Applicant: Turquoise Moon Trading 157 (Pty) Ltd

DMR Reference Number: LP30/5/1/2/3/2/1/0201 EM

DEA Reference Number: 12/9/11/L386/5

LEDET Reference Number: 12/1/9-7/2-W110

CaseID: 2290

MOONLIGHT IRON ORE PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PROGRAMME

File 1 of 3

MAIN REPORT

SUBMITTED FOR AN APPLICATION FOR A MINING RIGHT IN TERMS OF SECTION 39 AND OF REGULATIONS 50 AND 51 OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (ACT NO. 28 OF 2002) (the Act)

AND

AS REQUIRED IN TERMS OF REGULATION 385 OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO. 107 OF 1998)

Compiled by

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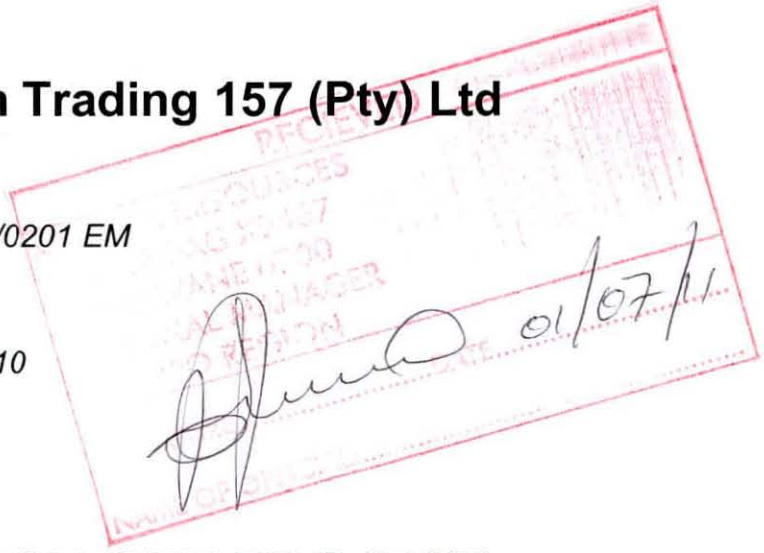

MOONLIGHT IRON ORE PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PROGRAMME

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IDENTIFICATION OF THE REPORT

Herewith I, the person whose name and identity number is stated below, confirm that I am the person authorised to act as representative of the applicant in terms of the resolution submitted with the application, and confirm that the above report comprises EIA and EMP compiled in accordance with the guideline on the Departments official website and directive in terms of Sections 29 and 39(5) in that regard.

Full names and surname:	**Kevin Scott Huntly**
Company:	**Turquoise Moon Trading 157 (Pty) Ltd**
Identity number:	**6201145048086**

MOONLIGHT IRON ORE PROJECT

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ACCRONYMS AND ABBREVIATIONS

Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	Definition
%	Percentage
Al	Aluminium
BID	Background information document
BIF	Banded Iron Formation
Ca	Calcium
Cd	Cadmium
CEC	Cation exchange capacity
Cl	Chloride
CO	Carbon monoxide
dBA	A-weighted decibel
DEA	Department of Environmental Affairs
DFS	Definite feasibility study
DLA	Department of Land Affairs
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWEA	Department of Water and Environment Affairs
EAP	Environmental Assessment Practitioners
EAPSA	Environmental assessment practitioner of Southern Africa
EC	Electrical conductivity (EC)
EIA	Environmental impact assessment
EMP	Environmental management programme
ESS	Earth Science Solutions
ESIA	Environmental Social Impact Assessment
Fe	Iron (Fe)
GDP	Gross domestic profit
HDPE	High density polyethylene
HPGR	High pressure grinding roll
IAPs	Interested and/or affected parties
IBA	Important Bird Area
IDP	Integrated Development Plan
K	Potassium
km^2	Square kilometres
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LIMS	Low intensity magnetic strip
LOM	Life of mine
LMB	Limpopo Mobile Belt
m	Meters
mamsl	meters above mean sea level
m/s	meters per second
m^2	Square meter
m^3	Cubic meter
MAR	Mean annual runoff
mbgl	Metres below ground level

Acronyms / Abbreviations	Definition
Mg	Magnesium
mm	millimetres
Mn	Manganese
MPRDA	Mineral and Petroleum Resources Development Act
MWG	Metago Water Geosciences
MVA	Megavolt ampere
MW	Megawatts
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
Na	Sodium (Na)
NB	Nominal Bore
NEMA	National Environmental Management Act
Ni	Nickel
NLA	Newton Landscape Architects
NO_2	Nitrous oxide
^{O}C	Degrees Celsius
PH	Professional Hunter
PM10	Particulate matter with a fraction smaller than 10µm (microns)
PM_{10}	Particulate matter
PrSciNat	Registered professional in natural science
ROM	Run-of-mine
RWD	Return water dam
SACNSP	South African Council for Natural Scientific Professionals
SAHRA	South African Heritage Resources Agency
SANBI	South African National Botanical institute
SAS	Scientific Aquatic Services
Se	Selenium
SDF	Standard Design Flood
SO_2	Sulphur dioxide
SO_4	Sulphate (SO_4)
TDS	Total dissolved solids
Ti	Titanium
TSF	Tailings storage facility
TSP	Total suspended particles
UMD	Unified model
WHIMS	Wet high intensity magnetic separator
WMA	Water Management Area

EXECUTIVE SUMMARY

Turquoise Moon Trading 157 (Pty) Ltd (Turquoise Moon) has mining-related interests, near Lephalale (Ellisras), in the Limpopo Province. Turquoise Moon is a South African holding company which is 74% owned by Ferrum Crescent Limited (listed on the Australian and London Stock Exchanges). The iron ore prospect covers an area referred to as the Moonlight project area. The location of the project is outlined below.

Location of project	
Province	Limpopo
District	Waterberg District
Municipality	Lephalale Local Municipality
Farms	Moonlight 111LR, Gouda Fontein 886LR and Julietta 112LR
Position	Along N11 between Mokopane (Potgietersrus) and Botswana border
Nearest towns	Marnitz (±5km north), Lephalale (Ellisras) (±60km south), Polokwane (±145km south east)
Nearest villages	±6km south east - part of Seleka Traditional Authority
Catchment	Quaternary catchment A50H, which feeds the Lephalala River. Borders quaternary catchment A63A.

Legal framework and process

Given that the project will be a mine and that it incorporates several listed environmental and waste activities, the environmental assessment process and report was done and compiled in accordance with the requirements of the Mineral and Petroleum Resources Development Act, 28 of 2002 (MPRDA), National Environmental Management Act, 107 of 1998 (NEMA) and NEM:Waste Act, 59 of 2008 (NEM:WA) and the regulations there under. Other approvals/permits needed for the project as identified during the process, including an integrated water use license, will be applied for at the required time.

Metago Environmental Engineers (Pty) Ltd (Metago) is the independent firm of consultants that has been appointed by the applicant company to undertake the environmental impact assessment (EIA) and related processes. The EIA and environmental management programme (EMP) report is the product of the EIA process and provides a detailed description of the project, presents the results of specialist investigations, identifies and assesses potential impacts and recommends mitigation measures should the project be approved. As part of the EIA process, a stakeholder engagement process was conducted comprising notification of interested and affected parties (IAP) through newsletters, newspaper advertisements, site notices and a background information document; various focussed and general stakeholder meetings; and distribution of reports and report summaries for review. A team of professional specialists and engineers were appointed by Metago to investigate potential issues associated with the development of the project. All issues, concerns and comments raised by IAPs have been addressed in the EIA and EMP report and included in the comments and response report in Appendix F of the EIA and EMP report. Full copies of correspondence are included in Appendix E.

This is a **summary** of the EIA and EMP report for the project.

Overview of the project

Turquoise Moon intends to develop an iron ore mine comprising an open pit operation covering an area of approximately 286ha and reaching a depth of 160m. The target minerals to be mined include iron ore, nickel, manganese ore, limestone and marble. The mining operations will comprise conventional open pit mining methods – no underground mining is planned. Overburden and rock from the development of the open pit will be stockpiled on two waste dumps located near to the pit. Soil from the development of the site will be temporarily stockpiled for use in rehabilitation of the site. Run-of-mine (ROM) ore will be temporarily stockpiled on site before being fed through a concentrator plant to remove unwanted material as waste and extract the target minerals as concentrate. The proposed process makes use of a series of crushing and grinding steps and magnetic separation to do this. Tailings from the concentrator plant will be disposed of an engineered tailings storage facility. Process water on site will be recycled and re-used as far as possible. Water management facilities for diverting clean water around the site, collecting potentially dirty water from the site and managing potentially polluted process water will be established on site in line with regulatory requirements. Various support infrastructure and services are needed for the mine and include offices and administration buildings, employee training and induction facilities, change room and ablutions, a sewage treatment plant, clinic/medical station, workshops, stores, canteen, storage and handling areas for hazardous and non-hazardous materials, maintenance areas, washbay, parking, bus/taxi points, non-mineralised waste storage and handling (general and industrial hazardous waste), an explosives storage area, haul roads, mine access road, helicopter landing pad, power supply and distribution, telephone lines and communication masts, security and access control, and fencing. A conceptual site layout is provided in Figure 1.

The concentrator plant is designed to treat 6.5 million tonnes of run-of-mine (ROM) per annum, producing 1.84 million tonnes of concentrate, 390,000 tonnes of non-magnetic discard (overburden) and 4.27 million tonnes of tailings. It is expected that during the definitive feasibility study currently underway opportunities to maximise the recovery of magnetite will be investigated. On-going exploration will take place to refine the extent of the ore reserves.

At closure it is planned at this stage to leave the open pit and the TSF and waste dumps on surface. These will be rehabilitated in line with detailed closure plan to be developed at least five years prior to decommissioning of the site. The remaining site will be returned to low intensity grazing/wilderness land capability.

It is estimated that the construction workforce will peak at 1000 temporary jobs with approximately 455 jobs being created during the operation of the mine (this caters for shift workers). The target date for construction is early 2013, should the decisions for the project be positive. The construction phase will last between 24 and 30 months with commissioning of the plant anticipated in mid-2015. Ramp up to full production is expected to take six months. Open pit mining operations will commence three

months prior to the commissioning of the plant. The design life of the project is 30 years. The EIA and EMP report covers this 30 year period. The possibility exists to extend this life in future. The site is anticipated to operate 24 hours a day, seven days a week.

Environmental setting

A summary of the environmental aspects that describe the pre-mining environment as informed by specialist studies are listed below.

- Host rocks (banded iron formations) that belong to the Mount Dowe Group of the Beit Bridge Complex within the Central Zone of the Limpopo Mobile Belt
- An arid to semi-arid region with low rainfall (±420mm per annum) and high evaporation (±1654mm per annum); and relatively slow winds (between 1 and 4m per second) mainly from the north east
- Relatively flat topography, with main mountainous topographical features comprising the Koedoesrand formation and Waterberg Mountains, approximately 15km and 40km south, respectively
- A range of soils, including wet base soils (limited – 8% of the study area) and a calcrete layer (that occurs at varying depths across the site) that support arable land capability (with good water management), low intensity grazing and wilderness potential
- Biodiversity that ranges in sensitivity from very low to medium-high based on vegetation communities, vertebrate and invertebrate groups identified on site –protected tree species and conservation important fauna confirmed to occur on site, no wetland vegetation found on site
- Veld condition shows signs of overgrazing
- Overland surface runoff with isolated and scattered pan-like structures and ephemeral drainage patterns (off site)
- Groundwater quality ranging from moderate to good with some elevated elements
- Stable water table (ranging between 10 and 60 metres below ground level) providing groundwater as a water supply source of domestic use, stock watering, game ranching and irrigation (although signs of over-abstraction and low rainfall are evident in the area)
- Influences on existing ambient air concentrations near the project site limited to agricultural activities
- Poor regional ambient air quality due to contribution from industrial sources
- Quiet rural environment with a medium to high visual resource
- Open wilderness bushveld supporting low intensity agriculture (including livestock and game farming and irrigated farming) and tourism related industries (including hunting and accommodation facilities)
- Area to the north west, north, east and south dominated by large private farm units usually with a single farmstead and associated infrastructure for agriculture and/or tourism activities
- Area to the south west and west dominated by large farm units occupied by rural villages, with associated agricultural fields, falling under the authority of the Seleka Traditional Authority

Summary of environmental impacts

Potential environmental impacts were identified by Metago in consultation with IAPs, regulatory authorities, specialist consultants and Turquoise Moon. The range of environmental issues considered in the EIA was given specific context and focus through consultation with authorities and IAPs. All identified impacts are considered in a cumulative manner such that the impacts of the current baseline conditions on and surrounding the site and those potentially associated with the project are discussed and assessed together. A summary of the potential impacts (as per Section 7 of the EIA and EMP report), associated with the chosen alternatives (as per Section 2 of the EIA and EMP report), in the unmitigated and mitigated scenarios is provided in Table 2 below.

Issue: Hazardous structures

Hazardous structures include all excavations, infrastructure or land forms into or off which third parties and animals can fall and be harmed. Included in this category are facilities that can fail (such as the TSF). In the unmitigated scenario, in all project phases, most of the identified hazardous excavations and infrastructure present a potential risk of injury and/or death to both animals and third parties. At closure, the open pit, TSF and waste dumps will remain. The significance of this potential impact is therefore high. With mitigation as outlined in the EMP, the significance reduces to low in all project phases (except closure) as security, access control, public awareness, personnel training and rehabilitation measures can easily be implemented to minimise impacts and the TSF and any stockpiles with the potential to fail will be designed and operated by an appropriately qualified engineer to ensure stability of the facility. In the closure phase, the significance of the mitigated impact will either reduce to medium or low depending on access to the site, and more specifically the open pit, by third parties.

Issue: Loss of soil resources and associated natural land capabilities

Soil resources can be lost through physical disturbance, erosion and contamination by project-related facilities and activities. In turn, this could result in a loss of the natural capability of the land. The project will disturb approximately 1,020ha of soil resources with a range of natural capabilities. The majority of the area to be disturbed comprises arable (requires good water management) and low intensity grazing. Areas of wet soils will be disturbed by the placement of the TSF, return water dam and southern waste dump. The site layout has aimed to place infrastructure in as close a proximity to each other as possible, governed by the position of the ore body. In the unmitigated scenario, the significance of potential impacts is high. In the mitigated scenarios, the significance is reduced to medium-low through limiting the disturbance footprint, pollution prevention, good housekeeping, implementing a waste management procedure for general and industrial hazardous waste and implementing a site-specific soil management procedure that is aimed at conserving soil resources for re-use in rehabilitation of disturbed areas. At closure, the land capability of approximately 760ha comprising the open pit, TSF and waste dumps will be changed in perpetuity.

TABLE 2: TABULATED SUMMARY OF POTENTIAL IMPACTS

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)							
		Construction		Operation		Decommissioning		Closure	
		Unmitigated	Mitigated	Unmitigated	Mitigated	Unmitigated	Mitigated	Unmitigated	Mitigated
Topography	Hazardous structures and excavations posing risk to third parties	High	Low	High	Low	High	Low	High	Medium-Low
Soils and land capabilities	Loss of soil resources (from physical disturbance, erosion, contamination) and associated natural land capabilities	High	Medium-Low	High	Medium-Low	High	Medium-Low	High	Medium-Low
Biodiversity	Physical destruction and general disturbance of biodiversity	High	Medium	High	Medium	High	Medium	High	Medium
Surface water	Alteration of drainage patterns (including ephemeral pan-like structures)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Pollution of surface water resources	High	Low	High	Low	High	Low	High	High-Medium
Groundwater	Dewatering impacts on third party users	No impact expected		High	Medium	High	Medium	High	Medium
	Contamination of groundwater	Low	Low	High	Low	High	Low	High	Low
Air quality	Increase in air pollution	High-Medium	Medium-Low	High-Medium	Medium-Low	High-Medium	Medium-Low	High-Medium	Medium-Low
Noise	Increase in disturbing noise levels	Medium	Low	Medium-High	Low	Medium	Low	No impact expected.	
Visual impacts	Negative landscape and visual impact	High	High-Medium	High	High-Medium	High	High-Medium	High	High-Medium

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)							
		Construction		Operation		Decommissioning		Closure	
		Unmitigated	Mitigated	Unmitigated	Mitigated	Unmitigated	Mitigated	Unmitigated	Mitigated
Land use	Loss of current land uses	High	Medium-Low	High	Medium-Low	High	Medium-Low	High	Medium-Low
	Blasting hazards	Negligible		High	Low	No impact expected.		No impact expected.	
	Project-related road use and traffic	High	Medium	High	Medium	High	Medium	No impact expected.	
Heritage (and cultural)	Destruction and disturbance (indirect) of heritage resources	High	Low	High	Low	Medium	Low	No impact expected.	
	Loss of palaeontological resources	Low	Low	Low	Low	No impact expected.		No impact expected.	
Socio-economic impacts	Loss of mineral resources through sterilisation	No impact expected.							
	Economic impact (positive and negative)	High positive	High positive	High positive	High positive	High positive	High positive	Medium positive	High positive
	Informal settlements, safety, security and services and associated social ills	High	Medium-Low	High	Medium-Low	High	Medium-Low	High	Medium-Low
	Relocation	High	Medium-Low	No impact expected.		No impact expected.		No impact expected.	
	Change in land values	High	Medium-Low	High	Medium-Low	High	Medium-Low	High	Medium-Low

Issue: Physical destruction and general disturbance of biodiversity

The proposed project will be located within areas ranging from very low to medium-high conservation importance/sensitivity when considering vegetation communities, vertebrate and invertebrate fauna. No aquatic systems were identified on site. There are a number of activities/infrastructure in all phases that have the potential to destroy biodiversity through loss and/or transformation of habitat, increased pressures from harvesting and poaching, alien plant invasion, impoverishment and/or loss of important plant and animal species and disruption of animal movements. Disturbance of the more sensitive communities is unavoidable given their spatial extent and predominant occurrence across the project site. The significance of potential impacts in the unmitigated scenario is high. With mitigation as outlined in the EMP, that focuses on developing and implementing a biodiversity management plan, limiting the disturbance footprint, planning on flora and fauna removal and/or relocation, obtaining the necessary permits for disturbing protected tree species, pollution prevention, dust control, monitoring and rehabilitation, the significance is reduced to medium. Monitoring of biodiversity during the life of the project and at closure is needed to ensure that the recommended level of biodiversity is regained.

Issue: Alteration of natural drainage patterns (including ephemeral pan-like structures)

Given the relatively flat topography of the site, natural drainage across the site is via overland sheet flow. Apart from man-made dams (usually fed by borehole water) and the temporary isolated pan-like structures, there are no natural drainage lines on site. During the construction, operation and decommissioning phases, project-related infrastructure will occupy a relatively large piece of land (approximately 1,020ha). Clean stormwater controls will be in place diverting as much clean water as possible around the site. During the closure phase, final landforms such as the open it, TSF and waste dumps will remain. In the unmitigated scenario, for all project phases, alteration of drainage patterns resulting in the reduction in flow is expected to have a medium significance for downstream ecological users and commercial livestock and game on site. These pan-like structures are sensitive to disturbance and cannot be recreated once lost. The measures however to minimise the destruction of the pan-like structures and collection of runoff are limited, therefore the significance remains medium in the mitigated scenario.

Issue: Pollution of surface water resources

In the unmitigated scenario, especially in the construction, operation and decommissioning phases, surface water (from rainfall) may collect contaminants (hydrocarbons, salts, chemicals, metals) from mine activities and infrastructure and flow into the isolated pan-like structures downstream of the site and the downstream non-perennial drainage lines (off-site, northwest). At closure, surface water may collect in the open pit and become polluted. At elevated pollution concentrations these contaminants can be harmful to ecological users and commercial livestock and game. The significance of potential impacts is high if third parties (at closure) and animals (in all project phases) are exposed to the potential pollution (depending on the concentration and duration of exposure). With mitigation as outlined in the EMP that

focuses on pollution prevention, good housekeeping, stormwater control, professionally designed facilities, monitoring of the process water circuit, and emergency response the significance of potential impacts reduces to low in all phases except closure. In the closure phase, the significance of the mitigated impact will either remain high or reduce to medium due to the uncertainty associated with the quantity and quality, and use of water (if water collects) in the open pit.

Issue: Dewatering impacts on third party users

There is one main activity that has the potential to reduce the local groundwater level: active dewatering of the pit. Groundwater in the project area (within 15km of the site) is used almost exclusively for domestic purposes, stock-watering, game ranching and localised irrigation. Land users in the area (landowners and farmers) have raised concerns regarding water supply as from their viewpoint water is a scarce resource and a loss or reduction of the groundwater resource would impact on their livelihoods. Dewatering of the pit during the operation of the mine is expected to create drawdown propagating outward from the open pit. Dewatering effects will be most significant in the vicinity of the open pit, decreasing with distance away from the pit. The dewatering influence is expected to increase as the open pit develops in extent and depth. Groundwater users within the zone of impact may experience lower borehole yields and/or total water loss during the operational phase of the mine. Given the already declining water level that may be attributed to over-abstraction in addition to below average rainfall years, mine dewatering could exacerbate this trend. In the unmitigated scenario, the significance of potential impacts is high. With mitigation as outlined in the EMP, which includes the purchasing/leasing of farms within the application boundary, verification of potential users within zone of influence, verification of the groundwater model, licensing the dewatering use with the Department of Water Affairs, maintaining an up to date groundwater model, monitoring water levels on site and at third party boreholes and compensation (if mine-related loss occurs), the significance reduces to medium in all relevant phases except closure. In the closure phase, the significance of the mitigated impact could remain high due to the uncertainty with the rebounding groundwater levels. Depending on the outcome of the groundwater user verification survey and the measures implemented, this significance could reduce to medium-low at closure.

Issue: Contamination of groundwater

In the unmitigated scenario, pollution of groundwater from numerous pollution sources has the potential to negatively impact downstream water users. The most significant potential pollution is associated with the TSF and waste dumps. While geochemistry-related tests show that limited to no potential for acid rock drainage exists, there is potential for some (although limited) salt and/or metal-related pollution. This could present a number of pollution parameters that can have animal and human health impacts depending on how they are transported from the pollution source and at what concentrations they might occur in areas where animals and people have access to groundwater. In the unmitigated scenario, the significance of impacts is low in the construction phase and high for all other phases. With mitigation as

outlined in the EMP which focuses on professionally engineered facilities with pollution control measures, good housekeeping, maintaining an up to date groundwater model, monitoring groundwater qualities on site and at third party boreholes, the significance if potential impacts reduces to low.

Issue: Increase in air pollution

With projects of this nature, the main emissions include: inhalable particulate matter less than 10 microns in size (PM10), larger total suspended particulates (TSP), and gas emissions (limited). Gaseous pollutants (such as sulphur dioxide, oxides of nitrogen, carbon monoxide, etc.) derived from vehicle exhausts are regarded as negligible in comparison to particulate emissions. All mine phases present air pollution related impacts and the most significant mine phase is expected to be the operational phase. In the unmitigated construction (24 months), decommissioning and closure phases, it is expected that off-site impacts may exceed the PM10 daily standards and dust fallout limits. In the unmitigated operational phase, the model predicted that daily PM10 standards will be exceeded both at the mine boundary and at two of the identified receptor sites but that the predicted annual average will comply with standards. The exceedances are predicted to occur not more than twice a year at the two receptor sites. For dust fallout during the operational phase, the model predicted that the dust fallout rate at the mine boundary and therefore off-site will be within the dust fallout limit for residential areas and within the European vegetation limit at the mine boundary. In the unmitigated scenario the significance of potential impacts is high-medium. With mitigation, as outlined in the EMP, the significance will be reduced to medium-low through concentrating activities as close as possible to each other, developing and implementing an air quality management plan, establishing dust collection measures, implementing dust suppression techniques and monitoring the potential impact (PM10 and dust fallout).

Issue: Increase in disturbing noise levels

There are limited activities on site and in the area that contribute to current ambient noise levels. There are a range of project activities that have the potential to cause general noise disturbance or noise nuisance for sensitive receptors. The more significant impacts are expected to occur at night when ambient noise levels are lower and the sensitivity of the environment increases. Noise pollution will have different impacts on different receptors because some are very sensitive to noise and others are not. In the unmitigated scenario, potential impacts from on-site will have a medium significance, during construction and decommissioning, and a high significance during operation, for the nearest receptor sites. For receptors along the district gravel transport routes, the significance of potential impacts will be medium. In the mitigated scenario, the significance could reduce to medium-low through the maintenance of equipment and machinery, establishing noise berms, reducing operating hours of noise polluting equipment, establishing acoustic barriers, personnel training, monitoring of potential impacts at noise receptor sites, compensation (if mine-related noise is disturbing after mitigation) and implementing a grievance procedure.

Issue: Negative landscape and visual impacts

Visual impacts will be caused by activities and infrastructure in all project phases. These activities will be visible, to varying degrees from varying distances around the project site. The more significant activities and structures are considered to be construction activities, the presence of plant buildings, the TSF and waste dumps and night lighting needed for safety purposes. In the unmitigated scenario, the visual intrusion of the proposed project will be high as mining activities are introduced into a natural environment, and will remain high for the rest of the life of the project as activities continue and the TSF and waste dumps develop. The visual intrusion of the project at night, from construction through to decommissioning, will be high in the unmitigated scenario given the current absence of significant artificial night lighting. It is anticipated that receptors along local roads, at farmsteads and at lodges will be highly sensitive to a change in the visual resource, especially in the unmitigated scenario. These receptors include both local residents and local and international visitors. In the unmitigated scenario, the significance of potential impacts is high. With mitigation as outlined in the EMP which includes limiting the disturbance footprint, dust control, maintaining (and establishing) vegetation buffers/screens, good housekeeping, correct lighting, rehabilitation of disturbed areas and final land forms and compensation (if mine related disturbance occurs with mitigation), the significance will remain medium-high due to the intrusive nature of the mine in an area where these types of activities are non-existent.

Issue: Loss of land uses

When considering impacts on land use, the land use specialist took into consideration the range of environmental impacts that could occur as a result of the project. These include: groundwater, noise, visual, air, traffic, heritage, soils, blasting, grazing capacity and socio-economic. With this in mind, the main activity that could have an impact on existing land uses is the development of the mine site as a whole. The area is characterised by open undisturbed wilderness bushveld where the main economic activities are agriculture (cattle and game farming and some irrigated crop farming) and tourism (hunting and accommodation). It has been identified by the land use specialist that for each of these land uses the availability of water is identified to be the most important resource for sustainable land use. Current land uses on the site will be significantly impacted and lost through the development of the mine. The immediately neighbouring farms to the site are expected to experience significant impacts when considering groundwater, noise, blasting, air and visual collectively. In the unmitigated scenario the significance of potential impacts is high. With mitigation as outlined in the EMP which focuses on purchasing/leasing the three farms that form part of the application boundary, effectively mitigating impacts on the environment and compensation (if mine-related loss occurs after mitigation), the significance of potential impacts reduces to medium-low. At closure, it is expected that the land use potential on surrounding farms could return to current levels save for more clarity being required on the groundwater level recharge. For the project site, approximately 760ha associated with open pit, TSF and waste dumps will be compromised forever but the remaining areas could be used for grazing and hunting.

Issue: Blast hazards

The main activity that has the potential to cause blasting hazard is mining of the pit. This activity will occur during the operational phase only. Some blasting may occur during the construction phase, for foundation establishment, but this will be limited (if needed). Blasting activities have the potential to impact on people, animals, plants and structures located in the vicinity of the operation through ground vibration, airblast, fly rock, blast fumes and dust (considered as part of the air quality study). In the unmitigated scenario, ground vibrations and airblasts can cause damage to third party structures and can be a nuisance for animals and people, within the zone of influence. When considering fly rock, in the unmitigated scenario, fly rock (of varying sizes) has the potential to travel far distances from the blast site and cause injury and death to people and animals and damage to plants and structures. In the unmitigated scenario the significance of potential impacts is high. With mitigation as outlined in the EMP which includes undertaking a pre-blast survey within 1.5km of the site, implementing a design blast that meets recommended threshold criteria, restricting daily blasts, creating public awareness, monitoring on site and at third party structures and compensation (if mine-related blasting causes damage after mitigation), the significance reduces to low.

Issue: Project-related road use and traffic

The project will make use of the surrounding road network (N11 – tarred, D1553 – gravel, D1347 – gravel and R518 – tarred) with the addition of a dedicated mine access road off the public Road D1347 (gravel). Traffic on the existing road network is limited and is a combination of private, community access, small businesses and tourism-related traffic. An increased traffic on existing public road networks and diversion of a section of the Road D1347 can result in an inconvenience to current road users, greater accidents (for people and animals) and/or increased road damage. This in turn can put pressure on the relevant roads authority to increase the maintenance programmes and/or upgrade the roads. It is the view of the traffic specialist that project-related traffic will not significantly change the level of service required on the network of public roads in the vicinity of the project. From a capacity perspective, no changes to the road network are therefore required. This however does not consider the adequacy of the road surface. During the construction, operation and decommissioning phases, increases in traffic volumes and change in traffic patterns can result in road safety concerns. These could potentially result in serious injury or death to third parties. From a safety perspective, the significance of potential impacts will be high. With mitigation as outlined in the EMP which includes upgrading the relevant intersection as per the traffic specialist recommendations, re-routing the D1347, providing alternative access to landowners, obtaining approval from the roads authorities, working together with the roads departments to ensure the mine's safe use of public roads, providing dedicated taxi/bus points near the mine entrance, monitoring the emergency response and compensation (if mine-related traffic causes disturbance after mitigation) the significance reduces to medium.

Issue: Destruction (direct) and disturbance (indirect) of heritage resources

Heritage resources include sites of archaeological, cultural or historical importance. Heritage resources that will be impacted on by the positioning of project-related infrastructure include two graveyards. Heritage resources that could be disturbed by project activities include a historical house and a third graveyard. Unmarked graves could be uncovered during the construction of the site and operation of the open pit. In the unmitigated scenario the significance of potential impacts is high. With mitigation as outlined in the EMP which includes exhumation and relocation of graves in line with regulatory requirements, establishing barriers for heritage sites that will remain on site, providing access to relatives as and when required, personnel awareness and training and emergency response, the potential significance reduces to low.

Loss of palaeontological resources

The development of the site during the construction and operational phases, when sub-surface ground will be disturbed, has the potential to result in the loss of palaeontological resources for future generations and research. The main geological formation being targeted by the project (the Mount Dowe group of the Beit Bridge Complex) hosts no potential for fossils due to its pre-cambrian age and its course-grained, heavily metamorphosed nature. The Triassic-aged Bosbokpoort Formation of the Karoo Supergroup and the Tertiary-Quaternary sand and calcrete layer found on site have the potential to host fossils. The uncovering of fossils on site would have some research potential. However the host formations are widespread and do occur outside of the site boundary. In the unmitigated scenario, the significance of potential impacts is low. With mitigation which includes implementing an emergency response procedure the significance remains low.

Issue: Loss of mineral resources through sterilisation

It is important that no potential future resources be sterilised by the project as it may become feasible to mine them in the future. Significantly, there will be no sterilisation of minerals by the placement of surface infrastructure (the site layout took into consideration potential future mineable reserves) or disposal of tailings on the tailings dam.

Issue: Economic impact (positive and negative)

The development of the mine as a whole has the potential to impact on the economy both positively through potential growth in the mining sector and negatively through the potential loss of existing economic activities (agriculture, hunting and tourism). The project is located in area where the land uses both on site and in the surrounding area are mainly agriculture, tourism and hunting. It is the view of many stakeholders that these land uses cannot co-exist. As a cumulative issue, in the unmitigated scenario, the economic benefits of the mine are predicted to outweigh the potential losses to agriculture and tourism. The significance of potential impacts, in the unmitigated scenario, is therefore a positive high in the construction, operation and decommissioning phase and positive medium at closure. With

mitigation as outlined in the EMP which includes appointing a competent management team to implement the mitigation measures, proper closure planning in a timeously manner, minimising negative environmental impacts through the implementation of mitigation measures and environmental monitoring included in the EIA and EMP report, enhancing positive impacts by working together with regulatory bodies and community structures and monitoring compliance with the commitments in the EIA and EMP report, the significance increase to a high positive at closure. At closure, it is expected that the land use potential on surrounding farms will return to current levels save for more clarity being required on the groundwater level recharge. For the project site, approximately 760ha associated with open pit, TSF and waste dumps will be compromised forever but the remaining areas could be used for grazing and hunting.

Issue: Informal settlements, safety, security and services and associated social ills

Land in the project area is mostly privately owned. The nearest rural village is located approximately 8km from the site. Mining projects of this nature tend to bring with them an expectation of employment. In the unmitigated scenario, the proposed project could attract an influx of job seekers to the area, which could cause an increase of people moving through the area and the development of informal settlements. This situation can be worsened if the mine does not do adequate planning for employee and contractor housing (with linked basic services) and transport. In general, both increased movement of poor people into an area and informal settlements are associated with poor standards of living which can promote disease, crime and a general threat to the safety and security of an area. In addition, poor control of employees and contractors can lead to increased trespassing on private farm land. Linked to this influx of people is the ability of receiving areas to supply basic services such as water, food, electricity and sanitation. In the unmitigated scenario, the significance of potential impacts is high. With mitigation as outlined in the EMP which includes setting up and participating in a law enforcement forum, a clear and effective recruitment and training policy, a clear and effective housing policy, and a clear and effective transport policy the significance of potential impacts reduces to medium-low.

Issue: Relocation

The development of the mine, if approved, will result in the displacement of landowners and farm workers within the site boundary. It is assumed that the private land on which Turquoise Moon wants to establish the mine will either be bought by the mine or leased by the mine for a period of time (minimum of 30 years). In this regard, it is expected that the private landowners will receive fair compensation for the loss of their property. Should they decide to sell to the mine, then they would be expected to cover their own relocation and moving costs as is the case with the commercial selling of any property. It should be noted that some of the landowners do not want to sell their properties due to sentimental value of the property to their families. For the farm workers, in the unmitigated scenario, the negative impacts than can arise in this context are: loss of employment, loss of income sources and/or production resources, weakening of social networks and social structures, loss of cultural identity, long term hardship,

impoverishment, and xenophobic conflict in the receiving areas where these people try and relocate. The potential significance of impacts is high in the unmitigated scenario. With mitigation as outlined in the EMP which includes specific conditions in purchase agreements with landowners should farm workers relocate with landowners, development and implementation of a site-specific resettlement plan that meets World Bank standards, and consideration for employment at the mine, the significance reduces to medium-low.

Issue: Change in land values

Concern has been raised by land owners about the impact of the project on surrounding land values, associated hunting/agricultural practises and future benefits for family. The mine development as a whole has the potential to impact on land values and associated economic activity. In the unmitigated scenario, some land surrounding the project site will experience unacceptable impacts which are likely to cause a loss in land values and/or economic activity. The significance of potential impacts will be high. With mitigation as outlined in the EMP which includes establishing a base valuation prior to the start of the project, effective implementation of mitigation measures included in the EIA and EMP report and compensation (if mine-related loss of land use and/or economic activity occurs after mitigation) the significance of potential impacts reduces to medium-low.

Conclusion

The assessment of the proposed project presents the potential for significant impacts to occur on the bio-physical, cultural and socio-economic environments both on the site and in the surrounding area. The project is expected to benefit nearby communities both directly and indirectly as outlined above. Some local negative economic impacts are expected in the immediate vicinity of the mine if the mitigation as presented in the EIA and EMP report is not effectively implemented. The challenge facing Turquoise Moon is to contribute to the positive benefits while at the same time preventing and/or mitigating potential negative social and environmental impacts.

MOONLIGHT IRON ORE PROJECT

INTRODUCTION AND LEGAL FRAMEWORK

Introduction

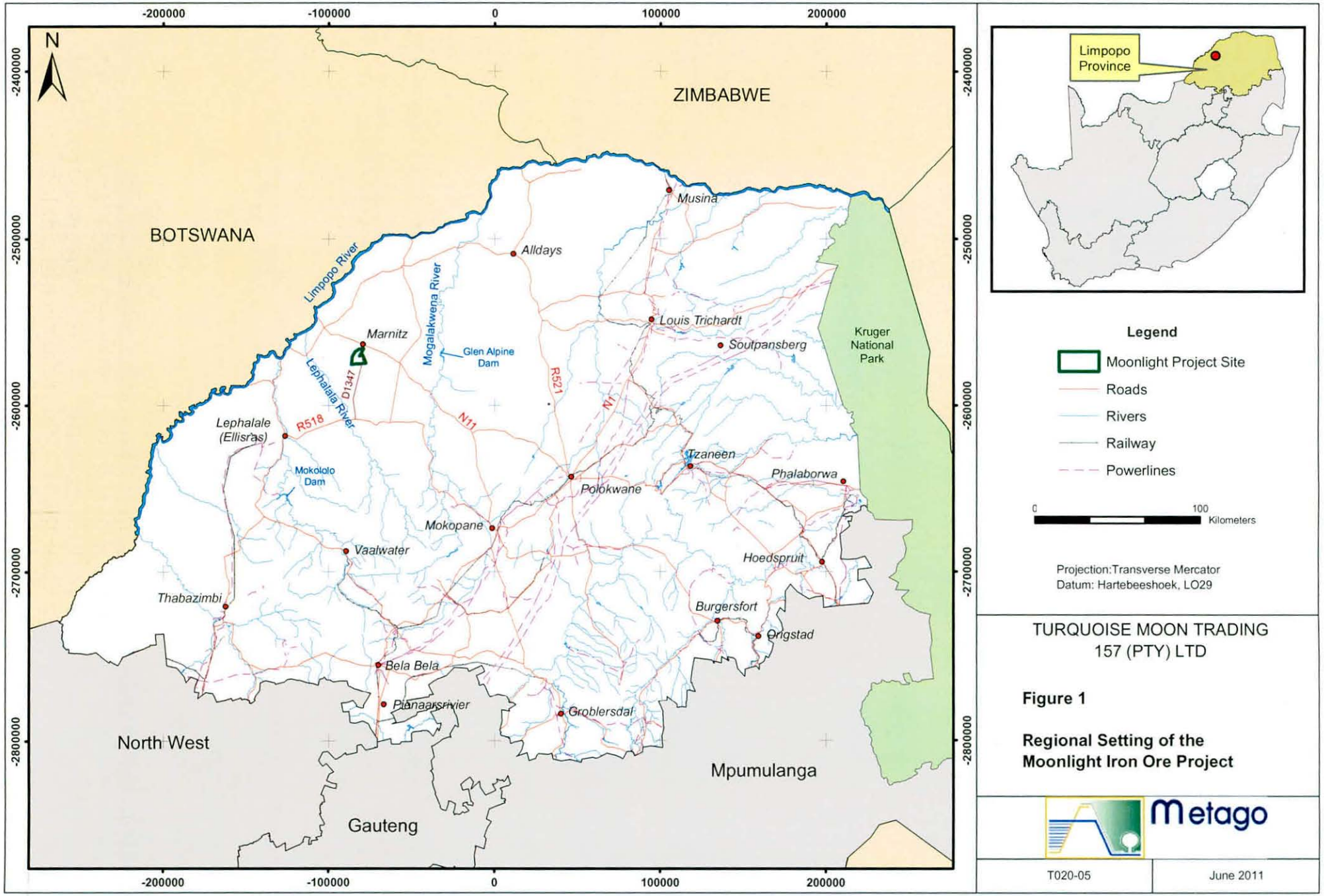
Turquoise Moon Trading 157 (Pty) Ltd (Turquoise Moon) has mining-related interests, near Lephalale (Ellisras), in the Limpopo Province. Turquoise Moon is a South African holding company which is 74% owned by Ferrum Crescent Limited (listed on the Australian and London Stock Exchanges). The iron ore prospect covers an area referred to as the Moonlight project area. The Moonlight project area comprises the farms Moonlight 111LR, Gouda Fontein 886LR and Julietta 112LR. It is located along the N11 between Mokopane (Potgietersrus) and the Botswana border, near to the town of Marnitz, and approximately 60 km north and 145 km north-west of Lephalale (Ellisras) and Polokwane, respectively (Figure 1, page 2).

In broad terms, Turquoise Moon intends to develop an iron ore mine comprising an open pit operation, waste dumps, stockpiles, mine-related facilities such as workshops, stores, a concentrator plant, tailings storage facility, and various support infrastructure and services. Further detail is provided in Section 2.

Decisions required and legal framework

Prior to the commencement of the project, environmental authorisations/licenses are required.

- An environmental decision from the Department of Mineral Resources (DMR) in terms of the Mineral and Petroleum Resources Development Act (MPRDA), 28 of 2002 for the proposed mining operation. An application was submitted to the DMR by Turquoise Moon and accepted by the department (Appendix C).
- Environmental authorisation from the Limpopo Department of Economic Development, Environment and Tourism (LEDET) in terms of the National Environmental Management Act, 107 of 1998 (NEMA). The project incorporates several listed activities (see Section 2.5). An application was submitted by Metago to LEDET in July 2010 and accepted by the department (Appendix C). The EIA regulation being followed for this project is Regulation 385 (2006 EIA Regulations).
- Waste license for waste-related activities from the Department of Environmental Affairs (DEA) in terms of NEMA: Waste Act, 59 of 2008 (see Section 2.5). An application was submitted to DEA due to the inclusion of industrial hazardous waste activities and accepted by the department (Appendix C).



TURQUOISE MOON TRADING
157 (PTY) LTD

Figure 1

Regional Setting of the Moonlight Iron Ore Project

Metago

T020-05	June 2011

This report is the environmental impact assessment (EIA) (Section 1) and environmental management programme (EMP) (Section 2) for the project. Given the legal framework above, this report has been compiled to meet the requirements of the 2006 EIA Regulations and MPRDA Regulations. In this regard, the new DMR report structure template has been used. To assist with cross-referencing in the report, the chapter numbering in the EMP section follows on from the chapter numbering in the EIA section.

In terms of Regulation 385 of the 2006 EIA Regulations, Table 1 provides a guide to the relevant sections where the information is contained.

TABLE 1: REQUIREMENTS FOR EIA AND EMP REPORTS

Environmental Regulation 385	**Section in report**
Environmental impact assessment (EIA)	
Description of the property and location of the activity on the property	1.3.1 and 1.4
Details of the person who compiled the EIA, and his/her expertise	Introduction
Details on the public involvement process including –compliance with the PSS, IAP database, issues table, additional comments/objections	10, Appendix C, Appendix D, Appendix E and Appendix F
Comment on the need and desirability of the proposed activity(ies) in the context of alternatives	Introduction
Description and comparative assessment of alternatives identified during the EIA	8 and Appendix B
Description of proposed activity(ies)	2 and Appendix A
A description of the environment that may be affected by the activity	1
Methodology used to determine impact significance	7.3
Summary of findings and recommendations of specialist reports	Throughout document
Description of environmental issues, assessment of significance, and extent to which these can be mitigated	7
Assessment to include: cumulative impacts, nature, extent, duration, probability, reversibility of resource loss, mitigation	7
Assumptions, uncertainties and knowledge gaps	11
Provide an authorisation opinion – with possible conditions	27
Environmental impact statement – summary of key findings and comparative assessment of the positive and negative implications of the activity and alternatives	27
Specialist reports as appendices	See appendices
Environmental management programme/plan (EMP)	
Details of the person who compiled the EMP, and his/her expertise	Introduction
Detailed description of the activity aspects covered in the EMP	2 and Appendix A
Details on the management/mitigation measures from planning and design stages through to closure (where relevant)	18, 19 and Appendix A
Time frames for implementation where appropriate	19
Identification of responsible persons for implementation	19

Secondary approvals / permits

Secondary approvals/permits needed for the project are listed below. In this regard, there are other approvals that are required prior to construction and/or commissioning of the mining and related activities. This list does not cover occupational health and safety legislation requirements.

- Prior to conducting any water uses as defined in Section 21 of the National Water Act, 36 of 1998, Turquoise Moon will submit an integrated water use license application (IWULA) to the Department of Water Affairs (DWA). This will include any exemptions from Regulation 704 of 4 June 1999. The water uses and exemptions could include taking water from a resource, storing water, impeding or diverting the flow of water in a watercourse (if required for the temporary pan-like structures), disposing of waste in a manner that may detrimentally impact on a water resource, altering the bed, banks, course or characteristics of a watercourse (if required for the temporary pan-like structures), removing/discharging/disposing of waste found in the open pit, and the use of waste rock in road and dam wall building.
- All dams with both a wall greater than 5m and a capacity of 50 000m^3 must be registered as safety risk dams with DWA in terms of the National Water Act, 36 of 1998.
- Prior to operating the sewage plant, Turquoise Moon or its contractor will obtain a registration of both the sewage plant and the required personnel from DWA in terms of Regulation 2834 of 27 December 1965.
- Prior to upgrading the road intersections and diverting the D1347, the necessary approval will be obtained from the Limpopo Department of Roads and Transport and Road Agency Limpopo (RAL) in terms of the relevant Provincial Road Ordinance.
- Prior to damaging or removing heritage resources such as graves, permissions are required in terms of the National Heritage Act, 25 of 1999, the Ordinance on Exhumations, 12 of 1980, and the Human Tissues Act, 65 of 1983.
- Prior to removing or damaging any protected plant species, the necessary permits will be obtained from DWA in terms of the National Forests Act, 84 of 1998.
- Prior to storage, handling, transportation and disposal of explosives the relevant licenses and written permissions are required in terms of the Explosives Act, 25 of 1956, and the Mine Health and Safety Act, 29 of 1996, as amended.
- The re-routing of the low voltage powerline and any communication lines that crosses through the project site will be done with the approval and in consultation with the relevant authorities.

EIA approach and process

A summary of the approach and key steps in the combined EIA process and corresponding activities are outlined in Table 2.

TABLE 2: EIA PROCESS

Objectives	Corresponding activities
Project initiation and application phase (June 2010 to January 2011)	
• Notify the decision making authority of the proposed project. • Initiate the environmental impact assessment process.	• Initial mining right application submitted to DMR on 25 June 2010. Application accepted. • Due to significant changes to the mine works programme as a result of various concerns and issues raised during the initial scoping process, this application was withdrawn (December 2010). • New mining right application submitted to DMR on 8 December 2010. Application accepted. • NEMA application for listed activities and a waste license application submitted to LEDET and DEA, respectively, on 5 July 2010. Applications accepted.
Scoping phase (July 2010 – February 2011)	
• Identify interested and/or affected parties (IAPs) and involve them in the scoping process through information sharing. • Identify potential environmental issues associated with the proposed project. • Consider alternatives. • Identify any fatal flaws. • Determine the terms of reference for the ESIA.	• Notify IAPs of the project and environmental assessment process (social scans, distribution of BIDs, newspaper advertisements, telephone calls and site notices) (July – October 2010) • First round of focussed and public scoping meetings with stakeholder groups (July to October 2010). • Submission of initial draft scoping report to DMR (July 2010) • Distribute draft scoping report to IAPs and other regulatory authorities for review (November 2010). • Record comments (in writing and at meetings) (November 2010 to January 2011). • Advertise and inform IAPs about second mining right application (via newspaper advertisements, newsletters) (January 2011) • Distribute final scoping report to IAPs for review (February 2011). • Submit final scoping report to DMR, LEDET and DEA (February 2011) • Second round of focussed and public scoping meetings with stakeholder groups (January to March 2011). • No new environmental issues raised in second round meetings, additional procedural comments incorporated into comments and response table for response as part of the EIA and EMP.
Detailed specialist investigations (October 2010 to June 2011)	
• Describe the affected environment. • Define potential impacts. • Give management and monitoring recommendations.	• Investigations by technical project team and appointed specialists (see Table 3) of issues identified during the scoping stage including investigations into alternatives.
EIA/EMP phase (January to December 2011)	
• Assessment of potential environmental impacts. • Design requirements and management and mitigation measures. • Receive feedback on application	• Compilation of draft EIA and EMP report. • Distribute draft EIA and EMP report to IAPs, DMR and other regulatory authorities for review (July 2011). • Feedback open days with IAPs (August/September 2011). • Record comments (September 2011). • Forward final EIA and EMP report to LEDET and DEA for review (September 2011). • Forward IAP comments to DMR (September 2011). • Circulate record of decisions to all registered IAPs registered.

EIA team

Metago Environmental Engineers (Pty) Ltd (Metago) is the independent firm of consultants that has been appointed by the applicant company to undertake the environmental assessment and related processes. Alex Pheiffer (project manager) has approximately ten years of relevant experience and is registered with the South African Council for Natural Scientific Professions (SACNSP) as a professional natural scientist (PrSciNat) (Environmental Management). Brandon Stobart (Reviewer) has 13 years of relevant experience and is certified as an Environmental Assessment Practitioner (EAP) with the Interim Certification Board of Environmental Assessment Practitioners of South Africa (EAPSA).

Neither Alex, Brandon nor Metago has any interest in the project other than fair payment for consulting services rendered as part of the environmental assessment process.

The environmental project team comprises Metago's environmental assessment practitioners, specialist consultants and the technical feasibility team (Table 3).

TABLE 3: PROJECT TEAM

Name	Designation	Tasks and roles	Company
Environmental impact assessment and public involvement team			
Alex Pheiffer	Project manager	Management of the assessment process, stakeholder engagement and report compilation.	Metago
Linda Munro	Project administrators		
Stella Moeketse			
Natasha Daly			
Brandon Stobart	Project reviewer	Report and process review	
Specialist environmental assessment consultant team			
Hanlie Liebenberg-Enslin	Air quality specialist	Air quality assessment	Airshed Planning Professionals
Warren McCleland and team	Terrestrial ecological specialist	Terrestrial ecological assessment	Ecorex Consulting Ecologists cc
Francois de Wet	Veld and grazing specialist	Veld condition and grazing capacity assessment	EnviroPulse CC
Ian Jones	Soil and land capability specialist	Soil and land capability assessment	Earth Science Solutions
Martin Holland	Groundwater specialist	Groundwater assessment	Metago Water Geosciences (Pty) Ltd
Robin Bolton	Water scientist	Surface and groundwater hydrocensus	Metago
Stephen van Niekerk, Luke Wiles and Mark Bollaert	Engineer and hydrologist	Hydrology and design of water facilities	Metago
Ben van Zyl	Noise specialist	Noise study	Acusolv
Leon Roets and Paul van der Westhuizen	Traffic specialist	Traffic study	Siyazi Limpopo

Name	Designation	Tasks and roles	Company
Dr Julius Pistorius	Heritage consultant	Heritage study	Private Consultant
Professor Bruce Rubidge	Palaeontology specialist	Palaeontology study	BPI for Palaeontological Research
Danie Zeeman	Blast specialist	Blast and vibration study	Blast Management CC
Stephen van Staden and Marine Pienaar	Land use specialist	Land use study	Scientific Aquatic Services and TerraAfrica Consult
Gerrie Muller	Socio-economic consultant	Socio-economic impact assessment	Strategy4Good
Graham Young	Visual	Visual impact assessment	Newtown Landscape Architects
Stephen van Niekerk	Engineer	Design of waste facilities and closure cost estimate	Metago
Technical project team			
Scott Huntly	Strategic Development Manager		
Vernon Harvey	Chief Operating Officer		Ferrum Crescent Ltd
Fanie Botha	Previous Project Manager		Ferrum Crescent Ltd
Miguel dos Santos	Project Leader	Feasibility study	Amec

Contact details for responsible parties

Turquoise Moon forms part of a larger holding company, Ferrum Crescent Limited. The directors of the Ferrum Crescent Board include Edward Nealon (Executive Chairman), Klaus Borowski (Independent Non-executive Director), Kofi Morna (Non-executive Director), Grant Button (Non-executive Director) and Theodore ("Ted") Droste (Non-executive Director).

Details of the applicant are provided in the table below.

Project applicant:	Turquoise Moon Trading 157 (Pty) Ltd (Turquoise Moon)
Postal address:	PO Box 877, Lonehill, 2062
Telephone No:	011 510 0159
Fax No:	086 219 5701 (fax)
Contact persons:	Mr Dave Richards (Compliance Manager) and Mr Scott Huntly (Strategic Development Manager)
E-mail address:	dave.richards@ferrumcrescent.com and scott.huntly@ferrumcrescent.com

Project Motivation (Need and Desirability)

Based on initial investigations and exploration work conducted to date at the Moonlight site, Turquoise Moon believes there is a feasible ore body worth developing. The anticipated market prices in the medium and long-term are considered highly favourable for project development of the Moonlight open pit iron ore mine. The project is expected to benefit nearby communities both directly and indirectly. Direct economic benefits will be derived from wages, taxes and profits. Indirect economic benefits will be derived from the procurement of goods and services and the increased spending power of employees. The challenge facing Turquoise Moon is to contribute these benefits while at the same time preventing and/or mitigating potential negative social and environmental impacts as discussed in detail in Section 7.

SECTION 1 – ENVIRONMENTAL IMPACT ASSESSMENT

1 DESCRIPTION OF THE BASELINE ENVIRONMENT

This section provides a description of the current baseline conditions of the project site and surrounding areas within which the project will be undertaken. Each discussion provides a link to anticipated impacts and highlights the relevance of the information provided, identifies how data was collected (either by the specialist and/or Metago) to inform the baseline description, provides the results/outcomes of research and/or studies undertaken and concludes with the main findings as relevant to the impact assessment and management plan.

The environmental aspects are discussed as follows:

- baseline description of bio-physical environment (Section 1.1)
- baseline description of land uses, socio-economic conditions, heritage and cultural aspects (Section 1.3).

Key environmental aspects requiring protection or remediation are identified in Section 1.2. Maps showing environmental features on and off site are included in Section 1.4 and cross-referenced in the relevant baseline descriptions. A list of supporting specialist information used in the baseline description included in Section 1.5. Assumptions and uncertainties identified by the specialist studies are outlined in Section 11.

1.1 ON-SITE ENVIRONMENT (BIO-PHYSICAL) RELATIVE TO SURROUNDING ENVIRONMENT (BIO-PHYSICAL)

1.1.1 GEOLOGY BASELINE

The geology, geological processes and associated structural features and stratigraphy in and surrounding the area influence soil forms (discussed further in Section 1.1.3), groundwater resources (discussed further in Section 1.1.6), palaeontological resources (discussed further in Section 1.3.3) and the presence of economical reserves (discussed further in Section 1.3.1). The potential for acid rock drainage and groundwater pollution is discussed in Section 3.3.

1.1.2 TOPOGRAPHY BASELINE

Information in this section was sourced from the hydrology study (Metago[c] 2011) (Appendix J), the groundwater study (MWG[a] 2011) (Appendix K) and site visits undertaken by the Metago EIA team and should be read with reference to Figure 4 (Section 1.4).

Introduction and link to anticipated impact

The topography of the project area influences surface water behaviour, safety of third parties, the location of soils and the visual character of a landscape. Project-related activities have the potential to alter the topography of the site through the establishment of both temporary (such as processing infrastructure and support facilities) and permanent infrastructure (such as the open pit, tailings storage facility and waste dumps). This in turn could result in changes to drainage patterns, landforms which could prove hazardous to people and animals, as well as changes to the visual character. As a baseline, this section provides an understanding of the topographical features relevant to the project site and surrounding area from which to measure potential change.

Data collection

Data on topography was sourced by Metago through the studying of topographical GIS data, an aerial survey of the project area conducted by Turquoise Moon (February 2011) and observations made by the Metago team during site visits.

Results

Regionally the sites fall within the Polokwane Plateau. Near the site, the Palala Granite inselberg and the Koedoesrand formation, and the Waterberg Group in the south (approximately 15km and 40km, respectively) form the main mountainous topographical features.

The topography of the site is relatively flat, with slopes ranging primarily between 1% and 3%. Elevations on site range from approximately 980m amsl along the eastern site boundary to 920m in the south east and west.

Limited activities (some disturbance due to agriculture) have taken place on site and in the surrounding area to alter the natural topography.

Conclusion

The topographical data of the project area has been used to determine the behaviour of surface water and floods which in turn has been used to inform the stormwater management plan. The design of project landforms and infrastructure should be such that any changes to topography result in stable topographic features which do not pose significant risk to third parties and limit impacts on the visual character of the area.

1.1.3 SOIL AND LAND CAPABILITY BASELINE

Information in this section was sourced from the soil specialist study (ESS 2011) (Appendix G) and should be read with reference to Figure 5 (soil forms) and Figure 6 (land capability) (Section 1.4).

Introduction and link to anticipated impact

Soil is a vital component of life on earth. It supports a variety of life forms and plants and creates new soil by breaking down rocks and sand. Furthermore, soil characteristics determine the natural capability of land. Soil resources have the potential to be lost through physical disturbance, erosion by wind and water, and contamination. As a baseline, this information will be used to identify sensitive soil types, to guide Turquoise Moon in the preservation of soil and rehabilitation of disturbed land and aid in informing an end land use for the project site.

Data collection

Data collection was done through review of published reports and maps and verification of site specific data through field work and collection of soil samples for analysis work. Further detail on the methodologies used is provided in the specialist report (Appendix G).

The Chamber of Mines Guideline document (Chamber of Mines 1991) was used to classify the soil units identified during the soil survey. The land capability of the study area was classified into four classes (wetland, arable land, grazing land and wilderness). A total study area of 4 700ha was investigated and mapped.

Results

Soil forms and characteristics

A variety of soil forms have been identified in the project area. The distribution of soils on the site is predominantly associated with the change in the underlying parent host material (geology) from which they are derived and less by the surface topography. An evaporite layer is expected to be the dominant pedogenetic driver in this area. This semi continuous calcrete (evaporite) layer occurs at depth (drilling results and test pit excavation) and there is the occasional surfacing of this layer as outcrop (resulting in pan structures), which confirms the idea of a relict land surface from which, and onto which the present soils have been deposited and/ or formed.

The soils mapped range from shallow sub-outcrop and outcrop to very deep sandy loams. As with any natural system, the transition from one system to another is often complex with multiple facets and variations that vary and grade over large distances. Five broad soil groupings were identified on the project site (Figure 5): structured soils, deep sandy soils, shallows soils, wet soils and pan-like structures. Each of these groupings is described below. It is important to note that these soil groupings are not

extensive in spatial area, and are relatively few in number. However, they are well distributed across the area of study.

- ***Structured soils***

  This is a group of generally deep to moderately shallow, structured (apedal to strong blocky or pedocutanic) fine to medium grained sandy to silty clay loams that are associated with the development of in-situ materials. The calcareous evaporite layer is often found occurring as sub outcrop or at surface. These zones comprise some of the better land capability units (good quality grazing and/or arable potential) in the area, with the soil water holding capability and associated clay content rendering the soils capable of sustained good vegetative growth through the dry spells that characterise the semi-arid environment. This grouping includes neocutanic soils, red to red brown in colour with moderately strong structured (weak blocky to strong blocky) and small but significant areas of neocarbonate and soft carbonate soils with varying depths of weakly structured to apedal sandy loams. The main soil forms are Hutton (moderately deep) (Hu 40-80), Valsrivier (Va) and Kimberley (Ky).

- ***Shallow soils***

  The shallow, to very shallow soil profiles are generally associated almost exclusively with the outcropping of the mineralised zone and/or the evaporite layer at surface. This recently developed evaporite layer (geologically) and ferricrete horizon are responsible for the barrier to water infiltration that results in surface water being held close to or on surface as temporary pan structures. These areas form a relatively small percentage of the overall area of study, but are believed by the soil specialist to have a relatively large and important function in the sustainability of the biodiversity in the area. This group comprise the pan-like structures and water holes. Groundwater is generally relatively deep (>15m) for the majority of the area of study and is believed by the groundwater specialist to play no role in supporting the pan-like structures. The main soil forms are Mispah (Ms), Glenrosa (Gs), some Glencoe (Gc40-60), Plooysburg (Py) and Coega (Cg).

- ***Deep sandy soils***

  In contrast, the deep (>1,5m) sandy profiles associated with aeolian processes that make up the majority of the well sorted soils are characterised by low clay contents (often <6%), are generally deep (greater than 800mm), and vary in texture from fine grained silty sands to highly sorted single grained sands. These soils are extremely well drained. The depth to a restrictive layer is variable throughout these environments, with the depth of sand determining the utilization potential of the soils. The main soil forms are Hutton (deep) (Hu>80), Avalon (Av), Bloemdal (Bd) and Bainsvlei (Bv).

- ***Wet soils and pan-like structures***

  In addition to these major soil groups, there are the ephemeral pan-like structures and the wet base soils that are associated with the retention of water within the soil zone or Vadose Zone. The main wet soil forms are Longlands (Lo), Avalon (Av), Bainsvlei (Bv), Bloemdal (Bd), Sepane (Se), Montague (Mu) and Westleigh (We).

Analysis was done of the physical and chemical properties of a number of soil samples.

- The pH ranges from neutral soils (pH of 7.3) to rather acidic with values as low as 5.6. The soils mapped returned at best moderate levels of some of the essential nutrients required for plant growth with sufficient stores of calcium and sodium. Levels of magnesium, potassium, phosphorous, copper, aluminium and zinc are generally lower than the optimum required. Significantly large areas of soil with a lower than acceptable level of plant nutrition were mapped across the study area. These poor conditions for growth are further compounded by the high permeability and low clay and carbon contents of the majority of the soils. There are no indications of any toxic elements that are likely to limit natural plant growth in the soils mapped within the study area. The growth potential on soils with these nutrient characteristics are at best moderate to poor.
- Generally, the cation exchange capacity (CEC) (a measure of nutrient retention capacity) values are low and enhanced due to the low clay content of many of the soils. The lower the CEC value, the lower the potential of the soils to retain and supply nutrients which reduces the ability of the soil to support vegetation growth.
- The concentrations of natural salts and stores of nutrients within these soils are a sensitive balance due to the extremes of rainfall, wind and temperature.
- The majority of the soils mapped can be classified as having a high erosion potential due to their very low clay content, very low organic carbon and limited structure, which is off-set and mitigated by the almost flat terrain, to a medium erosion potential. Established vegetation binds/stabilises soils ensuring maintained growth conditions and more essentially good soil retention.
- A feature that is unique to semi-arid and arid environments, similar to the site, is the calcrete or calcium carbonate formations noted at the base of the soil profile. In almost all cases mapped, the soil materials are founded on a hard base that comprises either the host lithology (bedrock) or a sequence of disconformable evaporite derived sediments of varying consistency (Calcium Carbonate) that occur at varying depths (20cm to greater than 1,500cm).

  The degree to which the evaporite layer has been cemented will determine the effectiveness of the layer as a barrier to water infiltration, with the depth of overlying soil or sand determining how easily or difficult it is for the soil water to be accessed and utilized.

  Evidence from the exploration drilling, pedological pitting and augering indicate that the calcrete layer is extensive regionally (a common feature in low rainfall and arid climates). The calcrete formation is linked to geological times and presence of the specific calcium rich waters and therefore difficult to recreate if impacted or destroyed.

Land capabilities

Approximately 63% of the study area is considered to be of an arable land capability however the low rainfall in this region limits the utilisation potential to low intensity grazing and wildlife conservation. Although these areas have deep soils, irrigation would be needed to realise the arable potential of these soils. Approximately 22% is considered to be of a conservation/wilderness land potential and 7% is considered to be low intensity grazing land potential (based on depth of materials alone). When considered with the discussion above, the conservation/wilderness/low intensity grazing land potential

covers the majority of the study area. Wet soils make up approximately 8% of the study area. Although these soils fall under the definition of wetland land capability (when using the Chamber of Mines classification - 1991), they are only classified as this based on the soils present and their ability to hold water for short periods of time. Pan-like structures do occur in the area however their coverage is negligible (see Figure 6).

Conclusion

The more sensitive soils on site are the wet soils and pan-like structures, which are limited in their spatial distribution on site, and the calcrete layer, which forms a discomformable undulating layer throughout the site. These features occur both on site and in the surrounding areas. The calcrete layer is expected to act as a barrier to water infiltration into the deeper aquifers. This baseline has been used to inform the soil (conservation and use) management plan to be used for the project. Given the current natural land capabilities and the scarcity of water in the region, thereby limiting the potential for arable land, the post closure land capability should be a combination of grazing and wilderness. This is similar to the current land uses on site.

1.1.4 BIODIVERSITY BASELINE

Information in this section was sourced from the biodiversity specialist study (Ecorex 2011) and should be read with reference to Figure 7 (Section 1.4).

Introduction and link to anticipated impact

The biodiversity value and conservation importance of any area requires an understanding of the vegetation communities together with the occurrence of fauna species. The presence and extent of fauna is directly linked to the natural vegetation. The establishment of project infrastructure as well as project related activities have the potential to result in a loss of habitat through the destruction/disturbance of vegetation and/or contamination of soil and/or water resources thereby reducing the occurrence of fauna on site and in the surrounding areas. As a baseline, this section provides an outline of the vegetation communities occurring on site, highlights the occurrence of sensitive ecological environments including sensitive/ endangered species (if present) that require protection and/or additional mitigation should they be disturbed, and outlines the conservation importance/sensitivity of the vegetation communities and associated vertebrate and invertebrate species. The presence and status of commercial livestock and game as it relates to existing land uses does not form part of this baseline discussion (this is covered in Section 1.3.1).

Data collection

Prior to the fieldwork, data collection was done through desktop assessments of most current aerial images, available published reports, plant and animal lists and maps. A field investigation was then undertaken during the December 2010 rainy season to verify desktop data collected. The timing of the

fieldwork was aimed at coinciding with the flowering times of most plants expected to occur in the study area. A follow up survey specifically aimed at invertebrates was carried out in January 2011. Field investigations covered day- and night-time activities. Caught faunal specimens were identified through reference to literature and input from expert specialists. The floristic importance of each vegetation community identified was determined using a flora index. The invertebrate and vertebrate importance of each vegetation community was then also determined. Further detail on the methodologies used is provided in the specialist report.

The specialist study covered flora and terrestrial fauna, both vertebrate and invertebrate. No aquatic survey was done as no natural aquatic systems were identified on site. The vertebrate fauna covered by the specialist included mammals, birds, reptiles and frogs. The invertebrate fauna covered by the specialist included scorpions, spiders, dragonflies and damselflies, leafhoppers, cicada, ground beetles, butterflies, and ants. For leafhoppers and cicadas, no specific field work was undertaken for these groups. The thorny nature of the vegetation makes the standard method of sweep-netting for leafhoppers virtually impossible and for cicada no conservation concern species were predicted to occur. The possibility of unknown or unexpected species was however kept in mind during the surveys.

Results – Flora

National vegetation types

Regionally, the Moonlight study area falls within the Roodeberg Bushveld vegetation type, at the boundary with the Limpopo Sweet Bushveld vegetation type (Mucina & Rutherford, 2006 as cited in Ecorex, 2011). Boundaries between similar vegetation types are rarely clearly defined, and it is likely that elements of the Limpopo Sweet Bushveld are also represented, at least in the western part of the Moonlight area (Ecorex 2011). A summary of these national vegetation types is provided below with further detail included in the specialist report.

- The Roodeberg Bushveld is endemic to north-western Limpopo Province, occurring from Marken and Villa Nora in the south to Blouberg Mountain in the north-east and Swartwater in the north-west (Ecorex 2011). Vegetation structure is short closed woodland to tall open woodland, with a poorly developed grass layer.
- The Limpopo Sweet Bushveld vegetation type occurs in Limpopo Province and neighbouring Botswana, stretching from the lower reaches of the Crocodile and Marico Rivers around Makoppa and Derdepoort, along the Limpopo valley through Lephalale (Ellisras) and Tom Burke, to the Usuthu border post in the north. Vegetation structure is short open woodland, with dense, impenetrable thickets in disturbed areas.
- Both vegetation types have a conservation status of Least Threatened because of a low level of transformation (18% and 5% respectively). This is due to both informal and formal conservation, through game ranching and formal conservation areas (Mucina & Rutherford, 2006 as cited in Ecorex, 2011).

The study area is not situated within any threatened terrestrial ecosystems as listed in Notice 1477 of Government Gazette No. 32689 (6 November 2009) (SANBI & DEAT, 2009 as cited in Ecorex 2011), nor within any centre of plant endemism. The closest centre of endemism is the Soutpansberg Centre, an aggregated centre comprising the Soutpansberg and Blouberg Mountain massifs (Van Wyk & Smith, 2001 as cited in Ecorex 2011). Blouberg Mountain is situated about 65 km east of the study area and none of its endemics are likely to occur in the study area.

Vegetation communities on site

Six broad vegetation communities were identified on the basis of vegetation structure, floristic composition and position in the landscape (Figure 7). Nature of the soils as determined by parent material appeared to be a significant driver of vegetation communities in the project area, as well as anthropogenic drivers such as overstocking of livestock, leading to overgrazing and subsequent dominance by woody species. A summary of the key aspects of the vegetation communities is provided below with further detail included in the specialist report.

- **Vegetation community 1: *Combretum apiculatum* Closed Woodland**
  - This vegetation community occurs on or near to dolerite outcrops, and is most well represented on the farm Moonlight 111 LR. It covers 323 ha which equates to 6% of the area surveyed. Rock cover is moderate to high, with many scattered boulders present. Vegetation structure is Short Closed Woodland characterised by dominance by deciduous, broad-leaved trees, with a sparse shrub understory and sparse to dense grass sward.
  - A total of 82 species (44% of the entire list) was recorded with no species of conservation concern being recorded.
  - Thirty species (41% of the community species list) appear to be confined to this vegetation community within the study area, a remarkably high fidelity level.
  - Two protected tree species, protected under the National Forest Act (84 of 1998), namely Shepherd's Tree *Boscia albitrunca* and Marula *Sclerocarya birrea* subsp. *cafra* were identified on site. However, both occur in small numbers resulting in a low importance for flora of conservation concern.
  - This vegetation community is not that representative of Roodeberg Bushveld and is not considered to be threatened.
  - A number of small temporary pan-like structures were located in this community, although no wetland-associated flora were encountered, indicating the ephemeral nature of the pan-like structures. The lack of diagnostic and associated flora meant that no separate description of these pan-like structures could be compiled.
- **Vegetation Community 2: *Acacia senegal var. leiorachis – Terminalia prunioides* Closed Woodland / Thicket**
  - This vegetation community is strongly associated with calcrete (shallow Coega soils) and is often on low ridges that are orientated west-east. It covers 456 ha which equates to 8.5% of the area surveyed. Rock cover is often high and is dominated by weathered calcrete. Vegetation

structure is Short Closed Woodland to Tall Thicket and is characterised by dominance of the distinctive tall, slender variety *Acacia*.

- A total of 86 species (46% of the entire list) was recorded with no species of conservation concern being recorded.
- Twenty species (30% of the community species list) appear to be confined to this vegetation community within the study area, which represents moderately high fidelity.
- This vegetation community has elements of both Roodeberg Bushveld and Limpopo Sweet Bushveld, but is not that representative of either and is not considered to be threatened.
- A number of small temporary pan-like structures were located in this community, although no wetland-associated flora were encountered, indicating the ephemeral nature of the pan-like structures. The lack of diagnostic and associated flora meant that no separate description of these pan-like structures could be compiled.

- **Vegetation Community 3: *Sclerocarya birrea – Boscia albitrunca - Acacia tortilis* Open to Closed Woodland Mosaic**
  - This is a fairly complex mosaic of vegetation associations occurring on deep reddish brown sands on plains across the project area. It covers just under 3 900 ha which equates to 73% of the area surveyed. Rock cover is mostly low. Vegetation structure is very variable, depending on a combination of edaphic factors (e.g. soil depth) and anthropogenic factors (e.g. overstocking leading to overgrazing). Structure varies from Short Sparse Woodland to Short Closed Woodland. Structurally distinct vegetation boundaries often follow farm portion boundaries, highlighting the importance of anthropogenic influences in vegetation community dynamics in the study area.
  - Twelve vegetation associations could be identified based on structural and floristic differences. These can be broadly divided into two groups, namely Sparse Woodland / Wooded Grassland associations and Open to Closed Woodland associations.
  - A total of 107 species (57% of the entire list) was recorded from the different associations with this vegetation community.
  - Twenty-four species (27% of the community species list) appear to be confined to this vegetation community within the study area, a lower fidelity level than the other vegetation communities in the study area.
  - Two protected tree species, namely *Boscia albitrunca* and *Sclerocarya birrea* subsp. *cafra* were identified. Both occur as dominant species resulting in a low-medium importance for flora of conservation concern.
  - This vegetation community is representative of Roodeberg Bushveld which is not considered to be threatened.
  - A number of small temporary pan-like structures were located in this community, although no wetland-associated flora were encountered, indicating the ephemeral nature of the pan-like structures. The lack of diagnostic and associated flora meant that no separate description of these pan-like structures could be compiled.

- **Vegetation Community 4: *Commiphora spp. – Grewia flava* Open to Closed Woodland**
  - This vegetation community occurs in the south-eastern corner of the project area and merges with both *Combretum apiculatum* Closed Woodland and *Sclerocarya – Boscia –Acacia tortilis* Open to Closed Woodland Mosaic, so that the boundaries are sometimes difficult to discern in the field. This vegetation community covers just under 300 ha which equates to 5.6% of the area surveyed. Rock cover is low to moderate. Vegetation structure is Short Open to Closed Woodland to Closed Shrubland characterised by dominance of short, dense shrubs and scattered taller trees.
  - A total of 69 species (37% of the entire list) was recorded with no species of conservation concern being recorded.
  - Only seven species (12.5% of the community species list) appear to be confined to this vegetation community within the study area, a low fidelity level that reflects how strong affinities are with adjacent vegetation communities.
  - Hosts two protected tree species, namely *Boscia albitrunca* and *Sclerocarya birrea* subsp. *cafra*. However, both occur in small numbers resulting in a low importance for flora of conservation concern.
  - This vegetation is moderately representative of Roodeberg Bushveld, which is not considered to be threatened.
- **Vegetation community 5: *Acacia tortilis – Dichrostachys cinerea* Old Lands**
  - This vegetation community is typical of old cultivated lands that have been left fallow for many years. The Umbrella Thorn *Acacia tortilis* and Sickle-bush *Dichrostachys cinerea* are dominant throughout, and a dense grass sward is dominated by grass species that typically colonise disturbed areas. This community did not have species of conservation importance and is unlikely to provide habitat for such species.
- **Vegetation community 6: Transformed Areas**
  - A few scattered homesteads, farm dams and ploughed lands are collectively referred to as Transformed Areas. These areas have low conservation value within the study area and were not surveyed.

Seven plant species of conservation concern have been confirmed within the quarter-degree grids 2328AA and 2328AC and surrounding grids, none of which were located during the fieldwork. However due to the size of the study area and small size of some species, some species may have been overlooked.

Two protected tree species, protected under the National Forest Act (84 of 1998), occur in the study area. These two species, namely Shepherd's Tree *Boscia albitrunca* and Marula *Sclerocarya birrea* subsp. *cafra*, were identified in three of the vegetation communities identified on site, *Combretum apiculatum* Closed Woodland (Vegetation community 1), *Sclerocarya birrea – Boscia albitrunca - Acacia tortilis* Open

to Closed Woodland Mosaic (Vegetation Community 3) and *Commiphora spp. – Grewia flava* Open to Closed Woodland (Vegetation Community 4).

Invasive alien species, namely *Solanum elaegnifolium* (in Vegetation Communities 1, 2, 3 and 4) and *Cereus jamacaru* (in Vegetation Community 3 and 4) were recorded on site. These were confined to road edges and other disturbed areas.

Results – Vertebrate fauna

Through field observations and discussions with local residents:

- Twenty three mammal species, 94 bird species, ten reptile species and six frog species were confirmed to occur in the study area.
- A number of these species are of conservation concern:
  - Five of the mammal species: Leopard (confirmed through anecdotal accounts, probably only moves through and is not resident, the only threatened species), Spotted Hyena (confirmed through anecdotal accounts, probably only moves through the study area and is not resident), Brown Hyena (confirmed through anecdotal accounts, probably resident in the study area), Serval (confirmed through anecdotal accounts, probably resident in the study area) and Bushveld Elephant Shrew (single individual caught during field survey).
  - Four of the bird species: White-backed Vulture (a flock of several birds seen soaring over the study area in December 2010), Bateleur (several solitary birds seen soaring over the study area over several days in December 2010), European Roller (fairly common in open to sparse woodland, particularly in the northern half of the study area) and Red-billed Oxpecker (a pair of oxpeckers was observed on a telephone pole at a farmhouse near the centre of the study area).
  - No conservation concern reptile or frogs were observed in the study area.
- Two biome-restricted bird assemblages are represented in the study area, namely the *Kalahari – Highveld Transition* with three bird species (Barred Wren-Warbler, Burchell's Sandgrouse and Kalahari Scrub-Robin) confirmed during fieldwork and the *Zambezian* with two widespread and common members of this assemblage (White-throated Robin-Chat and White-bellied Sunbird) confirmed during fieldwork.
- Most of the reptile species identified in the study area are widespread occurring throughout the savannah biome in South Africa. However, two species with restricted ranges in northern South Africa were also confirmed to occur: Variegated Skink (*Trachylepis variegata*) and Kalahari Dwarf Worm-Lizard (*Zygaspis quadrifrons*) (this is a rarely seen fossorial species).
- Most of the frog species identified in the study area are widespread species occurring throughout the savannah biome in South Africa. However, two species with more restricted ranges in northern South Africa were also confirmed to occur: Southern Ornate Frog (*Hildebrandtia ornata*) (the photographic record at a small man-made dam on the farm Moonlight appears to represent a new locality for this species) and African Bullfrog (*Pyxicephalus edulis*).

There is a low to moderate probability that bat and pangolin species of conservation concern could occur on site but these were not located during the fieldwork. For some bat species it is difficult to predict their likelihood of occurrence and therefore this species cannot be ruled out completely. For bird and reptile species there is a high probability that another five bird species and one reptile species of conservation concern could occur on site

No Important Bird Areas have been described for the vicinity of the study area. The nearest is the Blouberg Mountain IBA, about 65 km north-east of the property (Barnes, 1998 as cited in Ecorex 2011).

Results – Invertebrate fauna

Through field observations:

- Scorpions: Six species were found during the field surveys. Of these, two are protected under the Biodiversity Act (*Opistophthalmus glabrifrons* and *O. wahlbergi)*. *Opistophthalmus glabrifrons* occurred in all terrestrial habitat types surveyed within the study area, but was far more abundant in areas with deep red soils than in the haematite or calcrete outcrops. Only one specimen of *O. wahlbergi* was located and this was in an area with deep soils.
- Trapdoor and Baboon Spiders: Numerous burrows of *Augacephalus junodi* were found, all in areas with deep red soils and while one *Ceratogyrus darlingi* specimen was located (under a log at the border between a calcrete outcrop and an area deep red soils), it appears that *A. junodi* is the dominant baboon spider species on site.
- Dragonflies and damselflies: were abundant around the man-made dams found on the site, but diversity was low and all specimens collected belonged to the six widespread and common species.
- Ground beetles: Forty three species were collected during the surveys. Of the identified species six are protected under the Biodiversity Act. Many of the species are flightless and may thus be good indicators of local conditions.
- Butterflies: No Red Data butterfly species were found on the site and all butterflies observed were common and widespread species.
- Ants: No specific sampling for *Tetramorium microgyna* was carried, but ant specimens were collected on an ad hoc basis during searches for the main focus groups of the field surveys. A preliminary analysis of the samples collected suggests very high ant diversity in view of the lack of focussed sampling on this group (at least 54 ant species representing 20 genera were collected). Intensive focussed sampling of ants would be expected to at least double the number of species found, thus providing ample diversity for this group to form the basis of effective biodiversity monitoring.

There is a low to moderate probability that other invertebrate species of conservation concern could occur on site but none were located during the fieldwork.

Conclusion

From a flora perspective, only two protected tree species were located during the field work resulting in a very low to low-medium conservation importance/sensitivity for vegetation communities identified on site (Table 4). The vertebrate importance of the vegetation communities ranged from low to medium-high, while the invertebrate importance ranged from low to high. The biodiversity sensitivity for the project site ranges from low to medium-high (Table 4, Figure 7).

TABLE 4: BIODIVERSITY SENSITIVITY FOR THE PROJECT SITE

	Acacia senegal-Terminalia prunioides Closed Woodland / Thicket	*Sclerocarya-Boscia-Acacia tortilis* Open to Closed Woodland Mosaic	*Commiphora spp. - Grewia flava* Open to Closed Woodland	*Combretum apiculatum* Closed Woodland	*Acacia-Dichrostachys* Old Lands
Flora	Low	Low-Med	Low	Low	Very Low
Vertebrates	Medium	Med-High	Med	Med	Low
Invertebrates	Medium	High	High	Low	Low
Integrated Importance	Med-Low	Med-High	Med	Med-Low	Low
% of study area	**8.5%**	**73%**	**5.6%**	**6%**	**1.7%**

The natural vegetation of the area is mostly intact. It is expected that the biodiversity in the surrounding area would be similar to that found on site given the similarity in land uses. The majority of the area shows signs of anthropogenic influences (e.g. overstocking leading to overgrazing and dominance by woody species) with some areas showing signs of cultivation (mainly in the south eastern parts of the project site). Proper management of flora and fauna resources during the life of the project will assist in the rehabilitation of disturbed areas.

1.1.5 HYDROLOGY BASELINE

The information in this section was sourced mainly from the specialist hydrology (Metago[c] 2011) (Appendix J) and groundwater studies (MWG 2011) (Appendix K) and should be read with reference to Figure 4 (Section 1.4).

Introduction and link to anticipated impact

Surface water resources include drainage lines and paths of preferential flow of stormwater runoff. Project-related activities have the potential to alter the drainage of surface water through the establishment of both temporary (such as processing infrastructure and support facilities) and permanent infrastructure (such as the open pit, tailings storage facility and waste dumps) and/or result in the contamination of the surface water resources through seepage and/or spillage of process materials, non-mineralised (general and industrial hazardous) and mineralised wastes. Key to understanding the hydrology of the site is the climatic conditions of the site. As a baseline, this section provides an understanding of the climatic (rainfall, temperature and evaporation) conditions of the area, hydrological

catchments that could be affected by the project and the status of surface water features in the project area.

Data collection

No on-site weather station is present. The nearest station is the Marnitz weather station (A5E001), located 5km north of the project site boundary, operated by the Department of Water Affairs (DWA). The relevant climatic data was sourced as follows:

- monthly rainfall and evaporation data (converted to Lake estimates) was sourced from the Marnitz station
- rainfall depths were sourced from the Design Rainfall Estimation Software for South Africa (Smithers and Schulze technique) (further detail is provided in the hydrology report)
- temperature data was sourced from Lephalale.

Data used in determining the surface water characteristics of the study area included topographical data (see Section 1.1.2), climatic data (as discussed above), a land survey done by Turquoise Moon (to a 1m contour interval), and field observations by the specialists. Given the lack of perennial surface water features on site and on neighbouring properties, no project-specific surface water sampling was done and no floodline modelling was undertaken.

In terms of hydrological calculations:

- The mean annual runoff (MAR) for the catchments associated with the project was estimated using rainfall-runoff response parameters from WR2005. The rainfall-runoff response of the catchment was assumed to be the same as the regional rainfall-runoff response as determined for the quaternary catchment in which the project site falls (A50H).
- Flood peaks for the catchments associated with the project site were calculated using the Standard Design Flood (SDF) method (further detail is provided in the hydrology report).

Results

Climatic data

The region is characterised by semi-arid temperatures with dry, warm winters and hot summers. The mean annual rainfall varies between 300 and 700 mm. The annual average rainfall is approximately 420mm, mainly occurring as a result of thunderstorms between October and April, peaking in January. The maximum average summer temperatures in the region approximate 30°C, while the minimum average winter temperatures approximate 8.5°C. Regular frost also occurs during winter.

The average monthly rainfall record at Marnitz ranges between 1mm (in July) and 85mm (in January) per annum with an annual record of 419mm (Table 5). Evaporation ranges from 78mm (in June) to 184mm (in October) with an annual evaporation of 1 654mm. It is clear from the data that evaporation greatly

exceeds rainfall in the area both on a monthly and annual basis. The more significant rains occur in summer. Temperatures in the region tend to be warm to mild (Table 5), ranging from 23.4 to 33.0 °C (maximum) and 6.7 to 20.4 °C (minimum), with average temperatures between 15 °C and 27 °C.

TABLE 5: RAINFALL, EVAPORATION AND TEMPERATURE DATA

Month	Rainfall*	Evaporation (Lake)*	Temperature#		
	Mean monthly (mm)	Mean monthly (mm)	Average maximum (°C)	Average minimum (°C)	Average (°C)
Jan	85	177	33.0	20.4	26.7
Feb	68	142	32.2	19.8	26.0
Mar	46	150	31.8	18.9	25.4
Apr	35	115	28.9	15.0	22.0
May	7	96	26.6	10.3	18.5
Jun	3	78	23.4	6.7	15.0
Jul	1	90	23.9	6.9	15.4
Aug	3	120	26.3	9.5	17.9
Sep	10	155	29.2	13.5	21.4
Oct	33	184	30.6	16.9	23.8
Nov	63	178	31.5	18.2	24.9
Dec	67	166	32.2	19.5	25.9
Annual	**419**	**1654**	-	-	-

** Sourced from Marnitz weather station* *# Sourced from Lephalale weather station*

Maximum 24-hour rainfall depths for various recurrence intervals were used for all hydrological calculations (Table 6).

TABLE 6: 24-HOUR STORM DEPTHS

Return period (yrs)	Average 24-hour rainfall depth (mm)
2	65
5	92
10	111
20	130
50	157
100	179
200	202

Surface drainage

The study area falls within the Limpopo Water Management Area and within quaternary catchment A50H which feeds the Lephalala River (also known as the Phalala or Palala River), a tributary of the Limpopo River. The project site sits in the eastern part of the catchment, bordering quaternary catchment A63A.

Limited activities (some disturbance due to agriculture) have taken place on site and in the surrounding area to alter the natural drainage of the site. Man-made dams/water holes located on the properties are usually fed by borehole water (SAS and TerraAfrica 2011) (Section 1.3.1).

There are no perennial or non-perennial streams within the site boundary. This is due to the site's location on a watershed, as well as the aridity of the region, which results in a low drainage density. Being near the watershed, there are no significant catchment areas upstream of the site influencing surface water runoff volumes. The dominant flow regime within the site is that of overland flow. There are a number of isolated, temporary, shallow pan-like structures on site which hold water for a period of time after rainfall events. Although some of these pan-like structures exhibit wetland type soils, they are not supported by groundwater because the water table is on average deeper than 30m (Section 1.1.6). In addition there is no wetland type vegetation in the pan-like structures (Section 1.1.4). Some of these pan-like structures may be used as watering holes for livestock and game.

The site primarily drains in a westerly direction, although the south eastern corner of the site drains to the south (Figure 4).

Affected catchments including mean annual runoff

Six catchments have been identified in the study area (labelled 1 to 6 on Figure 4). The peak flow rate calculations are summarised in Table 7. Using WR2005 quaternary catchments dataset and an estimated 16.7km^2 of the site's runoff being contained, it is expected that approximately 0.04207 million m^3 of the quaternary catchments 4.9 million m^3 MAR will be held back. This accounts for 0.86% of the MAR for quaternary catchment A50H.

TABLE 7: DESIGN PEAK FLOWS FOR CATCHMENTS ON THE SITE

Catchment	Area (km^2)	Peak Flow (m^3/s) associated with return periods						
		1 in 2	1 in 5	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200
1	21.74	4.2	19.7	34.5	51.4	76.9	98.5	121.5
2	24.55	5.2	24.7	43.1	64.2	96.1	123.0	151.7
3	12.71	2.9	13.7	23.9	35.6	53.3	68.2	84.2
4	13.05	3.7	17.5	30.6	45.6	68.2	87.3	107.7
5	31.20	4.7	22.4	39.2	58.4	87.3	111.8	137.9
6	8.54	1.9	9.1	15.9	23.8	35.5	45.5	56.1

Floodlines

As no drainage lines occur on site, there is no need for floodline determination.

Water quality

No surface water quality information is currently available for the project site. Information sourced from DWAF Internal Strategic Perspective (DWAF, 2004) identifies that the project area falls within the Lephalale key area of the Limpopo WMA and water quality in this key area is generally good.