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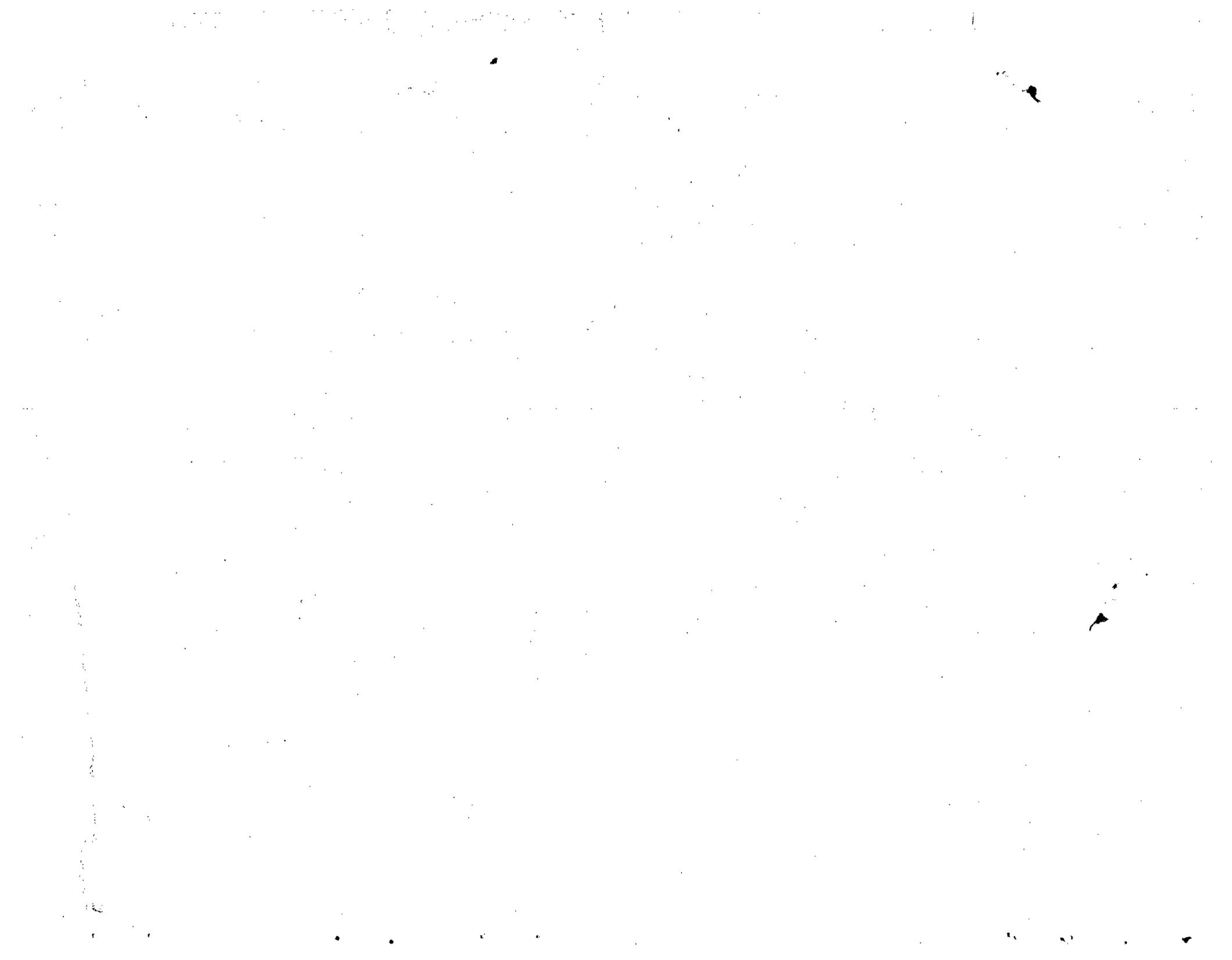
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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

**TECHNICAL REPORT
ON THE
EUPHRATES RIVER FLOOD CONTROL
AND
IRRIGATION PROJECTS
IN
IRAQ**

February 7, 1951

Loan Department



REPORT ON EUPHRATES RIVER FLOOD CONTROL AND
IRRIGATION PROJECTS - IRAQ

I. Purpose and Scope of this Report

1. This report covers an analysis of the technical and financial aspects of three projects (see map attached) involved in the flood control and irrigation program for the development of the Euphrates River Valley in Iraq, the foreign exchange costs of which have been proposed as a basis for a loan from the Bank. The projects are as follows:

- (1) The Warrar Barrage Project;
- (2) The Hillah Canal Project;
- (3) The Musayib Canal Project.

2. The report covers a technical description of the projects, estimated costs and probable earnings. A recommended basis for a loan is included in the report.

3. The information on which this report is based includes a detailed study of irrigation and flood control possibilities in Iraq which was completed by the Haigh Commission in 1949 and preliminary engineering work on the Warrar Barrage done by Coode, Vaughan-Lee, Frank, and Gwyther, Consulting Engineers of London. Some supplementary information was obtained from the Department of Irrigation of the Ministry of Public Works in Iraq and by personal observations at the sites. It is believed that the information available, while not complete, is adequate for the purpose of reaching a decision on these projects as a basis for a loan.

4. This report does not include a discussion of the complete Iraqi flood control and irrigation program. The reader is referred to a report by Gen. Glen E. Edgerton, No. C-5, dated September 6, 1949, for this information.

II. The Borrower

5. If a loan is made on these projects, the borrower will be the Government of Iraq. The execution of the works involved will be the responsibility of the Department of Irrigation, an agency of the Ministry of Public Works.

6. The Department of Irrigation does not attempt to carry out works of the type involved in these projects with its own personnel and equipment. In general, all engineering work is done by consultants and all construction work is carried out by contract. Therefore, the technical competence of the personnel of the Department, although considered to be good, is not an important consideration so far as the proper execution of the projects is concerned.

III. The Warrar Barrage Project

a. Description of the Project

7. The Warrar Barrage is an integral part of the Habbaniyah development which is the principal flood control and storage project to be built in the Euphrates River Valley. The complete project is to be executed in three stages, the first of which is well underway, is fully contracted except for the Warrar Barrage, and is the only stage under consideration by the Bank.

8. In this first stage an intake canal is being constructed from the Euphrates River to Lake Habbaniyah which will have a capacity to carry about 800 cumecs. ^{1/} This canal has a length of about 8.5 Kms. and a bed width of 210 meters. The canal is being excavated by means of a hydraulic dredge and the excavated material is being used for building levees on both banks which have adequate height to hold water at the maximum levels required in the Habbaniyah development.

9. A regulator is being constructed about 1 Km. downstream from the canal inlet. This regulator will have the same capacity as the canal. Above the regulator on the right bank of the canal, a spillway will be provided to allow flood water in excess of the capacity of the regulator to spill into an existing channel which discharges into Lake Habbaniyah. This channel has been used for a number of years for releasing flood waters into Lake Habbaniyah by breaching the main levee on the Euphrates River at the inlet of the channel.

10. An outlet channel about 9 Km. long has been completed which connects Lake Habbaniyah with the Euphrates River about 40 Km. downstream from the entrance of the intake canal. This canal is also dyked on both sides to hold water at the maximum level planned in this development. A regulator having a capacity of 200 cumecs is provided about 3 Km. downstream from the lake. This installation was completed prior to World War II and is in operation. An escape channel connecting Lake Habbaniyah with the Abu Dibis depression to the South has been completed. This canal is about 20 Km. long and has a capacity of 850 cumecs. A regulator has been installed near the inlet at Lake Habbaniyah.

11. The Warrar Barrage is an essential part of the complete Habbaniyah development in order to provide a sufficiently high level of water in the Euphrates River to fully utilize the storage facilities of Lake Habbaniyah. It will be constructed across the river at a site approximately 1 Km. below the entrance of the inlet channel described above. The barrage is designed to provide adequate gate capacity to pass 3,000 cumecs and will be provided with a small lock for river boats as well as a fish ladder. The dam will be 209 meters wide with suitable abutments from which the necessary embankments will be constructed to connect into the existing levee system on each side of the Euphrates. The height of the dam from the bottom of the sill will be 10.7 meters.

^{1/} Cumecs is the abbreviation for cubic meters per second.

12. The main section of the dam will be constructed of massive concrete and pre-cast concrete blocks. Iraqi cement will be used. Aggregate will be obtained near the site. Gravel and sand in this area must be carefully selected, however, and washed well in order to eliminate gypsum. The embankments will be constructed with clay cores and will be surfaced with large stones which will be laid dry.

13. The barrage will be provided with 24 vertical gates of steel construction, each 6 meters wide by 8 meters deep. The lock gates will be of the same size and of conventional construction. All will be manually operated. The fish ladder will be of conventional design.

14. The dam will also serve as a bridge for a roadway over the Euphrates. This feature requires the construction of a steel bridge over the lock and the design of the embankments is to be such as to provide sufficient widths for a two-lane highway.

15. Sufficient borings have been taken at and near this site to show that foundation conditions are only fair. This area is a part of an old Euphrates delta and consists of alternate layers of clay, gravel and sand. The foundation of the dam can be laid on hard clay, however, and the entire structure is designed with this consideration in view. Two cut-off walls are provided. It is believed that the design of the barrage is such that a tight, stable structure will be obtained.

16. The Euphrates River, during the flood period, carries a very high content of silt. The barrage, with vertical gates spaced across the main channel of the river, should effectively prevent the accumulation of silt in the channel to any appreciable extent. The useful storage capacity of Lake Habbaniyah, which has an area of 380 square kms. and a dead storage of about 500 million cu. meters, should not be affected by silting for at least 50 years.

17. The levee system upstream from the proposed barrage has sufficient height so that the river level can be raised to the maximum contemplated in the Habbaniyah system without overflowing land presently under cultivation. Raising of the level does not create appreciable storage in the river but allows the level of Lake Habbaniyah to be raised to the extent necessary to provide a useful storage of about 2 billion cubic meters.

18. The Habbaniyah project has been under construction at various times since 1913. Final plans for the complete system were concluded in 1949 as a part of the work of the Haigh Commission and these plans are considered to be relatively firm. In the first stage after completion of the Warrar Barrage and some minor changes in the regulator in the escape channel, full protection from floods greater than 2800 cumecs will be provided below the barrage and useful storage of about 1.2 billion cubic meters will be obtained in Lake Habbaniyah. In the second stage, by increasing the height of some of the dykes surrounding Lake Habbaniyah, the level can be raised to give 2 billion cubic meters, the maximum which is contemplated. In the third stage

of the development, the Abu Dibis depression will be used as perennial storage increasing the useful storage to about 20 billion cubic meters.

19. The engineering work on those phases of the project now under construction as well as the Warrar Barrage has been carried out by Coode, Vaughan-Lee, Frank, and Gwyther. In the case of the Warrar Barrage, all preliminary engineering work has been completed and a draft construction contract has been prepared. The job is now ready for bidding.

20. Based on the information now available, this project is considered to be technically sound. Additional cores must be drilled at the site of the barrage before construction work is started but this work has been established as the responsibility of the contractor. It is expected that the total cost of the project will not be materially affected as a result of additional exploratory work.

b. Estimated Cost of the Project

21. The total cost of the Warrar barrage was estimated by the engineers of the Haigh Commission as ID 912,000 in 1948. In October, 1950, this estimate was revised by Coode, Vaughan-Lee, Frank & Gwyther to ID 1,000,000. Since these estimates were made for budget purposes, they have not been completely itemized or broken down fully into foreign exchange and local currency. However, a partial breakdown is possible as follows:

<u>Item</u>	<u>Foreign Exchange In \$1,000</u>	<u>Local Currency In 1,000 Dinars</u>	<u>Total Cost In 1,000 Dinars</u>	<u>Total Cost In \$1,000</u>
1. Steel sheet piling	106.4	-	38	106.4
2. Barrage gates	369.6		132	369.6
3. Lock gates	44.8		16	44.8
4. Steel bridge	8.4		3	8.4
5. Miscellaneous fittings	16.8		6	16.8
6. Cement, labor, inland freight, etc. 2/		478	478	1,338.4
7. Ocean freight and insurance	56.0	-	20	56.0
8. Construction equip- ment 1/	299.0	-	107	299.6
9. Engineering fees 1/	56.0	-	20	56.0
10. Contractors profit 1/	139.0	-	50	140.0
11. Contingencies 15% 1/	164.0	72	130	364.0
Totals	1,260.0	550	1,000	2,800.0

Total Cost of Project Expressed as Dinars - - - - 1,000,000

Total Cost of Project Expressed as Dollars - - - - 2,800,000

1/ Estimated by Engineering Staff.

2/ Obtained by difference.

22. In the above estimate, the foreign exchange cost has been assumed as 45% of the total. This proportion is somewhat arbitrary but is in line with experience on similar projects in Iraq. The estimates with respect to both foreign exchange requirements and local currency are considered to be conservative.

23. No provision is made to cover interest during construction in the capital cost of this project.

24. The original estimate of the cost of the first stage of the Habbaniyah scheme as presented by the Haigh Commission was ID 2,700,000 (\$7,550,000). It is currently estimated that the cost will be ID 4,303,000 (\$12,050,000), the increase being due to rising prices, changes in the project, and unexpected difficulties in excavating the canals. Of this amount, it is estimated that expenditures up to December 31, 1950, will be ID 2,719,000 of which ID 663,000 (\$1,860,000) has been in foreign exchange.

IV. The Hillah Canal Project

a. Description of the Project

25. The Hillah Canal is the largest primary irrigation canal in Iraq servicing about 1,320,000 acres of land lying between the Euphrates and Tigris Rivers which is known as the Jazirah. Actually it is not a canal in the sense that it has been built by men and machines but rather is an old channel of the Euphrates River, the inlet of which has been excavated to allow flow of water from the present river channel into the old channel.

26. The Hillah Canal takes off the Euphrates on the left bank about 10 Km. south of the town of Musayib. The level of the Euphrates at the take-off is controlled by the Hindiyah Barrage. The canal is 104 Km. long and, in addition to feeding distribution canals along its full length, it also supplies four important secondary canals; the Babil which takes off about 20 Km. below the inlet, and the Hurriyah, Dagharah and the Diwaniyah which take off at the end of the Hillah.

27. At the present time the intake of the Hillah Canal is limited to about 114 cumecs and the discharge available at the tail of the canal to about 57 cumecs. It is proposed to remodel the entire channel to provide cross-sections adequate to permit an intake of 175 cumecs which is estimated to provide 87 cumecs at the tail. The new channel will be of standard cross-sections varying in width from 60 meters to 30 meters with depths of from 4.25 to 3.6 meters.

28. The amount of earth to be moved in this operation is estimated at 7.5 million cubic meters, about one-half of which will be accumulated silt in the channel. It is expected that all of this work will be done with standard dredging and earth moving equipment, the types and number of machines to be specified by the contractor at the time of bidding.

29. The earth removed from the channel will be used in the construction of embankments along both sides of the canal which will permit raising the level in the canal at a later date if the water demand increases beyond the present designed capacity. Existing regulators, bridges, culverts and similar items will be rebuilt by extending existing installations so far as possible.

30. The nature of the soil in the area is such that the canal will not require facing with stone or concrete. The clay strata are relatively hard and sufficiently stable to prevent slides or excessive erosion.

31. The Haigh Commission recommended that several of the bends in the existing channel be eliminated and the length be reduced from 104 Km. to about 85.5 Km. Cost studies completed by the Department of Irrigation have shown this to be uneconomical as compared with enlarging the present channel. The increased cost of shortening the channel would be due largely to the large number of new regulators which would be required at the cut-off sections. The Haigh proposal has, therefore, been abandoned in favor of remodelling the present channel.

32. The greatest shortage of water in the Hillah system is in the area served by the Dagharah Canal in the South Jazirah. As a part of this project, it is proposed to replace the first 23 Km. of this canal with a new section running adjacent to the Hurriyah Canal and connecting into the old channel of the Dagharah. The present supply of the Dagharah is limited to about 9.4 cumecs and the Hurriyah to about 6.6 cumecs or a total of 16 cumecs. On completion of the new section, the Dagharah will have a mean supply of 25.7 cumecs and the Hurriyah about 4 cumecs for a total of about 30 cumecs.

33. The design of the new section is not yet complete but it is estimated that approximately 2 million cubic meters of earth must be moved during construction. This work will be done by contract; the types and amount of earth-moving equipment required to be specified by the contractor. Three regulators will be required as well as a number of bridges, culverts and similar items.

34. The preliminary engineering, designing and estimating on this project was done by the engineers of the Haigh Commission. Their recommendations are being followed except that the Hillah Canal will not be shortened as mentioned above.

35. Based on the analysis of this project by the Haigh Commission and supplementary information received from the Department of Irrigation, the project is considered to be technically sound. The availability of sufficient water to provide the supply required by the Hillah Canal, however, will be dependent upon the completion of the first stage of the Habbaniyah project and, therefore, the two projects must be carried forward simultaneously to completion.

b. Estimated Cost of the Project

36. The total cost of this project is currently estimated at ID 770,800 by the Department of Irrigation. This compares with an estimate of ID 893,000 made by the Haigh Commission in 1949. The two estimates are not directly comparable since the Haigh estimate includes the shortening of the Hillah Canal and does not contemplate enlargement of the full length to the extent now contemplated.

37. A breakdown of the current estimate into principal items is not available. Furthermore, the foreign exchange requirements will not be known until the contractor has been finally selected and the details of the contract are known. However, an approximate breakdown of the estimated cost can be made as follows:

<u>Item</u>	<u>Foreign Exchange In \$1,000</u>	<u>Local Currency In 1,000 Dinars</u>	<u>Total Cost In 1,000 Dinars</u>	<u>Total Cost In \$1,000</u>
1. Construction Equipment	411.3	-	416.9	411.3
2. Local Materials, labor, freight, etc.	-	305.5	305.5	855.4
3. Remodelling of Existing Structures	14.0	15	20.0	56.0
4. New Structure	184.1	40	105.8	296.2
5. Contractors fees	216.0	-	77.1	215.9
6. Contingencies 15%	<u>145.5</u>	<u>63.5</u>	<u>115.5</u>	<u>323.4</u>
Total	970.9	424.0	770.8	2,158.2

Total Cost of the Project Expressed as Dinars - - - ID 770,800

Total Cost of the Project Expressed as Dollars - - \$2,158,200

38. The total cost of the project as given above is believed to be reasonably accurate. However, the breakdown by items should be considered as only approximate and subject to appreciable changes when firm prices have been received. The breakdown is based on information contained in the Haigh Report and on estimates made by the Engineering Staff. The estimates of total cost and foreign exchange requirements are considered to be conservative.

39. The total foreign exchange requirement as influenced by the items covering construction equipment, contractors' fees and contingencies, may be reduced substantially from the estimates. The total foreign exchange requirement is based on Iraqi experience which indicates that in this type of work foreign exchange costs represent about 45% of the total. However, Iraqi contractors can be used extensively on works of this type and, therefore,

depreciation charges on equipment and contractors' fees may be paid largely in local currency. The foreign exchange requirements, therefore, will not be accurately known until the contractor is selected and the terms of the contract are available.

40. As in the case of the Warrar Barrage, no interest during construction has been included in the estimate.

V. Musayib Canal Project

a. Description of the Project

41. An existing canal takes off the left bank of the Euphrates about 1 Km. above the town of Musayib and about 21 Km. above the inlet of the Hillah Canal. This canal now serves about 37,000 acres in the area between the Euphrates and Tigris Rivers known as the Northern Jazirah. The existing canal is 17.5 Km. long and provides a mean supply of 3.2 cumecs. Its capacity is estimated at about 5.3 cumecs.

42. It is proposed to enlarge the existing canal and extend it 31 Km. into a desert area of 126,000 acres. This land is government-owned and is not under cultivation at the present time. When completed the canal will provide a mean supply of 15.1 cumecs and will have a rated capacity of 20 cumecs. All of the work involved in this project will be done by contract. It is estimated that about 4.5 million cubic meters of earth must be moved, a portion of which will be done by dredging, the remainder with draglines and shovels.

43. It is planned that some secondary canals will be constructed as a part of this project and provision has been made in the estimates to cover the regulators necessary to tie these canals into the system. The design covering this project is not complete. Some bridges will be required over the new section. As in the case of the Hillah Canal, no facing of the channel will be required.

44. The studies and preliminary design of this system were made by the engineers of the Haigh Commission. The Department of Irrigation does not contemplate any basic changes in the original design. The works involved are simple and conventional in all respects. Based on available information, the project is considered to be technically sound.

b. Estimated Cost of the Project

45. The total cost of this project is currently estimated as ID 400,000 (\$1,120,000) which is the same as the preliminary estimate of the Haigh Commission. As in the case of the Hillah project, an itemized estimate is not available and the foreign exchange requirements have not been adequately estimated. An approximate breakdown can be made as follows:

<u>Item</u>	<u>Foreign Exchange In \$1,000</u>	<u>Local Currency In 1,000 Dinars</u>	<u>Total Cost In 1,000 Dinars</u>	<u>Total Cost In \$1,000</u>
1. Construction Equipment	148.5	-	53	148.4
2. Local Materials, Labor, Freight, etc.	-	142	142	397.6
3. Remodelling of Existing Structures	28.0	10	20	56.0
4. New Structures	140.0	35	85	238.0
5. Contractors Fees	111.9	-	40	112.0
6. Contingencies 15%	<u>75.6</u>	<u>33</u>	<u>60</u>	<u>168.0</u>
Totals	504.0	220	400	1,120.0

Total Cost of the Project Expressed As Dinars - - - - - ID 400,000

Total Cost of the Project Expressed As Dollars - - - - \$1,120,000

46. As in the case of the Hillah project, the foreign exchange requirement of this project has been taken as 45% of the total estimated cost. The same limitations as to the firmness of this estimate apply as in the case of the Hillah project.

VI. Construction and Expenditure Schedules

47. Construction and expenditure schedules have not been estimated for these projects. It is the practice in Iraq to allow the bidders to establish these schedules and include them as a part of their bids. This is necessary for works of this type since such schedules are dependent upon the amount of construction equipment which will be brought on the job by the contractor. It is anticipated, however, that the three projects will be executed simultaneously with completion of the Warrar Barrage in two years and the work on the canals in about three years.

48. Foreign exchange expenditures will be concentrated in the first year due to the relatively large amount of construction equipment involved. Local currency expenditures will probably be distributed about evenly over the construction period for each project.

VII. Methods of Financing

49. The local currency requirements for these projects will be provided as annual budget appropriations to the Development Board. In Iraq, firm budget appropriations cannot be made to cover more than the current fiscal year and, therefore, the local currency for these projects cannot be fully committed prior to starting work. The projects are regarded as having a

very high priority, and, in future years, funds will be made available for work in the Euphrates Valley from the oil royalties accruing to the Development Board. The foreign exchange requirements are the basis for a loan application to the Bank.

VIII. Justification of the Projects

a. Flood Control

50. The maximum recorded flood on the Euphrates occurred in 1929 at which time the flow was 5,200 cumecs as measured at Hit. This compares with an average discharge of 837 cumecs (1924-1946) and a mean dry season flow of 280 cumecs. With the installation of the Warrar Barrage, the downstream flow will be limited to 2,800 cumecs which is within the capacity of the existing levee system. The storage provided by Lake Habbaniyah plus the possibility of allowing water to escape in the Abu Dibis depression in times of excessive flooding will, therefore, provide adequate flood protection for that section of the river below the barrage to Hammar Lake.

51. The barrage will maintain a fixed level in the river which will not be influenced by the amount of water flowing. This will permit holding a relatively low level in Lake Habbaniyah until late in the flood season if no floods have occurred early, or if they have been moderate in amount and thus provide maximum flood protection throughout the season. This feature, plus the possibility of spilling water into the Abu Dibis depression, makes the operation unusually flexible for flood control and storage purposes.

52. Estimates of flood damage on the Euphrates are not available for past years. It appears that such damage has been confined largely to winter crops and on the average has not been excessive. The Euphrates is well confined by levees of such capacity as to give full protection in average years. This condition plus the fact that Lake Habbaniyah has been used by breaching the levee at the Warrar Channel and other points has kept flood damage to a relatively low level. It is evident, therefore, that savings resulting from the elimination of flood damage do not contribute greatly to the justification of this project.

b. Irrigation

53. The major justification for the Habbaniyah project is the provision of water storage for irrigation. At the present time about 228 cumecs out of the mean dry season flow of 280 cumecs in the Euphrates are used for the irrigation of about 2,900,000 acres in the area between the site of the Warrar Barrage and Hammar Lake. Completion of the first stage of the Habbaniyah project will provide an additional flow of 110 cumecs, bringing the dry season average to 390 cumecs. This will improve the water supply to existing land under irrigation and will provide water for an additional 1,180,000 acres at the present intensity of cultivation when the necessary irrigation works are completed. The increased area which can be irrigated is only about half of the new land accessible for flow irrigation in the section of the Euphrates

Valley under consideration, the total of which is estimated in excess of 2.5 million acres.

54. In Iraq, it is the practice to alternately plant 50% of the land in winter crops allowing the remaining 50% to lie fallow. Areas which have sufficient water to follow this schedule can also plant 10% of the land in summer crops. However, in the Euphrates Valley above Hammar Lake, the area of about 2,900,000 acres which are presently irrigated do not have an adequate water supply to maintain 50% under winter cultivation each year. The average now planted is stated to be about 40%. Shortage of water is particularly acute in an area of about 1,320,000 acres which is served by the Hillah Canal and where planting in winter crops is limited to about 36%.

55. Irrigated land in the Euphrates Valley is normally planted in barley and wheat as winter crops in the proportion of about two to one. On new land the yield of barley is about 525 Kilograms per acre and the yield of wheat is about 420 Kilograms per acre. For summer crops, about 50% of the land planted is in cotton, the remainder in vegetables and sesame. (See Table I attached hereto.)

56. The following considerations concerning costs and earnings are based on the assumptions listed below:

a) The intensity of cultivation of the area of 1,320,000 acres served by the Hillah Canal will be increased from 36 to 50%, or an increase of the area planted per year of 185,000 acres.

b) The total of new land brought under cultivation will be that served by the Musayib Canal amounting to 126,000 acres of which 63,000 acres will be in production annually.

c) Interest and amortization of a Bank loan would be on the basis of annual appropriations to the Development Board and will not be charged directly to the projects.

57. Based on the above assumptions, the minimum additional land which will be brought under cultivation annually as a result of these projects will be 248,000 acres or the equivalent of 496,000 acres of new land cultivated at an intensity of 50%. Taking the current estimated cost of the Habbaniyah project as ID 4,303,000 (\$12,050,000), the cost per acre of land in production each year is ID 17.4 (\$48.60) or in terms of new land cultivated at 50% intensity, the cost is ID 8.7 (\$24.30).

58. In the case of the Hillah Canal project, an additional investment of ID 770,800 (\$2,158,200) is required to attain an intensity of cultivation of 50%. This is equivalent to ID 4.18 (\$11.70) per acre cultivated annually, or in terms of new land cultivated at an intensity of 50%, is ID 2.09 (\$5.85). Including the proportionate cost of the Habbaniyah project, the total investment by the government in land to be brought into production by the Hillah area is ID 21.58 (\$60.50) per acre cultivated annually or in terms of new land is ID 10.79 (\$30.25).

59. If average interest payments required to service loans covering the estimated foreign exchange costs of the Warrar Barrage and the Hillah projects are taken into consideration, the above figures are increased by about 5%.

60. In the Musayib project, the additional investment amounts to ID 400,000 (\$1,120,000). This is equivalent to ID 6.35 (\$17.80) on the basis of land producing annually, or ID 3.18 (\$8.90) in terms of new land. Including the proportionate investment in the Habbaniyah project, total investment figures amount to ID 23.75 (\$66.40) and ID 11.88 (\$33.20) respectively.

61. Assuming that only winter crops will be planted on the land under consideration and that the proportion will be two acres of barley to one acre of wheat, the gross income to the farmer at current prices will be as follows:

	<u>Yield/Acre in Kg.</u>		<u>Crop Value/Acre</u>		<u>Average Crop Value</u>
	<u>Barley</u>	<u>Wheat</u>	<u>In ID</u>		<u>Per Acre</u>
			<u>Barley</u>	<u>Wheat</u>	<u>In ID</u>
Hillah	445	322	5.80	7.72	6.45
Musayib	525	400	6.83	9.60	7.76

On the basis of crop values, the Hillah project will pay out in $3\frac{1}{2}$ years and the Musayib project in about 3 years, with both carrying proportionate shares of the Habbaniyah project. Both barley and wheat are export crops and the gross value of these crops to the farmer, plus at least 50%, might be realized as foreign exchange, if the total additional output is exported. At current prices, this could amount to the equivalent of about \$1.5 million/year.

62. Iraq does not have a system of water taxes or one for the direct sale of water on land under irrigation. Government income is derived entirely from production taxes paid by the farmer at the time when the crop is sold. These taxes currently amount to $13\frac{1}{2}\%$ of the crop value. On this basis, in the case of the Hillah project, government income per acre will amount to ID .791 and at this rate the investment in the Hillah project, plus its proportionate share of the Habbaniyah project, would pay out in about 28 years.

63. The Government's position with respect to the Musayib project is somewhat better. It is planned to distribute the new land brought under cultivation to small farmers in plots of 50 to 100 acres. Farmers on this land will pay rent amounting to $12\frac{1}{2}\%$ of the crop in addition to production tax. Therefore, the total income to the government from this development will be ID 2.02 per acre which will amortize the investment in the Musayib extension plus its proportional share of the Habbaniyah investment in about 12 years.

64. The above calculations result in the estimation of the minimum benefits which can be expected from these projects. Actually there will be some increase in the intensity of winter cultivation in the areas not included in the Hillah and Musayib systems. Although the data contained in the Haigh report indicates increased production from this source to be relatively small, a

more likely development will probably be an increase in the production of summer crops such as cotton, vegetables and sesame in the entire area between the Warrar Barrage and Hammar Lake. The Department of Irrigation estimates that the value of such additional crops may reach ID 900,000 per year at current prices. This would provide a tax income of ID 121,000 and if this amount is realized the time required to amortize the cost of the projects from tax income will be reduced by about 30%.

c. Future Developments

65. The Habbaniyah and Hillah projects are essential to the further development of irrigation in the Euphrates Valley in which it is estimated that at least 2.5 million acres in new land can be brought under cultivation when the Habbaniyah project is completed to include the Abu Dibis depression for storage of flood waters. The Haigh Commission estimated the total program to cost about ID 17,000,000. It is long range in character and will require at least ten years to complete.

IX. Recommended Basis for a Loan

66. Iraq is probably the only country in the world which follows an extensive system of farming on irrigated lands, limiting their use to an intensity of cultivation of only about 50%. Elsewhere in the world, the intensity of cultivation on irrigated land approaches 200%, that is, all of the land is planted to produce two crops per year. This intensity requires the use of natural and artificial fertilizers, a practice not followed in Iraq. In the Euphrates Valley, the area now under irrigation is greater than that which can be maintained at 50% intensity cultivation with the existing water supply. Therefore, an investment which will provide additional water to the existing irrigated areas, such as the Habbaniyah and Hillah projects appears to be justified but, from a production standpoint, the need for the Musayib project which involves bringing about 130,000 acres of new land under cultivation is questionable.

67. Also it is obvious that from a standpoint of agricultural production, the installation of drainage systems in the present irrigated areas should have priority over the development of new land. Except for two small systems recently installed, no effort has been made to provide for drainage of irrigated areas. The result has been that the salt content of the soil in the older areas has reached the point where barley is the only cereal crop that can be grown and the yield obtained with this crop is as much as 50% lower than is obtained on newly cultivated land. The need for adequate drainage is fully recognized by the Iraqi Government but political considerations are said to require that more land must be made available for settlement in preference to increasing the productivity of existing irrigated areas and it is the established policy of the government to give preference to the development of new areas.

68. Considerable study has been given to the possibility of requiring the execution of some drainage works as a part of or as a condition of this

loan. This was finally considered to be impractical at this time due to the fact that no project had been studied to any extent and the time required for such studies was too great to consider drainage in connection with this loan.

69. The Habbaniyah project appears to be justified as a means of flood control and for increasing water supplies for irrigation, the latter being necessary for either more intensive cultivation or for extension of the irrigation systems. Construction work on this project is well along and Bank participation in the project would be limited to the equivalent of not more than \$1.26 million, the estimated foreign exchange requirement of the Warrar Barrage. The total estimated cost of the Habbaniyah project is equivalent to about \$12 million. The Hillah Canal project appears to be justified on the basis of increasing the productivity of a large irrigation area by maintaining a cultivation intensity of 50% which is conventional in Iraq. Bank participation in this project would be the equivalent of not more than \$1 million out of a total investment equivalent to about \$2.1 million.

70. The Musayib project is justified on the basis of earnings in terms of both gross income and income to the government from rent and taxes. While there is a question as to the priority of the project, as compared with an equivalent investment in drainage for irrigated areas, the Iraqi Government considers that greater short-term benefits will be obtained from extending the system for the purpose of settlement of nomads and unemployed workers. It seems that the Bank can accept the judgment of the government in this matter so long as the project is relatively small. Bank participation would amount to the equivalent of not more than \$500,000 in a total investment equivalent to about \$1,120,000.

71. Summing up, it is recommended that the Bank consider a loan for these projects as follows:

Warrar Barrage	\$1,260,000
Hillah Canal	1,000,000
Musayib Canal	<u>500,000</u>
Total	\$2,760,000

72. If a loan is negotiated for this project, the following points should be taken into consideration.

- a) The borrower should retain a fully qualified consultant satisfactory to the Bank to assist in the preparation of preliminary plans and specifications for the Hillah and Musayib projects, and for the qualification of bidders, the awarding of contracts, and to act for the borrower as resident engineer during the execution of the work on the three projects.

- b) The borrower should submit preliminary plans and specifications for the Hillah and Musayib projects for approval of the Bank before bids are invited for the execution of these projects.
- c) Contractors invited to bid on these projects should be fully qualified by experience in similar work and have the necessary facilities for executing the work in a reasonable time.
- d) The contractors selected for these projects, and the terms of the contracts should be subject to approval by the Bank prior to formal letting of the contracts.
- e) The borrower should agree to request a reduction in the amount of the loan made on each project, if the cost of the project as determined by firm prices established by contracts is less than the amount originally loaned by the Bank.
- f) The borrower will have acquired clear title to all of the lands required for the execution and operation of these projects prior to the effective date of the loan.
- g) The borrower should agree to provide all necessary roads and transport facilities not a part of the projects but required for their execution, and all of such facilities required for satisfactory operation of the projects prior to the estimated completion dates. 1/

E. Wayne Rembert

February 7, 1951

1/ It is believed that all such works have been included in the estimated cost of the projects. This cannot be definitely determined until preliminary engineering work and an itemized cost estimate is available. The above requirement would be necessary only if some such works are not included.

TABLE I

YIELDS OF VARIOUS CROPS ON IRRIGATED LAND - IRAQ

A. Irrigated Land - Hillah district

	<u>Crop area as % of total planted</u>	<u>Average yield/acre in kg.</u>
<u>1. Winter crops</u>		
Barley	66 2/3 %	403 - 408
Wheat	33 1/3 %	322
<u>2. Summer crops</u>		
Rice	50 %	322 - 408
Vegetables	25 %	
Sesame	25 %	290

B. Newly Irrigated Land

<u>1. Winter crops</u>		
Barley	66 2/3 %	408 - 564
Wheat	33 1/3 %	403
<u>2. Summer crops</u>		
Cotton	50%	403 - 408
Vegetables	25%	
Sesame	25%	290