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ACRONYMS AND ABBREVIATIONS

mm	Millimetres
km	Kilometres
m^3/s	Cubic metres per second
MAP	Mean Annual Precipitation
SEIA	Social and Environmental Impact Assessment
DWAF	Department of Water Affairs and Forestry, Namibia
HEC-RAS	Hydraulic Engineering Centre – River Analysis System (U.S. Dept. of Defense)
Pg	Page

SURFACE WATER ASSESSMENT FOR CORRIDOR INFRASTRUCTURE

CONTENTS

1 INTRODUCTION ... 1
2 APPROACH TO STUDY ... 2
2.1 TERMS OF REFERENCE ... 2
2.2 METHODOLOGY ... 2
2.3 INFORMATION REVIEWED ... 2
2.3.1 RUNOFF DATA ... 2
2.3.2 RAINFALL DATA ... 3
3 ASSUMPTIONS AND LIMITATIONS ... 3
4 LEGISLATIVE CONTEXT ... 4
5 DESCRIPTION OF THE AFFECTED ENVIRONMENT ... 4
6 DESCRIPTION OF THE ALTERNATIVES ... 6
7 IMPACT ASSESSMENT ... 6
7.1 AERIAL CONVEYOR ... 6
7.1.1 AERIAL CONVEYOR IMPACT ASSESSMENT ON SURFACE WATER ... 7
7.2 ROAD BRIDGE ... 7
7.2.1 ROAD BRIDGE IMPACT ASSESSMENT ON SURFACE WATER ... 8
8 ENVIRONMENTAL MANAGEMENT PLAN ... 8
9 RECOMMENDATIONS ... 8
10 CONCLUSIONS ... 9
11 REFERENCES ... 9

LIST OF FIGURES

FIGURE 1 : AREA AFFECTED BY PROPOSED INFRASTRUCTURE CORRIDOR ... 1
FIGURE 2 : DETAILED VIEW OF Z20 INFRASTRUCTURE CORRIDOR ... 5
FIGURE 3 : KHAN RIVER IN VICINITY OF PLANNED INFRASTRUCTURE CORRIDOR (LOOKING UPSTREAM) ... 6

LIST OF TABLES

TABLE 1 : RAINFALL DATA ... 3

1 INTRODUCTION

Rössing Uranium is investigating the feasibility of expanding their mining operations to include a new area to the south of the Khan River referred to as Z20. This would only be a mining and primary crushing operation and the ore processing would continue to be carried out at the existing plant located to the north of the Khan River.

In order to access the Z20 ore body, an infrastructure corridor across the Khan River would need to be established linking the Z20 site to the existing Rössing Uranium Mine. This infrastructure corridor would facilitate the transport by aerial conveyor of crushed ore generated at the Z20 site to the existing Rössing Uranium facilities, as well as provide road access between the existing mining infrastructure and the planned new Z20 mining area for transport of staff and operational materials.

A general location map is shown in Figure 1.

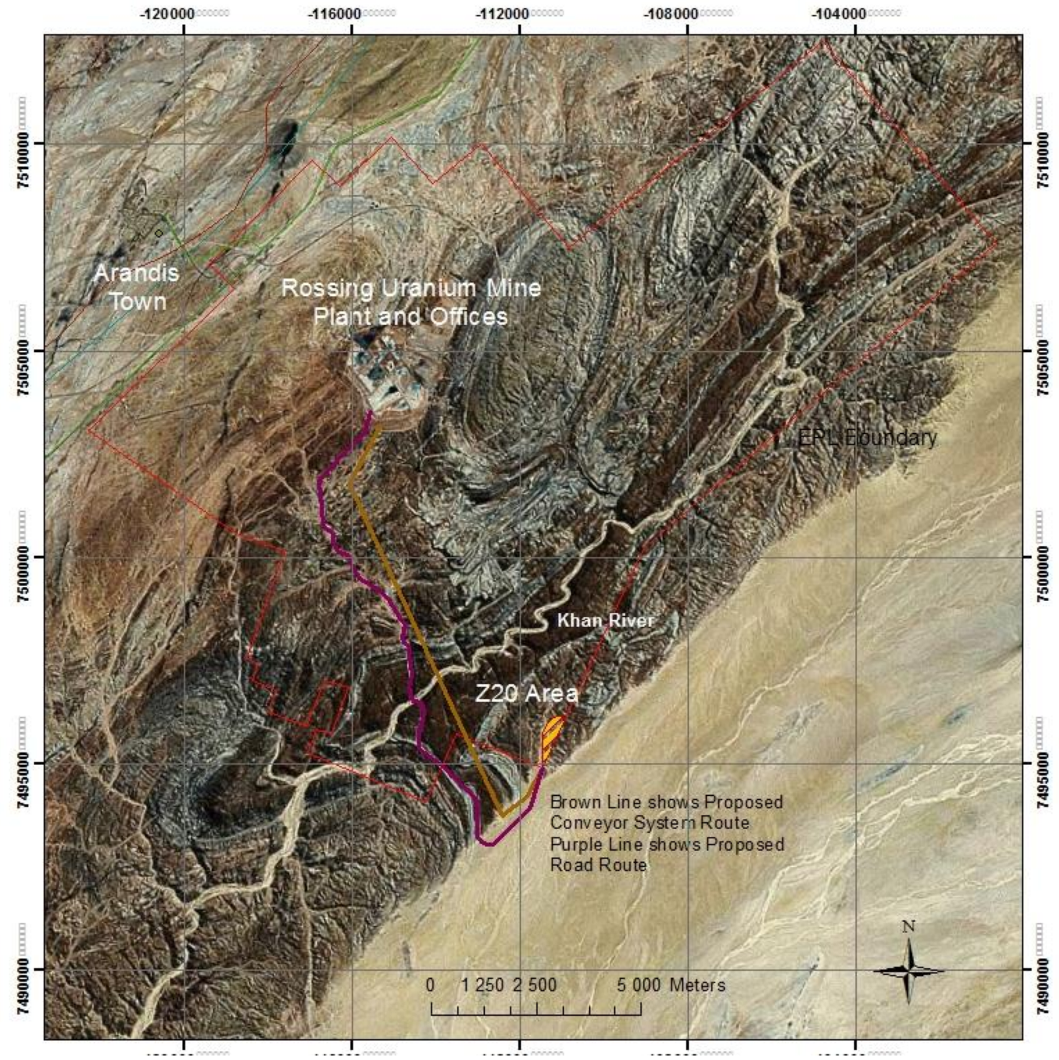

FIGURE 1 : AREA AFFECTED BY PROPOSED INFRASTRUCTURE CORRIDOR

2 APPROACH TO STUDY

2.1 TERMS OF REFERENCE

Terms of Reference for this specialist study are as laid out in the Aurecon & SLR SEIA Scoping Report (Aurecon October 2012). The relevant Terms of Reference for this surface water impact assessment study are the likely impacts of the proposed infrastructure corridor on the Khan River and possible mitigation measures.

2.2 METHODOLOGY

A field visit was undertaken on 15th October 2012 to investigate the area of the Khan River where the proposed infrastructure corridor would cross the Khan River.

Available relevant literature was used to gather data for the Khan River floods and local rainfall, to be used in the evaluation of the likely impacts of the proposed infrastructure corridor relating to surface water.

2.3 INFORMATION REVIEWED

2.3.1 RUNOFF DATA

Flood information was reviewed in the Metago Report for the Husab Mine Khan River crossing (Metago January 2011), which looked at siting a bridge in the Khan River approximately 2 km downstream of the area of interest for the Z20 infrastructure. The Metago Report looked at previous calculations of flow in the Khan River at Rössing, which were made by comparing the relationship between recorded flow at Ameib (approximately 100 km upstream of the study area) with calculated flow at Rössing (GKW, Bicon, Parkman 1966). Observed and synthetic flow data from these calculations produced a 1:20 year flood in the Khan River of 75 m^3/s, and a 1:100 year flood of 275 m^3/s. Using this 1:100 year flood peak, the cross sections for a length of river channel at the planned Husab Bridge site were modelled using digital terrain modelling and the flood routed down the river channel using HEC-RAS software. Results indicated depths to be 2 m or less at river sections wider than 100 m.

The Department of Water Affairs and Forestry Namibia provided an estimated flood value of 1,050-1,100 m^3/s and an estimated return period of 1:50 years for the 1985 flood at Usakos Bridge (approximately 85 km upstream of the proposed corridor) which was used for the conceptual bridge design for the infrastructure corridor. Previous studies have estimated that the losses to recharge are approximately 1 % per km in the river section downstream of the Usakos Bridge, so the likely flood peak at the infrastructure corridor would have been in the region of 470 m^3/s using this ratio.

Flood peak data for the Department of Water Affairs Gauging Station at Ameib (2986MO1), for the period 1967 to 2009 was studied and the February 1985 Ameib recorded flood peak of 987 m^3/s is a good match for the 1985 flood at Usakos Bridge. This February 1985 value is the highest recorded peak flow in the available 42 years of data for Ameib.

2.3.2 RAINFALL DATA

Rainfall data from Rössing was analysed and from the intensity data available from the tipping bucket rain gauges (2008-2011) a maximum intensity of 17.5 mm in 30 minutes (18.3 mm in 1 hour) has been recorded on 06/02/2011 at the Rössing mine rain gauge.

Rainfall calculations for different return intervals were reviewed in an internal memorandum compiled by SRK Consulting on 'Tailings Dam Erosion Control Measure Details' (M. Braune, SRK Consulting October 2003, Pg 2). From this work the 1:20 year rainfall event had been calculated as 34 mm and the 1:100 year rainfall event as 51 mm.

The Metago Report for the Husab Mine Khan River crossing (Metago January 2011) also looked at the daily rainfall record from Rössing (1987 to 2009) to calculate rainfall probabilities. The 22 year Rössing daily rainfall record was extrapolated to a 1,000 year rainfall record using a stochastic model from the Stochastic Climate Library, developed by the Australian Bureau of Meteorology to generate climatic data. Extreme events (design rainfall depths) were then determined by fitting a gamma distribution function (best fit, synthetic and observed), and the results produced a 1:20 year rainfall event of 12.6 mm and a 1:100 year rainfall event of 27.2 mm.

The standard work on southern African storm rainfall regularly used in most flood analysis in southern Africa is the Adamson Report TR102 (P.T. Adamson October 1981), which has tables giving derived data for various Weather Bureau stations across southern Africa. These tables gave rainfall values for Walvis Bay and Swakopmund as shown in Table 1.

TABLE 2 : RAINFALL DATA

Rainfall Site	Years of Record	MAP (mm)	Max. Recorded 1 day rainfall (mm)	1:100 year rainfall (mm)	Data Source
Swakopmund	31	14	39	48	Reference 5
Walvis Bay	40	23	42	61	Reference 5
Rössing Mine	45	12		51	Reference 2
Rössing Mine	22	28		27.2	Reference 3

3 ASSUMPTIONS AND LIMITATIONS

The limitations on surface water calculations in this area are the lack of sufficient data to fully model the long-term rainfall and runoff events likely to occur. However, this area has had extensive studies made over a reasonable period of time, due to the presence of a number of mining companies, who require a fuller understanding of these events for planning purposes.

The design report for the road bridge to cross the Khan River at Panner Gorge (Aurecon July 2012, Pg 21) indicates that only a conceptual design has been carried out using data from Usakos Bridge (approximately 85 km upstream). It is assumed for this current impact assessment that the flood values and data used to calculate the final design of the bridge will be conservative and that the bridge will be designed to survive a greater than 1:100 year flood after a flood line assessment has been carried out.

4 LEGISLATIVE CONTEXT

No legislation with reference to surface water flow is of relevance to this study of the proposed corridor infrastructure.

5 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Khan River is an ephemeral river, which only has surface flow after major rainfall events in the catchment. Most runoff is generated further upstream in the catchment, where the annual rainfall is significantly higher.

For this surface water impact assessment the affected environment is limited to a short section of the Khan River (approximately 1 km in length) to the south of the existing Rössing Mine, (as shown in Figure 1 and Figure 2), which covers the river section from where the proposed RopeCon conveyor system will cross above the Khan River, downstream to the section where the proposed road bridge will enter and cross the Khan River at Panner Gorge.

FIGURE 3 : DETAILED VIEW OF Z20 INFRASTRUCTURE CORRIDOR

The river channel in this section is generally sandy with no visible rock outcrops. There is scattered vegetation (grasses, shrubs, trees) and the width is between approximately 80 m and 150 m wide throughout. The edges of the river channel are constrained by the bedrock outcrops that rise steeply from the channel, (see Figure 2 and Figure 3).

FIGURE 4 : KHAN RIVER IN VICINITY OF PLANNED INFRASTRUCTURE CORRIDOR (LOOKING UPSTREAM)

6 DESCRIPTION OF THE ALTERNATIVES

No alternative schemes have been investigated for this study.

7 IMPACT ASSESSMENT

7.1 AERIAL CONVEYOR

The planned RopeCon conveyor system will cross the Khan River but will be elevated above the river at a height of approximately 120 m, suspended from towers located on the ridges at the edge of the river valley. Hence no infrastructure will be located in the main channel to restrict flow in the river. The location will be between Pinnacle Gorge and Panner Gorge.

The RopeCon conveyor system is designed to significantly reduce the risk of material spillage, with corrugated sides on the belt, a roof over the structure and an extra lower collecting structure at the river crossing to ensure that no material can fall from the conveyor into the river channel. An additional design feature is the monitoring system that continuously checks the height and weight of the loaded belt at the loading point to ensure that overloading does not take place. With these features plus the likelihood that any unstable material would have fallen from the conveyor during the approximately 4 km journey from the start of the elevated conveyor to the Khan River, then it is assumed that the risk of any contamination material falling from the conveyor system into the Khan River is very low. Hence there is not expected to be any contaminated material in the river channel for any flood to transport, so radiation levels will remain at current low background levels. This means that there will be no anticipated impact on the surface water quality due to the elevated conveyor system.

Possible mitigation measures during the first few years of operation would be to have regular monitoring of the area below the conveyor system, to confirm that there was no material accumulating in the river channel due to material falling from the conveyor system. If any material was found, further mitigation would be to have a 'cleaning team' carry out regular monitoring and removal of any fallen material, especially during the main flood season of November to April.

7.1.1 AERIAL CONVEYOR IMPACT ASSESSMENT ON SURFACE WATER

The radiological assessment carried out for the Scoping Phase of the EIA concluded that "*deposited dust may fall out onto the dry Khan River bed and a fraction thereof may be transported in the event of rain or a flood. However, the dust would not become soluble and as a result settles out in the river sediments. The dust is therefore not present in the surface water nor can it reach the ground water in this form"*, (De Villiers D, Necsa, November 2012).

Taking this into account, the extent of likely impacts from the construction of a high level conveyor system across the Khan River is local, the magnitude of the impact is very low and the duration of the impact is long term (life of mine). This gives a very low significance rating for this impact. However, it should be noted that at the end of the Z20 mine operating life, the risk reduces to zero.

7.2 ROAD BRIDGE

Approximately 650 metres downstream of the proposed conveyor system, the planned double-lane road bridge crosses the Khan River at the bottom of the Panner Gorge. This bridge will be mounted on concrete pedestals which will be spaced at 8 metre intervals across the river and the main road deck will be approximately 10 m wide and will be elevated 3.6 metres above the river channel. The river channel is approximately 165 metres wide at the bottom of Panner Gorge, so there will be approximately 18 concrete pedestals across this river section and the planned bridge will cross the river channel in a straight line perpendicular to the flow direction. The river channel at this section is sandy, with no visible rock outcrops, so excavation will be required to ensure that the footing of the pedestals are anchored to bed-rock.

Likely impacts of the proposed road bridge will be the possibility of raised water levels for a short distance upstream of the bridge during extreme flooding and some erosion/scouring of the river bed surrounding the bridge pedestals. The proposed bridge will be located in a fairly straight and uniform width section of river channel, so no impacts are likely to occur beyond 100 metres from the bridge structure.

Possible mitigation measures would be the addition of gabions at the bridge pedestals to reduce erosion/scouring effects.

7.2.1 ROAD BRIDGE IMPACT ASSESSMENT ON SURFACE WATER

Due to the current bridge design being only a conceptual design, this assessment will not look at structural issues for the bridge, but will simply assess the likely effects on the surface water flow in the river.

The extent of likely impacts from the construction of a high level road bridge across the Khan River is local. The magnitude of the impact is low and the duration of the impact is long term. This gives a low significance rating for this impact.

8 ENVIRONMENTAL MANAGEMENT PLAN

Recommended management strategy would include;

- Regular monitoring of the area below the conveyor system, with immediate removal of any identified spill material, especially before and during the main flood season (November to April).
- Regular bridge inspection after flood events to ensure no significant damage to structure has taken place, or erosion around pedestals. Removal of flood debris (vegetation/rocks) from the upstream side of the bridge should be carried out to prevent restrictions to flow. If erosion of the river bed is noted, then sand and rock material should be brought in to infill any areas of concern.

9 RECOMMENDATIONS

The recommendation is that the planned infrastructure poses little risk to the likely flow or the possibility of pollution of the Khan River. Hence, with suitable environmental management (as outlined above) the planned infrastructure corridor should cause no significant change to the Khan River outside of the corridor ‘footprint’ area.

An additional recommendation is that the design of the road through the gorges should take care when designing for runoff, as there is little data available on rainfall intensities. The final road structure should ensure that generated runoff is routed so as to prevent wash/erosion of material within the gorges and to minimise the transport of material into the Khan River.

10 CONCLUSIONS

The planned infrastructure corridor for the Z20 mining area will consist of amongst others an aerial RopeCon conveyor system and a road bridge. These will cross the Khan River in the vicinity of Panner Gorge, just south of the current Rössing Mine.

The aerial conveyor system will be mounted on towers located on the rocky ridges at the edge of the river channel and will span the Khan River at a height of approximately 120 m about 650 m upstream of the Panner Gorge, so this infrastructure will have no physical footprint in the Khan River.

The road bridge will cross the Khan River at Panner Gorge and will consist of a double-lane road deck approximately 10 m wide and elevated 3.6 m above the river channel.

From the review of available literature on rainfall and flooding in the area of interest, it is concluded that the likely risks to surface water associated with these structures are low to very low.

Jonathan Church
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Arnold Bittner
(Project Reviewer)

25 October 2012

11 REFERENCES

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Reference 2 : M Braune, SRK Consulting. 29 October 2003. Internal Memorandum : Tailings Dam Erosion Control Measure Details. (Project No.260422)

Reference 3 : Metago January 2011. Husab Uranium Project Access Surface Water Management. (Project No.341-002, Report No.1/10, Appendix 1)

Reference 4 : GKW, Bicon, Parkman, 1996. Water Supply to the Central Namib Area of Namibia, Final Report-Volume 4 : Existing Fresh Water Sources. Produced for the Department of Water Affairs and Kreditanstalt für Wiederaufbau, Windhoek.

Reference 5 : P. T. Adamson, Department of Environment Affairs, R.S.A., Directorate of Water Affairs, October 1981. Southern African storm rainfall, Technical Report TR102. ISBN 0 621 07121 8.

Reference 6 : Aurecon July 2012. Concept Design Report for Road Access, Water Supply, Fuel Supply and Electrical Provision to the Proposed Husab (Rössing South) Mine. (Report Ref.6377/108659, Revision A)

Reference 7 : D. De Villiers, Necsa, (5 November 2012), Radiological Public Dose Assessment for the SEIA: Proposed mining of the Z20 Uranium deposit - infrastructure corridor across the Khan River. (Report No. NLM-REP-12/185).