

CHAPTER 14 ENVIRONMENTAL ASPECT

14.1. Introduction

In accordance with the Environmental Management Act of Namibia of 1988, an Environmental Assessment Policy was developed by the Directorate of Environment Affairs, Ministry of Environment and Tourism, in consultation with various other Ministries, various institutions, organizations, consultants, and others (DEA, 1995). The principle of achieving and maintaining sustainable development (of natural resources) is embedded in this policy. In terms of this policy, all projects should be subjected to the established procedure as set out in Appendix A of the said policy document (DEA, 1995). It requires, inter alia, registration of the project proposal to the Environmental Commissioner, located in the National Planning Commission.

In the case of this project, the aim is

“To carry out the investigation of the groundwater flow and recharge mechanism in the Stampriet Artesian Basin, and to formulate a groundwater management plan for sustainable groundwater development.”

Thus the overall study as such is in reality an environmental assessment, which should lead to achieving and maintaining sustainable groundwater utilization in the Stampriet Artesian Basin. In view of the paucity of environmental base line studies in the area, this study will essentially comprise an environmental audit. Following a discussion with a representative of the Ministry of Environment and Tourism, it was concluded (Dohogne, *pers. comm.*, 8 November 1999) that no registration of a project proposal in terms of Namibia's Environmental Assessment Policy (MET, 1995) would be necessary for this investigation.

The Department of Water Affairs (DWA, undated) has drafted Guidelines for Environmental Assessments for New Boreholes (see Appendix B). These guidelines relate to new groundwater development schemes, and are, therefore, directly relevant to, for example, community water supply schemes. It could also be applicable to other new uses of groundwater, e.g. large-scale usage on farms. It may be important to test these guidelines in the present project, but as this project is not intended for developing a new well field, it is not directly applicable. The Desert Research Foundation of Namibia (DRFN) has carried out an assessment of the environmental impacts of an emergency groundwater supply scheme in the arid northwestern part of Namibia (DRFN, 1997). This will provide useful indicators for evaluating impacts in other arid areas.

Irrigation with artesian groundwater is practised on a relatively large scale in the Auob River valley in the vicinity of Stampriet, where free flowing water of high quality is available, but also in the surrounding areas where the piezometric level is close to the surface. The Department of Water Affairs has accepted Guidelines for Environmental Assessments of large Irrigation Projects (DWA, 1993) (see Appendix C) and these may be applicable in certain cases where either the limit of 9 ha under irrigation is exceeded, or the consumption for irrigation exceeds 100 000 m³/a. In the case of the Stampriet Artesian Basin, the total area on all farms being irrigated from this water resource is expected to exceed the specified quantity. This will necessitate the economic valuation of the use of water for different purposes.

The study area spans four regions, from the Khomas and Omaheke Regions in the north, southwards over the Hardap Region, ending in the northern part of the Karas Region. The rivers entering the area from the north, originate in the mountains near Windhoek, and form an integral part of the hydrological system. For this reason, the rivers, as well as their upstream catchments should also be considered when dealing with any environmental assessment. Similarly, as some of these rivers also cross the Botswana and South African borders, the downstream consequences of activities in these catchments also have to be considered.

The average annual rainfall in the study area itself varies from approximately 150 mm in the southwest to 300 mm in the northeast (Atlas, Map 10, 1983). The potential annual average evaporation ranges from approximately 3200 mm in the northeast to 3600 mm in the southwest (Atlas, Map 15, 1983). This places the study area in a semi-arid to arid environment. According to the Köppen system of climate classification the area is designated as having a hot desert climate (Bwhw) and receiving its rain during the summer (Atlas, Map 23, 1983).

Although Namibia is an arid country, being described as the driest country in sub-Saharan Africa (DRFN, 1997), evidence exist of wetter and drier conditions in Namibia over the past 130 ka (Brook *et al.*, 1999). Heine (1999, in Brook *et al.*, 1999) suggests that during the late Quaternary, periods of increased rainfall were more pronounced further inland at greater distance from the coast, so that in the Kalahari these increases were quite significant. Should such a phenomenon be verified, it may have a profound effect on the conceptual recharge model for the artesian basin.

Considering the hydrogeology of the aquifers in the Stampriet Artesian Basin, interaction between the groundwater and the vegetation, land-use activities, and other aspects, can only take place in the Kalahari aquifer and in the recharge areas and other unconfined parts of the artesian aquifers. The environmental impact assessment

would, therefore, largely relate to the effects of any over pumping and lowering of water levels due to non-sustainable exploitation.

Assumptions made for the study area, are partially based on evidence and partly on extrapolation from other areas.

14.2 Initial Environmental Assessment

The following section follows the sequence as set out in the JICA Guidelines (1992). However, as explained above, this project is not an infrastructure development project in the usual sense but rather a resource assessment. Therefore, in this chapter, the focus is placed on the examination of interrelationship between the groundwater management and the environmental issues, which potentially have impacts on the groundwater as a natural resource, and vice versa, have potential to receive impacts from activities related to groundwater management.

14.3 Social Environment

14.3.1 Resettlement by land occupation

Transfer of rights of residence, land ownership

It is not expected that any groundwater development and management activities will lead to resettlement, but the settlement of communities in rural areas may necessitate further groundwater development. Except in areas which are presently under exploited, the further development of (ground)water resources for domestic purposes and the watering of livestock is expected to have ramifications with respect to vegetation and other components of the ecosystem. The study of an emergency water supply scheme in the northwestern part of Namibia may provide valuable indicators for an evaluation in such a situation (DRFN, 1997)

Causes of Impacts

- Potential lowering of the groundwater level in newly settled areas
- Overgrazing and trampling of vegetation at water points

Possible Environmental Impacts

- Decrease of pumping capacity
- Loss of vegetation

Factors for Evaluation

- The longer-term trend of the groundwater level before and after addition of new wells
- The extent to which the stocking of the area conforms to the Rangeland Grazing Capacity (Atlas, Map 54, 1983)
- The extent to which the agricultural activities conform to those defined for the various agro-ecological zones (Agricola (Addendum), 1998/1999)

Measures

- Groundwater utilization plan
- Increasing available water supplies by artificial groundwater recharge

Related Subjects for Study

- Determine whether vegetation will sustain potential further stocking (DRFN, 1997)

14.3.2 Economic Activities

Loss of production base (land etc.) and change of economic structure

Economic activities in this area are mainly related to farming, tourism and trading (at towns). The farming activities involve stockbreeding and agricultural crop production by irrigation. The alternative of groundwater management plan proposes the reduction of irrigation water by 70% of the current water use of the region. If this is applied, it is estimated that the agricultural yield shall accordingly be constrained and lead to the potential deceleration in the economic growth in the Area. One possible mitigation measure on this issue is to shift the crops to those with higher market values. In this regard, natural resource accounting (Lange, 1997) could be applied to determine the domain where a reduction in water use could possibly be effected with the least impact on the economy of the study area. The specific study of the Stampriet Artesian Basin (Lindgren, 1999) may serve as a guideline in this regard. The detail of this subject is discussed in the Main Report (Chapter 6 and 7, “Groundwater Management Plan for Sustainable Use” and “Conclusion and Recommendation”).

Causes of Impacts

- Constraints on the conventional water use

Possible Environmental Impacts

- Change in agricultural productivity per unit farmland

Factors for Evaluation

- Economic return per cubic metre of water used for each economic activity

Measures

- Measuring of actual water use by means of water meters
- Generally allow most economical use of water resource (including the change of conventional irrigation scheme)
- Restrict least economical water use
- Improve the economic productivity per unit farm land by the conversion of crop species to cash crops

Related Subjects for Study

- Socioeconomic impact of restricting water use(s)
- Possible repercussions of crop conversions

14.3.3 Traffic and Public Facilities

Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)

No identified impacts. It is not foreseen that groundwater development will disrupt any traffic on main routes or affect any public facilities.

14.3.4 Split of Communities

Separation of regional communities by hindrance of regional traffic

No identified impacts.

14.3.5 Cultural Property

Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.

No identified impacts.

14.3.6 Water Rights and Rights of Common:

Obstruction of irrigation and water rights

The legal situation with regard to water in Namibia is still regulated by the Water Act of 1956 (Act No 54 of 1956). Surface water is controlled by various clauses in the Water Act and permits are required for example for the removal of any water from a catchment, or for the construction of any water controlling structures in rivers. In terms of this legislation, groundwater can also be controlled by the proclamation of subterranean water control areas. Outside such proclaimed areas, landowners have full access and rights to the groundwater underlying their property. However, this is essentially in conflict with the Constitution of Namibia and a new Water Act is being drafted for giving the Government full control over groundwater.

The Stampriet Artesian Basin, described as the Windhoek - Gobabis - Mariental - Keetmanshoop Artesian Area, was proclaimed a Subterranean Water Control Area by Government Notice No 302 of 1 October 1955. Subsequently, adjacent areas, including most of the surface catchment areas of the rivers flowing through the Stampriet Artesian Basin, were declared subterranean water control areas: the Windhoek - Gobabis Subterranean Water Control Area (Government Notice No 189 of 6 February 1970) and the Windhoek - Gobabis Subterranean Water Control Area (Extension) (Government Notice No 47 of 26 March 1976). The upper reaches of the White and Black Nossob fall outside these subterranean water control areas, which imply that, at this stage, no control can be exercised over groundwater abstraction in this area.

At present, the groundwater is abstracted without any particular control measure. The legislative control of water use itself does not have any legal conflict, but in practice, it may accompany a social conflict in the subject of water right. However, since the groundwater is a natural resource with highly public significance, the sustainable water use should be carried out all through. To achieve the goal, a step-wise implementation of regulation and public education on water use may mitigate the social impact in this regard.

Causes of Impacts

- Obstruction in irrigation water use by the legislative control

Possible Environmental Impacts

- Loss of agricultural production

- Impacts on phreatic vegetation

Factors for Evaluation

- Long term water level trend determination at several points
- Determine sustainable groundwater potential
- Long term water quality comparison
- Leaky borehole casings, or improper grouting or sealing of casings

Measures

- Step-wise implementation of water use regulation
- Establishment of intensive regulation zone
- Public education/information on the water use and regulation

Related Subjects for Study

- Most economical use of water (over and above drinking water needs), possibly making use of natural resource accounting (Lange, 1997)

14.3.7 Public Health Condition

Worsening of health and sanitary condition due to generation of wastes and appearance of harmful insects

In certain parts in the south of the study area no potable groundwater can be found. In the surrounding areas the water quality often does not conform to the limits for human consumption and may have detrimental health effects due to high salinity, or the presence of sulphate, fluoride, and/or nitrate. This is not a result of groundwater development, but rather of the natural conditions in the study area.

Increased population numbers and the development of towns lead to increased water use and the generation of wastewater. Wastewater discharges are controlled and where available, permits for wastewater treatment systems are listed in the Appendix.

According to the initial examination of the result of hydro-census conducted in this Study, the use of fertilizer is assumed to be very limited both in area and quantity. Accordingly, at present, the risk of groundwater contamination from the fertilizers has not been reported. However, certain agricultural chemicals can be harmful should these reach the aquifer and enter the groundwater resource. Others, such as fertilizers, may cause eutrophication of surface water supplies. Further examination and monitoring is

expected for the detection of long-term impact of these factors.

Causes of Impacts

- Naturally poor groundwater quality
- Water pollution
- Use of potentially harmful agricultural chemicals
- Increased occurrences of open water surfaces

Possible Environmental Impacts

- Increase in water-related illnesses

Factors for Evaluation

- Present occurrence of potentially water-related illnesses, e.g. diarrhoea, malaria
- Present usage and usage trends of agricultural chemicals

Measures

- Control of wastewater discharges for protection against groundwater pollution
- Control of potentially harmful agricultural chemicals
- Prevention of insect breeding where open water occurs

Related Subjects for Study

- Water-borne diseases, e.g. malaria, may cause a minor problem from time to time and it is considered important to obtain statistics for considering the need for further actions.
- It is potentially possible that groundwater pollution from wastewater discharges may occur which could cause water-related illnesses.

14.3.8 Waste

Generation of construction waste, surplus soils, sludge, domestic waste, etc.

The quantity of waste that this project may produce, is expected to be negligible, and will be restricted to the exploration drilling and related activities. Waste generation is related to towns, villages and other settlements, lodges and similar institutions.

No Namibian guidelines could be found for (solid) waste disposal activities. Pollution

derived from waste management and disposal will not be a consequence of groundwater development, but of existing anthropogenic activities. Depending on the nature of the disposal sites, they may have an effect on groundwater quality in the phreatic aquifers, and could eventually impact on the use of groundwater. Though the adverse impact has not been reported so far, a through investigation and constant monitoring and management are necessary for the prevention of contamination impacts from waste disposal.

Causes of Impacts

Waste disposal activities and sites, which do not comply with minimum requirements for environmental protection needs

Possible Environmental Impacts

- Groundwater pollution
- Littering

Factors for Evaluation

- Quantities of waste generated
- Types of waste (apart from domestic wastes)

Measures

- Informing local authorities on hazards involved
- Providing minimum guidelines (from other countries)

Related Subjects for Study

- Sewage sludge disposal

14.3.9 Hazards

Increase in risk of cave-ins, ground failure and accidents

No identified impacts.

There is a remote possibility that cave-ins may occur at boreholes that were incorrectly constructed, but then these would involve boreholes were constructed privately and would not include the study boreholes to be drilled as part of this project.

14.4 Natural Environment

14.4.1 Topography and Geology:

Change of valuable topography and geology due to excavation and earth fill

No identified impacts.

14.4.2 Soil erosion

Topsoil erosion by rainfall after land reclamation or deforestation

No identified impacts.

14.4.3 Groundwater

Lowering of groundwater table due to overdraft and turbid water caused by construction work

The lowering of the groundwater table is already an established trend for a large part of the study area. This may be due to a multitude of reasons, including, inter alia, a reduction in groundwater recharge, and possible overexploitation. Once the sustainable potential of the Stampriet Artesian Basin has been determined, measures will have to be implemented to ensure that overdraft is eliminated. This aspect will need detailed investigation and already forms part of the general project brief.

Causes of Impacts

- Overexploitation of groundwater
- Reduced recharge of aquifers
- Head losses due to leaky borehole casings

Possible Environmental Impacts

- Lowering of the groundwater table in phreatic and confined aquifers
- Ingress of brine from overlying or underlying aquifers, into aquifers with good quality usable groundwater

Factors for Evaluation

- Sustainable water resource potential of the whole aquifer system
- Water abstraction trends

- Water use for irrigation
- Water quality trends and saline water intrusion
- Areas of natural leakage

Measures

- Limit groundwater abstraction to the sustainable potential of the aquifer
- Investigate artificial groundwater recharge for augmentation of supplies
- Counteract natural leakage where possible by reversing hydraulic gradients

Related Subjects for Study

- Water-use situation study (economically and population induced)
- Water quality evaluation
- Isotope studies for determining aquifer recharge and sustainable yield
- Identify leaky boreholes and find solution for providing permanent casings

14.4.4 Hydrological Situation

Change of discharge and water quality due to reclamation and drainage

Apart from the reduction of spring flow due to receding groundwater levels, no other impact has been identified.

According to persons living in this area, the springs in the Stampriet Artesian Basin already dried up decades ago. As such it was part of the general groundwater utilization patterns. The reduction in spring flow is not a problem as such as it only affects the users of the spring, if any, and the fauna and flora in that specific area. Alternative measures can be taken for supplying water where necessary. In fact, where the springs are related to flow from the artesian aquifers, they actually represent losses from the system and reduction of these losses will save water.

However, the hydrological situation in the catchment areas of those rivers that enter the Stampriet Artesian Basin, provides reason for concern. These rivers also cross the recharge areas of the Karoo sandstones of the Stampriet Artesian Basin and any changes in stream flow will potentially also affect the recharge of the artesian sandstones. The stream flow in the rivers is possibly seriously affected (reduced) by the construction of dams in these rivers, both for town supply and for farm use. As far as it is known (Dohogne, *pers. comm.*, 8 November 1999) no environmental impact assessment has

been done before any of the dams were constructed. Town supply dams located in the catchments of the main rivers, which would directly affect stream flow towards the Stampriet Artesian Basin, are:

Dam Name	River Catchment	Capacity, Mm ³
Otjivero, Silt dam	White Nossob	7.795
Otjivero, Main dam	White Nossob	9.808
Daan Viljoen	Black Nossob	0.429
Tilda Viljoen	(Black Nossob)*	1.224

* Pump storage dam fed from the Daan Viljoen dam

It is evident that these dams will have an impact on the stream flow in the two rivers, even if it is relatively small as in the case of the Daan Viljoen dam. However, this would seem to be only a part of the problem. Following the completion of the Otjivero dams in 1984 and the good initial inflows, the possibility was considered of using the excess water for irrigation. However, after 1988 the inflow decreased to such an extent that the Department of Water Affairs decided to investigate what the reasons were for this phenomenon (DWA, 1995). From this study it would seem that the flow data on which the Otjivero dam designs were based, was unreliable and the safe yield was much lower than originally calculated. Another important fact that emerged was the existence of a total of at least 93 farm dams in the catchment area of the dams (DWA, 1995). The capacity of each of these dams was estimated and it was found that the total storage amounted to 6.455 Mm³, which is approximately 40 per cent of the combined capacity of the two Otjivero dams. The impact of dams, and particularly farm dams, on ephemeral rivers, was investigated by the DRFN for rivers along the west coast of Namibia (Jacobson *et al.*, 1995). This information can serve as an indication of the potential impact on ephemeral rivers in the Stampriet Artesian Basin.

A second reason for diminished stream flow and a potentially related decrease in groundwater recharge could be the increase in alien vegetation (*Prosopis* sp.) in the riverbeds, and the related increase in evapotranspiration. It would seem that the alien vegetation invasions are increasing, causing a loss of water from the alluvial riverbeds and a degeneration of the indigenous trees. Initial observations indicate that this is also the case where the rivers cross the sub outcrops of the artesian sandstones. If this is correct, less water will be available to recharge the artesian sandstones.

Causes of Impacts

- Decreased stream flow in the rivers entering the Stampriet Artesian Basin

- Alien vegetation invading the river beds and surrounding areas

Possible Environmental Impacts

- Decreased availability of water for groundwater recharge
- Loss of indigenous vegetation

Factors for Evaluation

- Stream flow measurements compared to rainfall and runoff simulation
- Extent of alien invasions (satellite or aerial photography)

Longer-term groundwater level recording (in recharge area)

Measures

- Control construction and interception of water by farm dams
- Planned water releases from large impoundments

Related Subjects for Study

- Impacts of impoundments for town supply and farm dams on stream flow
- Alien vegetation infestations.

14.4.5 Coastal Zone

Coastal erosion and sedimentation due to littoral drift and reclamation

No impact is foreseen as the study area is far from the coastline with rivers flowing inland in a southeasterly direction. These rivers flow very seldom and only reach Botswana and South Africa very infrequently. Accordingly, their contribution to the Orange River, to which they eventually link in South Africa, makes a negligible difference to the flow at the Orange River mouth.

14.4.6 Fauna and Flora

Interruption of reproduction or extinction of species due to change of habitat condition

According to Griffin (*pers. comm.*, 8 November 1999) a change in the natural vegetation will eventually affect the whole ecological chain. The Kalahari ecosystem in the area around the Auob and Nossob Rivers has been described by Leser (1971). Thomas and Shaw (1991) give a general description of the Kalahari environment.

The Giess Vegetation Map of Namibia (1971) is the only countrywide survey that exists for Namibia. Presently, the National Botanical Research Institute of Namibia is carrying out a project to update the Vegetation Map of Namibia at a scale of 1:1 000 000 (Strohbach and Sheuyange, 1999). The surveying has started in the Karas and Hardap regions during the 1997 growing season, and it has covered the part of the Stampriet Artesian Basin to the east of 18°E and south of 24°S. Although no quantitative data is available, it was postulated (Strohbach, *pers. comm.*, 10 November 1999) that the Kalahari is a relatively young desert, as only 10 to 15 plant species were found per 1000 m² compared the Karas Mountains where approximately 60 species per 1000 m² were recorded. It has to be noted that the climate in the Karas Mountains varies considerably and would lead to a greater diversity of species.

The alien *Prosopis sp.* is responsible for destroying the habitat of the natural vegetation. The camel thorn trees (*Acacia erioloba*) are very sensitive for such invasions and they would seem to be affected in many places. Strohbach (*pers. comm.*, 1999) has the impression that the *Prosopis* will grow in areas, which have ample supplies of water. In the Auob River, where such invasions occur, perennial grass, *Sporobolus tenuis*, was found which usually occur in marshy conditions, e.g. around a spring. The extent and success of attempts to control the invasions are unknown.

With regard to the fauna in the Stampriet Artesian Basin, no specific study has been undertaken. The closest area where any study was done, is the Hardap Dam National Park. Draft tables were compiled of the occurrence of amphibians, reptiles and mammals (Griffin, 1999). This type of study was carried out for all national protected areas under the control of the Ministry of Environment and Tourism. As the Hardap Dam National Park covers an area adjacent to the Stampriet Artesian Basin, the data obtained from Griffin (1999) is included in Appendix D.

Causes of Impacts

- Receding water tables in the phreatic Kalahari aquifers
- Alien vegetation invasions
- Potential overgrazing at stock watering points

Possible Environmental Impacts

- Reduction in numbers of plants and species, followed by a decrease in the numbers of and species of fauna
- Desertification

Factors for Evaluation

- Changes in vegetation determined by satellite imagery or aerial photography
- Potential desertification

Measures

- Control of alien invasive vegetation
- Control livestock numbers

Related Subjects for Study

- Occurrence of *Phragmites* sp in the Auob River bed on the farm Schilflage, R143, approximately 100 m south of the entrance road to the farm house (Strohbach, *pers. comm.*, 1999)
- Over grazing near, and trampling of vegetation at watering points (DRFN, 1997).

14.4.7 Meteorology

No identified impacts.

14.4.8 Landscape

No identified impacts

14.5 Pollution

14.5.1 Air Pollution

No identified impacts.

14.5.2 Water Pollution

This project in itself will not lead to any significant pollution impacts. Any activities during the groundwater exploration phase, e.g. drilling, which may lead to minor pollution, will be carefully controlled to prevent any pollution. Pollution is expected to occur through anthropogenic activities, existing and new, and that should be controlled by applying the necessary regulations and also by providing information to the local councils and the public.

The provisions of the Water Act, 1956 (Act No 54 of 1956) are intended to promote the maximum beneficial use to the country's water resources, and to safeguard public water

supplies from avoidable pollution. For this reason, permit applications are required for potential polluting activities, such as wastewater treatment and waste disposal (see application form in Appendix E). See also the attached list of Towns (Appendix F) and the list of Guest Houses and other establishments (Appendix G) within the area, some of which have applied for wastewater discharge permits in terms of the Water Act.

Causes of Impacts

- Potential causes are solid waste and sewage sludge disposal activities
- On-site sanitation

Possible Environmental Impacts

- Deterioration of water quality in the phreatic aquifers

Factors for Evaluation

- Extent of disposal activities (population related) and likely impact
- Control of permits for potential polluting activities

Measures

- Inspection by Government authorities
- Information dissemination to the local councils and the public

Related Subjects for Study

- Effluent standards (see Appendix H)

14.5.3 Soil Contamination

No identified impacts within the project itself. Anthropogenic activities, e.g. waste disposal, may lead to soil contamination.

14.5.4 Noise and Vibration

No identified impacts.

14.5.5 Land Subsidence

No identified impacts. The area is underlain by hard rock and any effect dewatering may have had, has not lead to any problems in the area. The project itself is not expected to cause any dewatering and subsidence.

14.5.6 Offensive Odour

No identified impacts.

In Tables 14-1 to 14-3 these impacts are summarised and evaluated for the Social Environment, the Natural Environment, and potential Pollution, based on the information as described above. It is evident that the main study of the sustainable potential of the Stampriet Artesian Basin will provide the necessary basis for the environmental assessment.

Table 14-1 Screening for Groundwater Development: Social Environment

No	Environmental Item	Description	Evaluation	Remarks (Reason)
1.	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	D	No resettlement is involved in the project.
2.	Economic Activities	Loss of production base (land etc.) and change of economic structure	B	Implementation of sustainable groundwater management may cause a change in the economic structure due to a potential need for reallocation of water according to basic needs and economic guidelines
3.	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	D	No permanent impacts are foreseen.
4.	Split of Communities	Separation of regional communities by hindrance of regional traffic	D	No infrastructure will be installed to this effect
5.	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	D	No infrastructure is planned that will have such an effect
6.	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation and water rights	B	For sustainable groundwater development, water abstraction rights for irrigation may need to be reconsidered
7.	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	C	No impact negative caused by the study itself is foreseen. Groundwater quality is deteriorating in some areas due to leaky borehole casings.
8.	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	C	The project will not cause any impact but existing and future anthropogenic activities can potentially cause pollution
9.	Hazards (Risk)	Increase in risk of cave-ins, ground failure and accidents	D	No impacts are foreseen. Precautions will be taken at the drilling sites to prevent any problems

Table 14-2 Screening for Groundwater Development: Natural Environment

No	Environmental Item	Description	Evaluation	Remarks (Reason)
10.	Topography and geology	Change of valuable topography and geology due to excavation and earth fill	D	No large-scale construction is planned in the initial stage of the project.
11.	Soil erosion	Topsoil erosion by rainfall after land reclamation or deforestation	D	No large-scale construction is planned for the initial stage of the project.
12.	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	B	The lowering of groundwater levels is already an established trend, which could be related to the overdraft, reduced recharge of aquifers, and/or leaky borehole casings. The project is aimed at sustainable use
13.	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	D	Spring flow already negligible. Thus, no negative impact from this project is foreseen. However, changes in the catchments of the rivers entering the Stampriet Artesian Basin will affect the water balance in the area.
14.	Coastal Zone	Coastal erosion and sedimentation due to littoral drift and reclamation	D	The area is situated far from the coastline and the ephemeral rivers are only linked very indirectly with the coast via the Orange River system
15.	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habitat condition	B	The study will not affect the fauna and flora. However, significant changes in vegetation may be taking place due to alien plant invasions. Overgrazing and desertification may also need to be evaluated.
16.	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	D	No impacts foreseen.
17.	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	D	No large-scale construction is planned.

Table 14-3 Screening for Groundwater Development: Pollution

No	Environmental Item	Description	Evaluation	Remarks (Reason)
18.	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	D	Short term limited exhaust gas generation during exploration drilling and test pumping only
19.	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	C	Environmental pollution will be limited by employing proper drilling control and management
20.	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	D	Impact due to existing and new systems are not related to project activities
21.	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	D	Short term exploration drilling and test pumping only
22.	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	D	Following completion of this project, groundwater exploration will be managed
23.	Offensive Odour	Generation of offensive odour and exhaust gases	D	Short term limited exhaust gas generation during exploration drilling and test pumping only
Overall Evaluation: Either IEE or EIA is necessary for the project implementation?			NO	However, the environmental impacts on the water quality and water balance of the Stampriet Artesian Basin may be significant

14.6 Discussion

The ratings of the various environmental items as defined by JICA (1992) are evaluated in the following categories:

- A: Serious impact is expected
- B: Some impact is expected
- C: Extent of impact is unknown
(Examination is needed. Impacts may become clear as study progresses.)
- D: No impact is expected. IEE/EIA is not necessary

As set out in the introduction to this report, the Study as such actually constitutes an environmental assessment for the Stampriet Artesian Basin. Accordingly, the project in itself will not lead to an environmental impact, but would rather lead to mitigation of any existing impact. For this reason, none of the 23 environmental items in the tables were evaluated as having a potentially serious impact (“A”-rating). The ratings given should be considered as the existing or potential future situation due to anthropogenic and other activities. All environmental items with a “B” rating reappear in Table 2 below, detailing a brief study plan and a few remarks.

The main thrust of the project is to determine the hydraulic relationships in the various aquifers as defined by means of the newly interpreted geology, and particularly the associated flow regimes in each aquifer. These findings will be supplemented with interpretations based on the water quality (chemistry and isotope) data in those areas where other information is unavailable or insufficient. Against this background, the environmental factors will have to be reviewed as the project progresses. For example, depending on the findings of the project with regard to the sustainable potential of the aquifer, it may be required that water rights have to be reallocated to conform to such potential of the aquifer. This will have to involve a detailed economic value assessment of the various water uses in the area, and the associated impacts.

The overall evaluation as set out above is summarised in Table 5-4, giving the evaluation for each item and a brief indication of the planned actions. These actions will be reviewed as the project progresses and further information becomes available.

Table 14-4 Overall Evaluation for Groundwater Development

No	Environmental Item	Evaluation	Study Plan	Remarks (Reason)
2.	Economic Activities	B	Determination of sustainable potential of artesian basin (<i>from main project</i>) Assessment of the economic value of groundwater for the different uses (<i>from DWA studies</i>) Possible reallocation scenarios (<i>DWA</i>)	Sustainable groundwater potential may be exceeded, requiring reallocation of water according to basic needs and economic guidelines
6.	Water Rights and Rights of Common	B	Water abstraction rights for basic uses, stock watering, irrigation and other purposes may need to be reconsidered (<i>DWA</i>) (<i>see item 2. above</i>)	If the sustainable groundwater potential is exceeded, water abstraction will have to be reduced
7.	Public Health Condition	C	Study use of potentially harmful agricultural chemicals Listing of permits issued by DWA for sewage and waste disposal Survey of sewage and waste disposal practices potentially harmful to health Establish potential impact of water quality deterioration due to leaky borehole casings	The JICA project will not create any health hazard, but existing health hazards in the study area which are identified during the study will have to be considered (<i>see also items 8. and 19. below</i>)
8.	Waste	C	Present and potential future anthropogenic activities producing waste need to be recorded (<i>see also items 7. and 19.</i>) Determine types and quantities of waste (apart from domestic waste)	The JICA project itself will not produce waste of any significance, but existing and future activities may present a hazard
12.	Groundwater	B	Evaluate abstraction trends and permanency of groundwater decline (<i>from main project</i>) Consider determining extent of impact of reduced piezometric heads on borehole leakage into/from artesian sandstones (<i>hydraulic modelling</i>) Estimate the extent of leakage due to corroded/inadequate borehole casings	Indications are that groundwater levels are receding, e.g. more and more boreholes, which were free flowing, stopped and are being pumped. Reducing/increasing water usage will affect piezometric heads and losses from the artesian aquifers
15.	Fauna and Flora	B	Estimate the role of the alien vegetation invasion with regard to groundwater losses, particularly in those areas directly affecting the natural recharge of the Karoo sandstones Consider the need for regulation of overgrazing and desertification	Removal of alien vegetation should reduce groundwater losses and increase the recharge and sustainable potential of the artesian basin
19.	Water Pollution	C	Estimate the order of magnitude of waste generation, sewage treatment and disposal (<i>see items 7. and 8.</i>) Investigate the extent of water quality deterioration due to leaky borehole casings Develop guidelines for identifying leaky borehole casings and remedial measures, including the sealing/grouting of such boreholes	Impacts due to existing and new sewage and waste disposal systems do not related to this project but need to be recorded and managed. Leaky borehole casings may contribute significantly to water quality deterioration

14.7 Conclusions

The project as such is aimed at establishing the sustainable potential of the Stampriet Artesian Basin. Thus, registration in terms of Namibia's Environmental Assessment Policy is not necessary.

As such, this project should only have a beneficial impact on the environment, as the outcome should indicate what measures are required for sustainable use of the groundwater and for resource protection. Aspects that should receive attention are, for example:

- The presumed long term lowering of the groundwater table
- The hydrological situation in the upstream river catchments and the effect on the water balance of the Stampriet Artesian Basin
- The natural recharge situation and the need for artificial groundwater recharge, in which case further environmental assessments will be needed
- Alien vegetation invasions, particularly of the river valleys
- Reconsideration of the usage of water for different economic purposes
- Reconsideration of water abstraction rights
- Considering environmental impact assessments where irrigation water use exceeds 100 000 m³/a as proposed in the guidelines of the Department of Water Affairs
- Leaky borehole casings and the associated water quality deterioration
- Control over anthropogenic activities, which potentially may pollute the soil and groundwater

14.8 Recommendations

It is recommended that the outlined study plans are followed for those four environmental items having a "B"-rating (see Table 14-4), viz. economic activities, water rights & rights of common, groundwater, and fauna & flora. The definitions of these items are as given in Table 14-1 to 14-3.

It is also recommended that the three environmental items with a "C"-rating (Table 14-4), i.e. public health condition, wastes, and water pollution, are reviewed as the project progresses and further information becomes available.