REPUBLIC OF NAMIBIA

MINISTRY OF AGRICULTURE, WATER AND RURAL DEVELOPMENT

TECHNICAL AND ECONOMIC FEASIBILITY STUDY OF THE TANDJIESKOPPE IRRIGATION PROJECT

PRELIMINARY REPORT

THE MAIN REPORT

Arab Organization for Agricultural Development
(AOAD)
Consultant

Arab Bank for Economic Development in Africa
(BADEA)
Donor

KHARTOUM **November, 1999**

TABLE OF CONTENTS

THE MAIN REPORT

EXECUTIVE SUMMARY

Background:

01 Namibia can be described as an arid to semi-arid country. The only perennial rivers in Namibia flow along its northern and southern borders. This implies that the only area with high potential for large irrigation projects are located immediately adjacent to the Orange, Kavango and Zambezi rivers. In order to realize a number of the objectives laid down for the agricultural sector in the First National Development Plan (NDP1) the Government wishes to embark on a programme of increasing crop production in the area under irrigation.

02 One of the high potential irrigable areas identified is the land bordering the Orange River in the Karas region in the country's southern border. It is this area which provides the focus for this project.

Project Objectives:

03 The main objective of the project are to utilize the available land and water potential in the project area along the Orange River for the development of irrigated agriculture in order to enhance national food security, diversification of agricultural production, provision of livelihood for rural population together with reducing poverty levels of rural population and curbing the high levels of migration from rural areas. Given the unique agro-environment of the project area and its comparative advantage, the main thrust of development would be on the production of high value crops which are suited to the agro-environment. Closely associated with the main objective are the following specific objectives:

(a) To avail basic information on the natural resource base; particularly soils and water.
(b) To assess the development potential of the natural resource base.
(c) To investigate alternative development scenarios for the socio-economic environment in which the proposed project would be situated; settlement of smallholder, nucleus estate/smallholder outgrower or estate only.
(d) To establish a sustainable irrigated agricultural production system that is economically viable.

Project Area

04 The study covered the area lying downstream and northwards of the settlement of Noordoewer as far as and including Aussenkehr Farm. It is bound on its lower part by he Orange River and on its higher part by contour line 350 m a.s.l. The total area investigated is 55976 ha. The project area is predominantly rugged and dissected terrain with localized flat patches. Rainfall is below 50 mm/a which does not contribute to water requirements of crops. Evapotranspiration is high hence crop water requirements are high. The thermal regime of hot, cold and transitional seasons offer an almost unlimited opportunity for growing a very wide range of tree crops as

well as seasonal crops. An advantage of the thermal regime is that crops ripen two to three weeks earlier than Southern Hemisphere areas.

04 Agriculture is the main activity in the project area. About 283 ha are irrigated by gravity through Noordoewer canal in the vicinity of Noordoewer settlement. The Aussenkehr Farm has recently attracted substantial investments in grapes production by private sector. The Government has state farms within the boundaries of Aussenkehr farm. The major crops produced are grapes, mango, dates, citrus, lucerne and vegetables.

Project Sites

05 A reconnaissance soil survey was conducted as part of this study covering the whole area. Based on the results of the soil evaluation an area of 5 978 ha of deep soils was identified (10.68%) of the surveyed area. However, land evaluation for suitability to irrigated farming reveled that only 2160 ha (3.86% of the total area) were suitable for irrigation. The soils are very light textured (80%-90% sand) and consequently they have high infiltration rates. Their chemical fertility is low. They are covered with various sizes of gravel, stones and boulders. However after the proposed amelioration treatments are performed these soils would have a potential crop suitability rating of CS1 i.e. suited for all crops. The remaining area have serious development limitations the most important of which are accessibility to the water source and high elevation imposing extremely high pumping heads. These results are evidence of scarcity of suitable irrigable land in the project area.

06 The suitable land is composed of seven locations scattered all the way from Noordoewer settlement the southern part Of Aussenkehr Farm. The scatter of suitable soils does not permit the adoption of the previously conceived gravity irrigation system which depends on building a dam upstream of Noordoewer and constructing a unified irrigation system for an approximate area of 8000 ha. Such an area was estimated on the bases of localized soil surveys which did not cover the whole project area. According to this concept Namibia could store its own water requirement from the Orange River.

07 The most feasible way to irrigate the suitable locations is to group them into three independent irrigation units abstracting water directly from the Orange River. In this case Namibia must rely on the controlled flows of the river and in consequence it must reach an agreement with RSA to ensure adequate flows for the project. The three irrigation units area:

a) The Noordoewer State Irrigation Unit: this site is composed of three suitable locations of gross areas 390 ha, 192 ha and 286 ha giving a total gross area of 868 ha on state land. This sit e could be irrigated from a pump station about 6 km downstream of Noordoewer Bridge. The net irrigable area is 720 ha.

b) The Tandjieskoppe State Irrigation Unit: The site is composed of two locations, one with a gross area of 102 ha and the other 242 ha total area 344 ha on State land). The two location are amenable to combining into one irrigation unit which has an access to the Orange River at a point 12 km downstream of Noordoewer Bridge. The net irrigable area is 320 ha.

c) Aussenker Irrigation Unit: this unit is composed of one relatively large location of 948 ha on privately owned land inside Auuenkehr Farm. Irrigation water could be provided from a pump site about 25 km downstream of Noordoewer Bridge. The net irrigable area is 760 ha.

Availability of Water:

08 The quality of the Orange River water is classified as C2-S1; medium salinity and low sodium content. This classification indicates that the water is suitable for almost all soils and crops except those sensitive to salinity.

09 Currently Namibia has no agreement with the Republic of South Africa (RSA) regarding the apportionment of the Orange River water. However, it is generally assumed by the two countries that the historic entitlement of Namibia from the Orange River is 50 million m3/a. this portion is defined as:

> "the share of the Orange River System, as it exists today, to which Namibia has a rightful access, based on historical events, without having prior consultation or permission from other party to utilize the water."

10 In essence, Namibia can abstract up to 50 million m^3/a according to its own will and free of any charges. To ensure additional quantities of water RSA is asking for a price to be paid by Namibia. Both the additional quantities to be ensured to Namibia and their price are currently negotiated.

11 Abstraction of water from the Orange River is subject to allocation and issue of permits by the Department of Water Affairs of the Ministry of Agriculture , Water and Rural Development (MAWRD). By September 1998 approved permit allocations for all types of uses amounted to 48,58 million m^3/a free of charge and 22.88 million m^3/a at cost. However in September 1998 the estimated water use from the Orange River was 23.25 million m^3/a. since then new land has been developed for irrigation. This situation indicates that availability of water to the project is not guaranteed. Nevertheless the Consultant was informed by the Technical Committee on Irrigation to assume that irrigation water would be made available to the project.

Availability of Land

12 State land is available for the development of gross area of 1212 ha in Noordoewer and Tanjdieskoppe State Irrigation Units. A gross area of 948 ha currently privately owned would have to be purchased by the Government. In addition about 6 ha of land required for the 3 pump sites and main pipelines must be purchased by the Government.

Population

13 Population in the project area is concentrated in Noordoewer settlement and in Aussenkehr labor camps; the respective number are 2000 and 1000 most other farms have small labor camps. The characteristics of the population were determined

The Project

14 A net area of 1800 ha will be developed for irrigated farming o f a high value tree and seasonal crops. The project is based on the concept of full cost recovery of development expenditure and beneficiary self management. The beneficiaries are small holders (4 ha farms) and medium scale- farms (40 ha farms) who would share the farm equally and Tandjieskoppe State Irrigation Units). These two units would accommodate 130 smallholders and 13 medium-scale farmers. The Government would undertake the development of 720 ha in Noordoewer State Irrigation unit and 320 ha in Tnadjieskoppe irrigation unit. Including construction of the whole irrigation system, land amelioration building houses for farmers and trellises for grapes as a long term loan to be retrieved over the project life of 25 years. The development of Aussenkehr irrigation unit would be based on both Government and entrepreneur participation. The farm size is 40 ha and the number of farmers is 19. The Government would purchase the land and construct the main irrigation headwork including the pump station, main pipes sedimentation, balancing, dams and sub-main pipes to farm gates. These cost would be considered as a long term loan to be paid by the farmers over the project life of 25 years. The farmers would undertake to construct on-land irrigation systems, trellises, houses and other buildings.

15 The crops chosen are grapes, dates, mangoes, Lucerne and vegetables (tomato, sweet melon, sweet potato and onion.) Two crop mixes were considered for NSIU and TSIU.

Alternative 1 Crop Mix:

Small Holder (4 ha)

Year 1 - 4 after Planting	**Year 5 After Planting Onwards**
2 ha grapes (50%)	2ha Grapes 50%
1 ha lucerne (25%)	½ ha dates 12.5%
1 ha vegetables (25%)	½ ha Mango (12.5%)
	½ ha vegetables (12.5%)
	½ ha Lucerne(12.5%)

Medium-Scale farmers (40 ha):

20 ha grapes (50%)
8.0 ha dates (20%)
8.0 ha (Mango 20 ha Lucerne) (5%)
2.0 ha Lucerne (5%)
2.0 ha vegetables (5%)

16 The total net irrigable area available on state land which would be allocated equally to small holder and medium scale-farmer is 1040. At project Maruun the total pictured of crop mix in state land would be as follows:

Crop	Area (ha)		Total	
	Smallholder	Medium Scale Farmers	Area (ha)	%
Grapes	260	260	520	50.0
Dates	65	104	169	16.25
Mango	65	104	169	16.25
Lucerne	65	26	91	8.75
Vegetables	65	26	91	8.75
Total	520	520	1040	100.0

17 The proposed crop mix for AIU is 32 ha grapes 80% and 8 ha dates (20%) accordingly net crop areas would be 608 ha grapes and 512 ha dates.

18 In total the crop area for the whole project would be as shown below:

Crop	Area (ha)		Total	
	Smallholder And Medium-Scale farmers	Entrepreneurs Farmers	Area (ha)	%
Grapes	520	608	1128	62.66
Dates	169	152	321	17.83
Mango	169	-	321	9.39
Lucerne	91	-	169	5.06
Vegetables	91	-	91	5.06
Total	**1040**	**760**	**1800**	**100.0**

Alternative 2 Crop Mix:

19 The proposed Alternative 2 Crop Mix for NSIU and TSIU is as follows:

Crop	Smallholder Farm (4 ha)		Medium-Size Farm (40 ha)	
	Area (ha)	%	Area (ha)	%
Grapes	3.2	80.0	32.0	80.0
Mango	0.4	10.0	4.0	10.0
Lucerne	0.2	5.0	2.0	5.0
Vegetables	0.2	5.0	2.0	5.0
Total	**4.0**	**100.0**	**40.0**	**100.0**

Accordingly the crop area in NSIU and TSIU will be as follows:

Crop	Smallholder	Medium-Size Farm	Total
Grapes	416.0	416.0	832.0
Mango	52.0	52.0	104.0
Lucerne	26.0	26.0	52.0
Vegetables	26.2	26.0	52.0
Total	**520.0**	**520.0**	**1040.0**

20 The crop mix for AIU will remain as proposed in Alternative 1 crop mix. Hence at project maturity the crop areas in the whole project will be as follows:

Crop	Area (ha)	%
Grapes	1440	80.00
Dates	152	8.44
Mango	104	5.78
Lucerne	52	2.89
Vegetables	52	2.89
Total	**1800**	**100.0**

21 Crop rotations and cultural practices for each crop were worked out.

22 the irrigation design is based on pump irrigation and pipe conveyance and distribution and sedimentation balancing dams. On land irrigation system would be micro irrigation for grapes dates and mango, sprinkler irrigation for lucerne and drip irrigation for vegetables.

23 Irrigation water demand will differ slightly between the two crop mixes as follows:

Parameter	Alternative 1 Crop Mix	Alternative 2 Crop Mix	Difference %
Maximum Flow rate (m^3/h)			
NSIU	3015	3141	4.18
TSIU	1340	1395	4.10
Total Irrigation Water Requirements (1000 m^3 /year)			
NSIU	12118	12587	3.87
TSIU	5386	5596	3.90
Total Irrigation water Requirement all project Unit same for both crop mixes 1000 m^3 /year	29319	29996	2.31

For the purpose of the study these difference are considered insignificant and the same designs of pumps station main pipes sub-main pipes, dams would be adequate for both crop mixes. The on-land irrigating for each crop would remain the same however du to the different proportions of crops the cost of on-land irrigainot for Alternative 2 crop mix would increase by 60 percent, this increase would be taken into consideration in the financial analyzes.

24 Housing, buildings, vehicles, storage facilities, roads mechanization and energy requirement were determined.

25 project management is based on the management of development works and beneficiaries, managing their own production affairs.

26 Implementation is scheduled for the phases extending over years Phase one will be implemented in the first two years.

27 The financial and economic analyses showed that the project with alternative crop mix is viable for both phase 1 and for the whole project. The financial and economic results are as follows:

Financial Analyses Results:

	Phase 1	**All project**
Financial IRR	18.5%	17.3
Discounted B/C ratio (12% discount)	1.3	1.26
NPV N$ Million	38.3	129.2
Payback period	12.0	15.0

Economic Analyses Results:

	Phase 1	**All project**
Economic RR	19.3%	19.18%
Discounted B/C ratio (12% discount)	1.35	1.26
NPV N$ Million	43.7	176.9

28 The total projects investment costs and working capital with contingencies amount to N$ 408.8 million for the whole project of which phase 1 required N$ 75 million the foreign component requirement of the whole project USD 47.7 million and for phase 1 it is USD 8.9 million.

29 It is e recommended that the Government takes a decision to implement the project. Financing should first be sought to cover the foreign component.

30 Specific issues that need to be addressed and recommendations are given.

ACKNOWLEDGEMENT

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The Consultant wishes to acknowledge the invaluable assistance, so willingly and consistently provided to the study team by the Ministry of Agriculture, Water and Rural Development of Namibia. While this assistance was overwhelming and has emanated from all concerned members of the Ministry, the Consultant would like to acknowledge particularly the Permanent Secretary for approving the attachment of Mr. T.E. Basson to the study team ; Mr. T. E. Basson for his able and willing contribution to the engineering aspects of the study; Mr. K. Kahuure (Chairman, Technical Committee on Irrigation) for giving personal and sustained assistance and guidance to the study team ; the Technical Committee on Irrigation for its valuable guidance and encouragement to the team ; the staff of the Directorate of Planning, particularly Mrs. P. Akwenye and Mr. M. Fowler, for looking after the team and for the consistent day-to-day assistance, and help in all matters concerning the study ; and the Deputy Director and staff of the Division of Agricultural Engineering for the unsparing assistance in technical, administrative and service related matters provided to the study team both at the head-office and at the field levels. The Consultant would also like to acknowledge the assistance provided by Mrs. M. Coetzee and the staff of the Agricultural Laboratory for carrying out the soil analyses. The Consultant also acknowledges the active participation of Mr. A. Hauge of the Directorate of Planning, Messrs. J. L. Lepen, J. Moortens and A. Hugo of the Division of Agricultural Engineering.

MAIN REPORT

INTRODUCTION

Arrangements by Which the Study was Carried Out:

01 The Namibian Government requested the Arab Bank for Economic Development in Africa (BADEA) to contribute to financing the feasibility study for the Orange River Irrigation Project in accordance with the Government's letter No. 22/15/1/3/1/20 dated 11th April 1995. BADEA informed the Namibian Government by BADEA's Telex No. G/965 dated 31.10.1995 that its Board of Directors has agreed to extend technical assistance in the form of a grant to finance the said study. Subsequently, BADEA's letter No. 3813/LAD/560 of 30.11.1995, conveyed to the Namibian Government the detailed terms and conditions of the grant. The Namibian Government accepted the Grant and signed the confirmation form on 27.3.1996.

02 Para 7 (a) of the terms and conditions of the grant stipulates that the Namibian Government shall recruit Arab experts and Arab or African or Arab-African consulting firms according to a procedure acceptable to BADEA. Both the Government of Namibia and BADEA agreed to entrust the study to the Arab Organization for Agricultural Development (AOAD), based at Khartoum, as Consultant.

03 The Permanent Secretary, Ministry of Agriculture, Water and Rural Development (MAWRD) Namibia, addressed AOAD by his letter No. 22/P of 13th August, 1997, expressing the Ministry's readiness to negotiate a draft contract for carrying out of the feasibility study. Representatives of the Consultant visited Namibia twice, the first visit was during the period 2 to 5 Nov. 1997 and the second was during the period 14 to 25 March 1998. In both events discussions took place between the Consultant's representatives and the concerned staff of the MAWRD regarding the project area, the terms of reference of the study and the terms and conditions of the draft Agreement to be entered into between the two parties.

04 The Consultant provided the MAWRD with the CVS of alternative experts from which those most suitable were selected. After approval by BADEA, the two parties signed the study agreement on 2.10.1998; which is entitled:

MEMORANDOM OF AGREEMENT

entered into between

THE MINISTRY OF AGRICULTURE, WATER & RURAL DEVELOPMENT

AND

THE ARAB ORGANIZATION FOR AGRICULTURAL DEVELOPMENT

FOR

CARRYING OUT A TECHNICAL AND ECONOMIC FEASIBILITY STUDY OF

THE TANDJIESKOPPE IRRIGATION PROJECT

05 Item 4 of the terms of reference (Appendix 1) specifies the issues to be studied and the format in which the study report should be structured. The main directive given is: "While only a summary description is required of each component in the main text of the feasibility study report, this will be derived from more detailed specifications and estimates given in the annexes, to which reference should be made". The Consultant was also encouraged to elaborate on any additional issues which are not mentioned in the specified format of the report, but which he feels may be of importance to the Government. The Consultant has, therefore, prepared this study report in conformity with the directives of the terms of reference.

The Origins of the Project:

06 In order to realize a number of objectives laid down for the agricultural sector in the First National Development Plan (NDP1), in particular the need for national food security and the diversification of agricultural production, the Government wishes to embark on a program of increasing crop production in the country by significantly expanding the area under irrigation. To this end, a Technical Committee on Irrigation (TCI) was set up in early 1997 in the MAWRD. In addition to technicians from a number of the directorates of the Department of Agriculture and Rural Development (DARD) , the TCI includes specialists from the Namibian Agronomic Board, the National Planning Commission and the Namibian Development Corporation.

07 The first exercise undertaken by the TCI was to investigate the potential of all the possible areas in the country, which can be irrigated and to provide a ranking of those areas which appeared (from a superficial review), to have the greatest potential. One of the high potential areas thus identified is the land bordering the Orange River in Karas Region along the country's southern border.

08 Prior to the setting up of the TCI, a study was made and a report was prepared entitled "Identification and Prioritization of Irrigation Development Opportunities on the Orange River; Report No. 2010 - 03, March 1994". The main objectives of the study were to identify and give priority to areas larger than 30 ha (warranting government concern), which have the greatest potential for development and to establish the quantity of water needed from the Orange River for irrigation in Namibia. The study area covered the part of the Karas Region, stretching along the Orange River, from 20^{o} longitude in the east over a distance of almost 600 km to the west where the river discharges into the ocean at Oranjemund.

09 The study identified eight projects as having development potential, which are, in order of increasing capital requirement, as follows:

- Khaais ; 62 ha.
- Haakiedoorn/Ramansdrif ; 1 300 ha.
- Noordoewer ; 520 ha above the existing irrigation canal.

- Daberas ; 371 ha.
- Hohenfels ; 56 ha.
- Koeskop ; 226 ha.
- Aussenkehr ; 600 ha.
- Tandjieskoppe ; 1 200 ha.

Of the eight identified areas, three fall in the present project area; viz.; Noordoewer, Aussenkehr and Tandjieskoppe.

10 The study concluded that "it would seem logical that development at Noordoewer, or on the Noordoewer - Aussenkehr axis, be considered first, as this will provide the additional injection required by the Orange River region as a whole, for the development of a substantial business and service center, for which the nucleus already exists". The study also gave the following main recommendations :

"The main recommendation of this report is that the GRN should now take an active role in stimulating and facilitating agricultural development along the Orange River. The following will be required:

- Securing water rights through negotiations with the RSA.
- Solicitation of interest from funding organizations for detailed feasibility studies and project implementation.
- Development of infrastructure and policy to enable development on the Orange River and trade over the RSA border.
- Integration of the proposed development projects into the national crop production and food security program of Namibia."

11 The Namibian Government's active involvement in the development of the Orange River started with the establishment of the Government Farm in Aussenkehr, which was developed in collaboration with the Chinese Government. Concurrently the interest of BADEA was solicited to finance this feasibility study. Negotiations with the Republic of South Africa (RSA) are on-going with regard to securing water-rights from the Orange River.

12 A project profile was prepared by MAWRD, Division of Agricultural Engineering for the "Noordoewer - Aussenkehr Irrigation Development Project". The project targets the development of 8 000 ha stretching from the existing irrigation scheme at Noordoewer up to Aussenkehr irrigation development. The development concept was based on the establishment of 2 000 small sustainable farming units for settlement of a similar number of small farmers who would be primarily engaged in the production of irrigated grapes. Irrigation water was envisaged to be provided by the construction of a storage dam in the Orange River and a distribution system of canal / pipe over a distance of approximately 60 km. In addition, the project concept included a soil survey and land evaluation, erection of buildings and facilities for agricultural activities as well as for social, health and educational requirements and provision of agricultural machinery.

The Study Team and Participation of Government Agencies:

13 The study team that participated in carrying out the study is composed of AOAD experts as well as Namibian staff as shown below:

AOAD Experts:

- Team Leader/Agronomist; Dr. K.A. Agabawi.
- Soil scientist / Land Use Planning; Dr. O. A. El Tom.
- Rural Sociologist / Socio-Economist; Dr. M. N. Gamei.
- Agricultural Engineer; Dr. Y. Z. El Shafei.
- Agricultural Economist / Financial Analyst; Dr. M. A. Dingle.

Namibian Expert:

- Agricultural Engineer ; Mr. T. E. Basson

Namibian Counterparts:

- Agricultural Economist; Mr. A. Hange.
- Agricultural Engineers; Messrs. J. L. Lepen, J. Moortens and A. Hugo.

14 Various Namibian Government organs were involved in the study, either directly or indirectly. Obviously MAWRD departments/organs were involved to a greater extent than other Government agencies. The TCI was fully involved with the Consultant through joint meetings and discussions regarding plans of work, discussion of the inception report and the Consultant's proposals and findings. The TCI provided the Consultant with guidance on overall policy issues and on various specific concepts and matters regarding the study. In particular the TCI was helpful in crystallizing the project concept and design, the cropping mix and the settlement pattern. The Chairman of the TCI provided assistance in urgent matters arising between meetings. The staff of the Directorate of Planning was involved in the day-to-day progress of the study and in coordination and liaison between the Consultant and the Namibian Government organs. In addition, the Directorate coopted an agricultural economist to work with the Consultant throughout the study period in Namibia. The Division of Agricultural Engineering provided facilities and personnel who assisted in the demarcation of the project area and in conducting the reconnaissance soil survey. The Division also supported the study team by availing valuable technical information and by the active participation of Mr. Basson in the design of irrigation works and infrastructure. In addition, three of its engineers participated in succession in the demarcation of the project area. The Agricultural Laboratory carried out the soil analyses (at cost) and prepared some of the maps. The Department of Water Affairs was the main source of information regarding water issues.

15 Relevant information was also obtained from the concerned Government agencies including, Ministry of Environment and Tourism, Ministry of Lands, Resettlement and Rehabilitation, National Development Corporation, Namibian Agronomic Board, Agribank, Social Sciences Department of University of Namibia, the Weather Bureau and the Office of the Surveyer General.

Financing Body :

16 The study was financed by the Arab Bank for Economic Development in Africa (BADEA)

17 The Bank was established pursuant to the decision of the VIth Arab Summit Conference at Algiers (28th November, 1973). The Bank began operations in March 1975. Its headquarters are established in Khartoum, the capital of the Republic of the Sudan. The Bank is a financial institution funded by the Governments of the Member States of the League of Arab States, which signed the Establishing Agreement (18th, February, 1974) . The Bank is an independent international institution enjoying full international legal status and complete autonomy in administrative and financial matters. It is governed by the provisions of its Establishing Agreement and the principles of international law.

The Bank was created for the purpose of strengthening economic, financial and technical cooperation between Arab and African countries, to make Arab-African solidarity a concrete reality and to base this co-operative venture on foundations of friendship and equality. To this end, the Bank was given a mandate to:

- Assist in financing economic development in non-Arab African countries.
- Stimulate the contribution of Arab capital to African development.
- Help provide the technical assistance required for the development of Africa.

The projects financed by the Bank are of national importance to the beneficiary countries and usually form part of their economic development plans. These projects can also be of a regional character, benefiting several countries simultaneously. BADEA's contribution to the financing of any given project cannot exceed 50% of the total cost of the said project and the amount of financing for the said project could not exceed 15 million U.S. dollars. However, for small projects with total cost not exceeding 10 million U.S. dollars, financing may be increased to 80% of the total cost of such projects. BADEA also provides technical assistance in the form of un-repayable grants.

18 BADEA has provided loans and grants to Namibia as detailed hereunder:

<u>1993:</u>			
- Grant ;	US$	200 000	Support of the Ministry of Finance (Training).
<u>1995:</u>			
- Grant ;	US$	250 000	Feasibility Study, Orange River Irrigation Project (present study).
- Grant ;	US$	150 000	Training of Cadres.
- Loan ;	US$	1 150 000	Human Resources Development, University of Namibia.

1996:			
- Grant ;	US$	300 000	Feasibility Study for Orangemund Road.
- Loan ;	US$	3 000 000	Construction of Windhoek - Aris Road.
1997:			
- Grant ;	US$	190 000	Arab Expert for Ministry of Finance.
Total:			
- Grants ;	US$	1 090 000	
- Loans ;	US$	4 150 000	
- Total ;	US$	5 240 000	

Work Plan and Timetable of the Study:

19 The Agreement between the Client and the Consultant specifies a twelve months period for the completion of the study and submission of the final report. Fieldwork was planned for the first 10 weeks and the rest of the period was to be spent at AOAD Headquarters in Khartoum. The consultancy agreement also specifies that the Consultant shall prepare and submit a Preliminary Report within (six) months of the commencement of the project. The actual implementation of the work plan deserves some elaboration.

20 The study commenced on 11th January 1999 with a team complement of the team leader, the soil scientist / land use planning specialist and the rural sociologist/ socio-economist. The agricultural engineer joined the team on 17th January. The team was warmly welcomed and the Directorate of Planning, MAWRD, provided logistics, facilities and assistance.

21 On 13th January the team met with the staff of the Division of Agricultural Engineering. The team pointed out that the available information on the soils of the project area does not constitute a reliable base upon which an irrigation project could confidently be designed. In order to do justice to the project the team decided to carry out a reconnaissance soil survey covering the whole of the project area . This survey was neither conceived by the Terms of Reference (TOR) nor specified and budgeted in the Agreement. As the project area was not previously demarcated and as precise demarcation is a prerequisite for the survey, it was agreed that the soil scientist together with a technician from the Division of Agricultural Engineering would explore the entire area stretching from Noordoewer to the irrigated development in Aussenkehr Farm and bound on its lower part by the Orange River and on its higher part by contour line 350 m a.s.l. i.e. an approximate area of 14 000 ha. The team was also informed that irrigation water would be provided at a certain point, e.g. the head of the irrigation system, at a fixed price to be given to the team at a later date. Hence the irrigation study would concentrate on downstream of that point.

22 The study team met with the TCI on 18th January 1999 and two main issues pertaining to the plan of work were discussed and decided upon. First ; regarding the irrigation water, it was pointed out that "the question of water availability is currently under negotiation with neighboring countries. As yet there is no treaty. However, as

far as the project is concerned water will be available at a fixed price in a specified point. The study team will be provided with the price of water to use for the purpose of the study at a later date". Second; regarding the project area, it was decided that "the project area is at present to be as outlined in the terms of reference, i.e. the area lying downstream and northwards of the settlement of Noordoewer as far as the current irrigation development on Aussenkehr Farm (No. 147). Soil survey should first cover this area. A meeting would be held to discuss the preliminary findings of the soil survey regarding the size of the area judged to be suitable for irrigated agriculture. The need, or otherwise, to extend the area under investigation would then be decided". The TCI also directed that, "in general, subsidies for settlers should be excluded. However, the study team can give proposals as to how much the Government should pay and whether it is realistic for the government to make such a payment".

23 By 3rd February 1999, the soil survey revealed that only 770 ha of the surveyed area is potentially suitable for irrigated farming and that the percentage of suitable land is likely to increase towards and including Aussenkehr Farm. The TCI requested the Consultant to extend the soil survey to the northern boundary of Aussenkehr Farm in an effort to identify additional suitable land for development, the target being about 5 000 ha. The Consultant agreed to concur with the TCI request at no additional cost. The total area actually covered by the soil survey amounted to 55 976 ha and an area of 5 978 ha of deep soils, which are suitable for tree crops, was identified by the end of March 1999. This area was subsequently evaluated with respect to its suitability for the development of irrigated farming as part of the proposed project. Only 2 160 ha (3.86% of the surveyed area) were identified as currently suitable for the proposed development project. In addition, the original concept of building a dam and irrigating land from one point at a fixed price was found to be not feasible and alternative irrigation systems must be investigated. According to the findings the Consultants suggested and the TCI agreed that the project should be based on three separate locations and that each location should have a separate system for abstraction and distribution of irrigation water.

24 The above mentioned findings were very crucial for the study, but the time taken to reach them was much longer than was originally conceived. Delay in identifying the location of the land for the project has contributed substantially to throwing the whole work plan out of schedule. The consultant was much concerned about the upset for the work plan to which he has drawn attention in Chapter VI para 7 of the Inception Report in the following manner:

> "Due to the nature of soils, the difficulty of carrying out soil surveys and the time taken to arrive at reliable results regarding the size and location of suitable soils, the study team, in hindsight, has discovered that the soil survey should have been started much earlier and completed before the arrival of other team members. Indeed the team would like to recommend that it would be more cost-effective to the Namibian Government to carry out the reconnaissance soil survey for other identified locations along the Orange River before deciding to carry out detailed feasibility studies".

Report Structure:

25 This feasibility study report is composed of a main report providing a synopsis of the essential elements of the study and highlighting the main conclusions and recommendations. The text of the main report is a summary description of each component, which has been derived from more detailed specifications, discussion, proposals and recommendations contained in the annexes. Each major component is dedicated a separate annex as shown below:

- Annex I ; Reconnaissance Soil Survey ; Volumes I and II.
- Annex II ; Agronomy.
- Annex III ; Socio-Economic Aspects.
- Annex IV ; Irrigation and Infrastructure.
- Annex V ; Economic Aspects .
- Annex VI ; The Project Financial Viability and Economic Justification.

26 Though an integral part of one feasibility study, each annex is written to provide a fairly comprehensive document that could almost stand on its own in so far as it treats a specific topic in relation to the project. In pursuit of this comprehensiveness of individual documents, some overlap in basic issues was inevitable.

CHAPTER I

BACKGROUND OF THE NATIONAL CONTEXT

CHAPTER I- BACKGROUND OF THE NATIONAL CONTEXT

A: GENERAL

Geography:

01 The Republic of Namibia is a vast country on the southwestern coast of Africa. Its land area is 824 290 km^2. It is bordered by Botswana and Zimbabwe in the east, Angola and Zambia in the north, South Africa in the south and the Atlantic Ocean in the west. The 80 to 110 km - wide Namib Desert extends along the entire coastline and a plateau ranging in altitude from 1 000 to 2 000 m covers the central part of the interior. The country's high point, Brandberg, rises to 2 573 m a.s.l. To the east, are low-lying extensions of the Kalahari and the Karoo Deserts. The perennial rivers are confined to the borders; the Orange River in the south and the Kunene, Kavango, Zambezi and Kivando-Linyanti rivers in the north.

Water Resources:

02 The Republic of Namibia is the driest in Sub-Saharan Africa with low rainfall, which is erratic and characterized by a high level of inter- and intra-seasonal variability. Over the north and northwestern parts of the country a semi-humid climate prevails which merges into a semi-arid climate that in turn gradually merges into an arid to very arid (desert) climate towards the south and west. The spatial distribution of rainfall is such that total annual rainfall is adequate for seasonal cropping in a relatively small area in the north and northeast. Areas in the center and south receive decreasing amounts of rainfall only sufficient for the growth of natural range vegetation. The ground coverage of the vegetation, its intensity and carrying capacity decrease as one proceeds from north to south where it ultimately becomes limited to depressions and water courses that support drought tolerant plant species.

03 Perennial rivers are confined to the northern and southern boundaries of the country, which are remote from the main centers of demand. This means that the only areas with a high potential for large-scale irrigation are located immediately adjacent to the Orange, Kavango and Zambezi rivers. The use, which Namibia makes of the water from these rivers, is subject to agreements with its neighboring states. However, the country is covered with ephemeral rivers, streams and watercourses that flow only after heavy rain has fallen in their catchment area. Because of their seasonal nature, such rivers require the construction of storage dams before they could be utilized for perennial irrigation. Some of the smaller runoff is held back by various types of structures to provide temporary water supply on a small scale for farmers and on a relatively large scale for urban areas.

04. Groundwater is available in most parts of Namibia and approximately two-thirds of the population rely on it as the main source of domestic water supplies. Some of this water is affected by high salinity. Groundwater resources are usually not available in quantities and/or quality which permit its use for irrigated farming. According to the First National Development Plan, groundwater is heavily exploited and is being dangerously depleted.

Soil and Land Resources:

05 The soil potential of Namibia is limited, for the bulk of the soils is sandy, stony and shallow with low clay and organic matter contents, hence with low water holding capacity. In addition, they have low plant nutrient content, which dictates substantial fertilizer application for satisfactory crop production. All these characteristics add up to classify the soil as having low crop suitability for arable farming. Consequently the Namibian land resource base has only a limited potential for arable farming.

06 Due to inadequate rainfall, low suitability of soils for crops and limitations regarding irrigation water supply the agricultural resource base of Namibia is limited.

Population:

07 Although Namibia is one of the most sparsely populated countries in Africa, it has a diverse population. Its eleven ethnic groups are, in order of size : the Ovambo (who live primarily in the north and constitute nearly 50% of the total population), the Kavango, whites (mainly persons of South African and German origin), Herero, Damara, Nama, Coloreds, Capriviani, San, Basters, and Tswana. Most of the people live in the north, where they are engaged in subsistence agriculture. Many Ovambo men are employed as migrant laborers in white-owned farms to the south and in mines.

08 According to 1991 census, the population of Namibia was 1.4 million; it was 1.6 million in 1993, and presently, in 1999 the population is estimated at 1.7 million. Population density is 1.9 persons per km^2. The population was 33% urban and 67% rural as of 1993. Two years earlier, i.e. in 1991 census, the corresponding figures were 28% urban and 72% rural. This clearly illustrates rural drift, that is, rural to urban migration. The annual growth rate was estimated at 3.1% in 1993. Adult literacy is 51% and life expectancy is 51 years.

09 The Namibian population is characterized by certain features that have relevance to the development process, the most important of which are the following: (for details refer to Annex III, Chapter II).

- The young nature of Namibians, particularly the ruralites.
- Ruralites are significantly less educated than urbanites, but with no gender bias against females.
- Proportion of female - headed households is relatively high
- Infant mortality and child mortality are high particularly in rural areas.
- Human development index is 0.7; Namibia ranks 79^{th} out of 174 countries with respect to income per capita and 117^{th} in terms of human development index in the 1996 UN Human Development Index.
- Poverty and inequality are extreme characteristics; the Gini coefficient for Namibia is 0.7 indicating extremes of wealth amongst the population.

The Economy :

10 The Namibian economy is based on mineral exports - gem quality diamonds and base metals - and agriculture and fisheries products. The GDP has been growing at an average rate of 3.5% per year since 1990. This performance is impressive given the low level of investments during the 1980s and the uncertainty that usually accompanies the transition from a long colonial era to independence. The most recent economic indicators as shown by the African Development Report (1999) of the African Development Bank are as follows:

– Gross Domestic Product at Constant 1990 Prices**	USD Million	3295.00
– Gross Domestic Product at Current Prices**	USD Million	3115.00
– Gross National Savings**	(% of GDP)	25.50
– Gross National Investment**	(% of GDP)	21.10
– Terms of Trades**	(1990 = 100%)	96.20
– Current Account**	(% of GDP)	6.40
– Broad Money Supply**	(Annual Change %)	20.30
– International Reserves**	USD Million	234.90
– Consumer Price Indices**	(1990 = 100)	214.90
– Overall Government Deficit**	(% of GDP)	-4.90
– Total External Debt*	USD Million	343.40
– Total Debt Service*	USD Million	212.20
– Labor Force by Sector (%) (1996)		
Agriculture		40.00
Industry		37.00
Services		23.00
– Total; Labor Force %(1994)		
Total		41.40
Female		16.80
Male		24.60
– Population with Access to Infrastructure % (1994/95)		
Sanitation		34.00
Safe water		57.00
Health services		59.00

Note:
* 1997
** 1998

11 The above indicators show that Namibia has a positive national savings-investment balance, but investment lags behind savings. This gap is a major concern of the Government. Both public and private investments will be essential to complement each other for effective rural development.

12 Land and other resources are inequitably distributed, which is clearly reflected in a substantial disparity in incomes. While the average per-capita income of the population is USD 1 832, that of the richest 5% is USD 16 500 and of the poorest 55% is USD 63. The richest 5% of the population contribute 71% of the GDP and the poorest 55% account for merely 3%.

13 The Namibian dollar was introduced in September 1993 and is linked to the South African Rand on one-to-one basis. The Republic of South Africa (RSA) is the chief trading partner of Namibia. Imports from RSA constitute nearly 90% of the total Namibian imports. However, export destinations are more diversified and benefit from the preferential access to European markets according to the Lomé Convention.

14 The inflation rate has dropped from 18% in 1992 to single digit figures, i.e. 8.0% in 1996, 8.82% in 1997.

15 It is worth noting that sub-sectors as fishing and fish processing, construction and public sector have shown positive growth in employment. In other sectors of the economy formal employment has either fallen, as in mining, or risen only marginally, as in service sectors. A particular factor, which has slowed the creation of jobs, has been the continued bias of the Namibian economy towards capital intensive enterprises. The Government has introduced policies to encourage substituting labor for capital by shifting investment to construction and industry and later to irrigated agriculture.

16 Economic activities are predominantly of private initiative in most sectors of the economy. Water, electricity and communications, which were previously provided by the public sector, have recently been privatized. However, the Government is committed to rural development, which features significantly in the Government budget.

17 Economic diversification is expanding, but with a slow pace in the labor extensive sector. However, there are signs of improvement resulting from the conducive investment environment, which has recently been created. The Government has started to use economic incentives, such as lowering taxes for national and foreign companies and individuals to improve the investment climate. Moreover, the Government offers special guarantees for investment. These guarantees focus on two principal concerns ; security of title, and guarantees for the availability of foreign exchange to meet essential investors' requirements. The Investment Code sets out undertakings to ensure that foreign exchange will be freely available. Such an encouraging investment climate is supported by signals of macro-economic stability which maintain the inflation rate within reasonable limits.

B: THE AGRICULTURAL SECTOR

Contribution of Agriculture to the National Economy:

18 Since independence the share of agriculture in GDP has fluctuated from a high of 12.3% in 1990 to a low of 6.6% in 1992. In 1996, the share of each of mining and manufacturing in GDP was 15.1% and 11.7% respectively compared to 9.7% for agriculture. The GDP in 1996 was N$ 8 226 million with per capita GDP N$ 5 007.

19 Within the agricultural sector, the share of the commercial sector was larger than that of the subsistence sector (3.7% and 2.8%, respectively, in 1997.) The share of tertiary industries (47.7% in 1997) was higher than that of primary and secondary industries combined. However, if meat processing is included in the agricultural sector, then in 1997, sequentially agriculture was the fifth most important sector in the economy following government services, manufacturing, mining and quarrying, and finance sectors[1].

20 Agriculture contributes more than 8% to the overall economic activity. However, agriculture's contribution to rural livelihood, particularly in the communal tenure areas, is much more than this figure might suggest. Subsistence farming provides the principal source of food for humans, grazing for animals and income for 41% of all households in the country. The sector is the main source of employment for the population with an estimated 70% of the population depending directly or indirectly on it. Furthermore, the private farms employ approximately 36 000 workers, representing some 13% of those employed in the rural areas, according to the First National Development Plan (NDP1), 1995.

Government Policies and Development Priorities:

21 The Government strategies defining the means by which its policies are to be implemented are stated in the NDP1 as follows:

- The strengthening and re-alignment of agricultural services - extension, research and animal health-towards the communal-tenure areas.
- The continuous upgrading of human resource capabilities at all levels in the sector.
- Privatizing/commercializing the provision of those agricultural services which can be more effectively supplied by the private sector.
- The phasing out of subsidies as rapidly as sensible.
- The expansion and strengthening of a well-managed network of cooperatives.

[1]For more details, please see: Ministry of Agriculture, Water and Rural Development. Agricultural Statistics Bulletin, Directorate of Planning, Windhoek, August, 1998.

- The support for the provision of agricultural finance for financially sound agricultural enterprises of communal-tenure farmers.
- The explicit incorporation of poverty reduction, employment creation, gender and environmental considerations into the planning and implementation of all development interventions in the sector.
- Support for the diversification of both farming enterprises and markets.
- The creation of an enabling environment in the sector, so that the rural people are able to fulfil their economic, social and human potential. Thus, the role of the Government in the sector is seen as being one of facilitating and complementing the workings of the private sector and non-government agencies.

22 Further policy directions that are going to be vigorously pursued in connection with the above strategies, are clearly elaborated in the National Agricultural Policy as follows:

- The Government is to pursue a policy of expanded diversified product base oriented towards export. It has to rely on market forces to determine the direction of diversification.
- The Government is to invest in infrastructure, institutions and human capital to encourage private sector contribution. Irrigation schemes offer potential for the production of high value crops based on high financial returns and sound environmental principles.
- The Government will encourage the participation of the private sector and NGOs in the provision of human resource development programs which serve rural communities.
- The Government will remove unnecessary barriers to the development of informal sector activities by relaxing or modifying restrictive regulations on small businesses and services as far as they relate to the agricultural sector.
- The Government will encourage investments, which promote the expansion of value-added enterprises. Agro-processing enterprises will be promoted, such as tomato paste production and feed milling. At community and household levels, efforts will focus on promoting improved techniques for small-scale storage and processing of local food supplies.
- Subsidies that distort the prices of farm inputs and outputs and discourage private sector investment and participation will be phased out. They will only be used to achieve social objectives and will be budgeted and accounted for in a transparent manner. Setting up loan guarantees and new financial arrangements to cushion farming risks and uncertainties could be one choice. The limited subsidized credit scheme under the National Agricultural Credit Programme could be a good example to follow. The scheme is designed to address the need for financing investments in farming, agro-processing and other agriculture related investment opportunities.

23 The general Government national objectives that highlight its commitment to rural development as detailed in NDP1 include the following:

- Employment creation.
- Diversification of the agriculture economic base as a drought proofing mechanism with attention paid to developing agro-industrial ventures.
- Providing livelihood for the growing rural population.
- Checking rural to urban migration.
- Reducing poverty levels.
- Land reform, as Government will undertake land reform on the basis of the Commercial Agriculture Land Act 1995. The aim of such legislation is to provide land to poor landless families without jeopardizing productivity. N$100 million has been allocated during the course of NDP1 to assist in carrying out the land reform program.

24 In addition to the preceding items, Article 139 of the National Agricultural Policy was addressed directly to irrigation schemes as follows:

> "Large scale irrigation systems depending on pumped water are usually costly undertakings that generally require high levels of subsidization. Experience in other African countries indicates that large-scale pumped irrigation has not been a cost-effective way of providing employment and incomes for rural families. Low-cost small-scale irrigation, using appropriate technologies, holds greater promise. The government will therefore encourage the use of cost-efficient irrigation methods that use low volumes of water to maximum effect, coupled with a pricing policy based on the scarcity of water and the long-term environmental sustainability. Public investment in irrigation for poor and food-insecure farmers may be provided when economically and socially justified. The use of cost-effective and low-cost irrigation methods, such as, but not limited to, community-based mini-dams or catchment basins for water harvesting and micro-irrigation techniques including drip irrigation-cum-mulching methods, will be encouraged through investment incentives"

25 Article 140 of the policy document spells out the broad policy and strategic guideline for irrigation development as follows:

- Minimizing direct Government intervention in irrigation schemes by encouraging private sector involvement, and by promoting the principle that water users themselves should pay for the operation and maintenance of irrigation schemes.
- Increasing the participation of women and unemployed rural youth in irrigated agriculture.
- Providing research, training and extension services to farmers using irrigation ;
- Minimizing adverse public health consequences which arise from irrigation development.

- Training of planners and irrigation engineers to plan and implement irrigation projects.
- Creation of greater field stability and adapt the system to regular supplies of high value horticultural products to local and external markets.
- Providing the small-scale farmers with the opportunity to participate in planning, financing, implementing, operating and maintaining irrigation systems as well as adoption of simple organization and management methods.

26 The Government is anxious to see agricultural production expand and for the production base to be diversified in order to reduce vulnerability to the vagaries of the local, regional and international markets. At the same time, the government is keen for the agricultural sector to provide livelihood for the rapidly-growing rural population, apart from anything else, so as to ensure that the current high levels of migration from the rural areas are reduced to a minimum. It recognizes as one of its guiding principles that a healthy agricultural sector will also have a beneficial impact on reducing poverty levels, which are significantly above average in the rural areas. In particular the Government wishes to embark on a program of increasing crop production by significantly expanding the area under irrigation. Such a program will contribute significantly towards employment creation, which is one of the objectives of the Government, as detailed in NDPI.

27 The development of this project area is in line with the Government policies and priorities and satisfies a number of Government objectives. The availability of a perennial source of irrigation water coupled with a favorable climate and suitable soils permit the expansion of irrigated agriculture and the diversification of agricultural production through high value export crops. Such a development would contribute significantly to employment creation, attract population to rural area, provide livelihood and reduces poverty for an increasing number of the unemployed.

CHAPTER II

BACKGROUND OF THE PROJECT AREA

CHAPTER II - BACKGROUND OF THE PROJECT AREA

A: LOCATION

01 According the Terms of Reference (TOR), the project area was defined as "the area lying downstream and northwards of the settlement of Noordoewer as far as the current irrigation development on Aussenkehr Farm (Number 147)". This definition specifies the length of the project area (about 25 km) along the Orange River, but it ignores the width, i.e. how far the project area extends away from the river. As stated earlier, it was agreed that the study would investigate all the area bound by the Orange River and contour 350 m a.s.l. throughout the specified length. As the soil survey progressed, it was evident that the areas suitable for irrigated farming are much smaller than was anticipated. The Client requested the Consultant to extend the project area to include all the area in Aussenkehr Farm lying below contour line 350 m a.s.l. This area stretches 65 km along the Orange River.

02 The Consultant demarcated the project area as requested by the Client and found that it is encompassed between longitudeS 17°: 20' E to 17 ° 42' E and latitudes 28° : 15' S and 28° : 45' S and stretches along the Namibian bank of the Orange River to contour 350 m a.s.l., excluding the irrigated development in Noordoewer settlement and on Aussenkehr Farm. Appendix Figure (II.l) is a location map of the study area marked in a map of Namibia and Appendix Figure (II.2) is a satellite image including the project area. The total area actually covered by the study is 55 976 ha.

B: PHYSICAL FEATURES

03 The project area is generally characterized by extensive mountains, hills, rock outcrops and severely dissected terrain resulting from run-off rain water. Areas of relatively flat land exist in between the rugged terrain. These areas are invariably covered with boulders, stones and gravel of various sizes. The general view of the surface and its color tone are indicative of a mosaic of soils and land types. The Orange River is deeply incising the mountainous and rugged terrain forming strips of alluvium near its course. The area above contour 350 m a.s.l. is predominantly mountainous with no flat patches.

C: NATURAL RESOURCES

General:

04 The project area has attracted much interest with regard to diamond prospecting and mining. This is evidenced by a number of exhausted mines (now closed) and by the fact that Aussenkehr Farm itself was previously owned by a mining company and that currently there is a dispute over part of the farm between the farm owner and a mining company.

Agricultural Resources:

05 Apart from a narrow strip of alluvium in Noordoewer and small areas in Aussenkehr Farm, agriculture did not attract much interest neither in the project area nor in its vicinity. This is attributed mainly to the scarcity of agricultural resources and the harshness of the environment. Soils, which are suitable for intensive farming, are scarce. The arid climate and the very small annual precipitation cannot support rain-fed farming nor induce the growth of natural vegetation for grazing. Irrigation water is available from the Orange River, but its utilization is constrained mainly by the scarcity of suitable land lying on reasonably low elevations. In addition, abstraction of irrigation water is still subject to negotiation with the RSA. Nevertheless a reasonable potential for the development of irrigated agriculture exists in the project area.

Climate:

06 The project area has no meteorological station to provide long-term records of climatic data. The only climatic data available for the project area are those collected by the Aussenkehr Government Farm for the year 1998, and are included in Table (II-1). However, climatic data for one year do not tell the true story of the climate; neither do they reflect the annual variations that are apt to occur over time. Due to this deficiency, resort was made to long-term records from the nearest meteorological stations for use as indicators of the climatic conditions that could be expected to prevail in the project area. Hence climatic data were obtained for Warmbad, east-north east, Keetmanshoop, north, Alexander Bay, west, and Goodhouse, east. In addition, results of previous efforts made to estimate the distribution of mean annual rainfall and evaporation as measured by Class A- Evaporation Pan for Aussenkehr, Tandjieskoppe and Noordoewer were collected and used for the purpose of this study; for details please refer to Annex II, Chapter II.

07 Drawing from the climatological data of the project area and the nearest weather stations, the climate of the project area can be described as dry hot climate, typical of sub-tropical regions. The significance of this type of climate to crop production is best illustrated by indicating the effects of the available major climatic parameters, namely temperature, rainfall and evaporation, on irrigated crop production:-

a) Temperature:

The thermal regime shows two extreme seasons and two transitional seasons. A relatively cool season prevails in May to August when mean monthly minimum temperatures fall below 10 °C and frost could occur in some days; and a very hot season occurs during November to February when mean monthly maximum temperatures rise to 38 °C. Absolute daily maximum temperatures can rise up to 47 °C. A transitional thermal regime prevails in the months of September and October, before the summer, and in the months of March and April, before the winter. This thermal regime is viewed as a valuable climatic resource for crop production where irrigation water is available to permit year-round cropping. The very hot and transitional

Table (II-1)

Climatological Data for Government Farm - Aussenkehr, 1998

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year		
Month	1	2	3	4	5	6	7	8	9	10	11	12			
Avg Temperature	29.1	29.3	28.7	26.5	21.2	17.3	17.0	15.6	22.3	24.4	26.2	28.4	23.8	°C	Average
Avg Humidity	41.2	44.2	42.7	38.1	42.4	39.0	50.2	41.9	42.2	41.5	39.7	43.5	42.2	%	Average
Avg Soil Temp	NA	26.8	36.5	33.0	27.4	22.8	21.7	18.9	28.0	31.6	34.6	37.6	26.6	°C	Average
Avg Soil Moisture	NA	2.4	1.9	2.8	2.2	1.7	1.7	2.5	9.1	7.9	7.6	6.7	3.9	N/A	Average
Avg Wind Speed	NA	2.7	3.4	3.0	2.9	2.3	2.9	3.3	3.7	3.7	3.8	3.8	3.0	m/sec	Average
Max Wind Gust	NA	9.9	9.5	10.8	8.4	6.8	8.3	9.0	10.6	11.4	10.4	9.4	11.4	m/sec	Maximum
Avg Maximum	38.4	40.5	38.5	35.7	29.4	26.1	24.9	24.0	31.0	34.1	36.2	38.7	33.1	°C	Average
Avg Minimum	21.2	22.4	20.8	18.5	14.1	8.8	9.8	8.7	14.8	16.4	17.5	19.7	16.1	°C	Average
Total Rain	0	0	8.4	0	0	0	0.2	1.4	4	2.4	0.2	0	16.6	mm	Total
Prev Wind Direction	30	30	90	60	60	60	60	60	90	60	21	30	60.0	degrees	Mode
Highest Maximum	44.1	47.1	46.4	42.0	36.7	30.5	34.5	34.0	41.3	42.3	47.0	44.3	47.1	°C	Maximum
Lowest Minimum	14.7	17.3	17.0	13.7	11.0	6.3	5.3	-0.4	8.3	10.1	10.7	16.1	-0.4	°C	Minimum

Source: Aussenkehr Government Farm.

months suit a wide range of warm-weather crops; the cool and transitional months suit a wide range of cool-weather crops and the combination of cool, transitional and very hot months over the year suit perennial and semi-perennial crops which require and/or which can thrive under different thermal conditions. It is almost ideal for specific crops which require low temperatures (some form of chilling) for the induction of flowering, moderate temperatures for fruit set and development and high temperatures for fruit ripening. Examples of these specific crops are grapes, citrus, dates and mangoes.

The thermal regime of the project area also offers an almost unlimited opportunity for growing seasonal crops under irrigation in the different seasons. Examples of climatically suitable major field crops are wheat, maize, sorghum, millet, barley, sunflower, cotton and lucerne. Climatically suitable vegetable crops include tomatoes, a wide range of cucurbits, onions, egg plant, peppers, cabbage, cauliflower, garden peas and beans.

The significance of the thermal regime is also manifested in the fact that cool and hot periods occur six months after the occurrence of similar periods in the Northern Hemisphere. This means that ripening of crops in the project area takes place at a time when Northern Hemisphere produce is out of season and supplies to markets depend on Southern Hemisphere produce. The relatively high temperatures in the project area induce many crops to ripen two or three weeks earlier than most Southern Hemisphere countries, thus offering an export market advantage to the project area products. This is particularly true for grapes and dates.

b) Rainfall:

Data regarding precipitation in the project area are lacking. One year (1998) record at the Aussenkehr Government Farm shows that only 16 mm of rain were received in that year. Available isohyet maps made for Namibia show the project area below isohyet 50 mm. Estimates based on records of rainfall at Goodhouse extrapolate total mean annual rainfall at 45 mm at Noordoewer and Tandjieskoppe and 50 mm at Aussenkehr. Precipitation is spread throughout the months of the year with the peak of 10.3 mm to 11.4 mm falling in March. Rainfall at this rate cannot have any contribution nor significance to irrigated crops or rain-fed crop farming. Indeed farmers who were interviewed by the Consultant reported that when rains occur they do so in the form of extremely light showers which do not affect their irrigation schedule. Usually they continue irrigating their crops even during the incidence of showers.

The significance of the low rainfall is that all irrigation water requirement must be provided artificially, hence increasing capital costs as well as annual production costs. On the other hand, the dry conditions are ideally suited to growing dates, which fruits are damaged by rainwater.

c) **Evaporation:**

Class A-Pan evaporation in the project area is estimated to range between 2 780 mm and 2 950 mm per annum. The monthly evaporation figures are closely related to temperatures. The minimum monthly evaporation occurs in June and July; between 129 mm and 154 mm; coinciding with the lowest temperatures. Likewise, the highest monthly evaporation, between 348 mm and 369 mm, occurs in December, which is the hottest month.

The significance of high evaporation rates to crop production is reflected in the need for high irrigation water requirements of all crops. Both the frequency of application and the quantity of irrigation water applied are increased resulting in increased cost of irrigation. In addition, more sophisticated, and consequently more expensive, irrigation methods must be adopted for a cost-effective use of irrigation water.

Soils:

08 Some soil surveys were previously carried out in parts of the project area. However these surveys covered patches of the area between Noordoewer and Aussenkehr Farm and soil suitability ratings did not specifically target deep-rooted tree crops. For the sake of consistency and standardization of land evaluation which are necessary to do justice to a costly irrigation project, which produces long-lived tree crops, a full reconnaissance soil survey was conducted in the whole project area. Details of the survey findings are presented in Annex 1. A summary of the survey is given in the following paragraphs.

09 The soils are covered with gravel and stones on the surface as well as within the calcareous soil profiles. These soils have high pH values, high sand content, poor fertility, low available moisture holding capacity, high infiltration rates and are subject to wind erosion of varying degrees in the different locations.

10 Twelve soil-mapping units with sub-divisions of deep (D), shallow(S) and very shallow (VS) soils were identified and classified according to the American and FAO Systems. The standard land suitability classification was modified to suit the project area's local conditions. Suitability of crops which are proposed for the project was rigorously assessed. Appendix II.1 including 3 maps of the project area illustrates the diversity of the mapping units.

11 The survey identified the following areas with various soil kinds:

5 978 ha (D) (10.68%): of deep soils (61 cm to 150+ cm), which were classified into nine mapping units.

3 801 ha (S) (6.79%): of shallow soils (30 cm - 60 cm), which were classified into three mapping units (S1 to S3).

6 487 ha (VS) (11.59%): of shallow soils (< 30 cm), which were classified into two mapping units (VS1 and VS2).

39 710 ha (M) (70.94%): of non-agricultural land (miscellaneous land types).

12 Land evaluation was made based on the results of the soil survey, topography,

proximity to irrigation water source and other relevant factors prevailing in the surveyed area. The results of land evaluation were used to classify land into various classes according to their current suitability for irrigated production of high value tree and field crops, which are proposed for the project. Land of classes S1 (currently highly suitable land) and S2 (currently moderately suitable land) were not identified by the survey. The following land classes were identified:

Class S3; (2 160 ha; 3.86% of the total land area).

This is currently marginally suitable land consisting of three land sub-classes according to the prevailing limitations in each sub-class. The subclasses and their limitations are;

- S3 mfp: with limitations of: moisture deficiency (m), low fertility (f) and adverse physical condition particularly presence of gravel, stones and boulders (p). The area of this sub-class is 868 ha occurring in four adjacent locations close to Noordoewer settlement.
- S3 mps: with limitations of moisture deficiency, adverse physical condition and salinity (s). The area of this sub-class is 344 ha occurring in two adjacent locations about mid-way between Noordoewer and Aussenkehr Farm, designated the Tandjieskoppe location.
- S3 mfa: with limitations of moisture deficiency, low fertility and sodicity (a). The area of this sub-class is 948 ha in one large location in Aussenkehr Farm.

Class N1; (7 377 ha; 13.18% of the total land area).

This is currently unsuitable land and includes five locations of deep soils with a combined area of 3 576 ha. In addition, all shallow soils (S type); 3 801 ha; were assessed as N1. The major limitations leading to the current unsuitability of land are:

- Sub-class N1 lmf: with severe limitations of distant location from the irrigation source (l), moisture deficiency and low fertility. This sub-class covers an area of 250 ha of deep soils.
- Sub-class N1 tle: with severe limitations of topography (t), distant location from the irrigation source and subject to erosion (e). This sub-class is given to two locations of deep soils with a combined area of 1 538 ha.
- Sub-class N1 lma: with limitations of distant location from the irrigation source, moisture deficiency and sodicity. This sub-class covers an area of 666 ha of deep soils.
- Sub-class N1 kmp: with limitations of land tenure dispute (k), moisture deficiency and adverse physical conditions. The total area of this sub-class is 1 122 ha of deep soils.
- Sub-class N1 ldm: with severe limitations of distant location from the irrigation source, shallow soil depth (d) and moisture deficiency. This sub-class includes all locations with shallow soils, (3 801 ha).

It should be borne in mind that class N1 land (currently unsuitable land), could be upgraded to Class S3 land (marginally suitable land) if ameliorated to substantially reduce the limitations. However, reduction of severe limitations is usually very expensive and must be preceded by detailed technical and economic studies.

Class N2; (46 439 ha; 82.96% of the total land area).
This is permanently unsuitable land usually designated "non-agricultural land" because of very severe limitations which render land permanently unsuitable for cropping. This class includes 242 ha of deep soils which are eroded and subject to uncontrollable wind erosion; 6 487 ha of very shallow soils and 39 710 ha of miscellaneous land types- such as mountains, hills, rock outcrops and severely dissected terrain.

13 Accordingly, only land currently of Class S3 designation is recommended for the project; total area 2 160 ha. To upgrade the suitability of these soils it is proposed to carry out land improvement operations in order to prepare the land before any cropping is practiced. These operations include removal of stones and boulders, addition of organic matter and leaching. When these improvements are made the land class would be upgraded to Class S2; moderately suitable land.

Crop Suitability Rating:

14 Crop suitability (CS) is a rating of the different kinds of soils according to their suitability for the production of specific crops. Well suited soils are designated CS1, moderately suited soils are CS2, poorly suited soils are CS3 and unsuited soils are designated CS4. The crop suitability rating for the selected soils under the current condition of the land is:

- S3 mfp (868 ha, Noordoewer location), have CS2 rating for all proposed crops.
- S3 mps (344 ha, Tandjieskoppe location) have CS2 rating for all crops except tomato and onion which have CS3 rating.
- S3 mfa (948 ha, Aussenkehr location) have CS2 rating for grapes, dates, mango, lucerne, sweet melon and sweet potato, and CS2-3 rating for tomato and onion.

15 After amelioration of soils, the land classification and crop suitability potentials would be raised as follows:

Land Classification Potential:

- S3 mfp would be up-graded to sub-class S2 m (868 ha).
- S3 mps would be up-graded to S2 m (344 ha).
- S3 mfa would be up-graded to S2 m 948 ha).

Crop Suitability Potential:

- Potential land class S2 m ; (area 868 ha, Noordoewer State Irrigation Unit) would have a potential crop suitability rating of CS1 for all crops.

- Potential land class S2 m (area 344 ha, Tandjieskoppe State Irrigation Unit) would have a potential crop suitability rating of CS1 for grapes, dates, mango, lucerne, sweet melon and sweet potato, and potential crop suitability rating CS2 for tomato and onion.
- Potential land class S2 m (area 948 ha, Aussenkehr Irrigation Unit) would have a potential crop suitability rating of CS1 for grapes, dates, mango, lucerne, sweet melon and sweet potato; and potential crop suitability rating of CS1-2 for tomato and onion.

16 Likewise land suitability classification and crop suitability rating would be upgraded for class N1 (currently unsuitable land) if the main limitations of irrigation water accessibility, land tenure and topography are removed or reduced. The anticipated up-grading of Class N1 would be as follows:

Mapping Unit	Area ha	Classification Current State	Classification Potential State
D1	250	N1 l m f	S3 l m
D21	372	N1 t l e	S3 t m
D31	1166	N1 t l e	S3 t le
D41	666	N1 l m a	S3 l m
D5	1122	N1 k m p	S3 k m
S1	740	N1 l d m	S3 l d m
S2	2399	N1 l d m	S3 l d m
S3	662	N1 l d m	S3 l d m
Total	7377	-	-

17 Crop suitability rating would be CS3 for all crops for mapping units D1, D21, D31, D41 and D5. Mapping units S1, S2 and S3 would be unsuited for all tree crops and lucerne (CS4) and poorly suited (CS3) for all vegetable crops. Locations with these soils are considered as potential areas for future development that must take into consideration the removable and non-removable land limitations.

Vegetation:

18 The vegetation in the project area is classified as Desert and Succulent Steppe. Vegetation is very sparse and is mostly limited to depressions and water courses where run-off water collects. Higher ground which is readily drained carries very little, if any, vegetation. The dominant species are xerophytes which have a very high degree of drought tolerance/resistance. The vegetation intensity is so low that it has practically no potential for domestic animal grazing.

19 The Orange River banks support a riverine forest vegetation mainly composed of *Tamarix usneoides* (tamarisk) and *Euclea pseudebenus* (false ebony). A number of aquatic plants thrive in the river. The water hyacinth *Eichhornia crassipes*, one of the

most serious aquatic weeds of irrigated agriculture in Africa, which occurs in the Vaal River, has not yet been found in the lower Orange River.

20 The significance of natural vegetation to agriculture is that naturally occurring plants constitute the potential weeds that can grow with crops. With regard to irrigated agriculture, both terrestrial and aquatic naturally growing species can be transformed into potential weeds. In addition, aquatic species could threaten intakes of pumping stations or could even have some adverse effects on the hydraulic properties of the river channel(s). Various algae species can constitute a problem needing attention in storage dams and other irrigation works. Fortunately however, almost all weeds can easily be controlled by appropriate husbandry practices.

Topography:

21 The project area is composed of a long narrow strip of land which appears as a plain bound by the Orange River in its lower part. It rises from the riverbed (154-120 m a.s.l.) to 350 m a.s.l. Much of the land is undulating and/or severely dissected terrain. In some parts hills and/or mountains separate the plain from the river. The most important limitations imposed by the topography on irrigated farming are difficulty of gaining access to the river and the high pumping head required for irrigation of high ground. Nevertheless some relatively flat or gently sloping areas exist in scattered locations.

C: LAND TENURE SYSTEMS

Systems of Holding the Land:

22 The land tenure arrangements in Namibian agriculture have been inherited in an extremely skewed fashion. While about 4 500 commercial farmers own on freehold basis, about 43% of the agricultural land, more than 150 000 households have access to 42% of communal land. The Government owns about 15% of the land. The whole situation of land tenure has been the subject of concern to the Government since independence. The Agricultural Commercial Land Reform Act No. 6 of 1995 has been passed by Parliament, but the Communal Land Act is yet to be formalized.

23 Land in the project area is owned either by the Government (State land) or by private individuals and identities (private land). Agricultural land in Noordoewer is located on the river bank and an area of 490 ha is owned by 37 owners; for details refer to Annex III chapter III . The land is severely fractionated into 152 plots varying in size between 0.24 ha to about 18 ha and each individual plot is registered in the name of the owner at the Deeds Office. Sixteen farmers practice agriculture in 52 plots of a total area of 286.3 ha. Most farmers cultivate more than one plot, whether his own land alone or with rented land.

24 In contrast to Noordoewer land, the whole Aussenkehr Farm No. 147 (99 273 ha) has only one registered deed in the Deeds Office ; deed number 1 227, dated 14 July, 1980, in the name of Aussenkehr Farms Limited, who bought the farm from Nameb Minerals Exploration. It is worth noting that the Government has bought 620 ha to establish the Aussenkehr Government Farm (now in existence) and that Namibia Grapes Company has also bought 857 ha (300 ha under development now), and three other farming enterprises are currently operating in Aussenkehr Farm. Neither the

Government nor the other enterprises have as yet (March 1999) had their share of Aussenkehr Farm land registered in their names in the Deeds Office.

25 The land lying on the upper terraces of Noordoewer and extending all the way along the Orange River to Aussenkehr Farm is State land. This land has no deed in the Deeds Office, which is the case with all state lands which were not subject to any form of transfer of ownership or change of jurisdiction. The size of this plot is 82 550 ha as measured by plainmeter from a 1:50 000 scale map of Namibia; Appendix Figure (II.3) shows the location of State land and Aussenkehr Farm.

26 Two townships have recently been planned, one in Noordoewer on State Land and one in Aussenkehr Government Farm. Such land would normally be granted to Regional or Local Authorities after it is mapped and registered. However, the Consultant did not find the record of registration for the proposed townships in the Deeds Office.

27 A strip of land, about one kilometer wide running along the Orange River bank; Appendix Figure (II.4), is designated Noordoewer Irrigation District. According to Article (5) of the Agreement on the Vioolsdrift and Noordoewer Joint Irrigation Scheme the Namibian Government "undertakes to maintain the Authority* with jurisdiction within the Irrigation District".

28 Housing in Noordoewer Settlement (the squatter camp) is on State land granted to settlers on usufruct permission from the local authorities. Other housing and buildings of private sector are mainly on privately owned land.

Cost of Land:

29 One farmer, who is interested to leave Noordoewer , is asking N$ 15 000 per ha for river bank land which is irrigated by gravity from Noordoewer canal. He believes that the real value of such land is N$ 20 000 but he is asking a low price because, he says, he is no longer interested in farming. The price of undeveloped land on the high terraces is extremely variable. Noordoewer farmers gave estimates ranging between N$200 to N$2 000 depending on the altitude of land and the required pumping head ; obviously the higher the altitude the lower the price. Land for the Government Farm was bought from Aussenkehr Farms Ltd. at a gross price of N$ 1 950 per ha for an area of 620 ha. Out of this area only 300 ha were found to be suitable for irrigated farming. In effect the Government has paid about N$ 4 030 per ha for undeveloped land which is suitable for irrigated farming. The most recent transaction made in Aussenkehr Farm by Namibia Grapes Company amounted to N$18 000 000 for 857 ha; i.e. N$ 21 003 per ha of undeveloped land, but the conditions of sale specify that the land is suitable for irrigated farming.

30 Land renting from absentee landowners is practiced for land commanded by Noordoewer canal. Average rent per hectare for good riverbank land is N$ 2 500 per annum.

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* Authority; refers to the management organ of Vioolsdrift and Noordoewer Irrigation Scheme.

D: AGRICULTURE

General:

31 Due to the prevailing aridity, rugged topography, scarcity of agricultural land and sparsity of natural vegetation it is not possible to practice rain-fed farming, open land grazing or ranching in the project area. Agriculture is limited to relatively small areas along the Orange River, mainly around the settlement of Noordoewer and on Aussenkehr Farm.

Farming Activities in Noordoewer Farms:

32 The Noordoewer settlement has its origins in the 1930s when the Vioolsdrift and Noordoewer Joint Irrigation Scheme was established to supply irrigation water for low-lying land adjacent to the Orange River on both the Namibian and South African banks. The scheme design includes a canal system with a capacity of 20 M m^3 /a of which 11 M m^3 is allocated to South African farmers (about 500 ha) and 9 M m^3 is allocated to Namibian farmers (16 farmers) who currently farm 283 ha in the vicinity of Noordoewer.

33 The irrigation system is managed by the Vioolsdrift and Noordoewer Joint Authority which is composed of water users in the two countries and representatives of the two Governments. The Authority operates on a cost-recovery basis for all operational and maintenance costs. It employs an Administration Executive Officer, a Canal Supervisor, 3 pump technicians and 10 general workers for maintenance of the canal on both sides of the river.

34 The Noordoewer canal can only command lower ground adjacent to the river. Four farmers, who farm higher land than the canal could command, pump their own requirement of water from the river. These farms are on soils similar to those selected for the project. They mainly grow mango and one of them grows grapes. Both tree crops appear to be growing well.

35 The prevailing system of application of irrigation water is surface (flood) irrigation for all field and vegetable crops. Water is not measured and is applied *ad-lib* according to farmers' judgement. This system is possible for the deep alluvium soils with high water-holding capacity, which are the predominant soils utilized for farming. Few farmers are using sprinkler irrigation for lucerne and drip irrigation for vegetables. Grapes and mango are irrigated by sprinklers.

36 Statistics on areas of the various crops grown are not available, as there is no particular agency concerned with collection of such information. Almost all farmers grow lucerne, which occupies 30 - 50% of the farm area. The crop has a ready local market and is sold as air dry hay at farm gate. According to farmers, lucerne is considered as the "bread and butter" crop because it secures revenue, though small, almost every month. In addition, lucerne tolerates short periods of flooding in case high river floods take place.

37 Vegetables, as a group, constitute a major component of the crop mix. The common practice is to rotate vegetables in a sequence which does not allow repeated

cultivation of any vegetable crop in the same piece of land in successive years. When lucerne land is ploughed up, lucerne alternates with vegetables. Tomato is the most popular vegetable crop grown by farmers. One farmer specializes in growing tomato under nets on 2.4 ha. The partially controlled net-environment keeps insects away, reduces high temperatures in summer and prevents frost in winter. Drip irrigation is adopted and high rates of fertilizer are applied.

38 Sweet melon assumes second importance to tomato. While some farmers grow it regularly, a few are not very keen on it. The aim is to have the crop in Cape Town market either in October or December when prices are high. The relatively minor vegetables are watermelon, squash, pumpkin, brinjals, green peppers, onion, beans and peas. Few farmers grow sweet corn on-and-off when they can secure contracts with dealers in Cape Town market.

39 Tree crops are not grown on lower ground because of the unpredictable danger of the river flood. Most farmers have suffered from the 1988 flood and they are not prepared to re-take the risk of loosing well-established fruit trees by floods. Only land not subject to flood danger is planted with tree crops. Mango has recently gained popularity and farmers are very positive about its prospects, being favorably influenced by the experience of South African farmers on the other side of the Orange River. Two farmers have started growing table grapes in 1997 on high ground encouraged by the Aussenkehr Farm experience. Citrus and dates are not grown commercially; only a few trees can be seen in some farms.

Farming Activities in Aussenkehr Farm:

40 The Aussenkehr Farm No. 147 is the largest farm in the Orange River region, but only a small proportion of the farm is suitable for irrigated agriculture. The farm is owned by Aussenkehr Farm Company and the agricultural activities by the owner started in 1989 with the production of vegetables. Since 1994 the company has gone into table grapes production, reportedly with great success. Currently the company's activities are limited to 150 ha of grapes, but, according to the General Manager, the company has plans to expand grape production by an additional 1 200 ha.

41 The Government has established a State Farm on a portion of Aussenkehr Farm. To-date the area planted includes 60 ha of lucerne, 30 ha of citrus and 30 ha of mango. In addition, 10 ha were planted to dates and a date gene bank of 20 varieties (10 plants of each variety) was established in collaboration with FAO Date Production Support Program. The irrigation system is the center pivot system for all crops. The National Development Corporation (NDC) manages the project.

42 Apart from the Aussenkehr Farms Company and AGF, three private sector enterprises have established grapes farms of a total area of 205 ha in Aussenkehr Farm. Namibia Grapes Company is currently developing 360 ha for grapes. All enterprises have plans to expand their grape production activities in future. Overall private sector future plans amount to 1 815 ha of grapes, which bring the total private sector current and proposed development in Aussenkehr Farm to 2 530 ha; for details refer to Annex IV, Chapter II. It is worthy of note that the private sector is concentrating on grape production only and is targeting the export market.

43 Farmers currently practicing in Noordoewer/Aussenkehr area are facing the problem of lack of scientific information emanating from the same agro-environment. It may be argued that such information could be drawn from the nearest Research Station at Upington in RSA. But Upington agro-environment is different from the agro-environment in the Namibian bank of the Orange River. Hence it is considered of primary importance that provision is made for generation of relevant, applicable and acceptable technologies within Namibia. Indeed, this is considered a pre-requisite for harnessing the Orange River water resource - which is considered to be one of the biggest assets of the country. In particular generation of farming technology is seen as a pre-requisite for the Tandjieskoppe Irrigation Project.

E: LOCAL ECONOMY

44 The local economy is based on diamond mining and agricultural production in Noordoewer Irrigation District and Aussenker Farm. The great majority of the population are employed as permanent, semi-permanent and casual workers in the farm. The most important crop is grapes grown for the export market. Business is poorly developed and is based on providing various services to the farming sector.

F: INSTITUTIONS

45 Noordoewer, being only a settlement, is not expected to attract many institutions. The Karas Region Local government is represented by a councilor who is resident in Noordoewer. None of the other Government Ministries is represented in the project area. The National Development Corporation (NDC) runs the Government Farm in Aussenkehr. The nearest agricultural research institution is in Mariental, some 550 km to the north. Other institutions that are usually deemed essential for the practice and development of agriculture do not exist, neither in the project area nor within easy reach of its farmers. This deficiency includes extension and training, crop protection, marketing, finance and cooperatives. The main farmers' institution existing in the project area is the Vioolsdrift and Noordoewer Joint Irrigation Authority, which operates the gravity canal irrigating land on both sides of the Orange River.

G: INFRASTRUCTURE AND SERVICES

46 Services are provided only in Noordoewer. Business is centered on two major activities; the Camel Lodge Hotel and the Noordoewer Bottle Store, which is a small supermarket. There are two gas filling stations and a small bank branch. In addition, there are two primary schools, teaching up to seventh grade. The number of pupils is 265. There are five literacy promoters provided by the regional government. Public services, in addition, include a post office, a police station and a clinic.

47 Noordoewer settlement is provided with piped domestic water supply. Business and farmers cater for their own domestic water. Electricity is supplied by Nampower to Noordoewer and the Government Farm at Aussenkehr. In March 1999 the power supply was upgraded to cater for all farms. Telephone service is in place. The main road connecting Namibia with South Africa passes through Noordoewer

and crosses the Orange River through Noordoewer Bridge. A well-maintained dirt road crosses the project area from Noordoewer through Aussenkher Farm to Rosh Pinah in the west.

48 Two townships, one in Noordoewer east of the existing settlement and one in Aussenkehr Government Farm, are already approved. The plan for Noordoewer Township includes 157 residential plots. Aussenkehr Township includes 112 residential plots, 7 Kraals, one police station, one clinic, one post office, a business center, a church and a school. The signifcance of these townships with their services to the project is that one is located on one side of the project area and the other is located on the other side. Hence they are within each reach of project settlers indicating that there is no need to propose extra services for the project.

49 There are two air strips, one in Noordoewer and another in Aussenkher Private Farm. These are simple dirt strips suitable only for small planes.

H: POPULATION

50 The Karas Region, in which the project area is located, is the most thinly populated region in Namibia (population 63 000). Nevertheless it ranks third among the nations thirteen regions with regard to human development indices; for details refer to Annex III, Chapter III.

51 Population in the project area is extremely thin and is concentrated in the settlement of Noordoewer and in Aussenkehr Farm. According to the 1991 census the total population was 1 069 and 422 in the two settlements respectively. By February 1999, the number of settlers in Noordoewer settlement increased to 361 registered house owners of which 65 are women. In some cases the house includes more than one family and it is estimated that about 400 families live in the settlement. The average size of the family is five, hence the total population is around two thousand. The settlement includes persons from many parts of Namibia. Nama tribe of the Karas Region appears to be the predominant group, but tribes of the north are also represented by various proportions of the settlers. The sixteen farmers of Noordoewer are all white and each farmer lives in his own well-constructed house within his farm. Several white business families live in the center of Noordoewer

52 Living conditions in the camps are not adequate. Houses are of various sizes and shapes and are constructed with various materials including old corrugated iron sheets, pieces of wood and thatch, which can only provide an inadequate shelter, being too hot in summer and too cold in winter. Services in the camps are very poor and aspects of a fulfilling community life are not observed.

53 In addition to Noordoewer settlement, there are many labor camps associated with farms. The largest labor camp is in Aussenkehr Private Farm. According to the farm manager the camp currently (Feb. 1999) houses about 1 000 persons of which 15% are permanent work force, 25% are semi-permanent (7-9 months employment) and 60% are casual migrant labor who reside in the camp during the period September/February. All farm laborers live in their own constructed houses, mainly

thatch, with communal water and health facilities provided by the farm. About 95% of them are single. The farm also employs about 120 permanent staff for various management jobs, and these are accommodated in good houses constructed by the farm.

54 The majority of the population work in the farming sector. Farmers met have reported that many of the workers have gained good experience in various types of specialized farming activities including machinery operation, irrigation, planting, harvesting and packing of crops. Each farm has a small core of permanent skilled labor and temporary (daily paid or paid on piecework basis) labor is appointed as required during peak labor demand of crops. There is excess unskilled labor in Noodoewer resulting in unemployment among settlers. Nama labor is particularly experienced with livestock production. Women are preferred as casual labor for harvesting vegetable crops (picking) and grapes and for grading and packing. The Camel Lodge Hotel employs 52 persons of which 35 are women. Few settlers are employed in schools, police station, post office, gas stations and other private sector activities.

55 Permanent farm labor earn about N$ 60 a week in addition to housing and some farm produce e.g. vegetables. Temporary laborers are paid N$ 10 - 12 per day and may be provided with accommodation if available. The average monthly earnings of the Camel Lodge Hotel staff in N$ 450 plus one or two meals per day.

I: WATER

Rainwater:

56 The project area is one of the driest parts in Namibia. With average annual rainfall of less than 50 mm distributed throughout the year. As stated earlier rainwater does not constitute an irrigation resource for the project.

Groundwater:

57 Information on groundwater in the project area is very scarce. Most of the rock formations have poor porosity and aquifer characteristics and groundwater can only be found in secondary features such as joints and fractures, which occur in parts of the project area. In addition, due to very low rainfall, amounts of water recharge are apt to be very small. Hence, where groundwater is available, it can only be in insignificant amounts, which would not support irrigated agriculture.

58 Another source of groundwater with a higher yield potential is the tertiary to recent alluvial sands and gravel of the Orange River. These formations occur along the riverbanks and terraces and in old abandoned river-courses or meanders. The few boreholes dug along the Orange River indicate that groundwater could be found in these river formations at depths of 20 - 80 m. The absence of boreholes as a source of irrigation water in the project area is an indication that there was no need for the farmers along the river to incur the cost of drilling boreholes for irrigation purposes, as they could more easily obtain water from the river itself. Such water may be considered for domestic supplies as it is of higher quality and suitability for the purpose of domestic use.

The Orange River:

59 The Orange River is the largest river in Africa south of the Zambezi. It rises in the northeastern corner of Lesotho at an altitude of about 3 300 m. From its source the river flows westwards for approximately 2 200 km into the Atlantic Ocean. From longitude 20° E westwards it forms the nearly 600 km long international boundary between Namibia and the Republic of South Africa . The total catchment area of the river, together with the Vaal River covers approximately one million km^2mostly in RSA, but also in Lesotho, Botswana and Namibia.

Orange River Flows:

60 The virgin (natural) mean annual runoff (MAR) of the Orange River basin is in the order of 11 310 M m^3 , with the Namibian catchment area contributing 480 M m^3. However, both the natural flow and the relative contribution of the various catchment areas are subject to extreme annual variability. The Orange River is a highly regulated river and its flows are directly influence by artificial regulation mainly in RSA. The long-term record of minimum and peak flows for the period 1944/45 to 1995/96, as recorded at Vioolsdrift were 7.1 m^3/s and 1957 m^3/s, respectively; for more details refer to Annex IV, Chapter I. These means conceal the influence of the control structures, which have been constructed during the period. The progressive influence of the control structures on the Orange River flows is illustrated by the 10-year period mean flows shown below:

Period	Mean Annual Minimum Flow m^3/Sec	Mean Annual Maximum Flow m^3/sec
1946-1955	0.5	2292
1956-1965	2.0	3080
1966-1975	6.0	2528
1976-1985	7.0	629
1986-1995	21.0	1255

61 Due to major upstream developments the MAR reaching the river mouth was estimated at 5 340 M m^3 in 1991.

62 Within Namibia several small seasonal rivers contribute to the lower Orange River, but the main contributor is the Fish River which has a basin of about 80 300 km^2. The virgin MAR of the Fish River at the confluence with the Orange River is about 470 M m^3/a. This flow is extremely erratic and differs from one year to another following the erratic rainfall in the catchment area. In addition to the existing dams, a number of other dams are proposed with a total storage capacity of 939.8 M m^3 and a total 95% assured yield of about 185 M m^3/a. When all proposed dams have been constructed, the spill into the lower Fish River is estimated at an average of 289 M m^3/a. However, this flow will be more erratic than at present and there will be many years without any flow. The implications of the construction of the proposed dams are that the remaining runoff in the lower Fish River will be so erratic that no water demand can reliably be met by using the remaining runoff. In consequence the project must depend on water that flows from RSA into the lower Orange River..

Flood Information:

63 In recent times two major flood events took place; 1974 and 1988. Peak levels were determined from local gauge plates and as such they have relevance only for comparison between the two floods and not between different locations or as reference to level above riverbed level or above sea level. The peak levels at Noordoewer were 14.69 m and 13.69 m in March 1974 and February / March 1988 respectively.

64 The comparison of peak flows during the two floods is portrayed below:

Location	Flood Event -Peak Flows (m^3/sec)		
	March 1974	Feb/March 1988	March 1988
Upington	8 800	8 000	6 150
Noordoewer	8 450	7 700	6 100

65 Although the levels and peak flows of 1988 - floods were lower than those of 1974 - floods, the flood volume of 1988 by far exceeds that of the 1974 - flood due to the longer duration of the flood peak. Flood damage in both years was limited to the narrow plains of the lower terraces of the riverbanks. Almost all the land irrigated by the Noordoewer canal was flooded with serious loss of crops and property. In addition, soils in the immediate vicinity of the main course of the river were completely or partially washed away. However, the higher terraces, including land above Noordoewer canal, were not affected.

66 The above information indicates that flood dangers are limited to agricultural land located at low elevations along the banks of the river. The proposed project area locations are on much higher ground than the 1974 and 1988 flood levels (at elevations of more than 20 m above the riverbed) and are, therefore, completely immune from any flood hazard. However, care should be taken in locating and designing pump houses, which must be constructed on the riverbanks.

Water Quality:

67 Water quality analyses of the Orange River have been undertaken by the Department of Water Affairs, MAWRD, Namibia. Samples were taken at different locations on the Orange River at *ad hoc* times. The available data do not cover all the months of the year. An analysis in May 1993 shows silt content of 24.0 mg/l and 5.0 mg/1 for water samples taken from Noordoewer canal and the river at Aussenkehr, respectively. In general the silt load in the months during which analyses are available is considered low and should not constitute a serious constraint to sprinkler and drip systems of irrigation. However, silt load is expected to be much higher during February and March, when the natural flood of the Orange River occurs. The silt content of the water during these months would depend very much on the magnitude of the natural flood and the control measures undertaken in RSA. The worst situation for sprinkler and drip systems of irrigation would be silt loads of over 2 000 mg/l which were recorded in 1988 during the highest recent recorded flood. It is , therefore,

important that in the case of micro-and drip irrigation, careful emitter selection and good irrigation management (regular flushing) have to be done. Provision for cyclone or settlement pond/silt-removal should be made.

68 Chemical analysis of water samples taken from Noordoewer during 6 different months of the year show an overall assessment of these analyses as follows:

- Classification for Drinking - Excellent
- Stock-watering - Suitable
- Irrigation Classification - C2-S1.
  * medium salinity: suitable for plants with moderate salt tolerance provided a moderate leaching of salts from soil occurs,
  * low sodium content : suitable for almost all soils and crops except those very sensitive to sodium.
- Stability of Water with respect to $CaC0^3$ -
  * Langelier Index = 0.2 to 0.7 ; Aggressive to Scaling
  * Ryznar Index = 7.1 to 8.0 ; Aggressive
- Corrosion Potential of Water Towards Steel -
  * Corrosivity Ratio = 0.4 to 0.9 ; Corrosive

69 According to this assessment, the Orange River water would not constitute any danger with regard to potential crop yields at present. However, long-term changes in water quality can occur. Low-flow conditions, as well as developments in the catchment areas and along the Orange River might result in water quality deterioration. The negative effects of deterioration can be mitigated by the judicious selection, management and monitoring of the irrigation system adopted for any particular farming model. However, to this end there is a need to monitor the changes that might take place in the Orange River water quality. In addition, care should be taken to guard against the corrosion potential of the water towards steel, both at the stages when construction material for irrigation works is chosen as well as during operation of the irrigation system.

Entitlement of Namibia from the Orange River

70 The Orange River course runs in the two sovereign independent states of Namibia and RSA and the middle of the river course constitutes the boundary between the two countries. However, neither the Namibian Constitution nor the RSA legislative measures contain any provision with regard to water utilization or apportionment; and a number of issues remain to be resolved. Such issues must be addressed by bilateral negotiations and formalized agreements. To-date Namibia and South Africa have concluded two such agreements, viz.:

* Agreement on the Establishment of a Permanent Water Commission (PWC), signed on 26 April 1993, and
* Agreement on the Vioolsdrift and Noordoewer Joint Irrigation Scheme (VNJIS), signed on 26 April 1993.

71 The Agreement on the Establishment of PWC addresses the establishment of such a commission and regulates its duties and functions as an advisory agency on the joint development of water resources of common interest to the two parties. The Agreement on the Vioolsdrift and Noordoewer Joint Irrigation Scheme formalizes at

an international level the arrangements regarding the diversion works and canal system constructed in 1933 to irrigate land on both banks of the Orange River at Vioolsdrift and Noordoewer. Current domestic use and the irrigation development within the irrigation district in Namibia are recognized by South Africa as existing use. The two governments further agreed on 20 M m^3 of water as the maximum volume of water to be diverted annually from the Orange River into the distribution system of the joint scheme to be apportioned into 11 M m^3 for South African users and 9 M m^3 for Namibian users.

72 While consultations and negotiations are still under way at various levels, the PWC agreed to quantify the existing water use of Namibia as follows:

Use	Location	Quantity M m^3/a
Domestic	- Noordoewer	0.01
Mining	- Orangemund	4.50
-	Rosh Pinah	1.35
Irrigation	- 1 507 ha	22.60
-	Aussenkehr	13.20
-	Noordoewer	9.00
Total		50.66

73 The PWC suggested that the total shown above should be rounded off to 50 M m^3/a and fixed as the **Historic Entitlement of Namibia**; defined as "the share of the Orange River System, as it exists today, to which Namibia has a rightful access, based on historical events, without having prior consultation or permission from any other party to utilize the water." In essence Namibia can abstract up to 50 M m^3/a, according to its own will, free of any charges. To ensure additional quantities of water RSA is asking for a price to be paid by Namibia. This price is still subject to negotiations.

Water Use from the Orange River

74 Currently water use/extraction from the Orange River in Namibia is subject to allocation and issuing of permits by the Department of Water Affairs of the Ministry of Agriculture, Water and Rural Development. By September 1998 approved permit allocations for all types of uses was 48.58 M m^3/a free (as it is within the free historic entitlement of Namibia) and 22.88 M m^3/a at cost. The total permits issued for irrigation purposes amount to 40.86 M m^3/a as free allocation and 22.88 M m^3/a at cost. On the other hand, the estimated actual consumption is 23.25 M m^3/a of which irrigated agriculture consumes 15.53 M m^3/a; for details refer to Annex IV, chapter II. However, recent irrigation development underway in Aussenkehr Farm would raise irrigation consumption. Likewise any additional uses of water for any purpose would demand more water.

75 The issue of future demand projections from the Orange River is discussed in Annex IV, Chapter II. The conclusion was reached that previous projections to year 2 015 under-estimated the development in Aussenkehr - Noordoewer axis. If current and projected demand in other areas along the Orange River remain as previously projected; and current and proposed developments in Noordoewer, Tandjieskoppe and

Aussenkehr were to take place according to this study, the total water demand for irrigation would be 171.38 M m^3/a in year 2015, compared to a projected demand of 108.7 M m^3/a for the same year. The shortfall in projections would increase as demand in other parts of the Orange River bank becomes in excess of current demand; for details refer to Annex IV Chapter II. It is recommended that information provided by this study would be utilized for updating Namibia's future requirements of water from the Orange River as basis for future negotiation with RSA.

Availability of Irrigation Water for the Project:

76 The issue of water availability to Namibia in excess of 50 Mm^3/a is still under negotiation between Namibia and RSA. However, for the purpose of this study the Consultant was informed by the TCI to assume that irrigation water would be made available for the project. However the Consultant believes that currently there is an element of uncertainty regarding availability of irrigation water for the project for three major reasons. First, there is no agreement as yet between Namibia and RSA. The out-come of on-going negotiations cannot be predicted. Second, the only portion of the Orange River water that Namibia is free to use without consultation or permission from any other party is 50 M m^3/a. Notwithstanding this limit the Namibian authorities have issued permits in excess of Namibia's entitlement. Third, while it is true that the current water use is estimated at 23.25 M m^3/a, there is no guarantee that permit holders will not use their entitlement before this project is implemented. Indeed while the study team was in the field (January-March 1999) Namibia Grapes Company was actively developing 360 ha for growing grapes and planting was scheduled for July/August 1999. At an average consumption of 16 000 m^3/ha/a. this would raise the annual use to 29.01 M m^3/a. In addition expansion of currently cultivated areas is planned by investors in Aussenkehr Farm and by the Government in Aussenker Government Farm. New mining activities are also anticipated. For these reasons the Government would have to guarantee water availability for the project before deciding on its implementation.

Current Cost of Irrigation Water:

77 The Vioolsdrift and Noordoewer Joint Authority operates on a cost-recovery basis for all operational and maintenance costs. The water cost for 1999 is N$314 per ha per annum irrespective of crops grown. The total annual tariff, in 1999, of about N$ 90 000 works out at N$ 0.01 per m^3 which is extremely low by any standard. Nevertheless it constitutes the actual operational costs under conditions where all capital costs are written-off for a gravity irrigation system. The Noordoewer canal can only command lower ground adjacent to the river. Four farmers, who farm higher land than the canal could command, pump their own requirement of water from the river at a fixed tariff of N$7 per ha per annum payable to the Division of Water Affairs of MAWRD. In comparison to canal water the pumped water costs N$ 0.15 to 0.18 per m^3 for electricity alone, according to reports from two farmers. Theoretically, a charge should be made for water abstracted in accordance with permits issued at cost. So far, the cost of water has not been determined and no charge is made because the total consumption from the Orange River is still below the free historic entitlement of Namibia.

78 Accordingly the feasibility study would include four scenarios of cost of water in the river to be added to the cost of extraction and distribution of irrigation water.

On-going Agricultural Projects:

79 The Orange River Irrigation Program encompasses all projects along the Orange River. The first Government study covering the region and entitled Identification and Prioritization of Irrigation Development Opportunities on the Orange River, was completed in March 1994. The study has identified eight locations with irrigation potential along the Orange River. Three of these locations are the subject of this study ; viz.: Noordoewer, Tandjieskoppe and Aussenkehr. The remaining locations constitute potential projects.

80 A substantial development based on grapes production has taken place in Aussenkehr Farm. A summary of the ongoing projects (for details refer to Annex II, Chapter II) is given below:

- Aussenkehr Farms Company Grape Farm; This farm was developed by the land owner in 1994 and constitutes the first sizeable venture along the Namibian bank of the Orange River. The project appears to be a technical as well as a financial success. Currently, the company's activities are limited to 150 ha of grapes, but according to the General Manager, the company plans to expand grape production by an additional 1 200 ha.
- Aussenkehr Government Farm; The Government has established a State Farm in a portion of Aussenkehr Farm with a gross area of 620 ha. The project, designated the Orange River Irrigation Project (ORIP) but is better known as Aussenkehr Government Farm (AGF), was launched by His Excellency the President on 11th February 1995. This action by the President demonstrates the keenness of the Government at its highest level to see irrigated agricultural development along the Orange River. The farm was financed through a loan from the Chinese Government. The objectives of the farm are set as follows:
  - To enhance the country's self-sufficiency in food production.
  - Create job opportunity.
  - Improve the socio-economic climate in a remote part of the country.
  - Improve the infrastructure.
  - Harness one of the biggest assets of the country-water from the Orange River.
  - Make optimum use of the existing facilities.
  - Develop human resources.
  - Exploit the unique climate for the production of export crops.
  - Establish an economically self-sufficient farming unit.

  The strategy of the project emphasized optimum use of the facilities to generate the maximum income. To make the project economically viable it was stipulated that the project would employ:
  - sound management,
  - scientific farming,
  - sharp business skills,
  - specialized training,

- sociological upliftment,
- sharing of facilities new and existing, and
- aggressive marketing.

The AGF is run by NDC as an independent enterprise. To-date irrigation development includes 60 ha of lucerne, 30 ha of mangoes and 30 ha of citrus. In addition, 10 ha were planted to date palms and a dates genebank of 20 varieties (10 plants of each variety) was established in collaboration with FAO Date Production Support Program. Future plans include the following:

- 30 ha lucerne (existing)
- 30 ha mango (existing)
- 30 ha citrus (existing)
- 10 ha dates (existing)
- 100 ha grapes (to be developed in a joint venture with the Chinese Government).
- 80 ha smallholder settlement (under negotiations with the Chinese Government).

The significance of the planned development is that; (a) the Government itself has become interested in growing grapes commercially, but not as the only crop and (b) the Government is planning to give a stake to smallholders to participate in the development of high-value irrigated crops, i.e. the concept of settlement of smallholders in the project area is already accepted and planned for implementation.

The proposed smallholder settlement consists of 20 farms of 4 ha each, which would be planted to grapes (2 ha), dates (0.67 ha), cash crops, unspecified (0.67 ha), and free cropping (0.67 ha). The settlement plan envisages the Government undertaking land development, irrigation works and establishment of tree crops including trellises for grapes at an estimated cost of about N$ 8 million, i.e., N$ 100 000 per ha. The plan also envisages building houses and facilities for settlers at an estimated cost of N$2 million, i.e. N$100 000 per settler or N$ 25 000 per ha. Settlers would pay the operational costs for provision of irrigation water only . These costs do not include irrigation head-works already in place, i.e., pumps, pipe-conveyance and dams. For more details refer to Annex II, Chapter III.

Though not explicit in the objectives and strategy of the AGF, it is implied that the project would contribute to the development of agriculture which aims to harness the water from the Orange River and to develop human resources. The strategy, which specifies scientific farming and specialized training, implies the generation and dissemination of farming techniques. However, the AGF design did not cater for technology generation and training in the project, neither did it indicate the source, which would provide knowledge for scientific farming. The emphasis on economic viability and high-value crops is relevant to the design of the current project. In this respect the AGF would be a useful source of information.

– Other Private Farms; Apart from the Aussenkehr Farms Company and AGF ; three private sector enterprises have established grape farms of a total area of 205 ha in Aussenkehr Farm. In addition, Namibia Grapes Company is currently

developing 360 ha for grapes. All enterprises have plans to expand their grape production activities in future. Overall private sector future plans amount to 1 815 ha grapes, which brings the total private sector current and proposed development in Aussenkehr Farm to 3 530 ha. It is worthy of note that the private sector is concentrating on grape production only and is targeting the export market.

80 The development that has taken place in Aussenkehr Farm together with the old Noordoewer farms offer valuable information on practical experience of farming in the project area, which is quite relevant to the present project. In spite of the absence of technical knowledge regarding cultural practices for high value crops in Namibia, farmers have succeeded in the profitable production of crops. They have gained knowledge and skills, mainly from RSA and almost every farmer has formulated a farming recipe that suits his farm conditions. They have also gained experience in management, provision of inputs and marketing of products. The availability of such experience in the project area is viewed as invaluable support to the present project both at the study and at the implementation stages.

81 The existence of AGF is considered as a valuable resource, not only for the present project but also for the development of the potential areas along the Orange River. In addition to experience gained by the Farm with regard to crop production in general, the land and infrastructure resources existing on it could be utilized and further developed to provide essential Government services, which are much needed in the Orange River region, such as research, extension and nursery services. Indeed, whether the present project is implemented or not the development of agricultural resources along the Orange River could not be conceived without these services.

I: DEVELOPMENT CONSTRAINTS AND POTENTIAL

Development Constraints:

82 The basic development constraints in the project area are the very dry and arid climate and the scarcity of land which is suitable for irrigated agriculture. Arid conditions do not permit rain-fed farming nor do they induce natural vegetation that could support animal rearing. Most of the land falls in the category of non-agricultural land for various serious land limitations. The small areas of agricultural land are scattered. Soils lack homogeneity and are formed in a mosaic pattern. Deep soils, which are required for high value crops are available in relatively small areas separated by non-agricultural rugged terrain. Hence cost-effective gravity irrigation systems that supply irrigation water for large areas are not feasible. A large proportion of these deep soils is located on high elevations in relation to the irrigation water source dictating high to very high pumping heads which increase the cost of provision of water.

83 In addition to the basic constraints, the following characteristics of the project area impose specific constraints.

- The long distances to large markets.
- The lack of supporting infrastructure and essential services.

- The sparse population and their low Human Development Index.
- The high cost per unit of land that is required for establishing pump irrigated farms.
- The unavailability of knowledge regarding agricultural resources and their optimum utilization.
- The uncertainties about the amounts and cost of irrigation water that could be abstracted from the Orange River.
- The potential conflict between farming and mining.

84 The above constraints have acted singly and have interacted with each other to render the project area uninviting for investment in agriculture in the past. Only in 1994 that a break-through has taken place as a result of the introduction of table grapes in Aussenkehr private farm. Since then both public and private sector interest has been attracted.

Development Potential; Previous Assessment:

85 As stated earlier the MAWRD study entitled "Identification and Prioritization of Irrigation Development Opportunities along the Orange River" has tentatively identified eight potential areas for development. Of these, five areas are located outside the present project ranging in size from 56 to 900 ha with a total area of 1 615 ha. Within the present project area, the study has identified potential areas of 900 ha in Aussenkehr Farm, 1 300 ha in Tandjieskoppe and 520 ha in Noordoewer above the existing irrigation canal. It must be noted, however, that the study had concentrated on land with elevations requiring a maximum pumping head of 60 m.

Development Potential; Current Assessment:

86 The current assessment is based on the reconnaissance soil survey and contour maps for the project area. The area extending from Noordoewer to the western extremity of Aussenkehr Farm was covered from the Orange River up to contour line 350 m a.s.l. The low water level in the Orange River is at approximately 154 m and 120 m a.s.l. in Noordoewer and the western extremity of Aussenkehr Farm respectively. This implies maximum pumping heads of 196 m and 230 m for the highest irrigable land at Noordoewer and Aussenkehr Farm respectivley.

87 The first criterion applied for assessing land potential was the suitability of its soils to high value tree crops. Based on soil suitability alone a potential area of 5 978 ha (10.68% of the total area) was identified in 14 locations as shown in Appendix maps 1,2 and as summarized below:

- Noordoewer: Five locations with a total area of 1 118 ha of State land.
- Tandjieskoppe: Three locations with a total area of 710 ha of State land.
- Aussenkehr Farm: Six locations with a total area of 4 150 ha of private land.

These locations were assessed for their suitability to irrigation development within the present project; for detailed assessment refer to Annex IV Chapter III. The results of the assessment were:

- Noordoewer: Four locations with a gross area of 868 ha were selected. These locations would yield a net irrigable area of 720 ha on State land.
- Tandjieskoppe: Two locations on State land with a gross area of 344 ha and a net irrigable area of 320 ha were selected.
- Aussenkehr: One location on private land with a gross area of 948 ha and a net irrigable area of 760 ha was selected.

88 The gross area of all selected locations is 2 160 ha, which yield a net cultivable area of 1 800 ha. While the other locations were not selected for the present project because of specified development limitations, these locations could be considered as a potential for future development, should the present limitations are removed or mitigated. Hence, the potential land in the various localities would be as follows:

- Noordoewer: One location with a total area of 250 ha on State land.
- Tandjieskoppe: One location with a total area of 366 ha on State land.
- Aussenkehr: Five locations with a total area of 3202 ha on private land.

89 The total potential area in the Noordoewer-Aussenkehr axis after implementing the present project is 3 818 ha.

Documentation on the Project Area:

90 Relevant documentation, which has been used for the study is included in each of the study annexes as a bibliography relating to the specific topics treated in the annex.

CHAPTER III

THE PROJECT

CHAPTER III: THE PROJECT

A: OBJECTIVES

General:

01 The TOR direct the Consultant to formulate the objectives of the project in line with the basic guidance provided in sections 1-4 of TOR. Accordingly the objectives of the project were drawn and included in the inception report which was accepted by the TCI.

02 The objectives laid down for the agricultural sector in the First National Development Plan (NDP1) stress the need for national food security and the diversification of agricultural production. Given the country's erratic rainfall and its poor spatial distribution, the poor soil potential and the limited water resources, irrigated agriculture appears to be the obvious choice for the expansion of the production base. By its very nature irrigation is capable of accommodating a very wide range of high value crops, both annual and perennial that offer the chance for diversification of production and creation of year-round rural employment. In addition to providing a more predictable and reliable harvest that contributes to the overall "drought-proofing", irrigated agriculture will have a beneficial impact on reducing poverty levels in the rural areas and help to curb the high levels of migration from the rural areas. A number of interventions have been made by the Government and private sector both pre- and post-independence in developing irrigated farming in the country. These efforts have mainly concentrated on the production of low-value grain crops. The government is keen to embark on a program of significantly expanding irrigated agriculture in order to fully exploit the country's irrigation potential and maximize its contribution to the national economic development. To this end the Government encourages private sector investment, either alone or in joint-venture partnership with the Government.

03 The Orange River area has been identified for possible intervention to develop irrigated agricultural production. However, only limited information is available on the area's natural resource base (soils and water in particular), its agronomic potential, and the socio-economic environment in which the proposed project would be situated. However, interventions made to-date suggest that the agro-environment is adequately suited to the production of grapes, dates, mango, lucerne and a wide range of vegetable crops.

Project Objectives:

04 The main objective of the project is to utilize the available land and water potential in the project area along the Orange River for the development of irrigated agriculture in order to enhance national food security, diversification of agricultural production, provision of livelihood for rural population together with reducing poverty levels of rural population and curbing the high levels of migration from rural areas. Given the unique agro-environment of the project area and its comparative advantage, the main thrust of development would be on the production of high value

crops which are suited to the agro-environment. Closely associated with the main objective are the following specific objectives:

(a) To avail basic information on the natural resource base; particularly soils and water.
(b) To assess the development potential of the natural resource base.
(c) To investigate alternative development scenarios for the socio-economic environment in which the proposed project would be situated; settlement of smallholder, nucleus estate/smallholder outgrower or estate only.
(d) To establish a sustainable irrigated agricultural production system that is economically viable.

B: THE PROJECT SITES

Selection of the Project Sites:

05 A detailed discussion regarding the selection of the actual project sites to be included in the project is embodied in Annexes I, II and IV. Each Annex emphasizes the aspect that it treats, thus Annex I stresses the land and soil aspects, Annex II concentrates on suitability to crop production and Annex IV evaluates the various deep soil sites according to their suitability for irrigation from the Orange River. Appendix III.I Maps 1, 2 and 3 show the deep soil locations which were evaluated, although they have been included in the annexes they are also appended to this report for easy reference. The general characteristics of the selected sites are described in brief below:

The Noordoewer Site:
This site is composed of locations BD (390 ha), DD (192 ha) and CDI + CD2 (286 ha). Location BD is on elevations between 188 m and 240 m a.s.l.; location DD is between 180 m and 200 m a.s.l. and location CDI and CD2 are on elevations between 206 m and 272 m a.s.l. All locations are on State land and are covered by deep soils suitable for high value tree crops. The four locations are adjacent and could be irrigated as one irrigation unit. Water supply is from a pump site about 6 km downstream of Noordoewer Bridge where the low water level is at 154 m a.s.l. The gross area of all locations is 868 ha of which 720 ha would be the net cultivatable area. The three locations will form one irrigation unit and is designated Noordoewer State Irrigation Unit (NSIU).

The Tandjieskoppe Site:
The site is composed of two locations, ED (102 ha) and FD (242 ha). Location ED is at elevations between 190 m - 240 m a.s.l. and location FD is at elevations 190 m - 230 m a.s.l. The two locations are on State land and are covered by suitable deep soils. The two locations are amenable to combining into one irrigation unit which could be provided with irrigation water from a pump site about 12 km downstream of Noordoewer Bridge, where the low water level is at elevation 151 m a.s.l. The gross area of 344 ha yields 320 ha of net cultivable land. This irrigation unit is designated Tandjieskoppe State Irrigation Unit (TSIU).

The Aussenkehr Site:
One relatively large location (IDI) of a gross area of 948 ha constitutes this project site, which lies on elevations between 189 m-270 m a.s.l. The land is privately owned and the soil is suitable for high value tree crops. Irrigation water could be provided from a pump site about 25 km downstream of Noordoewer Bridge. A net area of 760 ha would be available for cropping. This location is designated Aussenkehr Irrigation Unit (AIU).

C: PROJECT DESIGN CONSIDERATIONS

Categories of Farmers Considerations:

06 Success in the production of these crops requires a high level of technical knowledge, preferably emanating from the project agro-environment, coupled with efficient and sustained soil/irrigation/crop management, and aggressive marketing. Timely provision of a wide range of inputs, cooling and packaging are pre-requisites. Crop processing may also feature as a possibility to be considered at a later stage. Unfortunately, the technical knowledge available to farmers, who are currently producing crops, has been acquired originally through individual efforts of farmers, who sought it from RSA and subsequently modified and adapted it to local conditions, again through individual trial and error, which have led to significant failures in some cases, e.g. failure of maize production and failure of the first planting of mango in AGF. As a result almost each farmer has his unique "recipe" (so to speak) for growing his crops. This state of technical knowledge calls for the inevitable concerted effort by the Government to support development-oriented research. The absence of such an effort is a clear pointer to high powered commercial enterprises as the obvious choice of farmers with adequate capabilities to ensure success in the development of the project area. This type of enterprise is able to hire and/or solicit experienced professionals, carryout trials and withstand failure shocks. However, this alternative does not accommodate people with limited means. Hence, only well to do beneficiaries are accommodated and their number per unit of land is usually small.

07 Government-operated estates might be an alternative, but the Namibian Government will continue to have limited capacity to implement projects itself. The Government is keen to encourage private sector investment either alone or in joint venture partnership with the Government, in the development of the country's agricultural sector and in agro-industrial ventures. Particular encouragement is given to the production, processing and marketing of non-traditional, high-value crops in order to create a more diversified agricultural sector. However, farm management under the public sector is frequently constrained by many bureaucratic limitations and lack of cost/benefit commitment.

08 On the other hand and for various socio-economic reasons, the government is keen for the agricultural sector to provide livelihood for the rapidly growing rural population. It also recognizes as one of its guiding principles that a healthy agricultural sector will also have a beneficial impact on reducing poverty levels, which are significantly above average in the rural areas. The social considerations

would suggest the involvement of greater numbers of the rural population who, in the main, are landless and are with limited production assets or capital and are not capable, on their own, to undertake irrigated development. With Government support, many of the rural population are capable of transformation into small-scale economically-viable farmers when they gain a secured right to hold land, access to production assets and credit, access to training on production knowledge and farming skills and access to a range of services including procurement of inputs and marketing. For this category of farmers intensive Government support, direct or indirect, is needed, including settlement arrangements, intensive extension services, management support, and frequently, financial support. Nevertheless, this alternative has the advantage of involving the largest number of beneficiaries per unit of developed land.

09 A relatively small proportion of the rural population would have the making of a commercial family farmer or a medium scale farmer. They would have good knowledge of irrigated agriculture, some capital to invest and are motivated to acquire knowledge and to make the best use of resources availed to them. However, they do not have the capability of acquiring land and developing it for irrigated agriculture on their own, and would therefore need to be supported by the Government in the initial stages of development. They would have the capability of management, procurement of inputs and marketing.

10 Another group that can participate in the development consists of entrepreneurs who have financial capabilities to develop and manage high technology specialized irrigated production either as individuals or as groups (partnership or companies of various sizes). While this group is in no real need for Government support, financial gain is its prime motive; hence it seeks the most cost effective investment within its farms in anticipation of the highest net returns. However entrepreneurs usually shy away from remote harsh environment with serious constraints or inherent problems. In such cases Government intervention would be needed to remove constraints and solve problems before entrepreneurs become interested in investing.

Farming Models Considerations:

11 The selection of an appropriate farming model(s) and its institutional characteristics is determined by a multitude of inter-related factors which govern commercial farming enterprises in any specified agro-environment. Where settlement of smallholders is involved, it introduces a complicated confounding element of socio-political considerations that emanate from and are akin to government policies and other political considerations, but are not necessarily in harmonious conformity with pure financial validity, which is normally a pre-requisite of purely commercial enterprises. Given the possibilities of developing irrigated agriculture by various categories of farmers, each category would have to operate within a characterized farming model. To assess the viability of a farming model many approaches and systems of computations are available. The approach adopted in this study is a metric assessment based on selected weighted criteria and the ability of the farming model to satisfy those criteria. Obviously, both the selection/weighting of the criteria and the

degree to which the farming system is capable of satisfying that criteria, are matters that are subject to the project conditions and the expertise and logical/rational judgement of the assessor. The criteria defined in Annex III Chapter IV are chosen for the assessment of the farming models.

12 For an overall comparative assessment of the farming models, each farming model is given a score ranging from 0 to 10, for each criterion, which represents its relative ability to satisfy that specific criterion under the project conditions. For each criterion and farming model, the specific weight of the criterion is multiplied by the relative score of the farming model to obtain a weight/score value and the total of these values for all criteria would give a viability score for the farming model. To make this score value more meaningful and amenable to comparison of the various farming systems, the values were transformed into percentages. These computations are presented in Annex III, Chapter IV. However, it must be noted that this assessment emphasizes the sociological aspects more than the land potential aspects or the purely financial returns.

13 The farming models which were evaluated are, smallholder, family farm, private enterprise, private estate commercial/outgrower smallholder, government estate and government estate/outgrower smallholder. The evaluation revealed the superiority of private estate commercial/outgrower smallholder with 91.8% viability rating followed by private enterprise with 81% rating. Government estate/outgrower smallholder scored 78.8% and government estate alone was the least viable with a score of 55.3% . The viability of smallholder farms on their own was 67.3%. Though this evaluation has its limitations, nevertheless it can be taken as an indicator of the comparative suitability of the various farming models that are considered for the project. Obviously other relevant factors, not included in the assessment criteria must also be taken into consideration. These should include both national and project area specific consideration.

Specific Considerations Regarding Aussenkehr Site:

14 While the Government is justified to initiate a project on State land, the inclusion of privately owned land in the project deserves special consideration. The Government policy is directed towards privatization, but on the other hand the Government policy is also directed towards land reform for the benefit of the landless. It may be argued that since Aussenkehr site is on private land and that parts of it are already developed by private enterprise ,then the Government should leave private land to entrepreneurs rather than intervene in its development. While the principle of developing Aussenkehr site by entrepreneurs initiative is valid and acceptable and will be incorporated in this study, it is believed that entrepreneurs on their own are not likely to pick up this large location or parts of it, basically because of problems related to the provision of irrigation water.

15 Land Development on Aussenkehr Farm for irrigated agriculture has been very slow in the past. Since 1980, when the present owner has acquired the land , efforts to practice commercial farming, mainly vegetable growing, were met with many problems . The farm adopted growing table grapes for export in 1995 and since

then, commercial farming has attracted serious private sector interest and investment. For obvious reasons, private sector has selected the best land with the easiest access to the Orange River and with relatively low elevations requiring low pumping heads. With the exception of Namibia Grapes Company, the areas of land which were developed by a single investor ranged between 65 to 76 ha and pumping heads are less than 60 m. Namibia Grapes Company, with its large resources and with special Government support, is developing 360 ha with a maximum pumping head of 120 m.

16 The area of suitable land identified by this study is 948 ha. Due to the rugged and mountainous terrain of the area separating the land from the Orange River, and due also to the nature of the river course, the identified land could only be irrigated from one abstraction point at the river bank. Even this one point is considered to be a poor pump-site because it is right on the confluence of the dry Sambok River with the Orange River which is, at that point, wide and very shallow with loose boulders and only one reasonable pool exists. The main pipeline from the pump station to the identified land would have to be constructed on a rocky terrain and must pass partly through the dry Sambok River, necessitating above-ground steel pipes placed on concrete pedestals for about 1000 m of the length of the main pipe. For these reasons, the only feasible and cost-effective way to provide irrigation water for the identified land is to have a single abstraction and conveyance irrigation system from the river to an appropriate point in the identified area in order to irrigate the whole site. For private sector alone to do this for the development of 948 ha, an investor with large capital and strong will to invest such capital in agriculture is needed. The probability of finding such an investor in the private sector is extremely low.

17 On the other hand, the Government is very keen to see the resources along the Orange River fully utilized as soon as possible. Land in Aussenkehr Farm appears to offer an obvious priority in view of the availability of large tracts of suitable land. The keenness of the Government was sufficiently strong to prompt substantial Government intervention and participation in developing suitable land in Aussenkehr Farm as evidenced by (i) establishing AGF and (ii) commissioning this study to include undeveloped land in Aussenkehr Farm. Further participation of the Government is recommended to enhance and/or hasten the development of the most suitable areas.

General Design Considerations:

18 Promotions of the overall development goals and objectives set out for Namibia in general and for irrigated agriculture in particular. Diversification of agricultural production directed towards exports and creation of employment opportunities are key issues.

19 Lack of scientifically based and documented knowledge regarding soils, water and crops. Provision must be made for such knowledge to be generated and disseminated as a Government obligation.

20 Lack of experience with smallholder settlements engaged in high technology specialized commercial tree-crop production. Some experience must be gained

26 A form of secure land tenure must be provided for all categories of farmers.

27 In view of the lack of technical farming knowledge and experience with settlement in the project area; and in order to spread the development costs over a longer period of time, development should progress relatively slowly. This would permit accumulation of knowledge and experience to be utilized for introducing appropriate modifications in successive stages of development.

D: PROJECT CONCEPT AND DESIGN

28 In order to expand the benefits of the irrigation development to a larger sector of the rural population, smallholder involvement in the project should be considered as one of the means of realizing the Government broad objectives of agricultural development . However, smallholder involvement demands substantial Government support initially, as well as a sustained long-term support for input provision, processing, packing transport and marketing. While the government can provide the initial support, smallholders need perpetual support. This could be provided by smallholder groupings who would also need to gain experience. The involvement of medium-scale farmers, who are relatively better equipped with capital, knowledge of farming and marketing experience would introduce two important elements; (i) development of specialized irrigated agriculture through medium-scale farming by a well-to-do rural community and (ii) giving support to smallholders, particularly with regard to demonstrated on-farm technology and to provision of inputs and marketing of products. These two categories need to be moulded together within integrated irrigation units which are composed of individual farms. A third category, entrepreneurs, should be given a chance as their requirement for Government support is minimum, thus reducing the burden of development on the Government by using their financial ability and means. A balanced mix of smallholder, medium-scale farms, and entrepreneur farm must, therefore, be sought. This mix would also promote the integration of different income groups and foster a sense of community life and group self-help.

29 Two development models are proposed for settlement of farmers in the project, one model for State land and another model for privately owned land:

(a) On State Land:

A combination of medium-size farmers with smallholders is proposed for State land i.e. Noordoewer State Irrigation Unit (NSIU) and Tandjieskoppe State Irrigation Unit (TSIU). The medium-size farm is 40 ha and the smallholder farm is 4 ha. Medium-size farms (farmers) would alternate with 10 smallholder farms (farmers). Each Irrigation unit would be allocated equally to smallholders and medium-scale farmers, but the ratio of medium-scale farmers to smallholders would be 1:10. Hence NSIU (720 ha net) would accommodate 90 smallholders and 9 medium-scale farmers. Similarly TSIU (320 ha net) would accommodate 40 ha smallholders and 4 medium-scale farmers. Overall State land would accommodate 130 smallholders and 13 medium-scale farmers. With regard to

preferably prior to project implementation, but also during the early stages of development.

21 The existence of the Government Farm in Aussenkehr in close proximity to the proposed project should be viewed as the nucleus of development along the Orange River as well as a forerunner to this project. The farm is only partially developed and future plans include full development comprising commercial production of fruit trees and lucerne as well as an 80 ha settlement of smallholders (4 ha each) growing fruit trees and other cash crops. An experimental site, with a data gene bank, has already been established in collaboration with FAO Date Production Support Program. Though not an integral part of the present project it would be of great value to draw on the experience of the Government Farm and to re-orient its functions to include the generation and dissemination of development-targeting-packages and information for the present project as well as for the rest of the potential irrigable area along the Orange River. This would conform to the Government policy which stipulates "providing research, training and extension to farmers using irrigation". The farm infrastructure could also be utilized for establishing a nursery to provide farmers with quality planting material.

22 A project profile has been conceived by the Division of Agricultural Engineering, MAWRD, for Development of Noordoewer-Aussenkehr axis. The project assumed a suitable area for development of 8 000 ha to be apportioned into 2 000 farms of 4 ha each for the settlement of a similar number of smallholders. Provision of irrigation water was conceived by a unified irrigation system consisting of storage dam upstream of Noordoewer and a conveyance/distribution system of lined canals and pipes. This concept was adjudged by this study as not feasible because of a number of technical and economic reasons; for details refer to Annex IV, Chapter III. Due to the scatter of the suitable soils it was found that the most feasible method of provision of irrigation water is to group the various locations into three irrigation units; two units on State land and one unit on privately owned land. Each unit will have its independent pump station and irrigation system and could easily be farmed and managed as an independent unit.

23 The project should take account and make use of existing and planned settlements and townships in the project area. This would accommodate the project as an integral part of the overall development of the area, hence the project will benefit from the planned infrastructure and services.

24 The project should provide a healthy, safe and friendly environment in which to live and work. This is seen as a basic need to mitigate the harsh nature of the project area.

25 The available land is held partly by the state and partly by private sector. Development should therefore, be such that each irrigation unit should be on land with only one tenure system. Combining land under different types of land tenure is not feasible, because while State land is at no cost to the Government which has full jurisdiction over it, acquisition of private land involves a cost to be paid to the owner as well as legal procedures, which might tale a long time to settle.

Government support and services to be given to farmers, it is proposed that no distinction be made between smallholders and medium-scale farmers. The Government would carry out all pre-investment studies and arrangements, construct roads, plan for the development and bear these costs as its contribution to the development of the project. The Government would allocate the land to farmers on a secure long-term lease-hold and charge an annual rent at low concessionary rates. The Government would undertake the initial development of the project including construction of irrigation works and a house for each farmer, land amelioration and preparation to the extent that land is ready for growing crops, construction of trellises for grapes, provision of planting material for fruit trees. The initial development costs would be considered as a long-term loan to be retrieved from the beneficiaries by annual installments. Farmers would bear all crop production costs as well as all operational costs of the irrigation system. Arrangements would be made for them to receive short-term credit. They would manage their own affairs as a group within the irrigation unit, and to this end they must organize themselves, with Government assistance, in legally recognizable groups.

b) On Privately Owned Land:

The proposed development model takes into consideration the facts that (i) the Government has already established a State Farm in the area; (ii) the Government is planning to settle smallholders in the AGF, and (iii) it is proposed by this study that State land be developed through settlement of smallholders and medium scale farmers. These development models call for a high degree of Government involvement and financial support, which are considered a favorable contribution to the socio-economic development of one area of the country. In addition, the land is privately owned and a general private farming environment is in place. Another model with lower Government financial commitment is preferred. It is, therefore, proposed that the thrust for developing AIU be through the efforts and resources of entrepreneurs with some Government assistance limited to establishment of the unified irrigation head-works, which constitute the major constraint for entrepreneurs who are interested in farming portion of the irrigation unit.

In view of the low probability of one entrepreneur developing the whole unit, it is proposed that units of 40 ha be the farm size and an enterprise may be granted one or more units according to its financial capability. However, if allocations were made on the bases of one farm for each entrepreneur, AIU (760 ha net) would accommodate 19 entrepreneurs. The Government would undertake solving the problem of provision of irrigation water by constructing a unified water abstraction and conveyance system for the whole area and recovering its full cost over time from the entrepreneurs. This proposal should not stop the Government from considering other options, should private sector comes up with viable alternatives. Obviously, the Government would not stand in the way of the private sector in case it shows its interest to develop the land on its own and without the direct involvement of the Government. However for the purpose of this study the viability of developing AIU is assessed on the recommendation that the Government would participate in the development of AIU by purchasing land and constructing the headworks of a unified irrigation system.

Land would be acquired by the Government from the owner as ownership of land would give the Government a more assured control and ability to plan and implement development. Subsequently land would be leased to entrepreneurs on a secure long-term basis at an annual rent. The rent would be set at a level which ensures that the Government would retrieve the cost of all the land over a specified long period; e.g. 25 years. Alternatively an entrepreneur could acquire an area of land from the original owner and secure a deed for himself without losing eligibility to be included in the development venture.

The Government would carry out all pre-investment studies and relevant development arrangements, such as issuing permits for irrigation water, constructing roads and ensuring availability of power to irrigation works, housing and other infrastructure as the Government obligation towards development. The Government would construct the main irrigation head-works to each farm gate and consider the cost as a long-term loan to be retrieved on a per hectare basis from entrepreneurs. The option may be given to entrepreneurs to undertake on their own account land amelioration or alternatively the Government would ameliorate land and consider the cost as a long-term loan. Entrepreneurs would undertake construction of on-land irrigation system, houses and trellises for grapes. They would prepare land and bear the cost of crop production. They would also operate their irrigation system and bear the cost.

The proposed government intervention in AIU is seen as assistance which attracts private sector to develop irrigated farming in a difficult, but potentially productive location. Such an intervention would first provide the investor, free of charge, with pre-investment information required for development and basic infrastructure in place; second, the cost of land together with irrigation head-works (which may not be feasible for small areas) would be granted as a long-term loan which would reduce the initial capital requirement, which should normally be provided by an unassisted investor.

E: PHASING OF DEVELOPMENT OF PROJECT SITE

30 The development plan is based on implementing the development work and planting over a period of eight years. This would spread expenditure over a reasonably long period. For the purpose of the financial analyses the project life is assumed to be 25 years.

31 As stated earlier and to ensure project success it is proposed that implementation progresses gradually in order to gain experience, identify problems and constraints and introduce constructive modifications and refinements. Thus it is proposed that the project would be implemented in three phases; Phase 1 will be established in one location in Noordoewer State Irrigation Unit. This location is chosen because it is in close proximity to Noordoewer settlement and has an easy access to the riverbank where there is an acceptable pump site. Subsequently expansion is proposed to take place in two phases. Phasing of the development and planting would therefore, be as follows:

Phase 1

Phase 1 of the project would allow for gaining experience with regard to both crop production and settlement of farmers who are operating a new system. The unit would consist of location BD (390 ha gross, 320 ha irrigable area) which is part of Noordoewer State Irrigation Unit (NSIU). It would accommodate 40 smallholder farms and 4 medium-scale farms. Development works and planting would take three years. Land development includes construction of the irrigation system, buildings, roads, land amelioration and trellises for grapes. Planting refers to planting of all crops. Implementation of phase 1 would be as follows:

Year 1 :

- Construct irrigation headworks to cater for the whole NSIU (location BD, CD1+CD2 and DD).
- Land development for 160 ha in location BD; NSIU..

Year 2 :

- Planting of 160 ha in BD; NSIU.
- Land development for an additional 160 ha in location BD; NSIU.

Year 3 :

- Planting of the additional 160 ha in location BD; NSIU to complete phase 1.

Phase 2:

In this phase Aussenkehr Irrigation Unit (AIU) will be developed as follows:

Year 4 :

- Establish major irrigation headworks for all AIU; location ID1.
- On-farm land development would be implemented by entrepreneurs for 360 ha in part of location ID1; AIU.

Year 5:

- Planting of 360 ha by entrepreneurs in part of location ID1; AIU
- On-farm land development works would be implemented by entrepreneurs for 400 ha in the remaining part of location ID1; AIU.

Year 6:

- Planting of 400 ha in the remaining part of location ID1; AIU.

Phase 3:

During this phase the remaining part of Noordoewer State Irrigation Unit would be developed starting from project year five. Subsequently Tandjieskoppe Irrigation Unit would be developed starting project year seven. Development activities on yearly bases would be as follows:

Year 5:

– Land development for 160 ha in location DD; NSIU.

Year 6:

– Planting of 160 ha in location DD; NSIU.

– Land development for 240 ha in location CD1 + CD2; NSIU.

Year 7:

– Planting of 240 ha in location CD1+CD2; NSIU.

– Major irrigation works implemented for all Tandjieskoppe State Irrigation Unit (TSIU).

– Land development for 80 ha in location ED; TSIU.

Year 8:

– Planting of 80 ha in location ED, TSIU .

– Land development for 240 ha in location FD; TSIU.

Year 9:

– Planting of 240 ha in location FD; TSIU.

Figure (III.1) is a diagrammatic representation of phasing of development of individual project sites

F: PLANNED SYSTEMS OF LAND TENURE

32 The system of owning and/or holding the project land would be arranged by the Government in accordance with the prevailing land laws. The general principle to be followed focuses on security of tenure for the holder, be it the Government, the individual farmer or the group of farmers. Legal documentation and registration of rights to the land is the essence of security of tenure. Accordingly the following land tenure arrangements are proposed:

a) Land Required for Main Irrigation Works:

Currently land required for construction of pump houses and part of the main pipes is privately owned. For all irrigation units it is proposed that the Government buys the land and holds it as freehold land to be registered in its name. The rationale here is that the Government would construct the irrigation works and recover its cost during the project life of 25 years. Until the cost is recovered, the Government should maintain its full jurisdiction over the land.

b) Farm Land on State-Owned Land ; NSIU and TSIU :

Farms in the two irrigation units are located on portions, of the large plot of State land. It is proposed that the gross area required for each irrigation unit be demarcated, mapped and registered in the name of the Government. The Government will then delegate the Technical Committee on Irrigation to allocate farms to beneficiaries as proposed in this study. Farmers would hold the land on a long-term lease-hold basis according to a legally formulated agreement which should be officially registered in the Deeds Office. The conditions of the lease-hold should include a permit which gives the lessee the right to erect houses/dwellings and farm buildings as deemed necessary. Beneficiaries would pay land rent which is determined on concessionary basis. This arrangement provides adequate security of tenure for farmers to live within the boundaries of their farms and to grow long-lived tree crops, which are characterized by long lead time from planting to full production.

c) Aussenkehr Private Land:

The preferred land tenure arrangement for entrepreneur farm land is private ownership of the land. The ultimate aim is to allow entrepreneurs to acquire freehold title for the land since they will invest in on-land irrigation system, trellises and housing. To this end a number of options may be made available:

- The land owner himself may opt to participate in the project with an area to be agreed upon with the Government. That portion of land will continue to be registered in his name.
- An entrepreneur may purchase land from the land owner and secure a freehold deed for himself. Hence he/she joins the project as a land owner.
- The Government may purchase the land and register it in its name at the Deeds Office. Subsequently, the Government would lease it to entrepreneurs in the same manner proposed for NSIU and TSIU farmers. Land rent should be paid in such a manner which allows the Government to recover the purchase cost during a specified period, e.g. 25 years. At full cost recovery the entrepreneur would be entitled to free-hold ownership of the land and the Government would effect the necessary transfer of ownership. Should the entrepreneur opt to pay the full cost of the land at any time, he/she could do so and the Government would transfer the land ownership.

d) Land Required by the Group of Farmers:

Land required to secure all the farmers of an individual irrigation unit, e.g. for the purpose of office buildings, stores, etc.. should be leased to the farmers' group. Obviously the group must first gain the legal status that gives it

eligibility to hold such a lease. Only a nominal annual rent is charged for such land.

e) Land for Resettlement of Existing Population

The sites which have been selected for the project are located away form any existing settlement of population as of March 1999. Consequently implementation of the project does not entail any displacement of resident population, or arrangements for resettlement.

33 A prerequisite for entering into any form of land tenure arrangement is a signed agreement between the Government and the beneficiary, which entitles him/her to be a farmer in the project. The conditions of the agreement should include the relevant system of holding land.

34 The issue of whether the transfer of land ownership entails an automatic transfer of irrigation water rights is currently a matter of debate and dispute. When this issue is finally resolved, the essence of the resolution should be embodied in the relevant agreements between the Government and the beneficiaries.

F: PLANNED CROPPING PATTERN

Choice of Crops:

35 A detailed discussion of the suitability of crops to the project was made in Annex II Chapter III. The high cost of developing land for irrigated agriculture dictates the choice of high value crops. Taking into consideration the suitability of crops to the agro-environment (particularly soil and climate)and the farmers' practices and experiences in the project area, the crops chosen are grapes (as the major crop), dates, mango, lucerne and vegetables (tomato, onion, sweet melon and sweet potato). While the choice of tree crops is seen as a definite choice, lucerne and vegetables should be viewed as non-exclusive and fairly flexible. During the project life farmers may decide to grow other field or vegetable crops, as farm and/or market conditions dictate. However, for the purpose of evaluating the viability of the project, only the chosen crops would be considered.

Crop Mixes:

36 The proportion of land to be occupied by each of the proposed crops is an issue which must be addressed in project formulation. Due to the fact that crops have different gross margins, different crop mixes would have a significant influence on project financial results. Obviously the best financial returns would accrue if only the crop with the highest gross margin is adopted as the single crop. This approach has been fully adopted by purely commercial enterprises in Aussenkehr, as the prime motive of these enterprises is financial gain. In this case they are running production uncertainties that might occur, which adversely affect the crop, e.g. the incidence of a previously unknown pest or disease, unfavorable winter or summer temperatures. Apparently these uncertainties are considered worth taking for the possibility of realizing high returns. In this case crop insurance would be necessary and the farmer's

technical and financial resources could be used to mitigate risks. Another approach is to diversify crops as in the Aussenkehr Government Farm where lucerne, citrus, mango and dates are currently grown and grapes are proposed to be the major crop in future. AGF also plans for smallholder settlement farms (4 ha each) to adopt a diversified crop mix; 2 ha grapes 2/3 ha cash crops and 2/3 ha free cropping. Likewise, Noordoewer farmers follow a flexible and diversified mix of crops that does not allow for dependence on one crop. Where smallholders with minimum means and medium scale farmers with limited means are involved, it is considered too risky to adopt only one crop.

37 For the purpose of this project the choice of the crop mix, technical economic and social considerations were taken into account as follows:

- Selection of optimum crop sequence and rotation.
- Profit potential of the crop.
- Possibilities of early realization of crop revenues.
- Introduction of food crops with a good marketing potential
- Possibilities for spreading income generated over the whole year.
- Diversification of crops to reduce risks due to crop failure because of unforeseen circumstances.
- Matching demand in export markets.
- Possible distribution of labor requirements over the year.

38 For the purpose of the study two crop mixes are proposed; one is designated Alternative 1 Crop Mix and the other is designated Alternative 2 Crop Mix. The details if the two crop mixes are as follows:

a) Alternative 1 Crop Mix

As elaborated in Annex II, Chapter III, half the land on State land (NSIU and TSIU) would be developed as smallholder farms of 4 ha and the other half would be for medium-scale farms of 40 ha. One medium scale farm would be adjacent to 10 smallholder farms in alternate succession. On private land. (AIU) all the cultivable land would be developed as entrepreneur farms of 40 ha. The proposed crop mix for smallholder farms is as follows:

Year 1 - 4 After Planting	Year 5 After Planting Onwards
2 ha grapes (50%)	2 ha grapes (50%)
1 ha lucerne (25%)	½ ha dates (12.5%)
1 ha vegetables (25%)	½ ha mango (12.5%)
	½ vegetables (12.5%)
	½ ha lucerne (12.5%)

The over-riding consideration in the choice of this crop mix is that while tree crops may yield higher gross returns than vegetables or lucerne, they have the disadvantage of a long lead time from the date of planting to the first harvest. Hence, if small farmers were to grow only tree crops they would not have any income to support their livelihood for a number of

years. In addition, income generated from tree crops is realized once a year, which might be conductive to irrational spending due to the inability of small farmers to budget and keep money for a whole year. Grapes have the shortest lead-time followed by mango, and dates have the longest lead-time. Thus, half the farm area would be put under grapes in the first year of land allocation, while the other half would be equally shared by lucerne (to give a monthly revenue) and vegetables (to give a seasonal yearly revenue as well as home-grown food), while grapes are developing towards their productive stage. Lucerne has its peak of production in years two to four. In year five after allocation, lucerne productivity would be reduced while grapes would be very near full production. Lucerne land would be ploughed up and allocated equally to dates (0.5 ha) and mango (0.5 ha.) Vegetable land would be shared equally between lucerne (0.5 ha) and vegetables (0.5 ha) While dates and mango are developing to full production, the farmer would be receiving revenues from grapes, vegetables and lucerne. Vegetables particularly, sweet potato and onion and dates provide valuable food for farmers and their labor. Lucerne would support rearing small animals

The proposed crop mix for the medium-scale farms includes the same crops as proposed for the smallholder farms, but with different proportions and time of establishment. The essence of combining smallholder and medium-scale farmers in one location and in alternate farms, is to create a form of association between the two types of farmer with regard to gaining demonstrated farming skills and collective beneficiary management obtaining inputs and having access to better marketing facilities. The crop mix proposed for the medium-scale farm of 40 ha would be as follows:

- 20.0 ha grapes (50%)
- 8.0 ha dates (20%)
- 8.0 ha mango (20%)
- 2.0 ha lucerne (5%)
- 2.0 ha vegetables (5%)

The crop mix would diversify both tree crops and cash crops to avoid risks of a particular crop failure, spread labor requirement and ensure income over a longer period of time during the year. The farmer would have revenues from lucerne and vegetables (4 ha) a few months after the establishment of the farm. In year three he would start to get additional revenues from grapes and mangoes. The most profitable crop, grapes, is allocated 50% of the farm area which is considered as a reasonable proportion to guard against unforeseen hazards of production.

The total net irrigable area available on State land which would be allocated equally to smallholders and medium-scale farmers is 1040 ha. At project maturity the total picture of the crop mix in State land would be as follows:

Crop	Area (ha)		Total	
	Smallholder	Medium-Scale Farmers	Area ha	%
Grapes	260	260	520	50.00
Dates	65	104	169	16.25
Mango	65	104	169	16.25
Lucerne	65	26	91	8.75
Vegetables	65	26	91	8.75
Total	**520**	**520**	**1040**	**100.00**

The proposed crop mix for AIU is 32 ha grapes (80%) and 8 ha dates (20%) . This is a diversion from the current entrepreneur direction of 100% grapes in Aussenkehr Private Farm. The main reason for this diversion is to provide an element of security into the farming enterprise to guard against unforeseen problems that might face the newly introduced crops. Net crop areas would be 608 ha grapes and 152 ha dates.

In total the crop areas for the whole project would be as shown below:

Crop	Crop Areas (ha)		Total	
	Smallholder and Medium-Scale Farmers	Entrepreneur Farmers	Area (ha)	%
Grapes	520	608	1128	62.66
Dates	169	152	321	17.83
Mangoes	169	-	169	9.39
Lucerne	91	-	91	5.06
Vegetables	91	-	91	5.06
Total	**1040**	**760**	**1800**	**100.00**

b) Alternative 2 Crop Mix

The crop mixes discussed in the foregoing sections have been proposed by the Consultant and agreed upon with the Technical Committee on Irrigation on its meeting of 18th April 1999. Nevertheless, since all crops are suited to the agro-environment of the project area, a number of crop mixes is technically possible. For example, any of the three crops could be adopted as the only crop grown in the whole project without any technical limitations, i.e. 100% of one crop. However, the proportions of land allocated to lucerne and vegetables have to be subjected to technical considerations regarding crop succession and crop rotation. Since 80% of the land in AIU was proposed for grapes in Alternative 1 crop mix, a logical alternative crop mix for the other two units would be one which has the same proportion of grapes (80%) for both smallholders and medium-scale farmers. In this case dates will be excluded mainly because of their long lead-time from planting to full maturity. Mango will be retained as a supporting perennial crop, which starts to ripen after the harvest of grapes. In addition mango is gaining popularity amongst Noordoewer farmers. Lucerne and vegetables will be retained for the same reasons given for the

crop previous mixes. The proposed alternative crop mix for NSIU and TSIU, to be designated Alternative 2 crop mix, is as follows:

Crop	Smallholder Farm (4 ha)		Medium-Size Farm (40 ha)	
	Area (ha)	%	Area (ha)	%
Grapes	3.2	80	32	80
Mango	0.4	10	4	10
Lucerne	0.2	5	2	5
Vegetables	0.2	5	2	5
Total	**4.0**	**100**	**40**	**100**

Accordingly, the crop area in NSIU and TSIU will be as follows:

Crop	Area (ha)		
	Smallholder	Medium-Scale Farmers	Total
Grapes	416	416	832
Mango	52	52	104
Lucerne	26	26	52
Vegetables	26	26	52
Total	**520**	**520**	**1040**

The crop mix for AIU will remain as proposed in Alternative 1 crop mix. Hence at project maturity the crop areas in the whole project will be as follows:

Crop	Area (ha)	%
Grapes	1440	80.00
Dates	152	8.44
Mango	104	5.78
Lucerne	52	2.89
Vegetables	52	2.89
All Crops	**1800**	**100.00**

Crop Rotations:

39 The concept of crop rotations and sequences of cropping was discussed in Annex II chapter III. Tree crops occupy specific locations permanently and are not amenable to rotating. Lucerne and vegetables (as a group) will each occupy equal pieces of land for four years after which they will alternate on the land. During any four-year period vegetables will fallow a flexible sequence. The general principle is not to repeat planting of any one crop in two successive years in the same piece of land. Sweet potato and onion develop their produce under ground surface and should preferably alternate with tomato and sweet melon which produce fruit above ground for details refer to Annex II, Chapter III.

G: INPUTS

40 Inputs required for the production of each crop are elaborated in Annex II Chapter III and in Annex V Chapter V. Essential inputs are planting material for tree crops, seeds for lucerne and vegetables, fertilizers, herbicides, chemicals for control of pests and diseases and other agro-chemicals related to plant growth and reproduction. Machinery is required for the primary land amelioration for all crops and for seed bed preparation for lucerne and vegetables. Lucerne must be harvested mechanically and weeds, pests and diseases are controlled by spraying ; either by knapsack or motorized sprayers. Transport from the field to the packhouses will be required mainly for tree crops.

It is the Government policy to promote the involvement of private sector in both agricultural investment and production activities and in providing essential commercial services such as input distribution, output processing and marketing of produce. Government will also withdraw gradually from supplying services that are more appropriately and adequately handled by private sector initiatives (the supply of seeds, fertilizer and tractor hire services, for example). Therefore the Government would not have a role to play in provision of inputs.

Since the project beneficiaries are expected to manage their affairs it is proposed that they secure their own input supplies. This will be done on collective basis at the level of the individual irrigation unit or at the whole project level. The Government would be expected to encourage farmers to form appropriate groupings, e.g. cooperatives.

H: IRRIGATION DESIGN

General:

41 As stated earlier, and contrary to the original perception that a dam would be built in the Orange River upstream of Noordoewer and that water would be conveyed via a concrete lined canal to an area of +8 000 ha stretching over a distance of +60km downstream, the soil survey conducted by this study revealed that far less suitable land is actually available and that it is located in different localities which are in many cases far apart. It was thus proposed to group areas with suitable soils into irrigation units which meet certain technical, practical and economic requirements. Three irrigation units were therefore formed to include all the irrigable project locations.

42 Each unit will have its own pump station, main pipeline, storage/balancing dams and subsequent distribution systems to individual plots. Certain units will have to be developed in phases and the water supply systems thus have to be designed in such a way that they either already make provision for later expansion of the area, or that they can be enlarged/expanded at a later stage. A pump station can be designed and constructed in such a way that future expansion can be done by installing more pumps in parallel to existing ones. The main supply pipeline should however be large enough right from the beginning, because installation of a complete new pipeline at a later stage will be very costly.

43 A basic assumption has been made to split each irrigation unit on State land into 50% for small farmers and 50% for medium-scale farmers. Each irrigation unit will be divided into 40 ha blocks. In the case of small farmers, each block will be subdivided into 4 ha plots, while for medium-scale farmers, the plot size will be 40 ha. The principle is to have one medium-scale farmer adjacent to ten small farmers, since this co-existence will undoubtedly benefit the small farmers.

Pump Stations:

44 The Orange River is legendary for its high floods ; the most recent of which occurred during 1988. One of the most important parameters in the design of a pump station along the Orange River is thus the ability to withstand floods. Not only should any damage to the pump station be kept to an absolute minimum, but the pump station should remain operational during periods when very high river water levels are experienced, because irrigation has to continue. This holds true for all components such as civil structures, mechanical and electrical equipment and access to the pump stations. It is thus obvious that a reduction in the risk of damage, will lead to an increase in the capital cost to construct the pump station.

45 Detailed geotechnical site investigations such as core drilling to establish the depth and quality of the rock bed for foundation purposes, fall outside the scope of this feasibility study and certain assumptions based on visual observations and/or previous experience have to be made. Very little data with reference to high water levels is available and it is therefore difficult to establish final design parameters at this stage. The low water level at the bridge at Noordoewer is approximately at 157 m a.s.l., while the average slope of the river is $\pm$ 0.5 m per km, or 1 : 2000 . Different designs for pump stations can be adopted, each with its own advantages and disadvantages. A number of types were considered (as detailed in Annex IV Chapter IV) including inclined slope, dry/wet well inside the river, dry well inside the river and floating type. The technical advantages and disadvantages of each type were elaborated for comparison purposes.

46 Examples of all of the above types can be found along the Orange River and it is thus a matter of technical judgement to decide on which type to construct. In all cases, future expansion or enlargement will require a larger structure right from the beginning and this will definitely have an influence on the capital cost. Additional pumps and pipework can be added at a later stage. It has to be borne in mind that the quality of the water is classified as corrosive and all steel fittings and pipes should therefore be hot-dipped galvanized.

47 Taking into consideration the technical advantages and disadvantages in relation to the project conditions regarding the source of water and the locations of irrigable land, the inclined slope type was chosen for all irrigation units. In addition to the above considerations this type has been installed at the Aussenkehr Government Farm and has been functioning quite satisfactorily. Thus, reliable information is available regarding capital and operational experience and costs, as well as construction and other technical matters. Such information is deemed to be invaluable to the reliability of estimates of irrigation works of this study

Power Supply:

48 Nam Power, the national electricity supply utility company, is currently busy with upgrading of the whole power reticulation network in the region. A new power line is currently being built from Harib to Noordoewer. The line is designed to operate at a voltage of 132 KV, but will initially only be operated at 66 KV. Preliminary inquiries indicated that a total demand of up to 20 MW at the 3 project sites could be met without too many complications.

Pipelines:

49 The choice of materials for large diameter pipelines (500 mm upwards) is relatively limited. The most common types are Fibre Cement and Concrete, while Glass Reinforced Polyester Pipes (GRP) were introduced to Namibia over the last five years with variable degrees of success. Steel pipes have to be considered for cases where pipes have to be laid above ground. Medium diameters (80 - 500 mm), are dominated by uPVC and Fibre Cement pipes, while small diameters (10 - 80 mm) are virtually all polyethylene.

50 It is Government policy to only accept South African Bureau of Standards (SABS), or other internationally accepted and approved pipes and fittings in order to ensure a longer life span. All pipelines (except steel pipes), will be buried and will be laid according to the manufacturer's specifications and to accepted engineering standards. It is very important to make adequate provision for water hammer during the final design stage, because the combination of steep slopes and large diameter pipes can lead to critical cases of water hammer in case of power failures.

51 Main and sub-main pipeline routes were chosen to avoid passing through plots. It is undesirable to risk a burst pipeline inside a grape vineyard, because the damage to the vineyard could be extensive and thereafter even more damage could be caused as a result of the repairing operations. This will have the effect of longer and subsequently more expensive pipelines, but it is worthwhile.

Sedimentation / Balancing Dams:

52 Dams are proposed at the upper boundaries of the irrigation sites. Water will be pumped to the dams via the main pipelines, and it will then gravitate back into the irrigation systems via secondary and tertiary distribution pipelines. As the name implies, the dams will have a twofold function, firstly short term storage to allow for sedimentation, and secondly to allow for a mechanism to control the pumps. This configuration has the advantage that it will ease management, because individual farmers will not be responsible for starting or stopping of pumps and they will be able to irrigate whenever they like. Pumps on the river will start or stop automatically according to water levels in the dams. This control will be achieved by radio signals (telemetry).

53 It must be emphasized that the purpose of the dams is not to store water for long periods of time. This is totally impractical for large scale irrigation, because the

size of the dams would be so enormous that capital costs would become completely unrealistic. Water in the lower Orange River becomes very muddy (silty) during certain periods of the year, especially when rainfall occurs in the lower catchment areas. The silt is very fine and tends to block filters. It is thus imperative to have a certain retention period in the dams to allow for sedimentation. Sedimentation is considered essential as soon as the water contains more solids than 200 p.p.m. in suspension. The worst problems will be experienced during floods when 2 000 p.p.m. of silt can normally be expected.

54 Important design considerations for balancing dams include the following:

- The outlet and inlet should be as far away as possible from each other.
- Any backwash water should be dumped as far as possible from the outlet.
- Water should be withdrawn from the upper layer of the dam.
- Long, narrow dams are more effective (L/B = 2 is proposed)
- Cleaning should be easy.

The sedimentation rate for silt (particle size 0.002 - 0.05 mm) is approximately 0.015 m/min. Calculations show that for a depth of 1.8 m, the sedimentation time will be approximately two hours, which implies that the storage capacity of the dams should be twice the hourly flow rate of the area served by the dam.

55 Due to the fact that soils are light textured with subsequent high infiltration rates, lining of the dams will be a prerequisite. It is proposed to line the dams with flexible membranes. These membranes are normally polymer bitumen based and are ultra violet (UV) resistant. The installed lining cost is in the order of N$ 60/m^2, which is less expensive than either low density or high density polyethylene-membrane linings. Other types of lining such as geo-fabric, covered with a spray on bitumen layers might be cheaper but are not UV resistant and will not last long under the extreme conditions prevailing along the Orange River. Dam walls should have a slope of 1:2.5 on both sides and should be well compacted and free of protruding stones or other particles. A free board of at least 1 m has to be provided and attention should be given to any possible overflow- or scour water, because large volumes of water could cause erosion and destruction of downhill vineyards.

I: PARAMETERS AND DESIGN OF IRRIGATION PLOTS

Smallholder Plots:

56 Each smallholder will receive an irrigation plot of 4 ha The plot would be fully developed in terms of land preparation, the irrigation systems, trellises for grapes, plant material and housing.

57 Land preparation is a prerequisite for all crops. The soils generally have a high stone content; much of which is in the form of large boulders (up to 1 m or more in size). These have to be removed, leveling has to take place and amelioration has to be achieved as detailed in Annexes I and II.

58 The layout of the irrigation system is dependent on the crop and although each individual will have the opportunity to choose certain crops himself, it is a prerequisite that high value crops must be planted. It is of critical importance that the irrigation systems must be as efficient as possible in order to save water, whilst adequately providing the irrigation requirements of the plants. It is also important that the irrigation systems must be manageable by farmers who do not necessarily have experience in irrigation

59 The following irrigation systems with their respective efficiencies will be used for respective crops.

Grapes	- Micro Irrigation	80%
Dates	- Micro Irrigation	80%
Vegetables	- Drip Irrigation	85%
Lucerne	- Sprinkler Irrigation	70%
Mango	- Micro Irrigation	80%

60 Micro Irrigation Systems are proposed for the irrigation of grapes, dates and mango. Although drip irrigation has a slightly better efficiency, the sandy nature and subsequent high infiltration rates of the soils, will have the effect that water will not spread laterally and numerous drippers will therefore be required to effectively wet the whole root zone of the plant. This will increase the capital cost unnecessarily. In addition, drip irrigation requires a much higher degree of filtration of the water, because emitter openings are much smaller. Sand filters in combination with disc filters will be required and the capital cost will be further inflated. As stated previously, experience along the Orange River indicates that blocking of filters is a definite problem during periods of inflow from the lower catchment areas.

61 In line with the above argument, the use of drip irrigation for vegetables is challengeable. This will definitely have an influence on both the capital cost and management, because sand filters are required and they have to be checked and backwashed regularly. Lateral movement of water is less serious in this case, because the root zone for vegetables is much smaller than for trees. The option was, however, chosen because it is definitely the most appropriate system for vegetables where it is not always desirable to wet the leaves or fruit. (e.g. sweet melon, tomatoes).

62 In order to maintain a healthy soil status, crop rotation is required for vegetables and lucerne in year five after planting and the irrigation system must therefore be designed in such a way that either micro, drip or sprinkler systems can be accommodated. The only way to achieve this is to install the sub-main pipelines with quick-coupling (hydromatic) valves as a permanent system, while the micro-dripper, or sprinkler laterals are simply plugged in. The most important disadvantage of such a system is that while drip and micro systems can operate at 10 m pressure, the lowest working pressure for sprinklers is 20 m, which prescribes that the sedimentation/balancing dams must be more than 20 m higher than the plots on the upper boundaries, which in turn leads to longer pipelines. Another disadvantage is that laterals will be above ground and will be prone to mechanical damage, but this is unavoidable.

63 As stated previously, each individual must have the opportunity to irrigate whenever he/she wants to. The entire irrigation system will be under gravity pressure all the time and a main control point is therefore provided for each 4 ha plot, and further control valves are provided for the different crop units.

Medium-Scale Farmer Plots:

64 Plots for medium-scale farmers will be 40 hectares in size and will also include land preparation, irrigation systems, plant material, trellises and housing. Provision has been made for 4 blocks of 5 hectares each for grapes (20 ha according to Alternative 1 crop mix) to allow for planting of different varieties. Each block will have its own control point. For Alternative 2 crop mix modifications could easily be made for an area of 32 ha grapes.

65 The same types of irrigation systems proposed for smallholder plots with their respective efficiencies will be used.

Entrepreneurs Plots

66 Land in Aussenkehr Farm is proposed to be allocated to entrepreneurs as single 40 ha units or multiples of 40 ha units. While the private sector might opt for grapes only, as is currently the case, this study proposes a mix of 80% grapes and 20% dates as a security against the risk involved in growing only one crop. Micro-irrigation with an efficiency of 80% is chosen for both crops. It may be recalled that entrepreneurs are expected to construct their own on-land irrigation system.

J: CROP WATER DEMAND

Evapotranspiration:

67 Determination of the crop water demand is a highly disputable issue. Various methods and procedures exist ; each with its own advantages and disadvantages. The most crucial element in the application of any of these methods, is the availability of accurate, reliable and long term climatic data. Due to the absence of meteorological stations in the immediate vicinity of the study area, climatic data from the closest stations with similar conditions, namely Warmbad and Goodhouse, had to be used.

68 Calculation of the potential evapotranspiration can be done by various modified versions of the following methods:

- Direct measurement by means of lysimeters
- Blaney-Criddle method
- Penman-Monteith method
- Class A-Pan evaporation method

The class A-Pan and adapted crop factor method is currently the best known in Namibia and South Africa and it has been used for calculation purposes in this study. According to investigations by the FAO, the Class A pan method tends to over-estimate in arid regions. The FAO Blaney-Criddle method seems to be the most

accurate, but it is more demanding on long-term and complete climatological records which are not available for the project area.

69 The area is virtually deprived of any rainfall and no allowance for effective rainfall is included.

70 It is common to estimate the leaching requirement in the order of 15%. This is not attributable to poor quality irrigation water, but rather to poor soils. Saline soils can be improved by leaching out excessive salts. It may be recalled that the soil survey (Annex I) has revealed various salinity levels and that leaching is recommended. The leaching requirement of 15% is therefore added to irrigation requirement and will be included in the total annual water requirement.

71 Accordingly irrigation and annual water requirement were computed as detailed in Annex IV Chapter IV for Alternative 1 crop mix. In summary the crop irrigation requirements are as follows:

Crop	Total Annual Irrigation Requirement (Including Leaching Requirement) m^3/ha
Grapes	17065
Dates	9464
Mango	19484
Lucerne	34400
Tomato	2283
Onion	3039
S. Melon	2319
S. Potato	4005

72 These requirements were applied to the proposed Alternative 1 crop mixes for each of the three irrigation units to arrive at the annual quantities that must be abstracted from the Orange River to satisfy the irrigation requirement of the project. The results are shown below:

- Noordoewer State Irrigation Unit

Phase I (Pilot farm 320 ha)	=	5385912	m^3
Rest of Unit (400ha)	=	6732452	m^3
Total (720 ha)	=	12118364	m^3
Average requirement per hectare	=	16831	m^3

- Tandjieskoppe State Irrigation Unit:

All unit (320)	=	5385918	m^3
Average requirement per hectare	=	16831	m^3

- Aussenkehr Irrigation Unit:

All unit (760 ha)	=	11814304	m^3
Average requirement per hectare	=	15545	m^3

- All Project Units

Total area 1800 ha	=	29318586	m^3
Average requirement per hectare	=	16288	m^3

K: IRRIGATION SYSTEM REQUIREMENTS

73 Details of equipment, machinery and materials required for the project (Alternative 1 crop mix) are embodied in Annex IV Chapter IV. A summary of these requirements is depicted in Table (III.I). In addition, various items of electrical installations are required. These requirements are phased out in a manner which ensures provision of irrigation water according to the scheduled land development.

Table (III.I) Summary of Irrigation Equipment, Machinery and Materials.

Item	NSIU 720 (ha)	TSIU (320 (ha)	AIU 760 (ha)	Total 1800 (ha)
Pump Station	1	1	1	3
Pumps (on river)	10	5	10	25
Pumps (booster)	1	-	-	1
Main Pipes (m)	3300	4200	10780	18280
Sub-main Pipes (m)	13250	4300	12250	29800
Sedimentation Dams	3	2	4	9

Source: Compiled from Annex IV

Comparison of Water Requirement for Alternative 1 and 2 Crop Mixes:

74 As elaborated in Annex II, Chapter III, Alternative 2 crop mix was proposed for NSIU and TSIU as follows:

Crop	Smallholder Farm (4 ha)		Medium-Scale Farm (40 ha)	
	Area (ha)	%	Area (ha)	%
Grapes	3.2	80	32	80
Mangoes	0.4	10	4	10
Lucerne	0.2	5	2	5
Vegetables	0.2	5	2	5
Total	4.0	100	40	100

75 The major irrigation components were designed for Alternative 1 crop mix. The two major determinants of the irrigation system namely the annual water requirements and the maximum flow rates were computed for NSIU and TSIU according to Alternative 2 crop mix, for details refer to Annex IV, Chapter V.. The figures for TSIU also apply for the phase 1 as the crop areas in the two units are exactly the same. The comparison between the major irrigation components of the two crop mixes is shown below:

Parameter	Alternative 1 Crop Mix	Alternative 2 Crop Mix	Difference %
– Maximum Flow Rate (m^3/hr)			
NSIU	3015	3141	4.18
TSIU	1340	1395	4.10
– Total Irrigation Water Requirements (1000 m^3 /Year)			
NSIU	12118	12587	3.87
TSIU	5386	5596	3.90
– Total Irrigation Water Requirement All Project Units (AIU same for Both crop mixes (1000 m^3 /Year)	29319	29996	2.31

For the purpose of the study these differences are considered insignificant and the same designs of pump stations, main pipes, sub-main pipes dams would be adequate for both crop mixes. The on-land irrigation for each crop would remain the same for both crop mixes. However, due to the different proportions of crops the cost of on-land irrigation for Alternative 2 crop mix would increase by 6%. This increase would be taken into consideration in the financial analyses.

L: HOUSING AND BUILDINGS

76 The adoption of either crop mix would have no impact on the number and type of farmer and consequently the number and type of houses are the same for both Alternatives 1 and 2 crop mixes. Other buildings are also unaffected by the crop mix. Housing for smallholders as well as for medium-scale farmers is proposed for State land units. Housing will be grouped to a certain extent to minimize the cost of services like electricity, sewage and potable water, but it is important to have farmers as close to their plots as possible. Not only does this eliminate transport problems, but management and security are also enhanced. Housing for entrepreneurs in AIU will be the responsibility of the farmer.

77 Two-bedroom houses with a kitchen, lounge and bathroom, covering an area of 65 m^2, and which will cost about N$ 80 000, are proposed for medium-scale farmers. This type of housing is the same as that proposed for the settlement of small farmers in the Government Farm at Aussenkehr. The cost of housing works out at N$ 2 000 per hectare for medium-scale farmers. According to National Housing Enterprises, the repayment of an N$ 80 000 loan over 15 years at an interest rate of 18 % per annum amounts to a monthly installment of N$ 1 288. While this amount may be affordable by medium-scale farmers, it is certainly beyond the capability of small farmers.

78 The National Housing Enterprises (a parastatal of the Ministry of Local Government and Housing) has ready designs for a variety of housing. Low income housing ranges from 24 m^2 to 42 m^2. Construction is done with brick walls, 110 mm thick and corrugated iron roofing. A popular type is a two- bedroom house with a bathroom and kitchen (and is amenable to extension) with an area of 35 m^2 and is known as the Core-5 type. The total cost of the house is N$ 30 000 and payment is over 15 years at a monthly installment of N$ 483. This type of housing is recommended for small farmers.

79 It is assumed that farmers' housing would be ready at the time when the first crop planting is scheduled, in year 1 of planting. Therefore, houses would be constructed at the same time of initial land preparation for any location. The total number of houses to be constructed in NSIU and TSIU is 130 smallholder houses and 13 medium-scale farmer houses. The 19 entrepreneurs will build their own houses. For the purpose of financial analyses the assumption is that they would have a similar house to that proposed for the medium-scale farmer.

80 The proposed management at field level includes a Field Operations Manager (FOM), and a Technician for the whole project and a Phase 1 Manager for phase 1 (MP1). Provision for housing and office space is made for these three staff members as follows:

FOM and MP1	Three bedroom house plus sitting room, bath, toilet and kitchen of the type known by National Housing Enterprises as "Pelican T" type, 73.51 m^2 each.
Technician	A two-bedroom house plus living room, kitchen and bathroom, known by National Housing Enterprises as the "Gull" type, area 60.35 m^2.
Office Space	3 Offices with utilities, 60 m^2 .

For each irrigation unit housing and office space are required for the proposed Irrigation Unit Authority. These would be provided as follows:

Qualified Operator for the irrigation system:	73.51 m^2.
Irrigation Technician:	60.35 m^2.
Skilled Laborer:	35.84 m^2.
Office Space for irrigation management and Authority	60.00 m^2.

M: VEHICLES

81 Project Staff who would be provided with vehicles are:

- Project Coordinator (Windhoek)
- Manager, Project Implementation Unit (Windhoek)
- Field Operations Manager (Project Site)
- Technician (Project Site)
- Pilot Farm Manager (Project Site)

Each Irrigation Unit Authority requires one vehicle. The type of vehicle proposed for Windhoek based staff is sedan 1600 cc and for project site is 4x4 diesel pickup 2400 cc.

N: STORAGE FACILITIES

82 Storage space is required mainly for storage of production inputs, eg. seeds fertilizers and chemicals. The space required largely depends on the management of supplies and the period required for storage of individual items. It is assumed that provision of production inputs would be made through farmers' groupings e.g. cooperatives and it would be their responsibility to provide for storage. However, it is proposed that a nucleus storage facility be provided for the phase 1 in year 1. According to experience in this phase, storage facilities for the other locations / irrigation units could be worked out. It is proposed that the phase 1 be provided with storage facilities of 162 m^2.

O: ROADS

83 Service roads have to be provided for transport of produce within the plots and irrigation units and higher quality roads have to connect the units with existing proclaimed roads. Road construction costs should not be extravagant, because soils are generally firm with more than enough gravel material available within short haulage distances. It is proposed that primary roads for each irrigation unit be constructed in the year when initial land preparation starts in the irrigation unit. Internal roads would be constructed as far as possible for each location concurrently with initial land preparation of the location. A total of 42 km of primary roads and 55 km of internal roads is proposed.

P: MECHANIZATION

84 Machinery related expenses can form a significant item in crop production cost analysis. Large capital investments are required to procure equipment for agricultural crop production and prices of farm machinery, tractors, implements as well as rates for operation and maintenance are continuously rising. It is, therefore, worthwhile to invest in thoughtful mechanization planning in order to reduce costs.

85 The mechanization planning process in the case of smallholder farmers is further complicated by the fact that a number of crops are going to be produced, and each has different mechanization requirements in terms of implements. It will be

impossible for each small farmer to have his/her own set of machinery for a 4 ha plot. It is thus proposed to have centralized mechanization pools for each irrigation unit where tractors, implements and machinery can be rented against a predetermined price. This structure will also reduce the burden on small farmers to care for and maintain very expensive equipment. Medium-scale farmers should also be given the same opportunity; however it might happen that they would want to own certain equipment themselves, especially those that are required during critical periods such as during harvesting/transport of produce.

86 The two proposed crop mixes include three different types of crop which vary with respect to their requirements of mechanization, viz. tree crops, lucerne and vegetables. Initial land preparation/amelioration requires heavy machinery and large capital investment and is best done on contract with private sector in the same manner adopted by farmers in Aussenkehr Farm. Therefore, it is only necessary to cater for recurrent cultivation operations required by the crops. The requirement for tree crops is limited to spraying of herbicides and possibly of micro-elements. Spraying will also be done for pests, diseases and other chemicals (e.g. hormones) for grapes. Both mango and dates are generally pest and disease free (at least so far in the project area) and it is not recommended to plan for their spraying against pests and diseases. However, if and when the need arises for spraying, the same equipment secured for grape spraying could be used.

87 Lucerne requires ploughing after four years of growth. However, it requires cutting and baling almost every month. In some years spraying against pest in winter might be necessary.

88 Vegetables require ploughing/discing and seeding for every planting and are more demanding on spraying against pests and diseases throughout their period of growth.

89 All crops require transport from the field to the packhouses. In view of the areas involved, transport of grapes is the most important determinant of requirements.

90 Mechanization requirements are fairly well spread over the year. However, the areas involved and the volume of production requiring transport vary considerably during the year, and in consequence the need for machinery also varies considerably. It is worth mentioning here, that only land preparation and spraying are considered for mechanization of vegetables.

91 The total areas of land used for vegetables growing are relatively small in both Alternatives 1 and 2 crop mixes. Although land preparation is a prerequisite for vegetable growing, it would not be possible for neither the small nor the medium-scale farmers to contemplate having his/her own set of machinery for such small areas.

92 There appear to be three possible means for providing mechanization for land preparation of vegetables, namely:

- Use can be made of excess machinery now available with the farming community in Noordoewer. All farmers interviewed by the Consultant stated that they have excess machinery and implement capacity; e.g. one farmers who farms 27 ha, owns 3 tractors, (35 kW), 2 ploughs, a ripper, a harrow, a cultivator, a rake, a leveler, a baler and a trailer. Another farmer who farms 22 ha, has 2 tractors (35 kW), 1 tractor (50 kW), a rotovator, lucerne cutter and a binder, a leveler, a trailer, a ripper, 400-liter tank and a sprayer.
- One of the medium-scale farmers in the project may see the opportunity of having his machinery operating on his farm as well as being hired to others in the same irrigation unit. He might opt to go into such a business of hiring his machinery to others.
- Use of tractors basically acquired for transport of products together with specially procured implements for land preparation. The issue of transport of products is discussed in later sections. The same organ providing transport for products may provide mechanization for land preparation.

93 Considering that land preparation for vegetables would be limited to phase 1 during the early stages of development, (year 1 to year 5 of the project) and that the vegetable area during this period would be quite small in both Alternative crop mixes, it is recommended that various options of preparing vegetable land on hire basis be tapped and tested. For the purpose of financial analysis, an average cost of land preparation for vegetable crops of N$ 120 per hectare will be used for the two crop mixes. This includes a chisel plough action and seedbed preparation with an offset disc harrow.

94 The area of land allotted to lucerne is exactly equal to the area allotted to vegetables as a group in both crop mixes. However, lucerne land needs to be prepared only once every four years. The same arrangement proposed for vegetables would apply for lucerne land preparation, cutting and bailing. Estimated costs are N$ 92.00 per hectare for land preparation, N$ 70.00 per hectare for cutting and N$ 140.00 per hectare for bailing.

95 The issue of mechanization for spraying of vegetables is different from that of land preparation because (a) the need for spraying against pests and diseases is usually very urgent and (b) small relatively cheap and easy to handle manually equipment is available. Knapsack sprayers suitable for small vegetable areas or lucerne are recommended to be owned by each vegetable grower. A motorized type with a capacity of $\pm$ 16 liters costs about N$3 000, while the plastic manual type with a capacity of 5 liters will cost N$ 200. This equipment would be adequate for both crop mixes.

96 Mechanization of transport of tree crops produce at the time of harvest from farms to packhouses constitutes the major demand on machinery. Fortunately the harvest time of the three crops is ideally spread out over five months and the crops do not seriously compete for transport at any time. This is because the grapes require

transport in late November to mid January, followed by mangoes starting from mid-January to mid-March and dates during March and April. The only overlap is between the tail-end of the mangoes harvest and the early crop of dates when quantities harvested are expected to be small.

97 Naturally, the volume of produce of each crop requiring transport cannot be expected to be equally spread out over the harvest period as the volumes are usually small at the beginning and end of the harvest period and there is a peak in the mid-harvest period. Having different varieties of the same crop would bring about the changes of the volumes of produce harvested during the harvest period. The assumption made for the peaks of harvest are as follows:

Grapes:	75%	during 1 December to 20 December
Mangoes:	65%	during 1 February to 28 February
Dates:	75%	during mid-March to mid-April

98 Grapes have the highest volume to be transported over the shortest period. Hence if adequate provision for transport is made for grapes, the same provision would be more than adequate for mangoes and dates. Vegetables constitute only a very small proportion of the total produce and farmers are expected to seek their own ways to transport their vegetables.

99 The first requirement for transport of tree produce arises in Phase 1 in year 4 of the project. Subsequently the first need for transport of produce arises in year 7 for AIU, year 8 in locations DD and CD (NSIU) and year 10 in TSIU. In addition, peak production of grapes is achieved in year 7 Phase 1, in year 10 in AIU, in year 11 in locations CD and DD (NSIU) and in year 13 in TSIU. This is long time frame for accurate planning during which change of circumstance may set in.

100 It is, therefore, proposed that provision for grapes transport is made for Phase 1 in order to arrive at a ton/km cost which would be applied to the rest of the irrigation units. The general trend is to have a tractor with 3 small trailers for every 20 hectares of grapes. Such a trailer can carry 84 crates with a capacity of 7-9 kg each. The load per run is therefore approximately 2 tons. The total cost of a 35 kW tractor with 3 trailers amounts to N$ 44.00 per hour and if an average speed of 2 km/h is assumed, the cost is N$ 11.00 per ton km. The average distance over which the produce need to be moved from the fields to the packhouses should be about 2 km. This assumption would apply for the two Alternative crop mixes.

P: ENERGY REQUIREMENT

101 The Most demanding activity for energy is the operation of the irrigation system. Details of electricity requirement for the irrigation system are worked out in Annex IV, Chapter IV. At project maturity the total power requirement is about 14 million KWH which works out at 0.48 KWH/m^3 of irrigation water. The requirement of phase 1 alone is 5.25 M KWH when all 320 ha are developed. The difference between the energy requirement for the two crop mixes is 6% following the difference in the total irrigation water requirement.

102 Electricity consumption for domestic purposes is estimated at an average annual rate of 10 000 KWH for medium-scale farmers and entrepreneurs and 2 500 KWH for smallholders. At these rates, and at full development, the total annual domestic electricity requirement is estimated at 0.65 million KWH . Energy requirement for cooling of produce is difficult to estimate as it depends to a large extent on the quantity of the produce and the cold storage period from harvest to transport to markets. As stated earlier a power demand of up to 20 MW for the whole project could be met from the upgraded network.

W: LABOR EMPLOYMENT

103 The estimated labor requirement for each crop is detailed in Annex VI, Chapter II. At full development about 0.96 million mandays are required annually. Taking account of the seasonality of labor demand by crops, it is assumed that an individual could be employed 200 days during the year. Accordingly, about 4 800 laborers will be employed by the project as permanent, semi-permanent and seasonal labor; an average of 2.67 laborers per hectare. The opportunity of female employment as seasonal labor is substantial, since females are usually preferred for crop harvest and packing.

104 Currently, such numbers are not available in the project area. In addition, on-going irrigation development in the project area would no doubt increase the demand for labor. However, it must be remembered that development of the project would take place gradually over eight years. As the demand increases, labor is expected to be attracted from the unemployed resource from the Karas and other regions of Namibia.

105 There is a need for skilled and semi-skilled labor to carry out the specialized crop cultural operations. While some experience is building up amongst laborers in the project area, special training programs should be planned for residents and new comers. This task would rest upon the proposed extension service.

CHAPTER IV

PROJECT ORGANIZATION AND MANAGEMENT

CHAPTER IV-PROJECT ORGANIZATION AND MANAGEMENT

A: MANAGEMENT CONCEPT AND STRUCTURE

01 The proposed management draws heavily from the Government agricultural policy and strategic guidelines for future irrigation development which focus on "*minimizing direct Government intervention in irrigation schemes by encouraging private sector involvement, and by promoting the principle that water users themselves should pay for the operation and maintenance of irrigation schemes.*" Since the Government is initiating the project and the design of the project conceives that the Government undertakes the initial development, the basic concept of management is for the Government to manage the physical development and subsequently assists farmers to establish their own management. Nevertheless, and as the Government needs to recover the development costs, land rent and other loans provided to farmers in the early stages of production, the Government should be represented in the top management structure instituted by farmers, with the main object of participating in policy making, monitoring and ensuring cost recovery. In addition the proposed Government representation would constitute an advisory element on technical matters and major management issues.

02 A Project Steering Committee (PSC) would be set up at the level of the MAWRD. It would be composed of representatives of relevant Government organs and would be chaired by a senior member from MAWRD. The present Technical Committee on Irrigation could, at present, act as a PSC. The main function of the PSC is to provide policy directives, assist in securing financing, draw development budgets, approve development contracts and supervise/monitor progress of development works. The committee would also draw terms of eligibility for land allocation, endorse land allocation and sign formal agreements with beneficiaries. The executive arm of the PSC would be a Project Coordinator (PC), who would be provided by the Directorate of Planning. His functions would be to execute the PSC decisions and directives, execute/coordinate issues related to financing, budgeting, development works, land acquisition and land tenure arrangements, entrepreneur or joint venture arrangements etc., that require contacts and coordination between the project and the other Government ministries, agencies and private sector. He would be a permanently co-opted member (non-voting) of the PSC. He would also be the direct link between the PSC and the proposed implementing organ.

03 The PSC would institute a Project Implementation Unit (PIU) within the Division of Agricultural Engineering. The function of this unit would be to execute development as directed by the PSC. The PIU would have a Manager accountable to the Deputy Director of the Agricultural Engineering Division who, in this capacity, is in turn accountable to the PSC. The PIU Manager would be responsible for all development works in the project area. All development works would be executed on competitive bidding and contracting with private sector.

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04 The Directorate of Research and Training would establish the Research and Development Unit on the Aussenkehr Government Farm. This unit would function as

a service unit for generation and dissemination of including conducting studies on farmers settlements, research, extension service and training.

05 At the field level the PIU Manager would have under him a Field Operations Manager (FOM) who is resident on the project site; and assisted by a technician. He would supervise execution of development works contracted to private sector, promote the formation of a land allocation organ and assume its chairmanship, supervise phase 1 and assist in formation and capacity building of farmers' institutions/groupings. Practically, he would be the MAWRD representative for implementing the developments work in the project at the field level.

06 A Project Land Allocation Committee (PLAC) would be set up locally, chaired by the FOM with membership including representatives of the Ministry of Local Government and Housing, Ministry of Lands, Resettlement and Rehabilitation, Regional Council, local population (e.g., councilor resident in Noordoewer) and local resident farmers. The main function of the committee would be to receive and vet beneficiary applications and to nominate individual farmers to hold land for final official endorsement by the PSC.

07 A manager dedicated to Phase 1 (MP1) would be appointed with accountability to the FOM. His Function would focus on assisting farmers, particularly smallholders, in farming practices, arranging for their training and provision of extension services, arranging for studies to be conducted on settlements and monitoring of the settlement venture in general. He would also assist in the formation and early stages of operation of farmers' institutions/groupings. He would also be a useful member to attend the meetings of the PLAC. He will continue on the job until all developments works in the project are completed.

08 Actual management of production would rest on the beneficiaries themselves. Such management, indeed, viably existed for the provision of irrigation water via the Noordoewer irrigation canal; namely, the Vioolsdrift and Noordoewer and Joint Irrigation Scheme. For each of the three proposed irrigation units a similar irrigation authority would be formed, thus there would be Noordoewer Irrigation Unit Authority, Tandjieskoppe Irrigation Unit Authority and Aussenkehr Irrigation Unit Authority. The function of these authorities would be to operate the irrigation networks to farm gates; i.e., to the last point of the main works to the point of entry into farms. Each farmer would operate the irrigation system within his farm. The authority would be responsible for collection of water cost including repayment of Government capital cost of irrigation works and for collection of land rent, loans and other dues to the Government. As the Government has a stake in the proper functioning of the irrigation unit until it recovers its costs, each irrigation unit authority would have a representative from the Division of Agricultural Engineering. While the development work is on-going, this representative would be the FOM. The chairman and other members of the irrigation authority would be elected by and from amongst the farmers operating in the same irrigation unit. Where both smallholders and medium-scale farmers are operating in one unit, the membership of the authority would be shared equally between the two categories. The Noordoewer Irrigation Authority would include in its membership the MP1. A set of rules and regulations

would be laid by the PSC for the institution and functioning of the irrigation authorities. Such regulations should be set in a manner which would officially empower the Authority to carry out its functions. The irrigation works to farm gate would be operated under the close supervision of the FOM from the time of commissioning until all land in the irrigation unit is developed as well as during one year after completion of land development, i.e. from start of planting of the first developed area to the planting of the last area in the irrigation unit. When it takes over the irrigation works, the authority could appoint its own staff or contract private sector to operate and maintain the irrigation works according to its preferred option.

09 A farmers' grouping would be needed to assist farmers to secure their production inputs, marketing facilities (packing facilities and cold stores) and to market products. Such grouping would be a cooperative or any other form opted by farmers.

10 The above management concept was discussed and accepted by the TCI, particularly the concept that the Government will manage the physical development of the project. Figure (IV.I) shows the proposed general organization structure of the project.

Monitoring and Evaluation:

11 The PSC would constitute a Monitoring and Evaluation Unit (M&E) within the Directorate of Planning. Terms of reference for the operations of the unit would be clearly drawn and circulated to all those concerned with project in order to permit the unit perform its functions. The unit would be accountable to the PC.

Reporting:

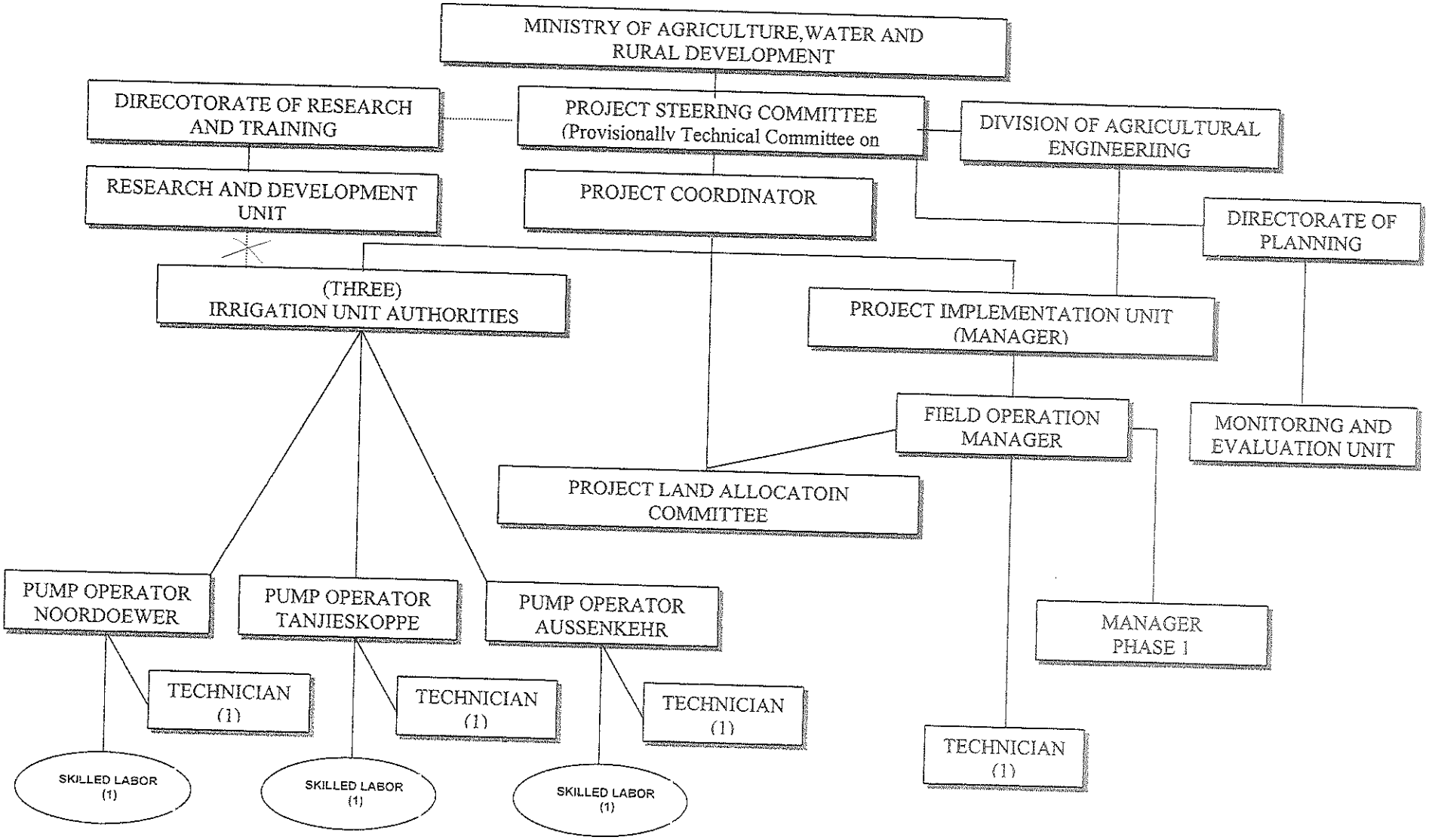
12 A set of directives would be drawn by the PSC to commit all concerned with the project to a system and procedure of reporting. The FOM would prepare a weekly report on the progress of implementation at a field level to be forwarded to the Manager PIU. A monthly report would be submitted by the Manager PIU to the PC. Through the Deputy Director of the Agricultural Engineering Division. Urgent matters requiring immediate action could be reported to the PC at any time.

13 The M&E unit would report monthly about all matters concerning the project to the PC. Based on the monthly reports from the PIU and the M&E the PC would report monthly tot the PSC. A project review report would be issued by the PSC every three month.

B: SETTLERS

14 Settlement of farmers will include both smallholders (in 4 ha farms) and medium-scale-farmers (in 40 ha farms) in Noordoewer and Tandjieskoppe units. The net irrigable area will be shared equally between the two categories. Settlement in Aussenkehr unit will be limited to entrepreneurs. The number of settlers and rate of settlement is determined by the rate of land development and the proposed settlement pattern is depicted in table (IV.1)

Figure (IV.1):The Proposed Project Management Organogram



15 The PSC should first obtain the necessary legal arrangements that enable it to allocate the land to farmers on behalf of the Government. Accordingly, it would draw criteria for selection of farmers and conditions for land allocation. It would also sign an agreement with selected farmers on behalf of the Government. Some important points to be included in the criteria for farmers' selection are:

- Experience with agriculture; and being a farm laborer in the area provides this experience for the prospective smallholder settler. The General Manager of the private Aussenkehr Farm suggested that including labor supervisors now working in his farm, who are highly experienced, in the newly created community will help to teach and train other settlers. This suggestion is very valid and should be considered by the PSC.
- Medium size farmers should have had experience in running their own farms or in managing other farms.
- Hard work, desire and having a vision and ambition. This criterion could be quantified by local leaders in Noordoewer.
- Recognizing the high percentage of women headed households; in addition to the hard-working nature of women in this area it is recommended to include a number of women in the selected smallholder settlers. It is worth mentioning that women constituted 65% of the labor force which executed the water pipe works in Noordoewer and that crop harvest and packing is done mainly by women. Even a concept like "husband of the farmer" is not so strange around here. Women applicants for medium size farms and entrepreneur farms should also be considered.
- Literacy is preferred that is, grade 7 and up for the smallholders. But illiteracy is not necessarily a problem, because it is not always too late to learn, especially if the illiterate is a hard-working ambitious person and has an experience with irrigated farming. Medium size farmers must be literate.
- Priority in selection should be given to local inhabitants in the Noordoewer-Aussenkehr area, especially because the area includes settlers from all parts and from all ethnic groups in Namibia.
- The prospective settler should be married, and his family must accompany him.
- The prospective settler must agree to an on-the-job training period as a trainee farmer, be receptive to extension services and make himself familiar with agricultural technologies.
- Financial ability is a pre-requisite for entrepreneurs but to a lesser extent for medium size farmers.

Table (IV.1)

Number of Settlers and Rate of Settlement

Project Year, Irrigation, Unit and Proposed Area Development	Type of Settlement	No. of Settlers		
		Smallholders	Medium Scale Farmers	Entrepreneurs
Year 2				
NSIU - 160 ha	SH+MSF	20	2	-
Year 3				
NSIU- 160 ha	SH+MSF	20	2	-
Year 5				
AIU - 360 ha	ENT.	-	-	9
Year 6				
AIU - 400 ha	ENT.	-	-	10
NSIU - 160 ha	SH+MSF	20	2	-
Year 7				
NSIU - 240 ha	SH+MSF	30	3	-
Year 8				
TSIU - 80 ha	SH+MSF	10	1	-
Year 9				
TSIU - 240 ha	SH+MSF	30	3	-
Total - 1800 ha	All TYPES	130	13	19

Notes:

SH = Smallholder,

MSF = Medium Scale Farmer

ENT = Entrepreneur Farmer

NSIU = Noordoewer State Irrigation Unit

TSIU = Tandjieskoppe State Irrigation Unit

AIU = Aussenkehr Irrigation Unit

Settlers Training

16 Training of all farmers chosen for settlement in the project is crucial for the success of the farming enterprise. It should be looked upon as a long-term process to cope with the changing nature of growth and production of tree crops and to provide farmers with new proven technologies. The task of training would be entrusted to the proposed Research and Development Unit to be established in AGF. The unit would draw an initial training program for the selected farmers, preferably based on the experience with the smallholder settlement in AGF. The agricultural extension expert in the unit would be responsible for organizing the training program. The curriculum would preferably include:

- Briefing about the project objective and organization, particularly the concept of beneficiary operated project.
- The role of the Government.
- The role of farmers as individuals in their farms and as a group operating an irrigation unit.
- Project rules, regulations and code of conduct.
- Farmers' obligations towards their farms and towards the irrigation unit.
- Land tenure arrangements.
- The fact that the project is based on cost recovery of specified capital items and full cost recovery of operational costs.
- Amounts and purposes of loans provided and conditions and methods of repayment.
- The merits and need for farmers' associations, cooperatives and other collective groupings.
- The irrigation system and its management particularly at field level.
- General farm management aspects including planning, organizing, entrepreneurial skills, control, etc.
- Farm records and account keeping.
- Personal financial management.
- Crops and crop husbandry practices.
- Importance and need for high quality produce.
- Product processing and marketing.

17 The initial training period may also be used to evaluate the aptitudes and general suitability of the prospective farmers. Where serious undesirable qualities are discovered, the case would be passed to the PSC for replacement of the farmer.

18 After allocation of land, training would be continued through the extension service. This would be designed according to cropping practices in the field. Particular attention would be given to the practices involved in establishment of tree crops. Handling of agro-chemicals and protection against their harmful effects would receive special attention. Training would cover almost every crop husbandry practice for new farmers. Gradually training would be limited to newer issues that arise and to recent developments in technologies of crop production.

C: PROVISION OF TECHNICAL SUPPORT

19 A rational justification for the establishment of a Research and Development Unit (RDU) in AGF was made in Annex II, Chapter VI. The conclusion was reached that development of the agricultural potential along the Orange River could not be conceived without strong technical backstopping which should be provided by the Government.

20 Thus, and concurring with the Government research policy, it is proposed that the Government establishes a "Research and Development Unit" with the object of promoting agricultural development in the Orange River area which would initially focus on the present project and on the planned irrigation development in Aussenkehr Government Farm. The presence of the Government Farm at Aussenkehr offers an excellent opportunity for the establishment of such a unit as it could avail land, irrigation infrastructure and other basic needs and facilities for the unit to be established in the most relevant agro-environment to the Orange River. The unit is seen as a Government obligation to provide research, extension and studies, which are vital for the development of irrigated agriculture along the Orange River. Indeed, and in this context, it is recommended that the Research and Development Unit be established immediately irrespective of the implementation of this project. If for any reason the project is not implemented, the unit would still be needed to serve the potential development undertaken by private sector along the Orange River. The cost of establishing and operating the proposed unit would be fully borne by the Government as part of its obligation to generate and disseminate farming knowledge.

21 The mandate of the unit is to include:

- Collecting, documenting, reformulating and disseminating technical knowledge available locally and abroad regarding crops and crop husbandry practices relevant to the Orange River environment.
- Planning and implementing appropriate adaptive research and on-farm trials aiming at problem-solving through a farming system research approach. The involvement of farmers in the planning stage of research would be crucial for identification of their problems and needs.
- Studying all aspects of the settlement established in the Government farm to make use of its results in the project settlement venture. Continue studies on project settlement with the aim of solving problems and introducing necessary modifications.
- Extending advisory services to farmers to encourage them to adopt proven improved practices. The main focus would be on smallholder and medium-scale farmers.
- Farmers training on appropriate agricultural practices.

22 The unit would be under the Directorate of Research and Training of the MAWRD. Additional buildings for offices, laboratories and staff housing would be

required. Staffing of the unit with qualified and experienced researchers is at present not possible because the Directorate of Research and Training is thinly staffed. The main problems facing recruitment of research staff are the unavailability of qualified Namibians and the inability to attract foreign researchers who would accept the Government salaries and terms of service. Under these conditions it is recommended that the operation of the unit be contracted as a package to an appropriate research institution. The most relevant would be one of the South African institutions (a research organ or university) involved in agricultural research, preferably in a similar environment to the Namibian bank of the Orange River. Namibia has already established relationships with the South African Agricultural Research Council through which such an agreement could be reached. In this case an element of free technical assistance from RSA may be sought.

23 The advantages of such an arrangement include:

- Provision of technical backstopping by a wide range of expertise operating within the research institution in the different specialized disciplines. This would cut down the need for employing resident permanent highly qualified staff solely for the proposed unit as the contracting agency would use its experts on a part-time basis to provide technical support.
- Drawing of research plans would be based on and would make use of research results already available from a similar agro-environment and from on-going experimentation in the home of the contracting institution. In essence, there would be an element of complementarity such that research which is on-going in the home of the contracting institution need not necessarily be repeated in the unit. In such cases the unit would only conduct site-verification trials to establish validity of results. However, the unit would have to carry out some of the location specific studies as needed to target location specific problems.
- Implementation of plans would require the minimum number of highly qualified resident staff, e.g., one station director. However, a number of technicians would be needed for field and laboratory work which would be supervised by the director on a full-time basis and would be monitored and followed up on a part-time basis by the technical staff of the institution who have originally drawn the work plans.
- Highly technical laboratory investigations could be carried out in the contracting agency laboratories. The volume of such work is not expected to be large, though it may be very crucial. This arrangement would cut down expenditure on expensive laboratory equipment and highly qualified and paid laboratory technicians.
- The pool of expertise within the contracting agency would serve as subject matter specialists when needed by the extension service.

24 In addition to contracting for the operation of the Research and Development Unit, the Namibian Government may also seek the help of relevant international and national agencies to provide technical assistance in specific fields. An example is the International Fund for Agricultural Development (IFAD) which is interested in and provides assistance to governments to promote smallholder agriculture. The South African Research Organizations may also be approached to provide assistance to the unit.

D: PROVISION OF SERVICES

25 As described in Annex III, Chapter III, the settlement of Noordoewer has some of the basic services such as those relating to health, education, electricity, communications and transport. There is also a business nucleus. In addition plans have already been approved for two small townships, one in Noordoewer and the other in Aussenkehr Government Farm. Some services are included in the township plans.

26 The selected project sites are located in-between the two planned townships; with NSIU lying in close proximity to Noordoewer Township, AIU in close proximity to Aussenkehr Township and TSIU at about 8 km to the north of Noordoewer. The assumption is, therefore, made that there is no need to plan for project specific services which are already in place or are being planned. Settlers are expected to make use of these services as the distances involved are quite small.

27 As detailed in Annex IV, Chapter IV, each settler in NSIU and TSIU will be provided with a house which is amenable to future extension. Each house is provided with a kitchen, bath room and sewage disposal. Electricity supply will be in place. Within each irrigation unit, the community is expected to arrange for its own residence-related services.

E: LAND AVAILABILITY

28 The gross area on which the project will be established is 2 160 ha of which an area of 1 212 ha is on State land and 948 ha is free hold land on Aussenkehr Farm. This area was evaluated according to the results of the soil reconnaissance survey and was found to be well suited for high value tree and seasonal crops. In addition, three two-hectare strips on private land will be required for pump stations and main pipelines. Project requirements from State land pose no problems as land is already under the complete jurisdiction of the Government. The Government will take the necessary legal action to demarcate and register the land. Land required for pump stations and main pipes must be bought and held by the Government. Farm land on Aussenkehr Farm is assumed to be bought by the Government. Purchase of private land by the Government can be made according to the Commercial Agricultural Land Act, 1995. Land for the establishment of a Research and Development Unit is available on Aussenkehr Government Farm.

F: WATER ARRANGEMENTS

29 As stated earlier in Chapter II of this report the issue of water availability from the Orange River is still under negotiation between Namibia and RSA, hence there is no agreement. The future national legislation and arrangements governing abstraction of water from the river can only be drawn in line with the terms of a finalized agreement. The current national arrangements for water use are based on the provisional agreement/understanding that entitle Namibia to draw 50 M m^3/a free of charge. MAWRD has already issued permits for abstraction of 48.58 M m^3 /a free allocation and 22.88 M m^3/a at costs. The total amount of water for which permits have been issued exceed Namibia's entitlement. However, the actual annual consumption was only 23.25 M m^3/a as estimated in September 1998. This estimate does not include the 360 ha under development by Namibia Grapes Company. Even if present consumption stays as it is in September 1998 (which is highly unlikely) the requirements of Namibia Grapes Company together with the proposed project 1800 ha estimated at 16 664 m^3/ha/a will be about 36 M m^3/a. When this is added to present consumption, the total will be about 59 M m^3/a which exceeds Namibia's historic entitlement from the Oranges River water.

30 Notwithstanding the above assumptions and if Namibia decides to implement phase 1 only with an abstraction requirement of 4.7 M m^3/a then free water will be available within the Namibian historic entitlement. However, the question of water availability for the project must be reviewed concurrently with taking the decision to finance part or all the project, as financing could only be secured after an unquestionable guarantee of the availability of irrigation waters.

31 As stated earlier an Irrigation Authority would be instituted amongst the beneficiaries of each irrigation unit and the government would be represented by one member. The authority would be autonomous and would sign an agreement with each farmer specify the conditions of provision and use of irrigation water. The government representative would be the link between the beneficiary and the PSC

G: PROJECT STAFFING

32 According to the proposed management arrangements, staffing of the project will be provided by both the government and the beneficiaries. The government staff consist of:

- The Project Coordinator.
- The Manager Project Implementation Unit.
- The Field Operation Manager, assisted by a technician.
- The Manager Phase 1.

33 In Addition, management support would be provided by PSC (or TCI), the staff of the Directorate of Planning and the Division of Agricultural Engineering. If need arises, support would be provided by any of the relevant MAWRD staff.

34 It is proposed to manage the irrigation system of each irrigation unit by an Irrigation Authority. It basically consists of an Irrigation Board, which is elected from

the farmers themselves and its staff will consist of a qualified operator with suitable equipment to operate and maintain the automated pump stations, electrical equipment, pipelines and sedimentation dams. The operator would be assisted by a technician and skilled laborers. As the major activity of the manager would be the maintenance of the irrigation system, the cost of the management and operation would be built into the maintenance cost of the various irrigation components.

H: IMPLEMENTATION SCHEDULE

35 The Implementation is designed in the light of the following considerations:

a) A pre implementation core management should be in place including establishment of PSC, PIU, RDU and Nursery, and appointment of staff..
b) The present study has evaluated land and soil suitability by conducting a reconnaissance soil survey. This level of survey is meant to differentiate between the different soil types and locates the suitable soil types within approximate boundaries. When a decision is taken to implement an irrigation project, it is usual to conduct a detailed soil survey, whereby an observation is made for every ten hectares, in order to determine soil boundaries precisely before construction of irrigation works.
c) Maps provided by MAWRD for the purpose of the study show contour lines at intervals of 20 m allowing for a preliminary irrigation design. Topo-maps showing contour lines at intervals of one meter are required for final irrigation design.
d) Detailed geo-technical site investigations are required.
e) Based of results of these activities final irrigation design would be made other engineering designs would be commissioned.
f) Arrangement for acquiring private land for the construction of pump houses must be made.
g) Depending on the land tenure status of the identified land on Aussenkehr Farm at the time of decision making, the Government would have to arrange for the most appropriate method of land tenure which it deems necessary for inclusion of land into the project. It is assumed that the Government would purchase all the land required by the project.
h) The issue of water availability must be resolved before implementation.
i) Proposal regarding services (Research and Development Unit) to be based on Aussenkehr Government Farm must be in place before implementation.
j) Land development would take place according to the proposed phasing. Land development includes construction of the irrigation system, buildings, houses, roads and stores.
k) Project year zero would start immediately after a decision is taken to go a head with the project and would end when actual implementation starts. Figure (IV.2) depicts the pre-investment implementation schedule. The implementation of development has already been illustrated in figure III.1 entitled phasing of development of project sites.

Figure (IV.2) **Pre-Investment Implementation Schedule**

Activity	0	1	2	3	4	5	6	7	8	9	Implementing Organ
A- Pre-investment											
Establish PSC											MAWRD
Settle Water Availability											Government MAWRD
Obtain Necessary Authorization for the PSC to act as Project Implementation Agency											MAWRD
Appoint Senior Government Staff											MAWRD/NDC
Establish RDU in AGF											MAWRD/NDC
Commission Engineering Design											PSC
Establish Nursery in AGF											MAWRD/NDC
Conduct Soil and Topographic Surveys											
Establish Land Allocation Committee											PSC
Settlement of Land Tenure Arrangements											PSC
Draw Farmers Selection Criteria and formulate Various Agreements to be Signed by Farmers											PSC

CHAPTER V

PRODUCTION AND MARKETS

CHAPTER V- PRODUCTION AND MARKETS

A: CROP YIELDS AND PRODUCTION

Yield Projections:

01 Projections of crop yields are discussed in Annex II Chapter V. Use has been made of previous studies conducted in the project area and in similar agro-environments. In addition, information collected by the Consultant from practicing farmers in Noordoewer and Aussenkehr was given special consideration. It is assumed that there would be a concerted effort by the Government to provide technical advice and training to farmers and laborers through a strong extension service backed up by adaptive research in the project area. It is also assumed that no serious constraints would arise regarding provision of irrigation water or production inputs.

02 Due to the significant role played by crop yields in the process of determining the project viability, yield projections, as prepared by the Consultant, were discussed by the TCI in its meeting of 8th April 1999. It was agreed that the following yields are well justified and could be attained by farmers and hence they could confidentially be used for the various project viability analyses:

a) Tree Crops:

Crop / Year After Planting	Projected Yield Tons/ha
Table Grapes:	
1 and 2	0.0
3	3.0
4	7.5
5 onwards	12.5
Dates:	
1 and 3	0.0
4	1.2
5	2.4
6	3.6
7	6.0
8	7.5
9	9.0
10	10.0
11	11.0
12 onwards	12.0
Mangoes:	
1 and 2	0.0
3	2.0
4	8.0
5	15.0
6	25.0
7	30.0
8 onwards	35.0

b) Lucerne:
Projected yield is 35 tons/ha per year of air-dry forage for a crop life-span of four years.

c) Vegetables:

Crop	Projected Yields Tons/ha
Tomatoes	70
Onion	25
Sweet Melon	20
Sweet Potato	40

Production:

03 Production is primarily governed by the area allocated to the individual crop according to the crop mix and to the phasing of development. In addition production of the tree crops starts low after trees reach their physiological productive stage and increase gradually until trees reach their maturity. Detailed calculations have been undertaken in Annex II, Chapter V showing production of each crop on yearly bases for phase 1, and for the project as a whole in accordance with Alternatives 1 and 2 crop mixes.

04 Lucerne and vegetables production is subject to variations in crop areas. It may be recalled that the crop mix for smallholder includes one hectare for each of the lucerne and vegetables during the first four years of farmers' settlement. From year five onwards the area allocation for each of the lucerne and vegetables is reduced to half a hectare. As a result the maximum total area cropped will be realized in year 9, but the area will stabilize in year 13; for details refer to Annex II, Chapter V. this pattern of area changes does not occur with regard to alternative 2 crops as the areas of lucerne and vegetables are fixed through out the life of the project:

05 At complete area development and full production maturity of tree crops the annual production of the various crops would be as follows:

Area and Production, Phase 1

Crop	Alternative 1 Crop Mix		Alternative 2 Crop Mix	
	Area (ha)	Production (Tons)	Area (ha)	Production (Tons)
Grapes	160	2000	256	3200
Dates	52	624	-	-
Mangoes	52	1820	32	1120
Lucerne	28	980	16	560
Tomatoes	7	490	4	280
S. Melon	7	140	4	80
S Potatoes	7	280	4	160
Onions	7	175	4	100

Area and Production, Whole Project

Crop	Alternative 1 Crop Mix		Alternative 2 Crop Mix	
	Area (ha)	Production (Tons)	Area (ha)	Production (Tons)
Grapes	1128.00	14100.0	1440	18000
Dates	321.00	3852.0	152	1824
Mangoes	169.00	5915.0	104	3640
Lucerne	91.00	3185.0	52	1820
Tomatoes	22.75	1592.5	13	910
S. Melon	22.75	455.0	13	260
S Potatoes	22.75	910.0	13	520
Onions	22.75	568.8	13	325

Quality of Produce:

06 The suitability of the proposed crops to the project agro-environment is discussed and established in Annex II, Chapter II. Within the suitable environment for crops the primary determinant of the quality of any agricultural commodity is the genotype of the plants grown. The cultivars/varieties which are recommended for planting in the project possess high quality characteristics that are acceptable in Cape Town and European markets. Another determinant of the quality is the farming practice followed to produce the commodity. Farmers' knowledge and skills will be augmented by extension services and training in order to ensure the adoption of practices that result in high quality produce. However, it is not usual to produce fruits and vegetables which conform fully to the quality standards of sophisticated markets. Based on the experience of farmers in the project area, it is estimated that 80% of the fruit production is of high export quality and the remainder is of lower quality and will be marketed locally. Only 50% of the vegetable crops are export quality and the remained will be for local consumption. All lucerne production satisfies the local market.

B: MARKETING

General:

07 Marketing is a crucial element of irrigated farming of seasonal perishable crops and Annex V, Chapter III has been dedicated to detailed considerations of this element. Although the main target is the export market, 20% of the lower quality produce must be marketed locally.

Local Markets:

08 The Namibian local markets for fruits and vegetables in Windhoek and other towns are small and lack the primary institutional and structural prerequisites of wholesale markets. As such, even the largest local market at Windhoek is not attractive to Noordoewer producers whose farms are equidistant from Cape Town and Windhoek, about 800 km to the South and North respectively. Wholesale merchants supplying Windhoek retailers with fruits and vegetables prefer to do so from Cape Town rather than from Noordoewer. This appears to be justified since they are able to

secure and transport their requirements of the whole range of commodities from one place. Obviously Noordoewer farmers can only supply a few items at a time and wholesalers have to reach Cape Town in any case for other items. It is estimated that 500 to 750 tons of fresh fruits and vegetables are imported every week from Cape Town market. In addition, small amounts of locally produced fruits and vegetables are marketed in Windhoek mainly from the back of trucks rather than through organized markets. Concerning the local markets in the vicinity of the production area, like Noordoewer and Oranjemund, they are very small and are not of interest to farmers. They cannot represent any present or future base for market development. Another feature in the local markets is that the rural people in most areas grow food crops exclusively for self consumption and the small quantities of the output of fruits and vegetables mainly from areas along the Orange River seek market outlets in neighboring South Africa.

09 The implementation of this project, the on-going and anticipated irrigation development in Aussenkehr Private Farm and the Construction of two planned Townships would no doubt result in a significant increase in the population of the project area. Concurrently, business activities would expand and a larger market for fruits and vegetables would evolve, at least for local consumption within the project area, but most likely also for neighboring areas. Such a market would no doubt absorb varying proportions of different commodities which do not meet the export market quality standards.

External Markets:

10 Cape Town market is very well organized and accommodates wholesalers who have appropriate experience to deal with all type of fruits and vegetables both at peak and off-season periods. Noordoewer farmers have well established connections with wholesalers in Cape Town market and the relationship between the two parties is based on a marketing commission of 13% of the sale price. Farmers arrange for the transport of their packed ready-to-market produce to be delivered to the wholesaler in Cape Town. Wholesalers can market produce either in Cape Town market or in European markets (mainly table Grapes). The existing practices as shown by the flow of horticultural products form Noordoewer and the neighboring farms along the Orange River towards the cape town markets proceed with the demand of the wholesalers of that market. Such produce is intensified by the regional orientation of South Africa Custom Union (SACU) member states including RSA, Botswana, Lesotho, Swaziland and Namibia.

11 The European grape trade is about USD 1.5 billion of which USD 500 million is imported from the Southern Hemisphere countries which usually supply the market during late November to June. Namibian grapes from the Orange River can be delivered to the European markets in late November and early December well ahead of the Chilean crop and at least two weeks earlier than the South African crop. Hence, there is a market for the early Namibian grapes both in South Africa and in Europe and there is a great market opportunity in the European markets after the South African crop is ready for marketing. The Namibian table grapes have an exceptional opportunity to fetch the highest prices in Europe which prevail in week 49 every year. For example, the very early Namibian crop fetches a price 30% higher than the South

African crop which reaches the European market two weeks later. It is noteworthy that Namibian table grapes exports to Europe have amounted to 1700 tons in 1995 and rose to 2800 tons in 1997. Aussenkehr Private Farm had marketed most of its 1998 crop in Europe.

12 Dates have an export market opportunity in both South Africa and Europe for dry dates (Tamr) and in the Gulf States for soft dates (Khalal). Namibian dates have the advantage of ripening six months earlier (or later) than the world's major producing areas in the Northern Hemisphere. Although the market for unripe dates in the Gulf States is not yet developed, the FAO dates specialist in Naimbia informed the Consultant that while investigating market opportunities for Naute Project dates in March 1999, he received orders for unripe Barhee variety khallal far in excess of what Naute Project could produce. It is worthy of note that unripe date consumption is a very common feature throughout the Middle-East and North Africa, where dates are grown.

13 Mangoes have a ready market both in Cape Town bad Europe. Having a longer shelf life and with a prolonged harvest period of about two months, the project production of mangoes could easily be marketed in Cape Town or sea-freighted to Europe.

14 The total annual production of lucerne at project maturity could reach about three thousand tons of air-dry hay i.e. an average of 250 tons per month. Such amounts are expected to be absorbed by the local market at the farm gate, which is the current practice in the project area.

15 The amount of vegetables produced in the project are relatively small and are expected to be marketed in Cape Town market without having a significant impact on the market.

16 Regarding prices in local and external markets they represent the producers prices influenced by the greater portion destined in export (80% of fruit and 50% of vegetables). The producers price set for the averages estimated from the export parity prices received at packhouses and the farm gate prices for the locally marketed portions for lucerne which is to be absorbed by the local market, the current farm gate price is used . details on prices are presented in Annex V Chapter III.

The Institutional Aspects:

17 The role of the Government in providing institutional framework to enable the efficient operation of markets and encourage private sector led growth is very important. The marketing frame work is to be designed in a way that ensure market access for all participants. The marketing needs of smallholders need special attention for facilitating the means by which they can have easy access to marketing services and facilities.

18 Individual farmers on their own, particularly smallholders, cannot meet the export market challenges. It may be recalled that the project concept includes collective beneficiary management for each irrigation unit. Indeed, farmers are in

greater need to market their produce in a collective manner. It is proposed that the collective organ should include fruit and vegetable growers along the Orange River; e.g. the Orange River Fruit and Vegetable Growers Association. Such an association would include both project and other producers and its main objective will be promotion of export oriented production and marketing of fruits and vegetables, for further detail see Annex V, Chapter V. This grouping can also initiate links and/or develop special relationships with the Grape Growers Association which was under constitution during the field work of this study.

Marketing Services:

19 The on-farm post harvest facilities are crucial when dealing with the horticultural export business. Therefore, the grading and packing requirement, refrigerated transport requirements, local processing units and cold stores together with the grading / inspection activities at the airports and the harbors are to be facilitated in order to minimize the risks of the producers in the project area.

20 Packhouses form an integral part of irrigation farming where grapes, dates, mangoes and vegetables are produced. Normally packhouses are only used for limited periods of the year and should therefore be operated efficiently to be cost effective. In the case where a number of crops are produced, the packhouses can be utilized much more effectively, because the crops ripen at different times of the year and usage of the packhouses can be spread out over a much greater part of the year.

21 Packhouses are very expensive, especially if cooling facilities are included. It is however of utmost importance that packhouses are properly designed and constructed, because it is of no use if great care has been exercised over the whole production season and good quality fruit is delivered to the packhouse, and it is then left to deteriorate or rot in the packhouse. The general trend for grape production in South Africa is to have a packhouse for each 50 ha unit. In the case of this project, three factors are taken into consideration; (a) projected yields in the project are about 25% to 35% lower than in South Africa (b) labor is abundant and the packhouse could be operated for longer hours per day, and(c) farmers are allocated adjacent 20 ha of grapes for each medium scale farmer and 20 ha for a group of ten smallholders (2 ha for each smallholder). It is, therefore, considered practical to have a packhouse for every 80 ha for grapes. These packhouses will then obviously be utilized for the packing of dates, mangoes and vegetables which would render the packhouses more cost effective. Packhouses will start on grapes in November, then mangoes then dates until the end of April.

22 In order to save costs., investigation could be done on suitability of having cooling facilities only at certain packhouses. Cooling facilities will therefore be centralized, which make management, storage and transport services much easier. This would require studies to be made in conjunction with actual areas planted to grapes. Packhouses will be designed to cope with incoming quantities of fruits and vegetables and their handling, washing, grading, packing and pre-transportation storage.

23 Packhouses are required only when grapes start to produce. There is therefore no need to construct packhouses earlier than required for operation. In addition, grape production starts in year 3 after planting and reaches its full level in year 5. Phasing of construction of packhouses has therefore taken into consideration the projected areas as well as the projected production of grapes. Due consideration was also given to the proximity of land to the packhouse. The first packhouse will be constructed in the phase 1 in the year three to handle the first grape production which is expected in year 4. Another packhouse will be constructed in year 4, subsequently packhouses will be constructed as required by the areas actually planted to grapes and with the necessary modifications indicated by the experience gained from the construction and operation of pilot farm packhouses.

Local Processing Prospects:

24 Processing of agricultural commodities is a highly specialized undertaking and must be conceived as such. A basic prerequisite is the production of commodities that are purposely grown for processing e.g. grapes for juice and wine, dates for production of alcoholic drinks, mangoes for juice and preservation and tomato for juice and paste. The present project is based on production of commodities for the fresh fruit and vegetable export market. Accordingly, crop varieties with specific production and quality characteristics were proposed. These are not necessarily suitable for the processing industry.

25 Notwithstanding the above considerations, the issue of crop processing can be investigated any time during the implementation phase. Perhaps phase 1 should be given a chance to operate before crop processing is considered. The Consultant is of the opinion that crop processing be left to private enterprise initiative.

CHAPTER VI

PROJECT BENEFITS, COSTS AND JUSTIFICATION

CHAPTER VI-PROJECT BENEFITS, COSTS AND JUSTIFICATION

A: INTRODUCTION

01 Based on the technical justification of the planning of implementation of the project, the costs and benefits illustrated for phase 1 and the overall project to be implemented in 3 phases (Chapter II), it is recognized that in the path of development, the pre-investment expenditures will be accomplished by the Government in year 0. The magnitude of investments geared to phase 1 in year 1 and year 2 with expected cash flows will be subject to separate financial and economic analyses. The government needs to justify the viability of the start of the project as a viable entity and then establish the viability of the whole project including the three phases. Therefore, the concern of the study at this stage is to prove that the mixed commercial/outgrowers with the entrepreneurship models in the area of horticultural development will serve both economic and social objectives. The impact of the project on the financial viability of the selected farm models for settlers (4 ha and 40 ha) will be investigated to justify if they represent an optimal size compared with other sizes that lead to a viable venture and at the same time optimal.

B: ASSUMPTIONS FOR THE FINANCIAL AND ECONOMIC ANALYSES.

02 The following assumptions were made:

i. The financial analyses in the study were run for the Pilot Farm of NSIU as Phase 1 of the project and for the project as a whole for a life period of 25 years following the pre-investment in year 0.
ii. The project capital costs that are subjected to loan disbursement and repayment schedules will be incorporated in sets of tables including both Phase 1 and the whole project.
iii. Physical contingencies at 4% were included. Price contingencies at 6% were estimated on the basis of the implementation schedules and expected increases of 9% on local costs and 3% on foreign costs per annum.
iv. The prices used to estimate the benefits from the crops grown in each irrigation unit are those given in Annex V, Chapter VI.
v. All prices expressed are those prevailing in 1999 and the exchange rate adopted to estimate the foreign exchange component is based on the rate of one USD = 6 N$.
vi. All capital cost items which have a life time less than the project life period have been replaced in the relevant financial order including contingencies. The residual values are considered with the remaining periods of capital and replaced items.
vii. Depreciation has been calculated using the straight line method. So each capital item has been depreciated according to the lifetime explained in Annex IV. Values of annual depreciation are shown in the set of tables of financial analyses.

viii. The project financial costs and benefits adjusted to economic costs and benefits that were used for the economic analysis were based on the following:

a) Imported materials mainly from RSA will benefit from intra-SACU imports regulations with a rate of 14% recovery to the Namibian economy on imported goods i.e. a conversion factor of 0.86 and adjustment factor of 0.14.

b) On domestic costs, only anticipated unskilled labor component in variable costs like harvesting will be adjusted by a conversion factor of 0.35. Variable costs are 70% foreign - 30% local on the average. Only 50% of the local expenses are unskilled labor. (-) 0.65 adjustment factor explains the acute unemployment status among unskilled people.

ix. The opportunity costs of capital is estimated at 12% conforming with commercial loan interest rate in the region.

x. The financial and economic indicators that will be used are; estimation of FIRR, EIRR, NPV, B/C, payback period and Break-even Point.

xi. Sensitivity analyses were made by; increasing investment cost by10%, decreasing revenues by 10%, increasing variable cost by 10%.

xii. According to the request of TCI four assumptions were set for the raw water cost estimates = N$ 0.00/m^3 ,N$ 0.10/m^3, N$ 0.20 m^3 and N$ 0.30/m^3. These assumptions are elaborated for Phase 1 and the whole project (table VI.III.1) implying further financial analyses of three scenarios. They represent additional sensitivity analyses calculations.

xiii. The financial analyses will be run on the base scenario with and without packhouses, but sensitivity analyses will be run for the condition without packhouses being the base scenario with which other options will be compared.

xiv. Other financial analyses will be run on any alternative to the base scenario, which could provide more convincing financial viability.

xv. The economic analyses will be run on the base scenario with the alternative crop showing viable financial returns.

C: PHASING OF THE PROJECT AND SCENARIOS

- **Phase 1 and All Units:**

The project is composed of three separate irrigation units, viz.; Noordoewer State Irrigation Unit (NSIU), Tandjieskoppe State Irrigation Unit (TSIU) and Aussenkehr Irrigation Unit (AIU). The proposal is to develop 320 ha out of 720 ha in NSIU as phase 1 of the project. A separate set of analyses, designated **Phase 1**, was run for phase 1 and a similar set of analyses, designated **All Units**, was run for the three irrigation units together representing the project as a whole.

- **Base Scenario; Scenario 2; Scenario 3 and Scenario 4:**

To ensure regular supplies for year-round irrigation of crops in this project requires special water regulation arrangements in South African dams and to do this RSA is asking for a price to be paid by Namibia. As the matter is still unresolved the

Consultant was requested by the TCI to run analyses for different river water costs. These analyses are designated:

- **Base Scenario** = River water cost zero.
- **Scenario 2** = River water cost at N$ 0.1 per m^3
- **Scenario 3** = River water cost at N$ 0.2 per m^3
- **Scenario 4** = River water cost at N$ 0.3 per m^3

– **Alternative 1 and Alternative 2:**

Alternative 1 design was based on a crop mix of 50% of the farm area to be planted to grapes and 50% to other crops in NSIU and TSIU and for both smallholders and medium-scale farmers; while, the crop mix for the entrepreneurs of AIU was designed for 80% grapes. Alternative 2 crop mix was formulated with 80% grapes and 20% other crops for all units.

D: PROJECT COMPONENTS

Pre-investment Costs:

06 The Government of Namibia would undertake the measures towards accomplishing the pre-investment tasks along the following assumptions:

a) Detailed soil survey for the selected project sites at the rate of N$ 120 per ha for the gross area identified as suitable for irrigated farming. The cost is based on the modified cost actually incurred by the Consultant for the reconnaissance soil survey.

b) Topographic survey for the gross area for each identified irrigation unit at the rate of N$ 100 per ha. To prepare topo-maps with contour lines every one meter.

c) Purchase of land for pump sites at both Noordoewer and Tandjieskoppe irrigation units at the rate of N$ 40 000 for 2 ha in each site.

d) Two vehicles to be used for the supervision of the pre-investment operations; one for the Project Coordinator and one for the Manager of the Project Implementation Unit. Both are stationed in Windhoek. The cost will be shared by the three irrigation units according to the net size of each.

The pre-investment costs amounting to about N$ 15.4 million are itemized in table (VI,1).

Capital Costs:

07 The Capital costs of the proposed project according to Alternative 1 crop mix envisaged as three independent irrigation units are estimated at N$ 234 million at current prices (without packhouses). Table VI.1 depicts the details of the capital costs and the phasing during the development period extending over nine years. For each year, starting from year zero, the investment costs are itemized in different categories for each irrigation unit destined to receive development expenditure in that particular year. The proportion of costs in local and foreign currency is shown in Table (VI.2).

08 the main investment costs and the replacement costs for phase 1 and the whole project are shown in tables (VI.1) and (VI.2) respectively. Depreciation has been calculated using the straight line method. So each capital item has been depreciated according to lifetime explained in Annex IV. Values of annual depreciation are shown in the set of tables of financial analyses in Annex VI.

E: FINANCING PLAN

The Financing Plan of the Project

09 The piloting phase of NSIU, (Phase 1) will be drafted in one financing proposal determining the magnitude of the soft loan to be negotiated with one or more donors. It is considered the feasible option to present Phase 1 in a separate financing proposal as a benchmark essential to be ready for quick financing. The remainder of the phases will then be set separately for loan negotiation.

10 For AIU where plots are allocated for entrepreneurs, the reasonable option is to seek a commercial loan agreement. Regional financing institutions like the PTA Bank of the COMESA will be interested in extending such commercial loans. Its main objective is the promotion of export capacities in food crops and inter-trade transactions in technologies and commodities among the country members. The impact of the project on the trade promotion on technologies and commodities between GRN and RSA meet the requirements of the PTA-Bank. The cost of finance is more and the loan repayment and grace periods are far less short than soft loan arrangements.

11 The Government commitments in the development of the three irrigation units are pre-requisite to ensure the supply of loanable funds from foreign sources. The earlier suggested Credit Guarantee Association could add to the viability of finance. In the different financing plans set for Phase 1 and the whole project, the Government commitments are about 30%. The government will seek a soft loan to meet the commitments in foreign exchange. Redemption periods and interest rates for loans will be 18 years for soft loan at 4% interest rate to be repaid in 13 years after 5 years grace period.

Table (VI.1) **Main Investment Costs**

Year	Pre-investment Costs		Total Irrigation Costs		Infrastructure and Logistics		Total	
	Phase 1	All Project	Phase 1	All Project	Phase 1	All Project	Phase 1	All Project
0	305800	15935200			-	-	305800	15935200
1	-	-	26397494	26397494	6827000	6827000	2639794	26397474
2	-	-	5730000	5470000	5730000	5730000	5470000	5730000
3	-	-			-	-	-	-
4	-	-		36389110	-	18004000	-	54393110
5	-	-		35898760	-	25010000	-	60908760
6	-	-		15394298	-	8675000	-	22269298
7	-	-		15629911	-	3727000	-	19356911
8	-	-		8205000	-	8605000	-	16810000
Total	**305800**	**15935200**	**31867494**	**141584573**	**12557000**	**76578000**	44730294	**234097773**

Table (VI.2) Replacement Costs

Year	Phase 1	All Project
6	325000	325000
7		
8		340000
9		297000
10		40000
11	325000	465000
12		
13		340000
14		297000
15		40000
16	6405000	15885338
17	6080000	6545000
18		340000
19		23204814
20		32323892
21	3520494	11958162
22		9009050
23		9415000
24		342000
25		310000
Total	**16855494**	**111807256**

12 The financing plans suggested for phase 1 and the whole project are shown in the financial analyses tables. It is anticipated that the local and foreign components will be 30 to 70% respectively. For the base scenario the capital cost of phase 1 will be N$67 658 151 while it is N$385 358 862 for the whole project. Loan reimbursement and interest are shown for Alternative 2 of the base scenario tables (VI.3-VI.6)

13 The management will keep record for each settler from the initial operation of the project. Such record will include all charges owed, payments made and balance of settlers account. The house annual rent is based on the construction cost and related loan from the AgricBank within 15 years of repayment. The development fee will depend on the investment cost in the foreign currency and related soft loan arrangement and also the portion in local currency which will be incorporated in the Government budget. The whole sum is to be apportioned for repayment in installments for 25 years. This method of financing of housing and development requirement will only apply to the smallholders and medium-scale farmers who will work with them. The entrepreneurs will be treated separately. They will only enjoy similar treatment on the portion of development expenditure that the Government will commit from its budget or loan arrangement on the basic infrastructure. No allowance

Financial Analysis

Table VI.3

TANDJIESKOPPE IRRIGATION PROJECT - *(ORIP)*- PHASE 1

Financing Plan Altern.2 (in N$)

Description	Total costs in N$			Total costs in US$		
	Namibia	Loan	Total	Namibia	Loan	Total
INVESTMENT COSTS						
Purchase of land	40,000	-	40,000	6,667	-	6,667
Pre-investment	265,800	-	265,800	44,300	-	44,300
Preliminary & General	1,584,551	-	1,584,551	264,092	-	264,092
Pump civil works	2,773,611	1,849,074	4,622,685	462,269	308,179	770,448
Mechanical installation	176,294	1,586,644	1,762,938	29,382	264,441	293,823
Power supply	208,500	1,876,500	2,085,000	34,750	312,750	347,500
Electrical installation	143,256	1,289,300	1,432,556	23,876	214,883	238,759
Main pipelines	771,240	6,941,160	7,712,400	128,540	1,156,860	1,285,400
Sub-main pipes	114,100	1,026,904	1,141,004	19,017	171,151	190,167
Dams	351,816	234,544	586,360	58,636	39,091	97,727
Land Preparation	1,152,000	768,000	1,920,000	192,000	128,000	320,000
On-Land Irrigation System	2,432,000	9,728,000	12,160,000	405,333	1,621,333	2,026,667
Trellises	2,560,000	10,240,000	12,800,000	426,667	1,706,667	2,133,333
House,Office,Store	446,400	1,785,600	2,232,000	74,400	297,600	372,000
Roads	42,000	28,000	70,000	7,000	4,667	11,667
Vehicles	31,500	283,500	315,000	5,250	47,250	52,500
Agicultural Equipment	-	20,000	20,000	-	3,333	3,333
	-	-	-	-	-	-
TOTAL - 1	**13,093,068**	**37,657,226**	**50,750,294**	2,182,178	6,276,204	8,458,382
				-	-	-
WORKING CAPITAL				-	-	-
Pumps Operation & Maintenance Costs	345,061	1,380,243	1,725,304	57,510	230,041	287,551
Irrigation Network Maintenance Costs	53,790	53,790	107,580	8,965	8,965	17,930
Management Costs	2,109,440	527,360	2,636,800	351,573	87,893	439,467
Land irrigation Maintenance	761,600	761,600	1,523,200	126,933	126,933	253,867
Crop Production variable costs	3,908,496	9,119,824	13,028,320	651,416	1,519,971	2,171,387
TOTAL - 2	7,178,387	11,842,817	19,021,204	1,196,398	1,973,803	3,170,201
Physical contingencies (4%)	523,723	1,506,289	2,030,012	87,287	251,048	338,335
Prices contingencies (6%)	832,315	2,397,373	3,229,687	138,719	399,562	538,281
Total contingencies	**1,356,037**	**3,903,662**	**5,259,699**	226,006	650,610	876,616
TOTAL	**21,627,492**	**53,403,705**	**75,031,197**	3,604,582	8,900,618	12,505,199
	28.82 %	**71.18 %**	**100 %**	**28.82 %**	**71.18 %**	**100 %**

Financial Analysis

Table VI.4

TANDJIESKOPPE IRRIGATION PROJECT - *(ORIP)* - ALL UNITS

Financing Plan Altern.2 (in N$)

Description	Total costs in N$			Total costs in US$		
	Namibia	Loan	Total	Namibia	Loan	Total
INVESTMENT COSTS						
Purchase of land	15,280,000	-	15,280,000	2,546,667	-	2,546,667
Pre-investment	655,200	-	655,200	109,200	-	109,200
Preliminary & General	4,157,469	-	4,157,469	692,912	-	692,912
Pump civil works	7,216,296	4,810,864	12,027,160	1,202,716	801,811	2,004,527
Mechanical installation	1,015,418	9,138,758	10,154,176	169,236	1,523,126	1,692,363
Power supply	482,000	4,338,000	4,820,000	80,333	723,000	803,333
Electrical installation	841,368	7,572,311	8,413,679	140,228	1,262,052	1,402,280
Main pipelines	2,832,508	25,492,572	28,325,080	472,085	4,248,762	4,720,847
Sub-main pipes	589,896	5,309,063	5,898,959	98,316	884,844	983,160
Dams	2,467,830	1,645,220	4,113,050	411,305	274,203	685,508
Land Preparation	6,480,000	4,320,000	10,800,000	1,080,000	720,000	1,800,000
On-Land Irrigation System	13,528,000	54,112,000	67,640,000	2,254,667	9,018,667	11,273,333
Trellises	14,400,000	57,600,000	72,000,000	2,400,000	9,600,000	12,000,000
House,Office,Store	1,539,200	6,156,800	7,696,000	256,533	1,026,133	1,282,667
Roads	384,000	256,000	640,000	64,000	42,667	106,667
Vehicles	90,000	810,000	900,000	15,000	135,000	150,000
Agicultural Equipment	-	142,000	142,000	-	23,667	23,667
	-	-	-	-	-	-
TOTAL - 1	**71,959,184**	**181,703,589**	**253,662,773**	11,993,197	30,283,931	42,277,129
				-	-	-
WORKING CAPITAL				-	-	-
Pumps Operation & Maintenance Costs	2,518,139	10,072,555	12,590,694	419,690	1,678,759	2,098,449
Irrigation Network Maintenance Costs	430,962	430,962	861,924	71,827	71,827	143,654
Management Costs	5,612,000	1,403,000	7,015,000	935,333	233,833	1,169,167
Land irrigation Maintenance	5,642,400	5,642,400	11,284,800	940,400	940,400	1,880,800
Crop Production variable costs	29,146,551	68,008,618	97,155,169	4,857,758	11,334,770	16,192,528
TOTAL - 2	**43,350,052**	**85,557,536**	**128,907,587**	7,225,009	14,259,589	21,484,598
Physical contingencies (4%)	2,878,367	7,268,144	10,146,511	479,728	1,211,357	1,691,085
Prices contingencies (6%)	4,529,868	11,591,819	16,121,687	754,978	1,931,970	2,686,948
Total contingencies	**7,408,236**	**18,859,963**	**26,268,198**	**1,234,706**	**3,143,327**	**4,378,033**
TOTAL	**122,717,472**	**286,121,087**	**408,838,558**	**20,452,912**	**47,686,848**	**68,139,760**
	30.02 %	**69.98** %	100 %	**30.02** %	**69.98** %	100 %

Financial Analysis

Table VI.5

TANDJIESKOPPE IRRIGATION PROJECT - (ORIP)- PHASE 1

Loan Reimbursement & Interests (in N$)

Alternative 2

Years / Item	0	1	2	3	4	5	6	7	8	9
Loan		29,566,205	16,181,975	4,933,734	2,721,790					
Total Loan after Reimbursement		29,566,205	45,748,180	50,681,915	53,403,705	53,403,705	49,295,728	45,187,750	41,079,773	36,971,796
Principale Reimbursement							4,107,977	4,107,977	4,107,977	4,107,977
Interests	-	1,182,648	1,829,927	2,027,277	2,136,148	2,136,148	2,136,148	1,971,829	1,807,510	1,643,191
Total Reimbursement	-	1,182,648	1,829,927	2,027,277	2,136,148	2,136,148	6,244,126	6,079,806	5,915,487	5,751,168

Years / Item	10	11	12	13	14	15	16	17	18
Loan after Reimbursement	32,863,818	28,755,841	24,647,864	20,539,887	16,431,909	12,323,932	8,215,955	4,107,977	- 0
Principale Reimbursement	4,107,977	4,107,977	4,107,977	4,107,977	4,107,977	4,107,977	4,107,977	4,107,977	4,107,977
Interest	1,478,872	1,314,553	1,150,234	985,915	821,595	657,276	492,957	328,638	164,319
Total Reimbursement	5,586,849	5,422,530	5,258,211	5,093,892	4,929,573	4,765,254	4,600,935	4,436,615	4,272,296

Assumptions of Financing:

Kind of loan:	Soft loan	
Loan amount (in N$):	53,403,705	
Loan amount (in US$):		8,900,618
Loan period:	18 years	
Loan repayment period:		13 years after 5 years grace period
Rate of interest:	4%	

Financial Analysis

Table VI.6

TANDJIESKOPPE IRRIGATION PROJECT - *(ORIP)*-

Loan Reimbursement and Interests (in N$) **(All Units)** **Alternative 2**

Years / Item	0	1	2	3	4	5	6	7	8	9
Loan		29,566,205	15,275,993	4,108,698	47,166,022	69,941,179	44,132,759	35,136,714	40,793,518	
Total Loan after Reimbursement		29,566,205	44,842,198	48,950,895	96,116,918	166,058,096	188,181,541	201,308,940	220,093,144	198,083,829
Principale Reimbursement							22,009,314	22,009,314	22,009,314	22,009,314
Interests	-	1,182,648	1,793,688	1,958,036	3,844,677	6,642,324	8,407,634	8,932,730	9,684,098	8,803,726
Total Reimbursement	-	1,182,648	1,793,688	1,958,036	3,844,677	6,642,324	30,416,949	30,942,045	31,693,413	30,813,040

Years / Item	10	11	12	13	14	15	16	17	18
Loan after Reimbursement	176,074,515	154,065,201	132,055,886	110,046,572	88,037,257	66,027,943	44,018,629	22,009,314	- 0
Principale Reimbursement	22,009,314	22,009,314	22,009,314	22,009,314	22,009,314	22,009,314	22,009,314	22,009,314	22,009,314
Interest	7,923,353	7,042,981	6,162,608	5,282,235	4,401,863	3,521,490	2,641,118	1,760,745	880,373
Total Reimbursement	29,932,668	29,052,295	28,171,922	27,291,550	26,411,177	25,530,805	24,650,432	23,770,060	22,889,687

Assumptions of Financing:

Kind of loan:	Soft loan			
Loan amount:	286,121,087	N$	=	$ 47,686,847.78
Loan period:	18 years			
Loan repayment period:		13 years after 5 years grace period		
Rate of interest:	4%			

is expected to apportion development expenses further than the purchase of land and the main pump mechanical and electrical installations. This will be collected as development fee in 25 years. The rest of development expenses are to be subject to loan reimbursement schedules with the current interest rate prevailing in he country. Normally such arrangement is to be channeled as a credit line with the AgricBank of Namibia. The same is expected with financing supporting services like mechanization, transport fleet and packhouses.

F: CROP ENTERPRISE BUDGETS

14 Gross margin analyses of the various crops are elaborated in Annex V, Chapter IV. It may be noted that the estimates of gross margins do not include cost of irrigation water which is treated as part of the operational costs as elaborated in the farm budget analyses of individual farms. Related to the actual financial setting of irrigation development. Such impact will be reflected in the net income of farm budgets. The highlights of the gross margin estimates are:

Tree crops show negative gross margins from the time of planting to first fruiting. Thus gross margins for table grapes and mango are negative for the first two years and those of date are negative for the first three years.

- Maximum gross margins are reached after planting in year five for table grapes, year eight for mango and year twelve for dates.
- Table grapes have by far the greatest maximum gross margin of N$104 915 per ha, followed by dates (N$52 100) and by mango (N$42 700).
- Tomato and sweet potato have similar gross margins N$ 47900 per ha and N$ 49180 per ha respectively. Sweet melon gross margin is N$ 41750 and onion has the lowest gross margin among vegetable crops; N$34540.
- The average gross margin. of all vegetables is N$ 43342.
- Lucerne has by far the smallest gross margin amongst all selected crops being N$ 14100 in year 1 of planting and N$15150 in year 2 to 4.

G: FARM BUDGETS

15 The gross margins of individual crops were used to work out the farm budgets for the various farm model according to the two alternatives crop mixes, for details refer to Annex V, Chapter IV, and Annex VI, Chapter III. A summary of annual net incomes is shown below:

Farmer Category	Alternative 1 Crop Mix (N$)	Alternative 2 Crop Mix (N$)
Smallholder (4 ha)	252280 (From year 16 onward)	309109 (From year 16 onward)
Medium-Scale (40 ha)	2631199 (From year 16 onwards)	3407470 (From year 16 onward)
Entrepreneur (40 ha)	3774080 (From year 10 onwards)	3774080 (From year 10 onwards)

It is clear from the above figures that the annual income for all categories of farmers are substantial.

H: PROJECT OPERATION COSTS

16 The project Phase 1 and the whole project involve sets of fixed and variable costs, the fixed costs will include pumps operation and maintenance, the irrigation network maintenance cost, the on-land irrigation system maintenance and the management costs. The variable costs are represented by the production expenses on crop enterprises. The details are explained in Annex VI the summary of fixed and variable costs for phase 1 and the whole project are shown in table VI.7. the table represents the situation under Alternative 1 of the crop mix.

I: PROJECT BENEFITS

17 The project phase 1 and the whole project involve sets of costs inflows depending on the annual value of crops sold and the residual value of the assets. The total sets are illustrated in the table of financial analyses in the appendices of Chapter III of Annex VI. For phase 1 the set of value of production for Alternative 1 range from N$ 1626000 in year 2 to N$ 26538500 in year 21 onwards. For Alternative 2 the value of Production range from N$ 605600 in year 2 to N$ 41851200 in year 10 onwards

18 Concerning the inflows of the whole project the sets of value of production under Alternative 1 range from N$ 1626000 in year 2 to N$ 210307250 in year 24. For Alternative 2 the value of production ranges from N$ 605600 to N$ 283160400 from year 16 onwards

J: THE RESULTS OF THE FINANCIAL AND ECONOMIC ANALYSES

19 Phase 1 of the project on part of NSIU (320 ha) Alternative 1 of the base scenario is the one with crop mix 50% Table Grapes of 25% lucerne, 25% vegetables for the first 4 years from year 5 onwards the crop mix will be 50% table grapes, 12.5% for mangoes, dates, lucerne and vegetables. By weighing the cost and benefits the result of the financial analyses are based on sets of the financial analyses as follows:

- Capital; Costs
- Financing plan
- Depreciation of the investments
- Residual values of investments
- Loan reimbursements
- Financial analyses on Zero cost of the river water (Base scenario)
- Sensitivity analyses (A) based on 10% of shortfall in project revenues)
- Sensitivity Analyses (b) bases on 10% in variable costs
- Sensitivity analyses © based on 10% increase on investment costs
- Financial Analyses with river water cost at N4 0.1 /m3 scenario 2
- Financial analyses based on river water costs at N$ 0.2 /m3 (Scenario 3)
- Financial analyses based on river water cost at N$ 0.3 /m3 (Scenario 4)

Table (VI.7) **Project Operation Costs**

Year	Variable Costs	Total Costs	Fixed Costs	Variables Costs	Total
1	0	659200	659200	0	659200
2	3682432	4957004	1819332	3682430	5501762
3	4426864	6368570	3031226	4426864	7458090
4	4366000	6307706	3031226	2246304	5277530
5	7196000	9803706	6055958	15890304	21946262
6	8718000	11325706	10161768	24924206	35085974
7	8746200	11353906	11501591	20140449	31642040
8	9100000	11707706	12358217	25844610	38202827
9	9408600	12016306	14208994	43624488	57833482
10	9673750	12281456	14198398	48716968	62915366
11	9811300	12419006	14176401	53535573	67711974
12	10077100	12684806	14158842	57276808	71435650
13	10145600	12753306	14158842	60601283	74760125
14	10168500	12776206	14158842	61601983	75760825
15	10168500	12776206	14158842	62196443	76355285
16	10168500	12776206	14158842	62587108	76745950
17	10168500	12776206	14158842	62945583	77104425
18	10168500	12776206	14158842	63389283	77548125
19	10168500	12776206	14158842	63477408	77636250
20	10168500	12776206	14158842	63536558	77695400
21	10168500	12776206	14158842	63477408	77636250
22	10168500	12776206	14158842	63477408	77636250
23	10168500	12776206	14158842	63477408	77636250
24	10168500	12776206	14158842	63477408	77636250
25	10168500	12776206	14158842	63477408	77636250

20 The similar elements were investigated for the base scenario (Alternative 1) for the whole project. The results of the financial analyses were as follows:

	Phase 1	**All the project**
Financial IRR	18.5%	17.3%
Discounted B/C ratio 12.0% discounted Rate	1.3	1.26
NPV(N$)	38316931	1292222.2
Payback period	Year 12	Year 15

21 The financial viability is more sensitive to shortfall in project resources. With 10% shortfall in revenue the IRR was 15.84% for phase 1 and 14.82 for the whole project. Similar impact was repeated when a change of a charge of N$0.3 /m3 was levied on water, more detail on the sensitivity analyses and the impact of water levies as alternative scenarios of the base scenario at zero cost of water are elaborated in Annex VI . the return to equity based on the financial results and interest on loans of 4.0% will be 50.3% for phase 1 and 44.3% for all the project. The results of the economic analyses for the base scenario alternative 2 as the =feasible option for both phase 1 and the whole project of comparing economic values of cost and benefits they were estimated as follows:

	Phase 1	**All the project**
ERR	19.39%	19.18%
B/C ratio (Discounted at 12%	1.35	1.36
NPV(N$)	4374042	176855226

22 The economic impact of the analyses will be as follows:

On foreign exchange:

The potential inflow of foreign income to Namibia will be attributed to the targeted 80% of the produce of fruit trees for export. This will amount USD 5.5 million for phase 1 alternative 2 and to USD 32.7 million for the whole project (Alternative 2). With a general declining trend in terms of trade expressed by 87.4 in 1995 compared to 1990 (100). Despite the little improvement in the last three year s export of fruit (80% of production) and vegetables (5)5 of production) from the project will have substantial impact on terms of trade. It will definitely reduce the deficit that used to occur in some years in the merchandise trade balance.

On Employment:

Concerning the creation of Job opportunities the expectation regarding the project are high. Based on the information form different studies the average annual labor required (mandays /ha) are: 636 for T. grapes. 144 for dates, 90 for mangoes 130 for vegetables and Lucerne . The overall impact on job opportunities on permanent, semi-permanent or seasonal bases will be as follows:

Labor Requirement in ALL Units (Alternative 2)

	Area	Mandays/ha	Total/Mandays
Grapes	1440	636	915840
Mango	104	90	9360
Dates	152	144	21888
Vegetables	52	130	6760
Lucerne	52	130	6760
Total	**1800**	-	**960608**

23 With the assumption of 200 mandays per person, the total employment effect is around 4803 persons will be employed either permanent semi-permanent or seasonal. The technical agricultural ; production capacities as well as market development capacities and the related human resources will be regarded as a valuable impact of the project for the region and the whole nation.

Implications on Government Budget:

24 Although the project draws heavily on the Government budget, the impact of the redistribution of ht national income to create commercial farmers from low income group could compensate in future the possible deficits in the GDP during short period

CHAPTER VII

ENVIRONMENTAL IMPACT CONSIDERATIONS

CHAPTER VII- ENVIRONMENTAL IMPACT CONSIDERATIONS

General:

01 Namibia's Environmental Assessment policy was approved in August 1999 by Cabinet Resolution 16.08.94/002 and has been proclaimed both within the country and internationally. The policy aims to promote sustainable development and economic growth while protecting the environment in the long term. The Ministry of Environment and Tourism is the chief Government organ responsible for ensuring a healthy Namibian environment.

02 The policy places a high priority on:

i. Maintaining ecosystems and related ecological processes, in particular those important for water supply, food production, health, tourism and sustainable production.
ii. Observing the principle of optimum sustainable yield in the exploitation of living natural resources and ecosystems, and the wise utilization of non-renewal resources.
iii. Maintaining representative examples of natural habitat.
iv. Maintaining maximum biological diversity by ensuring the survival and promoting their conservation in the natural habitat of all species of fauna and flora, in particular those which are endemic, threatened, endangered and of high economic, cultural, educational, scientific and conservation interest.

03 The policy recognizes the inherent need to incorporate adequate provisions to achieve "reduction-at-source" in the areas of pollution control and waste management.

04 Irrigated agricultural development in arid conditions has both positive and negative impacts on their environments. Usually the positive impacts outweigh the negative impacts which need to be mitigated in order to have an overall environment-friendly development. The TOR emphasize considerations of the impact of the abstraction of water from the Orange River, the effect of land preparation on erosion, the impact on the riverbank, the possible detrimental impact of crop chemicals on downstream users, the likelihood of soil salinization and the impact of more dense settlements in the area. The following sections will treat these issues together with other environment-related issues that result from the project.

Abstraction of Water from the River.

05 Annex IV discusses the whole question of water availability from the Orange River for the Namibian irrigation development. The Orange River is a highly regulated river and its flows are controlled mainly in RSA. Current situation of control takes into consideration the environmental requirements of the coastal wetlands situated in the river-mouth. In addition, current flows have developed a

recurrent regime of water levels to which aquatic as well as riverbank fauna and flora have been well adapted within the prevailing ecosystem.

06 The main impact on river flows will be the additional flows required for the project. Current flows are adequate for satisfying present abstraction rates and any additional flows should be regulated such that they are just sufficient to satisfy the requirements of the project. These additional quantities would be completely abstracted by the project at AIU pump site. Hence the project will not impose a different water flow regime downstream of the Aussenkehr Unit abstraction point. However the impact of the project on the abstraction of water from the Orange River should not be viewed as an isolated issue, because it is only a part of the impact that results from abstraction of water for all other purposes in future. As the whole question of ensuring Namibia's water demand form the Orange River is still subject to negotiation between the Governments of Namibia and RSA the impact of the project should also be assessed, together with other water uses, after a final agreement is reached between the two parties.

The Effect of Land Preparation on Erosion:

07 The project area is predominantly covered with gravel, common stones and few boulders. This cover is a good protection for the soil against wind erosion and is also a partial protection against water erosion. Removal of this cover to prepare land for cropping enhances erosion. However planting of crops and shelter belts will result in a vegetation cover which will provide a good protection against wind and water erosion. Indeed irrigated tree crops are a better protection of soils against erosion than stones and gravel.

Impact on the Riverbank.

08 The proposed land for development is located away from the riverbank. The only direct intervention by the project on the riverbank is the construction of three pump stations and a part of the main pipes. Land will be bought by the Government from owners who would receive a fair compensation. Construction will be limited to a very small area from which riverbank natural vegetation must be removed. This is viewed as inevitable but it is an insignificant impact on the vegetational cover because the area involved is very small.

09 It is likely that the construction of the pump stations will encourage growth of some species of aquatic vegetation in the immediate vicinity of the pump stations. This might initiate problems that threaten intakes of pumps or could even have some adverse effects on the hydraulic properties of the river channel. Such negative impacts are easily mitigated by routine clearance of pumps' intakes which should be a standard operational practice, to be included as part of the operational cost of the irrigation system.

10 The construction of an artificial structure will break the natural scenery of the riverbank. This is not necessarily undesirable as the architecture of the pump stations could be selected with a design that adds to the beauty of the riverbank.

11 The impact of pump stations on the stability of the riverbank depends on the location of the station and the design of the building. The sites chosen for the station are not expected to have a significant influence on the river flows and general hydrology. The design of the stations must take into consideration inclusion of the necessary structures to avoid any possible dangers to the riverbank that might result in erosion or silting.

Agro-Chemicals:

12 The soils chosen for the project are deep sandy soils characterized by high infiltration rates. They are also characterized by low chemical fertility, which dictates application of multifarious chemical fertilizers. Furthermore, the production of several different types of irrigated crops is apt to invite weed plants, insect pests and disease organisms. Hence the use of various chemical formulations such as herbicides, pesticides and fungicides becomes a necessary routine practice accompanied by dangers to both users and non-users in the project area..

13 The immediate danger is on farmers and their labor who must handle the toxic chemicals and apply them to the soil or to the crop. Intensive training of farmers to make them fully aware of the dangers must be made together with demonstrated means of protection against the hazards, in particular, protective clothing must always be worn and the correct techniques must be perfected. Special health care must be provided for farmers and their laborers who are involved in handling of chemicals. As far as possible priority of choice should be given to those appropriate chemicals which are least toxic to man and which have short residual effects such as those which are bio-degradable, decompose on contact with the soil or lose their chemical properties over a short period of time after application. As far as possible an integrated pest management (IPM) should be followed to encourage biological control and minimize use of chemicals.

14 The use of agro-chemicals in the project is not expected to have any impact on downstream users of the Orange River water. To do this chemicals must be leached through the soil or dissolved in run-off surface water and in both instances it should reach the river. This will not take place because:

- The cultivable area is located several kilometers away from the river.
- The rocky nature of the area between the cultivated land and the river does not offer an underground access for water to reach the river.
- Surface run-off is not expected to occur in view of the nature of the irrigation system used and the high infiltration properties of the deep sandy soils.

Soil Salinization:

15 Soil salinization depends on the nature of the soils, the quality of irrigation water and the amount of salts that are removed away from the farm by crop products. Soils which have been selected for the project are generally deep, sandy, non-saline, non-sodic and have high infiltration characteristics. However some saline and/or sodic patches were identified. A leaching factor of 15% has been included in the irrigation requirement of the project to off-set possible salinity problems. The quality of the Orange River, which is classified as CS_2-S_1 should not constitute any danger of salinization. Leaching of these light textured deep soils is an efficient mechanism for moving salts away from the root zone

Impact of More Dense Settlements

16 Increased density of population in any location is apt to be associated with some unfavorable impact on the environment resulting from inappropriate human activities. Considering the size of the gross area of the project (2 160 ha) and an influx of about 7 thousand persons (162 farmers with their families and about 4000 laborers mainly single and some others) the density of population would average 3 persons per hectare. i.e. 300 persons per km^2 which is a low density. Nevertheless attention must be given to providing labor camps with clean water and good sanitary facilities.

Impact on Bio-diversity

17 The project would have a favorable impact on bio-diversity. Currently the arid conditions do not offer a suitable environment for bio-diversity. The introduction of water and plants would attract a variety of domestic and wild animals, birds and insects both useful and harmful. Soils would be alive with increased variety and types of micro-organisms.

OUTSTANDING ISSUES THAT NEED TO BE ADDRESSED

OUTSTANDING ISSUES THAT NEED TO BE ADDRESSED

A few, but crucial issues need to be addressed by the Government before any further action can be taken. These are:

a) Availability of Irrigation Water:

It has been mentioned in various parts of the report that the issue of apportionment of the Orange River water is still under negotiation between Namibia and RSA. Currently Namibia's historic entitlement of water is accepted as 50 M m^3/a. Permits issued for the abstraction of water have already exceeded this limit. RSA has asked for N$0.50 to ensure every cubic meter in excess of historic entitlement, but this price was not accepted by Namibia. Hence, to-date neither the quantity nor the price of water required by the project are known in a definite manner. This issue must be resolved as an urgent priority.

b) Ensuring Availability of Land for the Project:

The possibility of purchasing private land for the pump sites for all the irrigation units and for farming on Aussenkehr farm need to be investigated. A policy decision should be taken as whether the Government would purchase land on Aussenkehr farm and re-allocate it to entrepreneurs as proposed in this study. If this is not acceptable the Government needs to decide on other alternatives.

According to information collected by the Consultant from various maps all state land included in the project area are not committed to any other purpose. However, State land is not mapped and not registered in the name of the Government. Hence the Government needs to map the required land and dedicate it to the project.

c) Transfer of Land Ownership and Water Rights:

The issue of whether the transfer of land from one owner to another entails an automatic transfer of water allocation has been a matter of controversy between some buyers and sellers in the project area. This issue must be resolved in particular with land to be bought from Aussenkehr Farms company.

d) Administrative Matters:

The study has proposed the institution of a Project Steering Committee (PSC) to be responsible for all matters regarding the project. It has also been proposed that the present Technical Committee on Irrigation (TCI) assumes the role of the proposed PSC for the time being. Depending on the progress of the project the Government needs to decide on one of the two options and draw terms of reference relevant to the project.

e) Credit Polciy:

Irrigated horticultural production is characterized by high initial capital and a long lead time between planting and full production. Maturity of

trees. This requires credit policies for short, medium and long term loans to be formulated to cater for farmers' needs involved in the development of irrigated horticulture . In addition the Government should cater for a special credit line for marketing services

f) Due to the shortage of technical knowledge in the Orange River Region in general the Government is in need to take a policy decision to expand its Desearch and extension services to that region. A Research and development unit should be instituted in the Aussenkehr Government Farm. Provision of extension services and training should be the main focus of the unit.

g) The Objective of the Aussenkehr Government farm need to be re-oriented so that the farm activities include production of high quality planting material for sale to farmers at reasonable prices . This implies the establishment of a nursery and importation of foundation stocks of the most suitable cultivars for propagation.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

01 Expansion of irrigated agriculture is an integral part of the Namibian Government plans and policies. The Orange River northern banks have been given priority for development and this study was therefore commissioned. The results of the study showed that a gross area of 2160 ha yielding an area of 1800 ha could be remuneratively developed for high value crops targeting the export market.

02 Suitable soils have been identified in seven locations, stretching from Noordoewer into the southern part of Aussenkehr farm. The scatter of suitable soils does not permit the adoption of the previously conceived gravity irrigation system which depends on building a dam upstream of Noordoewer and constructing a unified irrigation system for an approximate area of 8 000 ha. Such an area was estimated on the bases of localized soil surveys which did not cover the whole project area. According to this concept Namibia could have stored its own water requirement from the Orange River and need not pay a price for water regulated by RSA

03 The area with deep soils which has been identified by the reconnaissance soil survey, is 5 978 ha. Of this area only 2 160 ha were found to be suitable for development; i.e. 3.86% of the total project area. The remaining area suffers from severe land limitations, in particular very high elevation in relation to the level of the irrigation water source.

04 The most feasible way to irrigate the suitable locations is to group them into three independent irrigation units each abstracting water directly from the Orange River. In this case Namibia must rely on the controlled flows of the river and in consequence it must reach an agreement with RSA to ensure adequate flows for the project.

05 The project would accommodate three farmers' categories; mallholders, medium-scale farmers and entrepreneurs. Two irrigation units on State land would be shared equally between smallholders and medium-scale farmers. One irrigation unit on privately owned land would be allocated to entrepreneurs. The total number of farmers would be 162.

06 The crop mix which includes 80% grapes, 10% mango, 5% each of lucerne and vegetables is recommended foe smallholders and medium-scale farmers in respective farms of 4 ha and 40 ha. The crop mix recommended for entrepreneurs is 80% grapes and 20% dates in 40 ha farms.

07 The production of the proposed crops requires a high level of technical knowledge and skill. It is recommended that the Government provides for technology generation and dissemination through the establishment of a Research and Development Unit in Aussenkehr Government Farm. This unit would initially focus on the project and would cover the Orange River region in future.

08 It is recommended to implement the project in three phases. Phase 1 would be in Noordoewer State Irrigation Unit with as area of 320 ha and phases 2 and 3 would be viewed as expansion phases. Project implementation would take eight years. The

main reason for this phasing is to allow accumulation of knowledge by both the Government and the settlers.

09 It is recommended that the Government takes action on the issues of water and land availability for the protect before requesting financing.

10 A specific recommendation emanating from the experience of the consultant with the soil survey is that the Government should carry out a reconnaissance soil survey before deciding on a feasibility study for potential locations along the Orange River.

11 The total project investment cost and working capital with contingencies amount to N$ 408.8 million of which phase 1 requires N$ 75.0 million. The foreign component for the whole project is 70% of the total cost equivalent to USD 47.7 million and the foreign component for phase 1 is 71.2 % of the total cost, equivalent to USD 8.9 million.

12 The financial and economic results of both phase 1 and the project as a whole are favorable and acceptable, illustrating the viability of the project. The project would have a positive contribution to the Namibian economy. It is recommended that the government takes a decision to implement the project.

13 It is recommenced that the Government seeks financing for phase 1 through a soft loan according to the financing plan opposed by this study. Potential sources for financing include: Arab Bank for Economic Development in Africa (BADEA), International Fund for Agricultural Development (IFAD) and the African Development Bank (ADB).

14 It is recommended that the Government would take the necessary actions towards the outstanding issues that need to be addressed.

15 It is recommended that Government initiates a capacity building program for the Government organs and staff who would be engaged in implementing the project. Special attention should be given to the Directorate of Planning, the Monitoring and Evaluation Unit and the Division of Agricultural Engineering.

16 It is recommended that the Government establishes the necessary infrastructure and facilities for both internal and export-oriented markets.

APPENDIX 1

TERMS OF REFERENCE

Terms of Reference for a Feasibility Study of the Tandjieskoppe Irrigation Scheme (Orange River Irrigation Programme)

1. Introduction

In order to realise a number of the objectives laid down for the agricultural sector in the First National Development Plan (NDP1), in particular the need for national food security and the diversification of agricultural production, the Government wishes to embark on a programme of increasing crop production in the country by significantly expanding the area under irrigation. Irrigation will also, by its very nature, provide a more reliable harvest from one year to the next. Furthermore, it is clear that such a programme will contribute significantly towards one of the national objectives of the Government, as detailed in NDP1, namely: employment creation.

To this end, a Technical Committee on Irrigation (TCI) was set up in early-1997 in the Ministry of Agriculture, Water and Rural Development. In addition to technicians from a number of the Directorates of the Department of Agriculture and Rural Development (DARD), the Committee includes specialists from the Namibian Agronomic Board, the National Planning Commission and the Namibia Development Corporation.

The first exercise undertaken by the TCI was to investigate the potential of all the possible areas in the country which can be irrigated and to provide a ranking of those areas which appeared (from a superficial review), to have the greatest potential.

One of the high potential irrigable areas thus identified is the land bordering the Orange river in Karas region along the country's southern border. It is this area which provides the focus for these terms of reference.

2. Background to the project

A number of interventions have been made by the Government and private sector, both pre- and post-Independence, in developing irrigation in the country. Most of these efforts have been large-scale interventions and the majority of the Government's schemes have produced relatively low-value grain crops. As the country enters its eighth year of Independence, the Government is keen for the country's irrigation potential to be exploited to the full in order for the contribution made by the sector to national economic development to be maximised.

In particular, the Government is anxious to see agricultural production expand and for the production base to be diversified in order to reduce vulnerability to the vagaries of the local, regional and international markets. In addition, irrigation is seen as contributing to the overall "drought-proofing" of the economy.

At the same time, the Government is keen for the agricultural sector to provide livelihoods for the rapidly-growing rural population, apart from anything else, so as to ensure that the current high levels of migration from the rural areas are reduced to a minimum. It recognises as one of its guiding principles, that a healthy agricultural

sector will also have a beneficial impact on reducing poverty levels which are significantly above average in the rural areas.

The only perennial rivers in Namibia flow along its northern and southern borders. With Namibia being the driest country in sub-Saharan Africa, it means that the only areas with a high potential for large-scale irrigation are located immediately adjacent to the Orange, Kavango and Zambezi rivers.
Because of these geographical realities, the use which Namibia makes of the water from its perennial rivers is governed by water agreements with its neighbouring states. If new large-scale investments in developing irrigation are to become a thrust of the Government's agricultural programme, the existing water agreements will need to be looked at in great detail to ensure that adequate supplies of water can be guaranteed once the schemes are established. This issue is one aspect of the study which the consultants will need to investigate in depth.

Because of the need to limit the size of its public service, the Ministry of Agriculture, Water and Rural Development will continue to have only a limited capacity to implement projects itself. In addition, the Government is keen to encourage private sector investment, either alone or in joint-venture partnership with the Government, in the development of the country's agricultural sector and in agro-industrial ventures. This support extends across all commodities and sub-sectors of agriculture, although particular encouragement is given to the production, processing and marketing of non-traditional, high-value crop and livestock products, in order to create a more diversified agricultural sector.

The consultant will, therefore, need to investigate alternative institutional structures in depth and to come up with detailed, feasible recommendations.

3. Objective and scope of the study

The Orange river area has been identified for possible intervention to develop irrigated agricultural production - the river forms the border between Namibia and South Africa and its flow is almost entirely regulated by upstream dams in South Africa. However, only limited information is available on the area's natural resources base (soils and water, in particular), its agronomic potential, and the socio-economic environment in which the proposed project would be situated.

In 1994, the Government carried out a project identification study which identified eight areas on the north bank of the river - four of which have an area in excess of 500 ha - which, based on the suitability of their soils, could possibly be developed for irrigation. The areas extend from Khaais farm in the east (Farm Number 153), immediately north of Onseepkans, to Hohenfels in the west (20 kilometres inland from the town of Oranjemund). The areas thus identified are both privately-owned and owned by the State, while the most westerly sites are located in the controlled 'Diamond Area 1'. The total potentially-irrigable area covers more than 5,000 ha.

For the purposes of this study, however, the potential for developing large-scale irrigation in the Orange river valley, in the area lying downstream and northwards of the settlement of Noordoewer as far as the current irrigation development on Aussenkehr farm (number 147), needs to be studied in detail. The study will consider

a range of possible design alternatives for the scheme, coming up with a recommendation for the project site.

The information on the scheme thus chosen will include details on the area of land required (and the existing legal status of the land), the most appropriate cropping patterns, the preferred settlement pattern for the scheme (smallholder, nucleus estate/smallholder outgrower or estate only), the employment implications, the likely impact of the scheme on food security at the local, regional and national levels, the scheme's net foreign exchange earnings for Namibia and net incomes of participating farmers, and its likely impact on the local and regional environment. A full justification for the choices thus made will be provided in the report.

4. Issues to be studied

While only a summary description is required of each component in the main text of the feasibility study report, this will be derived from more detailed specifications and estimates given in the annexes, to which reference should be made. The study report should be structured in accordance with the following format, although the consultant is encouraged to elaborate on any additional issues which are not mentioned here but which it feels may be of importance to the Government - and its development partners - in their appraisal of the proposed project:

Executive Summary

This will provide a synopsis of the essential elements of the study, highlighting the main conclusions and recommendations. It will focus on those aspects of the national situation which are most relevant to the project, the reasons for the design chosen for the project, the main components, the costs and project organisation, the expected outputs, the beneficiaries and the impact on their incomes, the financial and economic results, risks, the financial structure and environmental considerations. It will also highlight any issues still to be resolved before appraisal and implementation. It should not exceed ten per cent of the length of the main report.

A. INTRODUCTION

The arrangements by which the study was carried out.
The origins of the project concept (drawing from the Terms of Reference which will be included as Annex 1 to the study).
A description of the team that carried out the study (including details of the Government agencies which were involved).
Details of the body which financed the study.
The work plan and timetable of the study.

B. BACKGROUND

The country, its geography and its agricultural sector.
The Government's development priorities (with a particular focus on the agricultural sector).

The project area (including natural resources, physical features, land tenure system(s)[1], agriculture, the local economy, institutions and existing infrastructure).
Water - flood frequency, maximum & minimum flows, quality, cost, etc.
The people.
Ongoing agricultural projects (of immediate relevance to the Orange river project) and other projects making use of the water (Aussenkehr Farms Pty Ltd operations, for example).
Development constraints and potential.
Details of documentation available on the area/project.

C. THE PROJECT

The objective(s) of the project (basic guidance on this is provided in Sections 1-4, above).
The design alternatives investigated/considered.
The reasons why the preferred project concept was chosen.
Description of the preferred project, describing in detail[2]:

The actual site(s) (climate, soils, topography)
Planned system of land tenure (including need for resettlement of existing population, numbers to be settled, etc.)
Planned cropping pattern and rotation
Inputs
Water requirements
Energy requirements
Labour
Basic design[3] : technologies to be adopted (depending upon method of irrigation - drip, sprinkler, etc.), detailing equipment, machinery & materials
civil works - irrigation layout, etc., - general project buildings, housing, roads, any other infrastructure required, etc.
Environmental issues

D. ORGANISATION AND MANAGEMENT

Land availability (suitability) and requirements.
Water arrangements (national legislation and international agreements affecting the Orange river) and availability.
Settlers: Number of settlers and rate of settlement
Selection criteria
Training
Size of plots

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[1] Including details of the land tenure arrangements already existing in the area.

[2] Additional details can be provided in Annexes.

[3] The level of detail required of the civil works, equipment and machinery components is a matter of engineering judgement. However, for important major works, detailed site investigations resulting in preliminary designs and specifications are expected. The consultant is expected to highlight those items for which detailed engineering studies would need to be commissioned (such as the main irrigation canals and water storage structures).

Housing (and related services) arrangements
Land tenure arrangements
Assistance from project centre (credit, research & extension)
Income
Project centre staffing
Management arrangements
Implementation schedule
Monitoring (reporting procedures) and evaluation

E. PRODUCTION AND MARKETS

Yield and output projections
Quality
Marketing (and own consumption) : volumes (including an estimation of present and projected demand, locally)
institutions/organizations (including inputs' supply)
Grading and packing requirements
Marketing arrangements (local and export markets), including refrigerated transport requirements
Local processing prospects (investment and O&M needs)
Storage (cold stores, etc.)

F. BENEFITS, COSTS AND JUSTIFICATION

Input and output prices (current and projected)
Crop enterprise budgets
Farm budgets for individual producers (or estate or nucleus estate/smallholder outgrower, depending on the model proposed), including proposed cost of water charged to farmers
Detailed project cost estimates: broken down between local & foreign and capital (including the cost of land) & operating/maintenance, over time for the whole project
Financial analysis (including calculations of both the Net Present value and the Financial Internal Rate of Return of the proposed project)
Economic analysis (including a calculation of the Economic Internal Rate of Return of the proposed investment, and its net impact on foreign exchange earnings, employment, poverty reduction, etc.)
Financing plan - if found to be economically and financially viable (including the proposed gearing of the project's finances and its cash flow situation, taking into account: (a) the repayment of borrowed funds; and (b) the projected return on equity).
Risk & sensitivity analysis
Environmental impact/considerations (This should include considerations of such issues as: the impact of the abstraction of water from the Orange river, the effect of land preparation on erosion, the impact on the river bank of the proposed developments, the possible detrimental impact of crop chemicals on downstream "users", the likelihood of soil salinisation, the impact of more dense settlement in the area, etc. Remedial measures to mitigate these potentially-detrimental impacts, are to be proposed and costed).

Social analysis (including gender issues)

G. OTHER

Outstanding issues (policy, administrative, etc.) which will need to be addressed by the Government before any further action can be taken.

H. CONCLUSION AND RECOMMENDATIONS

Annexes

These will include the terms of reference, a project/logical framework, maps, list of persons/organisations consulted, literature and documentation consulted, detailed description of technical issues only briefly presented in the main body of the report, detailed cost estimates, etc.

5. Plan of work

During the study, the consultant is expected to have its main base in Windhoek, where it will be able to liaise closely with many of the key agencies involved in irrigation activities in the country, as well as in agricultural development more generally. In addition, much of the general social, economic, engineering, agronomic and environmental information is available in Windhoek. A field base will be set up in Noordoewer, from where visits to the proposed site can be made as required. Much of the detailed field-level data will be collected, assembled and analysed here.

The consultant is expected to meet with senior officials in the Ministry of Agriculture, Water and Rural Development in order to obtain guidance on overall policy and programme issues. Technical staff from the Department of Water Affairs, and the Directorates of Extension & Engineering Services, Research & Training and Planning will provide the consulting team with relevant detailed information which they have at their disposal. Environmental issues will be discussed with officials in the Ministry of Environment & Tourism. The team is likely to need to consult also with representatives of the National Planning Commission Secretariat, the Ministry of Trade & Industry, the Ministry of Lands, Resettlement & Rehabilitation, the Ministry of Finance, Agribank and the Namibian Agronomic Board.

While in the field, the team will be expected to liaise closely with the regional officers of these same Ministries. The team will meet and discuss progress on a regular basis, with officials of the Karas regional government.

6. Expertise required

The team will comprise the following specialists who are expected to have had considerable experience of planning, implementing and running irrigation projects in developing countries, particularly in Africa south of the Sahara:

agricultural engineer

S/he will have a degree (or equivalent) in agricultural engineering or a related field and will have a minimum of 10 years' experience of designing and operating

irrigation schemes in developing countries; some of the field work will, ideally, have been undertaken in sub-Saharan Africa.

soil scientist/land-use planning specialist
S/he will have a degree or equivalent in agriculture, soil science, agriculture or a related subject. The specialist will have a proven track record of field work in developing countries. Prior experience of working on the planning of irrigation development schemes is essential.

agricultural economist
S/he will have a graduate/post-graduate qualification in agricultural economics/economics, as well as;

- a minimum of 10 years' experience working in less developed countries, some of which should, ideally, have been in sub-Saharan Africa;
- experience of working with irrigation schemes;
- experience with marketing issues as they relate to irrigated crop production;
- knowledge of irrigation institutions' issues; and
- previous experience in carrying out studies into the feasibility of irrigation schemes.

a rural sociologist/socio-economist
S/he will have a graduate/post-graduate qualification in rural sociology, social anthropology or an associated discipline. In addition, the specialist will have:

- a minimum of 7 years' experience of working in developing countries;
- considerable experience of involvement at the field level with rural communities;

agriculturalist
S/he will have a graduate/post-graduate qualification in agriculture, or a related subject, as well as:

- a minimum of 10 years' experience of working in the field of agricultural production in less developed countries, some of which should have been in sub-Saharan Africa;
- experience with marketing issues as they relate to irrigated crop production;
- previous experience in carrying out studies into the feasibility of agricultural production projects (including irrigated production).

The team leader will be appointed from amongst the team, by the consulting company itself.

One member from the staff of both the Directorate of Planning and the Division of Agricultural Engineering, DARD, will work together with the team during the period of the study. The two individuals will enhance the capacity of the team. In addition, the Government will make available to the consultant all pertinent data and information which it has on the project site, etc.

7. Reporting

The consultant will meet regularly with the TCI in order to provide the Committee members with verbal reports on the direction and progress of the work. For their part, the TCI members will be able to provide the consultant with guidance or propose changes in direction, where required.

Within three weeks of the start of the study, the consultant will submit a Project Inception Report to the Permanent Secretary of the Ministry of Agriculture, Water and Rural Development. The Report shall provide details of progress made to date, suggested changes in the Terms of Reference and any problems which may have arisen, or which can be expected, concerning the work of the feasibility study team in Namibia. Any points requiring a response will be answered by the Permanent Secretary in writing, within one week of receipt of the Report. The consultant will also forward one copy of the Project Inception Report to BADEA for its review and comment, within the same time limit.

Not later than six months after commencing work on the study, the consultant will present a Preliminary Report to the Permanent Secretary, in 10 copies. The layout of the Report will be in accordance with the standard report format presented in Section 4, above.

Comments by the Government on the Preliminary Report will be provided to the consultant within two months of its receipt in Windhoek. These comments will include suggested amendments, additions and/or deletions. Two copies of the Preliminary Report will also be forwarded to BADEA for its review and comment, within the same time limit.

Within two months of the receipt of these comments by the consultant, the Draft Final Report, incorporating the comments will be submitted to the Permanent Secretary.

The Government will have a further 60 days to provide any comments on the Draft Final Report to the consultant. Within 60 days following this deadline, the Final Report will be forwarded to the Permanent Secretary, in thirty copies. A further two copies will be forwarded to BADEA.

All reports will be drawn up in the English language. The reports and all of the Government's comments on them, will be forwarded to Windhoek and the consultant by courier.

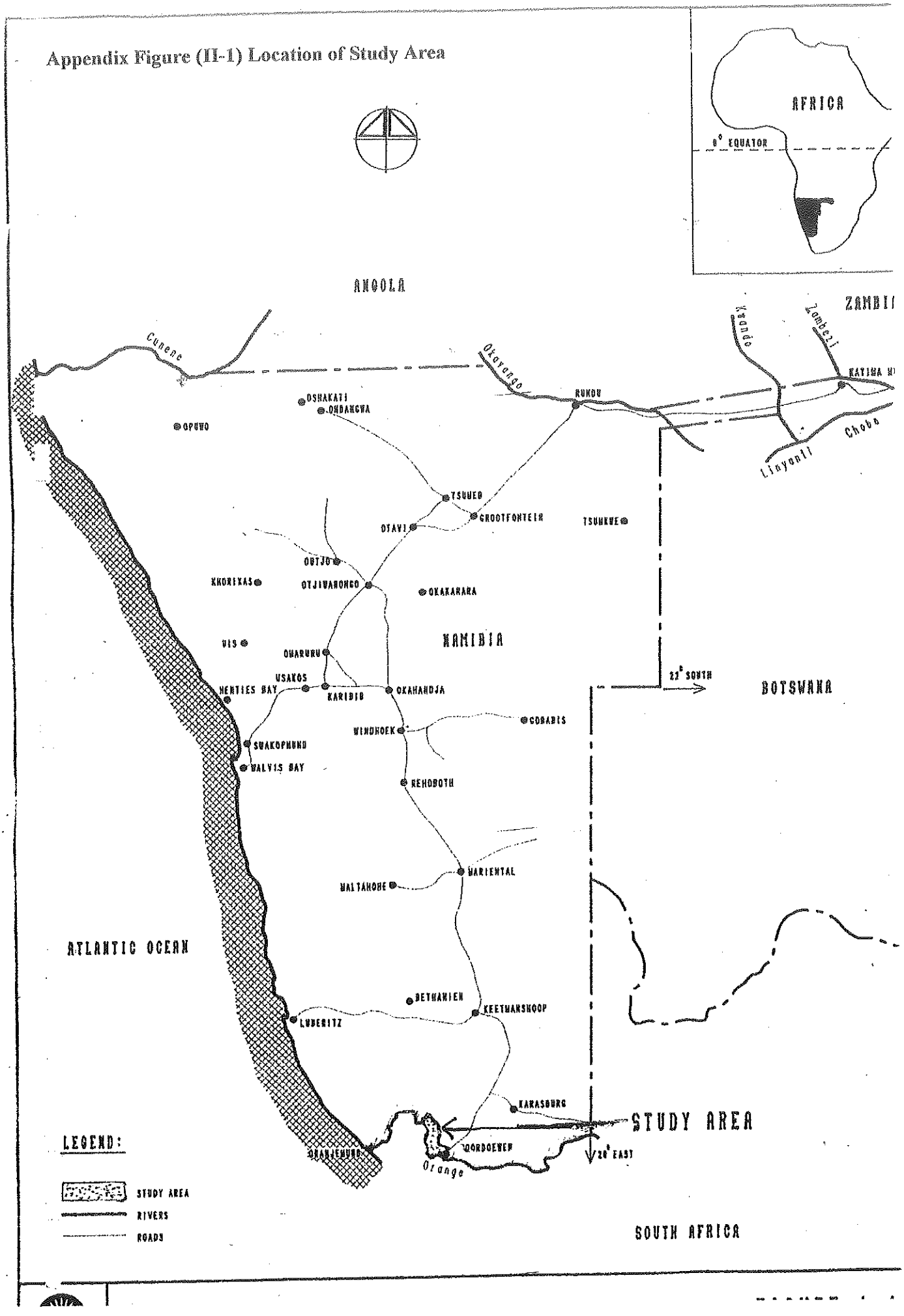
8. Time schedule

It is expected that the study will be completed within a sixteen-month period and begin within two months of concluding the contract with the consultant.

APPENDIX FIGURE (II.1)

LOCATION OF STUDY AREA

Appendix Figure (II-1) Location of Study Area



APPENDIX FIGURE (II.2)

SATELLITE IMAGE INCLUDING PROJECT AREA

MAPS 1, 2 AND 3
PROJECT SITES AND LOCATIONS