APPENDIX E: Specialist Reports Scope of Study

ANNEXURE A: Terrestrial Ecology

BASELINE TERRESTRIAL ECOLOGY STUDY & BIODIVERSITY VALUE ASSESSMENT SCOPE OF WORKS AND PLAN OF STUDY

OBJECTIVES

The objectives of the Ecology Survey will be to:

- Provide an ecological assessment of the terrestrial ecosystems that are likely to be impacted by the proposed development;
- Provide an assessment of the biodiversity value of potentially affected ecosystems; this would incorporate an assessment of the conservation value of the ecosystems;
- Make recommendations regarding infrastructure layout, where appropriate.

The primary deliverable will be a report on Terrestrial Ecosystems, including:

- Biodiversity baseline description;
- Biodiversity Value Assessment;
- Broad-scale Vegetation Map;
- Biodiversity Value Map;
- Recommendations regarding infrastructure layout, where relevant

STUDY AREA

The proposed dam is situated on a Remainder of Portion 1 of the farm Strathmore 214-JU, approximately 10 km west of the town of Malalane, Ehlanzeni District, Mpumalanga (Figure 1). The proposed dam site is situated on an unnamed stream to the south east of the existing Strathmore Magnesite Mine. This stream joins the Crocodile River 4.5 km further downstream and is dammed both upstream and downstream of the proposed Strathmore Dam. Most of the area to the south is planted to orchards while most of the area to the north is mined. Some natural vegetation is present to the east and west of the site. The topography of the general area is gently to moderately undulating, but reasonably steep gradients are found in some parts of the surrounding areas. The study area is situated in the quarter-degree grid 2531 CB at an altitude of approximately 360 mamsl. The total area surveyed covers approximately 12 ha.

METHODS

Flora

Desktop
Vegetation communities were identified prior to fieldwork using satellite imagery supplied by Digital Earth. Red Data plant species listed for the quarter-degree grid 2531 CB and adjacent grids with similar habitats in the Mpumalanga Tourism & Parks Agency's threatened species database, as well as PRECIS data from the South African National Biodiversity Institute (SANBI), were used to produce a list of the most likely threatened species, which were searched for during fieldwork.

Fieldwork
The vegetation communities identified in the desktop phase were ground-truthed during a site visit on the 20th February 2018. Representative meandering transects were surveyed on foot in each vegetation community and species lists compiled for each community. Plants were listed according to each of the vegetation communities identified during the desktop phase. Plants not identified to species level were collected and dried in a plant press for identification at a later stage.

Fauna

Desktop
Lists of conservation-important mammals, birds, reptiles and frogs potentially occurring within the proposed agricultural development were prepared using data from the MTPA's threatened species database, Swanepoel *et al*. (2016), the Southern African Bird Atlas Project 2 http://sabap2.adu.org.za/, Taylor *et al.* (2016), Minter *et al*. (2004) and Bates *et al*. (2014). The above data were captured mostly at a quarter-degree spatial resolution, but were refined by excluding species unlikely to occur within the study area, due to unsuitable habitat characteristics (e.g. altitude and land-use). Bat species thought to only forage over the study area (i.e. mostly cave-roosting species) were not included in the assessment due to the lack of suitable caves within the study area. Potential occurrence of fauna in the study area was predicted based on knowledge of known habitat requirements of local fauna species.

Fieldwork
Birds were identified audially and visually using Bushnell 10x42 binoculars. Observations were made incidentally during the time that the vegetation survey was conducted, and limited to birds seen and heard within the study area and immediate surrounds. Mammals, reptiles and frogs were recorded incidentally as they were encountered during the survey through direct evidence (sightings) and indirect evidence (spoor, dung).

Biodiversity Value Assessment

The biodiversity value of each vegetation community found was based on a combination of Conservation Importance and Functional Importance, each of which were rated on a fivepoint

scale, from Very Low to Very High, as indicated in Table 1. This method was based on Biodiversity Action Plan guidelines developed by Anglo American (Coombes, 2004).

Conservation Importance

The method of calculating conservation importance was based on six key parameters, which were each allocated a score that ranged between zero (Not Important) and twenty (Very Important) (Table 2). The overall conservation importance was based on the median value of the six parameters, namely:

1. *Protection Status*. The extent to which the vegetation community is currently formally protected (e.g. World Heritage Site; RAMSAR, National Park; Provincial Game Reserve; Private Conservancy etc.);

2. *Size*. The extent to which the larger vegetation type of which the defined area is a representative sample, still exists; this incorporates the conservation status of threatened vegetation types in that vegetation types with the highest threat status are assumed to have the lowest extent of habitat remaining;

3. *Species Diversity*. The extent to which the vegetation community supports a high diversity of plants or animals;

4. *Species of Conservation Concern*. The extent to which the vegetation community supports threatened species and other species of conservation concern;

5. *Unique Habitat or Taxa*. Presence of range-restricted plants or animals or unusual natural feature;

6. *Present Ecological State*. The extent to which the vegetation community is modified from natural conditions.

Functional Importance

The method of calculating functional importance was based on four ecosystem service categories, which were each allocated a score that ranged between zero (Not Important) and twenty (Very Important) (Table 3). The overall functional importance was based on the median value of the four ecosystem service categories, namely:

1. *Provisioning Services*. The extent and frequency that the vegetation community provides consumable goods (e.g. food, freshwater, timber, fibre, medicinal plants, etc.);

2. *Regulating Services*. The extent to which the vegetation community provides regulating services (e.g. flood attenuation, water purification, storage, climate regulation, carbon sequestration, etc.);

3. *Cultural Services*. The extent to which the vegetation community provides cultural services (e.g. tourism attraction, spiritual attraction, aesthetic value, etc.), and;

4. *Supporting Services*. The extent to which the vegetation community provides supporting ecological services, either positive (e.g. migration corridor, refuge area, primary production, pollination, pest control, nutrient cycling, soil formation), or negative (e.g. disease sources, pest outbreaks).

By integrating assessments of the conservation importance and functional importance of the vegetation communities, an assessment of Biodiversity Value was made. These are indicated spatially in Figure 5.

Table 1. Method of calculating Biodiversity Value of vegetation communities

Conservation Importance	Functional Importance				
	Very High	High	Moderate	Low	Very Low
Very High	Very High	Very High	High	High	Moderate
High	Very High	High	High	Moderate	Moderate
Moderate	High	High	Moderate	Moderate	Low
Low	High	Moderate	Moderate	Low	Low
Very Low	Moderate	Moderate	Low	Low	Very Low

Table 2. Method of calculating Conservation Importance of vegetation communities

Parameter	Very High	High	Moderate	Low	Very Low
Protection Status	International	National	Regional	Local	None
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Size / Length	Very small	Small	Moderate	Large	Very Large
	(<500km^2)	(500 to 1,000km^2)	(1,000 to 20,000km^2)	(20,000 to 50,000km^2)	(> 50,000km^2)
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Species Diversity	Noticeably High		Moderate		Noticeably Low
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Species of Conservation Concern	Noticeably High		Moderate		Noticeably Low
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Unique Habitat or Taxa	Noticeably High		Moderate		Noticeably Low
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Present Ecological State	Natural, largely Unmodified	Slightly modified	Moderately Modified	Considerably Modified	Severely Modified
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0

Table 3. Method of calculating Functional Importance of vegetation communities

Parameter	Very High	High	Moderate	Low	Very Low
Provisioning Services	Constant	Regular	Frequent	Occassional	Intermittent
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Regulating Services	Very High	High	Moderate	Low	Very Low
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Cultural Services	Very High	High	Moderate	Low	Very Low
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0
Supporting Services	Very High	High	Moderate	Low	Very Low
	20 19 18 17	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1 0

ANNEXURE B: Archaeological Survey

PHASE 1 ARCHAEOLOGICAL AND HERITAGE IMPACT ASSESSMENT ON THE FARM STRATHMORE 214 JU IN RESPECT OF THE CONSTRUCTION OF AN IRRIGATION DAM, MALELANE, MPUMALANGA PROVINCE. SCOPE OF WORKS AND PLAN OF STUDY

1.1. Terms of reference

Kudzala Antiquity CC was commissioned to conduct an archaeological and heritage resources survey in respect of a proposed irrigation dam on a portion of the farm Strathmore 214 JU near Malelane in Mpumalanga Province. The survey was conducted in order to assess the potential impact that the proposed dam construction may have on archaeological and heritage resources. The survey was conducted for Henwood Environmental Solutions.

1.1.1 Project overview

The client is in the process of obtaining environmental authorization to construct a dam approximately 6 hectares in extent. The proposed dam, to be named the Radley Dam, is to be an earth-fill structure for irrigation purposes. The dam will be fed by the Salt River, a tributary of the Crocodile River. The dam will be located on the farm Strathmore 214 JU which is approximately 10km west of Malelane, Ehlanzeni District, Mpumalanga Province.

1.1.2. Constraints and limitations

The piece of land earmarked for the project consists of typical Granite Lowveld, this veld type often has dense thicket and this is the case with the study area which is located in a valley with dense vegetation. This limits surface visibility and accessibility.

1.2. Legislative Framework

The National Heritage Resources Act (NHRA) (Act No. 25, 1999) and the National Environmental Management Act (NEMA) (Act No. 107 of 1998) require that individuals or institutions have specialist heritage impact assessment studies undertaken whenever development activities are planned and such activities trigger activities listed in the legislation. This report is the result of an archaeological and heritage study in accordance with the requirements as set out in Section 38 (3) of the NHRA in

an effort to ensure that heritage features or sites that qualify as part of the national estate are properly managed and not damaged or destroyed.
The study aims to address the following objectives:

- Analysis of heritage issues;
- Assess the cultural significance of identified places including archaeological sites and features, buildings and structures, graves and burial grounds within a specific historic context;
- Identifying the need for more research;
- Surveying and mapping of identified places including archaeological sites and features, buildings and structures, graves and burial grounds;
- A preliminary assessment of the feasibility of the proposed development or construction from a heritage perspective;
- Identifying the need for alternatives when necessary; and
- Recommending mitigation measures to address any negative impacts on archaeological and heritage resources.

Heritage resources considered to be part of the national estate include those that are of archaeological, cultural or historical significance or have other special value to the present community or future generations.

The national estate may include:

- places, buildings, structures and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living
- heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and paleontological sites;
- graves and burial grounds including:
    (i) ancestral graves;
    (ii) royal graves and graves of traditional leaders;
    (iii) graves of victims of conflict;
    (iv) graves of individuals designated by the Minister by notice in the *Gazette;*
    (v) historical graves and cemeteries; and other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
- sites of significance relating to slavery in South Africa;
- movable objects including:
    (i) objects recovered from the soil or waters of South Africa, including archaeological and paleontological objects and material, meteorites and rare geological specimens;
    (ii) objects to which oral traditions are attached or which are associated with living heritage

(iii) ethnographic art and objects;

(iv) military objects (v) objects of decorative or fine art; (vi) objects of scientific or technological interest; and (vii) books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1 of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

(v) Cultural resources are unique and non-renewable physical phenomena (of natural occurrence or made by humans) that can be associated with human (cultural) activities (Van Vollenhoven 1995:3). These would be any man-made structure, tool, object of art or waste that was left behind on or beneath the soil surface by historic or pre-historic communities. These remains, when studied in their original context by archaeologists, are interpreted in an attempt to understand, identify and reconstruct the activities and lifestyles of past communities. When these items are removed from their original context, any meaningful information they possess is lost, therefore it is important to locate and identify such remains before construction or development activities commence.

1.3. Approach and statutory requirements

The SAHRA Minimum standards of 2007 guideline document, forms the background against which the survey was planned and the report compiled. An Archaeological Impact Assessment (AIA) consists of three phases. This document deals with the first phase. This (phase 1) investigation is aimed at getting an overview of cultural resources in the project area, assigning significance to these resources, assessing the possible impact that the proposed activity may have on these resources, making recommendations pertaining to the management of heritage resources and putting forward mitigation measures where applicable.

When the archaeologist or heritage specialist encounters a situation where the planned project will lead to the destruction or alteration of an archaeological/ heritage site or feature, a second phase investigation is normally recommended. During a phase two investigation mitigation measures are put in place and detailed investigation into the nature of the cultural material is undertaken. Often at this stage, archaeological excavation and detailed mapping of a site is carried out in order to document and preserve the cultural heritage.

Phase three consists of the compiling of a management plan for the safeguarding, conservation, interpretation and utilization of cultural resources (Van Vollenhoven, 2002).

Continuous communication between the developer and heritage specialist after the initial assessment has been carried out may result in the modification of a planned route or development to incorporate or protect existing archaeological and heritage sites.

2. Methodology

This study consists of a detailed archival study in order to understand the study area in a historical timeframe, an archaeological background study which include scrutiny of previous archaeological reports of the area, obtained through the SAHRIS database, and published as well as unpublished written sources on the archaeology of the area, social consultation with people who live nearby and a lastly a physical survey of the affected and immediate area.

The South African Heritage Resources Agency (SAHRA) and the relevant legislation (NHRA) require that the following components be included in an archaeological impact assessment:

- Archaeology;
- Shipwrecks;

- Battlefields;
- Graves;
- Structures older than 60 years;
- Living heritage;
- Historical settlements;
- Landscapes;
- Geological sites; and
- Paleontological sites and objects.

All the above-mentioned heritage components are addressed in this report, except shipwrecks, geological sites and paleontological sites and objects.

The ***purpose*** of the archaeological, archival and heritage study is to establish the whereabouts and nature of cultural heritage sites should they occur on project area. This includes settlements, structures and artefacts which have value for an individual or group of people in terms of historical, archaeological, architectural and human (cultural) development.

The ***aim*** of this study is to locate and identify such objects or places in order to assess and rate their significance and establish if further investigation is needed. Mitigation measures can then be suggested and put in place when necessary.

3.1. Archaeological and Archival background studies

The purpose of the desktop study is to compile as much information as possible on the heritage resources of the area. This helps to provide an historical context for located sites. Sources used for this study include published and unpublished documents, archival material and maps. Information obtained from the following institutions or individuals were consulted:

- Published and unpublished archaeological reports and articles;
- Published and unpublished historical reports and articles;
- Archival documents from the National Archives in Pretoria;
- Historical maps; and
- South African Heritage Resource Information System (SAHRIS) database.

3.1.1. Previous archaeological studies in the area

An archaeological impact study focusing on a section of the Mozambique-Secunda gas pipeline in the Barberton District, conducted by Mr J.A. van Schalkwyk in 2002, resulted in the recording of a single rock art site on Salisbury Kop and a few surface finds of pottery on the farm Thankerton 175 JU.

The same author compiled a heritage survey report in 2007, in respect of a housing development on the farm Stentor Reservaat 656 JU located south of Strathmore. Finds included a historic structure, possibly an old house and a grave.

3.1.2. Historic maps

Historical maps were scrutinized and features that were regarded as important in terms of heritage value were identified and if they were located within the boundaries of the project area they were physically visited in an effort to determine:

(i) whether they still exist;
(ii) (ii) their current condition; and
(iii) (iii) significance.

3.1.3. Physical survey

- The survey of the proposed dam location was conducted on 28 February 2018
- The survey took one day to complete.
- The documented sites were numbered sequentially.
- Sites were recorded by using a handheld Garmin Oregon 450 GPS unit and the unit was given time to reach an accuracy of at least 5 metres.
- Sites were plotted on 1:50 000 topographical maps which are geo-referenced (WGS 84) and also on Google Earth.
- No sites or archaeological or historical significance were identified. A number of survey orientation sites were mapped for survey purposes.

ANNEXURE C: Wetland and Aquatic Assessment

2. Special Conditions

2.1 Approach

The approach to this study will be to apply standard rapid survey techniques approved by the Department of Water Affairs & Santitation (DWS) to determine the types and extent of aquatic ecosystems that could be impacted by the proposed dam, and to recommend an appropriate ecological Management Category needed to determine the Ecological Reserve. It is understood that the Ecological Reserve will be assessed separately as part of the hydrological assessment. Potential impacts on aquatic ecosystems will based mainly on observed impacts of the existing dam.

2.2 Study Area

The Study Area will comprise Salt Creek Catchment to its confluence with the Crocodile River (ie: ie the potential zone of Influence), but baseline data will be collected from key areas only. Delineation of aquatic ecosystems will be limited to the area within 500 m of the proposed dam and its Full Supply Level, as required in terms of Government Notice 509 (26th August 2016). Baseline data will be collected at three sites only as follows:

- control site, upstream of the proposed Full Supply Level;
- potential impact site, immediately downstream of the proposed dam; and
- potential cumulative impact site, near the confluence with the Crocodile River (ie downstream of the existing dam).

Alternatively, baseline data may be collected from the existing dam, should Salt Creek be dry at the time of the field survey.

2.3 Level of Detail

The following components are included:

2.3.1 Classification and Delineation

Aquatic ecosystems within 500 m of the proposed development will be classified a delineated according to the revised method of wetland delineation (DWAF 2008).

2.3.2 Surface Water Quality

Surface water quality samples will be collected and analysed for pH, conductivity, faecal coliforms, Total Suspended Solids, nutrients and major ions. The results will be compared to the DWS Resource Quality Objectives from the nearest appropriate node that has been gazetted.

2.3.3 Benthic Diatoms

Benthic diatoms will be collected to provide a measure of the overall biological water quality. Results will be classified into one of six Present Ecological State categories, ranging from Category A (Natural), to Category F (Critically Modified).

2.3.4 Aquatic Macroinvertebrates

Aquatic maxcroinvertebrates will be sampled using the standard SASS5 biomonitoring method, where appropriate. Results will be classified into one of six Present Ecological State Categories, as above.

2.3.5 Fish

Fish will be sampled using an electro-fisher, where appropriate. Results will be presented as a % species composition and Cath per Unit Effort, and classified into one of six Present Ecological State categories, as above. Attention will be given to species of conservation concern.

2.3.6 Riparian Vegetation

Riparian vegetation will be assessed using the Vegetation Response Assessment Index (VEGRAI). Results will be classified into one of six Present Ecological State categories, as above.

2.4 Exclusions

No provision in this budget is made for the following:

- hydrology
- hydraulics
- Reserve determination
- toxicity
- fluvial geomorpohology
- liaison with authorities
- public meetings
- printing of reports

2.5 Information Needed from Client

Information needed from the Client includes:

- details regarding access to the Study Area; details of relevant landowners; keys for locked gates etc (if relevant)
- contact details of relevant persons, including emergency contact details;

2.6 Schedule

To be decided.

2.7 Study Team

Aquatic Ecologist - Rob Palmer *PhD (Zoology); Pr Sci Nat*

2.8 Deliverables (electronic copy only)

ANNEXURE D: Water Yield

YIELD ANALYSIS OF THE PROPOSED RADELY DAM

DRAFT

March 2018

e-mail: info@waterresources.co.za
Cell: 083 415 7223
www.waterresources.co.za

TABLE OF CONTENTS

1 INTRODUCTION

The purpose of this study is to undertake a yield analysis of the proposed Radley Dam The dam site is on the Salt Creek, a tributary of the Crocodile River. See Figure 1.1.

The main purpose of the dam is to provide balancing storage for water delivered via the Malalane Canal.

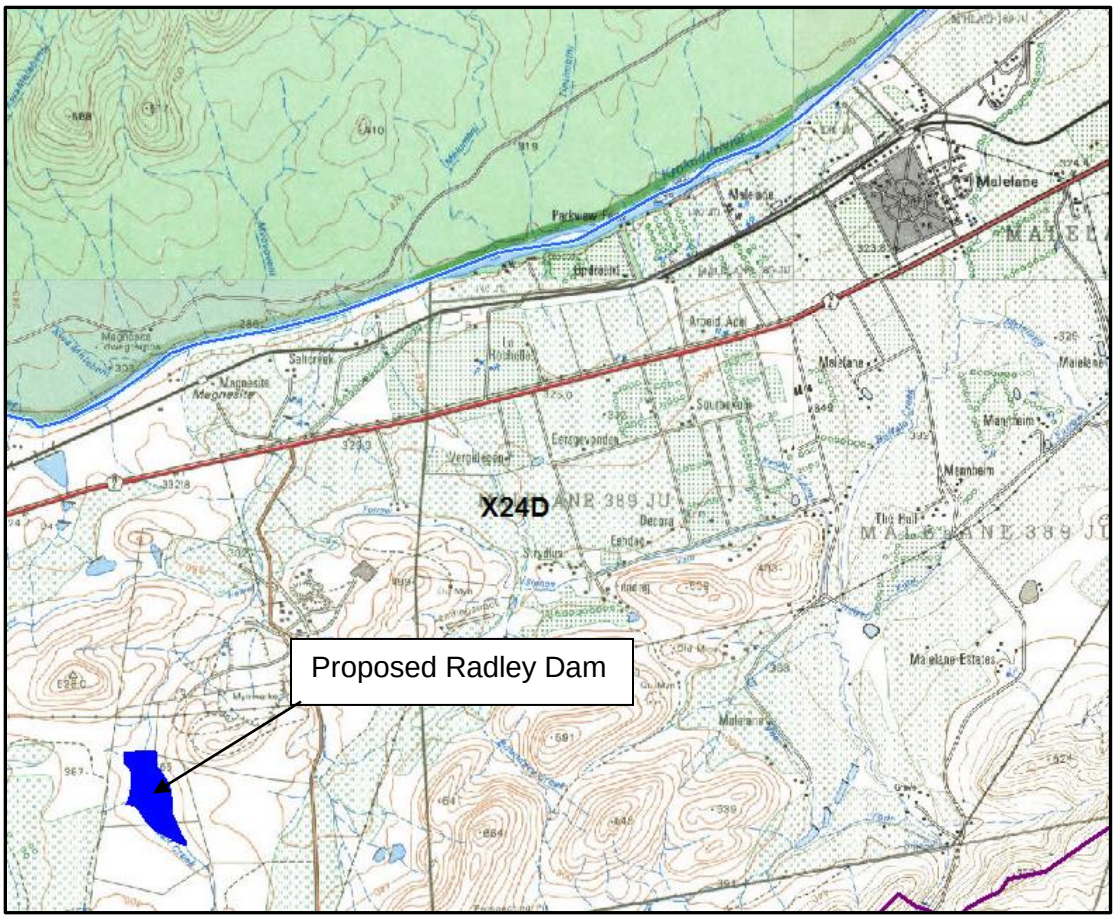

Figure 1.1: Location of the proposed Radley Dam

A yield analysis determines how much water can be abstracted from a dam (or river) on a sustainable basis. For irrigation use this would be done assuming a 70% which is the norm of the Crocodile catchment. What this implies that all the water will be available for 70% but restricted for 30% of the time of the time.

The yield analysis carried out is independent of the storage of water from the Malelane and determines how much water could be obtained from the catchment. A water use licence will be required to abstract this water.

2 WATER RESOURCES AND CATCHMENT INFORMATION

The Radley Dam site is located in the X24D quaternary catchment, as indicated in Figure 2.1. The relevance of this is that water resources and hydrological information is readily available at quaternary catchment scale from the Inkomati Water Availability Assessment (DWA, 2009). During this study, the X24D catchment was subdivided into two quinary catchments, X24D-1 and X24D-2. The Radley Dam lies in the latter sub-catchment.

The hydrological data for this catchment was used to estimate the yield of the dam.

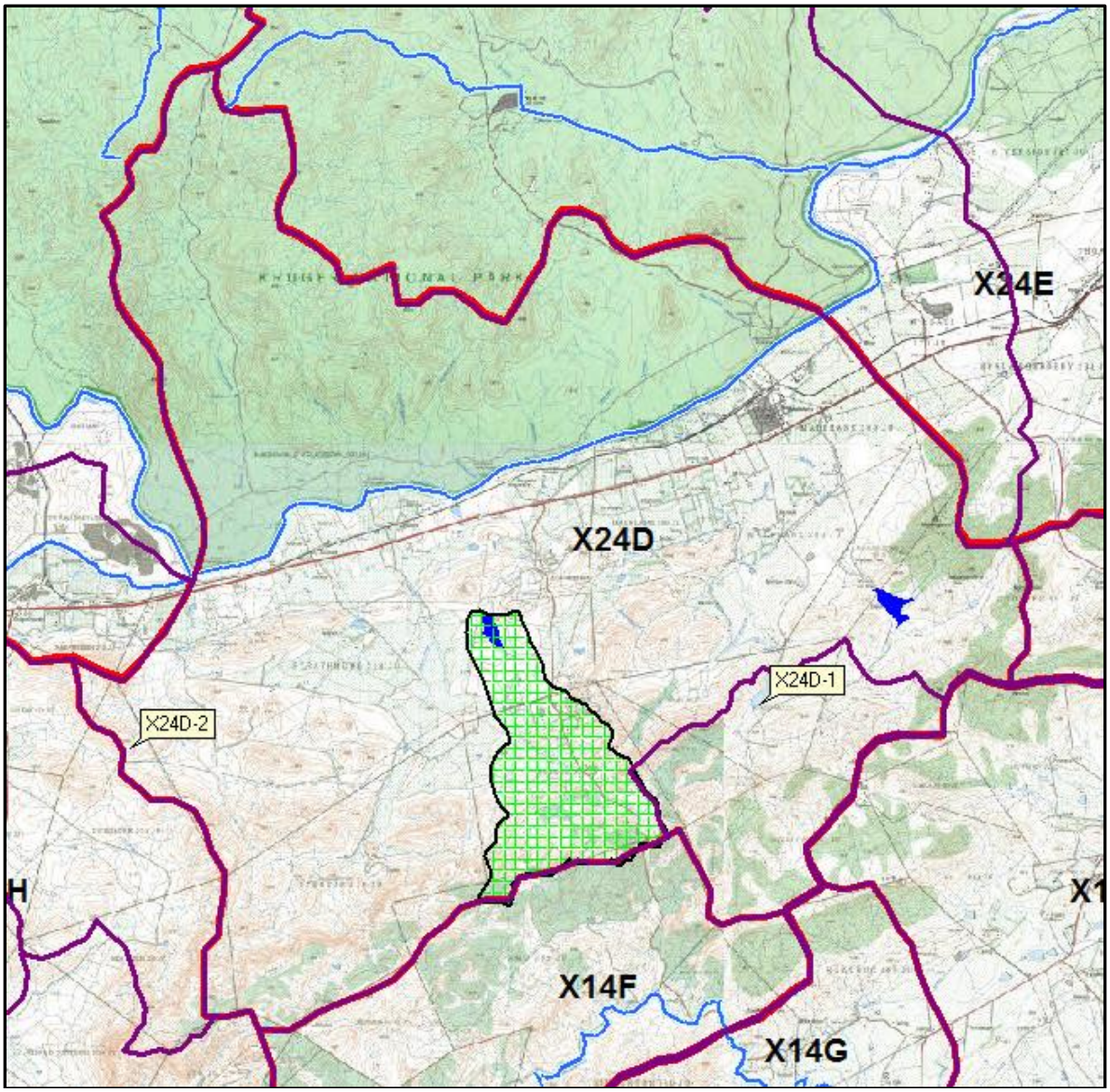

Figure 2.1: Location of the proposed Radley Dam within the X24D quaternary catchment

The hydrological information for the X24D-2 catchment is summarised in Table 2.1.

Table 2.1: Summary of climate and hydrology information for the X24D-2 catchment

Catchment Area (km^2)	Mean Annual Evaporation (MAE)	Mean Annual Precipitation (MAP)	Mean Annual Runoff (MAR)
	mm/annum		million m^3/annum
277.8	1 450	816	18.3

3 WATER RESOURCES ANALYSIS

3.1 Determination of natural flow

It is accepted practice when dealing with ungauged sub-catchments within a quaternary catchment to scale the natural hydrology for the quaternary catchment linearly. This is demonstrated in the example below.

X14D-2 catchment area: 277.8 km^2
Radley Dam catchment area:` 17.2 km^2. See Figure 3.1.
X24D-2 MAR: 18.3 million m^3/annum

Radley Dam MAR = (17.2/277.8) x 18.3
= 1.13 million m^3/annum **(based on linear scaling)**

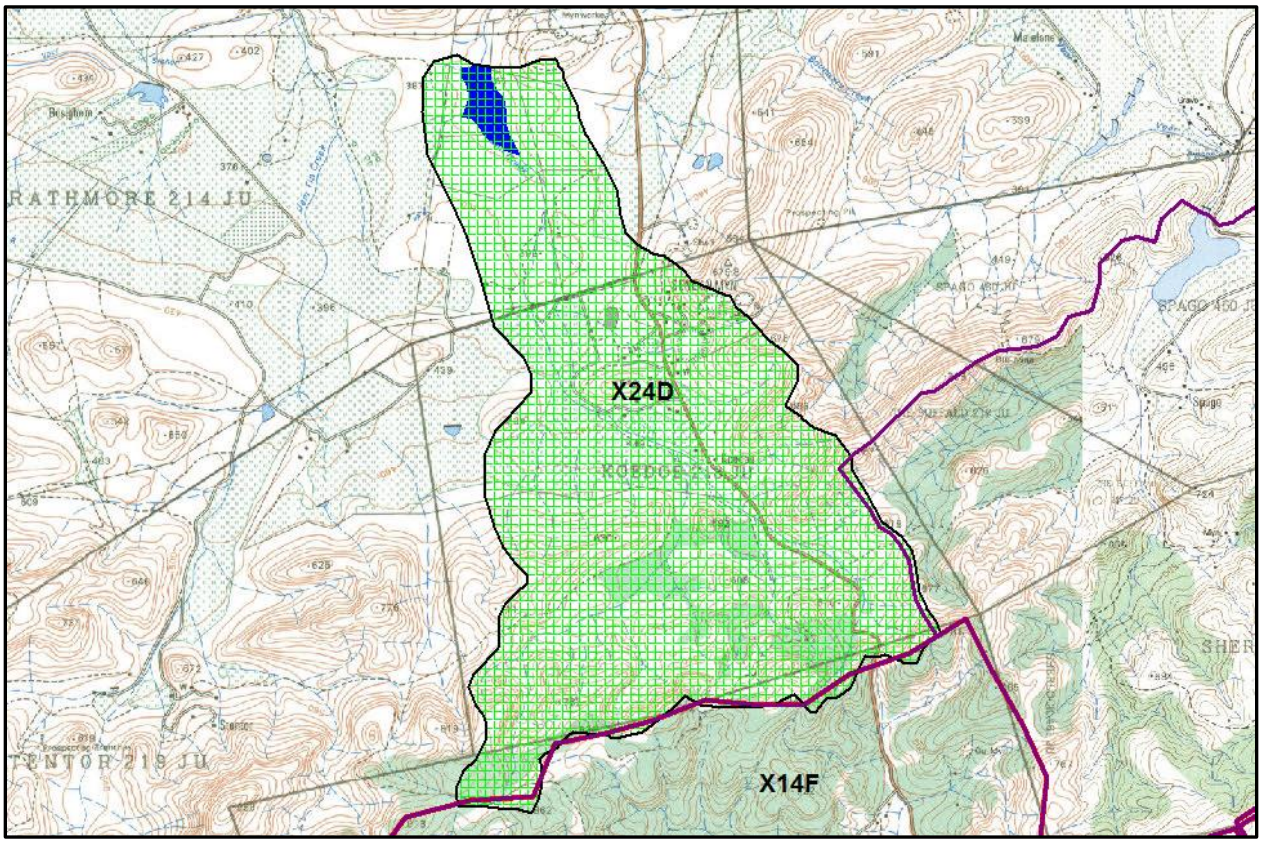

Figure 3.1: Radley Dam catchment

The time series of natural runoff into the Radley Dam is shown in Figure 3.2 and attached as Appendix A.

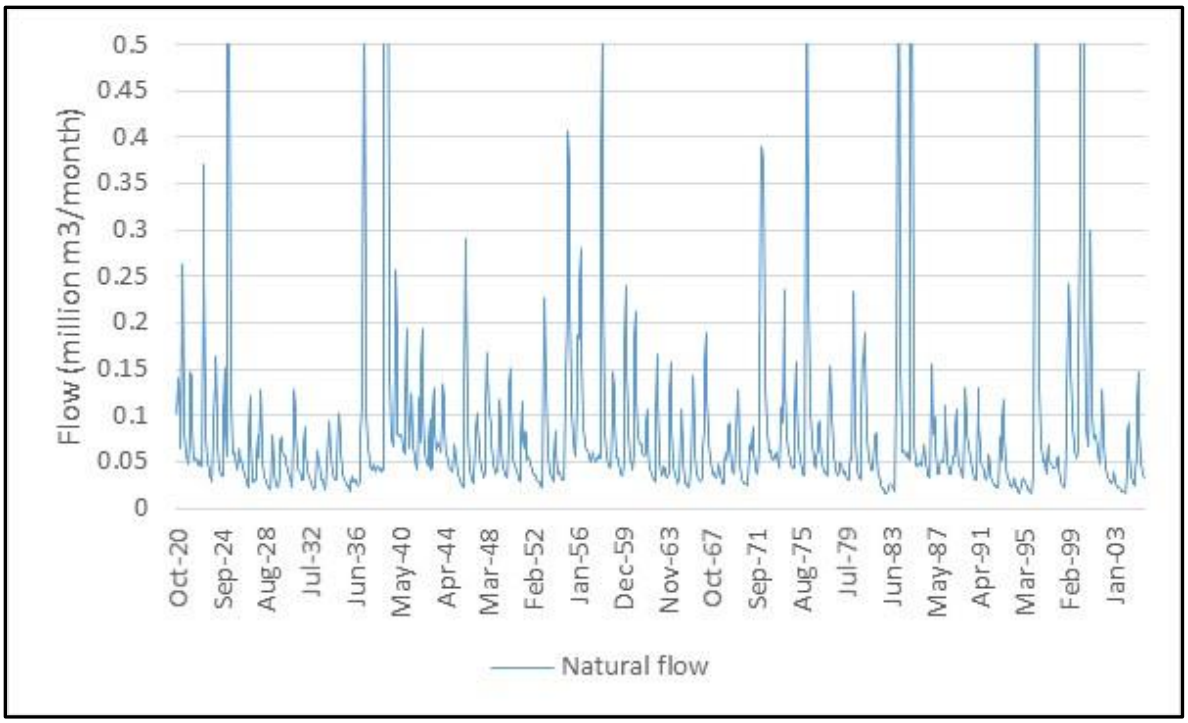

Figure 3.2: Natural flow into the Radley Dam

3.2 Water use in the catchment

It is important to take into account water use upstream of the dam since this will reduce the flow into the dam and hence reduce the yield. While there are substantial irrigated areas upstream of the proposed dam site, it is understood that this water is supplied from the Malalane canal and is not sourced from the catchment. There is a small area of forestry in the upper reaches of the catchment which reduces the runoff by an estimated 6 000 m^3/annum. This has been taken into account when estimating the runoff into the dam.

Depending on irrigation practices, there could be return flows from irrigation upstream of the dam and this water could be utilised. It is recommended that a system to measure return flows be installed so that at a later date, if these return flow prove to be significant, they can be reused. The licencing authorities would however need be made aware of this.

3.3 Ecological water requirements

The Ecological Water Requirements (EWR) of the Crocodile River have been determined and published in the Government Gazette. While there is no specific EWR requirement for the Salt Creek, it is possible to make a first order estimate if the EWR requirement using the Hughes Desktop model (Hughes and Hannart, 2002). Based on the recommendation of Dr R Palmer, a

D Class for the ecological status of the catchment was used when estimating the EWR. The EWR requirement was estimated to be 19% of the natural runoff, that is, 0.213 million m^3/annum ***on average***. The EWR is however not a constant flow but varies with the natural flow. Figure 3.3 shows the EWR and the Natural flow on the same axis in order to demonstrate this point.

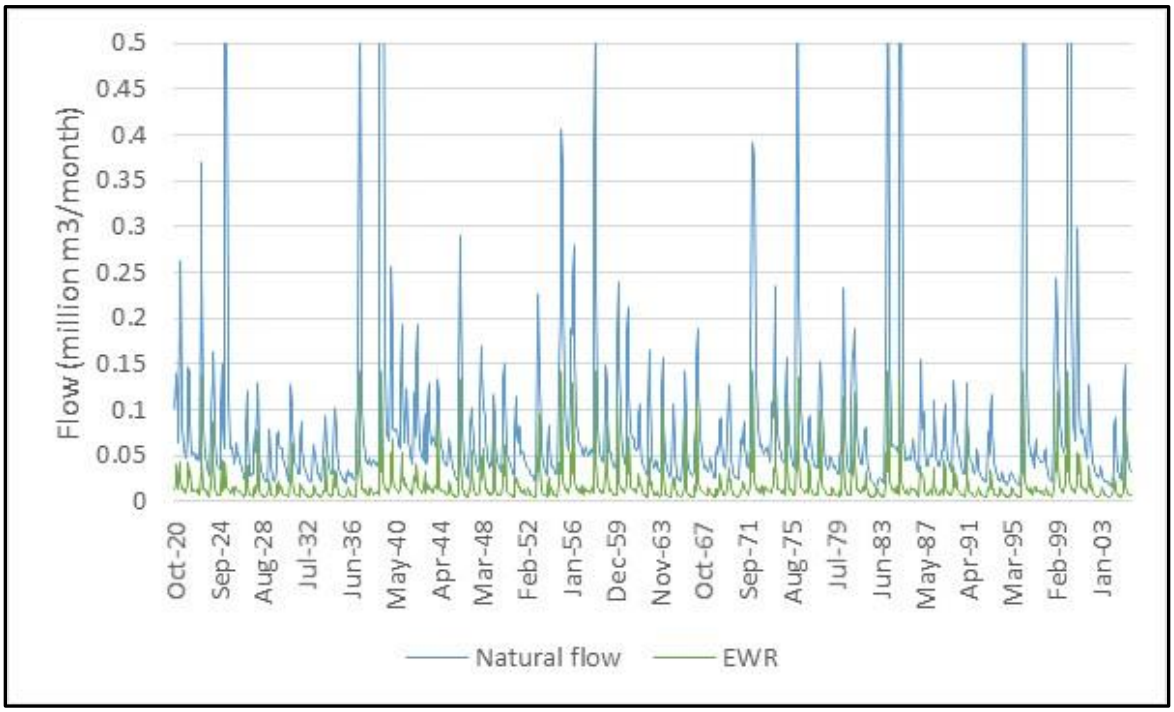

Figure 3.3: Time series of the Ecological Water Requirements compared to natural flow

3.4 Yield analysis

The yield calculations were carried out using the Water Resources Modelling Platform (Mallory et al, 2013). This is a monthly time step simulation model. The term 'yield' generally refers to the amount of water that can be abstracted from the dam on a sustainable basis. Typically the so-called Historic Yield is calculated for a dam which supplies domestic users and this is the amount of water that can be extracted every year without the dam quite emptying. Irrigators, on the other hand, accept a higher risk in exchange for a greater volume of water **on average** over the long term and in the Crocodile catchment irrigators operate at 70% assurance. This implies that they receive their full allocation 70% of the time but are restricted for 30% of the time.

The yield was determined for a dam with a full supply capacity of 315 000 m^3 and with a full supply surface area of 6.7 ha. See Table 3.1.

Table 3.1: Yield of the proposed Radley Dam

Assurance	Yield (m^3/annum)
Historic yield (~ 99% assurance)	323 000
70% assurance	650 000

Figure 3.4 shows a modelled time series of the water supply from the dam with an abstraction rate of 650 000 m^3/annum applied to it. Based on the scheduled application rate for the lower Crocodile River this equates to a crop area of 50ha.

The seasonal variation in the abstraction is due to the demand pattern of the crop, which was assumed to be sugar cane. See Appendix B. The long periods of under-supply are due to restrictions being applied during droughts.

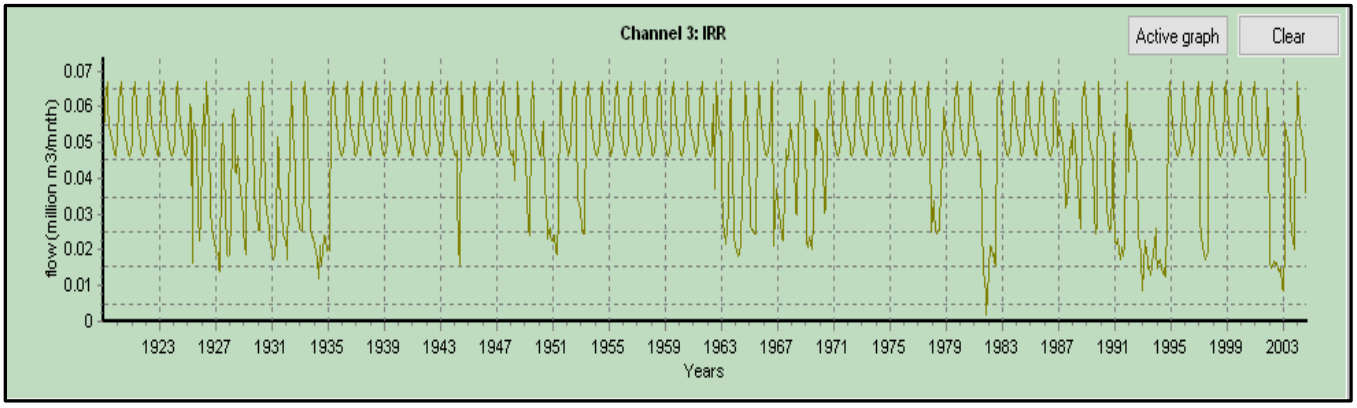

Figure 3.4: Time series of water supply from the Radley Dam

4 CONCLUSIONS AND RECOMMENDATIONS

The proposed Radley Dam on the Salt Creek, a tributary of the Crocodile River, should be able to supply up to 650 000 m^3/annum at 70% assurance if constructed to a full supply capacity of 315 000 m^3. The ecological requirement has been estimated based on a D Class and this will need to be released from the dam in preference to abstraction for irrigation. It will probably be necessary to develop an operating rule through which these releases can be managed.

It is recommended that a system to measure return flows be installed so that at a later date, if these return flow prove to be significant, they can be reused.

5 REFERENCES

Department of Water Affairs, 2008. Inkomati Water Availability Assessment. Hydrology of the Crocodile River. Report no. PWMA 05/X22/00/1508

Mallory, S.J.L, Desai, A.Y., Odendaal, P. (2013) *Water Resources Modelling Platform – User's Guide*, www.waterresources.co.za

APPENDIX A: NATURAL RUNOFF TIME SERIES

Units are million m^3

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1920	0.107	0.136	0.145	0.101	0.067	0.211	0.266	0.131	0.080	0.065	0.057	0.051	1.416
1921	0.049	0.073	0.151	0.146	0.085	0.055	0.053	0.053	0.054	0.051	0.048	0.047	0.865
1922	0.051	0.055	0.048	0.238	0.378	0.248	0.125	0.076	0.053	0.049	0.044	0.037	1.403
1923	0.033	0.030	0.079	0.105	0.137	0.165	0.103	0.066	0.048	0.043	0.038	0.037	0.882
1924	0.037	0.114	0.155	0.086	0.059	0.941	1.252	0.463	0.204	0.105	0.066	0.061	3.544
1925	0.062	0.057	0.049	0.044	0.043	0.056	0.065	0.051	0.053	0.048	0.043	0.040	0.611
1926	0.037	0.032	0.028	0.025	0.090	0.123	0.067	0.042	0.030	0.031	0.033	0.032	0.571
1927	0.063	0.082	0.056	0.113	0.131	0.072	0.048	0.040	0.035	0.032	0.028	0.025	0.726
1928	0.025	0.025	0.023	0.022	0.061	0.082	0.053	0.038	0.030	0.027	0.024	0.024	0.434
1929	0.037	0.076	0.082	0.065	0.059	0.059	0.059	0.050	0.045	0.041	0.037	0.033	0.641
1930	0.027	0.024	0.082	0.132	0.111	0.082	0.059	0.046	0.040	0.041	0.038	0.033	0.716
1931	0.032	0.033	0.074	0.092	0.058	0.049	0.041	0.037	0.033	0.031	0.028	0.024	0.533
1932	0.023	0.024	0.031	0.060	0.065	0.052	0.048	0.039	0.033	0.032	0.028	0.025	0.460
1933	0.023	0.045	0.059	0.085	0.097	0.065	0.054	0.043	0.038	0.037	0.035	0.031	0.612
1934	0.032	0.057	0.100	0.106	0.083	0.061	0.046	0.037	0.034	0.032	0.029	0.027	0.643
1935	0.025	0.024	0.020	0.030	0.036	0.030	0.031	0.033	0.032	0.028	0.026	0.025	0.340
1936	0.030	0.087	0.110	0.210	0.535	0.522	0.255	0.147	0.098	0.074	0.064	0.056	2.188
1937	0.048	0.043	0.045	0.050	0.047	0.042	0.045	0.048	0.046	0.046	0.042	0.041	0.544
1938	0.045	0.043	0.560	0.769	1.598	1.871	0.680	0.283	0.136	0.083	0.074	0.071	6.214
1939	0.070	0.158	0.262	0.199	0.115	0.082	0.080	0.077	0.081	0.080	0.071	0.066	1.341
1940	0.061	0.136	0.197	0.129	0.077	0.066	0.111	0.123	0.080	0.065	0.059	0.051	1.154
1941	0.046	0.045	0.095	0.123	0.072	0.160	0.194	0.100	0.066	0.059	0.053	0.050	1.063
1942	0.048	0.081	0.099	0.062	0.045	0.046	0.110	0.130	0.082	0.064	0.071	0.072	0.909
1943	0.069	0.067	0.064	0.095	0.137	0.121	0.082	0.061	0.057	0.056	0.049	0.042	0.898
1944	0.043	0.044	0.042	0.062	0.070	0.058	0.052	0.043	0.038	0.035	0.031	0.027	0.545
1945	0.028	0.027	0.024	0.147	0.297	0.238	0.125	0.075	0.051	0.042	0.037	0.032	1.124
1946	0.028	0.044	0.067	0.091	0.105	0.088	0.072	0.058	0.048	0.044	0.038	0.034	0.716
1947	0.041	0.123	0.174	0.144	0.108	0.101	0.093	0.068	0.053	0.048	0.042	0.038	1.034
1948	0.042	0.045	0.043	0.080	0.120	0.095	0.063	0.050	0.046	0.042	0.037	0.036	0.698
1949	0.034	0.068	0.142	0.155	0.109	0.070	0.053	0.050	0.047	0.044	0.041	0.035	0.848
1950	0.032	0.030	0.084	0.119	0.074	0.067	0.084	0.079	0.063	0.053	0.057	0.057	0.798
1951	0.054	0.048	0.045	0.043	0.038	0.039	0.037	0.033	0.031	0.031	0.030	0.025	0.454
1952	0.025	0.037	0.186	0.233	0.152	0.123	0.077	0.056	0.044	0.040	0.035	0.033	1.038
1953	0.030	0.064	0.087	0.060	0.047	0.040	0.039	0.041	0.039	0.035	0.033	0.032	0.547
1954	0.033	0.118	0.154	0.213	0.415	0.379	0.210	0.139	0.102	0.081	0.069	0.058	1.970
1955	0.069	0.116	0.192	0.187	0.251	0.285	0.157	0.100	0.085	0.077	0.067	0.064	1.651
1956	0.066	0.061	0.055	0.053	0.052	0.056	0.061	0.058	0.052	0.051	0.052	0.057	0.673
1957	0.060	0.055	0.056	0.407	0.526	0.227	0.118	0.080	0.059	0.054	0.048	0.046	1.737
1958	0.046	0.048	0.098	0.152	0.134	0.089	0.063	0.056	0.054	0.049	0.043	0.039	0.872
1959	0.038	0.038	0.052	0.061	0.191	0.243	0.144	0.108	0.077	0.059	0.052	0.047	1.111
1960	0.044	0.061	0.192	0.217	0.115	0.087	0.079	0.069	0.071	0.069	0.061	0.058	1.124
1961	0.059	0.061	0.098	0.110	0.067	0.046	0.043	0.041	0.038	0.035	0.032	0.029	0.660
1962	0.030	0.116	0.170	0.114	0.070	0.050	0.040	0.038	0.041	0.046	0.045	0.037	0.797
1963	0.034	0.036	0.040	0.131	0.160	0.085	0.055	0.045	0.040	0.036	0.032	0.027	0.721
1964	0.031	0.040	0.084	0.110	0.074	0.049	0.035	0.030	0.028	0.027	0.025	0.025	0.558
1965	0.027	0.044	0.054	0.108	0.145	0.094	0.058	0.041	0.035	0.034	0.032	0.030	0.702
1966	0.030	0.035	0.070	0.088	0.165	0.191	0.116	0.089	0.068	0.058	0.051	0.043	1.003
1967	0.039	0.041	0.039	0.034	0.035	0.044	0.048	0.041	0.038	0.036	0.033	0.028	0.457
1968	0.028	0.051	0.063	0.054	0.065	0.091	0.092	0.064	0.050	0.043	0.038	0.038	0.677
1969	0.069	0.089	0.121	0.131	0.073	0.048	0.038	0.033	0.030	0.029	0.029	0.028	0.718
1970	0.026	0.034	0.059	0.072	0.064	0.075	0.089	0.073	0.059	0.050	0.043	0.038	0.683

1971	0.041	0.067	0.191	0.385	0.399	0.384	0.344	0.188	0.128	0.096	0.082	0.068	2.374
1972	0.063	0.064	0.059	0.054	0.056	0.057	0.061	0.061	0.054	0.049	0.045	0.083	0.706
1973	0.113	0.094	0.117	0.228	0.241	0.128	0.088	0.073	0.063	0.059	0.055	0.048	1.307
1974	0.046	0.045	0.046	0.121	0.160	0.111	0.079	0.064	0.056	0.050	0.045	0.039	0.864
1975	0.037	0.039	0.418	0.620	0.348	0.219	0.144	0.100	0.077	0.067	0.058	0.050	2.179
1976	0.046	0.051	0.061	0.064	0.092	0.095	0.071	0.055	0.049	0.043	0.041	0.041	0.708
1977	0.039	0.038	0.072	0.150	0.157	0.118	0.095	0.070	0.054	0.048	0.043	0.037	0.921
1978	0.036	0.045	0.052	0.050	0.050	0.039	0.041	0.042	0.038	0.035	0.033	0.031	0.491
1979	0.032	0.050	0.061	0.055	0.192	0.236	0.119	0.071	0.050	0.041	0.037	0.034	0.977
1980	0.033	0.118	0.169	0.163	0.193	0.157	0.100	0.072	0.058	0.051	0.046	0.043	1.202
1981	0.043	0.054	0.069	0.084	0.084	0.054	0.038	0.036	0.032	0.030	0.027	0.024	0.573
1982	0.022	0.021	0.019	0.017	0.017	0.020	0.026	0.030	0.029	0.027	0.025	0.022	0.274
1983	0.021	0.133	0.190	0.568	0.697	0.285	0.145	0.087	0.061	0.063	0.064	0.059	2.373
1984	0.061	0.063	0.058	0.054	1.070	1.426	0.517	0.217	0.108	0.067	0.055	0.048	3.742
1985	0.048	0.049	0.050	0.053	0.048	0.051	0.064	0.069	0.054	0.049	0.043	0.037	0.613
1986	0.035	0.033	0.122	0.161	0.082	0.093	0.100	0.062	0.045	0.040	0.039	0.046	0.857
1987	0.054	0.051	0.054	0.052	0.077	0.112	0.093	0.064	0.049	0.045	0.040	0.039	0.730
1988	0.046	0.052	0.058	0.059	0.092	0.108	0.069	0.050	0.047	0.046	0.040	0.034	0.701
1989	0.035	0.090	0.136	0.105	0.080	0.072	0.066	0.058	0.051	0.045	0.040	0.034	0.812
1990	0.033	0.032	0.045	0.118	0.132	0.090	0.072	0.052	0.047	0.048	0.042	0.036	0.746
1991	0.032	0.032	0.046	0.061	0.050	0.036	0.033	0.032	0.028	0.026	0.027	0.025	0.426
1992	0.024	0.027	0.065	0.082	0.054	0.099	0.117	0.072	0.053	0.043	0.038	0.033	0.706
1993	0.030	0.028	0.027	0.026	0.024	0.028	0.034	0.028	0.025	0.024	0.021	0.019	0.314
1994	0.020	0.025	0.030	0.035	0.035	0.028	0.028	0.026	0.023	0.022	0.020	0.019	0.311
1995	0.018	0.036	0.083	0.395	1.541	1.617	0.585	0.251	0.128	0.080	0.067	0.058	4.859
1996	0.053	0.054	0.053	0.048	0.040	0.056	0.071	0.053	0.050	0.048	0.046	0.045	0.614
1997	0.045	0.046	0.048	0.056	0.059	0.043	0.035	0.030	0.027	0.026	0.025	0.025	0.464
1998	0.071	0.139	0.212	0.248	0.202	0.146	0.108	0.085	0.073	0.064	0.061	0.061	1.470
1999	0.055	0.065	0.187	0.306	2.028	2.780	1.224	0.478	0.218	0.124	0.085	0.074	7.625
2000	0.070	0.223	0.306	0.163	0.100	0.077	0.079	0.080	0.076	0.068	0.059	0.051	1.353
2001	0.050	0.098	0.132	0.092	0.069	0.050	0.045	0.040	0.036	0.035	0.032	0.029	0.707
2002	0.030	0.029	0.035	0.043	0.032	0.028	0.027	0.025	0.025	0.024	0.022	0.020	0.340
2003	0.020	0.020	0.018	0.017	0.037	0.085	0.093	0.059	0.043	0.035	0.033	0.028	0.487
2004	0.026	0.044	0.055	0.124	0.151	0.097	0.080	0.061	0.049	0.041	0.038	0.034	0.799
Average	**0.042**	**0.061**	**0.099**	**0.133**	**0.195**	**0.204**	**0.129**	**0.079**	**0.057**	**0.049**	**0.043**	**0.040**	**1.132**

APPENDIX B: CROP REQUIREMENT PATTERN

Month	% of annual requirement
January	10.3
February	9.2
March	8.5
April	8.1
May	7.9
June	7.6
July	7.2
August	7.1
September	7.3
October	7.7
November	9.3
December	9.9

ANNEXURE E: Palaeontological

PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED RADLEY DAM, MALELANE, MPUMALANGA PROVINCE. SCOPE OF WORKS AND PLAN OF STUDY

1. Background

Henwood Environmental Solutions has been appointed to carry out the EIA and WULA for a proposed dam in the Malelane area. The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected.