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WATER PLANNING FOR ISRAEL LTD.

T H E "M A I N" R E P O R T

FROM THE ENGINEERING POINT OF VIEW.

March, 1954

תוכן הענינים

INTRODUCTION AND SUMMARY.

A. Introduction.

1. Present Status of Irrigation Development in Israel.

Israel is still importing half of the food required to feed its population; the country could become self-supporting, as far as food is concerned, if an area of about 1 dunam was irrigated per head of population. Though irrigation has almost tripled since the establishment of the State of Israel-- we are now irrigating more than 700,000 dunams as against 230,000 dunams in 1948--, we still have not reached even the half-way mark, and at least 1,000,000 dunams additional irrigation has to be developed within the next seven - eight years at the rate of about 150,000 dunams per annum. This large scale irrigation program necessitates the full scale utilization of all available local water resources, ~~as well as at least partial implementation of Israel's National Water Scheme.~~

2. The Negev.

The Negev, the semi-arid to arid area southern half of Israel, contains more than one-third of the country's irrigable lands. The irrigation of the potentially fertile expanses of the Negev is an indispensable portion of Israel's short-time irrigation program, since, without the Negev, Israel cannot become self-supporting in its food supply. Israel's National Water Scheme will ultimately supply most of the water required for the irrigation of the Negev. Owing to the natural geographical, topographical and hydrological conditions, the scheme will necessarily be on the expensive side; it has, however, been found feasible, both from the engineering as well as from the economic aspect.

3. The Jordan River and Israel's National Water Scheme.

The Jordan river is the backbone of Israel's National Water Scheme: the benefits achieved by the Jordan river diversion are manifold and are not limited to the direct contribution to the water resources of the country. The construction of the National Water Scheme will make it possible to firm up considerable supplies of flood waters, which cannot be usefully developed without coordination with the National Scheme, owing to the lack of adequate hold-over storage sites in the southern part of the country; the main national conduit will, in addition, serve as a principal integrator and regulator to the whole water supply system of the country by receiving surpluses, where they occur, and supplementing deficient water supplies, where necessary. For these reasons, the non-inclusion of the Jordan would be tantamount to a death sentence to Israel's agricultural and economic independence.

4. The Authors of Israel's National Water Scheme.

The first notion of an integrated development of the Jordan basin water resources was conceived by Dr. W. C. Lowdermilk, more than a dozen years ago; ever since, a group of international top-notch experts have been directing the planning and design activities of an extensive Israeli organization; to name only the most outstanding ones:

The late James B. Hays	One time Project Engineer of T.V.A. and later in charge of many large scale overseas irrigation developments;
John S. Cotton	One time principal engineer for the Western States, Federal Power Commission, and Consultant to many foreign governments and organizations;

Dr. F. M. Nickell — One of the world's best known engineering geologists;

and many others. A Supreme Consulting Board of most prominent U.S. experts is reviewing project proposals from time to time; this board consists of:

Mr. Harry Bashore — One time Commissioner Bureau of Reclamation, Department of the Interior;

Mr. J. L. Savage — One time Chief Designing Engineer, Bureau of Reclamation;

Dr. Abel Wolman — Professor of Sanitary Engineering, Johns Hopkins University, and one of the most prominent water development consultants in the U.S.

All major projects constructed or under construction as well as those proposed for immediate construction, have been worked out under the direction of the above-mentioned consultants and have been approved by the above consulting board.

B. SUMMARY OF CRITICAL SURVEY ON CHAS. T. MAIN REPORT.

1. The report is avowedly a desk study, It is based on ~~out-dated~~ data which at least in the case of Israel has not been brought up to-date. ~~at least as far as Israel is concerned. Recent~~ data and reports have not been consulted.

2. After analysing the engineering aspects of the report, we have come to the conclusion that the engineering argumentation cannot be justified if one approaches the matter from a purely has been guided exclusively by the necessity to justify a politically inspired pre-determined allocation of water to the basin states. technical point of view.

3. The principal doctrines made use of to support this ~~unfortunate~~ allocation of water (e.g. exclusive within-basin use of water, exclusive use of gravity flow, exclusive use of within-basin storage sites, etc.) ~~are vague generalizations, long ago abandoned by planners~~ have generally been discarded in favour of

all over the world, and which certainly do not hold true in our specific case.

4. The limitations imposed by these misplaced doctrines forced the planner to forego the utilization of important quantities of water which could certainly be utilized within a sounder engineering layout.

5. The high water consumption assumed by Chas. T. Main, especially in the Jordan Valley and the Yarmuk Plateau is extravagant and wasteful, and last but not least, dangerous to the areas which it is intended to benefit. This is a dog in the manger policy at its worst.

6. The mismanagement of water resources implied in the Chas. T. Main water allocation to Jordan and Syria, leaves only 26% of the water resources of the basin for use in Israel; this quantity is so insignificant that it cannot possibly serve as a basis for allocation negotiations.

7. Sparing application of river water, in conjunction with the fullest possible utilization of local flood, spring and underground water, will benefit future hydro-power generation in the Jordan Valley within the framework of the Mediterranean - Dead Sea Power Project; the water use pattern implied in the Chas. T. Main Report will have an opposite effect.

8. Part of the flow of the Litani river, having no irrigation outlet within the Lebanese Republic, will, if diverted into the Jordan basin and conveyed through the conduits of Israel's National Scheme, initially generate important quantities of cheap hydro-power, while it would ultimately be diverted for irrigation, when replaced by sea

water in the hydro-electric plants.

9. The hydro-power schemes comprised in the report do not include some ~~of the~~ most attractive ~~developments.~~ recently started projects. This applies especially to the Lake Tiberias power project now under construction in Israel. This last mentioned project fits, incidentally, perfectly into the project layout of the Chas. T. Main Report.

C. RECOMMENDATIONS.

1. The project layout to be adopted to include all economic utilizable water resources of the Jordan basin, including ground water, as well as surpluses from the Litani river. Water allocations to be governed solely by the actual needs and development potentialities of the basin states.

2. Partial developments to be adopted in the first stage including diversion of part of the Jordan flow in Israel and part of the Yarmuk flow in Hashemite Jordan. First stage development to be designed so as to fit into the ultimate project framework while giving full benefits to the areas to be served already in the first stage.

15th March, 1954.

CHAPTER I.

THE "MAIN REPORT"

FROM THE ENGINEERING POINT OF VIEW.

1. Introduction.

The report on the "Unified Development of the Water Resources of the Jordan Valley Region", which is discussed on the following pages, was prepared under the direction of the Tennessee Valley Authority, upon the request of the U.N. Relief and Works Agency for Palestine Refugees in the Near East. The U.N. Relief and Works Agency—in the following abbreviated to U.N.R.W.A.—felt the need to review all the proposals, which had previously been prepared by various agencies, on the utilization of the water resources of the Jordan Valley Region, before committing itself to a project, having the main objective of making possible the establishment of Palestinian refugees in the newly irrigated areas. The T.V.A.—a regional organization set up by the United States Government for flood control, the utilization of hydro-electric power and general industrial and agricultural development of the Tennessee Valley—was approached by U.N.R.W.A. with the request to prepare such a survey and to indicate the most efficient way for utilizing the water resources of the Jordan Valley.

Without intending to belittle the spectacular achievements of the T.V.A., it is not understood why the T.V.A. was approached rather than the federal agency for the irrigation of the Western States of the U.S.A., the Bureau of Reclamation (U.S.B.R.). The Tennessee Valley is in an area with more than adequate rainfall with no similarity whatever with the Jordan Valley, while irrigation problems, similar in nature, scope and resources to those

of the Jordan Valley, have been successfully solved in the western semi-arid states of the U.S.A. by the U.S.B.R. It is therefore not surprising that the working out of the Report proper was entrusted to a private engineering firm, i.e. Charles T. Main, Inc., of Boston, Mass. (in the following termed the Consultant). For reasons, which cannot be evaluated by us, an eastern firm was again chosen, rather than a western consultant, which would probably have had more opportunity to deal, at first hand, with projects of a type and scope similar to those of the Jordan Valley.

The report discussed here (in the following called the Report) is the outcome of an office study made by the engineering firm of Charles T. Main, Inc., and submitted by Mr. Gordon R. Clapp, Chairman of the Board of the T.V.A., to the U.N.R.W.A.

2. Terms of Reference.

Describing the terms of reference for the Report, Mr. L. J. Carver, acting director of U.N.R.W.A., said in his Introductory Note:

> "It was found upon examination that no comprehensive survey of all the various proposals had been previously prepared; the director therefore decided, with the concurrence of the Advisory Commission, to place the responsibility for such an investigation in the hands of the T.V.A... The director also took steps to have studied the legal issues involved in the development of this international river ..... the T.V.A. was invited to disregard political boundaries, and to prepare a report indicating the most efficient method of utilizing the whole of the watershed in the best interests of the area".

It is, in addition, pointed out by Mr. Clapp, Chairman of the Board, T.V.A., that:

> "The assignment of the water to the various areas as listed in this Report is in no sense intended as an allocation of water".

According to these terms of reference, the U.N.R.W.A. Report contains no suggestions and no data on the legal issues, connected with a unified utilization of the Jordan Basin Resources; it is not known whether the separate study on legal issues, mentioned in Mr. L. J. Carver's Introductory Note, has been consolidated into a special report. The survey on earlier proposals, included in the above terms of reference, is--with the exception of the review of the Maquarin Project on the Yarmuk river--only very fragmentarily dealt with by the Consultant, probably, owing to the fact that no publications on the irrigation project adopted by Israel has been made available to him. The Report contains, however, definite

proposals for the utilization of the water resources of the Basin.

Keeping in mind the terms of reference to indicate "the most efficient method of utilizing the whole of the watershed in the best interests of the area" and interpreting the term "area" to include the whole area of the countries participating in the Jordan watershed,* a criterion must be established for the evaluation of the advantages and disadvantages of the use of water in the various existing proposals.

The foremost criterion, which, in our opinion, should be applied to an area like the Jordan Valley Region, where water resources are the limiting factor of agricultural development, is the volume of the crop which can be produced, at a cost which stays within the purchasing power of the population. It is felt that the volume of the crop, rather than the expenditure for water per unit of area, should, within reasonable limits, be decisive, as in relatively undeveloped countries, like the Jordan Valley Region, a slightly higher price of water would imply only a slight shift towards low-priced crops, while the lowering of the volume of agricultural production would--unless the country is supported from abroad--involve a radical reduction in the diet.

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* See page 13.

The Consultant says in Chapter 1:

> "The specific nature of the assignment requires a basic study and report depicting the most efficient and economical use of the region's meagre available water. With such a plan at hand, relationships therein to the political boundaries, present or future, can be considered with a clearer action of their value or effect. Because this assignment is somewhat unusual, it is especially important that the objective, basis and scope of this study and report be clearly understood".

This implies that it was the intention of the Report to ~~give only~~ a general engineering solution for the conservation and distribution of the water resources of the Jordan Valley Region, a solution which could later serve as a basis for allocation negotiations. At the negotiating stage, obviously, legal, political and other factors would have to be considered, which had not been allowed for in the Report.

Mr. G. E. Clapp says in his letter of transmittal:

> "It is recognized that each of these countries may have different ideas about the specific areas within their boundaries to which these waters might be directed".

It appears from the last two quotations that neither the quantity of water allocated to the basin states, nor the areas to which these quantities of water are intended for, are to be considered as definitive. Since the allocation of water and the disposition of land for irrigation are the gist of any irrigation project, it is felt that these qualifications deprive the proposed project of any real content; apparently, it is impossible to plan an irrigation project in a vacuum defined only by topographical and hydrographical features.

In addition, if the decision as to the ultimate use of water, within their political boundaries, is to be left to the basin states, what should prevent them (for geographical reasons, this applies only to Israel), to use the water outside the hydrographic basin proper? then, the whole argumentation of the Consultant would collapse, as it is ~~beyond any doubt~~ undoubtedly more economical and more beneficial to the region as a whole to irrigate by gravity with the high-elevation Jordan water extra-basin areas adjoining the Basin in Israel, than to use 2-3 times as much water per unit of land in the Lower Jordan Valley; so much more so ~~if no use is made of the power~~ when in the latter case as it appears from the Report would be potential of the Upper Jordan, ~~a procedure adopted in the Consultant's Report.~~

3. Objective and Scope of the Report.

The U.N.R.W.A. Report is an engineering office-study prepared from written material, maps, etc. made available to the Consultant, it is understood that neither field investigations nor even a preliminary field reconnaissance were undertaken. The various organizations and consulting engineers ~~which~~ who had, in the past, cooperated in the drawing up of ~~earlier proposals~~ plans in this region, were apparently not consulted. The Consultant had, therefore, to rely completely on the data contained in the material put at his disposal. The publications on the development of Hashemite Jordan, which were made available to the Consultant, included the latest reports, maps, and project data, while the material made available to him on the development of Israel included only data published until the end of 1945 (item 4 on the Report's reference list, "T.V.A. on the Jordan" by J. B. Hays, is a summarized reprint of reports published mainly in 1945).

since 1948

It is to be observed that extensive

~~A large amount of~~ basic investigations, planning work and numerous project suggestions have been ~~worked out~~ prepared in Israel, under the direction of ~~top-notch~~ notable U.S. engineering consultants, by an extensive engineering staff in Israel after 1948, and a number of detailed reports ~~have been issued~~ are available. ~~this material, which would have been of extreme value to the Consultant, was not made available to him.~~

The maps on Israel (Palestine) used by the Consultant, are all based on 1 : 50 000 surveys, and their topographical details are, according to our experience, ~~quite~~ inadequate, even for general planning work and preliminary cost estimates. This has a bearing on the actual length of the proposed conduits--actual lengths are about 20 p.c. higher than lengths scaled from small-scale maps, ~~and the cost~~ Consequently estimates of conduits included in the Report do not, ~~therefore,~~ in our opinion, reflect actual costs.

The material available to the Consultant on soil classification seems to have been ~~neither~~ equally inadequate, ~~since~~ The conclusions arrived at on the use of lands are not always reconcilable with facts established ~~by us~~.

It also seems, ~~in addition~~, that data available to the Consultant on ground water, salinity, relative crop expectancy, alkalinity of soils, water requirements and availability of storage capacity in Israel, was insufficient. This is reflected in ~~a number of minor and major~~ various discrepancies between facts and conclusions ~~quoted~~ appearing in the Report and actual observations made in Israel during the last few years.

CHAPTER II

PRINCIPAL ENGINEERING, AGRICULTURAL AND ECONOMIC DISADVANTAGES OF THE MAIN REPORT.

(a) General.

Economic and technical feasibility are relative terms: a project may have to be judged feasible if no better alternative exists, but the same project might be condemned as unfeasible, if more attractive alternatives can be devised. Therefore, it would be rather meaningless to enumerate the disadvantages of the U.N.R.W.A. Project as propounded in the Consultant's Report, without relating them to a possible alternative proposal. In the following, a comparison is made between certain aspects of the Project, as proposed by the Consultant and the regional development, as proposed by Israel's Master Plan.

(b) Non-inclusion of Litani river in Jordan Basin Resources.

The Jordan Valley Region and the adjoining Mediterranean watershed are deficiency areas, as far as water is concerned. On the other hand, there exists an unutilized river on the northern fringe of the Jordan watershed, which, in the opinion of all engineers who have studied the potentialities of the region, has no economical outlet for most of its water within its own basin or adjoining areas in the north and east: the Litani river in the Lebanon. This river, which has a flow larger than that of the Jordan watershed at the inflow into the Sea of Galilee, discharges unutilized into the sea, a few miles from a deficiency area, where it would work wonders.

When suggesting to pool the water resources of the watershed for most beneficial distribution, the Consultant should, certainly, have included the Litani river. The inclusion of a Litani diversion, while somewhat increasing in the Main Report, though it would increase somewhat

the construction cost of the Project, would make the whole proposition more attractive from the economic point of view, since the growth of capacity would by far outweigh the additional cost. The additional quantity of water diverted into the Jordan watershed could be usefully distributed to the best use of the whole watershed. The high head available between the Litani and the Upper Diversion, on one hand, and between this Diversion and the Sea of Galilee, on the other hand, could be utilized for power generation. Since the power feature is only an incidental feature of a project having primarily irrigation functions, the additional specific expenditure to be allocated to power generation would be relatively small.

The power that can be generated within the Jordan Basin from the water proposed for diversion from the Litani river, would, at least, be equal to the power developable from the same water within the Lebanon.

It appears that the inclusion of the diversion of part of the Litani flow into the Jordan watershed would be most desirable both from the point of view of irrigation within the Jordan watershed (and adjoining areas), as well as from the point of view of generation of hydro-power for the whole region.

(c) Deficiency of Data.

The U.N.R.W.A. Report is an office study and, at that, a study based only on part of the written material compiled during the last decade. No wonder that a number of misstatements have crept into the report, some of them having an important bearing on the crucial issue of water allocation, some having an influence on minor issues. In the following is a short statement of the more important cases:

(1) River Hydrology.

There is a number of discrepancies in the figures quoted by the Consultant regarding river flows and water balances in the Basin. The figures used in the following have been corrected according to latest available data.

(2) Wadi and Spring Flows.

The major discrepancy concerns the Beisan springs; these springs, rising in the Western Jordan Valley, south of the Sea of Galilee, are included in the water resources allocated for the irrigation of the Ghor, although these springs are, at present, completely utilized for the irrigation of lands in the Beisan Valley, which are within gravity control of these springs, though they are above the level of the Western Ghor Canal proposed by the Consultant and have--in orthodox compliance to the principle of gravity control by the canal--not been included among irrigable areas in Israel. Thus, an area, at present, successfully irrigated in Israel, has been excluded from the list of irrigable lands, while the water now used for this irrigation, has been allocated to the Lower Jordan Valley. Incidentally, a considerable part of this water has a high salinity (in the Beisan Valley, this water is mainly used for fish-ponds which have a higher salinity tolerance), and would, therefore, be a rather unwelcome addition to the relatively salty water issuing from the Sea of Galilee.

(3) Ground Water Hydrology.

The Consultant's estimates of utilizable ground water resources seem to be rather arbitrary; since ground water resources are included in the national water allocations, the order of magnitude of these resources included in the allocation of each nation is quite important. The Israel allocation in the Report includes 20 million cubic metres per annum from the small Yavneel Valley, and an insignificant and unidentifiable portion of the ground water from the western border of the Jordan Valley. The allocation to the Kingdom of Jordan, on the other hand, includes only 20 million cubic metres per annum for the more than 200 kilometres (straight line) of the west and east banks of the Jordan river below the Sea of Galilee. Incidentally, the safe yield of the Yavneel Valley ground water resources has been established--by actual long-term pumping-- to be in the order of magnitude of 3 - 5 million cubic metres per annum. Surely the ground water resources of both banks of the Jordan between Lake Tiberias and the Dead Sea must be of another order of magnitude! These estimates show certainly "misplaced generosity" in the Israel allocation of ground water and an unmotivated extreme pessimism regarding the potential ground water development in the Kingdom of Jordan. The inclusion of these arbitrary figures on ground water tend to distort the actual scope

THE MASTER PLAN FOR THE DEVELOPMENT OF THE JORDAN - YARMUK AND LITANI BASIN WATER RESOURCES.

1. General.

The engineering argumentation supporting the flow allocation according to the "Unified Development", contained in the Consultant's Report is motivated only by the necessity to justify a preconceived and politically inspired water allocation between the basin states of the Jordan Watershed. Since this objective was uppermost in the mind of the Consultant, no attention was given to a number of most important natural potentialities of the Region:

(a) the availability of a locally unutilizable water surplus at the doorstep of the Jordan Watershed in the Lebanon;

(b) the availability of first-class land and storage sites beyond the border of the Jordan Watershed within Israel;

(c) the availability of first-class hydro-power sites and of a power potential many times larger than that assumed by the Consultant;

(d) the division of the regions integrated water resources into a high-level group and a low-level group and the "natural" allocation of water evolving from this division, allocating the high-level sources to the relatively high-lying areas within Israel and the low-level sources mainly to the low-lying areas in the Jordan Valley proper.

An integrated utilization of all available water resources, based on the above principles, fits conditions created by nature so closely that no defensive argumentation is needed for its justification: areas many times larger can be irrigated, and many times more electrical units,

generated from hydro-power plants, can be made available than in the Consultant's plan. This integrated development surely fits the basic point of the terms of reference of the Consultant's Report, as laid down by Mr. L. J. Carver of U.N.W.R.A., to indicate "the most effective method of utilizing the whole of the watershed in the best interest of the area".

2. Water Resources.

The water resources, available for the regional Master Plan, can be summarized, as follows:

	Source.		Annual flow in million cu.m.
1.	Upper Jordan Tributaries		496
2.	Litani (diverted winter flow), say		400
3.	Return flow from Hula irrigation		60
4.	Springs and wadis in Hula Basin		159
5.	Yarmuk River		494
6.	Estimated total contribution in Lower Jordan Valley from springs, wadis and ground water.		540
	Gross total inflow into the Jordan Valley		2149
	Net evaporation losses in Lake Tiberias	Ddt.	94
	Est. irrecoverable and unutilizable portion of wadi and ground water flow in Lower Jordan Valley	Ddt.	160
	Net total available in Jordan Basin.		1895

The availability of water at various stations in the Basin is summarized in the following tabulation:

	Net average quantity available per annum.
At confluence of Upper Jordan tributaries with Litani diversion	896 million cubic metres
Beyond Lake Hula[x]	997 " " "
Beyond Lake Tiberias	898 " " "
Beyond confluence with Yarmuk river	1392 " " "
At Dead Sea	1895 " " "

The above figures are based upon measurements recorded for various sites within the basin. Where long-term observations were not available, correlative adjustments have been made.

3. Allocation of Water.

It can be seen from the foregoing tabulation that the water resources of the upper and the lower portion of the basin are almost equal. In allocating water to the basin states, the relation of the elevation of the water resources to that of irrigable areas has to be taken into account.

The Upper Jordan and Litani waters, which are available at an elevation around + 184 MSL are best suited for the relatively high lands along the proposed Upper Conduit both within the Jordan Watershed and in the adjoining portion of the Mediterranean Watershed of Israel: this upper diversion would supply the Hula Basin, the Esdraelon Plain, the Coastal Plain, and it would make possible to develop vast arid areas in the Negev. Regulative storage both en route and at the terminus is available. Water can be conveyed by gravity from the Upper Jordan and Litani diversions as far as the Negev.

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x After reclamation and irrigation of Hula Basin. The consumptive use of Hula irrigation is slightly smaller than the quantity of water reclaimed by the drainage schemes. Those two schemes, which are both under construction, will therefore effect no change in the downstream regime of the river.

Water occurring below Lake Tiberias, i.e. the balance of the Jordan, the Yarmuk river and local resources, aggregating about half of the region's total, would be allocated to the low lying lands of the Jordan Valley in the Kingdom of Jordan and Israel. Most of the water could be supplied by a gravity canal system issuing from Lake Tiberias; a small portion might however have to be pumped to lands located above the proposed canal elevation (mainly in the Kingdom of Jordan). This allocation includes also the water required for the irrigation of the Yarmuk Plateau in Syria.

According to experience of irrigation in the Jordan Valley, this allocation of water to the low-lying areas is more than ample; in our opinion, the quantities occurring below Lake Tiberias could not be completely utilized within the Jordan Valley; the Plan provides therefore the possibility to pump any surpluses from a point beyond Lake Hula to the Mediterranean Catchment.

4. Project Outline.

A project outline of the Regional Master Plan is now being drawn up by our consultant, Mr. John S. Cotton; since this outline is due to be completed shortly, no further details will further be given on project features, economics, etc.

FIRST STAGE OF REGIONAL MASTER PLAN FOR DEVELOPMENT OF JORDAN AND LITANI BASIN WATER RESOURCES

The planning, design and construction of the Master Plan in its entirety is due to take many years. On the other hand, at least some irrigation water is required by the Basin States in the near future: the Kingdom of Jordan needs water for the irrigation of the Jordan Valley in order to make possible the resettlement of Palestinian refugees; Israel has to increase irrigation in order to raise more locally grown food and reduce food imports from abroad. An early development of selected portions of the Master Plan is therefore most essential. The proposed Master Plan lends itself readily to realization by stages: a number of sections of the Plan can, although they form an integral part of the Master Plan, be independently executed, and will, when completed, benefit the area they are intended to serve, without having to wait for the completion of the whole Plan.

Such a development in stages has a number of important advantages: spreading of capital investment over a long period, the possibility to construct the less expensive features first, early initial benefits, etc. etc.

The main objectives of the first stages of the proposed Master Plan are discussed in the following:

Objectives of First Stage of Master Plan.

The objective of the first stage is to provide an adequate initial irrigation water supply to all participating countries at a reasonable cost and at an early date. Hydro-power can, at this stage, be also generated;

partly for pumping within the system and partly for general use. Both Israel and the Kingdom of Jordan will be benefited at this stage.

Important allocations of irrigation water for the irrigation of the Jordan Valley will in this first stage be made available to the Kingdom of Jordan to supplement existing inadequate supplies. These initial allocations will be derived from a main canal fed from the flow of the Yarmuk river and from improvements and additions to existing schemes utilizing spring, perennial wadi flow and wells; these works will certainly cover the needs of the Jordan Valley in the near future.

Israel will require water mainly for its Mediterranean Catchment, where local supplies are almost fully developed at present. Lands needing supplemental supplies are located mainly to the south of Tel Aviv. The deficiency of water is here felt very strongly and forms a serious handicap for further agricultural developments. The only resource available for the supplemental supply of these deficient areas is the Jordan river: it has been established that the most economical short-time solution would consist in diverting part of the winter flow of the Jordan below Lake Hula and conveying it via the Battauf reservoir to the Negev. Since only one-third of the river flow available would be diverted, an ample flow would remain in the Jordan for power generation utilizing the drop between the Hula and Tiberias Lakes, The power thus obtained will suffice to cover all power requirements for pumping within the system; as well as make available large power surpluses for general use.

A relatively small quantity of water will be required for the irrigation of the Lower Galilee during the summer months.

A second low-level diversion will, at this stage, become necessary for supplemental water supplies in the Israel's portion of the Jordan Valley and the Beisan Valley. These

areas are now only partially irrigated by the summer flow of the Yarmuk (Jordan Valley) and local springs (Beisan). This diversion will issue from Lake Tiberias and utilize part of the Lower Jordan flow. The canal will run parallel to the river on the west side of the Valley. The Beisan portion of the scheme is of particular importance, because it makes possible the full use of several saline springs, emerging in the Beisan Area, which, without mixing with the sweet Jordan water, could not be utilized for irrigation.

The Hula irrigation and reclamation schemes, which are now under construction, are not considered to form part of the Regional Master Plan, because, as far water is considered, they are complementary--the reclaimed water presently lost by transpiration and evaporation offsetting the consumptive water use of the irrigation project.

Power Balance of the First Stage.

A considerable quantity of power will be generated in the system at the first stage in the Tabgha hydroelectric plant.

The power balance in the system is summarized in the following:

Generation, in mill. Kwh. p.a.		Consumption in mill. Kwh. p.a.	
Tabgha plant	180	Battauf pumping plant	73
		Beisan " "	5
		Wells - Ghor	5
		Power required for pumping:	83
		Power losses:	8
		Total power required:	91

Gross power surplus - 89 million Kwh.

This power would be available for general use.

Allocation of Basin Water Resources at the First Stage.

From the total available Jordan - Litani basin water resources amounting to 1895 million cubic metres per annum, only about 720 million cubic metres would be utilized in the proposed first stage. Out of this amount, about 420 million m^3 would be diverted from rivers (270 million m^3 for Israel and 150 million m^3 for the Kingdom of Jordan), the balance would be drawn from local resources in the Beisan Area and in the Ghor. The total allocation to the participating countries would be about 370 million cubic metres to Israel and 350 million cubic metres to the Kingdom of Jordan.

This allocation would, it is assumed, satisfy the most urgent water needs of both countries for a number of years, while the annual investments, required for realization of the project, would stay within reasonable limits. It should be kept in mind that irrigation is only one--though the major--feature of agricultural development; and the agricultural development rate is limited by a number of conditions not connected with irrigation works development, like availability and training of manpower, preparation of land (especially in the Jordan Valley, where large-scale leeching operations will have to precede cultivation) provision of irrigation laterals and sublaterals, trying out of crops, drainage in especially affected areas, etc., etc. It is therefore felt that speeding up of the construction of irrigation works beyond a certain rate could not lead to a quicker rate of agricultural development and would not contribute to the economic benefits of the countries concerned.

of national allocations. It should, in addition, be kept in mind that a complete utilization of all ground water resources occurring in the Jordan catchment is most desirable from the point of view of the ultimate power potential of the Mediterranean - Dead Sea hydro-development, since every cubic metre of ground water actually consumed makes room for the admission of the same volume of sea water having a power potential of 0.8 Kwh per m^3.

(a) Unutilized Flow.

Though ~~being aware of the scarceness of water in the watershed, the Consultant --in order to remain consistent and not to trespass upon~~ Apparently, having regard for the limitations of the basin principle-- ~~had to~~ the Report assumes Lake Tiberias to be the only major storage reservoir available for the regulation of the Jordan and Yarmuk rivers, except for the limited capacity of the Hasbani and Maquarin reservoirs. ~~Owing to~~ As a result of this self-imposed limitations, ~~he had to infer that~~ the marginal 150 million cubic metres per annum of the mean river flows could not be regulated in this one reservoir, and they would ~~have~~ to be flow wasted into the Dead Sea, ~~at one stroke the Consultant has done to his proposal a double disservice: he has~~ Thus, ~~reduced~~ the quantity of water available for utilization is reduced by 150 million cubic metres per annum (about 9% of all regional resources), ~~and he has reduced~~ Similarly the potential annual power output of the Dead Sea power projects is reduced by 120 million Kwh per annum (!) (worth, at prevailing local fuel prices almost one million U.S. $ per annum).

Once the ban on extra-basin development is lifted, practically unlimited additional storage capacity becomes available, and the 150 million cubic metres per annum

wasted in the ~~Consultant's~~ project under consideration ~~can~~ (could) be fully included in the region's utilizable water resources to the benefit of both irrigation and power generation.

On the following pages, it will be shown that the Consultant's water allocation to the Ghor is excessive, and that large quantities of water would have to be wasted under this allocation.

~~The quantity of water which, in our opinion,~~ In the suggested allocation it is estimated that cannot be usefully consumed for irrigation in the Ghor ~~is estimated at~~ about 200 million cubic metres per annum. This affects again both the irrigation and the power potential of the Basin. It thus appears that about 350 million cubic metres per annum or about 21% of the total available water resources of the whole Basin would have to be wasted ~~if the Consultant's plan was adopted~~. This ~~wholesale waste~~ could be avoided if the basin principle ~~is~~ were abandoned and water allocation governed by agricultural needs ~~instead of political considerations~~ efficient. At the same time, the power potential of the Basin could be increased by about 280 million Kwh per annum worth, at prevailing local fuel prices about 2½ million U.S. $ per annum.

Actually, the quantity of water wasted in the Consultant's Project might still be larger, if allowance is made for the fact that "experience has indicated that on the average approximately 15% of the project lands are idle each year for one reason or another" (U.S. Bureau of Reclamation Manual, Volume IV, Chapter 7, 2 E.6). Since there exists no alternative irrigation outlet for this (statistically established) percentage of unused water (amounting to about 70 - 80 million cubic metres per annum) in the Ghor or adjoining areas, the water would actually have to be wasted, if firmly allocated to the Ghor. In order to remain on the safe side, this reduction of actual use, as compared to theoretical allocation, has not been taken into consideration.

(e) Overirrigation of the Jordan Valley (Ghor).

(1.) Irrigable Areas in the Jordan Valley.

The Basin States participating in the Jordan Basin are water deficiency areas: available water resources are not sufficient to irrigate available lands. Water will, therefore, be the limiting factor in agricultural development. The basic fact necessitates:

(i) Careful planning of the water conservation and conveyance features, with a view to conserve as much as possible of the available meagre resources and prevent any avoidable waste.

(ii) Careful planning of the agricultural aspects of water utilization, in order to assure the largest possible crops from available water resources.

(iii) Careful determination of most suitable lands for irrigation again with a view of optimum combined utilization of land and water resources.

The area is too poor in water to be able to afford projects which would not fulfil these basic conditions.

It is our feeling that the Consultant has/Report does not given enough weight to these basic facts, and the adoption of his Project would lead to extravagant waste of the limited resources of the Basin. In the following, are pertinent appurtenant facts and figures.

According to the Report Consultant claims that within the boundaries of the Jordan Basin 490,000 dunams are irrigable in the Ghor and 30,000 on the Yarmuk Plateau. These figures were computed from maps 1 : 50 000 or smaller scale. There exist, however, more accurate maps published by the Palestine Survey drawn on a scale of 1 : 20 000; a study of irrigable areas based on these maps indicates

Some of the major conclusions, arrived at in the Report, seem, therefore, to be based on inadequate supporting material and, it can be proved, in the light of the informations at our disposal, that, from the purely engineering point of view, an opposite conclusion would often better fit facts.

4. Synopsis of Main Project Features.

The project submitted to the U.N.R.W.A. includes three major diversions:

(i) The Upper Jordan Diversion including the canal Banias river--Galilee hills, as its principal feature. The objective of the diversion is to supply 284.0 million m^3 per annum for the irrigation of the Upper Hula region, the Ayeleth Hachahar area, the Lower Galilee, the Yavneel Valley and the Afuleh - Beit Alfa area. Generation of about 76 million Kwh per year, by developing the head available between a proposed storage reservoir on the Hasbani river and the level of the main canal, is an incidental feature of this part of the Project. It should be ~~kept~~ borne in mind that, although the canal starts at elevation above 180 m, the largest portion of the area irrigated is in the low valleys and does not require such a high head (Upper Hula, part of the Lower Galilee, and the major portion of the Afuleh - Beit Alfa area). The use of this high level water for relatively low lying areas, without integrated utilization of power, is a major