6. DESCRIPTION OF THE ENVIRONMENT

Key features of the study area are presented in this chapter.

6.1 CLIMATE

Climate data is provided for the towns of Tsolo and Maclear, which are considered to be representative of the general study area. Both towns have sub-tropical climate with moderate rainfall.

Tsolo receives an average annual rainfall of 749 mm, with most rainfall falling in summer. The lowest (15 mm) average monthly rainfall is experienced in June and the highest (108 mm) in January. The coldest month is July with an average minimum temperature of 3.2°C and January being the hottest month with an average maximum temperature of 26.5°C (**Table 11**).

Table 11: Climate data for Tsolo

Tsolo	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Average monthly rainfall (mm)	108	107	107	47	26	15	17	22	42	68	89	101
Average minimum Temp (°C)	15.1	15.2	14.1	9.3	7.1	3.5	3.2	5.2	8.2	11	12.4	13.7
Average maximum Temp (°C)	26.5	26.4	25.7	22.5	21.7	19.5	19.4	21	22.5	23	24.4	25.7

Source: www.climate-data.org

Maclear receives an average annual rainfall of 786 mm, with the wettest month being January receiving an average monthly rainfall of 130 mm. The driest months are June and July with both 13 mm average rainfall. The hottest temperatures are experienced in summer with average maximum temperature of 20.1°C in January. July is the coldest month with temperatures as low as 0°C (**Table 12**).

The variations in temperature and rainfall in the two towns is due to the difference in elevation: Maclear lies at an elevation of 1 280 m above mean sea level whereas Tsolo is at an elevation of 945 m.

Table 12: Climate data for Maclear

Maclear	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Average monthly rainfall (mm)	130	121	113	46	24	13	13	21	38	64	88	115
Average minimum Temp (°C)	13.9	13.9	12.6	9.3	5.6	0.8	0	3.1	7.3	9.5	11.3	12.6
Average maximum Temp (°C)	26.3	26	24.8	22.5	20	16.4	16.3	18.8	21.7	23	24.3	25.7

Source: www.climate-data.org

6.2 TOPOGRAPHY

The Ntabelanga Dam basin is located within an east-west valley with rising hills to the north and south.

The Lalini Dam basin is U-shaped in an east-west and north-south direction surrounded by hills mainly to the north, east and south. The dam wall is located in the east of the dam on the Tsitsa River. The dam site is located about 3.5 km upstream of the scenic Tsitsa Falls.

Deep dongas are evident where the soils are deep and easily erodible.

South of the proposed Lalini Dam, the proposed power line route linking the hydro power plant to the grid (including power line route alternatives) rise up out of the Tsitsa River valley onto the upper plateau over a rolling open landscape to where it meets the national grid approximately 18 km away.

The area around Tsolo earmarked for irrigation consists of gentle rolling hills, much of which used to be terrace farming. Sections are adjacent to drainage lines while others are on sloped terrain. The areas around the Ntabelanga Dam are mainly on flatter lying land adjacent to the edge of the dam and adjacent to the river downstream of the dam.

6.3 GEOLOGY AND SOILS

The study area is underlain by sedimentary rocks of the Tarkastad Subgroup of the Beaufort of the Karoo Supergroup and post Karoo dolerite intrusives. The Karoo Supergroup consists of light brownish grey, fine to medium grained sandstones and subordinate thinner bluish to reddish grey mudrocks. There are also traces of mudflake conglomerates. These sediments were deposited by north flowing braided river systems (**Figure 33**).

There is a low level of tectonic deformations in this region. Dolerite Sills and Dykes are found with thermally metamorphosed adjacent sediments. The dykes are only a few meters wide but stretch for long distances. Dolerite is a dark basic intrusive igneous rock consisting of plagioclase, feldspar and pyroxenes and its soils generally have high potential for both rain fed and irrigated crops and forestry. Beaufort sediments are characteristically erodible.

The bedrock is the main constituent in the study area with some thick colluvial soil deposits covering it.

Alluvial sand occurs in the course of the Tsitsa River and major tributary rivers and streams. Due to the steep and incised nature of the rivers, sand is mainly confined to the river channel, with few and only localised over-bank deposits (DWA, 2013b).

The area has Hutton 2200 salm and Hutton 2100 salm soil types. Orthic topsoils overlie red apedal subsoils. Topsoil texture is sandy loam becoming sandy clay loam in the subsoil. Soils thus have luvic character as clay has moved from top to subsoil over time. Textural transition from top-to subsoil is gradual providing free root penetration. Soil structure is apedal tending to weak crumb (DWA, 2013a).

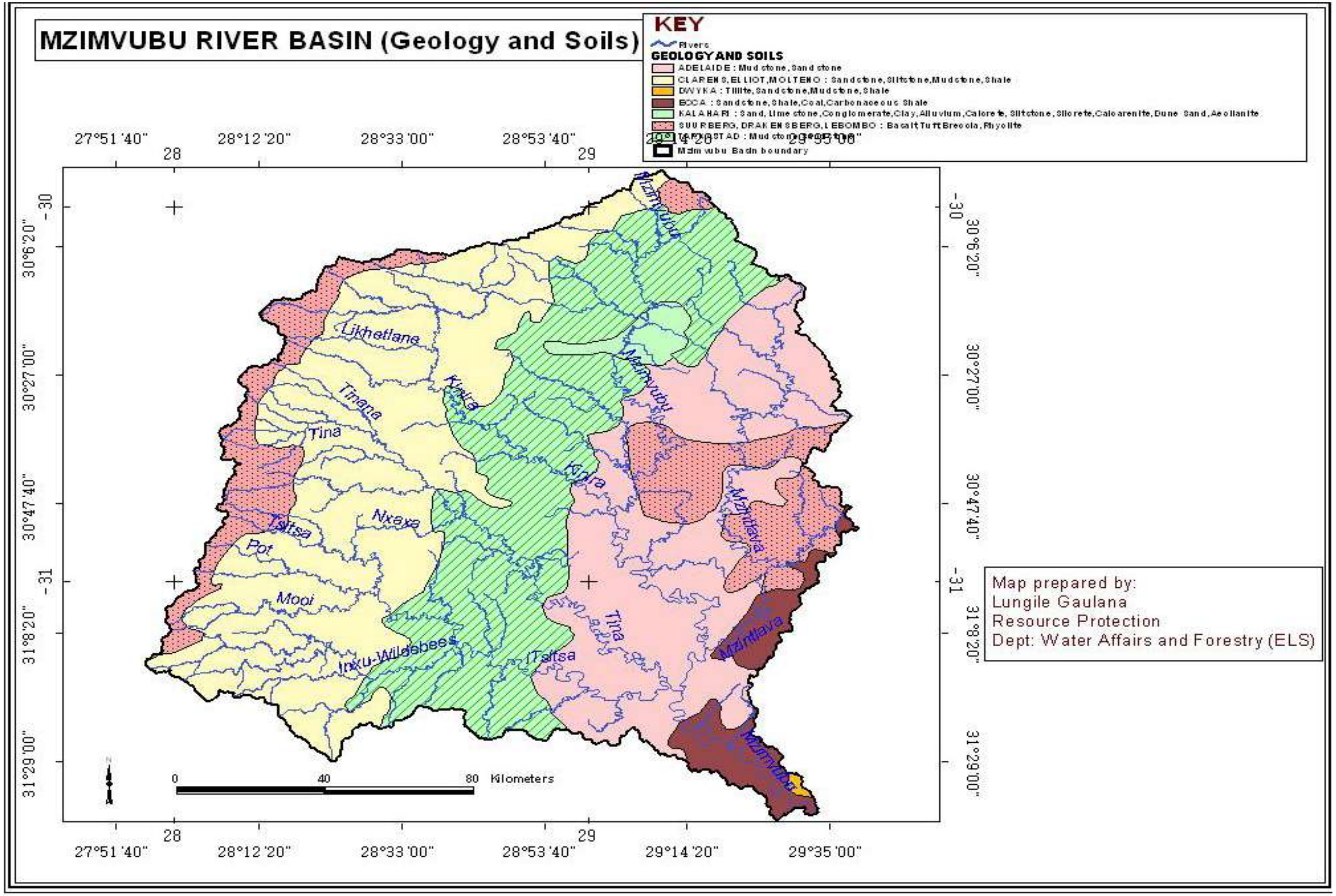


Figure 33: Geology and soils in the Mzimvubu catchment (DWAF, 2008)

Soil erosion

There are extensive areas of severe gulley erosion on the inter-fluvial areas adjacent to stream channels (**Figure 34**). The erosion and piping characteristics are suggestive of the presence of dispersive soils (DWA, 2013b).

In the Mzimvubu and Tsitsa River catchments, soil erosion is an outcome of high rainfall intensities, steep slopes, erodible soils and land use practices that are conducive to erosion. The latter include overgrazing and cultivation on unsuitable thin soils with sloping terrain, which causes grass to not recover, a loss of root structure and sheet erosion.

Figure 34: Donga in the Ntabelanga Dam area

Structures placed in the way of water flow paths have caused the interception of flood paths and springs, cutting off recharge to wetlands and the formation of artificial flood barriers, thereby also causing erosion, as well as sedimentation, and damage to the structures themselves.

Erosion and land degradation affect ecosystem health and negatively impact on the majority of downstream rivers, which are characterised by high turbidity and increased siltation. The high sediment loads in rivers will increase water treatment costs and decreases the lifespan of any dams or hydropower schemes.

A catchment rehabilitation and management programme, aimed at restoring eroded land and thereby reducing the levels of sedimentation that are expected to impact on the yield of the dams, has been initiated in the Mzimvubu River catchment. A budget of R 450 million over the next 10 years has been allocated to the programme. The work has begun in the Tsitsa River catchment in order to synchronise with the proposed new dams currently under investigation. The programme is being implemented by the Department of Environmental Affairs. It will include alien vegetation eradication, the phased restoration of eroded areas and future erosion preventative measures such as sediment trapping and reuse, planting of erosion reducing vegetation, improving land-use practices by rotational usage regime including rotational fencing of grazing areas for protection purposes.

The benefits of the programme include the restoration of wetlands and productive land, reduction of future erosion and land loss, and the reduction of sediment released into the river resulting in improved water quality, reduced water treatment costs and longer operational lifespan of proposed dams and hydropower plants. Improved runoff and river flow regulation via wetlands will improve base flow and reduce peak flood events. The programme will create temporary and permanent jobs.

While this project will impact positively on the Mzimvubu Water Project, it is conducted as an independent project and its activities are not a part of this WULA.

6.4 FLORA

6.4.1 Bioregions

The study area falls within the Sub-escarpment Grassland and Sub-escarpment Savanna Bioregions (Mucina and Rutherford, 2006) (**Figure 35**).

6.4.2 Vegetation types

The study area falls within several vegetation types (Mucina and Rutherford, 2006). These include the *Bisho Thornveld, Drakensberg Foothill Moist Grasslands, Eastern Valley Bushveld, Eastern Griqualand Grassland, Mthata Moist Grassland* and *Southern Mistbelt Forest* (**Figure 36**). These vegetation types are discussed below.

The *Bisho Thornveld* vegetation is found at altitude spanning 200-700 m. It is formally classified as a ‘Least Threatened’ vegetation type (provincial conservation target is 25%). Up to 20% has been transformed for cultivation, urban development or plantations. Erosion in this vegetation type ranges from low to moderate.

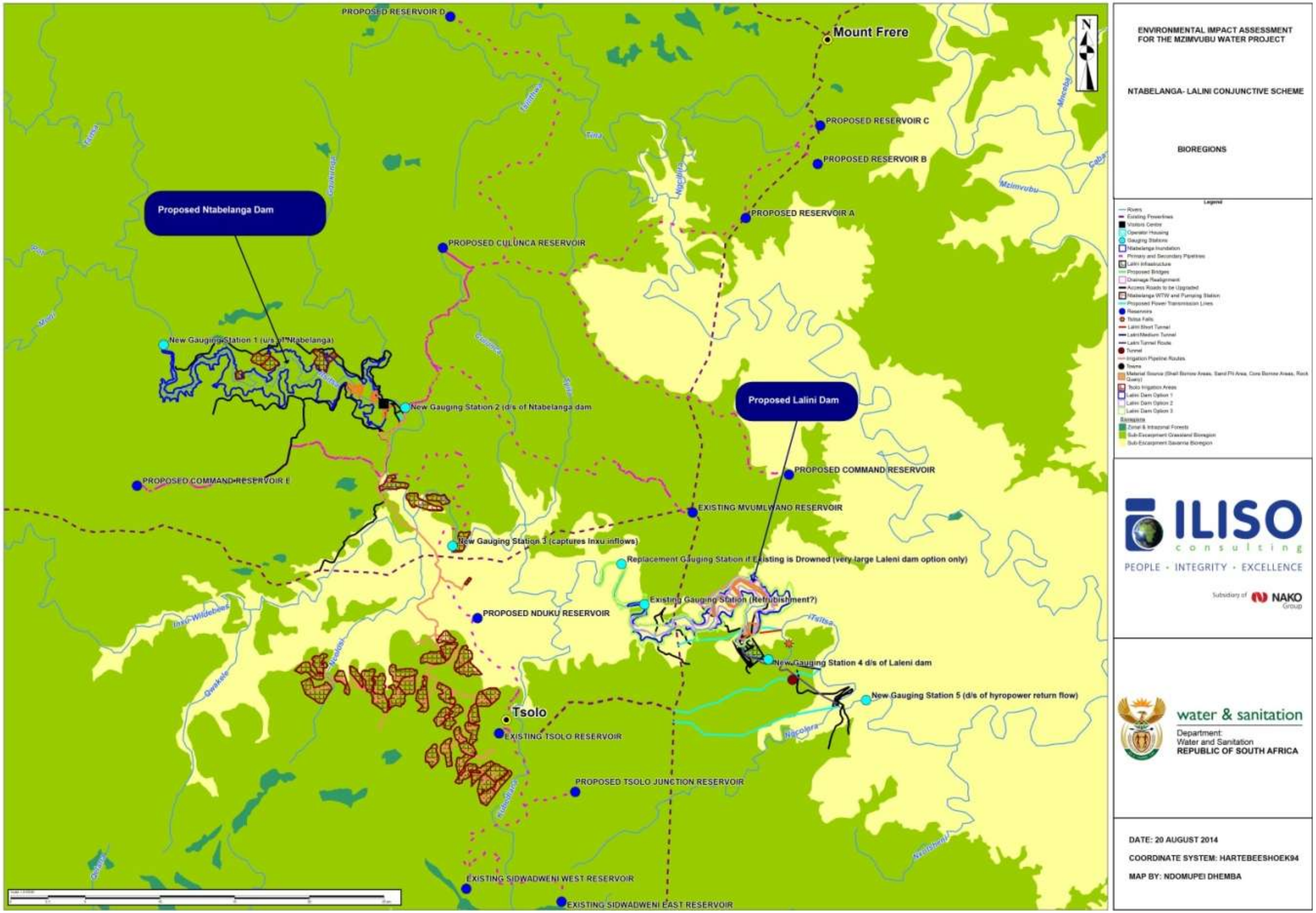


Figure 35: Bioregions

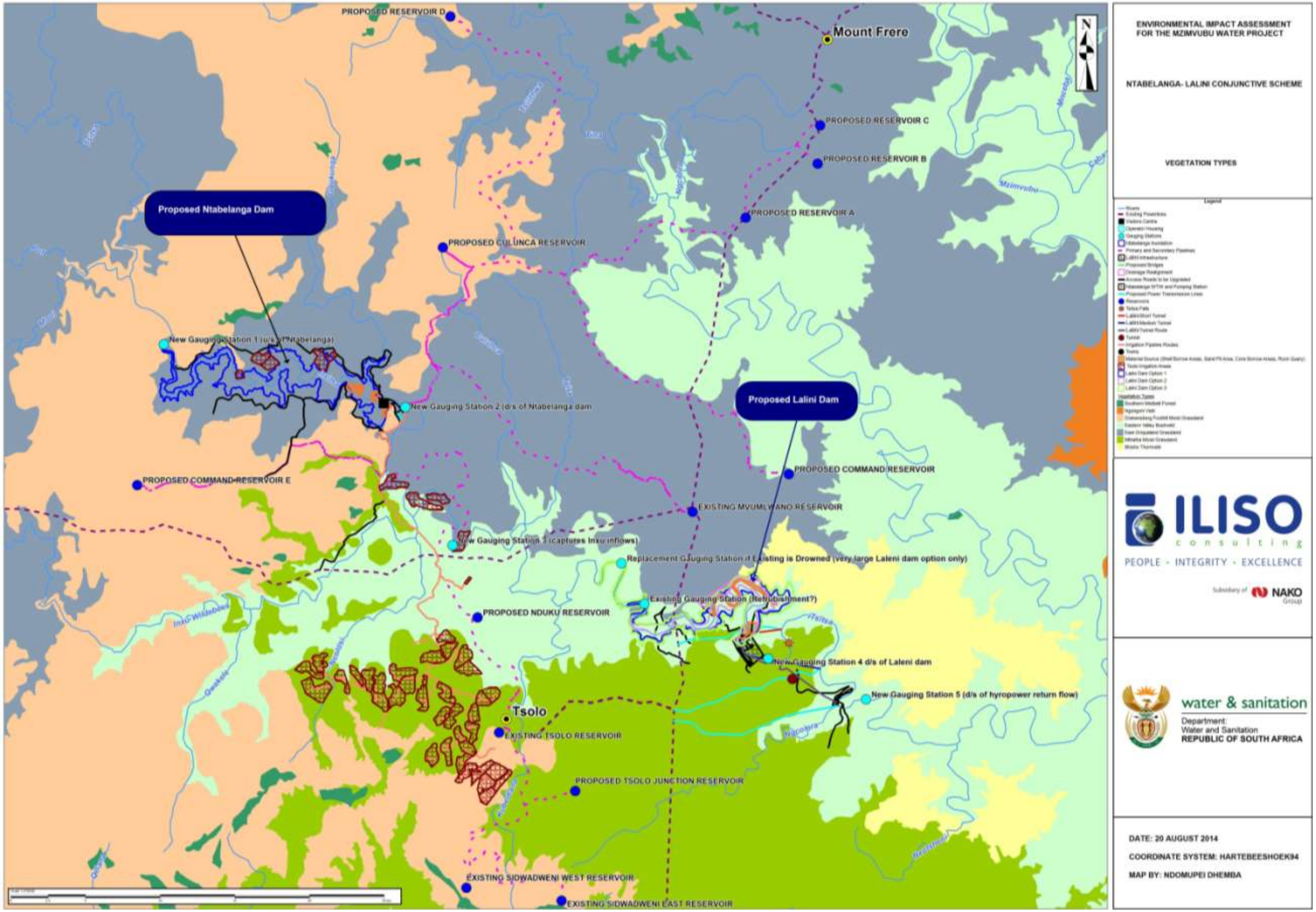


Figure 36: Vegetation types

The *Drakensberg Foothill Moist Grassland* is found at altitudes spanning 880-1860 m. It is formally classified as a 'Least Threatened' vegetation type (provincial conservation target is 23%). Almost 20% has already been transformed for cultivation, plantations and urban sprawl. Alien woody species of *Rubus*, *Acacia dealbata* and *Solanum mauritianum* are potential invasive species in certain areas. Erosion is very low in 28% of the vegetation type, low in 49% and moderate in 17%. Biogeographically important taxa include *Schizochilus bulbinella* and *Schoenoxiphium burttii*.

The *Eastern Valley Bushveld* vegetation is found at altitudes spanning 100-1 000 m. It is formally classified as 'Least Threatened' (provincial conservation target is 25%). Up to 15% of this vegetation type has been transformed mainly by cultivation. Alien plant invasion are a serious threat with *Chromolaena odorata*, *Lantana camara* and *Caesalpinia decapetala* being the most problematic species.

The *Eastern Griqualand Grassland* vegetation is found at altitudes spanning 920-1740 m. It is formally classified as a 'Vulnerable' vegetation type (provincial conservation target is 23%). Over one quarter of the area has already undergone transformation due to cultivation of maize, plantations and urban sprawl. *Acacia dealbata* and *Acacia mearnsii* are invading these grasslands in some places. Erosion is very low in 30% of the vegetation type, low in 31% and moderate in 30% (Mucina and Rutherford, 2006). Biogegraphically important taxa include *Encephalartos friderici-guilielmi.*

The *Mthata Moist Grassland* vegetation is found at altitudes spanning 600-1080 m. It is formally classified as an 'Endangered' vegetation type (provincial conservation target is 23%). More than 40% of the vegetation has been transformed for cultivation and plantations or by dense human settlements. *Acacia mearnsii*, *Solanum mauritianum* and *Richardia humistrata* are the most important aliens. Erosion is a serious problem with high to very high erosion levels in 34% of the vegetation type, moderate erosion in 35% and the remainder having low and very low erosion.

The *Southern Mistbelt Forest* vegetation is found at altitudes spanning 850-1600 m (most patches occur between 1000 and 1400 m). It is formally classified as a Least Threatened vegetation type (provincial conservation target is 30%). Almost 5% has already been transformed for plantations. Invasive aliens include *Solanum mauitianum, Rubus* species and several *Acacia* and *Eucalyptus* species. Uncontrolled harvesting of timber, poles and firewood, overexploitation of non-timber forest products and grasslands are considered as current major threats.

6.4.3 Habitat units and sensitivity

Four habitat units have been identified within the study area, namely the Mountain / Rocky Outcrops habitat unit, Grassland / *Acacia* Thornveld habitat unit, Riparian / Wetland habitat unit and the Transformed (Grassland) habitat unit (Figure 37 to Figure 41).

Figure 37: Mountain / rocky outcrop vegetation located within the western section of the Ntabelanga Dam footprint area

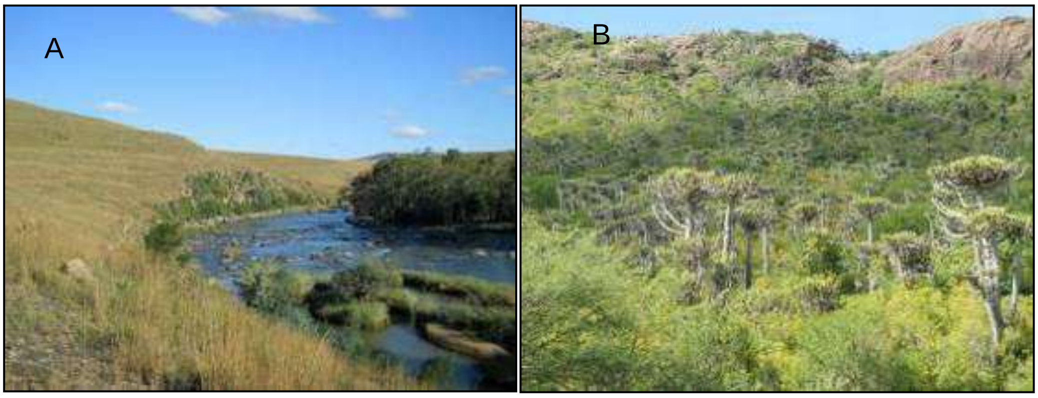


Figure 38: Mountain / rocky outcrop vegetation located within the A) western section of the Lalini Dam footprint area and B) within the eastern section at the dam wall


Figure 39: Acacia karroo dominating within the grassland / Acacia Thornveld habitat unit in the Ntabelanga Dam area


Figure 40: Riparian and wetland vegetation along the Tsitsa River and smaller tributaries


Figure 41: Transformed grassland vegetation along the proposed pipeline routes

The Vegetation Index Score (VIS) was determined for each habitat unit (**Table 13**).

Table 13: VIS for each habitat unit assessed.

Habitat unit	Score	Class	Motivation
Mountain/Rocky Outcrops habitat unit	18	**Class B – largely natural with few modifications**	This habitat unit has remained relatively undisturbed and is known to support high levels of biodiversity and is therefore considered of relatively high ecological importance. Although high levels of biodiversity and ecological importance occur within this habitat unit, transformation has occurred in transition areas between the woody mountain habitat and the open veld habitat unit. Protected tree species, *Podocarpus falcatus* and *P. latifolius* were located within this management unit
Riparian/wetland habitat unit	14	**Class C/D – moderately/largely modified**	This habitat unit is characterised by high levels of erosion associated with donga formation. Numerous drainage lines, valley bottom wetlands and seeps are located within the study area.
Transformed habitat unit	5	**Class E – extensive loss of natural habitat**	This habitat unit is associated primarily with community villages' historic cultivated fields and veld overgrazed and trampled by livestock. The ecological functionality and habitat integrity of the Transformed Habitat Unit is regarded as being extremely limited.
Transformed(Grassland) habitat unit	10	**Class D/E – largely modified/Extensive loss of natural habitat**	This habitat unit has undergone transformation due to over-utilisation of veld by cattle grazing and bush encroachment by *Acacia karroo*.

Figure 42 and **Figure 43** illustrate the sensitivity of the study area, based on the state and function of each habitat unit.

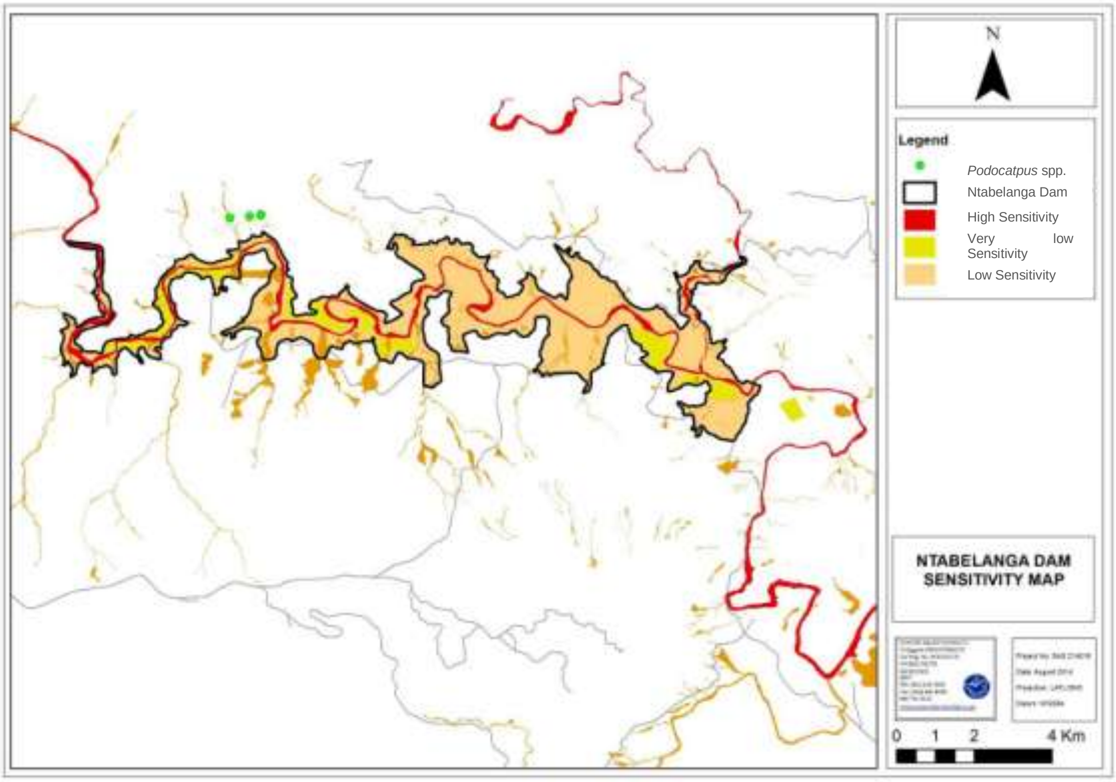


Figure 42: Sensitivity map for the Ntabelanga Dam area and associated infrastructure (DWS, 2014a)

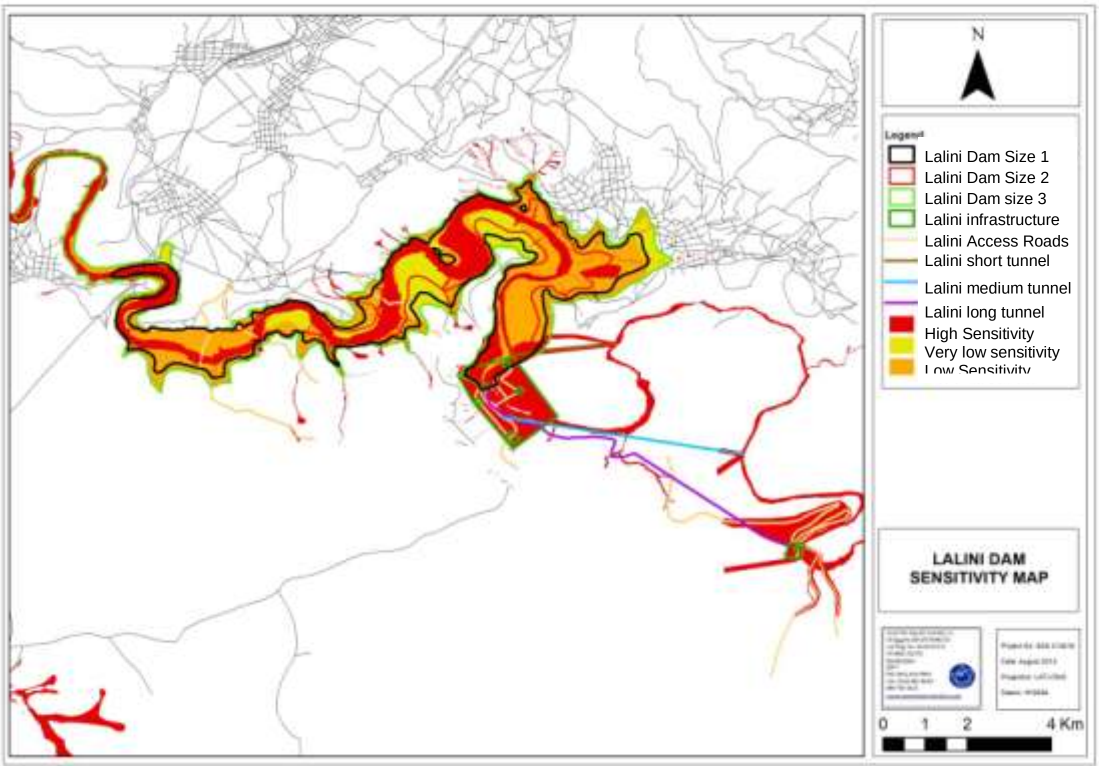


Figure 43: Sensitivity map for the Lalini Dam area and associated infrastructure

6.4.4 Alien and invasive plant species

A number of alien floral species occur within the study area, especially along the riparian features.

Weed species such as *Bidens pilosa*, *Cynodon dactylon, Ricinus communis* var. *communis, Nicotiana glauca* and *Tagetes minuta* are present that are associated with disturbance and agricultural activities. The transformed (Grassland) habitat unit contained mostly weed species associated with disturbance, overgrazing and trampling of veld by livestock. Very little invader floral species occurred within the Mountain / Rocky Outcrop habitat unit. The Mountain / Rocky Outcrop habitat unit are the most at risk for alien tree species to encroach into the area. These areas need to be monitored during the operational phase of the dam construction to ensure that alien invader tree species does not encroach into this habitat unit.

6.4.5 Medicinal floral species

Medicinal floral species are not necessarily indigenous species, with many of them regarded as alien invasive weeds. The medicinal species are all commonly occurring species and are no confined to the study area. A list of traditional medicinal plants identified during the field assessment and their main applications is provided in the Floral Impact Assessment (**EIR: Appendix C1**).

6.4.6 Threatened ecosystems

According to the National List of Threatened Terrestrial Ecosystems (2011), sections of the proposed infrastructure (e.g. road upgrades, pipelines and power lines) fall into a vulnerable ecosystem in terms of the original and remaining extent of the associated vegetation types (**Figure 44**). Vulnerable ecosystems have suffered a loss of structure, function and composition and any further degradation should be prevented or minimised where possible.

6.4.7 RDL species

Of the potential RDL species occurring in the area, the majority of the species are highly unlikely to occur due to the transformed vegetation from overgrazing, trampling and historic agricultural activities. The only species that have a moderate probability of occurring are *Pittosporum viridiflorum* and *Catha edulis.*

Podocarpus falcatus and *P. latifolius* were located alongside the road upgrade areas within the Ntabelanga Dam, on the northern section of the dam. More *Podocarpus* species were located on the secondary pipeline route south of the town Tsolo. These species are considered protected according to the notice of the list of protected tree species under the National Forests Act, 1998 (Act No. 84 of 1998). If they are affected, permits for the removal of these protected tree species need to be obtained from the relevant authorities before any construction activities occur within this area.

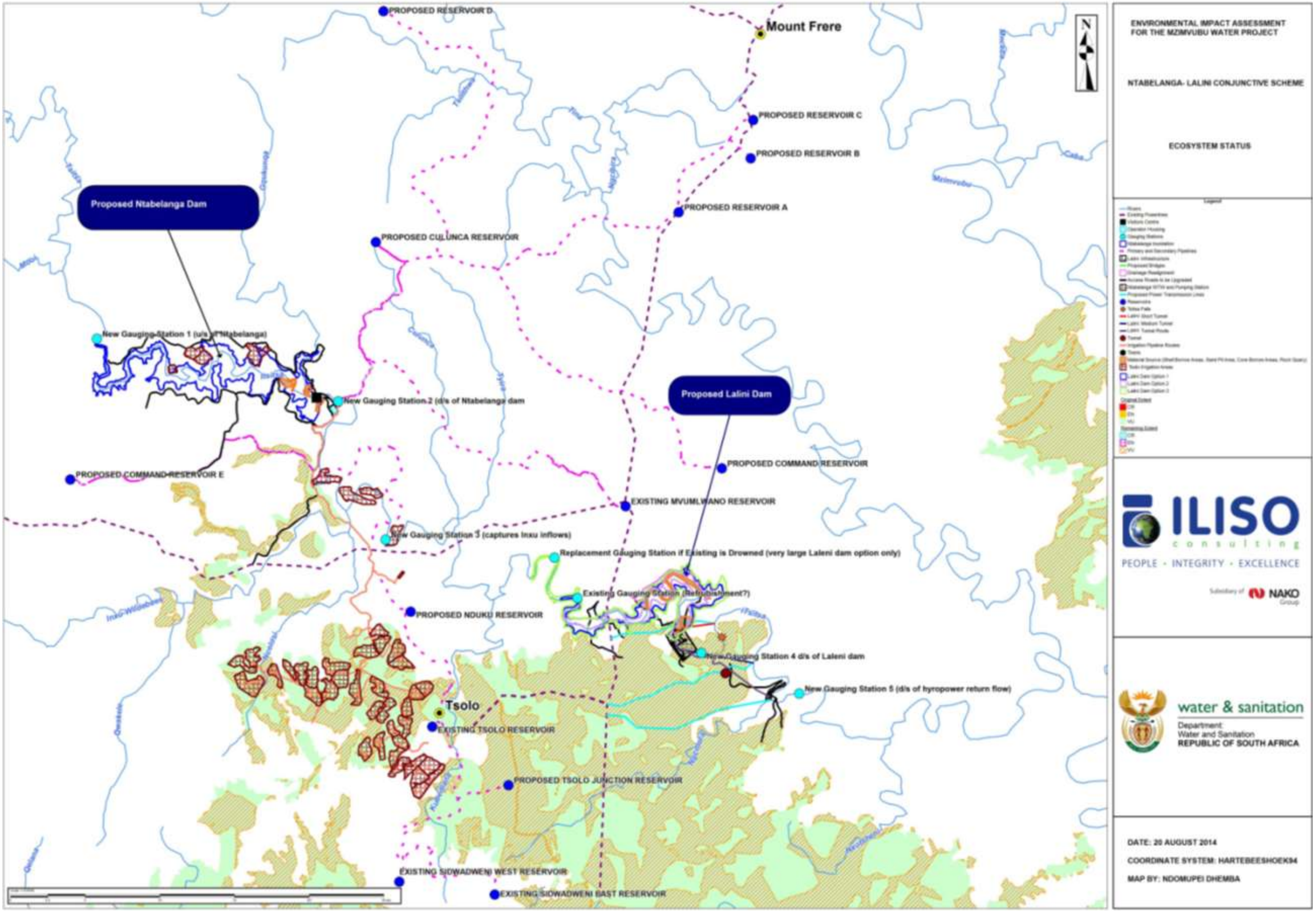


Figure 44: Threatened ecosystems

6.5 FAUNA

6.5.1 Faunal habitats

There are varying faunal habitats. These habitats vary from being anthropogenically transformed open grassland areas to largely natural rocky ridge habitats and secluded riparian areas.

6.5.2 Mammals

The mammal species observed within and surrounding the proposed Lalini and Ntabelanga Dams are considered to be mostly common species, found throughout South Africa, that are adaptable to changing and transformed habitats, as well as being known to occur around human settlements. None of the observed species are considered to be threatened on a national level or provincial level. Currently mammal species within the study area are subjected to high levels of impact from subsistence hunting as well as habitat loss and transformation.

Figure 45: *Procavia capensis* (Rock hyrax) on the left with spoor of *Atilax paludinosus* (Water mongoose) on the right (DWS, 2014b)

6.5.3 Avifauna

A large diversity of avifaunal species was observed in the study area. The majority of avifauna observed was within the mountain bushveld, rocky outcrop and riparian habitat zones.

The mountain bushveld habitat unit located near the dam wall of the Lalini Dam is a unique habitat with a varying number of woody species, providing a large diversity of avifaunal species breeding habitat.

The flowering shrubs and aloes in these habitats provide a food source for many of the smaller specialized avifaunal feeders, notably the sunbirds as well as the small insectivorous birds such as the flycatchers.

One of the avifaunal species that is of concern is that of *Balearica regulorum* (Grey-Crowned Crane) (**Figure 46**). This species was observed foraging in the grassland/ transformed habitat units alongside the river system in the vicinity of the Ntabelanga Dam. Cranes throughout South Africa are already threatened with extinction due to habitat loss, and this will further exasperate conservation efforts to protect and increase this species numbers. *B.regulorum* is listed as endangered by the IUCN, and with a rapidly decreasing population.

A second avifaunal species of concern within the study area and surrounds is *Gyps coprotheres* (Cape Vulture) (**Figure 46**). This species is listed as Vulnerable by the IUCN, and also listed as an endangered and protected species by NEMBA (Act 10 of 2004), and is endemic to South Africa.

Although none were observed during the time of assessment, NFEPA has indicated that the study area is a recognized breeding and foraging area for protected crane species, namely *Anthropoides paradisea* (Blue crane) and *Grus carunculatus* (Wattled crane). Both these species are listed as Vulnerable by the IUCN, and are listed protected species by NEMBA (Act 10 of 2004). *A. Paradisea* (Blue Crane) is of particular concern as it is indigenous to South Africa, as well as being South Africa's national bird.

Figure 46: On the left *Gyps coprotheres* (Cape Vulture) pair seen flying above the Lalini Dam study area; and on the right *Balearica regulorum* (Grey Crowned Crane) flock seen in the vicinity of Ntabelanga Dam study area (DWS, 2014b)

6.5.4 Reptiles

Reptiles are notoriously hard to detect in the field due to the shy nature, and as such an intensive search was undertaken within suitable reptile habitat, specifically in the mountain bushveld and rocky outcrop habitat units. Due to the habitat availability and study area location, a high diversity of reptiles was not expected to occur. The reptiles that were observed are commonly occurring species in the region. The rocky ridge outcrop and mountain bushveld habitat units are most suited to inhabitation by reptile species.

Figure 47: *Agama atra* (Southern Rock Agama) observed in the mountain bushveld habitat

6.5.5 Amphibians

A very low diversity of amphibians was observed at both the dams and surrounding areas. Although the dams presented a low diversity of amphibian species, the species that were observed were in fairly high numbers. The fairly isolated nature of the study area from surrounding amphibian populations in other active rivers, as well as the Titsa waterfall presenting an unsurpassable obstacle may be contributing factors to the low species diversity in the rivers. The mountains surrounding the river system and the waterfall would have limited amphibian colonisation of the river systems, resulting in only a few of the hardier and more far ranging common species being present in the river systems.

Figure 48: *Afrana angolensis* (Common river frog) observed throughout the study area.

6.5.6 Invertebrates

A wide variety of invertebrates was observed at both dam locations, and to a lesser extent along the proposed pipelines and power line routes as these predominantly followed existing roads. No NEMBA or Eastern Cape SoER (2004) listed invertebrates were observed during the site visit. As expected, the mountain bushveld, rocky outcrops and riparian zones provided the highest diversity of invertebrate species, with the transformed grassland areas providing habitat for common grasshoppers and locusts that are better suited to those habitats.

Figure 49:*Onthophagus taurus* (Dung Beetle) on the left; *Zonocerus elegans* (Elegant Grasshopper) on the right.

6.5.7 Spiders and scorpions

Only four species of spiders were observed during the site visit; however it is expected that more species do inhabit the study areas. Due to their reclusive nature when faced by a threat as well as their ability to camouflage themselves well, they are very hard to locate. None of the spider species observed are considered to be threatened or of conservation value, nor are any endangered species thought to persist within the study areas.

One scorpion was located in the mountain bushveld habitat near the dam wall of the Lalini Dam (**Figure 50**). The scorpion belongs to the Genus *Hadogenes* (Rock scorpion), of which all species in this genus are listed under NEMBA (Act10 of 2004). *Hadogenes* sp fall under the category of nationally protected species, and are an indigenous species of high conservation value or national importance that require national protection. The mountain bushveld habitat located by the Lalini Dam wall will invariably provide habitat for many of these scorpions, as well as other scorpion species. When the Lalini Dam reaches full supply level, and in the process of reaching such, the habitat availability for the scorpions will be greatly reduced. At full supply level, the scorpions would be restricted to the higher rocky areas on the mountainside. Although the higher mountainside does is of suitable habitat for the *Hadogenes* (Rock scorpion), the habitat size that remains may be a limiting factor, along with the increased rates of predation on the scorpions.

Figure 50: *Hadogenes sp* (Rock scorpion) observed near the Lalini Dam wall

6.5.8 RDL species

RDL species taken into consideration for calculation of the Red Data Sensitivity Index Score (RDSIS) are listed below:

- *Balearica regulorum* (Crowned Crane);
- *Hadogenes sp.*(Rock Scorpions);
- *Eupodotis caerulescense* (Blue Korhaan);
- *Anthropoides paradiseus* (Blue Crane);
- *Gyps africanus* (Cape Vulture);
- *Ciconia ciconia* (Black Stork);
- *Tyto capensis* (Grass Owl); and
- *Sagittarius serpentarius* (Secretarybird).

The species listed above were then used to calculate the RDSIS for the entire study area, the results of which are presented in **Table 14**.

Table 14: RDSIS score attained

Red Data Sensitivity Index Score	
Average Total Species Score	**84**
Average Threatened Taxa Score	**84**
Average (Ave TSS + Ave TT/2)	**84**
% Species greater than 60% POC	**8%**
RDSIS of Site	**46%**

Table 15: Species with a probability of occurrence of >60%

Common name	Scientific Name	Threatened Status	POC
Black Stork	*Ciconia nigra*	NT	60.67
Secretary bird	*Sagittarius serpentarius*	NT	100.00
Blue Crane	*Anthropoides paradiseus*	VU	61.67
Blue Korhaan	*Eupodotis caerulescens*	NT	65.00
Grass Owl	*Tyto capensis*	VU	64.00
Cape Vulture	*Gyps coprotheres*	VU	100.00
Rock scorpion	*Hadogenes sp*	VU	100.00
Crowned crane	*Balearica regulorum*	VU	100.00

VU = Vulnerable, NT = Near Threatened, LC = Least Concern, NYBA = Not Yet Been Assessed, EN = Endangered

The RDSIS assessment of the study areas potential RDL fauna yielded a score of 46%, indicating a medium importance with regards to RDL faunal species conservation within the region. All species with a Probability of Occurrence (POC) of 60% or more have an increased probability of either permanently or occasionally inhabiting the study area. The species that have a POC of 100% are those species that were directly observed at the time of the site visit. The species listed in **Table 15** are the only species that attained a POC of greater than 60%.

The majority of the above listed species would have a greater possibility of occurring at the Lalini Dam than the Ntabelanga Dam, as the Lalini Dam site provides more intact faunal habitats with lower levels of anthropogenic activities.

6.6 SURFACE WATER RESOURCES

The study area falls within the South Eastern Uplands Aquatic Ecoregion and the Mzimvubu to Kieskamma Water Management Area (WMA) (**Figure 51** and **Figure 52**). The subWMA indicated for the study area is Mzimvubu.

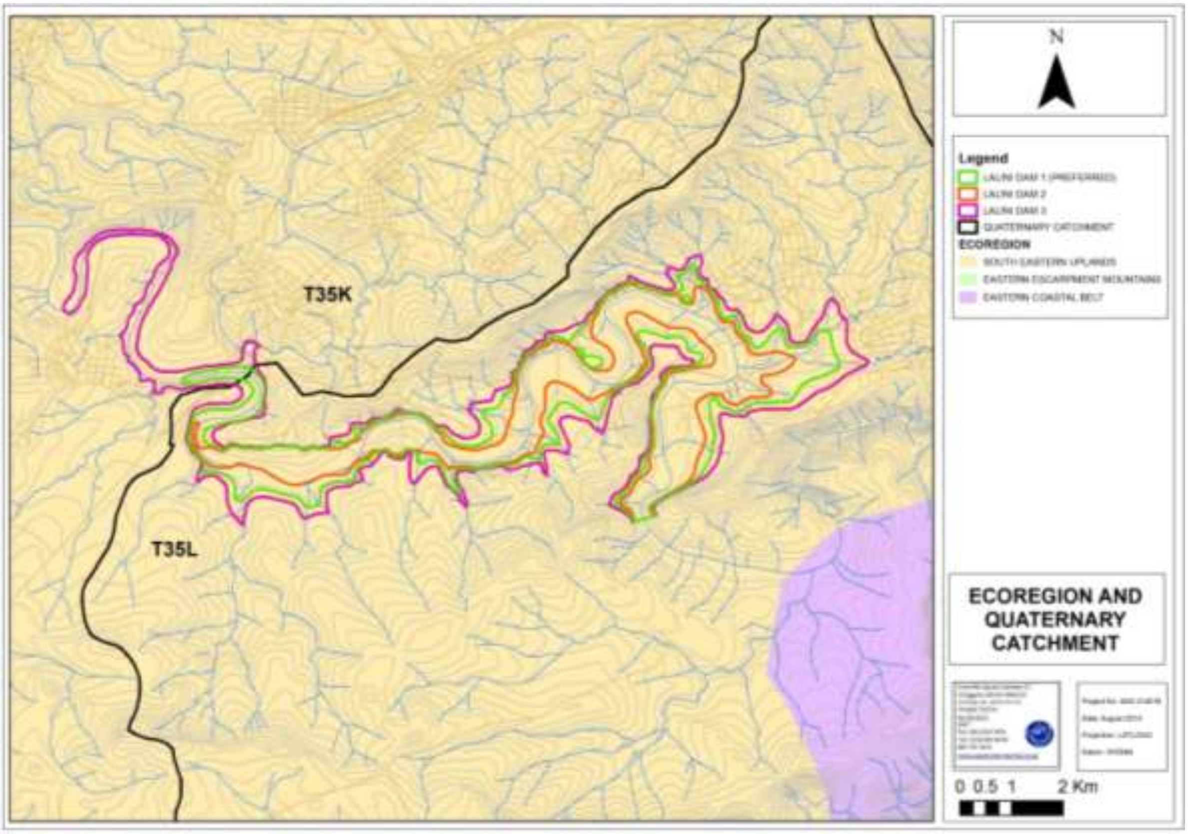


Figure 51: Aquatic Ecoregion and quaternary catchment associated with the Lalini Dam

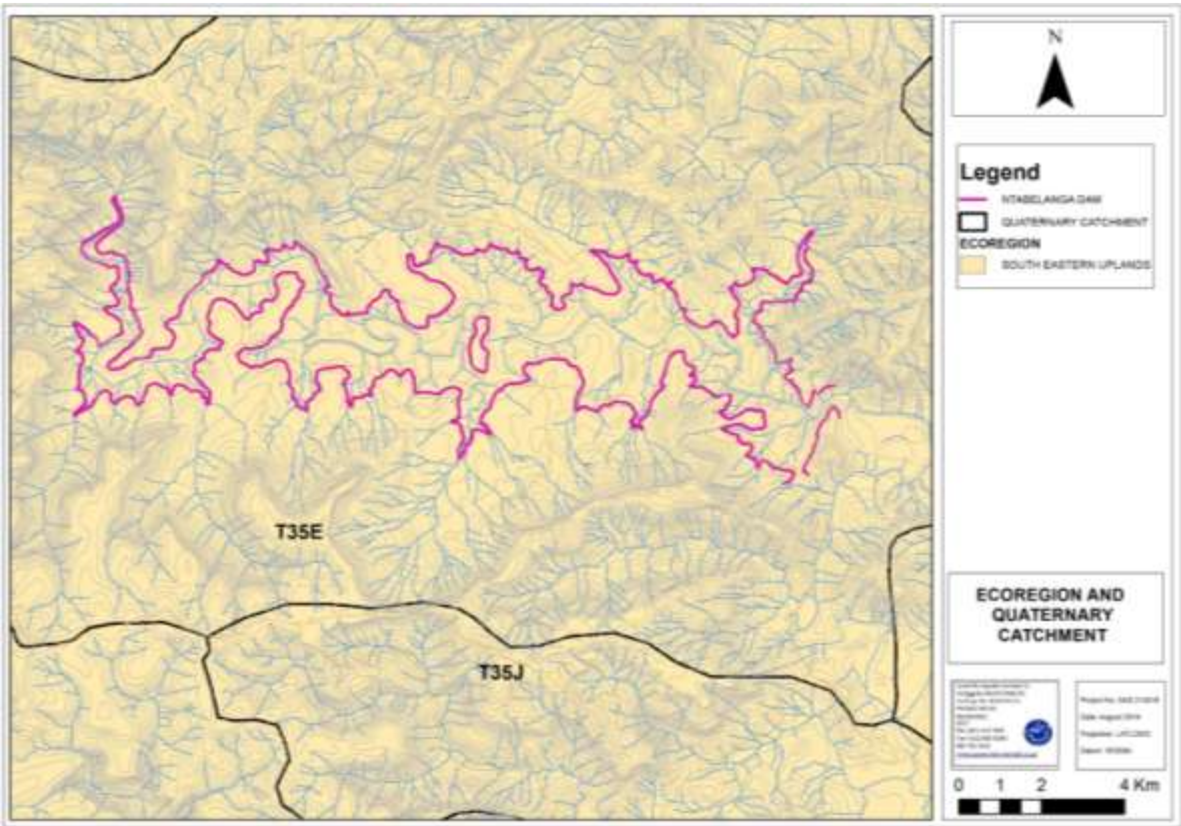


Figure 52: Ecoregion and quaternary catchment associated with the Ntabelanga Dam and the road upgrades

The Lalini Dam is located within the T35L and T35K Quaternary Catchments, whilst the Ntabelanga Dam and road upgrades are located within the T35E quaternary catchment and the particular river resource in the area is the Upper Ntata, Mzimvubu River. The pipelines traverse over several quaternary catchments, namely T20B, T34H, T34 J, T35E, T35H and T35K.

The Tsitsa River is tributary of the Mzimvubu River and will be partially inundated by both dams. It is a perennial river that is classified in Category C condition (Moderately modified).

The north-eastern areas of WMA12 catchment have the highest rainfall in the Eastern Cape Province. The mountain/highland grasslands in these areas maintain high water quality and yield, which is critical for the neighbouring rural communities and also for downstream consumption. This catchment therefore provides goods (water quantity) and services (clean water) to the downstream communities. These areas are however degraded and are characterised by severe soil erosion.

Although soil erosion is a natural process, in the Mzimvubu and Tsitsa River catchments is exacerbated by human activities and affects ecosystem health. Land degradation therefore negatively impacts the majority of downstream rivers, which are characterised by high turbidity and increased siltation. This phenomenon is dominant in the catchments that will yield water to the proposed Ntabelanga dam namely T35A (Upper Tsitsana), T35D (Pott Tsitsa), T35C (Mooi River), T35B (Pott River), and T35E.

Water quality is currently not a major concern in this catchment.

The study area falls within the South Eastern Uplands Aquatic Ecoregion and the Mzimvubu to Kieskamma Water Management Area (WMA). The subWMA indicated for the study area is Mzimvubu.

The PES Category of the various river systems in the affected quaternary catchments varies between PES B and PES C. The Tsitsa River, specifically, is classified as a PES Category B river, whilst the Inxu is considered to be in a PES Category C. All systems are considered to have a ‘moderate’ Ecological Importance (EI) whilst the Ecological Sensitivity (ES) varies between High to Medium sensitivity. The Tsitsa River is considered to be of moderate sensitivity whilst the Inxu River is deemed to be highly sensitive. The default Ecological Class (EC) of the river systems in these quaternary catchments, based on the median PES and highest of EI or ES means is considered to be either a Class B or a Class C. The Tsitsa River is deemed to be a Class C, and the Inxu is deemed to be a Class B system.

The subWMA, in which the proposed Lalini Dam will be located, is regarded as important with regards to fish corridors for movement of threatened fish between habitats and for the conservation of crane species and falls within the Sub-escarpment Savanna wetland vegetation group. The wetlands in the vicinity of the proposed Lalini Dam are classified as channelled-valley bottom wetlands in Category Z1 condition (critically modified) (**Figure 53**). This sub-WMA is classified as a FEPA system, with a rank of 2 indicating that the majority of its area is within a sub-quaternary catchment that has sightings or breeding areas for threatened *Balearica regulorum (*Grey Crowned Crane) and *Anthropoides paradiseus* (Blue Crane).

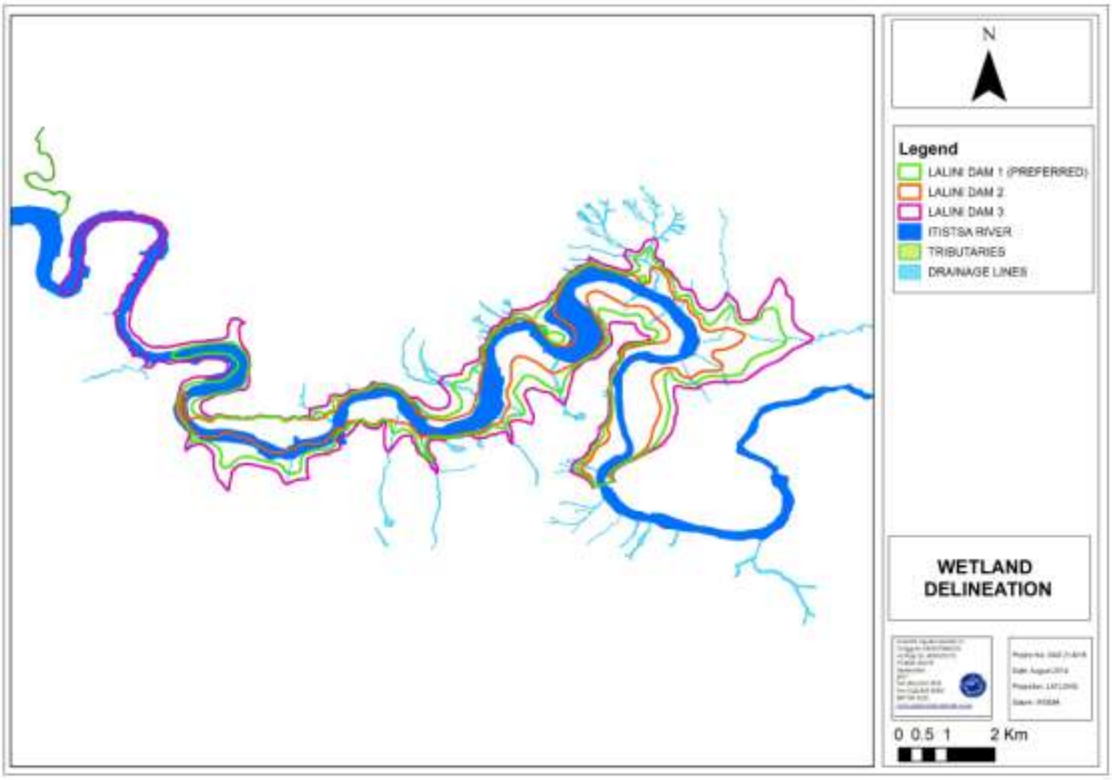


Figure 53: Wetland features identified within the study area, in relation to the proposed Lalini Dam site (DWS, 2014d)

The subWMA, in which the proposed Ntabelanga Dam will be located, is regarded as important in terms of the conservation of crane species and the wetland vegetation group is identified by the as Sub-escarpment Grassland Group 6. Wetland features identified in the Ntabelanga Dam area are indicated in **Figure 54**.

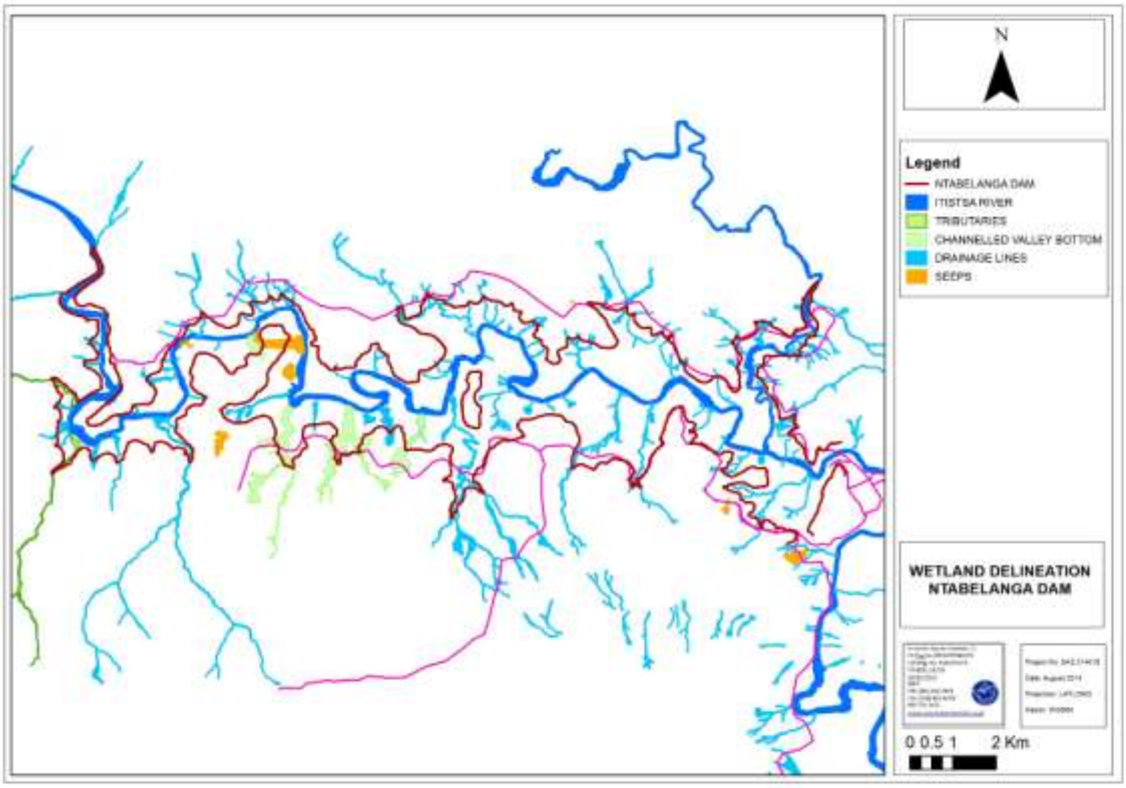


Figure 54: Wetland features identified within the study area, in relation to the proposed Ntabelanga Dam site (DWS, 2014d)

The northern pipelines cross the Thina River which is classified as being in Category C condition (moderately modified). The Thina River is regarded as an important fish sanctuary, translocation and relocation zone and is classified as being a fish support area.

6.7 GROUNDWATER RESOURCES

According to DWA (2013) a comprehensive desktop review was undertaken by Africa Geo-Environmental Services (Pty) Ltd (AGES) as a component of the BKS pre-feasibility study. Several sources of data were used to determine the potential for groundwater as a supply source. Some of the more pertinent data sources included:

- Eastern Cape GRIP Programme (hydrocensus);
- 1:500 000 DWA Geological Maps; and
- National Groundwater Database;

The 1:500 000 DWA hydrogeological maps were used to describe the groundwater potential and character of the study area based on the geological formations underlying the catchment. Areas underlain by the Tarkastad sub-group are described as predominantly argillaceous while the Katberg and Molteno formations are described as argillaceous and arenaceous in approximately equal proportions. All lithologies underlying the study area are described as having groundwater occurring intergranular and in fracture zones, with predominantly fractured aquifers to be found associated with the small section of Natal Group sedimentary rocks near the Mzimvubu River mouth. Groundwater potential assessments and aquifer types occurring within the study area are dependent on the type of dolerite intrusion associated with the specific site, as well as considering the geological formation present (AGES, 2010).

The expected median of the borehole yield class in the Natal Group sedimentary rocks could be described as 0.5 ℓ/s to 2 ℓ/s, although occasional higher yielding boreholes may be expected in ideally sited locations. Median borehole yields in Quaternary alluvium deposits in the Cedarville and Matatiele region are known to be between 2 ℓ/s and 5 ℓ/s (AGES, 2010).

AGES (2010) described the following groundwater occurrences associated with the study area:

- • Aquifers associated with doleritic intrusion;
- • Aquifers associated with fracturing unrelated to doleritic intrusion; and
- • Intergranular aquifers.

For the bulk of the study area groundwater occurs in dual porosity aquifers, comprising large, but infrequent principle transmissive fractures with relatively low storage capacity, and secondary but numerous microfissures with high storativity but lower transmissivity. The upper and lower zones are hydraulically linked and the microfissures are usually concentrated towards the surface (typically first 30 m), resulting in a higher storage capacity than the deeper lying rocks. The deeper fractures often have a high transmissivity but lower storativity when compared to the shallow zone fractures.

The study area is characterised by a range of groundwater levels varying across the area. The values vary from very close to the surface (1 to 2 m) to approximately 50 m below surface.

There was insufficient groundwater quality data to assess the potential for water supply based on expected water classes. General descriptions of the area provided on the 1:500 000 hydrogeological maps describe the groundwater as a Calcium Magnesium Bicarbonate water with sodium enrichment, which is most prevalent in the Burgersdorp formation in the study area. This can be used to conclude that there is active groundwater circulation with sodium and chloride enrichment occurring through ionic exchange in the groundwater flow paths (AGES, 2010). Groundwater conductivities (EC) are expected to generally range between 70 and 300 mS/m in the study area, while higher EC values (higher than 1 000 mS/m) have been noted in faulted Dwyka and Natal Group sandstone and also possibly alluvium associated with the Mzimvubu River near the river mouth at Port St Johns (AGES, 2010).

The findings from the review highlighted that there was a low to moderate supply potential distributed across the Mzimvubu Catchment that could possibly meet the individual demands of selected towns or irrigation schemes. However, this type of supply scheme would involve multiple abstraction sites spread across vast geographical areas. In consultation with thestakeholders during the project steering committee meetings, the water services authorities in the area stipulated that they would prefer one single surface water source rather than multiple groundwater sources.

The main concerns regarding multiple groundwater sources were:

- Maintaining a scheme with multiple abstraction sites spread across a vast spatial area has practical limitations regarding manpower and logistics when considering the operations and maintenance of the infrastructure.
- Operations and maintenance costs associated with a widespread, multi-abstraction scheme.
- The reliability of groundwater is not always as good as a large-scale surface water supply option, i.e. during the dry years, groundwater schemes can often experience shortages and, thus, restrictions could be imposed before they would be necessary in a large single-source scheme.
- Management of groundwater resources is critical in order to ensure the sustainability of the resource. This cannot always be monitored comprehensively in a widely dispersed supply scheme as would be required in this case, thus, the resource is open to misuse which could have negative impacts for water supply and for the aquifer.

Based on the above and discussions with DWA, it was decided that groundwater would not feature as a water supply option in this study and, hence, it was discarded from any further aspects of the project.

6.8 CONSERVATION IMPORTANCE

The Eastern Cape Biodiversity Conservation Plan (ECBCP) (2007) is a broad scale-biodiversity plan based on identifying Critical Biodiversity Areas (CBAs) and associated land use guidelines. It recommends limits to the total amount of land transformation that should be allowed if biodiversity is to be conserved. The approach rests on the concept of Biodiversity Land Management Classes (BLMCs). Each BLMC sets out the desired ecological state that an area should be kept in to ensure biodiversity persistence. Only land use types that are compatible with maintaining this desired state should be allowed.

Large areas within the project area have been identified as Critical Biodiversity Areas (CBAs) in terms of the ECBCP (**Figure 55** and **Figure 56**). These areas are of conservation importance due to the presence of Red Data species, endemic species and potential habitat for these species to occur.

The bulk of the project area falls within a Terrestrial CBA 2 (BLMC 2 - *Near Natural landscape)* while sections of the pipelines traverse terrestrial and aquatic CBAs 1 (BLMC 1- *Natural Landscape*).

According to the ECBCP's land use guidelines, while the conversion of virgin land to irrigated agriculture is not permissible in areas identified as CBAs 2, irrigated agriculture on existing and fallow cultivated land is allowed, on condition that an Environmental Authorisation is granted. Most of the areas earmarked for irrigated agriculture are cultivated, although many fields have not been planted in the recent past (DWA, 2013a).

There are no formal or informal protected areas within the project area. However, the National Protected Areas Expansion Strategy (NPAES) identified two Focus Areas in the north and east of the project area: Pondoland and Southern Berg Griqualand. A gauging station, and possibly a section of the Lalini Dam tunnel and the power line fall within the Pondoland Focus Area, while a section of the secondary distribution lines in the north of the study area falls within the Southern Berg Griqualand Focus Area (**Figure 57**).

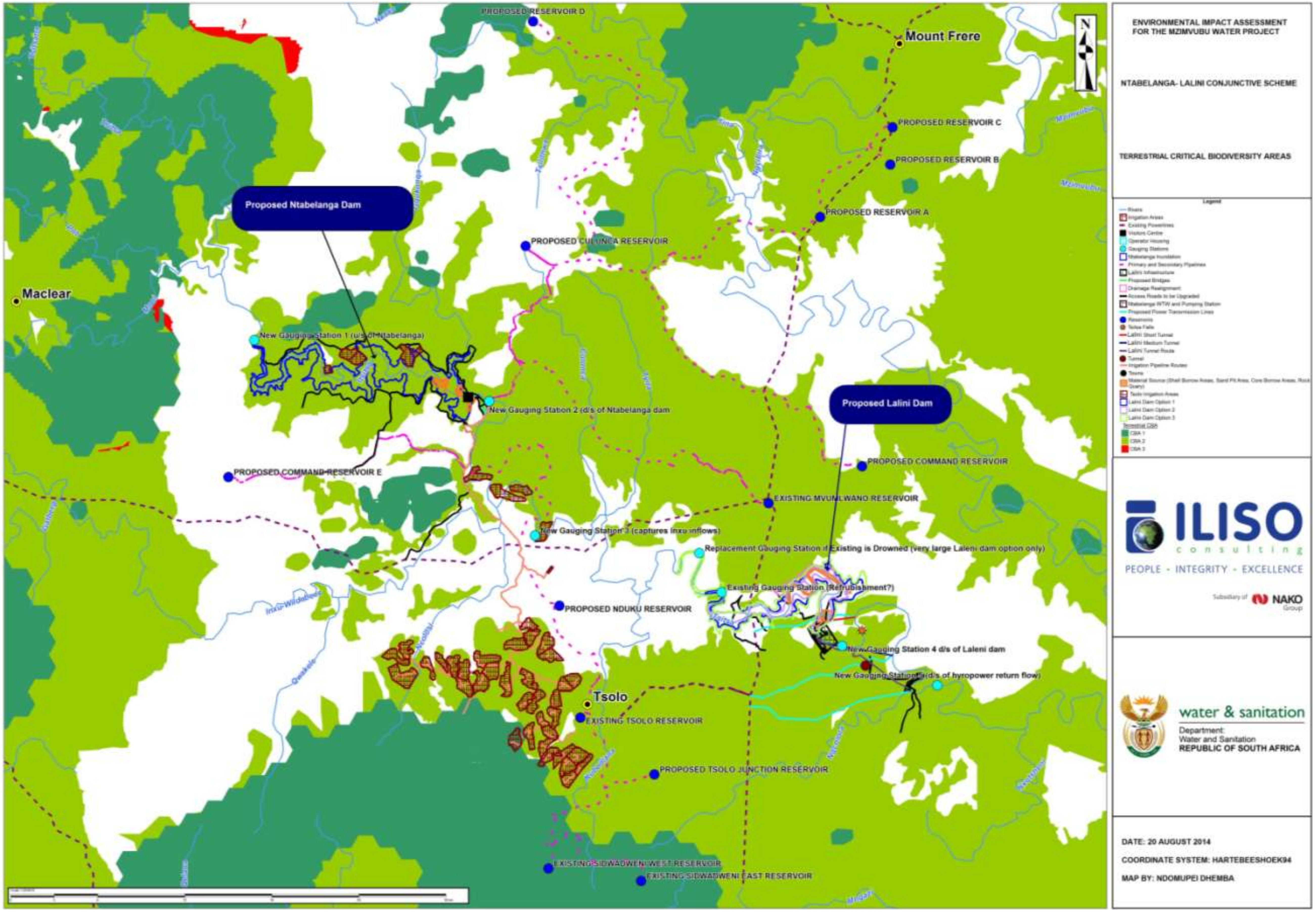


Figure 55: Terrestrial Critical Biodiversity Areas (CBAs)

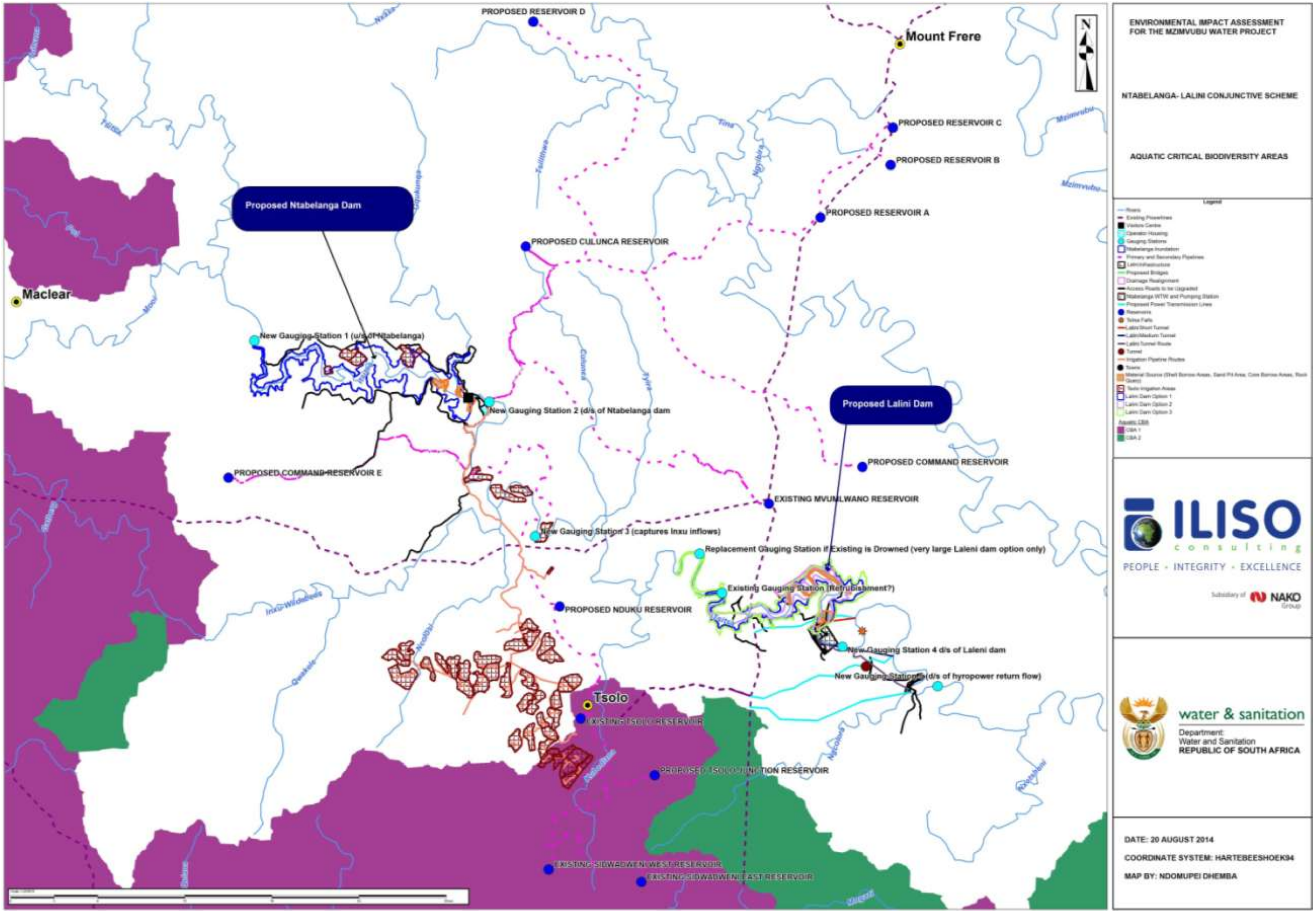


Figure 56: Aquatic Critical Biodiversity Areas (CBAs)

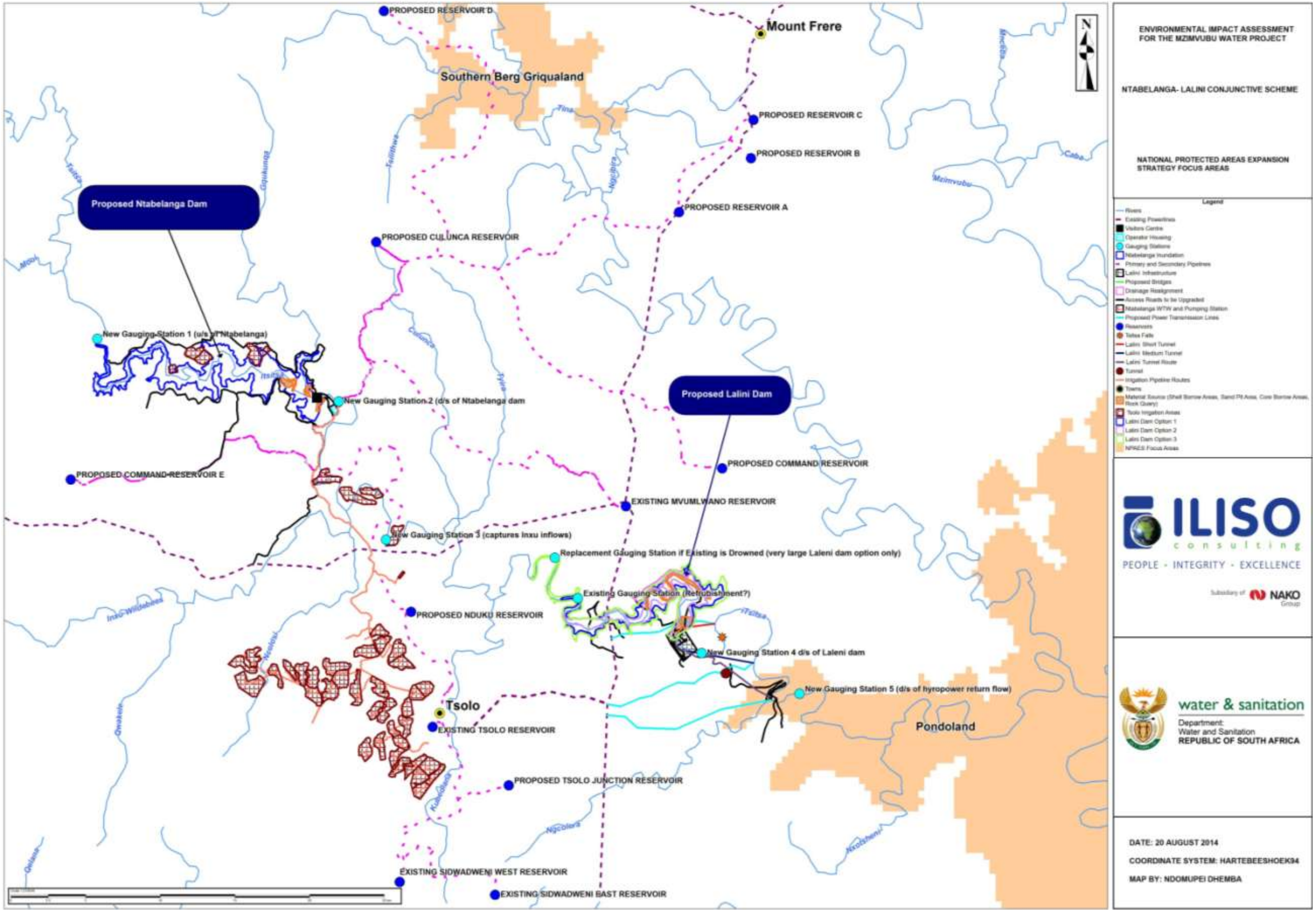
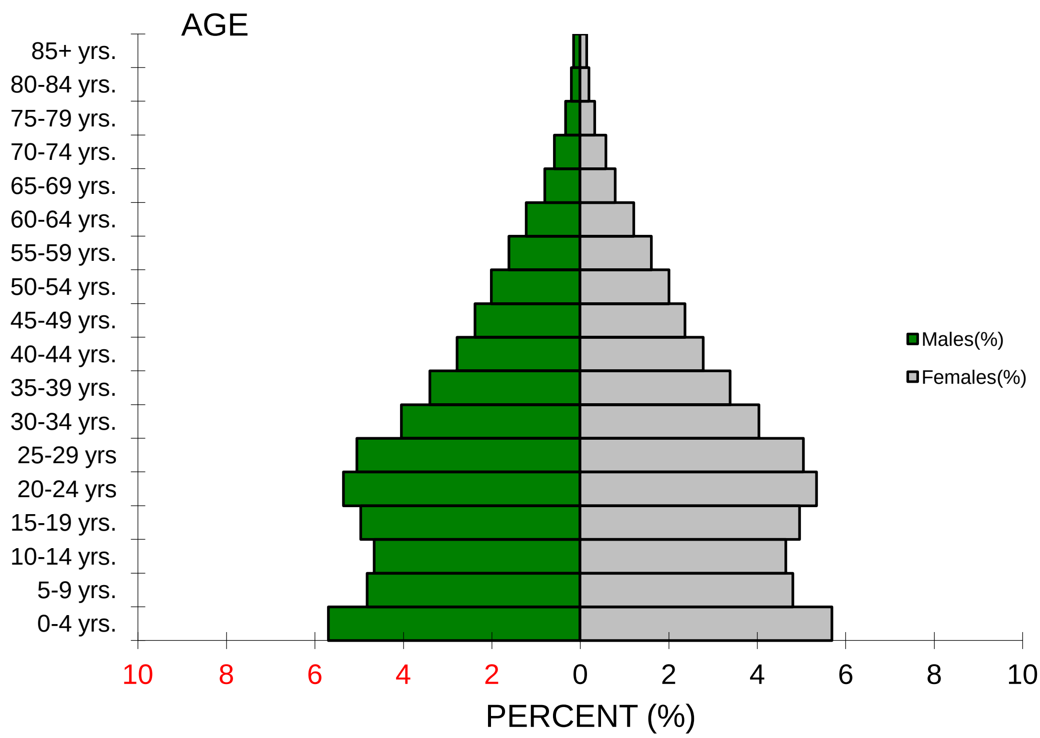


Figure 57: National Protected Areas Expansion Strategy Focus Areas

6.9 SOCIO-ECONOMICS OF THE EASTERN CAPE PROVINCE

6.9.1 Demography

The Eastern Cape Province covers an area of 168 966 km^2 making it the second largest province by geographical area, covering 13.8 % of South Africa's total land mass. This is only surpassed by the Northern Cape which covers an area of 372 889 km^2 accounting for 30.5 % of the total land area of the country. The total population of the province stood at 6 562 053 people in 2011 (Statistics South Africa, 2012) and was estimated at 6 620 100 people in June, 2013 (Statistics South Africa, 2013, p. 3). Consequently, the province is ranked third in respect of population size and has a population density of 39/km^2. This makes it the sixth densely populated province in South Africa. In respect of age structure, 33.0 % of the population is under 15 years of age, while 60.2 % is between 15 and 64 years with 6.7 % being over the age of 65 years. The population pyramid of the province is illustrated in **Figure 58.**



Data source: (Statistics South Africa, 2012)

Figure 58: Population pyramid Eastern Cape Province

In the Eastern Cape Province, 86.3% of the population are black African, 8.3 % are coloured, 4.7% are white and 0.4% are Indian or Asian people. IsiXhosa is spoken by 78.8 % of the population, followed by Afrikaans (10.6 %), English (5.6 %), and Sesotho (2.5 %).

The 2011 Census indicated that there were 1,687,385 households in the province with an average household size of 3.9. Of these households, 49.6 % were female headed, 63.2 % lived in formal dwellings and 59.6 % either owned or were paying off their dwelling.

The 2011 Census also indicated that 40.4 % of households in the province had flush toilets connected to the sewerage system, while 41 % had their refuse removed on a weekly basis. Piped water was delivered to 32.8 % of households and 75 % of Eastern Cape households used electricity as a means of energy for lighting.

The sex ratio across the study area indicates a higher number of females compared to males.

6.9.2 Unemployment

In the 4th quarter of 2013 the official unemployment rate in the province was 27.8 %, the second highest rate of unemployment in the country (after the Free State). It increased to 30.4 % in the 2nd quarter of 2014.

The expanded unemployment rate (which includes disillusioned work seekers) in the 4th quarter of 2013 was however 43.3 %, and increased to 44.4 % in the 2nd quarter of 2014, thus giving the province the highest expanded rate of unemployment in the country. The LMs in the study area have unemployment rates of between 40 and 50 % (*The Local Government Handbook*, 2014).

6.9.3 Poverty

Although there have been some improvements across the province, the study area remains one of the poorest parts of the country, characterised by high poverty and out-migration resulting in sex ratio imbalances, a high proportion of female headed households and a low or even negative population growth rate. At large the population lacks basic amenities and relies heavily on subsistence farming which is not highly successful.

The proportion of households owning household goods across the area is lower than that of the province.

The study area is characterised by a high dependency ratio which indicates the burden of supporting children under 15 years and people over 65 years placed on the working population aged 15–64 years.

6.9.4 Health

In addition to HIV AIDS, a further issue concerning health in the province relates to cancer. It is indicated that "[t]*he rate of the cancer in the Eastern Cape is six times the national average*" (Stassen, 2011) and new research is linking this with the processing of home-grown maize and the silica from the grid stones that may cause throat irritations (Sewram, 2011).

6.9.5 Education

The situation regarding schooling in the area improved somewhat between 2001 and 2011. Notwithstanding this, all the district and local municipalities within the study area (with the exception of uMzimvubu LM) are above the provincial level (10.5 %) in terms of the percentage of the population with no education.

6.10 MUNICIPAL DESCRIPTION

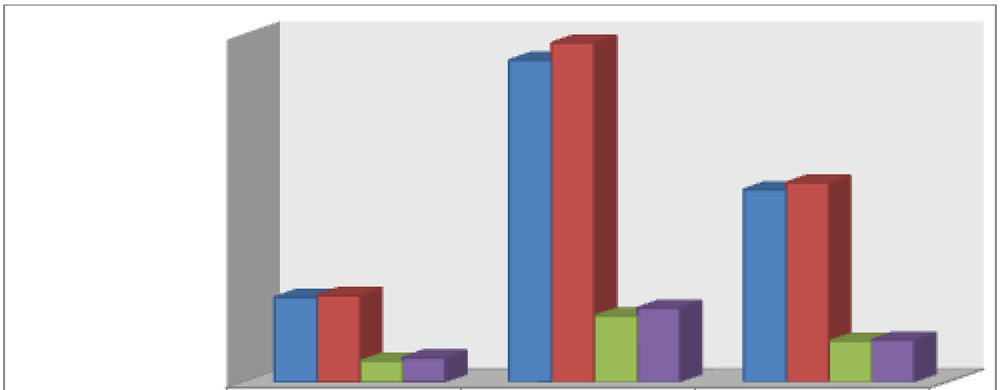
The project impacts the three district municipalities of Joe Gqabi, O. R. Tambo and Alfred Nzo. Of these districts Joe Gqabi covers the greatest land area and has the lowest population density across the region at 14 people/km^2 while O. R. Tambo has the largest population and the highest population density at 110 people/km^2. With regard to population group, black African people are the dominant group across all districts at over 90 %. Xhosa is the dominant language spoken in the area ranging between 70.5 and 94.2 percent. This data is represented below in **Table 16**.

Table 16: Demographic data district level

	Joe Gqabi DC14	O. R. Tambo DC15	Alfred Nzo DC 44
Geographical area	25,663 km^2	12,096 km^2	10,731 km^2
Population	349,768	1,364,943	801,344
Density	14/km^2	110/km^2	75/km^2
	Population group		
Black African	93.8%	99.0%	99.1%
Coloured	3.5%	0.5%	0.4%
Indian/Asian	0.2%	0.2%	0.1%
White	2.4%	0.2%	0.2%
	Language		
Xhosa	70.5%	94.2%	84.6%
Sotho	20.2%	0.27%	8.8%
English	1.4%	2.7%	2.3%
Afrikaans	5.9%	0.17%	0.84%
Zulu	0.25%	0.49%	1.2%
Other	1.8%	3.1%	3.1%

Data source: (Statistics South Africa, 2012)

The difference between the populations and households of the districts as they occurred in 2001 and 2011 are compared **Figure 59.**



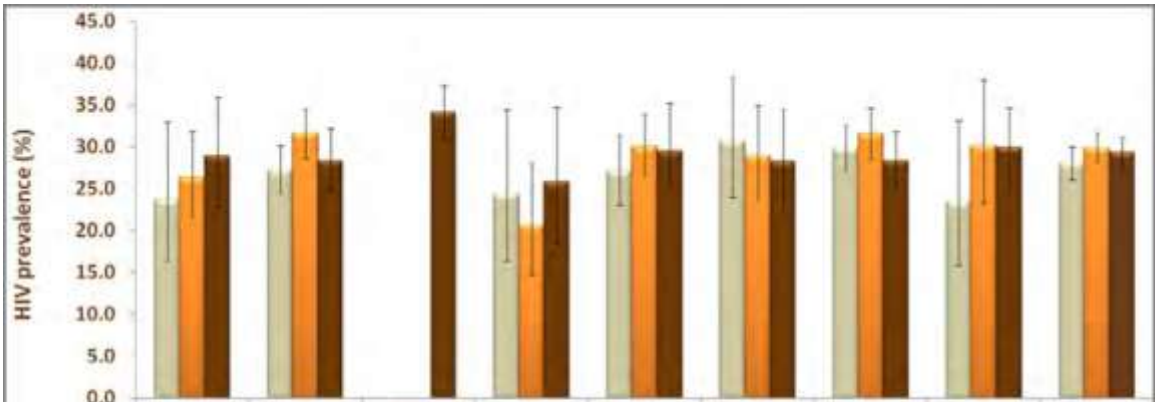
	DC14	DC15	DC44
Population 2001	341 750	1 295 145	773 708
Population 2011	349 768	1 364 943	801 344
Households 2001	84 835	266 709	164 667
Households 2011	97 775	298 229	169 261

Data source: (Statistics South Africa, 2012)

Figure 59: Population and households 2001 and 2011 across districts

6.10.1 Health

Concerning the HIV prevalence rate amongst antenatal women in 2011 as assessed across the affected districts, Joe Gqabi had the highest prevalence rate at 29.3 %. This is followed by the Alfred Nzo District Municipality at 28.9 % and O. R. Tambo at 28.4 %. Across both metropolitan and district municipalities in the Eastern Cape Province, Buffalo City had the highest prevalence rate at 34.1 % while Cacadu had the lowest at 25.8 %. This is illustrated in **Figure 60**.



	Alfred Nzo	Amatole	Buffalo City	Cacadu	Chris Hani	NMM	O.R. Tambo	Joe Gqabi	EC Province
2009	23.7	27.2		24.3	27.1	30.7	29.8	23.5	28.1
2010	26.3	31.6		20.7	30.1	29.0	31.5	30.2	29.9
2011	28.9	28.4	34.1	25.8	29.5	28.3	28.4	29.9	29.3

Source: (National Department of Health, 2012, p. 23)

Figure 60: HIV prevalence trends: Antenatal women by district 2009 – 2011

6.10.2 Local Municipalities

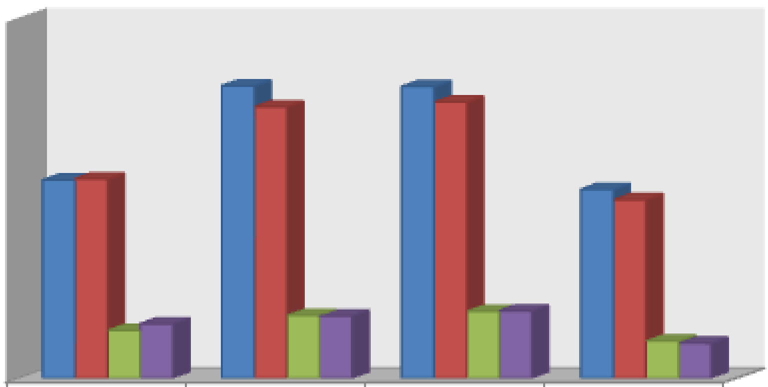
At the local municipal level the project impacts the following 4 local municipalities, Elundini, Mhlontlo, Umzimzubu and Ntabankulu. Of these municipalities Elundini covers the greatest geographical area at 5,065 km^2 and Ntabankulu the smallest area at 1,385 km^2. With a population of 123,976 people Ntabankulu the highest population density at 90 people/km^2. Umzimvubu has the highest population with 191,620 people living within the municipal area. At over 98 % Black African people are the biggest population group across all municipalities and Xhosa is the dominant language spoken. This data is represented in **Table 17**.

Table 17: Demographic data local municipalities

	Elundini EC141	Mhlontlo EC156	Umzimvubu EC442	Ntabankulu EC444
Geographical area	5,065 km^2	2,826 km^2	2,577 km^2	1,385 km^2
Population	138,141	188,226	191,620	123,976
Density	27/km^2	67/km^2	74/km^2	90/km^2
	Population group			
Black African	98.1%	99.4%	99.4%	99.4%
Coloured	1.0%	0.2%	0.3%	0.4%
Indian/Asian	0.1%	0.1%	0.1%	0.1%
White	0.7%	0.2%	0.1%	0.1%
	Language			
Xhosa	70.1%	94.9%	93.1%	95.2%
Sotho	24.8%			
English	1.6%	2.3%	2.6%	1.4%
Afrikaans	1.7%			
Zulu				
Other	1.8%	2.8%	4.3%	3.4%

Data source: (Statistics South Africa, 2012)

The difference between the populations and households of the local municipalities as they occurred in 2001 and 2011 are compared in **Figure 61**.



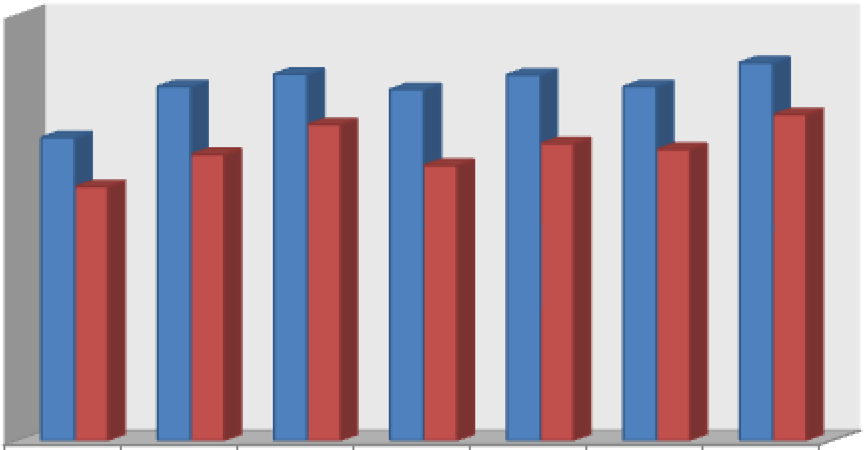
	EC141	EC156	EC442	EC444
Population 2001	137 394	202 933	202 369	130 980
Population 2011	138 141	188 226	191 620	123 976
Households 2001	33 209	43 573	46 460	25 812
Households 2011	37 854	43 414	46 891	24 397

Data source: (Statistics South Africa, 2012)

Figure 61: Population and households 2001 and 2011 across municipalities

6.10.3 Dependency Ratio

The study area is characterised by a high dependency ratio which indicates the burden of supporting children under 15 years and people over 65 years placed on the working population aged 15–64 years. Although there has been some improvement across all areas between 2001 and 2011 the burden still remains heavy with it being greatest in Ntabankulu at 91.7 and lowest being across the Joe Gqabi District Municipality at 71.4. This data is illustrated in **Figure 62**.



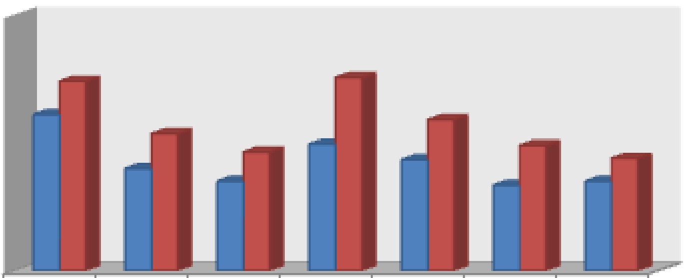
	DC14	DC15	DC44	EC141	EC156	EC442	EC444
2001	85.2	99.6	103.1	98.8	102.9	99.6	106.3
2011	71.4	80.5	88.9	77.4	83.5	81.9	91.7

Data source: (Statistics South Africa, 2012)

Figure 62: Dependence ratio district and local municipalities

6.10.4 Gender

The sex ratio across all areas indicates a higher number of females compared to males with Ntabankulu having the highest proportion of females to males and Elundini the lowest at 90.10 % as illustrated in **Figure 63**.



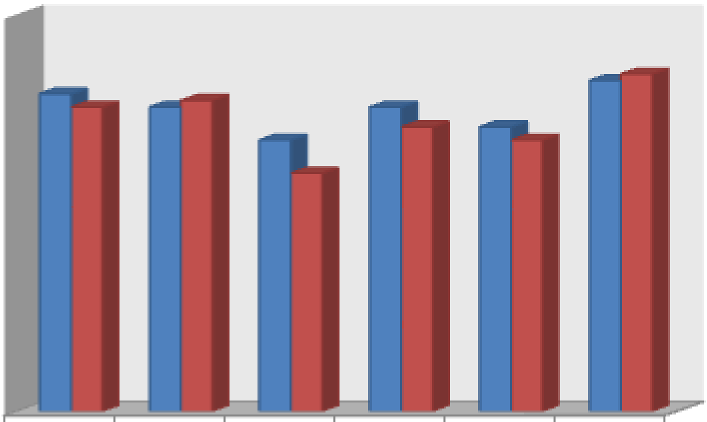
	DC14	DC15	DC44	EC14 1	EC15 6	EC44 2	EC44 4
2001	87.20%	83.00%	82.00%	84.90%	83.70%	81.70%	82.00%
2011	89.80%	85.70%	84.30%	90.10%	86.80%	84.80%	83.80%

Data source: (Statistics South Africa, 2012)

Figure 63: Sex ratio district and local municipalities

6.10.5 Household size

The average size of households in the area range between 3.6 in Elundini and 5.1 in Ntabankulu and is illustrated in **Figure 64**.



	DC15	DC44	EC141	EC156	EC442	EC444
Average household size 2001	4.8	4.6	4.1	4.6	4.3	5.0
Average household size 2011	4.6	4.7	3.6	4.3	4.1	5.1

Data source: (Statistics South Africa, 2012)

Figure 64: Average household size

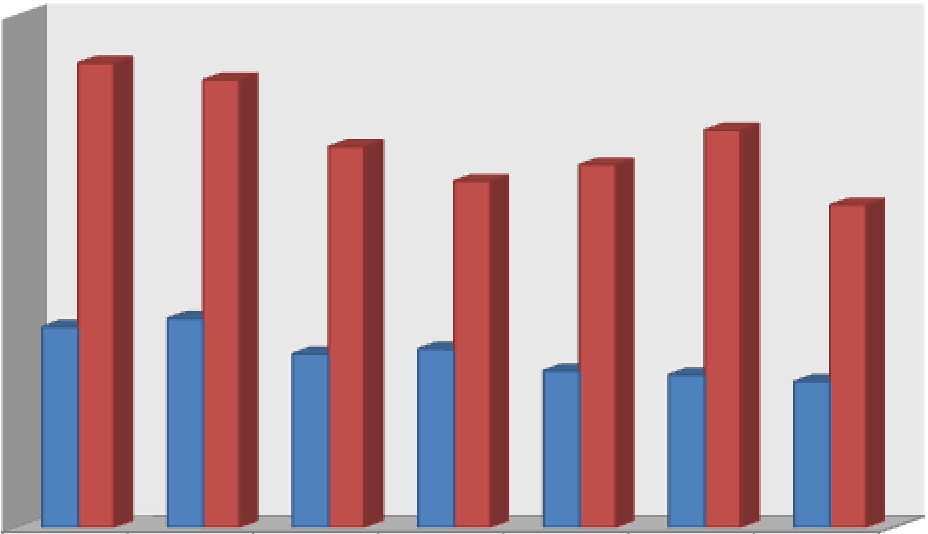
6.10.6 Household dynamics

Apart from the Joe Gqabi district, where 49.3 % of the households are female headed, all other areas have a higher percentage of female than male headed households with the greatest percentage of female headed households at 60.4 % being found in Ntabankulu.

When compared on a provincial level with the Eastern Cape Province at 1.0 %, the study area has a relatively high percentage of child headed households. In the O.R. Tambo and Alfred Nzo districts 1.9 % of households are headed by children under 18 years of age while in the Joe Gqabi district the figure is 1.2 %. The percentage of child headed households is marginally lower across the local municipalities, ranging between 1.4 and 1.8 percent,

Regarding household income, with an average household income of R 37 147 per annum Alfred Nzo has the lowest average household income in respect of all district municipalities. Amongst the local municipalities Ntabankulu has an average household income of R 31 446 making it the municipality with the lowest average income overall. The highest average income, at R 45 295, is found in the Joe Gqabi district as illustrated in **Figure 65**.

Most formal dwellings are found in the Joe Gqabi district with the lowest percentage of formal dwellings at 24.3 % being found in Ntabankulu. At 64.4 % the local municipality of Ntabankulu has the highest percentage of housing being owned or being paid off with the lowest percentage, 53.9 %, being found in Mhlontlo.



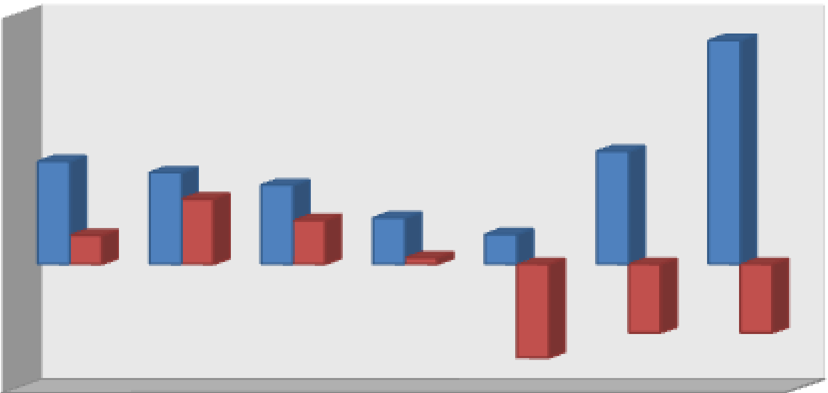
	DC14	DC15	DC44	EC141	EC156	EC442	EC444
2001	R 19 565.	R 20 375.	R 16 931.	R 17 388.	R 15 275.	R 14 890.	R 14 232.
2011	R 45 295.	R 43 652.	R 37 147.	R 33 775.	R 35 367.	R 38 762.	R 31 446.

Data source: (Statistics South Africa, 2012)

Figure 65: Average household income

6.10.7 Population Growth

Between 2001 and 2011 Mhlontlo, Umzimzubu and Ntabankulu all showed a negative population growth with the O. R. Tambo district having the highest population growth at 0.52 %. This is illustrated in below in **Figure 66**.



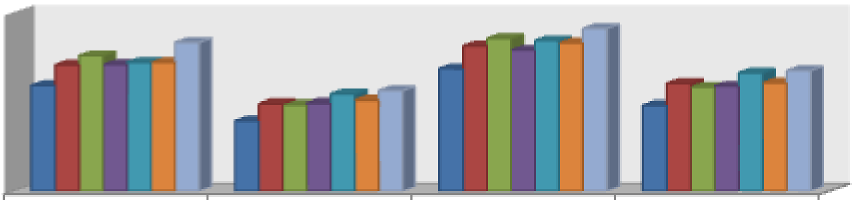
	DC14	DC15	DC44	EC141	EC156	EC442	EC444
1996-2001	0.82%	0.73%	0.63%	0.37%	0.24%	0.90%	1.79%
2001-2011	0.23%	0.52%	0.35%	0.05%	-0.75%	-0.55%	-0.55%

Data source: (Statistics South Africa, 2012)

Figure 66: Population growth % p.a.

6.10.8 Employment

In respect of the labour market, at 50.6 % the highest level of official unemployment is found in Ntabankulu with the lowest level being found in the Joe Gqabi district at 35.4 %. Amongst the youth between 15 and 34 years of age Ntabankulu also has the highest rate of unemployment at 60.7 % with Joe Gqabi again having the lowest at 43.3 % as illustrate below in **Figure 67**.



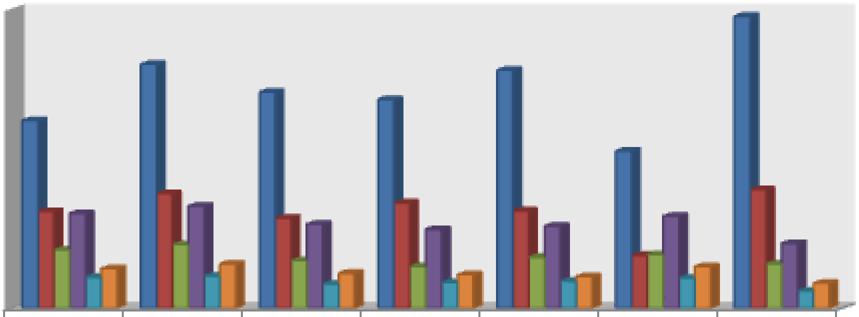
	Unemployment Rate (official) 2001	Unemployment Rate (official) 2011	Youth Unemployment Rate (official) 15-34 years 2001	Youth Unemployment Rate (official) 15-34 years 2011
DC14 Joe Gqabi	53.2%	35.4%	61.6%	43.3%
DC15 O.R. Tambo	63.6%	44.1%	73.2%	54.2%
DC44 Alfred Nzo	68.2%	43.5%	77.0%	52.3%
EC141 Elundini	63.7%	44.4%	71.0%	52.8%
EC156 Mhlontlo	64.8%	48.9%	75.8%	59.5%
EC442 Umzimvubu	64.8%	45.9%	74.7%	54.5%
EC444 Ntabankulu	74.9%	50.6%	82.0%	60.7%

Data source: (Statistics South Africa, 2012)

Figure 67: Official unemployment and youth unemployment rate

6.10.9 Education

The situation regarding schooling in the area improved somewhat between 2001 and 2011. Notwithstanding this, however, there is still a need to improve the situation further with areas such as Ntabankulu and the O. R. Tambo district still having over 17 % of the population over 20 years of age having no schooling. At a provincial level 10.5 % of the population aged over 20 years have no schooling, 19.8 % have a matric and 8.7 % have a higher education. This places all the district and local municipalities below the provincial level of education with only Umzimvubu, at 8 %, having a lower percentage of the population with no education. Education across the area is illustrated in **Figure 68**.



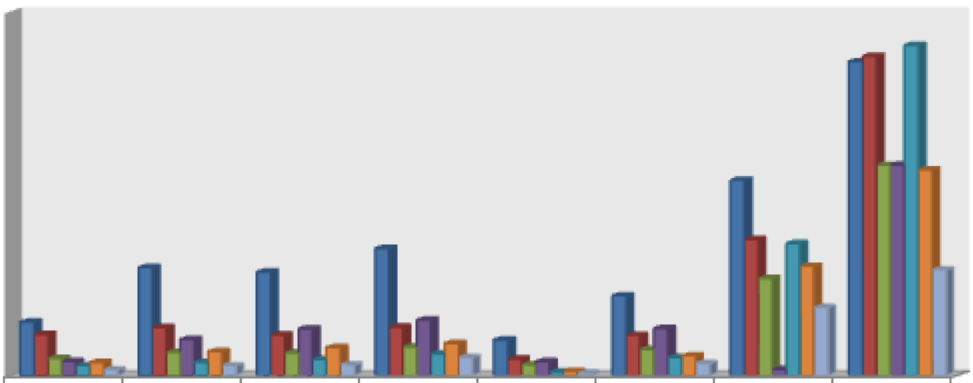
	DC14	DC15	DC44	EC141	EC156	EC442	EC444
No Schooling 2001	28.2%	36.7%	32.5%	31.4%	35.8%	23.6%	43.9%
No Schooling 2011	14.6%	17.3%	13.6%	15.9%	14.7%	8.0%	17.9%
Matric 2001	8.8%	9.6%	7.2%	6.3%	7.7%	8.1%	6.7%
Matric 2011	14.3%	15.4%	12.7%	11.9%	12.4%	13.9%	9.8%
Higher Education 2001	4.7%	4.9%	3.7%	3.9%	4.1%	4.6%	2.6%
Higher Education 2011	6.0%	6.7%	5.3%	5.1%	4.8%	6.3%	3.8%

Data source: (Statistics South Africa, 2012)

Figure 68: Education over 20 years of age

6.10.10 Services

In respect of household services, apart from electricity as a source of lighting, where it is surpassed by both the Mhlontlo local and O. R. Tambo district municipalities, on a general basis the Joe Gqabi District Municipality has the highest level of service delivery. Ntabankulu has the lowest level of service delivery across all indicators. The indicators of household services are illustrated in **Figure 69.**



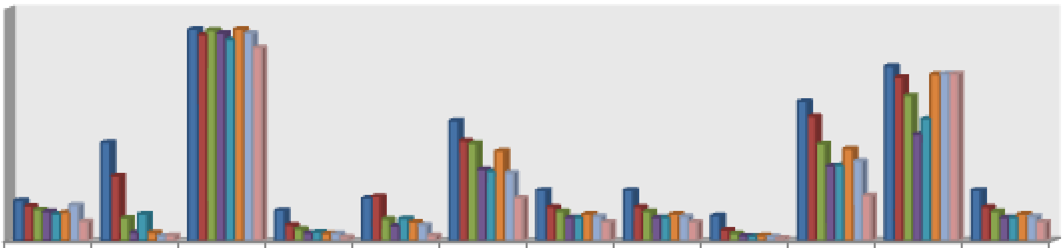
	Flush toilet to sewerage		Weekly refuse removal		Piped water inside dwelling		Electricity for lighting	
	2001	2011	2001	2011	2001	2011	2001	2011
DC14	11.8%	23.8%	22.8%	28.0%	7.9%	17.6%	42.9%	69.0%
DC15	9.1%	10.6%	9.0%	10.7%	3.7%	8.9%	30.0%	70.2%
DC44	3.8%	5.1%	5.0%	6.3%	2.4%	5.8%	21.4%	46.2%
EC141	3.1%	8.0%	10.3%	12.3%	3.1%	10.4%	1.4%	46.3%
EC156	2.2%	2.9%	3.6%	4.8%	0.8%	4.0%	29.1%	72.6%
EC442	2.9%	5.3%	6.2%	7.1%	1.0%	4.4%	24.1%	45.2%
EC444	1.3%	2.2%	2.4%	4.0%	0.6%	2.7%	15.0%	23.3%

Data source: (Statistics South Africa, 2012)

Figure 69: Household services

6.10.11 Household Goods

The proportion of households owning household goods across the area is lower than that of the province. On a general basis, households in the Joe Gqabi municipality own a greater proportion of household goods than those across the other municipalities with households in Ntabankulu owning the lowest proportion of household goods. The distribution of household goods across the study area is illustrated in **Figure 70**.



	Mail PO box	Mail residence	Cellphone	Computer	Satellite tv	DVD	Car	Radio	Landline	Fridge	Stove	Television
EC	16%	38%	82%	12%	17%	46%	20%	20%	10%	54%	67%	20%
DC14	14%	25%	80%	6%	17%	39%	13%	13%	4%	48%	63%	13%
DC15	12%	9%	81%	5%	8%	38%	11%	11%	3%	38%	56%	11%
DC44	11%	3%	80%	3%	6%	28%	9%	9%	2%	29%	41%	9%
EC141	10%	10%	78%	3%	9%	27%	9%	9%	2%	29%	47%	9%
EC156	11%	3%	82%	3%	7%	35%	10%	10%	2%	36%	64%	10%
EC442	14%	2%	80%	3%	6%	26%	10%	10%	2%	31%	65%	10%
EC444	8%	2%	75%	2%	2%	17%	7%	7%	1%	18%	65%	7%

Data source: (Statistics South Africa, 2012)

Figure 70: Distribution of household goods

Although there have been some improvements across the region the area remains one of the poorest parts of the country, characterised by high poverty and out-migration resulting in sex ratio imbalances, a high proportion of female headed households and a low population growth rate. At large the population lacks basic amenities and relies heavily on subsistence farming which is not highly successful.

6.11 LAND USE AND TENURE

The study area is rural, characterised by low densities and generally low levels of economic activity. The main land uses are pastoral stock and subsistence crop farming (**Figure 71**). Land cover in the broader study area is shown in (**Figure 72**).

Figure 71: Typical midrange housing structures and crop planting activities

The proposed project is located on state-owned land which is administered by traditional authorities. The land is therefore currently subject to communal land tenure arrangements. Under this system the State owns the land, but it is managed and allocated to community members by the Traditional Leaders.

Agricultural practices

About 37.7 % of households in the Eastern Cape engaged in agricultural activities over the period June 2011- June 2012. Of these households 24.8 % were involved with poultry production, 20.5 % with livestock production, 19 % with grains and food crops, 19.9 % with fruit and vegetables and only 0.2 % with industrial crops (Statistics South Africa, 2012, pp. 2-3). Of the households in the province involved with different crop planting activities, 23.8% were in backyard gardens, 0.2 % in communal gardens and 0.1 % in school gardens. The percentage of households classified as food access adequate was 72 % while 19.4 % were food access inadequate and 8.8 % food access severely inadequate. Although in this respect there are no statistics specific to the study area, it is unlikely that the situation in the study area will be significantly different.

An aerial inspection of the immediate area shows that much less crop production is currently practised than in the past, it is estimated that about 20 % of the previously contoured lands are currently still cultivated. Before 1994, communal farmer support structures were very active in the region and most of the families produced enough maize (a staple diet food) for their own consumption. This is not happening currently and the area is a maize import area.

The *Agricultural assessment and irrigation water use* study (AsgiSA EC, 2009) concluded that: “Substantial potential exists in the study area for the development of new agricultural enterprises under rain-fed conditions and for the improvement of existing agricultural practices and productivity. Whilst opportunity exists for small irrigation scheme developments, there are several limiting factors with respect to large irrigation schemes. An initial focus on the upgrading of rain-fed cultivation and livestock farming can bring great gains at moderate investment”.

Commercial irrigation farming is not the traditional farming method in the area and extensive public consultation will be required to obtain buy in from traditional leaders and communities and facilitate the transformation of this sector.

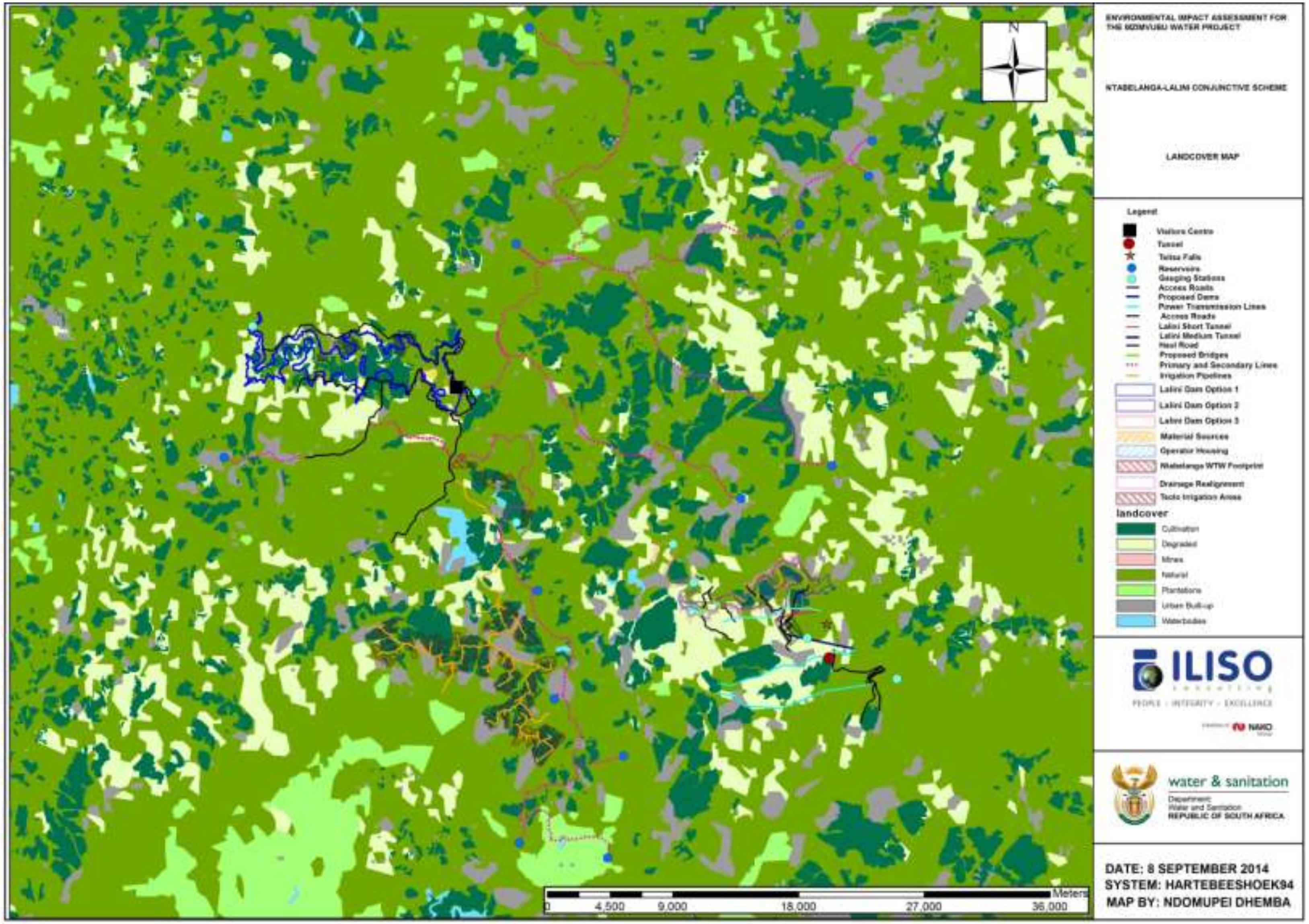


Figure 72: Land cover

7. MOTIVATION FOR THIS PROJECT

7.1 WATER USES BEING APPLIED FOR

The following water uses will be applied for:

- **Section 21 (a)**: taking water from a water resource;
- **Section 21 (b)**: storing of water;
- **Section 21 (c)**: impeding or diverting the flow of water in a water course;
- **Section 21 (e)**: engaging in a controlled activity identified as such in section 37(1) (c);
- **Section 21 (f)**: discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
- **Section 21 (g)**: disposing of waste in a manner which may detrimentally impact on a water resource; and
- **Section 21 (i)**: altering the bed, banks, course or characteristics of a water course.

A full description of each water use is provided in **Chapter 5**.

7.2 POTENTIAL SIGNIFICANT IMPACTS

During the EIA process, environmental aspects were identified that could be affected by the construction of the MWP. The EIR provides an in depth assessment of all environmental studies done in order to identify potential impacts of the MWP. The studies related to water use included:

- Wetlands;
- Aquatic; and
- Water Quality;

The impacts were categorised into those that have a low, medium or high significance and were assessed before and after mitigation measures were to be implemented. For full details on all significant potential impacts please refer to the ***Environmental Impact Assessment Report: P WMA 12/T30/00/5314/3.***

8. SECTION 27 NATIONAL WATER ACT MOTIVATION

8.1 27(A) EXISTING LAWFUL WATER USE

The MWP is a Strategic Integrated Project (SIP 3). Geographic SIPs were identified by the South African Government, one of which is the 'South Eastern node & corridor development' which includes the development of a new dam at Mzimvubu with irrigation system. There are currently no existing lawful water uses.

8.2 27(B) NEED TO REDRESS THE RESULTS OF PAST RACIAL AND GENDER DISCRIMINATION

One of the objectives of the NWA is to address past racial and gender discrimination and assist with alleviating poverty in South Africa. It is therefore important to support and stimulate economic development to assist previously disadvantaged groups.

The Eastern Cape Province covers an area of 168 966 km^2 making it the second largest province by geographical area, covering 13.8 % of South Africa's total land mass. In respect of population group, 86.3 % of the population are black African, 8.3 % are coloured, 4.7 % are white and 0.4 % are Indian or Asian people.

The sex ratio, which measures the proportion of males to females, is 89.0 indicating a higher number of females in the province. Between 1996 and 2001 the population growth rate was 0.46 % p.a. while between 2001 and 2011 it was 0.44 % p.a.

The project impacts the three district municipalities of Joe Gqabi, O. R. Tambo and Alfred Nzo. Of these districts, Joe Gqabi, covers the greatest land area and has the lowest population density across the region at $14/km^2$ while O. R. Tambo has the largest population and the highest population density at $110/km^2$. With regard to population group, black African people are the dominant group across all districts at over 90 %.

At the local municipal level the project impacts the following 4 local municipalities, Elundini, Mhlontlo, Umzimzubu and Ntabankulu. Of these municipalities Elundini covers the greatest geographical area at 5,065 km^2 and Ntabankulu the smallest area at 1,385 km^2. With a population of 123,976 people Ntabankulu has the highest population density at $90/km^2$. Umzimvubu has the highest population with 191 620 people living within the municipal area. At over 98 % black African people are the biggest population group across all municipalities. The sex ratio across all areas indicates a higher number of females compared to males with Ntabankulu having the highest proportion of females to males at 83.8 % and Elundini the lowest at 90.10 %

The area is characterised by high poverty and out-migration resulting in sex ratio imbalances, a high proportion of female headed households and a low population growth rate. Consequently there is a high dependency ratio and a high level of food access inadequacy. The population also lacks basic amenities and relies heavily on subsistence farming.

The MWP will contribute on a macro-economic level to the National as well as the Eastern Cape Province economy.

8.3 27(C) EFFICIENT AND BENEFICIAL USE OF WATER IN THE PUBLIC INTEREST

The Mzimvubu Catchment, one of the poorest regions in South Africa, possesses untapped economic potential in the form of its abundant water resources. The greater Transkei is the region in South Africa with the highest average rainfall and is host to the bulk of South Africa's untapped water, a rare commodity in an otherwise resource abundant nation. The Mzimvubu catchment area has a relatively high mean annual runoff but the water resource remains largely undeveloped and no large dams have been constructed in the area.

Associated with the lack in development are communities of people considered to be amongst the poorest in South Africa. It is for this reason that the Eastern Cape Provincial Government and National Government have identified the Mzimvubu River catchment area as requiring accelerated social and economic upliftment. It is envisaged that by harnessing the available water resources in the catchment area (through the construction of the dams and associated infrastructure), social and economic upliftment will follow (Department of Water Affairs, 2013).

Dams are criticised because of the high cost of construction involved and impacts such as flooding of large areas, and impacts on flow in aquatic and riparian ecosystems, disrupting livelihoods and destroying valuable, potentially arable, land (Department of Water and Sanitation, 2014).

However, dams provide many benefits. The primary benefit is in its supply of water for productive uses. Growth of populations, agricultural expansion and commercial and industrial economic activity relies heavily on South Africa's available water resources as a critical input into economic production. The availability of fresh water is increasingly an impediment to economic development. As such, the MWP is foundational to the development of the Mzimvubu Catchment, and the large scale development associated with the dam can generate significant economic activity in the region. Other medium term benefits include hydroelectric power, recreation, flood control, water supply, waste management and navigation (Department of Water and Sanitation, 2014).

The long term economic benefits associated with the MWP include an increase in quality of life and would impact positively on labour and economic productivity. Examples of these benefits include the value of time saved by households in collecting water, the reduced burden of water-borne disease, tax revenue accruing to the fiscus and most importantly, the long-term economic impact resulting from the improvement in local infrastructure (Department of Water and Sanitation, 2014).

8.4 27(D) SOCIO-ECONOMIC IMPACT OF THE WATER USE IF AUTHORISED

The authorisation of the water uses will impact positively on the provincial economy. During the peak of the construction period, 2 299 direct employment opportunities will be created with another 843 indirect and 1 036 induced jobs in the provincial economy. Of the direct jobs an estimated 1 057 will be semi-skilled and 771 low-skilled of which probably most will be recruited from the local community.

There is also a positive impact on the Gross Domestic Product to the value of R282.7 million. Low income households also receive a total of R82.42 million out of a total of R528.11 million of the total impact on households.

Although only for a short period, the construction of the Ntabelanga Dam will contribute considerably to the economy of the region and the province.

The proposed construction of the Lalini Dam and accompanying hydro-electricity plant will also contribute considerably to the economy. In the final year of construction of the dam 815 direct jobs will be created with another 491 indirect and 604 induced jobs in the provincial economy. Of the direct jobs an estimated 375 will semi-skilled and 273 low-skilled, of which probably most will be recruited from the local community.

There is also a positive impact on the Gross Domestic Product to the value of R164.6 million. Low income households also receive a total of R52.38 million out of a total of R335.64 million of the total impact on households.

Once the irrigation scheme is in full production it will also make a very positive contribution in terms of job creation and income to specifically low-income households. An estimated 4 000 individuals will be employed, although not all permanently.

The macro-economic contribution of the irrigation scheme is estimated at a total annual GDP contribution of R129.3 million per year and the total household income at R146.6 million with R38.6 million for low-income households, when expressed in 2013 prices.

The total fulltime employment opportunities are estimated at 1 976 of which 1 301 are direct on the farms which will comprise of the following number of people:

- Permanently on the farms – 7 per unit and 315 in total. This will be tractor drivers, irrigation workers and workshop staff.
- The temporary workers are estimated at 80 per unit with a total of 3 600. This is very often the only job that these workers have and over time a clearer picture will emerge regarding their social situation.

8.5 27(D) SOCIO-ECONOMIC IMPACT OF THE FAILURE TO AUTHORISE THE WATER USE OR USES

There is an obligation on the State to advance the interests of the poor and, in accordance with the Bill of Rights, take adequate measures in ensuring that all citizens have access to basic housing, health care, food, water, social security, education and a healthy environment (South African Human Rights Commission, 2004). In addition to this South Africa has a policy of recognising the human right to water at both the Constitutional and policy levels (Mehta, 2005).

Failure to authorise the water uses would contradict these obligations as the Department of Water and Sanitation and the Eastern Cape Province would lose an opportunity to supplement the water resources in the area and consequently to deliver both domestic water and water for irrigation. Together with this lost opportunity would be the loss of a number of job opportunities, not only associated with the construction of the dams and infrastructure, but also associated with the productive potential of the irrigation scheme. With the area being one of the least developed and poorest in the country these losses will have severe social consequences.

With the Mzimvubu River being the largest undeveloped water resource in the country any loss of benefits associated with the use of this river will be of national significance.

8.6 27(E) ANY CATCHMENT MANAGEMENT STRATEGY APPLICABLE TO THE RELEVANT WATER RESOURCE

8.6.1 Mzimvubu to Keiskamma Water Management Area – Integrated Strategic Perspective (ISP)

In support of catchment management, the DWS has developed Integrated Strategic Perspectives in order to guide critical decisions.

The DWS underpin the principles of environmental management in each strategy and there are a number of strategic areas with a particularly strong biophysical/ ecological emphasis. These include:

- The Reserve (groundwater, rivers, wetlands and estuaries);
- Water quality - surface and groundwater;
- The approach towards the clearing of Invasive Alien Plants;
- The management of wetlands;
- Land degradation. Erosion and sedimentation (land care); and
- Land use and especially how this is impacted by land reform and the re-allocation of water.

Much of the emphasis in water resource management has revolved around ensuring that users have sufficient quantities of water. However, as more water gets used and re-used, as quantities get scarce and feedback loops get even tighter, it is quality that begins to take on a dominant role.

The Mzimvubu catchment area has a relatively high mean annual runoff but the water resource remains largely undeveloped and no large dams have been constructed.

The Mzimvubu to Keiskamma Water Management Area ISP reiterates that the benefits to be derived from the development of the Mzimvubu River area will potentially be of national importance. It also identifies the requirement for large-scale development of the Mzimvubu River to be made subject to authorisation at national level.

The ISP proposes that, with appropriate planning, new dams for hydropower generation and irrigation can be located and designed in such a way as to permit the abstraction of water for transfer to other water management areas.

8.7 27(F) LIKELY EFFECT OF THE WATER USE TO BE AUTHORISED ON THE WATER RESOURCE AND ON THE OTHER WATER USERS

The effect of the water use on the water resource and the other water users is summarised in **Chapter 9**.

8.8 27(G) THE CLASS AND THE RESOURCE WATER QUALITY OBJECTIVES OF THE WATER RESOURCE

8.8.1 Ntabelanga Dam - Environmental Water Requirements

Environmental Water Requirements (EWR) are important to downstream ecosystems and are related to the characteristics and timing of natural stream flows.

For the purpose of assessing the impact of making EWR releases on the yield available from the proposed dam, a Rapid Reserve Determination was undertaken for the Ntabelanga Dam site.

The present ecological state of the Tsitsa River is classed as a C or a D, which could be considered low in undeveloped catchments. The low classes, especially the Class D of the Tsitsa River, is predominantly due to the very high sediment loads in the river, which limit habitat availability for the aquatic biota associated with an EWR study (i.e. macro-invertebrates and fish) (Department of Water Affairs, 2013) .

8.9 27(H) INVESTMENTS ALREADY MADE AND TO BE MADE BY THE WATER USERS IN RESPECT OF THE WATER USE IN QUESTION

The investments already made are summarised in **Table 18**.

Table 18: Investments already made

Feasibility Study	R18 849 960.00
EIA Study, Reserve and Lalini investigations	R 9 501 829.00
Detail Design	(services still to be procured)
TOTAL	**R28 351 789.00**

Expenditure, income and employment anticipated by the project is summarised in **Table 19**.

Table 19: Projected Expenditure, Income and Employment

Anticipated CAPEX value of the project on completion	R12.45 billion
Expected annual income to be generated by or as a result of the project	R 5.9 billion during construction R 1.6 billion during operation
New skilled employment opportunities created in the construction phase of the project	An estimated 3 880 jobs
New skilled employment opportunities created in the development phase of the project	Up to 2 620 jobs
New un-skilled employment opportunities created in the construction phase of the project	Up to 2 930 jobs
New un-skilled employment opportunities created in the development phase of the project	Up to 2 300 jobs
Expected value of the employment opportunities during the development and construction phase	R 376 million/year during construction R 268 million/year during operation
Percentage of this value that will accrue to previously disadvantaged individuals	At least 30% during construction
Expected current value of the employment opportunities during the first 10 years	R 3.33 billion

8.10 27(I) THE STRATEGIC IMPORTANCE OF THE WATER USE TO BE AUTHORISED

The development of the Mzimvubu River, the largest undeveloped water resource in the country, is of national significance.

Growth of populations, agricultural expansion and commercial and industrial economic activity relies heavily on South Africa's available water resources as a critical input into economic production. The availability of fresh water is increasingly an impediment to economic development. As such, the MWP is foundational to the development of the Mzimvubu Catchment, and the large scale development associated with the dam can generate significant economic activity in the region.

8.11 27(J) THE QUALITY OF WATER IN THE WATER RESOURCE WHICH MAY BE REQUIRED FOR THE RESERVE AND FOR MEETING INTERNATIONAL OBLIGATIONS

The National Water Act (NWA) No. 36 of 1998 requires that before water use authorisations can be granted to utilise a particular water resource, it is necessary to determine the Reserve for the relevant ecological component of the resource that will be impacted by the proposed water use. This requires the implementation of Resource Directed Measures (RDM) to protect the water resources of the country.

The construction of the Ntabelanga dam has been proposed in the Tsitsa catchment in quaternary catchment T35E. The proposed dam will have both direct (i.e. hydraulics) and indirect impacts (i.e. geomorphology, habitat integrity and response variables) on the downstream aquatic ecosystem. These impacts necessitate that the Reserve (ecological and basic human needs) are determined for the catchment to ensure adequate protection of the water resources (Departement of Water Affairs, 2013).

The Reserve study had the following findings (Departement of Water Affairs, 2013):

- The water resources of the Tsitsa River at the EWR site is currently in a C category (moderately modified state), mainly due to water quality impacts (a result of increased sedimentation in the system), and localised disturbances (e.g. alien invasive plants and concomitant bank erosion). These changes were observed in both abiotic (i.e. the Desktop Reserve Model (DRM), the Physicochemical Assessment Index (PAI) and Index of Habitat Integrity (IHI)) and biotic (i.e. Macroinvertebrate Response Assessment Index (MIRAI), Fish Response Assessment Index (FRAI) and Specific Pollution sensitivity Index (SPI)) assessments. The overall confidence in these results is medium.

- The system has a moderate Ecological Importance and Sensitivity. This is primarily driven by:

  - the unique Barbus anoplus-type minnow likely to be present in system as high waterfalls both up and downstream create barriers to fish movement, thus enabling the development of an Evolutionary Significant Unit;
  - Oligoneuridae were sampled during the survey (these macroinvertebrates are dependent on high velocities); and c) Perlidae and Prosopistomatidae being present in the system.

The Reserve study found that the Tsitsa River is moderately modified: impacted by both catchment scale processes (e.g. sedimentation) and localised impacts (e.g. alien invasive vegetation). It is critical that the ecological water requirements are met. This will allow management to maintain the REC of a C.

8.12 27(K) THE PROBABLE DURATION OF ANY UNDERTAKING FOR WHICH A WATER USE IS TO BE AUTHORISED

It is recommended that this licence be issued for the maximum allowed period in terms of the National Water Act, 1998, namely 40 years as this is a project of socio-economic significance.

9. IMPACT PREDICTION AND RISK ASSESSMENT

Impacts on the water quality and quantity were identified as part of the WULA. Relevant specialist studies are available in the ***Environmental Impact Assessment Report - P WMA 12/T30/00/5314/3***.

9.1 IMPACT ASSESSMENT METHODOLOGY

The key issues identified during the Scoping Phase of the EIA informed the terms of reference of the specialist studies. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative, from the project onto the environment or from the environment onto the project. In the EIA the significance of the potential impacts are considered before and after identified mitigation is implemented, for direct, indirect, and cumulative impacts, in the short and long term.

A description of the nature of the impact, any specific legal requirements and the stage (construction / decommissioning or operation) will be given. Impacts are considered to be the same during construction and decommissioning.

The following criteria are used to evaluate significance:

- **Nature:** This is an appraisal of the type of effect the activity is likely to have on the affected environment. The description includes what is being affected and how. The nature of the impact will be classified as positive or negative, and direct or indirect.

- **Extent and location:** This indicates the spatial area that may be affected (**Table 20**).

Table 20: Geographical extent of impact

Rating	Extent	Description
1	Site	Impacted area is only at the site – the actual extent of the activity.
2	Local	Impacted area is limited to the site and its immediate surrounding area
3	Regional	Impacted area extends to the surrounding area, the immediate and the neighbouring properties.
4	Provincial	Impact considered of provincial importance
5	National	Impact considered of national importance – will affect entire country.

- **Duration:** This measures the lifetime of the impact (**Table 21**).

Table 21: Duration of Impact

Rating	Duration	Description
1	Short term	0 – 3 years, or length of construction period
2	Medium term	3 – 10 years
3	Long term	> 10 years, or entire operational life of project.
4	Permanent – mitigated	Mitigation measures of natural process will reduce impact – impact will remain after operational life of project.
5	Permanent – no mitigation	No mitigation measures of natural process will reduce impact after implementation – impact will remain after operational life of project.

- **Intensity / severity:** This is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (**Table 22**).

Table 22: Intensity of Impact

Rating	Intensity	Description
1	Negligible	Change is slight, often not noticeable, natural functioning of environment not affected.
2	Low	Natural functioning of environment is minimally affected. Natural, cultural and social functions and processes can be reversed to their original state.
3	Medium	Environment remarkably altered, still functions, if in modified way. Negative impacts cannot be fully reversed.
4	High	Cultural and social functions and processes disturbed – potentially ceasing to function temporarily.
5	Very high	Natural, cultural and social functions and processes permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.

- **Potential for irreplaceable loss of resources:** This is the degree to which the project will cause loss of resources that are irreplaceable (**Table 23**).

Table 23: Potential for irreplaceable loss of resources

Rating	Potential for irreplaceable loss of resources	Description
1	Low	No irreplaceable resources will be impacted.
3	Medium	Resources can be replaced, with effort.
5	High	There is no potential for replacing a particular vulnerable resource that will be impacted.

- **Probability:** This is the likelihood or the chances that the impact will occur (**Table 24**).

Table 24: Probability of Impact

Rating	Probability	Description
1	Improbable	Under normal conditions, no impacts expected.
2	Low	The probability of the impact to occur is low due to its design or historic experience.

3	Medium	There is a distinct probability of the impact occurring.
4	High	It is most likely that the impact will occur
5	Definite	The impact will occur regardless of any prevention measures.

- **Confidence:** This is the level of knowledge or information available, the environmental impact practitioner or a specialist had in his/her judgement (**Table 25**).

Table 25: Confidence in level of knowledge or information

Rating	Confidence	Description
1	Low	Judgement based on intuition, not knowledge/ information.
2	Medium	Common sense and general knowledge informs decision.
3	High	Scientific / proven information informs decision.

- **Consequence:** This is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

- **Significance:** The significance will be rated by combining the consequence of the impact and the probability of occurrence (i.e. consequence x probability = significance). The maximum value which can be obtained is 100 significance points (**Table 26**).

Table 26: Significance of issues (based on parameters)

Rating	Significance	Description
1-14	Very low	No action required.
15-29	Low	Impacts are within the acceptable range.
30-44	Medium-low	Impacts are within the acceptable range but should be mitigated to lower significance levels wherever possible.
45-59	Medium-high	Impacts are important and require attention; mitigation is required to reduce the negative impacts to acceptable levels.
60-80	High	Impacts are of great importance, mitigation is crucial.
81-100	Very high	Impacts are unacceptable.

- **Cumulative Impacts:** This refers to the combined, incremental effects of the impact, taking other past, present and future developments in the same area into account.

  In this instance, no past, present or probable future uses/projects in the area that will result in cumulative impacts have been identified.

- **Mitigation:** Mitigation for significant issues will be incorporated into the EMPR.

9.2 IMPACT ASSESSMENT FOR DAMS AND ASSOCIATED WATER INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the dams and associated activities (DEA Ref no. 14/12/16/3/3/2/677).

The activities assessed under this chapter are listed below:

- The Ntabelanga and Lalini Dams;
- Five flow gauging weirs;
- Primary and secondary bulk potable water infrastructure:
  - Primary infrastructure: main water treatment works, including four major treated water pumping stations and three minor treated water pumping stations, main bulk treated water rising mains, and eight Command Reservoirs that will supply the whole region;
  - Secondary distribution lines: conveying bulk treated water from Command Reservoirs to existing and new District Reservoirs;
- Bulk raw water conveyance infrastructure (abstraction, pipelines, one raw water pumping station, one reservoir and two booster pumping stations) for irrigated agriculture (raw water supply up to field edge);
- Impact of commercial agriculture in earmarked irrigation areas;
- WWTWs at the Ntabelanga and Lalini Dam sites;
- Accommodation for operational staff at the Ntabelanga and Lalini Dam sites;
- Ten construction materials quarries and borrow pits;
- River intake structures and associated works;
- Information centres at the two dam sites; and
- Miscellaneous construction camps, lay down areas, and storage sites.

9.2.1 Construction and decommissioning phase

a) Water Quality

The surface water quality of the dam is fit for all users and is such that no water quality problems are expected to occur. The dam will be able to provide water of an acceptable quality to all users. Refer to **Appendix D: Water Quality Assessment**.

The release of cold and anaerobic bottom water during periods when the dam becomes stratified could impact on the water quality. This can effectively be mitigated by the installation and correct operation of multiple level outlets.

The sediment balance of the Mzimvubu River and associated estuary will be slightly altered during the life cycle of the project. Sedimentation is unlikely to lead to negative impacts on the Mzimvubu River and the associated estuary and some improvements in the overall sediment balance of the system is considered possible.

The impact on water quality by fertilizers contained in the runoff from irrigated areas was determined by calculating the potential salinity level in the dam. There will be a slight increase in the conductivity and phosphorous levels in the dam. Although this is relevant, it is not significant and the water quality still falls within the ideal range.

The following possible impacts on water quality have been identified for the construction, first filling and decommissioning phases.

i. Impact on river water quality: Contamination of river water by construction materials and the discharge of waste from the construction site.

Lalini and Ntabelanga Dams and associated infrastructure

Some impacts on water quality may occur during the construction and decommissioning phases. These have to do with possible contamination of the river by construction materials, as well as the discharge of waste from the construction site. During construction some increases in sedimentation of the Tsitsa River system and ultimately the Mzimvubu River system is deemed likely. The significance of these impacts is however considered limited as the duration of the impact will be limited to relatively short periods of time. These occurrences are governed by the National Water Act, and as long as this is adhered to, the effect will be minimal. This applies at both sites, namely the proposed Ntabelanga dam and the proposed Lalini dam.

Recommended mitigation:

As long as the construction site and the construction activities are managed properly in accordance with accepted practice, incidences of contamination should only occur under extraordinary circumstances.

ii. Impacts during first filling of the dam: The creation of anoxic conditions due to decomposition of organic material.

Lalini and Ntabelanga Dams and associated infrastructure

A potential problem that could occur is that any vegetation that is left in the dam basin will begin to decompose once the dam basin is filled with water. This will create anoxic conditions that may persist for a considerable period of time, and will pose a risk to downstream aquatic life, will render the dam basin itself unfit to support aquatic life, and will cause problems at the water treatment plant. The anoxic zone may consist as close as two meters from the surface.

Factors that should be considered when determining if de-bushing is required include:

- the depth of the water in storage;
- the size of the surface area;
- MAR;
- current and expected future water quality;
- land cover; and
- planned future use of the water surface.

The recommendations included in the EMPR regarding dam basin clearing should be adhered to.

This does not address the issues of community collection of plant material or plant rescue for bio-diversity conservation purposes.

The proposed Ntabelanga Dam and Lalini Dam sites both have a very small woody component with the area dominated by grass. Bush removal is recommended, but the amount of biomass is too little to cause serious oxygen depletion even over the short term.

In terms of water quality there is therefore no significant effect on the environment from the construction of the proposed new dams.

Recommended mitigation:

Clearing of trees/bushveld from the dam basin prior to impoundment is recommended. The following recommendations apply:

- Vegetation clearing should generally be understood to include trees and bushes, and to exclude grass. Identified very large trees may be left.
- The roots of plants should not be removed, but plants should rather be cut down close to ground level with a chain-saw.
- Topsoil should not be disturbed.
- The material that is removed will first be made available to the communities in the area.
- Non-commercial material to be removed should be burned in a hot fire in order to minimise air quality impacts. This can be achieved by stacking the material in rows and burning on a windy day.
- The areas of the basin that are cleared/ not cleared should be marked on a map for future use.

Table 27: Assessment of Water Quality Impacts during the construction, first filling and decommissioning phases

Impact on river water quality: Contamination by construction materials	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium -Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium -Low

With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium -Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium -Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Creation of anoxic conditions during first filling of the dam	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Low	Medium	Very low
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

b) Aquatic Ecology

Aquatic ecological assessments were undertaken at four points on the Tsitsa River (TS1 at the tail of the proposed Ntabelanga Dam; TS4 immediately upstream of the proposed Ntabelanga Dam wall; TS7 at the tail of the proposed Lalini Dam and TS8 downstream of the proposed Lalini Dam wall) and five other assessment points on tributaries of the Tsitsa River, in April and June 2014 (**Figure 73**).

Based on the aquatic assessment the EIS, PES and DEMC of the systems in the area can be summarised as follows:

Development	Relevant sites	EIS	PES	DEMC
Ntabelanga Dam development	TS1 and TS4	High	C	B
Roads associated with Ntabelanga Dam construction	TS2, TS3 and TS5	Moderate to high	C	C/B
Area between Ntabelanga Dam and Lalini Dam	TS6	Moderate to high	C	C/B
Lalini Dam development	TS7 and TS8	Moderate	C	C
Pipeline development	TS9	Moderate to high	C	C/B
EIS = Ecological importance and sensitivity; PES = Present ecological state; DEMC = Desired ecological management class.				

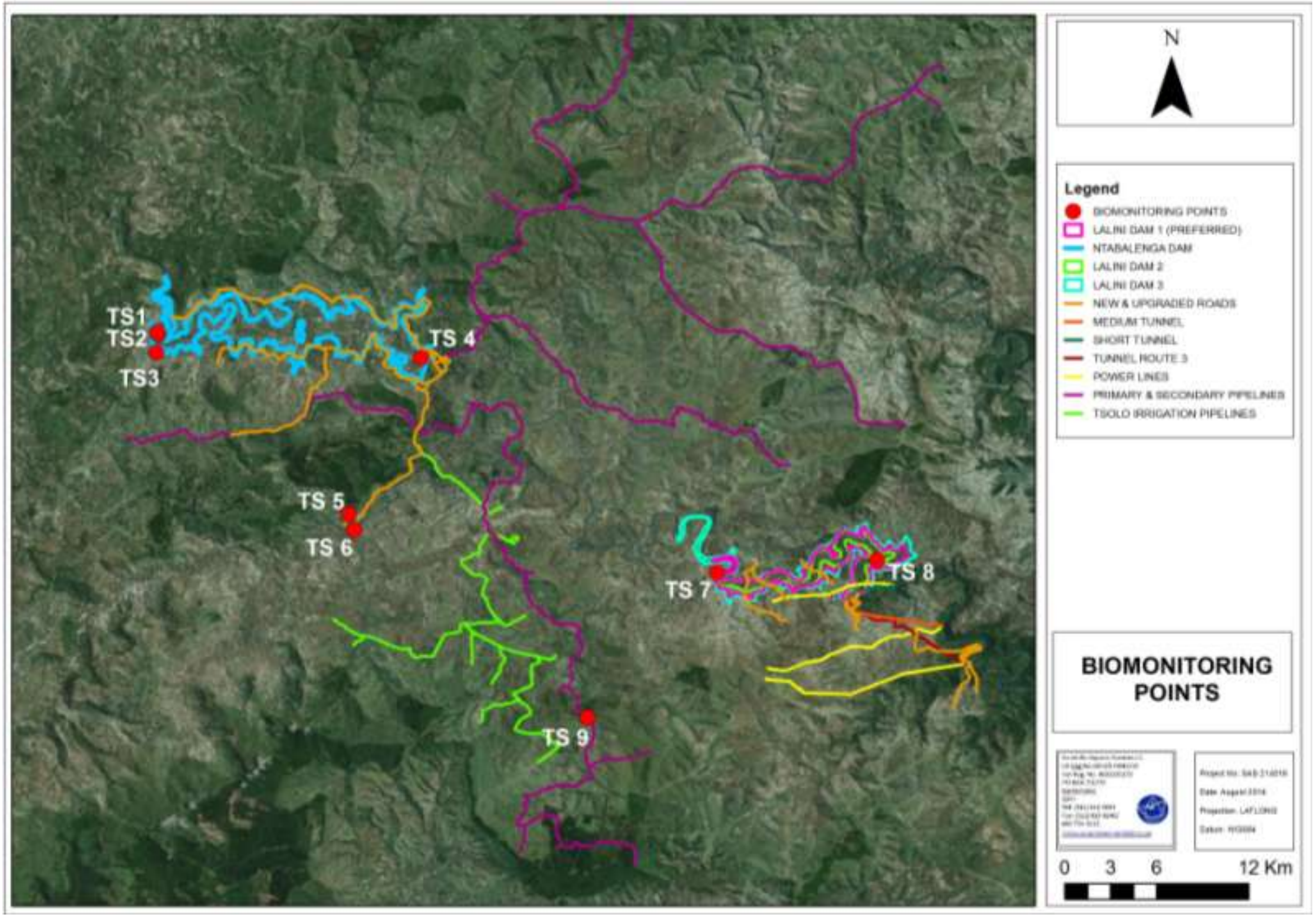


Figure 73: Digital satellite image of the study area showing assessment sites on the Tsitsa River (TS1, TS4, TS7 and TS8) as well as on tributaries of this river (TS2, TS3, TS5, TS6 and TS9) depicted on an aerial photograph in relation to surrounding areas.

The ecological importance of the greater study area is reflected in the findings of the aquatic assessment, particularly with reference to the four sites on the larger Tsitsa River (Ecostatus values ranging between A (Natural) to C (moderately modified) for assessments pertaining to invertebrates and invertebrate habitat). Fish fauna diversity was, however, depauperate as was also indicated in literature sources consulted. Smaller streams are thought to be less resilient to environmental change and more sensitive to disturbances, simply because of the smaller spatial scale in terms of potential areas of refugia and associated faunal and floral diversity to act as “buffer” to change. This is also reflected in the assessment results, with the tributary assessments generally yielding lower classifications. Seasonal changes in terms of the macro-invertebrate assessments are evident, with lower classifications being recorded during the lower flow period in June 2014. However, the contributions of lower flow and hence also potentially poorer water quality, as well as potential diffuse and point sources (agriculture activities and existing rural settlements) cannot be quantified at present.

During the first filling phase, the greatest impact will be habitat alteration/destruction as well as impacts on natural flow rate. These impacts result in secondary impacts on flow sensitive species, species of conservation concern and aquatic biodiversity in general. The impacts (inundation of habitat upstream of the dam walls and disruption of natural flow downstream) are considered high and permanent and hence also applicable to the operation phase. In terms of flow rate, baseflows need to be maintained during both the construction/initial filling and operation phases. Without periodic, seasonal floods with associated “purging” of the river system, impacts such as silting/sedimentation and decrease in general water quality is a possibility.

With the constant peak flow the system will be subject to daily unnatural variations in water level and flow rates, which will negatively affect flow sensitive species and as a result decrease biodiversity. With the seasonal peak flow during winter only, such negative effects can be restricted to a single season.

The area is known to harbour endemic mayflies (Kleynhans 1999). With the dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern. Both prior to and after mitigation this impact is considered to be high to moderately high. Through minimising the time in which stream flow, water quality and habitat is affected during the construction phase of the project this impact can, however, be mitigated to a limited degree.

<u>Electricity generation and distribution</u>

Construction of such infrastructure will be of low impact if mitigated. Mitigation includes minimising the spatial footprint of the development to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system. During the operation phase discharge through the Lalini Dam tunnel into the river will also be applicable. The section of river below the dam wall up to the tunnel discharge point will be largely subjected to baseflow which may impact on sensitive biota. The instream flow requirements of the systems are to be adhered to at all times

The shorter the length of the river between the dam wall and discharge point, the smaller the area of impact in terms of silting, sedimentation, decrease in water quality and excessive vegetation growth. The tunnel must also be constructed and positioned in such a manner as to preclude erosion effects at times of peak discharge.

Roads and pipelines

Anticipated impacts resulting from construction and use of roads include vegetation removal, increased risk of erosion, sediment loading into the system and inhibition of water flow. If not designed correctly roads can severely impact on instream habitat as well as bankside stability and riparian habitat. Mitigation again includes minimising the spatial footprint of the development to the greatest degree possible, with special reference to avoiding erosion, silting and sedimentation within the aquatic system during both construction and operation. During the operation phase increased run-off from hard surfaces may also result in erosion. Construction impacts of such infrastructure will be of low significance if mitigated.

i. Loss of aquatic habitat

The proposed dam construction project has significant potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area. Dam wall construction activities itself will be disruptive to current habitat conditions in the Tsitsa River within the dam wall footprint area and associated adjacent laydown areas. Construction activities also generally result in destruction of bank cover, generation of loose soil and other debris that may result in silting and sedimentation of downstream habitat. Apart from dam wall construction, construction of flow gauging weirs, bulk potable water infrastructure (pumping stations, reservoirs, treatment works and distribution lines) and bulk raw water conveyance infrastructure (pipelines, pumping station and reservoir) quarries and borrow pits, accommodation infrastructure and infrastructure will potentially have the same effect on the aquatic resources of the region albeit on a much smaller local scale. The macro-invertebrates community of the Tsitsa River relies on clear water and a stream substrate that is clear of fine silt and sediment. Close monitoring of erosion patterns downstream of the construction area is deemed essential and any areas which are showing erosion to be occurring should immediately be rehabilitated through resloping, stabilisation and revegetation techniques as part of the catchment management plan.

In addition inundation of upstream habitat as the dam fills will result in severe habitat changes, pertaining to the water column depth habitat as well as availability of riffle and rapid habitats upstream of the dam on a local scale. The impounding of the dam will thus lead to a significant loss of habitats comprising of flowing water over rock substrate which is significant for many aquatic macro-invertebrate taxa in the system. In addition less desirable species of fish such as *Micropterus salmoides* and *Cyprinus carpio* will become dominant in the system to the detriment of the endemic ecology of the region. Impacts due to sedimentation can be significant and have the potential to affect the biodiversity and functioning of the system. The still water in the newly created impoundment will allow sediment to settle and will smother the rocky substrate in the stream leading to a loss of rocky habitat types.

Recommended mitigation

- The construction of the dams will lead to reduced stream flow and hence loss of fast shallow riffle habitat and glide habitat. This impact is considered to be of high significance in the construction phase and even with mitigation the impact remains relatively unchanged. It is however deemed important that during construction the maintenance of baseflows in the system is maintained at all times and that the duration of impacts on flows is limited to as short a period as possible.
- Limit the footprint area of all construction activities to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation;
- Through ensuring that good construction practice is followed in terms of the clearing of areas, such as the use of water control berms and clearing footprint areas that are as small as possible, the severity of the impact can be reduced;
- Ongoing aquatic biomonitoring on a minimum of a quarterly basis must take place from 6 months prior to construction till 1 year after construction to determine trends in ecology and define any impacts requiring mitigation.

ii. Impact on flow dependant species

The damming of drainage areas that occur upstream of the proposed dam walls will lead to a loss of flow and an altered instream flow regime in the Tsitsa River system further downstream. It is notable that the aquatic macro-invertebrate community of the Tsitsa River system are reliant on good flow of water over the rocky stream substrate and the area downstream of the Lalini Dam, due to the remote nature of the gorge has an intact biodiversity. Impacts on instream flow can be significant and has the potential to affect the biodiversity and functioning of the system. Apart from the dam wall itself resulting in local to regional impact, gauging weirs will also have a smaller, local impact in terms of flow, habitat alteration and risk of erosion and sedimentation. With the varying hydro-electric energy generation options, there are varying levels of impact significance on the receiving aquatic environment with the degree of impact varying based on the extent of river in which a significant portion of the instream flow will be lost. All the proposed options are considered to have a borderline high to very high level of impact prior to mitigation while with mitigation, with specific mention of adhering to the Environmental Water Requirement releases the overall significance of the impacts can be reduced to high level impacts.

Recommended mitigation

- Downstream of both the Ntabelanga Dam as well as the Lalini Dam sufficient flows must be maintained during the first filling to support the flow sensitive aquatic macro-invertebrate community in this system;
- Impact on flow-dependent species is considered to be of high to very high in the first filling of the dam and even with mitigation the impact remains relatively unchanged;
- During the first filling the maintenance of baseflows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible;

iii. Loss of aquatic biodiversity

The Tsitsa River is regarded as being of very high importance for migration of eels although the significance of eel migration is considered limited. The system may also provide some migratory connectivity for smaller faunal species including avifauna. In addition to impacts on migration impacts on habitat and instream flow are likely to lead to impacts on biodiversity with the loss of taxa which are sensitive to habitat changes as well changes/reductions in flow.

In particular, the impact on the aquatic macro-invertebrate community which relies on rocky substrate in fast flowing clear water will be significantly impacted by the proposed development.

The movement of instream taxa, with special mention of eels, will be severely affected by the proposed dam, including local effects from gauging weirs. Impacts on migratory movements are likely to occur during the construction and operational phase of the proposed development. In the long term this may negatively affect populations upstream of the dams and may result in loss of this species in certain sections.

Loss of habitat and alteration of flow rate discussed previously will also negatively affect the diversity of the macro-invertebrate community within the system on a local scale. Even with mitigation the impact on aquatic ecology is considered high.

Recommended mitigation

- During the first filling the maintenance of baseflows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible;

- Ongoing aquatic biomonitoring on a minimum of a quarterly basis must take place from 6 months prior to construction till 1 year after construction to determine trends in ecology and define any impacts requiring mitigation.

iv. Impact on species with conservation concern

The proposed infrastructures, with special mention of the proposed dam and to a lesser extent gauging weirs, will lead to the formation of an migratory barrier for fish species and in particular eels, as mentioned in the previous section. The area is known to harbour endemic mayflies (Kleynhans 1999). With the location of the two dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern. Both prior to and after mitigation this impact is considered to be high to moderately high. Through minimising the time in which stream flow, water quality and habitat is affected during the construction phase of the project this impact can, however, be mitigated to a limited degree. The “construction phase” does not only refer to dam wall construction, but also all related activities and in particular the construction of the flow gauging weirs.

Recommended mitigation

Even with attempted mitigation impact will remain high, as first filling causing upstream inundation and alteration of flow rate downstream cannot be mitigated to any great extent.

- During first filling the maintenance of base flows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

Table 28: Assessment of impacts on aquatic ecology during the construction, first filling and decommissioning phases

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent –	High (4)	High (5)	Definite	High	High

		no mitigation (5)			(5)		
With Mitigation	Site (1)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Site (1)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
Impact on flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional	Permanent –	Medium	High (5)	Definite	High	High

	(3)	with mitigation (4)	(3)		(5)		
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Lalini Dam size 3 (alterative) and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	Definite (5)	High	High
Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – no mitigation (5)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	High (5)	High(4)	High	Medium-High
N.B.: reference to the respective projects also considers impact from associated activities, including gauging weirs, bulk potable water infrastructure, bulk raw water conveyance infrastructure, irrigation and agriculture, WWTWs, accommodation infrastructure, quarries and pits, river intake structures and associated works, information centres and miscellaneous activities like constructions camps, lay down areas and storage sites.							

c) Wetlands

Riparian and wetland resources can be considered to be in moderately modified condition, indicating that loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.

Wetlands of concern provide important ecological services in the way of sediment trapping, nutrient cycling and toxicant assimilation, flood attenuation and biodiversity maintenance. In view of the extensive, and often severe, erosion within the study area and greater catchment, sediment trapping is especially important. The proposed project has the potential to lead to loss of niche habitat for wetland-dependent faunal and floral taxa and/or alteration of the aquatic and riparian resources on the study area, with particular mention of the impacts that the two dams will have on the Tsitsa River and its tributaries, as well as the associated wetland and riparian resources.

The Ntabelanga and Lalini Dams will have the greatest impact on wetland and riparian habitat, as wetland habitat will be permanently lost during the first filling. Due to the nature of the development, this cannot be avoided. Additionally, roads and pipelines traverse wetland features; thus it will not be feasible to implement a buffer zone around all wetland features affected by the project. Effective mitigation is therefore necessary to reduce the level of impacts on the wetland features.

The anticipated loss of riparian and wetland habitat arising from the construction of the dams is estimated to be 1034.30 hectares; overall this is deemed to be a relatively insignificant fraction of the wetland resources within the Mzimvubu subWMA.

The following key impacts on wetlands have been identified for the construction, first filling and decommissioning phases:

Ntabelanga Dam and associated infrastructure

Construction of the dam wall not only necessitates the removal of riparian vegetation, but also requires the movement of construction vehicles in the vicinity of or through wetland features (existing roads, earmarked for upgrades, currently traverse several wetland features). The first filling of the dam will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the affected wetland features which will not be inundated. Construction of associated infrastructure such as accommodation, WWTW and the information centre has the potential to result in the loss of wetland habitat, although these impacts may be reduced with careful planning of the placement of these to minimise the footprint of these structures.

Lalini Dam and associated infrastructure

It is anticipated that the impacts on wetland and riparian habitat as a result of the construction and first filling of the Lalini Dam will be similar in nature to the impacts of the construction of the Ntabelanga Dam, i.e. loss of vegetation, sedimentation of features and permanent loss of habitat due to inundation.

Primary and secondary pipelines, and irrigation pipelines

Where pipelines cross wetland / riparian habitat, with specific mention of drainage lines and channelled valley bottom wetlands, support structures should not be constructed within the active channels and must be placed outside of wetland / riparian habitat wherever feasible. In order to achieve this wetland crossings should take place at 90 degree angles wherever possible.

Mitigation measures for these impacts are given below.

- Minimise the construction footprints and implement strict controls of edge effects;
- An alien vegetation control programme must be implemented, as encroachment of alien vegetation is apparent and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas, utilising indigenous wetland vegetation species, will assist in reducing the impact of construction;
- A method statement for erosion management and sediment controls must be developed, including the possible use of gabions or reno mattresses, re-vegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps, from the outset of construction activities;
- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;
- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels and infrastructure should cross wetlands at right angles.

Table 29: Assessment of impacts on wetlands during the construction, first filling and decommissioning phases

Loss of wetland / riparian habitat and ecological structure	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	2	5 (Very high)	5 (High)	(5) Definite	High	High

		(medium)					
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	3 (Medium)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low
Loss of wetland / riparian ecoservices	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low

Impacts on wetland / riparian hydrology and sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low

9.2.2 Operational phase

a) Water Quality

The following key impacts on water quality downstream of the dams and associated infrastructure have been identified for the operation phase.

i. Water Quality (Downstream effects): Temperature and Oxygen

Lalini and Ntabelanga Dams and associated infrastructure

The storage of a large quantity of water in the proposed dams could lead to eutrophic conditions and an increase in salinity due to the concentrating effect of evaporation losses. These problems tend to be accentuated during periods of prolonged low inflow.

The release of cold and anaerobic bottom water during periods when the dams become stratified could impact on water quality.

Recommended mitigation:

The installation of multiple level outlets and proper operation will completely mitigate the effect of water quality changes downstream of the proposed dam.

ii. Impact on water quality: Sediment balance

Lalini and Ntabelanga Dams and associated infrastructure

The sediment balance of the Mzimvubu River and associated estuary will be slightly altered during the life cycle of the project. During the operational phase of the two dams there will be reduced sediment input to areas below the dams. Although the reduced sediment load may lead to increased erosion and armouring of the river downstream of the dams this impact is not considered highly significant. The aquatic macro-invertebrate community of the Tsitsa River relies on fast flowing water and a substrate free of sediments on the rocky substrate. The reduced sediment load downstream of the dams therefore has the potential to improve the aquatic ecology in these sections of the system.

The Mzimvubu catchment is severely impacted by the erosion of soils due to the highly erodible nature of the soils in the catchment as well as the topography in the catchment and the associated agricultural practices in the catchment. The reduced sediment input that will occur from the Tsitsa River into the Mzimvubu River system is unlikely to lead to negative impacts on the Mzimvubu River and the associated estuary and some improvements in the overall sediment balance of the system is considered possible.

Recommended mitigation:

- There are not many options available to minimise impacts of altered sedimentation downstream of the impoundments however if any areas downstream of the two proposed dams are observed where excessive erosion are occurring, these areas should be rehabilitated immediately. Such measures should be included into the operation management program of the dams.
- In order to minimise the impacts on sedimentation within the dam a sediment management program should be implemented as part of the catchment management plan for the dam catchments and should include awareness training on sustainable agricultural practices.

Flow Gauging Weirs

Sedimentation will occur upstream behind the weir structures. Although this is unavoidable, no mitigation is required as this will not impact on the water quality downstream of the weir and the extent of habitat alteration will be very limited.

Recommended mitigation:

No mitigation required.

iii. Impact on water quality: Salinity

The impact on water quality by fertilizers contained in the runoff from irrigated areas was determined by calculating the potential salinity level in the dam. There will be a slight increase in the conductivity and phosphorous levels in the dam. Although this is relevant, it is not significant and the water quality still falls within the ideal range.

Recommended mitigation:

No mitigation is recommended as the water quality falls within the ideal range.

Table 30: Assessment of Water Quality Impacts during the operational phase

Water Quality (Downstream Effects): Temperature and Oxygen	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional	Long term	Medium	High	High	High	Medium-high
With Mitigation	Site	Short term	Negligible	Low	Improbable	High	Very Low
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional	Long term	Medium	High	High	High	Medium-high
With Mitigation	Site	Short term	Negligible	Low	Improbable	High	Very Low
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional	Long term	Medium	High	High	High	Medium-high
With Mitigation	Site	Short term	Negligible	Low	Improbable	High	Very Low
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional	Long term	Medium	High	High	High	Medium-high
With Mitigation	Site	Short term	Negligible	Low	Improbable	High	Very Low
Water Quality (Downstream Effects) : Sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional	Long term	Low	Medium	High	High	Medium Low
With Mitigation	Regional	Long term	Negligible	Low	Medium	High	Low
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Regional	Long term	Low	Medium	High	High	Medium Low
With Mitigation	Regional	Long term	Negligible	Low	Medium	High	Low
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Regional	Long term	Low	Medium	High	High	Medium Low
With Mitigation	Regional	Long term	Negligible	Low	Medium	High	Low
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Regional	Long term	Low	Medium	High	High	Medium Low
With Mitigation	Regional	Long term	Negligible	Low	Medium	High	Low

Cumulative Impact – *Additional loss of in stream and riparian habitat may occur downstream of the two dams.*

Sedimentation upstream of weirs	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Low	Medium	Very low
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

Salinity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Low	Medium	Very low
Lalini Dam size 1 (preferred) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 2 (alternative) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Lalini Dam size 3 (alternative) and associated infrastructure							
Without Mitigation	Local	Short term	Low	Low	Low	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

b) Aquatic Ecology

The proposed dam walls will lead to the formation of a migratory barrier and the movement of instream taxa, with special mention of eels, will be severely and permanently affected. As for the construction phase, permanent alteration of natural flow rates and habitat will negative affect aquatic biodiversity with specific reference to macro-invertebrates and riparian vegetation.

The impact on species of conservation concern pertains to eel migration and presence of endemic mayflies. With the two dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern.

During operation, the impact will remain local.

Recommended Mitigation:

- An investigation on the necessity and design specifications for an eel-way should be undertaken and findings implemented.

c) Wetlands

The following key impacts on wetlands have been identified for the operation phase:

Ntabelanga and Lalini Dams

Perceived impacts on wetland / riparian habitat will be of a considerably lower intensity during the operational phase of the project in comparison to the construction phase. This is attributed to the anticipated loss of habitat which will occur during the first filling of the dams. Thus, although the duration of the impact is considered to be permanent without the possibility of rehabilitation of those features which will be inundated, the intensity of the impact is considered low.

Fluctuations in the levels of water downstream of the dams as a result of incorrect environmental flow releases of water from the dams may have an impact on riparian vegetation. Prolonged exposure to dry conditions may result in the long-term loss of riparian vegetation, and subsequent increased incision and erosion of river banks leading to increased sedimentation of the river system. In addition rapid releases of large water volumes may lead to scouring of the riparian zone and a loss of some riparian zone cover and species.

Primary, secondary and irrigation pipelines

Major impacts on wetland / riparian features during the operational phases of the pipelines are not anticipated, provided that the impacts on these features are minimised during the construction phase, and that any wetland / riparian areas which were impacted during construction are monitored regularly for proliferation of alien vegetation and sedimentation in the areas of disturbance. During maintenance of pipelines, it is essential that maintenance vehicles remain on designated roads in order to limit the ecological footprint of maintenance activities and reduce further degradation of the wetland / riparian habitat.

Mitigation measures for these impacts are provided below.

i. Loss of wetland (riparian habitat, ecological structure and riparian eco-services) & Impacts on wetland (riparian hydrology and sediment balance)

Recommended mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operational use and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat is already severe due to the dam footprints.

Table 31: Assessment of wetland impacts during the operation phase

Loss of wetland / riparian habitat and ecological structure	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low
Loss of wetland / riparian ecoservices	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High

Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low
Impacts on wetland / riparian hydrology and sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low

9.3 IMPACT ASSESSMENT FOR ELECTRICITY GENERATION AND DISTRIBUTION INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the electricity generation and distribution related activities (DEA Ref no. 14/12/16/3/3/2/678).

The activities assessed under this chapter are listed below:

- Pipeline and tunnel (including tunnel alternatives) at the proposed Lalini Dam;
- Generation of hydro power and feeding of this power into the existing grid; and
- 13km power line from the Lalini Dam tunnel.

9.3.1 Construction and Decommissioning phases

a) Water Quality

The following key impacts on water quality have been identified for the construction and decommissioning phases:

i. Impacts during the construction of the electricity generation and distribution infrastructure

Some impacts on water quality may occur during the construction and decommissioning phases. These have to do with possible contamination of the river by construction materials. These occurrences are governed by the National Water Act, and as long as this is adhered to, the effect will be minimal. This applies to the proposed Lalini Dam site.

Table 32: Water Quality Impacts during the construction of the electricity generation and distribution infrastructure

Contamination by construction materials	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium - Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium - Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium - Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Base-load power generation and with hydropower tunnel and power line alternative 1							

Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium - Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium - Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium - Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

b) Aquatic ecology

The following key impacts on aquatic ecology have been identified for the construction and decommissioning phases:

i. Loss of aquatic habitat

Impacts due to canalisation and erosion will potentially be caused due to the disturbance of soils, during site clearing and construction, and the alteration of flow regimes in the Tsitsa River.

Recommended mitigation

- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation;
- Through ensuring that good construction practice is followed in terms of the clearing of areas, such as the use of water control berms and clearing footprint areas that are as small as possible, the severity of the impact can be reduced.
- During construction the maintenance of baseflows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

ii. Impact on flow dependant species, loss of aquatic biodiversity, and impact on species with conservation concern

Impacts on flow will mostly pertain to general construction activities and baseline flow as effected through the Lalini Dam tunnel. Impacts on diversity will mostly pertain to habitat alteration and flow alteration as effected through the Lalini Dam tunnel. These effects have been discussed with reference to dam impact. Construction of the electricity generation and distribution phases will have lower impact compared to that associated with the dams due to the smaller scale of both activity and potential impact. It must however be noted that the further the tunnel daylights from the Lalini dam wall the larger the impact on the instream ecology will be.

Recommended mitigation

- Limit the footprint area of the construction activity to what is absolutely essential;
- During construction the maintenance of baseflows in the system must be maintained at all times and the duration of impacts on flows should be limited to as short a period as possible.

Table 33: Assessment of impacts on aquatic ecology during the construction and decommissioning phases

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (3)	High (4)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 1 (near falls) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 2 (medium range) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Medium term (2)	Medium (3)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Low
Impact of flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and							

associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	High (4)	High	Medium-Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
Impact on species with conservation concern	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Project with Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 1 (nearest to falls lowest generation potential) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 2 (midway option) and associated infrastructure							
Without Mitigation	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Proposed Project with Lalini Dam hydroelectric generation site 3 (furthest from falls largest generation potential)							
High	Local (2)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low

Please note that reference to the respective hydroelectric generation projects also considers impact from associated power lines and the Lalini Dam tunnel.

c) Wetlands

The following key impacts on wetlands have been identified for the construction phase:

The construction of power lines is considered to be a moderately low risk activity in terms of wetland and riparian habitat conservation. The primary concern associated with this activity is the placement of support towers. Care should be taken to ensure that these structures are not placed within wetland or riparian habitat, or within their respective buffer zones. As with the construction of the pipelines, should it be necessary to place pylons within wetland habitat, it is highly recommended that these structures be placed outside of the active channels (in the case of the drainage lines or channelled valley bottom wetland features), in order to minimise the impacts on the hydrology of these systems.

Mitigation measures for these impacts are given below.

i. Loss of wetland / riparian habitat and ecological structure

Recommended mitigation:

- Careful planning of the placement of the pylons must be undertaken prior to commencing construction. Support towers for power lines should not be placed within sensitive wetland / riparian habitat;
- Construction vehicles must not be permitted to drive through wetland / riparian habitat, and must remain on designated roads; and
- Edge effects of construction, such as proliferation of alien vegetation and increased sedimentation due to soil disturbances must be strictly controlled, particularly in the vicinity of wetland resources, in order to minimise the loss of wetland habitat.

ii. Loss of wetland / riparian ecoservices

Recommended mitigation:

- Construction vehicles must not be permitted to drive through wetland / riparian habitat, and must remain on designated roads; and
- Edge effects of construction, such as proliferation of alien vegetation and increased sedimentation due to soil disturbances must be strictly controlled, particularly in the vicinity of wetland resources, in order to minimise the loss of wetland habitat.

iii. Impacts on wetland / riparian hydrology and sediment balance

Recommended mitigation:

- Planning of the placement of the infrastructure is essential, in order to prevent the placement of pylons within sensitive wetland habitat, particularly within active channels of drainage lines, channelled valley bottom wetlands and active river channels; and

- Strict control of edge effects of the construction of the power line infrastructure must be implemented in order to minimise sedimentation and erosion as a result of vegetation clearing and disturbances to the soil profile.

Table 34: Assessment of wetland impacts during the construction and decommissioning phases

Loss of wetland / riparian habitat and ecological structure	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Loss of wetland / riparian ecoservices	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low

Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Impacts on wetland / riparian hydrology and sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low

9.3.2 Operation Phase

a) Water Quality

i. Water Quality (Downstream effects)

Water quality changes (temperature) in the river downstream of the proposed hydropower plant outlet.

Table 35: Water Quality Impacts during the operation of the electricity generation and distribution infrastructure

Water quality changes (Temperature)	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

b) Aquatic ecology

The following key impacts on aquatic ecology have been identified for the operation phase:

i. Loss of aquatic habitat

The section directly below the dam wall up to the dam discharge point will only experience controlled base flow conditions that would lead to loss of the waterfall habitat as well as loss of seasonal natural flow fluctuation events that will affect availability of especially riffle and rapid habitats. Peak flow will result in daily changes in habitat availability, whilst seasonal peak flow (winter only) will result in seasonal variations in habitat availability. Both scenarios will have a high to medium-high impact, with the latter option restricting impact to a single season.

Water released from the Lalini Dam, if not correctly designed can lead to severe erosion and canalisation of the system at the point where the discharge from the Lalini Dam enters the river. This impact can be significant on a site to local scale in terms of river modification and habitat loss, with the potential to affect the hydrological functioning and biodiversity of riverine and wetland systems on a local to regional scale. The closer to the dam wall the pipeline enters the river, the shorter the section subjected to reduced instream flow will be. These impacts have been discussed previously with reference to the operational phase of the dams.

The section directly below the dam wall up to the dam discharge point will only experience controlled base flow conditions at most times that would lead to loss of the waterfall habitat as well as loss of seasonal natural flow fluctuation events that will affect availability of especially riffle and rapid habitats. It must be noted that although the impact significance for each of the alternative tunnel lengths was classified as being the same, the further from the dam wall water is re-introduced to the system the larger the impact on flow dependent species and on the Tsitsa River will be due altered instream flows.

Recommended mitigation

- The EWR defined for the Tsitsa system must be maintained at all times.
- The discharge point and discharge structure from the hydropower plant outlet must be designed and positioned in a way that would minimise incision, erosion and changes to instream habitat structures.
- The infrastructure should be adequately maintained to retain the smallest footprint possible and prevent post construction impacts on the local instream habitat due to a lack of infrastructure maintenance.
- An investigation must be undertaken by a qualified specialist to determine whether any waterfall dependant plants in the gorge and on the cliff could be significantly impacted and whether they require relocation; and findings of the investigation must be implemented

ii. Impact on flow dependant species

Abstraction for agricultural and other purposes from Ntabelanga Dam will negatively affect the amount of water for release and hence flow in the river section between the Ntabelanga and Tsitsa Dams. Even with the base- and peak flow regimes in operation at Lalini Dam, the river section between the dam wall and entry point of the discharge pipe will only be at most times which may affect some more sensitive taxa. As discussed in the section above there will be an impact on the aquatic community downstream of the dam due to the impacts altered streamflow regimes.

With an altered flow regime the river system, this section may be subjected to excessive vegetation growth or silting over the long term which will negatively affect flow-dependant species. Daily peak time flow will lead to drastic daily fluctuations in flow rate that will also negatively affect flow-sensitive species and a change in the natural aquatic macro-invertebrate community structure is deemed highly likely. Seasonal employment of peak time flow will limit such impact so a single season (winter) however impacts on aquatic biota will extend beyond the winter season of peak generation.

Recommended mitigation

- The impact on the aquatic community structures within the full supply level will be very significant with drastic changes to the aquatic community structure in these areas with more sensitive taxa no longer occurring and less desirable species of fish becoming dominant in the system;

- The impact on stream flow during the operational phase of the project is high if no mitigation measures are implemented;
- If mitigation takes place through ensuring that some release of water takes place throughout the life of the operation to recharge the downstream riverine and wetland resources and to ensure that base flows are maintained at all times, the severity of the impact can be reduced. However, the impact is still regarded as being a medium-high level impact.
- The Instream Flow Requirements defined for the Tsitsa system must be maintained at all times.

iii. Loss of aquatic biodiversity

Permanent alteration of natural flow rates and habitat will negatively affect aquatic biodiversity with specific reference to macro-invertebrates and riparian vegetation. Potential loss of biodiversity, with particular reference to mayflies from the order *Ephemeroptera*, will mostly pertain to habitat alteration and flow alteration as effected through the Lalini Dam tunnel.

Recommended mitigation

- The defined instream flow requirements must be adhered to at all times.
- The infrastructure should be adequately maintained to retain the smallest footprint possible and minimise post construction impacts on local habitat.

iv. Impact on species with conservation concern

As described for the construction phase, impact pertains to eel migration and presence of endemic mayflies. With the two dams situated between two waterfalls and hence geographically isolated, the area is likely to contain several macro-invertebrate species of conservation concern. The impact associated with the operational phase will be permanent and the only mitigation measures applicable pertain to flow regime.

Recommended mitigation

The instream flow requirements defined for the system must be maintained at all times. Preferably, peak generation should be implemented in winter with base generation in the summer. As such seasonal peak flows will restrict daily changes in flow levels to a single season (winter).

Table 36: Assessment of impacts on aquatic ecology during the operation phase

Loss of aquatic habitat	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent –	Medium	Medium (3)	High (4)	High	Medium-

		with mitigation (4)	(3)				high
Lalini Dam Base generation only and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-high
Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-high
Lalini Dam Base generation in summer and Peak in winter and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	High (4)	High (5)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-high
Impact on flow dependant species	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Lalini Dam Baseflow only and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Lalini Dam Baseflow in summer and Peak in winter and associated infrastructure							
Without Mitigation	Regional (3)	Permanent – with mitigation (4)	High (4)	Medium (3)	Definite (5)	High	High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High

Loss of aquatic biodiversity	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Lalini Dam Base generation only and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Lalini Dam Base generation in summer and Peak generation in winter and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with no mitigation (5)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
Impact on species with conservation concern	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Lalini Dam Base generation only and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Lalini Dam Peak time generation and associated infrastructure							
Without Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	High (4)	High	Medium-High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Lalini Dam Base generation in summer and Peak generation in winter and associated infrastructure							
Without Mitigation	Local (2)	Permanent –	Medium	Medium (3)	High (4)	High	Medium-

		with mitigation (4)	(3)				High
With Mitigation	Local (2)	Permanent – with mitigation (4)	Medium (3)	Medium (3)	Medium (3)	High	Medium-Low
Please note that reference to the respective projects also considers impact from associated activities, including gauging weirs, WWTWs, accommodation infrastructure, river intake structures and associated works and information centres.							

c) Wetlands

i. Loss of wetland / riparian habitat and ecological structure, loss of wetland / riparian habitat ecoservices and impacts on wetland / riparian hydrology and sediment balance

Release of water in the generation tunnels, and maintenance of the power line infrastructure will be the primary impacting factors on wetland / riparian habitat during the operational phase. Species composition and community structure of riparian vegetation may be influenced by the release of water in the generation tunnels if the EWR is not managed properly.

Recommended mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

Table 37: Assessment of wetland impacts during the operation phase

Loss of wetland / riparian habitat and ecological structure, loss of wetland / riparian habitat ecoservices, and impacts on wetland / riparian hydrology and sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							

Loss of wetland / riparian habitat and ecological structure, loss of wetland / riparian habitat ecoservices, and impacts on wetland / riparian hydrology and sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low

9.4 IMPACT ASSESSMENT FOR ROADS INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the road infrastructure (DEA Ref no. 14/12/16/3/3/1/1169).

The activities included under this chapter are listed below:

- Upgrading and relocation of roads and bridges; and
- Construction of new access roads around the Lalini Dam site.

9.4.1 Construction and Decommissioning Phases

a) Water Quality

The following key impacts on water quality have been identified for the construction and decommissioning phases:

i. Impacts during the construction of the road infrastructure

Some impacts on water quality may occur during the construction and decommissioning phases. These have to do with possible contamination of the river by construction materials. These occurrences are governed by the National Water Act, and as long as this is adhered to, the effect will be minimal. This applies to the proposed upgrading, realignment and construction of access roads.

Table 38: Water Quality Impacts during the construction of the road infrastructure

Contamination by construction materials	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	Regional	Medium term	Medium	Medium	High	Medium	Medium -Low
With Mitigation	Site	Short term	Negligible	Low	Improbable	Medium	Very low

b) Aquatic ecology

Relocation and upgrading of bridges will have site specific impacts at riverine points of construction. Impacts due to canalisation and erosion will potentially be caused due to the disturbance of soils, during site clearing, and the alteration of flow regimes in the Tsitsa River and tributaries. If effectively mitigated, such impacts will be of short duration and low intensity. It must be noted that many of the crossings will be over small streams of limited ecological importance and sensitivity although due to the limited flow in the systems care must be taken during construction to not adversely affect these systems.

Probable latent impacts on a site specific to local scale thus include:

- Localised erosion (not significant);
- Localised changes to instream and riparian habitat (not significant);
- Localised sedimentation of the system may lead to altered instream habitat (potentially significant);
- Localised changes to instream and riparian habitat (not significant);
- Some localised changes to aquatic and riparian zone community assemblages (not significant).
- Some changes to the hydrology of the system may occur altering instream habitats on a localised scale (not significant).
- Localised changes to instream and riparian habitat and cover types (not significant);
- Some localised changes to aquatic and riparian zone community assemblages (not significant).

Recommended mitigation

- All crossing construction should be undertaken in the low flow season as far as is possible;
- The duration of construction works needs to be kept to the absolute minimum and all project planning must be very well orchestrated to reach this goal;
- The construction infrastructure and coffer dams and stream diversions must at no time lead to upstream ponding and inundation or lead to the constriction of flow and downstream erosion;
- Minimise disturbance of instream and bankside areas and minimise activities in these areas;

- As far as possible keep all instream areas and stream banks off limits to general activity during the construction phase;
- Any construction-related waste must not be placed in the vicinity of any riparian areas;
- Ensure that on-site camp fires are forbidden;
- Edge effects (impacts on areas beyond the construction footprint due to less than desirable care and management) during construction and operation need to be strictly controlled through ensuring good housekeeping and strict management of activities near the stream crossing;
- During construction, drift fences constructed from hessian sheets should be installed at erodible areas to minimise erosion. Silt traps should also be provided to remove sand/silt particles from runoff;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise environmental damage;
- Riparian areas that may have been disturbed during construction should be rehabilitated through reprofiling and revegetation upon completion of the construction phase;
- Desilt all riparian areas affected by construction activities;
- Reprofiling of the banks of disturbed drainage areas to a maximum gradient of 1:3 to ensure bank stability if necessary;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles;
- During construction care must be taken to disrupt the riparian zone as little as possible to avoid erosion and sediment load into the system. This can be achieved by permitting only essential construction personnel within 32m of all riparian systems.
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area.

Table 39: Assessment of impacts on aquatic ecology during the construction phase

General impact	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed Roadways							
Without Mitigation	Local (1)	Short term (1)	Low (2)	Medium (3)	Medium (3)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Medium (3)	Low (2)	High	Very low
Cumulative Impact and Comments– Construction of the development will have temporary impact that could be mitigated to some extent.							

c) Wetlands

The following key impacts on wetlands have been identified for the construction and decommissioning phases:

Existing roads currently traverse some wetland or riparian habitat, and thus these habitats have already undergone some transformation as a result. The construction of new roads therefore poses a greater threat to the integrity of wetland or riparian habitats, particularly in the vicinity of the Lalini Dam where few roads presently exist.

Mitigation measures for these impacts are provided below.

i. Loss of wetland / riparian habitat and ecological structure and impacts on wetland / riparian hydrology and sediment balance

Recommended mitigation:

- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- New road routes must be planned in such a way as to avoid traversing wetland / riparian habitats, with special mention of drainage lines, channelled valley bottom wetlands and riparian habitat. Where it is necessary to traverse such features, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:
    - The crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels.
    - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
    - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 300mm of the soil surface at all times;
    - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer season;

- Stabilisation of river banks in the vicinity of any bridge crossings over the Tsitsa River or any of its tributaries by either employing one of the individual techniques below or a combination thereof, including:
  - Re-sloping of banks to a maximum of a 1:3 slope;
  - Revegetation of re-profiled slopes;
  - Temporary stabilisation of slopes using geotextiles; and
  - Installation of gabions and reno mattresses.
- Construction vehicles must be restricted to designated access roads and should not be permitted to drive through sensitive wetland / riparian habitat;
- Strict controls of edge effects such as proliferation of alien vegetation and increased sedimentation due to disturbances to the soil profile must be implemented;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles; and
- Monitor all systems for incision and sedimentation.

ii. Loss of wetland / riparian ecoservices

Recommended mitigation:

- Edge effects of activities including erosion and alien / weed control need to be strictly managed in the wetland areas;
- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. In this regard, special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented.

Table 40: Assessment of wetland impacts during the construction phase

Loss of wetland / riparian habitat and ecological structure and impacts on wetland / riparian hydrology and sediment balance	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Loss of wetland / riparian ecoservices	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low

9.4.2 Operation Phase

a) Water Quality

There will be no impacts on water quality of the Tsitsa River during the operation of the access roads.

b) Aquatic ecology

Extensive development project activities often cause a change to peak flows in the river system downstream of the project site, due to changes in surface coverage. Development of a project area will change the surface coverage in some areas from vegetated soil to buildings, hardened gravel roads, paved areas (parking), and compacted earth. These new surface types will allow considerably less infiltration into the ground (typically 0-20%) as compared to the natural surface (typically 60-70%), resulting in more surface runoff following storms and consequently higher peak flow rates. However, such an impact on river peak flow rates would be large insignificant on a local or regional scale. On a site specific scale run-off may result in erosion and sedimentation but such impact can be mitigated.

Recommended mitigation

- Roads and associated pipeline developments must be well maintained to avoid site specific impacts such as erosion or sedimentation resulting from run-off.
- Sheet runoff from access roads and the final road structure needs to be curtailed and slowed down by the strategic placement of energy dissipation structures;
- Adequate stormwater management must be incorporated into the design of the proposed structure in order to prevent erosion and the associated sedimentation of the system for the life of the structure; and
- As far as possible, all construction activities should occur in the low flow season, during the drier summer months;
- It must be ensured that migratory connectivity and stream continuity is maintained throughout the construction phase of the project;
- Removal of alien vegetation and good housekeeping within the road reserve must take place at all times;
- Any spills by maintenance teams or road users should be cleaned up immediately and all work overseen by a suitably qualified professional.

Table 41: Assessment of impacts on aquatic ecology during the operation phase

General impact	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Proposed road upgrades							
Without Mitigation	Local (1)	Short term (1)	Low (2)	Low (2)	Low (2)	High	Very low
With Mitigation	Site (1)	Short term (1)	Low (2)	Low (2)	Low (2)	High	Very low

c) Wetlands

As with the pipelines and power lines, the primary impact on wetland / riparian habitat during the operational phase of the roads is that of maintenance. Additionally, the anticipated increased volume of traffic on the roads due to the continued operations of the dams escalates the risk of toxicants such as motor vehicle oil reaching the wetlands and river systems in runoff from the roads. In the same manner, the likelihood of increased sediment and water inputs to the wetlands and river systems is increased.

Mitigation measures for these impacts are provided below.

i. Loss of wetland / riparian habitat and ecological structure, loss of wetland / riparian ecoservices and impact on wetland / riparian hydrology and sediment budget

Recommended mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision;
- Monitor wetland crossings for proliferation of alien vegetation;
- Spills from motor vehicles must be cleaned up and treated immediately; and
- All staff motor vehicles should be regularly inspected for leaks, and re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

Table 42: Assessment of wetland impacts during the operation phase

Loss of wetland / riparian habitat and ecological structure	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Loss of wetland / riparian ecoservices	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low

10. MITIGATION MEASURES

This section of the report will present the mitigation measures that have been incorporated into the preliminary design of the MWP to avoid environmentally sensitive areas in the study area.

10.1 RIVER AND STREAM CROSSINGS

- The Contractor is responsible for controlling riparian and in stream damage to the river systems that will be crossed. Construction shall be halted in the event of aquatic organism stress caused by the works, until adequate controls are put in place.
- The Contractor must prepare for each river crossing a detailed method statement that will include, but not be limited to:
    - A biophysical description of the site;
    - Timing and duration of river crossing construction;
    - An itemised list of the equipment that will be used for the river crossing construction;
    - Measures to maintain flow in the system throughout the construction period;
    - A description of the design and methods for the creation of any stream diversions;
    - Measures that will be used to control sediment and turbidity, spillage of fuel and cement, and monitoring programme to provide rapid feedback on the effectiveness of controls;
    - Measures that will be used to stabilise river embankments after construction and to return the channel to its pre-construction profile or to a more stable profile; and
    - Measures that will be used to minimise the impact of blasting (if any) on aquatic species.
- During Construction the contractor must make provision to maintain the natural flow of any drainage line affected by construction.
- In excavating the bed of the water body, the Csontractor must backfill the excavation with material which was originally removed from the stream bed. Further care must be taken to minimise the amount of material used for backfill which have abrasive surfaces.
- Where isolating the location of a works, the following measures, amongst others, may be considered by the contractor in order to minimise the risk of increased suspended sediment in the water column downstream of the works:
    - Elimination of surface flow through the construction site;
    - The use of non-erodible materials for the construction of berms, coffer dams or other isolation structures used in a works within a flowing water course. The use of non-earthen dam structures such as aquadams are possible options;

   - In cases where the entire flow of water of a water body is diverted around the water crossing site, it must be returned to the water body immediately downstream of the crossing site;
   - The use of silt fences or hay bales to isolate the construction area from the water body in situations where the flow velocities and volumes are low;
   - The removal and temporary storage of any material excavated from the bed or banks of the water body until the materials are replaced within the stream or permanently removed from the site;
   - The treatment of any water removed from the isolation area, prior to discharge into the downstream river course, to remove suspended sediment.
- The Contractor must monitor the effect of construction on downstream sediment loads. The monitoring programme shall include sampling in the river upstream and downstream of the works during the period when construction in the river is taking place.
- During the construction works, the Contractor must remove any fish that are found within the isolated portion of the river crossing, without harm to the fish, to an area of the water body immediately adjacent to the river crossing, outside the isolated portion of the river crossing site.

10.1.1 Bridges

- Clearly delineate the boundaries of the construction area as to ensure that the footprint of the impacted area is kept as small as possible;
- Use of an adequate long bridge span to avoid constricting the natural active channel and minimise constriction of any overflow channel;
- Placement of foundations onto nonscour-susceptible material (e.g. bedrock or coarse rock material) or below the expected maximum depth of scour;
- Set bridge abutments or footings into firm natural ground (e.g. not fill material or loose soil) when places on natural slopes;
- Use suitable measures as needed in steep, deep drainages to retain approach fills or use a relatively long practicable bridge span;
- Avoid the placement of abutments in the active stream channel to the extent practicable;
- Place in-channel abutments in a direction parallel to the streams flow where necessary; and
- Use suitable measures to avoid or minimise, to the extent practicable, damage to the bridge as associated road, from expected flood flows, floating debris, and bedload;
- Inspect the bridge at regular intervals and perform maintenance as need to maintain the function of the structure.

10.1.2 Temporary river crossings

- Temporary river crossings will be constructed to accommodate site traffic over the Tsitsa River.
- All temporary river crossings will be constructed by placing 1 m diameter pipes next to each other, the number of pipes that will be placed end to end will be determined by the width of the river crossing needed.
- Rocks, gabions or Reno mattresses will be placed along the intake and outlet of pipe culverts to reduce scouring of the river banks. This will be done in such a way as to limit the change of flow in the river.
- No river crossings are foreseen outside the construction area, however if this is required the Engineer and the ECO will be consulted and the method statement will be revised in accordance to address rehabilitation issues.

10.1.3 Culverts

- Align the culvert with the natural stream channel;
- Clearly delineate the boundaries of the construction area as to ensure that the footprint of the impacted area is kept as small as possible;
- Cover the culvert with sufficient fill to avoid or minimise damage by traffic;
- Construct at or near natural elevation of the streambed to avoid or minimise potential flooding upstream of the crossing and erosion below the outlet;
- Install culverts long enough to extend beyond the toe of the fill slopes to minimise erosion;
- Use suitable measures to avoid or minimise water from seeping around the culvert;
- Use suitable measures to avoid or minimise culvert plugging from transported bedload and debris; and
- Regularly inspect culverts and clean as necessary.

10.1.4 Construction campsites

- The Contractor must comply with all relevant laws and regulations concerning water provision, sanitation, wastewater discharge and solid waste disposal.
- The Contractor may not establish any campsite within 100m of any watercourse.
- The Contractor must prepare documentation that specifies details pertaining to site layout, topsoil management, sewage treatment, solid waste disposal, erosion control, litter management, provision for vehicle and plant servicing, water supply and rehabilitation.
- The Contractor must classify al hazardous material to be used on site according to recognised Codes of Practice such as SABS Code 0228 for the identification of Dangerous Substances and Goods and the Department of Water Affairs and Sanitation’s minimum requirements for the Handling, Classification and Disposal of Hazardous Waste, and must ensure that the handling, storage, transport and disposal of these materials meets the requirements of these Codes.

- At river crossings, the contractor must place on-site tools and equipment, such as pumps, compressors and generators on bermed impermeable sheeting to prevent hydraulic fluid or fuel leaks from contaminating soil or ground water or entering any watercourse or wetland.
- That contractor must ensure that all equipment which is required to work in rivers is cleaned of oil, grease and other contaminants damaging to aquatic life.
- The contractor must ensure that there is sufficient absorbent material available onsite to manage accidental spills.

10.1.5 Rehabilitation

- The river channel embankment must be returned to the pre-existing (or more stable) profile than that which existed prior to construction.
- The river embankment must be stabilised, using necessary protection measures, including re-vegetation, rip-rap, re -profiling, reno mattresses and other measures, to ensure that the embankments are protected against erosion.
- Measures using indigenous grasses to permanently stabilise disturbed areas must be fully effective by the end of one growing season.
- Debris disposal and clean up shall be carried out to return the river course to its pre-existing condition prior to construction.

10.1.6 Drainage from bridge crossing during the Operational Phase

The function of drainage is to dispose of sub-surface and surface water via designed outlets through various bridge components, in order to prevent the development of water pressure behind earth retaining structures or the accumulation of water on bridge decks which could prove hazardous to road users. In other locations drainage outlets are required to dispose of water which has percolated through joints, deck surfacing or fill beneath sidewalks, to avoid entrapment and durability problems.

The specific components which require the provision of drainage facilities are:

- Abutments, retaining walls and culvert barrels, behind which drainage filters and pipes are required to collect ground water and dispose of this through weepholes.
- Abutment girder beds which require the provision of collector channels and outlet pipes to remove water which has leaked through expansion joints or has arisen from driving rain or condensation;
- Deck roadway surface subject to direct rainfall, which must be disposed of via drainage scuppers, supplemented in certain instances by grid inlets and concealed drainage pipes;
- Deck concrete surface on the uphill side of concrete nosings, asphalt plug joints or proprietary joints, which cause the entrapment of water which has percolated through the asphalt surfacing and must be disposed of through small drainage pipes.

- Deck concrete surface on the uphill side of the transverse concrete housings for the expansion joints which seal off the area beneath the sidewalks and entrap water which has percolated through the sand fill and must be disposed of through drainage pipes; and
- Drip notches in the underside of deck cantilevers, strictly in compliance with the configuration and positions shown on the drawings. The careless omission of drip notches can lead to the defacement of the soffits and sides of bridge decks through runoff water laden with silt and other contaminants even before construction of the balustrades.

The monitoring staff is expected to verify that the particular products proposed by the contractor comply with the specification and that when installed are adequately secured in place to avoid being dislodged during the concreting and backfilling operations.

10.2 RIVER INTAKE STRUCTURES

River intake structures will take the form of mass concrete measuring weirs with upstream wells for pumped abstraction for the small water abstractions. This will be finalised in detail design stage.

10.3 RIVER OUTLET STRUCTURES

The main outlet works in the dams are multi-level towers and pipes within a reinforced concrete structure, discharging to a rock lined stilling basin just downstream of the dam wall. Other river outlets (from small hydropower plants) are generally from concrete headwalls, and are normally accompanied by appropriate erosion control such as stilling basins or gabion works. This will be finalised in detail design stage.

10.4 WETLAND CROSSINGS

- Mitigation measures to limit the impacts (such as ensuring the design of crossings allows for the retention of wetland soil conditions) must be implemented at all wetland crossings already in place;
- Quarries and borrow pits should ideally be placed within the dam footprints in order to preserve wetland and riparian habitat outside of the dam footprints, and to reduce sedimentation of the riparian resources;
- Minimise the construction footprints and implement strict controls of edge effects;
- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- An alien vegetation control programme is implemented, as encroachment of alien vegetation is already apparent in the study area and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of

disturbed areas, utilising indigenous wetland vegetation species, will assist in retaining essential wetland ecological services, particularly flood attenuation, sediment trapping and erosion control, and assimilation of nutrients and toxicants, thus reducing the impacts of construction related activities;

- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;
- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operations and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat and therefore ability of the wetlands to provide ecological services, is already compromised.
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.
- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- Where it is necessary to traverse features such as drainage lines, channelled valley bottom wetlands and riparian habitat, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:

    - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
    - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 300mm of the soil surface at all times;
    - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer season;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, Reno mattresses and geotextiles;
- Monitor all systems for incision and sedimentation;
- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. The use of indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented is essential;
- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat.

The first filling of the dams will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the affected wetland features which will not be inundated with special mention of areas downstream of the proposed dams.

- The Contractor must prevent permanent damage occurring as a result of construction of the works to all wetlands affected by the proposed infrastructure.
- As far as practical possible, the contractor must schedule construction activities to take place during winter when surface and subsurface water flows are lowest.
- The Contractor must not remove any vegetation within the wetland, other than that which is absolutely necessary.
- The construction area is to be defined and any areas beyond the construction area to be cordoned off with danger tape and designated as ‘no go’ areas for personnel and construction vehicles.
- The contractor must manage all temporary construction roads in or adjacent to wetlands so as to disperse runoff and avoid concentrating water flows.
- Disturb the least amount of area as practicable when crossing a standing water body. Clearly delineate the boundaries of the construction area as to ensure that the footprint of the impacted area is kept as small as possible;

- Avoid as far as practicable the movement of ground equipment on unstable, wet, or easily compacted soils and on steep slopes unless operation can be conducted without causing excessive rutting, soil puddling, or run-off of sediments directly into water bodies;
- Install suitable storm water and erosion control measures to stabilise disturbed areas and waterways during times of no construction in the specific area as to prevent sedimentation mobilization during rainfall events;
- Provide for sufficient cross drainage to minimize changes to, and avoid restricting, natural surface and subsurface water flow of the wetland under the road to the extent practicable;
- Use suitable measures to increase soil-bearing capacity and reduce rutting from expected vehicle traffic;
- Construct fill roads when necessary as to maintain road geometry and alignment;
- Don’t use drainage bottoms as turn-around areas for construction vehicles;
- The fill used in the construction of the road will be constructed as far as practicable possible parallel to the flow of water and be as low to the natural ground level as practicable; and
- Construct the road with sufficient surface drainage as to allow for surface flows in such a manner that it prevents erosion.

11. MONITORING AND COMPLIANCE

Please refer to the Environmental Management Programme (EMPR) attached as an appendix in the ***Environmental Impact Assessment for the Mzimvubu Water Project: P WMA 12/T30/00/5314/3****.* Monitoring will be required during the period of construction, when the disturbance will occur. Water quality will be monitored during the construction and operational phase of the dams.

11.1 ROLES AND RESPONSIBILITIES

A number of people are responsible throughout the project, i.e. during planning, construction and operation of the all water uses for this development, to ensuring that environmental best practices are adhered to. This list includes, and is not limited to the following people:

- Developer or Implementing Agent: Person or organisation funding the implementation of the project;
- Environmental Consultant: Independent environmental practitioner(s) responsible for the preparation and submission of environmental authorisation applications, impact reports;
- Project Manager: Representative of the Implementing Agent who co-ordinates all aspects of the project;
- Design Engineer: Involved during the design and planning stage and is responsible for ensuring that the relevant environmental planning and design considerations are taken into account during these phases;
- Contractor: Appointed by the Implementing Agent to conduct the construction. The contractor must ensure that all staff employed for the project receive sufficient training;
- Site Engineer: Person responsible for supervision and quality control on site and may at times assume the responsibilities of the Project Manager;
- Environmental Officer: Person responsible for managing the day-to-day on-site implementation of the Construction Contract;
- Environmental Control Officers (ECO): Person responsible for conducting environmental audits as required. An independent ECO is an unaffiliated party, generally appointed for external audits of projects conducted in sensitive areas.

11.2 MONITORING DURING THE CONSTRUCTION PHASE

11.2.1 Abstraction

During the construction phase the water abstracted directly from the water resource will be recorded and reported within the monthly monitoring report. The number of water tankers used will be recorded and the total volume used monthly will be calculated. The quantity of surface water abstracted must be metered or gauged and the total recorded as at the last day of each month.

11.2.2 Water Quality

a) Baseline water quality monitoring

The objective of the baseline water quality monitoring is to provide a background record against which the performance of the environmental management plan can be assessed. As such two conditions have to be considered, namely the construction phase and the operational phase. During the construction phase the impact is from the discharge of waste and waste water from the various construction activities, while during the operational phase the impact will be from storing water in the proposed dam, and the transfer of water from one catchment to another.

<u>Construction Phase</u>

Any waste water and/or storm water that is discharged during the construction phase will have to comply with the requirements of the National Water Act, specifically with the conditions set by the General Standard (Regulation 9225, Government Gazette, 18 May 1984) unless a licence is issued that sets specific standards for selected variables.

It is recommended that samples for a comprehensive analysis are collected at the recommended sites for baseline monitoring, in order to establish a more exact relationship between the variables that are measured as part of the National Water Quality Monitoring Network and the additional variables that are required for the baseline study. This can then be used for the purposes of correlation, should this be required.

Variables

The baseline monitoring should consider those variables that describe the fitness for use of all possible downstream users. This can only be done if guidelines are available, as without guidelines it is not possible to assess the impact. For this reason the variables that are considered in the South African Water Quality Guidelines should be used. The variables for which guidelines are available are shown in the **Table 43** (an **X** indicates that guidelines are available, shaded variables denote General Standard variables). Only four user groups were considered, as the variables that apply for human consumption also apply to livestock watering (the guideline values are different), and the same applies for aquaculture and the aquatic ecosystem.

Table 43: Water quality variables for which guidelines are available

Variable	User Group			
	Domestic	Irrigation	Ecosystem	Recreation
Aluminium	X	X	X	
Ammonia	X		X	
Arsenic	X	X	X	
Asbestos	X			
Atrazine	X		X	

Variable	User Group			
	Domestic	Irrigation	Ecosystem	Recreation
Beryllium		X		
Boron		X		
Cadmium	X	X	X	
Calcium	X			
Chloride	X	X		
Chlorine			X	
Chromium	X	X	X	
Cobalt		X		
Coliforms (F)		X		
Colour	X			
Copper	X	X	X	
Corrosion	X	X		
Cyanide			X	
Dissolved Organic Carbon	X			
Dissolved Oxygen			X	
Endosulfan			X	
Fluoride	X	X	X	
Indicator Organisms	X			X
Iron	X	X	X	
Lead	X	X	X	
Lithium		X		
Magnesium	X			
Manganese	X	X	X	
Mercury	X		X	
Molybdenum		X		
Nickel		X		
Nitrate	X			
Nitrogen (Inorganic)		X	X	

Variable	User Group			
	Domestic	Irrigation	Ecosystem	Recreation
Odour	X			X
pH	X	X	X	X
Phenols	X		X	
orus (Inorganic)			X	
Potassium	X			
Radioactivity	X			
Selenium	X	X	X	
Settleable Matter (Susp Solids)	X	X	X	
Sodium	X	X		
Sodium Adsorption Ratio		X		
Sulphate	X			
Trihalomethanes	X			
Temperature			X	
TotalDissolved Solids (Cond)	X	X	X	
Total Hardness	X	X		
Turbidity	X			X
Uranium		X		
Vanadium	X	X		
Zinc	X	X	X	

The proposed development will not affect all of the variables, nor are all of the variables relevant in the affected catchments (Uranium and radioactivity are examples of this), while other variables are not practical to measure (odour). Some variables are calculated from the concentrations of measured variables (Sodium Adsorption Ratio, Total Hardness, Corrosivity). The approach is therefore to use primarily those variables that are listed as part of the General Standard, and also those variables that were identified as variables of concern during the water quality study.

The variables that should be measured in terms of the General Standard are:

- Colour (Cobalt-Platinum Units)
- pH (pH Units @ 25 °C)
- Dissolved Oxygen (mg/l O2) (To be measured in situ)
- Faecal Coli (CFU/100ml)
- Temperature (°C) (To be measured in situ)
- Chemical Oxygen Demand (mg/l)
- Oxygen Absorbed (mg/l)
- Conductivity (mS/m @ 25 °C)
- Suspended Solids (mg/l)
- Sodium (mg/l Na)
- Soap, oil, grease (mg/l)
- Residual chlorine (mg/l Cl)
- Free and saline ammonia (mg/l N)
- Arsenic (mg/l As)
- Boron (mg/l B)
- Hexavalent chromium (mg/l Cr)
- Total chromium (mg/l Cr)
- Copper (mg/l Cu)
- Phenolic compounds (mg/l phenol)
- Lead (mg/l Pb)
- Cyanides (mg/l Cn)
- Sulphides (mg/l S)
- Fluoride (mg/l F)
- Zinc (mg/l Zn)
- Manganese (mg/l Mn)
- Cadmium (mg/l Cd)
- Mercury (mg/l Hg)
- Selenium (mg/l Se)

Some of these variables can be expected to be absent, or if present, occur in trace concentrations. However, confirming this will represent information that otherwise could be held in doubt.

- Calcium (mg/l Ca)
- Magnesium (mg/l Mg)
- Sulphate (mg/l SO_4)

- Fluoride (mg/l F)
- Chloride (mg/l Cl)
- Nitrate/Nitrite (mg/l NO_3 / NO_2)
- Potassium (mg/l K)
- Aluminium (mg/l Al)
- Phosphate (mg/l PO_4)
- Total Alkalinity (mg/l $CaCO_3$)

Sampling Frequency
Construction is scheduled to start in November 2014, and therefore less than one year of sampling is available to establish baseline conditions. However, site establishment will take some time, and it can be accepted that more time is available before any serious disturbance to the river occurs.

In order to determine accurate statistic parameters for the baseline condition, monitoring should be conducted over at least one year in order to detect seasonal variations. At the same time a total of at least 19 measurements are required in order to determine the 95th percentile value. Water quality data is under normal conditions highly correlated, and collecting samples at too short an interval will generate data that are not statistically independent. A sampling interval of at least two weeks is recommended in order to ensure the statistical independence of the measurements. A fortnightly sampling programme over one year will yield 27 results, which will be adequate to calculate statistical parameters at a reasonable confidence (± 10%).

A sampling interval of two weeks is therefore recommended.

A one year sampling programme is not sufficient to detect trends, but the historic data from the DWS can be used for this purpose.

Sampling Protocol
The sampling protocol as prescribed by the laboratory that will perform the analyses must be followed. In the absence of a clear sampling protocol, the guidelines presented in Water Research Commission Report No: TT 117/99 must be followed.

Sample Analyses
Measurements and analytical processes must conform to the appropriate SANS, or to the Standard Methods if no SANS method is applicable.

Sampling Sites
For the purposes of compliance monitoring, upstream and downstream samples should be collected during the construction period. For the purposes of establishing the baseline conditions, four sampling sites are recommended, one upstream of the Ntabelanga Dam, one downstream of the Ntabelanga Dam, one downstream of the Lalini Dam and one downstream of the Ngcolora tributary. The sites should be chosen such that they will not be directly affected by construction activities, or inundated after completion of the proposed dam.

11.2.3 Water Management

General

The Contractor shall submit a Water Management Method Statement (WMMS), including measures for water conservation, for approval to the Engineer prior to the commencement of works.

The WMMS should include an indication of how water and wastewater/effluent will be managed at/with respect to (i) camps and associated facilities, including batching/mixing plants; (ii) excavations, (iii) pumping operations, (iv) cleaning and washing bays, (v) site drainage (silt and erosion control), (vi) storm water, and (vii) river/wetland and erosion gulley crossings.

The Contractor shall take all necessary precautions and properly deal with and dispose of all water, in accordance with the specification to ensure that:

- the Works are kept sufficiently dry at all times for their proper and safe execution;
- there is no deleterious impact on the environment and adjacent properties; and
- damage, inconvenience or interference arising from flood waters is prevented.

Such operations shall continue for the duration of the Contract and shall at all times be subject to the agreement of the Engineer with regard to the sufficiency of measures and the degree of environmental protection achieved.

The Contractor shall minimise the use of water and shall immediately attend to any wastage. Natural water sources (e.g. springs, streams, open water bodies) shall not be used as a source of water by the Contractor without the Engineer's approval.

On completion of the Works, all temporary diversions, protective works and dewatering systems shall be removed by the Contractor. Affected areas shall be rehabilitated according to the specifications.

Quality and quantity monitoring

The Contractor must appoint a suitably qualified water quality specialist for approval by the Engineer to implement a water quality monitoring programme for monitoring the water quality in the Tsitsa River only.

The Water Management Method Statement must include monitoring and reporting mechanisms that cover all water abstractions from the river or any other water source, waste discharge, soil erosion and water quality aspects.

The Water Management Method Statement must include measures to prevent the pollution of any river, stream or wetland with grease, hydrocarbons, suspended solids or other contaminants emanating from construction activities, these measures shall include a site plan, approved by the Engineer, on which is shown monitoring points of all treated or un-treated discharges to a public stream (considered to be industrial wastewater for this purpose) where monitoring of flow rate and quality will be undertaken in accordance with the requirements of Schedule 3 of Government Notice 665 published in Government Gazette No 36820 dated 6 September 2013.

The flow rate and quality of all potential discharges of treated and un-treated waste water from the construction site, at points marked on a site plan in the WMMS for approval by the Engineer, will be monitored in accordance with the requirements of Schedule 3 of Government Notice 399 published in Government Notice 665 published in Government Gazette No 36820 dated 6 September 2013.

Water sampling must follow a clear protocol specified by the laboratory that will perform the analyses. Measurements and analytical procedures must conform to the relevant SANS.

All discharges from settlement ponds, sewage treatment works, batching plants, washing areas and any other areas must be sampled and tested at points approved by the Engineer. The quality of point discharges shall comply with the criteria given in **Table 44**. Water quality monitoring reports must be submitted to the Engineer within 10 days of taking the sample.

Table 44: List of Water Quality Variables to be Sampled at the Discharge Point

VARIABLE	REQUIRED EFFLUENT STANDARD
Arsenic (as As)	Not to exceed 0.1 mg/ ℓ
Boron (as B)	Not to exceed 0.5 mg/ ℓ
Cadmium (as Cd)	Not to exceed 0.05 mg/ ℓ
COD	Not to exceed 5 mg/ ℓ
Colour, odour, taste	Free of any substance in a concentration capable of producing any colour, odour or taste
Conductivity	Not to exceed 250 mS/m
Copper (as Cu)	Not to exceed 0.02 mg/ ℓ
Cyanide (as Cn)	Not to exceed 0.5 mg/ ℓ
Dissolved oxygen	At least 75% saturation
Feacal coliforms Thermotolerant (faecal) coliform bacteria	No *E. coli* (0/100 m ℓ) or No Thermotolerant (faecal) coliform bacteria (0/100 m ℓ)
Fluoride (as F)	Not to exceed 1.0 mg/ ℓ
Free & saline ammonia (as N)	Not to exceed 1.0 mg/ ℓ
Lead (as Pb)	Not to exceed 0.1 mg/ ℓ
Manganese (as Mn)	Not to exceed 0.1 mg/ ℓ
Mercury (as Hg)	Not to exceed 0.02 mg/ ℓ
Nitrate (as $N0_3$)	Not to exceed 1.5 mg/ ℓ

VARIABLE	REQUIRED EFFLUENT STANDARD
Nitrite	Not to exceed 1.0 mg/ ℓ
pH	Between 5,5 and 7,5
Phenolic compound (as phenol)	Not to exceed 0.01 mg/ ℓ
Phosphate (as $P0_4$)	Not to exceed 1.0 mg/ ℓ
Residual Chlorine (as Cl)	Non residual chlorine
Selenium (as Se)	Not to exceed 0.05 mg/ ℓ
Soap, oil, grease	No soap, oil or grease
Sodium	Not to be increased by more than 50 mg/ℓ above influent
Sulphides (as S)	Not to exceed 0.05 mg/ ℓ
Suspended solids	Not to exceed 10 mg/ℓ
Temperature	Maximum of 25°C. In addition the effect of water discharged into watercourses shall not raise the water within the watercourse at a point 500 m downstream of the point of discharge by more than 2°C above the temperature of the water 500 m upstream of the Works
Total Chromium (as Cr)	Not to exceed 0.05 mg/ℓ
Zinc (as Zn)	Not to exceed 0.03 mg/ℓ

<u>Watercourses</u>

The Contractor shall take all necessary measures when working within rivers to ensure that the water quality of these systems is not adversely impacted by the construction activities.

Up and downstream of monitoring is required (sites to be determined by specific context and up/downstream land-use/impacts). Pre construction (baseline) samples must be collected. The final monitoring sample must take place after rehabilitation is complete.

The following variables must be monitored:

- Temperature
- pH
- Electrical conductivity
- Dissolved oxygen
- Suspended solids.

The Engineer may require more detailed testing where there is evidence of contamination.

Water quality sampling at the upstream and downstream monitoring sites will be made at the same time –around noon - each day. The maximum “allowable limit of change” in any water quality parameter at the downstream monitoring point should not be greater than 10 % above the value for the respective water quality parameter measured at the upstream monitoring point. Careful records shall be kept of all occasions when the water quality at a downstream monitoring point has exceeded the limits of allowable change.

Should the values of any of these key indicator variables at the downstream site vary by 10 per cent or more relative to measurements of the same variables taken at approximately the same time at the upstream site, it could indicate that associated changes have occurred in some of the other water quality variables. Immediate mitigation action will be required on the site and water samples should be collected as soon as possible and sent to the accredited analytical laboratory for analysis of the full list of river and wetland variables (**Table 45**). The laboratory should be requested to provide the results of these samples within 14 working.

Table 45: Full list of Water Quality Monitoring variables for rivers and wetlands

Parameters and Variable	Testing Frequency	Test Responsibility
COD (mg/l)	Every 2 days when flow is present	Collect sample on site analyze in laboratory
Nitrate and Nitrite (mg/l)	Every 2 days when flow is present	Sample on site & laboratory analysis
Orthophosphates (mg/l)	Every 2 days when flow is present	Sample on site & laboratory analysis
Suspended Solids (TSS) (mg/l)	Every 2 days when flow is present	Sample on site & laboratory analysis
Soaps, oil and grease (mg/l)	Every 2 days when flow is present	Sample on site & laboratory analysis
Free & Saline ammonia (mg/l)	Every 2 days when flow is present	Sample on site & laboratory analysis
Faecal Coliform bacteria (per 100ml)	Every 2 days when flow is present	Sample on site & laboratory analysis
Conductivity (mS/m)	Daily when flow is present	Measure on site using hand-held meter
Dissolved oxygen (% saturation)	Daily when flow is present	Measure on site using hand-held meter
pH	Daily when flow is present	Measure on site using hand-held meter
Temperature	Daily when flow is present	Measure on site using hand-held meter when any one of the key variables deviates by more than 10% from the upstream value at the construction site
Turbidity (NTU)	Daily when flow is present	Measure on site using hand-held meter when any one of the key variables deviates by more than 10% from the upstream value at the construction site

Note: Concentrations of the above variables measured 50m downstream of the works in a water resource system must not differ by more than 10% of concentrations of the same variables measured 300 m upstream of the works.

As soon as practically possible, each incident of water contamination shall be investigated, the contamination source(s) located and mitigatory measures implemented to prevent further contamination. A set of confirmatory measurements shall be taken after the implementation of remedial/mitigatory actions to demonstrate that the problem has been dealt with successfully.

On-site management

Storm water and site drainage

Storm water drainage lines shall be constructed by the Contractor to divert runoff water around the construction site to prevent contamination of the water and collection of water in excavations.

All storm water drainage lines shall contain water flow arrestors to prevent erosive action on the sides of the drainage lines.

The Contractor shall not alter or damage existing drainage lines, levees or dams or modify the course or channel of water courses without the prior approval of the Engineer. The Contractor must ensure that all storm water lines are reinstated or rehabilitated on completion of construction activities.

The Contractor must submit a storm water management method statement to the Engineer for approval before the start of construction. The method statement must take into account relevant sections of the specifications.

Settlement ponds

The Contractor shall obtain the Engineer's approval for all settlement pond designs. Temporary settlement ponds must be constructed and maintained by the Contractor for the settling out of suspended solids. Each pond must be of sufficient capacity to allow for the steady through flow of waste water without threat of this water contaminating natural water courses. The ingress of water from natural water courses into settling ponds must be prevented.

Flocculants may need to be used if the settling ponds do not achieve the desired reduction in the concentration of suspended solids. The disposal of flocculated sludge will conform to the specifications for waste disposal.

Crossing of aquifers

A method statement shall be required to be submitted to the Engineer for approval before commencement of any works.

Where the aquifer is directly affected by the Works (i.e. the excavation will be through permeable / water-bearing strata), the methodology employed must ensure that contamination of the aquifer is prevented. Therefore, appropriate measures must be used to prevent the possible migration of pollutants or contaminated water from entering the aquifer.

Disposal of water into the receiving environment from dewatering operations will not proceed in areas overlying known aquifers. All contaminated water must be removed and dealt with outside a buffer zone 50 m around the aquifer.

Working in rivers and wetlands

The Contractor will ensure that adequate measures are in place to prevent contamination of natural water bodies. These measures will include coffer dams or pumping water from the point of source to be treated before release back into the system.

No impediment to the natural water flow other than approved erosion control works and Engineer approved river and wetland crossings shall be permitted. In addition, such crossings shall be performed according to the Engineer approved methodology for construction.

The Contractor must ensure substratum restoration during the rehabilitation phase of the contract. Impermeable clay layers must be recreated / restored to reinstate the sub-surface hydrology and to ensure that perched water tables sustaining wetland habitats are kept intact. Any impermeable layers encountered within the wetland, shall be recorded, and their depths and types noted. These layers will need to be recreated during rehabilitation. The Contractor shall submit to the Engineer for approval, a method statement that deals specifically with the restoration of impermeable substratum layers prior to the commencement of works.

Trench excavations and dewatering

The ingress of water into the trench excavation must be prevented with the placement of suitably constructed berms or drainage lines on either side of the trench. Topsoil or other excavated material shall be prevented from being washed away or allowed to contaminate the storm water.

Trenches shall be re-filled to the same level and state of compaction as the surrounding land surface to minimise erosion. Excess soil shall be stockpiled in accordance with the specifications.

Water that has entered the trench or found naturally underground must be removed from the working area in order to complete the safe and effective laying of the pipeline. Such water may not be pumped to or be allowed to drain directly into a water course, drainage line or wetland. Water removed from trenches during dewatering operations must be pumped at low pressures into suitable settling ponds for treatment (where necessary) to attain compliance to the water quality concentration limits (**Table 44)** prior to release from site. The water may not be used to irrigate a landowner's crops.

The Contractor shall prevent hydrocarbon spillage within the trench. All visible hydrocarbon spillages shall be skimmed off or removed by suitable methods before dewatering and shall be disposed of in terms of the specifications for waste management.

Pump attendants must be designated and trained to manage pumps in a responsible manner, ensuring no environmental degradation occurs whilst maintaining the pumps efficacy. All pumps must be fitted with drip trays and be securely placed to prevent the pumps from accidentally falling into the trench. Should pumps leak any hydrocarbons, the pumps will immediately be switched off and receive the appropriate off-site maintenance. All pumps will be operated and maintained in a good working condition at all times.

Cleaning and Washing

Washing of tools and/or equipment shall take place at dedicated washing facilities within the construction camps. Suitable wash facilities must be provided at all construction camps and all wastewater must be treated before discharge into any natural watercourse.

No surface run-off of oils, cement, litter, paints etc. which could pollute or alter current water quality are to be deposited into the river system or nearby streams and rivers. Any abstraction of water for construction purposes must be approved by DWS. Prevention and mitigation measures must be implemented to ensure water quality is not adversely affected by such abstraction.

Silt and erosion control

The Contractor shall implement measures to prevent, reduce and mitigate water contamination, including prevention of contamination by suspended sediments. The Contractor shall provide proper storm water drainage plans that shall not concentrate water on downstream receiving streams or water courses. Storm water shall be diverted to lessen its erosive impact upon the surrounding environment. All material and soil stockpiles will be managed to prevent erosion in accordance with the specifications.

Any runnels or erosion channels that develop during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored by the Contractor in accordance with the specifications for rehabilitation.

Oil interceptor

Oily waters and contaminated waters arising from vehicle refuelling yards, vehicle-washing facilities and vehicle maintenance yards will be directed to an impermeable oil/water interceptor. Separation tanks and oil interceptors will be inspected on a weekly basis. Hydrocarbons collected from the oil interceptor will be collected and pumped to a storage tanker for disposal or recycling at an appropriate facility. The

Contractor shall set up a waste register and log the volumes of all contaminated water removed from site for disposal. The Contractor shall obtain a waste disposal certificate from the registered general/hazardous waste landfill site or recycling company.

Oil separators will be installed in the drainage systems of diesel and oil storage facilities, and will be connected to a discharge system. A sketch of the discharge system comprising relevant data (depth, dimensions, etc.) must be provided by the Contractor on site for any required intervention or maintenance operation.These facilities will be inspected regularly by the Environmental Officer to ensure they are functioning correctly.

Construction waste water

The Contractor shall prevent discharge of any pollutants, such as cements, concrete, lime, chemicals and fuels into any water sources. Water from kitchens, showers, sinks, workshops, etc. shall be discharged into the prescribed waste water treatment works. Runoff from fuel storage areas / workshops / vehicle washing areas and concrete swills shall be directed via an oil separator into a settlement pond and this will be disposed of at a site approved by the Engineer. Appropriate measures to prevent water pollution at/from batching plants must be implemented.

Water not disposed of as above, must comply with the other environmental requirements if it is to be recycled or re-used.

Recycling water

Water derived from or generated through construction related activities that becomes contaminated must be treated to ensure compliance with Water Quality Monitoring Specifications before being released back into the environment. The Contractor shall re-use or recycle as much of this water as possible. Water whose quality meets these standards and is approved by the Engineer may be used for the irrigation of rehabilitated areas. Irrigation of agricultural lands shall not be permitted with water impacted by Construction activities.

11.2.4 Aquatic Bio-monitoring

Ongoing aquatic biomonitoring on a minimum of a quarterly basis must take place from 6 months prior to construction till 1 year after construction to determine trends in ecology and define any impacts requiring mitigation.

11.3 MONITORING DURING THE OPERATIONAL PHASE

11.3.1 Auditing and Reporting

- During the construction phase the site Environmental Officer shall compile a monthly report on the construction phase activities and record any impacts on the surface water resource and wetland areas;
- DWS shall conduct a bi-annual internal audit on compliance during the construction phase. A report on the audit shall be submitted to the act Regional Head: DWS within one month of finalisation of the report, and shall be made available to an external auditor.

11.3.2 Emergency Incident Reporting

Section 20 of the National Water Act, 1998 (Act 36 of 1998), requires that the responsible person or any other person involved in an incident that may cause potential pollution of the water resource to undertake the following actions as soon as reasonably possible after obtaining knowledge of the incident:

- Notify the Department of Water Affairs;
- Notify the South African Police Service;
- Notify the relevant catchment management agency;
- The responsible person must –
    - Take all reasonable measures to contain and minimise the effects of the incident;
    - Undertake the clean-up procedures;
    - Remedy the effects of the incident; and
    - Take such measures as the catchment management agency or the Department may verbally or in writing direct within a specified timeframe.

12. PUBLIC PARTICIPATION PROCESS

12.1 AUTHORITY CONSULTATION

A pre-application meeting was held at the Department of Environmental Affairs (DEA) offices in Pretoria on 25 March 2014. The purpose of the meeting was to introduce the project to DEA, and agree on the proposed process and programme to be followed as well as associated roles and responsibilities.

As the project is a Strategic Integrated Project (SIP3) and a priority for DWS, delays in the EIA process should be avoided as far as possible. The programme for the EIA study was presented at the meeting and it was resolved that an Authorities Forum be established for the project, in order to obtain inputs and comments on the draft reports from the various organs of state involved ,in a timeous manner.

The First Authorities Forum meeting took place on 28 May 2014. The objectives of the meeting were to present the project and the findings of the Draft Scoping Report to the various organs of State involved, and obtain their comments on the draft Scoping Report.

The Authorities Forum includes representatives from the following organs of State:

- Department of Environmental Affairs;
- DWS regional and head office;
- Department of Agriculture, Forestry and Fisheries;
- Department of Rural Development and Land Reform;
- Department of Trade and Industry;
- Department of Energy;
- Eskom;
- SAHRA;
- Department of Public Enterprises;
- Department of Minerals Resources;
- Economic Development Department;
- EC Department of Economic Development, Environmental Affairs and Tourism;
- EC Department of Rural Development and Agrarian Reform;
- Eastern Cape Local Government and Tribal Authorities;
- EC Department of Roads and Public Works;
- EC Provincial Heritage Resources Authority;
- Affected Local and District Municipalities; and
- Amatola Water.

12.2 STAKEHOLDER IDENTIFICATION AND DATABASE

DWS has engaged with a number of stakeholders and role-players on this project during the feasibility study stage. A stakeholder database, including existing I&APs was provided at the beginning of the EIA process, which is updated on an ongoing basis as new stakeholders register on the database.

12.3 PARALLEL STAKEHOLDER LIAISON BY THE DEPARTMENT OF WATER AND SANITATION

There are several parallel stakeholder liaison initiatives for the project as a whole in addition to the public participation process for the EIA. Issues relevant to the EIA identified during these initiatives are incorporated into the process on an ongoing basis.

Table 46 lists the Department's formal and informal liaison structures and activities for this project, their purpose and representation.

Table 46: Department of Water and Sanitation formal and informal liaison structures and activities for the Mzimvubu Water Project

Liaison Structure	Purpose	Representation
Project Steering Committee (PSC) (Meetings take place every second month)	Guidance pertaining to strategic issues related to the project	▪ Department of Water and Sanitation and other relevant national departments ▪ EC Government ▪ Municipalities in the project area ▪ Key sectors such as conservation
Study Management Committee (Meetings take place every second month)	To co-ordinate and synchronize all the activities, to ensure efficient communication and to manage components and phases of the project	Department of Water and Sanitation: Options Analysis and EAP.
Eastern Cape Social and Economic Consultative Council (ECSECC) (13 February 2014, 26 March 2014, 6 March 2014)	ECSECC is a multi-stakeholder policy research and development planning organisation dedicated to evolving new forms of development cooperation between government, labour, organised business and developmental non governmental organisations	The ECSECC team is made up of over 40 committed professional and administrative staff. Subject experts, facilitators and development practitioners work in multidisciplinary teams.
Integrated Wild Coast Development Programme Steering Committee (19 February 2014)		

12.4 NOTIFICATION LETTERS, ON-SITE NOTICE AND BACKGROUND INFORMATION DOCUMENT

A letter notifying I&APs of this application for environmental authorisation, as well as the applications for the Water Use Licence, heritage permits, and borrow areas approval was sent to all registered stakeholders together with a Background Information Document (BID). Both the English and isiXhosa versions were distributed by the local facilitators as well as placed on the DWS website. The BID covers all the applications that form part of the project. A newspaper advertisement was published in both local and provincial newspapers announcing the EIA process for this project and providing contact details for I&APs to register as a stakeholder. On-site notices were also posted, providing a brief background on the project and contact details in order for I&APs to request further information and/or to register as a stakeholder (**Figure 74**).

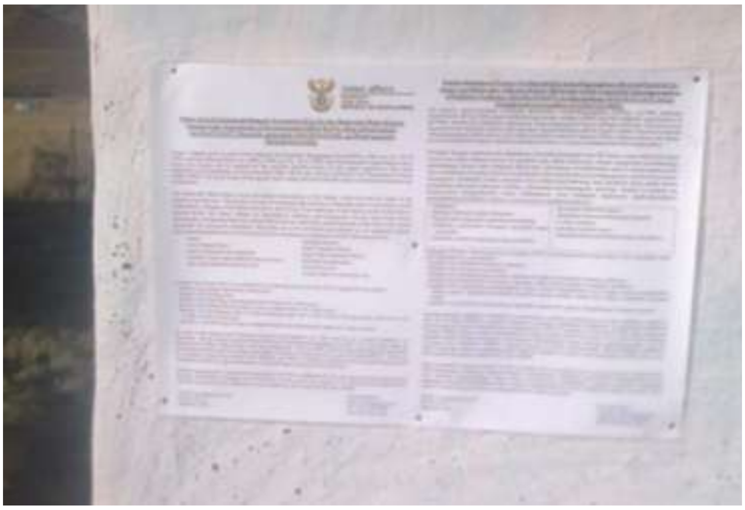


Figure 74: On-site notice (English and isiXhosa)

12.5 NEWSPAPER ADVERTISEMENTS

Notice of the applications was advertised in the Herald on 29 April 2014, in the Daily Dispatch on 05 June 2014 (**Figure 75**) and in the Mthatha Fever on 12 June 2014.

Figure 75: Advertisement in the Daily Dispatch (isiXhosa)

12.6 PUBLIC COMMENT PERIOD FOR DRAFT AND FINAL REPORTS

12.6.1 Draft Scoping Report

The Draft Scoping Report was made available to I&APs for a 30-day public comment period, from 9 May 2014 to 9 June 2014. The draft report was available for download from the DWS website (http://www.dwa.gov.za/mzimvubu) and hard copies were also available for perusal.

Copies of the Draft Scoping Report were available at the following venues:

Location	Venue
East London	Mrs Glenn Hartwig East Landon Central Library, Reference Library First Floor Gladstone Street East London 5200 (043) 722-4991
Mthatha	Mrs Vuyiswa Lusu Walter Sisulu University Nelson Mandela Drive Unitra, Umtatha 5117, 047-5022382 /2319

Tsolo	Mhlontlo Local Municipality 128 Mthuthuzeli Mpehle Avenue Tsolo 5170
Ntabelanga	Siqhungqwini Junior Secondary School Siqhungqwini A copy was also given to the local Chief (Chief Mabantla). Tel: 079 397 7131
Lalini	Mhlontlo Local Municipality Technical department Office 26 96 Church Street Qumbu 5180

Three public meetings were held during the week of the 12th of May 2014 near the proposed Ntabelanga Dam site (in Siqhungqwini), in Tsolo and in Lalini. The purpose of these meetings was to engage with the public, provide information and allow stakeholders to raise any comments or objections.

12.6.2 Final Scoping Report

The Final Scoping Report was made available electronically for a 21-day public comment period.

12.6.3 Draft Environmental Impact Assessment Report

The draft EIR is available to I&APs for comment from the DWS website (http://www.dwa.gov.za/projects.aspx) and hard copies are also available for perusal from the venues listed in section 7.7.1. I&APs have thirty (30) days to comment on the draft EIR.

A round of public meetings will take place in October 2014 in order to provide an update on the project and report back to stakeholders on the findings of the Impact Assessment phase.

12.7 FOCUS GROUP MEETINGS

A focus group meeting with the Department of Agriculture, Forestry and Fisheries was held on 20 May 2014 to discuss agriculture and land tenure issues associated with the project.

Between 28 June and 11 July 2014 a field trip was undertaken across the project region. During this time various meetings were held as indicated below.

Date	Venue
28 June 2014	Shukunxa Village

30 June 2014	Ngqongweni
10 July 2014	Mpetsheni
10 July 2014	Sibomvaneni Village
10 July 2014	Ntabelanga Dam Basin
10 July 2014	Mawasa Location
11 July 2014	Lalini Dam Basin

In addition, focus group meetings were held with the Department of Energy (18 July 2014) and Nyandeni LM (30 September 2014).

12.8 NEWSLETTERS

A Newsletter (Newsletter #3) was compiled, providing information on the Environmental Impact Assessment process, progress to date and the way forward.

The newsletter was distributed electronically to all registered stakeholders on 12 August 2014. In addition, 150 copies (in English) and 350 copies (in isiXhosa) of the newsletter were printed and distributed to local communities by the local facilitators within the project area on 19 and 20 August 2014. Hard copies were also left at the relevant municipal offices.

A follow up newsletter (Newsletter #4) will be compiled and distributed once a decision has been made regarding the application for environmental authorisation.

12.9 ISSUES AND RESPONSES REPORT

Feedback received from stakeholders is recorded in the Issues and Responses Report (IRR) and has been incorporated in the IWULA where applicable.

12.10 KEY ISSUES

The key issues that have been raised during the public participation process are summarised below.

1. The dams will store water that would previously have flowed down the Tsitsa River into the Mzimvubu River and ultimately through the estuary to the sea. Some water will be abstracted from the dams for, primarily, domestic and agricultural use. Other water will be released from the dams for power generation in a way that alters the natural flow regime. At some times the rivers will therefore have less water than natural and at other times they will have more. Changes to the flow regimes in rivers, especially where potentially sensitive area such as the Tsitsa Falls and associated pristine gorge downstream of the proposed Lalini Dam and the Mzimvubu estuary, could impact on the aquatic and riparian ecosystems and associated ecosystem services provided by the rivers. The

impact of the proposed altered flow regimes in the rivers on the **aquatic and riparian ecosystems** therefore need to be assessed.

2. The Mzimvubu Project is located in a part of the country that currently experience severe soil erosion with associated high **sediment** levels in the rivers. Concern has been raised that this condition will cause the dams to silt up, reducing their yield and affecting the functioning of the equipment (e.g. abstraction and water treatment). Impacts on the river channel and water quality immediately downstream of the dams, where water carrying less sediment than when entering the dam is released, are also envisaged.

3. When a dam is constructed the land that will be inundated by water will be permanently altered and the current functionality will be lost (and replaced with a lake). The proposed dams are expected to inundate 10.34 km^2 of wetlands, grassland and savannah habitats as well as man-made structures, roads and powerlines. The plants and animals that currently depend on the river, wetland, grassland or savannah habitats will either have to move/be moved to use other resources or will die. The significance of this **ecological impact** needs to be assessed.

4. Some people are currently living and providing for their existence from the resources in the areas that will be inundated by water or replaced by infrastructure. These families will have to be **relocated** to new homes and **compensated** for their loss of livelihoods. This is usually a socially disruptive and personally traumatic experience that needs careful attention and management.

5. The Mzimvubu Project is expected to cost R 12.5 billion. The **financial and economic viability** has been questioned. Financial viability implies the project is evaluated at market prices. Economic viability implies that the project is evaluated at prices which reflect the relative scarcity of inputs and outputs. The main purpose of this project is to contribute to the development of an impoverished rural area of the Eastern Cape by making water available to the area. The investment by government must therefore be evaluated against the background of the projected contribution to social and economic development. A project of this nature may make economic sense, but not be affordable. In such a case government's continuous grants and subsidies may be necessary. The EIA study is not the right vehicle to determine financial viability and affordability. An economic cost benefit analysis (ECBA) was therefore done as part of this EIA and not a financial cost benefit analysis. The funding of the project is an important issue and during this analysis it became clear that it will take up to 10 years to attain maximum production from the irrigation scheme and possibly financial profitability. Financial viability can only be attained by grant funding on an annual basis without any repayment pre-conditions. The high poverty levels in the project area are such that it is improbable that more than 10% of the domestic

users will be able to pay for the water. Therefore, a long term annual subsidy will have to be provided for. The Lalini Dam Hydro-Electricity Generation is financially viable and can be funded by loans.

6. The specific area of the Eastern Cape Province has a large untapped **agricultural potential**. Any agricultural development based on commercial principles will, however, be faced with a number of stumbling blocks. These include the problem of land ownership, shortage of management skills for commercial farming, available markets, and support structures such as production inputs and funding.

7. A large infrastructure project of this nature will result in an influx of people and consequently increase the demand for municipal services such as water, electricity, roads, sewerage, housing and social services (clinics, schools etc.). This will place a significant burden on an already over-extended **Local government**.

13. CONCLUSION AND RECOMMENDATION

The MWP is a Strategic Integrated Project (SIP 3) identified by the South African Government which includes the development of a new dam at Mzimvubu with irrigation system.

The MWP consisted of the development of the Ntabelanga and Lalini Dams and its associated infrastructure which is a conjunctive scheme that consists of water resource infrastructure, treated domestic water supply infrastructure, raw water supply infrastructure, power and affected infrastructure.

Although two separate WULA's will be applied for, development at the two dams should not be viewed in isolation.

The Mzimvubu Catchment is located in one of the poorest regions in South Africa and possesses untapped economic potential in the form of its abundant water resources.

The MWP will redress the results of past racial and gender discrimination by contributing, on a macro-economic level, not only to the National but the Eastern Cape Province economy. The long term economic benefits associated with the MWP include an increase in quality of life and would impact positively on labour and economic productivity.

Failure to authorise the water uses would contradict the obligation on the State to advance the interests of the poor. Together with this lost opportunity would be the loss of a number of job opportunities, not only associated with the construction of the dams and infrastructure, but also associated with the productive potential of the irrigation scheme. With the area being one of the least developed and poorest in the country these losses will have severe social consequences.

The benefits of the project in terms of economic and social development are expected to be high, provided the necessary conditions for the success of the project are met and the recommended mitigation and enhancement measures are adhered to.

However, some significant negative impacts, mostly related to aquatic ecology and wetlands, have been identified. Some of these impacts are permanent and cannot be mitigated to an acceptable level.

The Impacts on water quality, although relevant is insignificant and the development will not detract from the fitness for use of the water in the study area.

It is recommended that the licence is issued for a period of 40 years as this is a project of socio-economic significance.

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APPENDIX A

APPLICATION FORMS

Pending

APPENDIX B

WATER USE SUMMARY TABLE

Pending

APPENDIX C

MAPS

Pending

APPENDIX D

WATER QUALITY ASSESSMENT

Please refer to Appendix C-e of the Draft Environmental Impact Assessment Report

APPENDIX E

WETLAND STUDY

Please refer to Appendix C-c of the Draft Environmental Impact Assessment Report

APPENDIX F

AQUATIC ASSESSMENT

Please refer to Appendix C-d of the Draft Environmental Impact Assessment Report