CR-2

FILE COPY

TO- 277

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

INTERNATIONAL DEVELOPMENT ASSOCIATION

APPRAISAL OF THE ROSEIRES IRRIGATION PROJECT

REPUBLIC OF THE SUDAN

June 7, 1961

Department of Technical Operations

CURRENCY EQUIVALENTS

£S 1.00	=	US $2.872
US $1.00	=	£S .345
US $1 million	=	£S 345,000

1 feddan = 1.038 acres = .42 hectares
1 seed kantar = approximately 312 lbs. seed cotton = 110 lbs. lint
1 lint kantar = approximately 100 lbs. cotton lint

REPUBLIC OF THE SUDAN

APPRAISAL OF THE ROSEIRES IRRIGATION PROJECT

TABLE OF CONTENTS

SUMMARY

i. The Government of Sudan obtained a Bank loan of US$15.5 million equivalent in June 1960 to assist finance the Managil Irrigation Scheme. It has now requested a loan for the Roseires Irrigation Project as a further stage of its irrigation development program.

ii. The project comprises:

a) the construction of a dam 60 m in height on the Blue Nile near Roseires, 106 km downstream from the Ethiopian border and of the necessary works to regulate the release of stored water; and

b) the development of new pump irrigation schemes along the banks of the Nile and of the extension and intensification of the Gezira-Managil gravity irrigation schemes supplied with water through the existing downstream Sennar Dam canal network.

iii. Irrigation has proved most successful on the lands adjoining the Nile River in Sudan. Expansion has been restricted by irrigation water shortage during the season of low river flow (January 1 to July 15). An agreement has been negotiated between Sudan and the United Arab Republic regarding allocation between those two countries of the Nile waters and for the claims, as and when agreed upon, of other countries having riparian rights. It authorizes Sudan to construct storages to conserve water to supplement irrigation supplies during periods of low river flow.

iv. The dam would impound a net 2,724 million m^3 per annum for irrigation use. This water would be used to permit year round pumping for currently seasonally restricted pump irrigation schemes; intensification of the crop rotation on the two million-feddan Gezira-Managil gravity irrigation scheme; development of about 670,000 feddans additional pump irrigation and 200,000 feddans additional gravity irrigation; making good the deficiency in requirements for full irrigation in existing irrigation schemes in years of exceptionally low river flow; and the expansion of sugar cane production at Guneid by 3,000 feddans annually. An amount of about 800 million m^3 would initially remain as a reserve for future allocation.

v. Engineering for the dam has been performed by Sir Alexander Gibb & Partners and MM. Andre Coyne and Jean Bellier as joint consultants. Eight contracts for preparatory and associated works comprising the building of a township, airfield, roads and bridges have been placed following international competitive bidding. Tenders for the main civil contract have been obtained from qualified contractors on an international basis. The consulting engineers have reviewed the six offers received and have submitted their recommendations on the award. Due to climatic conditions and the type of structure, the construction program would cover six years. It would be supervised by Sir Alexander Gibb & Partners as engineering consultants.

vi. Gravity irrigation works required would comprise minor canals and field laterals only. These would be constructed, maintained and operated by the Ministry of Irrigation. Farm development including land clearing and leveling, the extension of light railways for cotton transportation and provision of ginning facilities would be undertaken by the Sudan Gezira Board, which would manage the scheme.

vii. New pump schemes would involve the supply and installation of pumps, canalization of the areas to be commanded and clearing, leveling and ditching for farm development. It is not yet certain how much of the pump scheme development would be undertaken by private enterprise and how much by the Government. Pump schemes would be subject to the Sudanese Nile Pump Control Regulations.

viii. The total cost of the project is estimated as follows:

	Local Currency millions		Foreign Exchange millions		Total millions	
	£S	US$ Equiv.	£S	US$ Equiv.	£S	US$ Equiv.
Preparatory & Associated Works	2.55	7.3	1.42	4.1	3.97	11.4
Roseires Dam	8.80	25.2	14.95	42.9	23.75	68.1
Irrigation Works & Farm Development	17.29	49.7	13.63	39.1	30.92	88.8
Interest during Construction	-	-	3.42	9.9	3.42	9.9
Total	28.64	82.2	33.42	96.0	62.06	178.2

ix. The Sudan Government would provide from its own resources the cost of preparatory and associated works and the local currency cost of dam construction. Irrigation works and farm development would only require to be commenced two to three years prior to completion of the dam. The external loan now sought, accordingly, is only the foreign exchange costs of the construction of the dam and of engineering consultants' fees paid since July 1960 in connection with the dam construction. The amount is US$43.2 million equivalent plus interest on the loan during the construction period which, under the proposed financing arrangements, amounts to US$8.3 million, making a total of US$51.5 million equivalent.

x. The German Government has agreed to participate in the financing by enabling a loan to be made by the Kreditanstalt fuer Wiederaufbau. This corporation proposes that its loan be US$15.1 million, plus interest during construction, US$3.9 million - a total of US$19.0 million equivalent. The term would be 20 years, including a grace period of seven years with interest at 5½ per cent.

xi. A Bank loan is proposed of US$15.1 million, plus interest during construction US$4.4 million, or a total of US$19.5 million. A suitable term would be 25 years including a grace period of seven years.

xii. The remaining US$13 million is proposed for an International Development Association credit for a period of 50 years, including a grace period of 10 years, carrying a service charge of three fourths per cent per annum on the unpaid balance of the drawn down amount of the credit. The credit would be repayable by annual installments of one per cent from the eleventh through twentieth years and three per cent from the twenty-first through fiftieth years. The service charge during construction would be met by the Sudan Government.

xiii. As part of the project, an agricultural research program would be undertaken to determine how the Gezira-Managil cropping pattern could be profitably further intensified. Provided this program is implemented vigorously and without undue delay, means could be found within the next decade for the use of the presently unallocated 800 million m^3 of stored water without additional capital investment in irrigation facilities and with benefits comparable to those conservatively estimated for the presently planned intensification. Assuming that uses are developed for all stored water in irrigation, the gross output investment ratio of the project would be about 50 per cent, the annual net benefits about 23 per cent of the investment and the combined direct net return to the Government and pump licensees on their investment over 11 per cent.

xiv. Pending development of these additional uses for water, only 70 per cent of that available would be used for new irrigation. During this period, the gross output/investment ration would be 42 per cent, annual net benefit 17 per cent and the net return on investment about 10 per cent, which would adequately justify the project.

xv. The system of irrigation farming which has been developed in Sudan enables tenant farmers, unskilled in modern farm practices to produce efficiently under supervision and is particularly well adapted to prevailing conditions. The Ministry of Irrigation and the Sudan Gezira Board are experienced and have proved they are fully capable to execute and operate the project.

xvi. Successful completion of the total project is necessary to ensure adequate economic benefits from the investment. Construction of the irrigation works and farm development would not need to start until three years after commencement of the dam. Assurances would be given in connection with the present financing that Sudan's ability to provide and obtain the future financial requirements for completion of the project will be safeguarded.

xvii. Subject to the Bank and IDA being satisfied on this point, the project is suitable for total borrowings of US$51.5 million, including a Bank loan of US$19.5 million and IDA credit of US$13 million.

REPUBLIC OF THE SUDAN

APPRAISAL OF THE ROSEIRES IRRIGATION PROJECT

I. INTRODUCTION

1. At the request of the Sudan Government, a Bank mission visited the Sudan in October 1958 to examine the technical and economic aspects of the Managil and Roseires irrigation projects. The mission reported favorably on both projects but recommended that Managil should be given priority. The Sudan Government was informed, however, that before the Bank could consider participation in financing these projects, adequate arrangements would need to be made with regard to the riparian interests of other countries on the Nile River.

2. In December 1959 the Government informed the Bank that agreement had been reached with the United Arab Republic allocating the waters of the Nile between Sudan and Egypt, with provision for the deduction in the future from this allocation of the requirements of other countries that had claims for water as and when these were agreed upon.

3. Concurrently, the Government renewed its application for assistance to finance the Managil scheme as the first stage of its irrigation program and the Roseires project as a subsequent stage. As a result and following a further appraisal of the proposal, negotiations were concluded during June 1960 for a Bank loan of US$15.5 million equivalent to assist financing the Managil scheme.

4. Technical missions visited Sudan in March and May 1960 for further examinations of the Roseires project. This report covers the appraisal of that project based on the findings of these missions and of that of 1958, and on information supplied by the Sudan Government.

II. GENERAL INFORMATION

5. Sudan is an agricultural country; 86 per cent of its population and 98 per cent of its export income depend on the land. Of about 17 million feddans that have been cultivated at various times, some 2.8 million feddans will be under command for irrigation on completion of the extension of the Managil scheme in 1962. Particulars of the areas under command and of the cropping pattern practiced in irrigation areas are given in Annexes 1 and 2.

6. Irrigation of these areas has proved most successful. About 1.6 million feddans of the commanded land are cropped each year and of this area 0.7 million feddans under long staple cotton produce some 70 per cent of total export income. The long staple cotton is of excellent quality and costs of production are highly competitive. Moreover, should market trends comparatively favor shorter staple cotton production, there could be some changeover to these types. Markets are available for the other crops grown in rotation with the cotton. The system under which the irrigation schemes are operated permits efficient production by comparatively unskilled labor, provides a living standard for the tenants above the national average, and allows a satisfactory return on the investment.

7. In comparison, except for the far southern area in the tropical rainfall belt, the remainder of Sudan comprises semi-arid country used for extensive grazing and marginal dry farming, mainly on a subsistence basis. Some improvement in productivity of significance to the economy is taking place and can be expected to increase over the long term in these areas, largely as a result of the promotion of large-scale mechanized farming now being sponsored, and by improvement in animal husbandry methods and breed selection.

8. Nevertheless, the immediate and major possibilities for expansion of commercial agricultural production lie in the development of irrigation. Prospective tenants capable of farming under the system that has been established are available for additional projects. Suitable land is plentiful and Nile water is available during the flood period. The principal limitation to expansion is the amount of water available during the season of low river flow (January to July).

9. The new Nile-Water Agreement of November 1959 between the United Arab Republic and Sudan provides that, when the reservoir at Saad el-Aali is in full operation, the regulated flow of the Nile will be shared on the basis of 18,500 million m^3 for the Sudan and 55,500 million m^3 for Egypt. The requirements of other countries having claims to the water will, when finally agreed, be deductible equally from the Sudan and UAR allocations.

10. Pending the construction and operation of the Saad el-Aali reservoir, Sudan is entitled to use a total of 1,925 million m^3 during the period of restricted river flow (January 1 to July 15). This is made up of the water stored in the Sennar Dam (791 million m^3), historic abstractions from the Nile flow (284 million m^3) and the equivalent of the release to Egypt of stored water from the Jebel Aulia Dam (850 million m^3, when the current raising of the level of that dam is completed in 1962/63). The amount may be increased only by additional storage of flood flow.

11. Furthermore, on completion in 1963 of the Managil Irrigation Project, present physical water availabilities on the Blue Nile during the first four months of the restricted period will be fully committed (see Annex 3). Any further expansion of irrigation activities and hydropower generation on this river is dependent on the construction of storage. Though the earliest suggestion for a storage reservoir on the Blue Nile at Roseires was made by Sir William Garstin in 1904, up to the present the only storage development on the river is the Sennar Dam which was built in 1925 to supply the Gezira area. The Nile-Water Agreement authorizes the construction of a dam at Roseires to augment the amount of storage.

III. THE PROJECT

A. General

12. The project comprises

a) the construction over a period of six years of a dam on the Blue Nile near Roseires, 106 km downstream from the Ethiopian border, and of the necessary works to regulate the releases of the stored water; and

b) the development over the final three-year period of the dam construction of new pump irrigation schemes and the extension and intensification of the Gezira-Managil gravity irrigation schemes supplied with water through the existing downstream Sennar Dam canal network.

13. The gross storage in Roseires reservoir is estimated at 3,024 million m^3, which after an evaporation allowance of 300 million m^3 would provide 2,724 million m^3 per annum for irrigation uses and thus somewhat more than double the amount of water available for use during the annual season of shortage.

14. The dam would be constructed so as to permit future heightening by 10 m, which would increase the reservoir capacity by an additional 4,600 million m^3 for further expansion of irrigation and for the possible generation of hydroelectric power.

B. The Dam and Associated Works

15. The dam would consist of a buttress type concrete center section with earth embankments on each end. It would have a maximum height of about 60 m and an overall length of 16.1 km, of which 15.0 km would be earthfill. The total volume of concrete and earthfill would approximate 610,000 m^3 and 5.2 million m^3 respectively. Technical details of the dam are given in Annex 4.

16. The design for the dam and the associated works was made jointly by the consulting engineering firms of Sir Alexander Gibb & Partners and MM. Andre Coyne and Jean Bellier. The Bank requested a review of the spillway capacity and as a result this has now been increased to 17,350 m^3 per second. With this change the design of the dam is satisfactory.

17. The consulting engineers have made extensive subsurface explorations of the site and have established that the geology is satisfactory. They have also performed tests to determine the silt load in the river and have estimated that with proper operation the annual depletion of storage due to sedimentation would not exceed one half of one per cent of the reservoir volume.

18. Major power facilities or canal headworks would not be constructed at Roseires at this time, but intakes for additions of both a future irrigation canal and a future powerhouse would be provided. A small generating installation would be furnished initially, however, to provide power for operation of the gates and for miscellaneous needs at the project.

19. The associated works comprise a township which would initially be used as a construction camp for about 2,500 people, an airfield with an all-weather landing strip, and a bridge downstream of the dam which would initially provide construction access to both sides of the river and would later be converted to a rail crossing.

20. The equipment and material required for construction will have to be transported from Sennar junction to the site over a single track railroad with light-weight rails and an unballasted bed. The Government has issued instructions to the railroad that all goods for the Roseires and Khashm el Girba projects shall have priority and the railroad foresees no difficulties in meeting these requirements. The contractor would establish offices in both Port Sudan and Khartoum to expedite unloading and transshipment and to provide close liaison with the Sudan railroad. In order to assist the railroad in planning the routing of its rolling stock, the contractor would submit an annual schedule of his transport requirements and would revise this schedule quarterly.

C. Construction of the Dam and Associated Works

21. The complete construction program has been divided into ten contracts. The first nine covering the associated works comprise the township, airfield, roads, and bridge. Eight of these nine contracts have been let to the successful tenderers and the work covered by the ninth, including clearing and drainage of the site, will be performed by the Ministry of Irrigation with its own forces. The associated works are scheduled for completion in two years.

22. Construction of the dam (Contract No. 10) is planned to start in the latter part of 1961 following the annual flood and to be completed by June 1967. The contract is of the unit price type with provision for changes due to fluctuations in the cost of materials. The construction schedule is given in Annex 5. Construction will be supervised by the engineering consultants, Sir Alexander Gibb & Partners.

23. Pre-qualification of prospective bidders was made on an open, international basis. The factors considered in the selection of bidders for the main dam contract were caliber, financial responsibility, and capacity to handle large quantities of concrete and earthwork. In addition, emphasis was placed upon previous experience in dealing with the control of large rivers and experience in working under conditions similar to those found in the Sudan.

24. Copies of the drawings and specifications for the dam have been issued to 17 groups of contractors; the closing date for the submission of bids was April 15, 1961. Proposals were received from six bidders and the award of the contract is expected to be made no later than July 1961. The bids have been analyzed by the engineering consultants and submitted to the

Bank for review. The dam would be able to store water to the maximum reservoir level from the falling flood in 1967. If construction proceeds on or ahead of schedule, useful quantities of water could be stored in 1966, a year before the final completion of the dam. The estimated cost of the dam construction is given in Para 40 and totals US$88.2 million equivalent.

D. Use of Roseires Water

25. Water for gravity irrigation requirements released from the Roseires reservoir would be diverted downstream through the intake of the existing canal network at the Sennar Dam. Requirements for pump irrigation schemes would be pumped direct from the river flow. The stored water would normally be released starting in December or January and, depending upon the magnitude of the natural flow, would continue until as late as May.

26. The use of the water stored in the Roseires reservoir, as presently planned by the Government, would be[1]:

	Million m^3
a) Conversion "restricted" pump schemes to unrestricted pumping	255
b) Intensification of cropping Gezira area	700
c) New Pump Schemes	601
d) Extension of Gezira-Managil area	162
e) Increasing supplies for existing schemes	161
f) Expansion sugar cane production, Guneid area	34
Total	1,913

27. Use (a) Approximately one million feddans are irrigated from pumps licensed and operating on the Blue, White and Main Nile Rivers. On 341,000 feddans of this area, irrigation is not permitted at the present time beyond early January owing to restricted availability of water. Investigations have shown that this limitation to watering reduces cotton yields by upwards to 20-25 per cent. It is proposed to avoid this loss by providing from Roseires the 255 million m^3 of stored water required to permit the conversion of these "restricted" pump licenses to unrestricted pumping.

1/ Water would not be available for the proposed Kenana Scheme (see report T.O. 204a, April 1959) from the storage currently proposed. Consideration would be given to the development of that scheme only in conjunction with proposals in the future to increase the height of the dam.

28. Use (b). Under the present crop rotation at Gezira and Managil, only 40 per cent and 66 per cent respectively of the land commanded for irrigation is under crop each year. The single crop produced annually on this area of land is grown during the flood season with stored water used during the restricted season only to extend the growing period of the cotton crop. This cropping pattern was adopted originally to make maximum use of the flood season water, supplemented by the limited quantity of restricted season water available. The long period of fallow in the rotation was introduced to minimize difficulties of disease and weed control but with modern techniques these difficulties could now be overcome more economically. Accordingly, with more water during the restricted season and within the limits of present technical knowledge, an additional crop (other than long staple cotton) could be grown on 290,000 feddans after October when peak water requirements of the existing rotations tax the capacity of the irrigation canals. The amount of water which it is planned to supply from Roseires for this purpose is estimated at 700 million m^3.

29. Use (c). Blue Nile Pump Licenses covering about 164,000 feddans have been approved but are not operative until additional supplies of irrigation water are available. Further substantial areas on both the east and west banks of the Blue Nile downstream from Roseires have topography and soils equivalent to those now under irrigation. It is proposed, therefore, to increase the operative area now under pump schemes by 670,000 feddans by an allocation of water from the Roseires storage of about 601 million m^3.

30. Use (d). Surveys have shown that approximately 200,000 feddans adjoining the existing Gezira area on the northwest comprise soils equal in quality to those of the successfully developed area and are suitable topographically for gravity irrigation. It is proposed that this area would be developed and brought into production when the necessary water, estimated at 162 million m^3 during the restricted season of the year, is available from Roseires.

31. Use (e). The water requirements for existing pump and gravity schemes during the restricted season are about 2,086 million m^3, or 161 million m^3 in excess of the amount currently permitted to be used under the Nile Waters Agreement until additional storage is provided. Furthermore, availability of even the permissible quantity is dependent on substantial abstraction from the river flow, which is not practicable during some years of below average flow. Another function of the Roseires storage, therefore, would be to make good the deficiency for the existing schemes and provide some reserve against years of subnormal river flow in the Blue Nile.

32. Use (f). It is planned to expand sugar cane production on the Guneid Pump Irrigation Scheme from 12,000 feddans to 15,000 feddans annually. The water required from Roseires storage for this purpose would amount to 34 million^3.

33. These proposals would require about 1,900 million m^3. The balance of more than 800 million m^3 has not yet been specifically allocated. Less reasonable provision for sedimentation, it would be used for further irrigation when firm plans have been developed. The Government would give assurances that an adequate research program be carried out to determine the most economic irrigation uses for this balance.

E. Irrigation Works and Farm Development

34. No additional capital expenditure would be required for the intensification of the cropping pattern in the Gezira-Managil area for the conversion of the currently restricted pump schemes to unrestricted irrigation, or for the expansion of sugar cane production at Guneid.

35. The additional area to be irrigated by gravity adjoins the existing Gezira-Managil Scheme and can be supplied from the main canals already constructed for these areas. The additional works required would be minor canals and field laterals, some drainage, land clearing and leveling and extension of existing light railways for cotton transportation to ginneries.

36. The new pump schemes would involve the supply and installation of pumps, canalization and drainage of the areas to be commanded and farm development, including clearing, leveling and ditching. Reconnaissance surveys have shown the availability of ample suitable land for these schemes. A program of soil survey is required, however, in sufficient detail definitely to determine the location of the areas most suitable for development. The survey would involve about twelve months field work. As part of the project, soil surveys would be undertaken during the early years of the dam construction either by the employment of foreign contractors or by an expansion of the Sudanese Soils Division, depending on the availability of experienced technicians.

37. Irrigation works and farm development would not need to commence until three years after the start of the construction of the dam. Their planning in detail has not yet been completed, but design of the gravity irrigation works is in progress. Designs for pump schemes would be undertaken when the sites are definitely selected.

IV. COST AND FINANCING OF PROJECT

A. Cost

38. In conjunction with the engineering consultants, up-to-date estimates of the costs of the dam have been prepared based on the average prices of the two lowest bids received. The bid prices include some allowances for contingencies and to these sufficient amounts have been added to bring the total contingency provision up to 15 per cent of the direct cost of the dam. Details of the costs of the dam and associated works are shown in Annex 6.

39. Plans of irrigation works and farm development have not yet been worked out in detail. The estimates of their cost are, therefore, not so firm but have been assessed on the basis of costs currently being incurred for similar work in Sudan. They include a provision of 15 per cent for contingencies. Details are given in Annex 7.

40. The following table shows separately the estimated local and foreign exchange cost of "Dam Construction" and "Irrigation Works and Farm Development."

Dam Construction (Including Preparatory and Associated Works)

	Local Currency millions		Foreign Exchange millions		Total millions	
	LS	US$ Equiv.	LS	US$ Equiv.	LS	US$ Equiv.
Preparatory and Associated Works	2.55	7.3	1.42	4.1	3.97	11.4
Roseires Dam	8.80	25.2	14.95	42.9	23.75	68.1
Interest on IBRD & KFW loans during construction	-	-	2.89	8.3	2.89	8.3
Service charge on IDA credit during construction	-	-	0.14	0.4	0.14	0.4
Total	11.35	32.5	19.40	55.7	30.75	88.2
Irrigation Works and Farm Development						
Gravity Irrigation & Farm Development	5.50	15.8	4.00	11.5	9.50	27.3
Pump Irrigation & Farm Development	11.79	33.9	9.63	27.6	21.42	61.5
Interest during construction	-	-	0.39	1.2	0.39	1.2
Total	17.29	49.7	14.02	40.3	31.31	90.0
Grand Total - Dam, Irrigation & Farm Development	28.64	82.2	33.42	96.0	62.06	178.2

B. Financing

41. Excluding US$350,000 equivalent paid between July 1960 and July 1961 for consulting engineering fees in connection with the contract for the dam, both local currency and foreign exchange expenditures for preparatory and associated works would be met by the Sudan Government from its own resources. The Government would also provide the service charge on an IDA credit and the local currency expenditure for the "Dam Construction". Expenditure on "Irrigation Works and Farm Development" would not commence until three years after the commencement of dam construction and would be expected to be spread over the following six years. The external loan required at this stage, therefore, is to cover the foreign exchange costs of dam construction, and the reimbursement of consulting engineers' fees. The amount is US$43.2 million equivalent, plus interest during construction US$8.3 million = a total of US$51.5 million.

42. The major expenditure of the loans would be spread over six years. The expected rate of disbursement is shown in Annex 6.

43. During August 1960, the Bank sought to enlist the support in financing the Roseires Project of individual member countries of the Bank interested in the development of Sudan. As a result, the German Government has agreed to participate by enabling a loan of US$19 million equivalent for construction of the Roseires dam to be made by the Kreditanstalt für Wiederaufbau (KFW), a corporation under public law of the Federal Republic of Germany. This represents a capital sum of US$15.1 million plus interest during the construction period. The KFW loan would carry interest at the rate of five and one half per cent and would be for a term of 20 years, including a grace period of seven years.

44. It is proposed that a loan of a similar capital sum, plus interest during construction (total US$19.5 million equivalent) be made by the Bank. An appropriate term for this loan would be 25 years, including a seven-year grace period.

45. The balance required to finance the foreign exchange component of the dam construction costs and the engineering fees, US$13 million equivalent, is proposed as an IDA credit with a term of 50 years, including a grace period of 10 years. Amortization would be one per cent annually from the eleventh through twentieth years and three per cent annually from the twenty-first through fiftieth years, with a service charge of three fourths per cent annually on the unpaid balance of the drawn-down amount of the credit.

46. The total borrowings under these proposals would be US$51.5 million equivalent. The borrower would be the Republic of Sudan.

47. It is proposed that the two loans and the credit would be disbursed pari passu. The expected rate of disbursement is shown in the following table. Disbursements for 1961/62 to 1966/67 correspond to the six-year construction period and disbursements for 1967/68 represent mainly release of retention sums.

Estimated Disbursements - Loans for Dam Construction
(millions of dollars)

	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	Total
KFW	2.94	2.54	2.73	3.22	3.33	2.49	1.74	19.00
IDA	2.47	1.98	2.03	2.30	2.23	1.37	0.62	13.00
IBRD	3.05	2.63	2.83	3.29	3.37	2.52	1.81	19.50
Total	8.46	7.15	7.60	8.81	8.93	6.38	4.17	51.50
£S million equiv.	2.95	2.49	2.65	3.07	3.11	2.22	1.46	17.95

48. Construction of irrigation works and development of farms are essential to obtain adequate economic benefits from the investment in the Roseires Dam. Sudan should therefore be required in connection with the present financing to undertake to carry out those parts of the project, as well as the dam. Although Sudan would thereby in effect be committed to provide or obtain the additional financing when required, to what extent it would implement the obligation from its own resources and to what extent from further borrowing or other sources would necessarily be left open. (For example, although it is expected that some of the pump scheme development would be undertaken by private enterprise, the extent to which funds would be provided from this source is not now clear.) It is reasonable to assume, however, that the local costs could be financed out of Sudan's own resources (see Economic Report, AS-86, May 1961), whereas recourse to further external financing for a substantial part, if not all, of the foreign exchange costs is highly probable. Assurances would be obtained in connection with the present financing that Sudan's ability to provide or obtain the future financial requirements of the project will be safeguarded. Even so, the very real probability would remain that the Bank and IDA would be asked later to finance at least part of the foreign exchange costs of the other parts of the project.

V. OPERATION AND MANAGEMENT OF IRRIGATION SCHEMES

A. Existing Schemes

49. Government-controlled irrigation schemes in Sudan are operated and managed under a system which has proved successful over a long period.

50. The gravity irrigation schemes (Gezira and Managil) are managed by the Sudan Gezira Board, which develops farms, allots tenancies, provides cotton seed and fertilizer and undertakes the heavy land cultivation and pest control programs as a charge against the crop, and transports, gins and markets the cotton produced. The Ministry of Irrigation undertakes the execution, operation and maintenance of the irrigation works. The tenant supplies the labor for the production and harvesting of the crop. The costs of the centralized services provided by the Board are a first charge against the proceeds from the sale of the cotton crop and the remainder is divided as follows:

Ministry of Irrigation	42	
Social Development Fund	2	
Local Government Councils	2	46%
Sudan Gezira Board		10%
Tenants' Collective Account	42	
Tenants' Reserve Fund	2	44%
Total		100% net crop proceeds.

The tenant is permitted to crop annually without charge for land or water an area equal to that under cotton. The tenants receive the full proceeds of such crops but have to undertake all aspects of production and marketing themselves.

51. Government Pump Schemes are operated and managed similarly to the Gezira and Managil Schemes by boards established for this purpose.

52. Private pump schemes are operated by the licensee under Nile Pumps Control Regulations, which prescribe relationships between licensee and tenant in detail. The licensee is responsible for functions like those of the Ministry of Irrigation and the Gezira Board(except for cotton ginning) under the Gezira Scheme and operations are supervised by District Agricultural Inspectors of the Ministry of Agriculture. Tenants in most circumstances receive 40 per cent of the proceeds of the cotton crop (plus full proceeds of other crops) and the licensee receives 60 per cent. The Government makes no direct charge for water or land rental. In lieu it receives, from the licensee's share of the returns, land tax equivalent to 4 per cent of gross cotton proceeds.

B. Expansion of Irrigation from Roseires Storage

53. It is intended that the gravity irrigation works of the Roseires Project would be constructed, operated and maintained by the Ministry of Irrigation. Farm development, allotment and operation would be managed by the Sudan Gezira Board. Pump schemes would be subject to the Nile Pumps Control Regulations. It is not yet certain how much of the pump scheme development would be undertaken by private enterprise and how much by the Government but preference would be given to privately operated schemes. Under the Loan Agreement, the Bank would be given the opportunity to exchange views with the borrower on any proposed amendment to the Gezira Ordinance or the Nile Pumps Control Regulations prior to any such action being taken.

54. The Ministry of Irrigation is well equipped and organized to undertake efficiently the construction, operation and maintenance of irrigation works. Though a number of expatriate engineers are still employed, the level of output of trained nationals is sufficiently high for the present shortage to be progressively overcome.

55. The Sudan Gezira Board was established in 1950 to take over the previous responsibilities of the Concession Companies which had developed and operated the Gezira Irrigation Scheme. The operations of the Board are efficiently managed and it maintains staff training programs designed to meet replacement and planned expansion requirements. Farming supervision by the Board is at present mainly confined to the cotton crop and is responsible largely for the high standard of production of this crop. Comparatively, the

production of other crops is at a much lower standard. There would be a need, therefore, for an expansion and strengthening of the agricultural advisory services to implement satisfactorily the intensification of the cropping rotation in the Gezira area proposed in the Roseires Project. This would best be done by recruitment to the Board's staff of additional trained agriculturists. As the Board receives no revenue from non-cotton crops, the additional costs might be met from the charge which the Government should make for the water supplied, above existing requirements, for intensification of the present cropping pattern. Suitable qualified technicians are now becoming available in increasing number under the arrangements that have been developed for graduate and postgraduate training in agriculture.

56. The standard of farming on the pump schemes is not as high as of that under the supervision of the Gezira Board. Operations are overseen by District Agricultural Officers who are unable to have the same degree of contact with the tenants as the Board's decentralized inspectors have. Any substantial expansion of privately operated pump schemes as envisaged under the Roseires Project would require a considerably augmented District Agricultural Officer staff to obtain optimum results. This would be the responsibility of the Ministry of Agriculture and, if sufficiently well planned in advance, would be possible owing to the graduate and postgraduate training opportunities now available.

57. Existing irrigation areas carry large numbers of sheep and goats and smaller but substantial numbers of cattle. Very little extension work, however, is done on animal husbandry. After successfully reducing the incidence of some of the more serious stock diseases, the Department of Animal Industry, which is separate from the Ministry of Agriculture, is concentrating its activities on breed improvement. There is obvious scope for considerable improvement and rationalization in livestock management and production in conjunction with the cash cropping undertaken. It would, therefore, be necessary for greater attention to be given to the promotion of improved techniques in livestock management and, to this end, better coordination of the activities of the Departments of Agriculture and Livestock would be required. The employment of persons trained in animal husbandry to work alongside agricultural extension officers would be needed to evolve a properly balanced farm production program. Plans for the recruitment and training of the personnel required would be worked out so that this service is operating by the time that additional water becomes available.

58. There would be no shortage of tenants to cultivate the new lands. The Managil Extension now under construction will not fill the demand for tenancies from villagers within the general Gezira area and there would also be a strong demand from suitable villagers in surrounding districts. At present, these men work for a low wage as seasonal labor and produce their bare subsistence needs from dry-land farming.

59. Tenancies for the new irrigation lands would be of 15 feddans. The farm family can provide most of the labor for holdings of this size and there should be little or no difficulty in finding the relatively small amount of additional seasonal labor required.

VI. VALUE OF PRODUCTION

60. Crop yield expectations, forward price assumptions and production costs are reviewed in Annex 8.

61. As stated in Paragraph 31, during the restricted season there is under the Nile Waters Agreement a current shortage of 161 million m^3 of irrigation water for existing schemes. The provision of stored water from Roseires reservoir to meet this deficiency would ensure that all crops on these areas could obtain their full water needs even in dry years. The benefit from this water use (Para 31) could be substantial, but cannot be evaluated specifically in terms of additional production. No figure is included for it in the following calculation of benefits.

62. The conversion of restricted pump license schemes to unrestricted pumping (Para 27) can be expected to increase cotton crop yields by the 20 per cent by which they are now reduced when watering ceases at the end of December. This would be equivalent to the production from an additional 22,000 feddans (20 per cent of 110,000) of cotton crop.

63. Incorporation into the existing crop rotations in the Gezira-Managil schemes of an additional crop on 290,000 feddans (Para 28) is a minimum assumption of the degree of intensification practicable within existing technical knowledge. There is sufficient evidence that at least wheat and groundnuts would yield profitable returns. Even the limited amount of research currently being undertaken on crops other than cotton will find means of increasing yields of wheat and groundnuts and can be expected to develop even more remunerative crops by the time Roseires water becomes available. The assumption in this appraisal that the increase in annual production from the use of this water will come from 145,000 feddans each of wheat and groundnuts, at existing crop yields, is therefore conservative[1].

1/ Given sufficient water during the restricted season, there is no agronomic reason why the cropping pattern assumed above should not be further intensified. A greatly expanded program of research would be necessary fully to explore possible variations in crop rotations and to develop additional crops and fit them into the farming system. Since a substantial volume of stored water would remain available for additional irrigation use (see Para 33), the Government would give first priority in its research program to this question and make available the small amount of restricted season water necessary for this purpose. If such a research program were pushed vigorously, it could within a decade find means for the profitable use of this additional water within the Gezira-Managil Schemes. The benefits would be comparable to those estimated from the present intensification and would be obtained without additional capital investment in irrigation facilities.

64. The production from the 670,000 feddans of new pump schemes, based on the present three-course cropping pattern for pump schemes of one third of the irrigable area under cotton, one sixth under dura and one sixth under lubia annually, would be about 220,000 feddans cotton, 110,000 feddans dura and 110,000 feddans lubia.

65. Similarly, by adoption of the current three-course rotation used in the Managil Extension Project, the annual production from the 200,000 feddans further extension of the Gezira (Para. 30) would comprise 66,000 feddans cotton, 33,000 feddans dura and 33,000 feddans lubia.

66. The expansion of sugar cane production at Guneid consists of the growing of an additional 3,000 feddans of cane annually, which would be expected to increase the annual production of sugar by about 16,500 tons.

67. The volume and gross value of the annual agricultural production resulting from the use planned to date by the Government of the water stored in the Roseires reservoir would be in summary:

Scheme	Area of Crop (Feddans '000) Cotton	Dura	Lubia	Wheat	Ground-nuts	Sugar	Gross Value Production £S Millions
Conversion of "restricted" Pump Licenses to "unrestricted"	22 1/						1.36
Intensification Gezira cropping				145			2.54
					145		3.48
Pump Schemes:	220						13.64
		110					1.21
			110				0.60
Gezira Extension	66						4.28
		33					0.36
			33				0.18
Expansion Guneid sugar cane production						3	0.57
Total	308	143	143	145	145	3	28.22

1/ Crop equivalent for 20 per cent increased yield from 110,000 feddans.

VII. ESTIMATED BENEFITS FROM THE INVESTMENT

68. The 1958 Bank Mission recommended that a charge of not less than £S 4 per feddan be made for water supplied to intensify the cropping pattern beyond the currently practiced rotation. The Sudanese Government has approved this in principle but considers the actual figure should not be decided until just prior to the additional water becoming available, when it would be fixed on consideration of the profitability of the crops to be grown and the cost to the Government of the supply of the water. In this appraisal a charge of £S 4 per feddan has been credited to the Government for water supplied for the additional cash crops to be produced by intensification of the cropping pattern on Gezira.

69. Based on the pattern of water use as presently planned by the Government and on present operating and production costs, current yields, conservative forward price assumptions and the present allocation of crop returns between the Government and its agencies, the tenant farmers and irrigation pump licensees, the estimated net return from the investment in the Roseires Project and its division among the interests concerned would be:

£S Millions

Scheme	Gross Value of Production	Costs of Production 1/	Return to Tenants	Return to Government 2/	Return to Licensees
Conversion pumps to "unrestricted"	1.36	0.75	0.18	0.16	0.27
Intensification Gezira cropping	6.02	1.96	2.90	1.16 3/	-
Pump schemes	15.45	8.86	3.11	1.67	1.81
Gezira Extension	4.82	2.49	1.00	1.33	-
Expansion Guneid Sugar	0.57	0.42	-	0.02	0.13
Total	28.22	14.48	7.19	4.34	2.21

1/ Excluding water charges, and license fees and land tax in connection with pump schemes payable to the Government and excluding tenants' return for their own labor.

2/ Including cotton export tax.

3/ Water charge of £S 4 per feddan for additional non-cotton crops.

70. These benefits are calculated on the uses of the Roseires water that have been planned to date. There is, however, a further 800 million m^3 (less reasonable provision for reservoir siltation) of water available for additional irrigation uses (see Para 33). More land is available for the development of pump schemes than now planned but, as stated in Para 63 footnote, there is also scope for further intensification of the cropping pattern of the Gezira-Managil schemes.

71. The loan documents would provide assurances that all stored water would be used for irrigation when uses have been developed. As part of the project, the Government of Sudan would undertake research to determine how the Gezira-Managil cropping pattern can profitably be intensified to a greater extent than currently planned. The cost of the research would be borne by the Government but some assistance might be required in obtaining the services of senior officers with experience of research into the production of the crops concerned. The Bank would at an early date reveiw with Sudan the research program and its organization with the object of ensuring agreement as to the adequacy and effectiveness of the work that would be undertaken.

72. Provided the research program is implemented vigorously without undue delay, means could be found within a short time after the completion of the project for the profitable use of the additional available water without further investment in irrigation facilities. There is little doubt but that the benefits would be comparable to those conservatively estimated for the present planned intensification.

73. Assuming this course is followed and that the use of the additional water would give similar benefits to those estimated for the present intensification, the gross value of increased annual agricultural production would be LS 34.2 million or 50 per cent of the total investment of LS 67.2 million[1/], which is a favorable relationship. The annual net benefit of the project would include the return to the Government (LS 5.5 million), the return to pump licensees (LS 2.2 million) and the increased return to the tenant farmers (LS 8.0 million)[2/], who provide the labor but no capital, for production of the crops. The total net benefit, therefore, would be about LS 15.7 million, which represents about 23 per cent of the investment. Since the tenant would invest no capital in the project, the combined direct net return on the capital investment of the Government and pump licensees would, within a few years of completion of the dam, be LS 7.7 million, or over 11 per cent of the investment (Government 12%, licensees 10%).

1/ For the calculation of economic benefits, LS 5.14 million has been added to the cost estimate of Para 40 to cover interest during construction on the IDA credit at conventional Bank terms and on costs met from Government revenues. The opportunity cost of Government capital has also been taken as 5-3/4 per cent.

2/ The estimated return to the tenants of LS 6.0 million from intensification of the Gezira cropping pattern and from conversion of pumps to "unrestricted" would be over and above the present return for their labor. It would be net of their cash costs of production and represent an increase in their net cash incomes. The return to the new tenants who would work the new pump schemes and the Gezira extension would be LS 4.1 million. On the reasonable assumption that their present subsistence livelihood in the surrounding villages would represent about half of this amount, their increased return resulting from the project would be about LS 2.0 million. The net benefit to the economy via the tenants would, therefore, be about LS 8.0 million.

74. Until additional uses of this water materialize, at a minimum the gross value of increased annual agricultural production (£S 28.2 million) would represent about 42 per cent of the total investment. The annual net benefit would include Government £S 4.3 million, pump licensees £S 2.2 million, and tenants about £S 5.1 million, and total about £S 11.6 million, or about 17 per cent of the investment. The combined direct return on the capital investment of the Government and pump licensees would be about £S 6.5 million, or almost 10 per cent of the investment (Government 9.5%, licensees 10%). These benefits, while derived from the use of only about 70 per cent of the stored water, would adequately justify the project.

VIII. CONCLUSIONS AND RECOMMENDATIONS

75. The immediate and major scope in Sudan for expansion of agricultural production for commercial markets is in the development of irrigation. Suitable land is available and there is ample water during the flood period of river flow. The principal limitation to irrigation expansion is the amount of water available during the period of low river flow from January through mid-July each year. The increased storage following construction of the Roseires dam would somewhat more than double the amount now available during that period.

76. The proposed dam is well designed. The construction cost estimate for the present design is realistic and includes adequate allowances for contingencies. Satisfactory arrangements are being made for the construction of the dam by qualified contractors and supervision of the construction will be provided by the firm which made the design. The detailed planning of the proposed use of the water will not be completed for about three years, but is sufficiently advanced to show that the proposals are sound.

77. The system of irrigation farming which has been developed in Sudan enables tenant farmers, unskilled in modern farming practices, to produce efficiently under supervision and is particularly well adapted to prevailing conditions. The organizations to undertake the execution, maintenance and management of irrigation schemes are equipped, experienced and well capable of handling the proposed expansion.

78. Under the proposals, new lands would be brought into production, the productive use of existing irrigation facilities within the area would be further improved and the cropping pattern would be more diversified. Satisfactory local or export markets exist for the proposed production. It has been demonstrated that Sudan can produce extra long staple cotton profitably at the conservative forward price assumption of £S 11 per kantar lint f.o.b. Port Sudan, used in this appraisal, or at even lower prices.

79. When all the stored water is used for irrigation, the gross output/investment ration would be 50 per cent. The annual net benefit from the project would be 23 per cent of the investment and the direct return on investment would be over 11 per cent. Pending the development of additional uses for water, only 70 per cent of that available would be used for new irrigation. During this period the gross output/investment ration would at a minimum be 42 per cent, annual net benefit 17 per cent and the net return on investment almost 10 per cent, which would adequately justify the project.

80. Subject to the Bank and IDA being satisfied concerning Sudan's ability to provide or obtain the future financial requirements for completion of the project (Para 48) the project is suitable for total borrowings of US$51.5 million equivalent, including:

a) A Bank loan of US$19.5 million for a term of 25 years including a grace period of seven years; and

b) An International Development Association credit of US$13 million for a term of 50 years including a grace period of ten years.

ANNEX 1

GROSS AREA COMMANDED BY NILE WATER IRRIGATION SCHEMES

(in Feddans '000)

	1959/60	1960/61	1961/62	1962/63	1963/64
Gezira Gravity	978	978	978	978	978
Managil Gravity	427	567	712	793	793
Pump Schemes					
a) Year round	642	642	642	642	642
b) Restricted	341	341	341	341	341
c) Guneid Sugar Scheme	34	34	34	34	34
Total	2,422	2,562	2,707	2,788	2,788

DETAILS OF LICENSED PUMP IRRIGATION SCHEMES

(in Feddans '000)

	Blue Nile	White & Main Nile	Total
Operative			
a) Year round	125	517	642
b) Restricted	195	146	341
c) Guneid Sugar Scheme	34	-	34
Total	354	663	1,017
Not Operative1/			
a) Year round	3	34	37
b) Restricted	161	356	517
Total	164	390	554

1/ License approved but not operative until water available during period of low river flow.

ANNEX 2

CROP ROTATIONS

The Four-Course Rotation

The four-course rotation (actually eight-course), practiced in the Gezira since 1933/34, operates as follows:

1st year - cotton
2nd " - resting
3rd " - dura
4th " - resting or lubia
5th " - resting
6th " - cotton
7th " - resting
8th " - resting

In this rotation, dura always follows a resting period and cotton follows two rests or lubia and a rest. It is not compact; although cotton is confined to the four fields of a tenancy, the dura and lubia range over the eight fields of two tenancies. In some smaller areas which practice the four-course rotation, the cotton also ranges over eight fields in such a way that the cotton fields of two neighboring tenants adjoin each other. This was instituted for blackarm control, with the incidental feature of easier supervision. In practice it has no effect on blackarm and, while excellent for concentrating labor, it suffers from lack of compactness.

The four-course rotation was introduced in 1933/34, following the disastrously low cotton yields of the 1930/31 and 1932/33 seasons. Holdings were then increased from 30 to 40 feddans and each year the tenant farmer was allowed to grow 10 feddans of cotton, five feddans of dura and up to five feddans of lubia. This rotation is wasteful with regard to the use of land, but it makes maximum use of flood, as against restricted, season water and has minimized difficulties in controlling weeds and diseases.

The Three-Course Rotation

The three-course rotation (actually six-course), currently in use on the Managil Project and practiced in the Gezira until 1930/31, operates as follows:

1st year - cotton
2nd " - dura or lubia
3rd " - resting
4th " - cotton
5th " - lubia or dura
6th " - resting

Tenancies are of 15 feddans at Managil and the peasant farmer each year is permitted to grow five feddans of cotton, two and one half feddans of dura and up to two and one half feddans of lubia. In practice, each tenant is allowed a free feddan on which he may grow a crop of his choice, vegetables,

groundnuts, etc., in place of lubia. The three-course rotation has the advantage of compactness as regards tenancies (although tenants still must share land for the dura and lubia crops), but the yield of dura is somewhat reduced. This is not regarded as a serious disadvantage, however, and, if necessary, it could be overcome by the use of nitrogenous fertilizers on the dura crop. Variants of the three-course rotation are in use on pump schemes - Government and private. All of them plant one third of the land to cotton each year but the amounts of dura and lubia grown are highly variable. In some the rotation consists merely of cotton, resting, resting.

In considering the three-course rotation, it should be borne in mind that only two thirds of the land grows one crop each year, which is a low intensity of use compared with perennial irrigation. In Egypt all the land carries one crop and much of it carries two or more crops each year.

ANNEX 3

AVERAGE RIVER FLOW OF BLUE NILE AT ROSEIRES AND WAD EL AIES
for Period 1912-1952 in millions m^3 per day

Days of Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1-10	29.4	18.0	12.6	10.0	12.3	39.2	114	460	489	284	111.0	53.3
11-20	24.8	15.7	11.3	10.3	19.3	54.5	190	512	430	215	84.5	43.0
21-end	21.0	14.3	10.9	10.1	28.9	72.5	321	521	367	148	86.5	35.0
Mean	24.9	16.2	11.6	10.1	20.5	55.4	212	499	428	213	87.3	43.6
Total for Month	722	456	359	305	634	1,660	6,570	15,500	12,800	6,620	2,620	1,330

Note: A net amount of 791 million m^3 is stored in Sennar Dam during period surplus flow to augment availability for irrigation during months of restricted flow.

WATER REQUIREMENTS GEZIRA, MANAGIL STAGES 1-4, AND OPERATIVE LICENSED PUMP SCHEMES ON BLUE NILE AT JUNE 1960, in millions m^3

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
786	671	610	319	322	305	498	812	916	1,170	1,122	987

Note: Requirements above also include allowance of 8 million m^3 daily to pass down Blue Nile below Guneid.

TECHNICAL DETAILS OF THE DAM

Location

The damsite is located on the Blue Nile about 265 kilometers upstream of the Sennar dam and about 106 kilometers downstream of the Ethiopean border. In its first stage the backwater surface of the reservoir at elevation 480 would extend to about 15 kilometers from the border. The site is in the Damazin rapids which have a length of about 4 kilometers and are located above the town of Roseires. This section of the river is the only area where a dam can be constructed to store a large amount of water completely within Sudan territory. Throughout this section of the river the normal bed is confined to a width of a few hundred meters, but the adjacent terrain consists of gently sloping plains. For this reason, the total length of dam would be approximately 9 kilometers.

Geology

At the location of the dam rock is visible in the river bed. It consists of gneiss, granite, and pegmatite and is largely unweathered. On the banks of the river, the rock is below the surface and weathered. The left bank has an almost continuous bed of clay at about the 470 elevation which will effectively eliminate underseepage. However, there are some sections of the flanks where there is no impervious cover and the underlying rock could allow leakage. To prevent seepage, the embankment sections of the dam would be constructed with an upstream clay blanket. Except where rock is exposed in the river channel, the entire reservoir area is covered by beds of clay, silt, sand, and gravel. This type of material in combination with the expected deposition of silt should effectively prevent seepage losses through the floor of the reservoir.

Hydrology

The flow in the Blue Nile at Roseires is due almost entirely to the rainfall on the Ethiopian highlands. This rainfall has a well defined pattern but varies in intensity from year to year, causing the same type of variation in the river flow. Although rainfall records of the drainage area have not been made, a continuous record of flow in the river at Roseires since 1903 is available. The record shows that for an average year the flow is very low in January, drops to an absolute minimum by March or April, then starts to increase gradually during May and June. Around the middle of July the rate of flow increases sharply, reaching a peak by the end of August. From September through December the rate of flow decreases rapidly to the relatively low values of January. These average flows for period 1912-1957 are tabulated in Annex 3. The following table is a summary of data based on 10-day mean flows during this same period.

Summary of Blue Nile Discharge at Roseires

Description	Date	Discharge m^3/s	Discharge Million m^3
Maximum (10-day mean) discharge	August 1946	10,078	-
Minimum (10-day mean) discharge	May 1914	38	-
Maximum annual discharge	1917 - 1918	-	70,580
Maximum but one annual discharge	1929 - 1930	-	66,800
Minimum annual discharge	1913 - 1914	-	20,100
Minimum but one annual discharge	1912 - 1913	-	37,210
Mean annual discharge	1912 - 1957	1,588	50,100

Dam

The Roseires Dam would consist of three main elements, a buttress concrete center section tied into left and right bank earthfill sections. The concrete section would have a length of 1,110 meters with a maximum initial height of about 60 meters. The earthfill sections would be approximately 9,000 m long on the left bank and 6,000 m long on the right bank with a maximum initial height of about 30 meters. Both the concrete and embankment sections of the dam have been designed so that they may be raised an additional 10 m without interference with normal reservoir operation.

The concrete center section would be composed of massive-head buttresses founded on rock. Provision would be made for passing the flood discharge through a combination of low level sluiceways and high level spillways. The center section would also contain the intake structure for the future Kenana irrigation canal and intakes for a future power house.

Deep sluices would occupy the five bays at the lowest portion of the river bed. Each sector type sluice gate would be 10 m high by 6 m wide and be hydraulically operated from the downstream side. A reinforced concrete apron would protect the river bed against scour. The apron will be constructed with a deflector at the downstream end in order to induce an hydraulic jump at flood discharges. The highlevel spillway would be seven bays wide located closer to the left bank. The spillway would have an ogee shape and would be hollow. Control would be by means of electrically operated sector gates 12 m high by 10 m wide. During the initial stage the spillway discharge would be of the free-overall type but after the raising of the dam the discharge will be of the orifice type.

The future powerhouse would be located in seven bays adjacent to the spillway. In this area the buttress spacing would be increased to provide sufficient space for the turbine intakes. For the first stage, the intakes would have temporary concrete bulkheads and would be constructed so as to provide easy connection to the future penstocks. The present plan is to ultimately install seven generators with a capacity of 25,000 kw each. The generators would be driven by vertical Kaplan turbines. During times of very low flow in the river, the station output

would be limited by the availability of water and during times of flood the output would be limited by the reduced head due to the high tail-water. Based on an average year, the energy available from the installation would be approximately 1,000 million kwh. In a single bay between the spillway and the future powerhouse, two small 1,000 kw generating units would be installed initially to supply power for operation of the gates and for the offices and living quarters of the operating personnel.

The intake structure for the proposed Kenana canal would be located near the left end of the concrete section. It would consist of five bays controlled by electrically operated sector gates. Construction would be similar to the deep sluice section except that the discharge would be at a higher elevation.

Neither the intake for the future irrigation canal nor the intake for the future powerhouse are necessary for the present development. However, a minimum of construction for both of these appurtenances would be performed initially because of the impracticability of doing this work after the reservoir is in operation.

The embankment sections would be comprised of zones of compacted sand and clay with a central core of impervious material. The upstream face would be protected by rip-rap and have a vertical wave wall at the top. Including the wall, the embankments would have a total free board above maximum flood level of 2.2 meters. Where required an impervious horizontal blanket would be used upstream to minimize under-seepage.

Provisions for Raising

Each section of the dam could be raised at a later date to the proposed final height without the use of coffer dams. The typical buttresses would be constructed in the first stage with all work complete up to elevation 445 so that the extensions could be made on the downstream side above the tail-water level during the dry season. The sluice section and spillway would have all the required ultimate construction below the maximum flood level performed with the first stage. In the same manner, the canal intake would be completely constructed up to the command level. The flank embankments are also laid out to permit economic future heightening. Below the first stage water level, all material to be added would be on the downstream side, thereby leaving the original upstream face undisturbed. The future raising would also result in a considerable lengthening of the embankments. The topography indicates they would require extension from 9 to 16 km on the West bank and from 6 to 8 on the East bank. Total final dam length would then be about 25 km.

Materials, Labor and Transportation

The major bulk of the dam would be made up of materials available at the site. Suitable quarry sites have been located for the supply of aggregate and rip-rap within reasonable haul distance and soils investigation indicates that no difficulty would be experienced in providing suitable materials for the flank dams. However, cement, steel, dimensional lumber, finished products and fuel would all have to be transported to the area.

Reservoir Operation

Following the completion of the High Aswan Dam (Saad el-Aali) in Egypt, it is planned to fill the Roseires reservoir during the month of September when the river is in the falling flood stage. In this manner the quantity of silt deposited in the reservoir would be minimized. After filling, the reservoir would be kept at the maximum level for as long as possible with the irrigation needs being met by the natural flow. Before the end of the calendar year, it will be necessary to start withdrawing reservoir water to supplement the flow in the river. Depending upon the variation of flow in the river, the reservoir would be drawn down by February at the earliest and April at the latest. By the middle of May all the gates would be fully open and would remain so until after the maximum floods have passed. Any necessary maintenance on the gates or aprons could be performed during the May-July dry period.

Spillway Capacity

The maximum flood of record for the Blue Nile at Roseires is calculated to have been 10,800 m^3/s in August 1946. The combined capacity of the sluices and the spillways as originally designed was 15,000 m^3/s, which is less than $1\frac{1}{2}$ times the 47 year record flood. The Bank had questioned whether the flood used for design was not too low, especially since the dam contains very long earth embankment sections where any over-topping would prove disastrous. In order to be certain of obtaining an adequate spillway capacity, the Bank requested that the magnitude of the design flood be checked by an International Board of Consultants. This board, which consisted of a meteorologist, hydrologist, and geologist, was appointed in October 1960 and reported its findings in May 1961. The board has estimated that the probable maximum inflow to the reservoir would be 18,750 m^3 per second. Based on the findings of the board, the spillway capacity will now be increased by the addition of two more high level spillway gates and the maximum rate of outflow will be 17,350 m^3 per second.

Evaporation

Evaporation losses from the reservoir at any given time are related to the area of the water surface, which in turn depends upon the operating regime. Using an average year's flow and an assumed schedule of operation, the losses due to evaporation from the reservoir are estimated to be 300 million m^3 during the drawdown period from December through May. This average annual evaporation loss amounts to about 10 per cent of the gross storage.

Sedimentation

Based upon actual measurements made in 1954 and 1955 at Wad el Ais, a method of estimating the quantity of suspended matter was developed by the consultants. This method indicates that the average annual silt load of the river is 133 million tons. A study of the assumed reservoir operation, which provides for the filling of Roseires late in the falling flood, shows that the average annual volume of storage depletion due to sedimentation would be about 15 million m^3 which is about one half of one per cent of the gross volume.

Engineering

Engineering for the project has been performed by Sir Alexander Gibb & Partners and MM. Andre Coyne & Jean Bellier as joint consultants. The consultants have conducted subsurface investigations including permeability tests and core borings, aerial surveys with ground control, and hydraulic model tests of the dam. Contract drawings and specifications for the dam and associated works are completed and were issued to potential bidders in November and December of 1960. The consultants' agreement includes provisions for supervision during construction. The contemplated arrangements covering engineering supervision would be adequate to ensure proper execution of the project.

Future Development

Raising the storage level of the Roseires Dam to elevation 490 would provide an increase of 4,600 million m^3 of water which could be used for both generation and additional irrigation. Although cost estimates have not been prepared for raising the dam, it can be assumed that the cost per cubic meter of water for the incremental volume would be substantially lower than the initial unit cost. The average annual amount of energy available from the hydroelectric development would be about 1,000 million kw-hrs before raising and proportionally more after raising. When the system demand reaches the point where large blocks of energy could be absorbed, the construction of the generating station could easily be justified. Additional study would be required to determine which schemes offer the best possibility for the further development of agriculture and the timing for the installation of the generating units.

SCHEDULE OF CONSTRUCTION OF DAM

Project studies, including model experiments, indicate the working season on the river bed will average only about eight months a year due to the July-October floods. Work on the flank dams during the wet season would be interrupted by the rain and saturated soil and, in addition, it may be difficult to retain local labor during the rainy season when food crops are sown. Starting immediately after the floods of 1960, the project construction is scheduled to take seven dry seasons. The construction of the associated works would extend over two seasons with work on the main contract for the dam commencing the second season.

(a) First Season: (1960/61)
- Site work, housing and airstrip
- All-weather roads
- Bridge construction.

(b) Second Season: (1961/62)
- Diversion channel excavation
- Cofferdam foundations
- Completion housing and airstrip
- Completion of roads and bridge.

(c) Third Season: (1962/63)
- Cofferdams and excavation
- Flank dams started

(d) Fourth Season: (1963/64)
- Concreting
- Flank dams continued.

(e) Fifth Season: (1964/65)
- Concreting (deep sluice section completed)
- Flank dams continued.

(f) Sixth Season: (1965/66)
- Sluice gates installed
- Spillway completed
- Flank dams continued.

(g) Seventh Season: (1966/67)
- Concrete complete
- Flank dams complete
- Mechanical equipment complete.

The schedule is shown diagramatically in Table 1.

ANNEX 5
Table 1

Construction Schedule

Bar Graph

	1960	1961			1962			1963			1964			1965			1966			1967		
	Dry	Dry	Wet	Dry	Dry	Wet	Dry	Dry	Wet	Dry	Dry	Wet	Dry	Dry	Wet	Dry	Dry	Wet	Dry	Dry	Wet	Dry
ASSOCIATED WORKS																						
Bid Period	x																					
Evaluation and award	x																					
Site Preparation	xxxx	xxx		xxxx	xxx																	
Housing and Camps	xxxx	xxx		xxxx	xxx																	
Airstrip & Roads	xxxx	xxx		xxxx	xxx																	
Bridge	xxxx	xxx		xxxx	xx																	
MAIN CONTRACT																						
Bid Period	xxxx	xxx																				
Evaluation and award		x	xx																			
Assembly and Shipping of Construction Plant			x	xxxx	xxx	xxx	xxxx	xxx	xxx	xxxxx												
Diversion Channel and Cofferdams				xxxx	xxx		xxxx	xxx									xxxx	x				
Concrete Dam Construction					xxx		xxxx	xxx		xxxxx	xxx		xxxx	xxx		xxxx	xxx		xxxx	xxx		
Flank Dam Construction								x		xxxxx	xxx		xxxx	xxx		xxxx	xxx		xxxx	xxx		
MECHANICAL EQUIPMENT																						
Bid Period			xxx																			
Evaluation and award				xxxx																		
Manufacture & Erection											xxx	xxx	xxxx	xxx	xxx	xxxx	xxx	xxx	xxxx	xxx		

ANNEX 6

COST OF THE DAM AND ASSOCIATED WORKS

An estimate of the cost of the dam is shown in the attached Table 1. This estimate is based upon the average of the two lowest bids for Contract No. 10 which were opened on April 15, 1961. Contract No. 10 which covers the dam is of the unit-price type. The bid prices are subject to adjustment only for changes in the cost of the three basic materials - cement, reinforcing steel, and structural steel - or for changes in the statutes and ordinances of Sudan. The estimate includes an amount to cover the two spillway gates which have been added since the tenders were received. It also includes total contingency amounts equal to 15% of the direct cost of the dam. The total cost of the dam including interest and service charges during construction is £S26.78 million, of which £S17.98 million (US$51.55 million) is foreign exchange. Estimated disbursements (excluding preparatory and associated works) are shown in Table 2.

The Sudanese Government is financing the associated works from its own resources. These works have been started and should be completed in 1962. The disbursements will be made by the Government in accordance with the several contracts. The total associated works expenditures including all moneys previously spent on the project by the Government amount to £S3.97 million of which the equivalent foreign exchange portion is £S1.42 million. The previous expenditures are listed below:

	£S million
Soil investigation and aerial survey	0.07
Engineering fees and supervision	0.37
Gauging station, rest house, additional surveys	0.20
Land and compensation	0.15
Total	0.79

The expenditures to be made in the next two years covering the work included in the first nine contracts are listed below. These are the actual bid prices.

	£S million
Site clearance and drainage	0.05
Water supply, electricity, airport, roads	0.82
Temporary and permanent housing	0.97
Hospital, offices, post office, schools	0.22
Bridge	0.64
	2.70
Contingencies	0.41
Engineering and supervision	0.07
Total	3.18

ANNEX 6

Table 1

COST ESTIMATE OF DAM

(Excluding Preparatory and Associated Works)

(in million Es)

Item	Total	Local Currency	Foreign Exchange	Foreign Exchange Equiv. in US$ millions
Contract #10 1/	21.15	7.74	13.41	38.43
Additional Contingencies 2/	1.60	0.76	0.84	2.41
sub-total	22.75	8.50	14.25	40.84
Engineering and Construction Supervision 3/	1.00	0.30	0.70	2.01
sub-total	23.75	8.80	14.95	42.85
Interest on IBRD & KFW Loans during construction	2.89	-	2.89	8.30
Service Charge on IDA Loan during construction	0.14	-	0.14	0.40
Total	26.78	8.80	17.98	51.55

1/ Average of two lowest bidders. Includes provision for some contingency allowances.

2/ Additional allowance to provide a total contingency amount equal to 15% of the direct cost excluding customs.

3/ Fee after July 1, 1961.

ANNEX 6

Table 2

ESTIMATED DISBURSEMENTS - DAM CONSTRUCTION[1]
(in millions)

Year	Local Currency[2]		IDA Credit Service Charge[2]		Foreign Exchange[3]		Total	
	£S	US$ Equiv.	£S	US$ Equiv.	£S	US$ Equiv.	£S	US$ Equiv.
1961/62	0.79	2.27	0.00	0.01	2.95	8.46	3.74	10.74
1962/63	1.53	4.39	0.01	0.02	2.49	7.15	4.03	11.56
1963/64	1.78	5.11	0.01	0.04	2.64	7.60	4.43	12.75
1964/65	1.66	4.76	0.02	0.06	3.07	8.81	4.75	13.63
1965/66	1.51	4.33	0.03	0.08	3.11	8.93	4.65	13.34
1966/67	1.28	3.67	0.03	0.09	2.22	6.38	3.53	10.14
1967/68	0.25	0.72	0.04	0.10	1.45	4.17	1.74	4.99
Total	8.80	25.25	0.14	0.40	17.93	51.50	26.87	77.15

1/ Excluding disbursements for preparatory and associated works but including US$0.35 million reimbursement for engineering fees between July 1, 1960 and July 1, 1961.

2/ Payable by Sudan Government from own resources.

3/ Proceeds of the three loans.

ANNEX 7

COST OF IRRIGATION WORKS AND FARM DEVELOPMENT

The conversion of "restricted" pump schemes to unrestricted pumping, the intensification of the cropping pattern in the gravity areas, and the expansion of sugar cane production at Guneid would not involve additional capital expenditure in irrigation works or farm development.

New pump scheme development would involve the supply and installation of pumping plants, canalization of the area and the clearing, leveling and cultivation of the farm lands. In Report No. T.O. 204, the cost of this development to be undertaken by pump licensees was calculated at from LS 22 to LS 33 per feddan and averaging LS 27.5 per feddan. Since that time, costs have risen particularly as a result of increased import duties and the estimate of the average developmental cost for pumping schemes, including a provision for contingencies of 15 per cent, is now about LS 32 per feddan.

The investment in the proposed new pumping schemes development is estimated, therefore, as follows:

670 feddans at LS 32 per feddan = LS 21.42 million

The foreign exchange component would be about LS 9.63 million equivalent.

Plans for development of the 200,000 feddans new gravity irrigation proposals have not yet been worked out in detail. The existing Gezira and Managil canals would convey the water to the edge of the area. New irrigation works would be confined to minor canals and distributory channels in the area and the necessary regulators and bridges. These works would be carried out by the Ministry of Irrigation. Costs have been assessed on the basis of those being incurred for the Managil Extension Scheme, Stages 3 and 4, and include a provision for contingencies of 15 per cent. The costs of land preparation, extension of light railways for transport of cotton, and provision of ginning and storing facilities that would be undertaken by the Sudan Gezira Board, are estimated on the same basis. The total cost for the 200,000 feddans gravity irrigation, therefore, is estimated at LS 9.5 million. Approximately LS 4.0 million equivalent would be foreign exchange.

The portions of both gravity and pump schemes developed during each year would be placed in production in the subsequent year. The total cost of the irrigation works and farm development for the Roseires Project, including interest on the foreign exchange component during construction, is estimated as follows:

(in LS million)

	Local Currency	Foreign Exchange	Total
Pump Schemes	11.79	9.63	21.42
Gezira Gravity Extension	5.50	4.00	9.50
Interest during constr.	-	0.39	0.39
Total	17.29	14.02	31.31

ANNEX 8

YIELD EXPECTATION, FORWARD PRICE ASSUMPTIONS AND PRODUCTION COSTS OF CROPS

The irrigation areas included in the Roseires Project have soils and operating conditions similar to those of existing irrigation schemes. The crop yields and production costs of the established areas used in the following review are considered to be applicable, therefore, to the Roseires Project.

Cotton

The present price for Sakel G 5S cotton is about 44 cents per lb. c.i.f. Liverpool and the forward price assumption of LS 11 per lint kantar f.o.b. Port Sudan, that is used in this appraisal, is conservative (see statement of Bank Economic Staff, attached hereto).

a) Gravity Irrigation Schemes

The average yield of cotton over the last 12 years is 4.6 kantars of seed cotton per feddan. At the price assumption of LS 11 per lint kantar (LS 12.1 per seed kantar) and allowing the value of seed (LS 2 per seed kantar of cotton), the gross return is LS 14.1 per kantar seed cotton or LS 64.8 per feddan.

The cost of production chargeable to joint account is estimated at LS 16.3 per feddan and LS 5.0 (LS 1 per lint kantar) export tax is payable to the Government.

The net proceeds of LS 43.5 per feddan is divisible as follows:

Ministry of Irrigation	42%	LS 18.27
Social Development Fund	2%	0.87
Local Government Council	2%	0.87
Gezira Board	10%	4.35
Tenants' Collective Account	42%	18.27
Tenants' Reserve Account	2%	0.87
Total	100%	LS 43.50

Based on Gezira experience, the Ministry of Irrigation's costs approximate LS 5.0 per feddan cotton and those of the Gezira Board LS 2.5 per feddan cotton. Tenants' cash costs are estimated at LS 10 per feddan cotton and the return for his labor LS 9.14.

b) Pump Irrigation Schemes

The average yield of cotton from pump schemes is 4.4 kantars of seed cotton per feddan. At the forward price assumption of LS 11 per kantar lint, the gross proceeds are LS 62.0 per feddan. Export tax of LS 4.8 per feddan (LS 1 per lint kantar) is payable to the Government. Of the net proceeds (LS 57.2 per feddan), the licensee receives 60 per cent (LS 34.3) and the tenant 40 per cent (LS 22.9).

The cash costs payable by the tenant are estimated at £S 14.7 per feddan and those of the licensee £S 19.3. The remaining £S 8.2 per feddan received by the tenant represents the return for his labor. From his remaining £S 15 per feddan, the licensee has to pay land tax of four per cent of gross return (£S 2.5) and license fee (£S 0.3) and make provision for depreciation (£S 2.8) and interest on working capital (£S 1.2). The £S 8.2 remaining to the licensee represents the net return on his investment (before business profits tax).

Dura

The average yield expectation is 13 cwt. grain per feddan, which has a normal market value of about £S 15 per ton. This gives a return of £S 9.75 per feddan. The residual fodder value of the plant is estimated at £S 1.20 per feddan, giving a gross return of £S 11 per feddan. Tenants' cash costs are estimated at £S 3 per feddan, so that the return for tenants' labor is £S 8 per feddan.

Lubia

The average expectation of yield is 5 cwt. pods per feddan. The normal price of £S 12 per ton gives a gross return for pods of £S 3 per feddan. The grazing value of lubia is valued at £S 2.4 per feddan. The gross return from lubia is thus £S 5.4 per feddan. Cash costs of production are estimated at £S 1.5 per feddan, so the return for the tenants' labor is £S 3.9 per feddan.

Sugar

The expected yield of sugar cane is 50 tons per feddan of 11 per cent cane. This would give 5.5 tons sugar per feddan, which at the present price of £S 35 per ton delivered Sudan would return £S 192.5 per feddan. Production costs of cane under pump irrigation are estimated at £S 14.4 per ton sugar and the processing costs at £S 12.7 per ton sugar - a total production cost (including all labor) of about £S 27 per ton, or £S 148.5 per feddan. The margin of £S 8 per ton, or £S 44 per feddan, represents the return on investment in land and pumping plant and irrigation works.

Groundnuts

The average yield of groundnuts is 1,700 lbs. per feddan which, at a price of £S 30 per ton, gives a return of £S 23 per feddan. Fodder value of straw is estimated at £S 1 per feddan. The gross return for groundnuts is therefore estimated at £S 24 per feddan. Experience at the Experimental Village Farm shows that cash cost of production, excluding any land rental or water charge, averages about £S 5 per feddan and the return to the tenants in these circumstances £S 19 per feddan.

Wheat

The average yield of wheat is 12.5 cwt. per feddan. The current price of £S 28 per ton delivered Sudan gives a gross return of £S 17.5 per feddan. Cash costs of production, excluding any land rental or water charge, at the Experimental Village Farm are approximately £S 8.5 per feddan, and £S 9 per feddan would represent the return received by the tenant in these circumstances.

ANNEX 8
Attachment

EXTRA LONG STAPLE COTTON

Recent Price Movements

The price of extra long staple cotton continues at a relatively high level, primarily because of substantial consumption growth in the free world which began during the 1959/60 season and which appears to be continuing during the current season. At the same time, sizeable demand for extra long staple cotton by the Soviet Bloc appears to be continuing and even growing.

Sudanese extra long staple cotton (G5S) has been selling at over 40 cents per pound in Liverpool for the last twelve months, and for most of this period it was selling at around 44 cents or higher. A similar situation has prevailed for the higher-priced Egyptian Karnak Fully Good and for Peruvian Pima No. 1.

At the same time, the price spread between extra long staple cotton and American Upland cotton has widened as the latter has remained relatively stable for more than a year. The attached table summarizes these price movements.

Supply-Demand Developments

Consumption of extra long staple cotton in the free world during the 1959/60 season, which ended last July 31, was over 20% higher than during the preceding season and over 50% higher than during the textile recession season of 1957/58. Exports to the Soviet Bloc, including Communist China, represented over one third of aggregate exports of Egypt and the Sudan during the 1959/60 season. This ratio had been one fourth of aggregate exports as recently as the 1956/57 season. The Sudan's exports of extra long staple cotton to the Soviet Bloc increased from 4 per cent of its total exports in 1957/58 to 18 per cent in 1959/60.

Production of extra long staple cotton reached an all-time peak of about two million bales during the 1958/59 season, declined by 5 per cent during the 1959/60 season, and may remain at about the same level during 1960/61. The International Cotton Advisory Committee reports that the current crop in the Sudan has been adversely affected by various insects and, despite increased acreage, yields may be materially reduced.

Long-Term Problems

Despite the recent favorable developments, several long-term problems appear in the offing for extra long staple cotton.

First, the US, the world's fourth largest producer of extra long staple and probably the largest holder of surplus stocks of extra long staple cotton, announced in December 1960 that it would sell for export some 60,000 bales from its stocks on a competitive basis. The US does not normally export this type of cotton. Since the domestic price and the purchase price of the

stocks which the US is selling are higher than the world price, this action will mean the subsidization of these exports. Although in itself the export in this way of 60,000 bales of cotton will not make a major impact on the world price, what is more important is that the US is holding in addition at least a quarter of a million of bales of surplus extra long staple cotton, most of which is of foreign origin, having been procured for its strategic stockpile some years ago.

The capacity of the US to increase its production of extra long staple cotton is substantial. What is not known at present is to what extent the recently announced policy of subsidizing exports of extra long staple portends the further disposal of unsold stocks by the US and the expansion of domestic production.

A second problem in this field is the increase in output which can be expected from the San Lorenzo Project in Peru, when it is settled and the land cultivated, and from the Managil Extension and the Roseires Projects in the Sudan. The recent growth in consumption of extra long staple cotton has been substantial, but the long-term growth rate has been more modest. What is not known at this time is whether the anticipated large growth in output from projects now in sight will be absorbed by anticipated growth in consumption.

This growth in output intensifies a third problem, namely, the growing dependence of Egypt and the Sudan on the Soviet Bloc as an important outlet for their extra long staple cotton crops. There are major uncertainties for extra long staple cotton built into this growing dependence on a market which may be subject to arbitrary curtailment.

Conclusion Regarding Long-Term Price

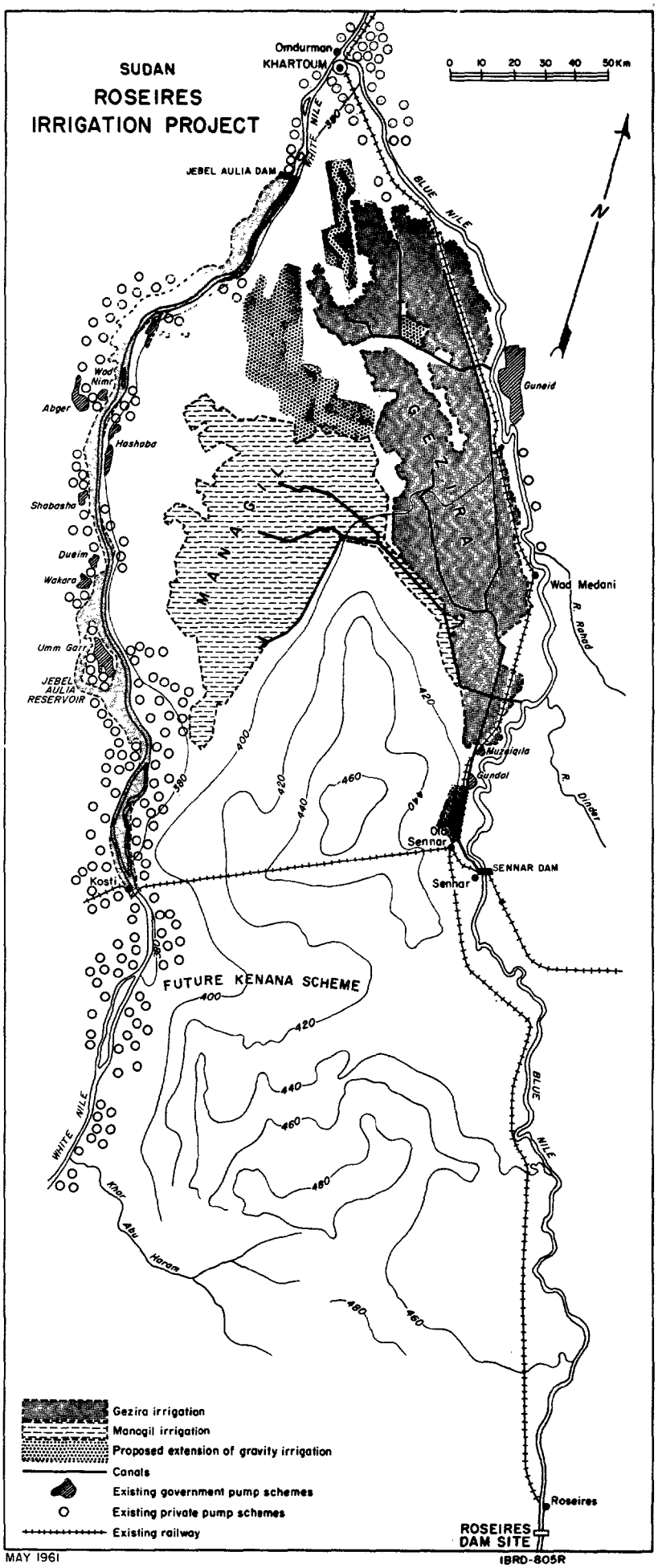
Although the short-term situation regarding extra long staple cotton has been favorable, the long-term uncertainties suggest continued caution in the long-term price forecast. Therefore, a price of around 34 cents per pound for Sudanese Sakels, c.i.f. Liverpool, is recommended. This is 10 cents per pound below the current price and is equivalent to LS 11 per kantar, f.o.b. Port Sudan.

ECONOMIC STAFF
February 1961

RAW COTTON PRICES, C.I.F. LIVERPOOL, 1957/58 TO 1960/61 SEASONS
(US cents per pound)

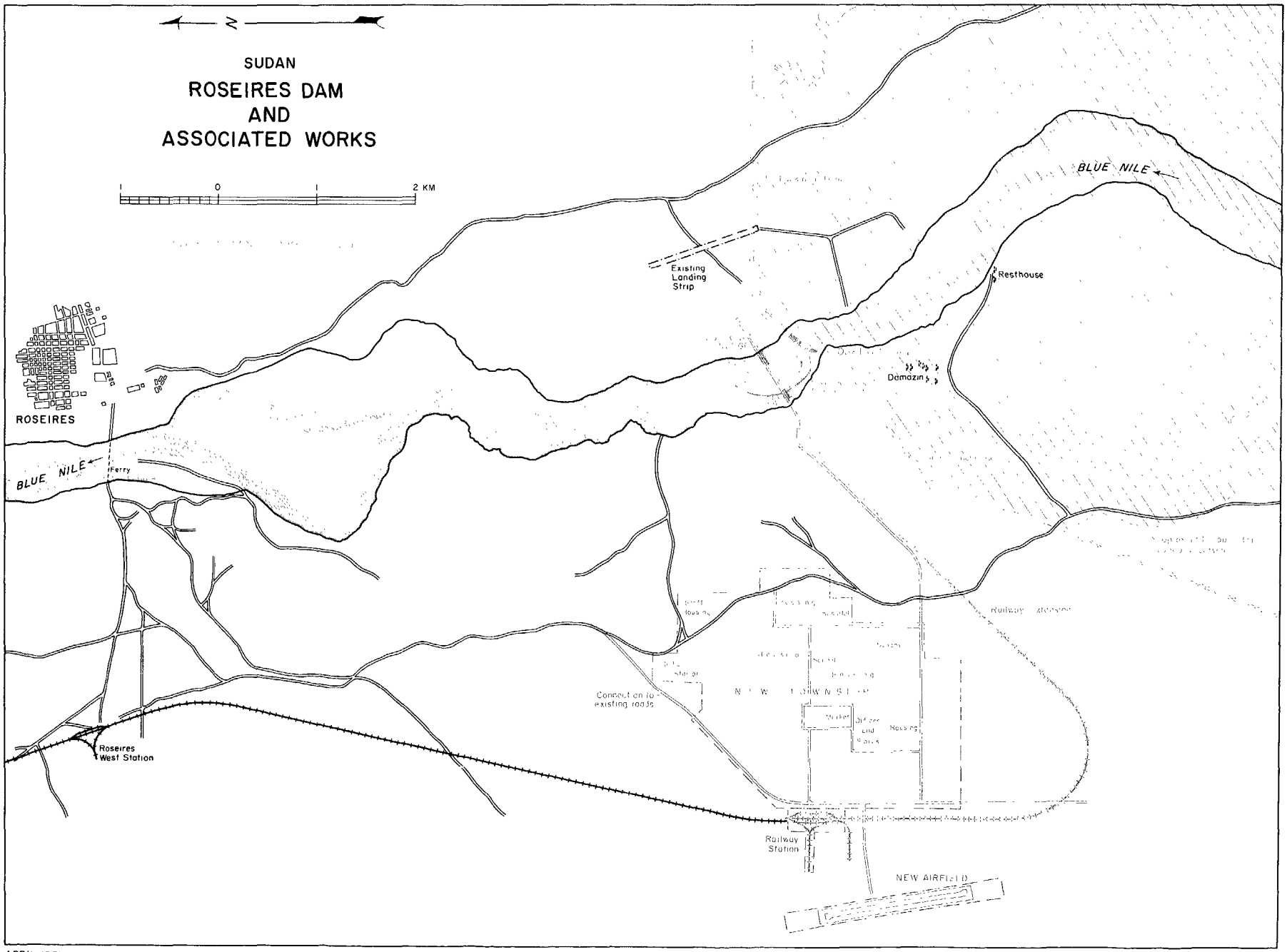
Season (beginning August)	Karnak FG	Sakel G5S	US Middling 1-inch
1957/58	49.57	48.51	30.73
1958/59	35.70	34.59	28.18
1959/60	44.77	41.63	26.45
1960/61			
August	48.30	44.36	26.88
September	48.77	44.17	27.09
October	48.85	44.93	27.26
November	49.29	45.96	27.50
December	48.56	45.71	27.67
January	47.58	45.24	27.66
February	47.62	44.81	28.29
March	46.54	43.87	28.93

Source: International Cotton Advisory Committee



MAY 1961

IBRD-805R

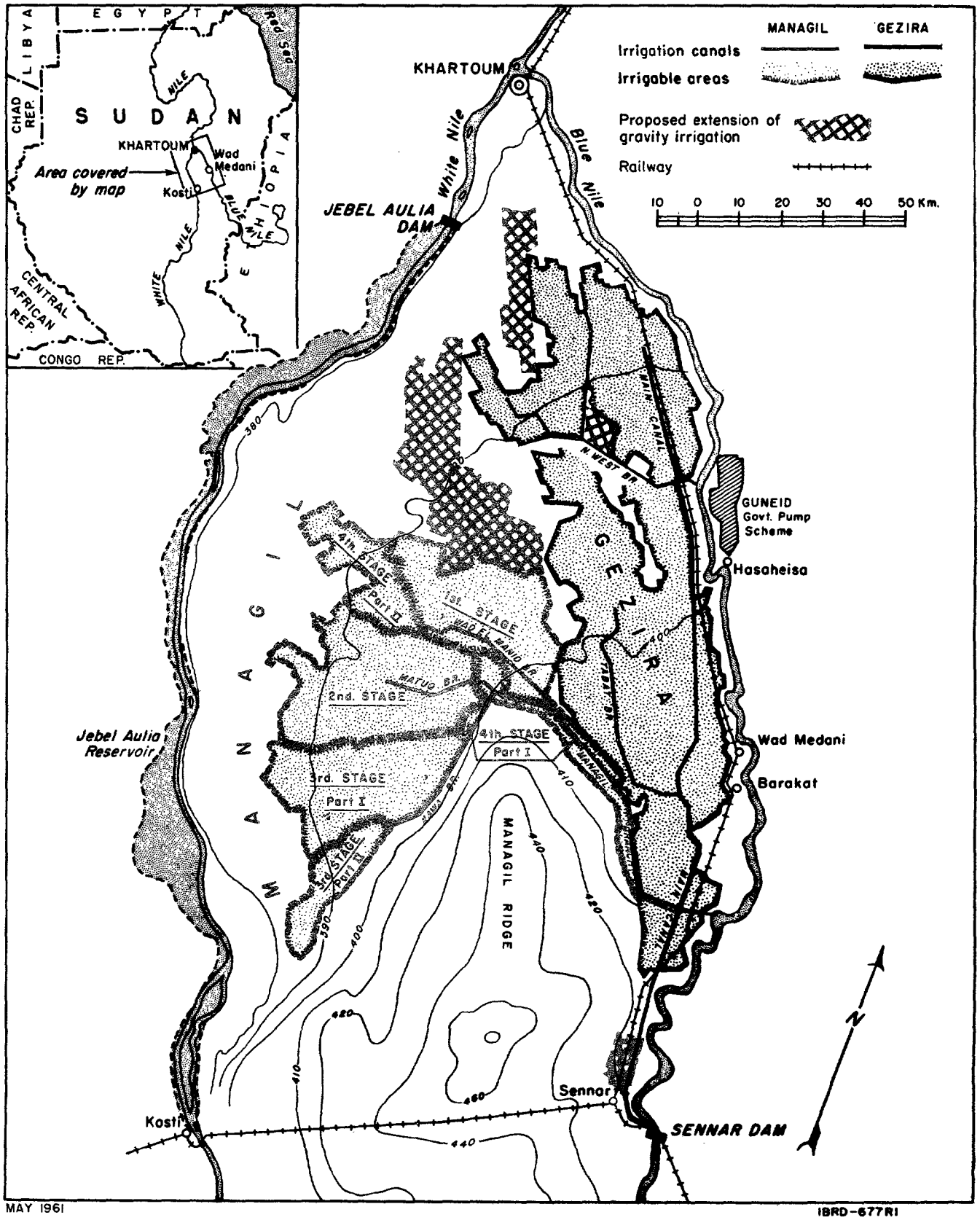


APRIL 1961

IBRD-806

SUDAN

GEZIRA AND MANAGIL SCHEMES



MAY 1961

IBRD-677R1