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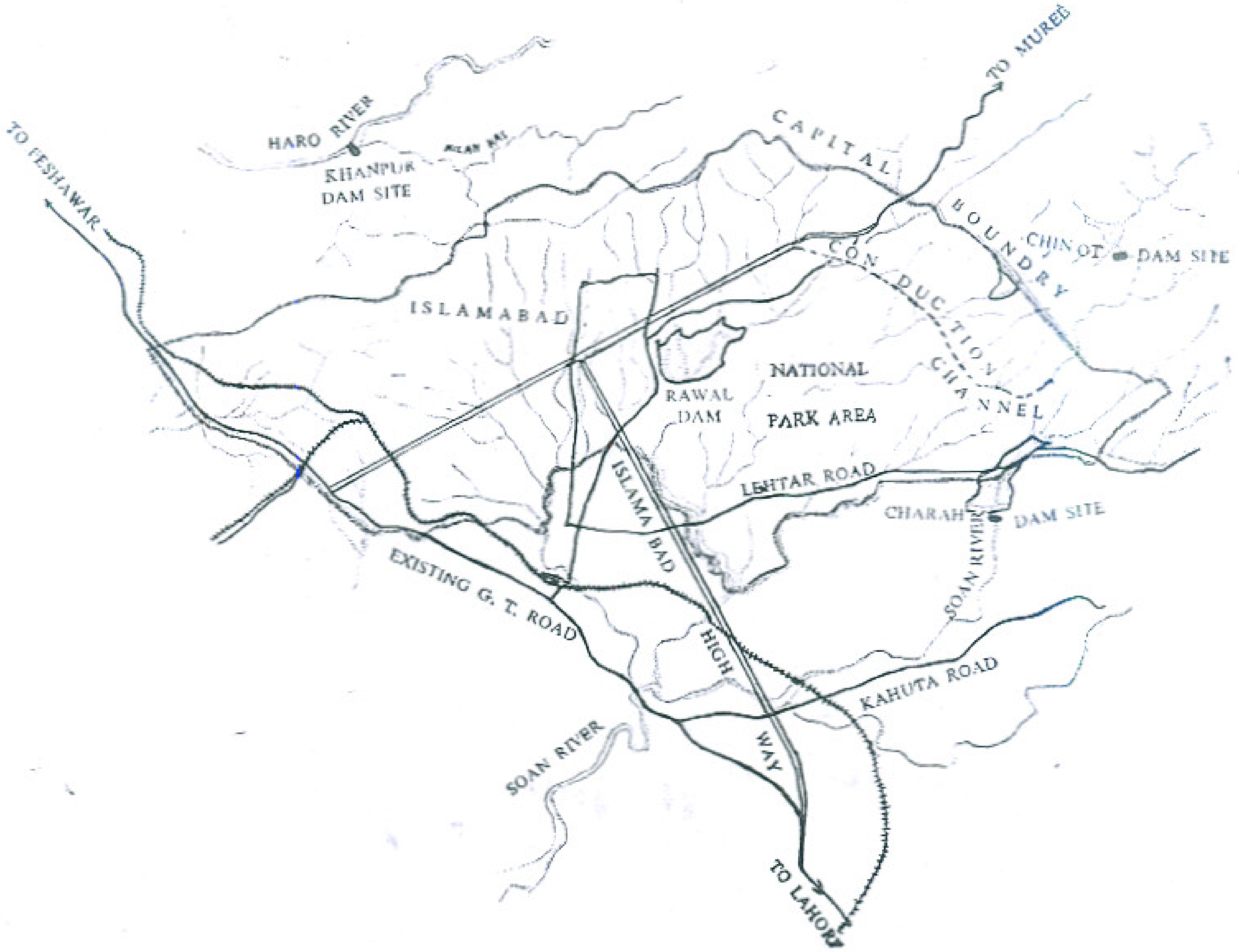

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In this issue


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Editorial

Be Your Own Builders

IN his memorable presidental address to Cento Scientists Dr. I.H. Usmani, Chairman, Pakistan Atomic Energy Commission stressed the lack of knowledge, poverty, hunger and disease in Pakistan. He said that just a few centuries ago Europe envied the wealth of Shah Jehan of India, the splendours of the courts of Iranian Kings and Turkish Caliphs. But it is quite a different story now. The past splendour was a result of the zeal and enthusiasm of the earlier Muslims who dominated the intellectual world. Quoting Robert Briffault from the "Making of Humanity" he said "that never before and never since on such a scale has the spectacle been witnessed of the ruling classes throughout the length and breadth of a vast Empire given over entirely to a frenzied passion for the acquirement of knowledge. Learning seemed to have become with them the Chief business of life. Khalifas and Emperors hurried from their Diwans to close themselves in their libraries and observatories ; to attend lectures and converse on mathematical problems with men of science ; caravans laden with manuscripts and botanical specimens plied from Bokhara to the Tigris, from Egypt to Andalusia".

It is true that, in the race of progress, we lag much behind others, but encouraging examples of Russia, China and Japan are before us. Modern science and technology are not the monoply of a few Nations. They can be acquired in a short time. Given the necessary will and zeal, laurels will come. It is the urge to know which advances a country.

Is not Japan without iron, coal, oil, fibres, minerals, gas, infact any natural resources, afflicted by typhoons, hurricanes and earthquakes, it now vies with the most advanced nations of the world in industrial output.

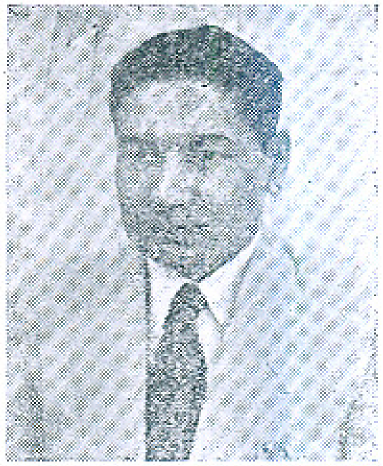
The backwardness of the Czar Russia was proverbial; but has it not acquired the scientific knowledge and technology within a span of 40 years, to rank far ahead of many advanced nations ?

The Engineers of this country had their traditions and excelled in many aspects of the art of building low dams, weirs and barrages. During the last sixty years, was developed a unique technique of building structures in the mighty rivers of the subs-continent ; structures based on sand ; a technique of constructing regime and silt trouble-free channels and an intricate system of irrigation. Even the present dam constructing experts of America found it necessary to learn the technique of founding structures on sand of this country. The foot-prints of the delegations sent a few decades before are still fresh on the sands of our rivers.

The nation stlll has fresh, the technique and background of structures completed by their own skill. Unfortunately at this stage, particularly during the last decade, under the garb of training and acquainting this backward nation with advanced techniques and methods whatever little confidence the nationals of this country had, whatever self reliance existed, whatever ability to think, to experiment, and to solve problems was there, is being snatched away. This spoon feeding by designers, thinkers and builders has already taken away our ability to face our problems and find their solution, and very soon, with the passing of the present generation, sixty years of accumulated technique and knowledge will be dead and gone and this country will become the chattle of foreign countries.

What is happening with the teaching of other sciences ? The more young scientists we train abroad, the more our Institutions have dearth of science teachers. This vacuum can be filled only if we train them ourselves.

Let the nation stand on its own feet, let it scrupulously guard the knowledge and traditions it has developed, let it face its own problems and solve them. A nation with no initiative is worse than dead. Never have mercenaries fought and won. The engineers of the country have a great responsibility to build up the nation. They should rise to the occasion and build their country themselves with their own sweat and labour.



WATER SUPPLY PROJECT OF ISLAMABAD

by
ABDUL HAMID CHOWDHRY. B.Sc., (Roorkee), F. ASCE, M.I.E.P., P.S.E. I.
Director General, Works, Capital Development Authority, Rawalpindi.

The problem of water supply for Islamabad is a major one, confronting the capital development authority. In this article, Chowdhry Abdul Hamid, Director-General Works, fundamentally an Irrigation Engineer and with the background of several years of study and planning of dams has put forth an estimate of future water requirements of the inhabitants of the area. He has analysed the possible sources from which the water could be drawn and the way it could be stored and utilized. The article is very informative.

The problem of supplying water to the residential and industrial sectors of the Capital presents the following main aspects :—

(*a*) Water demand,

(*b*) Water sources, and

(*c*) Permanent solution.

The curves of figure 1 show the population increase of Islamabad and Rawalpindi as foreseen for the next twenty years.

1. Per Capita Consumption of Water

The main factor influencing the design of the water supply system is the average per capita daily water consumption which is influenced by the passage of time, variations of the population character, its needs, its income, the city zoning, the green spaces, etc. :—

(*a*) *Domestic* : This includes all water to be used in and around residences, for drinking, cleaning and washing purposes, for sprinkling lawns and private gardens and, in general, water required by each resident and the house as a whole. This also includes water to be used in business or commercial concerns, and by light industries and handicrafts.

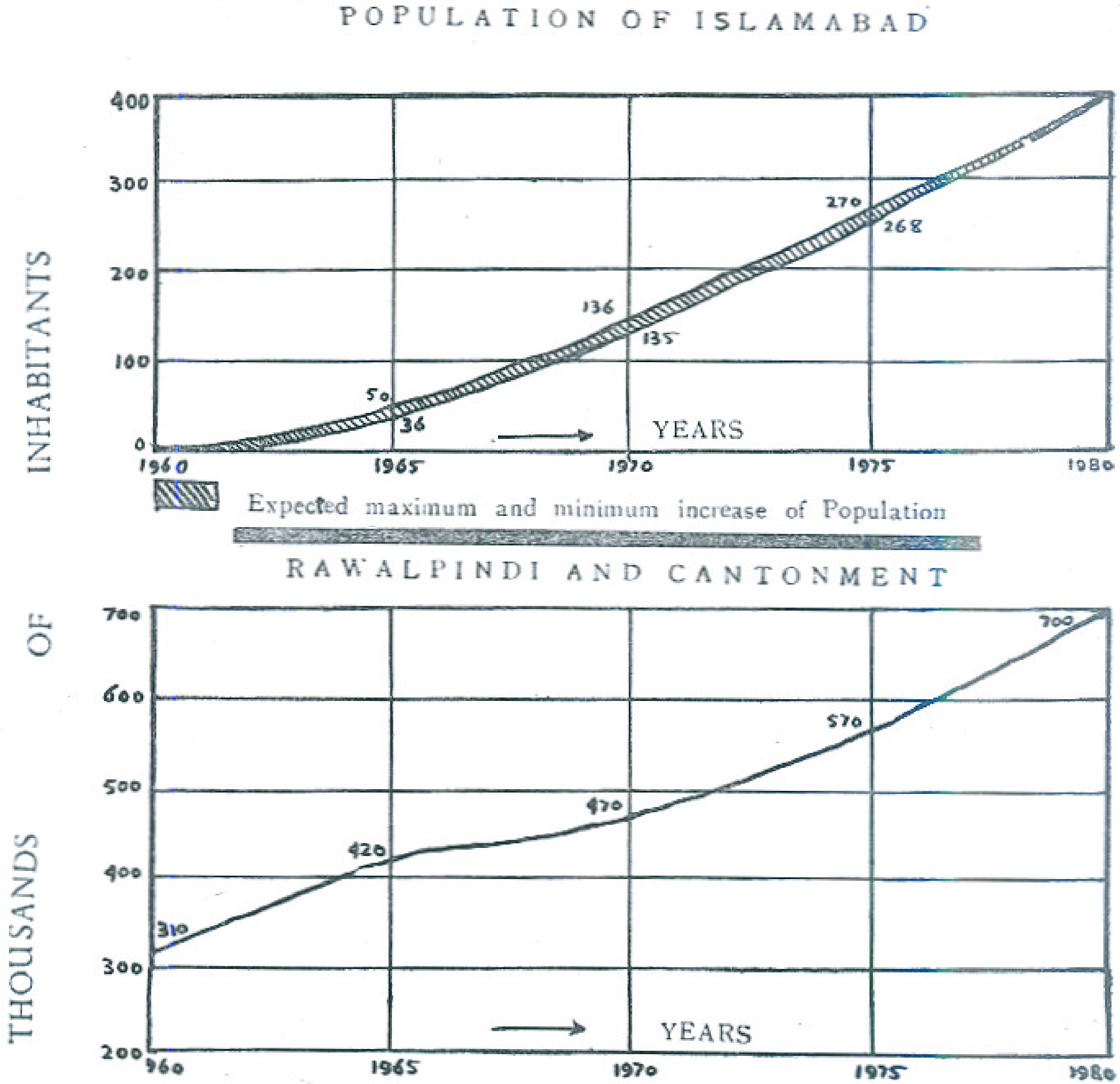
(*b*) *Public* : This includes water to be used for sprinkling large amenity open spaces like parks and lawns. The areas set aside for playing fields are considered to be incorporated in the residential quarters and thus served in the same way as the houses and the buildings.

A unified system for domestic and public needs is proposed to be laid.

2. Water Consumption of Inhabitants

Taking into consideration the expected standards of living, the availability of water and the manner in which it will be supplied to the city, the climate, as well as the

Fig 1



factors for computing peak flows (50% in excess of the seasonal peak and an additional 50% in excess of the seasonal peak for the hourly peak), the average consumption per capita per day for domestic, commercial and light industrial areas has been estimated as follows :—

Year	*Average water consumption per capita per day in gallons*
1965	40
1970	44
1975	47
1980	50

The design of the internal water supply system is based on 50 gallons per capita per day.

It is further assumed that the average per capita per day water for domestic consumption as mentioned above will be broken down among the various consumer groups as follows :—

(*a*) Private houses and minor centres ... 50%

(*b*) Private gardens ... 30%

(*c*) Municipal and major centres (Civic-Commercial-Business) ... 10%

(*d*) Light industry and workshops ... 10%

While working out requirements of water for private gardens, it is assumed that 40 to 60% of each plot in a residential area would be open space needing a delta of 2.25 to 3 40 feet giving an average figure of 3 feet per year.

The above-mentioned percentage and the corresponding daily average per capita water consumption have been taken into account in drawing up the following table.

TABLE

PARTIAL WATER CONSUMPTION IN IMPERIAL GALLONS PER CAPITA PER DAY FOR THE CORRESPONDING USAGES

S. No.	Kind of water usage	Percentage of the total	Total average in years			
			1965 40g/c/d	1970 44g/c/d	1975 47g/c/d	1980 50g/c/d
1	Private houses and minor centres.	50	20.00	22.00	23.50	25.00
2	Private gardens	30	12.00	13.20	14.00	15.00
3	Municipal and major centres.	10	4.00	4.40	4.70	5.00
4	Light industry and workshops.	10	4.00	4.40	4.70	5.00

3. Water Requirement of Industry and Lawns

In addition to the above mentioned unit consumption for the main part of Islamabad, there are some special areas whose needs of filtered water should be based for the time being on area basis. These are :

(*a*) Industrial area.

(*b*) Green areas with special buildings and highway terminals.

(*a*) Water Demand in Industry

In order to develop the industrial zones, especially those South of Murree Highway, provision has to be made for a water supply system capable of supplying each industry with the water it needs. It is not possible, however, to estimate how much water will be required, as this will depend largely on the number and types of factories, their capacity, schedule of work, technique, standard etc. Before a proper water supply system can be planned for the industrial zone, it will be necessary for each factory to give an estimate of its daily requirements. It is probable that there will be industries with a very high consumption, *i.e.* industries in which water is the raw material required in processing their products, and that there may be industries which will need water only for washing and cleaning purposes. The water supply system is, of course, not being planned on the basis of either of these extremes. To assume that all the industrial plots have a high water consumption would result in the use of very large conduits and an increase in the cost of the system. On the other hand, plans based solely on the rates of consumption common to all types of industry would make no allowance for the greater needs of certain industries, and would therefore, not be a practical proposition. In seeking a reasonable average rate of consumption which permits, a fair degree of approximation, an average daily consumption of one gallon per square yard, or approximately 5000 gallons per acre, has been assumed.

(*b*) Water Demand in Green Areas

With due consideration for the conditions prevailing in Islamabad, a quantity of 500 g.p.d. of filtered water per acre is proposed for green areas in special buildings and the highway terminal area. This quantity of water or sprinkling public greens depend on the green areas and the delta per year needed in excess of rainfall. A three feet delta of water per year has been adopted.

4. Total Water Demand

Table No. 1 based on expected population and consumption data, shows the anticipated average daily water consumption for domestic use and sprinkling purposes over the next 20 years.

TABLE NO. 1

AVERAGE DAILY WATER CONSUMPTION FOR DOMESTIC AND SPRINKLING PURPOSES IN ISLAMABAD.

Year	Expected Population in Thousands (Inhabitants)	Area Occupied 20 inh/acre, in 1000 (Acres)	Area of Green spaces 4ac/1000 inh. (Acres)	Daily Average Consumption Sprinkling delta of 3.0 ft. per year (Domestic Imp. Gallons)	Average Daily Consumption Domestic in 1000 Imp. Gallons)	Average Daily Consumption for Sprinkling in 1000 Imp. Gallons	Total Daily Consumption Domestic Sprinkling in 1000 Imp. Gallons
1961	5	0,25	20	32	160	44	204
1962	12	0,60	50	34	408	111	519
1963	20	1,00	80	36	720	178	898
1964	28	1,40	110	38	1,064	245	1,309
1965	36	2,21	140	40	1,440	312	1,752
1966	60	3,00	240	40	2,400	535	2,935
1967	83	4,15	330	41	3,403	736	4,139
1968	106	5,30	425	42	4,452	948	5,400
1969	130	6,50	520	43	5,590	1,160	6,750
1970	150	7,50	600	44	6,600	1,338	7,938
1971	162	8,10	650	44	7,128	1,450	8,578
1972	188	9,40	750	45	8,460	1,673	10,133
1973	215	10,75	860	45	9,675	1,918	11,593
1974	241	12,05	960	46	11,086	2,141	12,227
1975	268	13,40	11,070	47	12,596	2,387	14,983
1976	294	1,47	1,180	47	13,818	2,632	16,450
1977	320	1,600	1,280	48	15,360	2,855	18,215
1978	347	1,735	11,390	49	17;003	3,101	20,104
1979	376	1,880	1,500	49	13,424	3,346	21,770
1980	400	2,110	1,600	50	20,000	3,569	23,569

Figures taken from Dox—PA 83
Equal to 2231 Imp. Gal./Acre/day.

5. Water Sources

As the whole of the urban and agricultural area of Islamabad is to be developed to a high degree in the years to come, the water requirements will increase accordingly. The capital will develop and function in close corelation with the old town of Rawalpindi and the surrounding agricultural area. The needs of the new city will be met more or less by the same water resources as the remaining area. It is thus of great importance to examine the water sources of the whole area, and their sufficiency with regard to the total water consumption of the area, after a reasonable time period. In order to meet the special water requirements of the new city during the first stages of its development, account was taken not only of the existing water resources, but also of those which are possible to be developed in the near future.

Under "existing water sources", the Rawal lake and the existing springs in the area have been considered. Under "possible water sources" the probable tube-wells and various large water reservoirs which it is possible to construct in various locations within the surrounding area, are listed.

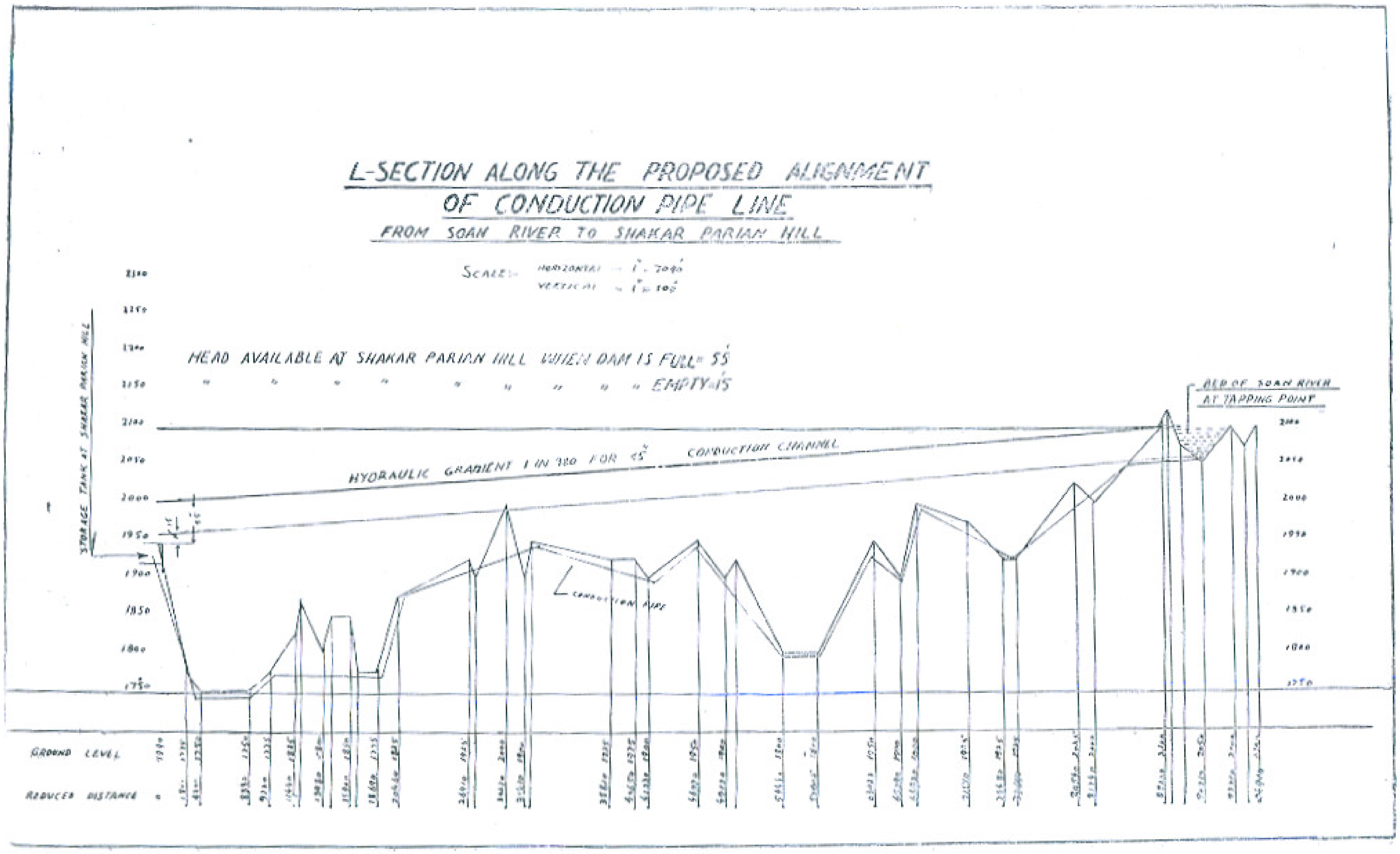
(*a*) *Rawal Lake* :—To be more accurate the above mentioned existing source is not the Rawal lake but Kurang river and its corresponding catchment area upstream of the Rawal Dam. Kurang river is now practically controlled by Rawal lake. Any attempt to divert its water at higher elevations or construction of another dam in the upper reaches, would seriously affect the operation and revenues of Rawal lake, which is capable of giving 110 cusecs of regulated discharge throughout the year. Out of this 30 cusecs (16.5 million gallons per day) have been earmarked by WAPDA for water supply to Islamabad, Rawalpindi and Cantonment. Out of this supply 10 millions, must be given to Rawalpindi and Cantonment which includes 3 million, per day to be given as a matter of right free-of-cost. The remaining quatity of about 6.5 million gallons per day would meet the requirements of Islamabad upto 1968 only after which new sources of supply will have to be tapped. Even upto 1968, heavy pumping would have to be resorted to, entailing capital cost and heavy recurring expenditure.

(*b*) *Springs* :—There are mainly two groups of springs in Islamabad *viz.* (*i*) The Saidpur springs, and (*ii*) the Nurpur springs. Saidpur springs rise in the Saidpur area at an elevation of 2050 ft. and have a minimum discharge equal to 1.7 cusecs. The source of the Nurpur springs is at a high elevation but it can be tapped at an elevation of 2200 ft. Discharge measured upstream of the village of Nurpur was found during droughts to be about 2 cusecs.

Based on the discharge observations carried out during one year (11-7-60 to 10-7-61), it is believed that at least 3.3 cusecs, which can deliver 1.7 million gallons per day to Islamabad throughout the year, can be obtained from the Saidpur and Nurpur springs during the worst periods.

(*i*) *Soan River*—Charah Dam. Among the "possible water sources" Charah Lake (see fig. front page as F2) has been considered as a source of supplementing the water supply of Rawal Lake. A report has already been prepared by the Associated Consulting

Fig. 3


L-SECTION ALONG THE PROPOSED ALIGNMENT
OF CONDUCTION PIPE LINE
FROM SOAN RIVER TO SHAKAR PARIAN HILL
SCALE:-
HEAD AVAILABLE AT SHAKAR PARIAN HILL WHEN DAM IS FULL= 55'
" " " " " " " " " EMPTY=15'
HYDRAULIC GRADIENT 1 IN 380 FOR 45" CONDUCTION CHANNEL
CONDUCTION PIPE
STORAGE TANK AT SHAKAR PARIAN HILL
BED OF SOAN RIVER
AT TAPPING POINT
GROUND LEVEL
REDUCED DISTANCE

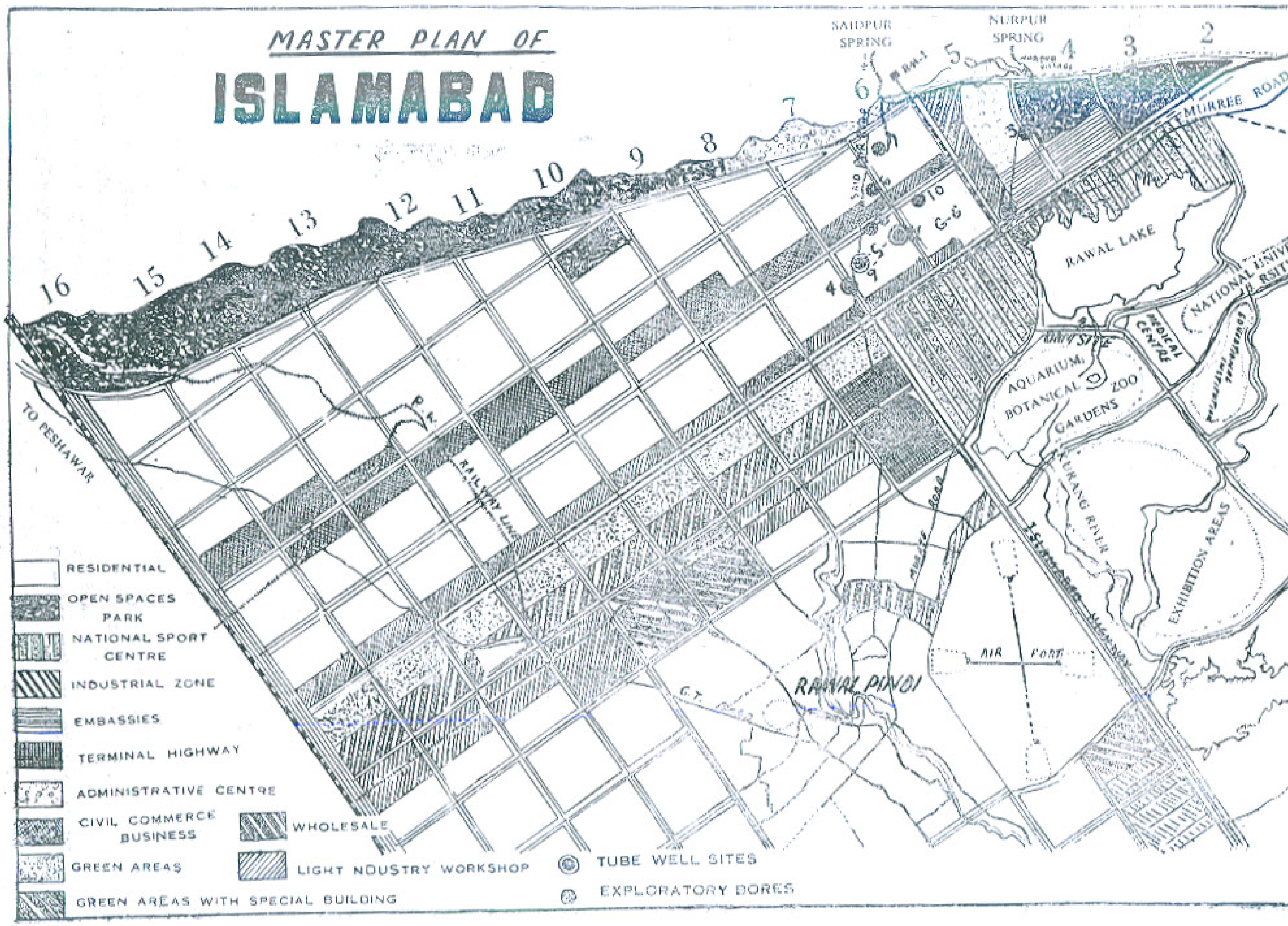
Engineers on this Project which shows that a reservoir of 76,241 cft. (gross capacity) can be created by constructing a masonry arch dam 175 ft. high at a cost of Rs. 200 lacs. The dead storage level would be 1875 ft. A conduction channel 14 miles long will have to be constructed for diverting Charah reservoir into Rawal Lake. Twenty-five ft. head would be lost in the conduction channel. The level of water at delivery point in Rawal Lake would thus be 1850 ft. Most of the area of Islamabad being above this level, even after spending Rs. 200 lacs on Charah Dam and conduction works, pumping will still have to be resorted to for supply to Islamabad.

(*ii*) *Chinot Dam* :—Soban river can be tapped at a higher level. If it is tapped at a level of say 2050 ft. and the water is carried through mains, it can be delivered by gravity to Islamabad at 1950 ft. level, which would cater for the major portion of the area in Islamabad. (See alignment proposed of main in fig. 3) Soan river has been gauged at Chinot and it was found that the minimum flow at times becomes as low as 2 cusecs. There is however, plenty of run-off in the river in wet season and if this surplus water is stored, the requirements of Islamabad can be met by gravity up to the year 1980.

To cope with the water needs of the whole area of Islamabad by gravity, efforts have to be made to find potential dam sites above 2050 ft. There are three potential dam sites on Soan river above 2050 contour namely Barahotr Samli and Chinot. The Chinot site appears to be best from considerations of run-off, access to site, narrowness of the gorge, and other geological and physical factors.

Capacity of Chinot Dam.—According to preliminary studies on the Project it is found that a masonry arch dam of 170 ft. height would impound 12,587 acre feet (gross) of water at a full reservoir level of 2,647 ft. The location of this Dam is 12 miles upstream of Cheerah Dam site. About 45 cusecs regulated release from Chinot Dam can either be let down the river for diversion into mains at Sambli Tajjal, 3 miles downstream, or led through a tunnel of 3 miles upto Sambli Tajjal The dead storage elevation at Chinot is 2585 ft. and the off-take of mains is proposed at 2050 so that a fall of 545 ft. can be created by constructing a 3 miles tunnel connecting Chinot with mains. Forty-five cusecs continuous discharge could thus produce a firm hydel power equal to 1500 kw.

Islamabad water requirements (domestic and irrigation) upto the year 1980 are estimated at 45 cusecs out of which 3.3 cusecs are available from Nurpur-Saidpur springs. The balance of 42 cusecs is proposed to be met from Chinot Dam. Soan river near Chinot Dam site is being gauged by West Pakistan Government Staff since 19-2-60. Discharge studies of the inflows and outflows showed that to get 42 cusecs continuous supply only 7100 c. ft. live storage is required in comparison to the 9,548 expected live storage of the Chinot Dam. This will give a spare Capacity of 2448 c. ft. equivalent of about 1.5 million gallons per day. It is proposed to utilise this capacity for meeting the requirement of National Health Centre, Islamabad University and other institutions in the National Park area which are not commanded by Rawal Lake.


MASTER PLAN OF
ISLAMABAD
SAIDPUR SPRING
NURPUR SPRING
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
MURREE ROAD
TO PESHAWAR
RAILWAY LINE
RAWAL LAKE
NATIONAL UNIVERSITY
MEDICAL CENTRE
AQUARIUM, BOTANICAL GARDENS
ZOO
KURANG RIVER
EXHIBITION AREAS
AIR PORT
RAWALPINDI
ISLAMABAD HIGHWAY
G.T.
RESIDENTIAL
OPEN SPACES PARK
NATIONAL SPORT CENTRE
INDUSTRIAL ZONE
EMBASSIES
TERMINAL HIGHWAY
ADMINISTRATIVE CENTRE
CIVIL COMMERCE BUSINESS
WHOLESALE
GREEN AREAS
LIGHT NDUSTRY WORKSHOP
TUBE WELL SITES
GREEN AREAS WITH SPECIAL BUILDING
EXPLORATORY BORES

The conducting mains:—Several alignments for the mains conducting water from Sambli Tajjal to Shakarparian Hills are feasible. Final selection of the alignment would be a matter of detailed study of the site topography, geology and economics. A tentative alignment from Sambli Tajjal to Shakarparian Hills is shown to the attached profile. It will be seen that the $18\frac{1}{2}$ miles length in prestressed concrete pipe, 45 inches in diameter to withstand a pressure of 200 ft. static head would have to be laid. The rough cost estimate is :

One mile tunnel	...	Rs: 6 lacs.
$17\frac{1}{2}$ miles pipe laid in position	...	Rs. 14 lacs

The requirements of water for Islamabad upto 1973 would be 11.5 m.g.p.d., *i.e.*, half of the estimated requirements by the year 1980. Half the capacity of 45 inches dia. mains may, therefore, remain un-utilised upto the year 1974. If the economics justify, 26 inches dia. pipe may be laid in the first instance and the same dia. pipe duplicated by the year 1974. Of course the tunnel and crossings over nullahs would have to be designed on 1980 population basis.

(*d*) *Tubewells :*—The second "possible water sources" is the tube wells. Eleven exploratory borings as shown in Fig. 4 were done in Islamabad area. Four of them prove to be prospective sites for development of tube wells. Trial borings are now in hand. If the yield of the bores and the quality of the water are acceptable, they would be converted into tube wells and integrated into the water supply system by sending their water up to the nearest water reservoir.

6. General Layout of the Water Supply

The water distribution system for Islamabad is designed with the highest possible flexibility so that it might receive and distribute water from any of the above sources and to any point of its area. Should, for instance, the construction of Chinot Dam prove unfeasible it is very probable that resort is had to Rawal Lake and water sent to the system by pumping. In this case Rawal Lake would have to get supplement water from Cheerah Dam.

There are large differences in elevation between the various parts of the city which fluctuate between 1700 ft. and 2000 ft. resulting in high pressure at the lowest points of the system either during pumping from the lowest points or during reverse flow of the water from the high point reservoirs towards the distribution system. The water supply of the city has, therefore, been divided into high and low-service systems, each having its own distribution pipes and distribution reservoirs. As a boundary line between the two systems, 1850 ft. contour has been selected with location of the low-service area distribution reservoirs on the Shakarparian Hills, as the centre of gravity of the whole low area system.

Pumping water from Rawal Lake towards the low and high service area of Islamabad through separate rising mains has to be adopted to avoid raising the whole quantity of the water to the highest points of the system and then distributing it through an integrated system.

It is estimated that pumping of water from Rawal Lake would entail continuous recurring expenditure of approximately

Rs. 10 lacs a year. For this reason investigation of the feasibility of the Chinot Dam has been given a high priority. In the event of its feasibility the headworks of the whole supply system, at as high an elevation as possible, would be located so that the water requirements of Islamabad will be met by gravity flow. In any case, the main distribution reservoirs and the way of performance of the distribution system would remain unaltered.

7. Immediate Construction Programme

Both the springs, Nurpur and Saidpur, yield at least 1.70 million gallons per day, which would be sufficient to meet the requirements of the Capital upto the year 1964. Ultimately, these sources would be reserved for the high service area only. For further increase of the water supply, the choice would be among tube wells, the existing Rawal Lake and a dam on Soan river-Chinot or Cheerah. The selection would depend on the economics and the time factor, which can be studied only after detailed investigations are carried out. In any case, Soan river would have to be harnessed.

It is estimited that little filtration is required for treating the Saidpur spring water. However, the Nurpur spring water would need complete filtration since the water becomes turbid during the rainy season. The spring water, however, presents some degree of hardness. This will necessitate the softening of the water by using lime in special sedimentation tanks to be constructed preceding the filter beds or the water storage reservoir. Chlorination would follow the softening process. The construction of the following works is in hand :

(a) *Low Service Area* : Water collection works to be constructed at an elevation 2050 ft. for sealing the Saidpur springs and conducting part of the spring discharge, equal to 2.5 cusecs, to the low service area. The remaining amount of the discharge, overflowing from a special weir will be left to be used for local irrigation purposes. The spring water, after having been collected, will be conducted to a baffled mixing chamber to be mixed with lime or other coagulants and immediately afterwards will pass through a sedimentation tank for the settlement of the calcium compounds. This water, after having been chlorinated, will be sent directly by gravity to the distribution system of the low service areas. During the low water demand of the system surplus water will be discharged to the RL_1 water reservoir to be constructed at Shakarparian Hills (elevation 1950 ft.). Reservoir RL_1 is one of the two 450,000 gallons capacity reservoirs provided for in this location in the final design of the whole network. Continuous water demand of the industrial sectors (I-9), South of Murree Highway, and peak demand of the low service residential areas North of Murree Highway (G6, G7) can be met from the above-mentioned reservoir RL_{1}. Supplementary water needs, arising during the development, will be met from tubewells discharging directly to the reservoirs. Upon the completion of the Soan river installations and the laying of the main feeders, the group of reservoirs at Shakarparian Hills will be fed directly by gravity from the Soan river works. Should the Soan river work prove unfeasible, pumping water from Rawal Lake to the Shakarparian reservoirs would be resorted to.

(*b*) *High Service area* : Water collection works will be constructed at a suitable location in a torrent North of the village of Nurpur at an elevation of 2150 ft. The collection work will mainly consist of an infiltration gallery which will lead water to the water softening installations and filtering installations to be constructed nearby. The softening installations will consist of a baffled mixing chamber and sedimentation tank, similar to that which is to be constructed at Saidpur springs. Water, passing through the sedimentation tank, wlll be filtered, chlorinated and stored in a 250,000 gallon capacity reservoir RH_1. This reservoir will be connected directly to the high service water system. The RH_1 reservoir will be utilised as a permanent one of the development of the system. Should the Soan works prove feasible, new reservoirs at suitable locations will feed the high service area system, otherwise water would have to be pumped from the Rawal Lake to the reservoir RH_1.

8. **Conclusions**

(*i*) The springs of Saidpur and Nurpur are to be commissioned immediately to meet the requirements of Islamabad by gravity up to 1964. Storage reservoirs, softening, filtration and chlorination plants, would be installed at suitable points.

(*ii*) Trial boring for exploitation of under-ground water are continuing. All borings which prove prospective would be converted into tube wells and their waters sent directly to the nearest water distribution reservoir.

(*iii*) The feasibility of the Chinot Dam, the tapping and conduction works of Soan river to divert part of its water to Islamabad are being planned. Should these prove feasible, they would provide the main and permanent water supply source to Islamabad by gravity.

(*iv*) The combined discharge of the springs and diverted supplies from Chinot would take care of the entire demand of Islamabad upto the year 1980, and would have 1.5 m.g.p.d. surplus available for feeding by gravity the National Health Centre, Islamabad University and other institutions in the National Park Area which cannot be commanded otherwise.

(*v*) Should the construction of Chinot Dam prove unfeasible, Rawal Lake would be resorted to for sending water to the distribution reservoirs of Islamabad by pumping.

(*vi*) By the year 1980, Islamabad would have developed further West of G.T. Road. Development after this year would come under the command of Khanpur Dam on Haro river. This source may then be tapped, and its water utilised for the expanding portions of the Capital.

ACKNOWLEDGEMENTS

References have been freely made to :

(1) Various reports by Chief Consultants—Doxiadis and Associates.

(2) Associated Consulting Engineer's report on Cheerah Dam.

CENTO
SCIENTIFIC SYMPOSIUM

(LAHORE Jan. 8—13, 1962)

The Pakistan Atomic Energy Commission organized a Symposium of the Central Treaty organization countries on. "The Role of Science in the Development of Natural Resources". The subjects of the symposium included Fuel and Power, Hydrology and Water Conservation, Atomic Energy, Plant Products, Forestry, Agricultural and Soil, Public Health and Animal Husbandry. The subjects were discussed in ten sessions. In this issue we give brief information on the participants and the subjects discussed. Brief extracts from the addresses of the Presidents are also given.

The symposium was well organised. Many top scientists of Cento countries participated. The United Kingdom sent Sir William Slater F.R.S and Prof. D.H. Wilkinson F.R.S. Prof. D.K. Todd, Dr. Earnest G. Watson and Dr. I. H. Schoonover represented the U.S.A., Dr. G.H. Mojidi, A.A. Azad, Dr. A. Rafri. Eng. Rakhahani and Dr- R. Rafyi were sent by Iran, Dr. W. O. Lock Gernf, Geneva, Prof. Fabri Domanic and Prof. Fabri Firat represented Turkey, Dr. William L. Haltiwanger adviser T.C.M., and Armin Grunewald T.C.M. came from New Delhi.

A large number of scientists from the home country participated. Their names are given along with the subjects of their addresses. After the inaugural addresses by Dr. I.H. Usmani and Mr. Akhtar Hussain, Minister for Education and Scientific Research, and brief addresses of delegates from U.K., Iran, Turkey and the U.S.A., the regular session on Fuel and Power started. The Chairman, Prof. Fabri Domanic of Ankara University, Turkey, called on five speakers on the subject, which included :—

(*i*) Mr. M. Yusaf who spoke on "Why Pakistan should have nuclear power".

(*ii*) Mr. Ashiq Ali, on "Natural gas utilization in Pakistan."

(*iii*) Mr. Kabir-ud-din Mirza, on "The roll of natural gas in national development."

(*iv*) Mohi-ud-din Khan, on"Superiority of Hydro-electric over thermal stations in Southern area of West Pakistan."

(*v*) Eng. Rakhsham of Iran on "The roll of science in the natural gas fertilizer scheme in Shiraz."

The Hydrology and Water Conservation Session was presided over by Mr. Todd of California University, Berkelay, who spoke on Hydrology in National Development Programme. The speakers on the subject included Dr. Mushtaq Ahmad, who dealt with Hydraulic Models in the Development Project of Pakistan, Dr. Nazir Ahmad, on Exploitation of Ground Water, a Review of the Technique Developed in Pakistan. Mr. Ahmad Tariq on Surface Water Resources of Federal Capital Area of Rawalpindi and Mohammad Rafi on the Role of Water-shed in the Development of Water Resources of Pakistan.

The session on Atomic Energy was presided over by Prof. D.H. Wilkinson of Oxford University who dealt with relationship between pure and applied research. The other participants included Prof. A. A. Azad of Iran, Prof. Fabri Domanic of Turkey and Mr. W.O. Lock Gern of Geneva who spoke respectively on Atomic Energy Problems of Iran, Atomic Energy Projects in Turkey and international Co-operation in Scientific Research.

Dr. Salimuzzaman Siddique of the Pakistan Council of Scientific and Industrial research presided over Plant Products session. Mr. M.M. Ally of Dacca spoke on Potentialities of Medicinal Plants of East Pakistan. Mr. M.Q. Khuda spoke on Research on indegeneous Drugs in Pakistan, Dr. Rifat Hussain Siddiqui discussed Medicinal Herbs, their Conduct and Development and Dr. Karim Ullah gave information on Application of Our Forests and Plant Products.

The sixth session on Forestry was presided over by Mr. Amir Ahmad Khan, who discussed the Scope of irrigated Forests in Land Use Planning of Pakistan. The next five speakers and their subjects were, Prof. Fabri Firat, Forest Wealth of Turkey, Dr. Abdul Hamid Khan, Arid Regions of Pakistan, their Problems and Potentialities Mr. M.A.K. Khalil on Forest Resources and Research Problems of East Pakistan, Mohammad Sharif Choudhary on Forest in Relation to Catchment Hydrology and Range Land Management.

The Agricultural and Soil session was presided over by Sir William Slater when Prof. W.T. William spoke on the Role of Experimental Botony on Agricultural Development. He was followed by Dr. Mohammad Afzal on the Role of Science in the Development of Agriculture, Dr. A. Wahab on Soil Problems of Pakistan, Dr. William L.Haltiwanger on Improved Seeds, Dr. Maqsood on Role of Atomic Energy in the Develomennt of Agricultural Science, Dr. A.G. Asghar on Salt Tolerance of Crops, Mr. Armin Gruenewald on Scientific Approach to Soil Survey and Dr. A.B. Khan on Some Aspects of Availability of Soil Nutrients with Special Reference to Pakistan.

The seventh session was on public health. Dr. C. Mojidi of Tehran, who presided, spoke on the Scientific Problems in Malariology Programme of Iran, Dr. Kh. Samad Ahmad dealt with Public Health Problems in Pakistan, Dr. M.S. Qureshi dealt with Some Scientific Aspects of Malarial Mosquito Control, and the last speaker was Dr. Niaz-ud din of the Institute of Hygiene and Preventive Medicine, Lahore.

The last session on Animal Husbandry was presided over by Dr. H.E. Carver of T.C.M. New Delhi. The three speakers were Dr. R. Rafyi of Tehran who spoke on Eradication and Control of Epizootic Diseases in Iran, Col. M. Masud on problems of Animal Nutrition in Pakistan and Dr. S.M. Sarwar on Animal Health in Developed Countries with Special Reference to Pakistan. In the afternoon session, Dr. Irshad Ahmad Sheikh spoke on Utilization of Indegenous Waste Product in Animal Husbandry. The last speaker was Mohammad Nawaz of the College of Animal Husbandry, Lahore.

The symposium came to an end after holding a panel discussion in which all the top scientists took active part.

Fuel and Power

Experts should keep under review the feasibility of nuclear power relative to the cost of generation from conventional sources.

Hydrology and Water Conservation

(*a*) As the number of technically qualified persons working in water resources is inadequate, efforts be made to increase educational facilities inhydrology in the CENTO nations, to encourage competent students to pursue professional careers in hydrology, and to this end additional hydrology courses in universities should be established ;

(*b*) CENTO national governments should increase financial support of hydrologic research in university and/or government institutions ;

(*c*) CENTO nations should strive to creat unified, water resources agencies which embrace functions of basic data collection, investigations, research, planning, design and constructions, and management of water resources.

(*d*) International cooperation in hydrology deserves the full support of the CENTO nations.

Atomic Energy

(*a*) CENTO region countries should collaborate to work out a research programme round the reactors with the aim of utilizing the research facilities for attaining the maximum benefits ;

(*b*) In promoting the uses and applications of radio-isotopes and radiation sources in the fields of medicine, agriculture and industry ;

(*c*) To increase the international cooperation in this field.

Plant Products

(*a*) CENTO region should take cooperative measures for establishing national and regional centres on the pattern of the 'Bureaux of Plant Industry ;

(*b*) Possibilities of establishing a Drug Research and Development Institute in Iran or Turkey should be explored as a cooperative measure among CENTO countries.

(*c*) Efforts be made to facilitate the exchange of experience, scientists, experts and plant materials among the countries of CENTO region.

Forestry

(*a*) Utilization of the forest wealth in the region should be encouraged;

(*b*) Range management should be improved the to make best use of land at present lying ineffective ;

(*c*) Knowledge on Irrigated plantations should be shared with other countries of CENTO region ;

(*d*) The Government of Turkey be asked to provide facilities for forest officers of Pakistan and Iran to study in the Poplar Institute at Istanbul;

(*e*) Turkish experience in forest fires be shared with the other countries of the region ;

(*f*) Encouragement be given to the exchange of technical information among the regional countries;

Agriculture and Soil

(*a*) Basic research in the fields of plant physiology and plant ecology be fostered wherever possible in universities and research institutes ;

(*b*) Maximum efforts be made to promote cooperation at all levels;

(*c*) Efforts be made to intensify and coordinate research to the solution of soil salinity and water-logging problems in Pakistan and the other CENTO countries.

Public Health

(*a*) CENTO Institutes of Nuclear Science be developed further with the assistance of international aid-giving agencies ;

(*b*) There is a great need for further development of health research activities in the region of CENTO governments ;

(*c*) Among research problems first priority be given to transmissible diseases ;

(*d*) Question of development of rural health networks and basic health services be incorporated in the agenda of the future CENTO seminar.

Animal Husbandry

Concentrated efforts be made to develop a coordinated animal disease (viral and parasitic) control programme and to strengthen the animal disease research programme, nutritional research and the development of livestock.

General Recommendations

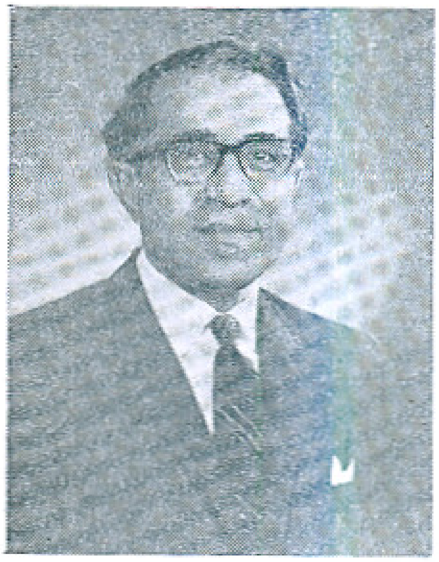
(*a*) It is essential that pure research should be fostered along with applied research and that research should be fostered in the universities.

(*b*) It is recommended that appropriate means of training should be set up.

(*c*) Means be made to encourage exchage of scientific workers among the countries of the region.

(*d*) Means should be taken to build up scientific libraries in the region.

(*e*) In view of the obvious importance of all the subjects included in the present meeting, individual seminars should be held as appropriate on each of these topics at regular intervals.



Presidential Address

by
Dr. I. H. USMANI
Chairman, PAKISTAN ATOMIC ENERGY COMMISSION

This is a brief excerpt from an hour long presidential address by Dr. Usmani. which he delivered at the opening of the Cento Scientific Symposium. In this 14 pages long address Dr. Usmani dwelt on many aspects of the scientific development of the country. The excerpt is in Dr. Usmani's own words.

Lahore Welcomes the Cento Scientists

On behalf of the Pakistan Atomic Energy Commission, I have the honour to extend a very hearty welcome to the members of the Cento Scientific Council and the delegates to the scientific symposium organized by us. We are grateful for the response to our invitation, particularly to the scientists from Iran, Turkey, the United Kingdom and the United States who have travelled long distances and have come so far at great personal inconvenience to participate in the deliberations.

We welcome you all in this cultural centre of Pakistan, rich in the heritage of our past and symbolic of our future.

Common Culture

Iran, Pakistan and Turkey have a common culture, a common religion and a common historical eminence in the sense that the people of of these countries have been rulers of big and prosperous empires in the past. Today we share the poverty and backwardness of our people and the common urge to recover from the lethargy of the past. Fortunately we have friends in the United Kingdom and the United States who are among the most advanced and highly developed countries of the world. We will learn from them what we taught Europe for centuries.

Muslim Rulers and Minorities :

Our faith which originated in the deserts of Arabia 1400 years ago spread from the shores of the Atlantic in the West to the Seas of China in the East. It was not the brute force of the naked sword which conquered these territories but the force of faith which could proclaim the Unity of God and equality and brotherhood of man irrespective of caste, colour and creed. We did not believe in the divine right of Kings but only in the divinity of God, the Creator, the Designer and the Master of the Universe. Islamic history is full of instances where not the sons but slaves became successors of Kings. Wherever the Muslims ruled, they protected the non-muslims rather than destroyed or converted them to their faith by force. The liberalism of Islam did not permit them to put the non-believers to the sword. In Spain the Muslims ruled for centuries but always remained in a minority till the Crusades wiped them out. In India we ruled for nearly seven centuries and had all the power and armed strength to spread Islam by force but even in the heart of the Indian Empire—the Capital City of Delhi—we remained in a hopeless minority till we had to quit. The loss of the Spanish and Indian Empires stands as a testimony of unparalleled liberalism of Islam. Between the second half of the 8th century and 1150 A.D., the Muslims monopolized the intellectual world and contributed to the pool of knowledge in the fields of Mathematics, Astronomy, Physics, Chemistry, Medicine and other sciences.

Eleventh Century Muslim Society

It is tragic that the forces of religious bigotry, orthodoxy and intolerance which began to creep into the Muslim society in the eleventh century, destroyed the progressive elements to such an extent that thinkers, philosophers and scientists began to be purged and persecuted with disastrous consequences to our leadership of the world. Nature abhors vacuum and it filled it up when the leadership passed on to the Jews and Christians who kindled the flame of renaissance in Europe which burns to this day with ever increasing brightness. Gradually the discoveries of the laws of nature began to be applied to solve the problems of every day life so much so that they gave birth to the industrial revolution of the 18th and 19th centuries. Today we witness the unfolding of a breath taking era of the Atomic and Space Age which is a sequence of the development of Science and Technology in the West. Before the advent of the industrial revolution, the standards of living in Asia and contemporary Europe were not very different. In fact Europe envied the wealth of Shah Jehan's India and the splendour of the courts of the Kings of Iran and the Caliphs of Turkey. It was when machines multiplied the production of goods a million times and gave man easy means of communication, power generation and house-building that the gap in prosperity began to widen.

Prosperity Through Hard Work

As a people we must realise that we are living in a period of national emergency fighting a holy war-the war against hunger, poverty and disease. There is no time to stand, no time to muse, no time to stare. We must work at least eight hours a day, seven days in a week, 365 days in a year, to win the battles on so many fronts. Only then can we produce results. There is no short cut to prosperity except through hard work.

Pakistan's 30 M. Male Adults

Out of Pakistan's population of nearly 94 millions nearly 30% are children upto the age of 15 years. If we discount old men and women we are left with a core of nearly 56 million adults. Eliminating women for light work we have 30 million male adults for hard work. An adult is a much better human material to educate than a child. Whereas it takes 10 years to educate a child of 5 years, it takes only one year to make an adult literate and to teach him the use of modern machines and technology. Let us not spend the resources of the country on a man literacy compaign but concentrate on training our adult man-power for increased production. It may be of interest to know that England led the industrial revolution in the 18th century when her percentage of literacy was as low as that of Pakistan of today.

Scientific Education

We must organize the programme of scientific education in a systematic way. The syllabi should change, the books must be reprinted and the teachers must be trained.

Here I cannot refrain from remarking how callous we are to the needs of teaching of science and scientific research in our Universities. Their Laboratories are ill equipped, costly instruments, if any, lie unused for want of spares or repairing facilities, libraries are starved of scientific journals and technical books, workshops are practically non-existent and science teachers draw less pay than stenographers of Secretaries and Ministers to the Central Government. The budget of the Universities is nominal which does not admit of planning in advance because of annual vagaries of financial grants. The total budget of all the science departments of all the six Universities of Pakistan is less than 40% of the budget of the Council of Scientific and Industrial Research, when most of the basic work of the Council could well have been done in the Universities, except when a process reaches the pilot plant stage. Under such conditions no wonder, Sir, that the best of our talented scientists emigrate and settle in countries abroad. If this state of affairs continues, we will produce a generation of angry youngmen with consequences too horrible to imagine.

There is such a woeful lack of facilities for the training of scientists and technicians in every field that till we set up and organize our own institutes we will have to send hundreds of our youngmen to the universities and scientific establishment of advanced countries for some years to come.

Material Resources

Having dealt at some length with man-power, I come to the availability of material resources and money. Japan is a case similar to Pakistan. Her population is comparable to that of Pakistan, but the main islands cover only one third the area of Pakistan. Japan has no iron, no coal, no oil, no fibres, no minerals, no gas. Only 16% of the total area is cultivable. The rest is volcanic ash. It is frequented by typhoons, hurricanes, and earthquakes. Despite these handicaps Japan is the most advanced country of Asia and her industrial output can throw many countries of Europe into the shade. Compare this with the resources of Pakistan with equivalent population. We have almost a world monopoly of jute. We produce cotton, wool, tea, hides, and skins, in addition to minerals like salt, limestone, gypsum chrome ore, natural gas and some quantities of oil. We have nearly 62 million acres of cultivable land but cultivate only 52 million acres—31 million in West Pakistan and 21 million acres in East Pakistan. Our total production of food-grains is a little over 13 million tons which leaves a gap of nearly 3 million tons per year to meet our requirements at the barest existing diet level. The yield per acre is about the lowest in the world. In the industrial sector we have made remarkable progress in that starting from almost scratch at the time of independence, manufacturing now accounts for nearly 11% of the gross national product and the production of large scale industries has increased five fold in the last ten years. Impressive as this record is, Sir, there are serious gaps in our industrial development. Nearly 75% of the industries produce consumer goods and the trend is still in that direction. We seem to have built the top without a base. For a healthy growth, what a developing country needs is cheap and abundant power, good communications and basic chemical and metallurgical industries. Efforts could be made to get the requisite man-power trained and these industries started without delay. There is another serious shortcoming and that is the lack of scientific research in the use of indigenous raw materials and waste products and in the development of designs of machines and processes. What we are, therefore, achieving is not industrialization but "factory-ization". We have unlimited quantities of rock salt, limestone, gypsum and extensive deposits of natural gas and yet we continue to import caustic soda and soda ash. There is, therefore, no reason why a chemical complex of industries cannot grow round these natural resources.

Scientists to Bost Agriculture and Industry

Both in the agricultural as well as the industrial sectors, we can produce more without doing any original research if only we had an efficient extension service which could pass on the benefits of scientific work already done and published. Here we have the paradox of science which all under-developed countries face today. We know, for instance, that we can double our production of crops if we used fertilizers and can preserve the fruits that otherwise perish. We know that plastics can be produced from natural gas and that waste products of one industry can be utilized as raw material for others. Why then is it not possible to achieve the results ? The answer again goes back to non-availability of scientists and technologists.

Money :—

There is not the slightest doubt that the colossal problems which developing countries have to solve, require colossal investment of money. Owing to the limited financial resources they can go ahead to some extent but not far enough. They have, therefore, to depend upon external financial resources. Our friends in the West have given generous aid in the form of commodities, loans and grants, but it is ironical that all the packets of external aid received by developing countries have been completely washed away by the adverse terms of trade due to the fall in the prices of primary commodities which we export and simultaneous rise in the prices of capital goods which we import for our economic development. Mathematically speaking, therefore, no external aid has, in fact, been received. What is given as aid is offset by the loss in terms of trade.

Technology not the monopoly of any nation

Nations like Russia, China, Japan have shown that modern science and technology are not the monopoly of any one nation and that science can be absorbed and techniques can be acquired within the span of one or two generations. The tide of time is irreversable and unless we wake up now and manage our affairs according to the dictates of our Age, we will sink under the weight of our own problems. We are fortunate that our President, Field Marshal Mohammad Ayub Khan, is conscious of the importance of science to the economy of Pakistan. It was because of his deep interest that he appointed a Scientific Commission nearly two years ago which reviewed in great detail the obstacles in the way of development of science in Pakistan and suggested measures to promote scientific efforts of the country. Among other things, the Commission recommended that the following five autonomous research councils should be set up.

(1) The Council of Scientific & Industrial Research,

(2) The Agricultural Research Council,

(3) The Medical Research Council,

(4) The Atomic Energy Council, and

(5) The Council for Irrigation and Works.

Unfortunately the report of the Scientific Commission has gone in the hands of the bureaucrats and administrators who see things from a different angle.

In fact we have still with us in the senior most positions in Government, civil Servants who served the British. When the British ruled here, they had no interest in the planned development of national resources. They set up an administrative machinery which suited their ends. They wanted every policy case to be examined by an Under Secretary, then by a Deputy Secretary, then by a Joint Secretary, an Additional Secretary and a Secretary, members of the Viceroy's Council and finally by the Viceroy himself before it was sent to Whitehall in London for orders.

This tortuous procedure has still remained scared to our administrators.

I beg the Government to accept the recommendations of the Scientific Commission and give us the autonomy we want to build up the scientific efforts of the country.

RADIO ISOTOPE TECHNIQUES
SOLVE
HYDROLOGICAL PROBLEMS IN TURKEY

by

D. I. PAGE

Cento Institute of Nuclear Science Tehran, IRAN.

The Irrigation Engineer is faced with many problems of water flow, the understanding of which is still in its infancy One important problem is that of underground flow. Water seeps through the canal, from the drains and embankments, under the weirs, into pumping well and so on, yet there is no known and exact method which can give an answer to an engineer. The load carried by a stream has not yet been measured. There are only empirical formulae which give only a rough estimate. Very often at high stage of a river none dare to gauge the river. It has sometimes been thought to use latest devices to have an exact estimate. Even development of cracks in under structures. existence of the quantity of cement in set concrete, moisture and density estimate of soil and such several problems have still to be solved by tracer technique. The present paper by Mr. D.I. Page gives a brief account of the attempts, by scientists of the Cento Institute of Nuclear science who along with Mr. D. D. Smith of Isotope Research Division of Atomic Energy Research establishment at Wantage, England, to solve some problems of Turkish Hydrology by this technique.

The General Directorate of the States Hydraulic Works (D.S.I),which is responsible for all water utilisation in Turkey, has set up a Research Department in Ankara. This department has laboratories for routine work such as soil testing and also a field station at the Cubuk Dam, eleven kilometres outside Ankara, where many hydraulic models have been constructed. Much work on dam design, siltation and irrigation problems, is being done.

It was decided that a radio-isotope laboratory would be the most useful aid to future work for water tracing and flow rate measurements. In this connection the Research Department requested advice from the Tehran centre for equipping the laboratory. For this purpose, Mr. D. B. Smith of the Isotope Research Division, at Wantage, England and Dr. D.I. Page of the CENTO Institute of Nuclear Science visited Ankara.

This report describes the problems which were posed by the Research Department and discusses the practicability of tackling them by radioisotope techniques.

Turkish Hydrology.

The annual rainfall on the central plateau of Turkey is about 13 inches and much of this falls in heavy storms. The vegetation is sparse so the run-off time is short, the erosion is great and flooding is normal. A river can reach its maximum flow rate in about eight hours and consequently flow rates are large. A number of rivers are capable of peak flow rates of 60,000 cusecs. Exceptionally, a few can flood at 300,000 cusecs. Much debris is carried by these rivers and eventually is deposited in the dams, resulting in excessive siltation. For example, the Cubuk Dam was constructed in 1936 with a capacity of 22m. cu. meters (240m. cu. ft.) ; echo sounding in 1955 showed the capacity to be only 15m. cu. meters (163m. cu. ft.).

In South-West Turkey, the drainage system results in many lakes being formed in the Taurus Mountains. It is suspected that these lakes discharge through the limestone of the mountains, giving rise to large rivers which flow to the sea. Source to sink relations have not been proved.

There is much movement of water under ground in some parts of the country. This forms a steady water supply when surface rivers dry up.

Hydrological Problems.

(*a*) *Discharge of rivers.*

The two standard radioisotope methods of isotope dilution [1,2] and the total count technique [3] both require complete mixing of the isotope with the river water. The river must be turbulent and narrow enough to ensure complete mixing. Clearly these methods are not applicable to the rivers with the largest flow rates (over 2,000 cu.m/sec.) and widths of 500—1,000m. at flood time.

Hull [3] measured flow rates of between 10-40 cu.m./sec. using between 400-1,000 mC. of activity. For torrents with flow rates fifty times are great, the activity must be correspondingly increased.

This constitutes a large health hazard and the experiment would require much planning. It is not an experiment to be recommended, particularly early in the programme of a radioisotope laboratory.

It appears that radioisotope techniques cannot be used successfully to measure the flood rates of large broad rivers and can be used only as a result of great experience and careful planning to measure flood rates of torrents.

(*b*) *Tracing of debris.*

During flood time large amounts of material, ranging in size from large rocks to fine sand, are eroded by the streams, carried along and deposited down stream to produce siltation. It is important to know the distances the different types of meterial are carried. Techniques for labelling and tracing sand and pebbles [4,5,6] are well tried. The principle is that an amount of material is labelled, deposited in a river and located, after being moved by the water, using portable detectors. So far only experiments using a uniform size of particles have been done. However, the D.S.I. would like a debris tracing experiment carried out on all sizes of particle simultaneously because flood conditions change each time and it would be extremely difficult to correlate a series of experiments (using a different particle size each time) carried out with differing flood conditions. To do a complete size analysis would be extremely tedious. Each particle would have to be located and identified individually. Fortunately the Turkish rivers dry up very quickly after flooding and it becomes possible to examine the river bed and collect the active material. There should, of course, be the same amount of activity on each particle and this is difficult for the smaller particle sizes.

It is suggested that a preliminary experiment using a single size of particles, would be very useful in the first instance and, when experience is gained, the experiment using a heterogeneous mixture could be attempted.

(c) Desnity of suspended matter.

When in flood, a river may carry in suspension 20% of the material which it erodes. A gamma absorption gauge would be quite suitable. Initial experiments can be done using gamma source and detector.

(d) Underground Movement of Water.

Both the flow rate and the direction of movement of ground water need to be known.

If a radioactive solution is injected into the river bed, extensive mixing is unlikely to occur and information can be obtained only by tracing the movement of the pulse. The sample could be injected through a borehole at a suitable depth 1-2 metres apart. These holes would have to ring the original injection hole if there was no information on the suspected direction of flow. Ideally the tracing holes should be deeper than the injection holes, so that change in depth can be plotted ; the holes should also have a tight lining tube to prevent easy movement of water from one depth to another inside the hole. The radioactivity could be detected either by portable scintillation or Geiger counters and traced both horizontally and vertically. Further holes could then be excavated along the expected path of the pulse.

This would not have to suffer ion exchange or be absorbed by the soil. The ultimate tracer to use would be tritiated water. No absorption would occur and the only loss would be through ion exchange with bound hydrogen atoms in the soil. However, the low energy β-particles which are emitted by tritium make their detection very difficult. At present the counting techniques for tritium include incorporating the tritium either in a liquid scintillator or the gas filling of a Geiger counter. It cannot, as yet, be detected in the field and the only method is to take water samples to a laboatory for measurement. This is a very laborious and slow method, rapid water movements cannot be followed.

Until a method is produced of detecting tritium in the field, the use of tritiated water is likely to be severely limited.

(e) Movements of Water in Earth Dams.

Knowledge of water movement through the body of earth dams is important to their design. Theoretically it is possible to inject a labelled sample of water into the face of the dam. However, the network of access holes for the counters necessary to follow the pulse cannot be tolerated in the design of the dam. At present there appears no way to overcome this problem.

(f) Leakage "Piping" Through Dams.

Occasionally water can force a small path through a dam, resulting in a stream emerging from the base of the dam. The problem is to locate the inlet to the "pipe" to seal it. It might be possible to localise the area of entry by injecting active solution at various points in the face of the dam and observing the arrival of the activity at the outlet of the pipe.

(*g*) *Leakage From Canals.*

Shortlived gamma emitting materials must be used for irrigation canals. Suitable ones are Bromine 82 (half-life of 36h), Gold 198 (269d.), Lanthanum 140 (40.2 h) and Sodium 24 (15h).

(*h*) *Source Sink Relation*

Sometime leaks develope through Limestones. It is possible to detect the fession but the flow is so slow that the activity is sometime lost and hence this type of investigation is not considered very practicable with radio-isotopes.

(*i*) *Cement Content in Concrete.*

Estimates of cement content by chemical methods is laborious. Suggestions are put forth to use radio active materials and detect them. The additions are expensive except Boron which effects concrete. It is extremely difficult to reach the required standard of accuracy.

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Scope of Irrigated Forests in Land Use Planning of West Pakistan

by

AMIR AHMAD KHAN

Chief Conservator of Forests, Lahore.

Amir Ahmad Khan presided over the Forestry Section of Cento Scientific Symposium and his address dealt with the irrigated forests of West Pakistan. We reproduce his main inferences in this note.

Land and Water resources.

West Pakistan has an area of 198 million acres of which the Indus Basin occupies 131 million acres. About 23 million acres are irrigated by irrigation channels delivering 313000 cusecs of water through canals, branches and distributaries over 35000 miles in length.

Unfortunately only 6.5 million acres are under forest in Pakistan. This constitutes only 3.1% of the whole area. It compares very unfavourably with the rest of the world. A table for comparison is given below :—

Country		Percentage of forest area as compared to the total land area	Country		Percentage of forest area as compared to the land area
Finland	...	74	Norway	...	21
Burma	...	63	Italy	...	20
Japan	...	57	India	...	20
Sweeden	...	55	France	...	19
U.S.S.R.	(European)	44	Spain	...	14
Austria	...	38	Denmark	...	9
Canada	...	33	United Kingdom	...	6
U.S.A.	...	33	Australia	...	4
Germany	...	24	Turkey	...	14
Switzerland	...	23	Iran	...	12
Poland	...	23	West Pakistan	...	3.1

Irrigated Forests.

Irrigated forests are being raised as compact plantations, shelter belts or check plantations. It is necessary to select a suitable Site, prepare the command maps and then develop the site into small size compartments. It is necessary to design the lay out of the irrigation system.

Choice of space is guided by the greatest possible quantity of marketable material produce in as short a time as possible. Establishment and trading of crops is carried out under set principles.

As to the economics of irrigated forests, in case of Changa Manga plantation which is the oldest, having been started in 1866, and which is now under full production, the last five years average was that the total expenditure per acre per year was Rs. 34.12 and gross income per acre per year was Rs. 129.45, so that the net income per acre per year was Rs. 95.33. The expenditure includes pay of officers, staff labour and water supplies. In comparison, good quality agricultural land with perennial water supply yields an income of Rs. 100 per acre per year whereas land with *Kharif* supply only, hardly yields Rs. 50 per acre. The average income of Rs. 95.33 per acre of irrigated plantation with *Kharif* water supply compares favourably with agricultural crops.

Advantages of Irrigated Forests.

Irrigated forest is a big source of fodder grasses for livestock. Availability of fire wood will result in the saving of 63 million tons of farmyard manure which otherwise is burnt.

Nearly all timber consumed by the Sports Goods Industry at Sialkot is supplied by Changa Manga and the forest plantations. The other indirect advantages are the development of sericulture industry, basket and rope making and maintenance of wild life, besides a place of recreation for the dwellers of big cities.

INDEX TO ADVERTISERS

EXPLOITATION OF GROUND WATER

A REVIEW OF THE TECHNIQUE DEVELOPED IN PAKISTAN

by

NAZIR AHMAD

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SYNOPSIS

Ground water is an important natural source, the scientific exploitation of which can add considerably to the agricultural wealth of the country. During the last fifty years many experiments have been conducted in this country to exploit this resource efficiently and cheaply, both for human consumption and agricultural operations. As a result of extensive laboratory investigations and field tests it is now possible to install a cheap and durable tubewell which can work both as a drainage measure for irrigation of land and water supply. In this note designs of such measures for exploitation of ground water are set forth. Some instances of their field performance are also given.

General.

West Pakistan is as much a gift of the Indus as is Egypt of the Nile. Its vast fertile plains have been built up by the Indus and its tributaries, its agricultural potential is a result of the water which flows through these plains and the very existence of its 41 million inhabitants depends directly and indirectly on this river.

The total catchment area of the Indus is 222.7 m.ac. (Million acres) of which 1300 m.ac. lie within the boundaries of Pakistan. Out of this area the total culturable land of the Indus plains consists of 61 million acres, of which 33 million acres are irrigated from the waters of this river and its tributaries and about 6 to 8 million acres are sown under dry farming. The rest 20 million acres are still needing irrigation.

The vast Indus plains have been built up by the deposition of the alluvium brought down by the rivers In the former province of the Punjab where an estimate of the deposits has been carried out, its thickness at places is more than 10,000 ft. There are at a few sites underground rocks and ridges with out-crops on the surface but the dip of the rocks is so steep that even close to the outcrops, the thickness of the alluvium extends to hundreds of feet. Very extensive boring in this region has recently been carried out generally to a depth of 600 ft. and in special cases upto 1500 ft. The formation has been found to consist of alternate layers of sand, silt and clay. Sand deposits predominate and clay layers of varying thickness are also encountered. Their location often varies at short distances. This formation is saturated with water. Like all water-transported and water-deposited sands, its uniformity, which represents the gradation characteristics, is very high, with the result that although the sand is of medium to fine grade, yet its water yielding character is high.

The underground water reservoir is naturally a result of infilteration from the rivers, the streams and some of it may have been of prehistoric periods, enclosed during the deposition of the alluvium.

So far little is known about the age of this underground water and its exact origin. Perhaps radio isotopic technique, which is proposed to be employed shortly, may yield an answer. The water located in the central regions of the land far off from the influences of the rivers where the original water depth before the introduction of irrigation was very great, is very saline and unfit for human and animal consumption. The depth of ground water before the development of irrigation was 80 to 100 ft. below surface.

The recent analysis of ground water has shown that at some places it has electrical conductivity of 20 to 40 thousands m.mohs per cm.

The land close to the influence of the rivers infilteration had always a high water-table and the quality of the water was suitable so that the earliest land utilization was within the spill of the rivers which deposited fresh fertile silt after every flood, left considerable moisture on the land and the inhabitants who were few in number planted their crops. The water requirement of the crops in other seasons was met by lifting ground water from shallow wells by Persian Wheel.

The Indus plains have many other advantages for growing crops. The temperature of this region lies within a range that can grow two and even three crops in a year, the soil is also generally very fertile but like all arid zones, this region is also deficient in precipitation. Except for a strip of the land near the foot hills, the rainfall is generally insufficient and its distribution is particularly unsatisfactory. Eighty percent of the precipitation occurs in one or two months of the year. Generally there is no rain at the important sowing seasons and artificial irrigation is very essential to grow crops. About 80 to 100 years back the present irrigation system started to take shape and now out of 135 MAF. of annual flow of the three western rivers, Indus, Jhelum and Chenab, 57 MAF are in use and 24 MAF. will be transferred to feed the canals the water of which is being taken away by India. The losses of water amount to 31 MAF so that only 29 MAF will now run off to sea during two summer months of the year whereas originally about 99 MAF used to go waste to the sea. During the winter months the water in the rivers is insufficient for proper irrigation. The country needs large volume of water which is not available in the rivers. Ground Water is the obvious alternative *source* which can be exploited to the maximum extent. The ground water-table after the introduction of irrigation has risen, so that in practically the whole of the Indus plain under irrigation, the water-table now lies within 5 to 20 ft. from the surface. In quite a big area, the water quality is good probably as a result of the introduction of irrigation measure, infiltration from irrigation channels, rivers and the canals. Yet in about 1/3rd of the area the water quality is too bad for direct use by living beings or crops.

Exploitation of Ground Water.

Exploitation of Ground Water for land irrigation was actively considered from 1906 to 1910 and several experimental tubewells were installed in the former Punjab Province. The first project to irrigate in the land by tubewells was completed in 1940 when 20 tubewells were installed in an area close to Lahore. In 1945, a big scheme for the installation of 1800 tubewells in the Rechna and Chaj Doabs ,was undertaken. The scheme was called Rasul Tubewell Project and in a few years about 1500 tubewells were installed.

Recently West Pakistan WAPDA has planned to install about 33000 tubewells in the remaining area of the region.

Design of Tubewell.

The design of tubewell has undergone only slight changes during the last 50 years. The tubewells installed in the region have been of two types, those worked by centrifugal type of pumps and those in which deep turbine pumps were used. All centrifugal pump fitted tubewells have been of two cusecs capacity whereas in the case of turbine pumps, the capacity has been raised from 3.0 to 5 cusecs.

A tubewell generally consists of a strainer made of brass or some other material. The strainer is usually a brass pipe of 8.0 or 10 inches diameter having fine slits with opening varying from 0.25 to 0.6 mm. Usually 8 per cent of the surface area of the brass pipe is covered with slits. It was found that at least 120 ft. of the length of a strainer installed in medium sand was necessary to pump 2.0 cu. ft. of water in one second. It was also found that this type of strainer should have an envelope, upto 3.0′ thick, of fine, one grade hard gravel. The original boring was done either by a casing pipe or by rotary drilling machine to form a bore of 18 to 22 inches in diameter in which the strainer was installed and then it was enveloped by the shrouding material. Regions of fine sand or clay layers which were considered to be zones of poor yield, were blocked by iron pipe of the same diameter as the brass strainer. In a bore of 250 to 350 ft. it was possible to locate about 150 ft. of medium sand in which the strainer could be installed. Such a strainer when pumped by a centrifugal pump coupled to 15 or 20 H. P. motor was found to discharge about 2 cusecs with a suction head varying from 15 to 20 ft. Certain alternatives to brass strainers have also been tried. These included Wooden, Gravel packed with iron bars and Punched iron sheet strainers. The slit width in wooden strainers had been upto 1.0 mm. whereas in a punched iron sheet strainer, slit width upto 1/16 and 1/8 inch have been tried.

TABLE :1

PERFORMANCE OF TUBEWELLLS IN CHAJ & RECHNA DOABS.

Type of Stra-iner	Doab	Total No of Tubewells installed.	Total No. of Working T.W.	Total No of Damaged	Closed due to other Reasons	Giving desig-ned discharge	20% below design	40% below design	30% below design
Brass Strainer	Chaj	443	303/68	102/23	40 / 9	32/10	154/51	76/25	41/14
	Rechna	775	557/72	102/13	113/15	36/ 6	192/35	196/35	133/24
Wooden Strainer	Chaj	50	10/20	60/80	...	4/40	4/40	2/20	...
	Rechna	169	65/38	104/65	...	1/ 2	25/38	20/31	19/29
M.S.Plate Strainer	Chaj	...	...	...	...	...	...	...	...
	Rechna	12	10/83		2/17	...	8/80	2/20	...
Ghafoor Stra-iner	Chaj	...	...		...	...	...	...	...
	Rechna	28	27/96		1/ 4	8/30	11/40	8/30	...
Total		1479	972/65	348/24	189/11	81/ 8	304/41	304/31	193/20

NOTE :—In this table data is given for the number of tube-wells/% with respect to total installed.

Performance Studies.

During the last 15 to 20 years much experience has been gained with the working tubewells having different types of strainers. It has been found that :—

(*i*) the discharge of a tubewell does not remain constant but continues to fall with time.

(*ii*) the depression or suction head which correspond to the power input, continues to increase slowly.

(*iii*) certain tubewells inspite of possessing brass strainer and located in good quality water of conductivity within 500 m. mohs/cm., have started to give quite uneconomical yield after working for 7 to 10 years.

(*iv*) after 7 to 10 years of operation, hardly 8 per cent of the tubewells have been found to give the designed yield fixed at 2 cu. ft. per sec. In 30% tubewells, the yield within this period has fallen below 40% of the design. About 40% of the tubewells have started to yield 20% below design and the rest 20% tubewells are giving 50% below this value (see table 1).

(*v*) this fall in yield is a result of deposition of fine particles of clay, some salts such as carbonates, sulphates and chlorides of sodium and calcium cemented together with the help of iron oxide formed out of the iron pipe. In some tubewells these materials have simply plastered the outside and inside of the strainer and the shrouding around the well. At places where the ground water was highly saline, the incrust formation has been very strong. The deposition of these salts on the metallic strainer may even be as a result of electrically charged ionic particles of clay and of mineral salts.

(*vi*) the presence of salts and oxygen in water in some cases has caused the rusting of 1/8 inch iron pipe within the short period of ten years, so that a damaged iron pipe has resulted in complete failure of the tubewell. In highly saline areas even the pumping machinery was damaged after 7 to 10 years of operation.

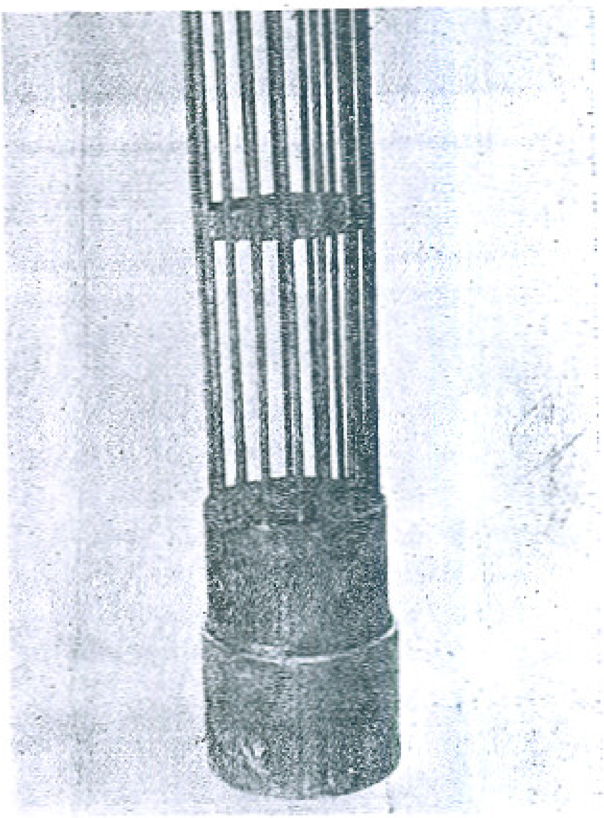
(*vii*) in some cases, the occasional tripping of the electric current has been considered to be a cause of water hammer resulting in damage to weak joint of the strainer and shearing away of the strainer pipe.

(*viii*) if during installation, the shrouding is not uniform or a slit of the strainer is damaged or a slit is too wide and the tubewell starts pumping sand, the removal of underground formation results in a sudden failure of the strainer pipe, damage to the supper structure or sinking of the strainer into the formation, etc.

(*ix*) as a result of these causes, coupled with carelessness of installation, failure of tubewells occurs and this has been found to be of the order of 25% in case of Rasul tubewell project. This percentage of failure has increased considerably due to the general failure of wooden strainer tubewells which have failed due to faulty construction of joints. Very few of these have failed due to incrustation of the formation as has happened in the case of brass strainers.

Cost of a tubewell.

The cost of a tubewell can be split up into the cost of pumping machinery and the cost of installation, construction of the strainer and the blind pipe. A 2 cusecs capacity centrifugal pump fitted with an electric motor costs about Rs. 3500/- or $700. If a deep turbine pump is used, its cost goes up to $ 2600 (Rs. 13,000). This part of the tubewell with proper care can last for 15 to 20 years with minor repairs. The other costly item is the strainer and the iron pipe. A brass strainer of 10 inches diameter costs $ 16.0 per foot and 140 ft. length of this size and type costs $ 2240 (Rs. 11,200). The cost of wooden strainer or a gravel packed strainer also ranges between $850 to $14000. Even the iron pipe of 10 inches diameter costs about $ 6·0 per foot and in case a turbine pump is used, this has to be housed in 14 to 16 inches housing pipes, about 100 ft. long. This adds another $ 1200 to the cost.



IRON CAGE Fig. 1a.

The cost of boring, transport, construction of a pump, discharge measuring tanks etc. is extra.

The cost of brass strainer and iron pipe is constantly rising. A tubewell which could be installed for $ 1600 in 1910-15 and for $ 4000 in 1945, at present costs upto $ 6000. A three cusecs tubewell with iron strainer now costs $ 10,000 and the latest cost estimate which will include the cost of electric transmission and supply is $ 23,000/-.

Naturally the country is faced with two problems, the short life of the tubewells and the exorbitant cost of installation. If the country is to successfully solve its problems of high water-table and salinity, it must have cheap tubewells and lasting ones at the same time.

Certain experiments were undertaken in the Research Institute with these two aims and the results achieved so far are briefly discussed below.

Coir String Strainer, Device No. 1 :—

In order to lower the cost of brass strainer or iron pipe strainer and also to counteract the deposition of incrustation and rust formation, a string type strainer has been evolved for its performance. Initially, an iron cage is made, supported by iron flanges. The cage can be of any material which will be robust and will last in water for several years. Iron bars 2/8 to 3/8 inch in diameter or iron strips 1/8 inch thick and 1/2 to

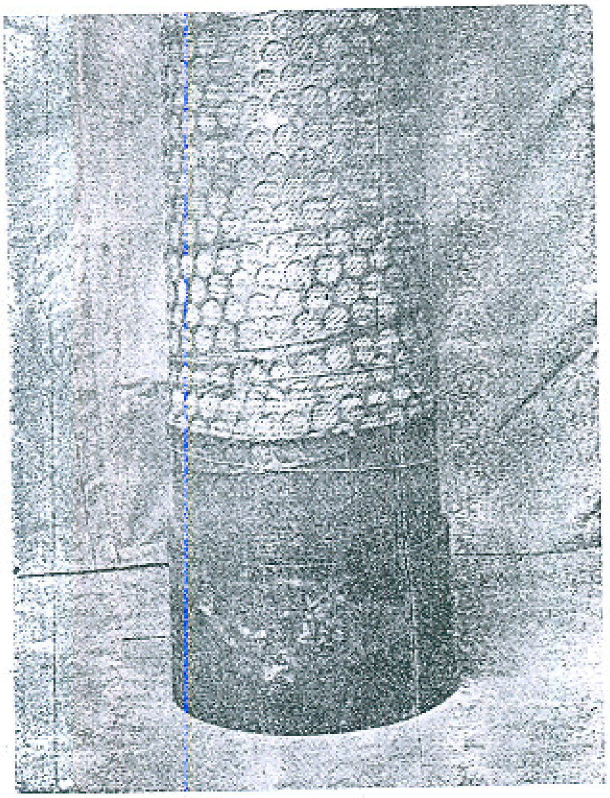


Fig. 1b
Coir Strainer Protected by Punched Iron Strip.

3/4 inch wide, can easily be welded to iron flanges. In some cases strips of stiff wood or bamboo, supported by some stiffners can be used. A coir string generally 1/8 inch to 3/16 inch can be wound around the cage. This string can be further protected by an iron or copper plated iron strip having 1.0 inch diameter holes Fig. 1 (*a*, *b*, *c*).

Sometimes a strainer with double winding of coir string can even be made. In that case the first winding is inclined, followed by the second straight winding at right angles to the length of the strainer. In this way there can be extra safety to the string and there will be less possibility of its being damaged.

The cost of this type of string strainer is between $ 1 to $ 3 per foot, depending upon the material used. This strainer has an open area varying from 12 to 20%. It is much more than even having 1/16 inch slit width on brass strainer. The coir string lasts indefinitely in water and even highly saline water has no deteriorating effect on the material. There are instances of its performance, without trouble, for more than twenty years. The Irrigation Department has now agreed to use it in their tubewell projects. It has been used in the highly saline water of Ghulam Muhammad Barrage having m.mohs/cm. 50,000 as electrical conductivity and these are working there for the last 18 months without trouble.

Another advantage of the use of this material is that its slit opening lies between 1/32 to 1/64 of an inch, so that these can be installed in fine sand without the necessity of adding a gravel filter for shrouding. It is thus possible to utilize even the fine sand grade formation which in case of brass strainer has often to be excluded.

Baked Clay Strainers, Device No. 2.

In the region close to the foot hills, the underground formation is comparatively coarser than the rest of the Indus plains, the water quality is excellent and for this reason many open wells exist in those areas. These are worked by persian wheel and draw about 0.2 cusec of water.

If in these open wells, particularly if they are deep, a string type strainer or a backed clay strainer is installed,

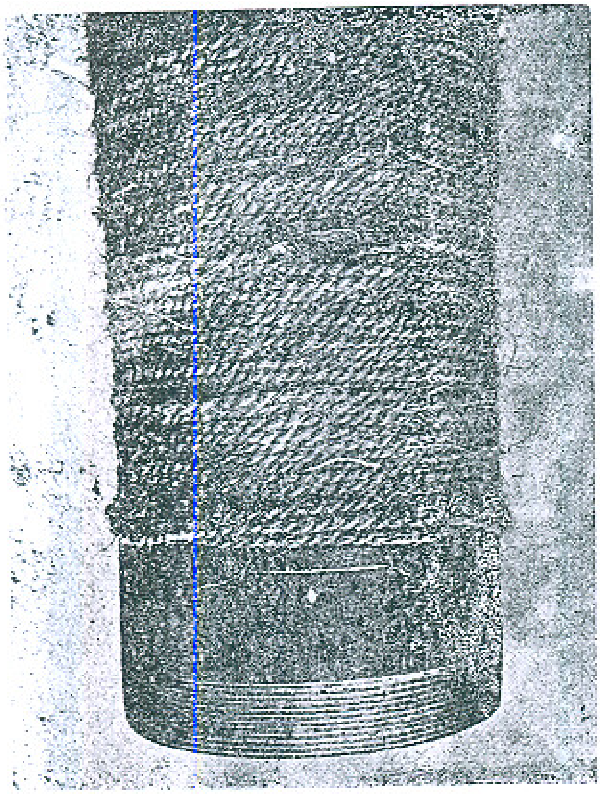


Fig. 1c.

their yield can be considerably increased. These can even be pumped by a centrifugal type pump. This measure will decrease the cost of the strainers. A backed clay strainer is inert to electrically charged ions and resists deterioration due to salts and other causes if kept under water. This suggestion has also been put to practice and found to work satisfactorily.

Other suggestions such as the use of plastic strainer, cement asbestos strainer and such other cheap materials are still in the course of development.

The use of Coir String Strainer lowers the cost from $ 11000 to $ 280 and has other advantages not possessed by brass or iron strainer.

Use of Multiple Strainers, Device No. 3.

It is well known that working of a tubewell at a high depression causes greater sub-soil flow velocities and this results in the movement of fine electrically charged particles of clay. A reduction of pressure as a result of suction can change soluble bi-carbonates into carbonates which get deposited around the strainer.

The yield of a well is limited by the permeability co-efficient of the formation and the length of the strainer.

These factors limit the yield of a tubewell and shorten its life.

As an alternative to this method it was suggested to install more than one strainer close by and pump them together by the same centrifugal pump which will create equal order of suction head in each and each strainer will

TABLE 2

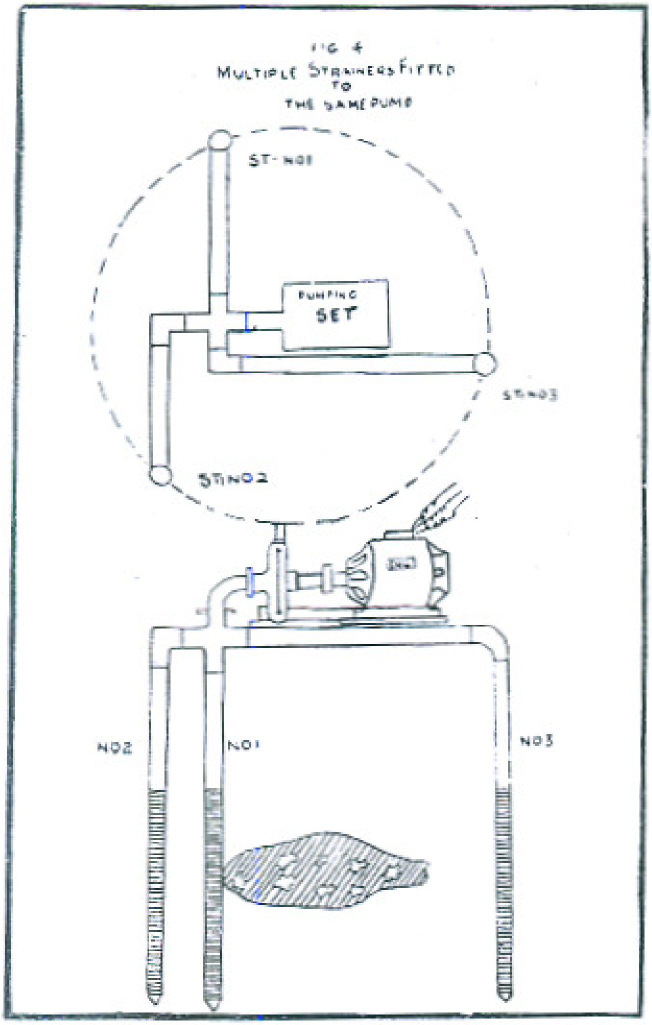
Performance of Multiple Tubewells at Naizbeg, Kohali Distributary and Gaja Area

S. No.	Site	Discharge in cusecs	Increase of discharge %	Power Input K.W.H. %	Increase of Power %
	Niazbeg				
1	Single Strainer (Brass) ...	0.9	...	9.5	...
2	Two Strainers (Brass+Coir) ...	1.46	62.2	9.95	17.06
3	Three Strainers (Brass+Munj 1 +Munj 2) ...	1.6	80.0	10.0	17.65
4	Four Strainers (Brass+Coir +Munj 1 & 2) ...	1.9	111.1	10.4	22.35
	Kohali Distributary				
1	Single Strainer ...	1.06	...	8.10	...
2	Two Strainers ...	1.57	47.9	8.83	9.07
3	Three Strainers ...	1.67	37.2	9.05	11.70
4	Four Strainers ...	1.75	64.90	9.04	16.05

Ghulam Muhammad Barrage (Gaja) Area.

T/well No.	Operating Condition of Bore	Discharge at 15 ft. Depression Head	% Increase in discharge of both strainers w.r.t. single strainer
1	Both Bores ...	1.45	—
	Main Bores ...	1.1	32
	Twin Bores ...	0.93	56
4	Both Bores ...	0.98	—
	Main Bores ...	0.74	34
	Twin Bores ...	0.57	72
5	Both Bores ...	1.05	—
	Main Bores ...	0.52	102
	Twin Bores ...	0.57	85
10	Both Bores ...	0.67	—
	Main Bores ...	0.45	50
	Twin Bores ...	0.42	60
14	Both Bores ...	1.26	—
	Main Bores ...	0.69	81
	Twin Bores ...	0.40	200

yield water (see fig. 4). This idea has been to put actual test in different areas and it was found that if two strainers are installed 100 ft. apart, the combined discharge is 70 to 80 percent more than that from single bore. If the distance in between is reduced to 25 ft. the combined discharge is 50 percent more than that from the single bore with nominal increase in power input. This idea has been tested in Ghulam Mohammad Barrage area, on tubewells located along Lahore Branch and in the Niazbeg Field Research Station. The results are given in table 2.



This method of installation of tube-wells not only gives the desired discharge for a long time but there is a considerable saving in the power input, the tubewell will work at a low depression creating low order of sub-soil velocities with lesser possibility of particle motion. Such an arrangement is more effective for drawing water from an extensive area and is a more effective drainage measure.

Those countries of the CENTO alliance which are faced with problems like Pakistan, where the formation is alluvial, water table is high, salts are present in water and yet it is desired to pump economically and have a long-life tubewell, can adopt the devices explained in this note. These will help them to solve their problems

THE ROLE OF
WATERSHED MANAGEMENT

(in the development of water resources of West Pakistan)

by

MUHAMMAD RAFI

Project Director, Watershed Management West Pakistan WAPDA Rawalpindi

Mr. Muhammad Rafi stated in the CENTO symposium that agriculture was our major industry. The limiting factor in increasing agricultural production is availability of water, huge quantities of which are lost through floods. We are harnessing a fraction of the water flow of rivers Jhelum and Indus by constructing Dams at Mangla and Terbela. These reservoirs are doomed to die in a very short period. Can we afford to lose them so quickly even if we have more suitable sites for building dams? Will it not be better to maintain what we have by reorienting our efforts and reap their benefits for a longer time.

This is the theme of his paper. He has described the measures which he, as Project Director is undertaking to prolong the life of the storage and to save much valuable land and reap other benefits as a result of water-shed management.

The Indus water treaty of 1960 has allowed India to divert 33 M.A.F. water of the three Eastern rivers Sutlej, Beas and Ravi. Pakistan has to make alternative arrangements to make good this loss. This involves the construction of two dams one at Mangla and the other at Terbela in river Jhelum and Indus respectively. The division of Indus Basin water under the treaty is as shown below :—

Name of river	Mean annual run-off in M.A.F.	Pakistan M.A.F.	India M.A.F.	Storage Pakistan M.A.F.	Capacity India M.A.F.
Indus	89	89	—	4.20	—
Jhelum	23	23	—	4.75	—
Chenab	23	23	—	—	—
Ravi	6	—	6	—	—
Beas	13	—	13	—	5.50
Sutlej	14	—	14	—	11.00
Total	168	135	33	8.95	16.50

The distribution of precipitation in West Pakistan during the course of the year is very uneven. More than half of the total annual precipitation is received during monsoons except in outer Himalays where it is received during winter mostly as snow. This gives rise to extreme variations in river flows : the maximum summer dicharge of the Indus Basin rivers is about 100 times the winter minimum. Therefore we have droughts and floods during the same year and canal supplies are generally short during critical periods of sowing and planting. The following table gives data of distribution of annual precipitation and maximum and minimum flows of various rivers.

Precipitation and discharges of Indus Basin rivers.

Name of river.	Hill catchment area in sq. miles	Summer precipitation in inches.	Winter precipitation in inches	Total precipitation in inches	Run off (ins).	Discharge in cusecs	
						Max.	Min.
Indus	118,400	8.6	8.4	17.0	14	917,013	173,04
Jhelum	12,445	22.9	20.9	43.8	33	760,000	392,13
Chenab	11,399	30.3	14.5	48.8	38	718,000	361,8
Ravi	3,562	34.7	18.7	53.4	32	310,000	121,6
Beas	5,384	43.1	13.2	56.3	45	346,223	213,0
Sutlej	23,400	11.5	7.4	18.9	11	490,242	277,3

Continued from page 46

Sedimentation Problem :—

The sedimentation problem concerns either displacement of sediment or its deposition by water. There are three considerations which determine the method of tackling the sedimentation problem. We have to determine, firstly, the nature of sedimentation ; secondly, the sources of the sediment which cause this problem and thirdly, the types of watershed management practices which may be feasible for application in the catchment above the site of the problem.

Watershed Management :—

Soil conservation measures may be grouped in three types :

(*a*) management of vegetation.

(*b*) agronomic practices, and

(*c*) engineering works.

Management of vegetation includes control in the use of forest and grazing lands, re-afforestation and fire control. Agronomic practices include measures like crop rotation, cover crops, soil improvement crops, mulching etc., usually carried out on croplands to protect soil against erosion. Engineering measures include terracing, water disposal systems, check-dams, gully control structures, stream bank stabilization, torrent control and small detention dams.

The Pilot Watersheds :

The West Pakistan Water and Power Development Authority organized Water-

SUPERIORITY

OF

HYDRO-ELECTRIC OVER THERMAL STATIONS

OF

THE SOUTHERN AREAS OF WEST PAKISTAN

by

MOHI-UD-DIN KHAN,

Director, Design & Research, Irrigation Department, West Pakistan, Lahore.

The hydro-electric potential of all rivers and canals in Pakistan is 10 million K.W. All the big hydro-electric sites in West Pakistan are in the northern region. Apart from Warsak Dam on Kabul river and other smaller hydro-electric projects aggregating to 263,000 K.W. already completed, the biggest project under construction is that at Mangla on river Jhelum with an ultimate capacity of 6,00,000 K.W. Power may be generated from the proposed Tarbela Dam on the Indus up to a maximum of 1.1 million K.W There is large hydro-electric power potential on river Indus in the upper reaches in Gilgit. By constructing tunnels about 4 miles long to shoe short circuit made a 30 miles long horse loop in the river, a 1000 feet drop can be available to generate 1 to 2 million K.W., from the run of the river. Kunhar river has a similar big loop with steep slopes in the river.

Hydro-Electric Potentials in the North:—

The biggest hydro-electric power potential in the Southern areas is at the tail of D.G. Khan canal where a drop of 100′ is available from this point at Choti in Rajanpur Branch where 13,000 K.W. or Hydro-electric power could be generated purely as a bye-product. A multi-purpose project is possible by extention of D.G. Khan canal beyond mile 70 upto Kashmore both for irrigation of the new areas as well as for hydro-electric power generation. A channel of about 6,000 cusecs, can be made with 50% of its discharge for irrigation and the balance for hydro-electric power generation. The redeeming feature of this station is that it would generate the maximum power in winter when all other hydro-electric stations suffer from low supplies. This station would generate a minimum of about 20,000 K.W. in flood months of June to September when irrigation supplies are needed for the new areas. The maximum power of 37,500 K.W. for 9 to 10 months in winter will go a long way in stabilising the future West Pakistan grid in the Southern areas.

On Kalri Baghar Feeder off-taking from Kotri Barrage, there is a good site for generating 12,000 K.W. at competitive rates as compared with Sui Gas.

There are possibilities of Hydro-electric power generation from some of the cannals of Sukkur Barrage such as Rohri canal which is being remodelled. The ultimate fall that

COMPARATIVE ECONOMICS OF SOME PROPOSED HYDRO-ELECTRIC AND THERMAL PLANTS IN THE SOUTHERN AREAS OF WEST PAKISTAN.

No. Item	Thatta Hydro-electric scheme (Kalri Lake)	Suigas installation in Hyderbad already executed by WAPDA (Extension Scheme)	Jamrao weir Hydro Electric Project (Nara Canal)	Sukkur Hydro-Electric scheme (Rohri Canal)	Suigas installation near Sukkur proposed by WAPDA.	Kashmore Hydro electric project (D.G. Khan Canal).	Choti Hydro electric project (D.G. Khan Canal).
1. Discharge available	7705 cs. 1360 cs.	...	4725 cs. 1007 cs.	11725 cs. 6694 cs.	...	5200 cs. 2700 cs.	3600 cs.
2. Drop { Max Min.	22.9 ft. 19 9 ft.	...	18.29 ft. 14.87 ft.	21.5 ft. 19.9 ft.	...	100 ft. (average)	53 ft. (average).
3. Total installed capacity	12,000 K.W.	15000 K.W.	5,600 K.W.	15000 K.W.	30,000 K.W.	37,500 K.W.	13,000 KW.
4. Capital cost	Rs. 230.42 lac	Rs. 130.00 lacs	Rs. 205.70 lacs	Rs. 460.50 lacs	Rs. 360.00 lacs	Rs. 960.0 lacs	Rs. 341.2 lacs.
5. Annual output	70.35x10^6 KWH	131.20x10^6 KWH	114.71x10^6 KWH	262.6x10^6 KWH.	233.8x10^6 KWH.	233.8x10^6 KWH.	105x10^6 KWH 10^6
6. Cost per installed K.W.	Rs. 1.920	Rs. 866	Rs. 3.620	Rs. 3.070	Rs. 1.200.	Rs. 2.580	Rs. 2,625
7. Total annual charge	Rs. 24.99	Rs. 55.17 lac	Rs. 16.78 lacs	Rs. 39.52 lacs	Rs. 127.00	Rs. 73.21	Rs. 27.01 lac.
8. Cost per unit at bus bars.	3.5 paisa	4.2 paisa	4.8 paisa	3.45 paisa	4.84 paisa	3.25 paisa	2.58 paisa.

N.B. For the sake of comparison same load factor (*i.e.* 100%) has been assumed for all the schemes.

would develop on this canal is 21.5 feet 3 miles from Sukkur Barrage to generate about 15,0?0 K.W. Nara canal off-taking from Sukkur is another prennial canal where there are some possibilities of hydro-electric power generation. At Jamrao which is 115 miles from Sukkur, there is a weir on this canal where it is possible to generate hydro-electric power. A maximum drop of 18 feet could be developed at this point to generate 5,600 K.W. of power.

Atomic Energy at present Costly :-

Sir John Cockcroft member of the Atomic Energy Authority of United Kingdom, in his address to the Pakistan Science Conference in 1961 on "Atomic Energy in under-developed countries" indicated that a nuclear power station in the South Western area of Pakistan is justified probably after 1970 when the cost of nuclear power station would have fallen by another 30% compared with stations to be completed by 1963 due to further advances in the new types and better design of nuclear power stations. He gave figures for the cost of electricity per unit ranging from 0.054 rupees per unit to 0.072 rupees per unit depending on reactor type as compared with 0.044 rupees per unit for Multan Sui Gas Power Station. He also stated that as a 60 magawatt nuclear power station costs 50% more per kilowatt than a 120 magawatt station, Pakistan should wait for the most opportune time when a nuclear power station could be economically justified.

Hydro-Electric more Economical :—

Hydro-electric sources which are more economical should be developed first. It is possible that after 1970 Pakistan's requirements of power in the Southern areas and the load factors would justify a nuclear power plant.

In the table are shown the data for all the stations where hydro-electric can be generated.

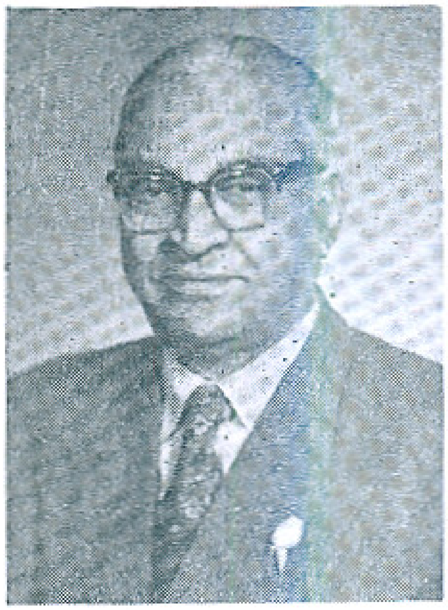
Continued from page 43.

shed Management Project during October 1959. M/S Hunting Technical Services Limited were employed as consultants to carry out survey of the Mangla reservoir catchment lying within West Pakistan and Azad Kashmir territories and to develop a plan for improving its management so as to bring about desired degree of control in the regime of stream flow and for reducing its sediment load.

In the meantime watershed management operations were started in three pilot watersheds *viz.*, Khaner Kas near Murree, Upper Kanshi near Kahuta and Kas Bishandaur near Sohawa.

We have been in the field for about a year. We are no doubt facing a number of difficulties in applying the watershed management practices on the ground but the response from the farmers has been quite encouraging. The farmers in general appreciate the programme and are willing to organize themselves in order to carry out an integrated programme of land use improvement. We are confident of making satisfactory progress provided the major surmountable difficulties are solved. Even at this stage we have received voluntry co-operation from farmers to plan 60-80 percent area of various pilot watersheds and field operations are in hand over about 25 percent area.

PAKISTAN ASSOCIATION
FOR
THE ADVANCEMENT OF SCIENCE
14th ANNUAL MEETING, PESHAWAR
March 29th to April 3rd, 1962



The Pakistan Association for the advancement of science was established in December, 1947. It has been holding its annual general meetings at various places of learning in Pakistan. The present was its 14th Annual meeting and it was held at Peshawar. After the inauguration by Field Marshal Muhammad Ayub Khan, Hilal-i-Pakistan, Hilal-i-Jurat, President of Pakistan, in the afternoon of 29th March The General President, Dr. A. G. Asghar, read his Presidential address which has been reproduced below. The regular session of the conference was held from March 30th to April 3rd when papers and sectional presidential addresses were delivered. The president elected for the section of Engineering, Irrigation Hydel Power, Hydraulics, Communication, Electricity and Public Health was Chaudary Abdul Hamid, extracts from whose presidential address are also given in this volume. Mr. U. Durrani, Principal, Engineering College, Peshawar acted as Secretary of the section. Out of the several symposia held during the session, that on salinity and waterlogging, and Freedom from Hunger attracted a large number of participants.

LAND AND WATER USE PROJECTS IN PAKISTAN

by

Dr. A. G. ASGHAR.

At the outset the General President referred to the memorable address of outgoing president on technology in relation to Pakistan's attack on poverty. The choice of the subject of the present address was inspired by Professor Abdus Salam's discourse and it examined the recent advances of utilizing the land and water resources of the country.

Economic development in undivided India :—

British economic policy in India was a legacy of the commercialism of the East India Company. In its stark essentials the object was to feed British industry with Indian raw materials obtained as cheeply as possible, and to sell the products of British industry in India at the most profitable prices.

Harnessing the rivers for the purposes of irrigation was the first step in the economic development of British India, and an extensive network of canals was laid down in the Indo-Gangetic plain between the last quarter of the 19th century and the first half of the 20th century.

Further attention to agricultural development was drawn by the occurrence of famines towards the end of the 19th century. A Famine Commission appointed by the Government of India made the first effort to develop agriculture on a planned basis. The Royal Commission on Agriculture appointed in the twenties contributed a valuable study of conditions in the country, and focussed attention on measures necessary to develop a more scientific attitude towards agriculture.

Post independence Planning :—

Immediately after the attainment of independence in 1947, the new state of Pakistan set up a Planning Commission which drew up the First and Second Five Year Development Plans for the years 1955 to 1960 and 1961 to 1965.

The first five years plan proposed on investment of 10,800 million rupees for the development of agriculture, industry and power. In the effort to implement this plan the most disappointing failure occurred in the key sector of agriculture. As a result, extensive imports of food-grains became necessary, and the country spent about Rs. 700 million out of its precious foreign exchange earnings on this account, compared with Rs. 410 million provided in the Plan. The water development plan, too, fell much behind schedule and the acreage reclaimed from water-logging and salinity was considerably below the planned objective.

There was, however, unmistakable progress in the evolution of a planning machinery within the Government, and in public recognition of the importance of planning and development.

How far the targets of the Five Year Plan for Agricultural production were achieved will be seen from the following :—

Crop.	Planned increase in production.	Actual increase or decrease
	%	%
Rice ...	8	—2
Wheat ...	12	—4
Maize ...	15	4
Other food grains ...	8	—5
Total foodgrains ...	9	negligible
Sugar-cane ...	33	30
Fruits and vegetables	19	nil
Oil-seeds ...	15	8
Cotton ...	21	2
Jute ...	15	5
Tea ...	15	—3
Tobacco ...	16	—20

The Second Five Year Plan provides an estimated investment of Rs. 19,000 million which with the upward fluctuation in prices has already been revised to Rs. 22,000 million. In the Second Five Year Plan with an investment of Rs. 11,000 million on agriculture works and industries connected with agriculture, the increase in food-grains is estimated as under :—

Foodgrains	Expected % increase in a year.
Rice	22
Wheat	17
Maize	45
Others	11
Fibre crops	
Jute	22
Cotton	38
Miscellaneous	
Gram and other pulses	11
Fruits and vegetables	22
Oil seeds	32

Sugar-cane	...	35
Tea	...	18
Tobacco	...	14
Fish	...	24
Timber	...	25

These increases are planned by the addition in cultivated area of about 2.2 million acres in West Pakistan and 2,30,000 acres in East Pakistan ; and also by the improvement of about 6 million acres by drainage and reclamation in West Pakistan, and eleven million acres in East Pakistan by drainage, embanking and dredging. Contribution is also to be made by increased use of fertilizers, expansion of measures for plant protection, better seeds and improved agricultural practices.

The present production level :—

Merely increasing the area under cultivation to keep pace with growing national demands has been tried for many years in the past with poor results. The increase in output from the additional area under cultivation has been largely theoretical.

The yield per acre of cotton in Pakistan is 181 pounds of lint which is lower than any of the other cotton growing country The highest yield of 469 lbs. is obtained in Egypt. Pakistan's record yield is 260 lbs. only.

The yield of maize in West Germany is 2,551 lbs. per acre against 922 lbs. of Pakistan. The yield of wheat in the country is 691 lbs. against 4,690 lbs. in United States. In this country the highest record is 4690 lbs. Rice has yielded 1,662 lbs. against 4,284 lbs. in Italy. The record yield in the country is 5,266 lbs.

The record yield of potatoes is 13400 lbs. against the averge yield of 4100 lbs.

Soil Reclamation in West Pakistan :—

The most serious obstacle in increasing production is the twin problem of salinity and water-logging. Out of 23 million acres of canal-irrigated land not less than 50 percent is already in different stages of deterioraion and the rest deteriorating at a very rapid rate.

The largest reclamation programme in the world is about to be launched at a total cost of about Rs. 55,000 million as estimated by the Planning commission as follows:—

Items		Million Rs.
Storage	...	13,500
Revamping of canals	...	500
Drainage	...	40,000
Sea-water Barrier	...	100
River channel rectification work.	...	1,000
Total ...		55,100

The colossal investment required will either come in the shape of foreign aid or else we shall be forced to find cheaper remedies for our national ailments. **For instance, it may be possible to reduce the major expenditure of Rs. 40,000 million if we can avoid exploiting aquifer 250 feet or more in depth.** Investigations may show that the development of shallower aquifer can provide the required quantities of supplemental water-supply with optimum drainage, and may cost much less.

Large scale Reclamation Programmes:-

The large scale reclamation programme will need soil protection, diversion of crops, seed potential, fertilizers etc. The three more important items are mechanization of agriculture, requirement of foreign exchange and the scientific equipment and man-power.

In order to protect soil from salinity and water-logging it is necessary to :

(*i*) supplement the existing canal water supplies by pumping from shallow aquifers and open drains.

(*ii*) secure effecient distribution of water.

(*iii*) avoid fertilizer from saline and alkali soils under inadequte irrigation facilities.

(*iv*) provide drainage.

(*v*) provide crop coverage and

(*vi*) heavier presowing irrigation and mulches.

In the matter of diversification crops we should explore the possibility of potato and maize in place of rice and wheat. Sugar beet can be an alternative source of sugar.

Use of improved seeds and chemical fertilizer apart from farm-yard manure are the next essentials to get higher yield.

Mechanization of agriculture :—

About 85% of our, population lives in villages, and agriculture is the only industry of the rural area. While considering man-power resources we generally take it for granted that the entire rural population is engaged in agriculture, and this same group is ignored in determining the extent of unemployment.

Actually, the facts are quite different. Even the adult male population which constitutes the agricultural man power is far less than fully employed. In a study of the cost of production of crops it was revealed that an adult male worked only for 675 hours during the year against 1,500 hours which may be considered as full employment. Thus the cultivator works for only 25 to 30 percent of the time considered necessary for full employment of an adult male.

In the United States of America, one agricultural worker produces enough for feeding 23 persons. In Pakistan, although 85% of the population is considered employed in agriculture, the country is deficient in food. Thus one agricultural worker does not produce enough food even for himself.

We cannot look forward to quick industrial development if we keep our agricultural labour at the present level of under-employment. In other words, to provide the skilled and unskilled labour for industries, we have to reduce agricultural labour to the minimum and at the same time increase agricultural production to the maximum by resort to scientific farming. It is, therefore, necessary to have industrial development on a large scale and manufacture suitable agricultural machinery and spare parts within the country.

Foreign Exchange :—

In the past, we have been depending for foreign exchange earnings mostly on the export of cotton from West Pakistan and jute from East Pakistan. Lately, major steps have been taken to restrict the export of raw jute which is being processed within the country for export as finished products.

Western economists, mindful of the trend of development in this country, have sounded the alarm and a rapid switch-over to the manufacture of artificial fibres may soon have the same effect on the jute fields of East Pakistan as the discovery of synthetic dyes had on the once flourishing indigo plantations of Bihar and Orissa.

In the case of cotton, our export has fallen because of the increasing needs of our rapidly expanding textile industry. Foreign countries are responding to this trend by making vigorous efforts to increase their own cotton outputs, by producing synthetic alternatives, and by stepping up exports of fabrics of very refined quality. This can only be interpreted as an attempt to curb our cotton exports and become independent of this basic raw material.

We should now explore other avenues for foreign exchange earning.

Scientific Equipment and Manpower :—

The various departments utilizing foreign technical and material aids are working in water tight compartments. Some organizations have more equipment than they need and so is the case with technicians and scientists.

It is rather unfortunate that selections for technical services are made in water tight compartments.

The major administrative concept is seniority of services. **A person fortunately born earlier occupies a higher position by virtue of his seniority, although technically he may be inferior to his subordinates.** Specialized technical personnel serving under such an administrator become frustrated when their technical advice or proposals are not respected by him.

Instances arise when our scientists are invited by foreign **organizations, some of which are prepared to bear the expenses of the visit. The admnistrator, alas, does not find it possible to spare the scientist for even a couple of weeks to enable him to participate in scientific symosia and conferences held in a foreign country.**

No one will dispute that any development programme must be preceeded by scientific research. The basic research is the same in all countries but it is the application of the results what would vary under different conditions. **Let me give you an example from the ground water development project in West Pakistan. The basic concepts of hydrology are the same but even the foreign technicians have realized that applied research within the project areas is essential before we can expect tangible results from investments of a very high order. We have embarked on a huge programme of ground water development without actually carrying out pilot projects and gauging the results which can be achieved.** The projects thus undertaken may not be basically unsound but they can be improved only on the basis of results which will come from applied research within the country.

The knowledge available in foreign countries has to be made use of, but blind acceptance of details is rather like acceptance without reservations of a prescription made out by a doctor living in the West for a patient living in the East without his examination. We must utilize the experience and knowledge of our foreign brethern but only **after trimming the corners** so that the solution fits our local conditions. On no account should we adopt the attitude that **we must do something in Pakistan simply because it has been done in some particular country.**

News and Notes

(i) I. C. A. HELPS WAPDA TO DISCOVER WORLD'S LARGEST GROUNDWATER RESERVOIR

The worlds largest exploitable reservoir of under-ground water has been discover'd in West Pakistan. According to the studies made by Wapda, Pakistani and American Engineers and U. S. Government experts who have been surveying the West Pakistan Ground Water resources for the last nine years and have already spent upward of ninety million rupees, have estimated that in the Upper Indus Plains there exists 1900 million acre feet of usable ground water. It is over 10 times the yearly average discharge of all the Indus Basin, and probably more than the whole quantity of water that will be made available by both Mangla and Tarbela Dams in a period of 100 years. The detail of this discovery is given in Appendix B of West Pakistan Wapda Programme for Water-logging and Salinity Control, issued in May 1961, and reported in Wapda Weekly of 2nd March 1962 and other dailies of Pakistan.

A few more details of this discovery may interest the readers.

The Area Studied

The area under consideration comprises Bari, Rechna, Chaj and Thal Doabs of the former Punjab province. A narrow belt of land about 15 miles wide along the left Bank of Sutlej River in Bahawalpur, and along the right bank of Indus River in D. I. Khan and D. G. Khan have been omitted because according to the scanty data available, the ground water potential of these is too meagre to warrant consideration in a general survey of this type.

Geology of the Area

From the stand-point of the ground water potential and the area, the significant facts are as follows :—

(i) Geologic investigations indicate that practically all of the area, about 25.9 million acres of the total area of 27.3 million aeres is underlain to depths of 1,000 feet or more by unconsolidated alluvial sediments which are saturated to within a few feet of land surface. The sediment ranges in texture from medium and to silty clay, but the sandy sediments predominate and according to WASID'S experience, high capacity wells yielding 5 cusecs or more can be developed at virtually any site. The remaining area 1.4 million acres in the northern reaches of Rechna and Chaj Doabs is underlain by piedmont type deposits which have in different water bearing properties. For the purposes of this note, these portions of Rechna and Chaj Doabs are not included in the total areas of the Doabs.

(*ii*) Quantity of water studies show that the alluvium beneath 79 percent of Chaj Doab (2.0 m. acres) and 85 percent of Rechna Doab (4.7 m.a.) is saturated to a depth of at least 500 ft. with water of acceptable quantity for irrigation about 72 percent of the area of Thal Doab (5.3 m.a.) underlying the narrow belts of land bordering the left bank of the Sutlej and the right bank of the Indus and 60 percent of Bari Doab (4.4 m.a.) is underlain by fresh water bearing beds. Thus the total area underlain by water bearing aquifer is about 18.1 million acres.

(*iii*) Water level studies for Rechna and Chaj Doabs indicate that the average potential rate of recharge from the existing irrigation system to the fresh water bearing part of the alluvial aquifer is about 0.5 ft. of water per year. The distribution of potential recharge is not uniform but varies by a factor of 2 to 1 for upper and lower parts of the doabs.

The potential rate of recharge from natural sources including seepage from rivers, infiltration from local precipitation under flow from upland area, may range from 0.2 to 0 3 feet of water per year.

Summing up, the fresh water aquifer underlain a total area of 16.1 million acres of the present gross area of irrigation. Assuming a fresh water saturated thickness of 450 ft. and an effective porosity of 25%, there are about 1900 million acres feet of usuable ground water in storage. It is equal to 10 times the yearly average discharge of the entire Indus Basin and is more than the total quantity of water that will be available by both Mangla and Tarbella Dams over a period of 100 years.

Under the existing development regime the average potential rate of recharge to 16 fresh water aquifer is in the order of 11 to 13 MAF per year which is comprised of about 8.1 MAF per year from current irrigation and 3.2 to 4.8 MAF per year from natural sources.

Withdrawals from Doab

Ground-water development in the future should be based upon an average rate of withdrawal of 1.2 feet per year.

The rate of withdrawal will yield about 19.3 MAF per year comprised of about 5.3 MAF from Bari Doab, 5.6 MAF from Rechna Doab, 2.4 MAF from Chaj Doab, 3.9 MAF from Thal Doab, 2.1 MAF from the narrow strips of land along the left bank of the Sutlej river in Bahawalpur and the right bank of the Indus through D.I. Khan and D.G. Khan.

A pumpage of 1.2 feet per year will only un-water the aquifer at a rate of about 1.2 feet per year which will not result in excessive decline of water level during the 20 to 30 years useful life of the pumping equipment.

Quality of Ground Water

About 6.5 million acres in the Punjab is underlain by ground water with dissolved solid concentration greater than 1750 ppm. To ensure containment of the inferior quality water, the ground water level in the washing zone should be maintained at about the same or slightly lower altitude as the water level in the continguous area of development. Thus about 4.6 MAF per year of inferior quality water should be pumped from the Punjab. This quantity includes about 2.4 MAF per year from Bari Doab, 6.75 MAF per year from Rechna Doab, 0.42 MAF per year from Chaj Doab and 1.0 MAF per year from Thal Doab.

Initially the water pumped to waste from Rechna, Chaj and Bari will contain an average of about 5000 to 6000 ppm dissolved solids although water from individual wells will range from 2000 to 20,000 ppm. The water from Thal Doab will be of better quality with an average concentration of about 3500 to 4000 ppm.

It is assumed that the successive cycles of recirculation of the mineral content of the ground water will increase and the salts will tend to migrate down gradient. The concentration of dissolved solids in the ground water will increase down gradient, towards the lower parts of the doabs until the ground water supplies become too highly mineralized for irrigation use. Ground water from this zone in each doab must be pumped to waste to accomplish the removal of salts necessary to preserve a satisfactory salt balance within the doab.

(*ii*) Mr. HAROLD T. SMITH

Predicts

USEFUL LIFE OF WAPDA TUBEWELLS

at

50 to 100 years.

Harold T. Smith President of International firm who has recently completed installation of 1000 tube-wells in salinity control project No. 1, WAPDA has written an article on the useful life of tube-wells. This is given as appendix C of Wapda programme for water logging and salinity control, May 1961. Some of the principles enumerated to prolong the life of wide slits iron strainer will be informative for readers of Engineering News. This article is thus produced.

Good Engineering Ensures Useful Life.

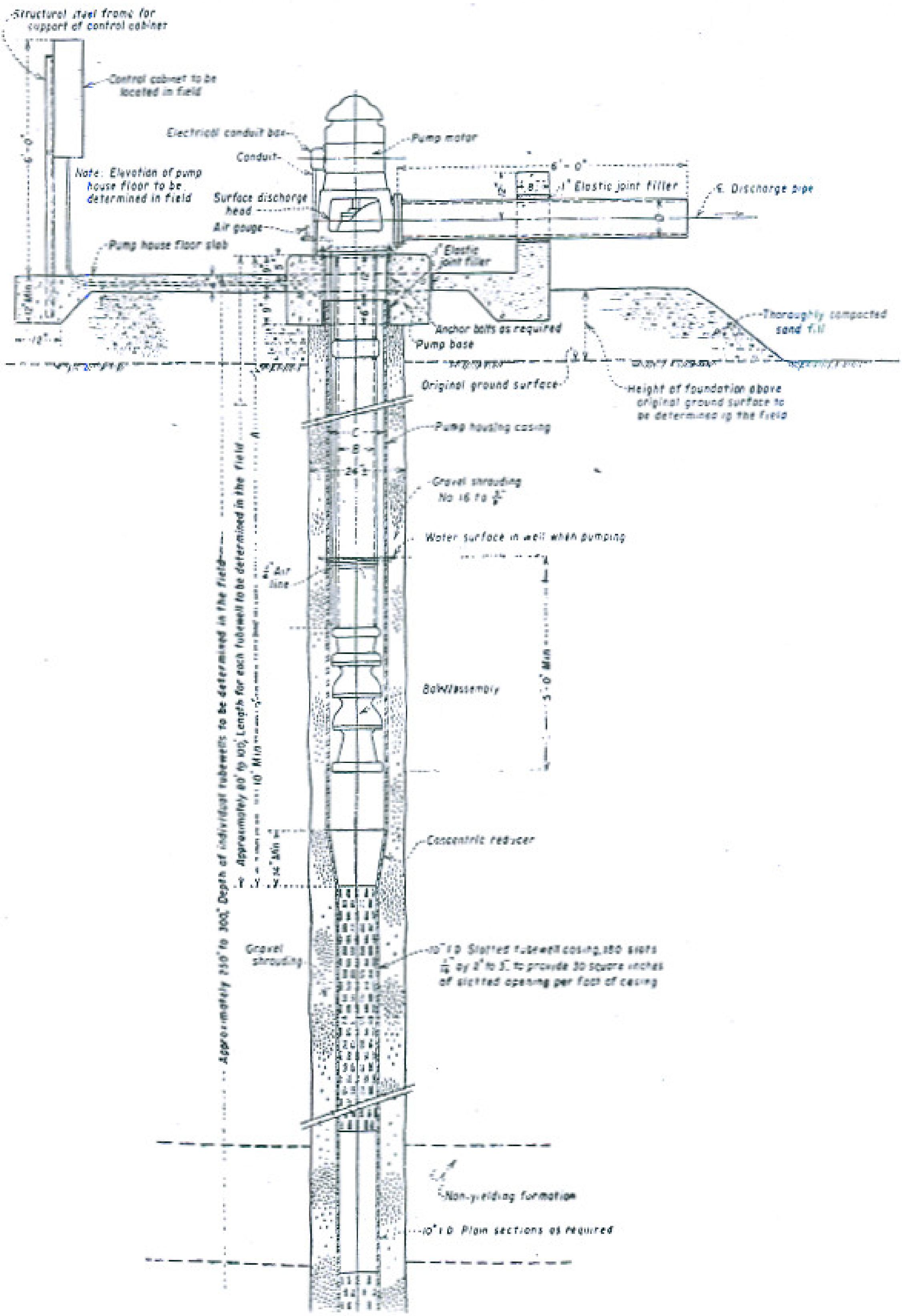
The useful life of wells depends on good engineering design, the use of suitable materials, correct operation and efficient maintenance.

As a rule of thumb, wells will have a short life if constructed with a small diameter drilled hole, thinwall pipe, screen with limited openings and without a gravel pack around the screen. The life of wells also will be limited if over-pumped or if inadequately maintained.

Conversely wells constructed to conform to good engineering practice have a long life expectancy.

Good design provides for a large diameter drilled hole, heavy wall well casing, manufacturing from good quality metal selected as best suited for the chemical properties of the water and soil through which the well is drilled : well screen with an open area sufficient to ensure low entrance velocity of the water, a relatively thick gravel pack, graded to accommodate

PLAN OF WAPDA'S DEEP TURBINE TUBEWELL



the size of the aquifer sands and made of hard material which will not deteriorate when subjected to the chemical action of the water. The pumping unit must be designed to prevent overpumping the well and causing an excessive drawdown of the water level.

The wells constructed under the Salinity Control and Reclamation Programme were designed to conform to the most severe standards established for water wells. Rigid control and inspection of every phase of construction and of the development of the aquifers was maintained by WAPDA engineers and WAPDA consultants. A drawing of a typical tube-well is shown in Figure C-I.

Material Specification for Long Life.

To ensure long life of the wells, the general specifications required are :—

"All materials and equipment shall be new and shall be the best available for the intended service and in accordance with the best engineering practice for which used, considering strength ductility, durability and suitability for intended service."

All materials, equipment and fabrication and testing thereof shall conform to the latest applicable standards and specifications established and approved in the country of manufacture of the equipment and materials.

The Technical specifications for these wells require a minimum diameter of 22 inches ; well casing and slotted steel pipe that conforms to all applicable requirements of the "Specifications of Line Pipe. (1) having a minimum wall thickness of 1/4 inch. All slots to be machine-cut, with not less than 30 square inches of open area per linear foot of pipe ; a gravel pack with a minimum thickness of 6 inches around the screen, made with a hard gravel that would not deteriorate with the chemical action of the water.

The large diameter hole ; the heavy wall pipe manufactured from good quality steel ; the large open area of the slotted pipe, which ensures a low velocity of the water entering the well ; the thick gravel pack which screens out the fine materials in the aquifers and helps to reduce the velocity of the water, are all specifications that contribute to a long life expectancy of the wells.

Over pumping to be avoided.

To be certain that the well would not be operated under conditions that might impair or lessen its life expectancy, the pumping equipment was designed so that water withdrawn from the wells pumping from 2--3.5 cubic feet per second was 35 per cent less than the well capacity developed, and from the wells pumping 4—5 cubic feet per second, the withdrawal was 25 per-cent less.

Because of the design of the well, the materials used, the rigid inspection maintained throughout the construction and development of the wells, and because the analysis of the water and soil show no properties that would promote excessive corrosion, there is every reason to conclude that, with adequate maintenance, these

(1) API Standard 5 L, Seventh Edition, March 1958 of the American Petroleum Institute,

wells will have a useful life from 40—50 years.

Hundred Years Useful Life if Maintained Properly.

It may be of interest to note that the Engineering News Record, in a special issue on construction costs and requirement published in 1957, fixed the useful life of wells constructed to conform to similar specifications at 100 years. The United States Internal Revenue Service in its published "Tables of Useful Lives of Depreciable Property" also establishes the useful life of such wells at 100 years. The United States Bureau of Reclamation records successful operations, for periods of 40 years, of irrigation wells drilled in the semi-arid areas of the United States even when the wells were cased with thin-wall "Stove pipe" casing,

Emphasis must be placed on future maintenance. The wells have been designed and constructed for long useful life but maintenance will be large factor in ensuring this life expectancy. The pumps should be removed periodically at least every third year. The wells should be cleaned to the bottom by bailing or compressed air. The well screen, the gravel pack and adjacent aquifer sands should be cleaned and agitated by wire brushing, surging, blowing with compressed air, backwashing and, if required, by chemical or acid treatment.

(*iii*) NUCLEAR-SOIL TESTING GAUGE BOON TO EARTHWORK CONTRACTORS

A DEVICE has been developed by South African engineers and scientists which is finding quick acceptance on a problem long plaguing road builders and others concerned with earth compaction and the application of soil mechanics in construction. This is a nuclear testing unit which speedily tells the inspector whether an earth grade has been compacted to specified density, and whether the moisture content is within the specified range.

The unit is the fruit of a policy of the Council for Scientific and Industrial Research in Pretoria. It is manufactured under license by Instrument Manufacturing Corporation, 7 Plimstead, Cape Province. This agency's policy is to patent its inventions and, where possible, license them to South African manufacturing firms. In this way the Council and private enterprise co-operate in creating manufacturing opportunities for local industry. The nuclear testing device has not only a local but also an export potential and in fact has found tentative endorsement by some of the state road building agencies in the United States, as the following article will relate. Specially the nuclear unit is the result of co-operation between the Protea Holdings Limited of Johannesburg and the National Institute for Road Research of the C.S.I.R. Scientists of the N.I.R.R. demonstrated the new instrument near Pretoria recently before representatives of the Department of Transport and the Transvaal Provincial Administration Roads Department. Briefly described, the new

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instrument irradiates a small test area with a radium beryllium isotope source, giving off neutrons and gamma rays. For measuring moisture content the instrument relies on the fact that hydrogen slows down these neutrons and reflects them back where they are picked up and counted. The results are displayed visually. To measure density, the intensity of the gamma radiation is reflected from the soil and recorded, the two values being inversely proportional.

A knowledge of soil density is essential in all problems where the body weight of the strata is an important factor in the stability of the construction. This include slopes, earth dams, retaining wall backfill, tunnel linings, road beds. The value of the new instrument will be seen readily, since it provides undisturbed sampling and gives a correct reading of density and moisture content directly on site, from the calibration supplied with the instrument.

Instrument Details

The radiation backscatter gauge, as the new instrument is now called, can be used either on the surface, giving average moisture and density to a depth of approximately one foot, or in bore holes to a depth of up to 100 ft. for subsurface data. Accuracies are of the order of 1 percent over a sample 6" to 12" in diameter, depending on the density and moisure content.

As the sturdy portable instrument is fully transistorized very little current is consumed. All circuits, *i.e.*, power supplies, accumulators and dekatron counting circuits, are designed in the form of individual units, and replaceable printed circuit boards are arranged to plug into their respective positions.

A stop watch is provided as a standard accessory for timing. The presentation of counts is in the form of a five decade dekatron scaler arranged at an angle on the panel of the instrument to give easy reading. Immediately in front of the dekatrons a voltmeter is located for checking the H.T. voltage applied to the probes of geiger tube, and, also, for checking the state of charge of the two 6 volt 11 A.H. accumulators which power the instument.

Low Current Consumption

These accumulators are used separately, and each has a capacity sufficient to provide one week's working under normal field conditions, the total drain on the accumulators being approximately 1.5 amperes. They power a transistorized oscillator supply that provides the extra-high, high, and low voltage for all the circuits. Provision is also made, and a selector switch provided, whereby an external accumulator may be employed and connected into the circuit by means of a shrouded plug and socket on the front of the instrument. This switch is also used for switching either of the two internal accumulators.

Basic control of the instrument is obtained *via* a three-button push switch controlling start, stop and reset functions. The high-voltage supply for polarizing the geiger tube, or scintillometer, is variable in steps of 10 volts, through 100 to 1,000 volts, and in steps of 20 volts from 1,000 to 2,000 volts.

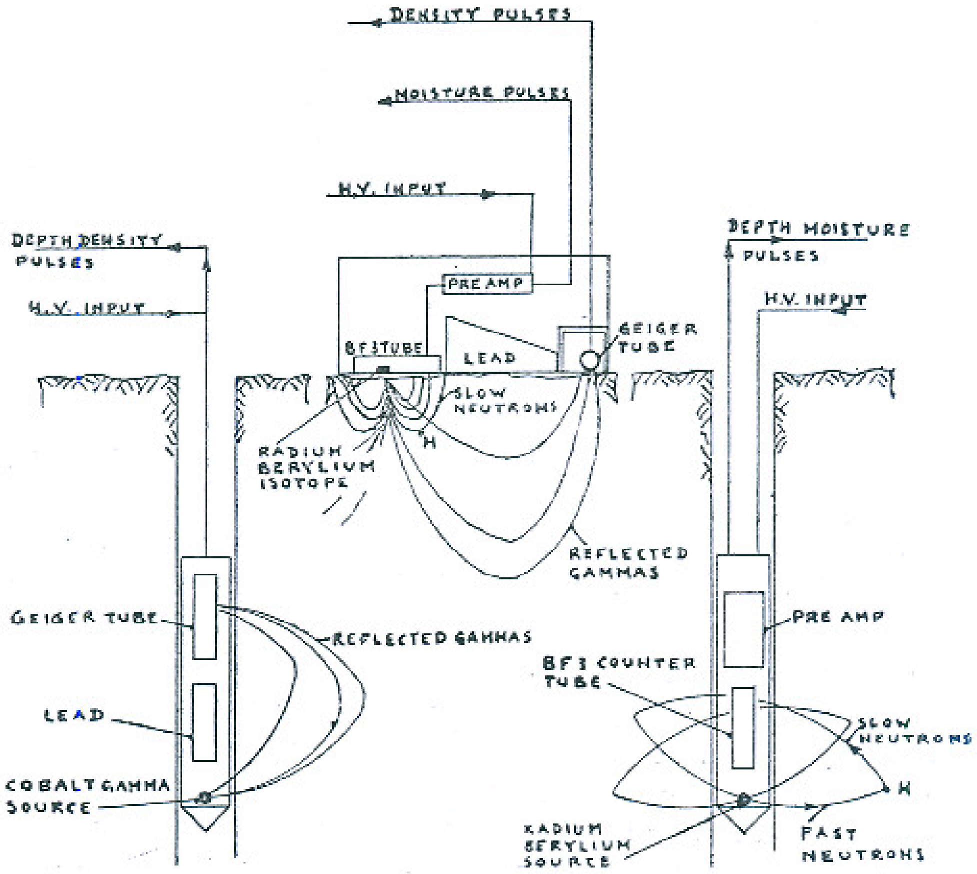
A 3-position switch on the panel marked "High Voltage × I" "Test" and "High Voltage × II", serves the various functions.

The lower half of the case is in the form of a deep box which can be removed easily for access to the chassis for servicing.

The depth moisture probe consists of a watertight aluminium tube containing the B_{10} enriched borontrifluoride neutron detector and a 10 millicurie radium-beryllium neutron source which has a half life of approximately 1,600 years.

Coupled to the BF_3 tube is a five transistor preamlifier with a low impedance output stage so that the moisture probe can be used with up to 100 ft. length of cable. For transport the moisture probe is housed in a container of lead and paraffin wax which gives sufficient shielding against gamma and neutron radiation to prevent any radiation hazard. The weight of the shield is about 30 lbs.

The depth density probe consists of a Halogen filled Geiger-Muller tube and a 5-millicurie cobalt 60 gamma emitting source. The tube is protected from direct radiation from the cobalt 60 by lead shielding. A lead shield and container are provided for transport to avoid any radiation hazard. The weight of the shield is approximately 20 lbs.



Graphical representation of radiation back scatter.

All probes are designed to meet approved standards regarding surface radiation levels to ensure that there can be no hazards to health of operating personnel due to radiation.

Due to the high-efficiency detectors used in the Protea instrument, counting times of between one and five minutes are adequate to give statistical counting accuracies of one per cent or better, and for density and moisture content measurement reproducibility of better than one per cent.

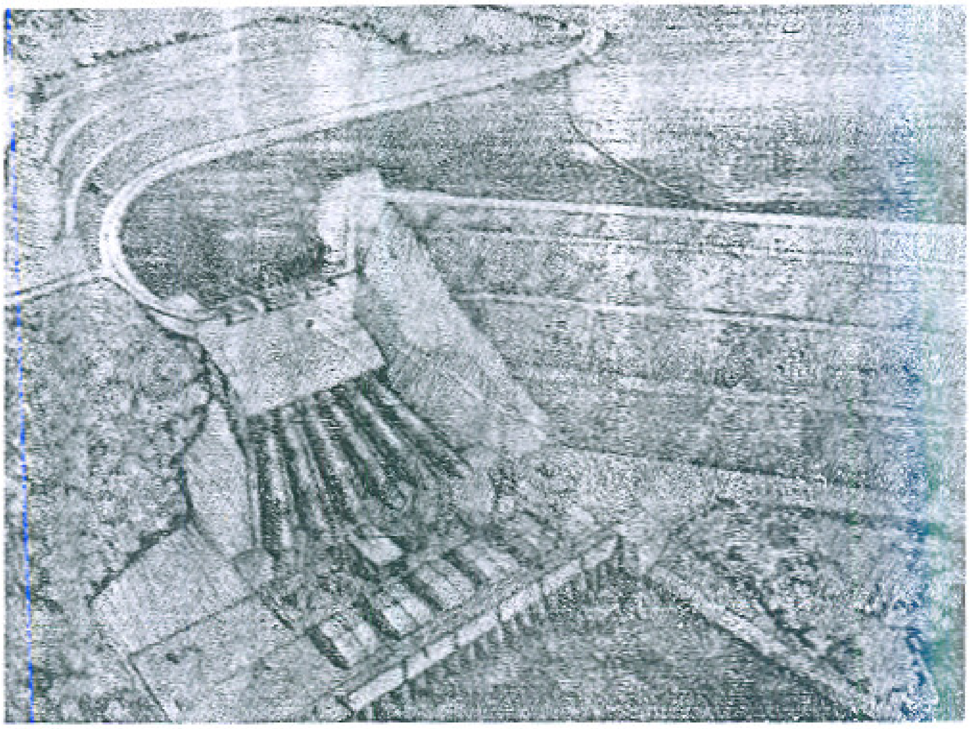
Readings are taken directly from a calibration curve of count rate against percentage moistrue or density in lbs. per cu. ft. Where test probes are to be taken on asphalt road surfaces in which hydrogen is present the road surfaces must be cut away locally to suit the probe.

(*iv*) ITALIAN DAM BUILDERS AWARDED BIG GHANA PROJECT

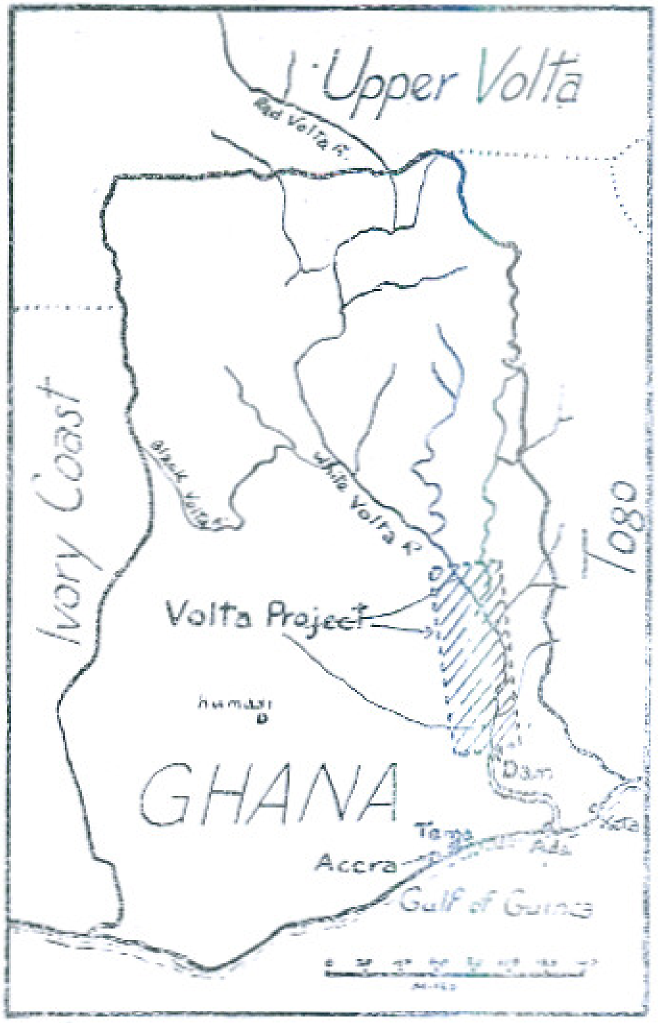
(World Construction, Nov. 1961. Page 19)

Although Ghana's Volta River scheme is somewhat over-shadowed by pro-Communist influence, work was expected to start recently on the 850 million dollar project.

The scheme is envisaged as transforming Ghana's economy through a huge complex of hydro-electric development for aluminium production, using the rich local bauxite deposits, and power distribution to secondary industries and new towns, and a harbour on the River Volta. It will end the nation's dependance on one-crop economy : cocoa.



DAM from an Artists point of View.



Showing location of the Volta project and the Tema aluminum smelter.

The scheme has taken 45 years to get started, since Sir Robert Kitson, the English chief geological officer to the Gold Coast Government realized the potential in the bauxite deposits. Several British Government commissions and teams from industry later formulated plans that came to nothing. Then, three years ago, Dr. Nkrumah, President of Ghana, visited Washington and persuaded President Eisenhower that the project should be undertaken.

Kaiser Industries, of California, produced a "re-assessment report" which is the basis of the present scheme. Edgar Kaiser, President of Kaiser Industries, took the lead in forming an international consortium of American and British aluminium interests—Volta Aluminum Company, known as VALCO to build a $180 million dollar smelter with maximum capacity of about 2,10,000 tonsyearly at Tema, 17 miles East of Accra.

At Akosombo, 60 miles north of the mouth of the Volta, the main dam and its power plants will be built at a cost more than 170 million dollars. The Ghana Government has undertaken to supply more than half the capital, the balance being made up by loans from the World Bank and the U. S. and British Governments. Work on the main dam is expected to take five years. The power plants are scheduled to go into operation by late 1965.

The dam will create a lake of 3,275 square miles, the largest man-made lake in the world. About 62,000 people will have to be resettled from this area. On the lake, a port is planned, to be the centre of an inland waterway system based on the Volta River. The main dam will be 2,100 ft. long, 370 ft. high, requiring 109 million cu. yd. of rock and clay. A smaller side-valley dam is also involved.

Impresit, the Italian company which built the Kariba dam in Rhodesia, has been awarded a 45 million dollar contract for the first stage of the Akosombo dam. The power house is designed for six generators, each of 128,000 kilowatts continuous output. The power transmission system is to be about 270 miles long.

Over 600 sq. miles of shore land will be flooded each season at high water intensive cultivatian of rice and other crops. A ferro-manganese plant and iron smelter, fed by ore from north-east Ghana, may be built within the network of the Lake's facilities. A lake fishing industry is to be established, and tourists are to be attracted by a first-class hotel.

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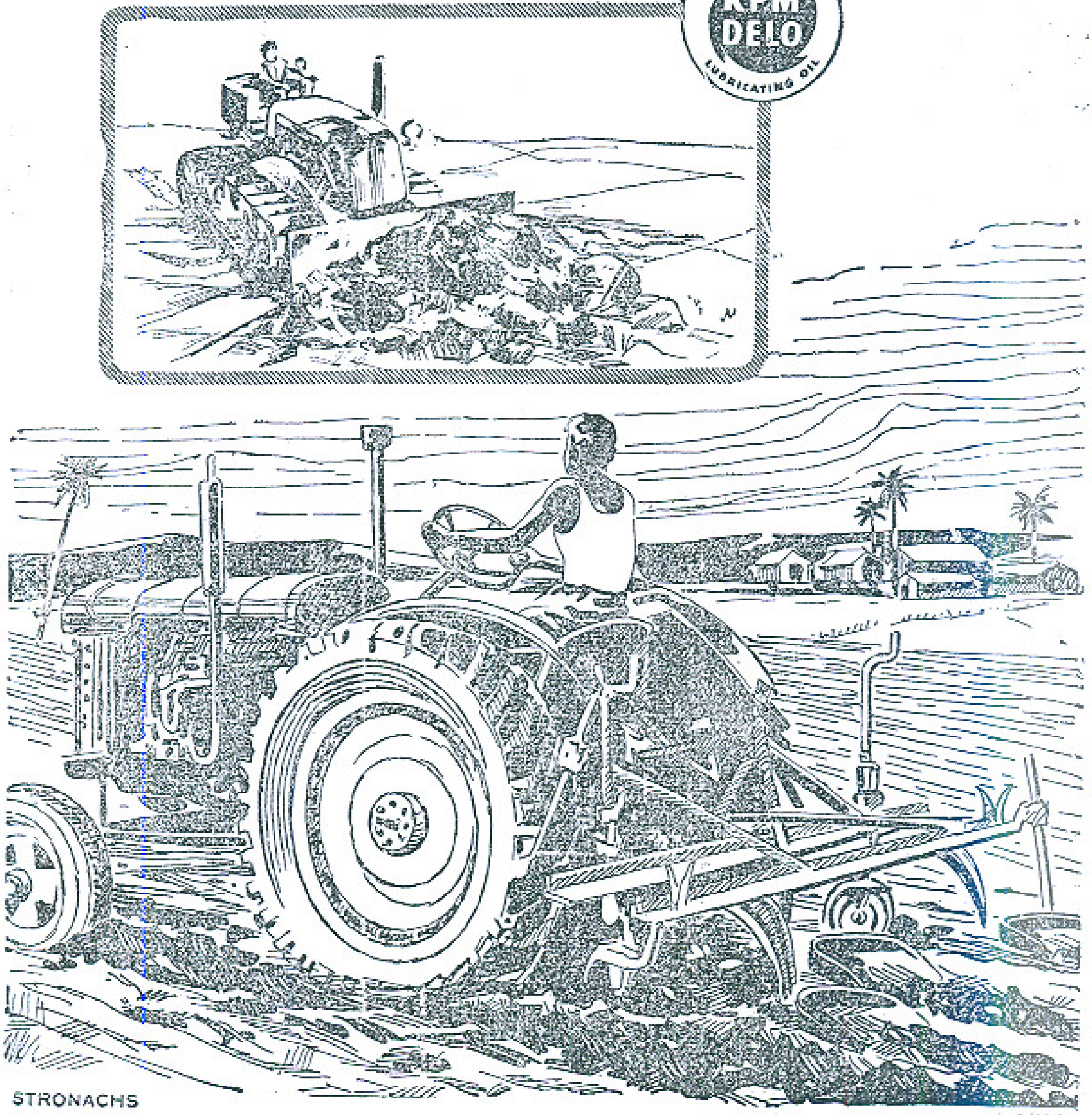

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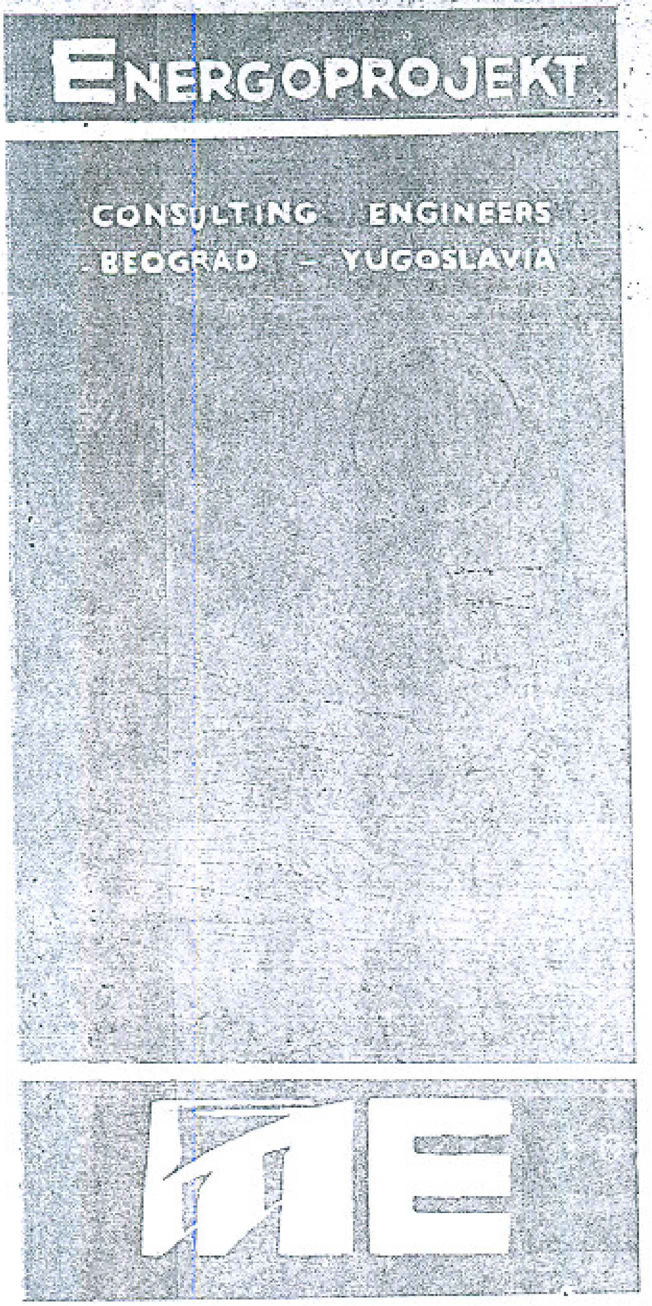

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