6. ENVIRONMENTAL SCOPING STUDY – BIO-PHYSICAL ASPECTS

This ESR documents the results of an Environmental Screening Investigation (ESI) report and additional desk-top and field investigations in some specialist studies for the proposed Pumped Storage Scheme, undertaken by the environmental consultant. Assessments covered all three alternative sites, together with a number of scheme options for each site (for a description of the scheme options studied, refer to Chapter 3 – Alternatives). The following aspects were assessed in terms of the bio-physical environment (aspects not considered within the ambit of the ESI, but studied as part of the ESS, are indicated and *italicized*):

- **Biophysical aspects**
  - Terrestrial Ecology (including fauna and flora)
  - Riverine Ecology
  - Water Quality
  - Hydrology
  - *Assessment of Ground Water (ESS)*
  - *Wetlands (ESS)*
  - Soils and Agricultural potential

6.1. Description of Affected Environment

6.1.1. Location and Topography

The sites are located in the Limpopo and/or Mpumalanga Provinces (there is uncertainty at the provincial government level as to the precise location of the Limpopo / Mpumalanga provincial boundary). The alternative sites are located on the eastern escarpment of the Nebo Plateau, to the west of the Steelpoort River, with altitudes varying between 800 and 2000 meters above mean sea level (mamsl). These alternative sites are located within the Sekhukhuneland Cross Boundary District Municipality with Sites A and B situated within the Greater Groblersdal Local Municipality, and Site C located within the Makhudutamaga Local Municipality. Townships are located on the escarpment in close proximity to the alternative sites, with cultivation occurring on the level areas in the valleys and plateau.

6.1.2. Drainage

The major river in the B4 sub-drainage region is the Steelpoort River and its smaller tributaries. The Steelpoort River forms the Western border of the region, while the Spekboom River drains the eastern part of the region and has its origin near the town of Lydenburg, and flows into the Steelpoort River near the end of the region. The Dwars River drains the area between the Steelpoort and Spekboom River and the main reservoir of this area is the Buffelskloof Dam which is situated in the Dwars River.

6.1.3. Land Use

The main land use features in this region are agriculture (mainly in the form of citrus, vegetables and maize), low industrial development, various mining activities, residential areas and tourism.

The lower and upper dam sites at Sites A and B are relatively undisturbed and no current farming occurs on these sites. The site of the upper dams at Site C are currently being used for agricultural activities, while the Site C lower dam site is the proposed De Hoop Dam.

6.1.4. Climate

<u>Precipitation and evaporation data</u>

Rainfall patterns in the area are typical of the eastern half of South Africa, with the highest rainfall occurring during the summer months (October to March). Annual rainfall for the area is approximately 878mm, with the highest 24-hour rainfall occurring in December. Only desktop rainfall and evaporation calculations were conducted during the scoping phase.

The B41C Quaternary Catchment receives an annual average rainfall of 694 mm, the majority of which falls during the months of October to March, according to the *Surface Water Resources of South Africa report (Water Research Commission 1990*). The month of January has the highest average monthly rainfall of 123.1 mm. Mean annual evaporation for this region is 1500 mm.

Mean rainfall and evaporation data for the B41C and B41D Quaternary Catchments can be found in Appendix J (Air Quality Assessment Report), together with the average monthly rainfall for the Lydenburg weather station. The rainfall is typical of the summer rainfall region of South Africa. The annual average of 132.2 mm recorded at Lydenburg is considered to be low for the Lydenburg-Witbank area. This is probably due to the data availability of 83% recorded for the Lydenburg station during February. The average monthly rainfall for the Witbank weather station is included in Appendix J for purposes of comparison. The annual average rainfall of 540.4 mm received at Witbank is considered to be more representative of rainfall in the Lydenburg-Witbank area.

Frost occurs yearly for an average of 25 days per year, normally between May and September, but it may occur as early as March and as late as October (Soil and Irrigation Research Institute, 1987).

Temperature and humidity

Temperatures generally vary between 7°C and 20°C, with the highest recorded temperature being 32°C and the lowest -8°C (South African Weather Service, 2006).

Table 6.1: Average temperatures for the region

Month	T max	T min
January	23	12
February	22	12
March	22	11
April	20	8
May	18	4
June	15	1
July	16	1
August	18	3
September	22	6
October	22	8
November	22	10
December	23	11

Reference: South African Weather Services, 2006.

Relative humidity in the study area is lowest during winter and early spring (Appendix J).

6.1.5. Nature and Extent of the Impacts

It is not anticipated that the proposed project will have any impact on the local climate or topography, or vice versa. Potential impacts on drainage are discussed in the section on Hydrology and potential impacts of dust (which might be either ameliorated or exacerbated by climatic aspects such as precipitation and wind) are discussed in the section on Air Quality. It is therefore recommended that no further studies are required with regards to topography or climate.

Table 6.2: Rating Of Impact: Topography and Climate

RATING OF IMPACT: TOPOGRAPHY AND CLIMATE		
Dimension	**During construction**	**During operation**
Duration	Short term	Long term
Extent	Regional	Regional
Probability	Highly unlikely	Highly unlikely
Significance	Negligible	Negligible
Significance*	Negligible	Negligible
Status	Neutral	Neutral

Rating of sites (1 = not suitable, 5 = ideal): **Site A**: all options are equal. **Site B**: all options are equal. **Site C**: all options are equal.		
Site A: 5	**Site B:** 5	**Site C:** 5
***** Significance with mitigation		

6.2. Terrestrial Ecology

The report on the terrestrial ecology assessment conducted as part of the ESI is attached in Appendix K. A detailed summary of this appendix is provided below.

6.2.1. Species of Concern

The World Conservation Organisation (IUCN) has six main categories indicating the priority of endangered species (Minter *et al*, 2004) (Table 6.3).

Table 6.3: The six main IUCN categories indicating the level to which a species' survival is threatened (Minter *et al*, 2004).

CATEGORY	DESCRIPTION
Critically Endangered	Species facing an extremely high risk of extinction in the wild.
Endangered	Species facing a very high risk of extinction in the wild.
Vulnerable	Species facing a high risk of extinction in the wild.
Near Threatened	Species that do not meet the criteria for the threatened categories, but are close to classifying as threatened or will likely classify as threatened in the near future.
Least Concern	Species that have been evaluated and do not qualify for the Critically Endangered, Endangered, Vulnerable or Near Threatened categories. Species that are widespread and abundant are normally included in this category.
Data Deficient	A species for which there is a lack of appropriate data on its distribution and/or population status. The category indicates that more data is needed and that there is a possibility that the species may be classified into one of the threat categories in the future.

Plant species data received from the South African National Biodiversity Institute (SANBI) has been classified according to the old IUCN Red Data categories of 1986 (Table 6.4).

Table 6.4: The "old" IUCN Red Data categories (1986) (Hilton-Taylor, 1996).

CATEGORY	DESCRIPTION
Extinct / Presumed Extinct)	Species classified as Extinct as per the old Red Data classification are no longer known to exist in the wild; it is also possible that a species may be classified as Extinct in one country, but still survive in another. Due to the possibility that rediscoveries of a species can be

	made the category is sometimes referred to as Presumed Extinct.
Endangered	Taxa in danger of extinction and which are unlikely to survive if the current situation continues.
Vulnerable	Taxa that are likely to move into the Endangered category in the near future if the factors causing the decline continue to be present.
Rare	Rare taxa are taxa with small populations that are not classified as Endangered or Vulnerable, but are at risk as an unexpected threat may cause a critical decline in the population.
Indeterminate	Taxa known to be in one of the four above categories, but insufficient information is available to determine which of the four categories.
Insufficiently Known	Insufficiently Known taxa are suspected to belong to one of the above categories, but this is not known for certain as there is a lack of information available on the species
Not Threatened	Taxa that are no longer included in any of the threatened categories due to an increase in the population size or the discovery of more individuals of populations.
No Information	Taxa without any information available.

The Out of Danger category is used for taxa that have formerly been included in one of the threat categories, but are now considered relatively secure (Hilton-Taylor, 1996). The Rare category is therefore seen as similar to the Near Threatened category in the new classification and the Insufficiently Known category seems to be similar to the Data Deficient category in the new classification.

The Transvaal Nature Conservation Ordinance (no 12 of 1983) lists species protected in the old Transvaal area (now the North West, Limpopo, Mpumalanga and Gauteng Provinces). Species noted as protected in the tables below are protected in accordance with this Ordinance.

In Sections 6.2.2 and 6.2.3 below, species of concern have been identified that have a possibility of occurring at the three sites.

6.2.2. Flora

The alternative sites are located on two vegetation types described by Low and Rebelo (1998):

- Mixed Bushveld (18)
- Moist Sandy Highveld Grassland (38)

Acocks (1988) also indicates two vegetation types occurring on the site, but with different distributions:

- Mixed Bushveld (18)
- Sourish Mixed Bushveld (19)

Vegetation Type 18 (Mixed Bushveld) covers nearly 29% of the Limpopo Province but only 1.57% is conserved, while Vegetation Type 38 (Moist Sandy Highveld Grassland) covers only 0.04% of the Limpopo Province without any current conservation status. Almost 7.5% of Vegetation Type 19 (Sourish Mixed Bushveld) is conserved in the Limpopo Province.

The sites are also located within the Sekhukhuneland Centre of Endemism, which is located within the rain shadow of the Drakensberg and is therefore relatively arid compared to the surrounding areas. Climatically this region comprises an arid (karoid) subtropical (lowveld) enclave surrounded by areas that are temperate (frost in winter) and much wetter (particularly towards the north, east and south) (van Wyk and Smith 2001).

The major plant communities found within the centre relates to soil properties, aspect and terrain (Siebert *et al* 2003), which explains why this area is floristically noteworthy in that many rare and endemic species with localised distribution correlate with the geological substrate that occurs here (Siebert *et al* 2003).

Siebert (2001) conducted a survey on the vegetation of the Sekhukhuneland Centre of Endemism as part of his Philisophiae Doctor Degree. Six basic vegetation types were recorded during the study; five of the communities occur on the alternative sites. The communities of interest are the following (descriptions in Appendix K):

1. *Fuirena pubescens – Schoenoplectus corymbosus* Wetland Vegetation
2. *Themeda triandra – Senecio microglossus* Cool Moist Grasslands
3. *Combretum hereroense – Grewia vernicosa* Open Mountain Bushveld
4. *Kirkia wilmsii – Terminalia prunioides* Closed Mountain Bushveld
5. *Hippobromus pauciflorus – Rhoicissus tridentate* Rock Outcrop Vegetation

A number of protected plant species occur in the Sekhukhuneland Centre of Endemism (a list of species of concern that may occur in the study area, is attached in Appendix K). These species are most likely to occur in areas with little disturbance:

- Six taxa of *Zantedeschia*
- 17 taxa of *Aloe*
- Four species of *Kniphofia*
- *Gloriosa superba*
- *Littonia modesta*
- *Agapanthus inapertus*
- Three species of *Eucomis*
- *Nerine rehmannii*
- *Brunsvigia radulosa*
- Three species of *Crinum*
- *Ammocharis coranica*
- Three species of *Cyrthanthus*
- Five species of *Dioscorea*

- *Schizostylis coccinea*
- Four species of *Dierama*
- *Babiana hypogea var. hypogea*
- 10 taxa of *Gladiolus*
- 35 taxa of *Orchids*
- *Tinospora fragosa*
- *Spirostachys africana*
- *Euphorbia barnardii*
- Four species of *Cussonia*
- *Erica alopecurus var alopecurus*
- *Erica cerinthoides var cerinthoides*
- *Pachypodium saundersii*
- Four species of *Brachystelma*
- Eight taxa of *Ceropegia*
- *Riocreuxia picta*
- *Tavaresia barklyi*
- Six species of *Heurnia*
- *Huerniopsis atrosanguinea*
- *Duvalia polita*
- Two species of *Stapelia*
- *Orbea tapscottii*
- *Pachycymbium keithii*
- Two species of *Orbeopsis*
- Three species of *Streptocarpus*

6.2.3. Fauna

Due to the wide range of habitats occurring at the sites, it can be expected that a large number of fauna can occur there.

The Groothoek Greeff Private Nature Reserve is located a short distance to the north of Site A, between Site A and Site B. Some of the species that occur on the Private Reserve are likely to migrate to suitable areas surrounding the site.

- <u>Avifauna</u>

  Bird life in the area is very rich, due to the diverse habitat present in the area. The quarter degree grid 2529BB provides habitat to 305 bird species (Sites A and B). Site C is located within the quarter degree grid 2429DD, in which 171 bird species have been identified.

  Five species of birds classified as vulnerable may possibly utilise the site. The remaining species of concern which could also utilise the sites, are classified as near threatened. According to the Transvaal Nature Conservation ordinance, all bird species except for the most common species are protected.

- Mammals

A total of 78 mammal species may possibly utilise the site. Large mammal species such as the red hartebeest, wildebeest and warthog have been observed during site visits. It is expected that various other large and small mammals occur in the area.

Only 2 Red Data mammal species may utilise the sites. The remaining species have been identified as species of concern.

- Reptiles

A large number of reptile species possibly occur in the various habitats on the site. One tortoise species, one terrapin species, 38 snake species and 15 lizard species can possibly occur on the site.

No Red Data reptiles species where identified as possibly occurring that the sites. According to the Transvaal Nature Conservation Ordinance all reptile species are protected except for the Water and Rock Monitor, and all snake species.

- Amphibians

Small wetlands are important for frogs and play a large role in the meta-population dynamics of certain taxa (Channing 1995). Frogs can be seen as bio-indicator species, whose abundance and diversity reflect the general health and well-being of aquatic systems. Nine amphibians may possibly utilise the riverine areas at Sites A and B (Minter et al. 2004). No Red Data amphibian species are expected at any of the three sites (see Photograph 6.1).

No Red Data or Protected species were identified that could possibly utilise the sites.

Photograph 6.1: Habitat for amphibians (Tributary at Site A Lower)

- Invertebrates

Southern Africa has an extremely high diversity of insects, with more than 80 000 species already recorded. Insects are the most abundant and successful terrestrial species, occupying almost every habitat type except the ocean. Insects are essential in various roles within ecosystems, e.g. nutrient recycling, plant pollination, maintenance of plant community composition and other insectivorous animals. Each insect forms part of a wider ecosystem, and if lost, the complexities and abundance of other life will be affected. While some insects have a negative effect on human lives, others are necessary to our survival (Scholtz & Holm 1989; Gullan & Cranston 1994). In many ecosystems insects are the main grazers and play a vital role in the decomposition of plant and animal wastes (Picker *et al*. 2004).

Scorpions occur in every terrestrial habitat in Southern Africa and in many cases some have a preference for highly specialised habitats (Leeming 2003). In general, scorpion species are not protected by the Conservation Ordinance (1983) but an increase in knowledge regarding distribution data as well as potential threats represented by habitat fragmentation and destruction has led to some species being recognised as being in need of protection.

It is expected that due to the high biodiversity, a large number of invertebrate species will utilise the site. The invertebrate species that are protected under the Transvaal Nature Conservation Ordinance, which could potentially occur on the sites, are listed below in the table below.

6.2.4. Site-specific Ecological Evaluation

- Site A

  Upper Dam

  Three of the vegetation communities (nr. 2, 4 and 5) mentioned in Section 6.2.2 above and described in Appendix K, occur at this site, of which community 4 is dominant, with some patches of communities 2 and 5. The site is still intact, with very little disturbance.

  Lower Dam

  Four of the five vegetation communities occur here (nr. 1, 2, 3, 4) (see Photograph 6.2). The dominant vegetation communities are community 2 and 3. Only a small patch of community 4 is present on the site and the riverine areas are represented by community 1. Community 2 is very important due to the high number of species of concern that may utilise this community. The site has been disturbed in some areas due to the construction of electricity lines and other infrastructure. The disturbance is however limited to these areas and therefore localised.

Photograph 6.2: Panorama of Site A Lower Dam

This community has a high sensitivity due to the high biodiversity and number of species of concern that may utilise the site.

- Site B

  Upper Dam

  Only two vegetation communities occur at this site (1 and 2) (Photograph 6.3). Community 2 is the dominant community and community 1 is represented in the drainage area. The site is still fairly intact with some ruins occurring on the edge of the site.

Photograph 6.3: Site B Upper

Lower Dam

The dominant community at all options at this site is community 3, with community 1 representing the perennial stream on site. The site is still intact, with very little disturbance.

The site has a high sensitivity due to the low level of disturbance and the presence of a perennial drainage line.

- Site C

Upper Dam

The site is highly disturbed (Photograph 6.3). Maize (*Zea mays*) is planted on a large portion of the site and the rest of the site is old cultivated fields colonised by *Tagetus minuta*, *Eragrostis* sp., *Pogonarthria squarrosa*, *Hyparrhenia* sp., *Bidens* sp., as well as various other grass and forb species. Several of these species are indicators of disturbance.

Photograph 6.4: Site C Upper Dam

The site has a low sensitivity due to the intense disturbance at the site.

- Site selection summary – terrestrial ecology

Site A is slightly disturbed, but is still fairly intact and offers habitat to a high number of species. All the communities are present at the two locations for the dams at Site A. Habitat diversity is very high at this site.

Site B is the most intact habitat. A large number of species of concern occur in these habitats; however, the richness is lower than that possibly occurring at site A due to the lower habitat diversity.

After the screening process it was determined that **Site C** is the least ecologically sensitive, therefore this site would be preferable from an environmental perspective for the pumped storage scheme upper reservoir.

Table 6.5 below summarizes the ratings given to the various alternative sites and the options within them. For an outline of the ratings used, please refer to Chapter 5 – Approach.

Table 6.5: Alternative site ratings based on terrestrial ecology

Location	**Site A Option 1**	**Site A Option 2**	**Site A Option 3**	**Site B Option 1**	**Site B Option 5**	**Site B Option 7**	**Site C Option 1**
Rating	2	2	3	2	2	2	4

- Nature and Extent of Impacts

The general area is located within the Sekhukhuneland Centre of Endemism and the number of species of concern is therefore high. Although there might be alternative habitat available for the species, a more detailed study would be necessary. Some of the species of concern have only been discovered recently and therefore very little is known about them. The specific habitat requirements of some of the species are also unknown. The sites should therefore be investigated in detail prior to decreasing the risk of loss of sensitive species and habitat. This will be done during the EIA phase of this project. Detailed, site-specific management and mitigation measures will be developed during the EMP phase and must be strictly adhered to during the construction, operational and decommissioning phases. All activities onsite must be monitored by an Environmental Control Officer (ECO).

Table 6.6: Potential impact on Terrestrial fauna and flora

RATING OF IMPACT: TERRESTRIAL FAUNA AND FLORA		
Dimension	**During construction**	**During operation**
Duration	Short term	Long term
Extent	Localised	Localised

Probability	Highly probable	Highly probable
Significance	High	Medium-high
Significance *	Medium-low	Medium-low
Status	Negative	Negative
Rating of sites (1 = not suitable, 5 = ideal): **Site A**: Slightly disturbed, but with very high habitat diversity. **Site B**: Most intact, but with lower habitat diversity. **Site C**: Least ecologically sensitive.		
Site A: 2 – 3	**Site B:** 2	**Site C:** 4
Recommended studies for EIA phase: More detailed studies to be done during EIA phase. At this stage site C appears to be preferred from an ecological perspective.		
* Significance with mitigation		

Due to the sensitivity of most sites, detailed studies are required on the preferred site in the EIA phase to identify sensitive areas and habitats that could be avoided and provide suitable recommendations and mitigation measures, such as possible relocation of specimens of sensitive plant species. The entire footprint of the proposed dams will not incorporate an extremely large area, therefore habitat that may be lost due to the placement of the dams will still be present and should be conserved for the remaining fauna and flora.

6.3 Riverine Ecology

The riverine ecology assessment that was conducted as part of the ESI is contained in Appendix K. A detailed summary of this appendix is provided below.

6.3.1. Sites A and B

Riverine ecology was considered for screening at the lower reservoirs (all options) comprising site A and B. The upper reservoirs do not influence riverine ecosystems and have therefore not been investigated at the screening / scoping level. The lower reservoir for Site C is the proposed De Hoop Dam.

The assessment of riverine ecology that could be affected by the lower dam at Sites A and B is based on the findings of the Olifants River Water Resources Development Project Environmental Assessment Specialist Study on Aquatic Ecology, conducted by R Palmer, 2004.

The small tributary of the Steelpoort River which will be affected by the proposed dam at Site A is similar in nature to the Klip River which will be inundated by the construction of the proposed De Hoop Dam. The information obtained in the proposed De Hoop EIA for the Klip River is thus relevant to this environmental screening.

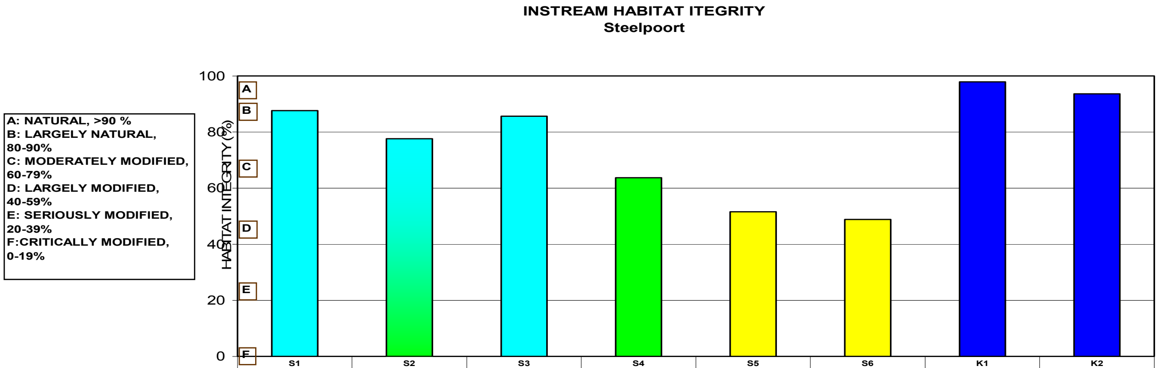
Photograph 6.5: Klip River streambed (left) tributary at Site A (right)

- Riverine Habitat

  The habitat of the Klip River contains some well-developed small riffles and runs with larger rocks and backwaters that provide good cover. The site also supports well developed marginal vegetation that provides good cover for fish. Site A Tributary is expected to have the same characteristics.

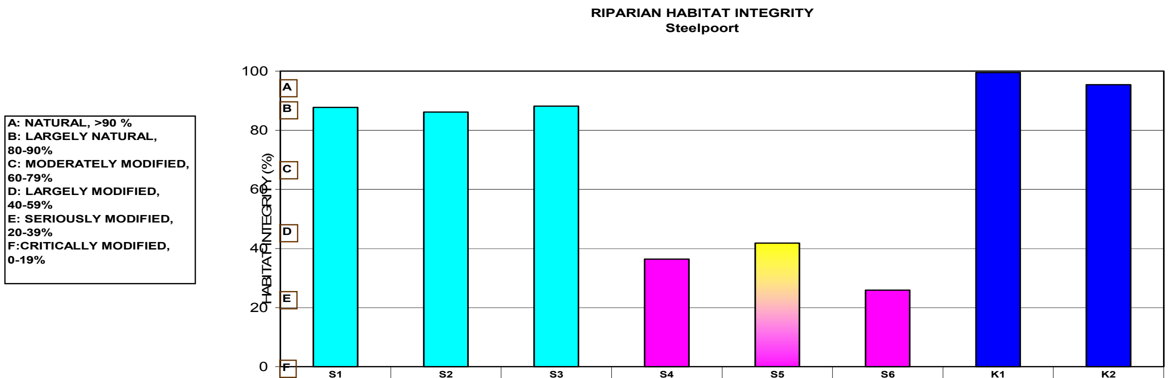
  Habitat integrity for both in-stream and riparian components in the vicinity of the Klip River tributary is considered to be Natural (Category A) (Figure 6.5).

  Discussions with farmers at Site A identified that during high flood events, massive boulders roll down the river bed which has led to significant alteration of the channel morphology and has resulted in the destruction of the road bridge below the planned option A3 location. It is expected that a more detailed examination of this phenomenon would be required as part of the detailed engineering and environmental studies.



	S1	S2	S3	S4	S5	S6	K1	K2
INSTREAM HABITAT INTEGRITY (%)	88	78	86	64	52	49	98	94
WATER ABSTRACTION (IMPACT 1 - 25)	5	6	6	9	11	13	1	3
FLOW MODIFICATION ((IMPACT 1 - 25)	4	4	4	5	6	6	1	2
BED MODIFICATION (IMPACT 1 - 25)	4	15	5	12	14	15	1	2
CHANNEL MODIFICATION (IMPACT 1 - 25)	5	6	5	16	16	16	1	2
WATER QUALITY (IMPACT 1 - 25)	5	5	5	6	12	15	0	2
INUNDATION (IMPACT 1 - 25)	0	0	0	0	0	0	0	0
EXOTIC MACROPHYTES (IMPACT 1 - 25)	0	0	0	0	0	0	0	0
EXOTIC FAUNA (IMPACT 1 - 25)	0	0	0	0	0	0	0	0
RUBBISH DUMPING (IMPACT 1 - 25)	0	0	4	5	6	7	0	2

SECTOR NO (---> FLOW DIRECTION)



	S1	S2	S3	S4	S5	S6	K1	K2
RIPARIAN ZONE HABITAT INTEGRITY	88	86	88	36	42	26	100	95
VEGETATION REMOVAL (IMPACT 1 - 25)	5	6	8	16	16	16	0	2
EXOTIC VEGETATION (IMPACT 1 - 25)	3	3	2	6	8	17	1	1
BANK EROSION (IMPACT 1 - 25)	6	6	5	16	11	15	0	2
CHANNEL MODIFICATION (IMPACT 1 - 25)	6	6	5	15	15	15	0	2
WATER ABSTRACTION (IMPACT 1 - 25)	2	4	3	5	5	7	0	1
INUNDATION (IMPACT 1 - 25)	0	0	0	0	0	0	0	0
FLOW MODIFICATION (IMPACT 1 - 25)	1	1	0	2	2	2	0	0
WATER QUALITY (IMPACT 1 - 25)	1	1	0	2	3	3	0	1

SECTOR (-> FLOW DIRECTION)

Figure 6.1: Habitat integrity at various sites in the vicinity of the proposed De Hoop Dam, assessed in August 2004 (Site K2 is the reference site for Site A Tributary).

- <u>Invertebrates</u>

  The only invertebrate taxon which is sensitive to water pollution and needs flowing water was the stonefly *Neoperla spio*. This species was present in the Klip River, indicating that the Klip River provides an important refuge area for sensitive taxa.

- <u>Fish Community</u>

  Eleven of fifteen expected fish species were recorded during the survey at the Klip River. A total of 131 specimens were collected and the catch per unit effort was 3.1 fish/minute, which is higher than those recorded in the Steelpoort River. The presence of an additional two species is related to available habitat conditions present at the site and being in a relatively well-conserved tributary. Analysing the expected and observed fish diversity in terms of habitat preferences, it is evident that that all habitat preference categories were less impacted at this site than at any of the other sites in the Steelpoort River. The Klip River most likely serves as refuge for highly sensitive species such as *Opsaridium peringueyi* and *Amphilius uranoscopus* from where they can repopulate the Steelpoort River during favourable conditions. This site is also potentially one of the few sites that may still support some specimens of *Barbus lineomaculatus* that has not been collected in this river since 2000. Overall, this site in terms of fish was classified as Slightly Impaired (Category B).

A variety of small barbs such as *Barbus lineomaculatus, Barbus paludinosus, B. trimaculatus* and *B. unitaeniatus* have been recorded from this area and they need access to inundated marginal vegetation during summer to spawn. The maintenance of shallow, slow-flowing vegetated backwaters as nursery areas, during the breeding season is also essential.

The proposed dam is expected to inundate the Site A Tributary. This is certain to eliminate all flow-dependent fish species, particularly the Barred minnow (*Opsaridium peringueyi*) and the Shortspine rock catlet (*Chiloglanis pretoriae*). The Barred minnow listed in the Red Data book for fish as Rare – Indeterminate (Skelton 1987). These flow-dependent species are currently found in the lower sections of Klip River. There is also a risk that alien fish species, such as black bass, which are currently absent from this stream, may colonise the stream.

- <u>Disruption of Fish Migration</u>

The proposed dams are certain to create a permanent barrier to upstream fish migration and isolate the river fish population into two distinct populations, with consequent long-term implications for genetic diversity and vigour. Species that will be most affected by this barrier to migration include Largescale yellowfish *(Labeobarbus marequensis)* and Labeo *(Labeo molybdinus*).

- <u>Birds</u>

Inundation of the Steelpoort River will be highly detrimental to a number of riverine bird species (Barnes 2000). However, a wide range of aquatic species are likely to benefit from the proposed impoundments. At least 64 species of birds that are commonly associated with water or wetlands have been recorded in the vicinity of the proposed De Hoop Dam. It is likely that many of these bird species will benefit from the impoundments and that the remainder will be very little affected by the change.

- Mammals and Reptiles

  It is possible that crocodiles will inhabit the new impoundments, as they occur in the nearby Flag Boshielo Dam on the Olifants River and may migrate to the proposed De Hoop Dam, at a similar altitude. Crocodiles were also recently recorded about 5km upstream of Steelpoort Bridge. Crocodiles are listed as Vulnerable in the South African Red Data book of reptiles and amphibians (Branch 1988). The only other aquatic reptile listed in the Red Data book that is expected to occur in the area is the Water monitor (Leguan), also listed as Vulnerable.

  At least 23 species of mammals that are commonly associated with water or wetlands are expected to occur or have occurred in the vicinity of the proposed De Hoop Dam and thus could be expected at Site A Lower Dam. Of these, only three species are commonly associated with water or wetlands: clawless otter, spotted necked otter and water mongoose. It is likely that water mongooses, which are common throughout South Africa, will benefit from the higher water level. It is possible that water mongoose could carry rabies. There are presently no known hippos in the area and they are not expected to colonise the dam. However, hippos are known to travel long distances, particularly after floods, and there is a small chance that they could establish in the impoundments.

- Eutrophication and Emission of Greenhouse Gases

  The conversion of a large area from a terrestrial to an aquatic ecosystem leads to the decomposition of vegetation and subsequent release of nutrients and emissions of significant quantities of greenhouse gasses. Elevated nutrients can lead to the development of blue-green algae, such as Microcystis and Anabaena, which can be toxic.

  The main gasses of concern are carbon dioxide, which is foreseen to be released under aerobic conditions within the epilimnion of the new impoundments, and methane, which will be released under anaerobic conditions within the hypolimnion. Both gases contribute to the greenhouse effect, but methane is by far the more potent of the two. The proposed dam basins contain significant numbers of large *Acacia galpinii* and *Combretum* trees that characterise the riparian zone. The vegetation survey estimated that there are in the order of 10 000 *Acacia galpinii* trees that will be inundated.

- Increased Bilharzia

  Bilharzia snails were not found during the baseline survey in August 2004, and a detailed survey of aquatic snail distribution in the Olifants River Catchment conducted between 1958 and 1970 failed to find urinary bilharzia snails (*Bulinus* spp.) in the Steelpoort River Catchment (de Kock *et al* 1983). However, intermediate host snails for rectal bilharzia (*Biomphalaria pfeifferi*), were recorded from two tributary streams in the vicinity of the proposed dam (de Kock et al 1983). These snails are usually not found at altitudes above 914 m (Schutte and Frank 1964). The proposed dams, with a FSL of 1000 m, are therefore in excess of the altitudinal distribution range for rectal bilharzia

6.3.2. Site C

The upper reservoirs are located in the upper reaches of the catchment within a drainage line and not within a clearly defined river system.

6.3.3. Site selection summary – riverine ecology

Table 6.7: Alternative site ratings based on riverine ecology

Location	**Site A Option 1**	**Site A Option 2**	**Site A Option 3**	**Site B Option 1**	**Site B Option 5**	**Site B Option 7**	**Site C Option 1**
Rating	2	2	2	2	2	2	4

6.3.4. Nature and Extent of Impacts

The proposed dam is expected to inundate the Site A Tributary, if this site is selected. This will eliminate all flow-dependent fish species. There is also a risk that alien fish species, such as black bass, which are currently absent from this stream, may colonise the stream.

The proposed dams will furthermore create a permanent barrier to upstream fish migration and isolate the river fish population into two distinct populations, with consequent long-term implications for genetic diversity and vigour.

Inundation of the Steelpoort River is likely to be highly detrimental to a number of riverine bird species; however, a wide range of aquatic species are likely to benefit from the proposed impoundments. It is likely that many of the water-associated bird species recorded in the vicinity of the proposed De Hoop Dam (including certain Red Data species) will benefit from the impoundments and that the remainder will be very little affected by the change.

It is possible that crocodiles will inhabit the new impoundments. It is likely that water mongooses will benefit from the higher water level; however, it is possible that water mongoose could carry rabies. There is a slight chance that hippos might migrate to and establish in the impoundments.

Decomposition of plant material inundated by filling of the dams may lead to eutrophication and emission of greenhouse gases, notably carbon dioxide and methane.

It is unlikely that the risk of Bilharzia will increase with the project.

Sites A and B seem not to be very suitable for the proposed development. Site C appears to be the most favourable location from the perspective of riverine ecology, as it is not situated within a drainage line or within a clearly defined river system.

Table 6.8: Rating Of Impacts on Riverine Ecology

RATING OF IMPACT: RIVERINE ECOLOGY		
Dimension	**During construction**	**During operation**
Duration	Short term	Long term
Extent	Localised – sub-regional	Localised – sub-regional
Probability	Possible – highly probable	Possible – highly probable
Significance	Medium – high	Medium – high
Significance*	Medium	Low – medium
Status	Negative	Negative
Rating of sites (1 = not suitable, 5 = ideal): **Site A:** All options are equal and not very favourable. **Site B:** All options are equal and not very favourable. **Site C:** Site C option 1 is considered favourable.		
Site A: 2	**Site B:** 2	**Site C:** 4
Recommended studies for EIA phase: More detailed studies to be done during EIA phase. At this stage site C appears to be preferred from the perspective of riverine ecology.		
*Significance with mitigation		

6.4. Water Quality

The State of the Rivers report for the Olifants River (2001) describes the ecological state of the Steelpoort River as fair to unacceptable. Land-use practices such as overgrazing has led to erosion, which causes high silt levels in the river. Runoff from mines and other activities in the area also contributes to reduced water quality.

The pumped storage scheme must be viewed as an inter-basin transfer scheme and while the effects on the three alternative upper dam sites will be similar, a more detailed assessment is required to determine the implications of catchment transfer impacts.

Various water quality studies undertaken along the Steelpoort River are reviewed and the main water quality concerns addressed at each proposed site location.

6.4.1. Site A

An EIA undertaken for Site A in 1999 assessed the water quality situation of the Steelpoort River. The DWAF monitoring station on the Steelpoort River on Buffelskloof was used to assess the water quality in the River downstream of the position of the proposed dam location. Data obtained for the period 1987 to 1999 found the water to be of relatively good quality, although problems with high salinity were observed (Wates, Meiring and Barnard, 1999).

In the feasibility study of the Steelpoort Pumped Storage Scheme (Louwinger *et al*., 2000), water from the stream at the upper reservoir site and the Steelpoort River was found to meet the SABS standard for drinking water.

It is therefore expected that since the water quality of the river is good, the relative changes that may occur as a result of dam construction would be internal. Such water quality impacts may be the result of:

- The formation of a chemocline after filling as inorganic particles are dissolved into the water and the breakdown of organic matter (vegetation) has a similar effect
- The formation of a hypolimnion (depending on the depth of the dam) leading to an anaerobic bottom layer in the layer
- The development of elevated levels of nutrient enrichment through the process of vegetative breakdown. This is a reduced risk as the breakdown process happens over time and there are no external sources of nutrient enrichment which would lead to eutrophication. It is expected that the dam would be oligotrophic.

The implications on water quality regarding bush clearing and pure flooding would need to be considered during later phases of the project and is not considered here because:
- There is no available water quality data for the river; and
- The impacts would be similar for all sites.

6.4.2. Site B

No studies have been carried out regarding the water quality at the proposed site (alternative site B). However, it is anticipated that water quality issues addressed by various studies undertaken for Site A and C will be similar for Site B Option 7 due to its location along the Steelpoort River.

A similar impact to Site A is expected at the Option B5 site, but with one difference. Development plans for the area immediately upstream of the dam include a conference centre. The impact of the conference centre could be significant on the quality of the water in the dam, in terms of the following:

- Increased paved areas accelerate the potential for oil contamination of the dam;
- Increased landscaping and maintenance could increase the level of suspended sediment in the dam
- The additional fertilizers in garden maintenance could increase the level of nutrients in the system (i.e. eutrophication)
- The treatment of waste water from the centre may add a nutrient load to the dam resulting in eutrophic conditions

While the assessment of Site B is considering the impact of the dam on the environment, it is important to take into account future development plans for the catchment. The potential increase in turbidity could affect the lifespan of the pumps. Additionally, the potential increase in eutrophication would increase the risk for additional enrichment and associated impacts not only in the river section downstream of the dam and ultimately the proposed De Hoop Dam, but also the upper reservoir and its downstream catchment which is relatively unaffected at present.

6.4.3. Site C

Various studies (Palmer, 2001; Palmer and Rossouw, 2001; Claassen *et al.,* 2004) have been undertaken regarding the water quality situation of Steelpoort River due to the proposed development at Site C.

Previous studies by Palmer (2001) and Palmer and Rossouw (2001) indicated that the Steelpoort River was in a fair state for water quality (Class C). Significant increases in total dissolved salts in the downstream parts of the river were observed. This can be attributed to mining activities, irrigation and land-use practices in the area. The increase in total dissolved salts was found to be highly seasonal with high concentrations recorded during the low flow months. Nutrients were slightly elevated as a result of treated domestic effluent from Burgesfort (Palmer and Rossouw, 2001).

As part of an EIA in 2004, a water quality assessment was undertaken to identify the expected water quality impacts associated with the development of the proposed De Hoop Dam. The potential water quality impact was assessed during each developmental phase of the dam i.e. construction, filling and operational phase (Claassen *et al*., 2004).

6.4.4. Nature and Extent of the Impacts

During the construction phase, water quality will be influenced by increased sediment levels and water contamination could potentially occur due to the storage of chemicals on-site. However, the impact will be for a **short duration** and will be limited to the construction period. Within the dam basin, contamination may occur due to human activities or due to eutrophication. Both these contaminants will have a serious impact on the water quality, should appropriate mitigation measures not be used. Impacts associated with the filling phase are associated with a reduction in flow and changes in the water quality though alterations in the sediment load, turbidity, temperature, oxygen, nutrients, salts, toxicants and introduced species. The impact will be continuous and will remain over the life time of the dam. Other impacts such as changes in temperature, oxygen, turbidity and sedimentation will also occur over the life time of the dam (Claassen *et al*., 2004).

Overall, the residual impact is expected to be within the compliance requirements of the ecological Reserve and not influence existing water users if reasonable mitigation measures are employed during the construction and operational phase of the dam (Claassen *et al*., 2004).

As part of the same EIA, Donohue (2004) addressed health impacts associated with the proposed De Hoop Dam development. Potential water quality impacts were also addressed in the document, with particular emphasis on human health. Water quality concerns are associated with faecal contamination, eutrophication, organic chemicals and heavy metals contamination. Diseases such as bilharzias are anticipated to increase as a result of the development. Dam usage for recreation and agriculture should be limited to maintain water quality (Donohue, 2004).

The water quality assessment for the proposed De Hoop Dam also considered that the resultant water quality in the dam would be corrosive (implications for construction) and turbid (implications for lifespan of pumps). Additionally, has indicated that off-channel storage schemes may offer a reduced risk for siltation as filling from the river typically happens on a continuous basis during base flow conditions. This reduces the potential impact on turbidity within the impoundment.

The upper dam water quality will reflect the quality of the proposed De Hoop Dam.

Table 6.9: Rating Of Impacts on Water Quality

<table>
<tr><th colspan="3">RATING OF IMPACT: WATER QUALITY</th></tr>
<tr><th><u>Dimension</u></th><th><u>During construction</u></th><th><u>During operation</u></th></tr>
<tr><td>Duration</td><td>Short term</td><td>Long term</td></tr>
<tr><td>Extent</td><td>Localised – sub-regional</td><td>Localised – sub-regional</td></tr>
<tr><td>Probability</td><td>Highly probable</td><td>Possible</td></tr>
<tr><td>Significance</td><td>Medium – high</td><td>Medium – high</td></tr>
<tr><td>Significance*</td><td>Medium</td><td>Low – medium</td></tr>
<tr><td>Status</td><td>Negative</td><td>Negative</td></tr>
<tr><td colspan="3">Rating of sites (1 = not suitable, 5 = ideal):
Site A: Water quality currently relatively good. Relative changes that may occur as a result of dam construction are expected to be internal.
Site B: Planned development upstream could result in turbidity which could reduce the lifespan of the SPSS.
Site C: Water quality currently fair.</td></tr>
<tr><td>Site A: 4</td><td>Site B: 3 – 4</td><td>Site C: 2</td></tr>
<tr><td colspan="3">Recommended studies for EIA phase:
More detailed studies to be done during EIA phase. At this stage site A (all options) appears to be preferred from the perspective of water quality.</td></tr>
<tr><td colspan="3">*Significance with mitigation</td></tr>
</table>

6.4.5. Site Selection Summary – Water Quality

Table 6.10: Alternative site ratings based on water quality

Location	Site A Option 1	Site A Option 2	Site A Option 3	Site B Option 1	Site B Option 5	Site B Option 7	Site C Option 1
Rating	4	4	4	3	4	3	2

6.5. Hydrology, Surface Water and Groundwater

The hydrological, surface water and groundwater assessments can be found in Appendix K (ESI) and Appendix L (of this draft ESR.

6.5.1. Methodology

The study comprised a desktop study of available information. All hydrological data was based on preliminary desktop analyses. The *"Project Lima Supplementary Feasibility Study- Phase 1 Site Selection Study Main Report Volume 1"* conducted by BKS Palace Consortium during May 2006, was consulted for the purposes of this study. A number of potential sites were identified and ranked during the BKS study. The Geohydrological division at the Department of Water Affairs and Forestry (DWAF) in Pretoria was requested to provide borehole locations, measured yields, drilled depths, and chemistry data for any existing boreholes from their data base within the proposed study area (reference block coordinates S: 24° 55' - 25° 08 ' and E: 29° 45' - 30° 00')This data provided additional information for use in the geohydrological screening study.

Although all the available borehole information within the provided grid coordinates were provided by DWAF, only the applicable farms on which the three actual options (Site A, B, and C) are located, were considered.

6.5.2. The study area

The study area comprises various properties, which is situated within the lower parts of the B41C Quaternary Catchment as well as within the middle to lower parts of the B41D Quaternary Catchment.

The following catchment characteristics have been noted:

- The general geology of these quaternary catchments comprises Bushveld Igneous Complex rocks and basic/mafic and ultramafic intrusives.
- Soils in this region vary from moderate to deep sandy loam, with steep relief.
- Vegetation for this area comprises of savannah (Simplified Acocks Veld Types).

The major river in the B4 sub-drainage region is the Steelpoort River and its smaller tributaries. The Steelpoort River forms the western border of the region. The Spekboom River drains the eastern part of the region and has its origin near the town of Lydenburg, and flows into the Steelpoort River near the end of the region. The Dwars River drains the area between the Steelpoort and Spekboom River.

6.5.3. Hydrogeology

The main points identified during the ESS phase from a hydrogeological perspective, were the following:

- Geologically the formations underlain by the study area belong to the Bushveld Igneous Complex and comprise felsic rocks of the Rashoop Granophyre Suite overlying the mafic rocks of the upper and main zones of the Rustenburg Layered Suite. The high plateau is underlain by granophyre in the south of the area by mixed granite and granophyre in the north.
- The aquifer type is intergranular (i.e. weathered) and fractured.
- Groundwater occurs typically in faults and shear zones.
- The mean annual recharge is between 27-37 mm per annum.
- The contribution of groundwater to the base flow of streams and rivers in the area is considered negligible.
- The average depth to groundwater is between 10 and 20 m.
- The harvest potential[1] for the Steelpoort area is seen to be between 10 000 and 15 000 m^3/km^2/annum.
- The factor restricting the harvest potential in this area is the limited effective storage. Recharge occurs regularly most years but cannot all be absorbed into the aquifer because of low storage. The limiting factor is how much groundwater can be storing the wet season to bridge abstraction during the drier season.

Isolated alluvial aquifers are recognised to form in association with Steelpoort River. The regional mapping and data sources do not indicate any alluvial aquifers on any of the three candidate sites. These aquifers, if present, will be assessed during the EIA phase of work, i.e. when site-specific data is compiled.

Static water levels

Static water levels for all boreholes within the two quarter-degree grids, within site C in 2429DD, and Sites A and B in 2529BB were provided by DWAF. The information provided was with the exception of the farm names or coordinates and consequently no unnecessary information, not being applicable to the three sites, could be discarded.

[1] The harvest potential is defined as "the maximum volume of groundwater that may annually be abstracted per surface area of an aquifer system to preserve a sustained abstraction".

Areas of shallow groundwater levels, typically located in the valley, within the alluvial and weathered (shallow) aquifers are more vulnerable to surface contamination. All three sites have incidents of shallow groundwater, thus no one site is more vulnerable than the next.

Yields

Site C has enhanced groundwater potential, due to underlying geological structures, these resultant high yielding aquifers have the potential to be utilised in the future and are thus recognised to be of more value than the lower yielding boreholes on sites A and B.

Groundwater Chemistry

Although all the available borehole chemistry results within the requested grid coordinates were provided by DWAF, only the applicable farms covering the three actual sites (Sites A, B, and C) were investigated. Data covering farms that would not be affected by the 10 preliminary options for Sites A-C were discarded. No preferential site can be selected based on the available hydrochemical data.

6.5.4. Site Selection Summary – Groundwater

The three possible sites (Site A, B, and C) which have been identified during the pre-feasibility study, are discussed for their significance from a hydrogeological point of view:

- Site A:

  Possible seepage through the bedrock at the upper reservoir position for option 1 as a result of dolerite dykes (resulting in contact metamorphism and enhanced groundwater potential) makes this a less favourable option than the upper off-channel option which is not situated on such structures.

  Stripping of 0.5 m of overburden material at this preferred upper reservoir position also favours it more as more fill material will be available opposed to the in-stream option.

  From a groundwater point of view neither the off-stream nor the in-stream lower reservoir options will be more beneficial as no significant faults or shear zones occur within any of the two options that may influence groundwater recharge positively or negatively. Though the in-stream option may be more beneficial towards groundwater recharge during the drier months, as the impoundment is likely to contribute towards groundwater recharge and baseflow, as the water table will be situated lower than the dam. During the wetter months the opposite is likely to happen, the water table will be more elevated and likely to contribute flow towards the impoundment.

Thus, either Option 3 or 4 is preferred at Site A.

- <u>Site B:</u>

Options B5 and B6 are the least favourable options from a groundwater point of view, as the lower reservoir position is situated directly south-east of the Steelpoort Fault. The possibility, therefore, exists that faults or shear zones, associated and parallel to the main fault, may occur in the vicinity of the planned impoundments. This implies that grouting beneath the plinth of the rock fill embankment may be required in order to prevent large scale groundwater seepage losses.

Constructing the tunnel line through the Steelpoort Fault and associated shear and fracture zones may result in groundwater inflows (and associated dewatering), which makes options B1 and B2 less favourable.

Constructing the pressure tunnel, machine, and transformer halls for options 3, 5, and 7 may possibly intercept water bearing shear or fracture zones that may also result in increased groundwater ingress. This also applies specifically to the prominent lineation crossing the underground waterways for option 5, which should be avoided during the siting optimisation of the power station caverns and constructing the surge chamber.

The impact of the geological structures, which can act as preferential flow paths, can result in large inflows of groundwater into the workings and also the need for dewatering, which can impact on groundwater users and resources in the area.

This favours B4 and B8 as the two most favourable options.

The high incidence of geological structures and the location of the major Steelpoort Fault, in relation to site B, increase the probability that this project will impact on the groundwater resources in this area. These impacts can be both artificial recharge and dewatering.

- <u>Site C:</u>

Groundwater seepage through the trench at the lower reservoir overlying two limbs of the Steelpoort fault may be substantial.

Constructing the headrace tunnel, surge shaft, pressure shaft, and tunnel through potentially a number of northwest-trending fracture zones running parallel to the tunnel alignment may be troublesome if they are water bearing and high yields may be encountered.

The proximity of site C to the Steelpoort Fault (enhanced groundwater potential) and the proposed De Hoop Dam (isostacy) indicates that this site may impact more readily on the groundwater regime. This is a fatal flaw.

Site C is, from a hydrogeological perspective fatally flawed. It can therefore not be further considered as a possible site for the proposed SPSS.

6.5.5. Surface water quantity

- Catchment boundaries

  The study area is located within the Steelpoort River Catchment and its tributaries. The Steelpoort River catchment drains into a northerly direction and eventually flows into the Olifants River. The boundaries of the catchment are occupied by some dense rural residential related activities, some small scale farming activities, as well as some game farming areas. The affected watercourse that would be impacted upon would be the Steelpoort River.

  Identified sites are located towards the downstream western side of the Steelpoort River. This selection may be contributed to the plateau height (to the west of the river), which is required to achieve sufficient hydraulic head.

  Site A is located close to the current De Hoop Dam scheme. The site lends itself to both on- and off-channel options for the lower reservoir. Four different storage options have been identified for this site. Site B has one preferred location for an upper reservoir, with different locations for the lower reservoir. Eight different storage options have been identified for this site. Site C is located opposite the western edge of the proposed De Hoop Dam, which would serve the common purpose as lower reservoir for the Pumped Storage scheme. Two options have been identified for this site.

- Virgin Mean Annual Run-off

  The virgin mean annual run-off (MAR) for both quaternary catchment areas has been estimated. Water Research Commission publications *(Surface Water Resources of South Africa- Volume 1)* were used to obtain the MAR for each Quaternary drainage regions. The B41B Quaternary Catchment has an estimated MAR of 17.8 $x10^6$ m^3 per annum while the B41D Quaternary Catchment has an estimated MAR of 16.6 $x10^6$ m^3 per annum. No actual stream flow data was obtained during this study.

- Flood Peaks and Volumes

  Flood calculations will be determined as part of the feasibility process. Water storage reservoirs will be classified according to Chapter 12 of the National Water Act, 1998

(Act 36 of 1998) and relevant Government Notices, as dams with a Safety Risk. Social, economic, and environmental impacts will be used during the classification process. Freeboard and spillway sizes will be determined according to the relevant SANCOLD (South African Commission on Large Dams) publications. This will be done during the detailed design process.

6.5.6. Site Selection Summary – Surface Water and General Hydrology

- Favourability of the alternative sites and options

  - *Site A*

  At Site A, Option 1 is the least favoured as both the lower and the upper reservoirs will be located in-stream, which will result in high sedimentation yields which is a direct result of the high erodibility index for the study area. Both the in-stream options will also influence the hydrological regime for the streams they are located in negatively.

  Option 2 is the second least favoured. For the same reasons as above, although the upstream reservoir will be off-stream, the lower reservoir will still be in-stream.

  Option 4 is the third least favoured. Although both impoundments will be situated off-stream, a higher storage capacity (larger surface area) will be susceptible to higher evaporative losses. Less run-off will also be available to sustain the hydrological regime.

  From a surface water and general hydrological perspective, **Option A3** appears at this scoping stage to be the most suitable option at Site A. Both the upper and lower reservoirs will be off-stream. Less storage capacity than that suggested in option 4 implies a smaller surface area susceptible to less evaporative losses. More run-off will also be available annually to sustain the hydrological regime, downstream of the impoundments.

  - *Site B*

  Options B1, B3, B5, and B7 appear at this stage to be the more favourable options at Site B from the perspective of surface water and general hydrology, as these impoundment options will contain less (10 hours) storage oppose to the other alternatives which will contain 20 hours. The former options will favour the hydrological regime more as less run-off will require to be stored. Smaller storage volumes that will occupy smaller surface areas will also be susceptible to evaporative losses.

  - *Site C*

  Site C is the least favoured of the site options as the study area represents a lower MAR (16.6 x 10^6m^3) apposed to Site A & B which represents a MAR of 17.8 x 10^6m^3.

This implies generally speaking sites A & B have more available run-off available to be stored, thereby influencing the hydrological regime less negatively than the Site C option. Secondly on plan it appears that the lower reservoir Site C option will cover a much larger surface area than the other two options, which will be more susceptible to evaporative losses.

6.5.7. Nature and Extent of the Impacts

The proposed water storage reservoirs will consist of concrete faced rock-fill dams. It is anticipated that the surface areas of the upper reservoirs will be in the order of 80 ha, while the lower reservoirs would be 50 ha. It is also anticipated that an initial start up volume of 15 $x10^6$ m^3 per annum would be required for these dams and that 2 $x10^6$ m^3 per annum would be required as top-up water due to evaporative and seepage losses. It is also anticipated that water would be supplied to local communities along the Nebo plateau from this Pumped Storage Scheme, but this has to be clarified. Water would be pumped from the De Hoop Dam in a pipeline to the water storage reservoirs.

- Surface water

  Some potable water will be required for construction purposes as well as for the construction camp during the construction phase. These volumes will be abstracted over the whole length of the construction period for construction as well as for day-to-day operations in the camp. It is, however, still unclear what the workforce will consist off and what the level of service will be.

  Most water losses in the reservoirs would occur due to evaporation of water from the open water bodies. Some seepage and frictional losses will also occur. It is quite possible that water emanating from the dam wall as a result of seepage through the internal drainage system, will be measured and discharged back to the receiving water bodies. This volume may be small and can be considered as negligible.

  The impact on the Mean Annual Run-off (MAR) as well as on the yield of De Hoop Dam has not been determined yet, as no detailed design has been formalised.

  Increase in run-off and flow velocities are expected as a result of the increased impermeable surface areas and mitigation measures should be implemented to prevent the degradation of the watercourses. Soil conservation measures should be implemented at identified areas. Storm water collection and conveyance systems should be engineered.

- Groundwater

  - Site C is located on the most complex geology, which has resulted in enhanced groundwater potential

- Groundwater, associated with geological structures, intercepted during construction will result in groundwater ingress into the workings. Dewatering will be required which will impact on groundwater uses and resources on the sites.
- All three sites have incidents of shallow groundwater, thus no one site is more vulnerable than the next.
- Site C has high yielding aquifers and enhance groundwater potential, due to underlying geological structures, and is thus recognised to be of more value than the lower yielding aquifers on sites A and B.
- No preferential site can be selected based on the available hydrochemical data.
- Site A is the preferred site when compared to sites B and C, based on geological stability, groundwater / aquifer development, and potential dewatering impacts.

In summary, the preliminary groundwater assessment conducted during the ESS on the three candidate sites indicates that site A or B could be considered for evaluation in the EIA process, from a groundwater perspective.

- General hydrology

The damming up of small tributaries is expected to negatively impact on the current hydrological regime and future hydrological functioning. One of the main impacts of impoundments is that they change the timing, size and frequency of flow and flood events in the river. Altered flow patterns also lead to changes in sediment dynamics, habitat integrity, thermal and chemical (abiotic) conditions in rivers. Fluctuating discharges constantly change conditions through each day and season, creating mosaics of areas inundated and exposed for different lengths of time. The resulting physical heterogeneity determines the local distribution of species: higher physical diversity enhances biodiversity. The foreseen impacts on the Ecological and Basic human needs reserve will be negligible, since water released by the relevant reservoirs will be intercepted by the De Hoop dam, and may be lost due to evaporation, seepage or releases from the dam.

For the Site A alternative, **Option A3** was found during the ESS to be the most favourable, as both the upper and lower reservoirs will be off-stream. Less storage capacity than that suggested in option 4 implies a smaller surface area susceptible to evaporative losses. More run-off will also be available annually to sustain the hydrological regime, downstream of these impoundments.

For the Site B alternative, **Options B1, B3, B5 and B7** are the more favourable options as these impoundment options will contain less (10 hours) storage as opposed to the other alternatives which will contain 20 hours. At this stage, no distinction can be made between the four most favoured Site B options as mentioned above, but ultimately the option with the least upper reservoir storage capacity will be the most favoured with regards to impacts on the hydrological regime, as it will impact the least on the hydrological regime downstream. The reservoir with the smallest surface area will also be least susceptible to evaporative losses.

No distinction can at this stage be made between Site A3 and the various favoured B options based on surface water and general hydrological parameters.

From the ESS, Site C is the least favoured of all three sites as a result of the following factors:

- the study area represents a lower MAR, which will affect the hydrological regime more negatively, as it will be deprived of more available run-off.
- On plan it appears that the lower reservoir Site C option will cover a much larger surface area than the A & B options, which will be more susceptible to evaporative losses.

At this stage from a hydrological perspective, the preferred sites are therefore the following (in no particular order):

- **Site A3**
- **Site B1, B3, B5** and **B7**

Table 6.20: Rating Of Impacts on Hydrology

RATING OF IMPACT: HYDROLOGY		
Dimension	**During construction**	**During operation**
Duration	Short term	Long term
Extent	Localised	Localised
Probability	Definite	Definite
Significance	Medium – high	High
Significance*	Low – medium	Medium
Status	Negative	Negative
Rating of sites (1 = not suitable, 5 = ideal): **Sites A and B:** Sites A and B are considered favourable from a groundwater and stability perspective. Sites A3, B1, B3, B5, and B7 are favourable from a hydrological perspective. **Site C:** Not favourable.		
Recommended studies for EIA phase: More detailed studies to be done during EIA phase		
*Significance with mitigation		

6.6. Wetlands

A wetland assessment has been conducted by Paul da Cruz of SiVEST as part of the ESS and was based largely upon the findings of a desktop delineation as well as a site visit undertaken in October 2006, in which certain of the three alternative locations were examined (refer to Appendix M – Wetlands Assessment Report). The focus of this study was on identifying wetland areas that may be affected by the proposed development in keeping with the aim of scoping to identify major potential issues, and thus provided input on site selection in the context of wetland protection. A detailed wetland assessment will be conducted on the preferred site during the EIA phase, and site-specific mitigation and management measures will be developed during the EMP phase.

6.6.1. Methodology

The first stage of the wetland assessment was undertaken using desktop methodologies. This included analysis of ortho photographs and 1:50 000 topographical maps. Orthophotos of the site were examined to identify any wetland areas that may exist within the footprint of the proposed scheme alternatives. During the site visit undertaken on 18 October 2006, certain of the locations for the proposed scheme were examined for evidence of wetland habitat.

6.6.2. Evaluation of the ESI

The BKS screening report did not specifically assess the occurrence of wetlands on the three alternative sites. The report identified a number of vegetation communities which exist on the sites. One of the sites is described as *Fuirena pubescens – Schoenoplectus corymbosus* wetland vegetation, which is found in suitably saturated locations alongside watercourses in the river valleys and on seeps within mountain slopes and plateaus. This community is assessed to exist at the lower dam site at Site A and Site B (in the riverine areas), and at the upper dam site at Site B (it should be noted that the lower dam site at the Site C – the proposed De Hoop Dam – is not discussed in the BKS report).

As part of an assessment of agricultural potential, the screening report examined soil types found on the various sites. The screening report has concluded that type B soils (i.e. soil forms typical of wetland areas) occur at the lower dam sites of Sites A and B. The report concludes however that the wetland soils do occur in conjunction with red soils, which are not wetland soils and have good agricultural potential.

6.6.3. Site assessment

- Site A Upper Dam

Examination of the orthophotos for the eastern upper dam site (Site A3 upper reservoir site) did not reveal evidence of any wetlands within the footprint of the dam. The site was investigated during the site visit and the desktop findings were confirmed. There is no evidence of wetland habitat on this site, with the soils appearing well-drained and yellow in colouration. Furthermore, in most places over the footprint of the dam, there is evidence of bedrock-outcropping on the surface, thus entailing that soils would be shallow and not conducive to wetland formation.

The footprint of the second upper dam site (further to the west) would affect a wetland. The dam wall would be constructed along a narrow drainage line rising at the eastern end of Sehlakwane, and draining into a steep poort through the escarpment. A relatively narrow wetland (approximately 10-15m in width) occurs within the valley bottom. There is evidence of typical wetland vegetation as well as dark, clayey soils. There was also evidence of surface water flow through the wetland, suggesting that parts of the wetland are permanently wet (considering the site was inspected at the end of the dry season). Should the dam wall be constructed at this site, a certain portion of wetland habitat would be inundated, and would thus be lost.

- Site A Lower Dam

In the ESI, two options are indicated for the lower dam at Site A. One would dam the Steelpoort River, and the other would dam a tributary of the Steelpoort River which drains the escarpment. The second dam site is the preferred lower dam site at Site A. Accordingly this site was assessed for occurrence of wetland habitat. Desktop analysis indicated that a drainage line / river would be flooded by the dam. A riparian zone adjacent to the drainage line was evident, but analysis of the orthophotos did not seem to indicate any wetland habitat. This was confirmed by the site visit in which the river in the vicinity of the proposed dam wall was investigated. The river contained a well-defined riparian zone in which large indigenous trees existed, but there was no evidence of wetland habitat. The channel in the vicinity of the dam wall had eroded down to bedrock and thus there were no wetland soils within the channel, or within the riparian zone. It is at this stage uncertain whether wetland soils may exist further upstream; however, considering the nature of the terrain and soils in the vicinity of the dam wall, which seem to be similar to that upstream, this seems unlikely. Further investigation will be conducted on the preferred site during the EIA phase.

- Site B Upper Dam

One dam site has been selected for the upper dam at Site B. Analysis of the orthophotos for the site indicated that there does not appear to be any wetlands on the site. The site visit to the upper dam location at Site B confirmed that there was no wetland habitat on the site. Although part of the approximate footprint of the dam is located within a slight depression, the soils and vegetation on the site did not indicate that the site was a wetland.

- Site B Lower Dam

Four possible locations have been indicated for the lower dam at Site B. Analysis of their approximate footprint on orthophotos indicated that there was unlikely to be any wetlands present within the footprints of the four dam locations. The actual location of the 'preferred' location at site B was not visited; however an area close to the site was visited. The site assessment of this area in close proximity to the site did not indicate any wetland habitat.

- Site C Upper Dam

Two possible locations have been indicated for the upper dam at Site C. The site was not visited during the site visit due to the fatal flaw that has already been identified by the ESI (the presence of the Steelpoort Fault). In addition there was no orthophoto coverage of the upper dam locations at Site C. Thus assessment of wetland occurrence at Site C could not be undertaken, and the assessment has to revert to the results of the BKS screening report which listed no wetland habitat at Site C upper.

- Site C Lower Dam

The proposed De Hoop Dam would be the lower reservoir at site C. As the area to be inundated by the reservoir has been already assessed in terms of the Environmental Impact Assessment conducted for the proposed dam, analysis of Site C lower has not been undertaken.

6.6.4. Studies to be conducted during the EIA phase

The location of the *borrow pit* areas have not as yet been finalised by the project engineers – this will, however, be available during the EIA-phase studies. One of the possible borrow pit areas for site A is situated in the fields adjacent to the Steelpoort River. These may well contain wetland soils, and thus the assessment of borrow pit locations for the existence of wetlands will be undertaken during the EIA phase.

The location of *ancillary infrastructure* such as roads, and housing (if needed) have also not yet been established. The location of these will need to be further investigated in the EIA phase with regards to wetlands.

The findings of this scoping report are based largely on desktop investigation with very limited site investigation. During the EIA phase, a more detailed site investigation will be conducted utilising the four indicators of wetland occurrence (as listed in the DWAF guidelines for the delineation of wetlands and riparian areas (DWAF, 2003)). The findings of this report are subject to more detailed studies (including pedological and vegetation studies) that may need to be undertaken in the EIA phase of the project.

6.6.5. Site selection

The BKS screening report lists Site A as the 'preferred' site from an environmental point of view. The scoping-level assessment has indicated that there is likely to only be wetland habitat at the western location for the upper dam at Site B. None of the other sites were assessed to have wetland habitat present although there is a low confidence level in the assessment for the lower dam locations at Site B, and Site C could not be assessed due to a lack of data (site C is however, fatally flawed in terms of geological factors, notably the presence of the Steelpoort Fault).

From a wetland point of view only the western location of the upper reservoir at Site A should be avoided. Other than this, there is no clear preference in terms of the three sites (Sites A, B and C) in the context of the avoiding of destruction of wetland habitat, as long as the western location for the upper reservoir site at Site A is avoided.

6.6.6. Nature and extent of impacts

The creation of 'on-line' reservoirs (i.e. reservoirs constructed across an existing drainage line) at certain of the sites i.e. the lower reservoir site at Site A, and Site B may have implications for wetland functioning (if wetlands occur further upstream or downstream of the reservoir) in the context of the catchment in which the dam is located. The creation of a reservoir which would effectively remove water from a catchment to be used in the pump storage scheme may have implications for the functions performed by wetlands in that catchment in a greater catchment context. If the site taken through into EIA investigations contains such an online reservoir, the implications of the proposed development on upstream wetland functioning in that catchment and in a greater catchment context will need to be investigated in further detail during the EIA phase of the project.

Table 6.21: Rating Of Impacts on Wetlands

<table>
<tr><th colspan="3">RATING OF IMPACT: WETLANDS</th></tr>
<tr><th><u>Dimension</u></th><th><u>During construction</u></th><th><u>During operation</u></th></tr>
<tr><td>Duration</td><td>Short term</td><td>Long term – Permanent</td></tr>
<tr><td>Extent</td><td>Local</td><td>Local</td></tr>
<tr><td>Probability</td><td>Unlikely (all sites and options except A1) – Likely (Site A1)</td><td>Unlikely (all sites and options except A1) – Likely (Site A1)</td></tr>
<tr><td>Significance</td><td>Medium – high</td><td>High</td></tr>
<tr><td>Significance*</td><td>Low (all sites and options except A1) – medium (Site A1)</td><td>Low (all sites and options except A1) – medium (Site A1)</td></tr>
<tr><td>Status</td><td>Negative</td><td>Negative</td></tr>
<tr><td colspan="3">Rating of sites (1 = not suitable, 5 = ideal):
Site A: Western upper dam site (forms part of Site A1) should be avoided. All other options acceptable. Site A3 acceptable.
Site B: All options acceptable (based on the relatively limited scoping-level studies).
Site C: All options acceptable (based on limited scoping-level study).</td></tr>
<tr><td colspan="3">Recommended studies for EIA phase:
More detailed studies to be done during EIA phase</td></tr>
<tr><td colspan="3">*Significance with mitigation</td></tr>
</table>

6.7. Geology

The geological assessment conducted during the ESI for the proposed project is contained in Appendix K.

The rocks in the area fall within the Bushveld Igneous Complex and comprise felsic rocks of the Rashoop Granophyre Suite overlying the mafic rocks of the Upper and Main Zones of the Rustenburg Layered Suite. The high plateau is underlain by granophyre in the south of the area and by mixed granite and granophyre in the north. These felsic rocks are several hundred metres thick and form the steep scarp slopes. Below the bottom of the scarp at the base of the felsic rocks is a leptite formation approximately 250m thick, dipping approximately 10 degrees westwards into the slope. This is in turn underlain by diorite beneath the pediment slope, grading into olivine-bearing diorite and gabbro beneath the valley floor. These mafic rocks underlying the leptite formation contain bands of anorthosite and magnetite, and all of the horizons dip around 10 degrees towards the west.

All of the rocks discussed above have been intruded by dolerite/lamprophyre dykes, generally trending northeast (roughly parallel to the Steelpoort fault) and west of northwest (roughly perpendicular to the fault).

6.7.1. Nature and Extent of the Impacts

Geology plays an important role in the construction of dams, as unstable geological conditions may damage the structure of the dams. Failure of a dam structure would lead to significant down-stream damage as a result mainly of flooding, causing loss of lives (should the downstream area be inhabited) and damage to infrastructure.

It is important to note the **Steelpoort Fault**, situated in the **Site C** study area. In light of the significant risk not only to the project but to downstream communities and existing infrastructure, the Fault is considered a **fatal flaw**. Site C is therefore no longer considered a feasible alternative and Sites A and B remain as the only feasible site alternatives for the proposed SPSS. At this stage, these two sites seem to be equally suitable, but detailed geo-technical investigations will form an integral part of the detail engineering design stage in order to ensure that the selected site poses no risk in this regard.

Table 6.22: Rating Of Impacts on Geology

RATING OF IMPACT: GEOLOGY		
Dimension	**During construction**	**During operation**
Duration	Short term	Long term
Extent	Localised	Localised
Probability	Definite	Unlikely
Significance	Medium	Low

Significance*	Low – medium	Low
Status	Negative	Negative
Rating of sites (1 = not suitable, 5 = ideal): **Sites A and B:** Considered equally suitable at this stage. **Site C:** ***Fatal flaw*** in the form of the Steelpoort Fault.		
Site A: 2 – 3	**Site B:** 3 – 4	**Site C:** 4
Recommended studies for EIA phase: More detailed studies to be done during EIA phase and as part of the detail design phase.		
*Significance with mitigation		

6.7. Soils and Agricultural Potential

The soils and agricultural assessment conducted during the ESI for the proposed project is contained in Appendix K.

6.7.1. Land Types

Land types have been denoted for area with a uniform terrain form, soil pattern and climate. The different land types differ in one of these three characteristics. The dominant land types recorded for this area are Ba, Bc and Ib.

The B land types are plinth catena from the upland duplex and margalitic soils. These soils are typical wetland soils. These soils may have a thick organic layer (such as peat), be grey in colour or have mottles indicating a fluctuating water table. The soil forms present in these soil types are therefore mostly wetland soils including, but not limited to, Rensburg, Willowbrook, Katspruit and Champagne soil forms. The soil forms can only be classified as land type B if these soils are the dominant soil forms. Some other soils may however be patchily distributed in the area.

The Ib land type indicates areas with exposed rock on the soil surface. The rock should cover 60 – 80% of the area. The underlain soil may qualify the area to be classified into a different land type, if not for the rockiness.

6.7.2. Terrain Form and Terrain type

The terrain type has two parts, *viz.* slope and length. The *slope* is indicated by:

- A: more than 80% of the area has slopes less than 8%
- B: 50 – 80% of the area has slopes less than 8%
- C: 20 – 50% of the area has slopes less than 8%
- D: less than 20% of the area has slopes less than 8%

The *length* of the slope is divided into six classes:

- Class 1: 0 – 30
- Class 2: 30 – 90 m
- Class 3: 90 – 150 m
- Class 4: 150 – 300 m
- Class 5: 300 – 900 m
- Class 6: >900 m

6.7.3. Terrain Unit

The terrain unit, a homogenous portion of land in terms of form and slope, was identified for all the soil forms identified. Five terrain units are used and each soil form was limited to one of these terrain units. The terrain units are the following:

- crest (1)
- scarp (2)
- midslope (3)
- footslope (4)
- valley bottom / flood plain (5).

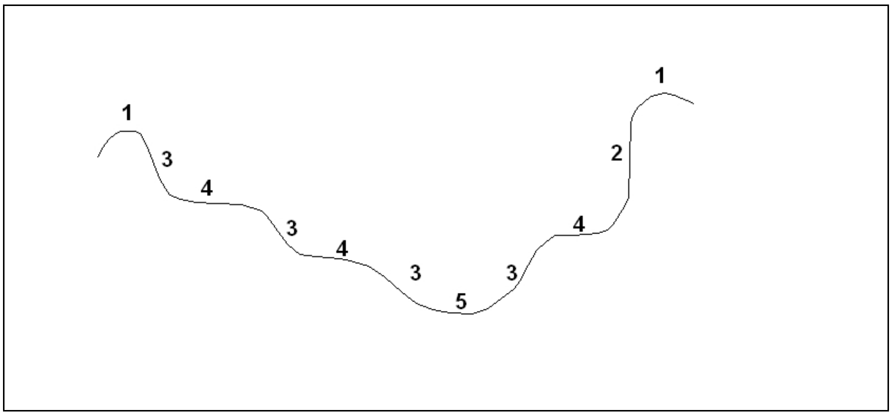


Figure 6.4: Schematic of terrain units

For a description of the terrain in terms of range in percentage slope, range in length, shape and area in hectares at each of the site alternatives, please refer to Appendix K.

6.7.4. Nature and Extent of the Impacts

Site A lower dam is located within the Ba land type and Site B lower dam in the Bc land type. Both of these land types have wetland soils; however, the wetland soils occur in conjunction with red soils. Red soils in general are good agricultural soils. Portions of these land types may not be suitable for ploughing. It is expected that cultivation activities at these sites may be successful. It should however be taken into account that, according to the Conservation of Agricultural Resources Act (Act No 43 of 1983) (CARA), no agricultural activities may take place within 10 m horizontal of a drainage line or wetland. These sites therefore have high agricultural potential.

Site A upper dam and Site B upper dam both occur within the Ib land type, and we assume that Site C also falls within this land type. Site C is however less rocky, probably due to small scale variation in the land type.

Site A upper dam is very rocky and may contain metals in the soil. The site is therefore unsuitable for agricultural activities. Thus the agricultural potential is low.

Site B upper dam has large boulders and is very rocky, thereby prohibiting ploughing of the soil. Some drainage areas also occur on the site and are protected by CARA. This site is not suitable for agriculture, and the agricultural potential is therefore low.

Site C is currently utilised in patches for agricultural activities. No large boulders are evident at the site. Portions of the area are currently being cultivated but some portions that have been cultivated in the past are not under cultivation any more and are colonised by pioneer species. The reason for this may be that these portions do not yield a good crop. Although the site is suitable for agriculture it is not prime agricultural land. Thus the agricultural potential is medium.

Construction and inundation of the dams forming part of the SPSS as well as the proposed administrative building and possible visitors centre, will effectively destroy any agricultural land forming part of the area inundated, or on which the buildings are to be constructed. Agriculture on the upper plateau (upper dam site) generally takes the form of subsistence farming, which makes a very small contribution to the economy. However, it provides these subsistence farmers with a livelihood. Destruction of agricultural land would therefore have significant impacts on their ability to generate income. On the lower level (lower dams) commercial farming contributes significantly to the local economy.

Construction of the proposed PSS at **Site A or Site B** is anticipated to have a **low significance** in terms of impacts on agricultural potential.

Table 6.23: Rating Of Impacts on Agricultural Potential

RATING OF IMPACT: SOILS AND AGRICULTURAL POTENTIAL		
Dimension	**During construction**	**During operation**
Duration	Short term	Long term
Extent	Localised	Localised
Probability	Definite	Definite
Significance	Low (Sites A & B), Medium-high (Site C)	Low (Sites A & B), Medium-high (Site C)
Significance*	Low	Low
Status	Negative	Negative
Rating of sites (1 = not suitable, 5 = ideal):		

Site A: Rocky soil containing metals. Low agricultural potential. **Site B:** Rocky soil. Low agricultural potential. **Site C:** Currently used patchily for agriculture. Medium agricultural potential.		
Site A: 4	**Site B:** 3 – 4	**Site C:** 2
Recommended studies for EIA phase: More detailed studies to be done during EIA phase.		
*Significance with mitigation		

6.7.5. Site Selection Summary

Table 6.24: Site selection – agricultural potential – ESI

Location	Site A Option 1	Site A Option 2	Site A Option 3	Site B Option 1	Site B Option 5	Site B Option 7	Site C Option 1
Rating	4	4	4	3	4	4	2