A HYDROLOGICAL IMPACT ASSESSMENT FOR THE KHUBU SOLAR POWER PLANT, VRYBURG, NORTHWEST PROVINCE

BY

EcoMonitor cc
Reaching out for nature

FOR

Khubu Solar Power Plant (RF) (Pty) Ltd.

REPORT NO. EM4603
MARCH 2016

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Introduction

Khubu Solar Power Plant (RF) Pty Ltd requested that a desk-top hydrological study be undertaken of the area on which a solar power plant is to be erected, followed by an impact assessment of the local hydrology on relevant components of the power plant together with mitigation of all identified impacts.

Hydrology of the area

Study area

The study area is located on Portion 5 (Shadow Eve), a portion of Portion 4, of the Farm Championskloof 731 HN. It is situated closest and directly south of the town named Vryburg in the Northwest Province. The surface area of Portion 5 is 397.3009ha. The Title Deed No. is 1648/2012. The study area is flanked by the N18 and the Dry Harts River to the west and the Harts River to the east and south (Figures 1 & 2), both of which are perennial rivers.

Smaller-scale maps (1:10 000) clearly show that the study area is bisected by a small, unnamed and perennial stream (Figures 3 to 5). None of these maps show anything that looks remotely like or can be identified as a wetland. The area is very flat - the 1200m radius depicted on these maps cross two contours, which have a height differential of 20m.

Local drainage area maps

This desktop hydrological assessment included a survey of all available information for the area under investigation. As requested by the client, the South African National Biodiversity Institute (SANBI) Wetland Database was accessed for available information. The Department of Water Affairs' Rivers Database is currently non-functional and offline. A hard-copy topographical map covering the area under investigation was also used.

Although the client requested maps demarcating the local drainage area of the respective watercourses, its respective catchment and other areas within a 500m radius of the study area, this radius was more than doubled in size (i.e. 1200m radius) as this would then cover the whole of the study area. These maps clearly show the connectivity between the site and the surrounding regions, i.e. the hydrological zone of influence. All of the maps included in this report are to a scale of 1:10 000, as requested by the client.

The small, perennial stream is depicted in the photos below. Note that there is no clear and distinct channel that clearly defines the borders of the stream. Furthermore, no floodline information is available for this stream.

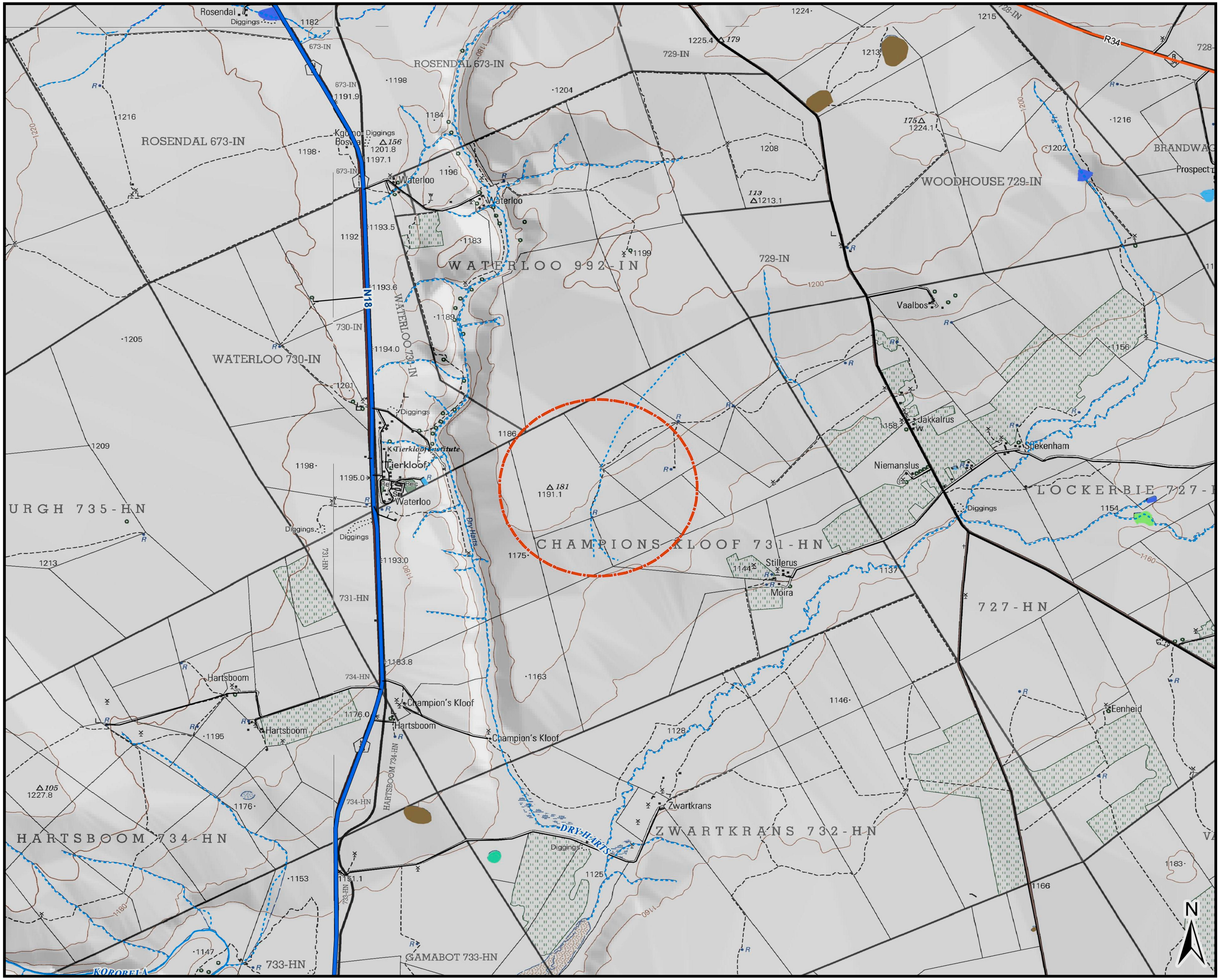

Figure 1: A large-scale GIS-based topographical map showing the location of the site (the red circle with a radius of 1200m) with the Dry Harts River (and the N18) to the west and the Harts River to the south and east. Both are perennial rivers. The study site is clearly bisected by a small, unnamed perennial stream.

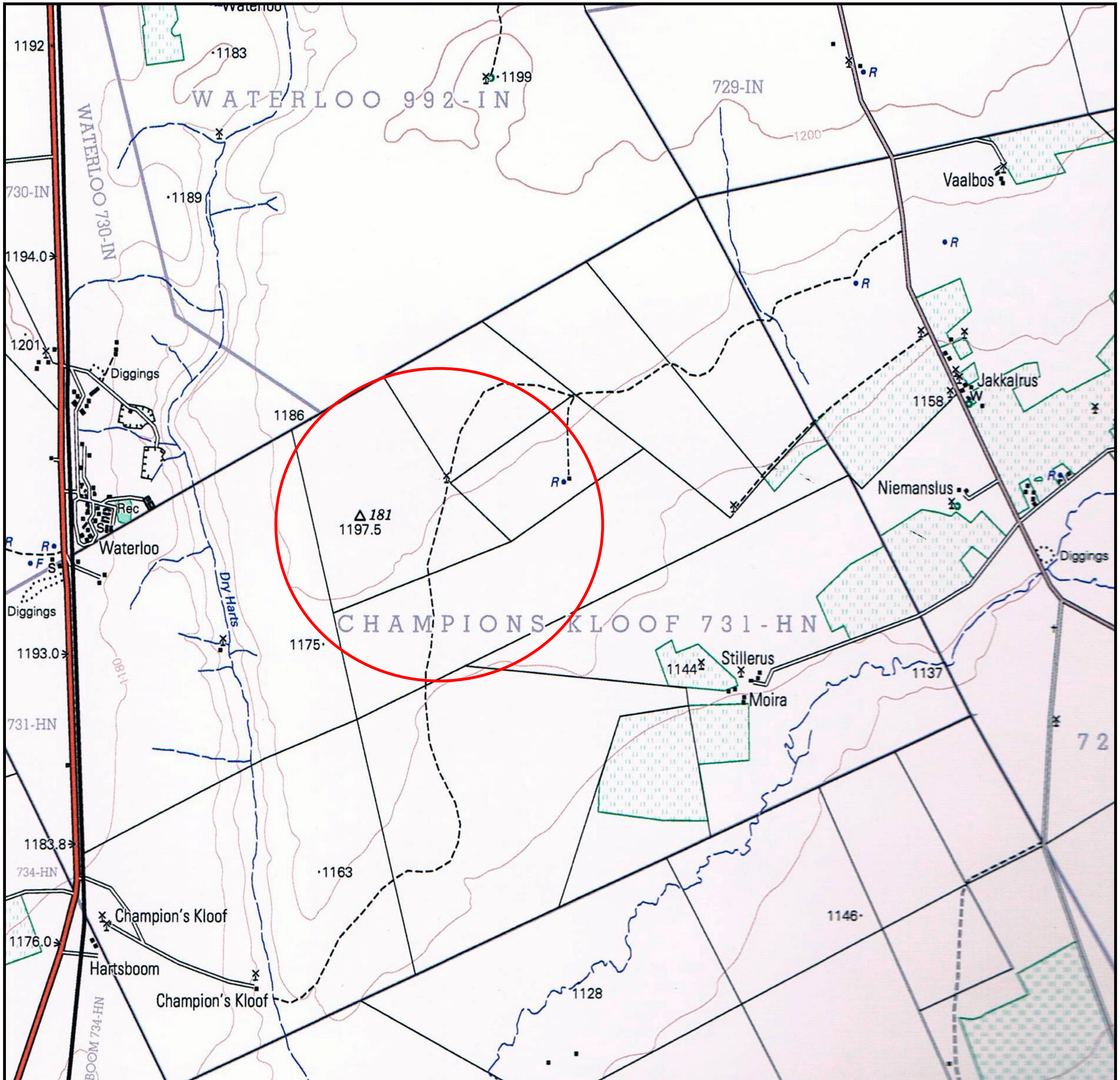

Figure 2: A smaller-scale map obtained from the 1:50 000 topographical map (2724BB Lefton (2001 edition) showing the location of the site (the red circle with a radius of 1200m) with the Dry Harts River (and the N18) to the west and the Harts River to the south and east. Both are perennial rivers. More clearly seen here is the small, perennial stream that bisects the study area. No wetlands are indicated on this map.

corner A
27°03'02.63"S & 24°46'18.19"E

corner B
27°02'34.35"S & 24°47'14.46"E

corner C
27°03'23.42"S & 24°47'32.66"E

corner D
27°03'47.78"S & 24°40'29.14"E

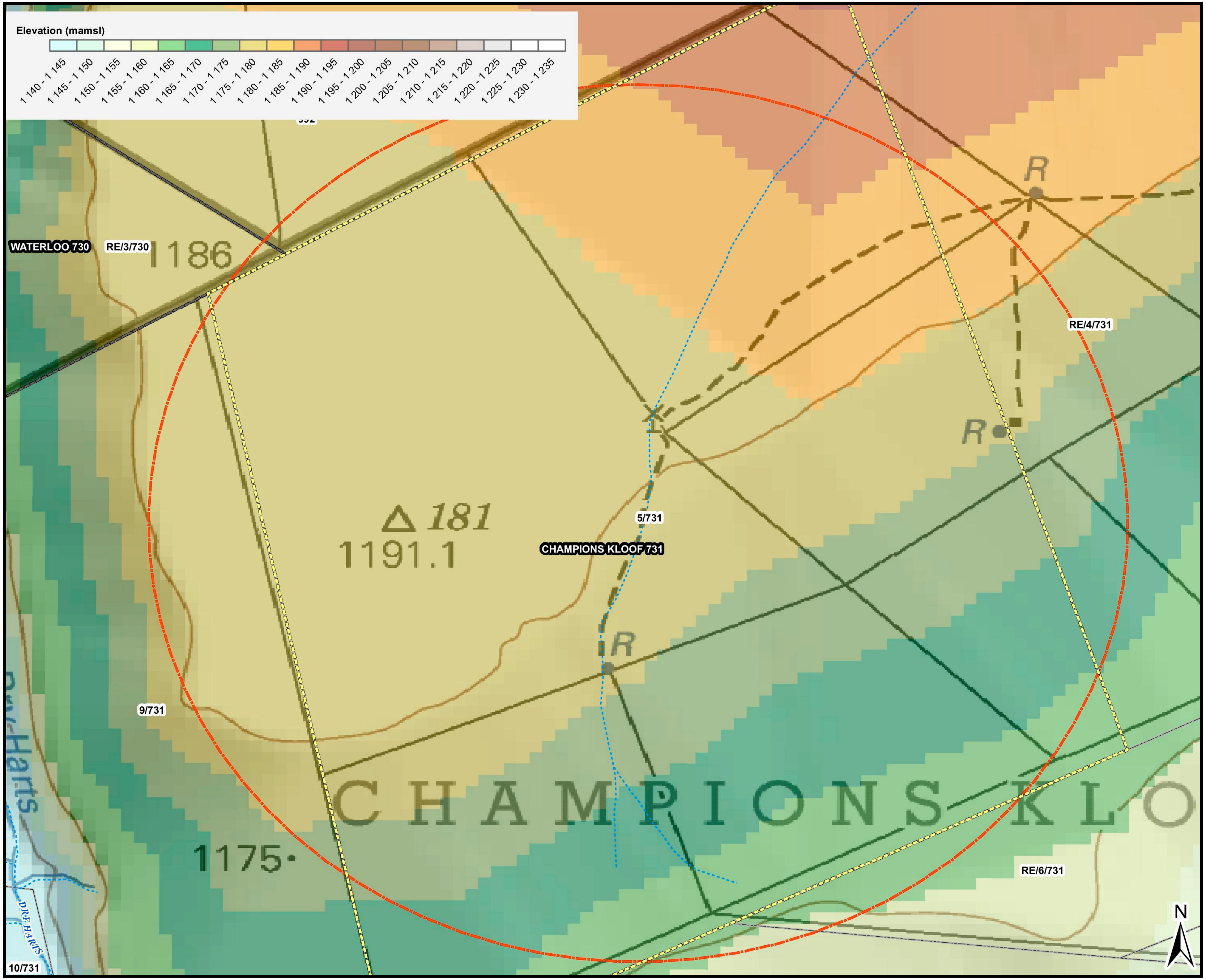

Figure 3: A 1:10 000 scale GIS-based elevation map showing the location of the site (the red circle with a radius of 1200m) with the Dry Harts River in the left-hand bottom corner. Portion 5 of the farm is outlined with a yellow dotted line. The study site is clearly bisected by a small, unnamed perennial stream (blue dotted line). No wetland is indicated on this map. The contours have a height differential of 20m.

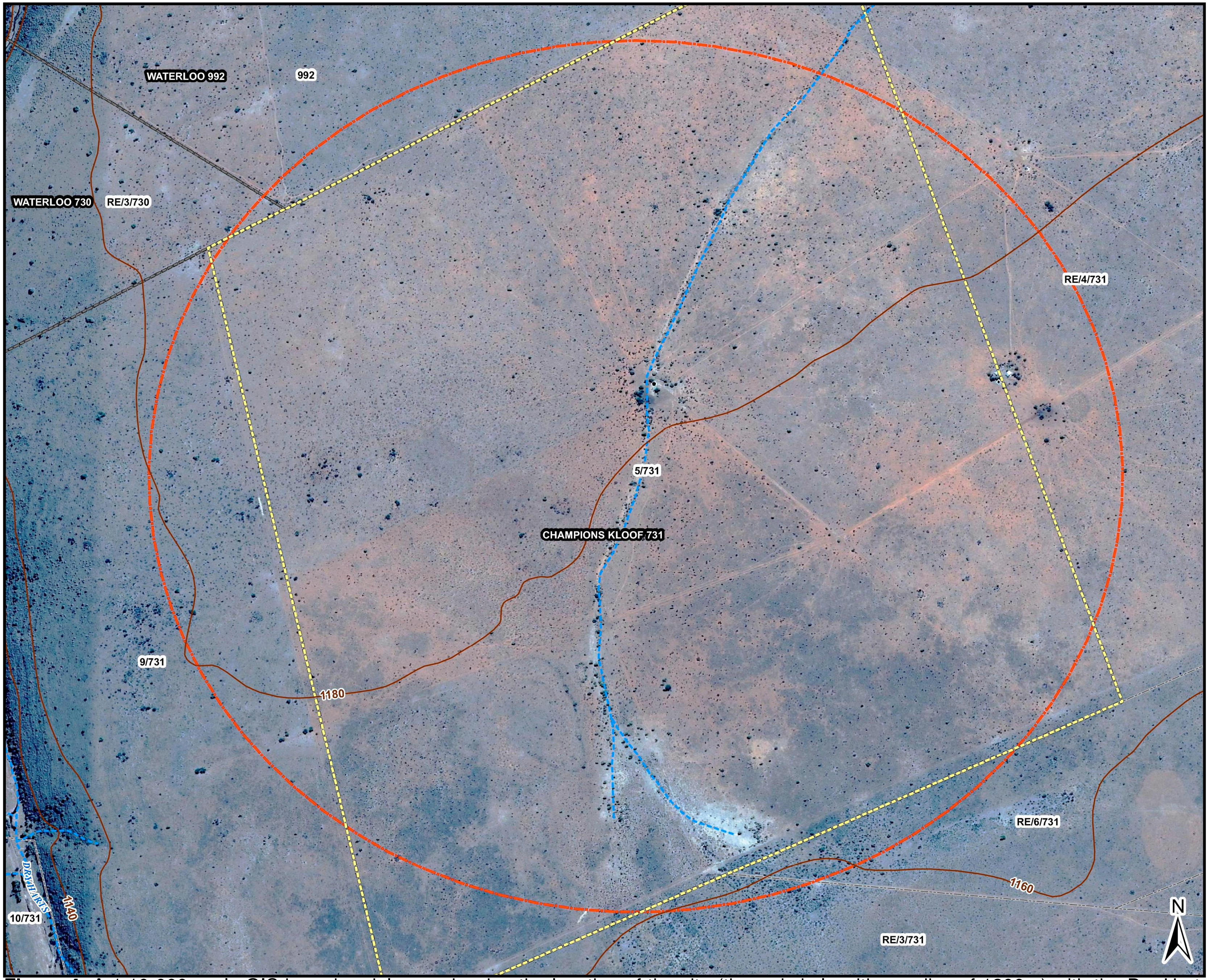

Figure 4: A 1:10 000 scale GIS-based aerial map showing the location of the site (the red circle with a radius of 1200m) with the Dry Harts River in the left-hand bottom corner. Portion 5 of the farm is outlined with a yellow dotted line. The study site is clearly bisected by a small, unnamed perennial stream (blue dotted line). No wetland is visible in this aerial photo. The contours have a height differential of 20m.

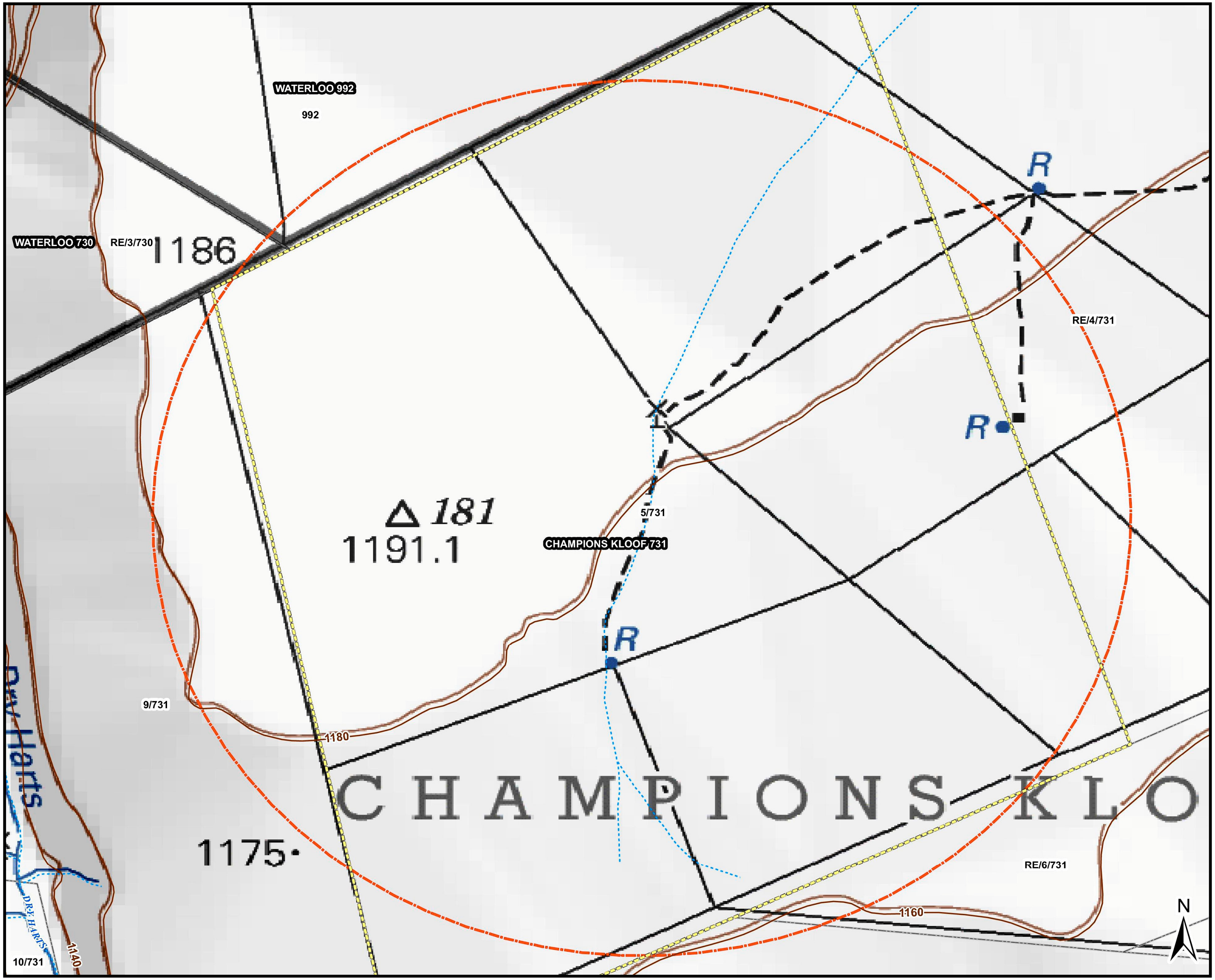

Figure 5: A 1:10 000 scale GIS-based topographical map showing the location of the site (the red circle with a radius of 1200m) with the Dry Harts River in the left-hand bottom corner. Portion 5 of the farm is outlined with a yellow dotted line. The study site is clearly bisected by a small, unnamed and perennial stream (blue dotted line). No wetland is visible. The contours have a height differential of 20m.

The specific wetland that is referred to is not displayed in Figures 3 to 5 simply because this wetland does not appear in the SANBI database. The reason why the wetland does not show up in the SANBI database is most likely that wetlands are extracted from satellite imagery that does not show sufficient detail to detect smaller wetlands. However, this wetland was confirmed during an on-site wetland survey[1].

The photo[1] shows a view of the wetland towards the north following substantial rainfall and sudden cover by grasses. Dispersed tufts in the photo are those of the sedge *Scirpoides dioecus*.

The wetland is classified as a depression (or pan). These types of shallow depressions occur on plains that have very gentle slopes. This pan clearly does have an inlet but an outlet is not evident (Figure 4). This depression is therefore exorheic[2], in that some of the water that flows into the pan during rainfall events leaves the pan through diffuse outflow (almost sheet-flow) whilst some water disappears through evaporation and infiltration. Surface water is probably only present following substantial rainfall events.

Components of the Khubu SPP

In order to do a hydrological impact assessment, it is first and foremost essential to identify those components of the plant layout that can effect the hydrology of the area or *vice-a-versa*. The following relevant or applicable components have been taken from a draft Scoping Report[3] and a draft layout design[4] prepared for the Khubu SPP:

- internal roads will be 5m wide
  there is no indication of how many roads will cross the stream
  there is no indication of where these roads crossings will be
- the facility will have electrical fencing surrounding the farm
  no indication is given as the type of fencing to be used
- terrain levelling will be minimal as the potential site chosen is relatively flat
  no indication is given as to what will be done with the soil removed during leveling
- construction of access and internal roads/paths – existing paths will be used were reasonably possible
  there is no indication of the type of road to be constructed
- the turning circle for trucks will also be taken into consideration
  it is not indicated where turning circles will be allowed
  it is not indicated how many turning circles will be allowed

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[1] *Wetland assessment*, February 2016, compiled by R.F. Terblanche, 48 p.
[2] exorheic means an open system, where water flows in and water flows out
[3] Draft Scoping Report: Proposed Khubu Solar Power Plant near Vryburg, North West Province. Environamics (Feb. 2016), compiled by Mrs. C. Otte & Ms. M. Griesel, 109 pp.
[4] Clearer and smaller-scale details of the layout plan kindly provided by Mr. Pramod Joshi

- trenching – all Direct Current (DC) and Alternating Current (AC) wiring within the PV plant will be buried underground. Trenches will have a river sand base, space for pipes, backfill of sifted soil and soft sand and concrete layer where vehicles will pass
  there is no indication of how many trenches will cross the stream
  there is no indication of where these trench crossings will be
- an internal electrical reticulation network will be required and will be lain ~2-4m underground as far as practical
  it is assumed that this reticulation network will be buried in the same trenches as the AC and DC cabling
- the layout plan will follow the limitations of the site and aspects such as environmentally sensitive areas (non-perennial stream), roads, fencing, servitude's and the farm infrastructure on site will be considered
- it has been stated that the buffer across the stream between the western and eastern arrays of solar panels is 32m on each side (Figure 6)
- a maximum buffer of 550m surrounding the pan is indicated (Figure 6)

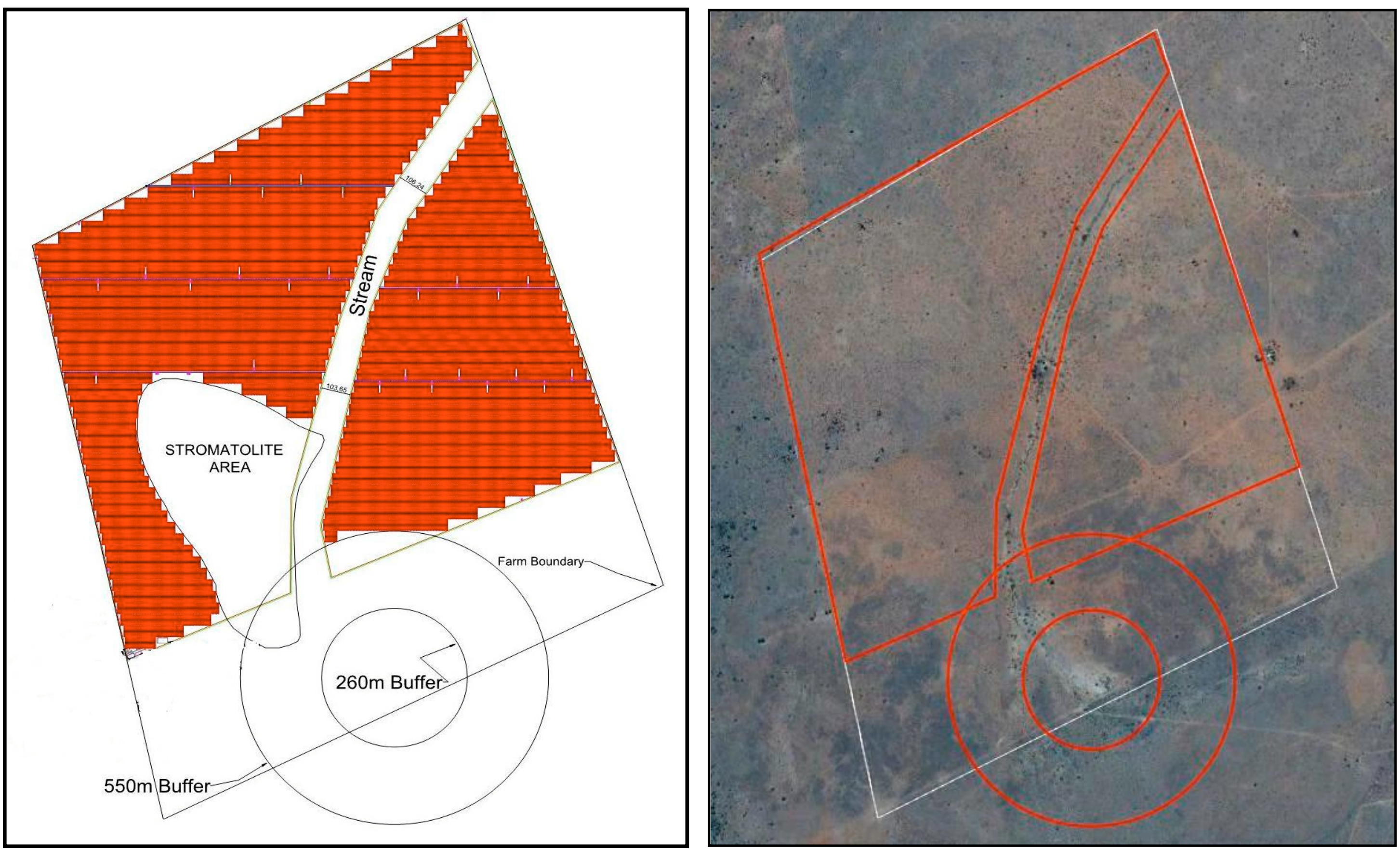


Figure 6: Two schematic drawings of the proposed layout of the Kbubu SPP. Note the buffer provided for the non-perennial stream and for the non-perennial pan.

Methodology for assessing impacts

The methodology that will be used to rate the significance of impacts is described as follows:

Significance rating

This defines the chance or likelihood that a certain impact can occur

Improbable	Low possibility of impact to occur either because of design or historic experience	1
Probable	Distinct possibility that impact will occur	2
Highly probable	Most likely that impact will occur	3
Definite	Impact will occur, in the case of adverse impacts regardless of any prevention measures	4

Intensity rating

This defines the extent or seriousness of a certain impact

Low intensity	natural and man made functions not affected	1
Medium intensity	environment affected but natural and manmade functions and processes continue	2
High intensity	environment affected to the extent that natural or man made functions are altered to the extent that it will temporarily or permanently cease	3

Duration rating

This defines the length of time or duration that a certain impact takes to occur

Short term	<1 to 5 years	1
Medium term	5 to 15 years	2
Long term	impact will only cease after the operational life of the activity, either because of natural process or by human intervention	3
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.	4

For example, an impact that is rated as “improbable, low intensity, medium term” will have a score of 1 x 1 x 2 = 2, in other words a very low impact. But should an impact be rated as “highly probable, medium intensity, long term”, it will have a score of 3 x 2 x 3 = 18, in other words a medium impact. Impacts can score anything from 1 up to a maximum of 48. In order to quickly visualise and assess the seriousness of an impact, the score is divided into four equal but colour-coded parts as follows:

1 – 12	13 – 24	25 – 36	37 - 48	for negative impacts
1 – 12	13 – 24	25 – 36	37 - 48	for positive impacts

Attributing a particular score to a particular impact is based on the author’s best experience, knowledge and available information. Once a particular impact has been identified and scored, any number of ways and means to mitigate (or reduce / or improve) the impact is suggested, after which the “mitigated impact” is scored again. Note that positive impacts can score as high as negative impacts; their colour codes are just reversed.

Impact assessment

Potential impacts		Proposed mitigation	Significance rating after mitigation	Risk of the impact and mitigation not being implemented
The more "formal road" crossings over the stream, the greater the damage following storm events.	4 x 3 x 3 **36**	I would suggest having only one (1) road crossing the stream, located more or less in the middle of the farm. Where possible, use existing farm roads. Select the most appropriate one to cross the stream. Roads should just be informal dirt roads, nothing more.	4 x 1 x 3 **12**	Every "formal road" crossing will be damaged following a storm event. Road damage will be cumulative depending on the number of road crossings. Even if dirt roads wash away, they are quick and easy to repair and there will be no foreign rubble to dispose of.
It is stated that internal roads will be 5m wide. It is assumed that roads crossing the stream will also be 5m wide. This implies that roads will be "formal built roads", leading to greater damage following storm events	4 x 3 x 3 **36**	Reduce road width to that of a standard vehicle, i.e. about 3.5m wide. Roads should just be informal dirt roads, nothing more.	4 x 1 x 3 **12**	Every "formal" road crossing will be damaged following a storm event. Road damage will be cumulative depending on the width of each road crossing. Even if dirt roads wash away, they are quick and easy to repair and there will be no foreign rubble to dispose of.
Electrical fencing crossing the stream will accumulate flood debris. This will be the case irrespective of the type of fencing used.	4 x 1 x 3 **12**	Following **each** storm event, the whole length of the fence line crossing the stream together with its buffer zones must be cleaned of all flood debris. Rocks and stones can be neatly packed within the buffer zone to act as erosion barriers. All plant material can be discarded outside the SPP farm area, away from the stream. All foreign debris and litter must be collected, stored in a container and then disposed of at a licensed landfill.	4 x 1 x 3 **12**	Mitigation proposed here wont lessen the impact and risk unless some ingenious method is used to allow the fence to open up (like a garage door) at the bottom and thereby allow flood water to pass unhindered. For this small perennial stream this is not a suitable mitigation. If flood debris is not removed, the electrical fencing will eventually be damaged, maybe beyond repair. Accumulated dry plant material may pose a fire hazard.

Electrical fencing crossing the stream may be damaged or washed away during storm events. It was stated that usually galvanised steel security wire about 2m high is used.	4 x 1 x 3 **12**	Any type of galvanised mesh fencing would be best to use since it can be repaired or straightened out should it be damaged or flattened during a flood event. Steel palisade fencing would be the 2nd choice since the individual palisades can be straightened out. Pre-cast concrete palisade is not recommended since individual palisades cannot be repaired once broken during a flood event.	4 x 1 x 3 **12**	Mitigation proposed here wont lessen the impact and risk unless some ingenious method is used to allow the fence to open up (like a garage door) at the bottom and thereby allow flood water to pass unhindered. For this small perennial stream this is not a suitable mitigation.
Truck turning circles will cause damage to the buffer or stream channel. It is assumed that there wont be trucks during the operational phase.	4 x 3 x 1 **12**	Truck turning circles **must not** be located close to or in the stream buffer area at all.	1 x 1 x 1 **1**	The deep ruts of trucks turning in the buffer zone and especially in the stream channel can lead to erosion (more material available to scour the stream bed) and will fill the pan quicker with washed-in soil. The root systems of plants hold the soil together. Turning circles will damage or even kill plants in the process.
Trenching for burying of AC & DC cabling and the electrical reticulation network will damage the streambed.	3 x 2 x 1 **6**	Trenching to be undertaken during the dry season of the year. Limit the number of stream crossings to the very minimum. Clean up each crossing site of all foreign material such as imported sand, concrete, cement powder, boarding, waste cables and other associated litter, etc. If the sifted sand and soft sand is obtained from the site, then discard any left over sand well outside the buffer zone. If the sifted sand and soft sand has been imported, then dispose of at a licensed landfill or use elsewhere.	1 x 1 x 1 **1**	Trenches that are not properly compacted or cleaned up can lead to erosion (more material available to scour the streambed) and will fill the pan quicker with washed-in soil. The root systems of plants hold the soil together. Trenches should preferably avoid most plants where possible.

If the trenching for burying of **AC & DC cabling and the electrical reticulation** network is not deep enough then the cabling and electrical reticulation can be damaged during storm events.	3 x 3 x 3 **27**	It is stated that the electrical reticulation network will be buried about 2m – 4m deep. The AC and DC cabling must also be buried to the same depths. The trenching should be the deepest when crossing the streambed and should become shallower closer to the edge of the buffer zone.	1 x 1 x 3 **3**	Too shallow trenches crossing the buffer and especially the streambed can very well lead to the uncovering of electrical cables during storm events. Live cables could be exposed or even damaged, which can lead to shocks or even electrocution, especially when still in water.
Soil discarded close to the stream after terrain leveling may be washed away during storm events.	4 x 2 x 1 **8**	**Strictly** adhere to the 32m buffer edges on **both** sides of the stream. No soil must be discarded in the buffer zone. No plants must be removed or damaged within the buffer zone.	1 x 1 x 1 **1**	Leaving heaps of soil in the buffer zone and especially in the stream channel can lead to erosion (more material available to scour the streambed) and will fill the pan quicker with washed-in soil.
Ignoring the approved layout plan, especially w.r.t. environmentally sensitive areas, will be detrimental to those sensitive areas, especially during storm events.	4 x 3 x 3 **36**	The **approved** layout plan must be followed, especially w.r.t. environ-mentally sensitive areas (i.e. the non-perennial stream and pan), in order to protect these during storm events.	1 x 1 x 3 **3**	Ignoring the approved layout plan can lead to damage or even destruction of the environment and all other man-made infrastructure or services during flood events.
Ignoring the buffer across the stream will be detrimental to the stream channel	4 x 2 x 3 **24**	**Strictly** adhere to the 32m buffer edges on **both** sides of the stream. Remember that the 32m buffer **starts** from the **stream edge**.	1 x 1 x 3 **3**	Ignoring the approved buffer across the stream can lead to damage of the stream channel and associated riparian zone during flood events.
Ignoring the buffer surrounding the pan will be detrimental to the pan.	4 x 2 x 3 **24**	**Strictly** adhere to the 550m buffer edges around the pan. No soil must be discarded in the buffer zone. No plants must be removed or damaged within the buffer zone. No truck turning circles must be allowed inside the buffer zone. No storage of waste soil or other rubble must be allowed inside the buffer zone. No vehicles to be parked or repaired inside the buffer zone.	1 x 1 x 3 **3**	Ignoring the approved buffer of 550m around the pan can lead to damage of the during flood events. Erosion may become a problem. Deposition of too much soil too quickly over time will lead to “suffo-cation” of the pan.

As is to be expected, unmitigated impacts can lead to environmental and property damage. However, if the proposed mitigations are followed, or even improved upon, then mitigated impacts will lead to very limited environmental and property damage, which is what the desired outcome of a risk assessment is.

Unknowns

The impact assessment undertaken above is based on the author's best experience, knowledge and available information. However, the accuracy of this impact assessment is affected by the lack of information related to factors that can affect the hydrology of a catchment, namely:

- Rainfall events (how often does storm events occur, what is the intensity of each storm event, what is the duration of each storm event),
- Soil permeability (how rapidly, or slowly, does rainwater infiltrate a specific type of soil before the soil becomes saturated. Following soil saturation, sheet flow will then occur and storm water will run off faster and be able to carry more sediments),
- Storm water management (the above information will have a certain impact on the severity of storm events, which in turn will have certain impacts on the environment and on built structures. Implementation of a storm water management plan can minimise the impacts of storm events, which in turn minimises or maybe even prevents impacts on the environment and built structures),
- Flood line data (all of the above information eventually determines the average annual flood line of the stream. In order to minimise impacts on the environment and especially on built structures, knowing the flood line of the stream becomes essential. In this regard, the determination of the 100-year flood line is a legal requirement[5].

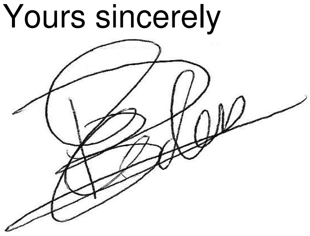
  The 100-year flood line may affect the proposed layout plan.

Recommendations

The following recommendation are made:

- a storm water management plan needs to be undertaken,
- a 100-year flood line determination needs to be undertaken.

Yours sincerely



Dr. Pieter van Eeden

Director

[5] Section 144 of the National Water Act, No. 36 of 1998