REPORT

SPECIALIST HYDROGEOLOGY COMMENT INFORMING THE PROPOSED ASBESTOS DISPOSAL SITE

AT

BUFFELS MARINE RIGHT (BMR), KLEINZEE

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NAMAQUALAND MINES

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EXECUTIVE SUMMARY

De Beers Namaqualand Mines is planning to demolish all infrastructure that does not have an alternative or future use. Some of these buildings contain asbestos material that was historically used for construction. This groundwater impact assessment considers the option of constructing a permanent waste site to store the estimated 1000 tons of asbestos waste rather than to transport the material to an existing facility. The aim would be to only dispose of asbestos waste at the location and nothing else. The proposed approach is to construct a landfill with a Class A lining and containment barrier.

Based on the locality of the site, the groundwater is not regarded as a sensitive environment, because groundwater occurring in the bedrock was found in other studies in the area to be of very poor quality. Secondly, the nature of asbestos is such that it does not leach or dissolve.

The impact assessment considered surface water transport to outdoor air and found that capping of such a facility will be crucial to prevent run-off from occasional rain to expose asbestos fibers from where wind transport can take place. Leaching to groundwater was found to be so unlikely that the proposed mitigation of lining the waste site is considered to be unnecessary. It is only capping that is required.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

µg/l	=	micrograms per liter
BDL	=	Below detection limit
bgl	=	below ground level
DIC	=	Dissolved Inorganic Carbon
DEA	=	Department of Environmental Affairs
EC	=	Electrical Conductivity (in µS/cm or mS/m)
GWCoC	=	Groundwater compounds of concern derived from soil samples
HASP	=	Health and Safety Plan
ICP-OES	=	Inductively Coupled Plasma Optical Emission Spectrometry
IR	=	Infra-Red
mamsl	=	meters above mean sea level
mg/l	=	milligrams per liter
ppb	=	parts per billion
ppm	=	parts per million
SPME	=	Solid-phase microextraction
SIW	=	Stable Isotopes in Water
SWL	=	Static (ground) water level

SPECIALIST HYDROGEOLOGY COMMENT INFORMING THE PROPOSED ASBESTOS DISPOSAL SITE

1 BACKGROUND

De Beers Namaqualand Mines has extracted diamonds in the Buffels Marine Right area (BMR) for many decades. Many of the buildings that were erected contained asbestos material, which was widely used as construction material at the time. Subsequently, asbestos has been recognized as hazardous and has been classified as such in South Africa. Now that the mine is in a care and maintenance phase, it will demolish all infrastructure that does not have alternative use or future purpose. Many of the buildings and pipelines that were used at the mine were constructed with material containing asbestos and during demolition, this asbestos would require disposal. One of the options that are being considered is to construct a waste site in one of the old abandoned mining pits where the approximately 1000 tons of asbestos waste can be disposed of. The aim would be to only dispose of asbestos waste at the location and nothing else. The proposed approach is to construct a landfill with a Class A lining and containment barrier.

1.1 Objectives

Following a meeting between the relevant governmental stakeholders and Namaqualand Mines, it was requested that input be gathered regarding the impact assessment from a variety of specialists. This report aims to provide input regarding the hydrogeological impacts associated with the proposed landfill disposal of asbestos in the BMR.

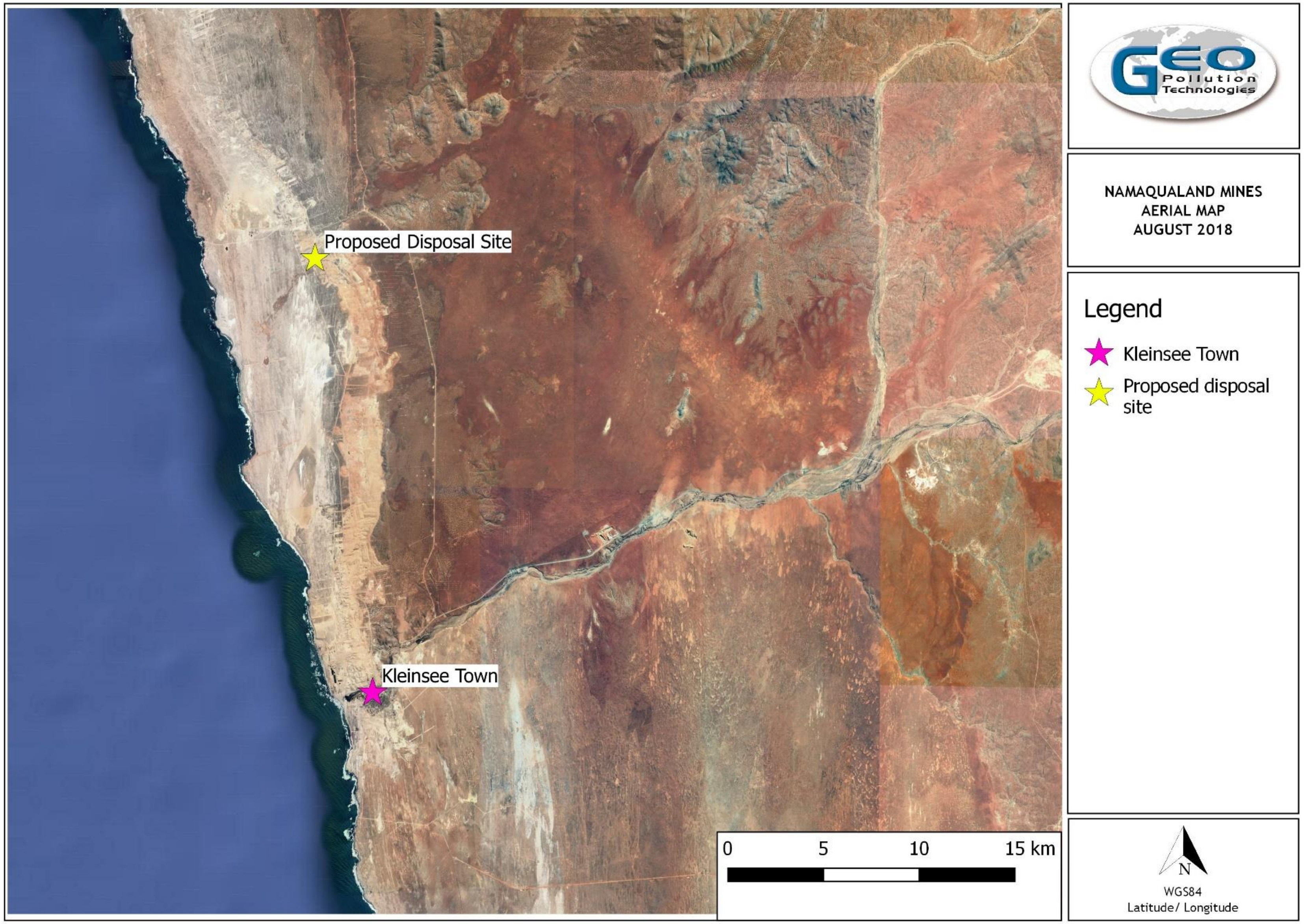

Figure 1. Map showing the location of the proposed disposal site (image from Google Earth).

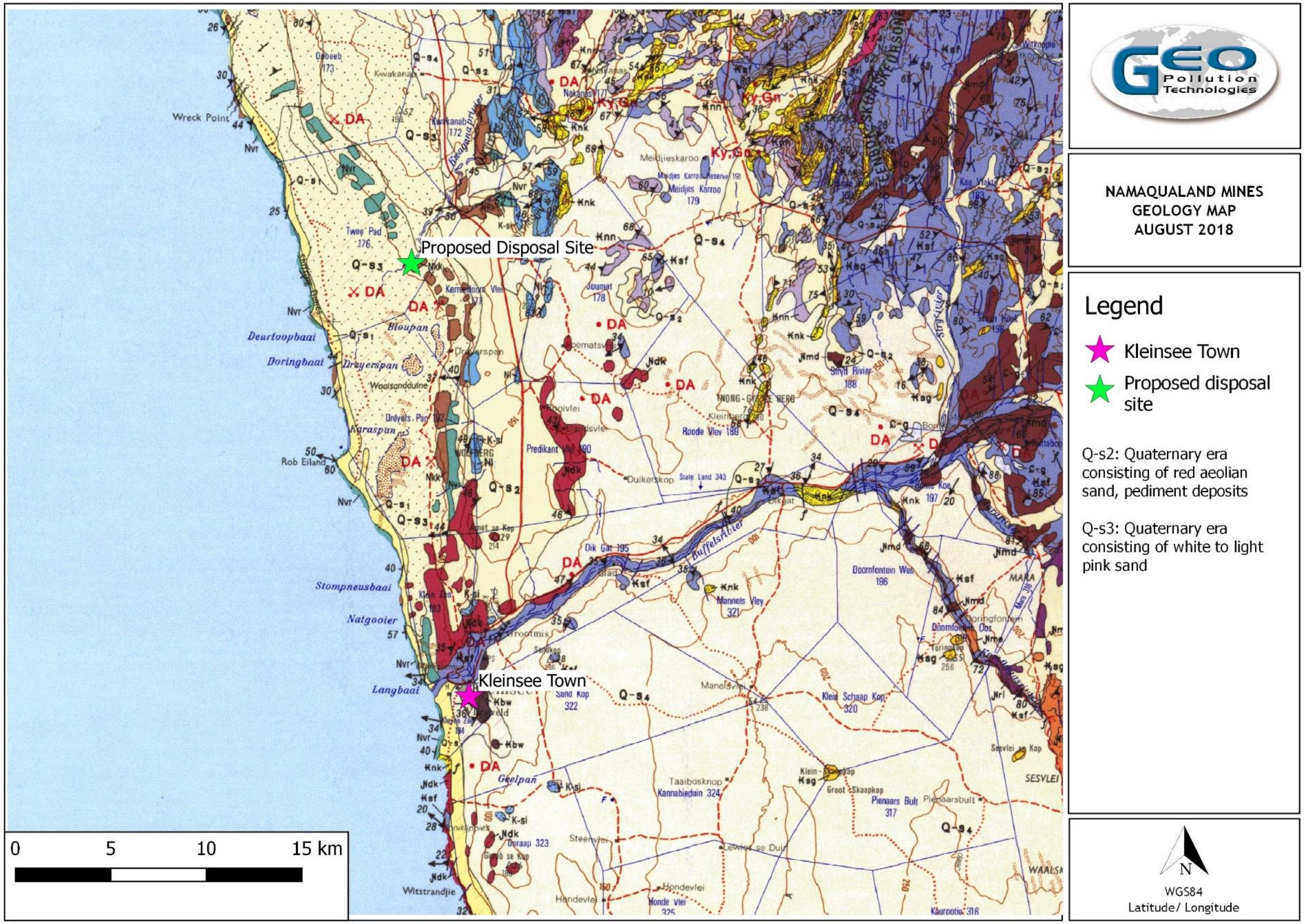

Figure 2. Geological map of the study area.

2 METHODOLOGY

This chapter describes the methodologies employed in this assessment.

2.1 Significance Assessment

The significance of Environmental Impacts is to be assessed in accordance with the following methodology:

Significance is the product of probability and severity.

Probability describes the likelihood of the impact actually occurring, and is rated as follows:

Improbable: Low possibility of impact to occur either because of design or historic experience.

Rating = *2*

Probable: Distinct possibility that impact will occur.

Rating = *3*

Highly probable: Most likely that impact will occur.

Rating = *4*

Definite Impact: Impact will occur regardless of any prevention measures.

Rating = *5*

The severity rating is calculated from the factors given to intensity and duration. Intensity and duration factors are awarded to each impact, as described below.

The Intensity factor is awarded to each impact according to the following method:

Low intensity: nature and/or man made functions not affected (minor process damage or personnel injury may have occurred).

Factor 1

Medium intensity: environment affected but natural and/or man made functions and processes continue (Some process damage or personnel injury may have occurred).

Factor 2

High intensity: environment affected to the extent that natural and/or man made functions are altered to the extent that it will temporarily or permanently cease (Major process damage or personnel injury may have occurred).

Factor 4

Duration is assessed and a factor awarded in accordance with the following:

Short term

<1 to 5 years - Factor 2

Medium term

5 to 15 years - Factor 3

Long-term impact will only cease after the operational life of the activity, either because of natural process or by human intervention –

Factor 4

Permanent mitigation, either by natural process or by human intervention, will not occur in such a way or in such a time span that the impact can be considered transient

Factor 5

The severity rating is obtained from calculating a severity factor, and comparing the severity factor to the rating in the table below. For example:

The Severity factor = Intensity factor X Duration factor = 2 x 3
= 6

A Severity factor of six (6) equals a Severity Rating of Medium severity (Rating 3) as per table below:

Table 1: Severity ratings.

Rating	Factor
Low Severity (Rating 2)	Calculated values 2 to 4
Medium Severity (Rating 3)	Calculated values 5 to 8
High Severity (Rating 4)	Calculated values 9 to 12
Very High severity (Rating 5)	Calculated values 13 to 16
Severity factors below 3 indicate no impact	

A Significance Rating is calculated by multiplying the Severity Rating with the Probability Rating.

The significance rating should influence the development project as described below:

Low significance (calculated Significance Rating 4 to 6)
- Positive impact and negative impacts of low significance should have no influence on the proposed development project.

Medium significance (calculated Significance Rating ≥ 7 to 12)
- Positive impact: Should weigh towards a decision to continue
- Negative impact: Should be mitigated before project can be approved.

High significance (calculated Significance Rating ≥ 13 to 18

- Positive impact: Should weigh towards a decision to continue; should be enhanced in final design.
- Negative impact: Should weigh towards a decision to terminate the proposal, or mitigation should be performed to reduce significance to at least a lower significance rating.

Very High significance (calculated Significance Rating ≥ 19 to 25)

- Positive impact: Continue definite.
- Negative impact: If mitigation cannot be effectively implemented, proposal should be terminated.

2.2 Risk Assessment

The Risk Based Corrective Action (RBCA) process[1] represents a streamlined approach for the assessment and response to subsurface contamination. It integrates risk assessment practices with traditional site investigation and remedy selection activities in order to determine cost-effective measures for the protection of human health and environmental resources. This methodology conforms to the assessment protocols stipulated in the Part 8 of the Waste Act (Act no. 59 of 2008).

Under this integrated approach, contaminant release sites are characterised in terms of sources, transport pathways, and receptors (Figure 3). If there is no residual source of contamination, then the resulting risk is low. Should a residual source of contamination be present, but contained and stable, and not linked to a receptor then the risk is regarded acceptable. In some cases, there is no receptor in the vicinity and if it is contained and stable the risk is acceptable. Only when there is a linkage between source and receptor can the risk be regarded as significant and requires intervention. Appropriate remedial measures, based on the outcome of the risk assessment, can then be designed and implemented at the site under investigation. These risk-based corrective actions can address any of the steps in the exposure process, including but not limited to the following:

- Removing or treating the residual source,
- Interrupting contaminant transport mechanisms, or
- Controlling activities at the point of exposure

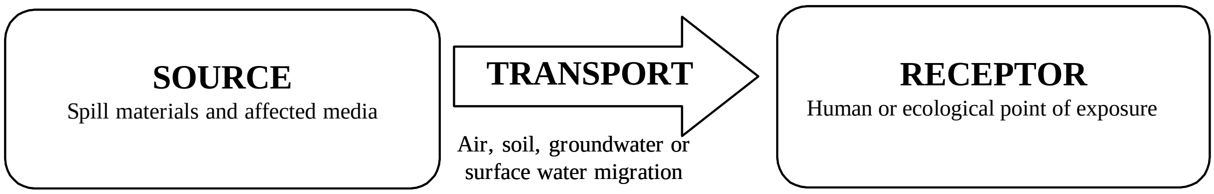

Figure 3: RBCA Conceptual Exposure Model

The approach is to use this methodology to determine the likelihood of an unacceptable risk developing. Risk assessment exposure pathway that were chosen to be applicable to this site are the following:

[1] ASTM E2081 Standard Guide for Risk-Based Corrective Action.

- Outdoor Air Inhalation – Potential risk to human health in the long term whereby asbestos fibres can be inhaled. This is the confirmed pathway whereby unacceptable risks to humans exist[2]. Potential exposure is to workers in the area and those that will be handling the asbestos. The necessary safety precautions will be required during the handling of the material, but these fall outside the scope of this document. Should the material not be covered, asbestos fibres might be transported by air or by storm water during infrequent rainfall events. In the context of water, only the second instance will be considered in the impact assessment.
- Leaching to Groundwater – Based on the physical properties of asbestos, there is no evidence that suggests that asbestos leaches and migrates with groundwater[3]. This aspect will be included in the impact assessment.

3 NATURAL SETTING

3.1 Geology

The regional geological map (Figure 2) shows that the coastal plain in the area of Kleinzee is mostly covered by Quaternary sediments (semiconsolidated piedmont deposits and red sand). The sand overburden covers a palaeotopography of wide valleys up to a depth of 130m in some places. Drainage from the highlands takes place into the sand and gravel deposits at the foot of the hills and flow then takes place in protodrainage channels towards the sea.

Along the Buffels River bed the Steinkopf Gneiss of the Gladkop Metamorphic Suite (Mokolian) has been mapped. On the farm Dikgat there is also an outcrop of the Nakanas formation (Bushmanland Group) consisting of garnet-staurolite-kyanite schist and interbedded quartzite. At several places in the riverbed Gannakouriep Suite diabase dyke intrusions have been found to intersect the flow direction diagonally. These are of a much younger age and dated as Namibium.

3.2 Climate, Topography and Rainfall

The coastal plain is classified as arid to semi-arid and most rain falls during the winter months. The higher lying regions have a much higher rainfall than the coastal plain (Titus, et.al., 2002). For the catchment F20E the mean annual precipitation is 92mm/yr[4] and the mean annual evapotranspiration 2200mm/yr. The whole catchment has an average rainfall of 143mm/yr. Evapotranspiration in this area is high with evaporation occurring up to a depth of 91cm in some places. The negative water balance will cause salts to form on the surface. The Buffels River flows in general once every three years. Significant baseflow in the river sediments provide roughly half of the water needs of the town of Kleinzee. Monitoring of the water levels in the town abstraction well (Fehlman well) over time show baseflow recession during dry periods.

Vegetation is only dependent on groundwater in those areas where the groundwater level is shallow like in the Buffels River alluvium where trees and shrubs are commonly found. Succulents, semi-succulents and grasses are most commonly found on the coastal plain.

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[2] http://www.who.int/ipcs/assessment/public_health/chrysotile_asbestos_summary.pdf

[3] https://www.des.nh.gov/organization/divisions/waste/orcb/prs/adsp/categories/faq.htm

[4] http://www.dwaf.gov.za/Geohydrology/gra2/3aEFinalReport.pdf

3.3 Hydrogeology

Previous work conducted by GPT in the area indicated that groundwater exists in two environments. Firstly, groundwater is found in the overburden or recent sedimentary deposits overlying the bedrock. These can form significant aquifers that are currently being utilised, e.g. the Somnaas Noup aquifer as well as all of the private boreholes situated south of the Buffels River. These boreholes were previously surveyed and monitored, showing fair water quality when compared to national standards and good water quality when compared to regional results. A second occurrence of groundwater is found in the fractured bedrock. Based on the previous work performed in the area, this water was found to be more saline than sea water and completely unsuitable for any beneficial use without significant treatment.

Based on the location of the proposed waste disposal site, it is unlikely that any beneficial water is available in the overburden. This area has been mined extensively and little to no groundwater was ever encountered on top of the bedrock. Some water might be present in the fractured bedrock, but the yields are expected to be low and the water quality is expected to be extremely poor.

4 IMPACT ASSESSMENT

Potential risks that the proposed activity poses to the environment and humans need to be considered along with mitigation measures that might be taken.

4.1 Surface Water Transport to Outdoor Air

The aim is to construct a landfill site that will be capped and sealed once all the material has been deposited into the landfill. The impact assessment considers leaving the disposal site open, or with mitigation of permanent capping. It can be seen below that the mitigation of capping is essential and is not optional. Capping will prevent storm water washing asbestos out of the landfill from where it can be distributed by wind.

Activity Rating	Without mitigation	With mitigation
Nature of impact	Negative	Negative
Probability	Highly probable	Improbable
Intensity	High	Low
Duration	Permanent	Medium term
Severity rating	Very high	Low
Significance rating	Very high	Low

4.2 Leaching to Groundwater

Due to the fact that asbestos is classified as hazardous waste, the disposal site will be lined. The impact assessment considers the two scenarios, 1) without lining and 2) with lining. Based on the physical properties of asbestos that is non-soluble and assuming that the disposal site will be capped, the mitigation of lining the disposal site underneath the waste makes no difference to the potential impact. This is further supported by the fact that there is no appreciable groundwater and that the waste will not generate any leachate.

Activity Rating	Without mitigation	With mitigation
Nature of impact	Negative	Negative
Probability	Improbable	Improbable
Intensity	Low	Low
Duration	Short term	Short term
Severity rating	Low	Low
Significance rating	Low	Low

5 CONCLUSIONS AND RECOMMENDATIONS

The desktop study determined that asbestos poses an insignificant risk to organisms through the pathway of groundwater, because it is insoluble and not likely to be mobilized in groundwater. Secondly, the hydrogeology of the area is not sensitive to impacts like storing insoluble material on top of it, due to the arid nature of the environment.

The impact assessment determined that capping of the proposed disposal site is crucial to prevent asbestos being washed from the site by occasional rainfall events from where wind dispersion could distribute the harmful fibers. Secondly, the impact assessment also indicated that lining a disposal site that is capped and only containing dry asbestos in a setting where there is no shallow groundwater, serves no purpose. The liner is designed to prevent leaching, which does not apply to insoluble asbestos. Therefore, even without mitigation of using a liner underneath the waste, the risk is acceptable.

6 LIMITATIONS

The following limitations are applicable to this study:

- No site visit or actual site data was used.
- It was assumed that only asbestos and bags will be disposed to the site and that no leachate will be generated.
- No external stakeholders were involved in the impact assessment.