Table 3: Summary of key issues and the significance of the anticipated impacts caused by the KARS Project, **without mitigation actions**. Shading indicates all impacts which are regional and which have medium-high to high severity and significance.

Environmental Component or Activity Affected		Impact Type	Sign	Scale	Duration	Severity	Certainty	Significance
Surface water flows	Khan	Direct	Negative	Local	Medium	High	Definite	High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium
Ground water flows	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate High	Definite Definite	High High
	Swakop	Direct	Negative	Regional	Medium	Moderate-High	Definite	Medium-High
Ground water levels	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate High	Definite Definite	High High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium-High
Ground water quality	Khan	Direct	Positive	Local	Medium	Moderate	Probable	Medium
	Swakop	Direct	Negative	Local	Medium	Moderate-High	Definite	Medium-High
Sediment loads	Khan	Direct	Negative	Local	Medium	Moderate-High	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Probable	Low-Medium
Riparian vegetation	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Regional	Medium Medium	Moderate-High High	Definite Definite	High High
	Swakop	Direct	Negative	Regional	Medium	Low-Moderate	Probable	Low-Medium
Birds		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Mammals		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Reptiles and amphibians		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Ecological integrity		Direct	Negative	Regional	Medium	Moderate	Probable	Medium
Dune encroachment		Indirect	Zero	Local	Medium	Low-Zero	Probable	Zero
Replacement of sand		Direct	Zero	Local	Medium	Low-Zero	Definite	Low
Beach/coastal erosion		Indirect	Zero	Local	Medium	Low-Zero	Probable	Low
Aesthetic values		Direct	Negative	Local	Medium	Low-Moderate	Probable	Low-Medium
Off-road vehicle travel		Direct	Negative	Local	Medium	Low	Definite	Low
River water utilisation	Khan	Direct	Positive	Local	Medium	Moderate	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium-High

Table 4: Summary of key issues and the significance of the anticipated impacts caused by the KARS Project, **with all mitigation actions implemented**. Shading indicates all impacts which are regional and have medium-high to high severity and significance.

Environmental Component or Activity Affected		Impact Type	Sign	Scale	Duration	Severity	Certainty	Significance
Surface water flows	Khan	Direct	Negative	Local	Medium	High	Definite	High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium
Ground water flows	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate Moderate-High	Definite Definite	High Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Low-Medium
Ground water levels	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate Moderate	Definite Definite	High Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium
Ground water quality	Khan	Direct	Positive	Local	Medium	Moderate	Probable	Medium
	Swakop	Direct	Negative	Local	Medium	Low-Moderate	Definite	Low-Medium
Sediment loads	Khan	Direct	Negative	Local	Medium	Moderate-High	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Probable	Low-Medium
Riparian vegetation	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Regional	Medium Medium	Moderate-High Moderate-High	Definite Definite	High Medium-High
	Swakop	Direct	Negative	Regional	Medium	Low	Probable	Low-Medium
Birds		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Mammals		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Reptiles and amphibians		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Ecological integrity		Direct	Negative	Regional	Medium	Low-Moderate	Probable	Low-Medium
Dune encroachment		Indirect	Zero	Local	Medium	Low-Zero	Probable	Zero
Replacement of sand		Direct	Zero	Local	Medium	Low-Zero	Definite	Low
Beach/coastal erosion		Indirect	Zero	Local	Medium	Low-Zero	Probable	Low
Aesthetic values		Direct	Negative	Local	Medium	Low-Moderate	Probable	Low-Medium
Off-road vehicle travel		Direct	Negative	Local	Medium	Low	Definite	Low
River water utilisation	Khan	Direct	Positive	Local	Medium	Moderate	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Low-Medium

7. ACTIONS THAT ARE REQUIRED, WHETHER OR NOT THE KARS PROJECT PROCEEDS

The investigative and communications processes which have been followed during the execution of this assessment of potential impacts associated with the KARS Project have yielded several important insights and findings. Also, many of the mitigatory actions which have been identified as having the potential either to minimize negative impacts or to improve the current situation, could be implemented with immediate effect. All of these mitigatory actions could assist individual landowners, Local Authorities and Government Departments with their efforts to ensure long-term, sustainable water resource management in the West Coast region of Namibia.

Therefore, whether or not the Management of Rössing Uranium decide to proceed with the KARS Project, it is strongly recommended that the following actions should be implemented and maintained. The direct benefits to all stakeholders concerned would consist of the following:

- Increased quantities of water available for utilization along the lower Swakop River;
- Improved ground water quality along the lower Swakop River; and
- Improved understanding and ability to manage the ground water resources of the lower Swakop River.

The essential actions which should be implemented as soon as possible consist of the following, in order of importance or priority:

1. **A carefully designed control programme to remove as many alien trees (particularly *Prosopis*) from the river beds of the lower Khan and Swakop Rivers should be implemented. In addition, a proportion (say 50 %) of the dense growths of indigenous *Tamarisk* trees which have developed in the lower Swakop River could also be removed. These dense *Tamarisk* growths have been promoted by the reduced size and number of floods in the Swakop River, due to construction of the Von Bach and Swakoppoort dams.**

2. **A set of suitably located piezometers should be installed in properly designed water-level monitoring boreholes, at appropriate intervals along the lower Swakop River, to assist with routine monitoring of ground water levels. Ideally, additional piezometers should be installed in the Khan River and Swakop River immediately above the confluence of the two rivers. Water quality samples should also be collected from these boreholes whenever water levels are recorded. Water levels should be recorded at least on a monthly basis and used to analyze ground water contributions from the two rivers, as well as changes in water level depth along the lower Swakop River. The information should be made available to the general public.**

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3. **All stakeholders should contribute to the formal development of an integrated catchment management plan for the Khan-Swakop catchment. Whilst the major responsibility for water resource management in Namibia lies with the Department of Water Affairs, it is essential that every water user group in these catchments contribute to the development, implementation and maintenance of a catchment management plan. This will allow clear and unambiguous decisions to be made as to the best use of an extremely scarce resource.**

4. **The type of bund design proposed for use in the KARS Project offers a simple yet effective method of increasing the infiltration of surface flood waters into the ground water in the river bed. This technique could be implemented in the lower Swakop River, say between Palmenhorst and Goanikontes, or even further downstream. This would provide water users along the lower Swakop River with an immediate improvement in both the quantity and quality of water available for agricultural use.**

5. **Farmers along the lower Swakop River should implement improved irrigation techniques (particularly drip irrigation), together with the cultivation of salt-tolerant crops, to minimize the adverse effects of saline ground water.**

6. **The Swakopmund Municipality should initiate a routine monitoring programme to record the profiles of beaches between the mouth of the Swakop River and the outskirts of Vineta. This will provide firm evidence as to whether or not the beaches are eroding, and the rate of such erosion.**

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LIST OF SPECIALIST REPORTS

Number	Title	Author and date
Appendix 1	Report on the Prediction of the Effects of the Proposed Khan Aquifer Recharge Scheme on Downstream Users. Report to Rössing Uranium Limited by Metago Environmental Engineers. Project 107/010, Report No. 1, 72 pp. +2 app.	A. James September 1997
Appendix 2	Irrigation Agriculture in the Lower Swakop River: An Evaluation of the Potential Impact of the KARS Project. Water Research Commission, Pretoria. 28 pp.	H.M. du Plessis October 1997
Appendix 3	Stable Isotopes in Water of the Rössing Mining Area and Surrounds. Contract Report to Rössing Uranium Limited, Namibia. Confidential CSIR Report No. ENV/P/C97083, Pretoria. 14 pp.	A.S. Talma & R Meyer May 1997
Appendix 4	Report on Uranium Activities in Rössing Ground Water Samples. Confidential Report to Rössing Uranium Limited, Swakopmund, by Division of Water, Environment & Forestry Technology, CSIR, Pretoria. 8 pp.	H.D. Oschadleus & J.C. Vogel May 1997
Appendix 5	The Age of Sediments in the Swakop River. Confidential Report to Rössing Uranium Limited, Swakopmund, by Division of Water, Environment & Forestry Technology, CSIR. 9 pp.	S. Woodborne, J.C. Vogel & G. Collett May 1997
Appendix 6	Fluvial and Aeolian Coastal Sedimentation Processes and Their Relation to the Condition of the Swakopmund Beaches and the Encroachment of Dunes from the South Towards Swakopmund. Division of Water, Environment and Forestry Technology, CSIR, Report No. ENV/P/C-97216, 11 pp.	R. Meyer September 1997
Appendix 7	Technical Details of Borrow Areas and Proposed Techniques for Construction of Ground Water Flow Retarders. Metago Environmental Engineers. 4 pp.	G. McPhail November 1997

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Mr Ben Hochobeb, Manager of Rössing's Environmental Services, actively participated in discussions and contributed advice and information to the Project Team.

The KARS Working Group was composed of members elected by the local community in Swakopmund. The members were: Mr E. Demasius, Mr E. Miller, Mr L. Hesse, Mr T. Tirronen and Mr P. Hamman. Rössing Mine was represented by Mr B. Hammond and Mr R. Schneeweiss, while Mr B. Gibson acted as facilitator. All these members of the Working Group are sincerely thanked for their participation and for the many constructive suggestions that were made to the Project Team.

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Dr M.K. Seeley	Desert Research Foundation of Namibia, and
Mr P. Tarr	Ministry of Environment & Tourism, Windhoek.

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Dr S.J. De Wet	Deputy Director: Water Environment Division
Mr G. Van Langenhove	Deputy Director: Hydrology Division
Ms A. Eggers	Geohydrologist: Hydrology Division

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Special thanks are due to the individuals and representatives of several organizations in Namibia who contributed advice and detailed information to members of the Project Team.

Several land-owners and farmers along the lower Swakop River kindly made time available to discuss their concerns with the Project Team. In particular, special thanks are due to the following: Mr B.W. Fleischmann, Mr L.E. Pohle, Mr E.A. Putzier, Mr J. Van Heerden, Mr C.B. Botha, Mr B.H. Hoppe, Mr H.H. Schreiber, Mr D. Godfrey, Mr S. van Niekerk and Ms C. Lees.

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1. INTRODUCTION AND BACKGROUND INFORMATION

Namibia is a very dry country with low rainfall and high evaporation rates. Rainfalls are erratic, unevenly distributed and often localized in extent; average annual rainfall varies from some 25 mm/year over the coastal Namib Desert to around 700 mm/year in the north-eastern Caprivi Region (**Figure 1.1**). Potential A-pan evaporation rates can exceed 3,800 mm/year in the interior of the country though they usually drop below 3,000 mm/year in the coastal zone (Crerar & Church, 1988). This excess of evaporation over rainfall leads to a marked water deficit in all months of the year and droughts are a common occurrence (Heyns, 1992).

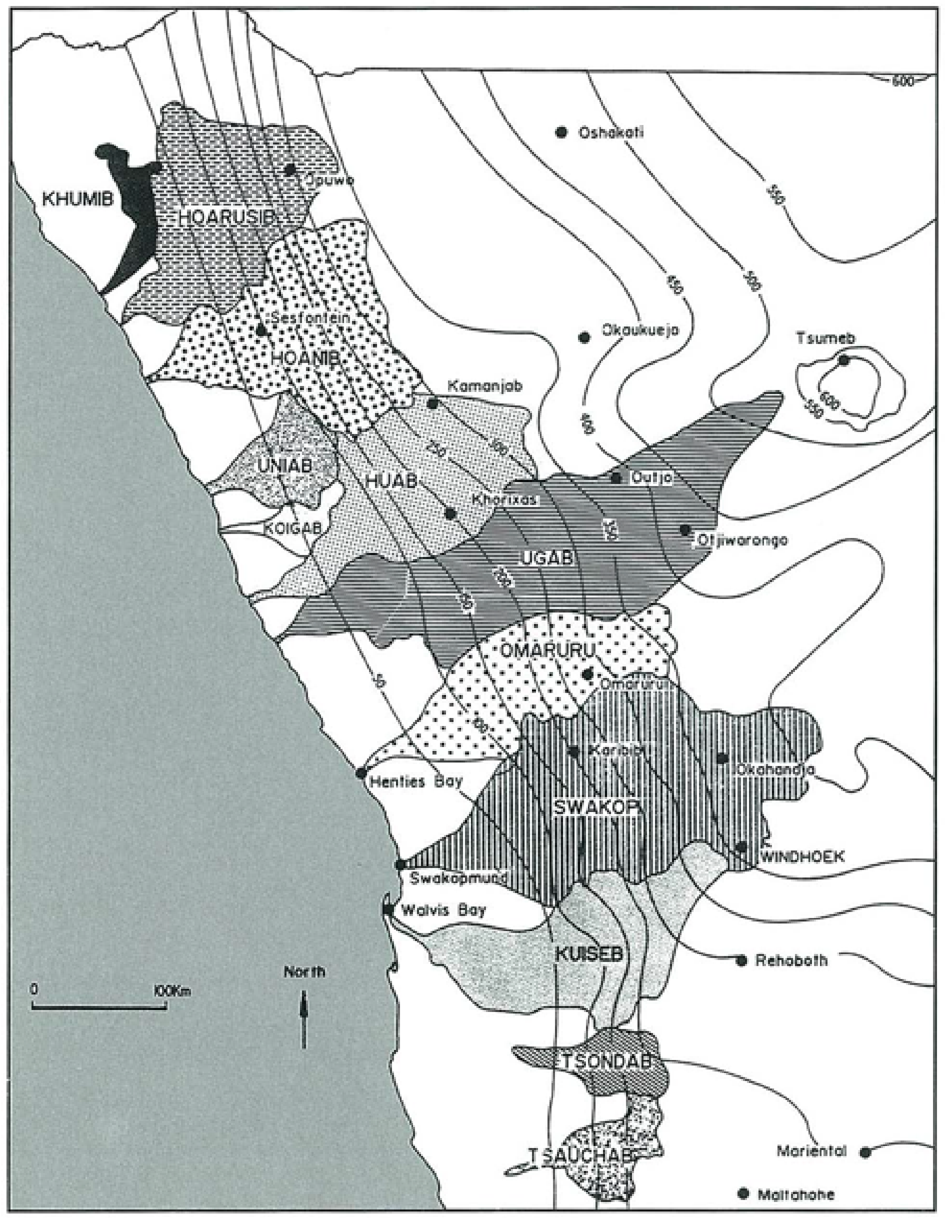

Figure 1.1: Average annual rainfall isohyets over north-western Namibia.

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Surface runoff is both erratic and sporadic, following seasonal rainfalls. The rivers in the interior of Namibia are episodic or ephemeral rivers that flow only after good rains in their catchment areas (Jacobson *et al.*, 1995; Bethune, 1996) (**Figure 1.2**). Most of these rivers are westward flowing, such as the Kuiseb, Swakop and Omaruru Rivers, and serve as life-giving linear oases in the otherwise dry Namib Desert. Namibia is characterized by an almost complete lack of perennial rivers or other perennial surface water resources, except for the Orange River along its border in the south and the Kunene, Okavango, Kwando, Linyanti/Chobe and Zambezi rivers on its northern borders (Heyns, 1992; Bethune, 1996).

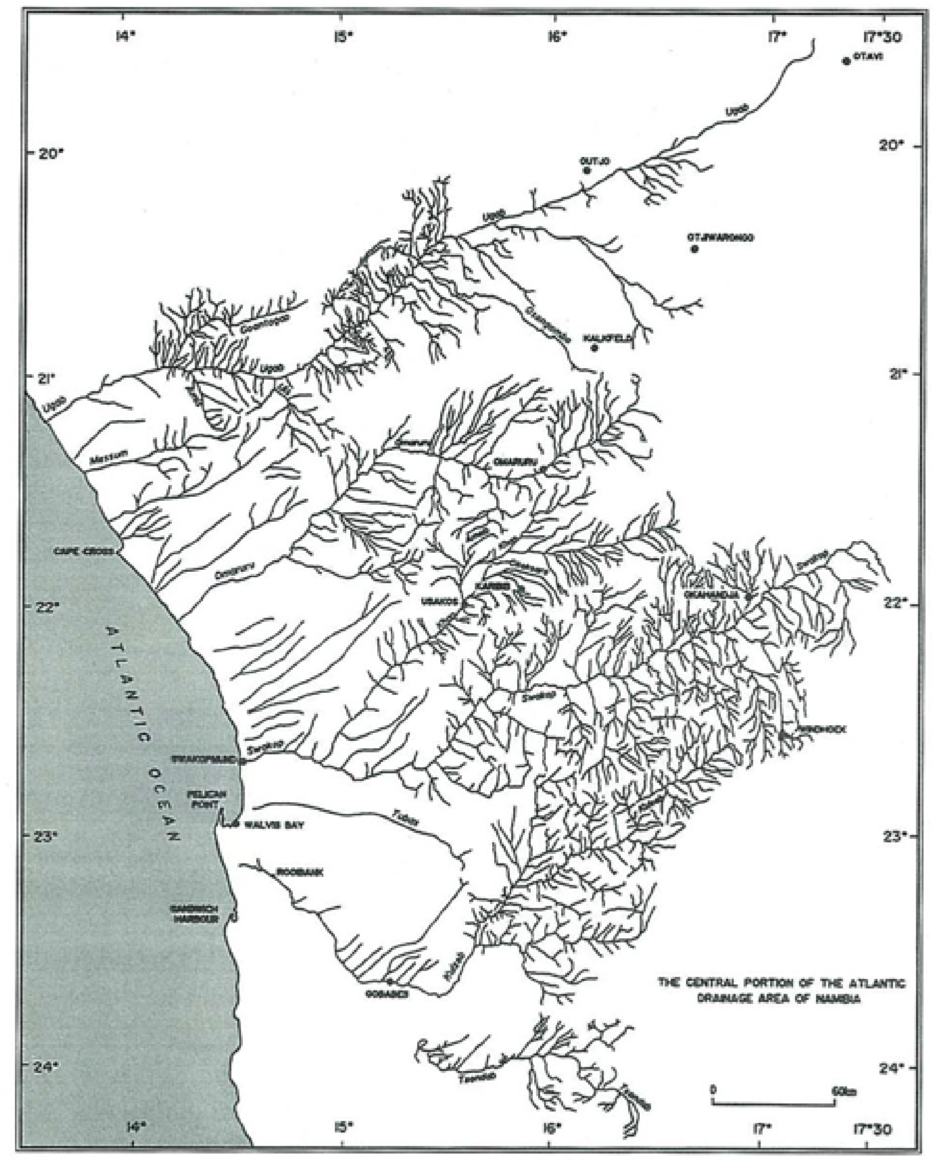

Figure 1.2: The ephemeral rivers of the central portion of the Atlantic drainage area of Namibia.