PART I:
EXECUTIVE SUMMARY

THE PROPOSED BALAMA GRAPHITE MINE IN THE CABO DELGADO PROVINCE IN THE DISTRICT OF BALAMA IN NORTHERN MOZAMBIQUE

PREPARED FOR

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DRAFT FOR REVIEW

1. Background

Twigg Mining & Exploration Lda, a subsidiary of Syrah Resources Limited, proposes to develop a graphite mine in northern Mozambique, approximately 7 km east from the small town of Balama. The Syrah Balama Project (SBP) is located on a 106 km^2 Prospecting Licence in northern Mozambique, within the District of Balama in the Cabo Delgado Province. The project area is approximately 265 km by road (3.5 hours' drive) west of the port town of Pemba, and 515 km to the port town of Nacala, where deep water ports are strategically located, and which is the preferred option for product export (Figure 1).

In December 2011, Syrah acquired 100% ownership of the Balama Graphite Project and has since conducted a large diamond drilling resource program to define a graphite resource with a very strong potential to be developed into a mining operation. Syrah aim to produce a high purity graphite concentrate (between 90-99% total graphite content - TGC), with a requirement to preserve flakes. Balama is a very large graphite deposit and excluding market considerations, has the potential to deliver a mine life of 100 years at a process rate of 2 million tpa. A mining license application for a period of 25 years will be submitted (an effective mine life of 23.5 years to allow for closure) with an option to extend for a further 25 years. The plant will operate 365 days per year.

The proposed project (Balama Graphite Mine), triggers an EIA and is classified as a category A project, requiring a full EIA. In accordance with Mozambican regulatory requirements the issuing of an environmental licence requires the preparation of an Environmental Impact Assessment (EIA). The Mozambican Ministry for Co-ordination of Environmental Affairs (MICOA) is the lead environmental agency in Mozambique, and it is MICOA who is responsible for the review and issuing of an environmental licence.

This ESHIA report intends to ensure that environmental and social concerns are integrated into the proposed development, and suggests ways of preventing, minimising, mitigating and/or compensating for possible adverse environmental and social impacts which may arise due to the proposed development.

2. Project Overview

The mine will consist of two open pits, Balama East and Balama West. Balama East is located approximately 1 km east of the process plant, whereas Balama West is located approximately 2.5 km south west of the processing plant. Both open pits are designed for a maximum depth from surface of less than 50 m.

It is the intention that conventional open pit mining be used to extract the ore, with a baseline scenario of 2 million tonnes per annum. The extraction of the graphite will require conventional flotation processing. The Chipembe dam, located approximately 13 km northwest of the project site, will be the primary source of water for this process. Water will be transferred to site via a pipeline.

Ore will be delivered from the mine onto stockpiles at the processing plant using haul trucks. The ore will then be fed into the crusher bin, which is the first step in the crushing process. . The crusher plant will consist of primary and downstream crushers. The crushed ore will be fed via a conveyor into a mill feed silo and then milled. The ore will then undergo cleaning, flotation and regrinding. All tailings from the process will be transferred to a tailings storage facility (TSF). The final concentrate will be pumped to final concentrate holding tanks ahead of a filter. This material will then be dried and bagged for transport. Once the graphite concentrate has been produced, it will be transported by road to the deep water port at Nacala and subsequently exported.

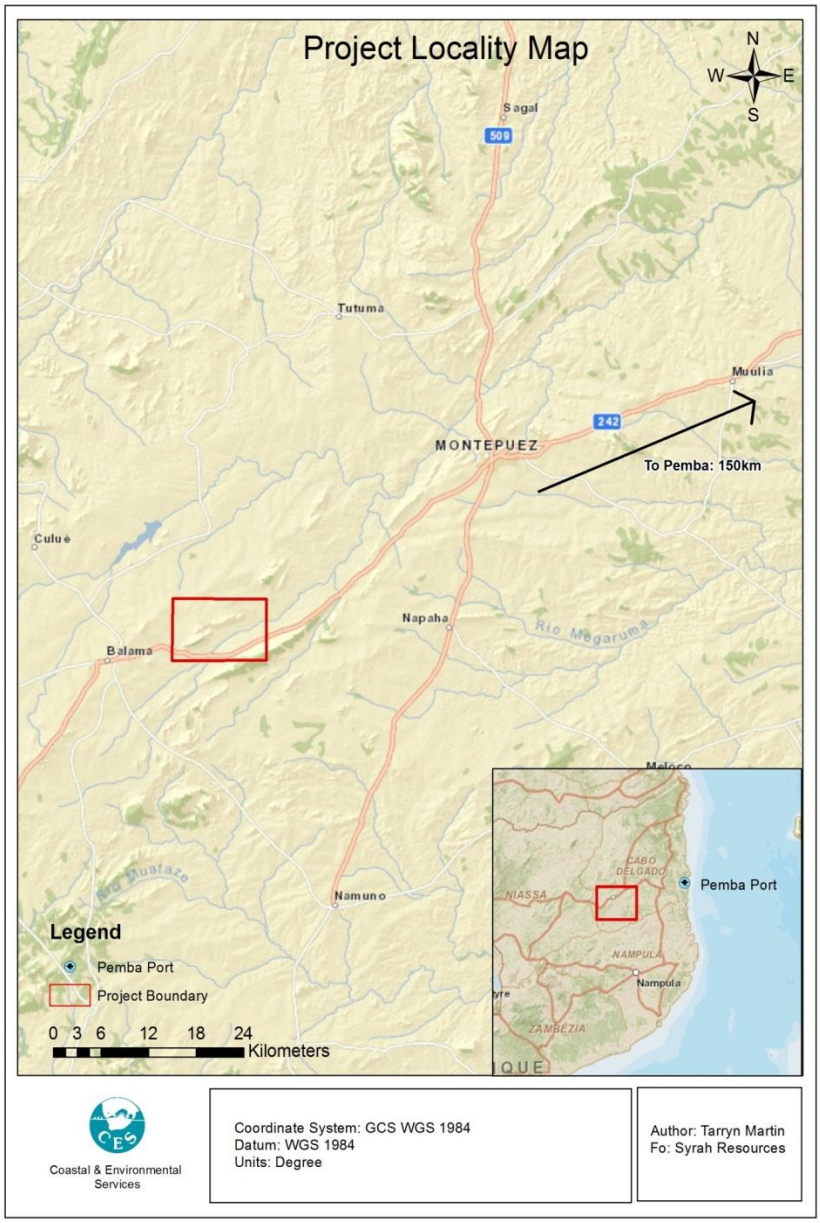

Figure 1: Locality map indicating the position of the proposed Balama Graphite Mine area

Infrastructure required for the graphite mine includes:

- A pipeline (±13 km) from the Chipembe dam to the project site;
- Pump houses at the dam and project site;
- Water reservoirs, for process and waste water;
- Internal roads to enable access to various parts of the development and for transportation of materials, equipment, supplies and employees;
- Grid power connection as well as a diesel powered electricity generation plant, inclusive of bunded storage areas for diesel fuel, lubricants and waste oil; and
- An ore processing plant.

The project will also require infrastructure related to auxiliary services including the following:

- Offices

- Accommodation at the project site for approximately 250 people;
- A lay-down area for construction materials and equipment. This area will continue to be used during the operational phase, although the actual area of land required may be reduced;
- Workshops for repair of equipment and machinery;
- Stores and a lay-down area(s) for equipment, spares and consumables;
- Offices for site staff;
- Ablution facilities and associated sewage treatment plants;
- Security measures

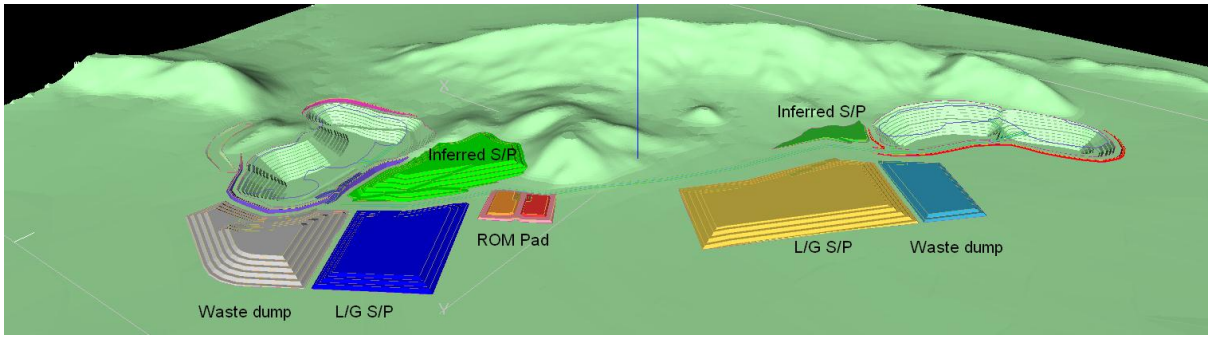

Figure 2 – Diagram of the overall layout of the operation

Raw and Potable Water - The Chipembe dam, located approximately 13 km northwest of the project site, will be the primary source of water during the operational phase of the project. It is estimated that 1 m^3 of water (1000 litres) will be required per tonne of ore processed, resulting in a minimum water requirement of 2 million m^3 per annum. Based on discussions between Twigg (Syrah) representatives and ARA-Norte, availability has been confirmed (Licence no 07/2012 valid till October 2018). The pump station will be located adjacent to the dam and the 13km above-ground pipeline will deliver water to a raw water storage pond to provide local storage in the event of pipeline maintenance.

Water will be pumped from this pond to a 300 m^3 tank at the offices and a second 300 m^3 tank located at the accommodation village. These tanks will provide water for general use and for fire water storage for fire fighting. Water will be distributed via a pump and piped reticulation system for general use and to a potable water treatment facility that will make potable water to be stored in a potable water tank, and reticulated for use in the office complex, change houses and tea room.

Process water - Tailings return water will be pumped to the process water tank and used for a variety of process applications. Storm water and a portion of the water used for general washing applications will be collected in process water ponds from where it will be recycled by pumping it to the process water tank.

Process water will be circulated through the plant in a ring main. Each required take off will be fitted with an isolation valve. The mill discharge, flotation feed, scavenger tails and tailings pumps will have flushing water connected to the suction line. The flushing points will be manually operated.

Reagent mixing water, fire water, sample cutter rinse water and gland service water will be supplied from a raw water tank.

Mine dewatering - The mine is not expected to generate large quantities of water. Water in the mine will be collected in sumps and either pumped into water trucks for dust suppression

on the mine haul roads or pumped to the process water pond to be used for processing.

Power - Grid power will be supplied from a 33 kVA line to the established by EDM. The power line is part of EDM's electrification programme to supply electricity to the area. A diesel generation plant will provide back-up power on site. In the event that grid power is unable to provide sufficient capacity, or has not come on line at the start of the project, the generation plant will provide the required electricity on a 24 hour, seven days a week basis. The ESIA assesses the option of 24/7 diesel powered generation in the event that EDM power is not yet available.

Roads- Mine site roads will consist of the following:

- A partial upgrade of 3km of the road meeting the main road at Piriri and running to Ntete village;
- A new road approximately 2.5 km from the provincial road (No. 242) to the mine office, workshop and processing area;
- A new road approximately 2.5 km from the mine office, workshop and processing area to the accommodation village;
- Mine haul road from the Balama East open pit to the ROM pad;
- Mine haul road from the Balama West open pit to the ROM pad;

Construction and Operation Accommodation - A permanent rural village has been proposed by Syrah Resources, as part of the Balama Graphite mining operations. This village will become an important contributor to the local economy and an opportunity to enhance the welfare and opportunities of many of the local residents. The village will be located on existing rural land in close proximity to the existing Ntete and Nquide villages as well as the proposed Balama Graphite mine. The village will be situated at the base of a 100 m high granite ridgeline. The location and design of the village has been selected based on areas with the least visual impacts and most suitable land in terms of environmental parameters to showcase the best global practices in mine workers' accommodation. Currently an existing gravel road links the Nquide and Ntete Villages with Balama. A new road network is planned to connect the mine to the existing villages as well as the proposed agricultural and rural village. Accommodation at the village will accommodate approximately 250 people, mainly workers, and will not include families or children. The local production of food will be integrated to supply some of the food requirement at the accommodation village.

The village will be structured to include the following:

- A residential area consisting of clusters of living pods;
- A recreational building, gym and barbeque courtyard (serving as an outdoor cinema as well);
- A mess hall, senior staff accommodation and visitor accommodation buildings;
- An administration building (office space, storage space);
- A medical clinic with a small pharmacy;
- A housekeeping area (e.g. laundry, linen stores, cleaning stores and parking house);
- A village hub (e.g. service area, barber shop, hairdresser, stationary store, small grocer, clothing store and guesthouse);
- A soccer field and basketball court adjacent to the hub;
- Bicycle paths running parallel to the main road; and

The construction of the following infrastructure will be required:

- Roads and paths for access (bitumen paved/spray sealed);
- Substation and generating plant;
- Electricity supply;
- Sewerage system;
- Water supply will be via a branch line from the main pipeline from the Chipembe

reservoir to the raw water distribution system;
- Small water treatment plant;

Locally sourced materials and labour will be used where possible.

Sewage System - The construction and operational phases' workforce of approximately 250 individuals (at peak period) will generate sewage and wash water that will need to be managed. The anticipated general sewage and domestic wash water effluent streams associated with the construction and operational phases of the Syrah Balama Graphite project have been calculated and are presented in the report.

Packaged sewage plant specification - Based on the calculated estimate of generated sewage and domestic wash water during the construction and operational phases of the project, a packaged sewage treatment plant with the capacity of treating ~40m^3 of domestic effluent per day is required for installation.

Landfill Site - The design and construction of the Syrah Balama Graphite general waste landfill site should be in accordance with international best practice as described in EPA (2000), details of which have been provided in the Minimum Requirements for Waste Disposal by Landfill, 3rd ed. (DWAF, 2005).

3. Key findings of specialist assessments

The key issues which have been identified by the various specialist assessments and the proposed mitigation and management actions which will be required in order to reduce all risks associated with the project to an acceptable level are discussed below.

Vegetation Assessment - Eleven impacts were identified and assessed for Construction and Operational Phases. The majority of the impacts will occur during the construction phase of the project. Three impacts were classified as HIGH NEGATIVE and six impacts were classified as MODERATE NEGATIVE. With mitigation, two of the HIGH impacts can be reduced to LOW NEGATIVE and three of the six MODERATE impacts can be reduced to LOW NEGATIVE. The following are key findings:

- Inselberg's form important "stepping stones" or linkage corridors between fragmented vegetation and have been documented as important features for the conservation and dispersal of different species. It is therefore important that a portion of the inselberg Mount Nassilala, where the graphite deposit has been identified, is conserved so that this process can continue.
- Infrastructure such as the tailings storage facility, mine camp and mine plant should be located in areas of low and moderate sensitivity. The position of the mine camp on Mount Coronge has been shifted out of this area of high sensitivity.
- Current land use is having a large impact on the natural vegetation in the low lying areas. Large tracts of land have been cleared and planted with crops such as cotton, maize and cassava.
- The vegetation on the slopes of Mount Nassilala and Mount Coronge is relatively intact. The plant communities on these inselbergs are important refugia for plant and animal species and they provide important ecosystem services for local human communities.
- The highest biodiversity was recorded in the *Riparian Woodland.* Although these exist as thin strips surrounded by a sea of agriculture they currently form important, natural ecological corridors and should therefore be rehabilitated, conserved and protected.

- The intact *Miombo Woodlands: Plains* that occurs near Nquide village has the next highest species diversity after the *Riparian Woodlands* and contains important species such as *Habenaria sp.* (Orchidaceae). This area should be conserved and protected

Faunal Assessment - Most of the observed amphibian fauna are characteristic species of wetlands in the lowlands of northern Mozambique, from which 25 species are recorded and a further 13 species are possible. No amphibians in the Balama region are endemic or of conservation concern. No amphibians are endemic to northern Mozambique. There is no evidence of significant direct utilization of amphibians in the region, either for international trade or for food consumption. Amphibian threats are thus indirect, of which the most significant is habitat loss due to existing agricultural practises

Of the potential 87 reptiles that may occur in the Balama region, only 20 were recorded during the survey. A further eight large or conspicuous species were reported by mine personnel and local villagers to be present. One lizard of scientific interest was collected during the survey. A series of small, snake-eyed skinks (*Panaspis* cf *wahlbergii*) were collected beneath cashew trees near Nquide village. The most significant threats to reptiles are indirect, and result mainly from habitat loss due to existing agricultural practises. Proposed industrial developments in the region will compound this threat, especially from the resulting habitat fragmentation that leads to elevated mortality from road traffic and exposure to predators as reptiles (particularly tortoises, snakes and monitors) move over the landscape.

Of the possible 300+ bird species which may occur in the study area, 133 were observed during the wet season survey. The number of birds recorded is to be expected for a short-term survey, especially as it is likely that many intra-African and Palaearctic migrant birds had already departed at the time of the field trip. No bird species which are considered threatened by the IUCN were recorded on site. However, several (11) CITES listed species were recorded, while a further 61 bird SSC may occur in very low numbers or as vagrants on site.

Of the possible 145 mammal species which may occur in the study area (including 13 large mammals now locally extinct), only 14 were recorded during the wet season survey. A further 21 species were reported to still occur in the region, although some are now acknowledged to be very rare. Domestic mammals observed on site included: cats (*Felis catus*), dogs (*Canis africanis*), zebu cattle (*Bos* sp.), pigs (*Sus scrofa*), and goats (*Capra aegagrus*). Eight mammal SSC were identified for the study area: three of these occurred in the area during historical times, but local people report no recent records and they are highly unlikely to still occur locally; two mammal SSC (African Elephant and Hippopotamus) were reported by locals to still occur in the area.

Ecological sensitivity - No habitats were classified as highly threatened or unique ecosystems and they are not associated with key evolutionary processes. While these habitats are not classified as critical habitats they have been classified as natural habitats using the IFC definition *"areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition."* (IFC, 2012).

In terms of ecological sensitivity (Figure 2), a large portion of the project area has been cleared for agricultural crops such as cotton, maize and cassava, resulting in these areas having a low sensitivity as they have been transformed through anthropogenic activities and are highly degraded. Areas of natural vegetation, such as the degraded Miombo Woodland: Plains, were assigned a medium ecological sensitivity as they still have a relatively high species richness and form important ecological process areas for small mammals and birds

in the area. These areas can withstand a limited loss of, or disturbance to, natural areas.

Areas of high sensitivity were assigned to the Miombo Woodland: Granite and Miombo Woodland: Graphite, the intact Miombo Woodland: Plains and the Riparian Woodland. These vegetation types were assigned a high sensitivity score as these areas are all relatively intact and have high species diversity. They also contain species of special concern such as *Sterculia appendiculata* (listed as Vulnerable on the Mozambique red Data Lists). A number of these species were noted to occur on the slopes of the Granite Inselberg (Mount Coronge). Although highly degraded in most parts, the Riparian zone was assigned a high sensitivity score as it is an important process area for ecosystem functioning. It also scored a high biodiversity value.

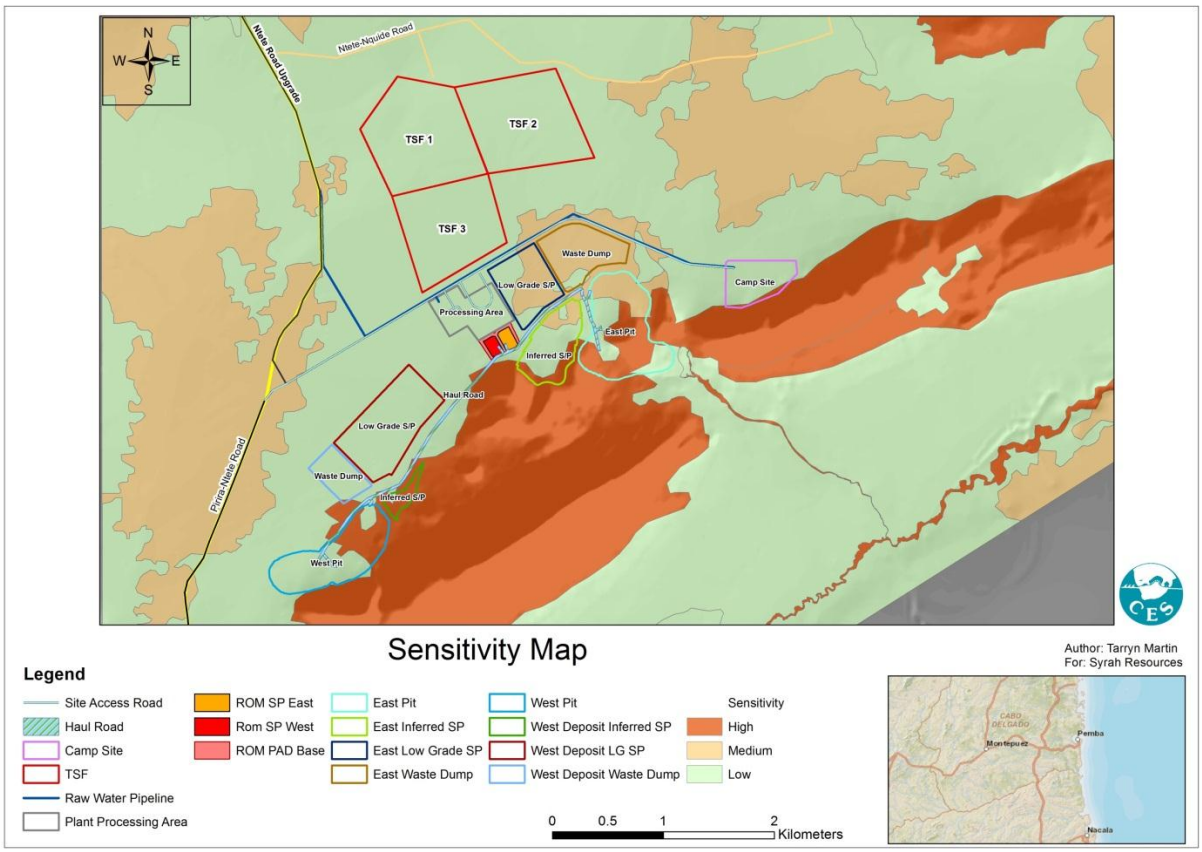

Figure 3 - Ecological sensitivity map of the project area.

Aquatic Assessment - The Mehucua River flows through the southern section of the project site in a south-west to north-east direction. At this point it joins the Montepuez River 25 km downstream of the project site. The Mehucua River has three major tributaries; two of which - the Namiticu and the Naconha rivers - are upstream of the project area and the third tributary joins the Mehucua some distance downstream of the project area.

In situ and ex situ water quality indicated that in general the water quality was good when compared to the various relevant water quality guidelines, specifically the MICOA standard for Category (a) human consumption (Ministerial Diploma of 18/2004).

Aquatic macroinvertebrates were collected using the standard South African Scoring System (SASS5) protocol. The number of aquatic macroinvertebrate taxa ranged from 16 at the Chipembe Dam site to 10 at the Mehucua River site. The moderate/high percentage contribution (25 - 30%) of Ephemeroptera, Trichoptera and Plecoptera (EPT taxa) to the

overall invertebrate assemblage in the general area indicates that biotic integrity remains high despite the impacts of riparian zone clearance and sediment load increases due to local farming practices. The relatively low levels of taxon richness measured at all sites can be attributed to the relatively poor habitat availability. This was due to various reasons related to seasonality, including high flow levels and flood damage to marginal vegetation. It is anticipated that the dry season taxon richness may be higher.

All rivers in the Study Area are considered to be seasonal and only flow in the wet summer months, considered to be from November to March or April. During the dry winter months when flow ceases, the rivers within the Study Area mostly consist of disconnected, shallow pools, barely able to support fish life. In addition, there are a few deeper pools with permanent surface water that provide refuge during the dry season.

A total of eleven fish species were observed and captured in the study area, with most of the species found at more than one site (Table 4.12**)**. Most species appear to be common throughout the study area and have widespread distributions throughout Southern Africa. However, one species (the Mozambique tilapia, *Oreochromis mossambicus*) is near threatened and two species, the sand catlet (*Zaireichtys cf. monotap*a) and the orange finned killifish (*Nothobanchius sp. "orange fins*") appear to be previously un-described scientifically.

Hydrogeology Assessment - Groundwater levels in the project area range between 2 meters below ground level (mbgl) at Pirrira BH3 (Balama west) to 33 mbgl in BH8 (Balama east). There are two sets of aquifer systems in the project area: a weathered aquifer and a fractured aquifer system. The aquifer associated with the weathered bedrock varies in thickness throughout the area, but it can extend to depths of about 40 mbgl. The weathered aquifer is fairly permeable as only minor seepages were recorded in the weathered material during drilling. The pockets of deeper weathering may allow seepage migrating to the fractured zone aquifer.

During the recent borehole drilling programme 8 boreholes were installed. All major water strikes intercepted during drilling were between 40 and 60 mbgl. The major water strikes had yields between 0.78 and 9 L/s. Besides the fault gouge at Balama East, all major water strikes were associated with fractured intrusives at contact zones. Six of these boreholes are still open and accessible for water abstraction. Of these eight boreholes, three are fit for human consumption and three would be fit for consumption if treated.

Geochemistry - The Acid-base Accounting (ABA) procedure measure the acid- and alkaline-producing potential of undisturbed soil and rock (overburden) in order to determine if, after disturbance, the waste material will produce acid and subsequently leach metals. This procedure includes Nett Acid Generation (NAG) tests that evaluate the Nett acid generation and neutralising potential of the material. From the ABA and NAG results the following can be concluded:

- The paste pH values of the waste rock material (hanging wall and footwall) are all above 8 with the exception of one sample;
- The mineralised zone has neutral paste pH values with only one sample showing a acidic formation in the material paste;
- The sulphur content of all the samples are above the margin concentration of 0.3% S with the exception of two samples being below 0.01%;
- Material with a sulphur content above 0.3% shows a tendency for acid generation if the neutralising potential of the rocks are not high enough;
- If the Nett Neutralising Potential (NNP) of a sample is below 0 the sample has the potential to produce acid. This is the case in all the samples with the exception of

two;

- All the samples with the exception of two are classed a rock type I and are thus potentially acid forming
- The acid forming nature of the rocks is of concern as it can lead to AMD formation as well as increase the leachability of metals and ions into the receiving environment.

The SPLP tests are a leachate procedure in which the contaminants that can potentially seep into the groundwater and surface water reserves from waste facilities and stockpiles can be determined. The quality of the leachate was classed against the SANS 241:2005 drinking water guidelines, as well as WHO drinking water guidelines to evaluate its suitability for human consumption and the potential for contamination; should leachate reach and mix with local water resources. WHO guideline values were only used where the SANS guideline do not give criteria for that specific parameter. SANS 241:2005 identifies 3 classes namely Class 1 (recommended operational limit), Class 2 (maximum allowable concentration for limited duration) and Class 3 (Not recommended for human consumption). The metals found to be above the recommended drinking water guidelines, but within the maximum allowable limits were Ca, Co, Cr, Mn, Se and Zn.

Based on the results of the Geochemistry assessment discussed above, it is evident that material representing the waste rock as well as the ore body has samples that could potentially generate acid drainage. The waster rock dumps and tailings storage facility has a moderate potential for AMD due to the high Sulphur content and acid generation potential in the samples that were tested. The ore material has a potential for AMD formation due to the high Sulphur concentrations and low paste pH levels, which could result in leachate water with a low pH and increased metal content. The high concentrations of U, Sr, Se and Rb in the graphite zone were also found to be potentially radioactive posing a health risk.

Land, Natural Resource Use and Agriculture Assessment - Almost all households are heavily reliant on the natural resources for their livelihoods. Natural resources are used for construction, medicinal consumption and to supplement their food. Charcoal production was also evident in the project site.

Socio-Economic Assessment - The proposed mining operation is being developed in an area that is poor and faced with limited economic opportunities at present, Most villagers are self-employed farm workers and lead a predominantly subsistence agricultural lifestyle supporting large and extended families. The largest industry in the area is Plexus, a cotton producer which supports many farmers in the area with cotton production. Some farmers do receive agricultural support either from companies such as Plexus, and the government through seed provision and support. Under the traditional jurisdiction of the Macua Tribe, the area and its people are male-dominated and very patriarchal. Thus, any development in the area has the potential to reinforce this system, which disempowers and marginalises vulnerable groups such as women, the elders, and the youth.

The SIA identified several impacts which need to be mitigated. Most of these issues revolve around a central theme of land and food security. The mining operation will affect a large area which is currently extensively utilised by almost all the households for agricultural farming. Nearly all the households have farms or machambas, many of which will be either affected or lost during the mine development. The extent of economic displacement is significant (more than 200 machambas will be lost), for which purposes the greatest mitigation measure proposed to manage social impacts is a Resettlement Action Plan (RAP) and the development of associated procedures to guide compensation (which has already been drafted). The most significant issue that needs to be addressed is future food security. Affected villagers should be empowered and provided with the capacity to continue with their preferred livelihoods after the mine has closed, which should not leave them being worse off. Large areas to be mined are also used by most villagers for natural resource harvesting,

whilst small areas used for cultural and religion practices will also be lost or affected by the development.

The proposed development is seen as needed in the area, especially since the villagers suffer from food insecurity and severe poverty. The villagers' socio-economic status would not improve without an external economic intervention. Local employment opportunities will be created, and the impact of even providing one household member with employment cannot be disregarded. The income dependency is very high, which means that even one regular income stream in one household might sustain a series of households in these villages. The development should create an economic opportunity which can, in the long-term, boost and empower these villages with education, skills, training and agricultural productions.

Health Assessment - Ten health issues were identified and discussed, namely:

Communicable diseases linked to housing design and overcrowding: Tuberculosis is widespread in Mozambique. There is poor case detection in the district. Acute respiratory infections are a major cause of morbidity especially in children under five years of age. Poverty, poor environmental health conditions and poor nutrition play a role in community susceptibility to infectious diseases.

Vector-related diseases: Malaria is a major public health challenge in the project area and is regarded as the biggest concern related to burden of disease. It accounts for a significant portion of consultations at the local level. Community knowledge on transmission and prevention of malaria is good. Ownership of insecticide-treated nets is good, although it is difficult to assess proper utilisation. There are a number of interventions in the area to reduce the burden of disease from malaria but monitoring and evaluation activities are limited.

Sexually transmitted infections, including HIV/AIDS: HIV/AIDS remains an increasing public health challenge in the area. HIV prevalence is about 6-8% in the general population. Although commercial sex work is not common in the area, there is a potential for this to increase. Knowledge and awareness related to HIV appeared good. However, this does not translate into behaviour change and high risk practices are reported. Stigma was still high within the communities. Moreover, comprehensive knowledge of HIV prevention and transmission is low due to the belief of some misconceptions within the community. There are frequent HIV campaigns in the area. However, the limited functionality of the community health worker units may affect the delivery of services.

Soil-, water- and waste-related diseases: Generally poor access to drinking water sources. Water is generally available during wet and dry seasons. With the exception of Chipembe Dam, improved water sources, such as water pumps are common in some communities while others rely on non-improved water sources. The vast majority of households throughout the villages do not have access to their own improved sanitation facility. Diarrhoeal diseases are common. Intestinal parasites and urogenital schistosomiasis are also common.

Food- and nutrition-related issues: Malnutrition and micronutrient deficiencies are challenges in the project area. These are generally linked to food shortages and poor feeding practices. Anaemia is a major concern in the area although the true burden is not known. It is mainly linked to malnutrition, intestinal parasites and malaria.

Accidents and injuries: Road traffic accidents (RTA) are the most common form of non-accidental injury in the area

Exposure to potentially hazardous materials, noise and malodours: Communities residing in the Project area live in close contact to their environment and are thus vulnerable to any changes in water and air quality, as well as to noise pollution. There have been no cases of heavy metal pollution or toxicity in the project areas. Exposures and environmental health determinants as a result of the project will be covered in other specialist reports.

Social determinants of health: There is very good health-seeking behaviour in the project area, and very few people consult traditional healers. However, most communities do not have easy access to a health facility. Affordability is an issue as not all health services are free. Transportation to health care facilities is a major determinant in evaluating affordability. Education is an existing need.

Health systems issues: Limited diagnostics and human resource skills at the health centre level reduced the fidelity of data around the PACs.

Non-communicable diseases: Non-communicable diseases are not well documented in the area due to limited capacity in the local health facilities.

Noise Assessment - The overall pre-mitigation significance of the noise impact from the proposed Balama Graphite Mine is moderate to high during the construction and operational phase and drops to a low significance during the decommissioning phase.

The noise contributions can be reduced through the implementation of the recommended mitigation measures, especially the construction of the earth berms around the pits, which will help with the noise attenuating towards the villages. Depending on the general construct of the earth berms, an effective noise contribution decrease of between 5dBA and 10dBA can be achieved. The post-mitigation significance of the noise impact is considered to be moderate to low.

Traffic and Transport Assessment - The most significant contribution to traffic will be due to transport of the graphite concentrate from the mine site to the port of Nacala or the Port of Pemba. The mine will produce approximately 380,000tons of graphite per year, which will require approximately 29 truck-loads per day (delivery 360 days per year, payload 37t) to the warehouse. Graphite will then be containerised at the warehouse, and transported the short distance to the port.

From the mine site to Nacala/Pemba, trucks will need to pass through a number of settlements, some of which have markets along the roadside. Pedestrians and shoppers frequently cross the road, or the sheer number of people present spill into the road. Additional hazards are caused by taxis, vehicles and bicycles pulling off and pulling onto the road. Drivers of trucks will need to be vigilant in these areas and will need to exercise extreme caution. Completion of the upgrade of the road between Balama and Montepuez is scheduled for December 2015. When this upgrade is complete there will be no gravel roads between the mine site and Pemba/Nacala and therefore dust generation due to transport will not be an issue. However, if construction begins before December 2015, or if the completion of the upgrade is delayed, dust generation may be an impact and mitigation measures for this have been suggested.

Impacts that have been identified and assessed relate to: safety of other road users, the generation of dust, and the transport of abnormal loads. Mitigation measures have been suggested which will significantly relieve the seriousness of these impacts. Many of the impacts identified will no longer be applicable of the upgrade of the EN242 is completed prior to the initiation of construction.

4. Construction Phase Environmental Impacts

During the construction phase there are two impacts of VERY HIGH, and eight of HIGH significance before mitigation. However, after mitigation there is only one impact of HIGH significance, caused by the loss of Miombo Woodland on the graphite outcrops which cannot be effectively mitigated. There are also two socio-economic impacts of VERY HIGH, and eight of HIGH significance before mitigation, and one positive impact of MODERATE significance. After mitigation there are no negative impacts of HIGH or VERY HIGH significance, and with optimization of the socio-economic benefits arising from the project, there are nine positive impacts, one of HIGH significance. There is one impact of VERY HIGH significance related to hazardous waste, which can be reduced to MODERTE significance after mitigation. This, together with an increase in traffic frequency are the only waste and process related impacts of MODERATE significance after mitigation.

Table 1: Impacts as a result of the construction phase

Impact	Significance Without Mitigation	Significance With Mitigation
BIOPHYSICAL IMPACTS		
Impacts on topography and geology	LOW -	N/A
Removal of topsoil and soil erosion	MODERATE -	LOW -
Soil contamination	MODERATE -	LOW -
Disturbance to existing soil profile will result in a decrease in agricultural capability	HIGH -	MODERATE -
Loss of agricultural land due to establishment of mining infrastructure	VERY HIGH -	MODERATE -
Loss of subsistence crops due to establishment of mining infrastructure	VERY HIGH -	LOW -
Sedimentation and elevated turbidity levels	HIGH -	MODERATE -
Contamination of non-ore pollutants	MODERATE -	LOW -
Aquatic habitat modification	HIGH -	MODERATE -
Loss of aquatic species of special concern	HIGH -	MODERATE -
In-stream structures blocking migrations (bridges, causeways)	HIGH -	LOW -
Over-utilization of fish resources	MODERATE -	LOW -
Loss of riparian woodland	MODERATE -	MODERATE -
Loss of Miombo woodland: graphite	HIGH -	HIGH -
Loss of Miombo woodland: granite	MODERATE -	LOW -
Loss of intact Miombo woodland: plains	MODERATE -	LOW -
Loss of degraded Miombo woodland: plains	MODERATE -	MODERATE -
Loss of biodiversity (general)	HIGH -	MODERATE -
Loss of floral species of special concern	MODERATE -	MODERATE -
Fragmentation of vegetation and edge effects	HIGH -	MODERATE -
Disruption of ecological systems and functions	MODERATE -	LOW -
Loss of amphibian diversity	MODERATE -	LOW -
Loss of reptile diversity	MODERATE -	LOW -
Loss of bird diversity	MODERATE -	LOW -
Loss of mammal diversity	MODERATE -	MODERATE -
Loss of faunal species of conservation concern	MODERATE -	LOW -
Faunal impact of habitat fragmentation and loss	MODERATE -	LOW -
Ecological impacts from dust	MODERATE -	LOW -
Disruption to fauna from increased noise levels	MODERATE -	MODERATE -
Chemical pollution	MODERATE -	LOW -

Impact	Significance Without Mitigation	Significance With Mitigation
SOCIO-ECONOMIC IMPACTS		
Reduced access to productive land and economic displacement	VERY HIGH -	MODERATE
Increased Food Insecurity	HIGH -	LOW +
Reduced access to Natural Resources	HIGH -	MODERATE -
Loss Sacred and culturally significant sites	HIGH -	LOW -
Loss of graveyards/sites	VERY HIGH -	LOW -
Community safety risk	MODERATE -	N/A
Employment, Skills traps	MODERATE +	HIGH +
In-migration in search of job opportunities	HIGH -	LOW-
Stakeholder and community engagement	MODERATE -	MODERATE +
Road traffic accidents and other accidental injuries	MODERATE -	MODERATE +
Air pollution, noise and mal-odours	MODERATE -	LOW +
Chemicals, pesticides and heavy metals	MODERATE -	LOW -
Gender-based violence, alcohol and drugs	HIGH -	MODERATE +
Social cohesion and well being	HIGH -	MODERATE +
Health system strengthening	HIGH -	HIGH +
Non-communicable diseases	MODERATE -	MODERATE +
Permanent loss of fruit trees, wood sources and other natural resources	MODERATE -	LOW -
Increasing demand for natural resources	HIGH -	MODERATE -
IMAPCTS ASSOCIATED WITH WASTE INFRASTRUCTURE AND PROCESS RELATED ISSUES		
Pollution of land and water (general waste)	MODERATE -	LOW -
Pollution of land and water (hazardous waste)	VERY HIGH -	MODERATE -
Nuisance impact (production of odours, visual impact and attraction of pests and vermin) from solid waste	MODERATE -	LOW -
Pollution of soil and water from domestic wastewater and sewage sludge	MODERATE -	LOW -
Health impacts to employees and communities	MODERATE -	LOW -
Nuisance impact (odour and flies) from domestic wastewater and sewage sludge	MODERATE -	LOW -
Pollution of land and water from disposal of run-off / storm water	MODERATE -	LOW -
Increase in traffic frequency through villages	MODERATE -	MODERATE -
Transport of abnormal loads	LOW -	LOW -
Dust generated from traffic	MODERATE -	LOW -
Impact of traffic noise on surrounding noise sensitive receptors in terms of annoyance during the construction phase	MODERATE -	LOW -
Impact on air quality as a result of site clearing (removal of topsoil and vegetation and stockpiling of overburden topsoil)	MODERATE -	LOW -
Impact on air quality as a result of the construction of any surface infrastructure	MODERATE -	LOW -
Impact on air quality as a result of the transportation of materials and workers on site	MODERATE -	LOW -
Impact on air quality as a result of temporary storage of hazardous products	MODERATE -	LOW -

During the operational phase there is potentially one impact of VERY HIGH and nine of HIGH significance before mitigation. After mitigation all impacts are reduced to either MODERATE or LOW significance. There is potentially one socio-economic impact of VERY HIGH and nine of HIGH significance before mitigation. After mitigation there are no

negative socio-economic impacts of HIGH or VERY HIGH significance, and five MODERATE negative impact. Optimization of benefits results in 13 of the 18 identified socio-economic impacts being positive, of which five are HIGH positive, and seven MODERATE positive. Potentially two negative impacts of VERY HIGH, and six of HIGH significance before mitigation are waste, infrastructure and process related. However, after mitigation there is only one impact of HIGH significance (Increase in traffic frequency through villages) with the rest being either of MODERATE or LOW significance.

Table 2: Impacts as a result of the operational phase

Impact	Significance Without Mitigation	Significance With Mitigation
BIOPHYSICAL IMPACTS		
Impacts on topography and geology	MODERATE -	N/A
Soil contamination	HIGH -	LOW -
Possible contamination of groundwater through leaching of toxic materials from tailings storage facility	VERY HIGH -	LOW -
Sedimentation and elevated turbidity in rivers	HIGH -	MODERATE -
Contamination from non-ore pollutants	MODERATE -	LOW -
Ore contamination	MODERATE -	LOW -
Alteration of river flow-dynamics	MODERATE -	LOW -
Mine dewatering	MODERATE -	LOW -
Mine water contamination	MODERATE -	LOW -
Hydrocarbon spillage	MODERATE -	LOW -
Aquatic habitat modification	HIGH -	MODERATE -
Loss of aquatic species of special concern	HIGH -	MODERATE -
In-stream structures blocking migrations	HIGH -	LOW -
Over-utilization of fish resources	HIGH -	LOW -
Invasion of floral alien species	HIGH -	LOW -
Loss of ecosystem services provided by the plant communities identified in the project area	HIGH -	MODERATE -
Disruption of ecological systems and functions	HIGH -	LOW -
Loss of faunal biodiversity	MODERATE -	LOW -
Loss of faunal species of conservation concern	MODERATE -	MODERATE -
Introduction of alien fauna	LOW -	LOW -
Faunal impact of habitat fragmentation and loss	MODERATE -	MODERATE -
Impact of increased dust levels on fauna	MODERATE -	MODERATE -
Impact of noise pollution on fauna	MODERATE -	MODERATE -
Impact of chemical pollution on fauna	MODERATE -	LOW -
Threats to animal movements	MODERATE -	MODERATE -
SOCIO-ECONOMIC IMPACTS		
Temporary or permanent in-migration in search of job opportunities	HIGH -	MODERATE -
Reduced access to the inselberg's forest cover and small wildlife	HIGH -	MODERATE -

Impact	Significance Without Mitigation	Significance With Mitigation
Personnel safety risk	MODERATE -	N/A
Health services and water provision	MODERATE -	MODERATE +
Employment opportunities and the stimulation of economic growth in the region	MODERATE +	HIGH +
Stakeholder and community engagement	MODERATE -	HIGH +
Transmission of communicable diseases due to overcrowding	HIGH -	MODERATE +
Malaria burden	HIGH -	HIGH +
Transmission of STIs and HIV/AIDS	VERY HIGH -	MODERATE +
Soil, water and waste related issues	HIGH -	HIGH +
Malnutrition	MODERATE -	MODERATE +
Road traffic accidents and other accidental injuries	MODERATE -	MODERATE +
Air pollution, noise and mal-odours	MODERATE -	LOW +
Chemicals, pesticides and heavy metals	MODERATE -	LOW -
Gender-based violence, alcohol and drugs	HIGH -	MODERATE +
Social cohesion and well being	HIGH -	MODERATE +
Health system strengthening	HIGH -	HIGH +
Non-communicable diseases	MODERATE -	MODERATE +
Increasing demand for natural resources	HIGH -	MODERATE -
IMPACTS ASSOCIATED WITH WASTE INFRASTRUCTURE AND PROCESS RELATED ISSUES		
Health and safety of employees and local communities	HIGH -	LOW -
Disruption of ecological function	MODERATE -	LOW -
Pollution of soil and water resources as a result of the storage of effluent in the process water pond	MODERATE -	LOW -
Risk to health and safety of employees due to storage of effluent in the process water pond	HIGH -	LOW -
Risk to health and safety of employees due to disposal of potentially hazardous process chemicals	VERY HIGH -	MODERATE -
Pollution of water resources and soil due to disposal of potentially hazardous process chemicals	VERY HIGH -	MODERATE -
Increase in traffic frequency through villages	HIGH -	HIGH -
Dust generation as a result of traffic	MODERATE -	MODERATE -
Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the operational phase	HIGH -	MODERATE -
Impact on air quality as a result of removal of ore material (opencast mining process) and ROM Stockpile	MODERATE -	LOW -
Impact on air quality as a result of operation of infrastructure	MODERATE -	LOW -
Impact on air quality as a result of the storage, handling and treatment of hazardous products	MODERATE -	LOW -
Moderate potential for acid mine drainage (AMD) formation from waste rock dumps (WRD) and tailings storage facility (TSF)	MODERATE -	LOW -
Potential trace element contamination from the WRD seepage into the receiving environment with high concentrations of Mn, Fe, Ni and U	MODERATE -	LOW -
High potential for AMD formation	HIGH -	MODERATE -

Trace element contamination from stock piles and exposed ore zones with a high potential of metal contamination with concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U entering the receiving environment	HIGH -	MODERATE -
Radiation (public exposure)	MODERATE -	LOW -
Radiation (worker exposure)	MODERATE -	LOW -

After the implementation of a closure report, there will be no residual impacts of HIGH significance, with the majority of impacts being of LOW SIGNIFICANCE.

Table 3: Residual impacts as a result of the decommissioning phase

Impact	Significance Without Mitigation	Significance With Mitigation
BIOPHYSICAL IMPACTS		
Sedimentation and elevated turbidity in rivers	HIGH -	MODERATE -
Contamination from non-ore pollutants	MODERATE -	LOW -
Ore contamination	MODERATE -	LOW -
Alteration of river flow-dynamics	MODERATE -	LOW -
Mine water contamination	MODERATE -	LOW -
Mine decant	MODERATE -	LOW -
Aquatic habitat modification	HIGH -	LOW -
Loss of aquatic species of special concern	MODERATE -	LOW -
Over-utilization of fish resources	MODERATE -	LOW -
IMPACTS ASSOCIATED WITH WASTE INFRASTRUCTURE AND PROCESS RELATED ISSUES		
Impact of increased dust levels on fauna	MODERATE -	LOW -
Impact of chemical pollution on fauna	MODERATE -	LOW -
Impact of noise pollution on fauna	MODERATE -	LOW -
Mine decommissioning traffic and transport impacts	MODERATE -	LOW -
Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the decommissioning phase	LOW -	LOW -
Impacts on air quality as a result of the demolition and removal of all infrastructure	MODERATE -	LOW -
Impacts on air quality as a result of rehabilitation (spreading of soil, re-vegetation and profiling/contouring)	MODERATE -	LOW -
Impact on air quality as a result of storage, handling and treatment of hazardous products (fuel, explosives, oil) and waste activities (waste, sewage, discard)	MODERATE -	LOW -
Impact on air quality as a result of post-closure monitoring and rehabilitation	MODERATE -	LOW -
Geochemistry related impacts	MODERATE -	LOW -

5. Recommendations

It is critical that the various mitigation measures outlined in the ESHIA report are implemented in order for reduce the significance of negative impacts to the “with mitigation” ratings, and optimize the benefits arising from the project. The preparation of an Environmental & Social Management Plan (ESMPr) and a Resettlement Action Plan are key management instruments to deal with the management of environmental and social impacts. Both these reports have been prepared as part of this ESHIA process.

In addition to the above, the following management plans will need to be developed ***prior to the construction phase*** to ensure that the various recommendations are implemented:

1. A Site Specific Construction Environmental & Social Management plan (CESMP).
2. A Labour Recruitment, Procurement and In-migration Management Plan.

3. A Cultural Heritage Management Plan
4. Occupational Health and Safety Management Plan

The following management plans will need to be developed ***during the construction phase and prior to the operational phase:***

1. Site Specific Operational Environmental & Social Management plan, incorporating:
    a. An Alien Management Plan
    b. Ecological and Conservation Management Plan
    c. Integrated Pest Management Plan
2. Integrated Waste Management Plan
3. Emergency Preparedness Management Plan
4. Community Health and Safety Management Plan
5. Environmental & Social Monitoring Plan
6. Hazardous Chemical Management Plan
7. Roads and Transport Management Plan
8. Storm Water Management Plan
9. Security Management Plan
10. A Radiation Management Plan
11. A Closure and Rehabilitation Management Plan
12. A Greenhouse Gas and Energy Management Plan

6. Conclusion

It is the opinion of the authors of this ESHIA that the Balama Graphite Mine will result in environmental, social and health impacts that can be managed to levels of significance that would be regarded as acceptable to society and the natural environment, provided the recommendations presented in this report are implemented as part of the social and environmental management programme developed as part of the EIA process (available as Part III of this document.