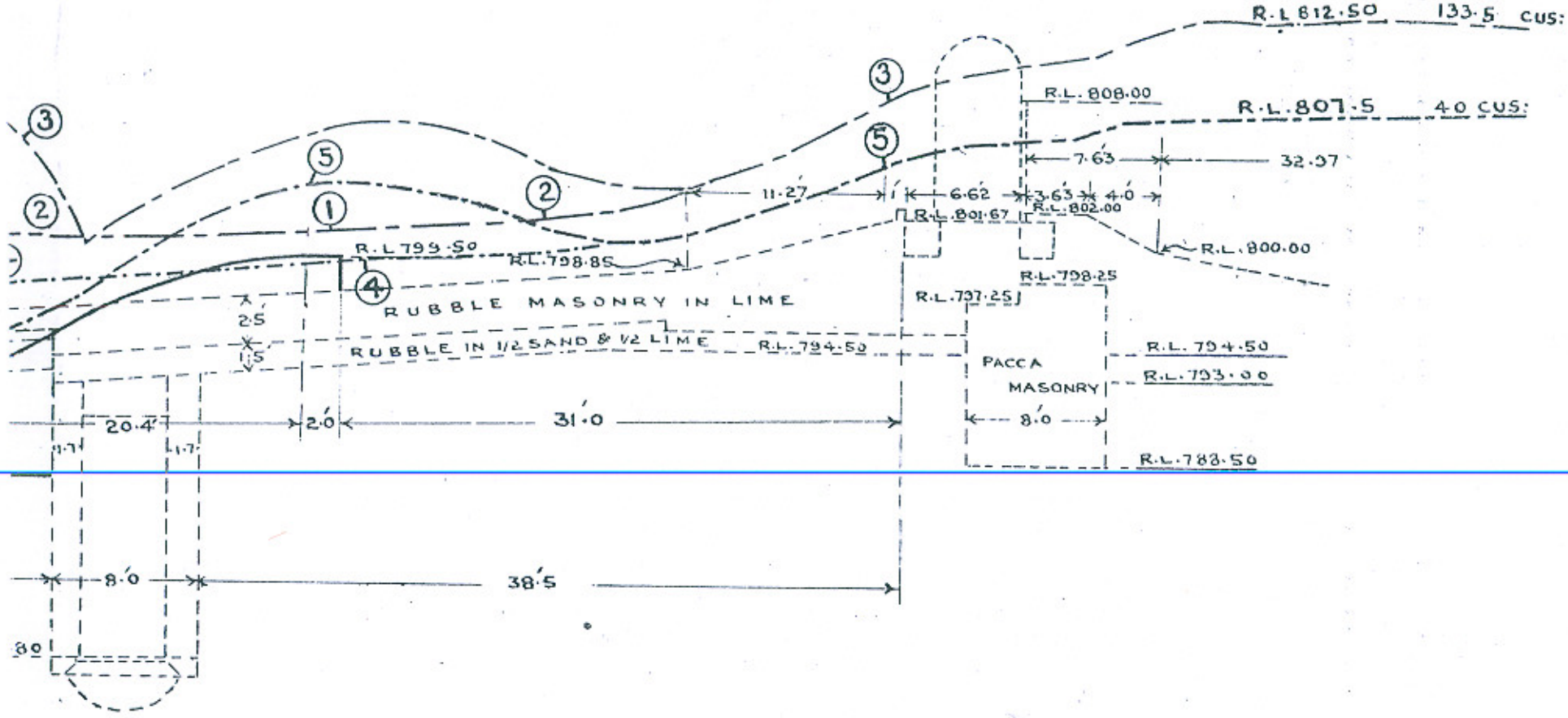
(5) " " " " " WITH THE PROPOSED WORK IN POSITION

WEIR

NDITIONING D/S. GLACIS

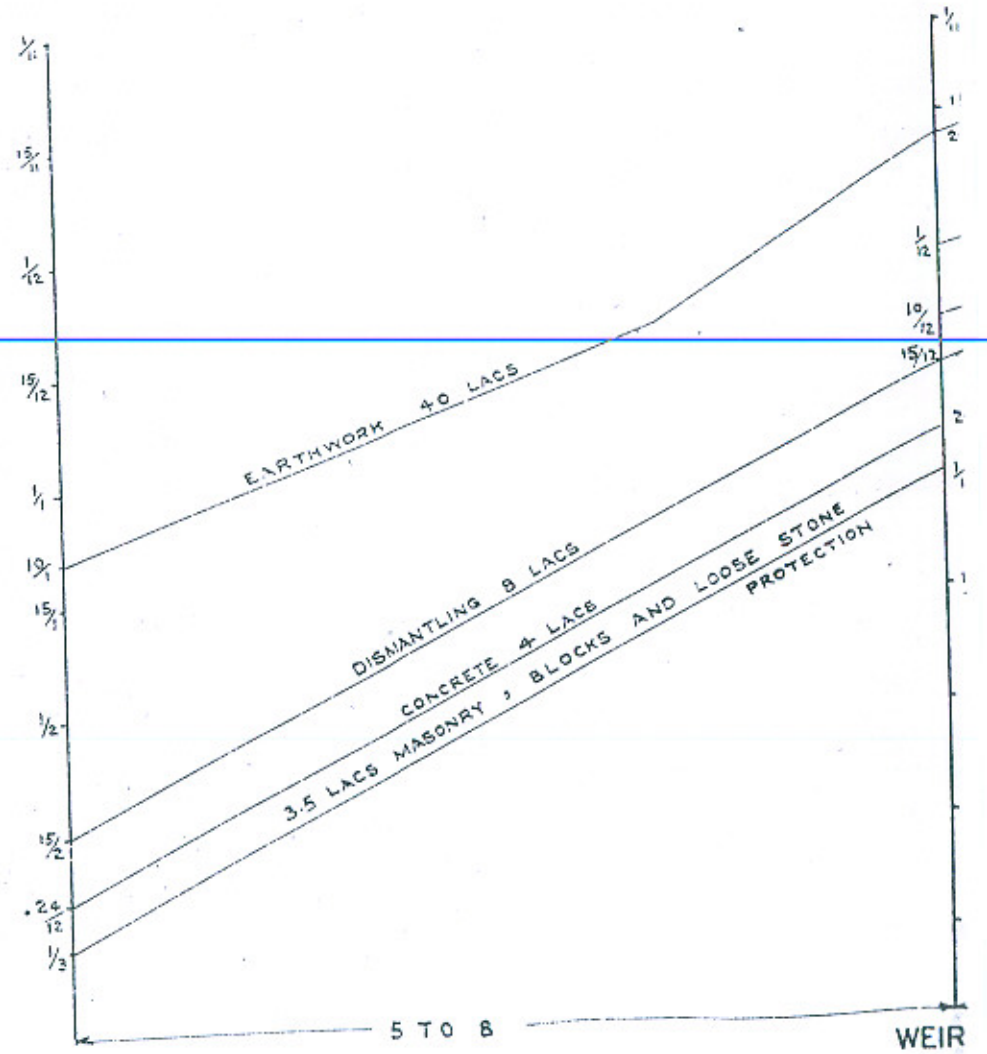
/100

PLATE IV
PAPER NO. 215



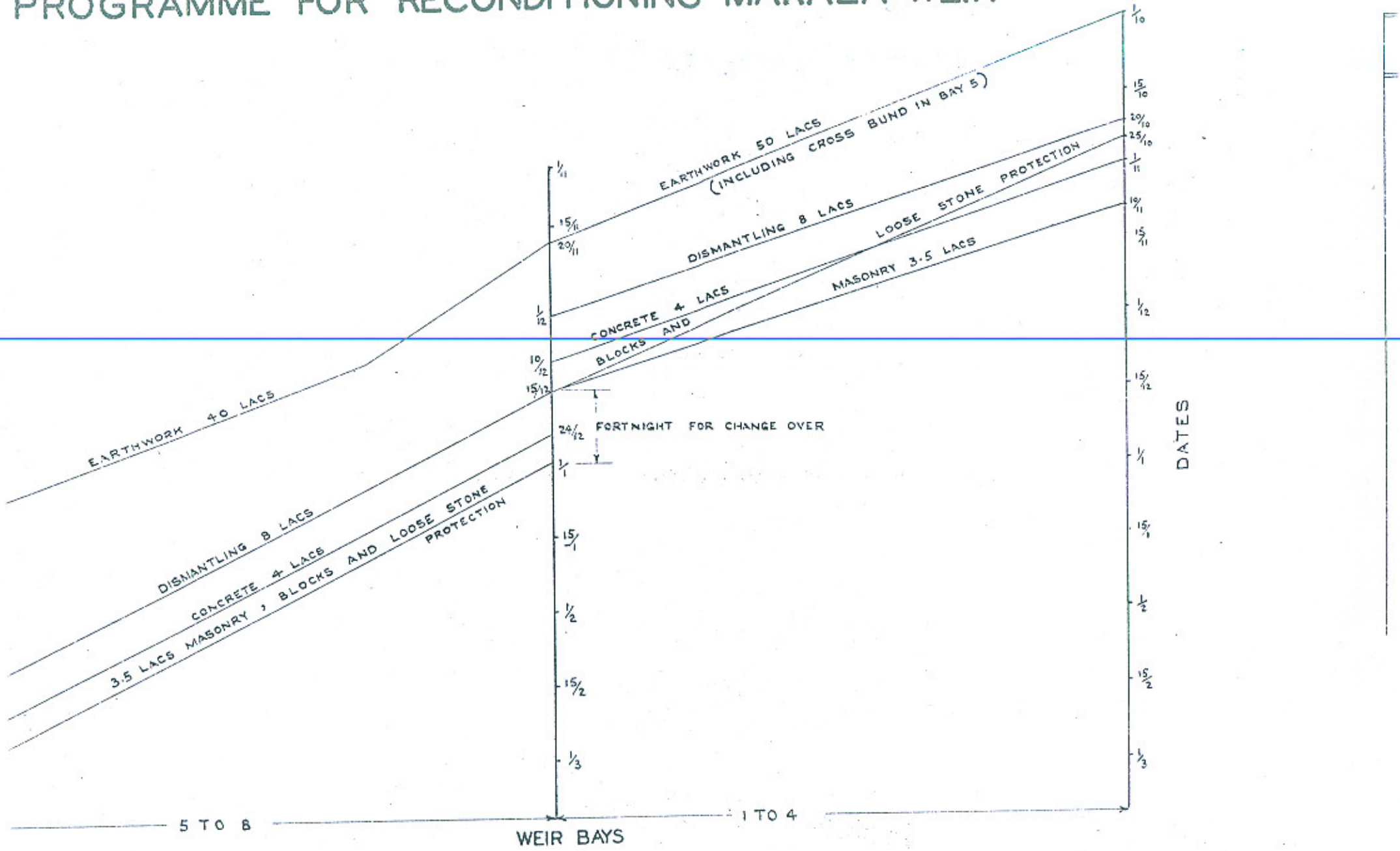
PUNJAB ENGINEERING CONGRESS
1938

MARALA DIVISIC
PROGRAMME FOR RECONDI

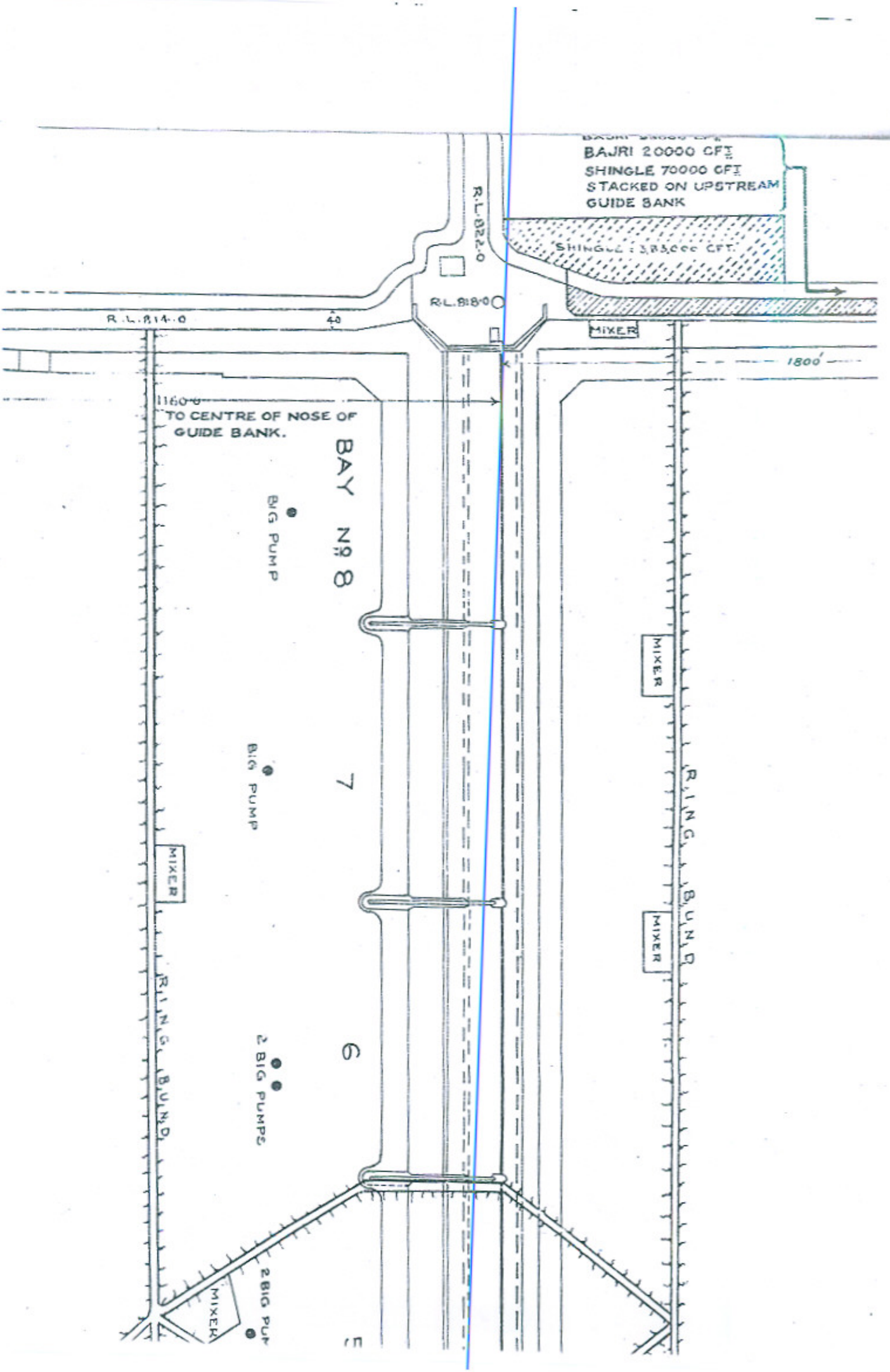


MARALA DIVISION U.C.C.

PROGRAMME FOR RECONDITIONING MARALA WEIR



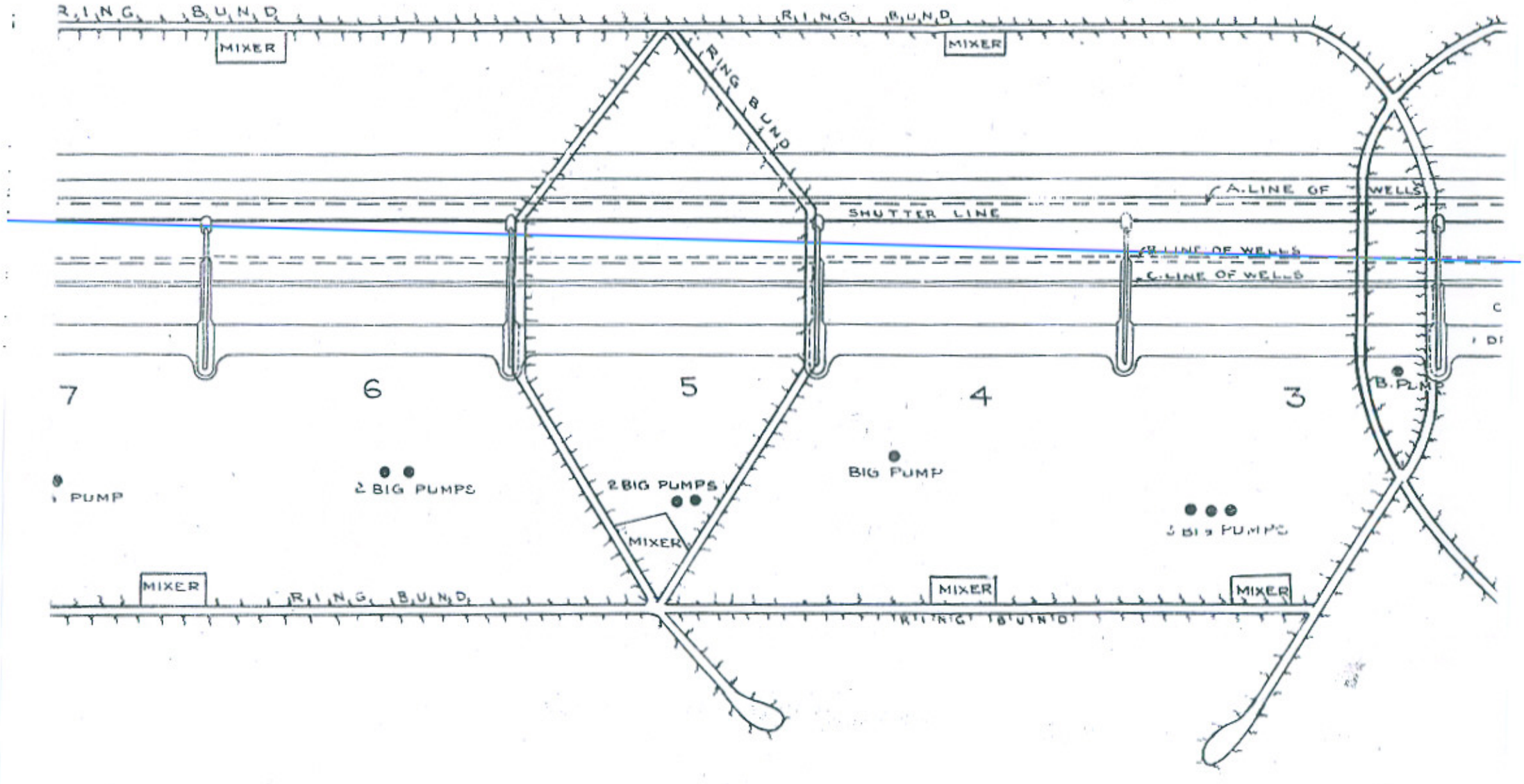
NAME OF WORK 1	DAILY PROGRESS 2	LABOUR					
		DONKEY 3	BOATS 4	MASON 5	COOLY 6	TACKLE COOLY	CAMEL 8
EARTH-WORK	1,00,000 C.F $\frac{T}{H}$ (70,000 BY DONKEY; 30,000 BY BOAT)	350	50	〃	200 300	〃 〃	〃
DISMANTLING	18,000 C.F $\frac{T}{H}$	100	〃	〃	50 FOR DONKEY AND 350 FOR DISMANTLING	〃	〃
CONCRETE	10,000 C.F $\frac{T}{H}$	〃	〃	25	300	〃	300 FOR SHINGLE AND 50 FOR CEMENT
MASONRY	10,000 C.F $\frac{T}{H}$	〃	〃	200	200	〃	50 FOR STONE AND 50 FOR CEMENT
BLOCKS	100 NOS A DAY	〃	〃	〃	〃	200	〃
UP STREAM WORK :- NO SPECIAL LABOUR NEEDED							
		450	50	225	1400	200	450
LABOUR STRENGTH TO BE ARRANGED.		600	60	250	1600	250	500


BAJRI 20000 CFT
SHINGLE 70000 CFT
STACKED ON UPSTREAM
GUIDE BANK
SHINGLE : 3,85,000 CFT.
R.L.822.0
R.L.818.0
R.L.814.0
40
MIXER
1800'
1160'-0"
TO CENTRE OF NOSE OF
GUIDE BANK.
BAY No 8
7
6
BIG PUMP
BIG PUMP
2 BIG PUMPS
MIXER
MIXER
MIXER
MIXER
RING BUND
RING BUND
2 BIG PUMPS
MIXER

RECONDITIONING OF

LAYOUT PL

SCALE = 1/2500



MARALA WEIR

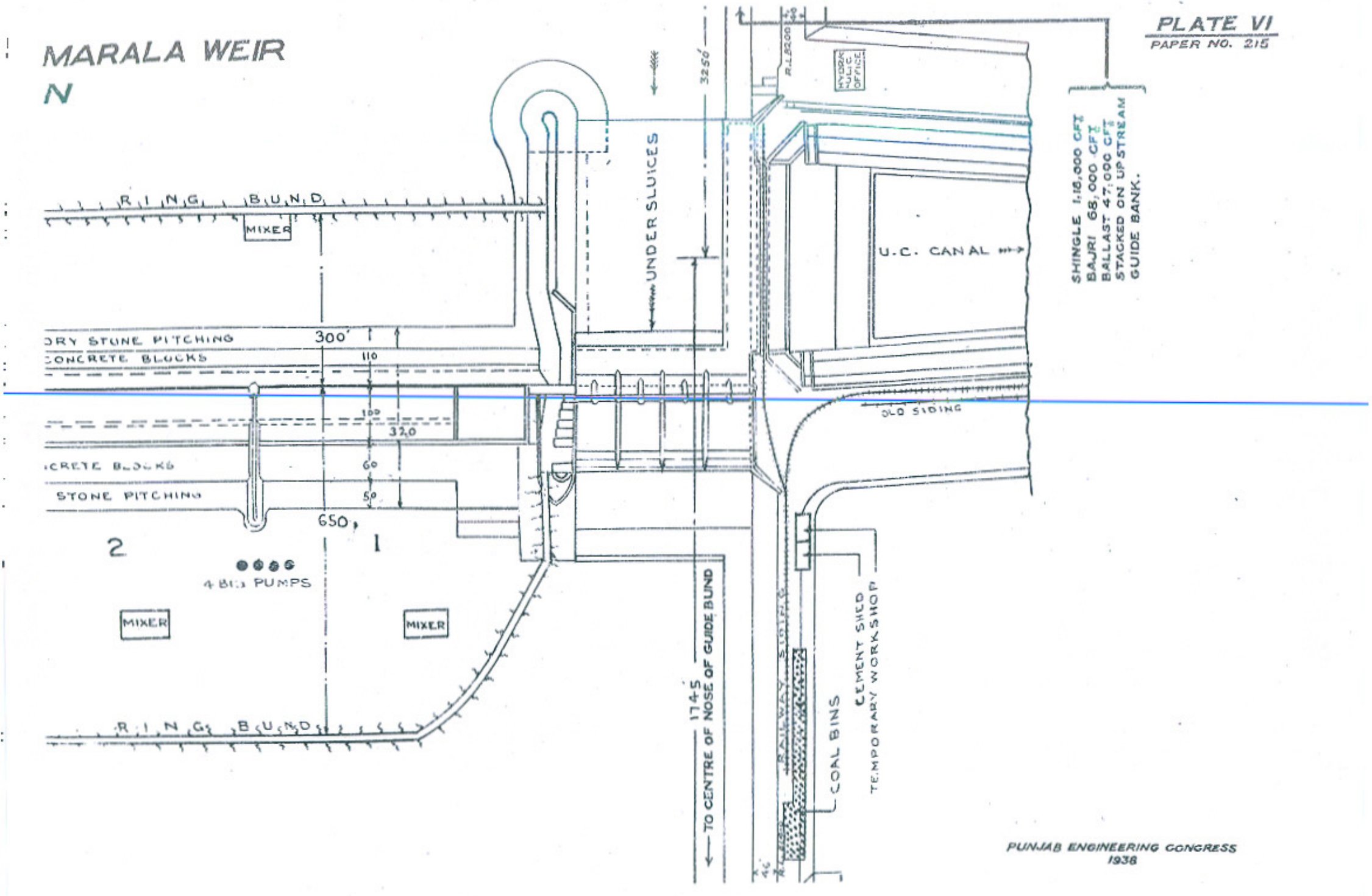
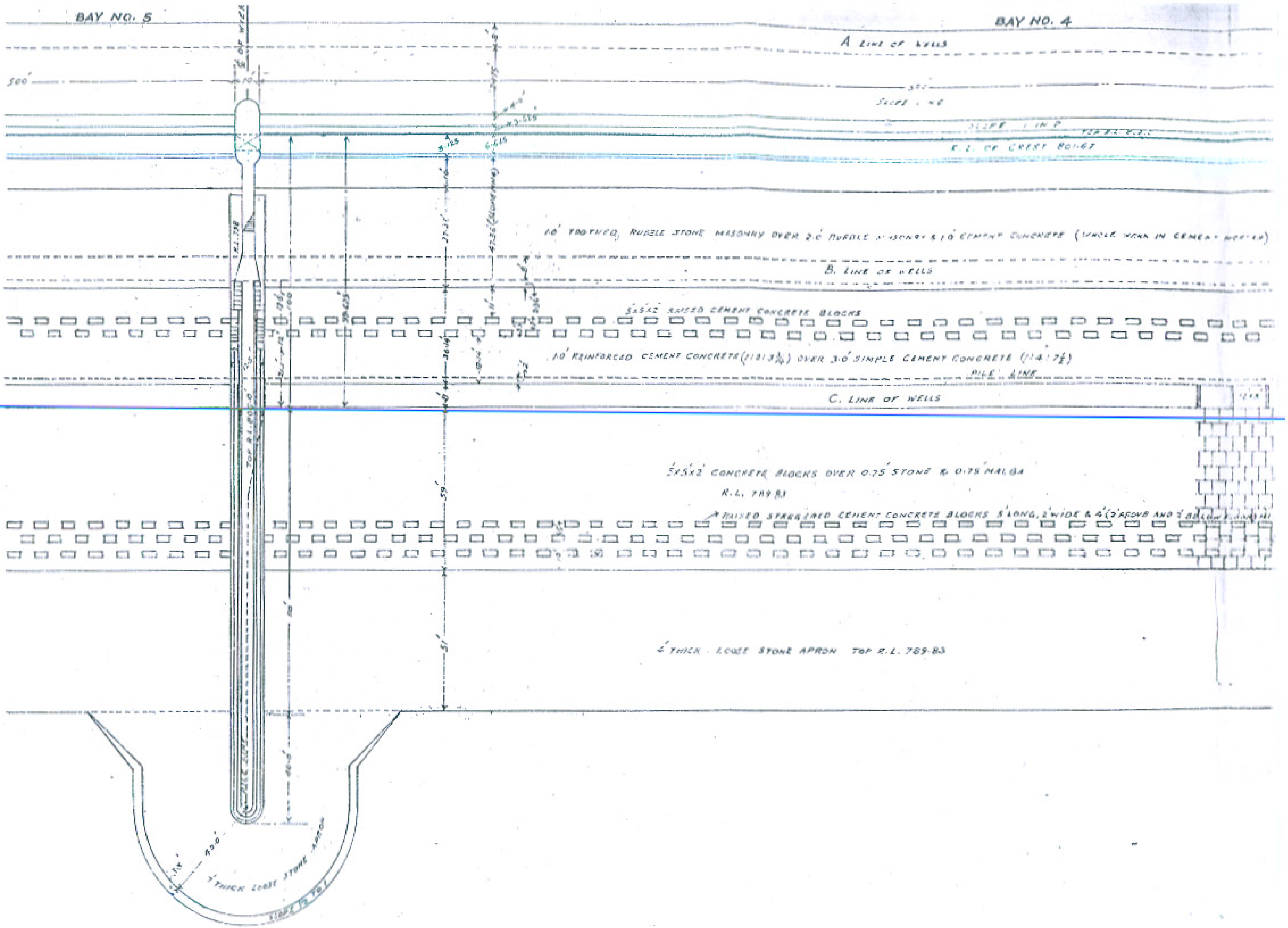


PLATE VI
PAPER NO. 215

PUNJAB ENGINEERING CONGRESS
1938


BAY NO. 5
BAY NO. 4
A LINE OF WELLS
R.L. OF CREST 801.67
B. LINE OF WELLS
5x5x2 RAISED CEMENT CONCRETE BLOCKS
PILE LINE
C. LINE OF WELLS
5x5x2 CONCRETE BLOCKS OVER 0.75 STONE & 0.75 MALBA
R.L. 789.83
4 THICK LOOSE STONE APRON TOP R.L. 789.83
7 THICK LOOSE STONE APRON
TOP R.L. 800.0
PILE LINE
SLOPE 1 TO 1
500'
51'
59'
110'
99.625'
40.0'