

This *Chapter* describes the potential physical, biological, social and socio-economic impacts for both the construction and operations phases of the proposed Batoka HES. The issues identified stem from those aspects investigated and presented in *Chapter 4* of this document, as well as from a review of the 1993 and 1998 feasibility studies. Each significant issue identified will be investigated further during the impact assessment phase of this Project.

*Chapter 9* will describe the methodology that will be used in the ESIA phase to indicate how environmental and social impacts, arising from both the construction and operations phase of the Project, will be assessed and mitigated.

## 7.1

### STUDY AREA

To investigate the potential social and environmental impacts as a result of the proposed hydropower project, the following study area (as presented in the Project Prospectus and Project Inception report), provided in *Figure 7.1* is defined. This study area encompasses the regional socio-economic impacts as a result of the proposed scheme, as well as the downstream in-river impacts up to the headwaters of the Kariba Dam. In addition this study area covers the proposed 70 km long Transmission lines to Hwange (and its alternative route) and the 21 km 330 kV line to Livingstone. The study area is extended to cover the second line running in parallel to the existing 220 kV line, terminating at the Muzuma substation in Choma, a distance of approximately 160 km (*Figure 7.2*).

At this stage of the project, transmission line corridors of 3 km in width will be investigated for possible environmental and social constraints, such as villages and homesteads, agricultural fields, industrial sites, pipelines, settlements and other infrastructure, including protected areas (see *Figure 7.2*). A way-leave of 50 m will be recommended within these 3km corridors, being investigated as part of the ESIA process.

## 7.2

### POTENTIAL ENVIRONMENTAL IMPACTS

This section describes the potential impacts to the environment as a result of the dam wall and spillway, the dam impoundment, two power houses, transmission lines in Zambia and Zimbabwe, associated access roads, a spoils area, construction camps, batching areas and permanent staff housing, all of which were described in *Chapter 3*.

The key environmental aspects that may be impacted by the proposed Project are provided in *Box 7.1* and are further described below. The key potential impacts on each of these environmental aspects, is also briefly described.

**Box 7.1**      ***Key Environmental Aspects that may be Impacted***

Terrestrial and aquatic flora;

- Loss of terrestrial (riparian zone) and flowing aquatic habitat will occur as a result of inundation of the Batoka Gorge and transformation into deep water pelagic habitat.
- The Batoka Gorge is listed as listed as an Important Bird Area (IBA), based on the presence of breeding Taita Falcons, a Vulnerable and range restricted species. Other criteria for this classification as an IBA are that the Batoka Gorge also contains an important breeding population of the Rock Pratincole and Black Stork, both of which are not threatened species but are regionally important populations. There is also a high diversity of raptors which include a variety of vulnerable and near threatened species. Habitat loss through inundation may impact on all these species.
- The Batoka Gorge is known to support a high abundance and diversity of bats which includes two near threatened species, namely Large-eared Free-tailed Bat (*Otomops martiensseni*) and Wood's Slit-faced Bat (*Nycteris woodi*), but little is known about the ecology of bat populations there (Clare Mateke, Livingstone Museum).
- Limited populations of large fauna do exist in the greater area and occurrence of human wildlife conflict has been raised by stakeholders in the area. An influx of people to the area could increase the occurrence of this conflict.
- De-bushing for way-leaves required for the construction of Transmission lines will result in vegetation clearance, possible habitat fragmentation, and will make access into new areas previously relatively inaccessible, easier - resulting in the potential for further deforestation, hunting etc.

Environmental flows and associated impacts to downstream water quality and aquatic ecology.

- Should the Batoka HES operate as a 'run-of-river' scheme, the impacts on downstream river ecology will not be significant. Should the HES operate more as a peaking scheme, changes in river ecology downstream of the impoundment may become more apparent.
- Water quality, both within the impoundment and downstream, including temperature and dissolved oxygen impacts downstream of the dam wall.

Fish and fisheries;

- The fish populations in the gorge can be regarded as near pristine, due to low anthropogenic effects due to limited access points and little nutrient enrichment. Loss of river habitat will occur as a result of inundation.
- With water impoundment, a few fish species will be threatened. Species that favour fast flowing water will be vulnerable.

Sedimentation and erosion;

- Change in the sedimentation levels in the river downstream of the impoundment.

Figure 7.1 Area of Interest for the Proposed Batoka HES

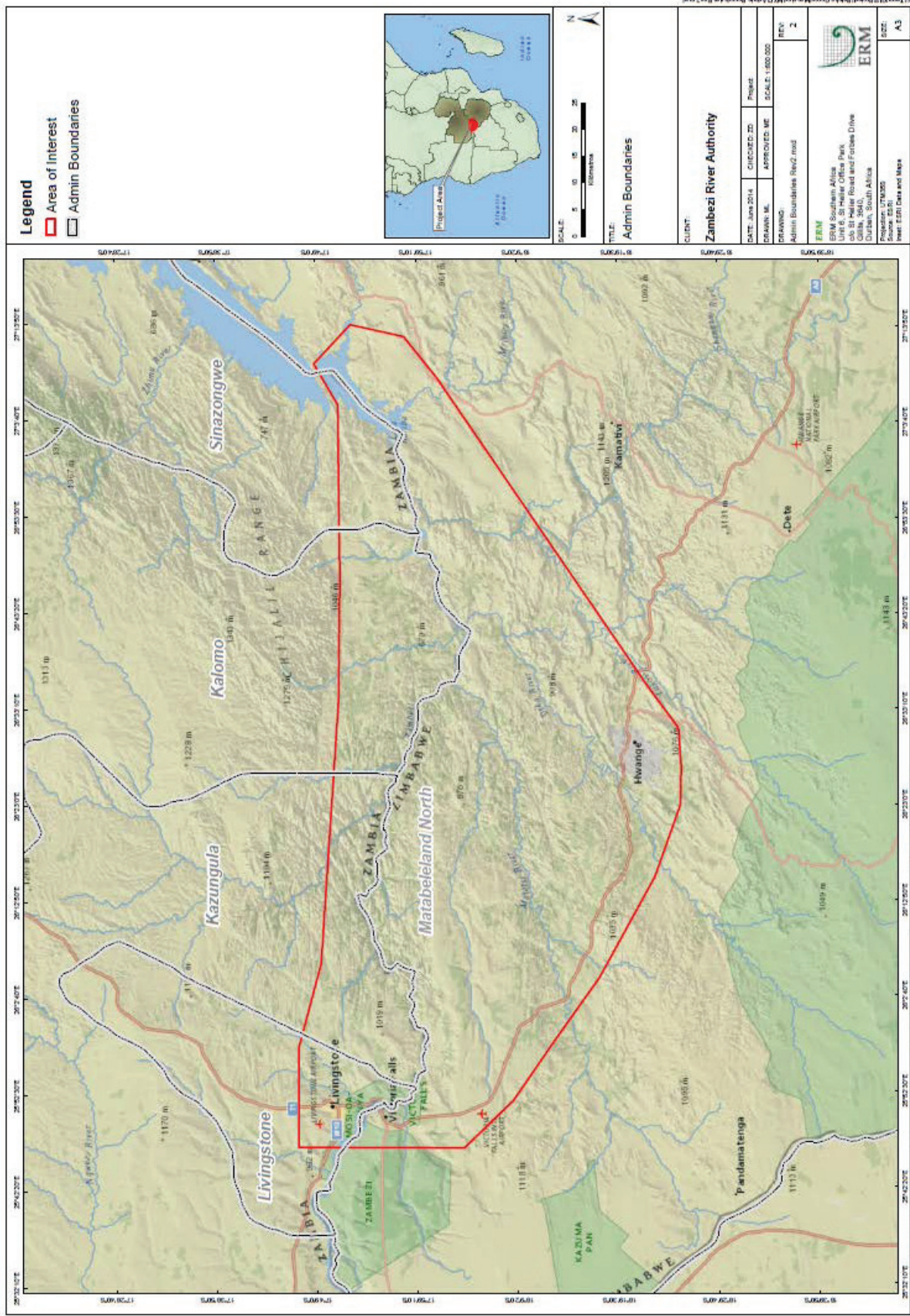
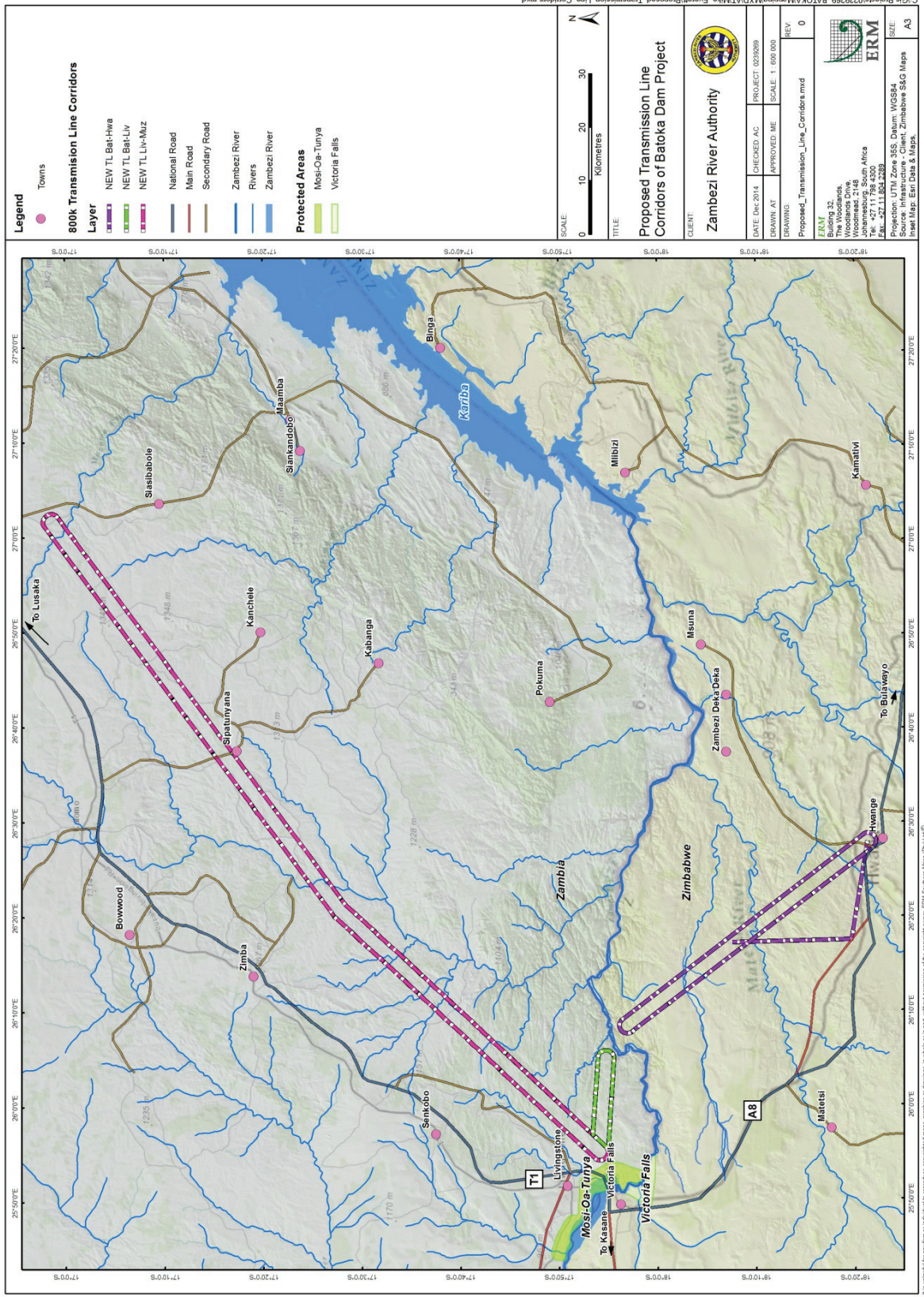




Figure 7.2 Areas to be Investigated for Proposed Transmission Line Corridors



It is unlawful for any firm or individual to reproduce copyright maps, graphics or drawings, in whole or in part, without permission from the copyright owner. (ENR Southern Africa Pty) Ltd

## 7.2.1 *Habitats and Flora (terrestrial and aquatic)*

### *During Construction*

Construction of the main dam wall and associated infrastructure will involve large equipment operations, the requirement for borrow pits, material storage areas, and administrative space (i.e. construction camp and others), which could remove and/or disturb vegetation in affected areas. This may primarily affect riparian habitats and hill-slope vegetation. Construction of new, and rehabilitation of existing construction access roads and new transmission lines, could remove and/or disturb riparian and other vegetation.

The loss or disturbance of riparian vegetation could cause increased river bank erosion in the vicinity of the construction activities. Large equipment operations and equipment lay-down could remove and/or disturb vegetation, potentially facilitating erosion of disturbed soils and compacting soils, thus increasing runoff velocity and erosion of down-gradient habitats.

Effects on aquatic habitats during construction of the project relate to the loss of riparian vegetation, diversion of surface flows around the construction areas, increased sedimentation and the direct loss and disturbance of in-stream aquatic habitats in the immediate vicinity of construction activities. These construction-related effects on aquatic habitats should be localised and smaller in magnitude compared to the operational effects of the project.

### *During Operation and Inundation*

Inundation of the reservoir will result in the direct loss of vegetation, primarily riparian vegetation along the river bank and succulent vegetation on the scree slopes of the gorge which could include unique or endemic species. As discussed in *Chapter 4* of this Report, five major vegetation communities were identified and well represented both above the FSL and in the downstream area. Much of the scree slope habitat will remain and, flooding of the reservoir will not result in a total loss, except for the riparian vegetation discussed above.

In the immediate catchment area, the impacts are secondary and related to the migration of humans, which may lead to the over-exploitation of hardwood timber.

Reservoirs often experience eutrophication, which can increase primary producers (phytoplankton and zooplankton) and spur the growth of aquatic vegetation including nuisance or 'sudd' plants, especially Kariba weed (*Salvinia molesta*) and water hyacinth (*Eichhornia crassipes*). Aquatic weed species can degrade aquatic ecosystems by growing and spreading rapidly over the water surface, restricting light to the underwater environment, depleting oxygen levels in the water and can cause a dramatic decline in fisheries production.

The breakdown of organic matter (ie woody vegetation) in the reservoir could result in large emissions of greenhouse gasses, particularly carbon dioxide and methane. The amount of these gases that could be produced could depend on the amount of vegetation that is inundated by the reservoir, the total surface area of the reservoir, and the flux rate.

### 7.2.2 *Faunal habitats and species (terrestrial and aquatic, including birds)*

#### *During Construction*

The noise, dust and human activity from construction activities could affect disturbance-sensitive animals and potentially result in their temporary displacement from current habitats. The construction or upgrade of new roads to enable access to construction areas as well as the construction of new transmission lines may cause fragmentation of terrestrial habitats, also causing wildlife disturbance and displacement. Displaced fauna may be subject to increased hunting pressure. In addition, poachers could have easier access to the area via the newly constructed project-related roads or via the newly established transmission line corridors.

#### *During Operation and Inundation*

Due to the rugged terrain in the Batoka Gorge, the species diversity of resident large mammals (more than 5 kg) is low. As these species are widely distributed elsewhere, the impacts due to flooding will not be significant. The impact on amphibian and reptile species occurring in the Gorge may also not be significant as the small population of resident crocodiles may adapt to the large permanent waterbody and persist there.

Limited wildlife is present in the area, but the Batoka HES could provide opportunities to enhance wildlife conservation in the area, particularly through collaborative efforts with community based natural resource management organisations active in the area (such as CAMPFIRE). Opportunities for such positive impacts should be explored and would require active participation of the project proponent with such organisations.

The steep basalt slopes represent a very specific habitat for raptors, especially the Taita Falcon. Seven breeding pairs of this rare species may be displaced (BJVC 1993) and their food prey base consisting of swifts that feed on emerging insects from the fast flowing rapids may decline. In addition the rock pratincole, a small migratory bird dependent on fast flowing habitat associated with large rivers, will be adversely affected through the loss of habitat resulting from development of the Batoka HES. Similarly to raptors, information on the extent of suitable habitat beyond the proposed area of inundation is required to assess the impact on this species.

Alterations of depth and flow regimes may alter the water temperature and dissolved oxygen concentrations at surface and at depth within and downstream of the reservoir. Changes in water temperature can affect the



suitability of aquatic habitats for fish and macro-invertebrates and potentially cause a shift in species composition to more generalist species that are tolerant of a wide range of temperature conditions.

The number and diversity of riverine aquatic species (riverine fish and macro-invertebrates) may decrease and conversely, while the habitats for lacustrine species (phytoplankton, zooplankton and lacustrine fish) could increase. A vacant niche will be created for pelagic fish such as Kapenta (*Limnothrissa miodon*) which could be introduced and could possibly lead to a large increase in the fisheries production compared to the current production from the Batoka Gorge. These pelagic fish could form a significant prey base and lead to an increase in the Tiger Fish (*Hydrocynus vittatus*) populations which could support additionally support a sport fishing industry. A healthy Tiger Fish population would also be dependent on low levels of eutrophication and on retaining some upstream fast flowing habitat.

The bird populations may be affected by loss of breeding and foraging habitat, primarily in the cliff/rocky outcrop habitats at the dam site and in the riparian habitats that could be inundated by the reservoir. Birds may also be affected by the additional transmission lines.

Natural flow regimes are important factors in determining the morphological characteristics, and thus the habitat value, of natural river channels. Habitat-forming flows often correspond to high-volume flows during flood events. Operation of the dam (ie flow releases) could limit the magnitude or duration of downstream high flow events and this could retard the natural progression of aquatic habitat formation in the river and potentially result in changes in species composition, density, and diversity of aquatic fauna downstream of the dam. For example the presence of the dam may potentially reduce or eliminate downstream floods, potentially reducing riparian wetlands and sandbanks that various aquatic and terrestrial fauna depend upon to spawn, rear, and/or breed.

Operation of the dam may also interrupt natural sediment transport mechanisms, especially for coarse gravel and cobble, and the availability of coarse substrate downstream of the dam could decline. The depletion of coarse substrate reduces fish spawning habitat and substrate for invertebrates (macro-invertebrates, molluscs, and crustaceans).

Operating rules for the dam should therefore not only consider the requirements for power supply, but should also be formulated, where necessary and practical, to reduce downstream impacts on aquatic species and human activities.

Migration patterns of fish, such as Eels and other aquatic species may be blocked by the dam (although a natural blockage does exist with the Victoria Falls), potentially causing disruption to spawning and foraging within a ~50 km stretch of river, which could lead to a possible decrease in gene flow and genetic variation in the river.

Limited populations of large fauna do exist in the greater area and occurrence of human wildlife conflict has been raised by stakeholders in the area. An influx of people to the area could increase the occurrence of this conflict.

### 7.2.3 *Water Quality*

#### *During Construction*

In addition to sediment loads from erosion (discussed above), the main water quality risks that occur from dam construction relate to the potential spillage of fuels, lubricants and chemicals at the construction site, and the inadequate treatment and disposal of waste and wastewater from worker compounds. These should all be mitigated by the effective implementation of industry-standard practices for safe environmental management and pollution control on construction sites.

#### *During Operation and Inundation*

Water quality impacts may occur in the reservoir and downstream river due to a range of factors. While the main use of the reservoir water is for hydropower generation, possible water quality impacts could affect aquatic habitats and may affect artisanal fishing and/or water supplies.

Potential water quality impacts are as follows:

- Insufficient clearance of vegetation at the reservoir site prior to inundation may lead to the widespread decomposition of organic matter on the reservoir bed, which may result in the generation of methane and possible depletion of oxygen levels in the water, such that fish kills may occur;
- Depending on the stratification patterns and the depth of the euphotic zone in the new impoundment (i.e. the depth of the water in a lake that is exposed to sufficient sunlight for photosynthesis to occur), temperature, dissolved oxygen, turbidity and nutrient concentrations may change drastically when compared to the previous flowing river environment. These changes could determine which species could adapt, which could die out and which may take on pest proportions in the impoundment.
- The timing of water releases downstream and the depth from which these releases are made, may affect the temperature, oxygen concentration, sediment loads and nutrient concentrations in the release water that could in turn, potentially impact on the river downstream and on what lives there.
- Finally, the rise in water table associated with the reservoir and its operation (see *Section 7.1.4*) may lead to changes in groundwater chemistry - and hence local borehole water quality - as chemicals are leached from newly submerged rock and soil formations.

The extent to which the above problems occur could depend on a number of factors, including in particular the hydraulic conditions within the reservoir



and the degree to which circulation or thermal stratification takes place. To some extent water quality downstream of the impoundment can be mitigated by careful “mixing” of the water released from the epilimnion (upper oxygen rich, warmer, less dense water layer richer in algae) and the hypolimnion (lower, oxygen poor, colder, denser, nutrient rich water layer). The incorporation of a suitable tower structure in the design of the dam to allow for simultaneous releases from different depths could be further investigated.

#### **7.2.4** *Groundwater levels*

##### *During Construction*

Apart from a localised depression in the water table due to any dewatering that could be necessary to construct the dam foundations, there are unlikely to be any significant impacts on groundwater levels as a direct result of construction activities.

Due to the remoteness of the site, the steep slopes, and the lack of any significant aquifers away from the Zambezi River, it is unlikely that there are any existing water supply wells or boreholes in the immediate vicinity of the construction sites which would be affected by the dewatering. The impacts of dewatering on the smaller alluvial aquifers of any tributaries to the Zambezi River in the project area could be investigated during the detailed impact analysis, and suitable mitigation measures developed if necessary.

##### *During Operation and Inundation*

The reservoir could raise the water table upstream of the dam to the extent that yields from existing boreholes (if applicable) around the reservoir are likely to significantly increase. Water logging (and possible soil salinisation) may also occur in some low-lying areas around the reservoir, particularly along the downstream reaches of some of the tributaries that drain into the newly formed lake. The geology of the area (specifically faults and fracture zones) surrounding the dam could influence the extent to which changes are experienced in the groundwater regime downstream and in the area of inundation of the dam.

#### **7.2.5** *Sedimentation and Erosion*

##### *During Construction*

The construction activities could by their nature lead to significant soil disturbance at a number of locations, including the dam site, the power house, the aggregate borrow (if applicable) areas and the workers’ camp. All of these areas could therefore be at increased risk of soil erosion and degradation (eg through compaction) and subsequent increased turbidity and sedimentation. These risks should all be mitigated by the effective implementation of industry-standard practices for soil conservation on construction sites.

### *During Operation*

In the reaches immediately downstream of dams, sediment supply is usually reduced due to the trapping of sediment in the upstream reservoir. Hydropower plants may also alter sediment transport very far downstream through alteration of the hydrology (and therefore the energy to move sediments), and this can be further exacerbated by peak daily releases (associated with peaking power generation). This may have a significant impact on the river morphology downstream of the dam, whereby patterns of erosion, transport and deposition along the river downstream gradually shift until a new status quo is established over time. This changing morphology could have a consequent impact on river water turbidity and flow velocities, and hence on riverine ecosystems.

## **7.2.6 Seismicity**

### *During Operation and Inundation*

The Batoka dam site and reservoir are located approximately 100 km upstream of the headwaters of Lake Kariba, one of the largest man-made lakes in the world, with a long history of seismic activity. Since its impounding in 1958, over 2,000 seismic events have occurred (BJVC 1993).

While engineering design will take into account the fact that seismic events also occur naturally in the region, seismic shocks can be induced by Batoka's artificial reservoir as has been happening at Kariba. As the volume of the lake and its weight on the earth's crust is expected to be less than 2 % of that of Lake Kariba, induced earthquake frequencies are expected to be much lower, however maximum magnitude may well reach 5.5 on the Richter Scale (BJVC 1993).

## **7.2.7 Downstream**

### *During Operation and Inundation*

Adverse impacts on the downstream stretch between the dam site and Lake Kariba are related to changes in water flows as a result of the operation of the proposed hydropower plant, water quality (in particular dissolved oxygen and temperature) and changes in sediment transport and river morphology, both discussed previously.

At Lake Kariba, it is anticipated that the lake fluctuations caused by the Batoka HES will cause no significant disruptions of the seasonal patterns in fish breeding, livestock/wildlife grazing and/or crop production around the shoreline of Lake Kariba, given that the proposed Batoka HES will operate as a "run-of-river" scheme, its small storage capacity and given the short resident time of water impounded by the dam.

Further downstream of Lake Kariba, the Batoka -Kariba conjunctive operations will continue impacts that already started as a consequence of the

Kariba Hydro Power Scheme. The greater rate of discharge from Kariba during the dry season is out-of-phase with the seasonal adaptations of many downstream biota and may accelerate riverbank erosion. This problem however already exists, as Kariba Dam acts as a silt trap and regulator of downstream flows (BJVC 1993).

The World Bank (2010) report on the multi-sectoral investment opportunity analysis for the Zambezi River basin, however reports that the riparian countries within the Zambezi basin can achieve short- and long-term benefits through the coordinated operation of existing and planned hydropower facilities.

Development of comprehensive planning, and eventually of an operational model for the Zambezi River Basin would result in (amongst others), better flood forecasting and flood management (both to release floods for beneficial uses and to mitigate high flows). With the construction of the Batoka HES, conjunctive management of all the major hydropower schemes on the Zambezi River is required.

#### **7.2.8 *Impact to Victoria Falls***

Under the proposed scheme, and at a FSL of 757 m, the backwaters of the Batoka HES will reach the outlets of the Victoria Falls Power Station (at Silent Pool). Other scenarios, however will also be investigated as part of the feasibility study; for example at a FSL of 740 m, the backwaters of the dam would limit the flooded extent due to the dam to around the bottom of the 5<sup>th</sup> gorge (based on low flow conditions in the river), and would limit any flooding of the Mosi-Oa-Tunya National Park.

The impact to Victoria Falls, a World Heritage site, needs to be investigated, and the decision on the FSL needs to take careful consideration of the potential impact of the impoundment's backwaters (especially during flooding scenarios) in terms of the scheme's potential impact on the Falls.

#### **7.2.9 *Reduced Emissions from Thermal Power stations***

##### *During Operation*

The 1993 Feasibility Study demonstrated that the Batoka HES could replace coal-fired power generation in Zimbabwe and South Africa.

The SAPP presents a Regional Generation and Transmission Expansion Study for the entire SAPP region (Nexant 2007), where a Base Case and an Alternative Case is proposed. For the entire SADC Region, the Base Case adds about 39,300 MW with greater emphasis on conventional coal fuelled steam plants. The Alternative Case instead adds about 36,600 MW with greater emphasis on hydro projects and the transmissions needed to move the power to areas of demand.



This Alternative Case over the period up to 2025 envisages development of almost all power plants in the Kariba Sub-basin, those in the Shire River/Lake Malawi/Nyasa/Niassa Sub-basin, Kafue Sub-basin, and the two major power sites (Cahora Bassa II and Mepanda Uncua) in the Tete Sub-basin. By adopting this development package as the total expansion of the hydropower system, the total power development is estimated at approximately 53 % (6,616 MW) of the total hydropower potential of the Zambezi Basin (Nexant 2007).

As far as hydropower development in the Zambezi Basin is concerned, the difference between the SAPP Base Case and the Alternative Case is mainly in the timing of the construction of the Batoka HES. The Kariba extensions will only provide peaking power and reserve capacity; they will not increase overall firm energy before the construction of the Batoka Gorge dam. The 750 MW Lower Kafue Gorge scheme and the 1,600 MW Batoka HES Project can make a substantial contribution to power supply.

The objective of the Batoka HES is therefore to increase power generation capacity in both Zambia and Zimbabwe, reduce power outages, but also to reduce reliance on coal fired power stations.

#### **7.2.10 *Impacts of Climate Change on the Batoka HES***

The Zambezi River Basin has been classified by the Intergovernmental Panel on Climate Change (IPCC) as the river basin to be subjected to the ‘worst’ potential effects of climate change among 11 major African river basins reviewed. This classification is largely based on the predicted climate change-induced increased temperature and decreased precipitation in the Basin <sup>(1)</sup>.

The literature suggests that there are four main ways in which climate change can affect hydropower operations, namely <sup>(2)</sup>:

- Reduced reservoir inflows as a result of a projected decline in basin runoff and more prolonged drought conditions. This will reduce overall power output;
- Increased risks in the form of uncontrolled releases and dam safety risks due to a projected increase in extreme flooding events, following higher rainfall intensity and more frequent tropical cyclones;
- A potential reduction in the reliability and predictability of hydropower production due to both a delayed onset of the rainy season, and general reduction in the water budget; and
- A likely decline in reservoir capacity and risks to flood management operations because of the projected increase in rainfall and flooding intensity increasing sediment loads to reservoirs.

(1) Ibid.

(2) Ibid.

Based on the analysis of future water availability, it is recommended that the Batoka HES feasibility study take into account both the potential worst case scenario of an up to 3.5 % reduction in the water budget per decade compared with baseline climatology (subject to additional studies), and the projected shortening of the peak flow season into their water budget calculations.

The impacts of climate change on the Batoka HES must be taken into account in the financial feasibility of the scheme.

Also to note, and as discussed in *section 7.2.9*, is the construction of the proposed Batoka HPP will reduce reliance on thermal coal in the SAPP; with increased hydropower production resulting in a positive impact to climate change. In reality though, given the power deficits in the SAPP region as a whole (as presented in *Chapter 2*), the construction of the proposed Batoka HPP and the refurbishment of existing and construction of new thermal power plants, will all be needed to meet the Region's power deficit.

### 7.3

#### *POTENTIAL SOCIAL AND SOCIO-ECONOMIC IMPACTS*

This section describes the potential impacts to the social and socio-economic environment as a result of the construction and operation of the proposed Batoka HES.

The key social and socio-economic aspects that may be impacted by the proposed Project are provided in *Box 7.2* and are further described below.

#### **Box 7.2**

#### ***Key social and socio-economic aspects may be impacted***

- *Resettlement:* The positioning of the project infrastructure has the potential to cause displacement either economic and/or physical. This was viewed as a key concern for the parties involved namely the affected communities (most notably Kasikiri village) and Hwange Rural District Council in Zimbabwe. The 1993 study reported that resettlement would face strong resistance from the parties involved, especially due to the legacy of resettlement undertaken for Kariba Dam and the limited amount of Hwange Communal Land available for further resettlement or other land use activities.
- *Impacts to tourism industry:* The project is likely to significantly reduce white water rafting opportunities on the Zambezi River. Tourism was noted as a key income source in the project area in the previous EIA studies.
- *Health:* Health infrastructure and the health profile of the communities was reported as poor. Influx of workers for construction of the dam may place further strain on health facilities and detrimentally affect health care services and health status.
- *Cultural heritage:* The 1998 studies concluded that the filling of the dam will create an island out of Chemapato hill which will restrict access to the site. Stakeholders were also concerned about the impact on Victoria Falls as a World Heritage site.

### 7.3.1 *Physical and Economic Displacement*

#### *During Construction*

Communities may lose land on which they currently undertake livelihood activities (such as the collection of natural resources, subsistence agriculture, livestock grazing) due to the construction of the following project components:

- Construction camps;
- Quarries and borrow pits;
- Access roads;
- Spillway;
- Permanent camps;
- Transmission lines.

The location of the construction camps, quarries and borrow pits, transmission lines, permanent camps and access roads are currently not defined and will be confirmed during the impact assessment phase of the project. This will then define the extent of displacement involved and replacement land and compensation requirements as a result.

Physical displacement may be associated with all of the above infrastructure. As with economic displacement above, the implications thereof remain to be defined and will be addressed in the Resettlement Action Plan.

#### *During Operation and Inundation*

The Project has the potential to cause economic displacement with inundation. People are using the Batoka Gorge for fishing and tourism activities (eg white water rafting). In addition, land lost during construction on which people undertook land based livelihoods (eg agriculture and livestock grazing) will not be returned. The extent of economic displacement remains to be ascertained depending on dam design and area of inundation and a Resettlement Action Plan will commence following the refinement of the Options Assessment in order to identify affected assets and livelihoods.

### 7.3.2 *Increased Pressure on Ecosystem and Social Services*

#### *During Construction*

The construction of the dam is likely to require large numbers of skilled, semi-skilled and unskilled workers, many of whom are likely to come from outside the project area due to a lack of locally skilled labour, estimated at up to 3,000 construction and support staff. In addition, with the possibility of immigration to the area from people in search of jobs and the presence of large numbers of workers in the area may result in an increased demand for firewood, bush meat, fish, charcoal, and other natural resources from the surrounding riparian forests, open woodlands and rivers.



### 7.3.3 *Impact on the Local Economy*

#### *During Construction*

The potential impacts are summarised below.

- *Employment during construction:* The construction of the dam could take place over several years, requiring a potentially large workforce (up to 3,000 inclusive of support staff). It is not clear at this stage neither what skill types could be required, nor the extent to which employment opportunities could be created in the project area. The benefits to the local community from jobs could be dependent on the extent of local recruitment.
- *Increase in the local prices:* There could probably be a significant, though short-term improvement in the local economy (for example due to local procurement of supplies and services by the camp). However, there could also be an increase in the price of local goods, which could make life more difficult for those vulnerable sectors of society that are unlikely to benefit from the construction phase and are already finding it difficult to get by.

#### *During Operation and Inundation*

*Loss of White water rafting activities:* The proposed Batoka HES, depending on the FSL chosen (762 m versus 740 m) will result in the total flooding of rapids, either up to Silent Pool (762 m scenario) or up to the bottom of 5<sup>th</sup> gorge (740 m scenario). The latter scenario will result in rapids 1 to 11 being preserved. The dam will have an impact on the white water rafting industry, currently an eco-tourism venture enjoyed by primarily tourists, residing in either the town of Victoria Falls or Livingstone, and hence an important revenue stream to these two towns. According to the National Conservation Committee of Zambia, the Batoka Dam will not be able to offer significant alternatives to the white water rafting industry, as the gorge is too narrow to allow for alternative activities, which is further aggravated by the international border, which will need to be observed. There is some potential for this activity to remain below the dam, although the feasibility of this will be investigated as part of the Impact Assessment.

Other forms of tourism may well be realised, however, such as adventure canoeing, as well as the construction of lodges and hotels overlooking the lake. The impact of the proposed Batoka HES on the local economy will be investigated as part of the Impact Assessment.

### 7.3.4 *Impacts on Community Health*

#### *During Construction*

Key communicable and other diseases that may be affected by the presence of the project during construction are:

- Acute respiratory infections and tuberculosis (TB);
- HIV/AIDS, Hepatitis B and C, and other sexually transmitted infections; and
- Malaria.

There is a risk that the workforce employed during the construction period of the dam could impact the local communities' health status. Groups vulnerable to health impacts would include young children, the elderly, the socio-economically deprived, and groups with chronic health conditions. The origin, size and health status of the workforce (a large percentage of which could be recruited outside of Zambia and Zimbabwe), and their cultural norms, could influence the nature and severity of these risks. For example, case studies of large construction projects elsewhere in the world have shown that the presence of a large number of single males in the construction workforce has increased demand for casual sex. Measures to manage the interaction between the local community and the workforce could need to be developed and implemented.

Flooded or open trenches during construction may create additional mosquito breeding grounds, in particular during the rainy season; hence the prevalence of malaria may increase. Sewage, hazardous substances and poor waste management associated with the construction camps (and later, the permanent townships) may also cause health issues. In addition, noise and dust pollution from the construction activities, as well as the heavy construction traffic, may affect the communities residing close to the construction areas and main haul roads.

A significant increase in traffic levels combined with a number of factors including poor current road conditions, uneven surfaces and the limited understanding of road safety among local drivers and pedestrians is likely to increase the number of accidents.

The construction of the dam may lead to a rapid encroachment and influx of "exotic" in-migrant populations, which could overwhelm the indigenous populations. There are risks that high in-migration may bring about the dilution, alteration and erosion of indigenous cultures and significant weakening of local cultural systems among the riparian populations. The combination of rapid influx of people to a dam site and weakening of traditional structures can lead to changes in lifestyles, behavioural changes and loss of personal dignity, which could promote prostitution and crime. This can quickly lead to increased prevalence of sexually transmitted infections (STIs) such as syphilis, gonorrhoea and HIV/AIDS.

#### *During Operation and Inundation*

In some respects, dam projects can improve the well-being of populations around the dam area (eg safe water more readily available, new infrastructure, better access to health care), and potentially increase the food supply (for example, as a result of improved transport infrastructure, increased fish

catches from a reservoir fishery). However, there are risks that health and nutrition may worsen, particularly in young children. Communicable diseases directly related to the presence of large quantities of standing water include:

- Malaria, which increases in incidence immediately after the building of the dam, after which a new balance develops between the human population and the parasites;
- Schistosomiasis, the disease which increases most in response to the building of dams, particularly in its most severe gastrointestinal form;
- Diarrhoea, as water is a major means of dissemination for many organisms, including those causing digestive tract infections;
- Gastroenteritis (amebiasis, salmonellosis, cholera), due to poor sanitation; and
- Other parasitic infections such as onchocerciasis and trypanosomiasis.

Other communicable diseases may appear or increase in incidence owing to the influx of migrants to the area. Sexually-transmitted infections and HIV/AIDS are a particular problem.

An increase in the numbers of insects particularly mosquitoes and blackfly may also have harmful effects on populations adapting to the new environment. There are also likely to be socio-demographic changes associated with changes in reproductive behaviour and women's activities. The location and nature of new homes and infrastructure (eg schools, health centres and roads) also contribute to the success or failure of dam projects.

### **7.3.5 *Disturbance due to Dust, Noise and Safety Hazards from Traffic***

#### *During Construction*

The construction of the dam could require large quantities of building material and other supplies (fuel, supplies to the construction village etc.), some of which could be delivered to the site by trucks that are most likely to pass in close proximity to homesteads (although the exact access routes to site are yet to be defined). The road to the site is unpaved and the traffic through these homesteads could result in significant disruption from dust and noise from passing traffic. These homesteads are very small and due to the rural nature, have experienced little traffic so far, increasing their susceptibility to disturbance. Safety could also be an important issue for residents who are unused to much traffic.

### **7.3.6 *Archaeology and Palaeontology***

#### *During Operation and Inundation*

Recorded archaeological sites, apart from one situated at the junction of the Songwe Gorge with the Zambezi, are all located on the escarpment. Although



they will not be flooded, these sites may be threatened by possible uncontrolled immigration and increased tourism.

Access to Chemapato Hill, an important cultural/spiritual area, may become problematic due to the flooding of the Gorge. Other archaeological sites identified within the transmission line corridors should be identified and if possible, avoided.

#### 7.4 *ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY*

All potentially significant environmental impacts (physical, biological, socio-economic and cultural and heritage) associated with the proposed Project have been identified in the Scoping Study and (where applicable) will be further investigated and assessed within the ESIA study through specialist studies. Where required, mitigation measures will be proposed.

The ESIA will suitably investigate and address all environmental issues in order to provide competent authorities with sufficient information to make an informed decision regarding the proposed Project

##### 7.4.1 *Aim of the ESIA*

The ESIA will aim to achieve the following:

- Provide an overall assessment of the physical, biological, socio-economic and cultural and heritage environments affected by the proposed Project;
- Assess the Project Area in terms of its environmental criteria;
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public participation process.

The adequate assessment and evaluation of the potential impacts and benefits that will be associated with the proposed Project necessitates the development of a scientific methodology that will reduce the subjectivity involved in making such evaluations. A clearly defined methodology is used in order to accurately determine the significance of the predicted impact on, or benefit to, the surrounding natural and/or social environment. For this the proposed Project must be considered in the context of the area and the people that will be affected.

Nonetheless, an impact assessment will always contain a degree of subjectivity, as it is based on the value judgment of various specialists and EIA practitioners. The evaluation of significance is thus contingent upon values, professional judgement, and dependent upon the environmental and community context. Ultimately, impact significance involves a process of determining the acceptability of a predicted impact to society.

The purpose of impact assessment is to identify and evaluate the likely significance of the potential impacts on identified receptors and resources according to defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise, reduce or compensate for any potential adverse environmental effects, and to report the significance of the residual impacts that remain following mitigation.

There are a number of ways that impacts may be described and quantified. An impact is essentially any change to a resource or receptor brought about by the presence of the proposed Project component or by the execution of a proposed Project related activity.

The nature of the Project may determine whether one needs to assess both routine and non-routine impacts. Non-routine impacts generally relate to accidents and could include oil/chemical/fuel spills, emergency venting of noxious gases, etc. In most cases, it would be sensible to have separate chapters for the assessment of routine and non-routine impacts.

The types of impacts and terminology to be used in the assessment are outlined in *Table 7.1*.

**Table 7.1** *Defining the Nature of the Impact*

Term	Definition
<b>Impact nature</b>	
<b>Positive</b>	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
<b>Negative</b>	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
<b>Direct impact</b>	Impacts that result from a direct interaction between a planned Project activity and the receiving environment/receptors (eg between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
<b>Indirect impact</b>	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (eg in-migration for employment placing a demand on resources).
<b>Cumulative impact</b> <sup>(1)</sup>	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

#### 7.4.2 *Assessing Significance*

There is no single accepted definition of ‘*significance*’ and its determination is, therefore, somewhat subjective. However, it is generally accepted that significance is a function of the **magnitude** of the impact and the **likelihood** of the impact occurring. It is widely accepted that Impact Magnitude (or Severity) is a function of the extent, duration and intensity of the impact.

(1) The assessment of cumulative impacts is qualitative and is often discussed in a separate chapter in the ESIA Report. One should remember to include the assessment of cumulative impacts in the terms of reference to specialists.

The criteria used to determine significance are summarised in *Table 7.2*. These criteria (specifically Extent and Duration) should be customised to suit individual Projects.

**Table 7.2**      *Significance Criteria*

Impact magnitude – the degree of change brought about in the environment	
<b>Extent</b>	<p><b>On-site</b> – impacts that are limited to the site boundaries.</p> <p><b>Local</b> – impacts that affect an area in a radius of XX km around the site.</p> <p><b>Regional</b> – impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystem.</p> <p><b>National</b> – impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences.</p> <p><b>Transboundary/International</b> – impacts that affect internationally important resources such as areas protected by international conventions.</p>
<b>Duration</b>	<p><b>Temporary</b> – impacts are predicted to be of short duration and intermittent/occasional.</p> <p><b>Short-term</b> – impacts that are predicted to last only for the duration of the construction period.</p> <p><b>Long-term</b> – impacts that will continue for the life of the Project, but ceases when the Project stops operating.</p> <p><b>Permanent</b> – impacts that cause a permanent change in the affected receptor or resource (eg. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.</p>
<b>Intensity <sup>(1)</sup></b>	<p>BIOPHYSICAL ENVIRONMENT: <i>Intensity can be considered in terms of the sensitivity of the biodiversity receptor (ie. habitats, species or communities).</i></p> <p><b>Negligible</b> – the impact on the environment is not detectable.</p> <p><b>Low</b> – the impact affects the environment in such a way that natural functions and processes are not affected.</p> <p><b>Medium</b> – where the affected environment is altered but natural functions and processes continue, albeit in a modified way.</p> <p><b>High</b> – where natural functions or processes are altered to the extent that it will temporarily or permanently cease.</p> <p><i>Where appropriate, national and/or international standards are to be used as a measure of the impact. Specialist studies should attempt to quantify the magnitude of impacts and outline the rationale used.</i></p> <hr/> <p>SOCIO-ECONOMIC ENVIRONMENT: <i>Intensity can be considered in terms of the ability of Project affected people/communities to adapt to changes brought about by the Project.</i></p> <p><b>Negligible</b> – there is no perceptible change to people’s livelihood</p>

(1) The frequency of the activity causing the impact also has a bearing on the intensity of the impact, ie. the more frequent the activity, the higher the intensity.

	<p><b>Low</b> - People/communities are able to adapt with relative ease and maintain pre-impact livelihoods.</p> <p><b>Medium</b> - Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.</p> <p><b>High</b> - Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.</p>
<b>Impact likelihood – the likelihood that an impact will occur</b>	
<b>Unlikely</b>	The impact is unlikely to occur.
<b>Likely</b>	The impact is likely to occur under most conditions.
<b>Definite</b>	The impact will occur.

Once a rating is determined for magnitude and likelihood, the matrix in *Table 7.3* can be used to determine the impact significance.

**Table 7.3** *Example of Significance Rating Matrix for Positive and Negative Impacts*

SIGNIFICANCE RATING				
	LIKELIHOOD	Unlikely	Likely	Definite
MAGNITUDE	Negligible	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

A colour scale for negative and positive ratings is given in *Table 7.4*.

**Table 7.4** *Colour Scale for Ratings*

Negative ratings	Positive ratings
Negligible	Negligible
Minor	Minor
Moderate	Moderate
Major	Major

*Table 7.5* outlines the various definitions for significance of an impact and is based on the significance rating matrix.

**Table 7.5** *Significance Definitions*

Significance definitions	
<b>Negligible significance</b>	<p><i>An impact of negligible significance is where the magnitude is negligible, low or medium and the likelihood of the impact occurring is unlikely or likely.</i></p> <p>An impact of negligible significance is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels.</p>
<b>Minor significance</b>	<p><i>An impact of minor significance is where the magnitude of the impact is low but the likelihood is high or where the magnitude is high but the likelihood of occurrence is unlikely or likely.</i></p>



	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.
<b>Moderate significance</b>	<p><i>An impact of moderate significance is where the magnitude is medium to high and the likelihood of the impact occurring is likely or definite.</i></p> <p>An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that “moderate” impacts have to be reduced to “minor” impacts, but that moderate impacts are being managed effectively and efficiently.</p>
<b>Major significance</b>	<p><i>An impact of major significance is where the magnitude of the impact is medium to high and the likelihood of the impact occurring is also likely or definite.</i></p> <p>An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the Project.</p>

Once the significance of the impact has been determined, it is important to qualify the degree of confidence in the assessment. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence can be expressed as low, medium or high.

## 7.5

### *MITIGATION POTENTIAL AND RESIDUAL IMPACTS*

It is expected that for the identified significant impacts, the Project team will work with the client in identifying suitable and practical mitigation measures that are implementable. Mitigation that can be incorporated into the Project design in order to avoid or reduce the negative impacts or enhance the positive impacts will be developed. A description of these mitigation measures should also be included within the EMP.

Residual impacts are those impacts which remain once the mitigation measures have been designed and applied. Once the mitigation is applied, each impact is re-evaluated (assuming that the mitigation measure is effectively applied) and any remaining impact is rated once again using the process outlined above. The result is a significance rating for the residual impact.

The approach taken to defining mitigation measures is based on a typical hierarchy of decisions and measures, as described in *Box 7.3*.

**THE MITIGATION HIERARCHY FOR PLANNED PROJECT ACTIVITIES***Avoid at Source; Reduce at Source*

Avoiding or reducing at source is essentially 'designing' the Project so that a feature causing an impact is designed out (eg a waste stream is eliminated) or altered (eg reduced waste volume). Often called minimisation.

*Abate on Site*

This involves adding something to the basic design to abate the impact - pollution controls fall within this category. Often called 'end-of-pipe'.

*Abate at Receptor*

If an impact cannot be abated on-site then measures can be implemented off-site - an example of this would be to use the stand-by vessel to help control the level of interference with fishing activity.

*Repair or Remedy*

Some impacts involve unavoidable damage to a resource, eg land disturbance. Repair essentially involves restoration and reinstatement type measures, such as base camp closure.

*Compensate in Kind*

Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate.

---