ENGINEERING NEWS

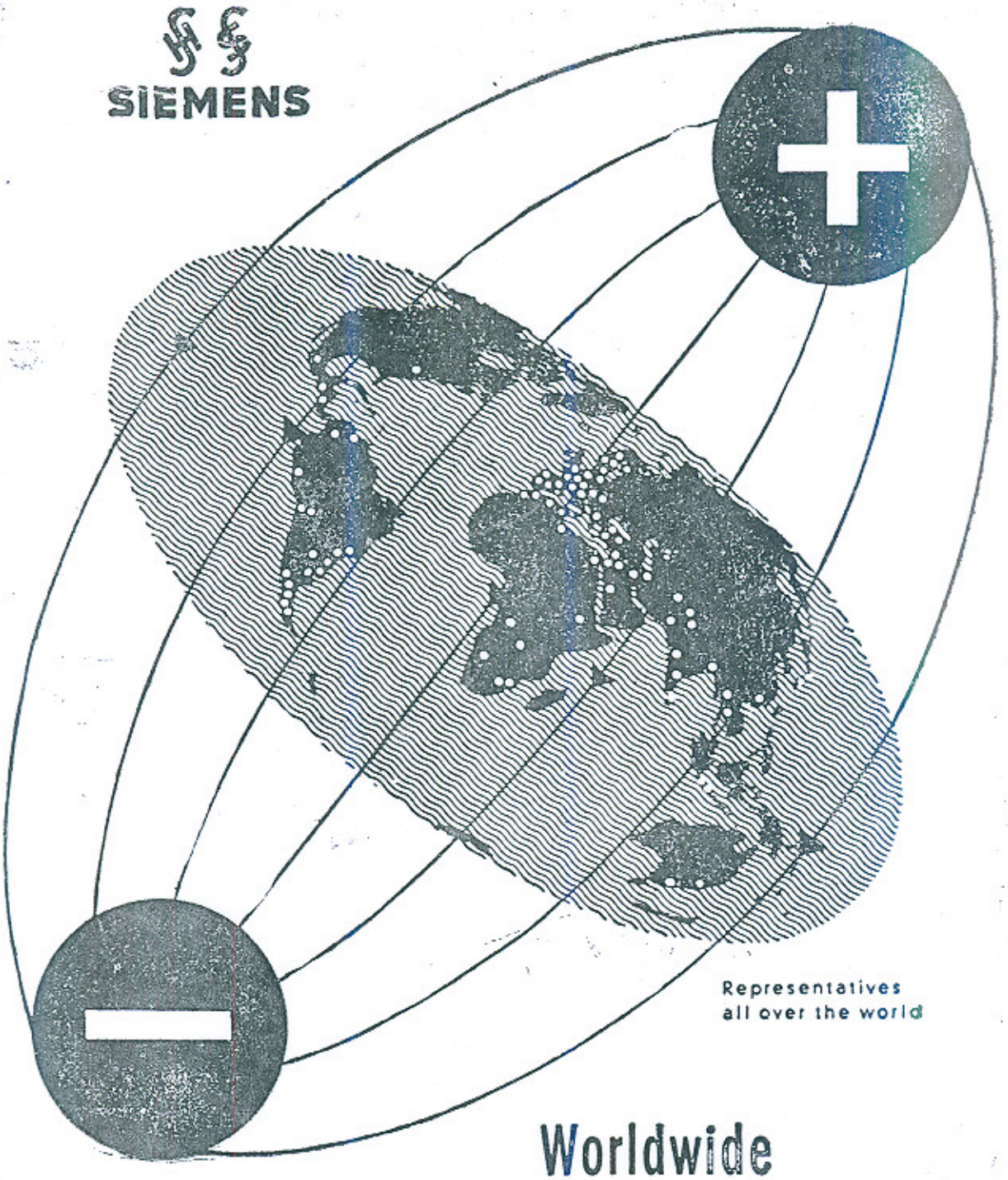
QUARTERLY JOURNAL OF THE WEST PAKISTAN ENGINEERING CONGRESS

UME 6 No. 4 | LAHORE (West Pakistan) | DECEMBER 1961



MANGLA DAM FROM AN ARTIST'S POINT OF VIEW

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Editorial

Hydrologist Fights Silt

FLOWING water has tremendous energy to transport materials. When moving over erodable beds, it tears them up breaking them into pieces and carrying them along. Even the hardest rocks cannot resist the persistent action of flowing water. It cuts them asunder, tosses them down, hurles them against more rigid and resisting rocks and pulverises them. The heavier materials which cannot be lifted are rolled on and light materials are lifted up and carried along. Thus flowing water contains quantities of various sizes of particles of the eroded materials.

A young river full of energy and vigour at its birth brooks no obstruction. It can cut through the hardest rocks and plays with boulders and stones as balls kicked and tossed. Often millions of them are carried and accumulated in a few hours, which task would require thousands of man days. Rivers plan and execute their playful actions at their own sweet will. They are born free and would like to live free. A hydraulic engineer wanting to tame them, trying to curb their freedom of action, desiring them to dig and erode according to his needs and to deposit according to his design, is confronted with stiff opposition. Thus ensues a continuous struggle between the river and the hydraulic engineer each adversary going for the weak points of the other.

A hydraulican aiming to store a river supply faces the problem of silt deposition at the very outset. Every year the river reduces the storage which has cost the nation millions of rupees. The Tarbela Dam is a case in point. It may cost 2500 million rupees; but the Indus will avenge the curb of its free flow by depositing silt the removal of which will cost 500 million rupees per year. All the planning of the engineer will be rendered futile within theshort span of 50 years. The Jhelum will also avenge the construction of storage and will cause the nation to spend 15 million rupees per year for removing its silt

deposit. The struggle is expected to last 130 years before the dam silts up. Although in the plains a river loses much of its youthful energy, yet even the old and infirm river is without its punch. A slight relaxation on the engineers part and the river retaliates

Recently in the proceedings of the Institute of Engineers on Water Resources Conference of East Pakistan, many instances of the fight of the engineers with the old, infirm and dying rivers of East Pakistan were cited. An engineer's design to draw a fragment of the discharge of the mighty rivers for the good of his people are made null and void when the intake silts up. The river resents the curbs put on it by the engineer, and takes its own course. It does not like to be confined within the artificial embankments put up by the engineer. It bursts them, and millions of rupees spent train it and use a fraction of its water are washed away in hours.

Recently, West Pakistan spent about 100 million rupees on the M.R. Link Canal. The Chenab resented the change in its age-old flow directions. It started taking revenge, now a stage has reached when the very existence the M.R. Link is in danger.

The control of the Indus during its flow through the Sind is an illustration. For six months, the engineer fights day and night river's attack on the embankment constructed for its control. This fight costs the millions of rupees every year and the slightest complacency on the part of the engineer causes innumerable woes and worries.

East Pakistan affords instances of many such battles fought and won. West Pakistan has yet to open its account but its battles will be many. The sedimentation problems arising from the Indus Basin works are bound to be serious. The West Pakistan Engineering Congress is planning to discuss at its next annual meeting the necessary strategy. The earliest encounters are likely to be the result of the expected fights. Nazir too has made suggestions for winning the struggle at the Tarbela and the Mangla Dams. Binnie, Dicken and Drisko has predicted "Ringenoldus" and Amir Khan have both made plans to nip the mischief in the bud the struggle improper water-management; but inspite of these precautions the river's retaliation counter measures and after effects are detailed by Kirmani in his "Mushtaq in the Indus Basin" and by Lewis in his "Changes in Regime Expected of L. Canals". caused by the Molzer and Mohi-ud-din have suggested proper treatment of the illnesses shortly. Finally Sadiq has indicated methods of diagnosing the illnesses. symposium that the West Pakistan Engineering Congress is planning to hold will await the outcome of the symposium with eagerness.

MANGLA DAM
IN
CONSTRUCTION STAGE

Mangla Dam, the first of its kind, is expected to be in operation by 1970. Recently, tenders of Guy F. Atkinson to complete the dam within Rupees 1685.5 Lakh have been accepted. The contractors are now on the job. In this article general information about the dam is given. A panoramic view of the dam appears on the front page of this Magazine.

TENDERS ACCEPTED

The biggest single construction contract in Pakistan was awarded on 15th November, 1961, to Guy F. Atkinson Consortium of America.

Four tenders were received from four American firms, *viz.*,

1. Guy F. Atkinson Consortium.
2. Pakistan Constructors.
3. Utah Consortium, and
4. Mangla Constructors.

The tender amount in rupees from each of the above-mentioned firms of contractors was

(1) 1,685,534,652
(2) 1,783,331,549
(3) 1,812,471,359
(4) 2,196,491,097

Messrs Binnie, Deacon and Courley, Consultants for Mangla. Dam, completed their report on the analysis of the bids. This report was reviewed by Harza and Wapda during a meeting held in December, 1961., in London. Wapda submitted its recommendations to the IBRD for the award of the contract.

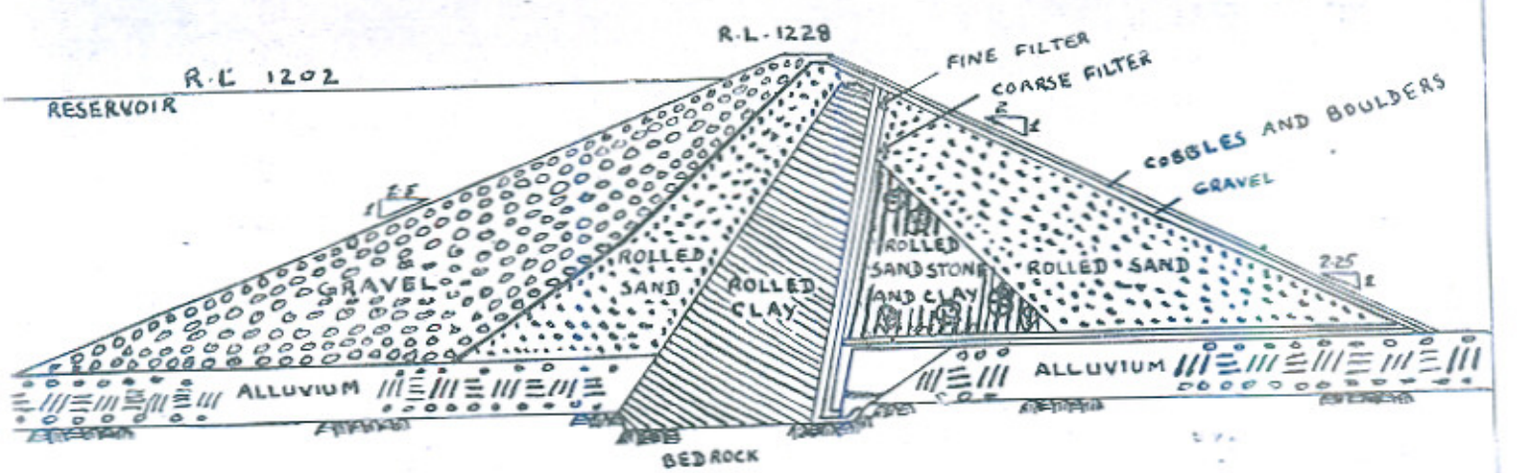
Mangla will be a rolled earthfill dam with a sloping clay core. It will be built by a joint venture headed by the Guy F. Atkinson Co. of San Francisco. Other members are S.J. Groves & Sons, Minneapolis ; Walsh Construction Co , New York ; Chicago Bridge & Iron Company, Chicago ; Charles J. Herney, Inc., San Francisco ; C J. Langenfelder & Son, Baltimore ; Ostrander Construction Co., Portland, Ore.; and R.A. Trippeer, Memphis.

THE DAM

Mangla Dam will be built across Jhelum river, a tributary of the Indus, at a site about two miles up-stream of the existing Mangla Headworks for Upper Jhelum Canal The dam will be 374 feet high, with crest elevation at 1228 and maximum water conservation height equal to 1202 Length at crest will be 11,000 ft.

Various sections of the proposed fill of the dam are shown in Figure 1.

Extracted Partly from Engineering News Record, Page 16, 87th Annual Report and Forecast.



CROSS SECTION OF PROPOSED MANGLA DAM

The construction of the dam will involve 5,700,000 cu. yds. of rock excavation and the total fill will amount to 77,000,000 cu. yds. It will rank among the big dams of the world.

RESERVOIR CAPACITY

The dam is to store 5.55 MAF of water corresponding to 2,775,000 cusec days.

It will have a usable capacity of 4.75 MAF and dead storage equal to 0.8 MAF. An additional raising of the dam by 50 ft. at a later stage will increase its capacity to 8.5 MAF.

The storage lake will spread 40 miles up-stream in the river and will be more than 2½ miles wide. It will spread in the three tributaries of the Jhelum: the Khad, the Poonch and the Kanshi. These tributaries will store a large volume of the water. The extent of the storage is shown in Figure 2.

SUKIAN DYKE AND JARI DAM

Storage of 5 55 MAF of water will necessitate a 17,000 ft. long dyke 74 ft. high. This will be necessary to protect the spilling away of stored water.

In the catchment of the Khad, Jari Dam, 228 feet high and 5700 ft. long, will have to be constructed. Sukian Dyke will need 1,500,000 cu. yds. of excavation and 5,300,000 cu. yds. of fill whereas the fill for Jari Dam will be 23, 000,000 cu. yds The total fill at the Sukian Dyke and the Jari Dam will be equal to that of the main Dam itself.

Even though embankment construction at Mangla will be a notably large operation, it by no means comprises the whole job. On the left side five diversion power tunnels each 32 feet in diameter and 2000 ft. long are to be driven through the abutment rock, and a power house is to be built, that can accommodate 100,000 k.w. generators. The first stage of installed power capacity will be 300 M W. produced from 3 units of 100 M.W. generators. The tunnels will discharge just close to the existing head regulator of Upper Jhelum Canal.

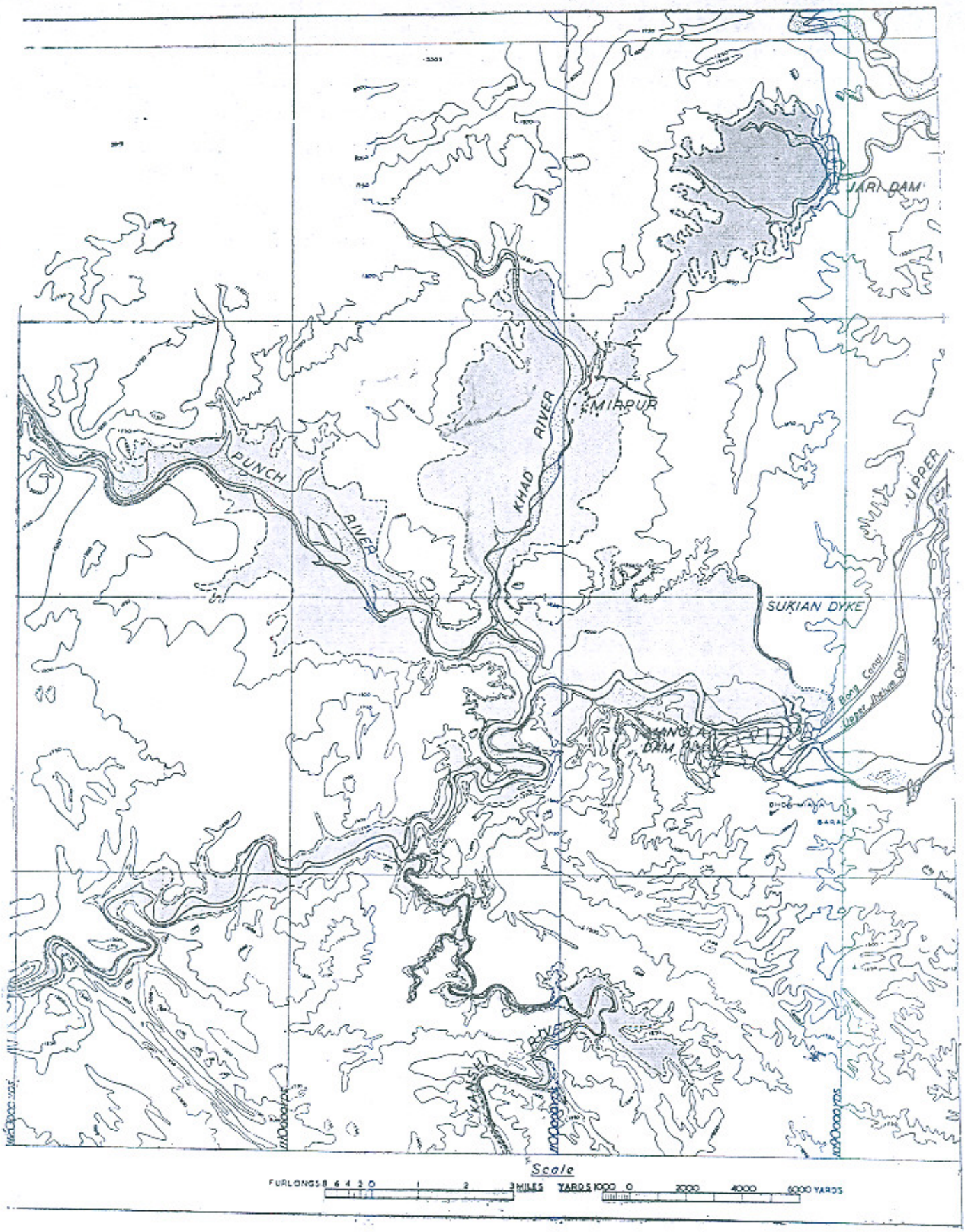

JARI DAM
MIRPUR
KHAD RIVER
PUNCH RIVER
SUKIAN DYKE
UPPER
Scale
FURLONGS 8 6 4 2 0
1 2 3 MILES
YARDS 1000 0 2000 4000 6000 YARDS

Fig. 2

SPILLWAY

On the right bank will be constructed the world's largest capacity spillway, capable of discharging 1.2 million cu. ft. per second. This will be a formidable job requiring the excavation of 26,700,000 cu. yds. and the placing of 1,2,000,000 cu. yds. of concrete.

The spillway head-works, 450 ft. wide, will incorporate nine 47 by 36 ft. tainter gates, which will be submerged and operated under 100 ft head of water when the reservoir is full. From gate sill to tail-race the spillway structure will be 1250 ft. long and the 300 ft. drop of its chute will be intercepted by two stilling basins, an expedient adopted to minimize foundation excavation.

BARA KAS SPILL CHANNEL

An unregulated open cut with crest level at R.L. 1206 will serve as spillway channel. It is designed to discharge 212,000 cusecs. This will need 12,000,000 cu. yds of excavation and about 3000 cu. yds. of concreting. Due to the limited capacity of Bara Kas Channel into which the emergency spillway will discharge, it was decided to limit the capacity of the emergency spillway to about 200,000 cusecs instead of 350,000 cusecs originally proposed. The reduction in the capacity of the emergency spillway will be made good by 6 0 ft. raising of the dam's crest to R.L. 1234 and this will absorb the excess flood. The raised crest will be provided by means of a cap superimposed on the dam project.

BONG CANAL

The canal into which the five tunnels will discharge will be 15,000 ft. long 100 ft. at bed and 37 feet deep. It will carry a discharge of 40,000 cusecs. The originally proposed side slope of the Bong canal will be flattened from 1 in 1.5 to 1 in 1.75 for protection against earthquakes.

ACQUISITION OF LAND AND BUILT UP PROPERTY

The work of acquisition of land that will be submerged by the Mangla storage is in full swing. So far compensation equal to Rs. 176.6 Lakh has been paid to inhabitants of Azad Kashmir and West Pakistan, the money paid to West Pakistan zone being 27 Lakh only. So far 844 families of Azad Kashmir territory have been resettled in Sargodha and Multan districts and 22 families from West Pakistan in the later district.

Survey and investigation for a new Mirpur town are in progress. Alignment for a new road outside the reservoir as an alternative to the present Mirpur Kotli Road is in progress.

JOB MANAGEMENT

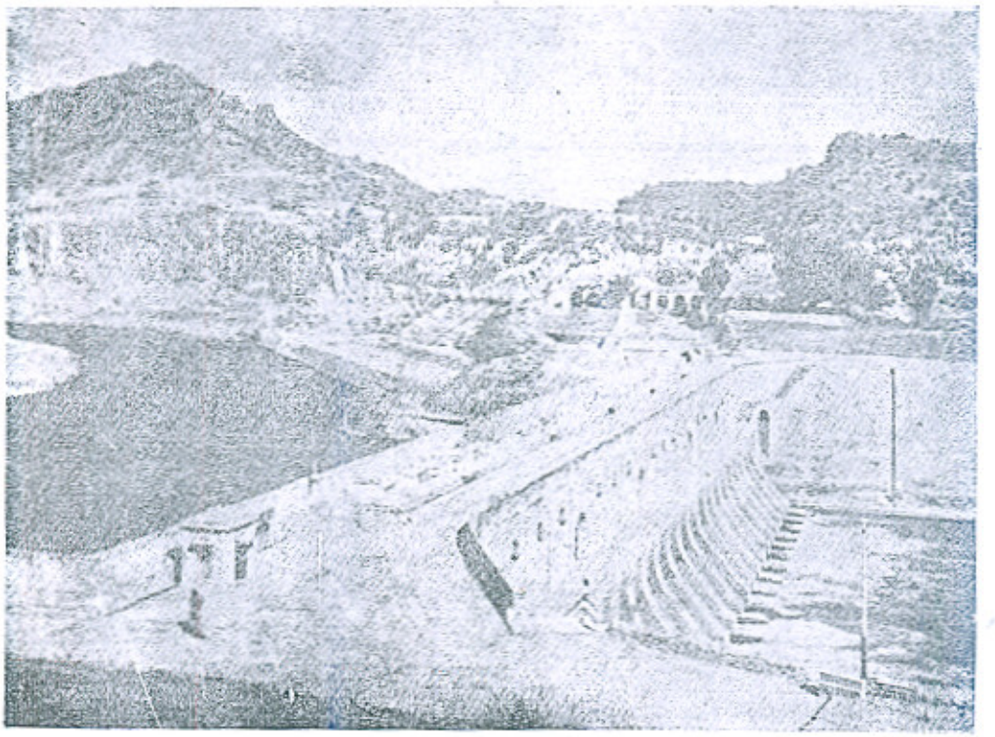
Mangla Dam Contractors, the name adopted by the joint venture firms, has set a 6½ years construction schedule, one year shorter than stipulated. The schedule is pegged on making the river diversion through the power tunnels on Oct. 1, 1965.

The contractors hope to start their first pay work by the end of this summer and be in full production by the end of the year. They will start with tunnel intake excavation, a 6.5 million cu. yd. job. In the meantime, they are faced with a huge logistical task in moving in and setting up.

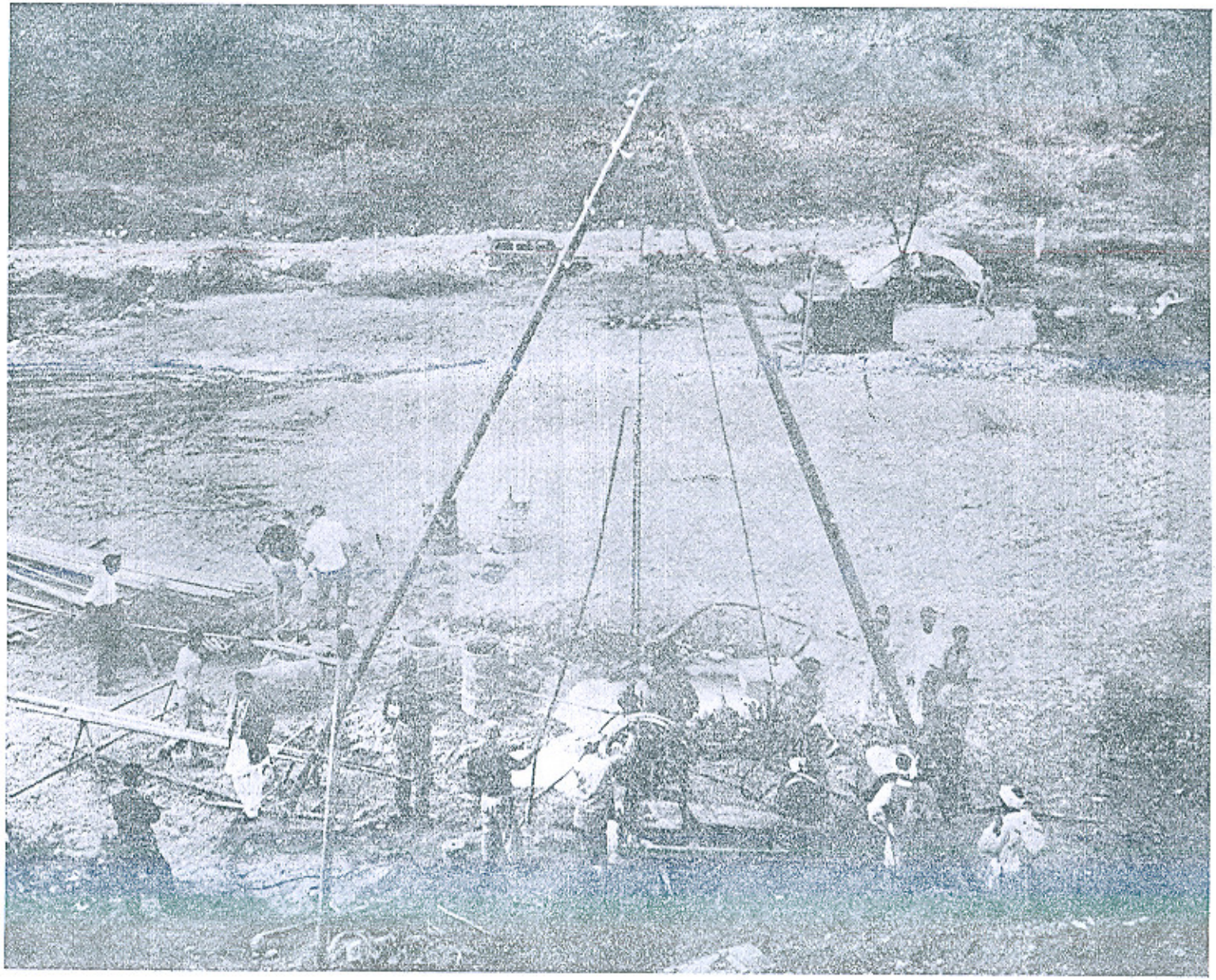
Top staff organisation has already been established. It is headed by a Mangement Committee including representatives of all the joint venture partners with George H. Atkinson as Chairman and Frank Groves and J. A. Henderson as Vice-Chairmen. The Guy F.Atkinson Co. has been selected as Sponsor and will actually manage the job from its headquarters office in South San francisco.

An Operating Committee consisting of Atkinson executives will run the work. This group includes F. R. Bonner, Chairman, R.S. Kerr, A.H Steiner and George H. Atkinson.

Heading up field activities will be George H. Archibald as General Project Manager. He has held similar posts for the Atkinson firm at Ambuklao Dam in the Philippines and Miboro Dam in Japan. Under Mr. Archibald will be Joseph B. McNabb as Construction Manager. Many of the general superintendents, as well as shift superintendents and some general foemen, will be selected from the permanent Atkinson organization. Others, particularly at the foreman level, will be hired specifically for the job from English speaking countries.



View of the Existing Mangla Headworks.



Drilling operations in Progress at Mangla Dam Site Project.

The important task of job site logistics will be headed by Errol Platt who will have the designation of Assistant General Project Manager. He will be in charge of accounting, finance, purchasing, warehousing and transportation. This last is important, because all supplies and equipment must be transported 800 miles by rail from Karachi. Other important job site officials already selected are Richard Byers, Chief Project Engineer and C. Lyoyd Thorpe, City Administratory. Thorpe will be incharge of the three camps to be built, one for about 400 non-Pakistani supervisory staff, one for Pakistani families and one for Pakistani men. Present plans put the Pakistani work force at about 8,000.

EQUIPMENT PLANS

The contractors plan to follow traditional construction procedures. They are reluctant to experiment with new equipment on a job halfway around the world. The equipment will be large but it will not include the new super-size rigs that are becoming available. They hope to do most of the excavation with scrapers.

Big shovels will be put to use too. Major equipment items include 6cu.yd electric shovels, 15cu.yd. dump trucks, 40cu. yd. bottom dump wagons. Altogether, it will be the largest peace time assembly of construction equipment in Pakistan's history. No final dollar cost has been worked out yet. About 95% of the equipment will be new, and probably about 90% of it will be acquired from the U.S.

A screening plant will be installed just below the dam to develop the concrete aggregate and the sands and gravels for the dam for filter zones and the like. Capacity will be 2,700 cu. yd per hour with more than 2 million cu. yd. of other screened material. A standard concrete plant will be set up near the screening plant, with mixed concrete to be trucked to the point of use. Concrete will be placed for the most part by revolving, rail-mounted cranes.

First construction priority will be the the camps. Most buildings are to be brick construction for durability. But even before camp construction starts, the contractors plan to get a trade school programme established, to train Pakistani equipment operators and foremen, with special emphasis on safety. Initially, as many as one-fourth of the operators will be foreign operator-instructo s. By the end of the construction programme all of the operators may be Pakistanis.

WORKS ALREADY COMPLETED

Certain preliminary work has already been done at the Mangla site by the Water and Power Development Authority of West Pakistan (WAPDA), the government agency handling the entire Indus Basin Project. Buildings for administrative offices and housing for WAPDA have been constructed, as well as a heavy-duty bridge across the river just below the dam site. Extensive foundation drilling and the driving of a 600-ft-long exploratory tunnel are other items of preliminary work.

WAPDA'S consulting engineer incharge of the design of the Mangla Dam project is Binnie, Deacon & Gourley of London. Harza Engineering Co. Chicago, designed the spillway. For the World Bank, which administers the finances of the whole Indus Basin Project. Gen. Raymond A. Wheeler is Chief Engineering Advisor. The Bank's consulting engineers on the work are Sir Alexander Gibb & Partners.

WEST PAKISTAN WAPDA PROGRAMME
for
WATERLOGGING & SALINITY CONTROL
IN THE IRRIGATED AREAS

A high-powered conference presided over by the President of Pakistan was held on 3rd April, 1961 in which West Pakistan WAPDA was entrusted to submit by the middle of May, 1961, its programme for control of waterlogging and salinity. It was to be submitted for consideration by a consortium of friendly nations which was to meet in Washington D. C. in June, 1961 to frame a long term aid plan for Pakistan.

The programme was to present :

(1) An overall appraisal of the magnitude of the waterlogging and salinity problems in West Pakistan.

(2) A programme of works consisting of such features as tubewells and drains, which will be required to be provided in all the affected lands in West Pakistan.

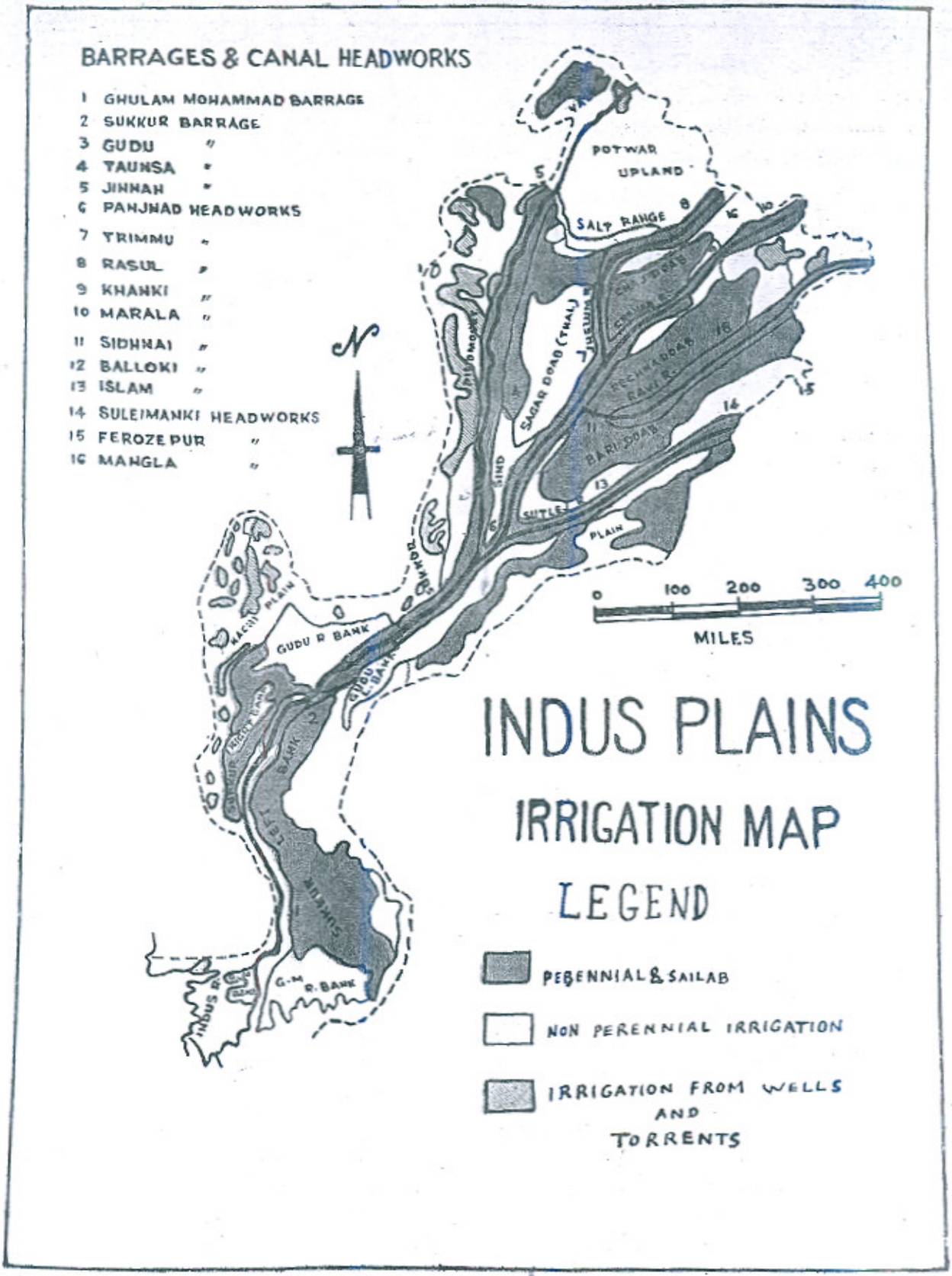
(3) An appraisal of the magnitude of resources which will have to be mobilised to undertake the programme within a period of 10 years.

(4) Proposals for the utilization of the land and water resources west of the Indus, in place of areas where reclamation of affected lands is not feasible or is prohibitively expensive.

The West Pakistan Water and Power Development Authority appointed Mr. Sayyid Hamid, its Project Director, incharge of the Ground Water and Reclamation Division, as Chairman of the Special Committee for the preparation of this plan. The Committee included representatives of Messrs Harza Engineering Co. International, General Consultants to the Authority ; Tipton and Kalmbach, Inc., who have been cousultants to WAPDA in connection with reclamation work in the former Punjab area since 1959 ; Hunting Technical Services, Ltd., who in association with Sir M. Mcdonald and Partners, have been consultants to WAPDA in connection with reclamation work in the former Sind area since 1959 ; and International Co-operation Administration Group with Water and Soil Investigation Division of WAPDA.

The Draft programme prepared by the Special Committee of WAPDA was approved by the authority and submitted to the Government.

A comprehensive report dealing with all aspects of the problem, its solution, the programme of its implication, cost justification, management operation etc., was printed in May 1961 as a publication


BARRAGES & CANAL HEADWORKS
1 GHULAM MOHAMMAD BARRAGE
2 SUKKUR BARRAGE
3 GUDU "
4 TAUNSA "
5 JINNAH "
6 PANJNAD HEADWORKS
7 TRIMMU "
8 RASUL "
9 KHANKI "
10 MARALA "
11 SIDHNAI "
12 BALLOKI "
13 ISLAM "
14 SULEIMANKI HEADWORKS
15 FEROZEPUR "
16 MANGLA "
POTWAR UPLAND
SALT RANGE
SIND SAGAR DOAB (THAL)
JECHNA DOAB
RAVI R.
BARI DOAB
SUTLEJ PLAIN
SUTLEJ
SIND
JHELUM
CHENAB
INDUS
GUDU R BANK
GUDU L. BANK
KACHHI PLAIN
KACHHI CANAL
LEFT BANK
SUKKUR
G-M R. BANK
INDUS R.
0 100 200 300 400
MILES
INDUS PLAINS
IRRIGATION MAP
LEGEND
PERENNIAL & SAILAB
NON PERENNIAL IRRIGATION
IRRIGATION FROM WELLS AND TORRENTS

of the authority. The report is accompanied by seven appendices, many tables and ustrations.

In this issue of the ENGINEERING NEWS we have extracted the chapters dealing with the problem, its solution and the programme to be followed. Information about the justification of the programme and the cost is also given.

GENERAL INFORMATION ABOUT WEST PAKISTAN

West Pakistan is a region of scanty precipitation. Practically the whole of the 2,04,000 square miles area of West Pakistan included in the Indus Basin receives annually less than 15 inches of rainfall. Its 60 percent area receives rain less than 10 inches and 16 percent receives less than 5 inches. In the remaining 1,06,000 square miles area of the region drained by the coastal tributaries and desert streams, which constitute a hydrological unit distinct from the Indus Basin, the annual rainfall seldom exceeds 10 inches. In the Indus Plain it averages about 5 inches, going down in some cases to 2 inches per year. With the exception of the sub-mountainous tracte in the North and North East of the Indus Basin, which receive on the average 30 to 40 inches of rainfall annually, the whole of West Pakistan is thus semi-arid and its water wealth lies almost exclusively in the stream flows which its rivers bring and in the water that may be available under-ground.

The Indus is the major river and the Indus plain in West Pakistan is a gift of the Indus. It has five left bank tributaries, the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej which flow across the alluvial plains in shallow, meandering channels.

IRRIGATION SYSTEM

During the last century one of the world's greatest irrigation system has been developed in the country to fully utilize the water of its rivers.

The first barrage to be installed was at Madhopur (now in India) on the Ravi, in 1859, to feed the Upper Bari Doab canal. From the turn of the present century, barrages have been constructed along the Indus and its major tributaries, together with a system of link canals so that the natural river flows have been utilized almost to the full extent. There are now fourteen barrages in West Pakistan, four on the Indus, two on the Jhelum, three on the Chenab, two on the Ravi, and three on Sutlej River. When the Gudu barrage, now under construction on the Indus goes into operation, virtually all of the major canal systems in West Pakistan will be under weir control. (Indus Plains Irrigation Map).

The mean annual flow of the Indus River System is about 168 million acre feet (MAF). Of this mean annual flow, between 60 and 70 million acre feet at present go to the sea unused during the monsoon (summer rain) period. Under the terms of the Indus Waters Treaty of 1960, the flow of the three Eastern rivers, Sutlej, Beas, and Ravi, will be for the exclusive use of India, thus reducing the total flow potential available to West Pakistan by 33 (MAF). In accord with the above mentioned treaty, a programme of providing a vast system of engineering works which will transfer waters from the three Western rivers to areas formerly dependent on the Eastern rivers is now underway. These "Settlement Plan" works will be completed within a period of approximately ten years.

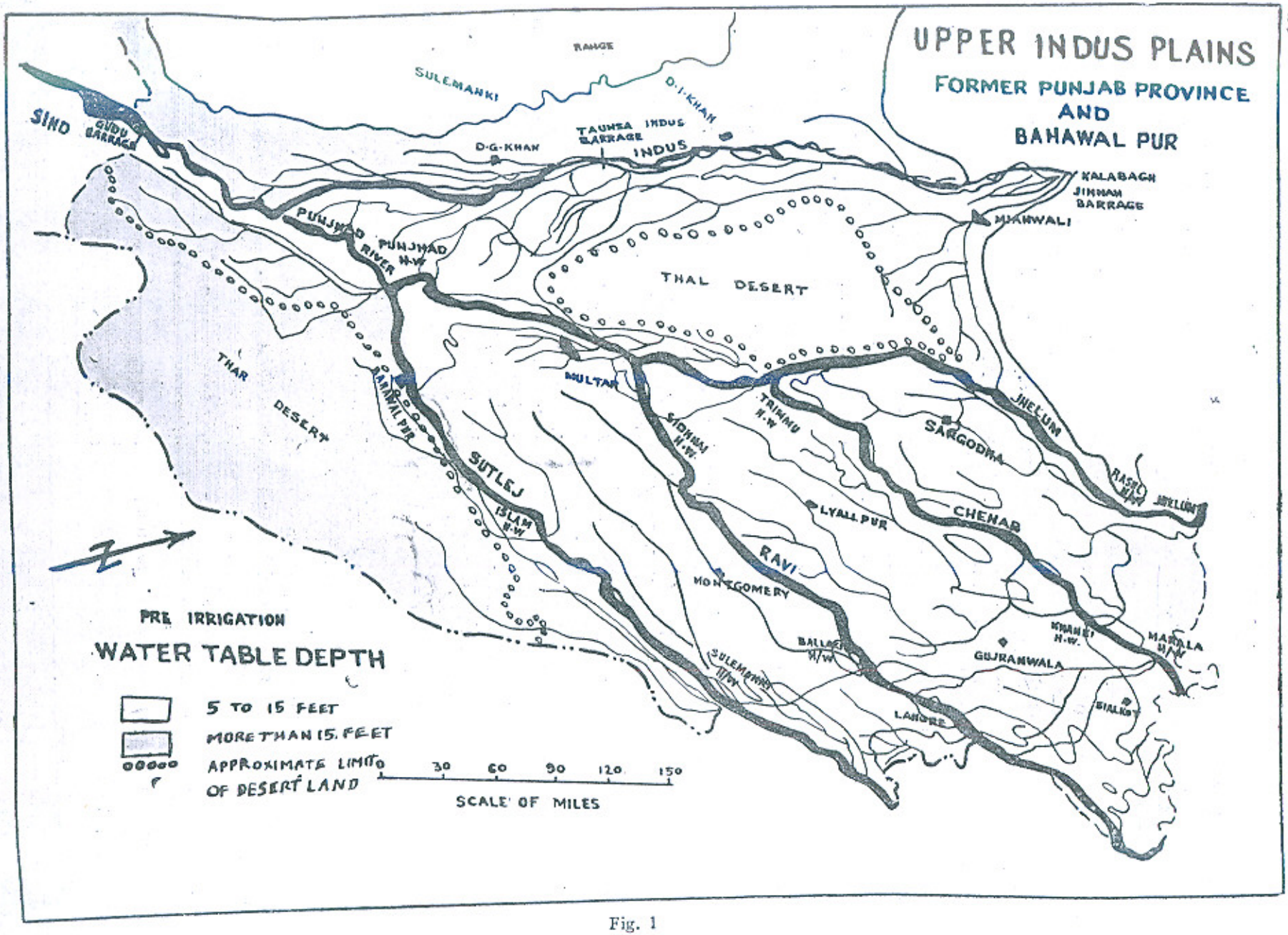

UPPER INDUS PLAINS
FORMER PUNJAB PROVINCE
AND
BAHAWAL PUR
SULEMANKI
RANGE
D.I.KHAN
SIND
GUDU BARRAGE
D.G.KHAN
TAUNSA INDUS BARRAGE
INDUS
KALABAGH JINNAH BARRAGE
MIANWALI
PUNJNAD RIVER
PUNJNAD H.W.
THAL DESERT
THAR DESERT
BAHAWALPUR
MULTAN
SIDHNAI H.W.
TRIMMU H.W.
SARGODHA
JHELUM
RASUL
SUTLEJ
ISLAM H.W.
LYALLPUR
CHENAB
RAVI
MONTGOMERY
SULEMANKI H/W
BALLOKI H/W
KHANKI H.W.
GUJRANWALA
MANGLA
LAHORE
SIALKOT
PRE IRRIGATION
WATER TABLE DEPTH
5 TO 15 FEET
MORE THAN 15 FEET
APPROXIMATE LIMITS OF DESERT LAND
0 30 60 90 120 150
SCALE OF MILES

Fig. 1

Out of a total area of 198.4 million acres in West Pakistan, land use data are available for 115.9 million acres. Of these the area fit for cultivation is 61 million acres. The area upon which crops are presently raised is equivalent to 39 million acres. The major portion of this area is irrigated, some 33 million acres being under the command of existing irrigation systems. That lands presently being irrigated with the waters from the Indus and its tributaries are tabulated below :

Agriculture is by far the most important factor of the economy of West Pakistan. Nearly two-thirds of the population is engaged in agricultural pursuits, and about one-fifth work with agricultural products. Notwithstanding the fact that West Pakistan is a predominantly agricultural country and that a larger proportion of its lands are irrigated than in any other country of the world, it presently does not produce sufficient food to supply the needs of its people. Although great strides have been made towards developing an important industrial sector of the economy in the relatively short term of years since the birth of Pakistan, it is upon agriculture that a large part of the present and future population must depend, not only for basic food supplies but for a livelihood for some time to come.

POPULATION & THE CROPS YIELD

In 1951 the population of West Pakistan was 33,780,000. On the basis of the provisional figures from the 1961 census, it is estimated that the present population is nearly 41 million. Various estimates of population growth indicate that by 1970, the population of West Pakistan will be approaching 50 million, and by the year 2,000 will exceed 80 million or double the present population.

Present crop production levels in West Pakistan are low. Comparison with world and selected country yields and estimated West Pakistan Potential yields of selected crops are as follows :

CANAL IRRIGATED AREA IN MILLION ACRES

	Culturable Comanded	Kharif, (Summer)	Rabi (Winter)	Total
Northern Zone :—				
Former Punjab	15.936	6.182	7.286	13.468
,, Bahawalpur.	3.561	1.429	1.527	2.956
,, N.W.F.P.	0.586	0.370	0.275	0.645
Sub total ...	20.083	7.981	9.088	17.069
Southern Zone:—				
Former Sind.	12.907	3.721	2.839	6.560
Total ...	32.990	11.702	11.929	23.629

CROPS YIELDS

(All figures in pounds per acre)

Crop.	W. Pakistan 1958-59 ave. yield	Iran ave.	U.S.A. ave.	World ave.	Estimated W. Pakistan potential
Wheat	725	800	1640	1030	1600-1800
Maize	955	...	2900	1690	2000
Rice	765	1820	3310	1730	2000
Barley	725	980	1520	...	2000
Pulses	360	940	1090	...	2000
Dry Peas	400	...	...	1080	1000
Cotton	184	...	500-1000	...	1000
Millets	360	...	...	...	1200
Oil Seeds	300	...	...	...	800-1000

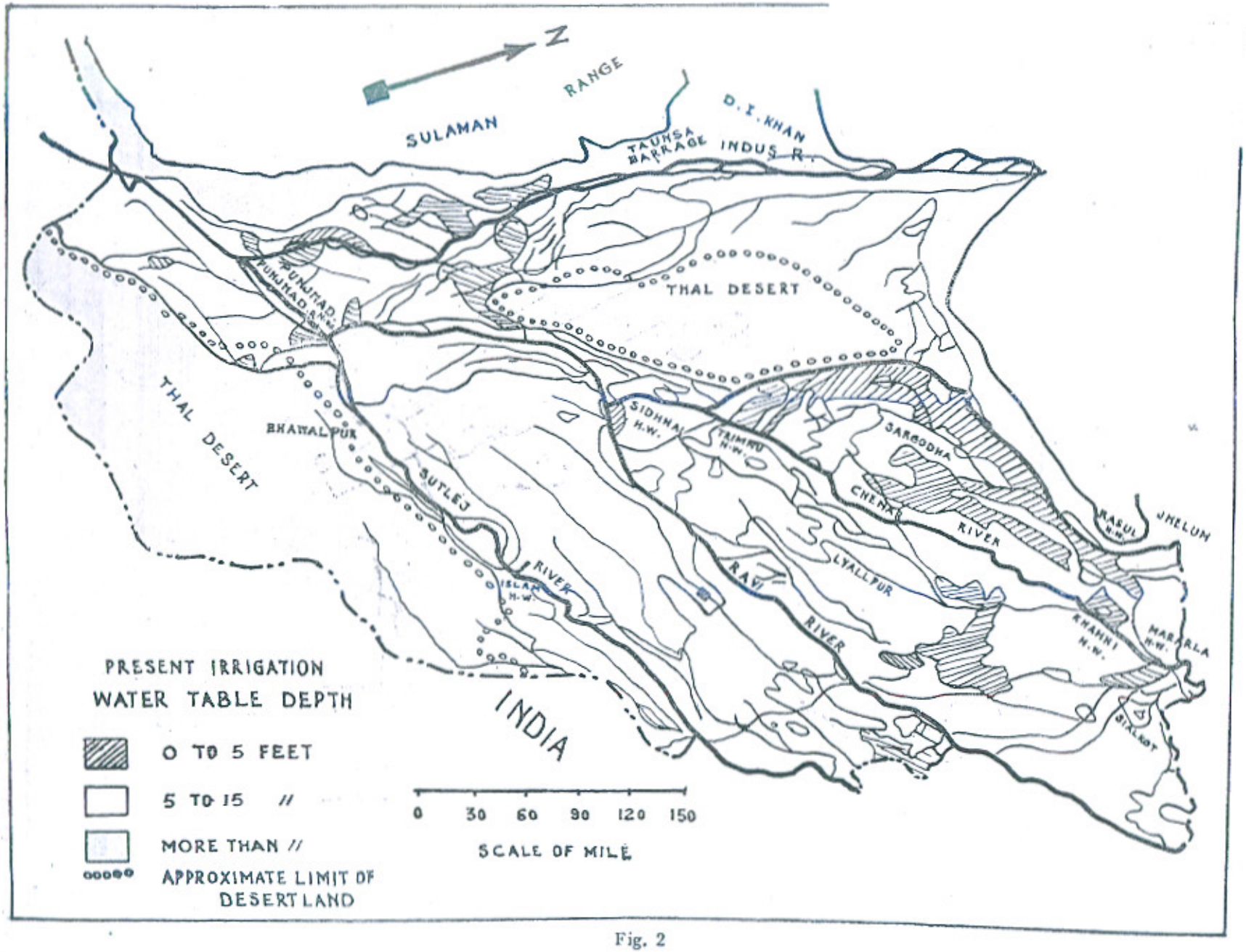

N
SULAMAN
RANGE
D.I.KHAN
TAUNSA BARRAGE
INDUS R.
PUNJNAD
PUNJNAD R.W.
THAL DESERT
THAL DESERT
BHAWALPUR
SUTLEJ
RIVER
ISLAM H.W.
SIDHNAI H.W.
TRIMMU H.W.
SARGODHA
CHENAB
RIVER
RAVI
RIVER
LYALLPUR
RAWI H.W.
JHELUM
RIVER
KHANKI H.W.
HARARLA H.W.
SIALKOT
INDIA
PRESENT IRRIGATION
WATER TABLE DEPTH
0 TO 5 FEET
5 TO 15 //
MORE THAN //
APPROXIMATE LIMIT OF DESERT LAND
0 30 60 90 120 150
SCALE OF MILE

Fig. 2

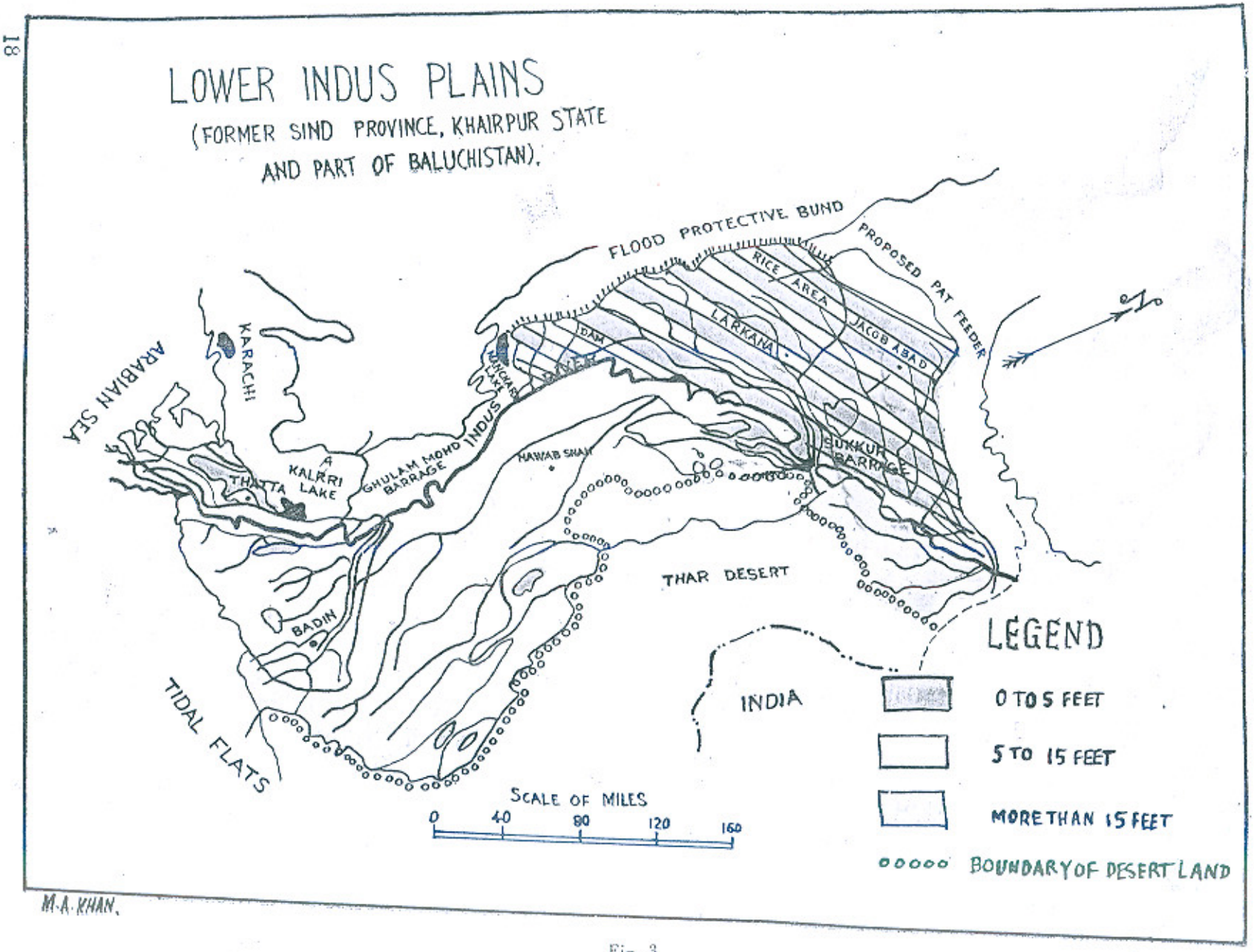

LOWER INDUS PLAINS
(FORMER SIND PROVINCE, KHAIRPUR STATE
AND PART OF BALUCHISTAN).
FLOOD PROTECTIVE BUND
PROPOSED PAT FEEDER
RICE AREA
LARKANA
JACOB ABAD
DAM
KOTRI
NARA R.
LAKH
INDUS
ARABIAN SEA
KARACHI
KALRRI LAKE
THATTA
GHULAM MOHD BARRAGE
NAWAB SHAH
SUKKUR BARRAGE
THAR DESERT
BADIN
TIDAL FLATS
INDIA
LEGEND
0 TO 5 FEET
5 TO 15 FEET
MORE THAN 15 FEET
BOUNDARY OF DESERT LAND
SCALE OF MILES
0 40 80 120 160
M.A. KHAN.

Fig. 3

It may be noted that crop yields in West Pakistan are far below those attained in other parts of the world, notwithstanding the fact that the overall environment of climate and soils permit a much higher level of agricultural produce. The low crop yields are attributed to a number of factors, one being defficient water application. A low crop yields and a rapidly growing population with the menace of waterlogging and salinity, has reached proportion which today threatens the very existence of the country and the survival of its people.

WATER-LOGGING AND SALINITY PROBLEM

The situation of ground watertable which existed before the introduction of weir controlled irrigation is shown in Fig. I. As soon as water was brought from the rivers by the large new irrigation systems, the dynamic equilibrium between ground water recharge and discharge was destroyed. The deep percolation of seepage from canals and from water applied to the lands for irrigation formed a new increment of recharge which added to the normal recharge from the rivers and precipitation, and was greater than the rate at which water could be discharged from the aquifer. As a result, watertables have risen ever since the barrage controlled irrigation systems were put in operation.

As a consequence, as early as the late 1930's and 1940's, watertable had risen over much of the irrigated areas in both zones to within 10 to 15 feet of the ground surface, as shown in Figures 2 and 3.

As the watertable continued to rise, more and more lands became adversely affected. Essentially all of the water applied was transpired by the crops leaving very little water to pass below the zone of the crop roots, with the result that most of the salts contained in the irrigation water remained in the uppermost soil strata. The canal seepage continued and maintained the water table at dangerously high levels, even though the inadequate field applications contributed little to the rise. Occasionally monsoon rains and overland floods provided sufficient excess water to leach some of the accumulated salts down-ward but, with waterlogging, effective drainage was prevented. Thus, while salinity was not a major problem when water tables were low, it is an immediate consequence of waterlogging of the lands.

Flood problems likewise have been aggravated with the rising of the water-table. When the water-table was many feet below the land surface, a part of the storm run off and overflowing river floods percolated down-ward, thereby reducing the quantity that had to be removed by overland run off or by drainage ditches.

An idea of the severity and extent of waterlogging and salinity can be gained from the results of a comprehensive survey of soils and land use carried out in 1953-54 under the auspices of the Colombo Plan Administration. Table 1 shows the results of that survey. It may be noted that at that time more than 11 million were poorly drained or waterlogged. Some 16 million acres were affected by salinity, about 5 million acres of which were severely salinized and with patches of salt being evident on the remainder. The rate of land deterioration is known to have increased annually with tne result that the present situation has reached even more serious proportions than existed in 1954. The present extent of salinity is shown in Fig 4.

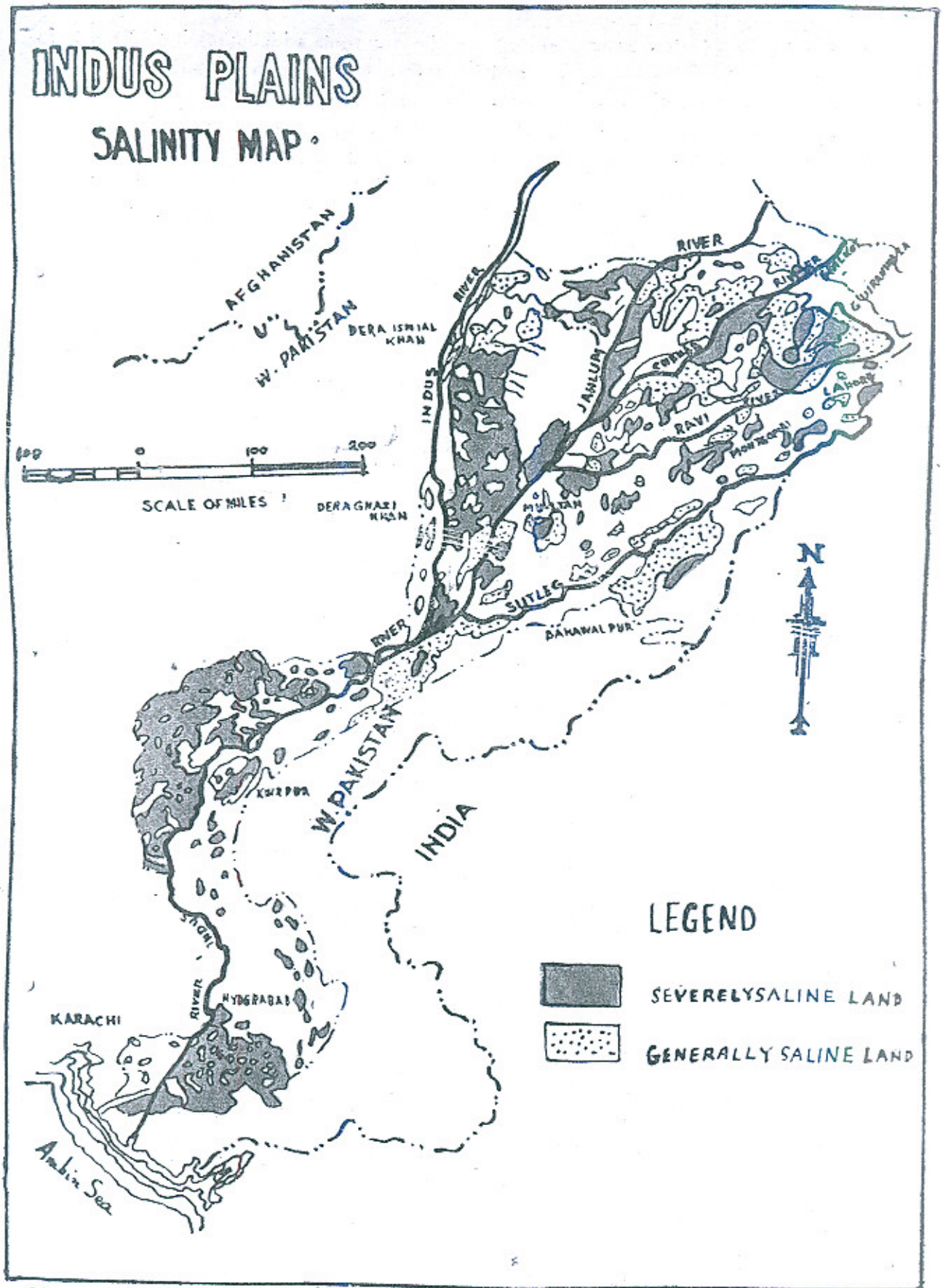

INDUS PLAINS
SALINITY MAP
AFGHANISTAN
W. PAKISTAN
DERA ISMAIL KHAN
INDUS RIVER
JHELUM RIVER
CHENAB RIVER
RAVI RIVER
SUTLEJ RIVER
BAHAWALPUR
MULTAN
LAHORE
GUJRANWALA
DERA GHAZI KHAN
SCALE OF MILES
N
W. PAKISTAN
INDIA
KARACHI
HYDERABAD
Arabian Sea
LEGEND
SEVERELY SALINE LAND
GENERALLY SALINE LAND

Fig. 4

TABLE NO. 1

EXTENT OF WATERLOGGING AND SALINITY

(Abstract from Colombo Plan Survey of "Land Forms, Soils and Land Use of the Indus Plains")

	Predominantly Poorly Drained or Waterlogged (1,000 acres)	Predominantly Severely Saline (1,000 acres)	Area in which Saline Patches are common (1,000 acres)
NORTHERN ZONE. (Excluding Right Bank Indus and former N.W.F. Province)			
Sind Sagar Doab	510	180	450
Chaj Doab	650	170	570
Rechna Doab	2,710	1,140	2,300
Bari Doab	40	100	590
Bahawalpur Plain	500	...	160
Sub-total ...	4,410	1,590	4,070
SOUTHERN ZONE			
Indus Corridor	50	100	1,880
Upper Sind Plain	3,290	1,090	2,160
Central Sind Plain	1,030	220	1,910
Lower Sind Plain	1,850	990	860
Indus Delta	680	830	270
Sub-total ...	6,900	3,230	7,080
TOTAL ...	11,310	4,820	11,150

Hundreds of thousands acres of once productive crop-lands have gone out of production, and still larger areas have been adversely affected because of high watertable and salinity. Nearly 100,000 acres of irrigated lands are being severely affected or going out of cultivation each year because of waterlogging and increase in salinity. Other areas measured in million of acres have watertables lying within a few feet below the ground surface. These facts make the reclamation of presently irrigated lands, the most important task confronting West Pakistan today.

THE PROGRAMME

The reclamation and drainage programme for the region is separated into Northern zone and Southern zone. In the former, ten distinct projects are proposed whereas for the later, projects are divided into six sub-divisions.

For Northern zone, CENTRAL RECHNA, salinity control and reclamation Project No. 1 is ready for operation. The Project embodies 1800 tube wells in a gross commanded area of 1.2 million acres. Average pumping of ground water will be 1.5 MAF per year.

CHAJ DOAB

Salinity Control and Reclamation Project No. 2, includes all of Chaj Doab. This project has been planned in detail and presently is ready for the construction phase. The gross commanded area within the Project is 2.3 million acres, and construction of 3,300 tube wells is planned. Average pumpage of ground water will be 2.0 MAF per year.

LOWER THAL

This project is situated in the lower part of Sind Sagar (Thal) Doab ; it includes lands irrigated from Muzaffargarh canal, which diverts water from the Indus at Taunsa Barrage, and from the Rangpur Canal, which diverts water from the Chenab at Trimmu. The gross commanded area within both the canal systems is 1.0 million acres. In order to provide the quantities of water necessary for the perennial irrigation and to control waterlogging and salinity, a total of 2,400 tubewells will be required producing more than 1.7 MAF per year. This project will need about 210 miles of flood drainage channels also.

UPPER RECHNA

This project is situated in the upper part of Rechna Doab. The project area is served by the Upper Chenab Canal, which is mostly a non-perennial system, and embraces all presently irrigated lands in Rechna Doab north east of Project No. 1. The gross commanded area within the project is 1.5 million acres. About 1,750 tubewells will be required, which will be operated to produce an average of 1.3 MAF per year. About 330 miles of flood drainage channels will be required within the project area. In addition, this project includes construction of about 190 miles of flood drainage channels in the Project No. 1 area, making a total construction requirement of 520 miles.

LOWER RECHNA

This project is located in the lower part of Rechna Doab and includes lands served by the Lower Chenab Canal and a portion of lands served by the Haveli canal. The gross commanded area within this project will be 2.6 million acres. Perennial canal supplies are available and the additional water requirement to control water-logging and salinity will be provided by 2,580 irrigation tubewells and 415 drainage tubewells. An average of 1.9 MAF per year will be pumped for irrigation supplies and an additional 1.2 MAF will be pumped for drainage purposes. Approximately 900 miles of surface drainage channel will also be required.

SOUTHERN BARI

This project embodies the southern part of Bari Doab, and includes land served by the Dipalpur and Pakpatan Canal Systems. The gross commanded area within these systems, is 2.4 million acres. The authorized full supply in Kharif is almost four times that of Rabi. For proper perennial irrigation a total of 2,800 tubewells will be required. The average pumpage will not exceed 2.0 MAF per year. Approximately 720 miles of surface flood drainage channels will be required.

UPPER THAL

This project is situated in the northern part of Sind Sagar (Thal) Doab and embraces lands served by the Upper Thal Canal system. The gross commanded area within this system is 2.0 million acres. Perennial canal supplies are available but because of poor quality ground water in part of the area, canal supplies will be transferred from other parts of the system to this poor quality area. The additional water required will be supplied by 3,630 irrigation tubewells in the good quality ground water areas, and will provide

average of 2.6 MAF per year. At least 353 drainage wells will be required to pump 0.6 MAF per year of bad quality water. Approximately 370 miles of surface flood drainage channels will also be required.

BAHAWALPUR

This project is situated in the northern portion of the former Bahawalpur State. This project includes parts of the lands served by the Eastern Sadiqia, Fordwah, Bahawal, Qaim, Panjnad and Abbasia Canals. The gross commanded area, within the systems is 4 0 million acres. The ground water is of fair to good quality in the zone between the main canals and Sutlej River. At greater distances from the river, the quality of ground water deteriorates, the southern limits of the area merging into a vast sump of depression of virtually stagnant groundwater of very poor quality. A total of 3,500 tubewells are planned for this area which will pump about 2.5 MAF of ground water annually. Approximately 800 miles of surface flood drainage channels will be an additional requirement.

NORTHERN BARI

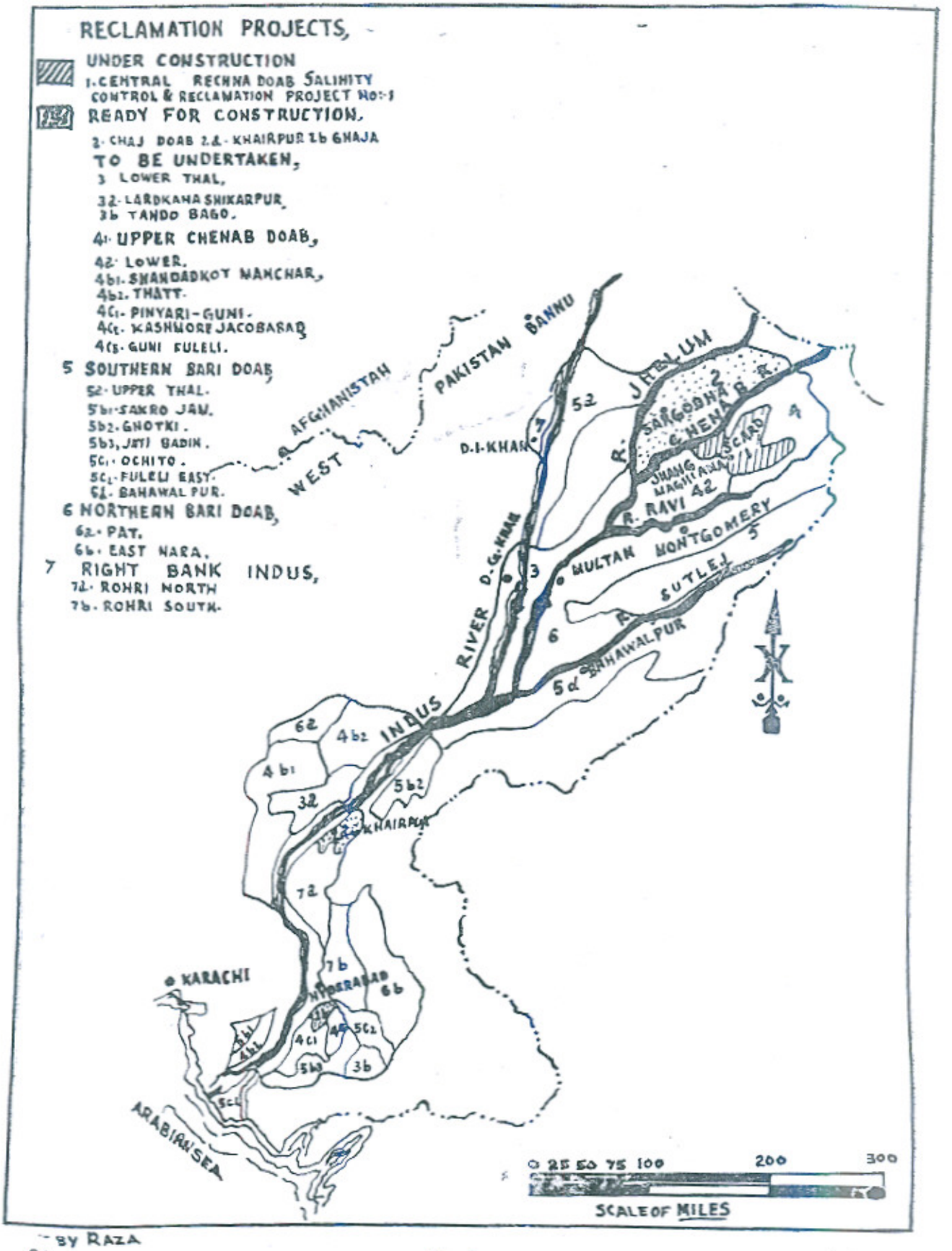
This project embraces the northern parts of Bari Doab, and includes lands served by the Sidhnai, Mailsi, Lower Bari Doab, and Central Bari Doab Canal System. The gross commanded area within these systems is 4.4 million acres. Approximately 45 percent of the project area is under-lain by poor quality ground water which will need 648 drainage wells pumping out 1.9 MAF per year. The remainder of the project area will need more tubewells so that a total of 5,075 tubewells will be required and average pumpage will amount to 3.7 MAF per year. Approximately 1,830 miles of surface flood water drains will also be required.

RIGHT BANK OF INDUS

This project embodies three widely separated areas, D. G. Khan, D. I. Khan, and Peshawar Vale. Very little data has been collected for these areas and, therefore, even tentative planning is difficult. The gross commanded area within the project area is 1.0 million acres. It is estimated that in order to supplement existing canal supplies and to control waterlogging and salinity, a total of 2,425 tubewells will be required. The average annual pumpage will be approximately 1.6 MAF per year. Approximately 190 miles of surface flood drainage channels will be required.

SOUTHERN ZONE

The Southern Zone falls into six separate drainage regions. In the northern portion, the right bank areas of the Sukkur and Gudu barrages form one large unit of 4.15 million acres draining west and south into the Manchar Lake. On the left bank of the Gudu Barrage, the area commanded will be 85,000 acres and its drainage is southward towards the fringe of the Thar Desert. The left bank of the Sukkur barrage command falls into three separate drainage areas ; the main Khairpur area of 5,70,000 acres falling towards the south-east ; the central 1.85 million acres which may be drained to the Indus some 20 miles north of Hyderabad and the southern Rohri and Nara canal areas of 3.46 million acres which drain to the south-east. The sixth drainage region is the Ghulam Mohammad barrage command of


RECLAMATION PROJECTS,
UNDER CONSTRUCTION
1. CENTRAL RECHNA DOAB SALINITY CONTROL & RECLAMATION PROJECT No:-1
READY FOR CONSTRUCTION.
2. CHAJ DOAB 2a. KHAIRPUR 2b GHAJA
TO BE UNDERTAKEN,
3 LOWER THAL,
3a. LARKANA SHIKARPUR,
3b TANDO BAGO.
4. UPPER CHENAB DOAB,
4a. LOWER.
4b1. SHAHDADKOT MANCHAR,
4b2. THATT.
4c1. PINYARI-GUNI.
4c2. KASHMORE JACOBABAD
4c3. GUNI FULELI.
5 SOUTHERN BARI DOAB,
5a. UPPER THAL.
5b1. SAKRO JAM.
5b2. GHOTKI.
5b3, JATI BADIN.
5c1. OCHITO.
5c2. FULELI EAST.
5d. BAHAWAL PUR.
6 NORTHERN BARI DOAB,
6a. PAT.
6b. EAST NARA.
7 RIGHT BANK INDUS,
7a. ROHRI NORTH
7b. ROHRI SOUTH.
AFGHANISTAN
PAKISTAN
BANNU
WEST
D.I.KHAN
JHELUM
SARGODHA
CHENAB R.
SCARD
JHANG MAGHIANA
R. RAVI
MONTGOMERY
MULTAN
SUTLEJ
BAHAWALPUR
RIVER D.G.KHAN
INDUS
KHAIRPUR
KARACHI
HYDERABAD
ARABIAN SEA
0 25 50 75 100 200 300
SCALE OF MILES

by RAZA

Fig. 5

2.37 million acres draining directly to the sea and the Rann of Cutch. Thus the gross area under consideration in all the regions is about 13.35 million acres.

The drainage systems proposed in each of the drainage areas are described below.

Sukkur and Gudu Barrage, Right Bank Areas :—

Four drainage projects for this area are proposed. These are the Larkana-Shikarpur (5,04,000 acres) Shahdad kot-Mancher (1.92 million acres) ; Kashmore-Jacobabad (1.48 Million acres) ; and the Pat Extension (25,000 acres).

In all these schemes a general system of deep surface water drains out-falling to the Indus *via* the Manchar Lake is proposed. All these deep drains will require pumping into the surface drain system.

SUKKUR LEFT BANK AREA

The area on the left bank of SUKKUR BARRAGE has the following irrigation Systems :—

(a) Khairpur Command

This area has been investigated in detail. Alternatives have been examined for drainge by tubewells and by open drains.

(b) Upper Rohri Command :—

This area lies immediately to the south of the Khairpur command on the left bank of Sukkur Barrage. At present it is being assumed that no works need be started within the next ten years.

(c) Southern Rohri and Nara Canal Commads :—

This area also contains regions requiring drainage.

The Ghulam Mohammad Barrage Area :

This area has been the subject of investigations which are now being completed. Except for isolated patches, the soils are generally very saline ; the sub-soil water is also highly saline but it is at present seldom above eight feet below ground level. Rice is the main crop in the non-perennial areas which account for 74 per cent of the gross commanded area.

Nine separate drainage projects are included in the barrage area, namely : Gaja (127, 000 acres) on which construction work has already started ; Tando Bago (341,000 acres) ; Thatta (1188,000 acres) ; Pinyari-Guni (652,000 acres) ; Guni-Fuleli (332,000 acres) ; Sakro-Jam (206,000 acres) ; Jati-Badin (337,000 acres) ; Ochito (62,000 acres) and Fuleli East (320,000 acres).

The foregoing drainage projects in the Southern Zone will benefit a total area of 9.5 million acres.

Priorities of Reclamation :

For the purpose of this special study each of the foregoing projects has been assigned a tentative order of priority of construction. While reclamation is urgently required in most of the area, the sequence in which the various projects can be undertaken is largely dictated by the status of the overall area investigations and the programme for the more detailed field investigations. Taking into account these factors, together with the degree of severity of water-logging and salinity of the several areas, the time required to implement and complete the reclamation work in those areas, and other related factors, a priority has been established for each project and subunits

thereof. Figure 5 portrays in graphic form, a suggested sequence of undertaking the reclamation works in each area to complete the entire programme within a period of ten years. The numbers assigned to each project, (Figure 5) represent the relative priority of construction to be adopted.

COST ESTIMATES OF THE PROJECTS

Preliminary estimates of cost have been prepared for each of the projects described in the previous section. On the basis of these estimates, the capital cost of the reclamation programme will be of the order of 3,400 million Rupees. Of this total 2,200 million Rupees represent the cost of reclamation projects in the Northern Zone and 1,200 million Rupees the cost of reclamation works in the Southern Zone. Table No. 2 shows a summary of the estimated cost of the various projects in each of the two zones. Tables No. 3 A and 3 B show, for the Northern and Southern Zones respectively, summaries of the principal physical works embodied in each project, the areas benefitted and their cost, the expenditure is separated into foreign and local currencies.

The foregoing estimates represent the cost of construction of the reclamation works including the cost of investigations, planning, engineering, land and interest during the construction period. The estimates do not include, however, the cost of the electrical power distribution or the generation necessary for the supply of power to the tube-wells and pumps of the drainage system, this cost is included in the annual cost of operation of the reclamation works.

The power requirements for the entire programme when completed will be of the order of 800,000 kilowatts measured at the point of use. The requirements for electric energy will average some 2,100 million kilowatt hours annually.

The capital cost of the power supply facilities for the reclamation programme will amount to 2,500 million Rupees which, with the expenditures for reclamation works, will increase the total cost of the programme to Rs. 5,900 million.

ANNUAL COST OF THE PROGRAMME

Estimates of the annual cost of the various reclamation works have been prepared. These have been arrived at on the basis of a number of assumptions which are that :—

1. The tubewells, pumping plants, and their corollary works will have a useful life of at least 40 years, and their mechanical electrical equipment, consisting of pumps, motors and motor controls, will have a useful life of at least 20 years.
2. The various drainage channels and appurtenant works, with proper maintenance, will have an indefinite life.
3. A fair value of fixed charges on the investment in tube-well features during the first 20 years period is obtained by assuming that the capital cost of such works is repaid in 20 years with interest at 4 percent, and that a sinking fund reserve, (with interest at 4 per cent), is established to cover the cost of sinking fund reserved for the replacement of all of such features including their pumping equipment by the end of that period.

TABLE No. 3-A

Proposed number of T/w. and Drains for Reclamation with Cost estimates for Northern Region.

S. No.	NAME OF PROJECT	Gross commanded area M. Ac.	Culturable commanded area M. Ac.	Cost of Tube-Wells for Irrigation & Drainage					Tube-Well for Drainage					Surface Flood Water Drains				
				No. of T/W	Water to be pumped MAF/year	Foreign Exchange M. Rs.	Local Currency M. Rs.	Total cost M. Rs.	No. of T/W	Water to be pumped MAF/year	Foreign Exchange M. Rs.	Local Currency M. Rs.	Total Cost M. Rs.	Miles	Foreign Exchange M. Rs.	Local Currency M. Rs.	T. C. in M. Rs.	G. Total M. Rs.
1.	Central Rechna ...	1.2	1.1	1795	1.5	4.26	4.9	9.21	—	—	—	—	—	—	—	—	—	9.12
2.	Chaj	2.3	2.1	3250	0.9	8.14	4.67	12.8	61	—	0.29	0.11	0.40	460	0.38	4.81	5.19	18.4
3.	Lower Thal	1.0	0.9	2400	1.7	7.90	3.92	11.82	—	—	—	—	—	210	0.19	4.24	2.43	14.25
4.	Upper Rechna	1.5	1.4	1755	1.3	6.56	3.16	9.72	—	—	—	—	—	520	0.48	5.55	6.04	15.76
5.	Lower Rechna	2.6	2.0	2580	1.9	8.47	4.22	12.69	415	1.5	1.91	0.75	2.66	903	0.76	9.62	0.38	25.73
6.	Southern Bari	2.4	2.3	2800	2.0	9.19	4.57	13.76	—	—	—	—	—	720	0.62	7.70	8.32	22.08
7.	Upper Thal	2.0	1.6	3630	2.6	11.9	5.93	17.88	353	0.6	1.48	0.62	2.10	370	0 33	3.96	4.29	24.27
8.	Bahawalpur	4.0	3.5	1505	2.5	4.95	2.46	7.41	2000	—	6.57	3.27	9.84	800	0.71	8.55	9.26	26.51
9.	Northern Bari	4.4	3.7	5075	3.7	16.66	9.29	24.95	648	1.9	3.00	1.17	4.17	1830	1.57	19.56	21.13	50.25
10.	Right Bank Indus ...	1.0	0.9	2425	1.6	8.24	4.13	12.37	—	—	—	—	—	190	0.14	2.03	2.17	14.54
	TOTAL ...	22.4	19.5	27216	—	86.46	46.30	131.89	3477	—	13.25	5.92	19.17	5990	5.18	64.03	69.21	210.55

TABLE No. 3(B)

Areas, works and costs of drainage and reclamation

OF SOUTHERN ZONE

Project & Priority No.	NAME OF PROJECT	Gross Commanded area 1000's ac	Culturable Commanded Area 1000's ac	METHOD OF DRAINAGE				Foreign Exchange M. Rs.	Local Currency M. Rs.	Total Cost in Equivalent M. Rs.
				Cost of open Drains.			Tubewell			
				Deep Drains 1000's GCA ac	Recl. Drains 1000's GCA ac	Surface Drains 1000's GCA ac	T/W Drainage 1000's GCA ac			
2a.	Khairpur	565	525	219	—	—	354	3.58	4.40	7.98
2b.	Gaja	127	115	127	—	—	—	1.36	2.08	3.44
3a.	Larkana-Shikarpur ...	504	442	—	75	429	—	0.91	1.50	2.41
3b.	Tando-Bago	341	314	341	—	—	—	3.50	5.61	9.11
4b. 1	Shahdadkot-Mancher ...	1,915	1,613	116	347	1,452	—	8.00	15.10	23.10
4b. 2	Thatta	118	103	118	—	—	—	1.21	1.87	3.08
4c. 1	Pinyari-Guni	652	600	—	253	399	—	1.56	2.72	4.28
4c. 2	Kashmore-Jacobabad ...	1,482	1,363	—	238	1,244	—	2.74	4.76	7.50
4c. 3	Guni-Fuleli	332	305	—	165	167	—	0.82	1.68	2.50
5b. 1	Sakro-Jem	206	190	—	63	143	—	0.38	0.62	1.00
5b. 2	Ghotki	947	788	—	—	—	947	1.91	1.05	2.96
5b. 3	Jati Badin	337	310	—	159	178	—	0.94	1.50	2.44
5c. 1	Ochito	62	57	62	—	—	—	0.57	0.84	1.41
5c. 2	Fuleli East	320	294	—	160	160	—	0.80	1.78	2.58
6a.	Pet	250	225	—	125	125	—	0.80	1.25	2.05
6b.	East Nara	2,457	2,210	1,000	1,457	—	—	18.10	26.70	44.80
	TOTAL ...	10,615	9,454	1,983	3,042	4,297	1,301	47.18	73.46	120.64

4. A fair value of annual fixed charges on the investment in surface drainage works is represented by assuming that the capital cost of such works is repaid in a period of 40 years with interest at 4 per cent.

The cost of energy required for pumping has been based on energy charge of Rs. 0.065 per kilowatt hour. The assumption has been made in this case that this rate will, when new hydroelectric plants come into operation, produce sufficient revenue to cover all costs of supplying electric energy to the pumps including the cost of the generation, transmission and distribution of the energy consumed.

In accord with the foregoing criteria, the estimated annual cost of the reclamation works will be of the order of the values indicated in Table No. 4. It may be noted that the total annual cost of all the works in both zones is about 400 million rupees. This cost is equivalent to an overall average cost of approximately *14 rupees per year per acre benefited*. By comparing the data shown in Table No. 4 with the capital cost of the reclamation programme shown in Table No. 2, it may be noted that annual costs for the individual projects vary from about 9 to 15 percent of the capital investment in reclamation works.

The report gives justification of the programme and the management. There are a number of useful appendices attached.

It is hoped that some of the appendices will be reproduced in the next issue of the journal.

TABLE No. 4

ANNUAL MONETARY REQUIREMENTS

(Millions of Rupees)

Central Rechna years	1	2	3	4	5	6	7	8	9	10	TOTAL
FOREIGN EXCHANGE											
Northern Zone	42.6	44.0	119.7	112.8	115.7	115.8	119.3	93.9	93.8	95.0	94.9	1,004,9
Southern Zone	...	24.7	59.2	47.5	42.9	47.4	58.3	56.1	45.3	45.2	45.2	471.8
Sub-Total	42.6	68.7	178.9	160.3	158.6	163.2	177.6	150.0	139.1	140.2	140.1	1,476.7
LOCAL CURRENCY											
Northern Zone	49.5	48.0	122.3	123.0	124.6	174.6	123.5	120.1	120.2	103.3	103.4	1,113.0
Southern Zone	...	32.4	92.6	83.1	75.5	72 7	92.0	86.1	66.8	66.7	66.7	734.6
Sub-Total	49 5	80.4	214.9	206.1	200.1	197.3	215.5	206.2	187.0	170.0	170.1	1,847.6
TOTAL											
Northern Zone	92.1	92.0	242.0	235.8	240.3	240.4	242.8	214.0	214.0	198.3	198.3	2,117.9
Southern Zone	...	57.1	151.8	130.6	118.4	120.1	150.3	142.2	112.1	111.9	111.9	1,206.4
Grand Total	92.1	149.1	393.8	366.4	358.7	360.5	393.1	356.2	326.1	310.2	310.2	3,324.3

PROCEEDINGS
OF
WATER RESOURCES CONFERENCE
INSTITUTE OF ENGINEERS, DACCA.

The Institute of Engineers, Dacca, planned a Water Resources Conference in Dacca from 20 to 23, October, 1961. It was sponsored jointly by the Water & Power Development Authority of East Pakistan and the SEATO Graduate School of Engineering. Dr. Einstein, Dr. Ippen and Mr. J. B. Smith took part in the three days proceedings of the Conference. They arrived in East Pakistan on October 16, They visited the Hardinge Bridge, the Ganges-Kobadak Project and Gumti Embankments. They also saw the mighty Meghna. Before coming to East Pakistan after spending a few days in India, they had visited Lahore.

PAPERS DISCUSSED

The papers presented and discussed at the conference were on Sediment Control, Hydraulics and Fluid Mechanics. In all, eight papers were submitted. The procedure adopted was that after the introduction of the paper by the author, it was thoroughly discussed in all its aspects. The contributions of Dr. Einstein, Ippen, Khan Azam, Blommestein, Rahman, Jabbar Kibria, Farrant, Murad and a number of other Engineers who took part, brought out many new and informative points.

Below we give a brief summary of each paper.

PAPER 1

"Sediment Control with reference to intake Channel for Ganges, Kobadak pumping stations, Bheramara.

The author, Mr. F. A. Siddiqui, stated that a channel leading to the pumping house is located one mile down-stream of the Hardinge Bridge. This is to be kept deep and free of silt to ensure continuous supply of water. It is proposed to keep the channel free by a system of deflectors. Several systems of deflectors to control the silt were suggested and the floating type was adopted due to its flexibility of operation, easy supervision and maintenance. The disadvantage is the cumbersome shore installations which require careful manipulation.

PAPER 2

Intake works for Diversion into old Brahmaputra.

This paper was introduced by Mr. K. J. Murad.

It dealt with the problem of locating and designing intake works so as to ensure continuous supply of water, safety of works and exclusion of excessive silt, etc.

The old Brahmaputra Project envisaged diversion of 72,000 cu. ft. per sec. of water from the main river into its old channel flowing in a south easternly direction through the district of Mymensingh. The

old course was abandoned by the river in 1787-1830. The river is 1480 miles long and drains an area of 207,000 sq. miles with an average peak annual discharge of 2300 million cusecs. It has a maximum discharge of 5 million cubic feet per. second. The lowest stage is equal to 90,000 cubic feet, per second. During floods it possesses as high silt concentration as 2500 ppm. and during winter silt charge is 400 ppm.

The entrance to intake channel is located on the outside curve of the main channel with intake structure about 5 miles down-stream, comprising a diversion regulator with ten 40'x40' double leaf gates, and a scouring sluice structure with eleven 40'x23' stoney gates. A system of three levees is designed to create a huge desilting basin. The double leaf gates on diversin regulator will permit flexibility of operation so to draw off from top layers which have less concentrations. The flow of scouring sluice is depressed 7.5 feet below the crest of regulator to keep heavier bed load moving through. The intake channel has been designed according to both Lane's tractive force theory and Lacey's regime equations. Silting is expected in intake channel. However, the diversion channel is expected to be relatively free from silt problems.

PAPER 3

Protection against erosion by Ganges river at Rajshahi.

The paper was introduced by M. A. Razzak. He discussed the safety of an embankment located near the Rajshahi town, which is threatend to be eroded away by the shifting course of an alluvial river of as big a magnitude as the Ganges.

The town of Rajshahi, with an average elevation of 58.00 (PWD), is protected by means of an average elevation of 60.45 (PWD) and peak elevation of 64.30 (PWD). No data on the shifting of the river course is available. However, in the year 1960, the main channel came near the embankment, thus threatening to erode it. A temporary measure of protection is being taken by providing a 6 inches thick brick mattress, enclosed in hexagonal plane wire netting of 4 inches mesh and 12 s.w.g. The mattress extends 2 feet below low water elevation of 30 and 3 feet above the highest recorded elevation of 64.30.

The author invited suggestions to ensure permanency of the proposed measure.

PAPER 4

Gumti Embankment

Mr. S. N. HSU pointed out that the Gumti river rises in India. It carries an estimated maximum flood flow of over one lakh cusecs. The channel on the Pakistan side is flat and carries only a flow of 20 to 30 thousand cusecs.

A flood problem crops up every year, mostly on the north side of the river. The dikes are often breached here and there, and the river floods the country side. On the northern side, the flood water inundates the country side, flows to the Meghna river, and to the sea. On the southern side of the river, there are however a few river channels which can be utilised to carry the flood flows to the sea.

In order to deal with the problem of dike breaches a couple of regulators are now under design for the coastal area. One

is for Noakhali and the other for little Feni.

During discussion, a dozen persons offered their comments.

PAPER 5

Design of Earthen Canals

Mr. M. A. Khan discussed the procedures of design of earthen channels followed in East Pakistan. The section of a channel is designed by Manning formula in which the velocities are kept within 0.8 to 1.2 times the critical velocity as obtained by Kennedy formula, although the Kennedy equation, $Vo = cd^m$, has no justification for its use in East Pakistan. Similarly it is difficult to use the Lacey formula also, as 'f' in the equation

$f = 1.76\sqrt{m}$ is 0.55 for m value of 0.1 mm. Thus f and Q can only be related and used for channels with high discharges. The author advises the use of the USSR formula

$$G = 700 \frac{Vm}{Vo} \sqrt{\frac{Rm\ S\ Vm}{W}}$$

where G = silt carrying capacity.

Vm = velocity in metres per sec.

Rm = Hydraulic Radius in meters per sec.

W = fall velocity of particles, mm. per sec.

Wo = W for greater than 2.0 mm. per sec.

The author suggests the use of the Lane tractive formula, although no work has been done in East Pakistan to determine the critical tractive force.

This paper also led to a lively discussion.

PAPER 6

Stable Channel Design and Sediment Control in Kushtia Irrigation Project.

This paper was presented by H. Hekkel.

Canals of the Kushtia unit of the Ganges - Kobadak Project, varying in discharges from 1300 cu. ft. to 5 cu. ft, are designed by the Manning formula with the conditions that for main channels, the slope is kept 0.23 ft. per mile whereas for secondary channels it is 0.50 ft. per mile. For channels with bed width greater than 10 ft. 'N' is kept equal to 0.022 while for channels with bed width equal to or less than 7.5 ft. 'N' is taken as 0.21. The velocity in the main channel is maintained at1.85. or 1.62 ft. per sec., 1.5 to 0.81 ft. per sec. in secondaries and 1.1 to 0.67 ft. per second in tertiaries. During low supplies the flow may decrease upto 45 percent. According to Lane's tractive force theory the values work out 0.033, 0.032 and 0.019 lbs/per sq. ft. for main, secondary and tertiary canals against permissible value of 0.5 lbs. per sq. ft.

The author next discusses silting problem in channels bringing in all the latest conceptions of Blench, Albertson, Brown and DuBois. It is stated that all sediment load, except that smaller than 0.002 mm, will settle in the canals. This is a natural result of severe limitations of slope. This sedimentation will amount to 450,000 tons per year.

To remove sediment that cannot be transported, a desilting basin 3,300 ft. long, 1,500 ft. wide and 10 ft. deep with a velocity of 0.25 ft/sec. is designed. All particles above 5 microns and mostly between 5 and 2 microns will settle and are estimated amount to 30 million cubic feet in 4 years, which can be dredged at a cost of Rs. 3 lacs per year.

PAPER 7

Method of Estimating or Measuring Bed load in Running Channels.

No paper was presented on this subject. The Chairman in his opening

remarks said that reliable instruments and appliances are badly needed to collect the basic hydraulic information on modern technical lines. With this object in view Wapda has recently established its Hydrology Directorate. He then invited Dr. Ippen, Dr. Einstein and other engineers from abroad to enlighten the house particularly on the appliances that might have been developed in their countries for collection of bed load in running channels.

PAPER 8

Hardinge Bridge on the Lower Ganges at Paksey

The author, Mr. A. Choudhary, gives a brief account of the history of the Hardinge Bridge at Paksey, a vital and the only link in the railroad communications between regions to the north and south of the Ganges. The bridge, constructed during 1909-1915, consists of 15 main spans of 360 feet and 3 land spans, 75 feet each. The foundation rests on 63'x37' walls, which have been sunk quite deep, one being 160 feet below low water level.

The Ganges is about 1,553 miles long with a catchment area of 391,000 square miles. The highest and the lowest recorded water levels are 47.85 (24-8-1910) and 18.90 (22.8.1918). The maximum and minimum discharges are 2,085,524 cfs. and 41,421 cfs. The extent of meandering can be judged by the fact that the length of the level between Pabna and Sarda has varied from 72 miles to 47 miles from 1780 to 1960. fifty to sixty feet of bank cuts per day and 120 to 150 feet of scour depths have been observed due to swirl or whirlpools. There are no permanent banks.

The design of guide bank aprons has been done on the basis of Spring's methods. The thickness necessary is from 1.5 T (5.25 ft) at the heel to 1.5 T 0.75 T (7.x75 feet) at the toe. Stone pitching round the piers to prevent scour does not solve the problem because the current cuts the sand beneath it. The danger scour does not solve the problem because the current cuts the sand beneath it. The danger scour level is 71.00 feet. Constant vigilance has to be kept and stones and boulders have to be dumped regularly.

A SYMPOSIUM

ON

SEDIMENTATION PROBLEMS ARISING FROM INDUS BASIN WORKS

The Executive Committee of West Pakistan Engineering Congress is planning to hold a symposium on the sedimentation problems arising from Indus Bnsia Works in its next annual meeting to be held in April, 1962. So far the response from those who have worked long on the problem is very encouraging. Eleven papers have already been received. These are being printed and will shortly be sent to the members and those interested in the development of Engineering in this country. Below we give brief synopses of the eleven papers received so far.

1. THE SEDIMENTATION OF MANGLA RESERVOIR

by

BINNIE DEACON AND GOURLEY,
Chartered Civil Engineer, Westminster, London
and
Consultant, Mangla Dam Project.

The authors have discussed sedimentation of the Mangla Reservoir. They have estimated the mean annual sediment load of the river at the site, observed since 1954. The sediment yield of the whole catchment is high in comparison with other major rivers of the world. In assessing the life of the multipurpose Mangla reservoir, it was found that almost all the incoming sediment would be trapped and that negligible comparison of the deposited sediment would occur. Measures suggested to reduce sediment inflow are to pass the incoming sediment through the reservoir and the watershed management. It is stated that while the former is unlikely to be successful there is a possibility of partial success of the latter.

Future reservoir surveys of the deposited sediment are recommended.

2. THE SEDIMENT PROBLEM ON THE INDUS AT TARBELA

by

JOHN B. DRISKO
Associate, Tippets-Abbett-McCarthy-Stratton.

Deposits of sediment in a reservoir on the Indus at Tarbela would be very large because the annual volume of inflow would be several times the capacity of the reservoir.

The Indus at Tarbela drains an area of 70,000 sq. miles, bringing an annual load of 36 million tons It is expected that all suspended sediment would be deposited in the 45 miles long storage having a maximum depth of 400 ft.

Estimate of the probable time required to deplete the reservoir to the residual 1 MAF capacity ranges from 35 or 40 up to 55 or 60 years for the three sizes of the gross capacity equal to 6.0, 7.8 and 9.8 MAF respectively.

Down-stream of the reservoir the river would have a tendency to degrade, and alluvial deposits of fine material along the bank would probably be attacked. Means

to reduce the rate of depletion of the storage have not been studied in detail.

Possibilities of off channel storage exist at Tarbela and may ultimately provide a solution to the sediment problem of this site.

3. SILT TRAP EFFICIENCY OF RESERVOIR WITH SPECIAL REFERENCE TO TARBELA AND MANGLA DAMS

by

Dr. NAZIR AHMAD

Physicist, Irrigation Research Institute, West Pakistan, Lahore.

The Tarbela and Mangla Dams compare very well with the big dams of the world constructed on high sediment transporting rivers. It is presumed that their trap efficiency will be as high as that of the other dams of the world. The early sediment transport of the river separated into sand, silt and clay is given in the note together with life expectancy of the storages. A study of the temperature, sediment content, shape of the storage, inflowing water and the existence of low elevation conduits points to the possibility of the development of density currents in the Tarbela Dam storage and a certain portion of silt and clay being excluded as a result of high withdrawals from the conduits. As for the Mangla Dam the same conditions do not hold, primarily due to higher rise of temperature as a result of the existence of four prongs of the storage in Khad, Poonch, Kanshi and Jhelum rivers, withdrawal from which will have a disturbing effect on the density currents, so that silt exclusion through the five low level tunnels, each of 30 ft. diameter, will not be very effective.

REDUCTION OF MANGLA RESERVOIR SEDIMENTATION BY WATERSHED MANAGEMENT

by

JAMES C. RINGENOLDUS

Principal Hydrologic Engineer, Harza Engineering Company International, Lahore.

An extremely serious erosion problem exists in the catchment area of the Jhelum river above the Mangla Dam site. Agricultural and forest lands are being destroyed by erosion and the resulting sediment transported in the river system will rapidly deplete the water storage capacity of the Mangla Reservoir.

Certain areas within the Mangla catchment are subject to erosion rates far above the basin average. In most cases, these areas of severe erosion are areas where poor land management practices have caused a marked increase in erosion rates in the past century. It is physically possible to reduce erosion rates in these areas through proper land management practices and construction of erosion control works.

It is not possible to predict quantitatively the extent af sediment reduction which may be achieved. The benefits to the land as a result of a watershed management programme can, however, be predicted with reasonable accuracy. The general experience elsewhere with programmes of this type has been that about 90% of the benefit is to the land and agriculture and about 10% of the benefit is in reduction of downstream damages. The benefits estimated by Hunting Technical Services for the Mangla catchment are also in about the same proportion.

The cost benefit ratio of a watershed management programme was estimated

by Hunting to be about one-to-one. The irretrievable loss of land resources and of reservoir storage potential must be considered in addition to the strictly financial aspect of the proposed watershed management project.

5. SILT TRAPPING EFFICIENCY OF VEGETATIVE COVER IN THE CATCHMENT AREA

by

AMIR AHMAD KHAN

Chief Conservator of Forests, West Pakistan.

For a long time it has been recognized that plant cover exerts a considerable influence on the run-off of precipitation and tends to reduce the erosion of the soil on sloping lands. The canopy above ground and the surface litter accumulation operate as barriers interposed between the atmosphere and the soil. They intercept precipitation and thus hamper the delivery of water to the soil. At the soil surface vegetation obstructs the overland flow of water which has picked up soil material. This is accomplished by stems and litter accumulations that form miniature anchored dams and diversion walls, and by roots decaying organic matter that mat the soil or bind it. Beneath the soil surface, to depths reached by roots, vegetation acts both directly and indirectly.

The use of vegetation for the control of erosion may be either a supplement to constructional methods or a self-sufficient procedure in suitable situations. It has distinct advantages. The first cost is low. Little or no maintenance is requiered. There is the possibility of realizing valuable by-products such as fuel, posts, timber, or landscape beauty. It is a constructive method, because the vegetation, once established, becomes more and more effective each year as it grows, as a means of controlling erosion.

6. SEDIMENT PROBLEMS IN THE INDUS BASIN PART II. SEDIMENTATION IN RIVER CHANNELS AND FLOODWAYS

by

S. S. KIRMANI

Director, Indus Basin Project, WAPDA, Lahore.

This is the second paper in the series on "The" Sediment problems in the Indus Basin. The first paper related to sediment problems in the mountain valleys of the Indus rivers with particular reference to the problems of sedimentation in reservoirs. The present paper deals with the sediment problems in river channels and floodways of the Indus rivers during their passage through the vast alluvial plains from the foot of the Himalayas to the Arabian Sea The third and last paper in the series will deal with the problems of sedimentation in irrigation canals and will be presented as a separate paper.

7. CHANGES IN RIVER REGIME AS A RESULT OF LINK CANAL

by

R. K. LEWIS, M.I.C.E.

Resident Chief Engineer, Coode & Partner, Consulting Engineers.

The essential function of a link canal is to transfer water from one source where an adequate supply is available to another where additional supplies are desired.

In order to maintain control of the quantity and quality of the waters so transferred, it is usual to provide head and tail regulators on the link canal. In itself, this has little effect on the regime of the rivers at the head or tail of the link ; but the controlling structures may have far-reaching effects.

8. SOME SALIENT FEATURES OF SILT EJECTOR IN A FLUVIAL CHANNEL BASED ON HYDRAULIC MODEL STUDIES.

by

MUSHTAQ AHMAD AND MUHAMMAD ALI,

Irrigation Research Institute, Lahore.

When canal withdrawls are heavy and surplus discharge in the river at the site of diversion headworks above requirements of the off-taking canal is reduced appreciably to flush the sediment back to the river, the exclusion of silt from offtaking canals becomes a very difficult problem. The Marala Ravi Link with a head discharge of 22,000 cs. was completed in 1956 and opened the same year for transfer of surplus supply from the Chenab to the Sutlej through Balloki Headworks on river Ravi. By the end of 1960, 252 million cft. of silt had deposited in its head with the result that the capacity of the link at designed full supply level was reduced almost to nil.

The Nara canal draws silt at its intake which is less than its transport capacity and it picks up silt in the reach, Sukkur to Jamrao head, thereby causing undesirable deposits in the Nara Canal system at and below Jamrao head. When the Upper Jhelum Canal will be fed by clear water from the Mangla Dam through the Bong Canal, it will scour and the hydraulic structures are likely to be damaged, if the canal is not regraded.

For satisfactory sand exclusion from the Chenab the methods employed include.

(*a*) Reducing the rate of sediment production in the watershed of a stream in head water mountain.

(*b*) Sand exclusion at the intakes of a canal, and

(*c*) Sand ejection after it has entered the canal.

The paper is based upon the latest results.

9. A REVIEW OF SEDIMENT PROBLEMS AND POSSIBLE SOLUTIONS

By

V.A. KOELZER AND MARCEL BITOUN

Associate Hydraulic Engineer, Harza Engineering Company, Chicago.

In this 37 page article the authors have presented a summary of the subject of sedimentation. Sources of sediment and fundamental laws of sediment transport are discussed. The various sediment problems that may arise are described. Methods of measuring and computing sediment loads are given. Possible solutions to the various problems of sedimentation are indicated.

10. THE PRESENT AND FUTURE OF SILT EXCLUDING DEVICES

By

MOHI-UD-DIN KHAN

Director, Design and Research West Pakistan, Lahore.

West Pakistan is fully utilizing all the flow supplies of the rivers Indus, Chenab, Ravi and Sutlej except in the flood months. The existing culturable commanded area in the Indus Basin is 33 million acres. Even in the existing irrigated area the yields of crops are far below the standards of modern agriculture. The major cause of low production is the insufficient quantity of irrigation water. The culturable commanded area under canals is less than 50% of the total culturable area in West Pakistan. The position is quite critical, as West Pakistan has to depend on storage dams, the existing method of diversion of water by barrages and canals no longer serving the purpose. The division of rivers has further accentuated this problem.

The usable flow with storage on the western rivers on Indus, Jhelum and Chenab is 110 million acre feet against the existing average withdrawal of about 71 million acre feet. Hard pressed for water, West Pakistan will have to go in for a storage which is both economical and capable of speedy completion. The author proposes Chashma Dam on the river Indus and deals with its silt excluding devices, operation, etc.

11. SAMPLING AND ANALYSIS TECHNIQUE FOR SUSPENDED SEDIMENT.

By
M. M. SADIQ
Executive Engineer, Wasid, Lahore.

With many storage projects coming up on the rivers of West Pakistan, the importance of sediment data becomes greater and greater. It is a well known fact that rivers in this country transport tremendous quantities of sediment every year, the major portions being borne in suspension. Eventually, when this sediment laden water is stored behind a dam an appreciable reduction in the capacity of the reservoir will occur every year due to the deposition of sediment. Therefore to plan and design a storage project economically, its productive life must be ascertained. One factor that determines the life of a reservoir is the annual sediment deposited in it. This shows the importance of the observation programme being conducted by Water and Soil Investigations Division of WAPDA in association with Harza Enginereing Co. International.

Several types of samplers used to obtain samples of water sediment mixture from a stream are described. The various methods of analysing the samples are explained.

Contd from page 55.

RUNCORN, S.K.
Methods and Techniques in Geophysics.
Interscience Publ. Inc., New York (U.S.A.), 1960.

GROUND WATER

PLOTNIKOV, N.A.
BOGOMOLOV, G.B.
Classification of Underground Water Resources and their Reflection on Maps.
Association Internationale d'Hydrologie Scientifique (France), 3-14 Sept. 1957.

KUDELIN, B.I.
The Principles of Regional Eastimation of Underground Water Natural Resources and the Water Balance Problem.
Association Internationale d'Hydrologie Scientifique, 3-14 Sept. 1957.

Proceedings

of

The Fourth International Congress

on

IRRIGATION AND DRAINAGE, MADRID, 1960.

The transactions of the fourth congress on Irrigation and Drainage held in Madrid 1960, have been distributed. The transactions are printed in six volumes, Vol. I which is still under preparation will contain the organizational data about participating countries ; Office Bearers of the International Commission on Irrigation and Drainage ; Extract from the constitution and origin ; Organization and activities ; Invitation by the Spainish National Committee ; Introduction ; Inaugural Session ; Official Banquet ; Closing Session ; Study Tours ; and Index to volumes I to VI.

We have put forth some information extracted from these volumes for the benefit of the readers of the Engineering News. The heading of the Papers presented under each question is only put forth. The proceedings are available in the irrigation Research Institute.

QUESTION 11.

The question pertained to Reclamation of waterlogged and marshy lands which was to discuss procedures, results, control of watertable and sources, exclusion of specific treatment of saline and alkali lands was very well contributed. There were 43 reports coming from all over the world. Dr. D. Diaz Amlrona of Spain who was entrusted with the general report had a very busy time for several months. After he had presented his long report of ten pages, many contributors took active part in the discussion. The two papers on this question submitted by Dr. Asghar and Dr. Nazir of Pakistan were presented by Mr. S. I. Mahbub and the saliant features of the papers were explained by him. Below we have put forth only the headings of contributions which are printed in Vol. II and III of the Transactions.

1. Reclamation of tidal soils—by Frank G. Viets, Jr. and Dean C. Muckel (U.S A.).

2. Procedures for evaluating drainage projects feasibility-by Victor I. Myers (U.S.A.).

3. Reclamation of waterlogged and marshy lands by R. L. Akers (Malaya).

4. Drainage in the Zuiderzee-Reclamations-by B. Fokkenes and J. C. de Koning (Netherlands).

5. Watertable control in arid and semi-arid regions by Arthur F. Pillsbury (U.S.A.).

6. Some aspects of irrigation and reclamation in British Guiana-by Peter A. Scott (Great Britain).

7. Surface and subsurface drainage investigations in the Central Gippsland Irrigation District, Victoria-by A. A. Long and A. Webster (Australia).

8. Drainage of overwet lands in the USSR (U.S.S.R.)

9. Water-table control—The function of drainage of irrigated land-by M. R. Lewis (U.S.A.)

10. Irrigation for marshlands-by Lyman S. Willardson (U.S.A.)

11. World problems in irrigation and reclamation of waterlogged lands-by Orson W. Israelsen and Bruce M. Anderson (U.S.A.)

12. The problems related to the reclamation of the waterlogged areas of the Adana Coastal Plain in Turkey-by Orhan A. Akyurek and Muzaffar Gizbili (Turkey).

13. Mise en valeur des terres marecageuses et des terres incultivables en raison de leur teneur excessive en eau-par Giovanni Padoan, Curzio Batini and Carlo Molinari (Italy).

14. Mise en culture de terrains de marais salants submerges par des eaux exterieures-par Ricardo Grande Covian (Spain).

15. Some aspects of the design of the drainage systems in low-lying areas-by J. W. Zeeuw (Netherlands).

16. Hydrological data for reclamation of water-logged land by drainage projects-by Jaromir Nemec (Czechoslovakia).

17. Discharge and temporary storage of excess water in cultivated lands-by H. Van Rossum (Netherlands).

18. Assechement et mise en irrigation de "La Nava de Campos"—5,000 Ha-par Federico Macau Vilar (Spain).

19. Drainage et accumulation des eaux a surface des bassins versants de plaine basse par Paul Salamin Hungary).

20 Mise en valeur des terres marecageuses et des terres incultivables en raison de leur teneur excessive en eau-Presente par L'Association Francaise pour l'Etude des Irrigations et du Drainage et redige par M. M. Rossin et M. F. Ciolina (France).

21. The survey of soils, vegetation and waters of waterlogged and marshy lands before reclamation, with special reference to the Elephant marsh of Nyasaland-by Robert Smith and Vernon C. Robertson (Great Britain).

22. A new method for the determination of appropriate depths and spacings of tile drains with regard to hydraulic conductivity of soil and to depth of an impermeable layer-by K. Zanker (Federal Republic of Germany).

23. In-place permeability tests and their use in subsurface drainage-by R. J. Winger, Jr. (U.S.A.)

24. Reclamation of 0·5 million waterlogged acres of Rechna Doab-by Nazir Ahmad and Zia-ul-Haq (Pakistan).

25. Problemes d'irrigation et drainage-par Salvador Trevijano Molina (Spain).

26. Size and shape of sub-divisions in drainage areas-by W. C. Visser (Netherlands).

27. Drainage of the Polder Districts in the Netherland-by J. Wesseling and J. A. Van't Leven (Netherlands).

28. Waterlogged problems and the remedies-by P. R. Ahuja and R. H. Sainani (India).

29. Reclamation of waterlogged and marshy lands in Collair Lake Basin-by L. Venkatakrishna Ayyar and A. R. Venkataraman (India).

30. On results brought about by land improvement enterprises executed in low lying areas and development farming management-by Kiichi Watanabe (Japan).

31. Method of depressing water level by drainage canals in low swampy lands by Tokutaro Kano (Japan).

32. The regime of phreatic water in an embanked area on the lower course of the Danube and relations to the soil humidity-by Const. Haret and Maria Apetroaei (Rumania).

33. On pF curve of peat soil-Basic research for the drainage of peat land-by Fujio Yamasaki (Japan).

34. Reclamation of submerged and marshy lands and check on ground-water rise in Sarda Canal area in Uttar Pradesh-by Baleshwar Nath (India).

35. The Ghab Development Project-by Abdul Basset Khatib (U.A R.)

36. Reclamation of waterlogged lands in Bombay-Deccan-by Dr. D. G. Kulkarni (India).

37. Reclamation of waterlogged and marshy lands in West Pakistan-by Dr. A. G. Asghar (Pakistan).

38. The evolution of marsh land vegetation in consequence of decreased salinity-by Ricardo Grande Covian and Ramon Bellas Rivera(Spain).

39. Le probleme de la mise en valeur des marais de I'Algarve-by Armando Da Palma Carlos et Ruy Alves Da Silva Sanches (Portugal).

40. Post-Reclamation desalting of the Ferrarese salt loamy ground with an appendix by Dottor G. Ravalli-by Dr. Giuseppe Ragazzi.

41. A method of determining the location of feeding veins and strata in waterlogged areas-by Eilzer Gereb (Israel).

42. Investigation methods for subsoil drainage design-experience with four characteristic sites-by B. Z. Kinori (Israel).

43. La transformation fonciere et agricole des sols marecageux des terres qui ne peuvent pas etre mises en labeur par exces de'eau-by Dr. Gretano Nevano (Italy).

QUESTION 12

Sprinkler Irrigation and comparison with other methods of Irrigation.

This subject was to include design, equipment, installation, operation and maintenance, special uses of sprinkler irrigation, comparative studies with other methods of irrigation with particular reference to cost, economical use of water, yield of crops, etc.

Fourteen countries contributed 31 papers on the subject. Dr. FRANCESCO GURATO Technical Manager *Itala Consult*, Rome, Italy was the general reporter.

This system, still limited to Laboratory experiments at the beginning of this century, received its first large scale applications in Germany and in Italy, in the years bridging World War I. The first sprinklers were of the stationary type. Only between 1930 and 1935 rotary sprinklers appeared. By 1939,

sprinkler irrigation had spread to many countries, but still covered rather small areas, estimated at 100,000 hectares as a whole.

Sprinkler irrigation spread at an increasing tempo after World War II : successful applications are recorded in all countries and new sprinkling techniques are mulitplying. According to recent estimates, sprinkler irrigated areas are growing at a rate of 10 percent annually, and are now totalling 2.5 million hectares.

These fast developments in the practical field did not lead to a sufficient amount of scientific research on experimentation of application techniques in all countries and at all times. Nevertheless substantial efforts are being devoted to research and experimentation, as demonstrated by the 31 reports submitted by 14 countries to the congress.

The subjects and the authors of these reports were as under :—

1. Water application efficiency of surface and sprinkler methods of irrigation—by Lloyd E. Myers and Howard R. Haise (U.S A.).
2. Sprinkler irrigation for frost protection—by E.H. Kidder (U.S.A.).
3. Economics of portable sprinkler irrigation system design for annual crops in subhumid areas—by H.D. Ayers (Canada).
4. Factors influencing plant growth under sprinkler and surface irrigagation by Yoash Vaadia and Robert M. Hagan (U.S.A.)
5. Application a des cas concrets du critere du meilleur emploi de l'eau d'irrigation-par D. Malossi et U. Terenzio (Italy).
6. Generalites au sujet de la comparaison entre differentes methodes d'irrigation, appliques au milieu geographique Italien-par Gualtiero Fiori et Federico Bonetti (Italy).
7. Le development de la situation de l'irrigation par aspersion en Allemagne-par Dr. H. Winkhaus (Westren Germany.)
8. The design, construction, and operation of a project-type sprinkler irrigation system-by Percy M. Pharr, Jr. (U.S.A.).
9. Sprinkling and watering machines by the Division of Scientific and Technical Information of the All-Union Research Institute of Hydrotechnics & Amelioration (U.S S.R.)
10. Sprinkler irrigation and comparison with other methods in Egypt-by Dr. Mohammed A. Selim and Farid Nicola (U.A.R.)
11. Indices d'uniformite des aspergeurs-par Gabriel Baquero (Spain)
12. La preparation du terrain pour l'arrosage par aspersion-par Gabriel Baquero (Spain)
13. Effect of intake rate of soils on irrigation levels by Eng. M. Ram (Israel).
14. Sprinkler irrigation compared with surface irrigation-by C.S.Wright (Great Britain).
15. Possibilities of sprinkler irrigation in India-by K.B. Khushalani (India).
16. Irrigation paraspersion et comparaison avec les autres methodes d'irrigation-Presente par l'Association Francaise Pour l'Etude des Irri-

gations et du Drainage et redige par M.R.M. Lyon (France).

17. Influence of the design of a sprinkler irrigation installation on its efficiency and the cost of handling-by Faustino Garcia Lozano (Spain).
18. Optimum intensity of spray irrigation-by Ing. Dr. Jan Dovorak. and Ing. Dr. Milos Holy (Czechoslovakia.)
19. Vues de project I'rrigation par aspersion dans le perimetre d'irrigation de la Gauche Pescara-par Dott. Ing. Carlo Lotti et Dott. Ing. Ferruccio Patuzzi (Italy).
20. Comparison between sprinkler irrigation method and furrow irrigation method in Japan by Kazushi Oshima (Japan).
21. Irrigation by sprinkling and comparison with other systems in the present conditions at the Cadiz Province and adjacent areas, Spain by Antonio Hidalgo Granados (Spain).
22. Comparative study of costs for surface and sprinkler irrigation in Southern Spain based on true water needs of crops-by Antonio Hidalgo Granados (Spain).
23. Some water management problems in projecting spray irrigation-by Ing. Dr. Miloslav Pycha (Czechoslovakia).
24. Application de I'arrosage sur degrands perimetres-par Ing. Bozidar Blagojevic (Yugoslavia).
25. Efficiency of sprinkler irrigattion at the sloping field-by Shiro Sakurai, Masateru Mizunoe and Akira Yoneya (Japan).
26. Recent developments in boom sprinkler irrigation—by Bassel D. van't Woudt (U.S.A.)
27. Beginning of sprinkler irrigation in India-by Mahavir Prashad (India).
28. Sprinkler versus surface irrigation—by Samuel Kantor (Israel).
29. Irrigation by sprinkling-by Lt.-Col. B Z. Eldad (Israel).
30. Aspects pedologique de I'irrigation-par aspersion-par Aristo Degan (Italy).
31. The efficiency of sprinkler irrigation in desert soil reclamation at Inchass farm-by Ahmad G. Abd El-Samie (U.A.R.).

QUESTION 13

Tolerance of plants to minerals in solution in irrigation water and in soil.

The scope of the subject included, factors affecting the salt tolerance of irrigated crops, salt and exchangeable sodium tolerance of irrigated crops, influence of saline substrata upon the absorption of nutrients by plants when grown under saline conditions.

Thirteen contributions from eleven countries were received. These included one from Dr. Asghar of Pakistan.

Professor V. Kovda, Director, Department of Natural Sciences Unesco, Paris, was the general reporter and in his remarks he stated that :

"For thousands of years peasants have observed the strong, but complex and controversial influence of water on soils and

their fertility. It is generally and correctly believed that fertility of arable soils can be progressively increased by long periods of well organized irrigation. However, the history of irrigation also contains frequent examples of contrary phenomena, *i.e.* decreasing soil fertility after several years or decades of irrigation. This is why the problem of quality of water used for irrigation has always been of intense interest to engineers, agronomists and scientists.

The quality of the water used for irrigation and its long term influence on fertility cannot be correctly estimated without also taking into consideration the plant physiology, climatic conditions. Soil properties and other factors render the problem extremely complex, which explains the large number of scientific institutions studying the interrelationships of soil, water and vegetation.

Thirteen papers were utilized in the preparation of this report, the titles and authors of which are listed below :

1. Tolerance of plants to minerals in solution in irrigation water and soils —by Alfonso Draghetti of Italy.
2. Tolerance of cultivated crops to soluble salt and exchangeable sodium—by Dr. H. B. Peterson of U.S.A.
3. Relation of irrigation water quality to soil problems—by Dr. Milton Fireman of U.S.A.
4. Tolerance of plants to minerals in solution in irrigation water and in soil—by Dr. R H. Gunn of Great Britain.
5. Sanding in saline soils Dalias project Almeria, Spain by L. P. de los Cobos Spain.
6. The effect of exchangeable cations on hygroscopic soil water—by Miroslav Kutilek of Czechsolovakia.
7. Relative data on Salt-resistance of rice in the period of its germination —by Dr. E. Petrasovits & C. Darba of Hungary.
8. Tolerance of plants to Minerals in solution in irrigation water and soil —by Dr. A. G. Asghar of Pakistan.
9. Reclamation and drainage of saline sodic soils in the Upper Colorado River Basin—by Norman A. Evans of (U.S.A.)
10. Some factors affecting nutrients uptakes by rice plants grown under saline conditions—by Kozo Akihama of Japan.
11. The significance of salt-resistance of plants in the fight against salinization of soils—by Dr. B. P. Stroganov (U.S.S.R.)
12. Tolerance of sugar-cane to minerals in solution in soil and irrigation water in Adana Plain of Southern Turkey—by Dogan Tutuncu of Turkey.
13. Irrigation with waters of varying degrees of salinity and its influence on soil and crops—by S. Ravikovitch & E. Muravsky of Israel.

The detail contributions are contained in Volume V of the Transactions. In this very volume the subject mentioned below is also included.

QUESTION 14

Under the question the use of Longitudinal embankment levees as Flood protective measures is included. The scope of the question was limited to the merits and demerits of embankments, their effect on river regime conditions under which their use is indicated or under which they should not be used. Twenty six contributions from 19 different countries were received. The general report was put forth by Henry G.C. WeinKauff, Chief Project Development branch Office, Chief of Engineers, United States Army Washington D.C. These 26 contributions included two from Pakistan, one by Mohi-ud-Din Khan and the other by Dr. Mushtaq Ahmad.

The subject of each paper together with name of its author as included in Vol. V. of the transactions was :-

1. Comparison of levees with other methods of Flood control by Harry W. Adams (U.S.A.).
2. Use of longitudinal embankments or levees as flood protection measures by Mohi-ud-din Khan (Pakistan).
3. Advantages and disadvantages of closed dams—by Prof. Dr. Ing. Heinrich Press (Federal Republic of Germany).
4. Planning of levees flood protection by M/s. G. Batini, P. Colombo & Marzolo Iatly.
5. The use of longitudinal embankments or levees as flood protection measures with particular reference to the river Trent in Great Britain by Leslie J. Jaffrey (Great Britain).
6. Les utilisation des levees longitudinales commemoyen de protection contre les crues par G.E. Papadopoulos (Greece).
7. Canalization of the River Muga from Castello de Ampurias to the Sea (Province of Gerona)—by Don Eugenio Pienco Souviron (Spain).
8. Flood protection measures on the river Nile by Dr. Hassan Zaky (U.A.R.).
9. Embankment of rivers in Transcaucasia as a means of Flood control—by M.S. Gagoshidze and P.A. Shatberashvili (U.S.S.R.).
10. Advisability of having flood protective embankments along rivers—by K.B. Khushalani (India).
11. The Rio Grande floodway and its effects on river regime through the middle valley in New Mexico by Robert C. Woodson (U.S.A.).
12. Hydraulic criterion of protective levees Economic effectiveness on the basis of the example of the Nida River by Prof. Dr. Kazimierz Debski (Poland).
13. La correction des course d'eau en Suisse, ses principes et l'utilisation de digues, longitudinales par C. Lichten hahn (Switzerland).
14. Effects of longitudinal embankments on river regime of Chikugo River Basin by Yoshizo Kikkawa (Japan).
15. Longitudinal embankments as flood control measures by Saburo Namu- and Tadao Okazki (Japan).

16. Les caracteres g neraux des I' amenagement des cours d' eau par les digues par Fuat Senturk (Turkey)·

17. Some considerations of longitudinal embankments as flood control measures in Japan—by Syohei Inokuti (Japan).

18. 40 miles long flood protection embankments on the Ganga river —by G.K. Agrawal (India).

19. The establishment of the national cross section of the levees in the valleys of the R.P.R. (Rumania) by 1. Vladimirescu (Rumania).

20. Construction of levees in Turkey as flood protection measure—by Nazmi Karatekin and Yilmaz Karataban (Turkey).

21. Flood embankments above barrages in alluvial river by Mushtaq Ahmad and Mohammad Ali (Pakistan).

22. Control of flood in the Kosi by levees — by Debes Mookerjea (India).

23. Use of longitudinal embankments or levees as a flood protection measure by Dr. H. L. Uppal (India).

24. Drainage, irrigation, flood control and navigation problems in the Geba River (Portuguese Guinea) by Jose Beja Neves and Fernando Manzanares Abecasis (Portugal).

25. Protection of the Mondego river fields against flooding by means of both longitudinal dikes and regularization through storage reservoirs—by Armando da Palma Carlos and Rui da Silva Sanches (Portugal).

26. Sediment transportation by running water and the design of stable channels in alluvial soil (Netherlands).

Contd. from page 52.

Reprints of papers will be available to participants in the beginning of July 1962 and the proceedings, containing discussion and author's closing remarks etc., will be published after the symposium Further details can be had from Prof. F. Numachi, Chairman, Local, Organizing Committee, I.A.H.R. Symposium on Cavition and Hydraulic Machinery, Japan, 1962 and c/o Institute of High Speed Mechanics, Tohoku University SENDAI, JAPAN.

It will be of interest to the readers of the Engineering News that in 1955 a symposium on cavitation was held in Great Britain, when 21 papers were presented by Research workers from various countries. The contributions to this symposium are printed by Her Majesty's Stationery Office and costs £ 1, 10s net.

Communications

In addition to the 113 contributions on 4 questions discussed in the conference, there were 30 contributions sent by 16 different countries of the world. These included papers on all subjects, which had been discussed during the previous meeting. A contribution by Dr. Nazir Ahmad on "Improving stability of flood embankments" was also included in communications. The chairman for this session was Mr. T. Seeno of Japan. Marshall Jones of U.S.A. acted as Secretary. There was no reporter for this section, and all the contributions introduced their own paper. These papers are included in Vol. VI of the transactions of the headings and authors are as under :—

1. The atmometer method for determining the monthly use of water by irrigated crops-by Dr. N. A. Halkias (Greece).

2. Conditions for economical operation of furrow irrigation-by Jiri Divis, M. S. and Karel Zdra Zil, M. S.

3. The zone of "La Mancha," Ciudal Real, Spain-by Enrique Tomas Salmeron (Spain).

4. Control gates for irrigation and drainage projects-by A. C. Livingston (Great Britain).

5. A report describing recent developments in the chemical control of water weeds-by W.P. Dunk (Australia).

6. Design of gravity drainage systems with the outlet subjected to the influence of tides-by A. Lencastre (Portugal).

7. Behaviour of some spillways in irrigation structures-by Fluvial Hydraulics Section Laboratorio Nacional de Engenharia Civil (Portugal).

8. Method and nomograms for evaluating the sub-sidence of peat soils under the influence of drainage-by Prof. Dr. Jerzy Ostromecki (Poland).

9. Improving stability of flood embankments with sand core wall-by Nazir Ahmad and S. L. Shah (Pakistan).

10. The general study on the salinity of under-ground waters (Spain).

11. Comparison of field methods of measuring hydraulic conductivity-T. Talsma (Australia).

12. Evolution et avenir de l'Albufera de Valenciapar A. Garcia Lobraudero (Spain).

13. Present and future of irrigation in Spain-by D. Juan Manuel Pazos Gil and D. Claudio Rodriguez Porrero (Spain).

14. Method of computation of water surface curves with fixed water flow in regular, open river beds-by Zygmunt Sochon.

15. Winter wheat yields and spring rainfall in three Spanish Provinces-by Dario Maravall Cases-noves and Francisco Elias Castillo (Spain).

16. El canal de Monegros-Sa conservation et exploitation en terrains gypseux-par Rafel de Ureha (Spain).

17. Recent developments in the use of monomolecular films for reservoir evaporation reductions-by Quentin Florey. Lloyd O. Timblin, Jr. and Walter U. Garstka (U.S.A.)

18. Description du revetement (Dalles de berges autostables) adopte pour un canal agricole a recalibrer dans des conditions particulieres-par M. M. J. Cabanius, G. Desmoulins et R. Muller-Feuga (France).

19. The quality of irrigation water in South-East Hungary-by M. Dzubay (Hungary).

20. Excessive water use and drainage in permeable tile drained soils-by J. M. Blainey (Australia).

21. Lining of small irrigation channels with asbestos cement flumes-by Dimo Velev, Emil Strahilov and Konstantin Kochev Submitted through Swiss National Committee).

22. Construction and functioning of the drains in the irrigated zone of Orellana, Badajoz-Caceres, Spain-by Pedro Gomez Pompa (Spain).

23. New sources of water supply through improved utilization and management-by Floyd E. Dominy (U.S.A.)

24. Prefabricated canals and dykes-by Guillermo Castanon Albertos (Spain).

25. Mole drainage with plastic strip lining-Dr. Teneli Juusela (Finland).

26. The concept of "available water" and "useful water" in the determination of the amount of water per irrigation-by Dott. France Ravelli. (Italy).

27. Soil salinity problems-Current Israeli Research Projects-by Ing. E. Muravsky. (Israel).

28. Water development and water costs in Israel-by Zeev Kariv. (Israel).

29. Some studies about water requirements for reclamation of alkali soil-by Dr. Hilmy El G.baly (U.A.R)

30. Flow over escape weirs-by Dr. Ing. Abdel-Hadi Abdul-Fetouh (U A.R.)

FORTHCOMING

INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE

The fifth meeting of the International Commission on Irrigation and Drainage will be held in Tokyo, Japan in May, 1963. The Commission has invited papers through the National Committee on four subjects selected for discussion in the meeting. The last date for the submission of papers is 31st July, 1962. All papers will be examined by a sub-committee appointed by the National Committee before forwarding to the central office. It is stressed that the papers should contain new ideas and should be based upon original study, investigation or application.

The subjects selected for discussion are split up into four questions.

QUESTION 15

Economics and financing of Irrigation, drainage and flood control works.

The scope of the subject is limited to the various tests, like benefit cost ratio test, and productivity test for economics justification of a new project.

The basis, limitation and short comings of each test and actual results obtained, together with suggestions for effecting improvements may be put forth.

Charges levied on the beneficiaries, methods of assessment and determination of rates, practices for repayment of costs, capital as well as maintenance are to be given.

Analysis and appraisal of their effect on economic and social impacts are to be discussed.

Methods of allocation of costs in case of multiple projects can also be included.

QUESTION 16

Efficiency of water distribution and use on the land.

Its scope will be :

(1) Hydraulics of surface irrigation *i.e.*, flood irrigation and furrow irrigation.

(2) Rational methods of defining efficiency under various conditions of water supply and land use.

(3) Suggestions for improving irrigation efficiency.

QUESTION 17

Control of watertable in drained lands. Prevention of over-drainage.

SCOPE :—

(i) Optimum vertical range and frequency of fluctuations in the watertable under different climatic and soil conditions and cropping practices.

(ii) Methods to control watertable in accordance with (i)

(iii) Harmful effects of overdrainage (particularly in peaty soils) and methods of preventing such overdrainage.

(iv) Methods for measurement of the position of the watertable.

QUESTION 18

Flood prevention and control by surface and surface retention or spreading.

SCOPE :

(i) Effects of various lands management practices on flood control under different topographical conditions.

(ii) Particulars of various methods adopted for spreading of flood waters, their practical limitations, advantages and disadvantages.

(iii) Ground-water phenomena related to spreading of flood waters—Configuration of ground-water mound, its limiting magnitude, its effective temporary water retention both as to volume and time, its flow net for potential flow, and the drainage of the water stored in the mound.

In addition to these four questions, a seminar on "Crop growing by flood spreading and flood recession with regard to river control and its economics aspects" is also to be held.

In case of Seminar, detailed papers are not to be submitted, only detailed summaries of about two pages are to be submitted on the subject on which the author intends to speak.

Papers can also be submitted under the head Communications relating to all questions which have been discussed in the previous meeting of the Congress.

INTERNATIONAL ASSOCIATION
for
HYDRAULIC RESEARCH

Recently, from 3rd to 7th September, 1961, the International Association for Hydraulic Research held its ninth convention at Bubrovnik, Yogoslavia, when 182 papers on the following subjects were submitted.

Subject I—The effect of turbulence on hydraulic structures, 27 papers.

Subject II—Mechanics of ground water flow, 37 papers.

Subject III—Modification of natural streams by engineering structures, 27 papers.

Besides these, two seminars on Hydraulics of small structures in Irrigation, Drainage and Fundamental hydrodynamic of free surface flow and unsteady flow were held in which 10 and 38 contributions were made.

The meeting was attended by 213 persons representing 31 countries.

Three conferences were also held on

(*i*) Hydraulic problem of the Karst.

(*ii*) Three dimensional boundary layer flow.

(*iii*) Energy transformation in zones separation, in which Professor Dr. B. Knezevic, Dr. H. Schlichting and Dr. Hunter Rouse, took active part.

The meeting was followed by two excursions.

The proceedings comprising of 1500 pages are expected to be out by April 1962.

Prior to the holding of this bi-annual convention, a symposium of international character was held in France, under the auspices of SOCIETE HYDROTECHNIQE DE FRANCE at Nice in September, 1960. The subject of the symposium was Hydraulic Turbine Research.

Next year a four day symposium on Cavitation and Hydraulic Machinery is going to be held from 2nd to 5th September, 1962 in Japan. The first three days will be devoted to the presentation and discussion of papers on cultivation and on 5th September, Hydraulic Machinery will be discussed. A visit for observation is arranged for 7th and 8th September to various manufacturing concerns and research organizations dealing with equipment for experiments on hydraulic machinery, water turbine, rotary machine and hydraulic research. The visit will also include manufacturing organizations of compressors, water turbines, etc. In the Technical Research Institute, Ministry of Transportation and National Aeronautical Laboratory, Cavitation tunnel for ship propellers and Traisonic wind tunnel for jet engines will be seen. The attendance is open to members of I.A.H.R. as well as non-members.

Contd. on page 48.

Book Reviews

Theory of Elasticity.

V. V. Novozhilov, M.R.I.N.A. Translated by F. K. Lusher, B. Sc. (Eng). Published by Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 80s.

The author, a leading Russian authority in this field, has recognised the growing importance of non-linear problems in modern stress analysis. Starting from the basic ideas of strains and stresses, he develops a general method of approach to any problem in the theory of elasticity.

Asphalt : Its Composition, Properties and Uses

By

R. N, Traxler. Published by Chapman & Hall Ltd., 37 Essex Street, London, W. C. 2.

Ralph N. Traxler is known on both sides of the Atlantic as one of the leading authorities on asphalt.

The author starts by discussing the chemical, physical rheological, colloidal and durability properties of bitumen. This is followed by reviews of bitumen manufacturing methods and description of the major uses of bitumens—for roofing, hydraulic structures and for miscellaneous purposes.

Stress Concentration Around Holes

By

G. N. Savin. Translated from Russsian by E. Gros and edited by W. Fohnson. Published by Pergamon Press Ltd., Headington Hill Hall, Oxford. Price 84s. (S. 15.00).

This book, which was first published in Russia in 1950 and revised in 1959, is concerned with plane stress concentrations due to holes of various shapes. Particular attention is given to the effect of holes in plates and beams for a variety of conditions of loading.

It is a very useful book for designers, post-graduate students and research workers. It is the first volume of a two-volume work the second volume of which, according to the author's preface, deals with stress concentrations due to cavities, fillets and three dimensional effects generally.

Grasses of Burma, Ceylon, India and Pakistan.

By

N.L. Bor. Pergamon Press, New York. Price $25.

The author has based this book on some 40 years of study on grasses in Burma, Ceylon, India and Pakistan, while he was a member of the Indian Forest Service. Any scientist who is concerned with grasses will find this book of great interest and usefulness. It is indispensable for reference purposes.

Agricultural Engineer's Handbook

By

C.B. Richey, Paul Jacobson and Carl W. Hall. Mc Graw, Hill Book Company, New York. Price $19.50

Forty-four specialists and recognised authorities have assisted in the preparation of this highly important volume which can be used as a reference book.

Scientific Thinking and Scientific Writing.

By

Martin S. Peterson. Reinhold Publishing Corporation, New York. Price $6.95.

Scientific writing is an art as well as science. In Scientific writings, the author emphasizes, one must start with scientific thinking, which is integrated thinking that begins with a problem and proceeds towards its solution. The book is recommended for writers of scientific papers.

Soil Interpretation in Soil Survey

By

Charles E. Kellogg. United States Department of Agriculture, Soil Conservation Service, Washington, D.C. 1961.

"Our need is for a soil survey that will endure and be capable of accurate reinterpretation with changes in economic conditions and in the agricultural arts". This book fulfils the needs of the soil scientist.

Cement Engineers' Hand-book

By

Otto Labahn. Bauverlag GmbH. Wiesbaden 1960, 250 pp., $3.60.

This pocket sized book gives practical information on standard German cement making methods and techniques. The text is supplemented with tables, graphs, and simple formulae.

Topics covered include fineness of grinding, quarrying, proportioning of raw mixtures, choice of manufacturing process, preparation of materials such as crushing and drying, kilns, cement grinding mills and dust extraction.

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M/s Gulf Oil Co., Ltd.	64

BOOKS

LUDWIG PRANDTL.

"Gesammelte Abhandlungen zur angewandten Mechanik, Hydro und Aerodynamik."

Springer-Verlag, Berlin, 3 vols., 1961.

FLUID MECHANICS

GOVINDA RAO, N.S.
SEETHARAMAIH, K.
CHANDRASEKHARA Swamy, N.Y.

Dissipation of Energy of a Circular Jet Submerged in Water.

La Houille Blanche, no 6, November 1960.

DISKIN, M.H.

The Limits of Applicability of the Hazen-Williams Formula.

La Houille Blnache, no 6, November 1960.

LANDAU, H.G.
HLINKA, J.W.

Steady-state Temperature Distribution in a Counterflow Heat Exchanger Including Longitudinal Conduction in the wall.

A.S.M E. (U.S.A.), paper no 60-WA-236, 1960.

MARXMAN, G.A.
BURLAGE, H.

Expansion Co-efficients for Oridice Meters in Pipes less than One Inch in Diameter, A.S.M.E. (U.S A), paper no 60-WA-137, 1960.

MARRIS, A.W.

The Flow of Water in Curved Channels of large Width of Radius Ratio.

A.S.M E. (U.S.A.) paper no 60-WA-164, 1960.

Goschenen Power Scheme.

The Engineer (G. Britain), vol. 211, No. 5482, 17 February 1961.

Taum Sauk pumped-Storage Scheme.

Water Power (G.. Britain), vol. 13, no 2. February 1961.

MACKINTOSH, I.B.

The Upper Colorado River Project Water Power (Great Britain), vol. 13, no 1, January 1961.

BALJE, O. E.

A Study on Design Criteria and Matching of Turbomachines. Part A. Similarity Relations and Design Criteria of Turbines.—Part B. Compressor and Pump Performance and Matching of Turbocomponents.

A.S.M.E. (U.S A.), paper no 60-WA-230, 231, 1960.

TERZAGHI, K.

From Theory to Practice in Soil Mechanics. J. Wiley, New York (U.S.A), 1960.

SOIL MECHANICS & FOUNDATION.
ALPAN, I.

The Principle of Effective Stress Applied to the Problem of Lateral Earth Pressure.

The Dock and Harbour Authority (G. Britain), vol. XLI, no. 485 March 1961. *Contd. on page 40.*

ENGINEERING ABSTRACTS

ARON L. MIRSKY,

Kariba Power Scheme Reviewed.

"The Engineer" (London), V. 209, No. 5442, May 13, 1960.

The scheme entails both power and river regulation. The first stage is designed to produce 600 MW of firm power, with 1500 (and perhaps 1800) MW being produced after completion of second stage. The dam, approximately 400 ft. high is a double curvature, cupola type arch. There are two underground power-stations, one in each bank close to the dam.

ARON L. MIRSKY. (Reviewer).

New corrosion resistant concrete for conduits.

G. Roederer, "Le Genie Civil" (Paris) V. 137, No. 21 Nov. 1, 1960.

An exhaustive report on investigations of the effect of the "Ocrating" process in preventing disintegration of concrete due to chemical attack *is set forth* in this note.

L. ESCANDE, J. NOUGARO, L. CASTEX & H. BARTHET.

The influence of certain parameters on a sudden flood wave down-stream from a dam.

"LA. Houille Balanche" (Boite Postale 41, Grenoble, France) No. 5, 1961, pp. 565-575.

Initial experimental results obtained with a 1:300 scale model of the Truyere valley below the Sarrans dams are given.

Wave celerity, form and amplitude, as governed by various parameters such as impounded water level, initial rates or flow down-stream from the dam, and river bed roughness have been described.

M. B. ABBOTT.

On the spreading of one fluid over another.

"LA Houille Blanche" (Boite Postale 41, Grenoble, France) No. 5, 1961, pp. 622 to 628.

Although dealing particularly with the spreading of oil over water, this paper also tackles the general problem of determining the nature and rate of spreading of any incompressible fluid over another of greater density. It is in three parts.

RECENT INTERESTING PAPERS

PETERSON, D.F.
MOHANTY, P.K.
Flume studies of flow in steep, rough channels. Journal of the Hydraulics Division, Proceedings of the A.S.C.E. (U.S.A.), vol. 86 no Hy-9, part 1, Nov. 1960.

HAMA, F.R.
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Self-induced velocity on a curved vortex. The Physics of fluids (U.S.A.), vol. 4, no 1, January 1961.

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Viscosity of steam at supercritical pressures. The Journal of Mechanical Engineering Science Great-Britain), vol. 2 no 4, December 1960.

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A Modern Science

"PRESENT AND PAST"

(a) PROFESSORS EINSTEIN AND IPPEN IN PAKISTAN

In October, 1961, Pakistan had the good fortune to play host to two world famous Professors of Hydraulics and Fluids Mechanics. While in Lahore, they were guests of the West Pakistan Engineering Congress.

Dr. Hans Albert Einstein was born in Switzerland on May 14, 1904 He obtained his Diploma from Federal Institute of Technology, Switzerland, 1926 and Ph. D. (Civil Engineering) in 1937. He worked as a Design and Steel Construction Engineer at Kleenne, Dortmund, from 1927 to 1931 and as a first Engineer in the Hydraulics Laboratory of Federal Institute of Switzerland from 1931 to 1938 Dr. Einstein went to the U.S.A. in 1938 and was associated with the U.S. Department of Agriculture till 1947. From 1947 to 1953, he was Associate Professor of Mechanical Engineering at California University, and is Professor of Hydraulics since then.

Dr. Einstein is an eminent Hydraulics Engineer. He has done remarkable work in the field of Transportation of Bed Load, Movement of Beach sand by Water Waves, Bed Load Transportation in Mountain Creeks, etc., and is well known for his formulae of Bed Load Transportation.

While in Lahore he visited the Irrigation Research Institute, the Nandipur Field Reseach Station and the Marala Headworks. He delivered two lectures, one in the Institute of Chemistry and one



Prof. EINSTEIN AND IPPEN at Nandipur Research Station.



Prof. EINSTEIN AND IPPEN visiting the Irrigation Research Institute Lahore.

at the Engineering University of Lahore. The subject of both the lectures pertained to Bed Load, sediment transport and the regime theory.

Dr. Ippen also delivered two lectures at the two places mentioned above. He dealt with fluid turbulence and the latest advances in the subject.

PROFESSOR ARTHUR THOMAS IPPEN was born on July 28, 1907 in London. From 1926 to 1931, he worked at Technical University of Aachen, Germany, and obtained the degree of Diploma-Ingeniur, In 1932, he worked as an assistant in Geodesy, Aachen, Germany. The same year he went to America as an exchange fellow and worked at Iowa Institute of Hydraulics Research in 1932-33. He was associated with California Institute of Technology, Pasadena, California, from 1933 to 1938 and worked as a research fellow in Hydraulics Research Engineer and Instructor and obtained his M.S. in 1935. and Ph. D. in 1936. From 1938 to 1945, DR. IPPEN was Assistant Professor incharge of Hydraulics Laboratory and Model Testing, Lehigh University, Bethlehem, Pennsylvania. He went to Massachussetts Institute of Technology and acted as Associated Professor of Hydraulics incharge of Division of Hydraulics and of Hydrodynamics Laboratory, Department of Civil and Sanitary Engineering, M.I.T.

Dr. Ippen has devoted a life time to Hydraulics Research. He has done remarkable work on Channel Transitions, Mechanics of Supercritical flow, Design of Channel Contractions, etc., and is one of the world's foremost authorities on the hydraulics of channel flow.

(b) DR. WILLIAM THOMPSON KELVIN & JEANS CHARLES BORDA

To physicists, the name KELVIN conjures up an absolute scale of temperature, the mirror galvanometer, the Thomson effect, the mariner's compass, the premises of thermodynamics and the first physics laboratory to be founded in Great Britain.

Hydraulic engineers also consider him to be one of their member for they remember that it was Kelvin the sailor who invented an improved sounding apparatus, a tidal harmonic analyser, a tidal predictor which predicted high and low tides on a given day, that is the first paper written in 1811, concerned with hydrodynamics in the light of Fourier's theorems and that a chapter of Kelvin's "Elements of Natural Philosophy" deals with hydrostatics.

William Thomson, who was born in Belfast in 1824, was the son of a Professor of Mathematics at Glasgow University. He was educated at St. Peter's College, Cambridge and at the age of twenty-two, was given the chair of Natural Philosophy at Glasgow University, a post which he held for fifty-three years, during which he wrote more than three hundred papers.

He had a precise and ordered mind and was constantly concerned with improving existing methods of measurement and instruments, and creating new ones.

Veracity and uprightness, simplicity and modesty, good-heartedness and kindness, courtesy and benevolence were outstanding features of the character of the scientist who, besides being an eminent teacher and a canny industrialist, can be looked upon as one of the greatest physicists of his day.

In 1892 William Thomson was raised to the peerage and became Baron Kelvin of Largs.

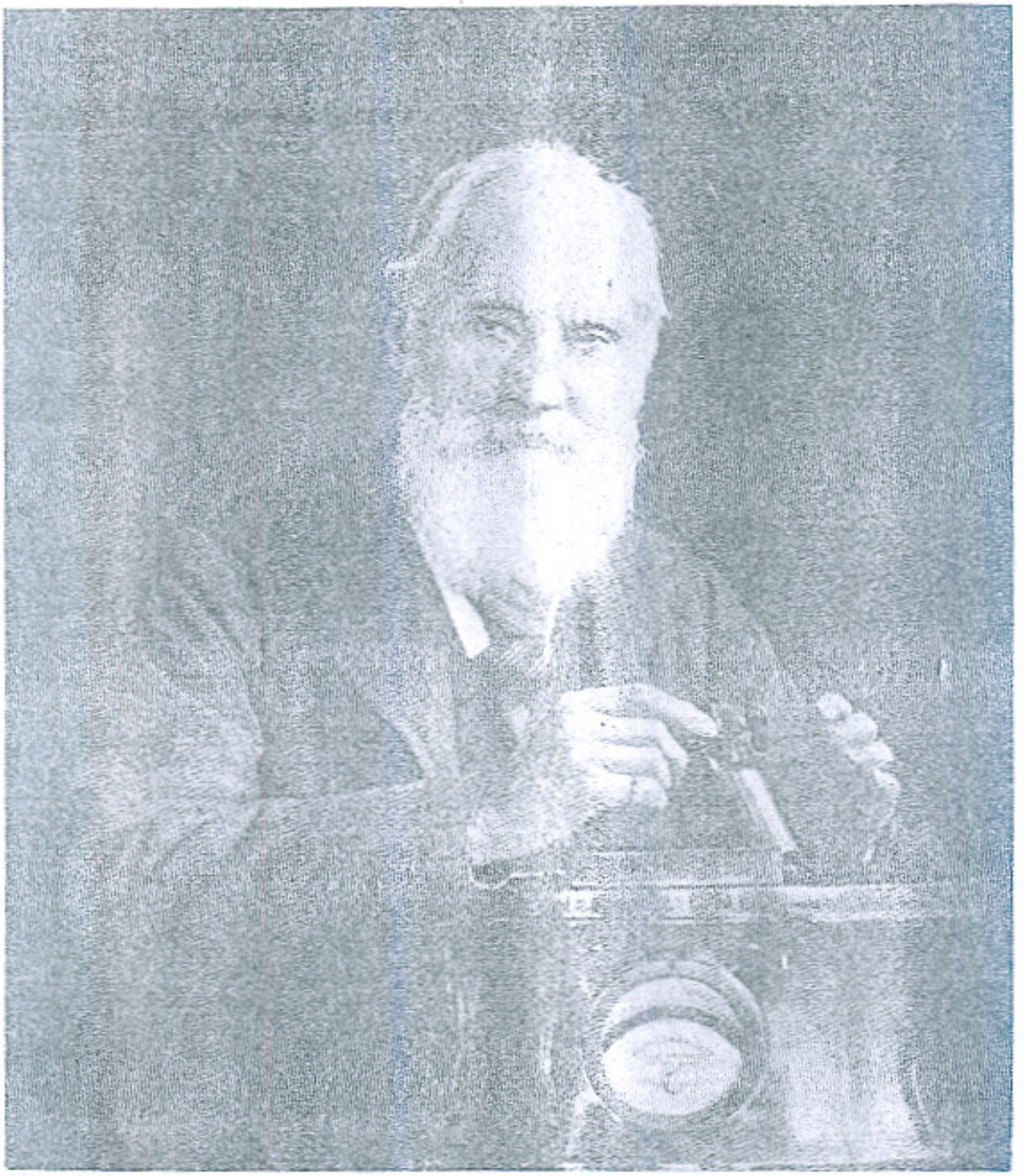
He died at his estate at Netherall near Largs, Scotland, in 1907.

JEAN CHARLES BORDA

Part of BORDA'S fame is due to the fact that the French Naval Officer's Training ship bore his name for 73 years. His name was a symbol of scientific, technical and naval merit but it was not the exclusive property of the Navy for Borda belonged to science in its most general form.

Jean-Charles Borda, who was born into a family of sixteen children at Dax on May 4th, 1733, had a strange career, for he who eventually became a magistrate was first of all an officer in the Corps of Engineers, then an officer in the light cavalry, a captain in the Navy, director of the school of naval engineering and a member of the Institute, of which he had been a corresponding member since the age of twenty.

From 1756 onwards he was greatly interested in Fluid dynamics as is evident by his paper on the resistance of air to



LORD KELVIN (1824-1907)

projects fired from guns, a paper which was to be of great importance in the history of ballistics. He took up hydrodynamics and investigated the resistance of water to the motion of ships, stream lines in pumps and flow through various orifices and outlet tubes. In connection with this he drew attention to the head losses which occur at a sudden increase in cross section. Such losses have ever since been known as Borda losses and their algebraic expression, $V_1 - V/2\ g$, is also named after Borda. Apparently, Borda was the first hydraulic engineer to make explicit use of the factor $2g$ in a flow equation. In a paper presented at the Academy of Sciences in 1767, he defined the conditions under which input apparatus, such as a hydraulic runner, would have satisfactory efficiency. He said, "The water should enter without shock and leave without speed." He thus outlined the theory of "a special type of horizontal wheel with curved blades." which was one of the most remarkable forerunners of the Burdin and Fourneyron turbine.

The immense scope of Borda's work won him universal scientific recognition. Among his contributions are the famous repeating reflecting circle, the double weighing method (a precursor of the zero methods), investigations relating to chronometers aimed at determining longitudes (which he computed and published at his own expense) and above all the work which resulted in the creation of the metric system.

His proverbial generosity, his absolute disinterestedness and his excessive modesty are among the outstanding features of the character of this scientist, of whom it has been said that "this magnificent example of humanity" kept one ideal in mind throughout his life. "To know things in order to serve mankind."

Borda died in Paris on February 19th, 1799.

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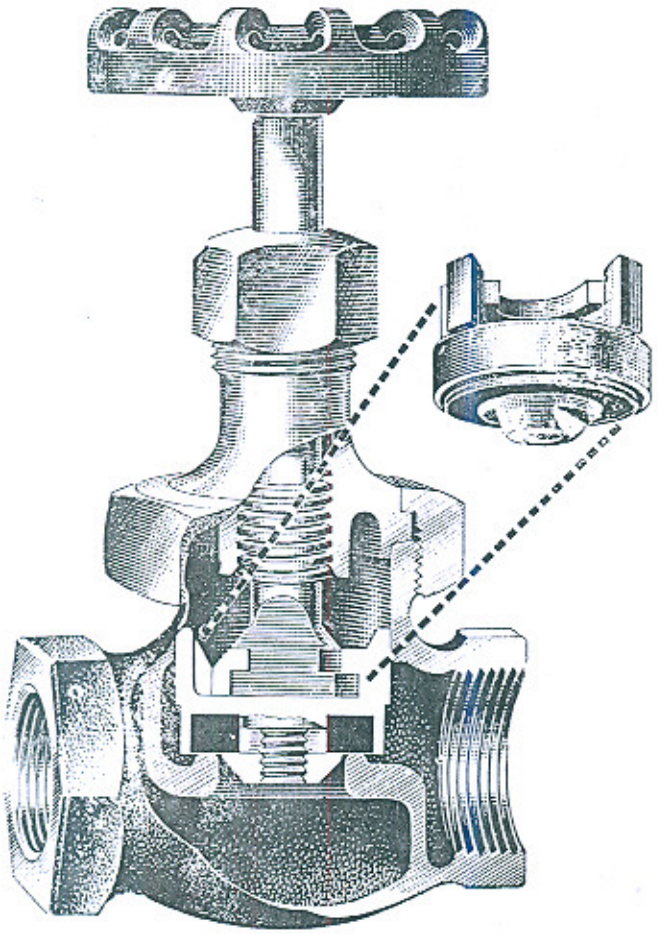
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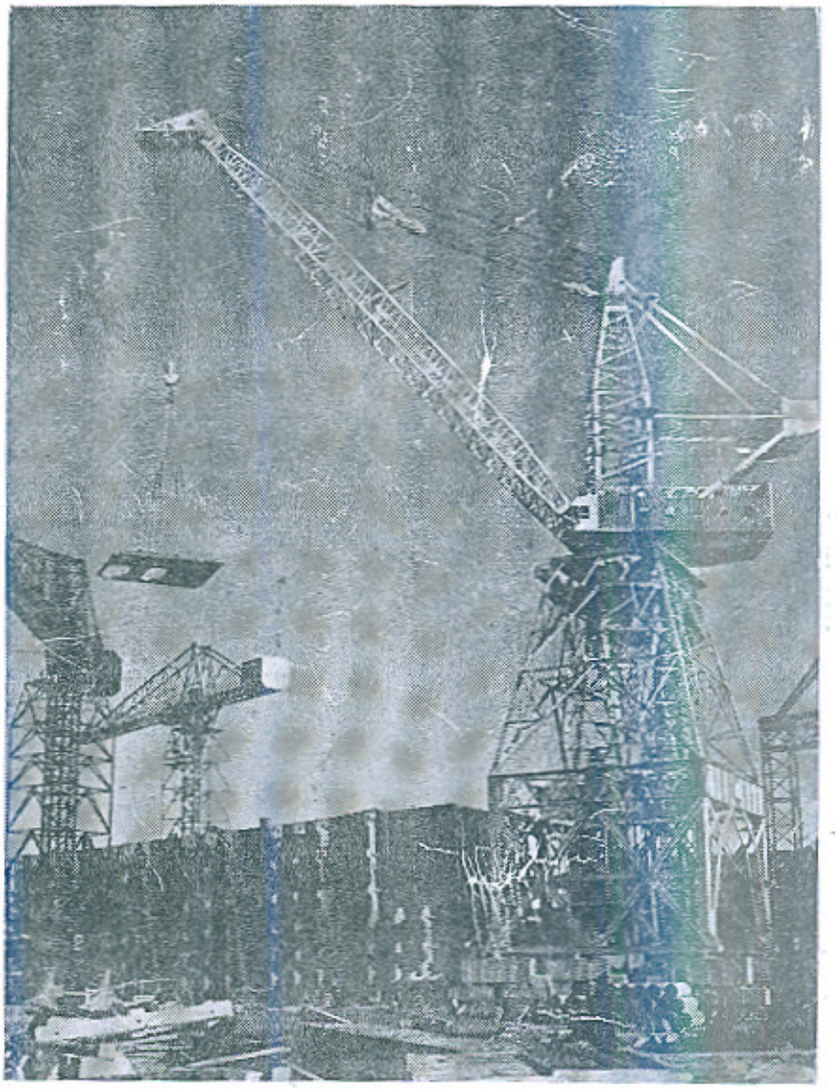
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