GHQ/SCAP Records (RG 331, National Archives and Records Service)

Description of contents

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(2) Folder title/number: (5)
Water System - Tokyo-To

(3) Date: Jan. 1945 - Nov. 1947

(4) Subject:

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(5) Item description and comment:
Tokyo

(6) Reproduction: Yes (circled) No

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(Compiled by *National Diet Library*)

File water supplies

4 November, 1947

TO : Director of Health Bureau, Tokyo-to.

FROM : Y. Uegaki, chief of Tokyo Milk Co.

(12, 1-chome, Tamachi, Shiba, Minato-ku, Tokyo)

Application for recommendation for getting chlorine

On 15 February 1947 chlorine was designated as one of the appointed materials for production. Before that time we used to get it from Isomura Industrial Co. However since it was designated, it has been very hard to get it. We requested Ministry of Forestry and Agriculture several times but Ministry people said that sterilization of milk bottle by chlorine was unnecessary because supplied water contained at present **a fairly** lots of chlorine in it. So there has been no ration of chlorine to our company. We request you to certify that chlorine is urgently needed for milk production.

Results - Chlorine obtained for next 6 months

[illegible]

Capt Horris
File -45

REPORT ON WATER-SUPPLY IN FOOD - AREA

Affected area	Supply- situation Amount supplied	Line	Area without supply on 9 .Oct.
Adachi Ku	Whole Adachi Ku 40 450 ton	Kanemachi Line	none
Katsushika Ku	Whole Katsushika Ku 48 500 ton	" "	none
Edogawa Ku	most part 31 900 ton	Received from the Chiba Water-work and supllied through Kanemachi-plant	Higashi Funabori, Nishi Hitonoe, Higashi Komatsugawa (caused by break of the Funabori bridge)
Most part of Arakawa Ku (except 9 chome Nippori)	Arakawa Ku 38 700 ton	Kanemachi Line	none
Sumida Ku (except Yokozunamachi)	Whole Honjo Ku 59 100 t.	Yodobashi Line Kanemachi Line	none
Koto Ku (except most part of Fukagawa)	14 850 ton		none
Daito Ku (except most part of Shitaya)	whole area 25 000 ton		none
Total	258 500 ton		

Affected area	Supply- situation Amount supplied	Line	Area without supply on 8 .Oct.
Adachi Ku	Whole Adachi Ku 41 700 ton	Kanemachi Line	none
Katsushika Ku	" Katsushika Ku 52 000 ton	" "	Hirai Naka machi and other section, remitted supply caused by repairing of the Kyonomia Pump station)
Edogawa Ku	most part 33 800 ton	Recieved from the Chiba water-work and supplied through Kanemachi Plant	Higashi Funabori, Higashi-Komatsugawa, Nishi Hitonoe, Kyonomia, Honishikimachi & part of Nishi Koamtsugawa 1,2 cho. (caused by the break of Kasaibridge)
Most part of Arakawa Ku (except 9 chome Nippori)	Arakawa Ku 39 300 ton	Kanemachi Ku	
Sumida Ku (except Yokozunamachi)	Whole Honjo Area 63 000 ton	Yodobashi Line & Kanemachi Line	
Koto Ku (except most part of Fukagawa)	13 900 ton		
Daito Ku (except most part of Shitaya)	whole area 25 000 ton		
Total	265 000 ton		

REPORT ON WATER-SUPPLY IN FOOD - AREA

Affected Area	Supply- situation Amount supplied	Line		Area without supply on 7 .Oct.
Adachi Ku	Whole Adachi Ku 41 700 ton	Kanemachi Line	none	Nishi Komatsumachi, Hirai-Nakamachi & part of Ka Kami Komatsumachi (casued by break of Heiwa Bridge, Kamihirai Br.
Katsushika Ku	Whole Katsushika Ku 52 000 ton	" "	none	
Edogawa Ku	most part 33 700 ton	Received from the Chiba Water-work and supllied through Kanemachi-plant		Higashi Funabori, Nishi Komatsugawa, Nishihitonoe, Kyonomia, Honishikimachi ((break of Kasai Bridge)
Most part of Arakawa Ku (except 9 chome Nippori)	Arakawa Ku 39 300 ton	Kanemachi Line		
Sumida Ku (except Yokozunamachi)	Whole Honjo Ku 63 000 ton	Yodobashi Line Kanemachi Line		
Koto Ku (except most part of Fukagawa)	12 900 ton			
Daito Ku (except most part of Shitaya)	whole area 25 000 ton			
Total	265 000 ton			

""

Affected area	Supply- situation Amount supplied	Line		Area without supply on 6 .Oct.
Adachi Ku	Whole Adachi Ku 40 400 ton	Kanemachi Line	none	Kami Hirai machi, Kami Komatu machi, ShimoKomatu machi, Hio raimachi (Heiwa Bridge, Kami Hirai-Bridge 's breaks)
Katsushika Ku	" Katsushika Ku 39 000 ton	" "		
Edogawa Ku	most part 33 200 ton	Recieved from the Chiba water-work and supplied through Kanemachi Plant		Nishi Koamtsugawa, Higashi-Komatsugawa, Higashi Funabori Kyonomia, Honichikimachi, Nishi Hitnonoemachi (break of Kasai Bridge)
Most part of Arakawa Ku (except 9 chome Nippori)	Arakawa Ku 46 00 ton	Kanemachi Ku		
Sumida Ku (except Yokozunamachi)	Whole Honjo Area 23 100 ton	Yodobashi Line & Kanemachi Line		
Koto Ku (except most part of Fukagawa)	39 200 ton			
Daito Ku (except most part of Shitaya)	whole area 25 000 ton			
Total	234 900 ton			

REPORT ON WATER-SUPPLY IN FOOD - AREA

Affected Area	Supply- situation: Amount supplied	Line	Area without supply on 5 .Oct.	
Adachi Ku	Whole Adachi Ku 40 400 ton	Kanemachi Line	none	
Katsushika Ku	Whole Katsushika Ku 39 000 ton	" "	[illegible]	Kami Hiraimachi, Kamikomatsu-machi, Shimokomatsumachi, Hi-raixxxxxnakamachi (break of Heiwa Bridge, Kami-Hirai Bridge)
Edogawa Ku	most part 32 200 ton	Received from the Chiba Water-work and supllied through Kanemachi-plant		Nishi, Higashi Komatsugawa, Higashi Funabori, Kyonomia, Honishikimachi, Nishihitonoe (Break of Kasai Bridge)
Most part of Arakawa Ku (except 9 chome Nippori)	Arakawa Ku 39 000 ton	Kanemachi Line		
Sumida Ku (except Yokozunamachi)	Whole Honjo Ku 46v000 ton	Yodobashi Line Kanemachi Line		
Koto Ku (except most part of Fukagawa)	13 100 ton			
Daito Ku (except most part of Shitaya)	whole area 25 00 ton			
Total	234 900 ton			

""

Affected area	Supply- situation: Amount supplied	Line	Area without supply on 4 .Oct.	
Adachi Ku	Whole Adachi Ku 41 360 ton	Kanemachi Line	none	
Katsushika Ku	" Katsushika Ku 39 000 ton	" "		Kami Hrai machi, ShimoKomatsu-machi, Kqmikomatsu, Hirai-Naka machi (break of the Heiwa Bridge and Kamihirai Bridge)
Edogawa Ku	most part 32 210 ton	Recieved from the Chiba water-work and supplied through Kanemachi Plant		Nishi , Higashi Komatsugawa, Higashi Funabori, Kyonomia, Honishikimachi, Nishihitonoe, (break of Kasai-bridge)
Most part of Arakawa Ku (except 9 chome Nippori)	Arakawa Ku 39 230 ton	Kanemachi Ku		
Sumida Ku (except Yokozunamachi)	Whole Honjo Area 46 030 ton	Yodobashi Line & Kanemachi Line		
Koto Ku (except most part of Fukagawa)	11 320 ton			
Daito Ku (except most part of Shitaya)	whole area 25 00 ton			
Total	234 200 ton			

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HEADQUARTERS
TOKYO-KANAGAWA MILITARY GOVERNMENT DISTRICT
TOKYO DETACHMENT
APO 181

INFORMAL
CHECK SLIP

FILE NO. AG

NOTE: Use this slip for notes in connection with this paper. All notes will be NUMBERED CONSECUTIVELY, top to bottom. All records necessary for intelligent action should be attached. A line will be drawn the full width of the slip below each note. Both sides will be used before additional sheets are added.

SUBJECT: Drinking water for Public Health and Welfare Personnel

NO	DATE	FROM	TO	REMARKS
	3/4/47	Public Health and Welfare Section	CO.TKMGD Tokyo Det. APO 181	1. Request consideration of problem of furnishing a potable water supply to personnel of this office. Warm weather will result in an increased demand for drinking water. Jacobson Jacobson
2	8 apr	Ex O	Procurement.	Request comment and suggestions. DWP
3	8 Apr	Proc	Ex O	Concur - Has the possibility of drawing water coolers from QM been explored? [illegible]
4	9 apr	Ex O	Det Comm Capt. Streetman	advise as to availability of water coolers from the QM. DWP
5	24 Apr.	~~Adj.~~ Hq. DET. COMDR	ADJ.	Mr. Lillard at Dist. Hq. has requisitioned coolers from QM. He will let the DET. know if they are available. STREETMAN.
6.	25 Apr	Adj.	H&W.	Info.
7.	Mrs Sarkes — ~~Jud~~		WP 9 L	Hease

DECLASSIFIED E.O. 12065 SECTION 3-402/NNDG NO. 775013

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HEADQUARTERS
TOKYO-KANAGAWA MILITARY GOVERNMENT DISTRICT
TOKYO DETACHMENT
APO 181

I-N-F-O-R-M-A-L
C-H-E-C-K S-L-I-P

FILE NO. AG

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6.	25 Apr	Adj.	H&W.	Info.
7.	Mrs Sarkis — ~~Info~~			WPGL Hearn

HDS 25 April 47

file

WATER SUPPLY 20 March 1947

Inspection and Discussion

Summary: 1 Report of inspection trip Sakai Filter Plant
Plant slow filtration; chlorination - liquid chlorine;
Operation fair; bacteriological work needs investigation.

2. Brief outline of water supply in Tokyo.

1. Discussion with Mr. Iwasaki, Chief Water Supply Section. Water Bureau, Tokyo to.

   a. Source and filter plants
   Tokyo Water Supply comes mainly from 2 sources Tama river and Edo river.
   About 40 km. from Tokyo there is the Hamura Intake from the Tama river. There are 2 reservoirs - Yamaguchi, Muriayama.

   The Sakai Filter Plant is main plant filters (slow sand) and chlorinates (liquid chlorine). This water arriving from Tama river and then it is piped to a service reservoir in Setagaya from which it is distributed to the central part of the city.

   Edo river

There is an intake and filter plant at Kanamachi. This plant is being arranged for rapid sand filter using alum as coagulant. Much difficulty is being experienced, partly because of sewage problems nearby.

There are 11 filter plants altogether taking care of piped water from the 2 (?) intakes.

Quantities of Water Supply

Date — Tokyo Water Works Bureau

Filter Plants	Design Capacity m^3/day	Actual Quantity	Remarks
Yodobashi	240,421		
Sakai	240.421		
Kanamachi	316,089		
Tamagawa	104,350		
Kinuta-Kami	83,479		
Kinuta-Shimo	44,500		
Yaguchi	2,783		
Suginami	9,339		
Komae	15,120		
Sekiyama	10,780		
Wells	8,000		
Itabashi			
Total	1,075,282		

In addition certain areas receive water from 8 wells - artesian 100 meters deep.

Much of the city (mostly northern) has its own private wells, also, usually used for washing, etc. or dry spells. Very few have only wells.

b. Chlorination

Filter plants use liquid chlorine, being added in 2 p p m. 100 fixed points in the city tap system are tested daily. Requirement for these is 0.4 ppm.

c. Tests - bacteriological

There are 3 laboratories which test samples of water bacteriologically. Once a week samples from tap test points are made and twice a week from reservoirs and filter plants. These laboratories are at - Kanamachi, Yodobashi, and Tamagawa.

d. Consumption

Consumption figures ~~is~~ are based on the filtration output. It is estimated leakage amounts to 50-60%. This is obtained from a district area meter system, cutting off area use at designated times, and checking leakage.

It is almost impossible to adeuately cut off a given area at one time. Most of the war damage has been corrected but pipes and the whole system are in bad repair due to poor war maintenance.

e. Employees

700 work in Water Supply section -
8 working on tap check points.

2. Inspection Sakai Filter Plant

Sakai Filter Plant is located in Kitatama Gun nearly 1 hour's drive from here. It can be reached by following Route 2 and turning down road to Roosevelt Recreation Center, turning to the right when that road turns to the Center. It is a mile or 2 from there (a few turns).

The Plant is on a good sized reservation. About 100 employees operate it.

H_2O comes from Tama river via a canal from which it is diverted thru network of small canals thruout the filter bed area. Slow sand filtration is used whereby in a 24 hour period 320000 cu.m. of water is filtered in 17 beds (20 total ones). The inlets were on both ends; there was also an overflow pipe and emptying valves. The system of in and out seemed satisfactory.

Each filter bed is made up as follows:

60 cm. graded gravel
78 cm. ungraded sand
90 cm. H_2O
Filtration rate 4 m/day
Area 4600 sq. m.

Every 20 days each bed is cleaned by removing 1 cm. of sand. The whole sand bed is changed once a year.

The water is chlorinated with liquid chlorine - meter reading 4500 ? /hour. This flows into water going at 1 m/second thru 1-6 meter diameter pipe giving 2 ppm., thence to 2 connecting wells (pipe 1.9 m.) thence 10 km. to a service reservoir in Setagaya.
Bacteriological work is done at bacteriological lab. in Yodobashi once a week with 3 - 500 cc. samples - canal, filter, chlorination plant.

Pote

46A

Water Plant Inspection

4 April 1947

1. Hachioji City -

   1) Source of water - Asakawa River

   2) Area Supplied - Hachioji City - (70,000)

   3) Method - 3 filtration tanks - 6 M. per day 760 Cu M. per tank. Beds cleaned

      From Filt. beds → service tank → main pipe into Hachioji.

   4) Amt. water supplied - 6370 cu. m. per day

   5) Data on Chlorination -
      At present repairing liquid chlorine equipment and using $CaoCl_2$ will resume liquid Cl_2 soon.
      Amount liquid Cl_2 - 200 Kg. per month
      1 Gm. liquid Cl_2 per cubic meter H_2O
      Cl_2 content of water - o.1 ppm at most distant tap.
      0.6 ppm - average

2. Itsukaichi -

   1) Supplies water to town

   2) 2 filtration beds - have not been cleaned in a long time - service tanks.

   3) Now being operated (?) by farmers assoc. & town people.

   4) No chlorination procedures used at present is no evidence of anyone taking active interest in its operation.

3. Ome -

   1) Source - Water from deep well - about 50 feet from Tama River.

   2) Method - Liquid chlorine added to well - well water pumped from well to service tanks and filtration beds on top of near - by hill.

3) Chlorination data - 0.2 ppm added to water (0.4 ppm on raining days). Water at top - practically 0.00 ppm. Total - 6 Kg. per month.

4) Amount water supplied - More than 1000 cu.m. per day. Supplies about 3000 houses.

5) Filtration System - 3 filter beds - Sand - 1 m. Gravel 1 m. from filter beds → service tanks → town.
Comment: This seems to be a very efficiently operated plant.

-COLLODI-

46A4

LIAISON OFFICE
GOVERNOR'S SECRETARIAT
TOKYO METROPOLITAN GOVERNMENT

October 31,1946.

SUBJECT: Information On The Water Works.

TO : Col. P.H.Sperati, Commanding Officer,
Hq.Tokyo-Kanagawa M.G.D. Tokyo Detachment.

On the Alteration of place for drawing water to inspect remaining chlorine.

Traditional 115 places for drawing water for inspection in Tokyo, have been reduced to 100 places by the Water Works Bureau after the permission of the Eighth Army Headquarters on October 16.

FOR THE GOVERNOR:

Eiichi Isomura,
Director of Liaison Office,
Tokyo Metropolitan Government.

HEADQUARTERS EIGHTH ARMY
United States Army
Office of the Engineer
APO 343

9 August 1946

SUBJECT: Chlorination of Tokyo Municipal Water Supply

TO: Tokyo Prefectural Government

1. References:

a. Memo to Imperial Japanese Government, Headquarters 8th Army, 15 July 1946, subject: "Municipal Water Supply Chlorination."

b. Memo to Imperial Japanese Government, Headquarters 8th Army, 28 July 1946, subject: "Chlorination of Municipal Water Supply System".

2. Under the authority of the above referenced directives it is desired to begin the chlorination of the entire Tokyo Municipal Water Supply to U.S. Army Standards at the earlies practical date.

3. The Imperial Japanese Government has been directed, by the above references, to deliver 160 metric tons of chlorine by 5 August 1946 and 80 tons by 1 September 1946 and by the first of each month thereafter to the Tokyo Prefecture for distribution to the plants concerned. The chlorine will be delivered promptly to the Tokyo Municipal Water Works by the agencies of the Japanese Imperial Government as required in the above mentioned instructions. You will keep the necessary records thereof.

4. A 30-days supply of chlorine will be maintained at each water treatment point at all times as an emergency reserve supply. If it becomes necessary to use any of this reserve at any plant, the reserve chlorine supply will immediately be brought back to the normal quantity. An immediate report by the Tokyo Municipal Water Works will also be made by phone and by written communication to this office.

5. Priority in use will be given to Japanese - produced chlorine up to the limit of the available supply.

6. Monthly reports will be delivered to this office by the 10th of each month, giving information up to the end of the preceding month on the state of chlorine supply at each of the Tokyo Municipal Water Works water treatment points, and as a total for the entire supply. These reports shall show for each point:

Chlorination of Tokyo Municipal Water Supply (CONT'D)

a. The amount of chlorine on hand on the first and last days of the month covered by the report, with United States and Japanese chlorine shown separately.

b. The amount of chlorine received during the month covered by the report, with United States and Japanese chlorine shown separately.

c. The amount of chlorine used during the month covered by the report, with United States and Japanese chlorine shown separately.

d. The total amount of water delivered during the month covered by the report, with an estimate of the leakage loss for each plant.

e. The amount of chlorine required for the monthly period following the month in which the report is submitted.

f. The number and type of empty chlorine cylinders on hand at the end of the monthly period reported upon, with United States and Japanese cylinders shown separately.

7. The Tokyo Municipal Water Works will immediately begin the chlorination of its various sytems to U.S. Army standards. Two parts per million of chlorine will be added to the water at treatment points. The Water at the farthest ends of the mains shall show not less than 0.4 parts per million of chlorine before approval for consumption will be recommended. If it is necessary to add more than 2.0 parts per million of chlorine at the treatment points to secure 0.4 parts per million at the ends of the pipe lines, more chlorine will be added at the treatment points and a report thereon will be forwarded this office by phone and written communication, without delay. This dosage will be maintained, pending further instructions from this office.

8. The Tokyo Municipal Water Works will establish a system of weighing chlorine cylinders during use as a check on the chlorinator delivery indicating devices. They will prepare and use record forms to be completed by their chlorinator operators as an accurate chlorine administration log, with half-hourly check entries for each chlorinator. Determination of chlorine concentration in the water of treatment plant reservoirs shall be made at least every two hours. A copy of the data on the tests at these points shall be supplied to this office at intervals of not more than 48 hours, preferably daily.

9. With the advice of representatives of this office, the Tokyo Municipal Water Works will set up a series of chlorine test points, so

located as to give an accurate idea of the chlorine concentration in the water of each water supply system. Chlorine tests will be taken daily at these points and recorded. At least once a week a specimen will be collected at each test point for bacteriological examination. Daily reports will be made to this office on the results of free chlorine tests and will be delivered on the day following that covered by the report. Bacteriological results will be reported to this office with a minimum of delay.

10. Reports on the treatment of water, on the state of repair of chlorinating and other equipment, proposed changes and improvements to plants and procedures and other matters, will be submitted to this office as required.

11. The order in which the various plants of the Tokyo Water Supply System will be brought to conform to United States Army Standards is as follows:

a. The Sakai and Yodobashi Systems

b. The Kanamachi, Tamagawa and Chofu Systems

c. The Upper Kinuta, Lower Kinuta and Itabashi Systems.

d. The Komae, Suginami and Yaguchi Systems

e. The Eight individual well Systems

f. The Sekiyama System when put into use.

12. Standby chlorinating equipment will be secured and maintained at each plant and in general reserve. In no case will the available chlorination apparatus at any plant be less in capacity than 150% of normal chlorine delivery. Where only one chlorinator is normally required, a duplicate machine shall stand ready to function if required. Chlorinators will be installed as rapidly as available until the above requirements are met.

FOR THE ENGINEER:

E.A. BROWN, JR.
Colonel, CE
Executive

13A4

HEADQUARTERS EIGHTH ARMY
United States Army
Office of the Commanding General
APO 343

AG 671.1 (LE)

MEMO FOR: The Imperial Japanese Government

5 AUG 1946

THRU : Central Liaison Office

SUBJECT : Chlorination of Municipal Water Systems

1. Reference: Memo for the Imperial Japanese Government, this headquarters, subject: "Municipal Water Supply Chlorination", 15 July 1946.

2. The Imperial Japanese Government is directed to proceed on 5 August 1946 with the chlorination to United States Army standards of the following municipal water systems in Kanagawa and Tokyo Prefectures:

a. Yokohama Water Works
b. Kawasaki Water Works
c. Yokosuka Water Works
d. Kanagawa Prefectural Water Works
e. Tokyo Municipal Water Works

3. The Imperial Japanese Government will:

a. Ship the following amounts of liquid chlorine to Kanagawa Prefecture for distribution to the plants as indicated below:

Water System	By 5 August	By 1 September and by first day of each month thereafter
Yokohama Water Works	33.0 Metric tons	16.5 Metric tons
Kawasaki Water Works	13.0 Metric tons	6.5 Metric tons
Yokosuka Water Works	6.8 Metric tons	3.4 Metric tons
Kanagawa Prefectural Water Works	8.4 Metric tons	4.2 Metric tons

b. Ship the following amounts of liquid chlorine to Tokyo prefecture for distribution to the plants concerned:

Water System	By 5 August	By 1 September and by first day of each month thereafter
Tokyo Municipal Water Works	160.0 Metric tons	80 Metric tons

4. The amounts of chlorine designated in paragraph 2 above include both American manufactured chlorine acquired under the import-export program and Japanese manufactured chlorine. No change in the present allocations of Japanese manufactured chlorine to the municipalities designated in paragraph 2 will be made without approval of this headquarters.

AG 671.1 (LE), , Subj: "Chlorination of Municipal Water Systems"

5. Detailed instructions regarding the chlorination of the above systems will be issued by this headquarters as separate memoranda to the prefectural government concerned.

BY ORDER OF LIEUTENANT GENERAL EICHELBERGER:

OTIS N LUCKMAN
1st Lt. AGD
Asst Adj Gen

cc: CG, IX Corps
Commander Naval Activities
Japan

45

HEADQUARTERS EIGHTH ARMY
United States Army
Office of the Commanding General
APO 343

15 July 1946

MEMORANDUM FOR: The Imperial Japanese Government

THROUGH : The Central Liaison Office, Tokyo

SUBJECT : Municipal Water Supply Chlorination

1. Reference is made to Memorandum for the Imperial Japanese Government, AG 720.2(7 June 46) ESS/IE (SCAPIN-1419-A) subject: "Liquid Chlorine". Liquid chlorine has been requested from the United States as part of the Japanese import-export program to arrive on the following schedule:

July	150 metric tons
August	150 metric tons
September	150 metric tons
October	200 metric tons
November	200 metric tons
December	200 metric tons
TOTAL	1050 metric tons

2. The following policies and procedures will be complied with:

a. Chlorine procured from the United States for this program will be used only for the chlorination of municipal water supply systems designated by this headquarters.

b. No change in the allocation of Japanese manufactured chlorine in effect prior to the time a municipal system is designated for chlorination to United States Army standards will be made without approval of this headquarters.

c. This headquarters will issue separate memoranda to the Imperial Japanese Government:

(1) Giving details of each shipment of United States manufactured chlorine due in. Upon receipt of such memoranda the Imperial Japanese Government will complete arrangements to unload, receipt for and place the chlorine in a central storage depot.

(2) Designating the municipal system or systems to be chlorinated to United States Army standards.

(3) Prescribing the total amount of chlorine per month to be furnished each municipality. The initial issue of chlorine will provide for a two (2) months supply. Thereafter, chlorine will be supplied monthly. A one (1) month's reserve supply will be maintained on hand at all times in each municipality.

d. The Imperial Japanese Government will:

(1) Establish a central depot in the Tokyo-Yokohama area for storage of United States manufactured chlorine and inform this headquarters by 1 August 1946 of the site location.

(2) Take proper precautions to insure that all United States manufactured chlorine received for this program is safeguarded and used only as authorized herein.

(3) Upon receipt of United States manufactured chlorine, paint "U. S. Mfd. Chlorine I/E" lengthwise along the cylinder in three inch (3") lettering with red paint.

(4) Give priority for procurement of water supply equipment to those municipalities which have been designated by this headquarters for chlorination to United States Army standards.

(5) Furnish this headquarters with quantitative receipts in English and in quadruplicate for the liquid chlorine at the points of delivery.

(6) Receipt within twenty-four (24) hours for all memoranda issued by this headquarters pursuant to paragraph 2c above.

e. This headquarters has requested that all chlorine furnished by the United States for this program be supplied in one hundred and fifty (150) pound cylinders. However, it is possible that the chlorine will arrive in one (1) ton cylinders or larger. All cylinders received will be strictly accounted for and safeguarded.

4. A monthly report in triplicate will be submitted to this headquarters by the fifteenth (15th) of each month listing the following information:

a. Part I.

(1) The amount of United States manufactured chlorine in the central depot on the first and last days of the previous month.

(2) The amount of United States manufactured chlorine received during the previous month.

(3) The amount of United States manufactured chlorine shipped to each municipality during the previous month.

b. Part II.

The number and size of empty United States manufactured cylinders in the central depot on the first and last days of the previous month.

c. Part III. A list of all municipalities which have been designated by this headquarters for chlorination of the municipal water supply system to United States Army standards with the following information:

(1) The amount of chlorine on hand in each municipality on the first and last days of the previous month with United States and Japanese manufactured stocks shown separately.

(2) The amount of chlorine received at each municipality during the previous month with United States and Japanese manufactured stocks shown separately.

(3) The amount of chlorine used at each municipality during the previous month with United States and Japanese manufactured stocks shown separately.

(4) The total amount of water delivered at each municipality during the previous month.

(5) The amount of chlorine desired for each municipality for the monthly period following the month in which the report is submitted.

5. The instructions issued herein do not affect the present chlorination policies of the Imperial Japanese Government for municipalities which are not designated by this headquarters for chlorination to United States Army standards.

BY COMMAND OF LIEUTENANT GENERAL EICHELBERGER:

J. M. Glasgow
J. M. GLASGOW
Colonel, AGD
Adjutant General

Incl 1 to OD No. 68, Hq 8A, 20 July 1946.

46-17 Water Bureau — Tokyo-to 1946

東京市水道
山口貯水池

	山口貯水池	村山貯水池
滿水有効容積	1,770萬立方米	1,236萬立方米
堰堤高	32.7米	上 24.2米; 下 30.3米
堰堤頂長	690.9米	上 320.0米; 下 590.0米

YAMAGUCHI RESERVOIR

YAMAGUCHI RESERVOIR

山　口　貯　水　池

沿　革

東京市水道の水源である多摩川の羽村に於ける流量は、平水時に於ては毎秒 22.6m³ であるが、渇水時に於ては近年著しく減少し、當初水道擴張計畫を樹てた大正2年の、前後5年間の最渇水の平均は毎秒7.6m³であつたものが、十年を經た大正12年の前後5年間は、毎秒 5.5m³ に低下してしまつたのである（第一圖多摩川各年渇水流量圖表參照）而してこの多摩川流量は羽村に於て大部分取り入れられて、約半分は東京市水道に、他の半分は玉川上水に導かれ之は三百年來關東平野の灌漑其の他の用水に使用せらるゝのである。

元來東京市水道擴張設計は、多摩川から毎秒 7.0m³ の原水を取入れて、之を毎秒 5.6m³ の淨水として全市に供給するを標準として計畫せられたのであつて、多摩川の流水ばかりでは渇水時に不足を來すことになり、水量調節の必要避くべからざることゝなりて、曩に村山貯水池が設けらるゝに至つたのであるが、上記の様な渇水量低下の傾向から考へる

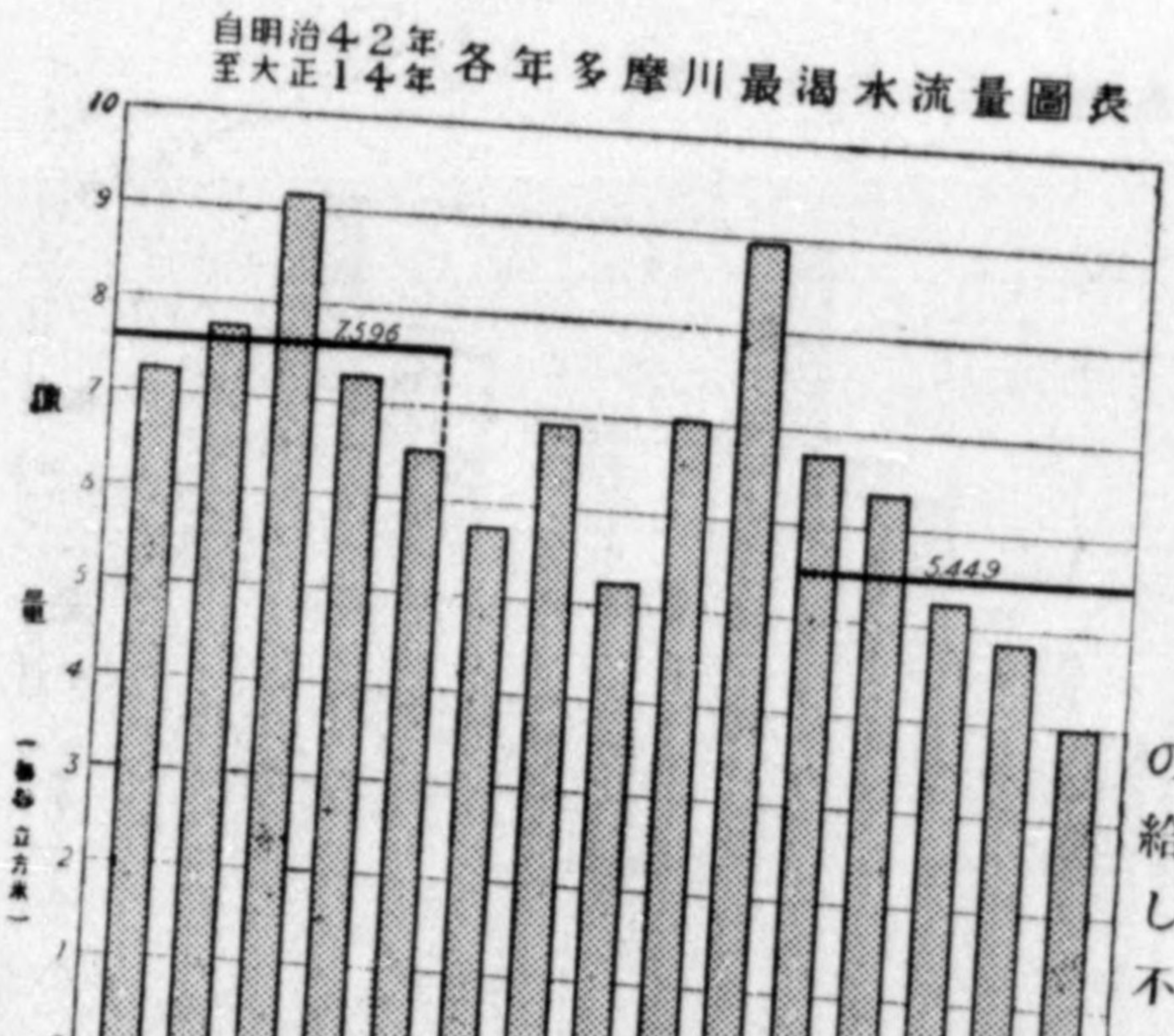
寫眞1、山口貯水池及村山貯水池鳥瞰圖

と、同貯水池有効容量 12,360,000m³ のみでは、どうしても調節の機能を果すことが不可能に陥るから、給水の完全なる使命を果すには、渇水調節の爲猶有効容量 17,700,000m³の貯水量を必要とすると云ふ計算となつたのである。

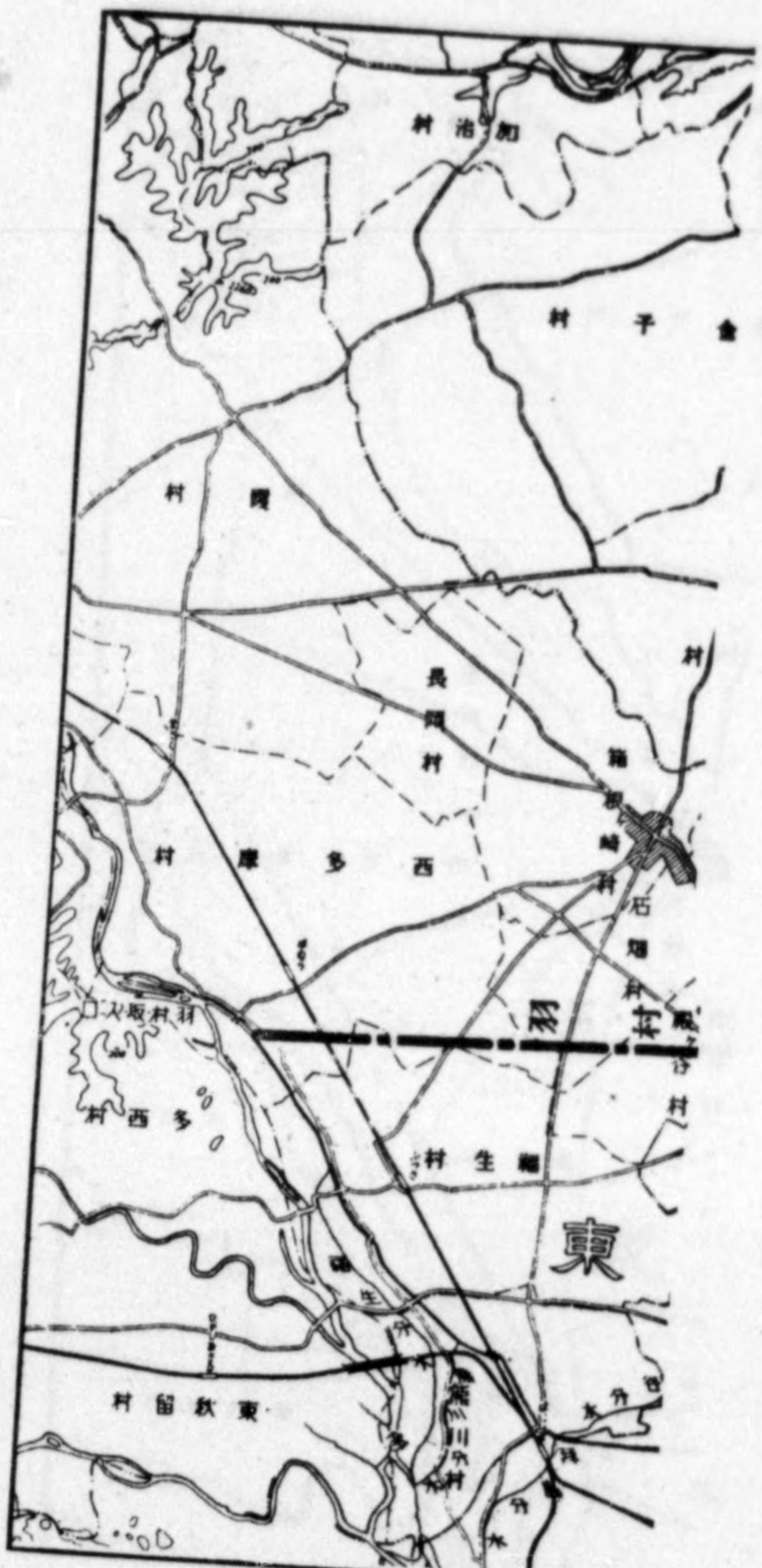
そこで此の様な容量を保つに適する貯水池の地點を普く踏査したところ、村山貯水池の北側に隣接して、三方丘陵に圍まれた袋地の口元に、高さ約33mの堰堤を築きて貯水池を設けることとすれば、丁度所要條件を満足せしめ且引入及引出水路の設計も容易に出來る利益があるので、此の計畫が採用せらるゝに至つた。之が卽ち玆に述べんとする山口貯水池である。

而して多摩川流量が水道の所要原水量に充たない期間は、冬期の12月から翌年４月迄の５ヶ月間であつて、此の期間を便宜上こゝで渇水期間と名づければ、最渇水の場合にはこ

第一圖、多摩川最渇水流量圖表

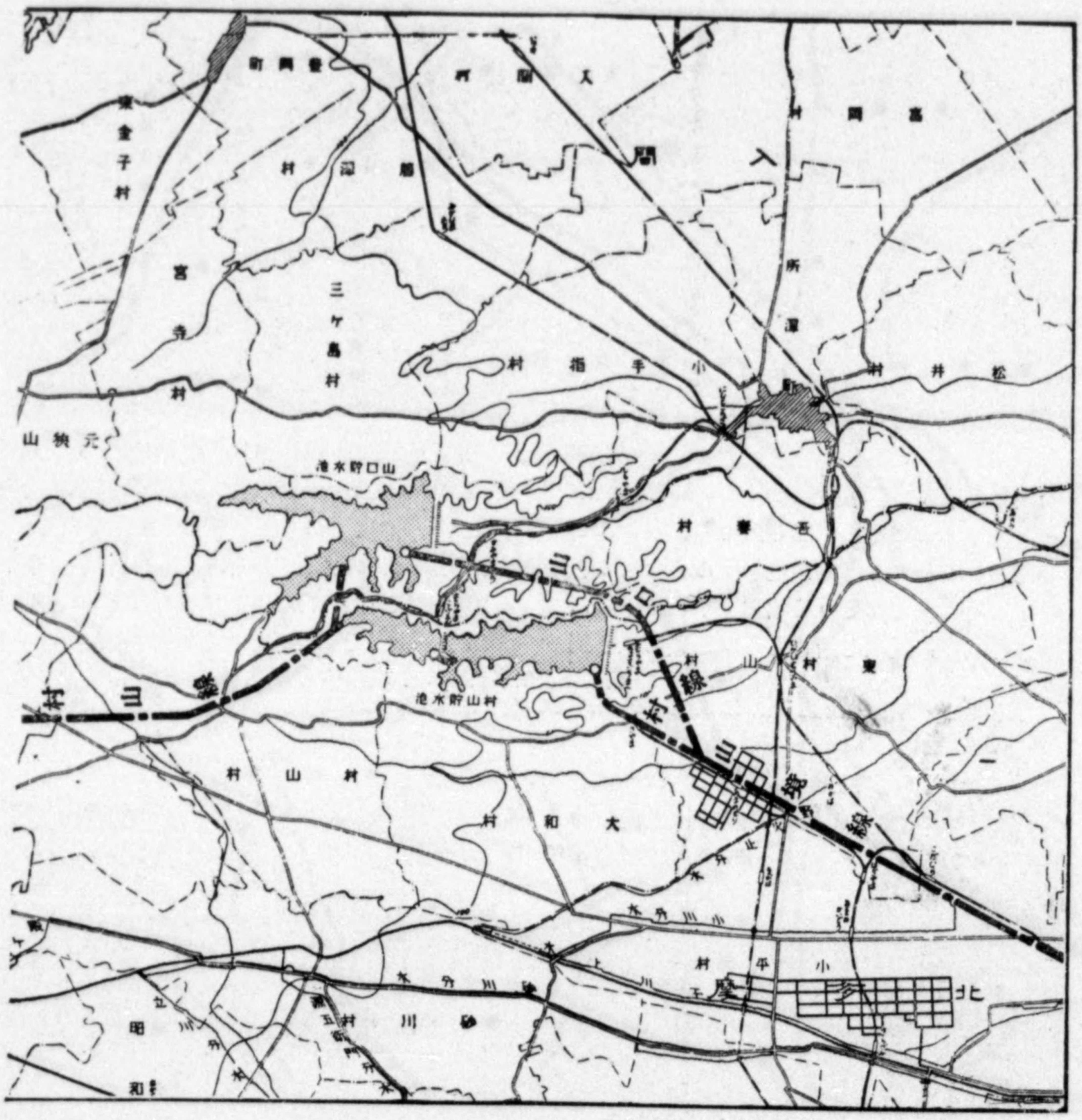


年	月	日	流量 (m³/sec)
明治 42	12	25	7.264
〃 43	3	12	7.745
〃 44	3	20	9.146
大正 3	7	24	7.296
〃 4	1	16	6.531
〃 5	2	21	5.766
〃 6	2	26	6.907
〃 7	2	18	5.251
〃 8	5	1	7.026
〃 9	12	31	8.960
〃 10	3	10	6.759
〃 11	1	31	6.375
〃 12	2	5	5.223
〃 13	3	30	4.878
〃 14	3	9	4.010



第二圖、山口貯水

の５ヶ月間に平均毎秒 1.4m³ を新たに調節補給（村山貯水池の調節量約毎秒 1.0m³ を別にして）を要する計算になるから、上記の様な不足を補ふ爲には、必ずしも貯水池に依らなくとも、他の水系から毎秒 1.4m³ の流水を導き來つて其の不足に充てる設計に依つても、敢て差支なく、否寧ろ適當な水源が得らるれば其の方が有利の様に考へられるので、計畫の當初に於ては遍く他の水系に就ても愼重に調査した。卽ち多摩川支流秋川及荒川に就て



池及村山貯水池附近圖

調べた處によると、夫等の最渇水流量は各毎秒 0.6m³ 及 0.8m³ に過ぎずして所要の補給水量に充たず、又相模川は流量に於ては豐富なるも水源が遠距離にして、隧道に多額の工費を要するの不便があり、尙又利根川の派川江戸川は流量豐富にして且水源が近距離でもあり、最も有力なる比較案であつたが、配水系統上と水質との點に於て利益ならざるところがあつて、終にこの山口貯水池案が採擇せられた次第である。而して山口貯水池工事は第二期水道擴張設計の殘工事と併せて工事費 2,230 萬圓を以て、大正 15年度から昭和6年度（後に昭和2年度から同7年度に改む）に至る6ヶ年繼續事業として、大正15年3月市會の決議を經、尙昭和2年7月都市計畫委員會の議定を經て、同年8月内閣の認可を得たのである。それより直ちに土地買收に着手し幸にも地元村民との圓滿なる諒解成りて協議は頗る順調に纒まり、翌年3月には用地の主要部を手に收むることが出來、認可後1年を

寫眞2、工　事　着　手　前　に　於　け　る　山

出ずして早くも工事に着手するの運ひに到達し、爾來工を進むるに鋭意努力し、幸ひにして施工上さしたる障害に遭遇することなく、略豫定の工程をたどりて昭和７年10月中旬には本貯水池に通水を始めんとする迄に立ち到つたのである。而して本貯水池全體の竣功を遂ぐるのは、昭和８年３月末の見込であるが、主要工事は大體既に出來上つても居り、今や將に通水を始めんとするに當つて、本貯水池工事の概況を述べんとするのである。

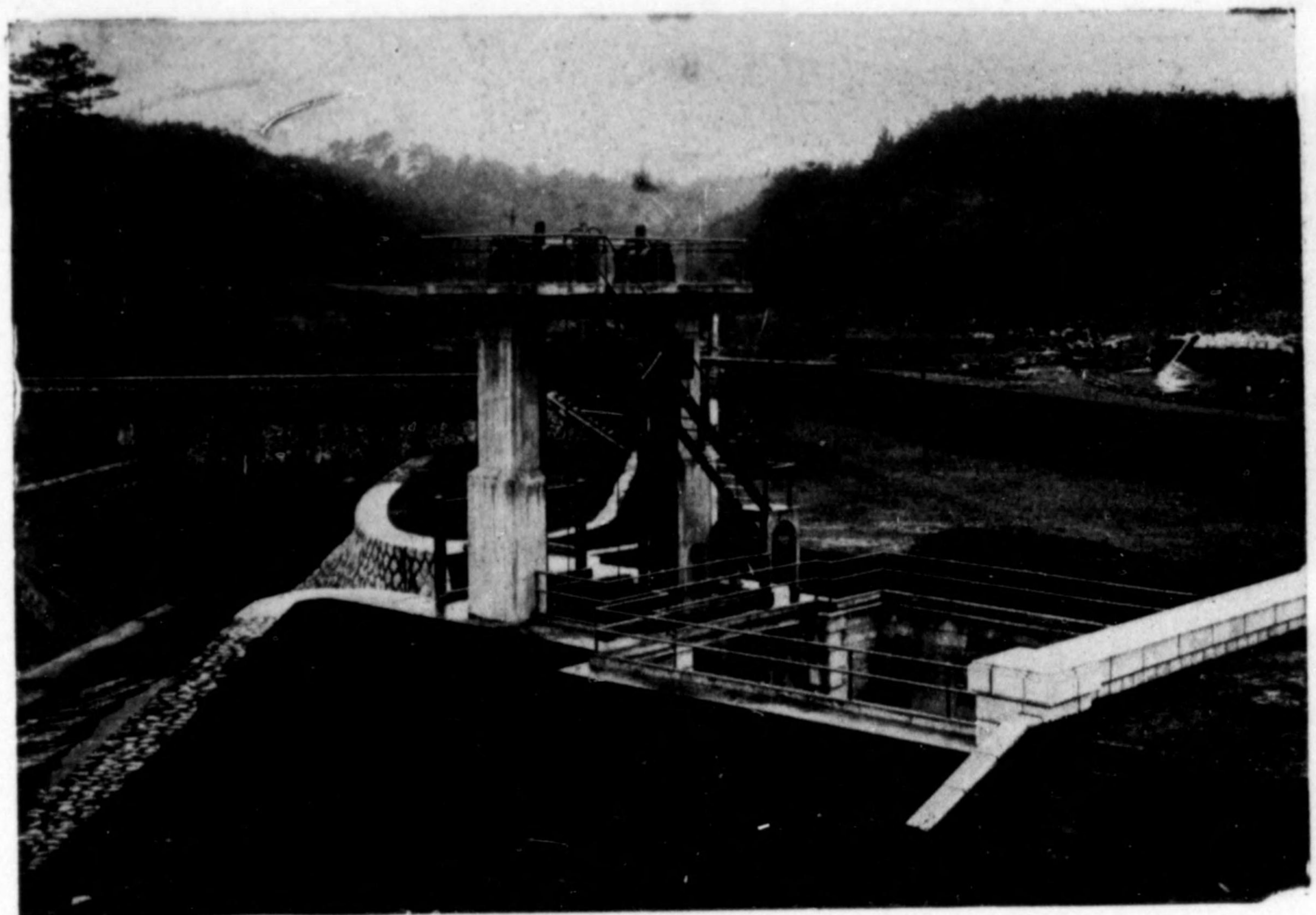
寫眞3、工事竣功に近づきつゝある山口貯水池（7年9月）向つ

口貯水池用地内村落の遠望

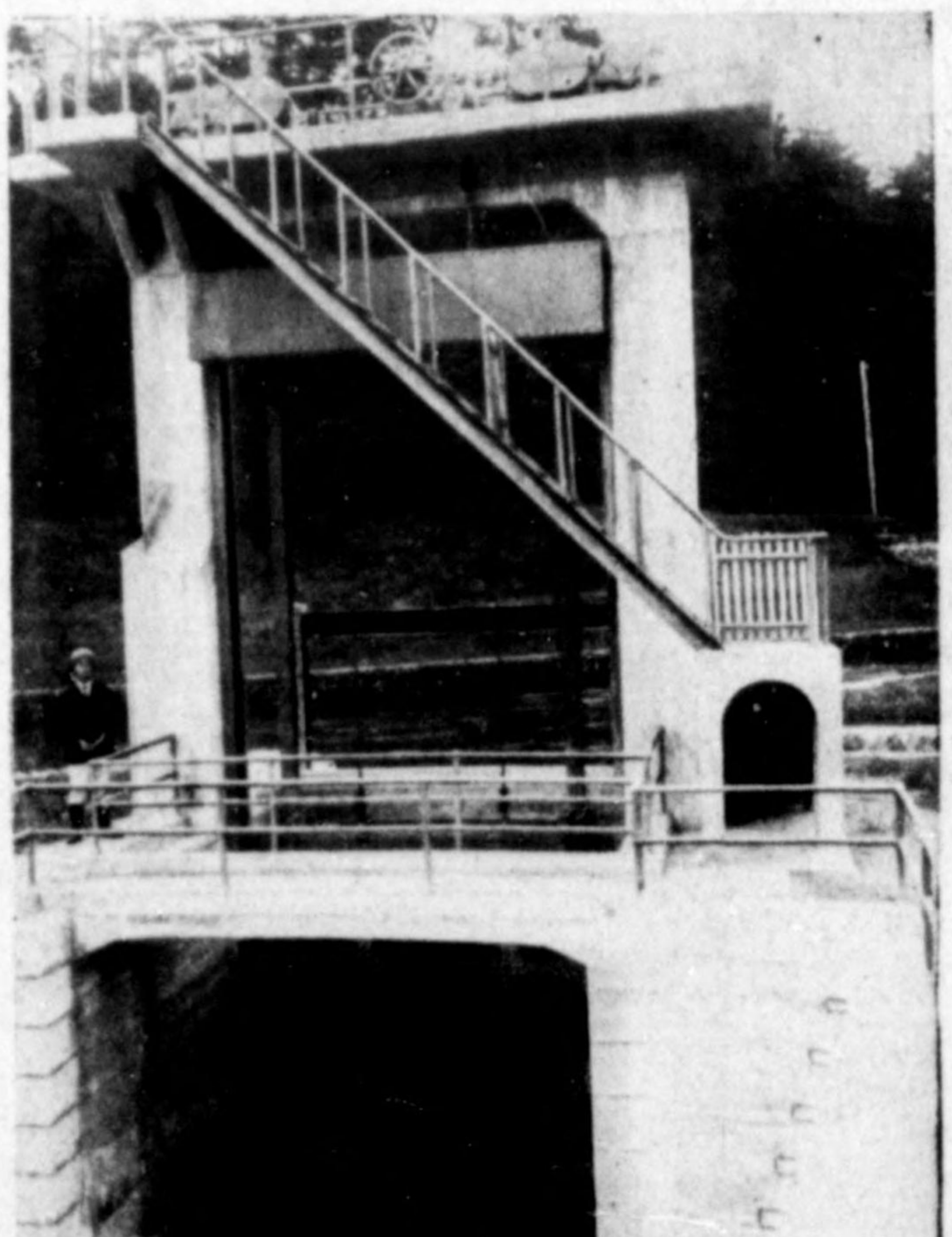
設計の要領（第三圖）

埼玉縣入間郡山口村大字上山口に土堰堤を築き、山口、宮寺、元狭山、東京府西多摩郡石畑及北多摩郡村山の各村に跨りて貯水池を設け、羽村村山線終點附近より引入水路を分岐し、多摩川の流量豐富なるとき同線を經て之に導水す。其の滿水有効容積約 17,700,000 m³（636,000,000尺³）にして、堰堤は高さ根掘敷以上 32.7m（108尺）池底以上 30.6m（101尺）

て左方に直線狀に見えるは堰堤、右方一圓の廣漠たる平野は不日貯水池底となる部分



寫眞4、引入水路の引入口制水門（7年9月）向つて左方の隧道口は羽村村山線導水渠の終端にして其前方の開渠は村山上貯水池に接續す。



寫眞5、背面より見たる引入口制水門（七年九月）

長 690.9m(380間)、堤頂幅 7.3m(24尺)とす。(滿水面の周圍約 5.0 里、用地面積217萬坪、滿水面積50萬坪)、堰堤の南端に近く取水塔を設け、塔内に引入れたる水は引出隧道に依り山口線導水渠に導き、倘取水塔に接近して餘水吐を設け、貯水池滿水位以上の餘水を柳瀬川に放流するものとす

工事着手前後の山口村（寫眞2～3）

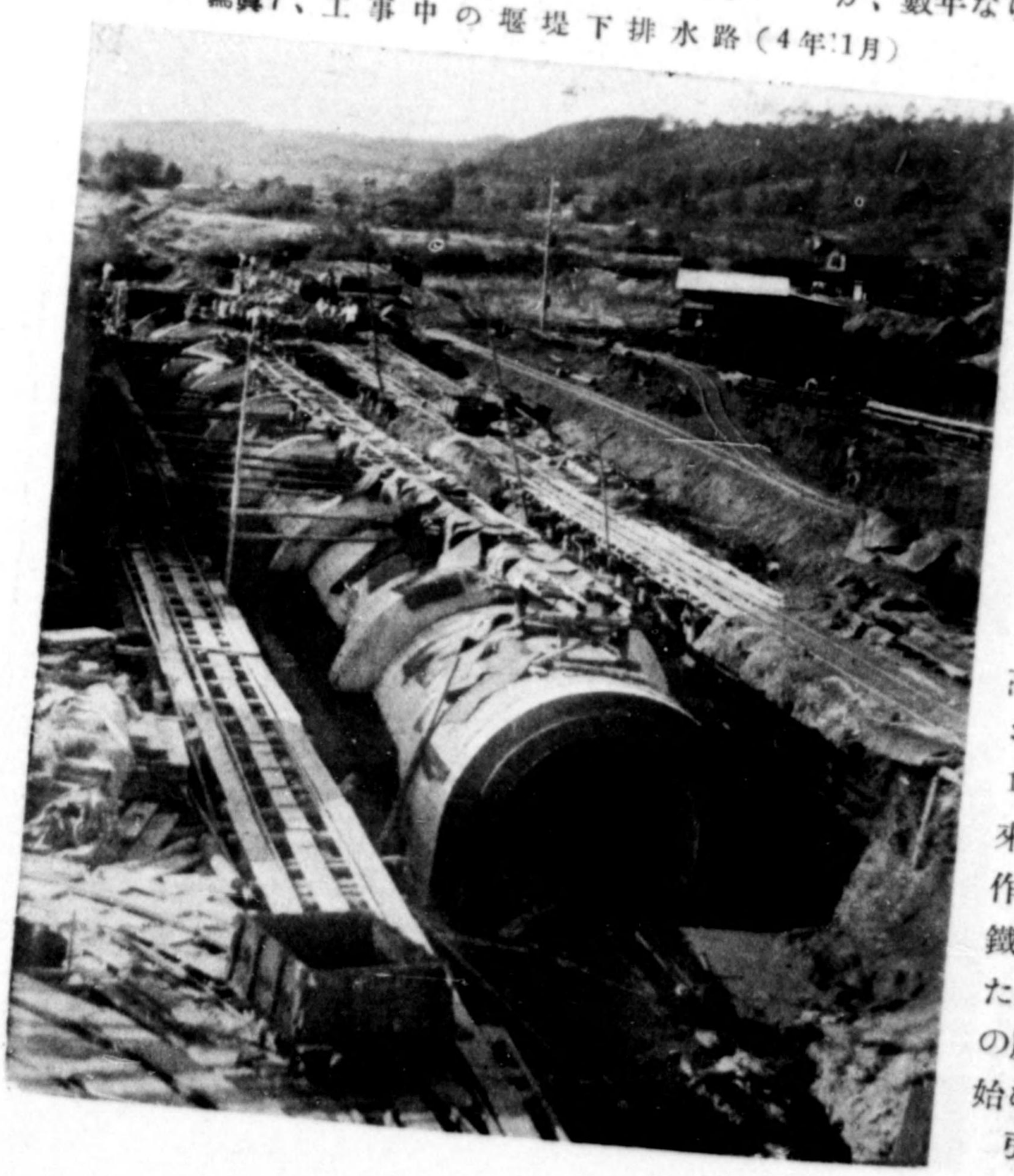
貯水池の池底に沒せんとする山口の地は、古來有名な狹山の峯續きの谷合で、古くから開けて居つたことは、所々に石器、矢の根及土器類の發見に由り明かである。其の後武藏に移住せる高麗人に依つて開發された形跡もあり、降つて中世に至りて武家の跳梁した頃は、武藏七黨の一なる村山黨から出た山口氏の根據地があつたものゝ如く、今でも山口領の名が殘つて居る。近年に至る迄この谷合に

生業を營んでをつたものは、戸數345程で、總棟數436を數へ、住民の半ばは農業半ばは機業に從事しておつて、寫眞2に示す樣な極めて純朴にして平和なる村落であつたが、貯水池工事の爲土地が買收せらるるに及んで何れも其の近在に移住し、今日では周圍の小山は掘り取られて堰堤に運ばれ、又滿水面以下に當るところは草木の根まで拔き取られ、廣漠たる原野と化し、昔の面影だにも止めない有樣である。

寫眞6、引入水路隧道出口（6年2月）

文明が自然を破壊することは現世の勢であるが、數年ならずして斯くも變り果てた樣は、他にもあまり例のないことであらう。寫眞3は最近の狀況を示したものである

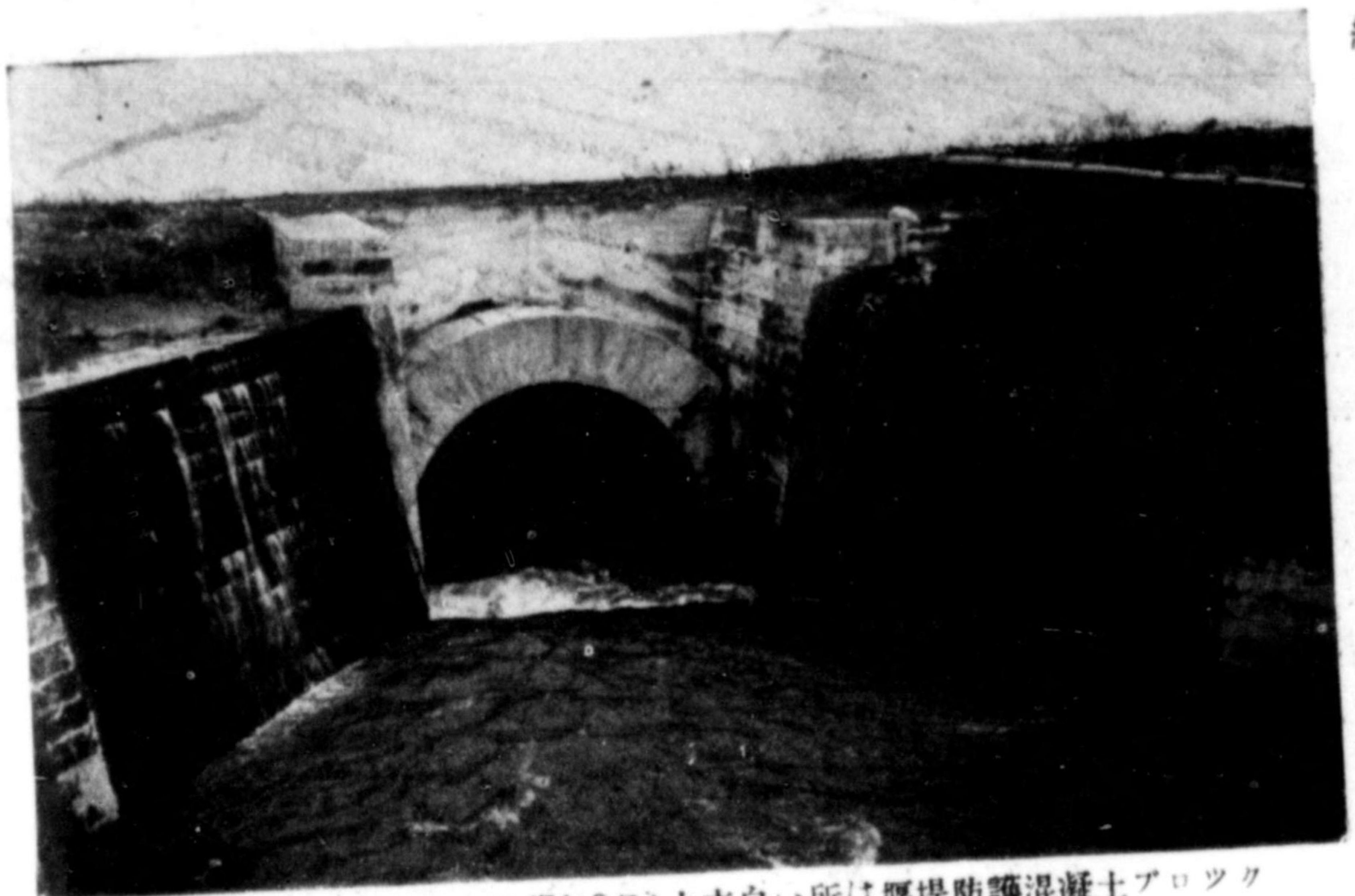
寫眞7、工事中の堰堤下排水路（4年1月）



引入口制水門及引入水路（寫眞4～6）

羽村取入口から村山貯水池に至る導水渠の終端の在來開渠の左岸を取り壞ちて、山口貯水池引入水路の引入口制水門を設けた。此の制水門はストニーゲート式にて、門扉は高14.5尺幅11尺にして、カウンターウエイトの働きに依り1人で自由に開閉する事が出來る。此の制水門扉は日立製作所の製作に係り、捲揚機等鐵部一切で約2,600圓を要した。山口貯水池通水式には此の扉が東京市長の手に依つて始めて開かれることになる。

引入水路は此の制水門から



寫眞8、堰堤下排水路入口(7年9月)上方白い所は堰堤防護混凝土ブロツク

要した工事費は約 195,000 圓である。

堰堤（第3圖）

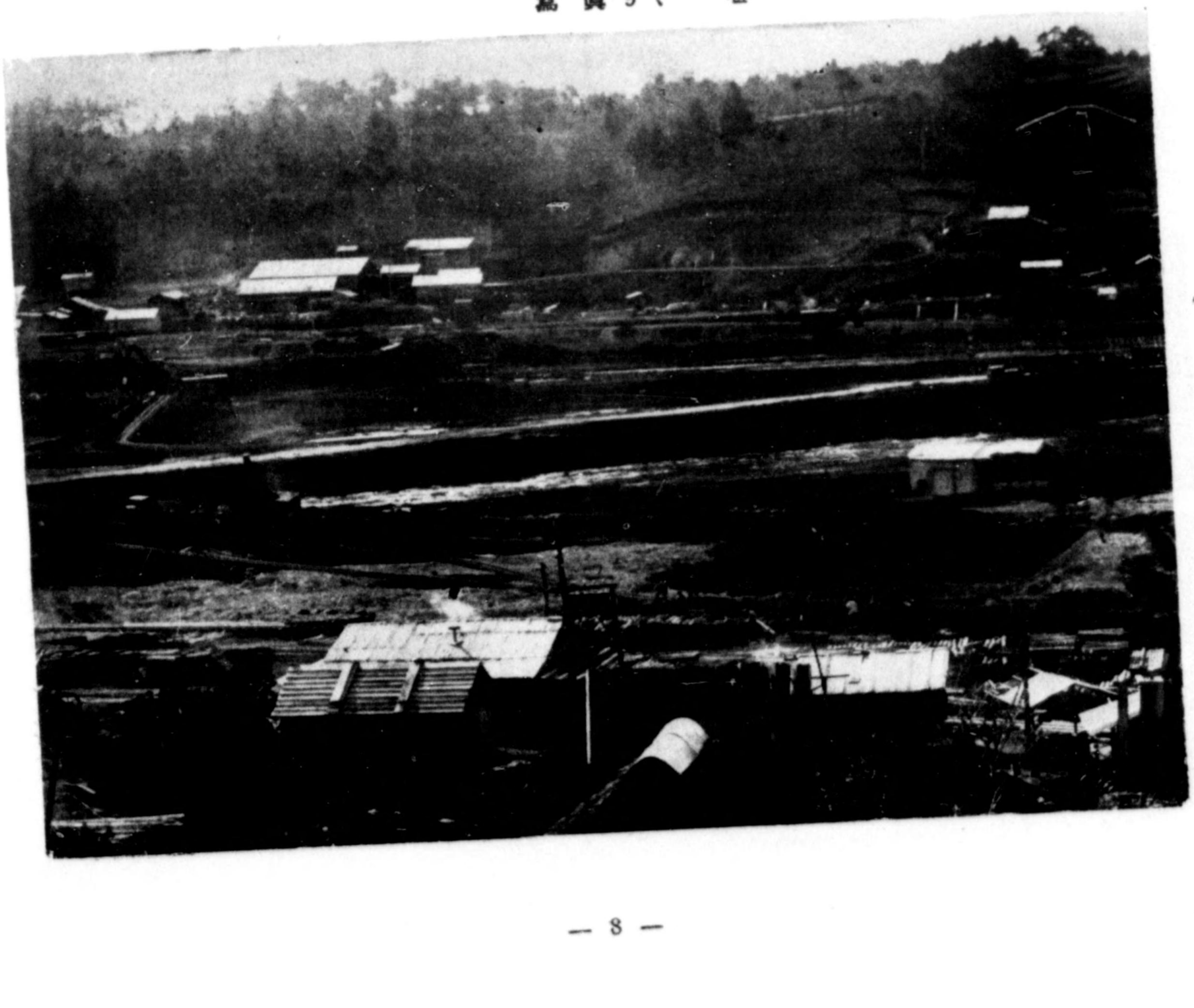
乾式工法に依る土堰堤にて、其の前面は 3 割勾配、背面は上半 2 割、下半 2.5 割勾配であつて、斷面の中央に止水壁を設け共の上部は粘土工、下部は混凝土工とし、止水壁下部は不透層なる粘土盤中に箝入せしむるものである。

山口貯水池に至る延長 1,124m で、暗渠、隧道及開渠より成り、送水量は毎秒 16.7m³ 水路勾配 $^{1}/_{1,200}$〜$^{1}/_{1,500}$ であつて、此の引入水路

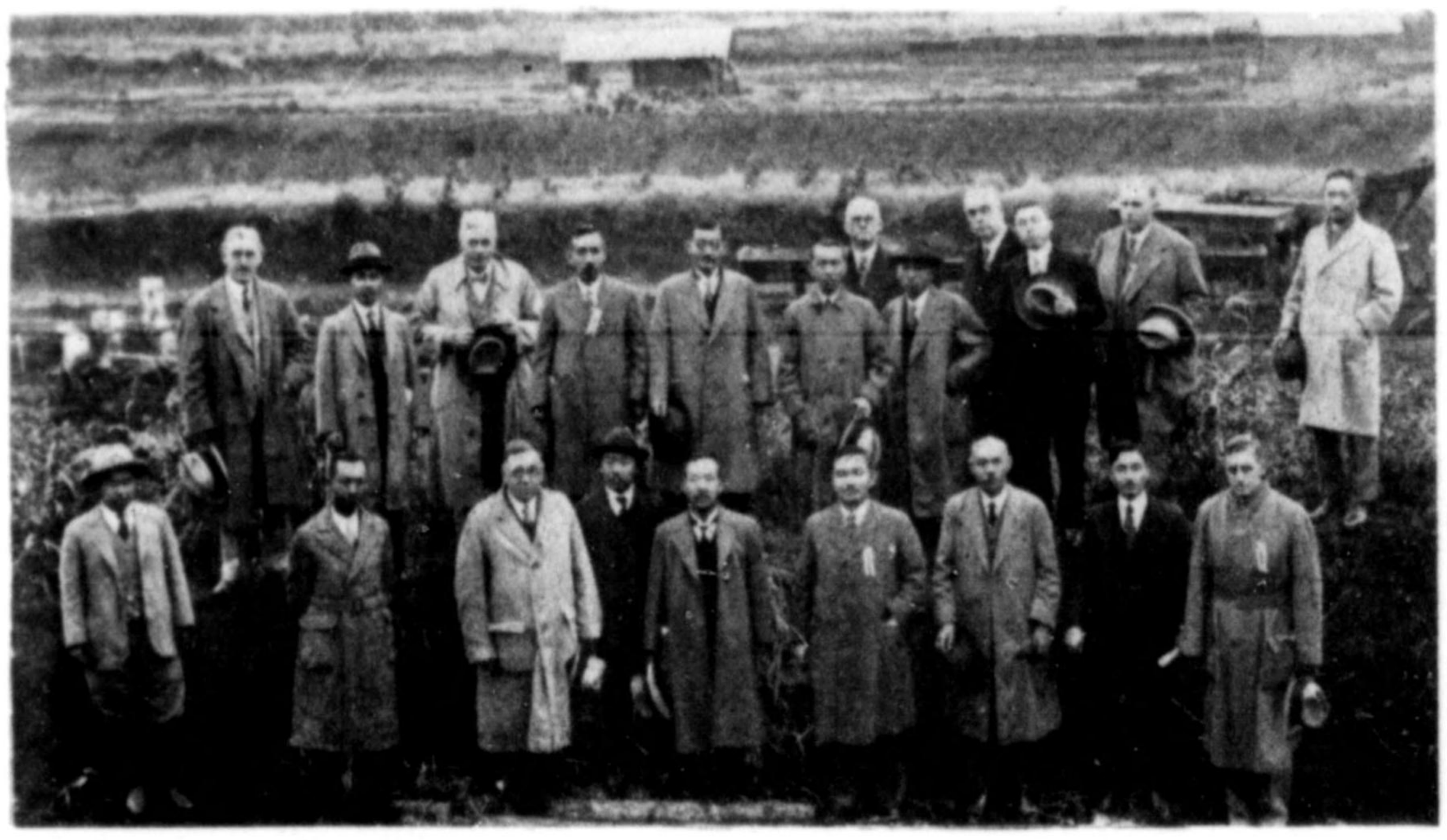
其の主要部の寸法は下の通りで ある。

長（堤頂に於ける左右兩岸距離） 690.91m(38

寫眞9、堰　　堤　　敷



高(根掘敷以上)
32.73m(108尺)
高(池底以上)
30.61m(101尺)
幅(頂　部)
7.27m(24尺)
幅(底　部)
184.55m(609尺)
粘土止水壁(堰堤中央に於て)
高
30.61m(101尺)
厚
(頂部)2.42m(8.0尺)
同
(底部)8.55m(28.2尺
混凝土止水壁(堰堤中央に於て)
高　12.27m(40.5尺)
厚　1.82m(6.0尺)

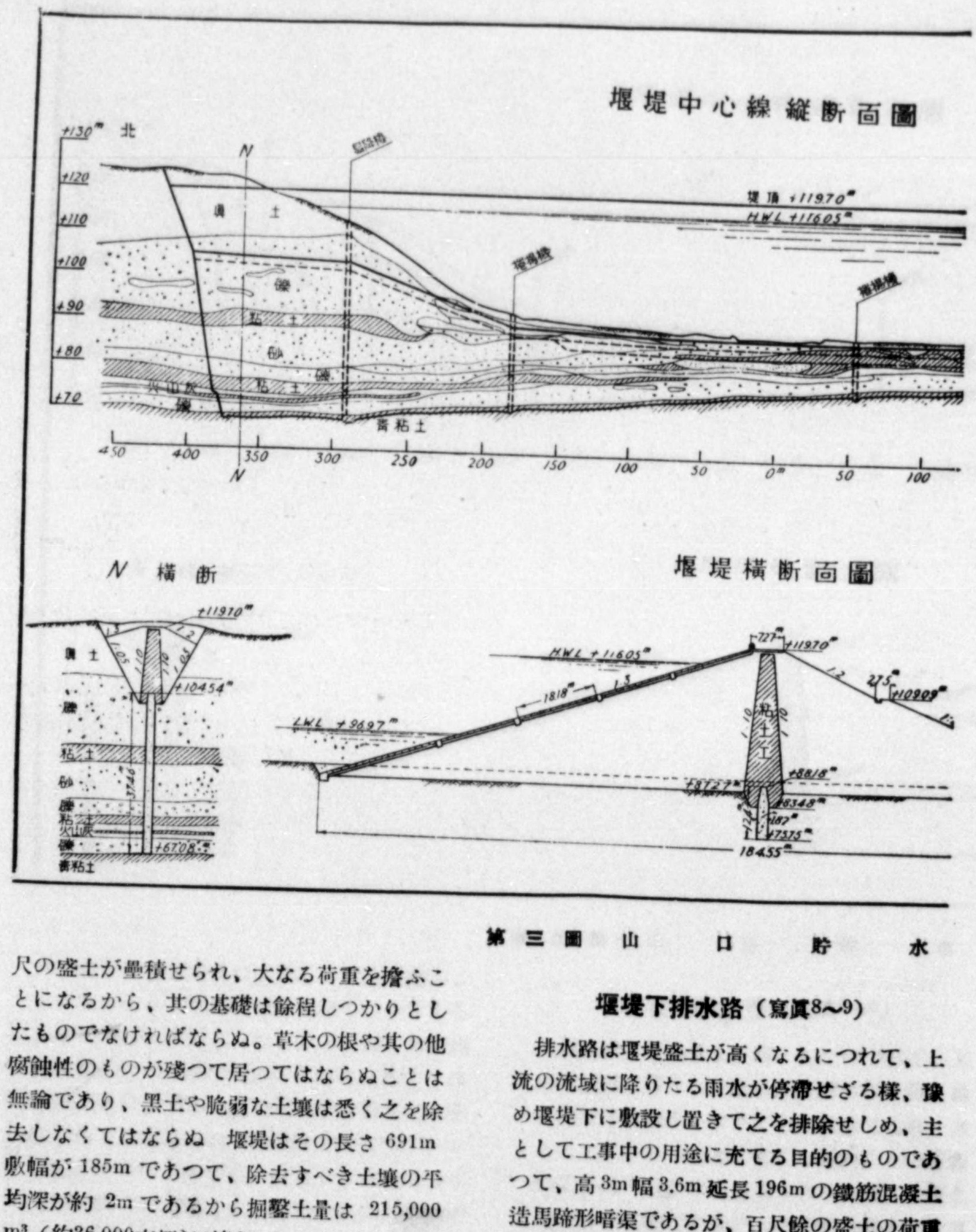


寫眞10、萬國工業大會の折山口貯水池現場を訪れたる世界の專門大家。前列向つて左から2人目 Nicanor Cortés(フィリッピン)3人目 W. E. Binnie(英)4人目菅原正志、5人目小川織三、6人目小野基樹、右端 G. K. Larrison(米)後列左から E. A. Cleveland(英) 2人目米元晋一、3人目 Allen Hazen(米) 4人目草間偉、5人目西大條覺、6人目Manuel Manosa(フィリッピン)7人目Wm. R. Carler(米) 8人目和田忠治、9人目 Francis. Mac. Math (米)10人目岩崎富久、右から2人目 Geo. H. Fenkell(米)右端堀江勝已の諸氏(5年11月)

堰堤敷の掘鑿(寫眞9

堰堤が新たに築造せらるゝ敷地には、100餘

の　掘　鑿　(5年1月)



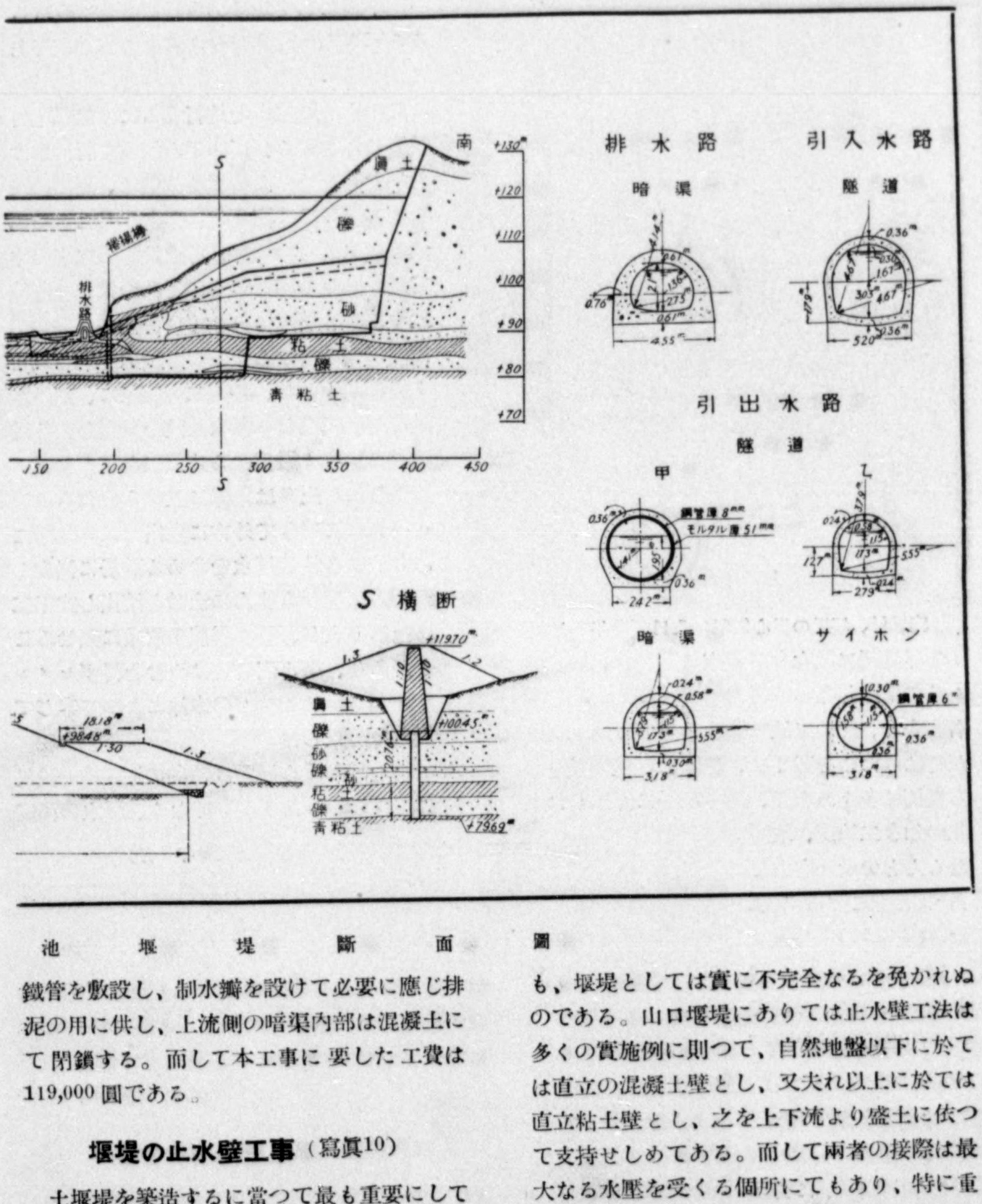
第三圖 山口貯水

尺の盛土が壘積せられ、大なる荷重を擔ふことになるから、其の基礎は餘程しつかりとしたものでなければならぬ。草木の根や其の他腐蝕性のものが殘つて居つてはならぬことは無論であり、黑土や脆弱な土壤は悉く之を除去しなくてはならぬ 堰堤はその長さ 691m 敷幅が 185m であつて、除去すべき土壤の平均深が約 2m であるから掘鑿土量は 215,000 m³ (約36,000立坪)に達し、此の土量の大部分はディゼル.ドラッグラインにて掘り取りて、貯水池外に排除した。而して之に要した工費は約 90,000圓である。

堰堤下排水路（寫眞8〜9）

排水路は堰堤盛土が高くなるにつれて、上流の流域に降りたる雨水が停滯せざる樣、豫め堰堤下に敷設し置きて之を排除せしめ、主として工事中の用途に充てる目的のものであつて、高 3m 幅 3.6m 延長 196m の鐵筋混凝土造馬蹄形暗渠であるが、百尺餘の盛土の荷重を擔ふ關係から特に頑丈な構造とし、又貯水後に於て本暗渠と盛土の接續面から壓力ある水が滲透せざる樣に多數の鍔を設けてある。

堰堤工事完成後は此の内部に徑 450mm の

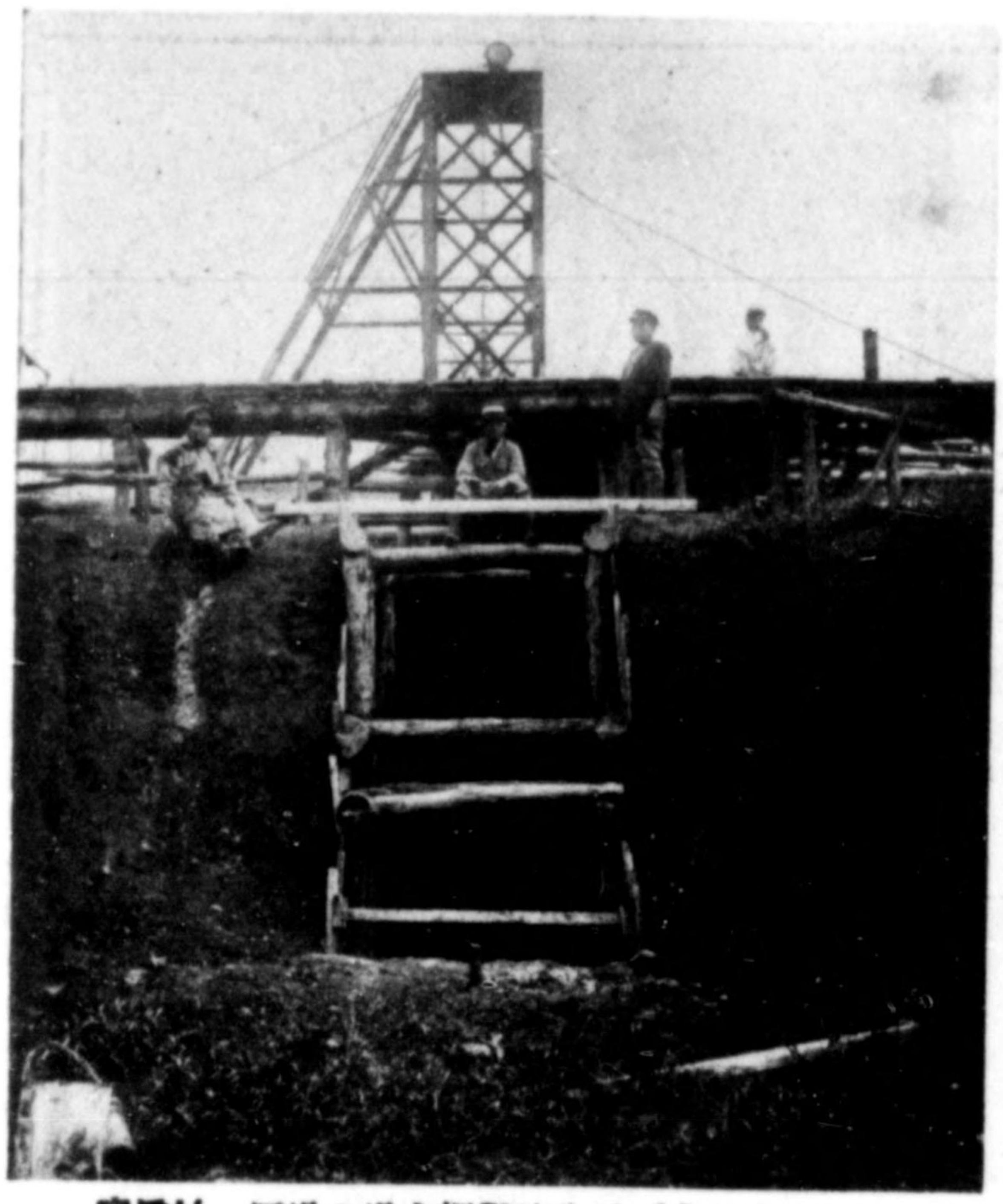


池　堰　堤　斷　面　圖

鐵管を敷設し、制水瓣を設けて必要に應じ排泥の用に供し、上流側の暗渠内部は混凝土にて閉鎖する。而して本工事に要した工費は119,000圓である。

堰堤の止水壁工事（寫眞10）

土堰堤を築造するに當つて最も重要にして愼重なる注意を要するものは、實に此の止水壁工事である　卽ち止水壁は大なる水深に相當する高壓の水を些少でも漏洩せざる樣完全に築造せらるるにあらざれば、之を支ふる大容積の盛土が如何に頑丈に築き上げられても、堰堤としては實に不完全なるを免かれぬのである。山口堰堤にありては止水壁工法は多くの實施例に則つて、自然地盤以下に於ては直立の混凝土壁とし、又夫れ以上に於ては直立粘土壁とし、之を上下流より盛土に依つて支持せしめてある。而して兩者の接際は最大なる水壓を受くる個所にてもあり、特に重要視し、卽ち混凝土止水壁の上部を尖頭形とし、此の部分を鐵筋によりて堅固に補強し、粘土止水壁中に深く揷入せしめ、若し後日粘土壁が沈下等を起せば益々深く揷入し、愈々水密を確保せしむる樣に築造せられた。



寫眞11、堰堤の堤心掘鑿坑入口（5年8月）

先年萬國工業大會が東京に開かれた折、偶々此の接際部分の施行個所に、專門大家が數名會合し、此の工法に關するデスカッションが行はれたるを聞くに、各國に各種の異りたる實例は多々あるが、此の現場に採用した上記の如き工法が、最適ならんとの說が有力であつた樣に認められた。（寫眞10）

以下に混凝土止水壁と粘土止水壁とに就て夫々施工の概況を述べる。

混凝土止水壁

（寫眞第11～13）

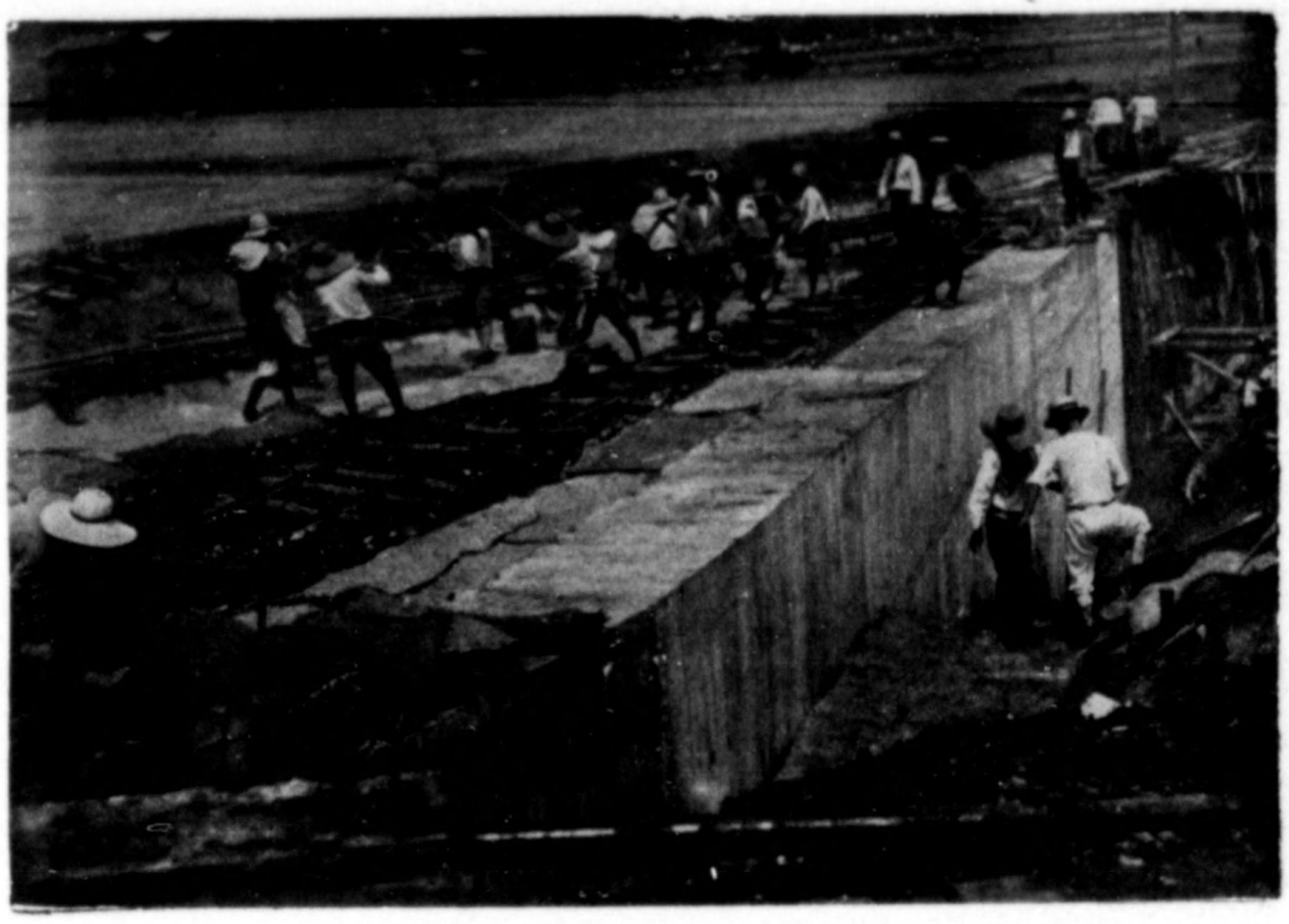
自然地盤以下に於ける透水を防ぐ目的を以て築造せらるゝものであつて、此の目的を達する爲め、堰堤の南北兩岸の奧深くに亘り、一連不斷にして地層の走行に直角に設けらるる厚さ1.8m（6尺）を有する直立壁である。

此の止水壁工事を施行するには先づ之を設置せんとする個所の堤心掘鑿を行はなければならない　この堤心掘鑿は、斷面の最大なる個所では幅6尺、高140尺にも及ぶ大隧道工事であつて、貯水池全般工事の中で最も困難を極めたものであつた。之を施工するには兩岸にありては、先づ6尺角の掘開斷面を有する上下の5段の隧道を以て1施行區分とし、各施工區分毎に、下段隧道を先づ掘進して漸次上段を掘開し、各段隧道には夫々嚴重なる支保工を施した。

掘鑿したる土砂は兩岸に設けられたるエレベーターに依りて外方に搬出した。北岸にありては多量の湧水を含める砂層に出會し土止板の背から盛んに土砂を流出し支保工に弛みを生じ、數々崩壞の危殆に頻せることがあり、斯る個所には止むを得ずセメント・グラウティングの方法によつて辛じて崩壞を防止した。

中央部の堤心掘鑿は、其の深さ40～50尺に過ぎなかつたばかりでなく、湧水の程度

寫眞12、堰堤混凝土止水壁個所の堤心掘鑿（5年8月）



寫眞13. 堰堤の混凝土止水壁（5年8月）

も少く左程困難を感ずること無く、掘鑿土砂は中央に設けられた捲揚機に依つて外方に搬出した。

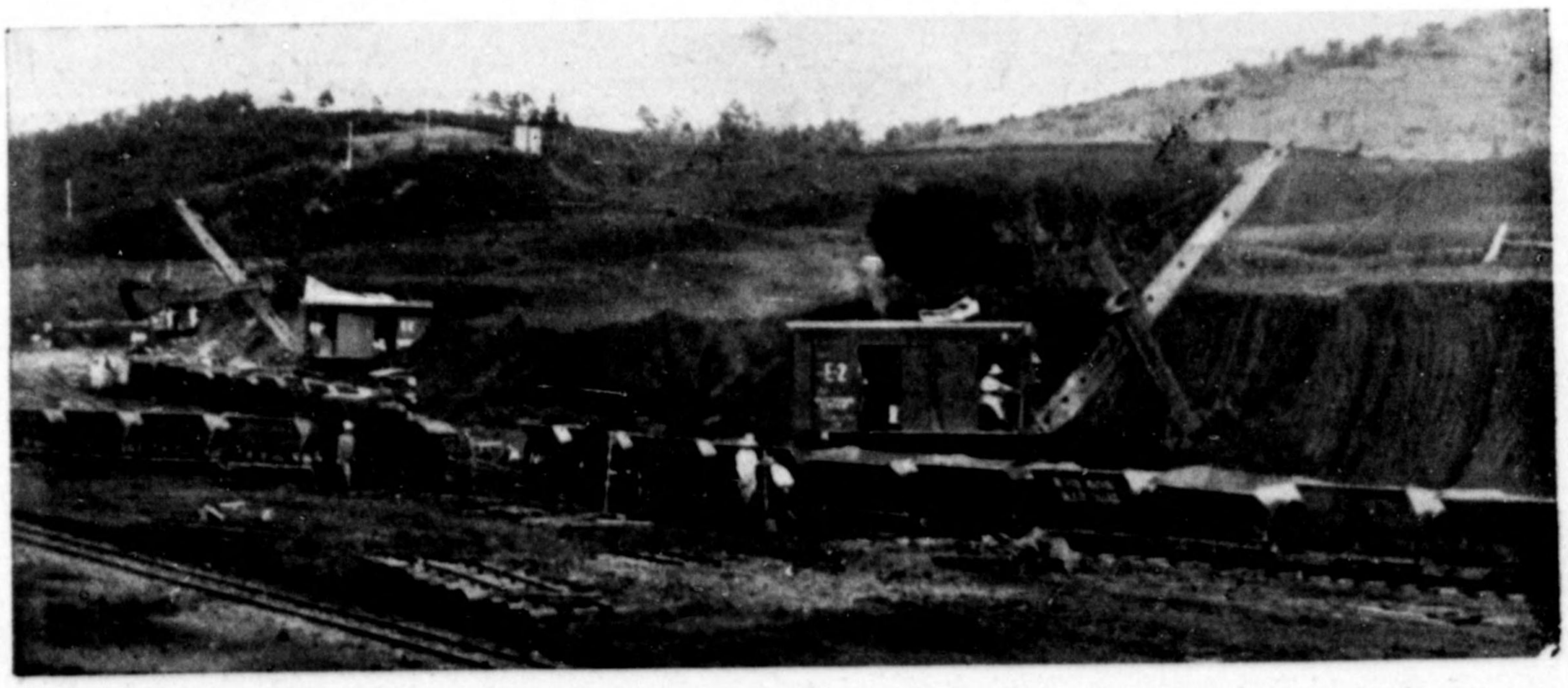
堤心掘鑿工の進行に伴ひ漸次下段隧道の最奥から止水壁混凝土工を開始した、之に用ひた混凝土は1：3：6配合とし、長さ36尺毎に構造接手を設け、此の接手個所には鐵板を挿入して漏水を防ぐこととし、又混凝土止水壁の上部は前述の如く尖頭形とし鐵筋にて補强した。

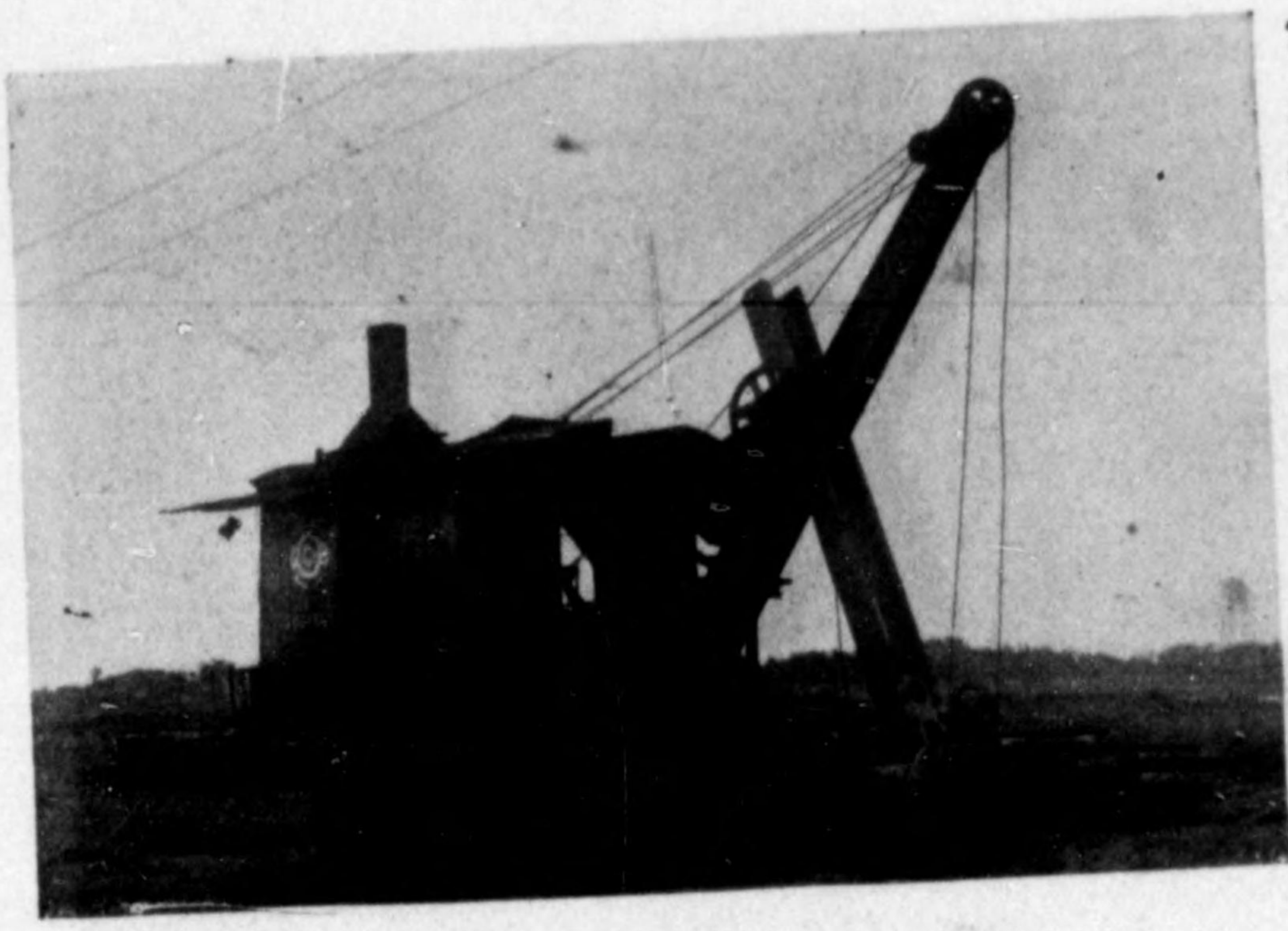
堤心掘鑿の土量は 120,000m³（2萬立坪）又止水壁の混凝土容積は 28,000m³（4,600立坪）であつて、是等に要した工費は夫々約 250,000圓及 430,000圓である。

粘土止水壁

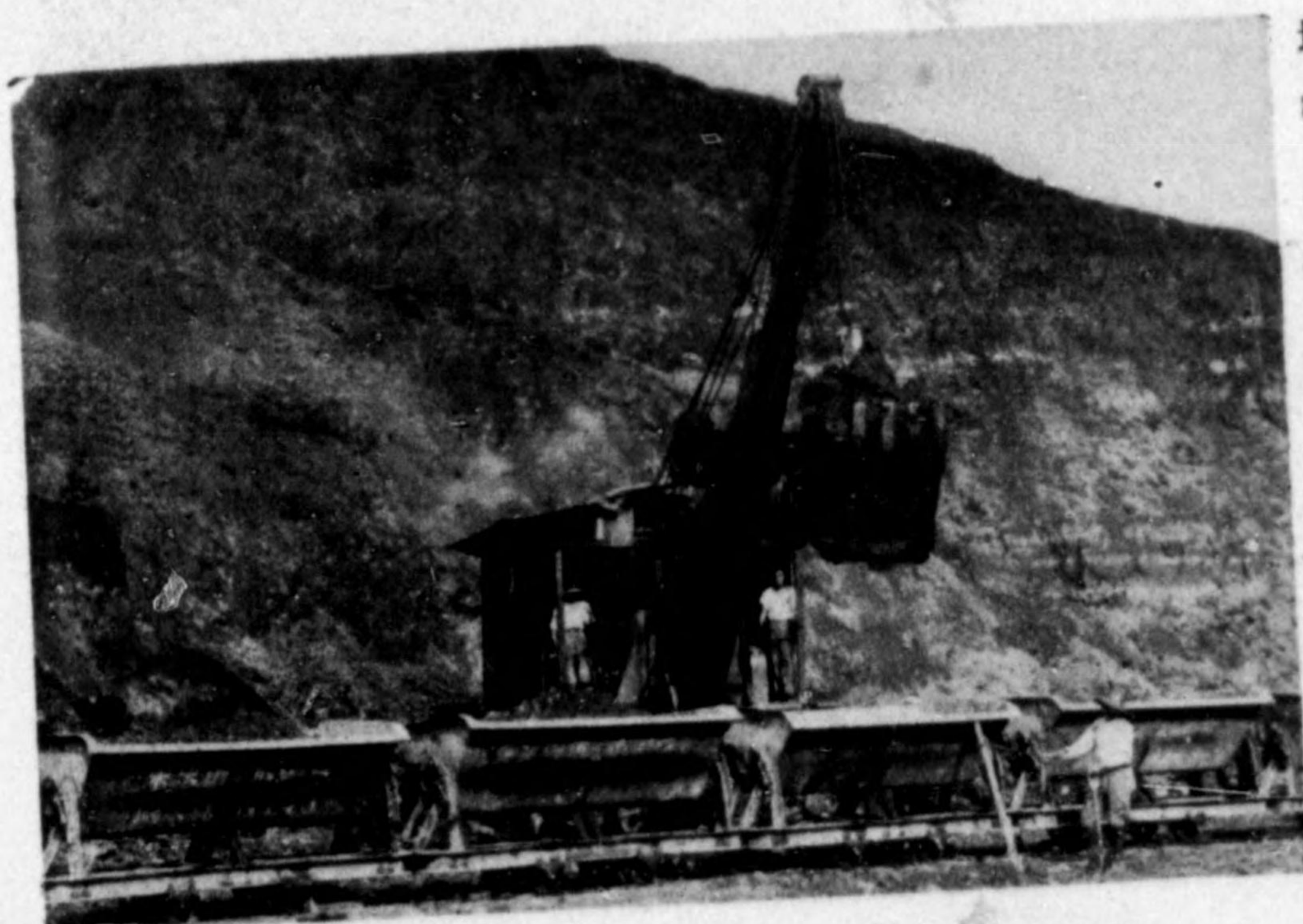
上述の混凝土止水壁の上部から堤頂に至る迄の間に位置して、止水の目的を達するものが卽ちこの粘土止水壁である。何故に此の部分を其の下部と同様に混凝土を以てせずして、特に粘土を用ふるやと云ふに、此の部分は自然地盤以上に該當し、止水壁は其の兩側の盛土に依つて始て直立の姿勢を保ち得るのであり、從つて地震等に際しては、盛土と一體となつて肌離れの生じないことを必要とする關係から、自然周圍の盛土と著しく材質の異る混凝土では、其の目的に添はぬと云ふ點

寫眞14、盛土採掘作業中にある掘鑿機其一（5年7月）





寫眞15、盛土採掘作業中の掘鑿機其二（6年7月）



寫眞16、盛土採掘に用ひたるスチーム・ショベル

があるからである。

此の粘土止水壁の形狀は第三圖に示す樣に、上部の厚さが 2.3m（8尺）にて兩側に$^{1}/_{10}$の勾配を付し、下部の厚さが 8.6m(28尺) 高さが 31m（101尺）の楔形を直立せしめた形狀をなしてゐる。

此の止水壁に用ふる粘土の材質如何は、堰堤全體の生命に係る、最も重要な問題であるからして、之が撰定に當りては各種の粘土材料に就て、充分なる科學的研究を遂け、此の附近に於て得らるゝものゝ中、最も水密性に富む適性の粘土の規格を定め凡て其の規格に合するものを採用することにした。之が爲めに特に粘土試驗所を置いて、出來るだけの試驗設備を整へて遺憾なきを期した。此の點に於ては從來迄の如く單に經驗に依る認識を材料撰定の基礎とせるに比して、一段の進境と認むる所である。

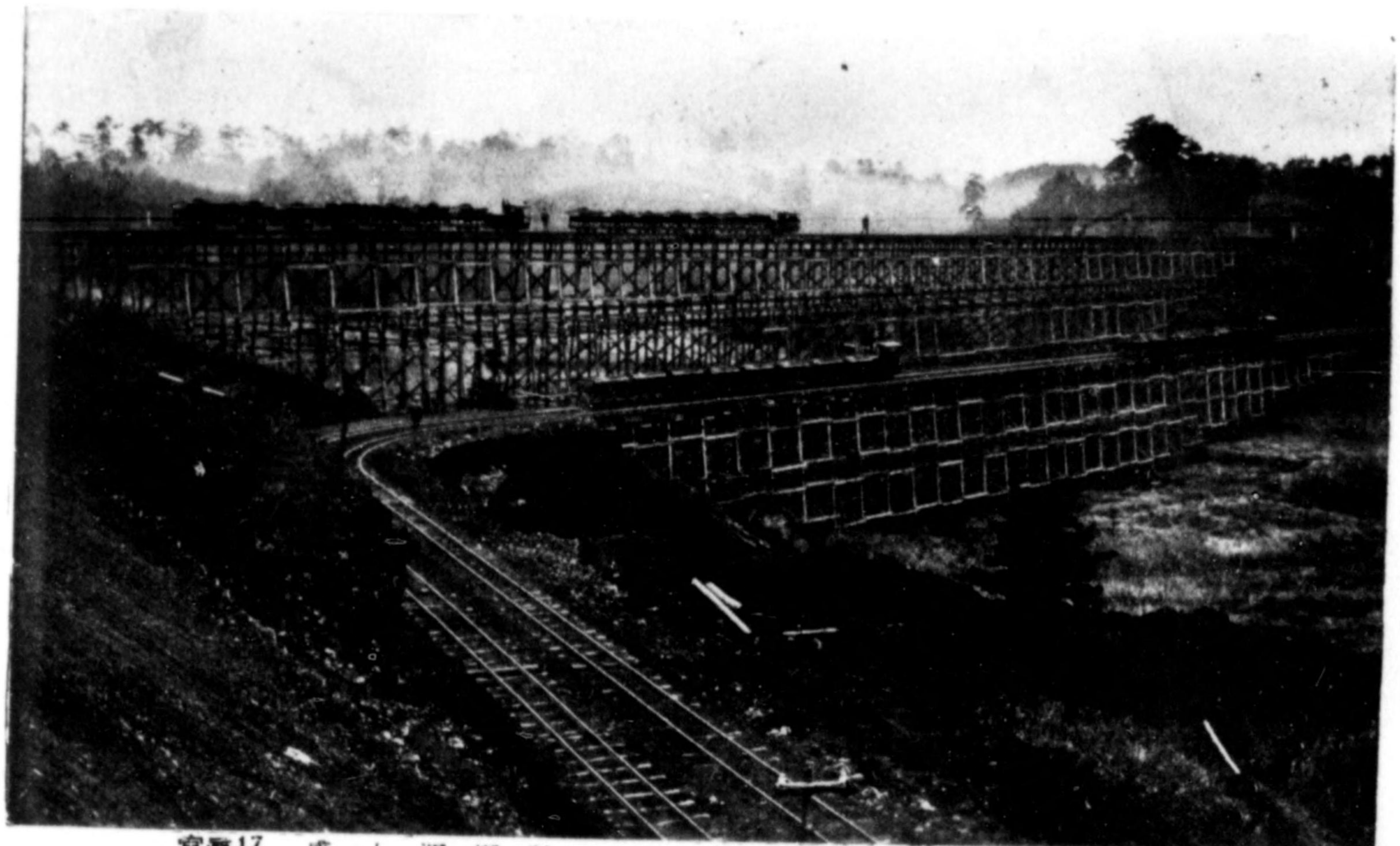
粘土止水壁の施工は、規格に合したる粘土の一定容積に對して、其の約半量の砂利を好く混合して現場に運搬し、厚さ約3寸の層に水平に敷き均し、蒸汽ローラー（8～10噸）にて充分締め固め、其の層の厚さが1寸5分となる迄輾壓し、盛土工と併行して順次上層に同じ工法を續け、堰頂迄に仕上げたのである。

本工事に用ひた粘土の容積は 109,000m^3（18,000立坪）にして、其の大部分は地元附近の請負者をして納入せしめた。又粘土止水壁に要した工費は 740,000圓である。

堰堤の盛土の採掘

（寫眞14～16）

堰堤の盛土は其の數量が莫大なるものであるから、之を採掘する個所は近距離にありて、且盛土の高さよりも幾分か高き所に在る良質の土壤を選ばなければならない。之れは大土量の運搬作業能率に影響する所、甚だ大なるものがあるからである　此の貯水池現場にありては、幸ひにして堰堤の南北兩岸に接續する丘地に、上記の條件を滿足する樣な土質が豐富に得られたから、單に極く僅かな不良土を排除した程度にて、是等の土取場から盛土全體の土量の採掘が出來、誠に好都合であつ

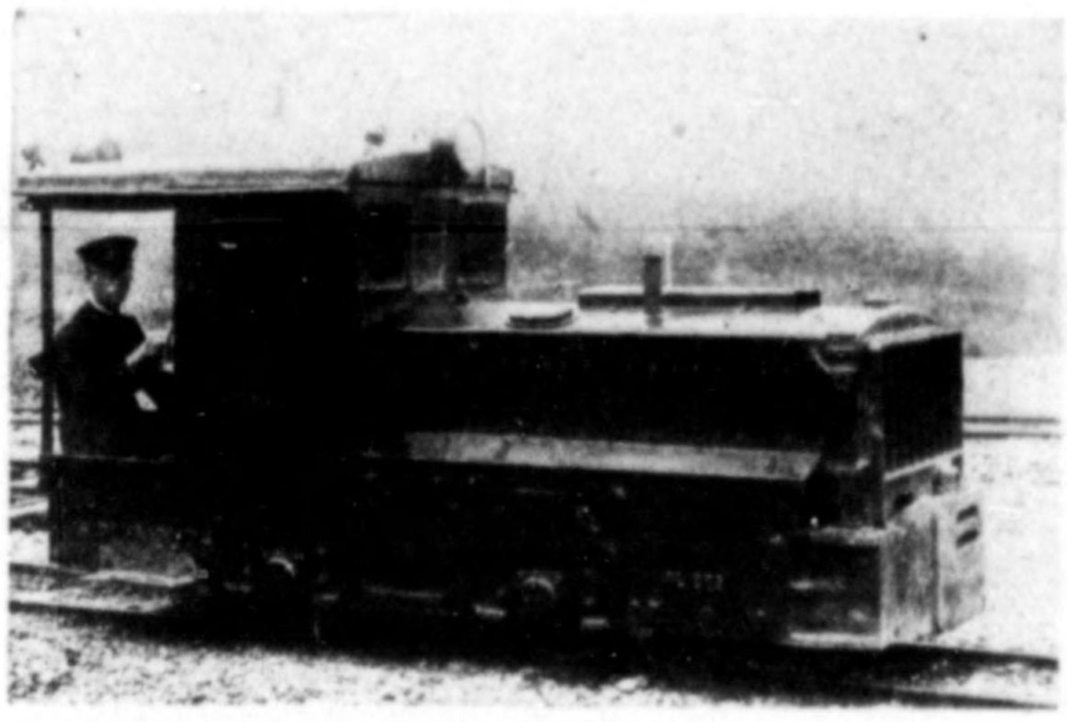


寫眞17. 盛土運搬線に架せられた棧橋（6年12月）

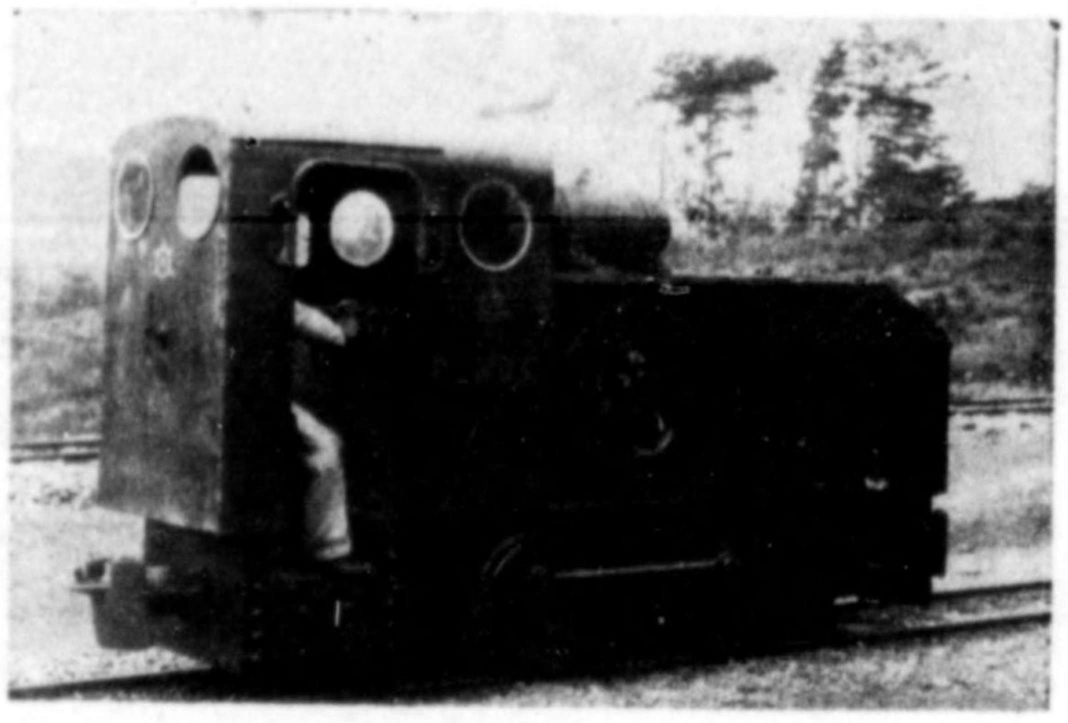
寫眞18、堰堤盛土工事全景（6年7月）

た。之を採掘するには凡て掘鑿機の力を藉りた。掘鑿機はすべて米國ビサイラス會社製のものを用ひ、其の種類は次の通りである

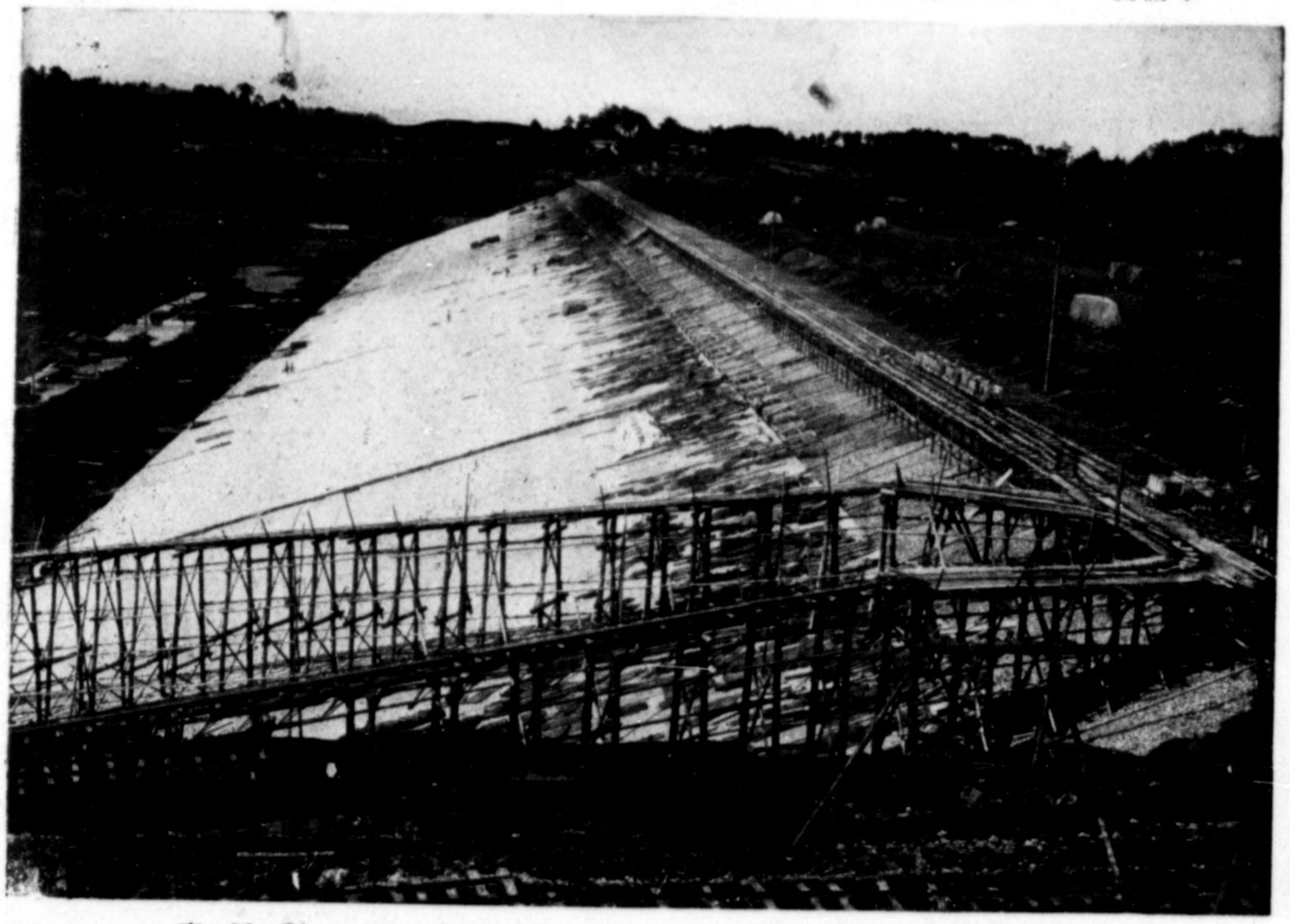
デイゼルショベル	$1.5 yard^3$	3臺	（新規購入）
同	$^3/_4$ 〃	1臺	（鐵道省より借入）
スチームショベル	$^3/_4$ 〃	2臺	（東電より購入）



寫眞19、盛土運搬のデイーゼル機關車



寫眞20、盛土運搬のガソリン機關車



寫眞 21、堰 堤 法 面 の 防 護 工（7年4月）

スチームショベル $^{5}/_{8}$ 〃　1臺（東京市土木局より讓受）

計　7臺

是等掘鑿機の作業能力は、1日24時間連續運轉にて次の通りである。

1·5 yard^3 機　3臺にて 360 立坪

$^{3}/_{4}$及$^{5}/_{8}$ 〃 機　4臺にて 360 立坪

合　計　720 立坪

1ヶ月の採掘工程は作業日數20日と見て、14,400 立坪である。而して盛土に關係する大土工は、工程を急ぐ爲昭和5年9月1日から其の竣功に至る迄、丁度滿2ヶ年間は晝夜連續作業とした。

各種掘鑿機の採掘作業に要した土工1立坪當り工費は次の通りである。

掘鑿機種別	臺數	1立坪工費	摘要
デイゼル(1.5)	3	圓 0.168	227 千坪の實績
同 ($^{3}/_{4}$)	1	0.195	27 〃

スチーム (5/8)	1	0.342	34千坪の實績
同 (3/4)	2	0.329	53 〃

上記各種の掘鑿機は高さ20尺程迄を採掘出來るが、夫れ以上には臂の長さが及び兼ねるし、又跡地が斷崖となつて崩壞の危險があるので、數々爆藥カーリットにて爆破切崩しをなした。其の實績に依ると、477個所に就て土量 8,344 立坪を爆破切り崩しをなし、藥量621瓩を要し、1個所の藥量は1.3瓩に當り、之を1立坪に割り當てれば0.75瓩となる。其の經費は下の通りである。

爆破の經費

名　　稱	數　量	單　價	金　額
カーリット	瓩 622.025	圓 1.080	圓 671.787
電氣發火用雷管	477本	.068	33.436
導火線其他			52.545
計			756.768
工夫及土工	人 152.6	1.600	244.160
合　　計			1,000.928
1立坪當り經費			0.120

堰堤の盛土の運搬作業 （寫眞17,19,20）

盛土の採掘には、上記の樣な大きな能率を有する掘鑿機7臺を使用したから、運搬設備も之に適應する樣に配備しなければならない。

大土量運搬の爲には、當初に於ては大型の機關車及貨車を使用せんとも考へたが、絕えず採掘個所を移動せしむるの要あり、又盛土の進行に伴ひ軌條を漸次高所に移動せしむる等の關係上、線路移轉に多くの經費と時間を要することを虞れ、すべて小型機關車を用ひ、18封度軌條にて間に合はせることにした

而して運搬作業の施設には下の如きものを用ひた。

デイゼル機關車（獨逸發動機會社製）

5噸車 4 臺

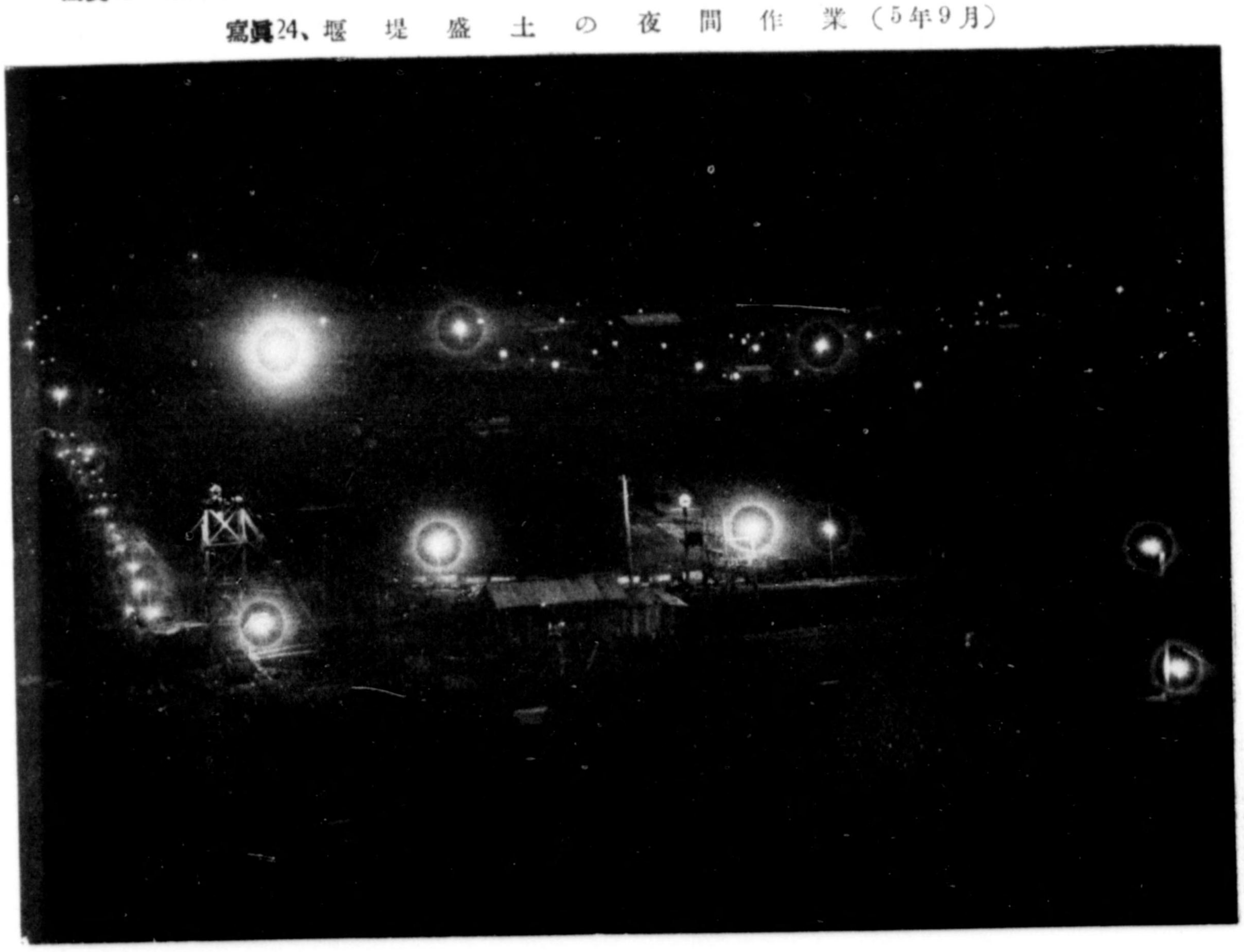
寫眞22、 村山貯水池上空より見たる竣功に近づきつゝある堰堤 （7年9月）

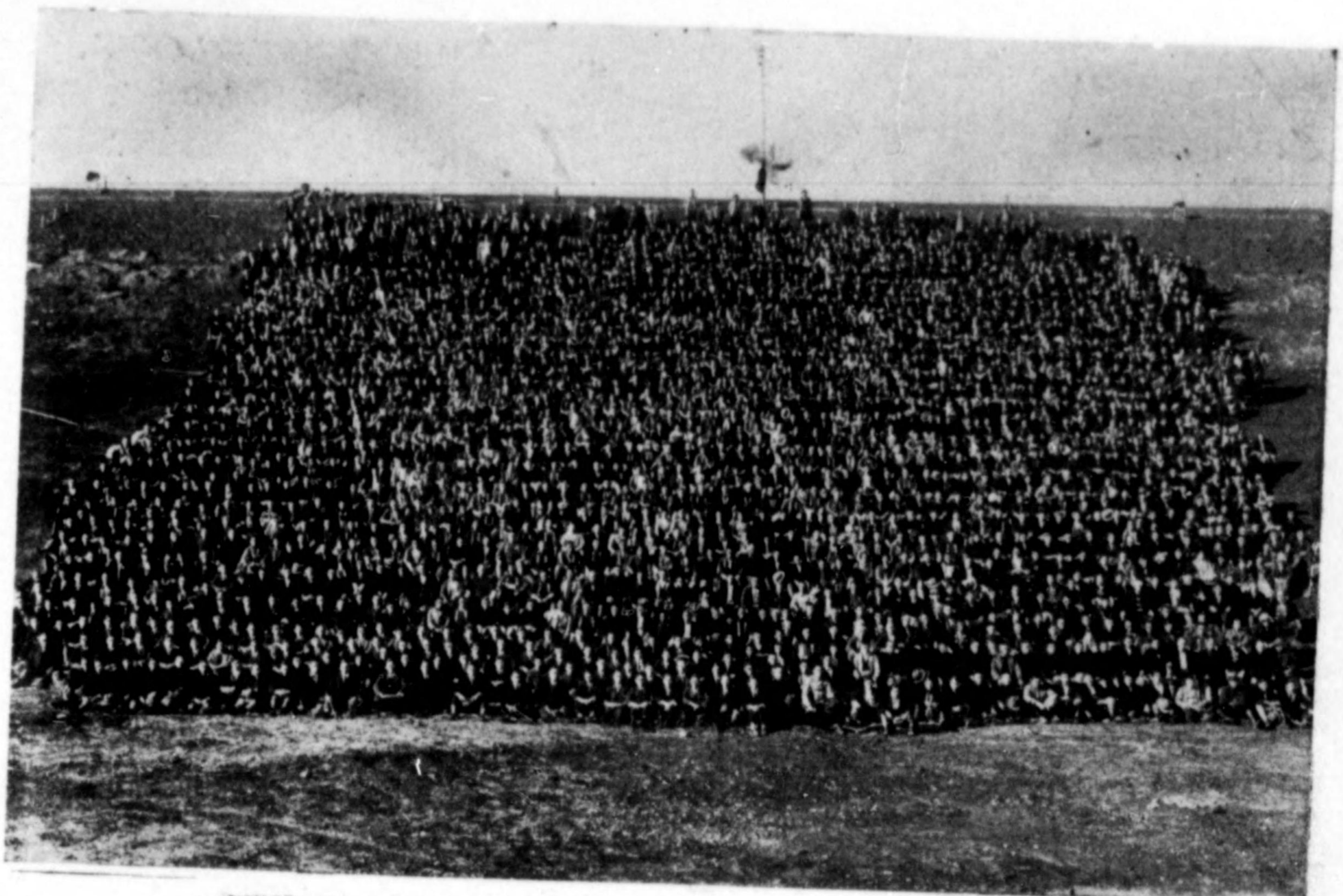
寫眞23 池內整理のための拔根作業（6年8月）

ガソリン機關車（米國ホキツトコム）
4.5噸車 6 臺
同 （米國プリマウス）
4.5噸車 5 臺
同 〃
6.0噸車 3 臺
蒸氣機關車
5.0噸車 2 臺
貨 車（鋼製V型橫斷車）
2.0噸積280臺
軌 條（18封度2呎軌間） 19哩

運轉列車の編成は、1列車が貨車10車仕立2立坪積載とし、1.5yard³ 掘鑿機1臺に付3列車、³/₄yard³掘鑿機1臺に付2列車を配屬せる故、合計17列車を晝夜運轉とした。運搬距離は平均2哩であつて、1往復30分を要し、積卸し時間を見込み1日36回運轉し、延612列車、1,234立坪となり、之を締め固むれば約六割となるから、1日運搬工程が締め固め後

寫眞24、堰 堤 盛 土 の 夜 間 作 業（5年9月）





寫眞25、堰堤工事の従業員、約2,200人（7年1月）

の容積にて730立坪となる。即ち掘鑿機7臺の1日採掘工程720立坪と略合致する。

各種機關車の1立坪當り運轉費の實績は下の通りである。

デイゼル機關車（ 24,103立坪の平均）31.9錢
ガソリン機關車（288,586立坪の平均）42.6〃
蒸汽機關車（ 23,095立坪の平均）49.9〃

即ちデイゼル機關車は他に比して運轉費に於ては頗る經濟的であつたが、速力に於て劣り、従つて同一線路を混合運轉する場合は、甚しく不便を感じた。尙當現場に用ひたものの最大時速はデイゼル機關車6哩、他は12哩であつたからして、空車運轉の場合に特に其の憾があつた。

盛土が漸次進行して高き位置に運搬線路を設くる必要から、谷合を渡る爲高き棧橋を各所に架設した。寫眞17は其の一例を示したものである。

寫眞26、砂利採集中のデイゼルドラグライン（5年9月）

寫眞27、砂利運搬用のディセル機關車（5年9月）

堰堤の盛土輾壓作業（寫眞18）

土取場から採掘した土は上記の如く堰堤敷地に搬入せられて、貨車上のV型箱を人夫3〜4人の手にて簡單に横轉して卸し、厚さ5寸程に一様に擴げて、蒸汽ローラーを其の上に反覆運行せしめ、厚さが3寸程に壓縮せらるゝ迄に締め固めるのである。ローラーは英國製10噸重量のもの2臺、米國8噸重量のもの2臺、別に補助として英國製6噸重量のもの1臺を用ひた

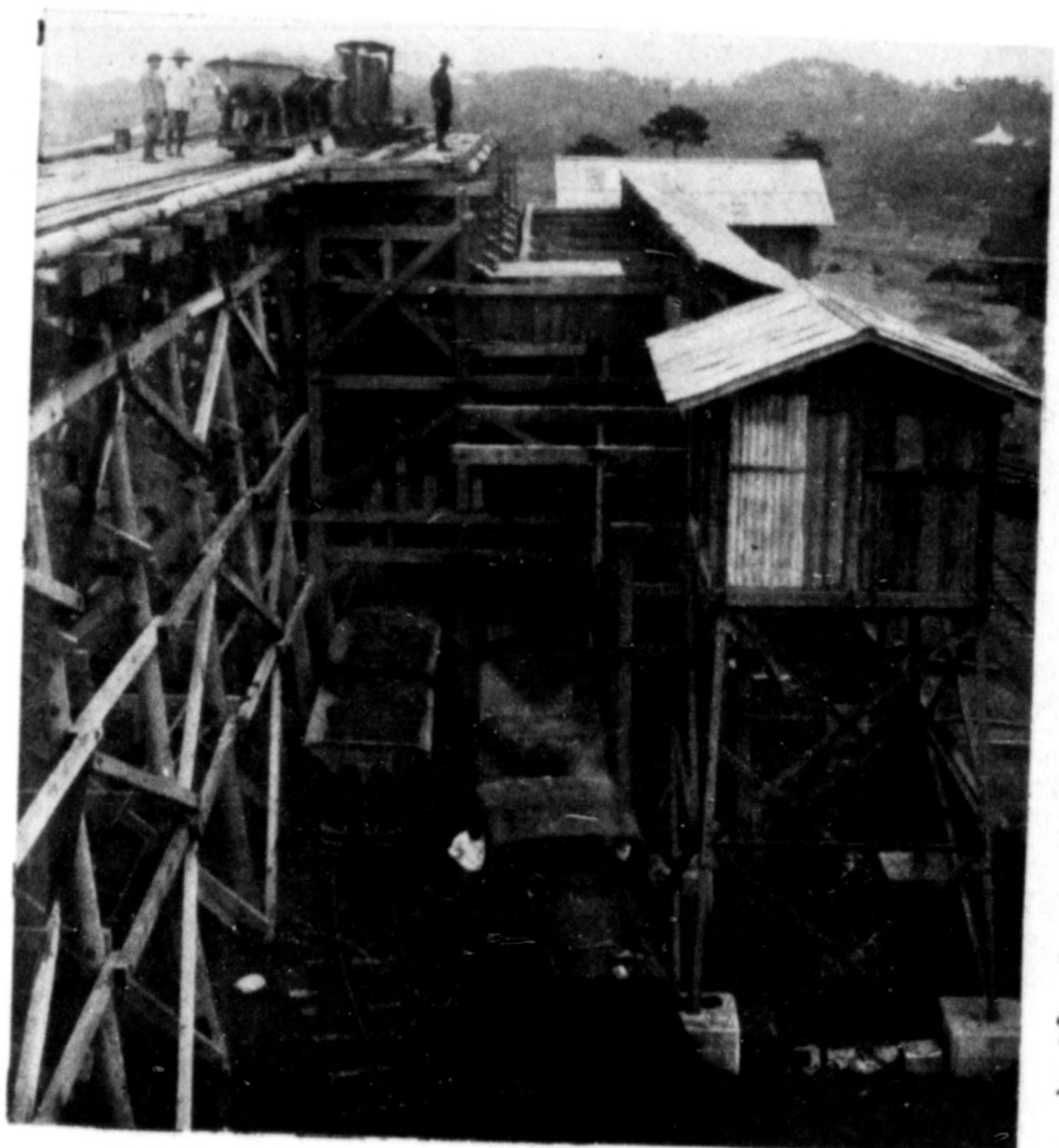
ローラー1臺1日の輾壓工程は晝夜連續運轉として180立坪であつて、4臺にて720立坪となり、卽ち上記採掘及運搬工程と合致することになる

ローラーの運轉費を、233千立坪の實績によりて1立坪當りに割り當れば、約24.8錢となる。

又天然狀態の土壤を採掘して敷き均しローラーで締め固めたもの、卽ち堰堤盛土として出來上つたものは、試驗の結果原狀に比して約1割2分密度が大であることが判明した。卽ち兩者の供試體1立方尺（比重2.66）の比較は下の通りである

種別	天然重量	乾燥重量	水分	締固率
地山	瓩 43.14	瓩 24.46	43%	100%

寫眞28、碎石場全景（5年9月）



寫眞29、碎　石　場、　側　面　（5年9月）

盛　　土	瓩 45.50	瓩 27.3	38%	1 1.9%

堰堤の盛土

（寫眞22, 24, 25）

以上の採掘、運搬、輾壓等其の他附帶諸工事が集まつたものが盛土を形成するので、其の總容積1,300,000m³（216,000立坪）工費は約1,185,000圓である。而して盛土工事は昭和5年3月に初めて着手したのであつたが、工事の進行を急ぐ關係もあり、又成る可く多くの地元青年を使役して農村疲弊の救濟に資せんとして、同年9月からその竣功に至る迄、丁度2年間は晝夜連續作業を敢行した。其の就業方法は次の通である。

第　一　組

午前6時〜午後2時　約500人

第　二　組

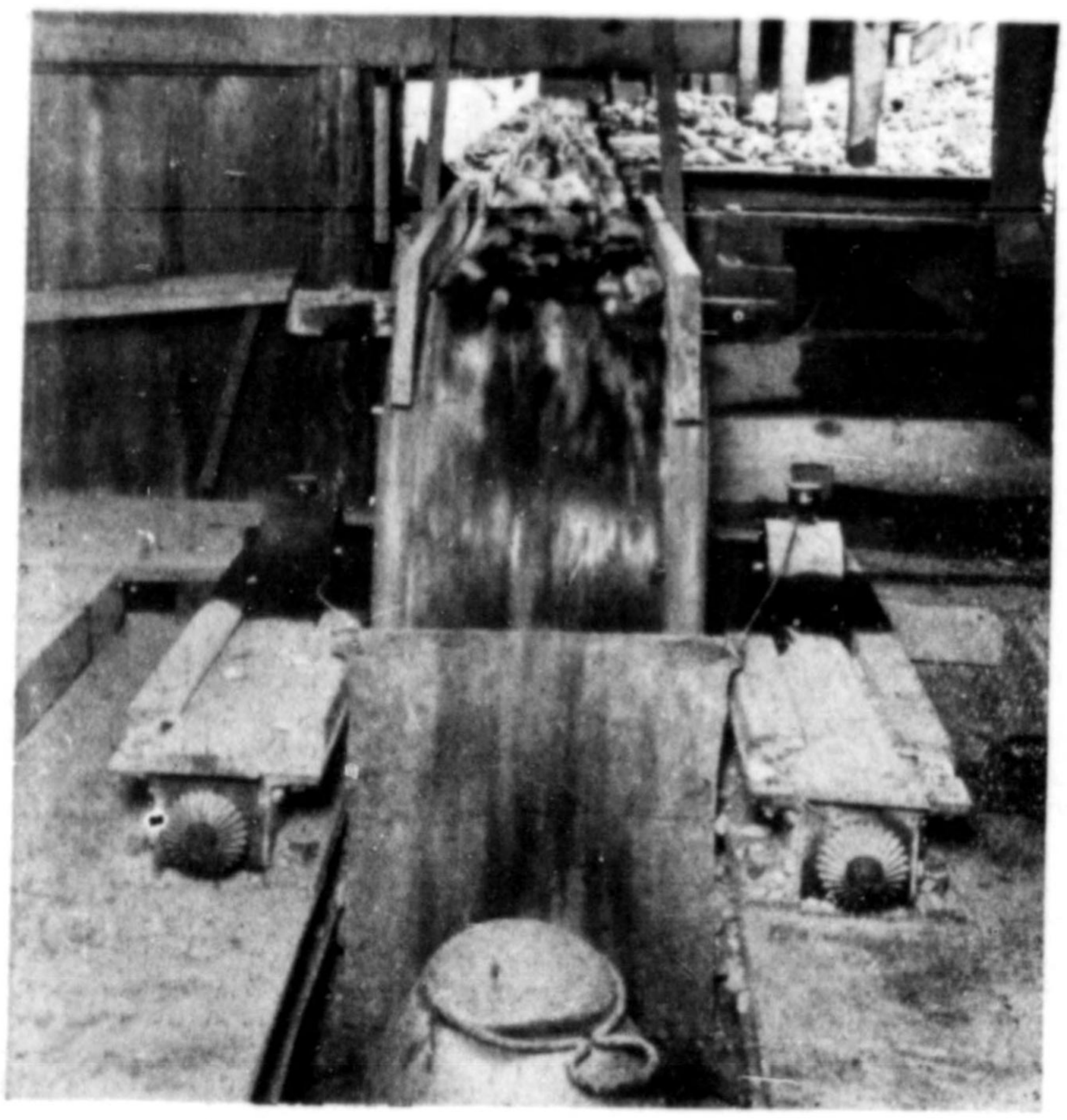
午後2時〜午後10時　同　上

第　三　組

午後10時〜翌午前6時　同　上

普通勤務者は、以上の外に約500人であつた。之れは主として盛土以外の工事に携つたのだが、平均1日2000人の人夫を此の現場に使役した。當初は夜間勤務の作業能率に就て疑を懷いたが、先づ照明設備を遺憾無き樣配置して、實施したる結果を見るに、却つて晝間作業能率よりも、遙に優りたる成果を擧げ得られた。之は周圍が晴黑であるから勞務者の氣分が散漫とならず工事にのみ集注し、尙四圍が靜寂であるから機關車運轉等の音響が耳に入り易く、却つて負傷者の數も晝間よ

寫眞30、碎　石　場、　玉　石　篩　分



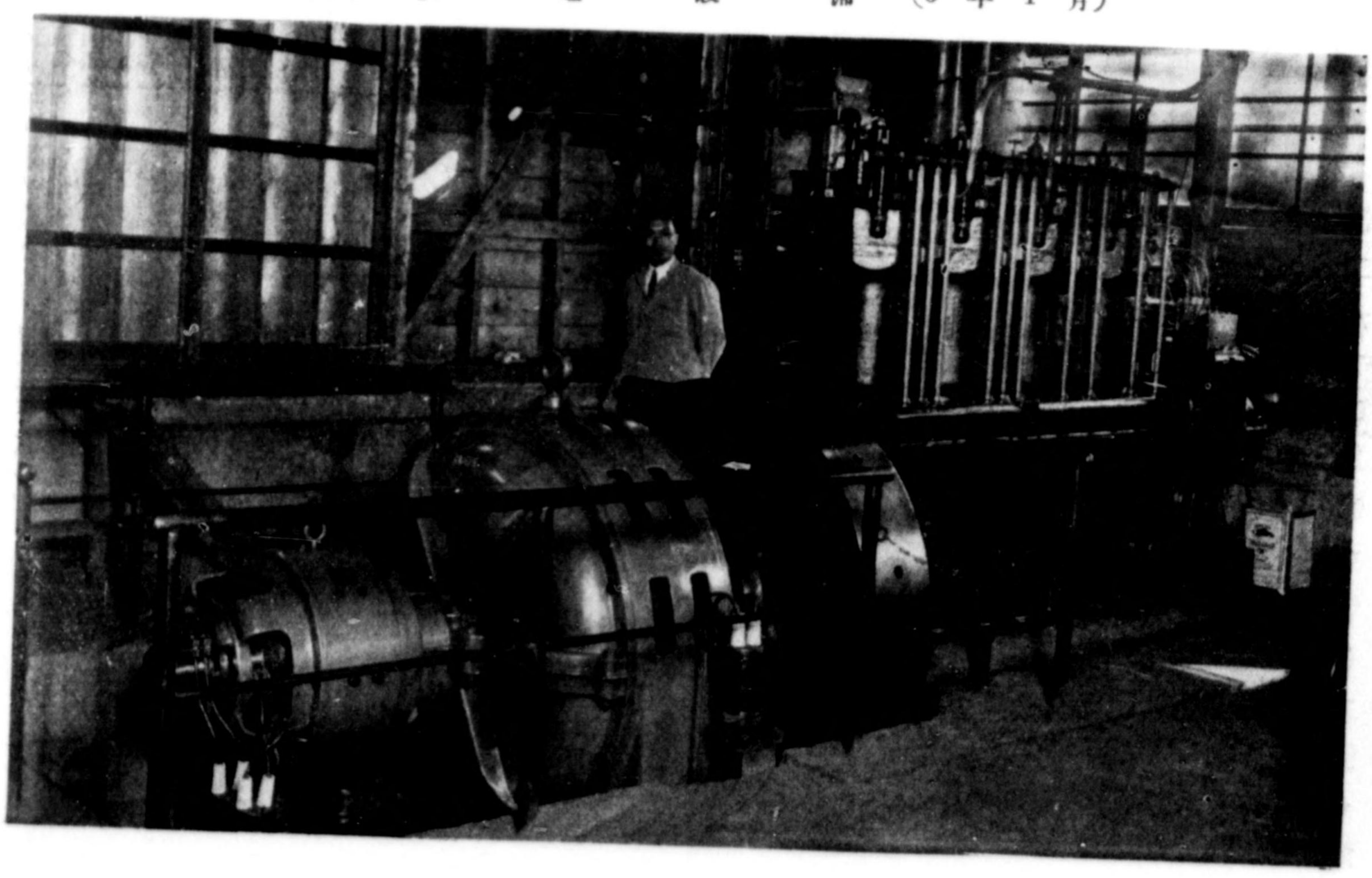
寫眞31、碎 石 場　ベルトコンベヤー

り少く、意外の好結果を得られた。尚夫ればかりでなく、直接夜間作業に從事して居らない者や、他の現場の從業者なども、嚴冬に於て鐵も凍る樣な深夜に起き出でゝ、寒風に吹き曝されながら野外に馳驅する、數百の同輩が嘗めつゝある勞苦を偲びて、相互にゆるむ心のネヂを捲き、一段の緊張味を奮起して、全般の工事施工上に於て、精神的に利する處が頗る多大であつた、しかも地元青年はすべて好く統制に服し、各自の鄕頭に誇るべき完全なる一大工事を出現せしめんとの誠意のひらめきも表はれて、眞に魂のこもつた眞劍なる努力を續けたのであつた。此の意味に於て、當局の執つた地元青年のみを現場に採用する方針は、斯くの如き重要施設を築き上げんとする場合に於ては、誠に當を得たものと思はるるのである。

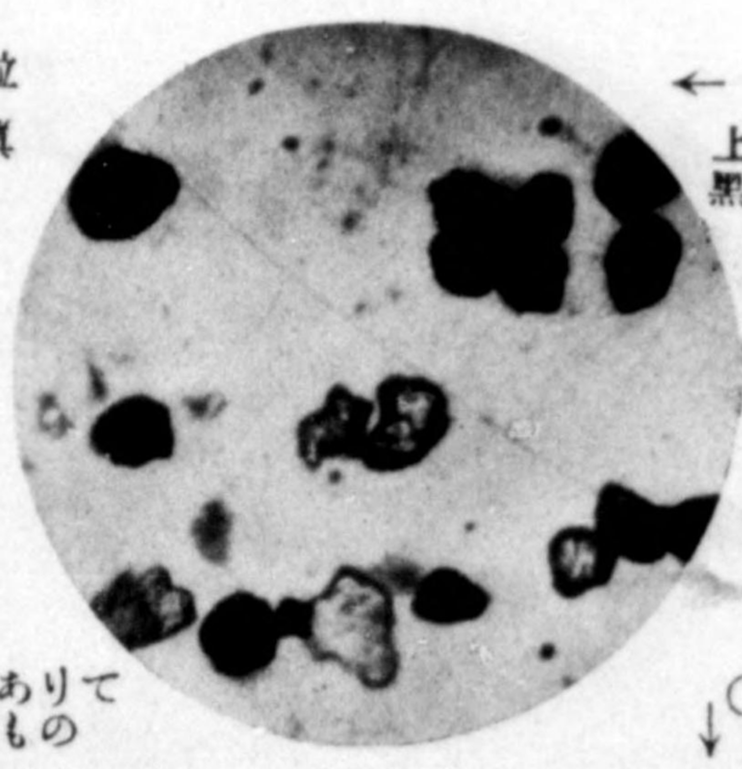
堰堤法面の防護（寫眞21）

堰堤の法面は、前面は3割、背面は上半2割、下半 2.5 割であつて、前面は波浪の浸蝕作用を防ぐ爲、硬質の材料で保護するの要あるが、背面は雨水に依る浸蝕のみであるから單に張芝を施すに止めた。

寫眞32、發　電　設　備　（6 年 1 月）



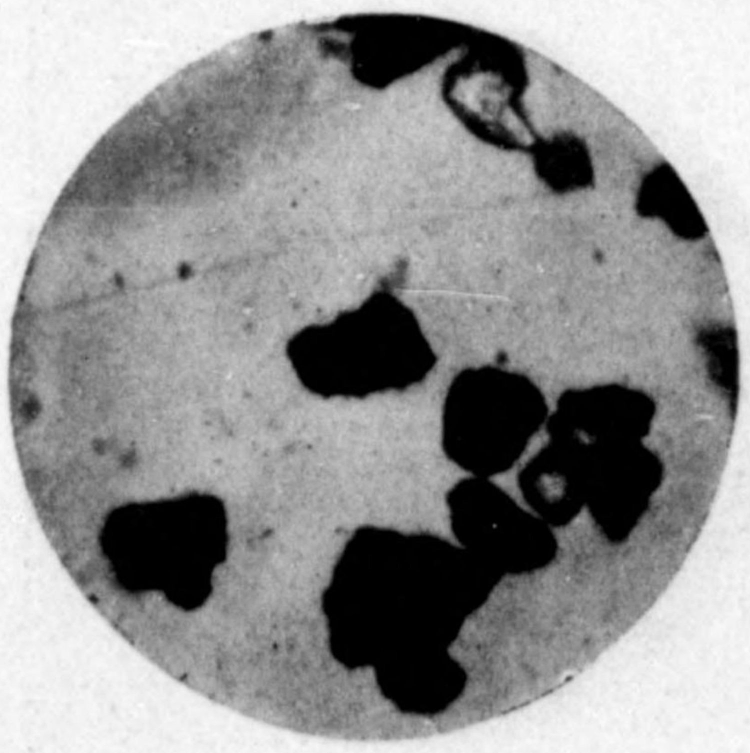
寫眞33、粘　　土　　試　　驗　　所（6 年 8 月）



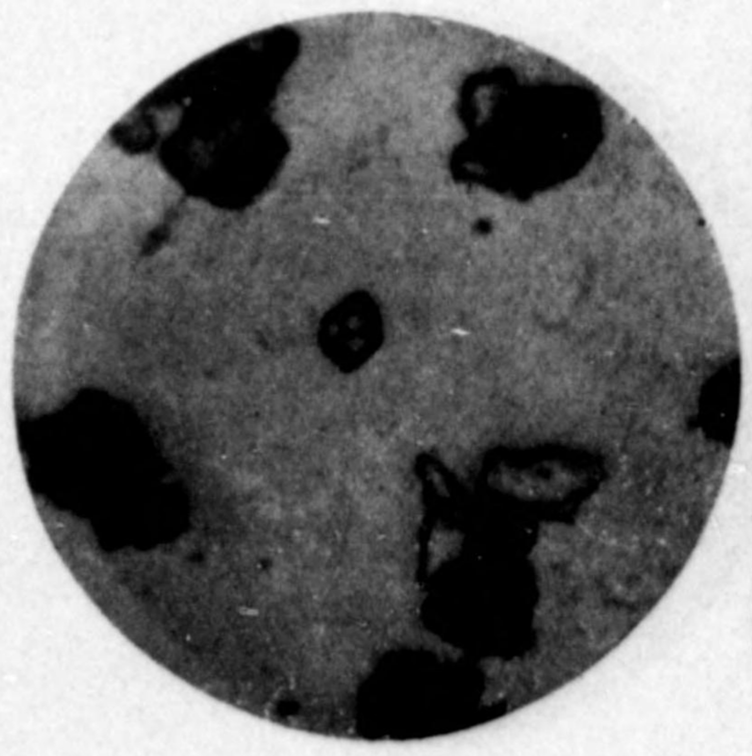
寫眞 4．粘土粒子の顯微鏡寫眞（500倍）

←（1）上層部にありて黑色のもの

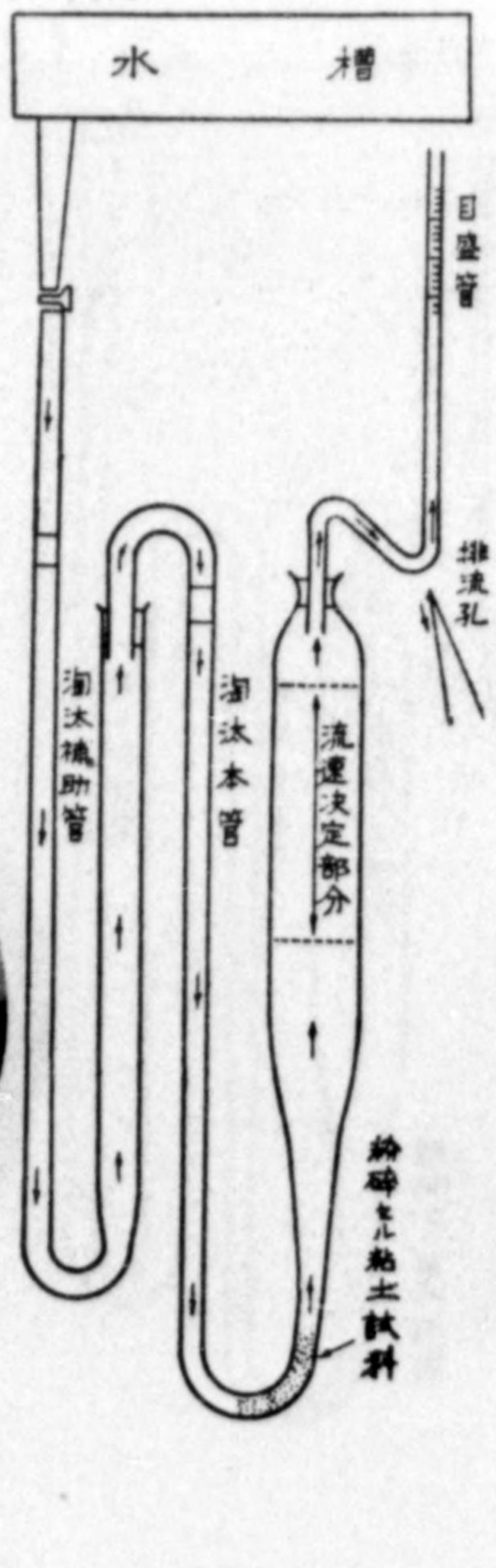
↓（2）中層にありて赤色のもの

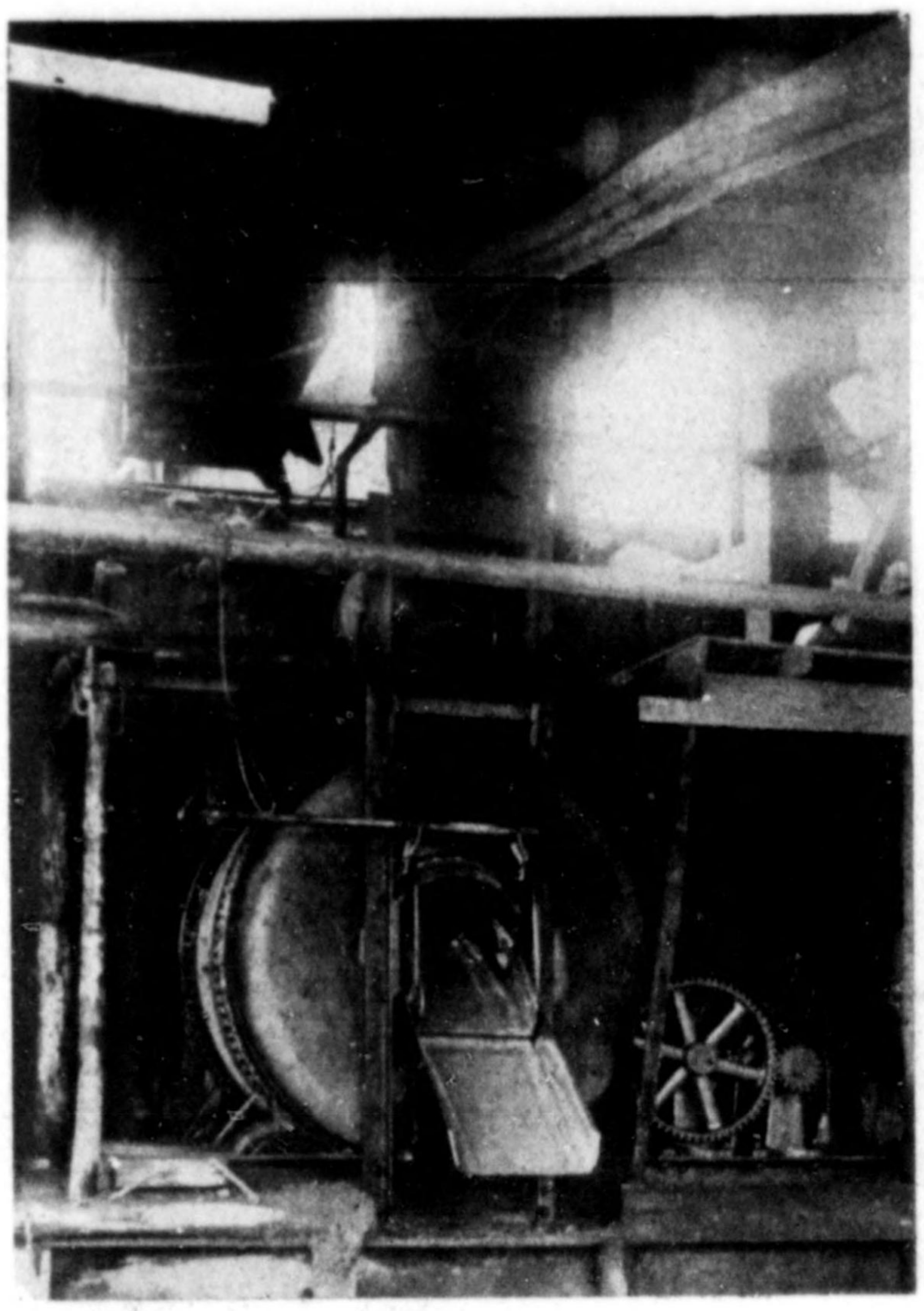


↓（3）下層にありて灰白色のもの



第四圖　粘土淘汰分析設備





寫眞35、コンクリートプラント

前面の防護工には混凝土ブロック張を用ひた。先づ盛土法面を平らに鋤き取り、厚さ1尺の基礎砂利を敷均し、其の上に內法6尺角の型枠を設けて、配合1:3:6の混凝土を厚さ1尺に、現場打ブロック仕上とした。尙セメントガンにて法面防護をなさんとして、試驗的に施工して見たが、經濟上有利でないことが判つて中止した。

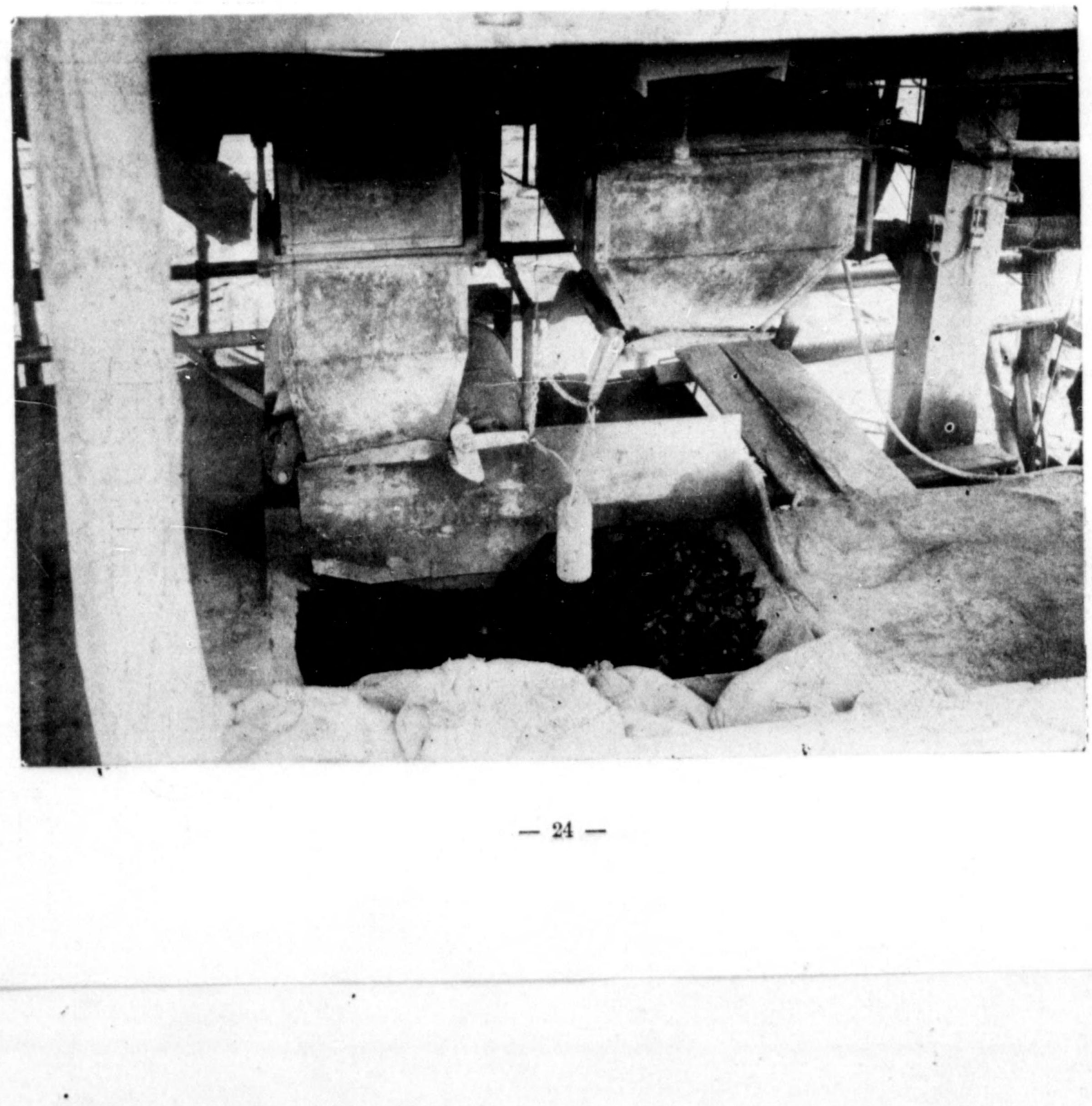
此のブロック張混凝土の面積は、16,000坪であつて、工費は317,000圓である。

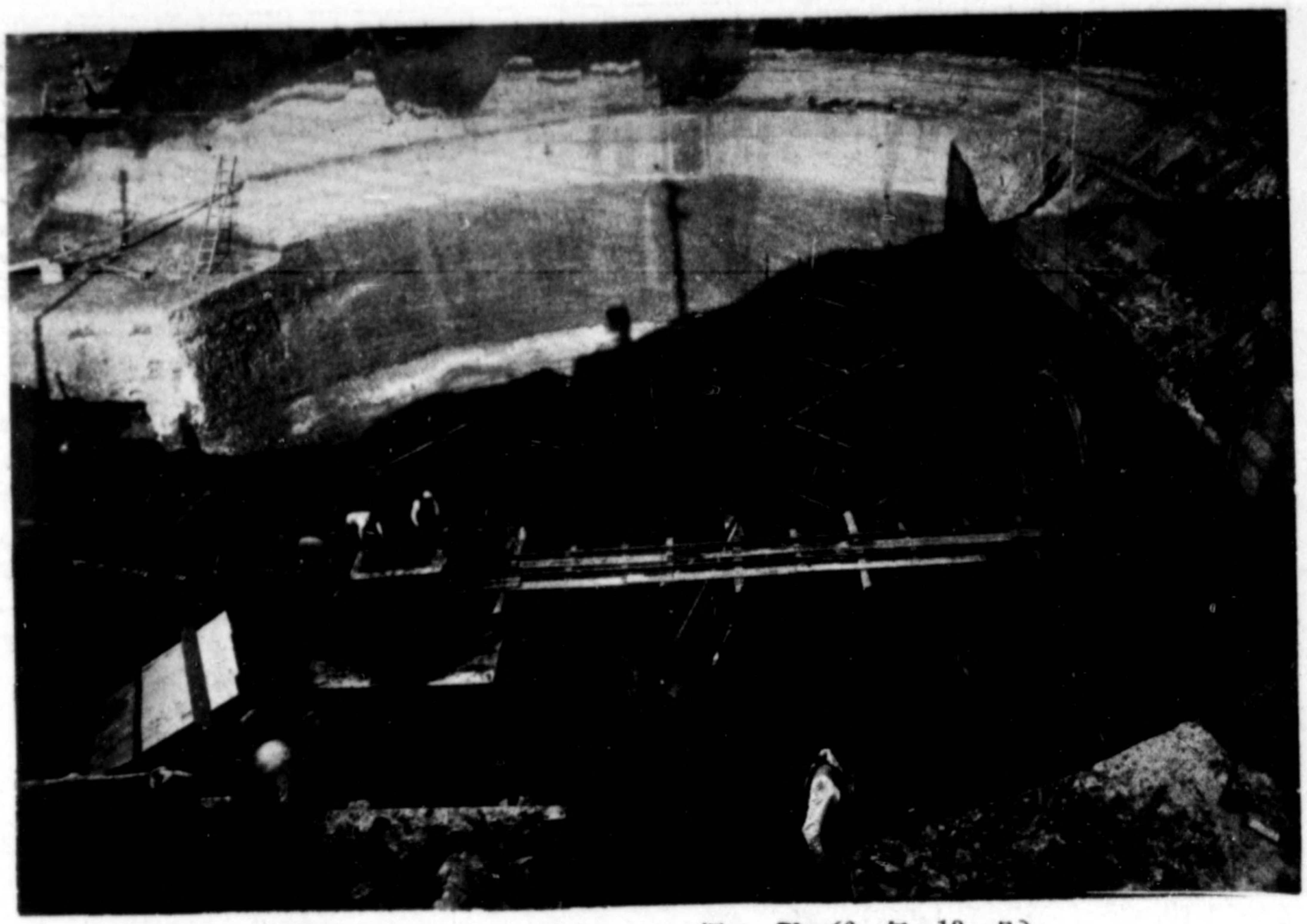
又背面法の張芝工は其の面積120,000坪、工費12,000圓である

池內整理工事（寫眞23）

滿水面以下となる貯水池內はすべて腐蝕性のものを取り去り、雜草は苅り取り、樹根は小なるものは拔根機に依り、又大なるものはカーリット爆藥に依つて之を取り除いた。カーリット拔根作業の實績に依ると、平均直徑1.5尺の樹根139本の平均は、1株當り藥量約

寫眞36、コンクリート調合機





寫眞37、取　水　塔　の　掘　鑿（6 年 12 月）

600 瓦を要し、爆薬代及其の装置費等を併せて經費約88錢となつて居る。單に勞力を以て之を除去するに比べて、餘程經濟的であつたばかりでなく、作業を進捗せしむる上に於ても非常に有効であつた。

砂利砂採集及篩別

（寫眞26～31）

本工事に使用した砂利、砂、玉石はすべて水道取入口羽村附近にてディゼル・ドラグラインにて採取し、羽村村山線隧道敷に延長約7哩の輕便軌道を敷設して運搬し、途中の殘掘と云ふ所に、碎石及篩別工場を設けて、此處で用途に應ずる大いさのものに破碎篩別して現場に持ち込んだ。

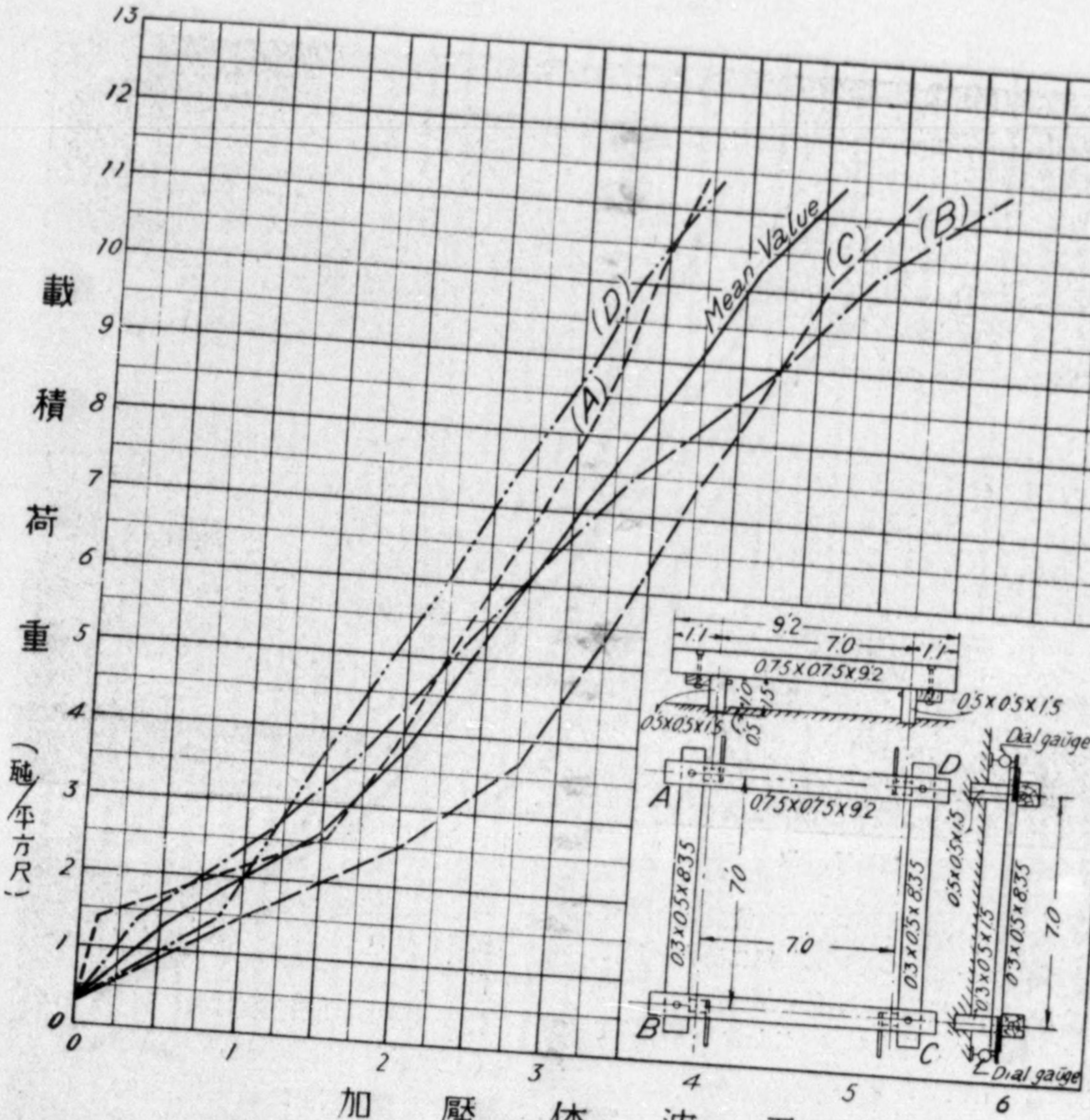
採石數量は次の通りである

砂　利	24,285立坪
砂	7,062立坪
玉　石	3,957立坪
計	35,304立坪

之が設備に要した經費は次の通りである。

（イ）採取設備費　　65,033圓

寫眞38、取水塔基礎耐壓試驗（6年2月）



第五圖、取水塔基礎地盤の耐重試驗

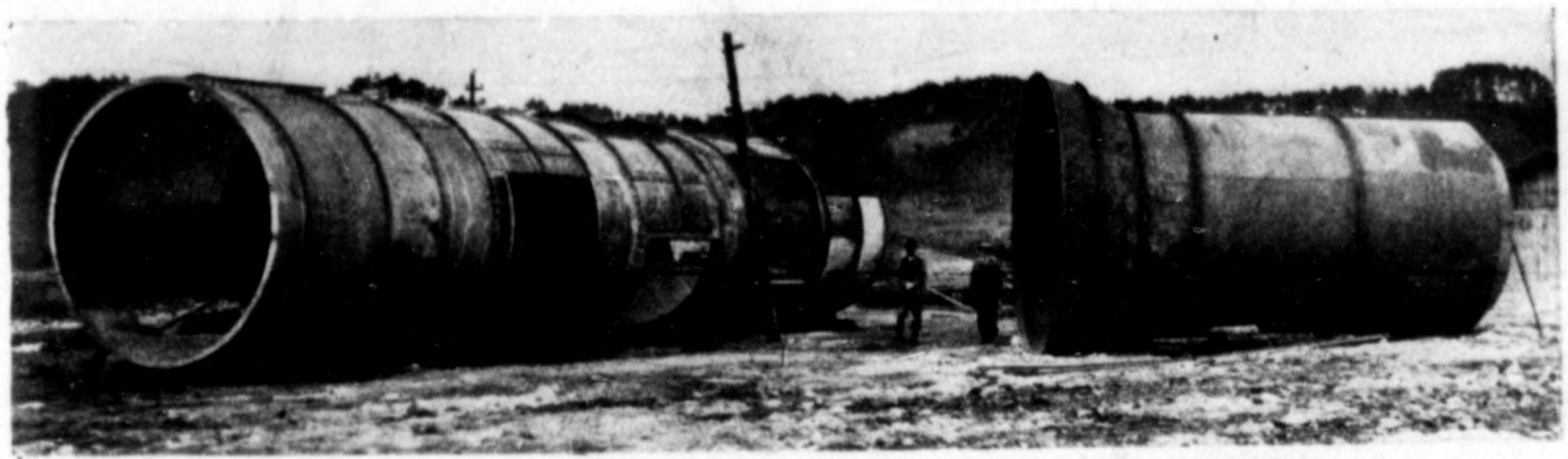
線路並棧橋工事費	17,433圓
ドラグライン	47,600圓
(ロ)篩別設備費 39,243圓	
工事費	25,280圓
碎石機(アリスチヤールマー製ゲーツ式碎石能力20屯)	9,050圓
ベルトコンベヤー	4,913圓
(ハ)運搬設備費 312,676圓	
工事費	207,127圓
機械費	105,549圓

上記諸經費を採取坪數に割り當てれば、1立坪當り約12圓となる。

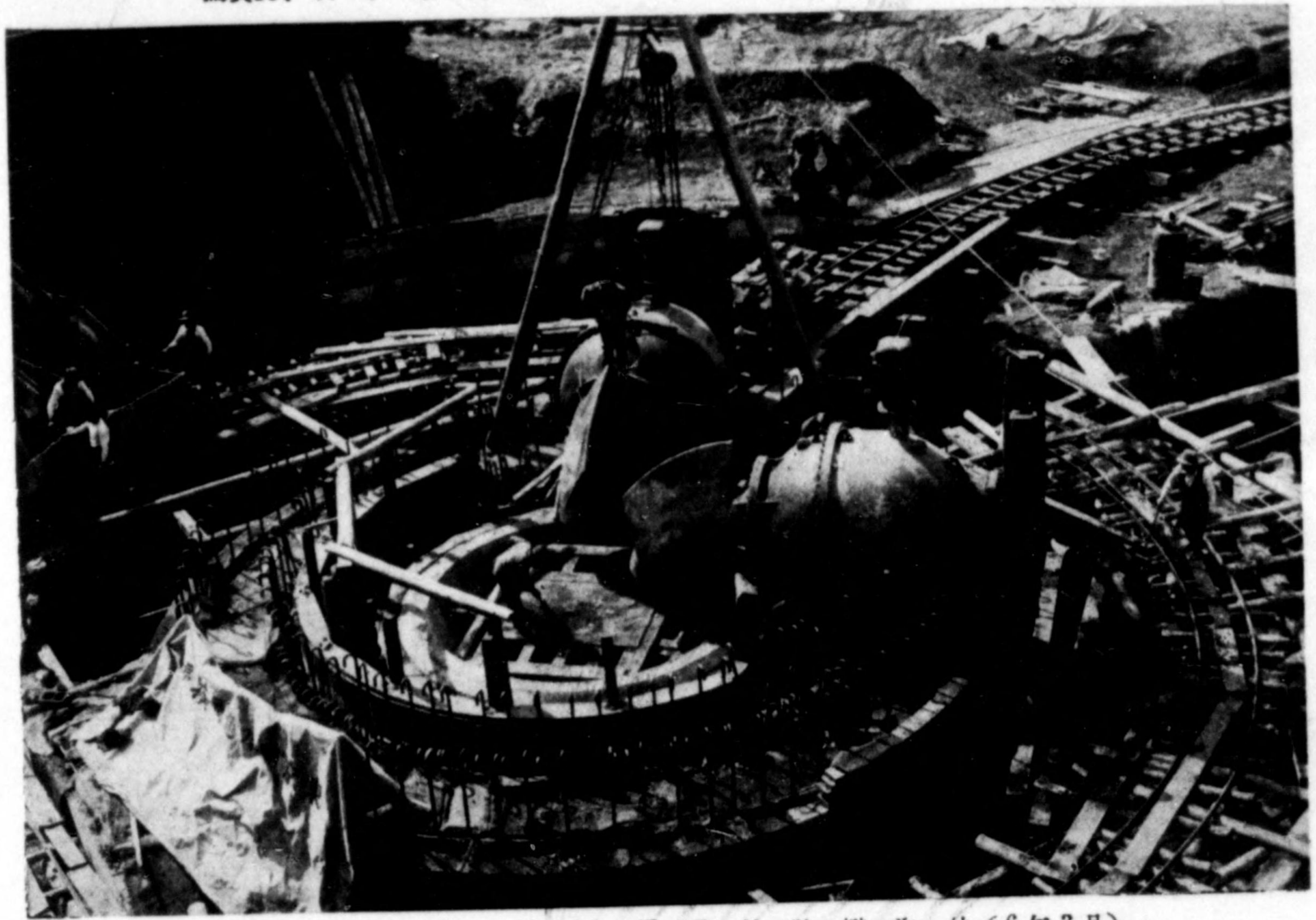
又平均1立坪當り運轉費は、採取に用ひたドラグライン運轉費は約25錢、碎石機運轉約50錢、運搬費約6圓合計約6圓75錢である。

電力設備 (寫眞32)

工事用諸機械運轉並坑內及夜業用電燈電力は容量200K.Wの設備をなし、其の中100K.Wは東電よりK.W時4錢にて購入し、100K.Wは停電等を顧慮し直營發電をなした。直營發電設備はディゼル機關を用ひ、直立單働4サ



寫眞39、取水塔内部ライニング用鐵管（6年1[illegible]）



寫眞40、取水塔の製水扉及針狀瓣取付（6年3月）

イクル無空氣噴油式4氣筩である。其の設備費及運轉費は次の通りである。

（イ）設　備　費　　33,701圓

機械費（デイセル機關　池貝鐵工場製／發　電　機　明電社製）　32,701圓

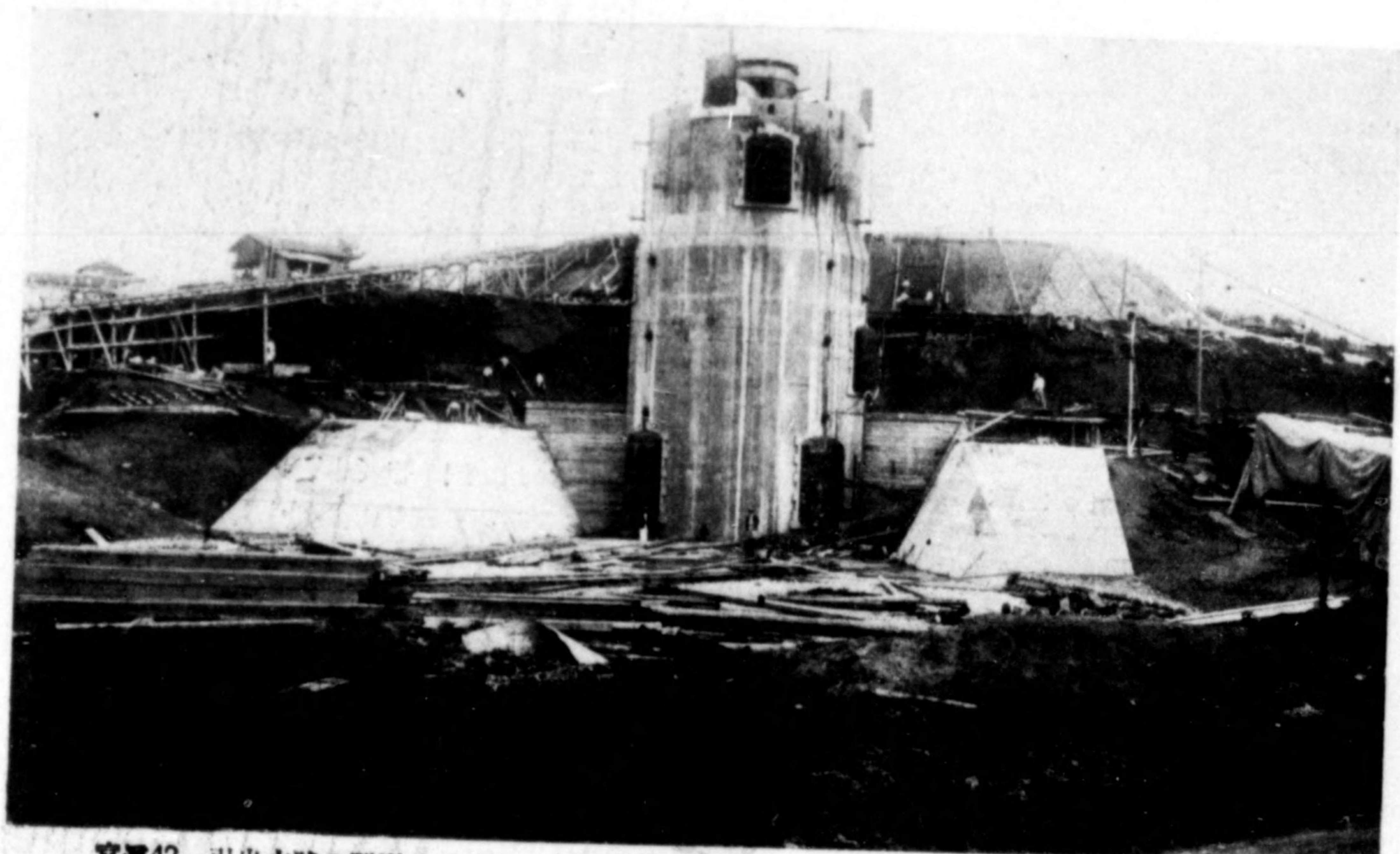
工　事　費　　720圓

（ロ）運　轉　費　　30日、330時間

種　　別	數量	單價	金額
		圓	圓
重　油（ミリ18立入）	295罐	1.080	318.600
モビール（カゴ,A.18立入）	2	12.670	25.340
モビール（カゴ,B.18立入）	1	10.880	10.880
軸油ボロ其他雜品	—	—	5.880
計	—	—	360.700
運轉手及助手	73人2	1.600	117.120
合　　計	—	—	477.826

發生電力 15,000K.W　1K.Wニ付　0.032

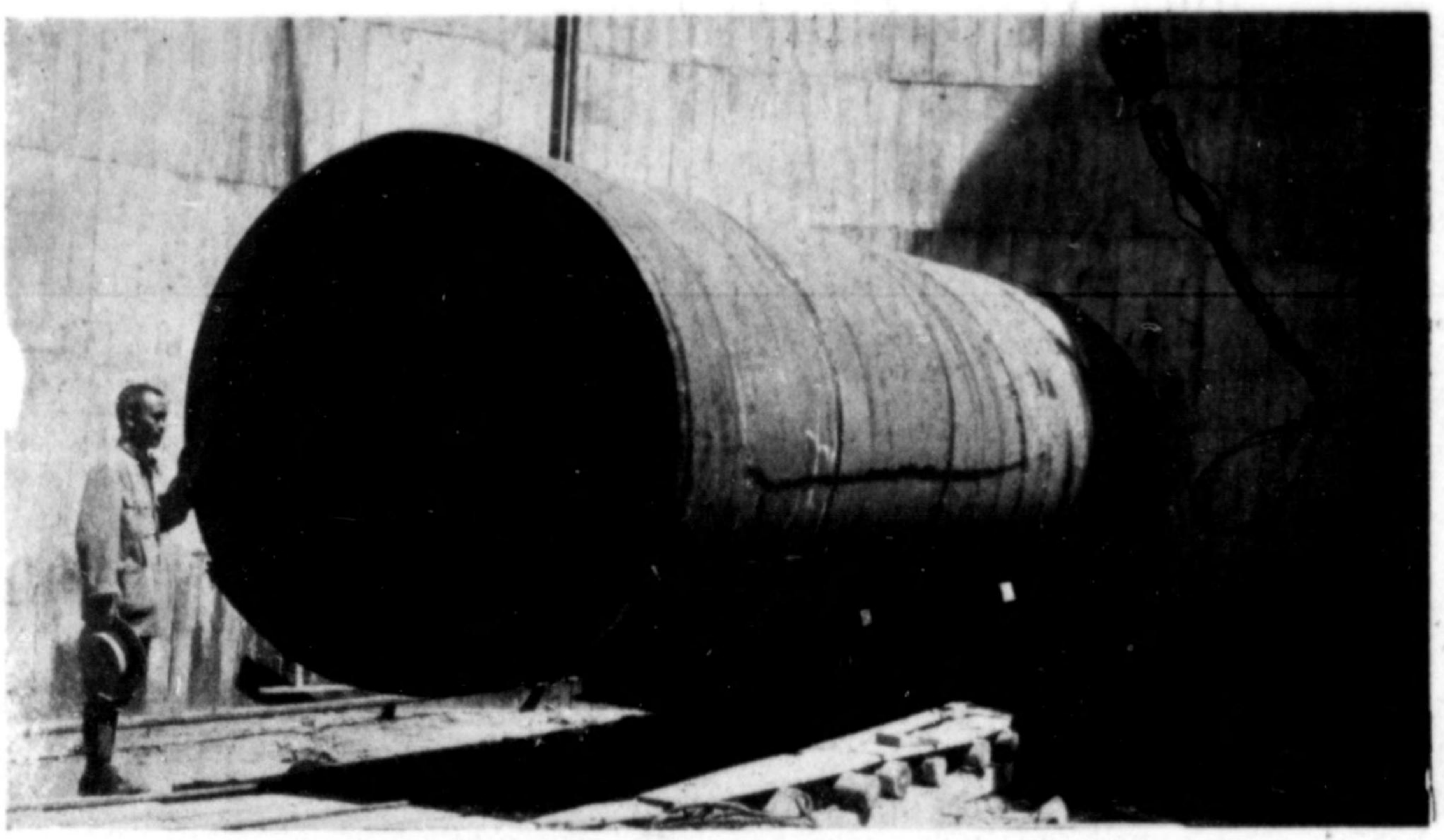
粘土試驗所（寫眞33, 34, 及第四圖）



↑ 寫眞41、取水塔の遠望（7年9月）

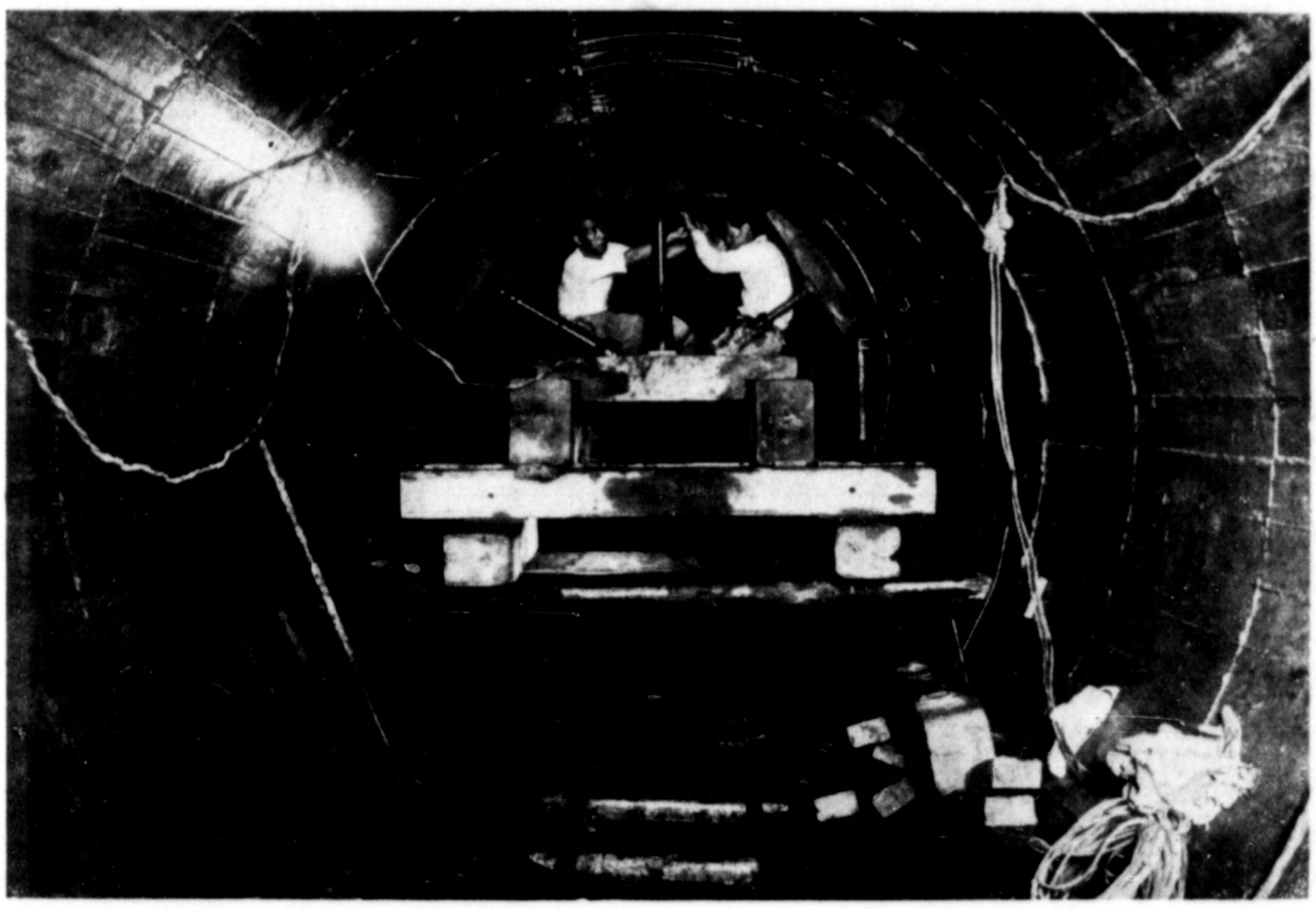
↓ 寫眞42、引出水路の隧道ライニング用鋼鐵管搬入其一（7年8月）

土堰堤には粘土が一番重要な材料であつて、其の數量も當現場に於て約18,000立坪を要する譯であるからして、之が材料試驗は出來るだけ愼重に行ひ、其の試驗設備も成る可く完備せしむる方針を執つたのである。故に出來得れば粘土は直營採取の方法に依り、之が爲めには、良質の粘土を埋藏する土地を發見して之を買收しやうと思つたのであつたが、種々の事情で、此の土地買收が意の如くならず、止むを得ずして特定の採掘地を指定し、尙特別の規格を設けて、競爭入札の方法に依りて購買したのである。特定の採掘地とは、現場を中心として1里內外の範圍內で、粘土を埋藏しさうの個所に就て夫々其の材質を試驗し、其の結果によつて最も優良な成績を示した山口村、箱根ヶ崎村及村山村の3個所を指定した。納入價格は現場に搬入配立をして1立坪に付約9.50圓であつた。之を採掘せんとするには、先づ檢查員



寫眞43、引出水路隧道ライニング用鋼鐵管の搬入其二 内徑2,800mmの未鎔接の下部を重ね合せたるもの。（7年8月）

寫眞44 引出水路の隧道ライニング用鋼管擴げ（7年8月）



の立會を求め試料を採取して本市粘土試驗所に於て試驗し、次の樣な規格に合格したものに限り搬入を許可した。

粘土標準規格

1. 粘土分　淘汰分析して0.01m.m以下の粒子を60%以上含有するもの（淘汰分析器は第四圖に示す）
1. 比　重　眞比重にて 2.6 以上
1. 沸　化　水中に浸し36時間以上沸化せざるもの
1. 粘結力　收縮停止時に於ける抗張力 6kg/cm² 以上
1. 收　縮　5cm長さに於ける完全乾燥收縮率10%以上

寫眞45・ 引出水路隧道ライニング鋼管の現場電氣鎔接（7年8月）

1. 水　分　天然含有水分30%以上50%以下

1. 其　他　有機物及腐蝕性悪臭なきもの

粘土試驗の結果に依るに、其の成績の平均値は下の通りである。

	粒子の大さ(mm)	淘汰分析さる流速
淘汰分析	0.01　以下(粘土分)	0.2(毎秒粍)
	0.01～0.05（細　土）	0.7　〃
	0.05～0.1（微　砂）	7.0　〃
淘汰管殘留	0.1～0.2　細砂）	
篩別分	0.2　以上(粗砂）	

比　重	2.66
沸　化	36時間以上
收縮度	14.13%
粘着力	9.12kg/cm²
水　分	36.64%

取水塔（寫眞37～41及第5圖）

貯水池の水を引出水路に導き出すに適する樣に構造せられたるものにて、直立圓筒形の鐵筋混凝土造とし、水位の昇降に應じ適宜の高さから引水し得る樣、5段の高さに夫々2個づゝの取水口を設けた　各取水口には、制水扉と針狀瓣とを併用して取水操作の確實を期した。又取水塔の底部には直立圓筒形の水褥を設けて、激しい水衝が引出隧道に及ばぬ樣に設計せられてある。

尙塔上には體裁よき上屋と步橋とを設けて管理に便ならしむると共に風致を添えしめた

其の主要部の寸法は下の通りである。

高(根掘敷以上)	33.3m(	110尺)
塔の內徑	7.3m(	2›尺)
塔の外徑	9.1m～10.9m(30尺～36尺)	
取水口の大さ	第1段～第4段	3尺
同	第5段	4尺

塔は高き重量大なるものであるから、直徑

54尺厚さ7尺の鐵筋混凝土基礎版の上に構築し、尙基礎地盤の耐重試驗（設計荷重 2.57廰/尺^2）を行ひ、不安無きを確かめた。（第五圖）

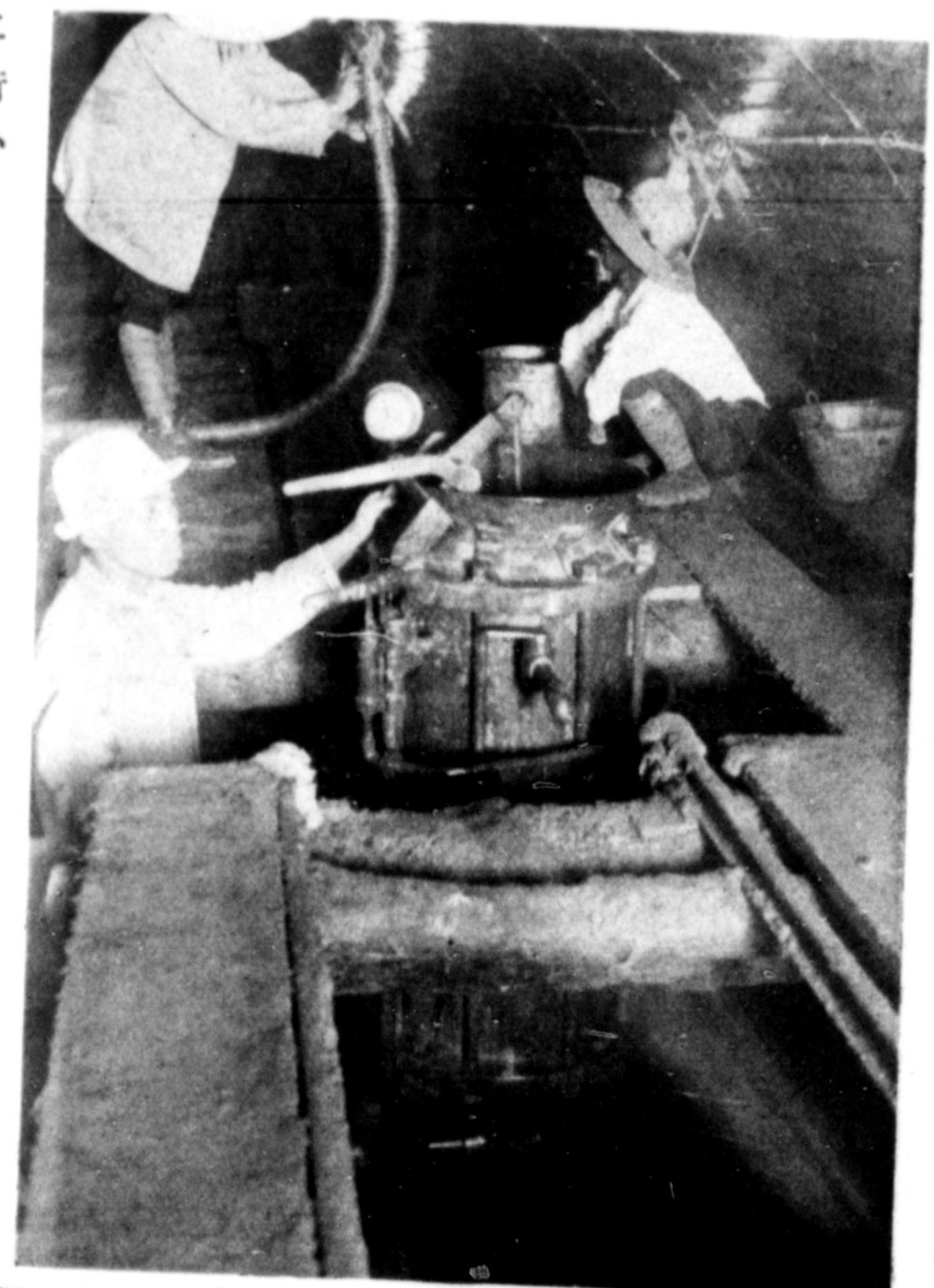
之に要する工費は 197,000 圓である。

餘　水　吐

豪雨の際に貯水池の水位が滿水位より高くならうとした時、之れから池外に放流せしめる目的で構築するものであつて、毎秒9.7m^{3}の放水能力を有せしめ、餘水吐（吐口延長35m）堅孔（內徑2.2～4.2m）隧道（延長241m馬蹄形）開渠（延長290m梯形）から成つてゐる。工費は 128,000 圓である。

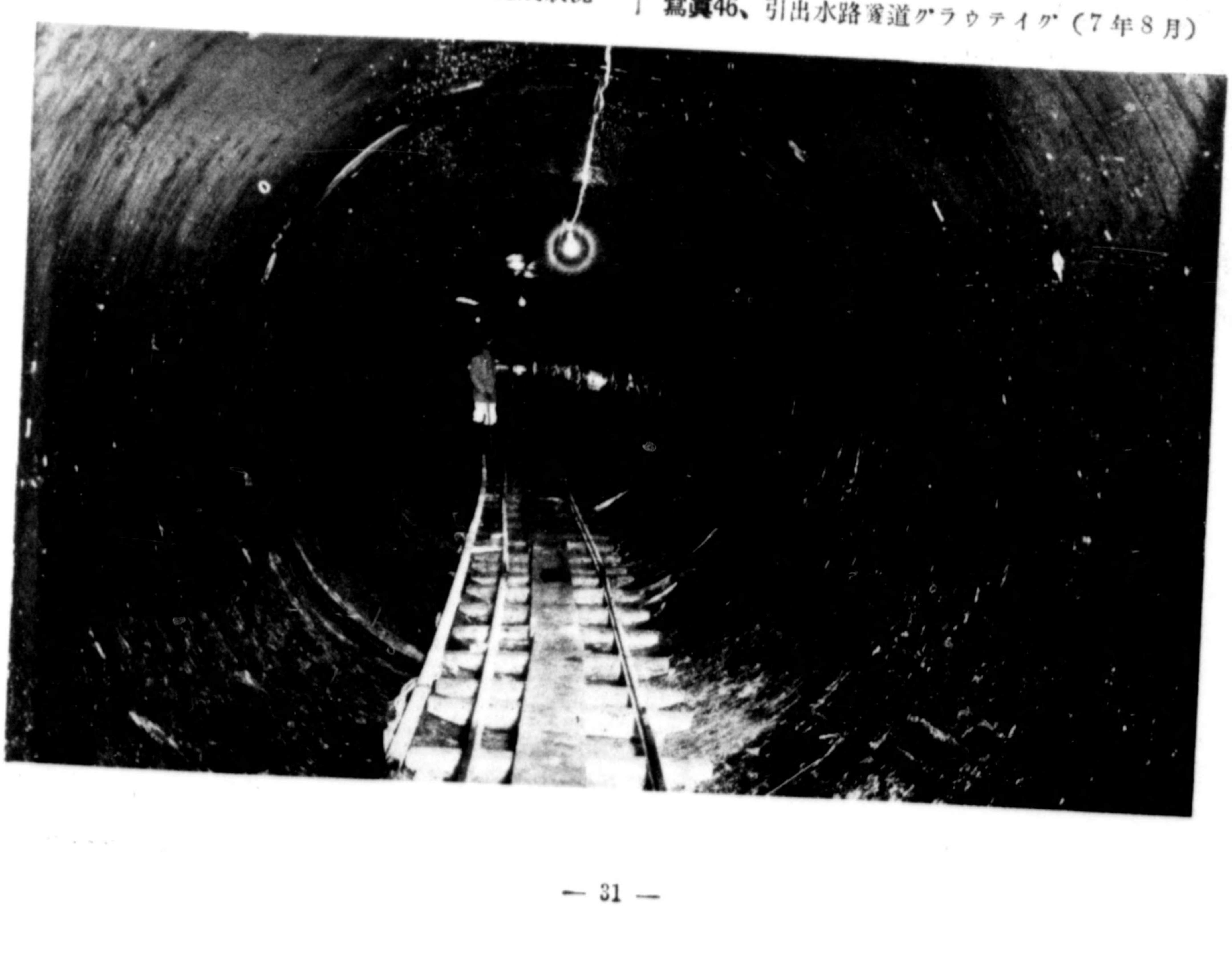
引出水路（寫眞42～48）

山口線と稱し、取水塔から引出された原水を、旣成村山境線第一急下水路に導く導水渠であつて、毎秒約7.0m^3（250尺^3）を通ずる大さとし、隧道、暗渠及「サイ



↑ 寫眞46、引出水路隧道グラウテイグ（7年8月）

↓ 寫眞47、引出隧道鋼管ライニング完成狀況



寫眞43、引　出　水　路　暗　渠　工　事（7年8月）

ホン」より成り、其の延長5,059.1(2782.5間)水路勾配は$^{1}/_{1000}$〜$^{1}/_{1,200}$である。

而して此の引出水路の工費は 958,000 圓である。

引出水路は全線を通じて、主として高幅共2.3m〜2.7mの馬蹄形混凝土造であるが、最上流部の取水塔に接續する隧道延長 378m は將來貯水池の水位を利用して發電設備を設けても差支なき樣、高壓に耐へしめる爲、內部も厚さ8m.m.の鋼板電氣鎔接のライニングをなし之と外圍の混凝土捲とを密着せしめる樣セメントグラウチングを施した。當初の設計は普通工法の如く、內部から厚さ33m.mの1:2:4混凝土で捲き立てることにしてあつたが、鋼管の現場に於ける電氣鎔接に關する經驗が積み、且防銹塗裝の方法が進步した今日では、鋼管ライニングの方が迅速に經濟的にして且混凝土の毛細罅裂に起因する漏水などは完全に之を防ぐことが出來るの利點があるので、此の工法を採用することにした、その工法は豫め鋼管工場にて長 6m の鋼板を管狀に縱方向に鎔接し只1鎔接線のみを殘して管狀に製作したものを、管徑を絞りて縮少せしめて現場に持ち込み、隧道內に搬入して之を正規の大さ迄擴げ、內部より支柱を施し置いて、上記未鎔接線を精確に合致せしめ、ボルトにて假締めをなし、現場鎔接をなしたる後、橫繼目卽ち各管の接合部も同樣に現場鎔接をして、逐次進工して行くのである

尙この隧道の外に水壓を受けるサイホン部にも、鋼管の現場鎔接に依るライニングの工法を用ひた

隧道內部から鋼板現場鎔接ライニングを施す工法は、我邦では當現場が始めての經驗と思はるゝが、今回の豫期以上の好成績を收め得た經驗から考へると、將來は內壓を受ける導水渠等には必ず博く此工法が利用せらるゝに至る事であらうと推察せらる。(7.9.20稿)

昭和七年十月

東京市水道局

1 gr / cm³

$\frac{1 \text{ gr}}{100 \times 100 \times 100 \text{ gr}}$

1 ppm

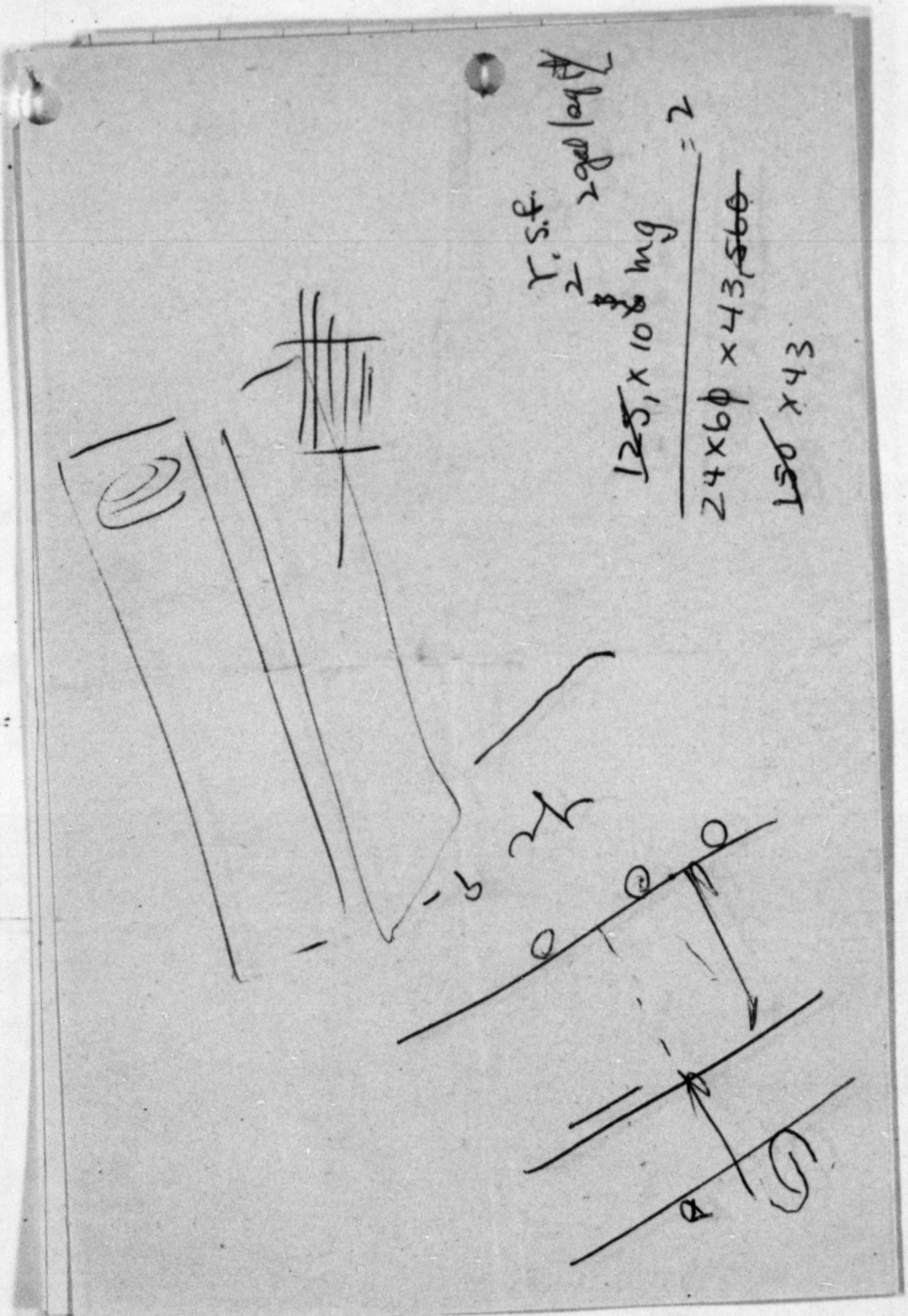
4 meters per day

$\frac{4 \times \overline{39.37}^3}{1728}$

$\frac{4 \times 39.37}{24 \times 60 \quad 12}$ ft/day cuft/sq ft

120

$\frac{1}{120}$ = 0.00825 cuft/min/sq ft.



DECLASSIFIED E.O. 12065 SECTION 3-402/NNDG NO. 775013

List 46-A4 File IU report

9 Aug. Chlor Tokyo M WS

Quantities of Water Supply

Date:

Tokyo Water Works Bureau

Filter Plants	Design Capacity	Actual Quantity	Remarks
(2) Yodobashi	240,421 m³/day	m³/day	
(1) Sakai	240,121		
(2) Kanamachi	316,059		
Tamagawa	104,350		
Kinuta-Kami	83,479		
Kinuta-Shimo	44,500		
Yaguchi	2,783		
Suginami	9,339		
Komae	15,120		
Sekiyama	10,780		
Wells	8,000	8–100 meter Artesian	type pipe for certain areas
Itabashi			
Total	1,075,282		

46A4

WATER SUPLLY

GENERAL

1. Natural sources adequate
   a. rivers, ground H_2O, canals, shallow wells (5--100 ft.)

2. City Supplies

   a. Wells and municipal supply
   b. Pop. over 10,000 have mun. supply
   c. Industries --- private supplies

3. Facilities

   a. Good design
   b. Reservoirs small --- little storage
      (1) Rationing not uncommon
   c. Leakage bombed areas
      (1) Lead service lines;
      (2) inadequate individual shut off chcks
      (3) uneven pressure
   d. Rx plants
      (1) alum-coagulant
      (2) Sand filter

4. Water Pollution

   a. Open contamination of wells
      (1) surface drainage
      (2) no tops
      (3) not cased
      (4) connected with city supply

   b. Inadequage Rx of H_2O

      (1) Chlorination low or poorly used
      (2) Coagulants often neglected
      (3) Filtration too rapid
      (4) Samples inadequate, infrequent
      (5) Raw waters seldom chedked
         (a) ph change from volcanic waters
      (6) Bacteriology poor --- often only total plate counts done; incomplete fermentation tests
      (7) Cross connections
      (8) Faulty plumbing
         (a) Leaking joints, concrete pipes
         (b) Seepage

5. Definite constructive measures

a. better care of raw waters
b. better Rx at plants; 0.1--0.4 ppm at distant taps
c. Repair leaks to 25%; maintain even pressure
d. Eliminate cross connections; better plumbing

DECLASSIFIED E.O. 12065 SECTION 3-402/NNDG NO. 775013

Sat.'s class — Don't depend on the looks, taste, etc. of H_2O
Be susp[illegible] of all part. [illegible] bid, abn. smell.

3.01 A
JAN 1945

ARMY SERVICE FORCES
MEDICAL FIELD SERVICE SCHOOL
Dept. of Military Sanitation
Carlisle Barracks, Pa.

S20 5 NOV. 45

WATER SUPPLY IN THE FIELD

S21

A. IMPORTANCE.

Water ranks in importance with ammunition and food as a unit of supply in military combat and often has an important bearing on its success or failure. Under all situations in the field, troops must be supplied sufficient water to meet physiological requirements and to carry out all sanitation and hygiene measures. This water must be safe for human consumption and within all reasonable limits free of objectionable tastes, odors, color and turbidity.

B. RESPONSIBILITY.

1. The Unit Commander. The primary and ultimate responsibility for water supply in the field rests with the unit commander. (FM 101-5, par. 1a; AR 40-205, par. 2a). A division commander must take whatever measures necessary to insure that all units of the Division at all times have an adequate, safe and attractive water supply. A squad leader must see that the members of his squad have a sufficient, safe and satisfying supply of water. The urge for self-preservation should strongly motivate the individual soldier to see to it that his own water is safe.

2. The Corps of Engineers. The actual selection, procurement and treatment of water for all major units of the army in the field down to and including the Division, is a function of the Corps of Engineers. (TM 5-295, par. 4a).

3. The Medical Department. The responsibility for checking the suitability of water sources, for advising with reference to methods of purification and for ascertaining the ultimate sanitary quality of water rests with the Medical Department. (AR 40-205, par. 2b and par 11).

C. QUANTITY REQUIREMENTS.

Water supply from the military viewpoint differs from that normally encountered in civilian practice, in that often it is necessary to take water from an undesirable source and treat it with whatever means are available to make it safe for consumption. First in importance then is the requirement of QUANTITY; that a sufficient amount of water be available for military needs.

The water supply problem in the field varies in magnitude with the season, the theater and the situation. The physiological requirement per man will range from two quarts per twenty-four hours when marching or working at night in the cold season to two and one-half or three gallons per twenty-four hours when working by day in the hot season. Some field water requirement figures that should be kept in mind are 1, 3, 5, 10 and 25 gallons per man per day.

In Combat a minimum of 1 gallon per man per day should be made available to all troops. Most of this of course will be used for drinking purposes.

On the March or in Bivouac at least 3 gallons per man per day should be supplied. This is barely sufficient for drinking and cooking purposes.

In temporary camps 5 gallons per man per day is minimum; at least 10 gallons are needed under most conditions; and 25 gallons are desirable.

D. QUALITY REQUIREMENTS.

When considering the acceptability of water for military purposes certain definitions should be well understood:

A POTABLE WATER- is water which is sufficiently free from organic and chemical impurities that it is safe for human consumption.

CONTAMINATION- is the introduction into a water of bacteria or disease-producing organisms which tend to render it unsafe for human consumption and unsuitable for domestic use.

POLLUTION- is the introduction into a water of substances of a character and in quantities which tend to render it objectionable due to offensive taste, appearance, or odor.

1. Water Safety.

a. Disease Factors. From the safety standpoint we are primarily concerned about the presence of certain pathogenic organisms, including in particular those that cause typhoid fever, paratyphoid fevers, bacillary and amebic dysentery, cholera and a few helminthic infections. No direct method has been developed for detecting the presence in water of minimum infectious quantities of these organism. However, since these organisms are of fecal origin, we have a group of convenient indicator organisms. Human excreta contains large numbers of bacteria of the coliform group. The presence of these bacteria in water is evidence of fecal pollution and therefore indicates the probable presence of disease producing organisms.

In the field it will seldom be possible to make bacteriological tests on raw water sources or even on treated water supplies. If, however, careful sanitary surveys of available sources are made it will usually be possible to select sources that are not too highly polluted with fecal matter. Then if proper treatment processes are applied and adequately controlled, the water may be consumed with a reasonable degree of safety.

2. General Quality Factors. The ordinary physical and chemical characteristics of water, such as taste, odor, color, turbidity, chlorine consuming properties and mineral characteristics may be of less direct health significance than the safety characteristics, but in an indirect sense may be of as great importance. These characteristics determine the attractiveness and palatability of water which are the deciding factors in water discipline. They may also serve as indicators of the extent of dangerous pollution, and the removal of tastes, odors, color, turbidity, and chlorine consuming materials constitutes difficult water treatment problems.

a. Turbidity: Turbidity of muddiness in water is commonly caused by finely divided silt or other earthy material. It may also be due to suspended iron and manganese oxides, and to finely divided organic matter such as from sewage, industrial wastes, surface drainage, algal growth and from decaying vegetation.

Turbidity producing materials are not necessarily physiologically harmful, but the character and quantity of turbidity in water are roughly indicatory of the nature and extent of contamination and other objectionable pollution in a water. The presence of turbidity is prima facie evidence of the presence of bacteria and/or protozoa. If water contains visible suspended particles it may certainly carry in suspension, particles which are invisible to the naked eye.

All surface water in the field will be more or less turbid and ordinarily should be given, in addition to chlorination, treatment for complete turbidity removal.

b. Chlorine Demand. Chlorine consuming characteristics of water are indications of the nature and extent of certain types of pollution. Sewage pollution, surface drainage carrying fecal matter or other similar organic matter, some industrial wastes, and the products of algal growth, produce heavy and a moderately rapid chlorine demand in water. Sulfites, sulfides, ferrous iron, manganous manganese, and certain chemical warfare agents produce a heavy and very rapid chlorine demand. Such water should be chlorinated considerably in excess of the quantity required for the satisfaction of the demand. In the case of most polluted waters except those contaminated with certain chemical warfare agents, such heavy chlorination will reduce the tastes and odors and render the water reasonably safe for consumption. When, however, a water has a 10 minute chlorine demand in excess of approximately 5 p.p.m. other sources should be sought. A two minute chlorine demand in excess of approximately 4. p.p.m. is some indication of chemical warfare contamination.

c. Mineral Characteristics: The mineral characteristics of water in the field are usually of no serious consequence. Hardness of water is of considerable sanitary significance. Water containing enough calcium and magnesium salts to produce 500 p.p.m. hardness is very unsatisfactory for use for mess sanitation, for bathing and for laundry purposes. Softer water should be procured whenever possible.

E. SOURCES AND SELECTION.

1. Selection Factors. For drinking water, the best available source should be selected, and in the selection of water supplies for military organizations in the field many factors must be given rapid, practical and decisive consideration. The over-all guiding factor, of course, is the military situation or military mission. The factors that are most directly connected with the problem of selecting satisfactory water sources include:

a. The availability and accessibility of adequate sources.
b. Relative safety and general quality of the accessible adequate supplies.
c. Procurement, treatment, storage and distribution facilities.

2. Five Sources. The five sources of water are surface, ground, rain, snow and ice, and sea water. Surface water includes streams, rivers, ponds and lakes. Ground water includes wells and springs. Rain water is obtained by catchment on roofs of buildings or on other available or improvised catchment surfaces.

Snow and ice water is obtained from melting of natural snow or ice. Sea water is from oceans or large inland salty seas--which, of course, cannot be used for human consumption without distillation or other demineralizing process.

Surface water will most commonly be accessible in adequate quantities in the field. It may be more highly contaminated and polluted than other sources but quantity requirements must usually be given priority over quality. Practically all surface water contains fecal pollution of human origin. Under no situation in the field should surface water be consumed or used in the preparation of food without adequate treatment to remove or neutralize all actual or potential contamination.

Ground water will ordinarily be the second "best bet" for water sources in the field. Wells and springs are usually less contaminated than surface sources, but they are commonly more highly mineralized.

It can not be emphasized too strongly that all sources of water in the field are potentially contaminated. Army Regulations specifically require that before water is consumed from a questionable source it must be declared potable by the appropriate Medical Officer (AR 40-205, par 11 a & b). The best procedure to follow in ascertaining that a water supply is potable includes the following steps:

(1) Estimating the maximum probable contamination and pollution of the supply.
(2) Prescribing and supervising the necessary treatment to render the water potable.
(3) Performing tests to check the efficiency of treatment processes.
(4) Inspecting the storage, handling and distribution of the water to prevent recontamination of the supply.

In sanitary surveys of surface water sources the extent of self-purification should be carefully evaluated, and the limitations of the processes should be recognized. In no case should it be considered that self-purification has converted a contaminated supply to a safe supply.

Natural filtration caused by passage of water through earth removes bacteria, other living organisms, and organic matter quite effectively. Ground water is, therefore, usually freer of contamination and organic pollution than surface water. A shallow well -- a well taking water only from above the uppermost impervious stratum of earth -- may yield a bacterially free water. Deep wells -- wells taking water from below one or more impervious strata of earth -- are considered relatively safer than shallow wells.

From a safety standpoint, however, the construction of the well is more important than the depth. It is particularly important that a well be adequately protected at the top to prevent the entrance of surface drainage.

F. WATER TREATMENT.

The objective of water treatment is to produce a safe, attractive and

A – Rx - chemically
B Test
C Details

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palatable water supply. The treatment processes in the field may be the same as those commonly used in civilian water treatment practice -- including in particular chlorination, plain sedimentation, aeration, coagulation, coagulation-sedimentation, filtration, storage, distillation and boiling. The primary objective of chlorination and boiling is to kill pathogenic organisms, and one or both of these processes should be used to whatever extent necessary to produce safe water. The primary objective of the other treatment processes is to remove materials that render water non-palatable and non-attractive. Each process should be used to whatever extent necessary to accomplish the desired objective. One process cannot be substituted wholly for another, but fortunately the various processes are somewhat complementary and supplementary to each other.

Chlorine is the best germicidal agent for use in purifying water for drinking purposes and other domestic uses. Extremely small quantities are required for satisfactory bactericidal action. No adverse physiological effects are produced by the chlorine among the water consumers and if the chlorination process is properly controlled the taste and odor of water are seldom impaired. In many cases chlorination properly controlled improves the taste and odor of water.

1. Chlorine Dosage, Demand and Residual. When chlorine or a hypochlorite is added to water in amounts ordinarily used for water chlorination a very dilute equilibrium solution of free chlorine and hypochlorous acid is formed. Most of the chlorine is probably in the form of hypochlorous acid but as a matter of convenience in this discussion this equilibrium solution will be referred to as available active chlorine. This active chlorine is a strong chlorinating and oxidizing agent as well as a germicidal agent. In the presence of reducing agents such as the ordinary organic pollution in water, chlorine is consumed with only moderate rapidity, but in the presence of hydrogen sulfide, sulfites, ferrous iron, manganous manganese, and most chemical warfare agents, the active chlorine is very rapidly consumed. If there are excessive quantities of these reducing materials present as compared to the amount of chlorine added, all of the available chlorine will be consumed before bactericidal action is complete. If the quantity of chlorine consuming material is limited, some of the chlorine will be left to continue germicidal action.

The amount of chlorine added to a portion of water is called the chlorine dosage. The amount of chlorine consumed during a designated period of time after the addition of the dosage of chlorine is the chlorine demand of the water for that designated period. The amount of available chlorine left after the designated chlorine demand period is the residual chlorine available for continued germicidal action. The chlorine demand of a water will vary not only with the nature and quantity of chlorine consuming material but also with the amount of chlorine added, the pH, the temperature of the water and the contact period. Some germicidal action will occur even while available chlorine is being consumed, but satisfactory germicidal action may not be effected until after satisfaction of most of the chlorine demand and a moderately stable chlorine residual is permitted to act for an additional length of time.

Ca hypochlorite 70%

each ampule contains 0.5 Gm. grade A 70% chlorine - Ca Hypochlorite
TO Lyster Bag (36 gal.) — 2.5 p.p.m. CHLORINE → ordinarily safe water
oxidizing — combined part = Chlorine demand - org. + inorg. comb.
Discard foul smelling H2O if possible - ; remaining = Resid. - at least 1 p.p.m.

Experience has shown that in the case of most water the major portion of the chlorine demand will be satisfied within 10 minutes after the addition of a chlorine dosage, and that if as much as 1 p.p.m. residual chlorine is present after the satisfaction of the 10-minute demand, satisfactory bactericidal action will usually be effected after 20 more minutes of contact time. Hence we have for field chlorination of water the requirements that a sufficient dosage of chlorine be added to water to effect a chlorine residual of at least 1 p.p.m. of available chlorine after a contact time of 10 minutes and that an additional contact time of 20 minutes elapse before the water is consumed. These are minimum requirements for chlorinating water in Lyster bags or similar containers.

Canteen cup = 42 TB use 1/7 (6TB) for 1/7 as much water

When a water is chlorinated, the Residual Chlorine, as determined by testing, varies greatly, depending upon what is in the water when the chlorine is added. When the nitrogenous material is low the residual will be preponderently active free chlorine; when the nitrogenous material is high the residual will be a chloramine. It oftens happens that the residual Chlorine content of a water (total) will be made up of both active free chlorine and chloramines.

3.3 p.p.m. - deep orange-red - 20 ... color after this

Ca hypochl. has expir. date Kept in dark

In the field treatment of water in the Lyster bag using Calcium Hypochlorite ampules, the type of residual generally encountered is this active free chlorine. The Portable Purification Unit which filters, as well as chlorinates the water uses Ammonium Aluminum Sulfate as a coagulant, and hence usually shows a residual Chloramine under normal dosages.

When it is suspected that water is highly polluted, heavier dosages should be used to effect higher residuals, and followed by longer contact periods to effect satisfactory germicidal action. Higher chlorine residuals and/or longer contact times should be used when chlorine is added to water containing ammonia or amino compounds, or when chloramines are used as chlorinating agents. This is necessary because of the slower germicidal action of chloramines.

2. The Effect of pH on Germicidal Action of Chlorine and Chloramines. The bactericidal action of active chlorine and of chloramines is less rapid at high pH values than at low pH values. Results of recent investigations (21) indicate that the bactericidal rate of active chlorine is only ½ as high at pH 8.0 as at pH 6-7, and only 1/3 as high as pH 9 as at pH 6-7. For chloramines, a similar effect due to pH variations is observed.

3. Storage. In the field it will seldom be possible to take advantage of the natural purification of water through long periods of storage in protected reservoirs. It may, however, often be possible to use storage as an aid to other treatment processes. Several hours of storage are needed when plain sedimentation or coagulation-sedimentation are the only available processes for clarifying water. The effectiveness of chlorination can also be greatly increased by storage. When extra-heavy chlorination is necessary in order to effect satisfactory bactericidal and cysticidal action, or to reduce objectionable tastes, odors and color, storage will afford a long contact time for the action of the chlorine. It will also permit the dissipation of the chlorine residual.

Halazone - water purif. tabs - chlor. comp. (chloramide) Brown bottles
1 tab/1 pint

Time factor - wait 10 min. if ok. wait 20 min. more

1 cc. orthotolidine - sol. in HCl - To 100 cc. H₂O sample
Residual ... + allow to stand in sh... if necessary ... yellow 1/ppm
(½ in. H₂O in canteen cup)

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4. Distillation. In some situations sea water or other heavily mineralized water may be the best available supply. Distillation is the most practicable method at present for reducing the mineral content of such water to tolerable limits. The Corps of Engineers has a limited number of large distillation units -- ranging in capacity from 2,000 to 10,000 gallons per day. Several of these are now being used in certain areas of the Theaters of Operation.

Distilled water may be almost sterile when first produced. In the handling and distribution, however, there are many possibilities of pollution. It should, therefore, be chlorinated before being consumed.

5. Boiling. Boiling of water for one minute will kill all of the organisms which are known to cause intestinal diseases. This process must be used when there is any doubt as to the adequacy of other available treatment process (Par 11b(3)(b), AR 40-205). Boiling, however, should not be considered just a last resort. It may often be the quickest and best method for obtaining safe water for drinking and for the preparation of food.

G. WATER EQUIPMENT.

Water Equipment of Unit Organizations. The unit organization water equipment is designed primarily for procuring water from Water Supply points and making it available to individuals or groups within the unit.

1. Quart canteens and 3/4 qt. canteen cups are provided for each enlisted man and officer in the field. These serve as individual water flasks and drinking cups. They should be kept clean and always be carried by the individual soldier or officer in the field when he is away from his immediate camp or bivouac area. They may be used for disinfecting individual supplies of water by chlorination, and if made of metal can be used for boiling small quantities of water.

2. Five-gallon water cans are supplied to all organizations in the field. The allotment is usually one can for each five men. These are primarily for transporting water from designated authorized Water Supply points to the unit organization. They may also be used for chlorinating 5 gallon portions of water. They should be used only for water, and must be kept clean. They may be disinfected as often as necessary by treating with a 50 to 100 p.p.m. chlorine solution.

3. Medical units, engineers, and some air corps units are provided with 250-gallon trailer tanks, convenient for transporting water from Water Supply points to unit organizations and for transporting an extra supply of water when a unit is on the move. The medical battalion of the infantry division is provided five of these trailer tanks -- one for each collecting company, and two for the clearing company. Chlorination of water may also be carried out in these tanks, but due to the numerous baffles in the tanks, adequate mixing is difficult.

4. Lyster bags are supplied to all field units, usually on the basis of one bag to each 100 men or fraction thereof. These bags are 36-gallon canvas rubberized bags with a spherical-shaped bottom. Five small spigots are

located near the bottom of the bag approximately six inches above the spherical bowl, for drawing water into canteens or canteen cups for drinking. The bowl-shaped portion below the spigots serves as sedimentation space when it is necessary to use turbid water. Each bag has a canvas rubberized cover, and rope supports for suspending the bag from a limb of a tree, a tripod or some other convenient object within the unit organization area.

The primary purpose of the Lyster bag is to store water within the unit area for drinking purposes. It is also the most convenient container for chlorinating water for drinking purposes.

H. WATER DISINFECTION BY UNIT ORGANIZATIONS AND BY INDIVIDUAL SOLDIERS.

To supply one gallon of water per man per day to a unit organization by normal water logistics requires one trip per day from the unit area to the WsP for all the available water cans of the unit. This will be possible under most conditions, but it will often be impossible to make a sufficient number of trips to WsP's to supply the reasonable basic minimum of 3 gallons per man per day. Only rarely will a unit be able to obtain 5 gallons per man per day from the WsP's. This means that a considerable proportion of the water consumed by units and individuals in the field must be procured from whatever sources are available and given treatment to render it safe and as palatable as possible. The most common treatment procedure will be adequate chlorination, but supplemented by other processes if possible. If there is any doubt about the adequacy of the applied treatment the water must be boiled. Water received from the Engineer WsP's should also be rechlorinated or boiled when there is evidence of inadequate treatment or of repollution of the water.

1. Chlorination in the Lyster Bag. The most convenient and satisfactory container for chlorinating water for unit organizations in the field is the 36-gallon water sterilizing bag (also called the Lyster Bag). The prescribed procedure for chlorinating water in this bag will be found in Par. 11b (3), AR 40-205; Par 20c (2) FM 21-10 and Change No. 5, 24 Apr. 1943. Experience has indicated that the above-mentioned procedure can be further simplified and shortened as hereinafter described.

a. Suspend the bag from a tripod or other strong support. Fill it with water to the mark or 4 inches from the top, straining through clean cheese-cloth if possible. The capacity is 36 gallons.

b. Take an ampule of calcium hypochlorite (0.5 gm), place it over the surface of the water in the bag under the cover, and by applying leverage at the ends break the tube and empty its contents into the water. Stir thoroughly with a clean stick or paddle for 30 seconds. The dosage effected is approximately 2.5 p.p.m. chlorine.*

c. Draw at least one-half canteen cup of water from each of the faucets and pour it back into the water bag. This serves to sterilize the faucets.

*0.5 gm of calcium hypochlorite contains 70% available chlorine or 0.35 grams of chlorine. 36 gallons of water equals 136, 274 grams, hence the dosage equals 0.35 x 1,000,000 / 136,274 or 2.56 p.p.m. approximately.

d. After the calcium hypochlorite has been in contact with the water in the bag for at least 10 minutes, wash out one of the faucets by allowing a small amount of water to run through onto the ground. Determine the presence of free (residual) chlorine in the water by one of the following methods:

(1) Liquid orthotolidine method. Fill a clean canteen cup to a depth of ½ inch of water from the same faucet. Add 1 cubic centimeter (15 drops) of orthotolidine solution to the water in the cup. Wait 5 minutes and note the color produced. Below is a guide for reading the color reaction between the free chlorine and orthotolidine.

(a) No color. - Insufficient chlorination. Add more calcium hypochlorite.
(b) Canary yellow. - Insufficient chlorination. Add more calcium hypochlorite.
(c) Deep yellow. - Satisfactory chlorination (Normally). This represents about one part per million (p.p.m.) of chlorine.
(d) *Orange red. - Indicates residual chlorine of more than 3.3 p.p.m.
(e) Bluish green. - Alkaline or hard water. Add a few more drops of orthotolidine to get a correct color reading.

Don't confuse ē Halogens (2) Orthotolidine tablet method. - Remove the inner vial from the testing kit and fill the outer vial with a water sample from the faucet, to the bottom of the (yellow) colored band. The inner vial contains orthotolidine testing tablets; drop one of these tablets into the sample and shake until dissolved. Note the color produced.

(a) Equal or darker yellow than the colored band. - Satisfactory chlorination. Wait 30 minutes before drinking.
(b) Lighter yellow than the colored band. - Insufficient chlorination. Add more calcium hypochlorite to the water being treated. Wait 10 minutes and retest.
(c) *Orange color. - Residual Chlorine is more than 3.3 p.p.m.

e. Wait 30 minutes after satisfactory chlorination has been accomplished before using the water. The cover should be kept on the bag to prevent recontamination. The unpleasant taste of chlorine is diminished by allowing chlorinated water to stand several hours before use. It is a good plan to chlorinate water in the evening for the next morning's use.

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*Note that the color obtained when testing for Residual Chlorine with Orthotolidine indicates the amount of such residual after the demand has been satisfied for a designated period of time (usually 10 minutes for water in the field) Therefore, if 1 ampule of calcium hypochlorite was added to 36 gallons of water (2.5 p.p.m. dosage), Orange or Red colors showing residuals of 3.3 p.p.m. and more obviously will not be possible. The concept of water being "over-chlorinat when orange-red colors are produced is misleading-. Chlorination of water should be specifically directed toward meeting existing problems, sometimes normal, som times abnormal (Amebiasis, Schistosomiasis, etc).

2. Chlorination in Water Cans, Trailer Tanks, and Other Containers. When inadequately treated water is procured from the Engineer WsP's or when water is procured in the water cans or trailers from some untreated supply, chlorine should be added at the time the cans or trailers are being filled. This permits a heavy dosage and long contact time, thereby insuring more effective germicidal action, and in many cases gives a more palatable water due to the more complete oxidation of organic matter. The chlorine should be added at the time the containers are filled in sufficient dosages to leave a chlorine residual of approximately 1 p.p.m. at the time the water is ready for consumption.

One 0.5-gram tube of calcium hypochlorite gives a dosage of approximately 2.5 p.p.m. to a 36 gallon Lyster bag of water. It would therefore require approximately 7 tubes to give an equivalent dosage to a 250-gallon trailer tank, or one tube would give a dosage of 2.5 p.p.m. to seven 5-gallon cans of water. One level teaspoonful of bulk calcium hypochlorite (Grade A, 70% available chlorine) (3 to 4 grams) is equivalent to approximately seven 0.5-gram tubes -- and would therefore give a dosage of approximately 2.5 p.p.m. to 250 gallons of water, or would be enough to give an equivalent dosage to approximately 50 5-gallon cans.

When the desired dosage is decided upon, the powdered calcium hypochlorite should be dissolved in some convenient amount of water (0.1 to 1% solution is convenient) and the proper proportions of the stock solution added to the containers during or just before they are filled. The filling will effect adequate mixing of the chlorine in the 5-gallon cans but not in the 250-gallon trailers. The trailer tanks are heavily baffled and transportation of several hundred yards may be required for a complete mixing of the chlorine with the water.

Tests for residual chlorine should be made on each trailer tank and on at least one tenth of the 5-gallon cans. Tests can be made in the manner described in the procedure for chlorinating in the sterilizing bag. A 10 minute residual of at least 1 p.p.m. is absolute minimum, and a 30 minute residual of 1 p.p.m. is desirable and practicable.

Any available clean container may be used for disinfecting water by chlorination. The approximate capacity of the container can be determined. Then a chlorination procedure similar to that described above or for the Lyster bag, can be followed.

3. Chlorination in Individual Canteens. (Par. 11b(3) (a) 2. AR 40-205; Par. 46½, 47, 47½ and 47 3/4, Change No. 5, of FM 8-40). There are two convenient and reasonably satisfactory methods for chlorinating water in individual soldiers quart canteens. One is commonly referred to as the Canteen Method. the other as the Halazone Tablet Method.

a. The Canteen Method. When one 0.5-gram tube of calcium hypochlorite is added to a quart of water a stock solution is obtained which contains approximately 350 p.p.m. of available chlorine. One ordinary canteen capful (approximately 6 c.c.) of this stock solution added to a quart of water will effect a dosage of approximately 2.0 p.p.m. of available chlorine. A small group of soldiers, e.g., a squad, operating alone should carry several 0.5-gram tubes of calcium hypochlorite and an extra quart vessel of some kind -- preferably an extra canteen. The squad leader can prepare the stock solution -- the contents of one tube dissolved in a quart. He can then add one capful of the solution to each man's canteen of water and instruct them not to drink the water until 30 minutes after the addition of the chlorine. If there is evidence that the raw water source is heavily polluted two or more capfuls should be added to each canteen.

A more convenient stock solution for use in chlorinating water in canteens is a 5% calcium hypochlorite solution prepared by adding the contents of one tube (0.5 gm.) to 10 c.c. of water. One drop of this solution added to a quart of water gives a dosage of 2 to 3 p.p.m. of available chlorine. (Depending upon size of drop). A small vial and an eye dropper, can be carried much more easily than an extra canteen. The eye-dropper is convenient but not required. The 5% solution is reasonably stable if kept stoppered and out of direct sunlight -- holding strength satisfactorily for 2 or 3 weeks. One 10 c.c. vial of 5% calcium hypochlorite is sufficient to chlorinate approximately 100-150 quarts of water. This would be sufficient to supply a squad of men for 2 to 4 days in the field.

b. The Halazone Tablet Method. The Use of Water Purification Tablets. Small bottles of water purification tablets (commercial name, Halazone Tablets.) may be available to troops in the field. These are chloramine tablets, (p-sulfone dichloramide benzoic acid) and may be available in either of two sizes - 4-milligram and 8-milligram tablets. Two of the 4-milligram tablets or one of the 8-milligram tablets added to a quart give a dosage of 2.3 p.p.m. of available chlorine as chloramine. This dosage followed by a contact time of at least 30 minutes will effect a reasonably satisfactory disinfection of most waters. Higher dosages, two to three times as much, should be used on water suspected of being highly polluted. Contact times of longer than 30 minutes should also be used whenever it is possible.

Directions for use of the water purification tablets are printed on the bottle containers. These directions, however, fail to indicate that the tablets dissolve slowly. At least two to three minutes of vigorous shaking are required to dissolve the tablets in a canteen of water.

4. Disinfection by Boiling. (Par 11b (3) (b), AR 40-205). If no calcium hypochlorite or water purification tablets are available, or if there is any doubt about the adequacy of these agents for disinfecting a highly polluted water supply, the water should be boiled for 1 minute. Care must be taken to see that the water actually boils for this period of time. This will insure complete disinfection of water, including the killing of all cysts of Endameba histolytica. Care must also be taken that boiled water is not recontaminated.

I. SPECIFIC APPLICATIONS OF CHLORINE.

Control of Amebiasis by Water Chlorination. Amebiasis among Military personnel stationed in certain theaters of operations may assume serious proportions, and its prevention thus becomes an important sanitary problem. A study has been made on the mechanism of destruction of cysts of E. Histolytica by chlorine and chloramine compounds in water.

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It was found that when cysts were exposed to solutions of gaseous chlorine, High Test Hypochlorite, dichloramine, monochloramine, Halazone, and succinchlorimide, there was penetration of chlorine into the cysts. The cyst-penetrating powers of these compounds are shown below in order of their activity.

1. Chlorine (free active)
2. HOCL (Hypochlorous acid)
3. Halazone
4. Dichloramine
5. Succinchlorimide and Monochloramine.

The greater the concentration of titratable chlorine, and the longer the contact period, the greater was the penetration of chlorine into the cysts. The effect of pH on the cyst-penetrating power of gaseous chlorine and HTH was due to the formation of free Chlorine (Cl_2), HOCl, and OCl (hypochlorite). Below pH 2.0 a significant amount of Cl_2 is formed. Between pH 2.0 and 5.0, most of the chlorine exists as HOCl. At pH above 8.5, a very small amount of HOCl is formed and most of the chlorine exists as OCl^-.

In the field, drinking water can be made safe only by special methods of chemical treatment (i.e. chlorination) or filtration, or by boiling. Troops should be cautioned not to drink water from untreated sources. Whenever possible good wells should be drilled and maximum use made of subsurface water.

For chemical treatment, a concentration of chlorine sufficient to give two p.p.m. residual after 30 min. contact is required to destroy the cysts of E. histolytica. The following alternatives are prescribed by TB MED 159:

1. When using canteens, two Halazone tablets are sufficient to kill the cysts (2.3 ppm), unless the water is turbid or colored, in which case four tablets should be used. A full 30 minutes contact must be allowed.

2. When using Lyster bags with Grade A Calcium hypochlorite, water will be treated to provide a 1 p.p.m. residual after 10 minutes contact time. Then an additional ampule of hypochlorite will be added and the water allowed to stand for 30 minutes more before use.

In many waters the above dosages of chlorine will give "break-point" chlorination; the residual will be indicated by a flash color formation with orthotolidine, and the water will have a pleasant, mild taste.

J. SCHISTOSOMIASIS.

In certain tropical and subtropical countries, a disease caused by worm parasites known as blood flukes may be contracted from contact with water containing the minute larval stages. This disease is called Schistosomiasis. The organisms which cause it usually enter the body by penetrating the skin while one is wading or bathing in contaminated water. More rarely the disease may be contracted through drinking water. The principal areas in which Schistosomiasis occurs are located in China, Japan, Africa, northern South America, and certain of the West Indies. In areas in which the disease is prevalent, wells and springs which are not subject to contamination by drainage and surface wash should be used in preference to natural bodies of surface water such as ponds and sluggish streams. The Medical Department is responsible for determining whether or not the infective form of the blood flukes (cercariae) are present in water which the troops will use for drinking or bathing.

Sulfite sulfate tablets to prevent bad taste
When have to overchlorinate

3.01A

In areas where Schistosomiasis is a problem, the same treatment prescribed for individual canteens and the Lyster bag under Amebiasis (TB MED 159) will give complete protection. Water for cooking and bathing should be secured from purification units operated by Engineer troops whenever possible. The following methods of treatment will be used by the operators of such equipment:

1. SEDIMENTATION- Settling tanks must be placed between the point at which chemicals are added to the water and the filter. The coagulant dosage should produce a heavy, rapidly settling floc. The sedimentation period should be at least 60 minutes.

2. FILTRATION- The filter rate must not exceed 6 gallons per minute per square foot of sand area. This means that the <u>maximum</u> filter rate with the portable unit will be 10 gallons per minute; or with the mobile purification unit, 60 gallons per minute.

3. DISINFECTION- For proper purification the chlorine dosage should be at lease 3 p.p.m. and the residual after 30 minutes contact with the water must be at least <u>1 part per</u> million. In making the test for chlorine residual, the reading is taken within 1 minute after the orthotolidine has been added. (This to insure that free active chlorine is present in addition to that present in the form of chloramines).

<u>Use of the Portable Bathing Unit</u>-The best available source of water should be used with the portable bathing unit. Prior to use in the unit the water should be treated by one of the following methods:

1. Treat the water as given in steps 1, 2 and 3 above, or

2. Place a dosage of 10 parts per million of copper sulfate in water. In a large body of water, this may be done by trailing behind a boat a small cloth sack filled with copper sulfate crystals. The water should not be used for at least 48 hours after the addition of the copper sulfate. This method of treatment is applicable to still bodies of water only; it cannot be used in fast moving streams.

<u>Protection of Water Supply Personnel</u>- Personnel operating water supply points should wear rubber gloves and rubber boots when they are required to place their hands in or wade in untreated water. (If accidentally exposed to such water, the prompt careful rubbing of exposed areas with a rough towel will afford reasonably safe protection).

K. WATER DISCIPLINE.

<u>Good Water Discipline</u>. When a unit organization has good water discipline:

1. Water is consumed only from authorized sources.
2. Water equipment is kept clean and in good repair.
3. All necessary measures are taken to prevent pollution of water.
4. No avoidable waste of water occurs.
5. In combat, on the march, or during other vigorous exercise men do not consume excessive quantities of water even if an adequate supply is available. They are particularly careful in the consumption of their allotted amount of drinking water.

2. All individuals of a unit, from the commander on down including the unit surgeon and his assistants, are intelligently conscious of the need for practicing all phases of good water discipline.

L. ADDITIONAL POINTS ON CHLORINATION AND TESTING RESIDUALS.

1. Residual Chlorine Test. It is required that all military water supplies be adequately chlorinated. It will therefore be necessary that the residual chlorine test be performed frequently and accurately. When chlorine is added to water it is consumed by any unoxidized organic or inorganic matter present and the bactericidal efficiency thereafter depends upon several factors, such as the amount and nature of the residual chlorine (free or Chloramine), pH, and the temperature of the water. Chlorinated water will also lose chlorine quite rapidly when exposed to direct or bright diffuse sunlight. It is therefore, necessary to add sufficient chlorine to satisfy the demand of chlorine-consuming materials present, to allow for any quantity which might be lost, and still leave a measurable quantity of chlorine for a period of at least thirty (30) minutes for bactericidal action.

Experience has shown that if the quantity of chlorine added to water is sufficient to yield, after a ten (10) minute contact period, a residual concentration of one (1) part per million, a satisfactory bactericidal concentration will usually be maintained for at least thirty (30) minutes. The residual chlorine test, therefore, as the name implies includes the time factor of contact period between the time of chlorine dosage and the time of testing. Reports of chlorine residual tests should include statements such as: 10-minute residual, 30-minute or 1-hour residual.

2. Active Chlorine Residual and Chloramine Residual. Active chlorine residuals develop maximum color with orthotolidine within 10 to 20 seconds, whereas chloramines develop maximum color much more slowly, requiring 5 minutes or longer when the water sample is quite cold. The procedure as prescribed in FM 8-40 and FM 21-10, (See page 9 of this mimeo), requiring a wait of 5 minutes after adding orthotolidine before noting the color, determines not only "free chlorine" but also chloramines. If the observer is aware of the significance of the rate of development of the orthotolidine color he will carefully note the color immediately after adding orthotolidine to a sample as well as at the end of five minutes. The rate of the development of color is roughly indicative of the bactericidal rate of a given chlorine residual. For example a residual indicated by the quick development of a deep yellow color will be 10-30 times as rapid in bactericidal action as a residual indicated by a deep yellow color that develops slowly to maximum in 4 to 5 minutes. When using orthotolidine tablets it is difficult to distinguish between an active chlorine residual and a chloramine residual due to the slow solution of the tablet. In the presence of active chlorine, however, it is usually possible to observe a flash development of color just as the tablet starts dissolving. However, when using tablet orthotolidine as the reagent for testing residual chlorine, a better procedure to follow to determine free active chlorine is to crush the tablet (with the plastic rod issued with the bottles of tablets) in two or three drops of water, and then add the water to be tested. From that point proceed as if using liquid orthotolidine.

TB MED 163, MAY 1945

SUBJECT: Sanitary Control of Army Swimming Pools and Swimming Areas

8. BEACHES AND OTHER NATURAL SWIMMING PLACES. a. Site selection. The principal factor involved in the selection of a site for a swimming beach is freedom from sewage pollution. In considering the dangers from sewage pollution, it is well to emphasize that dilution and the time to flow are factors of great importance. The hazards from a relatively small amount of sewage in close proximity to a swimming area is far greater than a large amount at a considerable distance.

b. Destruction of small hosts of schistosome parasites. Copper carbonate (3 pounds per 1,000 square feet of water surface to be treated) may be used to kill the snail intermediate hosts. A concentration of 10 parts per millon of copper carbonate after 48 hours of contact destroys free-swimming cercariae as well as snails. Copper sulfate may be substituted when copper carbonate is not available. Doses of this magnitude will destroy fish and other aquatic life. Because of the amphibious habits of the snail hosts of some schistosomes, chemical treatment of the water should be supplemented by the application of slaked lime to the ground and along the shoreline of the water. Measures for killing snails have their greatest usefulness where the infected bodies of water are small. Prevention of pollution of water by feces, infected individuals, or reservoir hosts will reduce the number of infected snails.

c. Bacterial quality of water at beaches. (1) Under the heading of beaches are considered swimming places along small streams, rivers, lakes, and tidal waters.

(2) It is not considered practicable or desirable to recommend any absolute standard of safety for waters of outdoor bathing places. Nor is the arbitrary wholesale condemnation of such places warranted without definite epidemiological evidence. Safety of such waters for swimming should be based upon information obtained by thorough sanitary surveys, and results of routine bacteriological examinations.

(3) As a means of determining the suitability of natural waters for swimming, the following classification is given, based upon the presence of E.coli. These limits may have to be altered in some cases, in view of existing local conditions and of the findings of a sanitary survey:

Classification	Average E. coli per 100 m.
Class A (good) - - - - - - - - - - - - - - -	0 to 50.
Class B (fair) - - - - - - - - - - - - - - -	51 to 500.
Class C (poor) - - - - - - - - - - - - - - -	501 to 1,000.
Class D (very poor)- - - - - - - - - - - - -	Over 1,000.

(4) In determining the safety of water at natural swimming areas or outdoor bathing beaches emphasis is laid upon the results of sanitary surveys rather than bacteriological examinations. When bacteriological examinations are made, inoculations in lactose broth will be made of three 10 ml., three 1.0 ml., three 0.1 ml., and three 0.01 ml. portions. The number of positive and negative tubes of each dilution will be reported under Remarks or on the reverse side of the Form 8-126. If, for example, three 10 ml., three 1 ml., and one 0.1 ml. portions are positive, the results will be reported as follows:

(OVER)

3.10A

10 ml. 3 +0 -
1 ml. 3 +0 -
0.1 ml. 1 +2 -
.01 ml. 0 +3 -

In the foregoing example, the "average" number of coliform organisms, is computed at 400 per 100 ml. Thus the quality of the sample is within the range specified for Class B waters.