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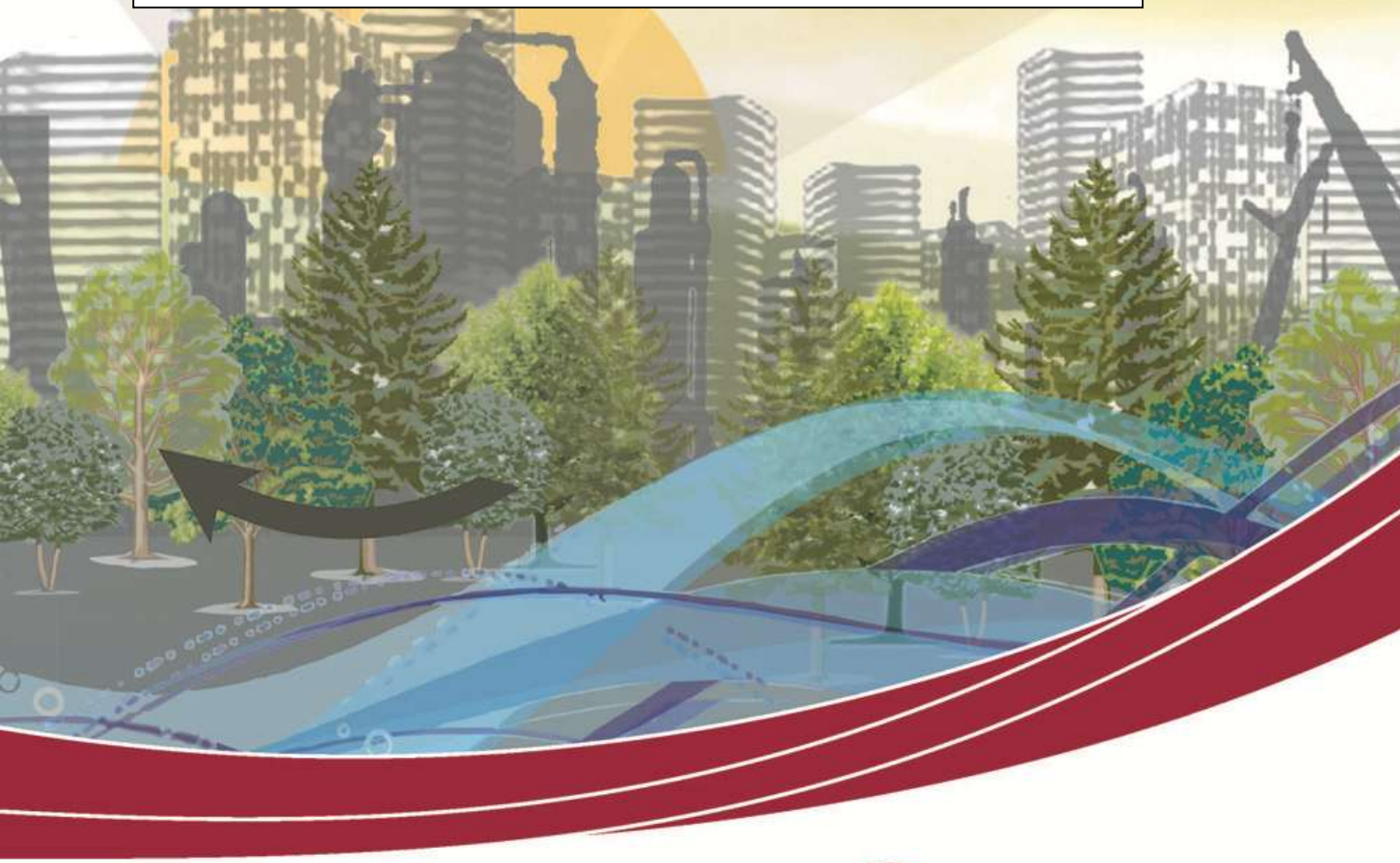
APPLICATION FOR ENVIRONMENTAL AUTHORISATION FOR THE PROPOSED CONSTRUCTION OF A PHOTOVOLTAIC SOLAR POWER STATION WITH ASSOCIATED INFRASTRUCTURE ON THE FARM BRAKFONTEIN 897 HN, BETWEEN TAUNG AND REIVILO IN THE NORTH WEST PROVINCE

BRAKFONTEIN SOLAR POWER PLANT (PTY) LTD

FINAL ENVIRONMENTAL MANAGEMENT PROGRAMME

(FOR PUBLIC REVIEW)

APRIL 2015



CEM® Centre for Environmental Management

NORTH-WEST UNIVERSITY®
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

VISION

The Centre for Environmental Management (CEM) is inspired by:

- The pursuit of generating appropriate knowledge in the fields of environmental and occupational health and safety management;
- Delivering structured, efficient and cost effective short course-based teaching and learning opportunities that is potentially credit-bearing;
- Finding innovative solutions and creating expertise in environmental and occupational health and safety management and governance;
- The pursuit to be the service provider of choice for progressive organisations; and
- The pursuit to be respected locally, regionally and internationally for its leadership as catalyst for change towards a more sustainable, healthy and safe future.

MISSION

The Centre for Environmental Management (CEM)'s mission includes the following:

- To effectively and efficiently manage the CEM as an innovative centre with a focus on customer satisfaction;
- To develop and deliver teaching and learning interventions by means of dedicated, potentially credit-bearing, specialist short courses of high quality;
- To empower students to:
    - find innovative solutions to challenges in the environmental and occupational health and safety management fields;
    - promote continuing professional development; and
    - upgrade skills and knowledge to ensure success in environmental and occupational health and safety management and other related fields;
- To provide structured and fast track learning and skills development opportunities for entrants to the environmental and occupational health and safety management and other related fields;
- To make the CEM's expertise available to organisations, assisting them to adopt more sustainable, healthy and safe strategies or practices;
- To conduct relevant integrated research programmes;
- To network and collaborate with organisations and individuals that support a transition to a sustainable, healthy and safe future; and
- To transform the CEM's activities to ensure that it's procurement processes, appointment of permanent staff, selection of participants in intern programmes, use of external presenters and selection and use of service providers become more inclusive in line with the policies of the North-West University.

CEM: Vision and Mission Rev 2011-01

Contents

1 DESCRIPTION OF THE PROPOSED PHOTOVOLTAIC POWER PLANT

The construction of the proposed PV facility will be the first phase of establishing the 75 MW facility that will generate electricity from solar radiation. The proposed facility will be comprised of:

- Arrays of photovoltaic panels for the generation of electricity;
- Dedicated inverters to convert the electricity from DC to AC;
- Concentrator boxes;
- Transformation centre;
- Electrical reticulation, consisting of underground cabling between the photovoltaic panels and dedicated inverters;
- An overhead 132 kV power line connecting into the proposed constructed substation;
- A new sub-station will be constructed as part of the project. In a loop-in-loop-out connection, a switching sub-station is either integrated into the distribution centre part of the facility or established close to the existing power lines.
- Evacuation line;
- Trenches.
- Administrative/security buildings;
- Buildings and services (Control room, small office and workshop);
- Parking area;
- Perimeter fencing;
- Security system;
- Internal and perimeter service roads of 3 m surface width and 5 m reserve width and a main access road of 10 m reserve width;
- Meteorological stations;
- Drainage systems;
- Lightning protection system;
- Auxiliary supply;
- Emergency power supply; and
- Monitoring and control systems

Table 1: Technical details of the proposed Solar PV plant

Component	Description/Dimensions	
Height of PV panels	3.5	m
Area of PV Array	185	Ha
Number of inverters	75	
Area occupied by inverters/ transformer stations/ substations	1.2	Ha
Inverters/ transformer stations	0.2	Ha
Substation	1	Ha
Capacity of on-site substation	75	MW
Area occupied by both permanent and construction laydown areas	15.7	Ha
Reception and control area	1.2	Ha
Laydown areas	7.5	Ha
Assembly areas	7	Ha
Area occupied by buildings	1.15	Ha
Reception and control buildings	0.15	Ha
Substation	1	Ha
Length of internal roads	22000	m
Width of internal roads	6	m
Proximity of grid connection	160	m
Height of fencing	2.4	m
Type of fencing	Multi-strand electric fence	

The aim of the design and lay-out of the facility will be to maximise electricity generation through exposure to solar radiation, while minimising infrastructure, operational and maintenance costs, as well as environmental and social impacts. This EMP provides a basis from which the potential impacts arising from the PV plant can be mitigated.

2 ENVIRONMENTAL ASSESSMENT PRACTITIONER WHO PREPARED THE REPORT

2.1 Details of the Environmental Assessment Practitioner

Regulation 16(1) in Government Notice No. R.543, published in terms of section 24(5) read with section 44 of the National Environmental Management Act (NEMA) (Act No. 107 of 1998), requires that an applicant must appoint an Environmental Assessment Practitioner (EAP) at own cost to manage the application. Regulation 18 furthermore specifies that an EAP appointed must be independent and have expertise in conducting environmental impact assessments, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity.

The applicant has appointed the Centre for Environmental Management, North-West University (CEM) to manage and facilitate the EIA process for the proposed development. The CEM is accredited by the North-West University (NWU) as a decentralised short course provider of potentially credit bearing, teaching and learning services. The CEM also specialises in finding innovative and cost-effective safety, health and environmental (SHE) management solutions of the highest international standard that are relevant to the African and developing country context, based on the principles of sustainability and safety. The CEM also delivers expertise and conducts research in environmental, safety and health management and related fields, including environmental impact and risk assessments and planning to ensure environmental legal compliance, as well as the development and implementation of various environmental management tools. The CEM benefits from the pooled resources, diverse skills and experience in the environmental management field held by its team, as well as its network of associates.

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ID. no.:	611129 5087 083		
Environmental Assessment Practitioner:	Mr Theunis Meyer		
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Professional affiliation(s) (if any)	• South African Council for Natural Scientific Professions (400029/08) • Member of the IAIAsa and IAIA • Ordinary Member of the GSSA • Senior EMS Auditor, SAATCA (E058)		

2.2 Expertise of EAP to carry out scoping procedures

This report was prepared by Theunis Christoffel Meyer, who is currently employed as Senior Environmental Manager at the CEM and acts as Environmental Assessment Practitioner (EAP) for this project. Mr Meyer holds Masters Degrees in Pasture Science and Environmental Management from the Free State and North-West Universities respectively, as well as an Honours Degree in Wildlife Management from the University of Pretoria.

Mr Meyer has 14 years' experience in the environmental management field and another 14 years as vegetation scientist.

In terms of professional affiliation, he is registered as Professional Natural Scientist with the South African Council for Natural Scientific Professions in Ecological Science and in Environmental Science. He is also a member of the Grassland Society of Southern Africa (GSSA), the South-African chapter of the International Association of Impact Assessment (IAIAsa) and a registered Senior Environmental Management System (EMS) Auditor with the Southern African Auditor Training and Certification Association (SAATCA).

He has been involved in numerous EIAs conducted throughout South Africa in terms of the Environmental Conservation Act (No. 73 of 1989) (ECA), the National Environmental Management Act (No. 107 of 1998) (NEMA) and the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA). His responsibilities in these EIAs included the identification and assessment of environmental impacts, the facilitation of public participation processes and the development of environmental management plans.

He also co-ordinated the popular environmental law public short course at the CEM and regularly lectures on the legal EIA requirements to various audiences. These presentations cover the requirements of Section 24 of the NEMA (No. 107 of 1998), of the regulations published in GN R.543 and the activity lists published in GN R.544, GN R. 545 and GN R.546, as well as the guidelines published by Department of Environmental Affairs (DEA), Gauteng Department of Agriculture and Rural Development (GDARD) and the Western Cape Department of Environmental Affairs and Development Planning (DEADP).

As registered EMS Auditor, Mr Meyer is also regularly involved in environmental legal compliance audits for clients to establish their legal non-compliances. He has also assisted a number of organizations in identifying not only environmental impacts, but also the root causes of these impacts (environmental aspects) during the development of ISO 14001 Environmental Management Systems.

2.3 Independence

Neither the CEM, nor any of the specialist sub-consultants on this project are affiliated to AE-AMD (Pty) Ltd. The CEM also does not have any interest in secondary developments that may arise out of the authorisation of the proposed project.

Furthermore, Mr Meyer and the specialist sub-consultants meet the requirements for independence as none of them has and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the EIA Regulations, 2010; has and will not have vested interest in the proposed activity proceeding; and also has no, and will not engage in conflicting interests in the undertaking of the activity.

3 ENVIRONMENTAL MANAGEMENT PROGRAMME

The EMP was generated from the issues identified during the detailed assessment of potential environmental impacts that may arise from the development of the PV Plant. The EMP must be read in conjunction with the Environmental Impact Report (EIR). The impact reference number refers to the description and significance ratings of various environmental impacts that are predicted in the EIR. The management objective is the overall objective that must be achieved in order to effectively manage the respective impacts. The management actions and interventions is the methodologies that must be utilised to mitigate impacts in order to ultimately achieve the objectives of the EMP. Targets are set to indicate the preferred outcome of the EMP and the achievement of these targets are also an indication of the level to which the objectives are achieved. Responsible persons are allocated to ensure that the EMP conditions are met. A timeframe is given in monitoring must take place to indicate extent to which the objectives have been met and a person is also allocated to monitor the progress on achieving the objectives.

4 ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE SITE ESTABLISHMENT AND CONSTRUCTION PHASES

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Water and soil quality management						
Nature of the impact: ➢ Increased chemical concentrations in surface water, including hydrocarbons and other contaminants ➢ Contamination and degradation of soil due to spillages of oil, petrol, diesel, and other contaminants used by vehicles and equipment on the site and stored on the site						
	• Prevent or minimise soil and water pollution • Prevent or minimise spillages of hazardous substance • Prevent soil	• Implement strict measures to ensure that waste and other contaminates, including hazardous substances, are effectively managed to prevent soil and water contamination (see sections dedicated to hazardous substances and waste management) • Install grids over storm water channels to prevent litter from entering storm water system. Inspect grids on a weekly basis. • Provide adequate on-site	• Zero spillages • No impact on water quality of downstream water courses • Preserve maximum amount of topsoil	Site establishment and construction contractors	• Three monthly inspection of site throughout site establishment and construction phases • Weekly inspections of storm water channel grids • Weekly inspections of road and other surfaces	Three monthly inspections – ECO Weekly inspections - contractors

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
	pollution	washing and disposal facilities • Regularly inspect road and other surfaces for spillages and clean up immediately • Spill kits must be readily available to clean up spillages • A reporting structure must be in place to ensure that all contaminant spillages are reported				
		• Demarcate vehicle maintenance site and implement measures to capture and contain runoff from this area • Vehicles and machinery must be operated by a trained operator to prevent accidents that may lead to spillages • Vehicles and equipment must be serviced regularly and maintained in good running condition • Vehicles must be serviced off			Weekly inspections of road and other surfaces	Weekly inspections - contractors

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		site. • There must be strict control over the safe usage of vehicles and equipment to minimise vehicle accidents and damage to vehicles by rocks and boulders which may cause spillages • Spill kits must be readily available to clean up spillages • Store topsoil prior to the commencement of construction activities at a predetermined are, and replace topsoil on completion of construction		Engineer and construction personnel	On a regular basis or when needed	ECO

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Erosion and siltation control						
Nature of the impact: ➢ Soil erosion due to digging of trenches for underground cabling ➢ Soil erosion on construction sites during and after the construction phase due to decreased vegetation cover and increased water run-off ➢ Soil erosion along the trenches dug during and after the construction phase due to decreased vegetation cover and increased water run-off ➢ Soil erosion along the newly constructed access road constructed during the site establishment phase due to decreased vegetation cover and increased water run-off ➢ Soil erosion in the area surrounding the workshop area ➢ Increased silt loading as a result of soil disturbance activities, leading to increased turbidity & sedimentation						
	Control storm water runoff to prevent soil erosion and siltation of downstream water courses	• Control and contain soil degradation at source • Retain good plant cover • If it is not possible to retain good plant cover during construction, other methods should be employed, including covering soil with i.e. straw, mulch, erosion control mats etc. • Establish an effective storm water drainage system and keep clear of any obstructions	Minimal soil erosion and siltation of downstream water courses Prevention and control of water erosion on the site	Site establishment and construction contractors and engineer	Throughout site establishment and construction phases	ECO - Monitor erosion rates and erosion sites on a weekly basis and after each storm water event
		• Build berms as well as cross mounds on the access road • Arrangements must be in		ECO		Monitor roads and construction sites on a regular basis

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		place to ensure that construction roads are maintained in good condition • Ensure that vehicles only drive on demarcated roads • A reporting structure must be in place to ensure that erosion problems are reported to the construction site manager or ECO • Soils which have not yet been rehabilitated with indigenous grasses should be covered with straw, mulch or erosion mats until vegetation has established • Rehabilitate construction sites by establishing it with indigenous grasses like *Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens*. • When laying underground cables in trenches, separate top and subsoil on opposite sides of the trench and replace in correct sequence when closing trenches				

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		• After construction the buffer zone around the building should be covered with gravel. Care should also be taken to control and distribute the storm water run-off from the roof of the building in such a manner that it does not lead to water erosion of the surrounding soil				

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Surface hydrology						
Nature of the impact: ➢ Interruption of surface water flows moving down the drainage line due to construction related activities ➢ Increase in volumes of water released off the site following storm events, as a result of the increase in impervious surfaces						
	Prevent alteration of surface hydrology	• Do not extend the PV plant footprint into the drainage features in the centre part of the proposed development area • Gravel should be placed on access road surfaces to protect the soil against water erosion • Cross mounds and other storm water drainage techniques must be employed to decrease the speed and force of the storm water properly from road surfaces • Where possible, make use of existing roads where possible and minimize the construction of new roads. • See erosion control section for measures to prevent alteration of surface hydrology	Minimum alteration of hydrology	Site establishment and construction contractors	Throughout site establishment and construction phases	ECO

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Air quality management						
Nature of the impact: ➢ Noise and vibration due to machinery/processes/equipment/vehicles employed during construction activities ➢ Dust/fumes generated/released during the earthworks/construction activities ➢ Smoke/gaseous emissions due to machinery/processes/equipment/vehicles employed during construction activities ➢ Light emitted at night due to construction activities						
	Ensure that on-site activities are conducted in a manner to avoid air pollution	• Regular watering (water spraying) of exposed surfaces for dust control • Machines and vehicles must only be switched on when in use to avoid diesel fume emissions • Restrict activities to working hours • Direct lighting downwards	Minimise emissions	Site establishment and construction contractors	Throughout site establishment and construction phases	ECO
Land use potential						
Nature of the impact: ➢ Interference of construction and operational activities with the day-to-day management of the livestock and veld due to construction and other activities on the site ➢ Loss of vegetation and grazing capacity ➢ Denudation of the soil due to construction activities and loss of carrying capacity						
	Retain as much as possible of the original	• All farming infrastructure, including fences, water pipelines, water troughs, etc.,	• Replace all removed farming infrastructure	Site establishment and construction contractors	Throughout site establishment and construction phases	ECO

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
	features that give identity to the land use of the site	that are damaged or removed during construction, must be replaced as soon as possible • Make use of existing roads as far as possible • Maintain as much natural vegetation as possible by providing adequate spacing between PV panels • If it is not possible to retain good plant cover during construction, other methods should be employed, including covering soil with i.e. straw, mulch, erosion control mats etc. • Construction and other activities must be communicated and co-ordinated with the land owner to put him in a position to properly plan his livestock and grazing management activities. Records of this communication must be kept on record by the ECO. • Damaged fences, due to construction activities should	• Limit vegetation clearance			

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		be replaced by the holder of the environmental authorisation. • See section dedicated to soil erosion				

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Natural resource use						
Nature of the impact: ➢ Water consumption (wastage) ➢ Fuel usage (fossil fuel reserves)						
SE **Co**	Efficient use of natural resources	• Limited on-site staff washing facilities • Use energy saving light bulbs in offices and staff facilities • All water leakages must be reported and repaired • Machines and vehicles must only be switched on when in use to avoid fuel wastage	Zero water leakages Limited electricity usage	Site establishment and construction contractors	Throughout site establishment and construction phases	ECO

Site establishment and construction phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Biodiversity/habitat loss (flora)						
Nature of the impact: ➢ Loss of indigenous species as a result of the spreading of alien and invasive plants ➢ Vegetation clearance during site establishment and construction phases ➢ Loss of vegetation due to contamination of habitat						
SE **Co**	Minimum vegetation disturbance	• Construction and operational staff must be made aware of the presence and importance of the no-go areas • Limit disturbance to the construction site • Develop an alien and invasive plant management plan to effectively manage such plants • Exotic and invasive plant species are not allowed to establish in the development area • Rehabilitate construction sites with indigenous grasses • See section dedicated to hazardous substances		Site establishment and construction contractors	Throughout site establishment and construction phases	ECO

Biodiversity/habitat loss (fauna)						
Nature of the impact: ➢ Displacement of species due to habitat destruction ➢ Restriction of animal movement ➢ Potential killing of animals						
SE **Co**	Minimum disturbance of faunal species	• Leave 100 mm below last cable in fence to allow passage of small mammals and reptiles; and leave 200 mm gates in fence at 500 m intervals to allow wildlife movement in and out of the site • Inspect fence for snares on a weekly basis • A strict no-kill policy must be communicated to construction workers and implemented • Power lines must be kept low, thickest possible cabling should be used, vertically separated arrays of lines should be avoided, power lines with common sources and destinations should run in close parallel, and lines with very different heights (avoid bird strikes) • See section dedicated to hazardous substances	No impact on animals Maintain fence in good condition	Site establishment and construction contractors	Inspect fence on a weekly basis	Security guard

Heritage/Archaeological resources						
Nature of the impact: ➢ Destruction of archaeological artefacts or palaeontological features						
SE **Co**	Protect all archaeological and heritage resources	• Construction managers/foremen or ECO must be informed before construction starts on the possible types of heritage sites and cultural material they may encounter and the procedures to follow when such sites are found • Construction workers, ECO and the site manager must be on the lookout for fossil bones during all excavations. Should fossil bones be uncovered, SAHRA and/or a Palaeontologist must be notified. • An application for a collection and destruction permit is made to SAHRA to allow for the collection and destruction of stromatolite structures during excavation of PV panel foundations. • If any exceptionally well-defined stromatolites are observed during excavations, the developer must employ a qualified palaeontologist to	• Zero damage to archaeological, palaeotological and heritage resources • Develop reporting structure before construction commences	Site establishment and construction contractors Management	Throughout site establishment and construction phases	ECO

		record these fossils and collect representative samples for further study at an appropriate institute suggested by SAHRA.				
Social economic environment						
Nature of the impact: ➢ Creation of temporary and permanent employment opportunities ➢ Benefit the local community indirectly through benefits associated with the provision of accommodation, catering and local spending by contractors ➢ Generation of renewable energy - benefit society in general ➢ Conservation of natural features by creating no-go areas and re-vegetating disturbed areas ➢ Potential hygiene and health impacts due to water contamination ➢ The construction and operation of the facility will affect the land-use of the area ➢ Potential of the development of veld fires						
SE **Co**	Prevent adverse social impacts	• Establish a community liaison committee to discuss possible issues and complaints • Provide employment opportunities to local people • Construction activities must be communicated and co-ordinated with the surrounding landowners • No open fires are allowed on site. • Fire breaks must be in place and maintained on a regular basis. • Fire-fighting equipment must be available on site at all times and properly maintained • The holder of the	• Establish community liaison committee prior to the commencement of the activity • Liaise with community on a 3 monthly basis	Management	Throughout site establishment and construction phases	ECO and

		environmental authorisation must join the local fire association • See section dedicated to soil and water pollution				
Visual and aesthetic						
Nature of the impact: ➢ Visual contrast caused by clearance of vegetation ➢ Visual disturbance caused by construction activities ➢ Visual disturbance due to poor housekeeping, i.e. uncontrolled littering ➢ Visual disturbance caused by large number of solar panels ➢ Visual intrusion of ancillary buildings and structures on views of highly sensitive visual receptors ➢ Visual intrusion caused by additional power lines in the view shed ➢ Glint and glare from solar arrays and other features, including buildings windows and roofs, cause visual intrusion on views of sensitive visual receptors						
SE **Co**	Minimise visual disturbance	• Clearance of indigenous vegetation should be minimised and rehabilitation of temporarily cleared areas should start as soon as possible • Vegetation matter from vegetation removal can be mulched and spread over fresh soil disturbances to aid in rehabilitation process • Laydown areas and stockyards should be located in low visibility areas and existing vegetation should be used to screen them from views where possible.	• Retain as much of the baseline aesthetic value of the area as possible • Establish firebreak	Site establishment and construction contractors	Throughout site establishment and construction phase	ECO

		• Minimise negative impacts of night lighting by directing lights downwards and shielding them from above • See sections dedicated to erosion and dust (air quality) management • Retain as much existing vegetation along the boundaries of the site as possible • Disturbed areas must be rehabilitation to prevent the exposure of soil, which may cause a reduction in the visual quality of the area • Fire hazards and dust emissions must be managed to reduce visibility of construction activities • Good housekeeping practices must be implemented				

Traffic						
Nature of the impact: ➢ Deterioration of road infrastructure during construction activities ➢ Disruption of traffic due to construction activities ➢ Increased traffic volumes and related negative impacts, i.e. congestion, noise, accidents etc. ➢ Negative impact of increased traffic volumes on surrounding farming communities						
SE **Co**	Minimise traffic impacts	• Avoid transportation of materials during peak traffic times; • Avoid unnecessary transportation on public roads (maximum loads)	N/A	Site establishment and construction contractors		
Hazardous substances management (hydrocarbons, herbicides and pesticides, certain cleaning detergents etc.)						
Nature of the impact: ➢ Inadequate management of hazardous substances can lead to severe water and soil pollution, and it can lead to potential health effects ➢ Spillage of hazardous substances can also influence biodiversity (fauna and flora)						

SE **Co**	Prevent spillages of hazardous substances, including hydrocarbons, herbicides	• Storage of hazardous substances must be limited to small quantities • Material Safety Data Sheets (MSDS) must be available for all chemicals used on-site • Establish bunding for hydrocarbon storage tanks and generators • Bunding must have a capacity to contain 110% of the tank's volume • Use environmentally friendly cleaning detergents • Herbicides and pesticides must be managed by a certified Pest Control Officer (PCO)	• Zero spillages • Clean up all potential spillages • Appoint PCO	Site establishment and construction contractors PCO	Inspect site on a three monthly basis	ECO
Solid waste management						
Nature of the impact: ➢ Inadequate waste management can lead to water and soil contamination ➢ Uncontrolled waste can damage the integrity of the natural features and the visual and aesthetic characteristics of the environment can be also be scarred						
SE **Co**	Environmentally sound handling, storage, transportation and disposal of waste	• Develop a Standard Operating Procedure (SOP) for waste management • Store general and hazardous waste, as well as building rubble, at an enclosed on-site demarcated area • Provide cages to separate	Zero littering	Site establishment and construction contractors	Throughout site establishment and construction phase Inspect site on a two monthly basis	

		waste types (general, hazardous and wet waste) • Vehicles transporting waste must be properly covered • All general waste must be disposed-off at a licenced landfill facility				
Liquid waste management						
Nature of the impact ➢ Contamination and degradation of soil and water due to spillages of liquid waste on-site ➢ Habitat disturbance as a result of uncontrolled liquid waste ➢ Potential hygiene problems resulting from contaminated water						
SE **Co**	Environmentally sound handling, storage, transportation and disposal of waste	• Minimise liquid waste generation • Store liquid water at a bunded, demarcated area • Liquid waste management must be included in the waste management SOP • All liquid waste spillages must be reported to the ECO and immediately remediated	Zero spillages of liquid waste	Site establishment and construction contractors	• Throughout site establishment and construction phase	

5 ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE OPERATIONAL PHASE

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Water quality management						
Nature of impact: ➢ Increased chemical concentrations in surface water, containing hydrocarbons and other contaminants.						
	Maintain water quality of downstream water courses	• Minimise or prevent pollution sources from contaminating downstream water courses • A Standard Operating Procedure (SOP) must be developed for the maintenance of PV modules and supporting infrastructure in order to prevent spillages, and it must state how to respond to spillages • Maintain grids over storm water channels in good condition and clean regularly • Spill kits must be readily available to clean up spillages • Regularly inspect road and other surfaces for spillages and clean up immediately • A reporting structure must be in place to ensure that all contaminant spillages are reported	• No increase in pollutants • Train personnel on the SOP for maintenance of PV modules and supporting infrastructure before commencement of operational phase • No obstructions in the storm water - keep storm water channels clear of any debris • No spillages	Operational manager	Throughout operational phase Three monthly inspection by the ECO	ECO

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Erosion and siltation control						
Nature of the impact: ➢ Increased silt loading as a result of soil disturbance activities, leading to increased turbidity & sedimentation ➢ Erosion due to increased runoff from impervious surfaces						
	Prevent erosion and siltation	• Control storm water runoff to prevent or minimise siltation of downstream water courses • Inspect storm water system channels to ensure that the system is kept clean to prevent clogging • A good plant cover during construction should be employed to keep the soil covered. This may include, straw, mulch, erosion control mats. • Rehabilitate sites by establishing it with indigenous grasses like *Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens* • Erosion problems must be reported to the ECO • Maintain at least 60% soil cover of indigenous lawn grasses (*Cynodon incompletus*, *Eragrostis beriana*) and low	• No obstructions in the storm water channels - keep storm water channels clear of any debris • Zero disturbance to soil and vegetation	Management team and maintenance contractors	Three monthly throughout operational phase	ECO

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		shrub cover through mowing • Removal of alien and invasive plants must be conducted in a manner to minimise disturbance to soil or natural vegetation. • Maintenance of buildings and infrastructure must be conducted in a manner to minimise disturbance to soil or natural vegetation. • Extension of current infrastructure or erection of new buildings must be communicated to the EAP or ECO				
Natural resource use						
Nature of the impact: ➢ Water consumption (wastage) ➢ Fuel usage (fossil fuel reserves)						
	Efficient use of natural resources	• Limited on-site staff washing facilities • Use energy saving light bulbs in offices and staff facilities • All water leakages must be reported and repaired immediately • Water usage must be limited during maintenance of PV	Zero wastage of natural resources wastage	Management team and maintenance contractors	Three monthly throughout operational phase	ECO

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		modules and supporting infrastructure				
Biodiversity/habitat loss (flora)						
Nature of the impact: ➢ Loss of indigenous species as a result of the spreading of alien and invasive plants ➢ Vegetation clearance during maintenance or expansion of supporting infrastructure ➢ Loss of vegetation due to contamination of habitat						
		• Maintain at least 60% soil cover of indigenous lawn grasses (*Cynodon incompletus*, *Eragrostis beriana*) and low shrub cover through mowing • Vegetation cover and composition beneath and between the PV panels must be monitored to detect changes in cover or composition causes by shading, watering, or height management • Implement relevant sections of the alien and invasive management plan developed during the construction phase • A suitably qualified or trained person must annually check all vegetated areas within a 200m buffer zone of the PV plant and	Zero additional disturbance of vegetation	Management team and maintenance contractors PCO	Three monthly monitoring of vegetation Annual inspection of area for invasive plants	Vegetation - ECO Invasive plants – specialist

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		the plant's footprint for the establishment of declared invasive plant species				
Biodiversity/habitat loss (fauna)						
Nature of the impact: ➢ Displacement of species due to habitat destruction ➢ Restriction of animal movement ➢ Potential killing of animals						
	Prevent harm to animals	• Inspect fence for snares on a weekly basis • Ensure that 100 mm below last cable in fence to allow passage of small mammals and reptiles; and the 200 mm gates in fence at 500 m intervals to allow wildlife movement in and out of the site are kept clear of any obstructions • A strict no-kill policy must be communicated to operational workers and strictly implemented • Maintain high visibility structures on powerlines to prevent bird strikes • The area beneath all powerlines must be monitored on a monthly basis and all birds or bats that	Zero	Management team, security guard and specialist	Weekly inspection of fence Annual inspection of area for invasive plants Monthly inspection of powerlines for bird and bat deaths	Fence – security guard Powerlines - security guard

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		appear to have died from power line strikes or electrocutions must be recorded and reported to the ECO				
Heritage/Archaeological resources						
Nature of the impact: ➢ Destruction of archaeological artefacts or palaeontological features						
	Protect all archaeological and heritage resources	• The maintenance SOP must make provision to prevent harm to archaeological, heritage or palaeontological features	Zero damage to archaeological features	Maintenance contractors and operational personnel	The buffer zones must be inspected on a three monthly basis	ECO
Visual and aesthetic						
Nature of the impact: ➢ Visual disturbance caused by large number of solar panels ➢ Visual intrusion of ancillary buildings and structures on views of highly sensitive visual receptors ➢ Visual intrusion caused by additional powerlines in the viewshed ➢ Glint and glare from solar arrays and other features, including buildings windows and roofs, cause visual intrusion on views of sensitive visual receptors						
	Minimise visual disturbance	• Retain as much existing vegetation along the boundaries of the site as possible • Good housekeeping practices must be implemented • See section dedicated to waste management and erosion control	Retain as much of the baseline aesthetic value of the area as possible	Operational staff and management	Throughout operational phase	ECO

Operational phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		• Minimise negative impacts of night lighting by directing lights downwards and shielding them from above				
Hazardous substances management (hydrocarbons, herbicides and pesticides, certain cleaning detergents etc.)						
Nature of the impact: ➢ Inadequate management of hazardous substances can lead to severe water and soil pollution, and it can lead to potential health effects ➢ Spillage of hazardous substances can also influence biodiversity (fauna and flora)						
	Prevent spillages of hazardous substances, including hydrocarbons, herbicides	• Storage of hazardous substances must be limited to small quantities • Material Safety Data Sheets (MSDS) must be available for all chemicals used on-site • Establish bunding for hydrocarbon storage tanks and generators • Bunding must have a capacity to contain 110% of the tank's volume • Use environmentally friendly cleaning detergents • Herbicides and pesticides must be managed by a certified Pest Control Officer (PCO)	• Zero spillages • Clean up all potential spillages • Appoint certified PCO	Maintenance and operational staff PCO	Inspect site on a three monthly basis	ECO

Solid waste management						
Nature of the impact: ➢ Inadequate waste management can lead to water and soil contamination ➢ Uncontrolled waste can damage the integrity of the natural features and the visual and aesthetic characteristics of the environment can be also be scarred						
	Environmentally sound handling, storage, transportation and disposal of waste	• Develop SOP for waste management during the operational phase • Train staff on the implementation of the waste management SOP • Provide cages to separate waste types (general, hazardous and wet waste) • Vehicles transporting waste must be properly covered • All general waste must be disposed-off at a licenced landfill facility	Zero littering	Management team, permanent employees and contractors	Throughout operational phase	ECO
Liquid waste management						
Nature of the impact ➢ Contamination and degradation of soil and water due to spillages of liquid waste on-site ➢ Habitat disturbance as a result of uncontrolled liquid waste ➢ Potential hygiene problems resulting from contaminated water						
	Environmentally sound handling, storage, transportation and disposal	• Minimise liquid waste generation • Store liquid water at a bunded, demarcated area • Liquid waste management must be included in the waste management SOP	Zero spillages of liquid waste	Management team, permanent employees and contractors	Throughout operational phase construction phase	ECO

	of waste	• All liquid waste spillages must be reported to the ECO				

6 ENVIRONMENTAL MANAGEMENT PROGRAMME FOR DECOMMISSIONING AND REHABILITATION PHASES

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Water and soil quality management						
Nature of the impact: ➢ Increased chemical concentrations in surface water, including hydrocarbons and other contaminants ➢ Contamination and degradation of soil due to spillages of oil, petrol, diesel, and other contaminants used by vehicles and equipment on the site and stored on the site						
	Prevent or minimise soil and water pollution	• Implement strict measures to ensure that waste and other contaminates, including hazardous substances, are effectively managed to prevent soil and water contamination (see sections dedicated to hazardous substances and waste management) • Provide adequate on-site washing and disposal facilities. • Demarcate vehicle maintenance site and implement measures to capture and contain runoff from this area • Vehicles and machinery must be operated by a trained operator to prevent accidents that may lead to spillages • Vehicles and equipment must be serviced regularly and maintained in	• Zero spillages • No impact on water quality of downstream water courses	Decommissioning contractors	Throughout site decommissioning phase	ECO Decommissioning contractors

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		good running condition • Regularly inspect road and other surfaces for spillages and clean up immediately • A reporting structure must be in place to ensure that all contaminant spillages are reported • Spill kits must be readily available to clean up spillages • Remediate the site completely of all hazardous substance spillages				

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Erosion and siltation control						
Nature of the impact: ➢ Soil erosion due to soil disturbance resulting from removal of buildings, infrastructure and PV modules ➢ Soil erosion due to decreased vegetation cover and increased water run-off from artificial surface ➢ Soil erosion in the area surrounding the workshop area ➢ Increased silt loading as a result of soil disturbance activities, leading to increased turbidity & sedimentation						
	Control storm water runoff to prevent soil erosion and siltation of downstream water courses	• Control and contain soil degradation at source • Establish an effective storm water drainage system applicable for the decommissioning phase and keep clear of any obstructions • Ensure that vehicles only drive on demarcated roads • A reporting structure must be in place to ensure that erosion problems are reported to the on-site manager or ECO • Slopes must remain as low as possible to prevent excessive runoff • Rehabilitate sites by establishing it with indigenous grasses like *Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens*	Minimal soil erosion and siltation of downstream water courses	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Surface hydrology						
Nature of the impact: ➢ Interruption of surface water flows moving down the drainage line due to decommissioning activities ➢ Increase in volumes of water released off the site following storm events, as a result of impervious surfaces						
	Prevent alteration of surface hydrology	• Decommissioning must not extend the original PV plant footprint into the drainage features in the centre part of the proposed development area • See erosion control section for measures to prevent alteration of surface hydrology	Minimum alteration of hydrology	Decommissioning contractors	Throughout site decommissioning phase	ECO
Air quality management						
Nature of the impact: ➢ Noise and vibration due to machinery/processes/equipment/vehicles ➢ Dust/fumes generated/released ➢ Smoke/gaseous emissions due to machinery/processes/equipment/vehicles ➢ Light emitted at night						
	Ensure that on-site activities are conducted in a manner to avoid air pollution	• Regular watering (water spraying) of exposed surfaces for dust control • Machines and vehicles must only be switched on when in use to avoid diesel fume emissions • Restrict activities to working hours • Direct lighting downwards	Minimise emissions	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Land use potential						
Nature of the impact: ➢ Interference of decommissioning activities with the day-to-day management of the livestock and veld ➢ Loss of vegetation and grazing capacity ➢ Denudation of the soil due to decommissioning activities and loss of carrying capacity						
	Retain as much as possible of the original features that give identity to the land use of the site	• A specialist must be appointed to develop a rehabilitation plan for the site • A final land use must be determined for the site • Place topsoil on areas where rehabilitation will occur • Rehabilitate sites by establishing it with indigenous grasses like *Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens* • See section dedicated to soil erosion • Effective land management and monitoring must be implemented to ensure that the rehabilitation of the site is successful	• Limit vegetation clearance • Rehabilitate total PV plant footprint • Establish end land use	Decommissioning contractors	Throughout site decommissioning phase Monitor rehabilitation success on a three monthly basis	ECO Specialist

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Natural resource use						
Nature of the impact: ➢ Water consumption (wastage) ➢ Fuel usage (fossil fuel reserves)						
	Efficient use of natural resources	• Limited on-site staff washing facilities • Use energy saving light bulbs in offices and staff facilities • All water leakages must be reported and repaired • Machines and vehicles must only be switched on when in use to avoid fuel wastage	Zero water leakages Limited electricity usage	Decommissioning contractors	Throughout site decommissioning phase	ECO
Biodiversity/habitat loss (flora)						
Nature of the impact: ➢ Loss of indigenous species as a result of the spreading of alien and invasive plants ➢ Vegetation clearance during decommissioning phase ➢ Loss of vegetation due to contamination of habitat						
	Minimum vegetation disturbance	• Rehabilitate sites by establishing it with indigenous grasses like *Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens* • Remove all alien and invasive plant species that has established during	• Zero additional vegetation clearance • Rehabilitate all disturbed areas	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
		the operational phase • See section dedicated to hazardous substances • See section dedicated to land use				
Biodiversity/habitat loss (fauna)						
Nature of the impact: ➢ Displacement of species due to habitat destruction ➢ Restriction of animal movement ➢ Potential killing of animals						
	Minimum disturbance of faunal species	• A strict no-kill policy must be communicated to all workers and it must be implemented • Remove all powerlines to prevent further striking or electrocution of birds • Remove fence to allow animals to move freely after decommissioning • Remove all supporting infrastructure • See section dedicated to hazardous substances	No impact on animals Maintain fence in good condition	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Heritage/Archaeological resources						
Nature of the impact: ➢ Destruction of archaeological artefacts or palaeontological features						
	Protect all archaeological and heritage resources	• SAHARA must be notified if any archaeological, palaeontological or heritage features are uncovered during the decommissioning phase	• Zero damage to archaeological and heritage resources	Decommissioning contractors	Throughout site decommissioning phase	ECO
Visual and aesthetic						
Nature of the impact: ➢ Visual disturbance caused by decommissioning activities ➢ Visual disturbance due to poor housekeeping, i.e. uncontrolled littering						
	Enhance aesthetic value of the area	• Minimise negative impacts of night lighting by directing lights downwards and shielding them from above • See sections dedicated to erosion and dust (air quality) management • Good housekeeping practices must be implemented	• Enhance aesthetic value of the site	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Traffic						
Nature of the impact: ➢ Deterioration of road infrastructure during decommissioning activities ➢ Disruption of traffic due to decommissioning activities ➢ Increased traffic volumes and related negative impacts, i.e. congestion, noise, accidents etc. ➢ Negative impact of increased traffic volumes on surrounding farming communities						
	Minimise traffic impacts	• Avoid transportation of materials during peak traffic times • Avoid unnecessary transportation on public roads (maximum loads)	N/A	Decommissioning contractors	Throughout site decommissioning phase	
Hazardous substances management (hydrocarbons, herbicides and pesticides, certain cleaning detergents etc.)						
Nature of the impact: ➢ Inadequate management of hazardous substances can lead to severe water and soil pollution, and it can lead to potential health effects ➢ Spillage of hazardous substances can also influence biodiversity (fauna and flora)						
	Minimise traffic impacts	• Storage of hazardous substances must be limited to small quantities • Material Safety Data Sheets (MSDS) must be available for all chemicals used on-site • Use environmentally friendly cleaning detergents • Herbicides and pesticides must be managed by a certified Pest Control Officer	Zero spillages of hazardous substances	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
Solid waste management						
Nature of the impact: ➢ Inadequate waste management can lead to water and soil contamination ➢ Uncontrolled waste can damage the integrity of the natural features and the visual and aesthetic characteristics of the environment can be also be scarred						
	Environmentally sound handling, storage, transportation and disposal of waste	• Store general and hazardous waste, as well as building rubble, at an enclosed on-site demarcated area • Provide cages to separate waste types (general, hazardous and wet waste) • Vehicles transporting waste must be properly covered • All general waste must be disposed-off at a licenced landfill facility	Zero littering	Decommissioning contractors	Throughout site decommissioning phase	ECO
Liquid waste management						
Nature of the impact ➢ Contamination and degradation of soil and water due to spillages of liquid waste on-site ➢ Habitat disturbance as a result of uncontrolled liquid waste ➢ Potential hygiene problems resulting from contaminated water						
	Environmentally sound handling, storage, transportation	• Minimise liquid waste generation • Store liquid water at a bunded, demarcated area • Liquid waste management must be included in the waste management	Zero spillages of liquid waste	Decommissioning contractors	Throughout site decommissioning phase	ECO

Decommissioning and rehabilitation phase						
Impact reference number	**Management objectives**	**Management actions and interventions**	**Targets**	**Responsibility for actions**	**Timeframe for monitoring**	**Responsibility for monitoring**
	and disposal of waste	SOP • All liquid waste spillages must be reported to the ECO and immediately remediated				

Table 2: Summary of the assessed and mitigated identified environmental impacts

		Activities that require mitigation measures	Surface water A	Ground water B	Hydrology C	Soil erosion D	Soil pollution E	Air pollution F	Land use potential G	Natural resource use H	Species/habitat loss (flora) I	Species/habitat loss (fauna) J	Habitat transformation K	Heritage/archaeological L	Social Economic Impact M	Economic N	Visual and aesthetic impact O	Infrastructural P	Traffic Q		
1	SE	Construction of electric fence to prevent access to site	Low N	0	Low N	Low N	0	Low N	Low N	Low N	Low N	Low N	Low N	Medium N	0	Medium P	Low N	Medium N	0	Construction of electric fence to prevent access to site	Be environmentally conscious when constructing electric fence. Maintain regularly and regularly clean-up. Control and contain surface water run-off. Heritage resources mitigation. Regular watering (water spraying) of exposed surfaces for dust control. Limit activities to normal working hours. Leave 100 mm below last cable in fence to allow passage of small mammals and reptiles; and leave 200 mm gates in fence at 500 m intervals to allow wildlife movement in and out of the site. Rehabilitate construction sites with indigenous grasses.
2	SE	Protection of natural features by creating no go areas	0	0	Medium P	Medium P	0	0	0	0	Medium P	High P	High P	0	High P	0	0	0	0	Protection of natural features by creating no go areas	Make construction personnel aware of the no-go areas (veins)
3	SE	Removal of pre-identified biota prior to earthworks	0	0	0	0	0	0	0	0	0	0	0	0	High P	0	0	0	0	Removal of pre-identified biota prior to earthworks	
4	SE	Handling and storage of soil and/or fill material	Low N	0	Low N	Low N	Low N	Low N	Low N	0	Low N	Low N	Low N	0	0	0	Low N	0	Low N	Handling and storage of soil and/or fill material	Store topsoil prior to the commencement of construction activities, and replace topsoil on completion of construction. When laying underground cables in trenches, separate top and subsoil on opposite sides of the trench and replace in correct sequence when closing trenches. Control and contain surface water run-off. Heritage resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site
5	SE	Construction of access road	Medium N	0	Low N	Low N	Low N	Low N	Low N	0	Low N	Low N	Low N	Medium N	Low P	0	Low N	0	0	Construction of access road	Conduct activities in an environmentally responsible manner. Remove invasive alien plants by using manual clearing and herbicide painting of stumps. Control erosion downslope of culverts and build berms as well as cross mound in access road. Control and contain surface water run-off. Heritage and palaeontological resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site. Make use of existing roads where possible. Construction activities must be communicated and co-ordinated with the landowners. Demarcate construction, storage and vehicle maintenance sites, remove, store and replace topsoil on completion of construction
6	SE	Earthworks	Medium N	Low N	Low N	Low N	Low N	Low N	Low N	0	Low N	Low N	Low N	Medium N	0	0	Low N	0	0	Earthworks	Conduct activities in environmentally responsible manner. Control and contain surface water run-off. Palaeontological resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site.
7	SE	Provision and operation of on site staff facilities and activities	Low N	Low N	Low N	0	Low N	Low N	Low N	Low N	Low N	Low N	Low N	0	Low N	0	Low N	Medium N	Low N	Provision and operation of on site staff facilities and activities	Provide adequate on-site sanitation for workers. No on-site staff accommodation. Responsible siting. Good housekeeping. House construction team off-site. Limited washing facilities on-site. No fires on-site. Employ security guards. Regular removal of sewage.
8	SE	Management of vehicles, machinery & equipment	Low N	Low N	0	Low N	Low N	Low N	Low N	Low N	0	0	0	0	Low N	0	Low N	Low N	Low N	Management of vehicles, machinery & equipment	Readily available spill kits to clean up spillages. Regularly inspect road surfaces for spillages. Reporting structure must be in place to ensure that all spillages are reported. Make arrangements for regular road maintenance. Vehicles and equipment must be services regularly and maintained in good running condition. Demarcate construction, storage and vehicle maintenance sites, remove, store and replace topsoil on completion of construction. Do not permit vehicles to drive outside demarcated construction sites. Vehicles must be operated by trained operators to prevent potential accidents that may lead to spillages.
9	SE	Transportation of bulk materials on-site	Medium N	Low N	0	Low N	Low N	Low N	0	Low N	0	Low N	0	0	Low N	0	Low N	0	Low N	Transportation of bulk materials on-site	
10	SE	Handling, use and spillage of hazardous materials	Medium N	Medium N	0	0	Low N	Low N	Medium N	0	0	Low N	Low N	0	Low N	0	Low N	0	0	Handling, use and spillage of hazardous materials	Storage of hazardous substances must be limited to small quantities and done under strict industry standards. Equipment must be operated by trained operators to prevent potential accidents that may lead to spillages. Establish bunding for hydrocarbon storage tanks that has the capacity to contain 110% of the tank's volume. Readily available spill kits to clean up spillages. Regularly inspect road surfaces for spillages. Reporting structure must be in place to ensure that all spillages are reported. Herbicides and pestecides must be managed by a certified pest control officer

11	SE	Solid waste management, storage and disposal	Low N	0	0	0	Low N	0	Medium N	0	Low N	Low N	Low N	0	Low N	0	Low N	0	0	Solid waste management, storage and disposal	Store waste and building rubble at an on-site demarcated area. Provide cages to separate waste types (general, hazardous and wet waste). Vehicles transporting waste must be properly covered to prevent waste from falling off the vehicle. All waste must be disposed off at a licenced landfill facility. Prevent soil contamination due to uncontrolled waste.
12	SE	Liquid waste management	Medium N	Medium N	0	0	Low N	Low N	Medium N	Low N	0	0	Low N	0	Low N	0	Low N	Medium N	0	Liquid waste management	Minimise liquid waste generation. Regular removal of sewage by a trained operator.
13	C	Handling and storage of soil and/or fill material	Low N	0	Low N	Low N	Low N	Low N	Low N	0	Low N	Low N	Low N	0	Low N	0	Low N	0	0	Handling and storage of soil and/or fill material	Store topsoil prior to the commencement of construction activities, and replace topsoil on completion of construction. When laying underground cables in trenches, separate top and subsoil on opposite sides of the trench and replace in correct sequence when closing trenches. Control and contain surface water run-off. Heritage resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site
14	C	Establishment of stormwater drainage and other services infrastructure	Medium N	Low N	Low N	Low N	0	Low N	Low N	0	Low N	Low N	Low N	0	0	Medium P	Low N	0	0	Establishment of stormwater drainage and other services infrastructure	Conduct activities in environmentally responsible manner. Control and contain surface water run-off. Heritage resources mitigation. Regular watering (water spraying) of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site. Rehabilitate construction sites with indigenous grasses such as Digitaria eriantha, Eragrostis curvula etc. Care must be taken with soil cover during construction. Demarcate construction sites, remove, store and replace topsoil on completion of construction
15	C	Construction of PV facility	0	Low N	Low N	Low N	Low N	Medium N	Medium N	Low N	Low N	Medium N	Low N	0	Low N	High P	Low N	Medium N	Low N	Construction of PV facility	Conduct activities in an environmentally responsible manner. Care must be taken with soil cover during construction. Demarcate construction sites, remove, store and replace topsoil on completion of construction. Maintain as much natural vegetation as possible by providing adequate spacing between panels. If it is not possible to retain good plant cover during construction, other methods should be employed, including covering soil with i.e. straw, mulch, erosion control mats etc. Do not install panels in drainage feature to the east of site. Rehabilitate construction sites with indigenous grasses such as Digitaria eriantha, Eragrostis curvula etc. Control and contain surface water run-off. Control and contain soil degradation at source. Heritage resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site. All farming infrastructure, including fences, water pipelines, water troughs, etc., that are damaged or removed during construction, must be replaced as soon as possible. Construction activities must be communicated and co-ordinated with the landowners.
16	C	Construction of electrical infrastructure (inverters, concentration boxes, transformation centre, electrical reticulation, underground cabling and distribution boxes)	0	0	Low N	0	0	0	Low N	Low N	Low N	Low N	Low N	0	0	Medium P	Low N	Low N	Low N	Construction of electrical infrastructure (inverters, concentration boxes, transformation centre, electrical reticulation, underground cabling and distribution boxes)	Conduct activities in an environmentally responsible manner. When laying underground cables in trenches, separate top and subsoil on opposite sides of the trench and replace in correct sequence when closing trenches. Demarcate construction sites, remove, store and replace topsoil on completion of construction. Control and contain surface water run-off. Heritage resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site. Rehabilitate construction sites with indigenous grasses such as *Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens*
17	C	Construction of electrical connection line to the substation	0	0	Low N	Low N	0	Low N	Low N	Low N	Low N	Low N	Low N	0	Low P	Medium P	0	Low N	Low N	Construction of electrical connection line to the substation	Conduct activities in an environmentally responsible manner. Minimise vegetation clearance when erecting pylons. Minimise disturbance to koppie habitat. Minimise disturbance in corridor to the north of the railway line. Do not blast koppie or embed power line foundations in the koppie. Control and contain surface water run-off. Heritage resources mitigation. Regular watering (water spraying) of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site. Power lines should be kept low, thickest possible cabling should be used, vertically separated arrays of lines should be avoided, power lines with common sources and destinations should run in close parallel, and lines with very different heights. Rehabilitate construction sites with indigenous grasses such as Digitaria eriantha, Eragrostis curvula etc. Construction activities must be communicated and co-ordinated with the landowners.
18	C	Removal of all temporary construction structures & services after completion of construction	Low N	0	0	Low N	Low N	Low N	Low N	0	0	Low N	0	0	0	0	Low N	0	Low N	Removal of all temporary construction structures & services after completion of construction	Conduct activities in an environmentally responsible manner. Control and contain surface water run-off. Heritage resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site.
19	C	Management of vehicles, machinery & equipment	Low N	0	0	Low N	Low N	Medium N	Low N	Low N	0	Low N	Low N	0	Low N	0	Low N	0	0	Management of vehicles, machinery & equipment	Readily available spill kits to clean up spillages. Regularly inspect road surfaces for spillages. Reporting structure must be in place to ensure that all spillages are reported. Make arrangements for regular road maintenance. Vehicles and equipment must be services regularly and maintained in good running condition. Demarcate construction, storage and vehicle maintenance sites, remove, store and replace topsoil on completion of construction. Do not permit vehicles to drive outside demarcated construction sites. Vehicles must be operated by trained operators to prevent potential accidents that may lead to spillages.
20	C	Transportation of bulk materials on-site	Medium N	Low N	0	Low N	Low N	Medium N	0	0	0	Low N	0	0	Low N	0	Low N	0	Low N	Transportation of bulk materials on-site	

21	C	Handling, use and spillage of hazardous materials	Medium N	Medium N	0	0	Low N	Low N	Low N	0	0	Low N	Low N	0	Medium N	0	Low N	0	0	Handling, use and spillage of hazardous materials	Storage of hazardous substances must be limited to small quantities and done under strict industry standards. Equipment must be operated by trained operators to prevent potential accidents that may lead to spillages. Establish bunding for hydrocarbon storage tanks that has the capacity to contain 110% of the tank's volume. Readily available spill kits to clean up spillages. Regularly inspect road surfaces for spillages. Reporting structure must be in place to ensure that all spillages are reported. Herbicides and pestecides must be managed by a certified pest control officer
22	C	Solid waste management, storage and disposal	Low N	0	Low N	0	Low N	Low N	Low N	Low P	Low N	Low N	Low N	0	Low N	0	Low N	0	0	Solid waste management, storage and disposal	Store waste and building rubble at an on-site demarcated area. Provide cages to separate waste types (general, hazardous and wet waste). Vehicles transporting waste must be properly covered to prevent waste from falling off the vehicle. All waste must be disposed off at a licenced landfill facility. Prevent soil contamination due to uncontrolled waste.
23	C	Liquid waste management	Medium N	Low N	0	0	Low N	Low N	Low N	Low N	0	0	0	0	Low N	0	Low N	0	0	Liquid waste management	Minimise liquid waste generation. Regular removal of sewage by a trained operator.
24	Op	Generation of electricity - operation of PV plant	0	0	Low N	Low N	0	High P	Medium N	High P	Low N	Medium N	Medium N	0	0	High P	0	High P	0	Generation of electricity - operation of PV plant	Store waste and building rubble at an on-site demarcated area. Provide cages to separate waste types (general, hazardous and wet waste). Vehicles transporting waste must be properly covered to prevent waste from falling off the vehicle. All waste must be disposed off at a licenced landfill facility. Prevent soil contamination due to uncontrolled waste.
25	Op	Maintenance of PV Modules	0	0	0	0	0	0	0	edium	0	0	0	0	0	Medium P	0	Medium N	0	Maintenance of PV Modules	Conduct activities in environmentally responsible manner. Remove invasive alien plants from PV site twice annually by implementing manual clearing and herbicide painting of stumps. Maintain high visibility structures on power lines to prevent bird strikes. Limit surface water run-off from artificial surfaces. Limit water use to clean solar panels. Maintain at least 60% soil cover of indigenous lawn grasses (Cynodon incompletus, Eragrostis beriana) and low shrub cover through mowing or sheep grazing. Vegetation cover will control runoff water, reduce dust on panels and minimize weed invasion. Check the wildlife gates weekly for snares. Use energy lighting and water efficient technology to limit natural resource use.
26	Op	Operation of on-site facilities for operational staff	Low N	Low N	0	Low N	Low N	0	0	Low N	0	0	0	0	0	0	0	Medium N	0	Operation of on-site facilities for operational staff	Provide adequate on-site sanitation for workers. No on-site staff accommodation. Responsible siting. Good housekeeping. House construction team off-site. Limited washing facilities on-site. No fires on-site. Employ security guards. Regular removal of sewage.
27	Op	Maintenance of supporting infrastructure	0	0	0	0	0	0	0	0	0	0	0	0	0	Low P	0	0	0	Maintenance of supporting infrastructure	Conduct activities in environmentally responsible manner. Prevent spillages, clean-up, dispose & rehabilitate. Heritage resources mitigation. Limit surface water run-of. The building of additional or expanding of current infrastructure must be communicated with the EAP and/or ECO. The building of additional infrastructure must adhere to all mitigation measures applicable to the construction of the PV plant.
28	Op	Pest and invader plant control	Low N	0	0	Medium P	Medium P	0	High P	0	0	0	High P	0	High P	Low P	0	0	0	Pest and invader plant control	Conduct activities in environmentally responsible manner. Remove invasive alien plants from PV site twice annually by implementing manual clearing and herbicide painting of stumps. Only a registered PCO is allowed to apply herbicides and use pesticides on site.
29	Op	Handling and use of hazardous material	Medium N	Medium N	0	0	Low N	0	Low N	0	0	Low N	Low N	0	Low N	0	0	0	0	Handling and use of hazardous material	Storage of hazardous substances must be limited to small quantities and done under strict industry standards. Equipment must be operated by trained operators to prevent potential accidents that may lead to spillages. Establish bunding for hydrocarbon storage tanks that has the capacity to contain 110% of the tank's volume. Readily available spill kits to clean up spillages. Regularly inspect road surfaces for spillages. Reporting structure must be in place to ensure that all spillages are reported. Herbicides and pestecides must be managed by a certified pest control officer
30	Op	Waste management, storage and disposal	Low N	Low N	0	0	Low N	0	0	0	Low N	0	0	0	Low N	0	0	0	0	Waste	Store waste and building rubble at an on-site demarcated area. All waste must be disposed off at a licenced landfill facility. Prevent soil contamination due to uncontrolled waste.
31	De	Removal of structures (buildings, PV panels, power lines etc.)	Low N	Low N	Low N	Low N	0	Medium N	Low N	0	0	Low N	Low N	0	Low N	Medium P	0	Medium N	Low N	Removal of structures (buildings, PV panels, power lines etc.)	Conduct activities in environmentally responsible manner. Remove all anthropogenic materials (iron, cement, plastic, glass, rubber) from PV site and dispose of them at an official landfill facility. Rehabilitate any bare soil areas by ripping compacted surfaces and planting sods or seeds of indigenous grass species that naturally occur/occurred on site. Control and contain surface water run-off. Heritage resources mitigation. Regular watering of exposed surfaces for dust control. Limit activities to normal working hours. Limit disturbance to the construction site.
32	De	Replanting of indigenous vegetation	Low N	0	High P	Low N	Low N	Low P	High P	Low N	Medium P	High P	High P	0	High P	0	0	Medium N	0	Replanting of indigenous vegetation	Rehabilitate construction sites by establishing it with indigenous grasses like Digitaria eriantha, Eragrostis curvula, Cenhrus ciliaris, Anthephora pubescens. Watering of revegetated areas should only occur if necessary.
33	De	Waste management, storage and disposal	Low N	Low N	0	0	Low N	Low N	Low N	0	Low N	0	Low N	0	Low N	0	Low N	0	0	Waste management, storage and disposal	Store waste and building rubble at an on-site demarcated area. All waste must be disposed off at a licenced landfill facility. Prevent soil contamination due to uncontrolled waste.

7 OPEN SPACE AND VELD FIRE MANAGEMENT PLAN

Veld fires are natural phenomena that have been part of life for millions of years, especially on the African continent. Veld fires may occur frequently, move quickly, be intense, and can cause significant environmental degradation and property damage. We can use veld fire to manage grazing and habitats and also to help prevent uncontrolled veld fires. Uncontrolled or unscheduled veld fires are a risk to life, property and the environment.

All public and private landowners and managers in South Africa have legislated responsibilities regarding veld fire management and fire fighting. Most of these responsibilities arise from the National Veld and Forest Fire Act 101 of 1998.

This open space and veld fire management plan should be closely aligned with the erosion and alien invasive plant management plans, as they are inextricably linked.

7.1 Purpose, scope and limitations

This plan aims to protect persons and property on or in the vicinity of the proposed solar facility from veld fires and to comply with legislation. It integrates the legal responsibilities arising from relevant veld fire management legislation with general advice, to help land owners and managers forming an overall picture of what is needed to achieve veld fire safety on rural properties (outside urban areas). It is designed to be used for a number of purposes, such as veld fire management planning, as information tool to improve general community knowledge about veld fire management and as training tool to facilitate improved veld fire management and fire fighting.

The plan focuses on:

- Providing landowners and residents with basic information about veld fire management for their safety and awareness;
- Preventing (undesired) uncontrolled veld fires;
- Controlling (fighting) uncontrolled veld fires; as well as
- Implementing monitoring and reporting of veld fires (for management purposes);

This plan provides general advice that may therefore not be relevant in all circumstances. Consequently, land owners and managers are encouraged to seek additional expert advice about veld fire management on their property where required.

The risk of veld fires be can minimised to achieve improved personal and community safety, protect assets including the environment, and meet legal requirements by addressing the following objectives and guidelines:

7.2 Objective 1: Plan for and undertake veld fire safety, as well as asset protection and recovery activities, with safety as a priority

All individuals have a responsibility for their own personal fire safety, while land owners and managers have an additional responsibility for the safety of all people living or working on or visiting their properties. When planning and undertaking veld fire management, landowners and managers are advised to:

- consider safety, practical, environmental and legal issues and the long-term sustainability of the property, with safety as a priority;

- take into account that it may not be possible to protect all assets from veld fires or have fire fighting services available in all circumstances;
- consult and work with adjacent public and private landowners, managers and users, where practical, to achieve veld fire safety benefits for all properties.

7.3 Objective 2: Take reasonable steps to prevent unplanned fires starting

- All individuals and authorities have a responsibility to minimise the risk that they may start an unplanned veld fire, particularly when they are operating machinery, vehicles and equipment or using fire.
- Landowners and managers must consider veld fire risk before engaging in construction or maintenance activities, such as grinding and welding, slashing and mowing or driving vehicles and motorbikes through dry grass or bush. They must consider avoiding these activities at times of extreme fire danger.
- Landowners and managers also have a responsibility to ensure that power lines and facilities (such as electric fencing, overhead power lines for electricity distribution etc.) will not start a veld fire.

7.4 Objective 3: Take reasonable steps to limit the spread of unplanned fire

- During periods of high fire danger, landowners and managers have a responsibility to extinguish unplanned veld fires on their property and to report such fires, if it appears that they will be unable to extinguish it.
- Anyone finding a veld fire burning in periods of high fire danger must report it to Fire Protection Association and adjacent land owners as soon as possible.
- Landowners and managers are required by law to:
    - have fire breaks on their properties and to implement fire prevention works as set specified;
    - have personnel that have been trained in fire fighting, with appropriate protective clothing and fire fighting equipment to fight veld fires;
    - nominate somebody that could in their absence from the property extinguish any veld fires or alert the neighbours and other relevant parties, if it appears that they will be unable to extinguish any veld fire.

7.5 Objective 4: Take reasonable steps to provide access to their property, assets and to water for fire fighting purposes

Landowners and managers are obliged to provide access to their property, assets and water for veld fire fighting purposes. They must provide this access under all circumstance.

7.6 Objective 5: Participate in community-based groups to minimise the impact of fire

People living and working in the area are encouraged to join the local FPA and other community groups to help improve veld fire safety on their properties and in their community.

7.7 Background

This section provides general information that may be useful when considering and planning veld fire management.

7.7.1 General understanding of veld fire behaviour

In the context of the plan, veld fire management focuses on fire protection.

- Fire behaviour refers to how fire spreads and burns given differences in fuel, weather and topography.
- Fire intensity is a useful means of comparing veld fires in the same fuel type, but should not be used to compare fuels in different fuel types. Different fuel bed structures can result in vastly different veld fire behaviours for the same fire intensity value.
- Flame height is an indicator of fire intensity - in general the longer the length of the flame the greater the fire intensity.
- Fire danger is the combination of all the factors that determine whether a veld fire starts, spreads and does damage and whether and to what extent veld fires can be brought under control (see Table 1).

7.7.2 The Anatomy of a Fire

(Goldammer, 2004)

Concept	Meaning
Head	The front section of the fire spread, usually moving with the wind and often the source of the most damage. Usually the head of the fire should be stopped first
Fire Line	Where direct action to containing the fire takes place
Origin	The place the fire started
Rear	The part of the fire backing against the wind
Flanks	Left and right side of the fire with head in front, origin behind
Fingers	Usually on the head and the flanks; long narrow strips extending out from the fire. Usually occurs when area has light and heavy fuels causing different burn speeds.
Pockets	Dents in the fire edge formed by fingers or slow burning areas. Usually build a fire line across the mouth the pocket and allow the pocket to burn out. Avoid

Concept	Meaning
	sending people into the pocket as that places them at risk.
Island	An area within the burn that is intact e.g. wetland, sparse vegetation
Perimeter	Outside boundary of the fire area

7.7.3 Predicting veld fire behaviour

The ability to predict veld fire behaviour is vital in the planning of veld fire fighting.

- **General behaviour:**

  In general, veld fires:
  - spread faster uphill than downhill;
  - spread with the wind rather than against it;
  - spread faster where the vegetation contains quantities of dead plant material;
  - spread faster in fine fuels;
  - spread faster where the vegetation canopy is intertwined;

  Doubling the fuel load will double the rate of spread, resulting in the intensity of the veld fire increasing four fold, while halving the fuel load will decrease the rate of spread four fold.

- **Veld fire behaviour "watch out" situations for fire fighters**

  Be careful -
  - when working downwind of a veld fire;
  - when working up-slope of a veld fire;
  - when fighting a veld fire on a slope;
  - when working near heavy fuels, or where there is un-burnt fuel between you and the veld fire.

  Remember that difficult terrain or vegetation impedes human travel.

7.7.4 Spread of Fire

Fire spreads in three main ways:
- direct flame contact,
- heat transfer, and
- from embers.

- **Table 1: Expected veld fire behaviour, suppression difficulty, and recommended and prescribed actions for different fire danger rating levels.**

Fire danger rating	Insignificant (blue)	Low (green)	Moderate (yellow)	High (orange)	Extremely high (red)
Fire behaviour	Veld fires are not likely to ignite but if they do, they are likely to go out without suppression action. There is little flaming combustion. Flame lengths generally lower than 0.5 metre. Rates of forward spread less than 2 metres per minute.	Veld fires likely to ignite readily but spread slowly. Flame lengths generally lower than 1.2 metres. Rates of forward spread less than 5 metres per minute.	Veld fires ignite readily and spread rapidly. Flame lengths between 1.2 and 2 m metres. Rates of forward spread between 5 and 25 metres per minute.	Veld fires ignited readily and spread very rapidly, Local crowning and short-range spotting. Flame lengths between 2 and 5 metres. Rates of forward spread between 25 and 35 metres per minute.	Conflagrations are likely in fynbos, stands of alien invasive trees and plantation forests together with long range fire spotting. Flame lengths between 5 and 15 metres or more. Rates of forward spread of head fires can exceed 60 metres per minute.
Fire suppression difficulty	Veld fires easily approached and suppressed using hand tools.	Veld fires can safely be approached on foot and suppression is readily achieved by direct manual attack methods.	Direct attack constrained as veld fires are not safe to approach on foot for more than very short periods. Back burning from fire control lines can be undertaken if prevailing conditions are safe.	Serious control problems where direct attack is not always feasible. Control through a combination of direct attack and indirect measures, such as aerial water bombing. Back burning should only be used after careful consideration.	Any form of fire control is likely to be precluded until weather conditions become more favourable. Fire-fighting equipment should be used to protect properties on the urban edge. Back burning is dangerous and should be avoided.
Recommended actions	None	None, other than prudent care to ensure that any open-air fires do not escape. Prescribed burning	Open-air fires should only be permitted in authorised fireplaces. Prescribed burning should be conducted with care, and any prescribed veld fires should	All efforts should be made to bring any veld fires under control. Areas should be put on standby for evacuation in the event of a veld fire, should	Dangerous areas to be evacuated in the event of a veld fire. Equipment such as water tankers should concentrate efforts on the protection of

Fire danger rating	Insignificant (blue)	Low (green)	Moderate (yellow)	High (orange)	Extremely high (red)
		permissible.	be extinguished should the forecast fire danger-rating become high.	the fire danger conditions be forecast become worse.	houses and other structures.
Prescribed actions	None	None	Any wildfires should be extinguished.	No outdoor fires permitted.	No outdoor fires permitted.

Heat is transferred through hot air currents and as radiant heat. The impact of radiant heat is also important when considering how fire spreads. Radiant heat can preheat un-burnt material so that ignition by embers or flames is easier, especially with a plant like camphor bush (Tarchonanthus camphoratus) that are common on the Ghaap Plateau. The amount of radiant heat people or objects receive varies with distance from the fire. If this distance is halved the amount of heat received will increase by approximately four times.

The role of embers is sometimes underestimated in the spread of fire. Embers can be carried forward by wind and air currents. These start new spot fires well ahead of the main fire front (spotting). Embers can easily carry fire across a fire break. Embers can also land on fine fuels, such as leaf litter near buildings, and start small fires that can grow and ignite heavier building materials. Indeed, most houses that burn down during a fire ignite from ember attack.

Trees, shrubs and tall grasses can produce embers and should be considered when planning fire management. Some trees and shrubs with fibrous bark, such as blue gum and pine trees (if crowning), may cause significant short-distance spotting, while trees with ribbons of bark may cause long-distance spotting under some circumstances.

7.7.5 Veld fire behaviour

Veld fire behaviour is influenced by three main factors, i.e. fuel, weather and topography. Consideration of these factors is important when considering veld fire management, as small variations in any of these factors can lead to significant changes in veld fire behaviour.

7.7.5.1 Fuel

Fire can occur in any type of vegetation, such as grasslands, trees, crops or shrubs. Knowledge of fuels is fundamental to understanding veld fire behaviour. How hot a fire burns and how quickly it spreads depend on the size, quantity, type, arrangement and moisture content of the fuel being burnt.

- ***Fuel type and arrangement***

  Fuel type refers to the source of the fuel, e.g. grasslands, savannah, plantations. The arrangement of the fuel will affect the probability of ignition and subsequent rate of spread.

- ***Fuel load***

  The fuel load is the quantity of fuel per unit area, commonly expressed as tonnes per hectare. Increases in the amount of fuel influences rate of spread, rate of energy release and flame lengths. Reducing fuel loads can help to protect assets from fire and make fires easier to suppress.

- ***Fuel size***

  Fine fuels (less than 6 mm in diameter), such as leaves, twigs, grass and bark, dry out rapidly and burn quickly. Because fine fuels burn easily, they contribute most to the heat of a fire front. Consequently, it is important to minimise the quantities of fine fuels near key assets to minimise the risk of radiant heat and direct flame contact.

Heavier fuels like branches and logs (greater than 25 mm in diameter) can also provide fuel for fires. Although they are slower to ignite than fine fuels, give off heat more slowly and therefore do not contribute to the heat of the initial fire front, they do need to be put out after the fire front has passed to prevent them being a continuing source of fire.

- ***Fuel moisture content***

  The moisture content of fuels affects ease of combustion, combustion rates, rate of spread, radiation efficiency of flames and probability of spotting. These factors together affect the difficulty of veld fire suppression.

7.7.5.2 Weather

Weather is a major factor in the ignition and spread of fire. Weather factors that have a major influence on veld fire behaviour include temperature, relative humidity, wind speed and wind direction. Preparing for common weather patterns, as well as unusual weather events, will assist landowners to minimise fire risk.

7.7.5.2.1 Weather and veld fire behaviour in general:

Strong and gusty, hot, dry winds generally favour the spread of veld fires.

Under unstable atmospheric conditions:

- Veld fires will develop strong convection columns
- Longer spotting distances may occur
- Winds tend to be gusty which make veld fire behaviour erratic
- Thunderstorms may develop and the resultant lightning could start more veld fires

7.7.5.2.2 Temperature and humidity

Temperature and humidity impact on fire fuels, especially fine fuels, which more rapidly gain and lose moisture than heavy fuels. The higher the air temperature and the lower the humidity the more easily fuel will burn.

7.7.5.2.3 Wind speed

Wind influences fire behaviour significantly. As wind becomes stronger, a fire can burn hotter because the wind makes the flames lean forward, increasing flame contact with dry fuel. This makes the fire spread faster.

7.7.5.2.4 Wind direction

On the Ghaap Plateau, in the area of the proposed PV facility, hot dry winds often come from the north and northwest and are often followed by a easterly and south-easterly wind changes. In this situation the side of the fire can quickly become a much larger fire front (head of the fire). Given these common wind patterns, it is often important to give priority to fire management on the northern and western sides of your property and assets. However, as fire can come from any direction, preparation for fire is still needed for the whole property.

7.7.5.2.5 Drought conditions

When planning fire management, consider the impact of drought and dry conditions. While grass paddocks tend to be heavily grazed in these situations, fire management still needs to be undertaken as fire can still travel across paddocks with very short grass.

During very dry conditions trees often shed leaves and the leaf litter dries out, increasing the amount of fuel available to burn in timbered areas, including plantations. Dry soil conditions associated with drought also increase the chance of tree roots igniting. These fires are difficult to suppress.

7.7.5.3 Topography

The shape of the land needs to be considered when planning fire management. Fire travels faster upslope than down-slope because when it is moving upslope the flames are closer to the un-burnt fuel. This preheats the fuels, making them easier to ignite. The rate of fire spread upslope approximately doubles for every 10 degrees of slope. Consequently, greater distances may be required between key assets and vegetation when building on a slope.

Aspect is the direction that a feature, such as a building or slope, faces. Northern and westerly aspects usually receive more sun and will therefore usually be warmer and drier and tend to burn more easily than other aspects.

Topography can also influence how the wind behaves. As wind passes over an object, such as a hill or windbreak, the wind can tumble, creating turbulence. Wind turbulence produces erratic winds, causing unpredictable fire behaviour.

Valleys and gullies can channel and strengthen winds, increasing the rate of spread of a fire and its intensity. Be aware of local wind conditions. New landowners should ask neighbours and previous owners about local winds when planning fi re management on their property.

7.7.6 General understanding of fire fighting measures

7.7.6.1 Techniques for controlling veld fires

Bringing a fire under control requires the fuel is removed, or the fire to be cooled. But, those steps are taken by people, and therefore managing those people is part of fire control. Team leaders and team members will find it useful to share an understanding of terms.

7.7.6.2 Direct Action

Direct action is used when the fire is small, and is burning in an area of light fuel e.g. short grass.

The advantages are –

- You can escape danger by moving onto the burnt area
- You are limiting the momentum and size of the fire, and therefore the damage

Disadvantages include –

- You are working in the heat and the smoke
- The risk of spot fires increases
- The line which is being controlled tends to be long and irregular. Changes in wind direction are more difficult to deal with on an irregular line
- The action may not take advantage of fire barriers (man-made or natural)

What to do –

- Take advantage of the wind dropping to knock back hot spots
- Use water (if available) to cool the flames so that fighters can get close to the fire
- Avoid the head of a fast-moving fire
- Always start working from an anchor point (a natural barrier or a point already burnt)
- The team should work together in a line from the anchor point
- If you tired or feel physically stressed, step out of the line so that others know to fill the gap. When you feel revived, join the end of the line
- The arrangement is ideally to allow for water to damp down the flame, the beater to extinguish the flame, and another water sprayer to follow to make sure no embers or smouldering clumps remain

7.7.6.3 Indirect Action

This action is usually taken parallel to the head of the fire, but some distance away. The intention is to deprive the fire of fuel, and consequently stop the advance. Use this approach when the rate of spread, the terrain, the smoke and heat are too great to work directly at the fire edge. This is also when you make use of your natural or man-made fire breaks to greatest effect.

The advantages are –

- You are avoiding the worst of the heat and the smoke
- You can reduce the irregularity of the fire line (keep it straight)
- You can make use of natural or man-made features
- Allows you to work better as a team

Disadvantages include –

- You may sacrifice more area to the fire
- It can be a dangerous approach as you can be flanked or outrun by the fire
- This second fire you have started can get out of control

What to do –

- Always start working from an anchor point
- Keep the fire line as close as possible to the fire’s edge
- Keep the fire line short
- Avoid sharp angles
- Always “anchor” fire lines to existing barriers or extinguished parts of the fire border
- Take great care when working on slopes. Set up communication with someone who is able to see both the fire and the work area. Make certain the team can reach safety quickly if needed (fires burning up a slope move more quickly).

7.7.6.4 Back-burns

This technique is generally a “last resort” and is an aggressive response to the fire. Back-burns deliberately set fire along the inner edge of the fire line toward a fire, with the expectation that it will be pulled to the oncoming fire and burn the vegetation between.

The keys to a successful back-burn are –

- Leadership of an experienced fire fighter – never even consider this option in the absence of an experienced fire fighter;
- Once the back-burn is started, it is imperative that all vegetation between the approaching fire and the back-burn is burned;
- A back-burn must be as close as possible to the approaching fire, taking into account the time it will take to prepare the burn, and the speed of the approaching fire;
- There should be a large team to hold the fire, and the size of the back-burn should be determined by the number of people able to control it (it should never be bigger than can be controlled).

7.7.6.5 Protecting the environment

To help secure the long-term sustainability of a property, all fire management planning needs to include consideration of environmental issues as well. Protecting and improving the environment is an important part of sound fire management planning. Care needs to be taken to ensure that fire management consider how to protect the property from environmental damage and promote environmental assets, such as indigenous vegetation and does not cause unintended consequences such as a loss of vegetation, wildlife and scenic quality, weed invasion, erosion and water quality problems.

Looking after the environment when undertaking veld fire management includes:

- identifying environmental assets (air, water, land and vegetation) that require protection from fire and how they might be affected by fire and fire management activities. This may include such areas as waterways, habitat for indigenous fauna, and revegetation sites;;
- avoiding environmental harm. Ensure that fire management actions do not result in large areas of bare ground that may cause erosion and encourage the growth of weeds
- minimising harm where it cannot be avoided. Remove weeds that have high fuel loads for fire safety and environmental benefits; and
- repairing environmental harm if it occurs. where necessary, rehabilitate areas as soon as possible after a fire.

7.7.7 Interaction with community groups

While personal fire safety is an individual responsibility, fire safety is also an important community issue.

7.7.7.1 FPA

People living and working in rural areas are encouraged to join FPA to help improve fire safety on their property and in their community. Opportunities to discuss local fire issues, including fire safety and fire management of public land, are provided by FPA and DAFF through a joint program called Working on Fire.

7.7.7.2 Other community groups

Other groups, such as local community, farm groups, and landowner associations will often provide opportunities for local communities to work together to improve fire management as part of caring for their local area. Other non-government organisations and wildlife rescue groups can provide opportunities for people to work together to help communities recover from the effects of fire.

7.8 Legal context

The following is an interpretation of the law and not a legal opinion.

It is clear that both the outbreak of veld fires and the use of fire as a management tool can pose significant risks. The owners of a PV solar facility can incur legal liability in a variety of ways, including:

- civil liability to compensate for damage caused as a result of the failure to take reasonable measures to prevent the spread of a fire from that facility (under the common law);
- criminal liability under different statutes (e.g. for failure to take adequate precautionary measures as required by the National Veld and Forest Fire Act);
- liability for the costs of rehabilitating environments degraded by fire as a result of a failure to take reasonable measures as required by section 28 of National Environmental Management Act or in the case of an (emergency) incident contemplated in section 30 of that Act; and
- contractual liability under any reciprocal support agreements entered into with local authorities (e.g. for the costs of using the local authorities' fire-fighting services).

7.8.1 The National Veld and Forest Fire Act 101 of 1998

The purpose of the National Veld and Forest Fire Act (No. 101 of 1998) (NVFFA), as amended, is to prevent and combat veld, forest and mountain fires throughout South Africa. The Act applies to all the open countryside beyond the urban limits and puts in place a range of legal requirements. It introduces some important innovations that fill the gaps between diverse statutes affecting veld fire management.

Although the NVFFA's principal aim is the regulation of veld fires, it also has a role to play in veld fire management generally. This is because it aims to control the spread of veld fires by imposing obligations on landowners to prepare and maintain firebreaks. The NVFFA thus applies both to preventing the spread of a veld fire through good management or operational practices, and to extinguishing veld fires through procedure set out in the Act.

The Act provides explicitly for compliance with environmental requirements, as well as for the management of risk to life and property. It is not an emergency services law, but links natural resource management by property owners collectively or individually to the integrated veld fire management system.

7.8.2 The responsibilities of people who own or control land

The landowner on whose land a fire may start, or from whose land it may spread across boundaries, must have in place:

- Fire breaks on their own side of any boundary, if there is a reasonable risk of fire.
- such equipment, protective clothing and trained personnel required to extinguishing such fire as may occur as prescribed in the FPA regulations. If there are no regulations applicable, then as reasonably required in the circumstances.
- Take all reasonable steps to notify the Fire Protection Officer (**FPO**) of the local FPA should a fire break out.
- Do everything in their reasonable power to stop the spread of the fire.

The Act also requires that should the owner be absent, a known and identified other person responsible needs to be present on or near this land to:

- Extinguish a fire if one breaks out, or assist or instruct others to do so
- Take all reasonable steps to alert the neighbours and the FPO.
- The owner may appoint an agent to act on his or her behalf to perform these duties.

7.8.3 Fire Danger Rating

The NVFFA requires the Minister to prepare and maintain a fire danger rating system for the entire country, and to communicate the rating to the FPAs in the region. The Minister has developed and published proposed five fire danger rating classes (Table 2).

The Minister must also publish warnings, in print and media, when the fire danger rating is high in any region. When a warning has been published, no person may light, use or maintain a fire in the open air in the region where the fire danger is high.

Table 2: Five fire danger rating classes proposed to by the Department of Water Affairs and Forestry to meet the requirements of Chapter 3 of the National Veld and Forest Fire Act, Sections 9(4)(c) and 9(4)(d).

Fire danger rating	Insignificant (blue)	Low (green)	Moderate (yellow)	High (orange)	High – extreme (red)
Fire prevention and preparedness measures	No precautions are needed.	Fires including prescribed burns may be lit, used or maintained in the open air on condition that persons making such fires take reasonable precautions against their spreading. Keep a watch out for unexpected changes in wind speed and direction.	No fires may be allowed in the open air except in designated fireplaces, if authorised by the Fire Protection Officer where a Fire Protection Association exists, or elsewhere by the Chief Fire Officer of the local fire service. Extreme caution should be taken when prescribed burning is done.	No fires may be allowed under any circumstances in the open air. Fire Protection Associations and Municipal Disaster Management Centres must invoke contingency fire emergency and disaster management plans.	No fires may be allowed under any circumstances in the open air. All operations likely to ignite fires must be halted and householders placed on alert. Fire Protection Associations and municipal Disaster Management Centres must invoke contingency fire emergency and disaster management plans, including extraordinary readiness and response plans.
Application of the NVFFA (101 of 1998)			Above precautionary measures to be prescribed and made applicable nationally on days rated moderate.	Section 10(1)(b) of the Act applies: no person may light, use or maintain a fire in the open air.	
Relationship with disaster management				The threat of disastrous veld fires exists at municipal level under these conditions. Municipal Disaster Management Centres must invoke contingency plans and inform the Provincial Disaster Management Centre. (Section 49 of the	

Fire danger rating	Insignificant (blue)	Low (green)	Moderate (yellow)	High (orange)	High – extreme (red)
				Disaster Management Act, 57 of 2002).	

7.8.4 Veld fire Prevention through Firebreaks

One of the requirements of the NVFFA is that landowners and users have adequate perimeter fire breaks. Section 12 of the NVFFA requires every owner on whose land veld fire may start, or burn, or may spread to prepare and maintain a firebreak on his/her side of the boundary between his/her land and adjoining land. It is important that adjacent landowners, both public and private, share responsibility and costs for preparation of breaks as provided for in the NVFFA.

Section 12 of the act allows landowners to agree among themselves where to position a common fire break. Owners of adjoining land may agree to position a common firebreak away from the boundary. This stipulation is useful as some portions are too small to have effective firebreaks without covering the majority or all of the property.

Section 12 furthermore stipulates that if fire breaks are to be prepared by burning, neighbours must determine a mutually agreeable date or dates for burning of fire breaks and inform the fire protection association, if any. However, an owner may not burn a fire break if: -

- a fire protection association objects;
- a warning has been published;
- the conditions are not conducive to burning.

Section 13 of the act stipulates that owners must ensure that a firebreak, with due regard to the weather, climate, terrain and vegetation of the area: -

- is wide enough and long enough to have a reasonable chance of preventing a veld fire from spreading to or from neighbouring land;
- does not cause soil erosion; and
- is reasonably free of flammable material capable of carrying a veld fire across it.

Section 15 of the NVFFA allows the Minister to exempt any owner or group of owners from the duty to prepare and maintain a firebreak for good reason.

7.8.5 Fire Fighting

Section 17 of the NVFFA stipulates that every owner on whose land a veld fire may start or burn or from whose land it may spread, must

- have such equipment, protective clothing and trained personnel for extinguishing fires.
- ensure that in his absence responsible persons are present on or near his or her land.

Section 5 of the act requires FPAs to inform their members of equipment and technology available for preventing and fighting veld fires.

Section 18 of the NVFFA requires any owner, who has reason to believe that a fire on his or her land or the land of an adjoining owner may endanger life, property or the environment, to immediately notify the fire protection officer, as well as the owners of adjoining land. In addition, such owner must also do everything in his/her power to stop the spread of the fire.

In terms of section 18 of the act, every able-bodied person present is obliged to assist in fighting a runaway veld fire, if called upon by the FPO, or an executive member of the FPA.

7.9 Fire Protection Associations (FPAs)

Owners may form a Fire Protection Association for the purpose of predicting, preventing, managing and extinguishing veld and forest fires and apply for its registration as a fire protection association in terms of the Act.

A fire protection association may be formed in any area that has regular veld fires; a relatively uniform risk of veld fire; relatively uniform climatic conditions; and relatively uniform types of forest or vegetation.

Benefits of a fire Protection Association include: -

- Saving costs by avoiding duplication of work;
- Enforceable rules of FPA protect members;
- Information and knowledge sharing between members;
- Free access to research commissioned by Minister;
- Possible exemption from preparing (individual property boundary) firebreaks;
- Possibility of receiving financial assistance.

7.9.1 General conditions of a FPA

- An application for registration as a Fire Protection Association (FPA), together with the FPA's Constitution, must be made in the prescribed manner to the Minister, and if successful it will be issued with a registration certificate.
- Only one fire protection association may be registered in respect of an area.
- All owners in an area for which a fire protection association has been registered have a right to join, provided they undertake to abide by its constitution and rules.
- Municipalities falling within the area of a fire protection association must join the association.
- The owners in respect of State land must join any fire protection association registered in the area in which the land lies.
- A fire protection association must elect a fire protection officer.
- Where a municipality is member and has a service, or where a designated service is a member, the chief fire officer is the fire protection officer.
- A fire protection officer may delegate his or her powers in terms of the Act, except the powers of arrest, search and seizure.
- The Minister may give a loan, grant or other assistance to a FPA or a landowner in certain circumstances.

7.9.2 Duties of a FPA

A fire protection association must at least: -

- Develop and apply a Veld fire Management Strategy for its area.
- Provide in the strategy for agreed mechanisms for the co-ordination of actions with adjoining fire protection associations.
- Make Rules, which bind its members to specific fire principles.
- Identify the Ecological Conditions that affect the Fire Danger.
- Regularly communicate the Fire Danger Rating (referred to in sections 9 and 10 of the Act) to its members.

- Organize and train its members in fire fighting, management and prevention.
- Inform its members of equipment and technology available for preventing and fighting veld fires.
- Provide management services, training and support for communities in their efforts to manage and control veld fires.
- Supply the Minister at least once every 12 months with statistics about veld fires in its area.
- Furnish any information requested by the Minister in order to prepare or maintain the fire danger rating system.
- Exercise the powers and perform the duties delegated to it by the Minister.
- Appoint a Fire Protection Officer (FPO), [unless there is a chief fire officer as contemplated in section 6(2)(a) who is willing to assume the powers and duties of a fire protection officer].

7.9.3 Presumption of Negligence

According to section 34 of the NVFFA, if a person who brings civil proceedings proves that he or she suffered loss from a veld fire which the defendant caused; or that started on or spread from land owned by the defendant, the defendant is presumed to have been negligent in relation to the veld fire until the contrary is proved, unless the defendant is a member of a fire protection association in the area where the fire occurred.

This presumption, however, does not exempt the plaintiff from the onus of proving that any act or omission by the defendant was wrongful.

7.10 Occupational Health & Safety Act (No. 85 of 1993) (OHSA)

A well-trained and practiced veld and mountain fire-fighting force is an essential component of any veld fire management operation.

The OHSA specifies that employees need to provide and maintain a safe working environment for their staff. Section 8 of the act requires every employer to provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of its employees. This includes the provision and maintenance of systems of work, plant and machinery that, as far as is reasonably practicable, are safe and without risks to health.

Section 13 of the act imposes a duty on employees to ensure that their employees are informed of the hazards related to their job function and the general duties to be performed at work. It stipulates that every employer has the duty to, as far as is reasonably practicable, cause every employee to be made conversant with the hazards to his health and safety attached to any work which he has to perform, any article or substance which he has to produce, process, use, handle, store or transport and any plant or machinery which he is required or permitted to use, as well as with the precautionary measures which should be taken and observed with respect to those hazards.

Section 14 of the act requires employees at work to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions; and to

co-operate with such employer or person to enable that duty or requirement to be performed or complied with.

7.11 Generic management measures

7.11.1 Awareness

It is estimated that as many as 90% of fires are started by people. It is therefore imperative that staff are educated about veld fire risk and management. Staff, visitors and neighbours must be must be made aware of the fire hazards and fire mitigation measures required at the site, using a variety of simple media (print, training, demonstrations, posters and notice boards).

The site security and maintenance staff must play an active role as a fire detection system and also be made aware of veld fire management response protocols. Information must be disseminated and annual fire drills undertaken to facilitate implementation of the procedure.

They must also be adequately informed about how to respond with regard to fire management and fire fighting. Regular training drills are necessary to ensure all those on the estate are aware of what their role is and able to response appropriately.

7.11.2 Veld fire prevention

Every landowner must take applicable precautionary actions, and in particular around their homes or infrastructure. Actions taken to secure property and natural assets in anticipation of a fire are called pre-suppression actions.

7.11.3 Pre-Suppression actions

7.11.3.1 Around the facility

- Trim vegetation / veld grass up to 30 meters from infrastructure;
- Remove dead and dry plants, trees, shrubs, excess leaves, plant parts, and low hanging branches around structures and infrastructure;
- Create fire safe zones using roads;
- Ensure that all electrical installations and appliances are correctly wired.
- Store flammable Liquids in manufactured metal containers specifically manufactured for that purpose;
- Provide sufficient fire fighting and supplementary equipment;
- Ensure all fire fighting equipment is regularly checked, serviced and in working order.
- When working with power tools, work in a cleared ventilated area (e.g. angle grinders, welders).
- When working on the site with power tools, (e.g. repairing or installing electrical fences, etc.) ensure the workmen have fire beaters at hand, and know how to beat down a fire).
- Keep a large area around buildings clear of combustible material, i.e. firewood, garbage.

- Prohibit fires for burning refuse and ensure that solid waste is removed from the site and disposed of at a properly operated landfill site.

7.11.3.2 In the general area

- Ensure a well-maintained road network for quick access
- Signpost access roads and have clear identification of property/portion number
- Create and maintain adequate fire breaks to provide fire fighters access and an opportunity to control a wild fire. Firebreaks need to be well positioned and regularly maintained to be effective.
    - Make firebreaks in good time
    - Use brush-cut breaks extensively, because the preparation of breaks by burning is a hazardous operation that has often been the source of wildfire.
    - Maintain costs at a reasonable level without jeopardizing good veld fire management and protection.
    - Use existing features of the landscape where possible, such as cliffs, sand dunes, tracks and roads as control lines.
- Form a fire response team for the facility.
- Appoint a responsible person for the area, who is tasked to receive all reports of fire and coordinate responses.
- Ensure workers are fully equipped and regularly trained.
- Hold regular training drills for emergency fire response.

7.11.4 Response planning

Landowners and managers must have a fire response plan for their properties and facilities. This must include the following

- Procedure for reporting clearly and accurately the status and response needs
- Dedicated response team with adequate and appropriate equipment
- Transport for the team to deploy rapidly
- Good communication system to mobilise support
- Immediate communication with Fire Chief
- Coordination of fire fighting on the ground (including communication)
- Monitoring for flanking, fresh fire fronts and re-ignition

7.12 Minimising the risk of fire to site developments

Research has conclusively found that the dominant mechanism of ignition of infrastructure is airborne embers entering buildings or landing on vulnerable parts of buildings. Fire management and mitigation should therefore focus on minimising the ability of swirling embers to ignite the site infrastructure or the surrounding areas.

The following key principles should therefore be taken into account:

- Minimise fuel loads around the site;
- Create fire breaks and fire buffer zones around the site.

7.12.1 Minimising Fuel Load

Indigenous vegetation (trees, grasses and shrubs) is an important asset on all properties. Management of vegetation on the property can have fire safety and environmental benefits.

Protect assets by reducing fuel loads around house blocks and sheds. Protect fences from radiant heat and direct flame contact by keeping them free of vegetation and weeds.

This can be done by:

- keeping dense stands of shrubs away from the inner zone, which is 10 m around buildings;
- using low fire fuel options, such as green lawns, paving and pebble mulch near buildings;
- consider having clumps of vegetation rather than continuous vegetation; and
- designing vegetation layout near buildings so that fire is not funnelled towards key assets.

Where indigenous vegetation needs to be managed or removed for fire safety reasons, a permit is required to remove or destroy large areas of indigenous vegetation in accordance with legislation. Such permission is, however, not required to remove or destroy small areas of indigenous vegetation

7.12.2 Create fire breaks and fire buffer zones

Create an open space around all the buildings - often called the defensible zone or asset protection zone - to act as a firebreak. The ideal space is 15 metres, although a minimum of six metres must be used. This space must be kept free of all flammable plants and fuels, bushy and tall vegetation and trees.

The use of fire breaks is an important part of veld fire management on rural properties and a requirement in terms of the National Veld & Forest Fire Act (No. 101 of 1998). Fire breaks are any natural or constructed breaks in fuel used to stop or control the spread of fire. There are different types of fire breaks. An understanding of the likelihood of a fire break being effective is an important part of planning fire management.

Maintain a 5m firebreak around the perimeter of the PV solar facility. This may be brushcut, but must be kept clear of any readily combustible material.

7.12.2.1 Types of fire breaks

7.12.2.1.1 Bare earth breaks

Bare earth breaks:

- may stop a fire under low fire danger conditions without anyone being present to fight the fire;
- can be ploughed, graded, burnt and/or sprayed to ensure they are clear of fuel;
- will behave more like slashed breaks if there is some fuel left on the surface;
- are less effective if nearby trees are producing embers that can be blown across the break; and
- may require a permit if they remove native vegetation.

7.12.2.1.2 Slashing and mowing

Slashing and mowing are common ways to reduce fire hazards. The rate of fire spread in dry slashed grass is about the same as in dry standing grass. However, the flame height is approximately halved in the slashed grass, making a fire in slashed grass slightly easier to control. However, slashed grass do not on their own constitute effective fire breaks. Fire will often move across slashed or mown breaks, unless someone actively puts it out.

7.12.2.1.3 Herbicide use

Herbicides can be used to prepare fire breaks. These could be bare earth breaks or a breaks where dry fuel is still present, but the fuel load has been reduced. Herbicides can also be used to keep fences, including electric fences, clear of weeds and grass. The most effective time to apply herbicide is in early autumn when grasses are still green and have moisture.

7.12.2.1.4 Locality of fire breaks

All fire breaks must reflect veld fire risk factors such as aspect, slope, local weather conditions and fuel loads on adjoining land. Standard 15 - 25m boundary breaks on each side of common boundaries are recommended. Where possible, land owners/users should consider using existing natural features, such as water bodies or road servitudes, as fire breaks.

7.12.2.1.5 Perimeter breaks

Where practical and environmentally responsible, landowners and managers must have a natural or constructed perimeter (boundary) fire break between neighbouring properties, including neighbouring public land such as roadsides. Consider whether these breaks can be used as access tracks as well as fire breaks. With agreement between neighbours or LRFPA, perimeter fire breaks could be located all or in part on a neighbouring property.

7.12.2.1.6 Internal breaks

Where feasible, land owners must consider the use of internal fuel breaks to minimise the travel of fire across a property. These internal fire breaks could be made between different enterprises or facilities, such as between the PV solar facility and the grazing areas and could also incorporate access roads/tracks.

7.12.2.1.7 Fuel reduction in open spaces

Landowners and managers are encouraged to manage vegetation (including natural vegetation and weeds) in open spaces to minimise fuel loads, particularly if they are located near key assets. Fuel reduction options include strategic grazing, slashing and herbicide use.

7.12.2.2 The effectiveness of fire breaks

Fire breaks may help increase the effectiveness of fire fighting and be used to protect key assets from fire. The effectiveness of fire breaks depends on the weather conditions, the width of the break and whether embers are being produced. In grasslands, wider fire breaks will stop a greater range of fires than narrow ones. Narrow breaks (under 10 m) are ineffective except under the mildest of conditions. It is recommended that 10 - 25m fire breaks are made on either side of a common boundary and that the width of internal fire breaks dependent on the fuel load / topography etc.

Most fire breaks can have some effect at slowing the progress of a veld fire, in particular if the break:

- is close to the source of fire ignition so that the fire has not built to its maximum potential;
- is approached by the side (flank) of the fire, because the flank has lower fire intensity than the front (head) of the fire (hence plan strategic breaks relative to prevailing winds for the area);
- effectively disrupts the continuity of the fuel, thereby reducing fire intensity and making the fire easier to suppress; or
- provides access for suppression.

7.12.3 Other fire prevention considerations

Preventing fires from starting is an important part of fire safety for individuals and the community.

7.12.3.1 Power lines

Where applicable, ensure that power lines are maintained in sound condition and that they are clear of vegetation.

7.12.3.2 Electric fencing

Electric fences can cause fires. This generally occurs when sparks jump from one wire to another in the presence of dry vegetation. Ensure that electric fences are free of wire, grass, weeds and other vegetation. Operate electric fences according to manufacturers' advice. It is a common practice to switch off electric fences at times of extreme fire danger.

7.12.3.3 Dangerous goods

Store fuel and chemicals away from vegetation and key assets in tanks or containers that are in good condition. This will minimise the risk of fire starting in, or spreading from, these areas. Consider minimising the risk associated with dangerous goods by minimising the amount of these items being stored on rural properties.

7.13 Providing personnel, equipment and infrastructure

7.13.1 Personnel

In order to adequately respond to veld fires on and around the proposed PV solar facility, the following personnel would be involved – property owner, estate fire officer or team leader and other workers. These people would all need to be provided with specific veld fire management training (e.g. fire ecology, fire management, fire fighting and first aid).

It is vital to work as a team. A team should consist of a leader and a number of people. A team leader has to give clear instruction and monitor the safety of the fire fighters.

Smaller teams are ideal to get to the fire quickly and commence the attack. Larger teams may come about as neighbours and others resident join – some with less experience than others.

The first on the scene fulfils the role of Incident Commander, and continues to coordinate and manage until the Fire Chief sends relief.

Not everyone should be at the fire front. You need at least one person who can be a lookout – the more hazardous the situation, the more important this job. The lookout alerts the team to any changes in fire behaviour. The team working at the head of the fire in the smoke and heat, may fail to notice changes.

Those in the community who are unable to fight fires can support the effort of the fire-fighters by tending to their physical needs. Specifically, those not actively engaged in fire-fighting should monitor and manage risk ahead of fire:

- Drench buildings and the vegetation in surrounding areas;
- Remove surplus combustible materials wherever possible;
- Alerted staff where needed and marshal them to a safe assembly /evacuation point; and
- Place emergency medical resources on stand-by if the risk increases.

7.13.2 Equipment

Having the capacity for a fast fire-suppression response is an important way to help protect properties from fire. Anyone operating vehicles, machinery and equipment is required to have some fire fighting equipment. In addition to this, landowners and managers should arrange for access to additional fire fighting equipment to stop the spread of fire. This may range from such simple tools as rakes and shovels to fi e extinguishers, farm fire fighting units, “bakkie sakkies”, or tankers, depending on the type of fire risks present.

The primary fire-fighting tools are beaters, spades, rakes, blowers and water sprayers. Hand tools are used to cool and extinguish fire, and to build a fire line. The following is a list of equipment that may be required to be able to adequately respond to veld fires on and around the facility:

- **Hand tools:** Rake hoes, fire beaters, spades, slashers, chain saws, fire extinguishers, drip torch / lighting canisters
- **Water related tools:** Back-pack sprayers / knapsacks, hydrant hoses (40mm x 30m), fire nozzles, suction hoses

- **Protective clothing:** Fire resistant shirts and trousers, anti-flash hoods, boots, gloves, goggles, breathing masks and hard hats
- **Other equipment:** Spotlight, torches (headlamps), bolt cutters, first aid kit with burn shields, estate maps, fire alarm
- **Vehicles:** 4x4 “Bakkies” (with designated fire-fighters), tractor drawn
- **Infrastructure:** Road network and water supply points.

7.13.2.1 Hand Tools

Principle: If you are at a fire and there is no equipment at hand, begin controlling the fire with whatever you can find. Break off a branch with leaves. Grab a wet sack or cloth and a bucket of water to keep it wet.

- One third of people at the scene should have beaters. Mark ownership with coloured bands or similar so that equipment makes its way back to owners.
- Backpack sprayers for controlling slow spreading fires in light fuel should best be used in conjunction with beaters.
- Spades are useful to throw sand on smouldering clumps

7.13.2.2 Brushcutters

- When the grass is very high and thick, the increased flame height and heat of the fire make it more difficult to get close enough to the fire to effectively use a beater. In such instances it may be prudent to have people cut the grass short ahead of the fire. This will allow beaters to be used in that short grass.
- If this method is used, the team should work close together. The effort of the cutters will be wasted if the beaters are delayed and the fire overtakes the short grass.
- An alternative is to fall back to a fire break, or an area where the fuel load is lighter, and then use all available resources to beat the fire.

7.13.2.3 Blowers

- Beaters are less effective in very rocky areas. Here it may be more effective to use backpack blowers in combination with water sprayers.
- In such situations, specific care should be taken with regard to the following risks:
  - The risk of leaving burning embers that can easily flare up in crevices.
  - The risk of team members stumbling on the uneven surface with the additional awkward burden on their backs.
  - The risk of blowers that will need to be re-fuelled. The staging area is the only place where flammable liquids should be transferred.

7.13.2.4 Fire-fighting Equipment

Principle: All fires start small. A change in weather conditions (rising temperature, increase in wind) should trigger a call for more assistance.

Water is a very useful tool to control fire. The most effective use of water is with a water tank mounted on a trailer or bakkie, with a pressure spray hose attached. Because water is heavy to carry and not but may not always be able to reach the fire. Therefore water tanks and pumps and similar equipment is not always feasible to transport in the veld. However, the equipment adds greatly to the efficacy of the fire fighting effort.

Where possible, backpack sprayers with water may be used. The spray mist is used to knock back the fire so that those with beaters can move in closer and beat the flames down. A follow-up backpack pump after the beaters can damp down any clumps, manure or stumps to make sure there are no flare-up in the team's wake.

The following principles should be considered when using backpack sprayers with water:

- Operators should always aim the water stream at the base of the flame.
- Team leaders should ensure the members carrying backpacks will not be in danger if the water runs out or the pump fails.
- Work parallel to the fire line.
- Plan where and how additional water will be obtained. Some people could be tasked to fill jerry cans and bring the cans to the staging area.

The following principles should be considered when mobile fire-fighters:

- One team member should "man" the hose, directing the spray at the base of the fire.
- Another team member ensures the hose is not snagged by vegetation and rocks. This task is difficult at night, and wearing a headlamp may assist. People not working directly at the fire line easily become night blind as their gaze shifts from fire to where they are working.

7.13.2.5 Infrastructure

Good building and property access for fire fighting is important for effective fire suppression.

7.13.2.6 Access roads/tracks

Generally, access tracks should:

- be free of overhanging trees and shrubs to a height of 4 m;
- be at least 7 m wide to allow two tankers to pass, or be 4 m wide and have passing bays every 200 m that are 6 m wide and 20 m long;
- have an average slope of no more than 1 in 7 (8.1 degrees) with a maximum grade of no more than 1 in 5 (11.3 degrees) for no more than 50 m;
- have dips with no more than 1 in 8 (7.1 degrees) entry and exit angles;
- be capable of a load limit of at least 15 tonnes;
- be aligned to provide straight through access at junctions; and
- be sign posted if visibility is poor due to terrain or vegetation.

Allow for, or manage, the growth of trees and branches when planning access tracks. Reducing adjacent fuel loads can increase the benefits and safety of access tracks. Consider the opportunity for access tracks to double as fuel breaks.

On the Ghaap Plateau, it is difficult for vehicles, including fire fighting vehicles, to travel safely across the uneven and rocky terrain. Landowners and managers should therefore provide a perimeter access track. This should generally be at least 7 m wide and free of overhanging trees to a height of 4 m to allow tanker access.

7.13.2.7 Water supply access

Access to water will assist in securing fire safety.

7.13.2.8 Property water supply

Generally, water supplies should:

- be obvious to or known to local fire suppression services (signs or property plans may be necessary);
- be located in an open and clear flat area with a hard standing area allowing a fire suppression pump to be within 4 m of the water supply;
- have a turning circle loop or turn-around point;
- where tanks are used, have couplings or adaptors that enable farm fire fighting equipment and fire services to fill from the tanks;
- be available even when water levels are low during winter months; and
- be independent of any mains power supply.

Water supplies could be from a dam, tank, mains water system or private water tanker. Bores and standpipes may also be suitable if flow rates are sufficient. Consider having a water supply and water distribution system that operates independently of mains power.

A suitable water supply may be available from a nearby property or water source with agreement from the relevant owner or manager.

7.13.2.9 Buildings and infrastructure water supply

To protect offices and other infrastructure, landowners and managers are encouraged:

- to have at least 10 000 litres of water supply, such as a dam or tank available for fire fighting, that is independent of the reticulated water supply and mains power supply;
- to have flame-resistant and heat-resistant or protected water supply pipes; and
- where tanks are used, to have couplings or adaptors that will allow fire tenders to be filled.
- to regularly maintain and annually check pumps and sprinklers to be used for fire protection.

7.13.2.10 Staging and first station

A staging area should be demarcated so that resources know where to get to, and additional equipment can be available. The area should be fire-safe. Demarcation can be with a flag, plastic tape or any other agreed clearly visible marking. A first aid and drinking station (with fresh water for drinking) should also be set up.

7.14 Assessing the Fire

The first thing to do when a person arrives on the scene is to assess the fire. Identifying where the fire is – a landmark and a distance, the access road, size of the fire (e.g. 20m front, 1 hectare), rate of spread, wind direction, suspected cause, landowner / property number. This may mean taking the time to walk around the fire. It is not wasted time: you will have vital information about the fire and the surroundings, allowing you to determine the best attack. Also, you will identify safe places for your team to take refuge, and a staging area where water can be replenished.

7.14.1 Basic information

At first notification of a fire, take time to get these details. Resist rushing because the information is needed to mobilise support. When you see the fire, check the fire size, height of the smoke, colour, direction and shape.

- **Location**: Understand the exact location. Use a map to orientate yourself, and to determine access points.
- **Reported by**: Write down the name of the person reporting the fire and their contact details. You may need more information later.
- **Best access**: Ask how to reach the fire, and check this on a map.
- **Fire behaviour**: What is the size of the fire, the rate of spread (slow/fast), the direction in which it is moving and ask if the cause is known. Remember that not everyone will use compass points for direction; ask about landmarks if they are unclear e.g. moving towards the airport, or away from the river.
- **Threats**: Ask if there is any immediate threat to people, infrastructure, animals. The person reporting the fire may be more familiar with the specific area and save you a lot of time.

7.15 Reporting fires

In accordance with legislation, during fire danger period owners, occupiers or managers of land must inform the FPA or police about the existence and location of the fire if they are unable to extinguish it. Anyone finding a fire burning during the fire danger period must report it as soon as possible. Ineffective reporting which delays response undermines all other response preparation.

7.15.1 Extinguishing fires

In accordance with legislation, during fire danger period owners, occupiers or managers of land must take all possible steps to extinguish fire on land under their management. Measures to be applied have been discussed under section 2.2.

The response to a veld fire is related to both the situation immediately after ignition, but also to the potential size and controllability of the fire. The PV solar facility will use the classification system described in Table 2.

Table 2: Active wildfire management response

Description	Fire class	Command structure
Small fire that can be controlled by the workers on-site.	Class C	Workers take initial command of the fire. If the facility manager becomes involved, he will take authority of the fire
Medium-sized fire that is manageable with existing resources, although additional resources may be required for mopping up	Class B	The facility manager takes command of the fire.

Description	Fire class	Command structure
Large, uncontrollable fire in which additional resources will need to be deployed	Class A	The Fire Chief or the Fire Protection Officer of the FPA will take command of the fire

7.15.2 Follow up / post-burn activities

- Ensure that the perimeter is safe from flare-up
- Douse all smoulder points with water (logs, manure, debris)
- Monitor, especially if the wind picks up

7.16 Management Principles

Fire suppression is only one part of veld fire management. Fire prevention is the most important component and combined with this is safety of all personnel during fire fighting operations.

The golden rules for fire management and fighting are as follows:

- Prevent the occurrence of human-induced veld fires at the PV solar facility.
  Do not allow smoking and fires in open spaces (and not at all on an orange or red FDI day).
- Safety first.
  Fight veld fires aggressively, but put the safety of your fire fighters first. The safety threat is not limited entirely to flames. Radiant heat, dehydration and asphyxiation are also real threats to safety and must be considered. Responding to fires is potentially very dangerous.
- Make arrangements to protect the PV solar facility
  Protect persons and property, on or immediately adjacent to the PV solar facility, from veld fires
  - Develop veld fire management at the facility as an integral part of any local/regional FPA established action.
  - Reduce fuel loads around the PV solar facility, to decrease the risk of run-away fires and to reduce the potential spread of wildfires on, from or across the facility.

    Implement the weeds and alien invader plants management plan to clear all weeds and invasive plant species cleared from the facility and its surroundings to reduce the fuel loads of invasive alien plants (notably the woody plants).
  - Prepare and maintain fire breaks annually in a manner that is least damaging to the environment and aesthetics of the property. Utilise current roads and tracks where possible.
  - Establish and maintain suitable water points for the provision of water to fire management teams.
  - Ensure that all staff on site are properly equipped and trained to assist in the suppression or containment of veld fires and to maintain fire mitigation measures, or outsource these duties.
  - Establish standard operating procedures and protocols to ensure effective response to the occurrence of veld fires and the proactive management of risk mitigation measures.

- Post a lookout for danger and safety aspects.

- Keep informed of fire weather conditions and forecasts.

  Identify and communicate daily fire danger ratings to staff, tenants and visitors to the facility. Erect a fire danger rating board at a centralised position, such as the entrance gate, for all to see and update the information daily.

  During fire fighting, a change in weather conditions (rising temperature, increase in wind) should trigger a call for more assistance.

- Veld fire fighting arrangements
  - Extinguish a fire as soon as possible
    All fires start small. If you are at a fire and there is no equipment at hand, begin controlling the fire with whatever you can find. Break off a branch with leaves. Grab a wet sack or cloth and a bucket of water to keep it wet.
  - Be alert, keep calm, think clearly, make clear decisions and act decisively.
    Know what the veld fire is doing at all times.
  - Base all actions on the current and expected veld fire behaviour.

    Maintain control of your personnel and fire fighting operations.
    Give clear instructions and have them repeated to ensure that they are understood.
  - Plan and make escape routes known to everyone.

- Maintain prompt communications with the persons in control of fire-fighting operations, as well as fire fighters under your control.
  Each fire fighting team, land user or landowner must carry a communication device when fighting fires. This is preferably a radio but may be a cellular phone.

  Communication with the Fire Chief neighbours or the Control Room is vital. This will inform the team of changing conditions and/or allow the team to request assistance or information. The Fire Chief's decision is final and must be complied with.

- Work co-operatively with all role-players (neighbours, FPA and municipal fire fighting services) in managing fire at the facility.
  Join the local FPA.

7.17 Site ecosystem context

Veld fire danger on the Ghaap Plateau (where the proposed solar facility is planned) could be considered as high under specific conditions, as medium to fine fuel (in the form of grass and shrub branches) accumulates annually and cures after frost or drought to form moderately high flammable material.

Veld fires are not very frequent, but due to the fuel loads and climatic conditions, move quickly, can be intense, and can cause significant degradation of the environment and property damage. Because of the rocky nature of the surface, movement of people and vehicles are restricted, making fire-fighting very difficult. Therefore, the consequences of runaway veld fires can be immense, destroying hundreds or thousands of hectares of natural vegetation.

7.18 Impact minimisation and control measures

7.18.1 Construction phase

Activity	Frequency
Create and maintain a fire management file, containing records of maintenance, inspections, audits, letters/communications, drills and training, meetings or formal discussions around fire management, etc.	Continuous
Clear firebreaks of brush piles, logs and debris.	Immediately
Control vegetation by brush cutting along perimeter firebreaks	Annually in October/November
Control vegetation by brush cutting 1m on either side of all pathways and road verges.	Annually in October/November
Ensure all tools, protective equipment, chemicals and fuels are stored in such a way that they are easily accessible, but safely secured.	Continuous
Ensure all staff are adequately informed, trained and equipped to respond to fires or that ensure a service agreement is signed with an appropriate service provider	Immediately
Conduct fire drills, check hydrants, hoses and hand tools; repair or replace as necessary	6–monthly, a check must be completed in October/November
Conduct annual review of fire risk areas and update map of risks and fire history	Once annually or after every fire (both prescribed and wildfire)
Install no smoking signage and Fire Danger notice board at the facility	As soon as possible, to be updated daily from November to April
Attend and participate in FPA meetings	At least annually at the HFPA AGM

7.18.2 Operational phase

Activity	Frequency
Maintain a fire management file, containing records of maintenance, inspections, audits, letters/communications, drills and training, meetings or formal discussions around fire management, etc.	Continuous
Clear firebreaks of brush piles, logs and debris.	Annually, in January
Control vegetation by brush cutting along perimeter firebreaks	Annually in January
Control vegetation by brush cutting 1m on either side of all pathways and	Annually in

Activity	Frequency
road verges.	January
Ensure all tools, protective equipment, chemicals and fuels are stored in such a way that they are easily accessible, but safely secured.	Continuous
Ensure all staff are adequately informed, trained and equipped to respond to fires or that ensure a service agreement is signed with an appropriate service provider	Continuous
Conduct fire drills, check hydrants, hoses and hand tools; repair or replace as necessary	6–monthly, with an annual check in November
Conduct annual review of fire risk areas and update map of risks and fire history	Annually, in January, or after every veld fire
Maintain and update no smoking signage Fire Danger notice board at the facility.	To be updated daily
Attend and participate in FPA meetings	At least annually at the local FPA AGM

7.18.3 Decommissioning phase

Activity	Frequency
Maintain a fire management file, containing records of maintenance, inspections, audits, letters/communications, drills and training, meetings or formal discussions around fire management, etc.	Continuous
Clear firebreaks of brush piles, logs and debris.	Annually, in January
Control vegetation by brush cutting along perimeter firebreaks	Annually in January
Control vegetation by brush cutting 1m on either side of all pathways and road verges.	Annually in January
Ensure all tools, protective equipment, chemicals and fuels are stored in such a way that they are easily accessible, but safely secured.	Continuous
Ensure all staff are adequately informed, trained and equipped to respond to fires or that ensure a service agreement is signed with an appropriate service provider	Continuous
Conduct fire drills, check hydrants, hoses and hand tools; repair or replace as necessary	6–monthly, with an annual check in November
Conduct annual review of fire risk areas and update map of risks and fire history	Annually, in January, or after every veld fire
Maintain and update no smoking signage Fire Danger notice board at the facility.	To be updated daily
Attend and participate in FPA meetings	At least annually at

Activity	Frequency
	the local FPA AGM

7.19 Roles and responsibilities

Effective re-vegetation and habitat rehabilitation during the construction, operational and decommissioning phases of the project will be dependent on the following of project personnel:

7.19.1 The Developer

The project proponent (developer) will be responsible for the following:

- Ensuring that the requirements set out in this management plan are adhered to and implemented;
- Appoint a suitably qualified project engineer prior to the start of construction, with overall responsibility for the implementation of the management plan during the construction phase of the project; and
- Appoint an independent suitably qualified individual prior to the start of construction as Environmental Officer (EO)/Environmental Control Officer (ECO) to monitor and verify the implementation of this management plan during the construction phase of the project; and
- Appoint a suitably qualified individual prior to the start of the operational phase of the project as Environmental Officer (EO) to implement this management plan during the operational phase of the project; and
- Provide all principal contractors working on the project with a copy of this management plan as part of tender documentation to allow the contractors to cost for the implementation of its requirements in their respective construction tenders.
- Provide the project engineer, appointed independent EO/ECO for the construction phase, appointed qualified EO for the operational phase, as well as all principal contractors working on the project with copies of the Final EIA report, the requirements of the EA, and this management plan.

7.19.2 The Engineer

The project engineer will be responsible for the overall implementation of the management plan during the construction phase of the project. To effectively implement the plan, the engineer must be aware of the findings, mitigation measures and conclusions of the Final EIA report, the requirements of the EA, and this management plan.

7.19.3 The Environmental Officer (EO)/ Environmental Control Officer (ECO) for construction

The independent EO/ECO is responsible for monitoring and verifying the implementation of the management plan during the construction phase of the project. To effectively monitor and verify the implementation of the management plan, the EO/ECO must be aware of the

findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

7.19.4 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the operational phase of the project. To effectively implement the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

7.19.5 The Principal Contractor(s)

The principal contractor(s), being any directly appointed entity undertaking the implementation of work, will be responsible for complying with the management plan at all times during the construction phase. It is likely that the principal contractor(s) will appoint a suitably qualified individual prior to the start of the construction phase of the project as Environmental Officer (EO) to implement this management plan during the construction phase of the project.

7.19.6 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the construction phase of the project. To effectively implement the management plan, the EO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

7.20 Monitoring Programme

An annual audit of needs, risks and progress must be completed annually to ensure that the plan remains dynamic and current (see annexure 9: Example of Fire Audit Checklist).

7.20.1 Construction phase

Activity	Frequency
Vehicles and equipment	
Check vehicle fuel levels	Daily
Check vehicle oil and coolant levels	Weekly
Vehicle service by agents	According to manufacturer's handbook
Inspect and clean, repair or replace protective equipment (overalls, gloves, water bottles, torches, rucksacks, eye goggles) as necessary	Immediately before the high risk fire season and after every fire
Inspect and replace used or expired First Aid kit & trauma bag supplies as necessary	Monthly, and after every fire

Activity	Frequency
Ensure that adequate complete set of GIS-based maps of site and 1:50 000 topo-cadastral maps of region are available	Annually in November
Ensure availability of miscellaneous materials (whiteboard, fire-log book, plastic overlays, dry-wipe pens, prestic putty, pins, magnetic markers, scissors)	Annually in November, and after every fire
Infrastructure	
Inspection of water supply points	Six monthly
Road network fringes mowed and maintained	Two monthly

7.20.2 Operational phase

Activity	Frequency
Vehicles and equipment	
Check vehicle fuel levels	Daily
Check vehicle oil and coolant levels	Weekly
Vehicle service by agents	According to manufacturer's handbook
Inspect and clean, repair or replace Protective equipment (overalls, gloves, water bottles, torches, rucksacks, eye goggles): as necessary -	Immediately before the high risk fire season and after every fire
Inspect and replace used or expired First Aid kit & trauma bag supplies as necessary – immediately before the high risk fire season and after every fire	Monthly, and after every fire
Ensure that adequate complete set of GIS-based maps of site and 1:50 000 topo-cadastral maps of region are available	Annually in November
Ensure availability of miscellaneous materials (whiteboard, fire-log book, plastic overlays, dry-wipe pens, prestic putty, pins, magnetic markers, scissors)– immediately before the high risk fire season	Annually in November, and after every fire
Infrastructure	
Inspection of water supply points	Six monthly
Road network fringes mowed and maintained	Two monthly

7.20.3 Decommissioning phase

Activity	Frequency
Vehicles and equipment	
Check vehicle fuel levels	Daily
Check vehicle oil and coolant levels	Weekly

Activity	Frequency
Vehicle service by agents	According to manufacturer's handbook
Inspect and clean, repair or replace Protective equipment (overalls, gloves, water bottles, torches, rucksacks, eye goggles): as necessary -	Immediately before the high risk fire season and after every fire
Inspect and replace used or expired First Aid kit & trauma bag supplies as necessary – immediately before the high risk fire season and after every fire	Monthly, and after every fire
Ensure that adequate complete set of GIS-based maps of site and 1:50 000 topo-cadastral maps of region are available	Annually in November
Ensure availability of miscellaneous materials (whiteboard, fire-log book, plastic overlays, dry-wipe pens, prestic putty, pins, magnetic markers, scissors)– immediately before the high risk fire season	Annually in November, and after every fire
Infrastructure	
Inspection of water supply points	Six monthly
Road network fringes mowed and maintained	Two monthly

8 EROSION MANAGEMENT PLAN

8.1 Purpose, scope and limitations

The purpose of the erosion management plan is to implement avoidance and mitigation measures to reduce the erosion potential and the likely impact of erosion associated with the construction and operational phases of the proposed facility. Measures to protect hydrological features from erosion damage are also included in the management plan.

This plan will introduce measures aimed reducing the negative impacts of erosion on biodiversity, as well as reducing the vulnerability of the site to erosion problems during the construction and operational phases of the development. It focuses on:

- protecting the land surface from erosion;
- minimizing the amount of disturbed soil;
- preventing runoff from offsite areas from flowing across disturbed areas by intercepting and safely directing run-on water from undisturbed upslope areas through the site, without allowing it to cause erosion within the site or become contaminated with sediment;
- slowing down the runoff flowing across the site;
- removing sediment from onsite runoff before it leaves the site; and
- reducing the construction phase impact on ecologically sensitive areas; and
- preventing damage to hydrological features such as drainage lines or wetlands, either within or adjacent to the site.
- The long-term benefits of an effective erosion and sediment control plan are enormous.
- There is less chance of soil washing of the site and clogging streets, drainage systems, and entering adjacent properties.
- The number and size of erosion control measures required will be minimized.
- The cost of maintaining erosion control facilities is minimized.
- The top soil is retained on the site, making re-vegetation and landscaping easier to establish.

The plan does not cover engineering aspects that are of relevance to soil and erosion management. Therefore, issues such as the potential presence of heaving clays, compressible soils, perched water tables, dispersive soils and corrosive groundwater at the site are beyond the general scope of this study and are not directly dealt with. These issues and their relevance to the proposed development would need to be assessed and addressed during detailed geotechnical investigations of the site.

This erosion management plan should be closely aligned with the re-vegetation and habitat rehabilitation and weed and alien invasive plant management plans, as they are inextricably linked.

8.2 Background

8.2.1 General understanding

Erosion is a process of detachment and transportation of soil materials by wind or water - often from a position where it is of value to a position where it represents a cost. The word erosion is derived from the Latin erodere meaning to gnaw away. Soil erosion occurs when the soil is being 'gnawed away' by the forces of raindrop impact, water flow, wind and gravity. Essentially, these forces detach particles of soil, carry or transport the particles and deposit the soil particles.

Erosion, by the action of water, wind, and ice, is a natural process in which soil and rock material is loosened and removed. There are two major classifications of erosion: natural or geological erosion and man-made erosion.

- Geological erosion, which includes soil-forming as well as soil-removing and occurs primarily on a geologic timescale, has contributed to the formation of soils and their distribution on the surface of the earth.

- Man-made erosion includes the breakdown of soil aggregates and the increased removal of organic and mineral particles; and is caused by clearing, grading, or otherwise altering the land. When human activities alter the landscape through activities such as clearing vegetation or overgrazing, the natural erosion process can be greatly accelerated. Land degradation caused by soil erosion not only involves the loss of fertile topsoil and reduction of soil productivity, but also leads to sedimentation of reservoirs and increases suspended sediment concentrations in streams, with consequent effects on ecosystem health.

Erosion of soils that occurs at construction sites is also man-made erosion. When land is disturbed at a construction site through the removal of ground cover, it increases the site's susceptibility to erosion and the erosion rate accelerates dramatically. Disturbed land on a construction site may have an erosion rate 1,000 times greater than the pre-construction rate. Construction site erosion is a source of sediments, toxicants and nutrients, which pollute the receiving water(s).

Construction site erosion causes serious and costly problems, both on-site and off-site. The major problems associated with erosion on a construction site are the movement of soil off the site and its impact on water quality. Sediment leaving the site may damage neighbouring properties, block drainage systems, and enter roadways, where municipalities and other government institutions must pay for removing the sediment from streets, sewers, ditches, and culverts.

In practice, soil erosion is irreversible, as in most practical circumstances, it is uneconomic to move the soil back to its original position. Therefore, emphasis must be placed on soil conservation, not remediation. Erosion prevention measures are more effective than the reactive control of sediment. Once soil particles become dislodged, it requires greater efforts and costs to contain the sediment on the site.

Even though construction requires that land be disturbed and be left bare for periods of time, proper planning and use of erosion prevention measures can reduce the impact of human-induced, accelerated erosion. Identifying erosion problems at the planning stage and noting highly erodible areas helps in selecting cost effective, environmentally sensitive erosion control measures. When combined with an understanding of basic erosion control and sedimentation processes, fundamental erosion prevention and sediment control principles will provoke the groundwork for successfully implementing an erosion and sediment management plan.

The following important concept must be kept in mind when developing erosion control plans: construction practices that minimize the amount of disturbed land area and avoid or minimize work on steep slopes, must be encouraged. Such practices can provide the following positive results:

- reduced probability of soil washing off the site onto streets, drainage systems, and adjacent properties;
- reducing the number and size of erosion control measures required;
- reducing the overall cost of maintaining erosion and sediment control facilities; and
- maximising the volume of top soil retained on the site, making re-vegetation and landscaping easier to establish.

8.2.2 Types of Erosion

Erosion comes in several forms, some of which are not immediately obvious (Figure 1). The major types of erosion are briefly described below.

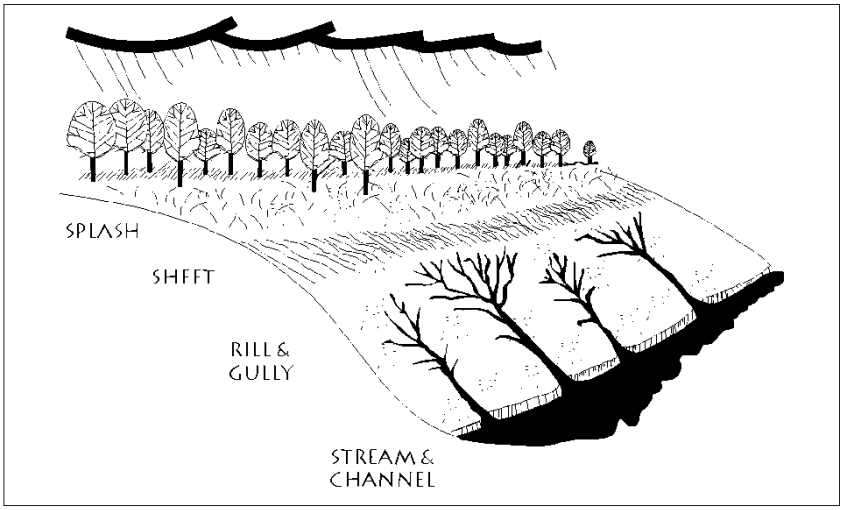

Figure 1. Four types of soil erosion on an exposed slope. (Source: Ref. 33)

8.2.3 Water erosion

Water erosion can occur through raindrop impact, in diffuse (un-concentrated) flow as sheet erosion, or in concentrated flow as rill and/or gully erosion.

- Raindrop impact

Splash erosion is the first stage of the erosion process. It occurs when the force of raindrops falls on bare or sparsely vegetated soil, after the vegetative cover has been stripped away and the soil surface is directly exposed to raindrop impact. The explosive impact breaks up soil aggregates, so that individual soil particles are 'splashed' onto the soil surface. The splashed particles can rise as high 600 mm above the ground and move up to 1.5 metres from the point of impact. This pounding action destroys the soil structure and the detached clay particles block the spaces between soil aggregates, so that the soil forms a crust when it dries. This crust inhibits water infiltration and plant establishment, increasing runoff and future erosion.

This effect is most important when large areas of exposed soils are present on a construction site, after site clearance.

- Sheet erosion

Sheet erosion is the removal of soil in thin layers by raindrop impact and shallow, unchanneled surface runoff. Shallow "sheets" of water flowing over the soil surface transports soil particles that have been detached by splash erosion, resulting in loss of the finest soil particles that contain most of the available nutrients and organic matter in the soil. The shallow surface water flow that causes sheet erosion rarely moves as a uniform sheet for more than a few feet before concentrating in the surface irregularities into rills.

Soil loss is so gradual that the erosion usually goes unnoticed, but the cumulative impact accounts for large soil losses. Early signs of sheet erosion include bare areas, water pudding as soon as rain falls, visible grass roots, exposed tree roots, and exposed subsoil or stony soils. Soil deposits on the high side of obstructions such as fences may also indicate active sheet erosion.

This is likely to be an important erosion type at a construction site, given the large exposed areas after site clearance, the gently sloping nature of the site, as well as the presence of susceptible soils.

Vegetation cover is vital to prevent sheet erosion because it protects the soil, impedes water flow and encourages water to infiltrate into the soil.

- Rill erosion

As surface flow changes from sheet flow to deeper concentrated flow in depressions (low points of the soil surface), wheel tracks etc. it creates rivulets. The energy of this concentrated flow is able to both detach and transport soil particles, cutting small, but well-defined shallow drainage lines (channels) less than 300 mm deep, called rills, into the soil surface. Rill erosion is often described as the intermediate stage between sheet erosion and gully erosion.

Rill erosion is common in bare agricultural land, particularly overgrazed land, and in freshly cultivated soil where the soil structure has been loosened. On construction sites, this type of erosion usually occurs on lower points of cleared areas.

Rill erosion can be reduced by reducing the volume and speed of surface water with grassed waterways and filter strips, ripped mulch lines, and contour drains. The rills can also usually be removed with farm and construction machinery.

- Gully erosion

Gullies are formed when runoff cuts rills deeper and wider or when the flows from several rills come together and form a large channel, deeper than 300 mm. Gully erosion begins as rill erosion which is not addressed and removes soil from the surface and sub-surface due to the concentrated runoff in the deeper channels. Most gullies extend upslope as a result of the head of the gully being continually undercut and collapsing. However, collapse and slumping of sidewalls usually contribute a greater proportion of soil loss. If the flow of water is sufficient, large chunks of soil can fall from a gully headwall in a process called mass wasting. Gullies cannot be removed by normal cultivation and once a gully is created, it is very difficult to control, and costly to repair.

- Channel erosion

Natural streams have adjusted over time to the quantity and velocity of runoff that normally occurs within a watershed and the vegetation and rocks lining the banks are sufficient to prevent erosion under these steady-state conditions. When a catchment is altered by removing vegetation, increasing the amount of impervious surfaces etc., increased volume and velocity of runoff may cause expansion of gullies into well-defined channels. These changes disturb the equilibrium of the stream, increasing the velocity or volume thereof and causing erosion of the stream banks and disturbance of the stream bank vegetation. Channel erosion is commonly found at stream bends, constrictions where installed structures control the stream flow, or discharge points where storm drain culverts release storm water into a stream.

8.2.4 Wind erosion

Wind erosion is the detachment and movement of soil particles by air moving at least 20 km per hour. It results from soil particles being picked up, bounced or moved by the wind and normally occurs in flat, bare arid areas with dry, sandy soils, or where the soils are loose, dry, and finely textured. Wind erosion damages land and natural vegetation by removing soil from one place and depositing it in another. It causes soil loss, dryness and deterioration of soil structure, nutrient and productivity losses, air pollution and sediment transport and deposition. Often the only evidence of wind erosion is an atmospheric haze of dust comprising fine mineral and organic soil particles that contain most of the soil nutrients.

Soil movement is initiated as a result of wind forces exerted against the surface of the ground. For each specific soil type and surface condition there is a minimum velocity required to move soil particles, called the threshold velocity. Once this velocity is reached, the quantity of soil moved is dependent upon particle size, the cloddiness of particles and the wind velocity itself.

Wind moves the soil in three ways, suspension, saltation and surface creep.

- Suspension

Suspension occurs when the wind lifts very fine dirt and dust particles into the air. They can be thrown into the air through impact with other particles or by the wind itself. Once in the atmosphere, these particles can be carried very high and be transported over extremely long distances. Soil moved by suspension is the most spectacular and easiest to recognize of the three forms of movement, leading to dust storms.

- Saltation

The major fraction of soil moved by wind is through the process of saltation. Saltation occurs when the wind lifts larger, fine soil particles off the ground for short distances. These particles drift horizontally across the surface, increasing in velocity as they go. Soil particles moved in the process of saltation cause severe damage to the soil surface and vegetation. They travel approximately four times longer in distance than in height. When they strike the surface again, they either rebound back into the air or knock other particles into the air.

- Surface Creep

The large soil particles that are too heavy to be lifted into the air are moved through a process called surface creep. In this process, the particles are rolled across the surface after coming into contact with the soil particles in saltation.

Actions to minimise wind erosion include improving soil structure so wind cannot lift the heavier soil aggregates; retaining vegetative cover to reduce wind speed at the ground surface; and planting windbreaks to reduce wind speed. Also, be ready for severe wind erosion seasons which tend to be the summers following dry autumns and winters.

Given the arid nature of the Karoo environment and the strong winds blowing across the flat landscape, wind erosion is likely to occur at the construction site after site clearance.

8.3 Promoting Factors

The four principal factors in soil erosion are climate, soil characteristics, topography and ground cover. These factors are interrelated in their effect on erosion potential. The variability in Oregon's terrain, soils, and vegetation makes erosion control unique to each construction site. Understanding the factors that affect the erosion process enables us to make useful predictions about the extent and consequences of on-site erosion.

Erosion outcomes depend on the combined and interactive effects of erosion factors, namely, rainfall erosivity, soil erodibility, slope steepness and slope length, soil surface cover and support practices.

- Climate (Rainfall characteristics)

Climate affects erosion potential both directly and indirectly. In the direct relationship, rain is the driving force of erosion. Raindrops dislodge soil particles, and runoff carries the particles away. The erosive power of rain is determined by rainfall intensity (millimetres of rain per hour) and droplet size. A highly intense rainfall of relatively short duration can produce far more erosion than

a long duration storm of low intensity. In addition, intense storms produce larger raindrops that are much more erosive than misty rain events with small droplets.

- Soil characteristics (erodibility)

Soil is a product of its environment. A soil's erodibility, or the vulnerability of soil to erosion, is a result of a number of soil characteristics which can be divided into two groups: those influencing infiltration, or the movement of water into the ground, and those affecting the resistance to detachment and transported by rainfall and runoff. Key factors that affect erodibility are soil texture, amount of organic matter, soil structure, and soil permeability.

- Soil texture refers to the sizes and proportions of the particles making up a particular soil. Sand, silt, and clay are the three major classes of soil particles. Because water readily infiltrates into coarse-textured soils high in sand content (sandy soils), the runoff, and consequently the erosion potential, is relatively low. Fine-textured or heavy soils high in content of silts and clays are resistant to erosion, , because the clay binds soil particles together due to its stickiness. However, once heavy rain or fast flowing water erodes the fine particles, they will travel great distances before settling.

- Organic matter consists of plant and animal litter in various stages of decomposition. Organic matter improves soil structure and increases permeability, water holding capacity, and soil fertility. Organic matter in an undisturbed soil or in mulch covering a disturbed soil reduces runoff and erosion potential. Mulch on the surface also cushions the soil from erosive impact of raindrops.

- Soil structure is the arrangement of soil particles into aggregates. Soil structure affects the soil's ability to absorb water. When the soil is compacted or crusted, water tends to run off rather than infiltrate. Erosion hazard increases with increased runoff. A granular structure is the most desirable one. Loose granular soils absorb and retain water, which reduces runoff and encourages plant growth.

- Soil permeability refers to the ability of the soil to allow air and water movement through the soil. Soil texture, structure, and organic matter all contribute to permeability. Soils that are least subject to erosion from rainfall and shallow surface runoff are those with high permeability rates, such as well-graded gravels and gravel-sand mixtures. Loose, granular soils reduce runoff by absorbing water and by providing a favourable environment for plant growth.

- Topography (Length and steepness of slope)

Topographic features distinctly influence erosion potential. Depressions and channels concentrate surface flow, which results in higher velocity run-off. The high velocity runoff tends to concentrate in narrow channels and produce rills and gullies. Slope length and slope steepness are critical factors in erosion potential, since they determine in large part the velocity of runoff. Long, continuous slopes allow runoff to build up momentum. The steeper the slope, the higher the velocity and the greater the erosion potential.

The shape of a slope also has a major bearing on erosion potential. The base of a slope is more susceptible to erosion than the top, because runoff has more momentum and is more concentrated as it approaches the base. Slope orientation can also be a factor in determining erosion potential. In South Africa, exposed north-facing soils are hotter and drier, which makes vegetation difficult to establish with consequent lower cover, while southern exposures tend to be cooler and moister, receiving less sunlight, which results in slow plant growth but also results in higher vegetation cover.

- Ground (soil surface) cover

The term ground cover refers principally to vegetation, but it also includes surface treatments such as mulches, matting, wood chips, and crushed rock. Vegetation is the most effective means of stabilizing soils and controlling erosion. Plant leaves and stems shields the surface from the impact of falling rain, provides a rough surface that disperses flow, reduces flow velocity and promotes infiltration and deposition of sediment. Plants also increase infiltration rates by improving the soil's structure and porosity through the incorporation of roots and plant residues and remove water from the soil through transpiration, thereby decreasing soil moisture content and increasing the soil's capacity to absorb water. Furthermore, plant roots help to physically restrain soil movement and hold the soil in place.

8.4 Legal context

8.4.1 Conservation of Agricultural Resources Act No. 43 of 1983

This Act provides for the conservation of our natural agricultural resources, by the maintenance of the production potential of land; the combating and prevention of erosion and weakening or destruction of the water sources; the protection of vegetation; and the combating of weeds and invader plants. Section 6 of the Act allows the Minister to prescribe control measures to achieve the objects of the Act, which shall be complied with by land users to whom they apply. These Control measures are prescribed in regulations published in terms of the Act, including control measures for the restoration or reclamation of eroded land.

The regulations stipulate that land users must effectively restore or reclaim the land on their land on which excessive soil1 loss due to erosion occurs or has occurred.

To protect land against water erosion, one or more of the following measures must be implemented:

- Construct and maintain a suitable soil conservation work to divert run-off water from other land or to restrict the run-off speed of run-off water;

- Cultivate2 the land concerned in accordance with such method or lay-out that the run-off speed of run-off water is restricted;

[1] the loss of soil through erosion that in the opinion of the executive officer exceeds the norm which he deems tolerable in a given situation with due regard to the relevant natural factors and farming practices

- Establish a suitable grazing crop on the land concerned; and
- collect sediment from run-off water.
- To protect land against wind erosion, one or more of the following measures must be implemented:
- Leave strips of natural vegetation at right angles to the prevailing wind direction, construct a suitable wind break or establish suitable vegetation to serve as a wind break;
- Cover denuded portions of the land with branches, hay, straw, crop residues or any other suitable material;
- Cultivate the land concerned in accordance with such method or lay-out that the surface movement of soil particles through the action of wind is restricted;
- Avoid the cultivation and grazing of the land concerned during periods of high winds;
- Construct and maintain a suitable soil conservation work to restrict the surface movement of soil particles through the action of wind;
- Establish a suitable grazing crop on the land concerned.

8.4.2 National Environmental Management Act No. 107 of 1998

Section 28 of the Act requires every person who causes, has caused or may cause significant pollution or degradation of the environment, to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. It furthermore stipulates that if such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, reasonable measures must be taken to minimise the pollution or environmental degradation caused at first and rectify/remediate the harm caused afterwards.

This duty relates to any significant change in the environment, caused by substances, radioactive or other waves or noise, odours, dust or heat emitted from any activity, where that change has an adverse effect on human health or well-being; on the composition, resilience and productivity of natural or managed ecosystems; on materials useful to people, or will in the future have such an adverse effect. It applies to activities such as the storage or treatment of waste or substances, as well as the construction and the provision of services, irrespective of whether it is engaged in by any person or an organ of state.

The responsibility to take the reasonable measures applies to land owners, persons in control of land/premises or persons who have a right to use the land/premises on which or in which any activity or process is or was performed or undertaken; or any other situation exists, which causes, has caused or is likely to cause significant pollution or degradation of the environment.

[2] any act by means of which the topsoil is disturbed mechanically

The reasonable measures may include measures to cease, modify or control any act, activity or process causing the pollution or degradation; contain or prevent the movement of pollutants or the causant of degradation; eliminate any source of the pollution or degradation; or remedy the effects of the pollution or degradation.

8.4.3 National Water Act No. 36 of 1998

Section 19 of the Act requires every person who occupies or uses the land on any activity or process is or was performed or undertaken, or any other situation exists which causes, has caused or may cause pollution of a watercourse, to take reasonable measures to prevent such pollution from occurring, continuing or recurring. Water courses include rivers or springs; natural channels in which water flows regularly or intermittently; wetlands, lakes or dams into which, or from which water flows; surface water, estuaries and aquifers. It also include the beds and banks of the above, where relevant.

This duty relates to any direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare, health or safety of human beings; to any aquatic or non-aquatic organisms; to the resource quality or to property. Sediments and other suspended solids are the most common pollutant in storm water runoff.

The responsibility to take reasonable measures applies to land owners, persons in control of land or persons who occupy or use the land.

The reasonable measures referred to may include measures to cease, modify or control any act or process causing the pollution; comply with any prescribed waste standard or management practice; contain or prevent the movement of pollutants; eliminate any source of the pollution; remedy the effects of the pollution; and remedy the effects of any disturbance on the bed and banks of a watercourse.

8.5 Erosion management principles

Erosion control is the prevention or minimization of soil erosion. Sediment control is the trapping of suspended soil particles. Erosion control is the preferred approach, but sediment control is always necessary, because some erosion is unavoidable.

Effective erosion and sedimentation control requires first that the soil surface is protected from the erosive forces of wind, rain, and runoff, and second that eroded soil is captured on-site.

The following principles are not complex but are effective. They should be integrated into a system of control measures and management techniques to control erosion and prevent off-site sedimentation.

8.5.1 Minimize the Amount of Disturbed Soil

Vegetation is the most effective form of erosion control and very little erosion occurs on a soil covered with undisturbed natural vegetation. Minimizing the amount of disturbed soil on the

construction site will decrease the amount of soil which erodes from the site, and it can decrease the amount of controls you have to construct to remove the sediment from the runoff.

This can be done by one or more of the following measures:

- Lay-out the construction project site so that it fits into existing land contours. Review and consider all existing conditions in the site lay-out for the project. Trying to significantly change the grades in an area can increase the amount of disturbed soil, which increases the amount of erosion which will occur. When construction is tailored to the natural contours of the land, little grading is necessary and erosion potential is consequently reduced. Significant regrading can also disturb the natural drainage of an area, and can be more costly.

- Only clear the portions of the site where it is necessary for construction. Scheduling can be a very effective means of reducing the hazards of erosion. Phased construction helps to lessen the risk of erosion by minimizing the amount of disturbed soil that is exposed at any one time. When less area is disturbed for construction, there is less erosion of soil. If your construction project will take place over a wide spread area, consider staging the project so that only a small portion of the site will be disturbed at any one time. Stage construction activities to minimize the exposed area and the duration of exposure. In scheduling, take into account the season and the weather forecast. Time grading to coincide with a dry season or a period of lower erosion potential.

- If there are disturbed portions of the site that will not be re-disturbed for a long period, these areas should be stabilized with temporary seeding or mulching. This will reduce the amount of erosion from these areas until they are disturbed again.

- By permanently stabilizing the disturbed areas as soon as possible after construction is complete in those areas, you can significantly reduce the amount of sediment which should be trapped before it leaves your site.

8.5.2 Prevent runoff from offsite areas from flowing across disturbed areas

When vegetative cover is removed from land, the soil becomes highly susceptible to erosion. Runoff from areas that have been denuded should not be allowed to cross the exposed soils, particularly when the denuded areas are on slopes. Diverting offsite runoff around a disturbed area reduces the amount of storm water that comes into contact with the exposed soils. If there is less runoff coming in contact with exposed soil, then there will be less erosion of the soil and less storm water which has to be treated to remove sediment.

- Overland flow can be diverted around a construction site by various types of engineering structures. The choice of diversion methods depends upon the size of the uphill area and the steepness of the slope the diversion must go down. If necessary, civil engineers should assist in selecting, designing and installing the appropriate diversion structures.

- Steeply sloped areas are especially susceptible to erosion. If there are steep areas on the site that will be disturbed, engineering structures may be used to divert the runoff from the top of the slope to a less steeply sloped area. These measures will minimize the amount of runoff

flowing across the face of a slope and decrease the erosion of that slope. If necessary, civil engineers should assist in selecting, designing and installing the appropriate diversion structures.

- Drainage channels and streams that run through construction sites must be protected from erosion and sediment, because they can be significantly damaged. Where possible, preserving buffer zones of natural vegetation should be used to protect drainage channels or intermittent streams.

- Where construction requires that the stream or drainage channels be disturbed, then the amount of area and time of disturbance should be kept at a minimum. All stream and channel crossings should be made at right angles to the stream, preferably at the most narrow portion of the channel. Once a stream or drainage channels is disturbed, construction should proceed as quickly as possible in this area. Once completed, the stream banks should be stabilized with the necessary engineering structures. If necessary, civil engineers should assist in selecting, designing and installing the appropriate diversion structures.

8.5.3 Slow down runoff travelling across the site

The quantity and size of the soil particles that are loosened and removed increase with the velocity of the runoff. This is because high runoff velocities reduce infiltration into the soil (and therefore also increase runoff volume) and exert greater forces on the soil particles causing them to detach. It is no surprise, therefore, that high flow velocities are associated with severe rill and gully erosion.

- When preparing the site development plan, try to make grades as gradual as possible without modifying the existing site conditions significantly. Steeper slopes result in faster moving runoff, which results in greater erosion. Erosion can occur on even the gentlest of slopes, depending on soil and climate conditions.

- To prevent high erosive velocities from occurring on long, steep slopes, interrupt the slopes at regular intervals using barrier or trap techniques. Gradient terraces could be used to break the slope and slow the speed of the runoff flowing down the hillside, while surface roughening can also be used on sloped areas as a method to slow down overland flow on a steep slope.

- Concentrated runoff can be more erosive than overland flow. Runoff concentrated into drainage channels can be slowed by reducing the slope and increasing the width of a channel. When site conditions prevent decreasing the slope and widening a channel, then channel velocities can be kept low by lining drainage ways with rough surfaces such as vegetation and riprap, and by constructing check dams at frequent intervals. If necessary, civil engineers should assist in selecting, designing and installing the appropriate diversion structures.

- Concrete channels, although efficient and easy to maintain, remove runoff quickly, often resulting in downstream channel erosion and flooding.

8.5.4 Prepare drainage ways and outlets to handle concentrated or increased runoff.

Construction changes the characteristics of runoff. The creation of impervious surfaces, removal of plant cover, and compaction of soil by construction traffic allows less water to percolate into the soil and therefore increases the volume of runoff.

- If a project can be so designed that runoff from development areas is allowed to infiltrate into the soil on-site, no off-site channel enlargement or protection should be necessary.

- To prevent channel erosion from occurring, design drainage ways to withstand the peak flows without erosion, select lining materials appropriate for peak flows, and de-energize concentrated flows at outlets using energy dissipaters.

- If development substantially changes the natural drainage conditions in a catchment, merely protecting the drainage channels on a project site may not be sufficient to prevent erosion.

8.5.5 Remove sediment from onsite runoff before it leaves the site

Some erosion during construction is unavoidable. Therefore, it is necessary on most construction sites to install measures which can remove sediment from runoff before it flows off of the construction site. The function of a sediment barrier is to prevent sediment from leaving a site after the soil has been eroded from its place of origin. Sediment laden runoff should be detained on-site so that the soil particles can settle out before the runoff enters receiving waters.

- The sediment control device which is most suitable for large disturbed areas is a sediment basin. A sediment basin should be installed at all locations where the upstream disturbed area exceeds 4 hectares, unless a sediment basin is not attainable and other sediment controls need to be installed.

- For upstream disturbed areas smaller than 4 hectares, a range of suitable measures could be implemented for sediment control. These include sediment basins, sediment traps, silt fences and gravel filter berms. If necessary, civil engineers should assist in selecting, designing and installing the appropriate sediment control structures.

- Locate sediment basins and traps at low points below disturbed areas. Use earth dikes or drainage channels to route drainage from disturbed areas into the basins. Sediment barriers and sediment fences can be placed below small disturbed areas on gentle to moderate slopes. Storm water temporarily ponds up behind these barriers, allowing sediment to settle out.

- Sediment removed from sediment control facilities should be placed in non-critical flat areas of the site. In no instances should the removed sediment be placed in a position where subsequent rainfall could return it to the sediment control devices.

8.5.6 Inspect and maintain control measures.

Inspection and maintenance of control measures are vital to the success of an erosion and sediment control program. Most control measures require regular maintenance, as problems often

develop during a single storm. Some problems left untreated can result in more erosion damage than might have occurred without any erosion control measures. Inspect control measures frequently, particularly before, during, and after storm events, to ensure that they are working properly. Correct problems as soon as they develop. Assign the responsibility for routine inspections of operating erosion and sedimentation control practices to a specific individual.

8.5.7 Generic revegetation/rehabilitation measures

Exposed and unprotected soils are the main cause of erosion in most situations. Therefore, the erosion management plan and the revegetation and rehabilitation plan should be closely linked to one another and should not operate independently, but should rather be seen as complementary activities within the broader environmental management of the site and should therefore be managed together.

General factors to consider regarding erosion risk at the site includes the following:

- Soil loss will be greater during wet periods than dry periods. Intense rainfall events outside of the wet season, such as occasional unseasonal showers can also however cause significant soil loss. Therefore precautions to prevent erosion should be present throughout the year.

- Soil loss is related to the length of time that soils are exposed prior to rehabilitation or stabilization. Therefore the gap between construction activities and rehabilitation should be minimized. Allied to this the fact that topsoil does not store well and should preferably be used within a month or at most within 3 months to aid in the revegetation and rehabilitation of disturbed areas.

- Phased construction and progressive rehabilitation are important elements of the erosion control strategy.

- The extent of disturbance will influence the risk and consequences of erosion. Therefore large areas should not be cleared at a time, especially in areas such as slopes where the risk of erosion is higher.

8.6 Specific recommendations to reduce erosion potential and degradation of wetlands and drainage systems

Although there are no large drainage lines within the development area itself, access roads and other infrastructure may impinge on such areas and precautions should be taken in these situations to reduce their potential impact.

8.6.1 Concentration of flows into downstream areas

- Road crossings over drainage lines, streams and wetlands can impact downstream wetland ecosystems. Crossings that result in narrowing of the downstream system can result in concentration of flows and channelization downstream. This may result in a loss of wetland function, and result in the drying out and shrinkage of the wetland area. Erosion and increased vulnerability to invasion of drier banks by alien vegetation may occur.

- Culverts should be adequately spaced such that they do not result in shrinkage of downstream wetlands. Where roads cross minor drainage channels, a single culvert may be adequate, aligned with the downstream drainage line. Where more substantial wetland systems are intercepted by a road, sufficient culverts should be provided such that downstream shrinkage of wetland width does not occur. Moreover, culverts should be aligned, as far impossible, with existing, natural channels.

- All crossings of drainage systems should ensure that both surface and shallow subsurface flows can be accommodated where appropriate and that unnatural channelization does not occur downstream.

8.6.2 Runoff Concentration

- The increase in hardened surfaces associated with the panels, roads and other infrastructure, will lead to a significant increase in the volume and velocity of flow generated from these areas during large rainfall events.

- Runoff from road surfaces is usually channelled off of the road surface towards the downslope side of the road. On steep slopes, the volumes and velocity of runoff generated may result in erosion of the surrounding areas. Therefore specific measures to curb the speed of runoff water are usually required in such areas, such as rock beds or even gabions. In addition, these areas should be monitored for at least a year after construction to ensure that erosion is not being initiated in the receiving areas. Once erosion on steep slopes has been initiated, it can be very difficult to arrest.

8.6.3 Diversion of flows

Diversion of flows from natural drainage channels may occur when roads interrupt natural drainage lines, and water is forced to run in channels along the manipulated road edge to formalized crossing points. Even slight diversion from the natural drainage line can result in excessive downstream erosion, as the new channel cuts across the slope to reach the valley bottom. Should the access road to the site traverse any major drainage lines, the following principles should apply:

- Adequate culverts should be provided along the length of all roads to prevent diversion of flow from natural drainage lines.

- Culverts should be carefully located, such that outlet areas do in fact align with drainage lines.

- The downstream velocity of runoff should be managed, such that it does not result in downstream erosion – on steep slopes, where roads have been constructed on cut areas, allowance should be made for culverts to daylight sufficiently far down the slope that their velocities are managed and erosion does not occur.

- Where necessary, anti-erosion structures should be installed downstream of road drains – these may comprise appropriate planting, simple riprap or more formal gabion or other structures.

- Roads and their drainage system should be subject to regular monitoring and inspection, particularly during the wet season, so that areas where head cut erosion is observed can be addressed at an early stage.

8.6.4 Existing Erosion

There is very little existing erosion within the site itself. The area towards the drainage line along the southern boundary of the site is however quite heavily impacted by erosion and therefore measures should be taken to ensure that any runoff from the site does not increase the erosion problems along the drainage line. There is a dam below the site in the drainage line and it is recommended that any runoff from the site is directed into the dam, rather than anywhere else.

8.6.5 Caution in using stones for erosion control

An extremely important principle with any soil erosion control method is that when natural materials are gathered for use in control structures, care must be taken to ensure that the removal (for example, of stones) does not become the cause of a new erosion problem at the source of the material. Stones, for example, should only be collected along roads, where they are displaced during road-making, or from piles of stones cleared off irrigation lands. Similarly, natural vegetation should not be destroyed by vehicles collecting or delivering materials for gulley control.

Surface stones in stable rangeland also play an important part in soil erosion prevention. They divert and reduce the speed and force of runoff water and they trap water-carried soil particles and organic matter. They help to trap valuable plant litter and keep it in place over the soil, protecting and enriching the soil and the important detritivores that live in it. Removing stones will thus destabilize the site they are removed from, thereby risking a new source of erosion.

The indiscriminate removal of stones from natural rangeland is not a good idea because each stone shelter a microhabitat, shades the soil, reduces excessively high soil temperatures and preserves soil moisture. Loading and removing all the handy-sized loose stones from an area of rangeland for the construction of an erosion control gabion may therefore disrupt a great number of micro habitats, food chains and possibly the productive potential of the soil at the site.

Stones thus have an important function in rangeland ecology and soil protection and their removal, for whatever purpose, must therefore be very carefully considered. Where stones are in short supply, consideration should rather be given to the use of alternative construction materials that will result in lower environmental impact.

8.6.6 Site ecosystem context

The proposed development site occurs within a semi-arid environment and a fundamentally different approach to storm water management efforts is required as compared to traditional storm water management approaches within more mesic areas.

The proposed development site is situated approximately 1 360m above sea level. From Taung, the topography gently ascends onto the Ghaap Plateau towards Reivilo. The topography at the Brakfontein site is very flat with little to no variation in topography.

The geology consists of surface limestone of the Tertiary to Recent age, as well as dolomite and chert of the Campbell Group (Griqualand West Supergroup, Vaalian Erathem). The geology supports shallow soil (0.1 – 0.25m) of the Mispah and Hutton soil forms, with very little erosion. Numerous dolerite and diabase dykes are also present in the area. These dykes vary from a few meters to more than 50 m thick and are vertical to near vertical. Dyke localities can normally be identified by distinct linear surface limestone ridges elevated some 0.5 to 2 m higher than the surrounding areas. Two such dykes occur in the vicinity of the proposed development site

The mean annual precipitation of the region is approximately 400 mm. The region has a mean annual potential evaporation of 2 728 mm, which is almost seven times higher than the mean annual rainfall.

No significant surface water resources are located on the proposed development site. On-site surface water features consist of small pan-like structures which form in rainy seasons and a few drainage lines. Due to the slow infiltration rate of the dolomitic surfaces in the area, these pan-like structures are likely to contain surface water for some months after excessive rain events before infiltration or evaporation.

8.7 Impact minimisation and control measures

The facility will consist of many hectares of panels as well as service roads between the arrays. These will generate a lot of runoff, several times greater than the natural site currently generates. This must be managed adequately, especially with regards to the distribution and velocity of the runoff.

Runoff from the site will be retained on site and slowly released in a controlled manner into the veld or the drainage line to the west of the site, in such a way that it does not to exacerbate existing erosion problems in those areas.

8.7.1 Construction phase

The following management actions are required to minimize soil and vegetation disturbance during the construction phase, as well as facilitate the re-vegetation/rehabilitation of disturbed/denuded areas:

Management action	Frequency
Site preparation	
The Environmental Control Officer (ECO)/Environmental Officer (EO) must provide permission before any natural vegetation is cleared for development.	As required, weekly.
Clearing of existing natural vegetation must only be undertaken as the work progresses. Mass clearing must not be permitted, unless the entire cleared area is to be rehabilitated immediately thereafter.	
Clearing of existing natural vegetation must be restricted to the affected development area and may not spill over into adjacent areas. No-go	

Management action	Frequency
areas will be clearly demarcated prior to construction.	
Construction activities	
Take care to avoid the introduction of weeds and invasive alien plant species to the site. Pay particular attention to imported material, such as building sand and other construction materials. Check stockpiles regularly and remove any weeds emerging from material stockpiles.	As required, once a month.
Take care to avoid the introduction of weeds and invasive alien plant species to the site. Pay particular attention to dirty earth-moving and construction equipment. Clean dirty earth-moving and construction machinery and equipment at a remote site before transporting these to the development site.	As required, every time new machinery and equipment is brought to the site.
Weeds and alien invasive plant identification and control	
Inspect the development site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation. Detect and identify weeds and invasive alien plants that occur on site.	Monthly
Control weeds and invasive alien vegetation, including post control regrowth throughout the entire site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	Monthly
Do no cultivate any alien species on site. If vegetation is required for aesthetic or other purposes, use non-invasive locally occurring indigenous species.	When necessary
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	As required, after re-vegetation and rehabilitation.
Re-vegetation and habitat rehabilitation	
Implement re-vegetation and habitat rehabilitation plan in areas disturbed during construction activities, as well as during the control of weeds and invasive alien plants as soon as possible in all areas after construction has been completed.	As required, after re-vegetation and rehabilitation.
Mulch used to encourage regrowth of vegetation on cleared areas should preferably not be brought onto site from remote areas, brush from cleared areas should be used as much as possible. Where it is imperative to source mulch from remote areas, the origin thereof should be established in order to gauge the risk of weeds and invasive alien	As required, every time new mulch is brought to the site.

Management action	Frequency
plant spread onto the development site. Use only mulch from remote areas with a low risk of weeds and invasive alien plant infestation/colonisation.	
Protection of areas where weeds/invasive alien plants have been controlled	
Once weeds/invasive alien plants have been controlled, and disturbed areas re-vegetated/rehabilitated, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas to prevent re-infestation/re-colonisation.	As required, after re-vegetation and rehabilitation.
Protection of adjacent disturbed areas	
Regularly monitor adjacent areas disturbed through human interaction that can act as a source of weeds and invasive alien plants or their propagating material (including seeds) and facilitate re-infestation/re-colonisation.	As required, during construction.

8.7.2 Operational phase

Weed and invasive alien plant management efforts will certainly fail without regular checking and maintenance. The complete site, especially disturbed, as well as revegetated and rehabilitated areas should therefore be inspected as required to assess if any follow-up control actions are necessary.

Management action	Frequency
Weed and alien invasive plant management	
Inspect the development site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation. Detect and identify weeds and invasive alien plants that occur on site.	Quarterly (every 3 months) for the first 2 years and biannually thereafter.
Control weeds and invasive alien vegetation, including post control regrowth throughout the entire site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	
Do no cultivate any alien species on site. If vegetation is required for aesthetic or other purposes, use non-invasive locally occurring indigenous species.	When necessary
Re-vegetation/rehabilitation maintenance	
Inspect the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant	As required, annually at the beginning of the

Management action	Frequency
infestation/colonisation and asses vegetation cover. Re-vegetate areas showing inadequate vegetation cover as specified in the re-vegetation and habitat rehabilitation plan.	rainy season.
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	As required, annually during the rainy season.
Protection of areas where weeds/invasive alien plants have been controlled	
Once weeds/invasive alien plants have been controlled, and disturbed areas re-vegetated/rehabilitated, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas to prevent re-infestation/re-colonisation.	As required, monthly.
Protection of adjacent disturbed areas	
Regularly monitor adjacent areas disturbed through human interaction that can act as a source of weeds and invasive alien plants or their off propagating material (including seeds) and facilitate re-infestation/re-colonisation.	As required, during operations.

8.7.3 Decommissioning phase

The following management actions are aimed at preventing invasion by invasive alien species of re-vegetated areas created during decommissioning activities.

Management action	Frequency
Weed and alien invasive plant management	
Inspect the development site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation. Detect and identify weeds and invasive alien plants that occur on site.	Bi-annually, for 2 years after re-vegetation and rehabilitation.
Control weeds and invasive alien vegetation, including post control regrowth throughout the entire site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	Biannually, for 2 years after re-vegetation and rehabilitation.

Management action	Frequency
Site re-vegetation/habitat rehabilitation	
Where the decommissioning activities resulted in areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation, such areas will be re-vegetated/rehabilitated as specified in the re-vegetation and habitat rehabilitation plan.	As required, as soon as possible after decommissioning.
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	As required, for 2 years after re-vegetation and rehabilitation.
Protection of areas where weeds/invasive alien plants have been controlled	
Once weeds/invasive alien plants have been controlled, and disturbed areas re-vegetated/rehabilitated, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas to prevent re-infestation/re-colonisation.	As required, for 2 years after re-vegetation and rehabilitation.
Protection of adjacent disturbed areas	
Regularly monitor adjacent areas disturbed through human interaction that can act as a source of weeds and invasive alien plants or their off propagating material (including seeds) and facilitate re-infestation/re-colonisation.	Biannually, for 2 years after re-vegetation and rehabilitation.

8.8 Roles and responsibilities

Effective weed and invasive alien plant control during the construction, operational and decommissioning phases of the project will be dependent on the following of project personnel:

8.8.1 The Developer

The project proponent (developer) will be responsible for the following:

- Ensuring that the requirements set out in this management plan are adhered to and implemented;
- Appoint a suitably qualified project engineer prior to the start of construction, with overall responsibility for the implementation of the management plan during the construction phase of the project; and

- Appoint an independent suitably qualified individual prior to the start of construction as Environmental Officer (EO)/Environmental Control Officer (ECO) to monitor and verify the implementation of this management plan during the construction phase of the project; and

- Appoint a suitably qualified individual prior to the start of the operational phase of the project as Environmental Officer (EO) to implement this management plan during the operational phase of the project; and

- Provide all principal contractors working on the project with a copy of this management plan as part of tender documentation to allow the contractors to cost for the implementation of its requirements in their respective construction tenders.

- Provide the project engineer, appointed independent EO/ECO for the construction phase, appointed qualified EO for the operational phase, as well as all principal contractors working on the project with copies of the Final EIA report, the requirements of the EA, and this management plan.

8.8.2 The Engineer

The project engineer will be responsible for the overall implementation of the management plan during the construction phase of the project. To effectively implement the plan, the engineer must be aware of the findings, mitigation measures and conclusions of the Final EIA report, the requirements of the EA, and this management plan.

8.8.3 The Environmental Officer (EO)/ Environmental Control Officer (ECO) for construction

The independent EO/ECO is responsible for monitoring and verifying the implementation of the Nmanagement plan during the construction phase of the project. To effectively monitor and verify the implementation of the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

8.8.4 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the operational phase of the project. To effectively implement the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

8.8.5 The Principal Contractor(s)

The principal contractor(s), being any directly appointed entity undertaking the implementation of work, will be responsible for complying with the management plan at all times during the construction phase. It is likely that the principal contractor(s) will appoint a suitably qualified individual prior to the start of the construction phase of the project as Environmental Officer (EO) to implement this management plan during the construction phase of the project.

8.8.6 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the construction phase of the project. To effectively implement the management plan, the EO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

8.9 Monitoring Programme

Monitoring is an essential component of successful weed and invasive alien plant control plans. Monitoring must be undertaken to monitor the extent of weed and invasive alien plant occurrence on site, as well as the success of the control plan.

In general, the following principles apply to monitoring activities:

- Simple records must be kept of
    - weeds and invasive alien plant occurrence, e.g. what plants were identified where, as well as the extent and nature of the occurrence;
    - control measures implemented, e.g. area/location cleared, date and nature of control actions undertaken, labour units and the amount of weed killer (herbicide) used, where appropriate;
    - climatic conditions at the site.
- A picture says more than a thousand words. Therefore, photographic records is a very important tool in any monitoring programme. Photos must be kept of:
    - any areas where weeds and invasive alien plants occur, immediately before and after control activities;
    - weed and invasive alien plant control activities;
    - control success over time, indicating the areas where control activities had been implemented at regular intervals after the control activities were implemented.
- It is important that when monitoring results in detection of weeds and invasive alien plants, control actions are immediately planned and implemented.

8.9.1 Construction phase

The following monitoring is required during the construction phase of the project:

Monitor Activity	Indicator	Frequency
Monitor weeds and invasive alien plant	Alien species list,	Pre-construction &

Monitor Activity	Indicator	Frequency
presence on site	distribution map & GPS coordinates	monthly thereafter
Monitor weeds and invasive alien plant control measures implemented	Record of control activities	Monthly
Monitor weeds and invasive alien plant control success	Decline in abundance of alien plant species over time, regrowth and/or re-infestation/re-colonisation	Monthly
Climatic conditions at the site	Rainfall	Monthly
Monitor re-vegetated areas to identify areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Monthly

8.9.2 Operational phase

The following monitoring is required during the operational phase of the project:

Monitor Activity	Indicator	Frequency
Monitor weeds and invasive alien plant presence on site	Alien species list, distribution map & GPS coordinates	Quarterly (every 3 months) for the first 2 years and biannually thereafter.
Monitor weeds and invasive alien plant control measures implemented	Record of control activities	
Monitor weeds and invasive alien plant control success	Decline in abundance of alien plant species over time, regrowth and/or re-infestation/re-colonisation	
Climatic conditions at the site	Rainfall	Monthly
Monitor re-vegetated areas to identify areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Quarterly (every 3 months) for the first 2 years and biannually thereafter.

8.9.3 Decommissioning phase

The following monitoring is required during the decommissioning phase of the project:

Monitor Activity	Indicator	Frequency
Monitor development site and re-vegetated/ rehabilitated areas where infrastructure has been removed to detect, identify and describe any weed and invasive alien plant occurrence.	Alien species list, distribution map & GPS coordinates	Biannually, for 3 years after decommissioning and rehabilitation or until natural vegetation has recovered sufficiently to resist invasion
Monitor weeds and invasive alien plant control measures implemented	Record of control activities	
Monitor weeds and invasive alien plant control	Decline in abundance	

Monitor Activity	Indicator	Frequency
success	of alien plant species over time, regrowth and/or re-infestation/re-colonisation	
Climatic conditions at the site	Rainfall	Monthly
Monitor re-vegetated areas to identify areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Quarterly (every 3 months) for the first 2 years and biannually thereafter.

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9 REVEGETATION AND HABITAT REHABILITATION PLAN

9.1 Purpose, scope and limitations

The purpose of the re-vegetation and habitat rehabilitation plan is to ensure that areas where vegetation has been cleared or habitat impacted during construction activities of the proposed facility are re-vegetated and the habitat rehabilitated.

The re-vegetation and rehabilitation at the site is aimed at:

- re-vegetating and rehabilitating all affected areas with suitable plant species, within the shortest possible timeframe after completion of construction activities, in order to speed up the natural recovery process;
- achieving the long-term stabilisation of all disturbed areas to minimise potential soil erosion and restore some ecosystem/habitat functionality.

This re-vegetation and habitat rehabilitation plan should be closely aligned with the erosion and alien invasive plant management plans, as they are inextricably linked.

9.2 Background

9.2.1 General understanding

Although rehabilitation, re-vegetation, reclamation and restoration are often used interchangeably by the layman, they will be used within their specific technical context in this document. All four of these processes relates to repairing the damage caused by human activities, i.e. assisting the recovery of ecosystems that has been degraded, damaged or destroyed. This plan covers the aspects of re-vegetation and rehabilitation, but does not explicitly focus on either reclamation or restoration, as defined below.

- Re-vegetation

To re-vegetate means to produce a new growth of vegetation (on disturbed or barren ground). Re-vegetation then is the growth of new vegetation on an area that has been cleared or otherwise disturbed.

Re-vegetation includes the process of replanting and rebuilding the soil of disturbed land. It also involves the re-establishment of vegetation, either by planting seedlings, sowing seed (direct seeding), or by using techniques to assist in the natural regeneration of the landscape.

Re-vegetation may occur as a natural process, produced by plant colonization and succession, or an artificial (manmade), accelerated process designed to repair damage to a landscape due to wildfire, mining, flood, or other causes. It may involve the use of exotic plants (aliens), indigenous plants that are not locally found, or indigenous plants that are found locally in the area being re-vegetated).

The motivations behind re-vegetation are diverse, but the prevention of soil erosion is usually a primary reason. Re-vegetation also enhances the ability of the soil to absorb more water during significant rain events, thereby reducing turbidity in adjoining bodies of water.

- Rehabilitation

To rehabilitate means to restore to good condition. Rehabilitation then means returning a disturbed environment to a socially, economically en environmentally acceptable condition that is similar to or better than its original condition. Rehabilitation attempts to provide specific services, to reintroduce certain ecosystem processes and functions, or to re-vegetate damaged lands, which are more appropriate goals in most degraded situations. It, however, but does not necessarily mean a return to pre-existing biotic conditions. Therefore, rehabilitation projects may require some attendance in time.

- Reclamation

Reclamation is a process where unusable land is returned to a useful state. It normally is the first stage in a rehabilitation or restoration process.

- Restoration

Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed to its original, historical (undisturbed indigenous) state. Restoration projects require no attendance once they are mature. It involves facilitating natural ecological processes to return a disturbed landscape to its original condition.

A 'true' restoration process, aimed at reconstructing a prior ecosystem and re-establishing former functions, communities and structure is very ambitious, extremely expensive, and almost impossible task, particularly at the landscape level.

9.3 Legal context

9.3.1 Conservation of Agricultural Resources Act No. 43 of 1983

This Act provides for the conservation of our natural agricultural resources, by the maintenance of the production potential of land; the combating and prevention of erosion and weakening or destruction of the water sources; the protection of vegetation; and the combating of weeds and invader plants. Section 6 of the Act allows the Minister to prescribe control measures to achieve the objects of the Act, which shall be complied with by land users to whom they apply. These Control measures are prescribed in regulations published in terms of the Act, including control measures for the restoration or reclamation of eroded land or land which is otherwise disturbed or denuded.

The regulations stipulate firstly that if a land user disturbs or denudes any land on a farm for purposes other than prospecting or mining activities, such disturbance or denuding shall be done systematically from a specified point; while the area that is left unprotected prior to the commencement of the restoration or reclamation thereof shall not at any time exceed one hectare or a larger area, approved on application.

The regulations further require land users to effectively restore and reclaim disturbed or denuded land by implementing a range of measures, as many as are necessary in the specific situation. These include the following:

- removing topsoil and keeping it separate, in order to replace it later on the disturbed or denuded land;
- using topsoil to stabilise the sides of hollows that has been caused by the exploitation or removal of material and, where possible, reclaiming part of the disturbed or denuded land;
- removing excavations so far from boundary fences, so that the sides thereof can be finished and stabilised without encroaching upon adjoining land;
- restoring the flow pattern of run-off water, the topography and the slope of the land as closely as possible to the original condition, depending on the volume of material exploited or removed;
- establishing suitable vegetation on the disturbed or denuded land to expedite the restoration and reclamation thereof;
- fenced off the land concerned and withdrawing it from grazing, until such time as vegetation has been sufficiently restored or established;
- constructing and thereafter maintaining a suitable soil conservation work, if necessary for the protection of the land concerned against excessive soil loss through the action of water or wind, or in order to collect sediment from run-off water.

9.3.2 National Environmental Management Act No. 107 of 1998

Section 28 of the Act requires every person who causes, has caused or may cause significant pollution or degradation of the environment, to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. It furthermore stipulates that if such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, reasonable measures must be taken to minimise the pollution or environmental degradation caused at first and rectify/remediate the harm caused afterwards.

This duty relates to any significant change in the environment, caused by substances, radioactive or other waves or noise, odours, dust or heat emitted from any activity, where that change has an adverse effect on human health or well-being; on the composition, resilience and productivity of natural or managed ecosystems; on materials useful to people, or will in the future have such an adverse effect. It applies to activities such as the storage or treatment of waste or substances, as well as the construction and the provision of services, irrespective of whether it is engaged in by any person or an organ of state.

The responsibility to take the reasonable measures applies to land owners, persons in control of land/premises or persons who have a right to use the land/premises on which or in which any activity or process is or was performed or undertaken; or any other situation

exists, which causes, has caused or is likely to cause significant pollution or degradation of the environment.

The reasonable measures may include measures to cease, modify or control any act, activity or process causing the pollution or degradation; contain or prevent the movement of pollutants or the causant of degradation; eliminate any source of the pollution or degradation; or remedy the effects of the pollution or degradation.

9.3.3 National Water Act No. 36 of 1998

Section 19 of the Act requires every person who occupies or uses the land on any activity or process is or was performed or undertaken, or any other situation exists which causes, has caused or may cause pollution of a watercourse, to take reasonable measures to prevent such pollution from occurring, continuing or recurring. Water courses include rivers or springs; natural channels in which water flows regularly or intermittently; wetlands, lakes or dams into which, or from which water flows; surface water, estuaries and aquifers. It also include the beds and banks of the above, where relevant.

This duty relates to any direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare, health or safety of human beings; to any aquatic or non-aquatic organisms; to the resource quality or to property.

The responsibility to take reasonable measures applies to land owners, persons in control of land or persons who occupy or use the land.

The reasonable measures referred to may include measures to cease, modify or control any act or process causing the pollution; comply with any prescribed waste standard or management practice; contain or prevent the movement of pollutants; eliminate any source of the pollution; remedy the effects of the pollution; and remedy the effects of any disturbance on the bed and banks of a watercourse.

9.3.4 National Environmental Management: Air Quality Act No. 36 of 1998

Section 32 of the Act allows the Minister to prescribe measures for the control of dust in specified places or areas, either in general or by specified machinery or in specified instances; steps that must be taken to prevent nuisance by dust; as well as other measures aimed at dust control.

The Minister has established standards for the acceptable dust fall rate, for residential and non-residential areas, in dust control regulations published in terms the Act in November 2013. The regulations also empower air quality officers to require any person to undertake a dust-fall monitoring programme, if there is reasonable suspicion that the person is releasing/emitting dust in excess of the standards, or if the activity being conducted by the person requires a fugitive dust emission management plan. If a dust-fall monitoring report provides evidence that any person has exceeded the dust-fall standard, the regulations

require such person to develop a dust management plan within three months after submission of the monitoring report, submit it for approval and implement it.

9.4 Re-vegetation/rehabilitation principles

9.4.1 Functional ecosystems

It is generally accepted that successful rehabilitation, re-vegetation, reclamation and restoration aims to establish functional ecosystems, i.e. ecosystems that are stable (not subject to high rates of erosion); effective in retaining water and nutrients; and self-sustaining.

It is important that the goals set for site rehabilitation should clearly identify the type of ecosystem that is required, and possibly some of the ecosystem services that it is expected to provide. For example, requirements may include a high level of protection against erosion, or provide food/shelter for some particular bird or animal species. The major issue is that the ecosystem services required should be achievable and reasonable.

If goals for rehabilitation specify a particular plant community, the above three criteria provide a basis for determining whether the desired community is sustainable (functional in the long-term). However, plant communities are typically temporally and spatially variable, and assessments of functionality need to consider such variation.

Where disturbed areas need to be rehabilitated, no attempt should be made to try and restore the sites to a pre-development condition. The rehabilitation actions should rather focus on the stabilization of soil erosion, the establishment of a dense and protective plant cover and the introduction of some of the more palatable plant species that were lost due to general habitat degradation. Rehabilitation methods should furthermore ensure that the maximum amount of rainwater infiltrates the soil and runoff is reduced through the capture and retention of water in the landscape.

Establishing a diverse vegetation community often requires a combination of methods. These can include the use of direct topsoil return, seeding, planting of seedlings, transplanting and habitat transfer and natural re-colonisation. The selected combination of methods will be documented in the rehabilitation plan, although some refinement may be necessary through trial and error during rehabilitation operations.

9.4.2 Minimise time that disturbed areas are left without vegetation

The time that the land is left without cover during construction must be minimised by taking steps to ensure that rehabilitation commences within 6 months of land becoming available for rehabilitation. where permanent rehabilitation cannot commence within such timeframe, temporary rehabilitation methods, such as covering disturbed areas with shade-netting or mulch, should be implemented.

9.4.3 Prioritise areas of rehabilitation and temporary cover to reduce impacts

Prioritise re-vegetation and rehabilitation actions, as well as temporary cover in those areas where leaving land exposed will have the biggest impact. These include areas that have the potential to generate dust leaving the site; that are important for biodiversity, such as rehabilitation adjoining or providing connectivity to remnant vegetation; as well as areas that have the greatest impact on visual amenity, such as areas that face townships, residences, or the highway.

9.4.4 Be realistic

It is important, however, to appreciate that veld re-vegetation and rehabilitation in arid areas is a slow process that is largely dependent on climatic conditions following the rehabilitation work.

9.4.5 Physical constraints

The physical attributes of a site place ultimate constraints on what can be achieved in a rehabilitation program. It may not be possible to re-establish some vegetation types, if the site lacks some of the required characteristics (such as rainfall and warmth). This could be due to the normal climatic regime of the site, processes such as climate change or the direct result of the development activity. It is essential to determine the physical constraints as early as possible in the re-vegetation/rehabilitation process in order to manage stakeholder expectations.

- Landform design

Disturbed landform reconstruction is aimed at cost-effectively achieving a sustainable land use, while managing the risk of environmental impact and limiting the need for on-going maintenance. Where the development actions significantly altered the landform, rehabilitated landforms should mimic natural landforms as much as possible. Rehabilitation earthworks should aim to reconstruct similar distributions of slope angles, slope lengths, vegetation patterns to those that were in place prior to development.

- Growth media

Growth media refers to materials placed on the surface of a rehabilitated area or landform, with the expectation that they will support plant growth. Such materials are commonly the topsoil harvested prior to construction, though not necessarily so. Timing, soil condition, and handling techniques all influence the ability to retain soil structure and to reduce compaction. It is essential that the limitations to plant growth in a given area be fully understood prior to planning rehabilitation work.

- Ecosystem succession

If the objective is to establish a diverse, sustainable indigenous ecosystem, then successional aspects of an eco-system must be considered. Pioneer species that readily colonise disturbed areas should be included in the seed mix. Species characteristics of

later successional stages should also be established early, if experience proves this can be done successfully. The relative abundances of species will change as early colonisers die out and longer-lived species, or those that colonise later, become proportionally more dominant. High seeding rates of some early colonising species may reduce overall diversity by out-competing other species.

- Natural re-colonisation

Natural re-colonisation can, over time, result in many indigenous plant species establishing through seed brought into a site by wind, water or fauna (such as seed in bird droppings). It is important to understand which species will quickly re-colonise in acceptable numbers and which will take much longer. There is little point in purchasing and applying seed of species that re-colonise naturally within an acceptable timeframe. However, where natural re-colonisation takes a very long time, seeding or planting may be needed to establish some key species in order to meet rehabilitation objectives. Protection of indigenous vegetation communities adjacent to development sites is essential for providing a source of seed and facilitating natural re-colonisation.

9.5 Generic re-vegetation/rehabilitation measures

9.5.1 Topsoil management

Topsoil is the top-most layer (0-25cm) of the soil in undisturbed areas. This soil layer is important as it contains nutrients, organic matter, seeds, micro-organisms fungi and soil fauna. All these elements are necessary for soil processes such as nutrient cycling and the growth of new plants. The biologically active upper layer of the soil is fundamental in the maintenance of the entire ecosystem.

Effective topsoil management is a critical element of rehabilitation, particularly in arid and semi-arid areas where soil properties are a fundamental determinant of vegetation composition and abundance. Depending on its constituents, topsoil can serve a number of important functions. Carefully managed topsoil can supply seed and other propagules, which could include species difficult to obtain or germinate; contribute soil organisms and micro-organisms that can improve plant growth and stabilise the soils and are not easily replaced if lost; supply a range of nutrients and trace elements essential to plant growth, that are not normally provided in equal measure by materials (especially un-weathered materials) deeper in the soil profile; and facilitate the rapid development of groundcover. In general, topsoil should be conserved and used in the re-vegetation/rehabilitation program.

9.5.2 Topsoil removal, handling and replacement

During rehabilitation operations it is critical that topsoil is removed, handled and replaced with great care and in a manner that will conserve plant diversity in the topsoil seed bank and maximise plant establishment after replacement.

In cases where the objective is the re-establishment of indigenous species, a thin layer of surface soil should be removed prior to the stripping of further soil, because most

indigenous seeds are concentrated in the top 50 millimetres of the soil profile. As the maximum depth of emergence of these species ranges from 30 millimetres to 100 millimetres, stripping and replacement of a surface layer greater than 100 millimetres can result in a considerable loss of potential seedlings through dilution of seeds and their failure to emerge.

The nature of the equipment used and the soil moisture content at the time of stripping influence the degree of soil compaction and structural breakdown that can occur during stripping. The combined use of a front-end loader, truck and bulldozer for the removal, transport and spreading of topsoil is the best combination to reduce compaction.

If required, soil stockpiles should be constructed to minimise deterioration of seed, nutrients and soil biota, by avoiding topsoil collection when saturated after rainfall (this will promote composting), and by creating stockpiles that does not exceed a height of three metres, but preferably not higher than one metre. The duration of stockpiling should be minimised, as periods longer than about six to 12 months may cause structural degradation and death of seeds and micro-organisms, especially when soil moisture content is high. If soil stockpiles are required for extended periods, seeding thereof with a grass/legume mixture or indigenous nitrogen-fixing species will assist in erosion control and reduce the loss of beneficial soil micro-organisms.

The total depth of topsoil replaced will be governed by such factors as the desired vegetation, the quantity and quality of the surface and subsoil available and the nature of the underlying material. A general principle is that the constructed root zone should have sufficient plant-available water to support the desired vegetation through the driest season. This can be achieved either by increasing the depth of replaced plant growth medium or, if possible, by using other materials with a high available-water capacity.

9.5.3 Topsoil treatments

If chemical and physical tests show that the growth medium does not have major limitations to root growth, a layer of topsoil as thin as 50 millimetres will aid vegetation establishment by providing a suitable environment for seed germination, by allowing infiltration of water, and by supplying nutrients and micro-organisms. If such tests, however, show major limitations to root growth, the use of ameliorants such as gypsum or lime may be required, or the application of fertilisers to replace the nutrient bank lost during vegetation removal and the construction process.

It is essential that the types and methods of application of macro-nutrients and micro-nutrients are carefully planned, based on detailed soil characterisation studies and rehabilitation objectives and targets. Inorganic fertilisers are most commonly used; however, organic fertilisers such as sewage sludge or vegetation mulch can be a cost-effective alternative provided care is taken not to introduce weeds and high concentrations of metals.

In some cases it may be necessary to inoculate with symbiotic micro-organisms such as nitrogen-fixers and mycorrhizae. Ripping along the contour will usually also be required

after construction to facilitate root penetration through compacted material and to reduce seed loss.

Other specific considerations include:

- collecting topsoil at a time of year when the soil seed bank is likely to be highest;
- stripping, stockpiling and replacing topsoil separately from subsoil, if required, to ensure that the nutrient-containing, microbial-containing and seed containing horizon is returned to the surface;
- topsoil should ideally not be stockpiled but directly replaced onto an area prepared for rehabilitation, where possible;
- where the amount of topsoil available is limited, it is best to spread it to a thinner depth or in strips;
- the final topsoil surface should be freshly disturbed and suitable for direct seeding, if this is to follow.

9.5.4 Vegetation establishment

Methods/techniques used for vegetation establishment are designed to fulfil long-term rehabilitation objectives, such as conservation of indigenous vegetation, dust reduction, water quality protection and provision of grazing.

It may be necessary to conduct re-vegetation operations in several stages. For example, rapid grass establishment may be required to control erosion, while infill planting of seedlings can occur later. However, grass can compete with indigenous species, especially those established through direct seeding. Care is needed to ensure that the optimal combination of methods is used to ensure that rehabilitation objectives are met.

9.5.5 Seeding

Seeding is widely used for establishing indigenous vegetation communities. It is often the most cost-effective means of establishing a range of plant species over a large area. However, it can be somewhat hit and miss if not carefully planned and implemented, or when unpredictable weather conditions follow seed spreading. A number of important aspects need to be taken into account to increase the chances of success when seeding.

It is essential that as much of the local seeds and propagules contained within the top few centimetres of soil be retained for re-vegetation purposes. Where feasible, vegetation established on rehabilitated land should be similar to the vegetation type and community that was present before construction started.

9.5.6 Seed supply

Seed may be collected or purchased. Where possible, seed should be collected locally, because it will be best adapted to the conditions and will maintain the genetic integrity of

local provenances. After collection, seed will need to be cleaned and stored under conditions that will maintain maximum viability over the period of storage and minimise damage due to pests and fungi.

Commercial seed companies also provide seed of many plant species that are suitable for rehabilitation. Use government certified seed that has been tested for purity, weed contamination and germination percentage, where possible. If seed is purchased from anybody other than a commercial seed company, ensure that the purity and germination percentage of the seed is guaranteed.

Pelleted or coated seed refer to seed coated or encapsulated into a so-called pellet. In this process, a thin layer of fertiliser, lime, inoculating glue and other nutrient is applied to the seeds of specific grass species according to a special procedure. The coating acts as a protective layer against unfavourable environmental conditions, such as high temperatures and low moisture availability, as well as predation by ants, insects and birds. Pelleting is suitable for many grass species, especially hairy of woolly seeds.

Seed of Karoo plant species, as well as Karoo plants are obtainable or can be ordered from Sue Milton-Dean and Richard Dean, Renu-Karoo Veld Restoration CC, Tel: 023 5411 828 Mobile: 082 7700 206, Email: sukaroo@telkomsa.net or renuaroo@gmail.com.

9.5.7 Seeding rate

The information required to determine seeding rate is not always readily available and seed viability and germination testing can help determine what rate might be necessary to achieve a desired plant density. Mortality of young seedlings, which can be high, depending on follow-up rainfall, will also need to be considered. Higher seeding rates of ground cover species such as grasses will be necessary where erosion protection is critical.

9.5.8 Seed mixes

Seed mixes generally include several species to take advantage of different site conditions, growth forms (e.g., sod formers and bunchgrasses), establishment rates, and persistence. Consider alternate species, varieties and costs. Match the site properties and special attributes such as acidity levels, drainage, winter hardiness, etc. The supply of seed and cost are important practical considerations in the development of all seed mixes.

9.5.9 Seedbed preparation

A well-prepared seedbed provides the best germination potential, and will allow some flexibility in reducing seed rates. A good seedbed has small cracks and discontinuities that trap seed and provide good contact between seed and soil. This improves germination because it helps prevent the seed from drying out. Large clods and very rough surfaces do not make good seedbeds because the clods dry out before the seeds germinate and seed tends to collect in the lowest points, resulting in very patchy distribution. Seedbed conditions are probably worst on compacted, smooth soil surfaces.

Seedbed conditions deteriorate with time after tillage because rainfall will cause crusting of the soil at the surface and filling the small cracks and pores that trap seed. For this reason, seeding should occur immediately after tillage. If seeding is delayed until after a rainfall event, seed application rates should be increased.

9.5.10 Seed spreading

The actual methods of spreading seed will partly depend on what labour and equipment are available. They can include spreading by hand, agricultural seed spreader or the bulldozer doing the ripping (this ensures that the seed is applied to a freshly disturbed surface rather than one that has developed a crust). It is important to ensure that each species is spread at the selected target rate. It is important to remember that some mechanical methods do not spread specific seed types well.

9.5.11 Timing of seeding

The timing of seeding is critical and can vary significantly, depending on local climatic conditions. Usually, the best time to seed is immediately after soil disturbance, when the seedbed is in good condition. Climatic factors affecting seed survival and plant establishment should be considered when planning rehabilitation so that soil and climatic conditions are optimal for vegetation establishment. Seeding at any time may fail if weather conditions turn unfavourable. In terms of climatic conditions, the best time to seed is in autumn, prior to reliable rainfall, but well in advance of extremely cold periods when seedlings could be killed by frost.

9.5.12 Spreading vegetation

In some plant communities, many plant species do not readily release their seeds. These species can be reintroduced by collecting vegetation from areas being cleared for mining and returning it directly to newly rehabilitated areas where it will release its seed and provide erosion protection.

9.5.13 Mulching

Once the re-vegetated/rehabilitated area is seeded, the site is ready for mulching. Mulching is the covering of the soil with a layer of organic matter of leaves, twigs bark or wood chips, usually chopped quite finely. The main purpose of mulching is to protect and cover the soil surface, as well as serve as a source of seed for re-vegetation purposes.

Mulches are non-living materials spread over the soil surface to reduce erosion and aid plant establishment by conserving moisture and moderating soil temperatures. Several types of mulches can be used, including relatively thick layers of organic material, manufactured mulch mats of various types, and thin layers of mulch primarily applied during hydro-seeding.

- Thick mulches

Materials suitable for thick mulches include logging residues (either fine slash or chipped debris), forest floor material, straw or hay. As a rough guideline, 5–10 cm should be a sufficient depth for most sites. Decomposition occurs slowly because the mulched layer dries out repeatedly, but the materials will eventually contribute to the restoration of soil organic matter. Thick mulches imitate the ecological functions of a forest floor and are recommended primarily for drought-prone sites. The mulch will keep fine-textured soils moist and soft and plant roots may explore the interface between the mulch and mineral soil.

- Thin mulches

Thin mulches are useful to aid the germination and establishment of grasses and legumes on drought prone sites, highly erodible soils, unconsolidated (sandy) surface soils, and slopes with southerly or westerly exposures. The mulches can be applied over the top of seed to protect it from desiccation and wind, water or gravity movement. Some types of light mulches need a binding agent applied to or with them to prevent them from blowing or washing away.

It is important to appreciate that a great deal of mulch will be required. Although finding suitable, and enough, mulch material is always a problem in arid areas; every effort must be made to provide adequate mulch material because of the important function that it has in the rehabilitation process.

If not enough material is available from the veld, then it is suggested that an alternative source of mulch material be found. These include alien blue-gum trees, pepper trees, old man saltbush or even Spanish reed that occur in the area can. Care must, however, be taken to apply mulch from the trees and saltbush only once dried out, as the branches and leaves may have an allelopathic (chemical) impact on soil. Spanish reed must be roughly cut, otherwise it blows away in windy weather if too fine.

The cut branches of trees or the reeds are then fed through a PTO-driven (or motorised) chip mulch machine. The chip mulch machine must be set to produce a rough mulch consisting of bits that are approximately 100 – 150 mm long. This will ensure that the mulch will form a dense mat on the surface rather than lie ineffectively above it, as is often the case with branch mulch or brush packing.

The mulch should be put down to completely cover the surface, but not seal it or shade it out too much. A layer of about 30 mm should be suitable but this must be tested on site to confirm the ideal thickness of the mulch. There must be enough mulch to create a microclimate suitable for plant germination, which means adequate, but not too much shading.

9.5.14 Erosion control

Soil erosion may threaten the stability and water retention capacity of re-vegetated/rehabilitated areas. Where this is likely, an erosion management plan must be developed and implemented parallel to this plan.

9.5.15 Animal control

Animals can cause significant problems to developing rehabilitation. Grazing livestock may need to be excluded by fencing during the establishment period and possibly longer. Grazing by indigenous mammals such as buck, rabbits and rodents can also be a problem and may require the use of protective methods not harmful to wildlife.

9.5.16 Weed and alien invader plant control

Weeds and alien invasive plants may compete with local indigenous plants. Where this is likely, a weed and alien invasive plant management plan must be developed and implemented parallel to this plan.

9.5.17 Habitat rehabilitation

Where the aim of rehabilitation is to establish a sustainable indigenous ecosystem, fauna habitat requirements should be taken into account. Re-colonisation of faunal species to rehabilitated areas can be encouraged by the provision of suitable habitat. Establishment of vegetation communities similar to those that existed prior to construction should ensure that most species will re-colonise in time. Natural fauna re-colonisation is almost always preferable to physically reintroducing animals, as there is no cost involved and fauna will return when the habitat meets their requirements.

Experience has shown that some key components of fauna species' habitat requirements may not be present in rehabilitation for many decades. Examples of how these habitat deficiencies were addressed include:

- transplanting of grass/trees;
- conservation and reuse of vegetation by chipping or spreading it as mulch, branches to provide shelter for small invertebrates and reptiles, erosion protection, and nutrients;
- the construction of nest boxes to provide shelter and breeding habitat for many bird and mammal species;
- construction of reptile habitat by limited use of surface boulders;
- construction of perches used by raptors and other birds (who may introduce seeds).

9.5.18 Site ecosystem context

The proposed development site occurs within a semi-arid environment and a fundamentally different approach to rehabilitation efforts is required as compared to traditional rehabilitation approaches within more mesic areas. In addition, rehabilitation techniques which rely on agricultural techniques, such as the application of fertilizer and the planting of annual grasses may not be appropriate. The major implication of the semi-arid nature of the site is that the use of appropriate species and techniques is key in order to achieve long-term success.

The site is situated on flat and gently sloping plains, interspersed with hills and rocky ridges. The geology of the area consists of mudstones and sandstones that supports duplex soils with dominant prismacutanic and/or pedocutanic diagnostic horizons, as well as some shallow Glenrosa and Mispah soils. The soils on most of the site is slightly to moderately susceptible to water and wind erosion, specifically to high volumes of concentrated runoff water, although a small portion of the site with duplex soils is sensitive to erosion, especially the sub-soil. The annual sediment yield from the areas the equivalent of 184 tons/ha. Most parts of the site have at least some topsoil, but the south-western parts of the site have shallow stony soils and the high rock cover limits erosion potential in this area.

The site lies within the summer rainfall region of South Africa, has a mean annual rainfall of 330 mm and receives rain mainly (61%) in autumn and summer, peaking in March. The region also has a mean annual potential evaporation of almost seven times higher than the mean annual rainfall. The site is likely to receive the majority of rainfall as thunder showers with a moderate to high erosion potential. The panels, roads and other hardened surfaces are likely to generate large amounts of runoff during such events, which would create erosion problems if not properly managed.

Given the slope and other characteristics of the site, the major types of erosion likely to be apparent at the site are sheet erosion and rill erosion, which if unchecked would lead to gully erosion. Runoff generated in the upper parts of the site will accumulate towards the bottom of the site and if not adequately controlled will pose a high erosion risk in this vulnerable area.

9.6 Impact minimisation and control measures

9.6.1 Construction phase

The following management actions are required to minimize soil and vegetation disturbance during the construction phase, as well as facilitate the re-vegetation/rehabilitation of disturbed/denuded areas:

Activity	Frequency
Site preparation	
Harvest mulch from areas that are to be denuded of vegetation during construction activities, provided that they are free of seed-bearing alien invasive plants. The standing vegetation should not be cleared and mixed with the soil during site clearing, but cleared separately, either mechanically or by hand using a brush-cutter. No harvesting of vegetation may be done outside the area to be disturbed by construction activities	As required, prior to the commencement of construction activities.
Stockpile the cleared vegetation and use it as is or shredded by hand or machine. Store brush-cut mulch for as short a period as possible.	

Activity	Frequency
Where the construction activities significantly altered the landform, rehabilitation earthworks should aim to mimic the natural landforms as much as possible, reconstructing slope angles, slope lengths, drainage channels and vegetation patterns similar to those that were in place prior to construction.	As required, as soon as possible after construction activities have ceased.
The Environmental Control Officer (ECO)/Environmental Officer (EO) must provide permission before any natural vegetation is cleared for development.	As required, weekly.
Clearing of existing natural vegetation must only be undertaken as the work progresses. Mass clearing must not be permitted, unless the entire cleared area is to be rehabilitated immediately thereafter.	
Clearing of existing natural vegetation must be restricted to the affected development area and may not spill over into adjacent areas. No-go areas will be clearly demarcated prior to construction.	
Topsoil management	
All topsoil will be retained on site in order to be used for site rehabilitation.	As required, prior to the commencement of construction activities.
Where excavations or topsoil removal is required, the topsoil will be excavated to a maximum depth of 300 mm.	
Soil deeper than 300 mm (subsoil) will be excavated, stored and replaced separately.	
Wherever possible, stripped topsoil will be placed directly onto an area being rehabilitated.	
If direct transfer is not possible, the topsoil will be stored separately from other soil stockpiles until construction in an area is complete.	As required, from stripping of topsoil to the re-use thereof for rehabilitation purposes.
To avoid compaction and the development of anaerobic conditions within the soil, topsoil stockpiles will not be higher than 1m.	
If topsoil is stored on a slope, upslope runoff will be directed away from the stockpiles and sediment fencing will be used downslope of the stockpile to intercept any sediment.	
The soil will be used as soon as possible and not be stored for longer than 6 months.	As required, as soon as possible after construction activities have ceased.
All disturbed areas that need to be rehabilitated will be covered by a layer of at least 150 mm of topsoil, once construction activities have ceased.	
If subsoil is required for rehabilitation purposes, it should be covered with topsoil prior to re-vegetation.	

Activity	Frequency
Vegetation establishment	
Prepare a proper seedbed for the direct seeding by disturbing/loosening the topsoil, especially in areas that have been compacted during construction, if this is to follow.	As required, preferably in late summer (February)
Use a commercial grass seed mixture of *Chloris gayana*, *Eragrostis curvula* and *Digitaria eriatha*. These species: • can be successfully established in areas with an average annual rainfall of 250-400 mm; • are moderately tolerant to drought and moderately to completely tolerant to frost; • require low to medium soil fertility; • can established successfully in sandy-loam to clayey soils; • are perennial species with high grazing value; and • are easily established from seed.	As required, preferably in early autumn (March)
Use 4.3 kg of the seed mixture per hectare, consisting of 1.9 kg *Chloris gayana* seed, as well as 1.2 kg seed of *Eragrostis curvula* and *Digitaria eriatha* each.	As required, preferably in early autumn (March)
Sow the seeds in shallow furrows, spaced 30-50 cm apart, preferably in autumn (March). Rainfall in autumn is fairly reliable, and it allows for an establishment period of at least 6 weeks before the first extremely cold periods could be expected, where seedlings could be killed by frost.	
Where perennial grasses, shrubs, succulents and geophytes or other species which may survive translocation are available in areas that are going to be cleared, individual plants may be dug out from such areas and planted into areas which require re-vegetation, if required. All transplants will remain within the site and will be placed within a similar environment from where they came in terms of aspect, slope and soil depth.	As required, prior to the commencement of construction activities.
Apply a 30 mm layer of mulch to the seeded are to protect and cover the soil surface and create a microclimate suitable for plant germination.	As required, after the seeding has been completed.
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	As required, after re-vegetation and rehabilitation.

Activity	Frequency
Animal management	
Exclude grazing livestock by fencing during the establishment period. Attend to problems related to grazing by indigenous small mammals such as buck, rabbits and rodents that can threaten the re-vegetation/rehabilitation success.	As required, after re-vegetation and rehabilitation.
Weed and alien invasive plant management	
Inspect the construction site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation and soil erosion.	Quarterly, during construction.
Detect, identify and control weeds and invasive alien vegetation, including post control regrowth that occur on site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	
Habitat rehabilitation	
Encourage re-colonisation of faunal species to rehabilitated areas by the provision of suitable habitat through mulching, strategic provision of surface rocks etc.	As required, after re-vegetation.
Protection of re-vegetated areas	
Once disturbed areas have been re-vegetated/rehabilitated, and weeds/invasive alien plants controlled, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas, to prevent re-infestation/re-colonisation and soil erosion.	As required, after re-vegetation and rehabilitation.
Protection of adjacent indigenous plant communities	
Protect indigenous vegetation communities adjacent to the development sites to provide a source of seeds and facilitate natural re-colonisation.	As required, during construction.

9.6.2 Operational phase

Re-vegetation and veld rehabilitation efforts will certainly fail without regular checking and maintenance. Re-vegetated and rehabilitated areas should therefore be inspected as required to assess if any maintenance actions are necessary.

Activity	Frequency
Re-vegetation/rehabilitation maintenance	

Activity	Frequency
Identify re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining. Areas showing inadequate vegetation cover should be re-vegetated again, as discussed under 6.1.	As required, annually.
Erosion management	
Assess the negative impact of soil erosion on the re-vegetated areas and implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of re-vegetated/rehabilitated areas.	As required, annually during the rainy season.
Animal management	
Evaluate the negative impact of indigenous small mammals such as buck, rabbits and rodents on the re-vegetated areas and attend to problems related to grazing by that can threaten the re-vegetation/rehabilitation success.	As required, annually.
Weed and alien invasive plant management	
Inspect the construction site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation and soil erosion.	Bi-annually, for 2 years after re-vegetation and rehabilitation.
Detect, identify and control weeds and invasive alien vegetation, including post control regrowth that occur on site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	Bi-annually, for 2 years after re-vegetation and rehabilitation.
Habitat rehabilitation	
Encourage re-colonisation of faunal species to rehabilitated areas by the provision of suitable habitat through mulching, strategic provision of surface rocks etc.	As required, annually.
Protection of re-vegetated areas	
Once disturbed areas have been re-vegetated/rehabilitated weeds/invasive, and alien plants controlled, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas, to prevent re-infestation/re-colonisation and soil erosion.	As required, annually.
Protection of adjacent indigenous plant communities	
Protect indigenous vegetation communities adjacent to the development sites to provide a source of seeds and facilitate natural re-colonisation.	As required, during operations.

9.6.3 Decommissioning phase

Activity	Frequency
Site preparation	
Where the decommissioning activities significantly altered the landform, rehabilitation earthworks should aim to mimic the natural landforms as much as possible, reconstructing slope angles, slope lengths, drainage channels and vegetation patterns similar to those that were in place prior to the development.	As required, as soon as possible after decommissioning.
Prepare a proper seedbed for the direct seeding by disturbing/loosening the topsoil, especially in areas that have been compacted during construction, if this is to follow.	As required, preferably in late summer (February)
Vegetation establishment	
Use a commercial grass seed mixture of *Chloris gayana*, *Eragrostis curvula* and *Digitaria eriatha*. These species: • can be successfully established in areas with an average annual rainfall of 250-400 mm; • are moderately tolerant to drought and moderately to completely tolerant to frost; • require low to medium soil fertility; • can established successfully in sandy-loam to clayey soils; • are perennial species with high grazing value; and • are easily established from seed.	As required, preferably in early autumn (March)
Use 4.3 kg of the seed mixture per hectare, consisting of 1.9 kg *Chloris gayana* seed, as well as 1.2 kg seed of *Eragrostis curvula* and *Digitaria eriatha* each.	
Sow the seeds in shallow furrows, spaced 30-50 cm apart, preferably in autumn (March). Rainfall in autumn is fairly reliable, and it allows for an establishment period of at least 6 weeks before the first extremely cold periods could be expected, where seedlings could be killed by frost.	
Apply a 30 mm layer of mulch to the seeded are to protect and cover the soil surface and create a microclimate suitable for plant germination.	As required, after the seeding has been completed.
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and	As required, for 2 years after re-vegetation and rehabilitation.

Activity	Frequency
invasive alien plant infestation/colonisation.	
Animal management	
Exclude grazing livestock by fencing during the establishment period. Attend to problems related to grazing by indigenous small mammals such as buck, rabbits and rodents that can threaten the re-vegetation/rehabilitation success.	As required, after re-vegetation and rehabilitation.
Weed and alien invasive plant management	
Inspect the construction site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation and soil erosion.	Bi-annually, for 2 years after post-decommissioning re-vegetation and rehabilitation.
Detect, identify and control weeds and invasive alien vegetation, including post control regrowth that occur on site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	
Habitat rehabilitation	
Encourage re-colonisation of faunal species to rehabilitated areas by the provision of suitable habitat through mulching, strategic provision of surface rocks etc.	As required, after re-vegetation.
Protection of re-vegetated areas	
Once disturbed areas have been re-vegetated/rehabilitated weeds/invasive, and alien plants controlled, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas, to prevent re-infestation/re-colonisation and soil erosion.	As required, after re-vegetation and rehabilitation.
Protection of adjacent indigenous plant communities	
Protect indigenous vegetation communities adjacent to the development sites to provide a source of seeds and facilitate natural re-colonisation.	As required, during operations.

9.7 Roles and responsibilities

Effective re-vegetation and habitat rehabilitation during the construction, operational and decommissioning phases of the project will be dependent on the following of project personnel:

9.7.1 The Developer

The project proponent (developer) will be responsible for the following:

- Ensuring that the requirements set out in this management plan are adhered to and implemented;
- Appoint a suitably qualified project engineer prior to the start of construction, with overall responsibility for the implementation of the management plan during the construction phase of the project; and
- Appoint an independent suitably qualified individual prior to the start of construction as Environmental Officer (EO)/Environmental Control Officer (ECO) to monitor and verify the implementation of this management plan during the construction phase of the project; and
- Appoint a suitably qualified individual prior to the start of the operational phase of the project as Environmental Officer (EO) to implement this management plan during the operational phase of the project; and
- Provide all principal contractors working on the project with a copy of this management plan as part of tender documentation to allow the contractors to cost for the implementation of its requirements in their respective construction tenders.
- Provide the project engineer, appointed independent EO/ECO for the construction phase, appointed qualified EO for the operational phase, as well as all principal contractors working on the project with copies of the Final EIA report, the requirements of the EA, and this management plan.

9.7.2 The Engineer

The project engineer will be responsible for the overall implementation of the management plan during the construction phase of the project. To effectively implement the plan, the engineer must be aware of the findings, mitigation measures and conclusions of the Final EIA report, the requirements of the EA, and this management plan.

9.7.3 The Environmental Officer (EO)/ Environmental Control Officer (ECO) for construction

The independent EO/ECO is responsible for monitoring and verifying the implementation of the management plan during the construction phase of the project. To effectively monitor and verify the implementation of the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

9.7.4 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the operational phase of the project. To effectively implement the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

9.7.5 The Principal Contractor(s)

The principal contractor(s), being any directly appointed entity undertaking the implementation of work, will be responsible for complying with the management plan at all times during the construction phase. It is likely that the principal contractor(s) will appoint a suitably qualified individual prior to the start of the construction phase of the project as Environmental Officer (EO) to implement this management plan during the construction phase of the project.

9.7.6 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the construction phase of the project. To effectively implement the management plan, the EO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

9.8 Monitoring Programme

Monitoring is an essential component of successful rehabilitation programs. Given the uncertainty that still exists in relation to many aspects of re-vegetation/rehabilitation, and the unpredictability thereof, particularly in arid areas, it is essential that rehabilitation success is monitored. Monitoring also provides the information needed to achieve continuous improvement in relation to the establishment of diverse plant communities.

In general, the following principles apply to monitoring activities:

- Simple records must be kept of
    - Occurrence of bare patches and degraded areas, e.g. what types of degradation were identified where, as well as the extent and nature of the occurrence;
    - control measures implemented, e.g. area/location re-vegetated/rehabilitated, date and nature of re-vegetation/rehabilitation actions undertaken, and labour units used, where appropriate;
    - climatic conditions at the site.
- A picture says more than a thousand words. Therefore, photographic records are a very important tool in any monitoring programme. Photos must be kept of:
    - any areas with bare patches and where degradation occur, immediately before and after control activities;
    - re-vegetation/rehabilitation activities;
    - control success over time, indicating the areas where re-vegetation/rehabilitation activities had been implemented at regular intervals after the control activities were implemented.
- It is important that when monitoring results in detection of bare patches and degraded areas, control actions are immediately planned and implemented.

9.8.1 Construction phase

Monitor Activity	Indicator	Frequency
Monitor rehabilitation activities: • to enable analyses and critical interpretation of initial establishment results and long-term trends; and • to be used (as an auditable checklist) to prove that agreed re-vegetation/rehabilitation plan commitments have been met.	Details of rehabilitation activities, such as topsoil placement, seeding, mulching, etc.	As required during re-vegetation/rehabilitation activities, at least monthly.
Monitor re-vegetated areas to assess the re-vegetation/rehabilitation success	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Quarterly (every 4 months) for the first 12 months following construction.

9.8.2 Operational phase

At the completion of re-vegetation/rehabilitation activities, monitoring will be carried out to assess early rehabilitation success, reveal the need for any remedial actions and determine whether rehabilitation is likely to meet long-term objectives (to the extent possible at this early stage).

Monitor Activity	Indicator	Frequency
Monitor rehabilitation activities: • to enable analyses and critical interpretation of initial establishment results and long-term trends; and • to be used (as an auditable checklist) to prove that agreed re-vegetation/rehabilitation plan commitments have been met.	Details of rehabilitation activities, such as topsoil placement, seeding, mulching, etc.	As required during re-vegetation/rehabilitation activities, quarterly.
Monitor re-vegetated areas to assess the re-vegetation/rehabilitation success	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Bi-annually (every 6 months) during the operational phase, in spring and autumn.

9.8.3 Decommissioning phase

Monitor Activity	Indicator	Frequency
Monitor rehabilitation activities: • to enable analyses and critical interpretation of initial establishment results and long-term trends; and • to be used (as an auditable checklist) to prove that agreed re-vegetation/rehabilitation plan commitments have been met.	Details of rehabilitation activities, such as topsoil placement, seeding, mulching, etc.	As required during re-vegetation/rehabilitation activities, at least monthly.
Monitor re-vegetated areas to assess the re-vegetation/rehabilitation success	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Quarterly (every 4 months) for the first 12 months following decommissioning.

9.8.4 References

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- South Africa. 1983a. Conservation of Agricultural Resources Act (No. 43 of 1983) , as amended. Government Notice No. 883, Government Gazette No. 8673, dated 27 April 1983
- South Africa. 1983b. Conservation of Agricultural Resources Act (No. 43 of 1983) Regulations, as amended. Government Notice R. 1048, Government Gazette 9238, dated 25 May 1984.
- South Africa. 1998a. National Water Act (No. 36 of 1998). Government Notice 1091, Government Gazette 19182.
- South Africa. 1998b. National Environmental Management Act (No. 107 of 1998). Government Notice 1540, Government Gazette 19519.

10 STORM WATER MANAGEMENT PLAN

10.1 Purpose, scope and limitations

The purpose of the storm water management plan is to ensure that areas where the potential for water runoff is high during construction activities of the proposed facility, is managed in such a manner that it simulates the natural flow of water and will have a minimal effect on soils and vegetation.

Storm water management at the site is aimed at:

- Managing surface water runoff from harden surfaces in cases of high rainfall events;
- Where water is used for cleaning of the PV panels for finally achieving minimal erosion and clean-and-dirty water separation.

This storm water management plan should be closely aligned with the erosion management plan, as they are inextricably linked.

10.2 Background

10.2.1 General understanding

It is widely recognised that developments impact negatively on natural drainage systems in several ways, including:

- Reduced permeability of catchment areas by introduction of impervious surfaces such as streets and buildings. This results in increased catchment runoff volumes.
- The introduction of efficient storm water drainage results in reduced catchment response times with concomitant increased downstream flow peaks.
- Manipulation of groundwater tables, which can have severe effects on wetland functioning and the survival of many terrestrial plant communities.
- Alteration to the natural flow regimes in river systems resulting in both geomorphologic (e.g. channel / bank erosion) and aquatic ecosystem changes over time.
- Deteriorating water quality as a result of industrial fallout, fertilisers and other pollutants that are conveyed by storm water systems directly to receiving water bodies, without any attempt to ameliorate en route (Storm water Management Planning and Design Guidelines for New Developments, 2002).

10.3 Legal context

10.3.1 Conservation of Agricultural Resources Act No. 43 of 1983

This Act provides for the conservation of our natural agricultural resources, by the maintenance of the production potential of land; the combating and prevention of erosion and weakening or destruction of the water sources; the protection of vegetation; and the combating of weeds and invader plants. Section 6 of the Act allows the Minister to prescribe control measures to achieve the objects of the Act, which shall be complied with by land users to whom they apply. These Control measures are prescribed in regulations published in terms of the Act, including control measures for the prevention or control of regulating of the flow pattern of run-off water.

The regulations stipulate that no land user shall in any manner whatsoever divert any run-off water from a water course on his farm unit to any other water course, except on authority of a written permission by the executive officer.

The regulations further require that no land user shall:

- Effect an obstruction that will disturb the natural flow pattern of run-off water on his farm unit or permit the creation of such obstruction unless the provision for the collection, passing through and flowing away of run-off water through, around or along that obstruction is sufficient to ensure that it will not be cause for excessive soil loss due to erosion through the action of water or the deterioration of the natural agricultural resource.

10.3.2 National Environmental Management Act No. 107 of 1998

Section 28 of the Act requires every person who causes, has caused or may cause significant pollution or degradation of the environment, to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. It furthermore stipulates that if such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, reasonable measures must be taken to minimise the pollution or environmental degradation caused at first and rectify/remediate the harm caused afterwards.

This duty relates to any significant change in the environment, caused by substances, radioactive or other waves or noise, odours, dust or heat emitted from any activity, where that change has an adverse effect on human health or well-being; on the composition, resilience and productivity of natural or managed ecosystems; on materials useful to people, or will in the future have such an adverse effect. It applies to activities such as the storage or treatment of waste or substances, as well as the construction and the provision of services, irrespective of whether it is engaged in by any person or an organ of state.

The responsibility to take the reasonable measures applies to land owners, persons in control of land/premises or persons who have a right to use the land/premises on which or in which any activity or process is or was performed or undertaken; or any other situation exists, which causes, has caused or is likely to cause significant pollution or degradation of the environment.

The reasonable measures may include measures to cease, modify or control any act, activity or process causing the pollution or degradation; contain or prevent the movement of pollutants or the causant of degradation; eliminate any source of the pollution or degradation; or remedy the effects of the pollution or degradation.

10.3.3 National Water Act No. 36 of 1998

Section 19 of the Act requires every person who occupies or uses the land on any activity or process is or was performed or undertaken, or any other situation exists which causes, has caused or may cause pollution of a watercourse, to take reasonable measures to prevent such pollution from occurring, continuing or recurring. Water courses include rivers or springs; natural channels in which water flows regularly or intermittently; wetlands, lakes or dams into which, or from which water flows; surface water, estuaries and aquifers. It also includes the beds and banks of the above, where relevant.

This duty relates to any direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare, health or safety of human beings; to any aquatic or non-aquatic organisms; to the resource quality or to property.

The responsibility to take reasonable measures applies to land owners, persons in control of land or persons who occupy or use the land.

The reasonable measures referred to may include measures to cease, modify or control any act or process causing the pollution; comply with any prescribed waste standard or management practice; contain or prevent the movement of pollutants; eliminate any source of the pollution; remedy the effects of the pollution; and remedy the effects of any disturbance on the bed and banks of a watercourse.

10.4 General storm water management principles

10.4.1 Minimise Impervious Areas and Maximise Vegetated Areas

These two principles go hand-in-hand. By minimising impervious areas one decreases the flow of storm water run-off, increasing filtration thus, reducing the risk of erosion and floods. This can be achieved by maximising vegetated areas.

10.4.2 Maximise Open Space

Structural best management principles are those that are engineered or constructed using man-made materials and/or natural systems, whilst non-structural BMPs tend to preserve existing open space or protect natural systems. By integrating open spaces costs will be kept low drainage will be improved as well as natural filtration (Switch, 2006).

10.4.3 Design to mimic or replicate natural hydrology of the site

One of the easiest ways to treat water as a resource is to work with the natural hydrology of the site. Taking into account the site's natural drainage features and balance of infiltration, evaporation, transpiration, and surface flow will allow you to minimize harmful off-site impacts and protect water resources. Ideally one can maintain or restore the site to function as it did under predevelopment conditions. In areas where impacts from existing development are severe, your site's capacity to absorb hydrologic impacts can be enhanced to have a net-positive (rather than net-zero) effect on the hydrology of the larger drainage area or watershed (Water Environment Research Foundation, 2007).

10.4.4 Infiltrate Storm Water Runoff

Many storm water best management practices aim to reduce site runoff by evaporation, infiltration, detention, and retention. This approach can reduce infrastructure costs (pipes and sewers, for example) and help maintain onsite water balance. Infiltration systems recharge groundwater, filer pollutants out of storm water, and irrigate plants. Detention and retention systems slow or eliminate the release of storm water from a site, protecting downstream water bodies from erosive flows, and they can provide an aesthetic and recreational amenity, as well (Water Environment Research Foundation, 2007).

10.5 Site ecosystem context

The proposed development site occurs within a semi-arid environment and a fundamentally different approach to storm water management efforts is required as compared to traditional storm water management approaches within more mesic areas.

The proposed development site is situated approximately 1 360m above sea level. From Taung, the topography gently ascends onto the Ghaap Plateau towards Reivilo. The topography at the Brakfontein site is very flat with little to no variation in topography.

The geology consists of surface limestone of the Tertiary to Recent age, as well as dolomite and chert of the Campbell Group (Griqualand West Supergroup, Vaalian Erathem). The geology supports shallow soil (0.1 – 0.25m) of the Mispah and Hutton soil forms, with very little erosion. Numerous dolerite and diabase dykes are also present in the area. These dykes vary from a few meters to more than 50 m thick and are vertical to near vertical. Dyke localities can normally be identified by distinct linear surface limestone ridges elevated some 0.5 to 2 m higher than the surrounding areas. Two such dykes occur in the vicinity of the proposed development site

The mean annual precipitation of the region is approximately 400 mm. The region has a mean annual potential evaporation of 2 728 mm, which is almost seven times higher than the mean annual rainfall.

No significant surface water resources are located on the proposed development site. On-site surface water features consist of small pan-like structures which form in rainy seasons and a few drainage lines. Due to the slow infiltration rate of the dolomitic surfaces in the area, these pan-like

structures are likely to contain surface water for some months after excessive rain events before infiltration or evaporation.

10.6 Impact minimisation and control measures

10.6.1 Site establishment and Construction phase

The following management actions are required to minimize surface water run-off during the construction phase:

Activity	Frequency
Site preparation	
Retain good plant cover to reduce the rate of flow of surface water run-off	As required, prior to the commencement of construction activities.
If it is not possible to retain good plant cover during construction, other methods should be employed, including covering soil with i.e. straw, mulch, erosion control mats etc.	
Establish an effective storm water drainage system by incorporating the natural drainage lines and keep clear of any obstructions	As required, weekly.
Slopes must remain as low as possible to prevent excessive runoff	As required, prior to the commencement of construction activities.
Build berms as well as cross mounds on the access road	
Interruption of surface water flows during site establishment and construction	
Do not extend the PV plant footprint into the drainage features in the centre part of the proposed development area	As required, prior to the commencement of construction activities
Gravel should be placed on access road surfaces to protect the soil against water erosion	
Where possible, make use of existing roads where possible and minimize the construction of new roads	

10.6.2 Operational phase

Storm water management efforts will certainly fail without regular checking and maintenance of storm water infrastructure. Areas where storm water management efforts have been implemented should therefore be inspected as required to assess if any maintenance actions are necessary.

Activity	Frequency
Management of storm water efforts	
After the implementation of the initial storm water management measures the ECO should identify areas of potential risk and re-establish adequate storm water management measures. Control storm water runoff to prevent or minimise siltation of downstream water courses Inspect storm water system channels to ensure that the system is kept clean to prevent clogging	As required, annually.
Berms and cross mounds across roads	
Berms and cross mounds should be kept in a good condition to ensure that water run-off is managed on road surface and to minimise erosion	As required, annually.
Water run-off from staff facilities and offices	
After construction the buffer zone around the buildings should be covered with gravel. Care should also be taken to control and distribute the storm water run-off from the roof of the building in such a manner that it does not lead to water erosion of the surrounding soil	As required, during operations.
Washing of PV panels	
Care should also be taken to control and distribute the storm water run-off from the PV panels in such a manner that it does not lead to water erosion of the surrounding soil.	

10.6.3 Decommissioning phase

Activity	Frequency
Decommissioning of site	
Establish an effective storm water drainage system applicable for the decommissioning phase and keep clear of any obstructions	As required, decommissioning phase
Slopes must remain as low as possible to prevent excessive runoff	
Decommissioning must not extend the original PV plant footprint into the drainage features in the centre part of the proposed development area	
Retain good plant cover to reduce the rate of flow of surface water run-off	

10.7 Roles and responsibilities

Effective re-vegetation and habitat rehabilitation during the construction, operational and decommissioning phases of the project will be dependent on the following of project personnel:

10.7.1 The Developer

The project proponent (developer) will be responsible for the following:

- Ensuring that the requirements set out in this management plan are adhered to and implemented;
- Appoint a suitably qualified project engineer prior to the start of construction, with overall responsibility for the implementation of the management plan during the construction phase of the project; and
- Appoint an independent suitably qualified individual prior to the start of construction as Environmental Officer (EO)/Environmental Control Officer (ECO) to monitor and verify the implementation of this management plan during the construction phase of the project; and
- Appoint a suitably qualified individual prior to the start of the operational phase of the project as Environmental Officer (EO) to implement this management plan during the operational phase of the project; and
- Provide all principal contractors working on the project with a copy of this management plan as part of tender documentation to allow the contractors to cost for the implementation of its requirements in their respective construction tenders.
- Provide the project engineer, appointed independent EO/ECO for the construction phase, appointed qualified EO for the operational phase, as well as all principal contractors working on the project with copies of the Final EIA report, the requirements of the EA, and this management plan.

10.7.2 The Engineer

The project engineer will be responsible for the overall implementation of the management plan during the construction phase of the project. To effectively implement the plan, the engineer must be aware of the findings, mitigation measures and conclusions of the Final EIA report, the requirements of the EA, and this management plan.

10.7.3 The Environmental Officer (EO)/ Environmental Control Officer (ECO) for construction

The independent EO/ECO is responsible for monitoring and verifying the implementation of the management plan during the construction phase of the project. To effectively monitor and verify the implementation of the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

10.7.4 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the operational phase of the project. To effectively implement the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

10.7.5 The Principal Contractor(s)

The principal contractor(s), being any directly appointed entity undertaking the implementation of work, will be responsible for complying with the management plan at all times during the construction phase. It is likely that the principal contractor(s) will appoint a suitably qualified individual prior to the start of the construction phase of the project as Environmental Officer (EO) to implement this management plan during the construction phase of the project.

10.7.6 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the construction phase of the project. To effectively implement the management plan, the EO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

10.8 Monitoring Programme

Monitoring is an essential component of successful storm water management programs. Monitoring also provides the information needed to achieve continuous improvement in relation to the establishment of diverse plant communities.

In general, the following principles apply to monitoring activities:

- Simple records must be kept of
    - Occurrence of areas with signs of erosion, e.g. did the area of effect increase from previous inspection;
    - control measures implemented, e.g. area/location re-vegetated/rehabilitated, date and nature of re-vegetation/rehabilitation actions undertaken, and labour units used, where appropriate;
    - climatic conditions at the site.
- A picture says more than a thousand words. Therefore, photographic records are a very important tool in any monitoring programme. Photos must be kept of:
    - any areas where erosion occur, immediately before and after control activities;
    - establishment of storm water channels, berms and cross mounds;

- It is important that when monitoring results in detection of bare patches and degraded areas, control actions are immediately planned and implemented.

10.8.1 Construction phase

Monitor Activity	Indicator	Frequency
Monitor areas where storm water management measures have been implemented: • to enable analyses and critical interpretation of initial management measures; and	Details of any erosion, plant debris etc.	At least monthly and more frequently during rainy season.

10.8.2 Operational phase

At the completion of initial storm water management measures, monitoring will be carried out to assess early success, reveal the need for any remedial actions and determine whether storm water management measures are likely to meet long-term objectives (to the extent possible at this early stage).

Monitor Activity	Indicator	Frequency
Monitor areas where storm water management measures have been implemented: • to enable analyses and critical interpretation of initial management measures; and	Details of any erosion, or excessive sedimentation etc.	At least monthly and more frequently during rainy season.

10.8.3 Decommissioning phase

Monitor Activity	Indicator	Frequency
Monitor areas where storm water management measures have been implemented: • to enable analyses and critical interpretation of initial management measures; and	Details of any erosion, plant debris etc.	At least monthly and more frequently during rainy season.

10.9 References

- South Africa. 1983a. Conservation of Agricultural Resources Act (No. 43 of 1983) , as amended. Government Notice No. 883, Government Gazette No. 8673, dated 27 April 1983

- South Africa. 1983b. Conservation of Agricultural Resources Act (No. 43 of 1983) Regulations, as amended. Government Notice R. 1048, Government Gazette 9238, dated 25 May 1984.

- South Africa. 1998a. National Water Act (No. 36 of 1998). Government Notice 1091, Government Gazette 19182.

- South Africa. 1998b. National Environmental Management Act (No. 107 of 1998). Government Notice 1540, Government Gazette 19519.

11 WEED AND ALIEN INVASIVE PLANT MANAGEMENT PLAN

11.1 Purpose, scope and limitations

The purpose of the weed and alien invasive plant management plan is to provide a framework for the management of weeds and alien invader plants during the construction, operation and decommissioning of the proposed facility.

The monitoring and control activities at the site are aimed at:

- preventing the establishment of weeds and alien invader plants in areas affected by the construction activities;
- controlling any weeds and alien invader plants that occurs in areas affected by the construction activities;
- monitoring the presence weeds and alien invasive plant species in areas affected by the construction activities; as well as the success of the weeds and alien invader plants.

This weed and alien invasive plant rehabilitation plan should be closely aligned with the erosion and re-vegetation and habitat rehabilitation plans, as they are inextricably linked.

11.2 Background

11.2.1 General understanding

Invasive alien plants cause problems globally when invader populations explode under favourable conditions and dominate indigenous plant and animal communities. Impacts associated with invasive alien plants include reduced surface water runoff and groundwater reserves, increased biomass and fire intensity, markedly reduced biodiversity and many economic consequences. Water use also increases where indigenous vegetation is replaced by dense stands of invasive alien trees. Fuel loads at invaded sites increase up to tenfold, increasing fire intensities and causing soil damage, increased erosion and decreased germination from indigenous seed pools. The invasion process also has many other ecological impacts, which include alteration of soil nutrient cycling, reduction of stream flow and reduction of light to the forest floor or near to the ground.

There are several reasons for this problem occurring, but most important is that aliens find themselves in an environment different from that in which they evolved. Usually such a drastic change in environment is fatal to an alien. Occasionally, however, conditions are superior to those in the native land. In particular the alien animal or plant is normally free of the diseases, parasites and predators which keep its numbers in check in its natural environment. Under these conditions populations can explode with the invaders overwhelming the indigenous fauna and flora, usually by crowding them out, by competition for resources, or by predation. They are thus able to dominate plant and animal communities either by out-competing native species for space, light, or nutrients, or through predation.

The majority of negative environmental impacts associated with weeds and alien invader plants may be reversible, even after up to 20 years of dense infestation. However, expensive and drastic measures are often required to control invaders.

Weeds and alien invader plants can be classified into the following categories:

- Alien plant species

A species which does not occur naturally in an area (i.e. is not indigenous), but which has been introduced there by people, is called an alien. Sometimes people use the word exotic instead of alien, but this is not the best word as it has many other meanings.

- Invader plant species

Invasive species are those that have the ability to encroach on undisturbed, pristine areas and to displace the indigenous species.

- Alien invasive plant species

Alien species that have been introduced accidentally/intentionally and encroach on undisturbed, pristine areas to displace the indigenous species.

- Weeds

Plants which can as a mono-species dominate or replace any canopy or sub-canopy layer of a natural or semi-natural habitat, thereby altering its structure, integrity and functioning. This group represents the most serious environmental weeds and include trees, aggressive climbers, thicket-forming shrubs and dense herbs.

- Minor weeds

Plants that invade and persist in any layer of a natural or semi-natural habitat, but are not particularly aggressive and cannot or do not dominate that layer as a mono-species or seriously alter the vegetation structure or functioning, although the accumulation of several species may do so.

- Ruderal and agrestal weeds

Annual or biennial plants (mostly), which are primarily weeds of waste places (ruderals) and cultivated lands (agrestals) and are only able to invade and persist in severely and recently disturbed areas. They scarcely invade or persist in established vegetation. Some species can invade natural or semi-natural habitats along watercourses that are subject to periodic flooding.

- Declared weeds and invaders (CARA legal status)

Plants which are declared as weeds3 and invaders4 in terms of the Conservation of Agricultural Resources Act No. 43 of 1983 (CARA). These plants are listed in Table 3 of the

[3] Any kind of plant which has under section 2(3) been declared a weed, and includes the seed of such plant and any vegetative part of such plant which reproduces itself asexually.

[4] A kind of plant which has under section 2(3) been declared an invader plant, and includes the seed of such plant and any vegetative part of such plant which reproduces itself asexually.

CARA regulations (GN. R. 1048), as amended on 30 March 2001 (GN R. 280), and subject to control activities as stipulated in the regulations.

- Listed invasive species (NEM:BA legal status)

Plant species that are listed as invasive species in terms of the National Environmental Management: Biodiversity Act No. 10 of 2004 (NEM:BA). These Category 1a & 1b, 2 and 3 plants are listed in Table 3 of the CARA regulations (GN. R. 1048), as amended on 30 March 2001 (GN R. 280), and subject to control activities as stipulated in the regulations.

11.3 Legal context

11.3.1 Conservation of Agricultural Resources Act No. 43 of 1983

This Act provides for the conservation of our natural agricultural resources, by the maintenance of the production potential of land; the combating and prevention of erosion and weakening or destruction of the water sources; the protection of vegetation; and the combating of weeds and invader plants. Although the CARA does not apply to any land in urban areas, the CARA provisions relating to weeds and invader plants also apply to land situated in urban areas.

Section 5 of the Act prohibits any person to sell, agree to sell or offer, advertise, keep, exhibit, transmit, send, convey or deliver for sale, or exchange for anything or dispose of to any person in any manner for a consideration, any weed. It further prohibits any person to in any other manner whatsoever disperse or cause or permit the dispersal of any weed from any place in the Republic to any other place in the Republic.

Section 6 of the Act allows the Minister to prescribe control measures to achieve the objects of the Act, which shall be complied with by land users to whom they apply. These Control measures are prescribed in regulations published in terms of the Act (GN R 1048), including control measures for weeds and invader plants.

- Management and control

Regulation 15 makes provision for the management and control of three groups of alien invader plants:

- Category 1 plants[5] are prohibited on any land or water surface in South Africa and must be controlled or eradicated by means of the methods prescribed (see control methods below).
- Category 2 plants[6] (commercially used plants) may be grown under controlled conditions in demarcated areas[7], provided that a permit has been issued for that purpose, the category 2 plants in the area or their products are demonstrated to primarily serve a commercial purpose, use as a woodlot, shelter belt, building material, animal fodder, soil stabilisation, medicinal or other beneficial function that the executive officer may approve and the category 2 plants in the area are cultivated under controlled circumstances.

[5] Plants of the kinds specified as category 1 in the CARA regulations, declared as weeds.

[6] Plants of the kinds specified as category 2 in the CARA regulations, declared as invader plants.

[7] An area in respect of which a water use license for stream flow reduction activities has been issued in terms of section 36 of the National Water Act, 1998 (Act No. 36 of 1998) shall be deemed to be a demarcated area.

All steps must furthermore be taken to curtail the spreading of propagating material of the category 2 plants outside demarcated areas and to control any category 2 plants that occur on any land or inland water surface outside demarcated areas by means of the methods prescribed (see control methods below).

No person may;

- sell propagating material of category 2 plants or any category 2 plants to another person, unless such other person is a land user of a demarcated area.
- acquire propagating material of category 2 plants or any category 2 plants, unless such material or such plants are intended for use in a demarcated area.

In addition, no land user may allow category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland, unless authorised thereto in terms of the National Water Act (No. 36 of 1998).

Lastly, propagating material of category 2 plants or category 2 plants may only be imported or sold in accordance with the provisions of the Plant Improvement Act, 1976 (Act No. 53 of 1976), the Agricultural Pests Act, 1983 (Act No. 36 of 1983) and the EIA regulations.

- Category 3 plants[8] (ornamentally used plants) may no longer be planted, therefore, any new plants must be controlled. However, existing plants are allowed where they already occur, under controlled conditions, as long as all reasonable steps are taken to prevent them spreading, i.e. their seedlings are controlled or eradicated by means of the methods prescribed (see control methods below), except if the executive officer impose any additional conditions as may reasonably be deemed necessary with regard to category 3 plants already in existence at the time of the commencement of these regulations.
- No land user may furthermore allow category 3 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland.

Category 1, 2 and 3 plants may occur in biological control reserves[9]. Therefore, no person may, except in or for purposes of a biological control reserve -

- With regard to category 1 or 3 plants:
  - establish, plant, maintain, multiply or propagate such plants;
  - import or sell any such plants or their propagating material or;
  - acquire any such plants or their propagating material.
- With regard to category 2 plants:
  - sell such plants or their propagating material to another person, unless such other person is a land user of a biological control reserve.

[8] Plants of the kinds specified as category 3 in the CARA regulations, declared as invader plants.

[9] An area designated by the executive officer in terms of regulation 15D of the regulations for the breeding of biological control agents.

- acquire such plants or their propagating material, unless such material or such plants are intended for use in a biological control reserve.

The executive officer may also, on good cause shown in writing by the land user, grant written exemption from compliance with the requirements of the control of category 1, 2 and 3 plants, on such conditions as the executive officer may determine in each case.

- Control methods

Regulation 15E stipulates that where category 1, 2 or 3 plants occur contrary to the provisions of the regulations, a land user must control such plants by means of one or more of the following methods of control, as is appropriate for the species concerned and the ecosystem in which it occurs:

(a) Uprooting, felling, cutting or burning;

(b) Treatment with a weed killer10 that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;

(c) Biological control carried out in accordance with the stipulations of the Agricultural Pests Act, 1983 (Act No. 36 of 1983), the Environment Conservation Act, 1989 (Act No. 73 of 1989) and any other applicable legislation;

(d) Any other method of treatment recognised by the executive officer that has as its object the control of the plants concerned, subject to the provisions of sub-regulation (4);

(e) A combination of one or more of the methods prescribed in paragraphs (a), (b), (c), and (d), save that areas where biological control agents are effective shall not be disturbed by other control methods to the extent that the agents are destroyed or become ineffective.

Regulation 15E further stipulates that

- the control methods must also be applied with regard to the propagating material and the re-growth of category 1, 2 and 3 plants in order to prevent such plants from forming seed or re-establishing in any manner.
- the performance of an act of control is not in itself proof that the objects of the control methods have been achieved and follow-up operations are mandatory to achieve the appropriate level of combating.
- where uncertainty exists about the presence or efficacy of any biological control agent, a biological control expert shall be consulted.
- any action taken to control category 1, 2 and 3 plants shall be executed with caution and in a manner that will cause the least possible damage to the environment.

[10] Any substance or remedy or any mixture or combination of any substance or remedy which is registered in terms of the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act No. 36 of 1947), as an agricultural remedy for use in connection with the combating of weeds or invader plants.

11.3.2 National Environmental Management: Biodiversity Act No. 10 of 2004

The National Environmental Management: Biodiversity Act (NEMBA) for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act (No. 107 of 1998). Chapter 5 of the NEMBA regulates species and organisms posing potential threats to biodiversity, including alien11 and invasive12 (plant and animal) species13. The purpose of this chapter is, amongst others-

- to prevent the unauthorized introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur;
- to manage and control alien species and invasive species to prevent or minimize harm to the environment and to biodiversity in particular;
- to eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Section 70 of the Act requires the Minister to publish and regularly review a national list of invasive species in respect of which Chapter 5 must be applied nationally. The National List of Invasive Species for South Africa (GN R599) lists 559 species under four different categories and includes 383 plants. A further 560 species are listed as prohibited and may not be introduced into the country.

Section 71 prohibit any person to carry out a restricted activity14 involving a specimen of a listed invasive species, without a permit issued in terms of the Act, which permit may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.

The Alien and Invasive Species (AIS) Regulations (GN R 598) promulgated under the NEMBA and primarily aimed at preventing the introduction of potentially invasive species into the country, came into effect on 1 October 2014. The regulations makes provision for the management and control of four groups of alien invader plants:

- **Category 1a: Listed emerging invasive species** that require immediate control and must be must be combatted or eradicated by all landowners.
- **Category 1b: Listed established invasive species** that are most destructive and require compulsory control15 as part of an invasive species control programme.

[11] A species that is not an indigenous species; or an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention.

[12] Any species whose establishment and spread outside of its natural distribution range threaten ecosystems, habitats or other species or have demonstrable potential to threaten ecosystems, habitats or other species; and may result in economic or environmental harm or harm to human health.

[13] A kind of animal, plant or other organism that does not normally interbreed with individuals of another kind, and includes any sub-species, cultivar, variety, geographic race, strain, hybrid or geographically separate population.

[14] importing into the Republic, including introducing from the sea, any specimen of an alien or listed invasive species; having in possession or exercising physical control over any specimen of an alien or listed invasive species; growing, breeding or in any other way propagating any specimen of an lien of listed invasive species, or causing it to multiply; conveying, moving or otherwise translocating any specimen of an alien or listed invasive species; selling or otherwise trading in, buying, receiving, giving, donating or accepting as a gift, or in any way acquiring or disposing of any specimen of an alien or listed invasive species; spreading or allowing the spread of, any specimen of a listed invasive species; releasing any specimen of a listed invasive species; or any other prescribed activity which involves a specimen of an alien or listed invasive species.

- **Category 2: Listed invasive species of value**, such as commercial plantation trees that are regulated by area and require permits for utilization within an area specified in either the listing notice or in a permit.
- A landowner on whose land a Category 2 species occurs or person in possession of a permit, must ensure that the specimens of the species do not spread outside of the land or the area specified in the listing notice or permit. Any such species that occurs outside the specified area must be considered to be a Category 1b Listed Invasive Species and must be managed accordingly.
- **Category 3: Listed invasive species that may remain in prescribed areas** or provinces and are regulated by activity. Further planting, propagation or trade is prohibited.
- The AIS regulations further stipulate that:
- All listed invasive plant species occurring in riparian and wetland areas must be controlled and are effectively category 1b in these habitats.
- The importing, growing, breeding, propagating, releasing, moving, selling and spreading of all listed invasive species is prohibited, except for permitted category 2 species.
- All categories of listed invader plants are deemed to have such a high invasive potential that infestations can qualify to be controlled under government sponsored invasive species management programmes. Where this has been done, every person must control the listed invasive species in accordance with such programmes.

11.3.3 National Environmental Management Act No. 107 of 1998

Section 28 of the Act requires every person who causes, has caused or may cause significant pollution or degradation of the environment, to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. It furthermore stipulates that if such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, reasonable measures must be taken to minimise the pollution or environmental degradation caused at first and rectify/remediate the harm caused afterwards.

This duty relates to any significant change in the environment, caused by substances, radioactive or other waves or noise, odours, dust or heat emitted from any activity, where that change has an adverse effect on human health or well-being; on the composition, resilience and productivity of natural or managed ecosystems; on materials useful to people, or will in the future have such an adverse effect. It applies to activities such as the storage or treatment of waste or substances, as well as the construction and the provision of services, irrespective of whether it is engaged in by any person or an organ of state.

The responsibility to take the reasonable measures applies to land owners, persons in control of land/premises or persons who have a right to use the land/premises on which or in which any activity or process is or was performed or undertaken; or any other situation exists, which causes, has caused or is likely to cause significant pollution or degradation of the environment.

[15] to combat or eradicate an alien or invasive species; or where such eradication is not possible, to prevent, as far as may be practicable, the recurrence, re-establishment, re-growth, multiplication, propagation, regeneration or spreading of an alien or invasive species;

The reasonable measures may include measures to cease, modify or control any act, activity or process causing the pollution or degradation; contain or prevent the movement of pollutants or the causant of degradation; eliminate any source of the pollution or degradation; or remedy the effects of the pollution or degradation.

Although weeds and alien invader plants do not contribute largely to environmental pollution, they do cause various forms of environmental degradation and therefor this section of the NEMA is also applicable. Where weed killers (herbicides) are used for the control of such plants, the lack of reasonable control measures could lead to environmental pollution.

11.3.4 National Water Act No. 36 of 1998

Section 19 of the Act requires every person who occupies or uses the land on any activity or process is or was performed or undertaken, or any other situation exists which causes, has caused or may cause pollution of a watercourse, to take reasonable measures to prevent such pollution from occurring, continuing or recurring. Water courses include rivers or springs; natural channels in which water flows regularly or intermittently; wetlands, lakes or dams into which, or from which water flows; surface water, estuaries and aquifers. It also include the beds and banks of the above, where relevant.

This duty relates to any direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare, health or safety of human beings; to any aquatic or non-aquatic organisms; to the resource quality or to property.

The responsibility to take reasonable measures applies to land owners, persons in control of land or persons who occupy or use the land.

The reasonable measures referred to may include measures to cease, modify or control any act or process causing the pollution; comply with any prescribed waste standard or management practice; contain or prevent the movement of pollutants; eliminate any source of the pollution; remedy the effects of the pollution; and remedy the effects of any disturbance on the bed and banks of a watercourse.

Weeds and alien invader plants do not contribute largely to water pollution. However, these plants could lead to soil erosion, contributing to pollution through the indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare, health or safety of human beings; any aquatic or non-aquatic organisms; the resource quality; or property. Therefor this section of the NWA is also applicable. Where weed killers (herbicides) are used for the control of such plants, the lack of reasonable measures to control the use and disposal thereof could also lead to direct water pollution.

11.3.5 Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947)

In terms of the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947, no person may use or recommend the use of any agricultural remedy or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or described on such container.

Furthermore, no person may for reward or in the course of any industry, trade or business use any agricultural remedy, unless he is a pest control operator registered in terms of this Act, or otherwise than using it in the presence and under the supervision of a registered pest control operator.

According to Government Notice No. 13424 dated 26 July 1992, it is an offence to "acquire, dispose, sell or use an agricultural or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or on such a container".

Contractors using herbicides need to have a valid Pest Control Operators License (limited weeds controller) according to the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). This is regulated by the Department of Agriculture, forestry and Fisheries.

11.3.6 Weeds and alien invader plant management principles

This section provides an outline of the overall approach that should be adopted at the site in order to minimize the probability of invasive alien plants becoming established and ensuring that any outbreaks are managed quickly to ensure that they do not become a long-term problem on site. The establishment of any dense infestations will be expensive to eradicate and will require more complex control measures than would be necessary for low density invasions.

- Prevention

The best way to prevent invasion by alien invasive plant species is to manage the natural vegetation in such a way as to reduce the opportunity for these plants becoming established. The general principle is to not disturb any areas beyond the footprint of the proposed infrastructure and to also ensure that the natural processes that maintain vegetation patterns are not disrupted.

A prevention strategy should be considered and established, including regular surveys and monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas. Prevention could also include measures such as washing the working parts and wheels of earth-moving equipment prior to it being brought onto site, visual walkthrough surveys every three months, etc.

- Early identification and eradication

Monitoring plans should be developed which are designed to identify and control invasive alien plant species shortly after they arrive in the project area. Keeping up to date on which weeds are an immediate threat to the site is important, but efforts should be planned to update this

information on a regular basis. When new Invasive alien invasive plant species are spotted, an immediate response of locating the site for future monitoring and either hand pulling the weeds or an application of a suitable herbicide should be planned. It is, however, better to monitor regularly and act swiftly than to allow invasive alien plants to become established on site.

- Containment and control

If any alien invasive plants are found to become established on site, action plans for their control should be developed, depending on the size of the infestations, budgets, manpower considerations and time. Separate plans of control actions should be developed for each location and/or each species. Appropriate registered chemicals and other possible control agents should be considered in the action plans for each site/species. The key is to ensure that no invasions get out of control. Effective containment and control will ensure that the least energy and resources are required to maintain this status over the long-term. This will also be an indicator that natural systems are impacted to the smallest degree possible.

11.3.7 Post-removal follow-up and rehabilitation

Re-establishment of indigenous vegetation needs to be undertaken to reduce the probability of re-emergence of invasive alien plants and to reduce the risk of soil erosion where the soil surface is poorly vegetated. In most soils, the seeds and other propagules of the plants of the former natural habitat still survive. So natural regeneration without the need for planting may be possible in many cases. However, if natural regeneration is not likely due to the length of time since disturbance or if the soil has been disturbed to such a degree that seeds and propagules no longer survive, then planting or seeding may be required.

Rehabilitation should follow these steps:

- Monitor cleared areas on a regular basis (monthly during construction and three-monthly during operation) for emergent seedlings of invasive alien species and remove these (hand pulling or chemical control).
- Protect all areas of exposed soil immediately be by placing packed brush on the slope, or creating erosion control barriers using branches, sticks or logs placed horizontally across the slope at 1m intervals (the steeper the slope the closer the barriers should be placed to one another). If topsoil has been lost, rehabilitation of indigenous vegetation will be a difficult and expensive process.
- If the soil remains relatively undisturbed and the area has some indigenous vegetation left intact, the natural regeneration process of the indigenous vegetation on the site should be managed. This involves regular follow-up to remove emerging invasive alien plants and protecting the area from other forms of disturbance (heavy grazing, trampling, disturbance by vehicles, etc.), while the vegetation re-established naturally.
- If required, indigenous vegetation can be planted on the cleared areas. This can be in the form of a seed mix or plants rescued from previous clearing.

11.3.8 Appropriate control strategy

To ensure the best use of limited resources available for alien plant control in any alien plant control strategy, it is necessary to determine priorities. There are three general principles to follow to prioritise control actions.

- The first is that light infestations are easier to deal with than heavy infestations. They can also get worse if ignored; heavy infestations may not. So tackle the easiest problems first.
- The second is that infestation generally proceeds downhill, particularly when considering riverine vegetation. It is pointless clearing an area when a reservoir of re-infestation exists uphill or upstream. Start at the highest point and work downwards.
- The third is that often no control operation succeeds the first time. Because initial treatment may miss individual plants and some treated plants may resprout, multiple treatments are usually necessary to successfully eradicate the majority of invader plant species, i.e. one or more follow-ups are essential. Therefore, when attempting to clear a large area piece-meal, it is better to do a follow-up operation on the first area cleared, than to start on a second area. Cleared areas should be inspected at intervals to ensure that weed and invasive alien plant elimination is complete.

11.3.9 Phased approach to control

Any control programme for alien vegetation must include three phases:

- Initial control: Drastic reduction of the existing population.
- Follow-up control: Control of seedlings, root suckers and coppice regrowth
- Follow-up control of alien seedlings, saplings and coppice regrowth is essential to achieve and sustain the progress made with initial control work. If this phase is neglected, the cleared area will soon become infested with dense alien vegetation again, arising either from re-invasion by the original species or from invasion/ encroachment by another species e.g. where smelter's bush was controlled, yellow-bells may invade the cleared area.
- Maintenance control: Sustain low alien plant numbers/density with low annual control costs. At this phase, alien plants are no longer considered a problem.

11.3.10 Use weed killers (herbicides) wisely

- Care for the environment
- In terms of the applicable legislation any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. See the latest edition of "A guide to the use of herbicides of bush encroachment, noxious plants and aquatic

weeds", published by the Department of Agriculture or obtain advice on chemical control from your local herbicide distributor.

- Care for worker health and safety
- Safety is of the utmost importance when working with invasive alien plant control. Staff are likely to be working in remote areas with potentially dangerous equipment and chemicals. Proper safety training and equipment is therefore required.
- The Occupational Health and Safety Act of 1993 is South Africa's principle legislation concerning health and safety of employees. It also aims to protect persons who are not at work against hazard to health and safety arising out of or in connection with the activities of a person at work. The Act places the responsibility on the employer to ensure a safe and healthy working environment and to cause every employee to be made conversant with health and safety requirements relevant to their work. It also places the responsibility on every employee to follow its employer's health and safety procedures and instructions.

11.3.11 Herbicide safety

- An employer must inform and train an employee about the hazardous chemicals before an employee is exposed to hazardous chemicals;
- A person who is exposed to hazardous chemical substances, shall obey lawful instructions given by or on behalf of the employer;
- An employer must assess on a regular basis whether an employee is exposed to a hazardous chemical substance by any route or intake;
- Herbicides must be stored in a dedicated storeroom that needs to comply with the legal requirements of the Occupational Health and Safety Act;
- Always store herbicides in the original labelled container to avoid confusion with other products. Do not store other products in the store, such as protective clothing, food, etc., as they can become contaminated;
- Obtain the Material Safety Data Sheet from the supplier of the herbicide and ensure that you are familiar with the product before using it. Keep the Material Safety Data Sheet in the storeroom in case of an emergency;
- Keep a spill kit in the storeroom to mop up any spill. The spill kit must contain a bucket with sand and a spade. The sand is to be placed on the spill to absorb the liquid. Once the sand has absorbed the spill, it is to be collected and disposed of where it cannot contaminate the environment;
- All empty herbicide containers, or herbicides that have reached their expiry date, need to be safely disposed of at a facility that is authorised to dispose of hazardous waste. This can be done at a registered chemical recycling company.
- The use of Personal Protective Equipment (PPE) by staff controlling invasive alien plants in the field is required by law. The PPE specifications differ for the different types of control.
- PPE required for manual control of weeds and invasive alien plants include the following:

Item	Specification
Protective clothing (overall)	100% cotton, two-piece overalls are best for absorbing perspiration, they last longer and are cooler.
Rubber gloves	Standard, wrist-length rubber gloves are sufficient.
Safety boots	Gumboots or standard safety boots, which support the ankles, are sufficient. Steel toecaps are recommended for workers that are working with heavy equipment or large trees.
Hat	If working with large trees, on steep gradients or if any other safety risk may be present, then wearing a hardhat is advisable. Otherwise a wide-brim hat can be used to protect the worker from the sun.
Safety glasses	Large, clear safety glasses, which allow air to pass through, are acceptable.
Face mask	A face mask which covers the nose and mouth is essential when mixing herbicides and for spraying thereof.

Mechanised control includes the use of chainsaws and brush cutters and will therefore require slightly different PPE from someone using manual control (slasher, knapsack sprayer, etc.).

11.3.12 Generic revegetation/rehabilitation measures

Each control operation requires a number of recommended control methods to achieve a reduction in the weed and invasive alien plant population. A recommended control method is a tried and tested method that is effective at the initial, follow-up and for maintenance control levels, when used correctly.

This section provides a summary of existing control measures that have published for the various alien plant species that could potentially occur on site. More detailed publications on control measures provide all the technical detail (some of these are referenced in this plan).

11.3.13 Physical/mechanical control methods

This entails damaging or removing the plant by physical action. Different techniques could be used, e.g. uprooting, felling, slashing, mowing, ring barking or bark stripping. These control options are only really feasible in sparse infestations or on small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice, need to have the cut stumps or coppice growth treated with herbicides following the mechanical treatment. Mechanical control is labouring intensive and therefore expensive, and could cause severe soil disturbance and erosion.

For the current project, hand pulling or manual removal using hand tools will be the most appropriate methods for control of weeds and invasive alien plants, since there are no existing dense stands of these plants on-site.

Advantages	Disadvantages
Effective method in areas with low infestation.	Not an effective method for dense infestations, as the cost of clearing is extremely high, with little or no impact.
High job creation and associated poverty alleviation potential.	Time consuming.
No contamination of water with herbicides.	If no herbicides are used then the manual control techniques must be very well executed to ensure success.

- Hand pulling

Hand pulling is effective where infestations are small and the invaders shallow rooted. Seedlings of yellow-bells, syringa, wild tobacco, smelter's bush etc. are easily uprooted particularly if the soil is damp.

11.3.14 Mechanical uprooting

Uprooting of shrubs e.g. oleander with mattocks results in soil disturbance, especially where large plants are present in dense thickets. Disturbance promotes soil erosion, especially on steep slopes with low grass cover. Soil disturbance also results in exposure of weed seeds. Germination of these seeds re-infests the cleared areas. Mechanical uprooting should therefore only be applied where the soil can be stabilized e.g. by dense grass cover. When soil has been disturbed, it is advisable to sow grass seed immediately after uprooting and soil levelling has been completed.

- Cutting

Nearly all invaders will coppice if cut once, but repeated cutting during the growing season causes depletion of root reserves eventually resulting in death. If terrain permits the second and subsequent cuts can be done with a mower. Such treatment favours grass, which will then be able to out compete the weeds and assist in their elimination.

- Felling

This control method is suitable where infestations are easily accessible and can be harvested. It is also suitable for trees that need removal for utility or aesthetic purposes or where they pose a potential hazard to waterways, building structures etc.

Use chainsaws, bow saws, brush cutters or cane knives to fell trees and saplings.

Felling by itself will not eliminate an invasive tree. Coppice growth usually results and this can be more difficult to control than the original problem. Coppice can be prevented by -

- stripping all the bark off the remaining stump, to below ground level;
- carrying out felling during autumn, stacking the timber over the stumps to dry over winter and burning the whole lot in spring;

- applying a registered herbicide mix with hand sprayers, paint brushes or knapsack sprayers at low pressure, using solid cone nozzles. Use a suitable dye to ensure that no stumps are missed. When this alternative will be used, stump height after cut should not be less than 15 cm.

- Ringbarking

Ringbarking of large trees can be successful but it is slow and is only preferred to felling and other treatments when the latter is impracticable. Every trace of cambium - the growing region between the bark and the hard wood - must be removed from the ring which must be at least 0.5m wide. Note that the subsequent felling of a dried out dead tree is much more difficult that felling the living tree in the first place.

- Burning stem bases
- Stack branches around the base of stems and burn the wood. This will control most of the trees. Spray any coppice regrowth.
- Chemical control

Chemical control should only be used as a last resort, since it is hazardous for natural vegetation. It should not be necessary if regular monitoring is undertaken, which should be effective for controlling invasive alien plants.

Chemical control involves the use of registered herbicides to kill the target weed/invasive alien plant. Herbicides are either classified as selective or non-selective. Selective herbicides are usually specific to a particular group of plants, e.g. those specified for use on broad leaf plants, but should not kill narrow-leaf plants such as grasses. Non-selective herbicides can kill any plant that they come into contact with and are therefore not suitable for use in areas where indigenous vegetation is present.

Chemical application techniques include foliar (leaf) application, stem applications (basal stem, total frill, stem injections) and stump applications (cut stump, total stump, scrape and paint):

Advantages	Disadvantages
Complements mechanical control methods, increasing the effectiveness of control activities.	May kill non-target plants or species. This is a very important consideration and poses risks for remaining natural areas on site.
Achieve results over short period (within 6 weeks of application).	Herbicides are expensive.
Large areas can be treated quickly.	The use of herbicides may contaminate sites used for drinking water, for washing and for fishing, and can therefore threatened human and animal health.
	Specialized training and certification is required for use of herbicides.

11.3.15 General considerations regarding the use of herbicides (chemicals)

- In choosing an herbicide there are several points to consider.

- Firstly, the herbicide should be one registered for use against the weed to be eliminated. Registered herbicides have been rigorously tested and the optimum mode of use determined.
- Secondly, it is important to note the level of persistence displayed by the herbicide after application. Residual herbicides preclude immediate regrowth or replanting.
- Thirdly, the degree of selectivity of action of the herbicide may be critical. Some kill all plants; others have no effect on non-target species, particularly grasses.
- Fourthly, the effect of the herbicide upon animal life must be considered. Some herbicides are dangerous to particular groups of animals. For example, fish are generally more sensitive than mammals and some herbicides should never be used near water.
- The state of the weather can greatly influence the success of chemical control. Rain, immediately after a spraying operation, can more or less nullify the treatment. Similarly, heavy dew can dilute the spray and cause it to drip off foliage and reduce its effectiveness. Dust is another factor to consider. Some herbicides deactivate upon contact with soil and have little effect upon dusty foliage. Such herbicides are best applied after rain, as soon as the foliage is dry. Avoid spraying in windy weather since spray drift onto non-target plants may occur.
- Some herbicides are effective when painted onto cut tree stumps as an alternative to stripping the bark. It is however, essential that painting be done immediately after felling and that the whole of the cambium is treated.
- Basal bark, cut-stem, frill or injection methods of herbicide application are recommended because these methods, if used properly, focus applications to target species, minimize the overall amount of herbicide applied, and reduce environmental impacts.
- Always adhere to the label recommendations when using herbicides. Avoid any contamination of non-target areas, especially erodable soil and water bodies. This method requires intensive management and close supervision. Contact the herbicide companies for further information regarding the correct application of these products.

11.3.16 Cut stump treatment

Apply the recommended herbicide mixed in water to the cut surface of stumps. NB: Do not spray the sides of stumps. Apply herbicide mix up to 1 hour after felling or the cut wound will seal. Stump application is best during the active growing season.

11.3.17 Total stump treatment

Apply the recommended herbicide mixed in diesel to the cut surface, down the sides of stumps and to any exposed roots. The herbicide mix can be applied even several days after felling.

NB: not all herbicides can be mixed with diesel - check the label for the recommended carrier.

- Stump treatment with herbicide plugs

After felling, make holes in the stumps and insert plugs containing the herbicide. The herbicide is released into the stumps.

- Frill

Use a cane or bush knife to frill the stems. Apply 1 or 2ml of herbicide solution per cut, according to label recommendations. Apply the herbicide mixed in water to newly cut frills within 30 minutes. Use a calibrated automatic refill syringe or a hand-held sprayer or a knapsack sprayer at low pressure, using a solid cone nozzle. Use a suitable water-soluble dye to aid application.

For total frill, make a complete ring of level downward-slanting cuts through the bark and into the sapwood near the base of stems.

For partial frill, make evenly spaced downward-slanting cuts through the bark and into the sapwood at a convenient height on all sides of the tree. The required number of cuts increases with stem diameter. Follow label recommendations.

- Soil application

Certain herbicides are taken up by trees and plants through the roots. Such herbicides are applied to the soil surface, leach into the target plant root zone and are taken up by the plant, which will then die. This is a non-selective control methods that may result in the death of target and non-target species. It may sometimes be possible to target specific species that are more susceptible to the herbicides than other, more resistant species.

- Foliar application

Foliar application of a registered herbicide can be used for the control of shrubs less than 1 m tall and broadleaf weeds. This method can also be used for the control of dense regrowth that are still less than 1 m tall. Use a sufficiently large team of knapsack operators to deal with this situation as rapidly as possible, while the regrowth is still short. Large accessible areas of dense regrowth can be sprayed with a tractor-mounted sprayer fitted with a 30 m long hose and a directional lance, or by aerial application.

Where grass is present, use selective broad leaf herbicides that do not harm the grass. Where grass is absent, use selective or non-selective herbicides. Where dense seedling growth of uniform height is present, use knapsack sprayers with flat fan nozzles. Use solid cone nozzles for seedlings of uneven height, coppice growth, root suckers and short saplings.

Many of the herbicides used in alien control are applied as leaf sprays that only kill the plant after being translocated to the roots. For this reason, they are not fast acting and indeed it is essential not to kill the foliage before the herbicide has been transported into the plant. Accordingly spray solutions should always be made up as instructed by the manufacturer: strong solutions will probably be less effective, and certainly more expensive. Efficiency of translocation to the roots is further improved if the herbicide is applied to a large leaf area on actively growing plants. Avoid spraying new, unexpanded growth.

- Biological control

Biological weed control consists in the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. Biological control agents include insects, mites, and micro-organisms such as fungi or bacteria. They usually attack specific parts of the plant, either the reproductive organs directly (flower buds, flowers or fruit) or the seeds after they have dropped. The stress caused by the biological control agent may kill a plant outright or it might impact on the plants reproductive capacity. In certain instances, the reproductive capacity is reduced to zero and the population is effectively sterilized. All of these outcomes will help to reduce the spread of the species.

To obtain bio-control agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF) can be contacted.

Advantages	Disadvantages
Most environmentally friendly and most sustainable of all control methods.	Generally slow, especially initially.
Usually does not require high or long-term maintenance.	Low levels of infestation, with occasional outbreaks, will remain a feature of systems under biological control.
Relatively low cost implication over the long term.	Any use of chemicals around bio-control agent colonies may adversely affect the potency of this control method.
	Cannot be used where the bio-control agent would threaten commercial populations of the target species that may exist nearby.
	Bio-control agents are not available for all target species.

11.4 Integrated control

An integrated approach involving the combined use of mechanical, chemical and biological methods is usually necessary to control invasive alien plants effectively.

Approaches available for integrated control depend on the species under consideration (features of individual species and the number and identity of species that occur together), features of the invaded systems, the availability of resources and other factors. Mechanical control and chemical control are short-term activities, whereas rigorous and disciplined follow-up and rehabilitation are necessary in the medium term. Biological control can provide effective control in the short and medium term in some cases, and it is often the only really sustainable solution in the longer term.

11.5 Site ecosystem context

The proposed development site occurs within a semi-arid environment and a fundamentally different approach to rehabilitation efforts is required as compared to traditional rehabilitation approaches. Approximately 97% of the land in the area is used for extensive livestock grazing, with very little alien plant invader problems. A total of 21 invasive alien plant species (IAPs) are reported to occur in the area (Table 1). The list provides an overview of the possible IAPs which could be expected at the proposed development site. At the moment none of these occur at the site, however, could be introduced into any disturbed areas associated with the construction and operation of the proposed PV facility.

11.6 Impact minimisation and control measures

11.6.1 Construction phase

The following management actions are required to minimize soil and vegetation disturbance during the construction phase in order to prevent and manage the potential establishment of invasive alien plants on site:

Management action	Frequency
Site preparation	
The Environmental Control Officer (ECO)/Environmental Officer (EO) must provide permission before any natural vegetation is cleared for development.	As required, weekly.
Clearing of existing natural vegetation must only be undertaken as the work progresses. Mass clearing must not be permitted, unless the entire cleared area is to be rehabilitated immediately thereafter.	
Clearing of existing natural vegetation must be restricted to the affected development area and may not spill over into adjacent areas. No-go areas will be clearly demarcated prior to construction.	
Construction activities	
Take care to avoid the introduction of weeds and invasive alien plant species to the site. Pay particular attention to imported material, such as building sand and other construction materials. Check stockpiles regularly and remove any weeds emerging from material stockpiles.	As required, once a month.
Take care to avoid the introduction of weeds and invasive alien plant species to the site. Pay particular attention to dirty earth-moving and construction equipment. Clean dirty earth-moving and construction machinery and equipment at a remote site before transporting these to the development site.	As required, every time new machinery and equipment is brought to the site.
Weeds and alien invasive plant identification and control	
Inspect the development site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien	Monthly

Management action	Frequency
plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation. Detect and identify weeds and invasive alien plants that occur on site.	
Control weeds and invasive alien vegetation, including post control regrowth throughout the entire site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	Monthly
Do no cultivate any alien species on site. If vegetation is required for aesthetic or other purposes, use non-invasive locally occurring indigenous species.	When necessary
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	As required, after re-vegetation and rehabilitation.
Re-vegetation and habitat rehabilitation	
Implement re-vegetation and habitat rehabilitation plan in areas disturbed during construction activities, as well as during the control of weeds and invasive alien plants as soon as possible in all areas after construction has been completed.	As required, after re-vegetation and rehabilitation.
Mulch used to encourage regrowth of vegetation on cleared areas should preferably not be brought onto site from remote areas, brush from cleared areas should be used as much as possible. Where it is imperative to source mulch from remote areas, the origin thereof should be established in order to gauge the risk of weeds and invasive alien plant spread onto the development site. Use only mulch from remote areas with a low risk of weeds and invasive alien plant infestation/colonisation.	As required, every time new mulch is brought to the site.
Protection of areas where weeds/invasive alien plants have been controlled	
Once weeds/invasive alien plants have been controlled, and disturbed areas re-vegetated/rehabilitated, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas to prevent re-infestation/re-colonisation.	As required, after re-vegetation and rehabilitation.
Protection of adjacent disturbed areas	
Regularly monitor adjacent areas disturbed through human interaction that can act as a source of weeds and invasive alien plants or their propagating material (including seeds) and facilitate re-infestation/re-	As required, during construction.

Management action	Frequency
colonisation.	

11.6.2 Operational phase

Weed and invasive alien plant management efforts will certainly fail without regular checking and maintenance. The complete site, especially disturbed, as well as re-vegetated and rehabilitated areas should therefore be inspected as required to assess if any follow-up control actions are necessary.

Management action	Frequency
Weed and alien invasive plant management	
Inspect the development site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation. Detect and identify weeds and invasive alien plants that occur on site.	Quarterly (every 3 months) for the first 2 years and biannually thereafter.
Control weeds and invasive alien vegetation, including post control regrowth throughout the entire site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	
Do no cultivate any alien species on site. If vegetation is required for aesthetic or other purposes, use non-invasive locally occurring indigenous species.	When necessary
Re-vegetation/rehabilitation maintenance	
Inspect the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation and asses vegetation cover. Re-vegetate areas showing inadequate vegetation cover as specified in the re-vegetation and habitat rehabilitation plan.	As required, annually at the beginning of the rainy season.
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	As required, annually during the rainy season.
Protection of areas where weeds/invasive alien plants have been	

Management action	Frequency
controlled	
Once weeds/invasive alien plants have been controlled, and disturbed areas re-vegetated/rehabilitated, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas to prevent re-infestation/re-colonisation.	As required, monthly.
Protection of adjacent disturbed areas	
Regularly monitor adjacent areas disturbed through human interaction that can act as a source of weeds and invasive alien plants or their of propagating material (including seeds) and facilitate re-infestation/re-colonisation.	As required, during operations.

11.6.3 Decommissioning phase

The following management actions are aimed at preventing invasion by invasive alien species of re-vegetated areas created during decommissioning activities.

Management action	Frequency
Weed and alien invasive plant management	
Inspect the development site, including re-vegetated areas, and assess the potential spread and establishment of weeds and invasive alien plants on the development site, including re-vegetated areas that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation. Detect and identify weeds and invasive alien plants that occur on site.	Bi-annually, for 2 years after re-vegetation and rehabilitation.
Control weeds and invasive alien vegetation, including post control regrowth throughout the entire site, including re-vegetated areas. Use the appropriate control methods, with regard to the site and the species that will be controlled.	Biannually, for 2 years after re-vegetation and rehabilitation.
Site re-vegetation/habitat rehabilitation	
Where the decommissioning activities resulted in areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation, such areas will be re-vegetated/rehabilitated as specified in the re-vegetation and habitat rehabilitation plan.	As required, as soon as possible after decommissioning.
Erosion management	
Inspect the development site, including re-vegetated areas, and identify areas the potentially prone to soil erosion. Implement the erosion management plan in areas where soil erosion is likely to threaten the stability and water retention capacity of the site, including re-	As required, for 2 years after re-vegetation and rehabilitation.

Management action	Frequency
vegetated/rehabilitated areas, and could therefore be prone to weed and invasive alien plant infestation/colonisation.	
Protection of areas where weeds/invasive alien plants have been controlled	
Once weeds/invasive alien plants have been controlled, and disturbed areas re-vegetated/rehabilitated, do not allow construction equipment, vehicles or unauthorised personnel onto cleared areas to prevent re-infestation/re-colonisation.	As required, for 2 years after re-vegetation and rehabilitation.
Protection of adjacent disturbed areas	
Regularly monitor adjacent areas disturbed through human interaction that can act as a source of weeds and invasive alien plants or their off propagating material (including seeds) and facilitate re-infestation/re-colonisation.	Biannually, for 2 years after re-vegetation and rehabilitation.

11.7 Roles and responsibilities

Effective weed and invasive alien plant control during the construction, operational and decommissioning phases of the project will be dependent on the following of project personnel:

11.7.1 The Developer

The project proponent (developer) will be responsible for the following:

- Ensuring that the requirements set out in this management plan are adhered to and implemented;
- Appoint a suitably qualified project engineer prior to the start of construction, with overall responsibility for the implementation of the management plan during the construction phase of the project; and
- Appoint an independent suitably qualified individual prior to the start of construction as Environmental Officer (EO)/Environmental Control Officer (ECO) to monitor and verify the implementation of this management plan during the construction phase of the project; and
- Appoint a suitably qualified individual prior to the start of the operational phase of the project as Environmental Officer (EO) to implement this management plan during the operational phase of the project; and
- Provide all principal contractors working on the project with a copy of this management plan as part of tender documentation to allow the contractors to cost for the implementation of its requirements in their respective construction tenders.
- Provide the project engineer, appointed independent EO/ECO for the construction phase, appointed qualified EO for the operational phase, as well as all principal contractors

working on the project with copies of the Final EIA report, the requirements of the EA, and this management plan.

11.7.2 The Engineer

The project engineer will be responsible for the overall implementation of the management plan during the construction phase of the project. To effectively implement the plan, the engineer must be aware of the findings, mitigation measures and conclusions of the Final EIA report, the requirements of the EA, and this management plan.

11.7.3 The Environmental Officer (EO)/ Environmental Control Officer (ECO) for construction

The independent EO/ECO is responsible for monitoring and verifying the implementation of the management plan during the construction phase of the project. To effectively monitor and verify the implementation of the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

11.7.4 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the operational phase of the project. To effectively implement the management plan, the EO/ECO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

11.7.5 The Principal Contractor(s)

The principal contractor(s), being any directly appointed entity undertaking the implementation of work, will be responsible for complying with the management plan at all times during the construction phase. It is likely that the principal contractor(s) will appoint a suitably qualified individual prior to the start of the construction phase of the project as Environmental Officer (EO) to implement this management plan during the construction phase of the project.

11.7.6 The Environmental Officer (EO)

The EO is responsible for the implementation of the management plan during the construction phase of the project. To effectively implement the management plan, the EO must be aware of the findings, mitigation measures and conclusions of the Final EIA Report, the EA, and this management plan.

11.8 Monitoring Programme

Monitoring is an essential component of successful weed and invasive alien plant control plans. Monitoring must be undertaken to monitor the extent of weed and invasive alien plant occurrence on site, as well as the success of the control plan.

In general, the following principles apply to monitoring activities:

- Simple records must be kept of
  - weeds and invasive alien plant occurrence, e.g. what plants were identified where, as well as the extent and nature of the occurrence;
  - control measures implemented, e.g. area/location cleared, date and nature of control actions undertaken, labour units and the amount of weed killer (herbicide) used, where appropriate;
  - climatic conditions at the site.
- A picture says more than a thousand words. Therefore, photographic records is a very important tool in any monitoring programme. Photos must be kept of:
  - any areas where weeds and invasive alien plants occur, immediately before and after control activities;
  - weed and invasive alien plant control activities;
  - control success over time, indicating the areas where control activities had been implemented at regular intervals after the control activities were implemented.
- It is important that when monitoring results in detection of weeds and invasive alien plants, control actions are immediately planned and implemented.

11.8.1 Construction phase

The following monitoring is required during the construction phase of the project:

Monitor Activity	Indicator	Frequency
Monitor weeds and invasive alien plant presence on site	Alien species list, distribution map & GPS coordinates	Pre-construction & monthly thereafter
Monitor weeds and invasive alien plant control measures implemented	Record of control activities	Monthly
Monitor weeds and invasive alien plant control success	Decline in abundance of alien plant species over time, regrowth and/or re-infestation/re-colonisation	Monthly

Monitor Activity	Indicator	Frequency
Climatic conditions at the site	Rainfall	Monthly
Monitor re-vegetated areas to identify areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Monthly

11.8.2 Operational phase

The following monitoring is required during the operational phase of the project:

Monitor Activity	Indicator	Frequency
Monitor weeds and invasive alien plant presence on site	Alien species list, distribution map & GPS coordinates	Quarterly (every 3 months) for the first 2 years and biannually thereafter.
Monitor weeds and invasive alien plant control measures implemented	Record of control activities	
Monitor weeds and invasive alien plant control success	Decline in abundance of alien plant species over time, regrowth and/or re-infestation/re-colonisation	
Climatic conditions at the site	Rainfall	Monthly
Monitor re-vegetated areas to identify areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Quarterly (every 3 months) for the first 2 years and biannually thereafter.

11.8.3 Decommissioning phase

The following monitoring is required during the decommissioning phase of the project:

Monitor Activity	Indicator	Frequency
Monitor development site and re-vegetated/ rehabilitated areas where infrastructure has been removed to detect, identify and describe any weed and invasive alien plant occurrence.	Alien species list, distribution map & GPS coordinates	Biannually, for 3 years after decommissioning and rehabilitation or until natural vegetation has recovered sufficiently to resist invasion
Monitor weeds and invasive alien plant control measures implemented	Record of control activities	
Monitor weeds and invasive alien plant control success	Decline in abundance of alien plant species over time, regrowth and/or re-infestation/re-colonisation	
Climatic conditions at the site	Rainfall	Monthly
Monitor re-vegetated areas to identify areas with inadequate vegetation cover that are not stable; effective in retaining water and nutrients; and self-sustaining and could therefore be prone to weed and invasive alien plant infestation/colonisation	Aspects of re-vegetation success, such as soil cover, plant density and plant vigour	Quarterly (every 3 months) for the first 2 years and biannually thereafter.

11.9 References

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Appendices

12 APPENDIX 1: GENERIC STANDARD ENVIRONMENTAL SPECIFICATIONS THAT SHOULD BE OBSERVED DURING CONSTRUCTION OF THE PROPOSED BRAKFONTEIN PV POWER PLANT

This document must be integrated with the Environmental Management Programmes described in the Environmental Management Programme, pending the DEA evaluation of the EIR, in order to generate a more detailed, expanded and elaborated EMP before construction, operations and decommissioning commences.

12.1 Scope

This Specification covers the requirements for controlling the impact on the environment of construction activities.

12.2 Interpretations

Supporting specifications

Where this Specification is required for a project the following specifications shall, inter alia, form part of the Contract Document.

(a) Project Specification;

(b) SABS 1200 A or SABS 1200 AA, as applicable;

12.3 Application

This Specification contains clauses that are generally applicable to the undertaking of civil engineering works in areas where it is necessary to impose pro-active controls on the extent to which the construction activities impact on the environment. Interpretations and variations of this Specification are set out in Portion 2 of the Project Specification (see 2.1).

In the event of any difference or discrepancy between the provisions of the Standardised Specifications and the provisions of the Project Specification, the latter shall prevail.

12.4 Definitions

For the purposes of this Specification the definitions and abbreviations given in the applicable specifications listed in 2.1 and the following definitions and abbreviations shall apply:

12.4.1 Environment

means the surroundings within which humans exist and that are made up of -

i) the land, water and atmosphere of the earth;

ii) micro-organisms, plant and animal life;

iii) any part or combination of i) and ii) and the interrelationships among and between them; and

iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

12.4.2 Potentially hazardous substance

is a substance which, in the reasonable opinion of the Engineer, can have a deleterious effect on the environment.

12.4.3 Method Statement

is a written submission by the Contractor to the Engineer in response to the Specification or a request by the Engineer, setting out the plant, materials, labour and method the Contractor proposes using to carry out an activity, identified by the relevant specification or the Engineer when requesting the Method Statement, in such detail that the Engineer is enabled to assess whether the Contractor's proposal is in accordance with the Specifications and/or will produce results in accordance with the Specifications.

The Method Statement shall cover applicable details with regard to:

- construction procedures,
- materials and equipment to be used,
- getting the equipment to and from site,
- how the equipment/ material will be moved while on site,
- how and where material will be stored,
- the containment (or action to be taken if containment is not possible) of leaks or spills of any liquid or material that may occur,
- timing and location of activities,
- compliance/ non-compliance with the Specifications,
- any other information deemed necessary by the Engineer.

12.4.4 Reasonable

means, unless the context indicates otherwise, reasonable in the opinion of the Engineer after he has consulted with a person, not an employee of the Client Directorate, suitably experienced in "environmental implementation plans" and "environmental management plans" (both as defined in the National Environmental Management Act, No 107 of 1998).

12.4.5 Solid waste

means all solid waste, including construction debris, chemical waste, excess cement/ concrete, wrapping materials, timber, tins and cans, drums, wire, nails, food and domestic waste (e.g. plastic packets and wrappers).

12.4.6 Contaminated water

means water contaminated by the Contractor's activities, *e.g.* concrete water and runoff from plant/ personnel wash areas.

12.5 MATERIALS

Materials handling, use and storage

The Contractor shall ensure that any delivery drivers are informed of all procedures and restrictions (including "no go" areas) required to comply with the Specifications. The Contractor shall ensure that these delivery drivers are supervised during off loading, by someone with an adequate understanding of the requirements of the Specifications.

Materials shall be appropriately secured to ensure safe passage between destinations. Loads including, but not limited to sand, stone chip, fine vegetation, refuse, paper and cement, shall have appropriate cover to prevent them spilling from the vehicle during transit. The Contractor shall be responsible for any clean-up resulting from the failure by his employees or suppliers to properly secure transported materials.

All manufactured and/ or imported material shall be stored within the Contractor's camp, and, if so required by the Project Specification, out of the rain. All lay down areas outside of the construction camp shall be subject to the Engineer's approval.

12.6 Hazardous substances

Hazardous chemical substances (as defined in the Regulations for Hazardous Chemical Substances) used during construction shall be stored in secondary containers. The relevant Material Safety Data Sheets (MSDS) shall be available on Site. Procedures detailed in the MSDSs shall be followed in the event of an emergency situation.

If potentially hazardous substances are to be stored on site, the Contractor shall provide a Method Statement detailing the substances/ materials to be used, together with the storage, handling and disposal procedures of the materials.

12.7 PLANT

12.7.1 Fuel (petrol and diesel) and oil

Unless allowed by the Project Specification, fuel shall not be stored on site but shall be transported to the site as and when required.

Where reasonably practical, plant shall be refuelled at a designated re-fuelling area or at the workshop as applicable. If it is not reasonably practical then the surface under the temporary refuelling area shall be protected against pollution to the reasonable satisfaction of the Engineer prior to any refuelling activities. The Contractor shall ensure that there is always a supply of absorbent material readily available to absorb/ breakdown and where possible is designed to encapsulate minor hydrocarbon spillage. The quantity of such materials shall be able to handle a minimum of 200l of hydrocarbon liquid spill. This material must be approved by the Engineer prior to any refuelling or maintenance activities.

12.7.2 Ablution facilities

Washing, whether of the person or of personal effects and acts of excretion and urination are strictly prohibited other than at the facilities provided.

12.7.3 Eating areas

The Contractor shall designate eating areas, subject to the approval of the Engineer. These shall be clearly demarcated. The feeding or leaving of food for animals are strictly prohibited. Sufficient bins as specified in Section 4.4 of this Specification shall be present in this area.

Any cooking on Site shall be done on well-maintained gas cookers with fire extinguishers present.

12.7.4 Solid waste management

No on-site burying or dumping of any waste materials, vegetation, litter or refuse shall occur. The Contractor shall provide vermin and weather proof bins with lids of sufficient number and capacity to store the solid waste produced on a daily basis. The lids shall be kept firmly on the bins at all times. Bins shall not be allowed to become overfull and shall be emptied at least once a day. Waste from bins may be temporarily stored on Site in a central waste area that is weather proof and scavenger-proof, and which the Engineer has approved.

All solid waste shall be disposed of off-site at an approved landfill site. The Contractor shall supply the Engineer with a certificate of disposal.

12.7.5 Contaminated water

Potential pollutants of any kind and in any form shall be kept, stored, and used in such a manner that any escape can be contained and the water table not endangered. Water containing such pollutants as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from the site. This particularly applies to water emanating from concrete batching plants and concrete swills, and to runoff from fuel depots/workshops/truck washing areas. Wash down areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas are not polluted.

The Contractor shall notify the Engineer immediately of any pollution incidents on Site.

12.7.6 Site structures

All site establishment components (as well as equipment), shall be positioned to limit visual intrusion on neighbours and the size of area disturbed. The type and colour of roofing and cladding materials to the Contractor's temporary structures shall be selected to reduce reflection.

12.7.7 Lights

The Contractor shall ensure that any lighting installed on the site for his activities does not interfere with road traffic or cause a reasonably avoidable disturbance to the surrounding community or other users of the area.

12.7.8 Workshop, equipment maintenance and storage

Where practical, all maintenance of equipment and vehicles on Site shall be performed in the workshop. If it is necessary to do maintenance outside of the workshop area, the Contractor shall obtain the approval of the Engineer prior to commencing activities.

The Contractor shall ensure that in his workshop and other plant maintenance facilities, including those areas where, after obtaining the Engineer's approval, the Contractor carries out emergency plant maintenance, there is no contamination of the soil or vegetation. The workshop shall have a smooth impermeable floor either constructed of concrete or thick plastic covered with sufficient sand to protect the plastic from damage. The floor shall be bunded and sloped towards an oil trap or sump to contain any spillages of substances (e.g. oil). The Engineer must approve a Method Statement detailing the design and construction of the workshop. When servicing equipment, drip trays shall be used to collect the waste oil and other lubricants. Drip trays shall also be provided in construction areas for stationary plant (such as compressors) and for "parked" plant (such as scrapers, loaders, vehicles).

All vehicles and equipment shall be kept in good working order and serviced regularly. Leaking equipment shall be repaired immediately or removed from the Site.

The washing of equipment shall be restricted to urgent or preventative maintenance requirements only. All washing shall be undertaken in the workshop or maintenance areas, and these areas must be equipped with a suitable impermeable floor and sump/oil trap. The use of detergents for washing shall be restricted to low phosphate/ nitrate and low sudsing-type detergents.

12.7.9 Noise

The Contractor shall limit noise levels (e.g. install and maintain silencers on machinery). The provisions of SABS 1200A Sub clause 4.1 regarding "built-up areas" shall apply to all areas within audible distance of residents whether in urban, peri-urban or rural areas.

Appropriate directional and intensity settings are to be maintained on all hooters and sirens.

No amplified music shall be allowed on Site. The use of radios, tape recorders, compact disc players, television sets etc. shall not be permitted unless the volume is kept sufficiently low as to

avoid any intrusion on members of the public within range. The Contractor shall not use sound amplification equipment on Site unless in emergency situations.

Construction activities generating output levels of 85 dB (A) or more, in residential areas, shall be confined to the hours 08h00 to 17h00 Mondays to Fridays.

12.8 CONSTRUCTION

12.8.1 Method Statements

Any Method Statement required by the Engineer or the Project Specification shall be produced within such reasonable time as the Engineer shall specify or as required by the Project Specification. The Contractor shall not commence the activity until the Method Statement has been approved and shall, except in the case of emergency activities, allow a period of two weeks for approval of the Method Statement by the Engineer. Such approval shall not unreasonably be withheld.

The Engineer may require changes to a Method Statement if the proposal does not comply with the specification or if, in the reasonable opinion of the Engineer, the proposal may result in, or carries a greater than reasonable risk of, damage to the environment in excess of that permitted by the Specifications.

Approved Method Statements shall be readily available on the site and shall be communicated to all relevant personnel. The Contractor shall carry out the Works in accordance with the approved Method Statement. Approval of the Method Statement shall not absolve the Contractor from any of his obligations or responsibilities in terms of the Contract.

12.8.2 Environmental awareness training

It is a requirement of this contract that environmental awareness training courses are run for all personnel on site. Two types of course shall be run one for the Contractors and Subcontractors management and one for all site staff and labourers. Courses shall be run in the morning during normal working hours at a suitable venue provided by the Contractor. All attendees shall remain for the duration of the course and sign an attendance register that clearly indicates participants names on completion, a copy of which shall be handed to the Engineer. The size of each session shall be limited to the numbers shown in the Project Specification and the Contractor shall allow for sufficient sessions to train all personnel. Subsequent sessions shall be run for any new personnel coming onto site. A Method Statement with respect to the organisation of these courses shall be submitted.

Notwithstanding the specific provisions of this clause it is incumbent upon the Contractor to convey the sentiments of the EMP to all personnel involved with the works.

12.8.3 Training course for management and foremen

The environmental awareness training course for management shall include all management and foremen. The course, which shall be presented by the Engineer or his designated representative, is of approximately one-hour duration. The initial course shall be undertaken not less than 7 days prior to commencement of work on site.

12.8.4 Training course for site staff and labour

The environmental awareness training course for site staff and labour shall be presented by the Contractor from material provided by the Engineer unless otherwise indicated in the Project Specification. The course is approximately one-hour long. The course shall be run not more than 7 days after commencement of work on site with sufficient sessions to accommodate all available personnel.

12.8.5 Contractor's Environmental Representative

The Contractor shall appoint an Environmental Representative who shall be responsible for undertaking a daily site inspection to monitor compliance with this Specification and the relevant Project Specification. The Contractor shall forward the name of the Environmental Representative to the Engineer for his approval seven days prior to the date of the environmental awareness training course. The Contractor's Environmental Representative shall complete daily Site Inspection Forms and these shall be submitted to the Engineer once a week.

12.8.6 Site division

The Contractor shall restrict all his activities, materials, equipment and personnel to within the area specified.

A Method Statement detailing the layout and method of establishment of the construction camp (including all buildings, hostels, offices, lay down yards, vehicle wash areas, fuel storage areas, batching areas and other infrastructure required for the running of the project) shall be provided.

12.8.7 Site demarcation

As required by the Project Specification, the Contractor shall erect and maintain permanent and/ or temporary fences of the type and in the locations directed by the Engineer. Such fences shall, if so specified, be erected before undertaking designated activities.

12.8.8 "No go" areas

If so required by the Project Specification, certain areas shall be "no go" areas. The Contractor shall ensure that, insofar as he has the authority, no person, machinery, equipment or material enters the "no go" areas at any time.

12.8.9 Access routes/ haul roads

On the Site, and, if so required by the Project Specification, within such distance of the Site as may be stated, the Contractor shall control the movement of all vehicles and plant including that of his suppliers so that they remain on designated routes, are distributed so as not to cause an undue concentration of traffic and that all relevant laws are complied with. In addition such vehicles and plant shall be so routed and operated as to minimise disruption to regular users of the routes not on the Site. On gravel or earth roads on Site and within 500m of the Site, the vehicles of the Contractor and his suppliers shall not exceed a speed of 45 km/hr.

12.8.10 Construction personnel information posters

As required by the Project Specification, the Contractor shall erect and maintain information posters for the information of his employees depicting actions to be taken to ensure compliance with aspects of the Specifications. Such posters shall be erected at the eating areas and any other locations specified by the Engineer.

12.8.11 Fire control

No fires may be lit on site. Any fires, which occur, shall be reported to the Engineer immediately. Smoking shall not be permitted in those areas where it is a fire hazard. Such areas shall include the workshop and fuel storage areas and any areas where the vegetation or other material is such as to make liable the rapid spread of an initial flame. In terms of the Atmospheric Pollution Prevention Act, burning is not permitted as a disposal method.

The Contractor shall appoint a Fire Officer who shall be responsible for ensuring immediate and appropriate actions in the event of a fire and shall ensure that employees are aware of the procedure to be followed. The Contractor shall forward the name of the Fire Officer to the Engineer for his approval.

The Contractor shall ensure that there is basic fire-fighting equipment available on Site at all times. This shall include at least rubber beaters when working in urban open spaces and fynbos areas, and at least one fire extinguisher of the appropriate type when welding or other “hot” activities are undertaken.

12.8.12 Emergency procedures

The Contractor shall submit Method Statements covering the procedures for the following emergencies:

i) Fire

The Contractor shall advise the relevant authority of a fire as soon as one starts and shall not wait until he can no longer control it. The Contractor shall ensure that his employees are aware of the procedure to be followed in the event of a fire.

ii) Accidental leaks and spillages

The Contractor shall ensure that his employees are aware of the procedure to be followed for dealing with spills and leaks, which shall include notifying the Engineer, Scientific Services (Contact Hamied Mazema on 083-6294280 or Keith Walpole on 083-629 4281 or Winston Kannemeyer on 083-629 4276) and the relevant authorities. The Contractor shall ensure that the necessary materials and equipment for dealing with spills and leaks is available on Site at all times. Treatment and remediation of the spill areas shall be undertaken to the reasonable satisfaction of the Engineer.

In the event of a hydrocarbon spill, the source of the spillage shall be isolated, and the spillage contained. The area shall be cordoned off and secured. The Contractor shall ensure that there is always a supply of absorbent material readily available to absorb/ breakdown and where possible is designed to encapsulate minor hydrocarbon spillage. The quantity of such materials shall be able to handle a minimum of 200 l of hydrocarbon liquid spill.

12.8.13 Safety

Telephone numbers of emergency services, including the local fire fighting service, shall be posted conspicuously in the Contractor's office near the telephone. In the event of an emergency, the Contractor shall contact the City of Cape Town’s Emergency Call Centre (Tel: 107).

No unauthorised firearms are permitted on Site.

12.8.14 Community relations

If so required by the Project Specification, the Contractor shall erect and maintain information boards in the position, quantity, design and dimensions specified. Such boards shall include contact details for complaints by members of the public in accordance with details provided by the Engineer.

The Contractor shall keep a "Complaints Register" on Site. The Register shall contain all contact details of the person who made the complaint, and information regarding the complaint itself.

12.8.15 Protection of natural features

The Contractor shall not deface, paint, damage or mark any natural features (e.g. rock formations) situated in or around the Site for survey or other purposes unless agreed beforehand with the Engineer. Any features affected by the Contractor in contravention of this clause shall be restored/ rehabilitated to the satisfaction of the Engineer.

The Contractor shall not permit his employees to make use of any natural water sources (e.g. springs, streams, open water bodies) for the purposes of swimming, personal washing and the washing of machinery or clothes.

12.8.16 Protection of flora and fauna

Except to the extent necessary for the carrying out of the Works, flora shall not be removed, damaged or disturbed nor shall any vegetation be planted.

Trapping, poisoning and/ or shooting of animals is strictly forbidden. No domestic pets or livestock are permitted on Site.

Where the use of herbicides, pesticides and other poisonous substances has been specified, the Contractor shall submit a Method Statement.

12.8.17 Erosion and sedimentation control

The Contractor shall take all reasonable measures to limit erosion and sedimentation due to the construction activities and shall, in addition, comply with such detailed measures as may be required by the Project Specification. Where erosion and/or sedimentation, whether on or off the Site, occurs despite the Contractor complying with the foregoing, rectification shall be carried out in accordance with details specified by the Engineer. Where erosion and/or sedimentation occur due to the fault of the Contractor, rectification shall be carried out to the reasonable requirements of the Engineer.

12.8.18 Aesthetics

The Contractor shall take reasonable measures to ensure that construction activities do not have an unreasonable impact on the aesthetics of the area.

12.8.19 Recreation

If so required by the Project Specification, the Contractor shall take measures to reduce disruption to recreational users of the area abutting the Site.

12.8.20 Temporary site closure

If the Site is closed for a period exceeding one week, the Contractor in consultation with the Engineer shall carry out the checklist procedure required by the Project Specification.

12.9 TOLERANCES

Environmental management is concerned not only with the final results of the Contractor's operations to carry out the Works but also with the control of how those operations are carried out. Tolerance with respect to environmental matters applies not only to the finished product but also to the standard of the day-to-day operations required to complete the Works.

It is thus required that the Contractor shall comply with the environmental requirements on an ongoing basis and any failure on his part to do so will entitle the Engineer to certify the imposition of a fine subject to the details set out in the Project Specification.

12.10 MEASUREMENT AND PAYMENT

12.10.1 Basic principles

Except as noted below and in PSEM8 as Scheduled Items, no separate measurement and payment will be made to cover the costs of complying with the provisions of this specification and such costs shall be deemed to be covered by the rates tendered for the items in the Schedule of Quantities completed by the Contractor when submitting his tender.

12.10.2 Scheduled items

12.10.2.1 The environmental awareness training course

The provision of a venue and attendance at the environmental training course will be measured as a lump sum.

The sum shall cover all costs incurred by the Contractor in providing the venue and facilities as detailed in the Project Specification and in ensuring the attendance of all relevant employees and sub-contractors, at the meeting.

12.10.2.2 Method Statements: Additional Work

No separate measurement and payment will be made for the provision of Method Statements but, where the Engineer requires a change on the basis of his opinion that the proposal may result in, or carries a greater than warranted risk of damage to the environment in excess of that warranted by the Specifications, then any additional work required, provided it could not reasonably have been foreseen by an experienced contractor, shall be valued in accordance with GCC 90 Clause 40.

A stated sum is provided in the Schedule of Quantities to cover payment for such additional work.

12.10.2.3 Work "required by the Project Specification"

Where a clause in this Specification includes a requirement as "required by the Project Specification", measurement and payment for compliance with that requirement shall be in accordance with the relevant measurement and payment clause of the Project Specification.

PRO FORMA

Employer

Contract No

Contract title

PROTECTION OF THE ENVIRONMENT

The Contractor will not be given right of access to the Site until this form has been signed

I/ we,.....{Contractor} record as follows:

1. I/ we, the undersigned, do hereby declare that I/ we am/ are aware of the increasing requirement by society that construction activities shall be carried out with due regard to their impact on the environment.

2. In view of this requirement of society and a corresponding requirement by the Employer with regard to this Contract, I/ we will, in addition to complying with the letter of the terms of the Contract dealing with protection of the environment, also take into consideration the spirit of such requirements and will, in selecting appropriate employees, plant, materials and methods of construction, in-so-far as I/ we have the choice, include in the analysis not only the technical and economic (both financial and with regard to time) aspects but also the impact on the environment of the options. In this regard, I/ we recognise and accept the need to abide by the "precautionary principle" which aims to ensure the protection of the environment by the adoption of the most environmentally sensitive construction approach in the face of uncertainty with regard to the environmental implications of construction.

3. I/we have signed the Declaration of Understanding with respect to the Environmental Management Programme

4. I/ we acknowledge and accept the right of the Employer to deduct, should he so wish, from any amounts due to me/ us, such amounts (hereinafter referred to as fines) as the Engineer shall certify as being warranted in view of my/ our failure to comply with the terms of the Contract dealing with protection of the environment, subject to the following:

   4.1 The Engineer, in determining the amount of such fine, shall take into account inter alia, the nature of the offence, the seriousness of its impact on the environment, the degree of prior compliance/non-compliance, the extent of the Contractor's overall compliance with environmental protection requirements and, in particular, the extent to which he considers it necessary to impose a sanction in order to eliminate/reduce future occurrences

   4.2 The Engineer shall, with respect to any fine imposed, provide me/ us with a written statement giving details of the offence, the facts on which the Engineer has based his assessment and the terms of the Contract (by reference to the specific clause) which has been contravened.

Signed .....…… Date.....

CONTRACTOR

Special Conditions of Contract

The following clauses must be added to the Special Conditions of Contract section of the Tender Document.

Additional clause

6(6) COMPLIANCE WITH APPLICABLE LAWS

The Contractor shall, within the time stated in the Appendix, deliver to the Employer a Protection of the Environment form (See Pro Forma: **Protection of the Environment** bound in the Tender Documents.)

12(1) COMMENCEMENT OF WORKS

Add to Sub-Clause 12(1):

"In the event that the Contractor fails to provide a Protection of the Environment form in terms of Sub-Clause 6(5), the Engineer shall be entitled to delay the order to commence the Works (and thus the Commencement Date) beyond the 28 days, stipulated in Sub-Clause 12(2), by the period that the Contractor is late in submitting the required form."

45(1) TIME FOR COMPLETION

Add to Sub-Clause 45(1)

“The Time for Completion of the Works shall be reduced by the amount of delay, if any, in the issue of the notice requiring the Contractor to commence with the execution of the Works occasioned by the failure of the Contractor to submit a Protection of the Environment form, in terms of Sub-Clause 6(5), within the stipulated time.”

- **Appendix**

The following clause must be added to the Appendix section (GCC/ SCC) section of the Tender Document together with the Pro Forma.

Time within which Protection of the Environment form to be provided	6(5)	14 days after receipt of Letter of Acceptance

13 APPENDIX 2: GENERIC DETAILED ENVIRONMENTAL SPECIFICATIONS THAT SHOULD BE OBSERVED DURING CONSTRUCTION OF THE PROPOSED BRAKFONTEIN PV POWER PLANT

This document must be integrated with the Environmental Management Programmes described in the Environmental Management Programme, pending the DEA evaluation of the EIR, in order to generate a more detailed, expanded and elaborated EMP before construction, operations and decommissioning commences.

13.1 Scope

The general principles contained within the SPEC EM shall apply to all construction activities.

13.2 Definitions

For the purposes of this Specification the following definitions shall apply: {*include any relevant definitions as illustrated below*}

working area means any area within the boundaries of the Site where construction is taking place

13.3 Materials

13.3.1 Materials handling, use and storage

Storage

1. Storage areas shall be roofed with impervious material. The ingress of wind-blown rain shall be avoided by sufficient roof overhang or sides of sufficient height. Rainwater run-off shall be channelled or piped away from the area into channels or catch pits as specified elsewhere.

Importation of fill/ soil/ sand materials

1. Imported materials shall be free of weeds, litter and contaminants.
2. Sources of imported material shall be listed and approved by the Engineer.
3. The Contractor shall provide samples to the Engineer for approval.
4. Stockpile areas shall be approved by the Engineer before any stockpiling commences.

Hazardous substances

Paints

1. No paint products may be disposed of on Site.
2. Brush / roller wash facilities shall be established to the satisfaction of the Engineer.

3. Oil based paints and chemical additives and cleaners such as thinners and turpentine shall be strictly controlled. A Method Statement, approved by the Engineer, is required.

PLANT

Fuel (petrol and diesel) fuel oil and other oils

{permissions/ general provisions}

1. Fuel (petrol and diesel) may be stored on site providing the following is strictly adhered to.
2. All necessary approvals with respect to fuel storage and dispensing shall be obtained from the appropriate authorities.
3. The Contractor shall ensure that all liquid fuels and oils are stored in tanks with lids, which are kept firmly shut and under lock and key at all times.
4. Areas for storage of fuels and other flammable materials shall comply with standard fire safety regulations and may require the approval of the Municipal Fire Prevention Officer.
5. Temporary above ground storage tanks may be permitted at the discretion of the chief fire officer based on the merit of the situation, provided that the following requirements are complied with:

    a. Written application together with a plan and authority from the City of Cape Town effluent inspector shall be forwarded to the chief fire officer at least fourteen (14) days prior to the installation being erected on site. Written permission shall be obtained from the chief fire officer for the erection of the installation.

    b. The drawn plan shall be acceptable to the chief fire officer and to contain the following information:

        i. the scale

        ii. the name and address of the premises,

        iii. the number and the quantity of the tanks,

        iv. the position of the tanks in relation to the boundary, other flammable or combustible materials, etc.

        v. the size and construction materials used for the bund

        vi. the product to be kept in the tank, and

        vii. any other information relevant to the situation.

{location}

1. The fuel storage area shall be located at one of the following locations: {provide a list of acceptable locations for the fuel storage area}.
2. The Engineer shall be advised of the area that the Contractor intends using for the storage of fuel.
3. The location of the fuel storage area will be approved by the Engineer.

4. The tank shall be erected at least 3,5 meters from buildings, boundaries and any other combustible or flammable materials.

{signs/good practice/safety precautions}

1. Symbolic safety signs depicting “No Smoking”, “No Naked Lights” and “ Danger” conforming to the requirement of SABS 1186 are to be prominently displayed in and around the fuel storage area. The volume capacity of the tank shall be displayed.
2. No smoking shall be allowed in the vicinity of the stores.
3. The capacity of the tank shall be clearly displayed and the product contained within the tank clearly identified using the emergency information system detailed in SABS 0232 part 1.
4. There shall be adequate fire-fighting equipment at the fuel storage and dispensing area or areas.
5. Fuel shall be kept under lock and key at all times.

{tanks}

1. The storage tank shall not have a capacity exceeding 9000 litres and shall not be used for the storage of liquids other than those with a flash point in excess of 40 ºC.
2. If larger capacity tanks are required or the tank is to be a permanent installation, then an acceptable rational design based on a relevant national or international code or standard shall be submitted to the local authority for approval in terms of the National Building Regulations.
3. The storage tank shall be removed on completion of the works.
4. The storage tank shall not be on the premises for longer than 6 months.
5. All such tanks to be designed and constructed in accordance with a recognised code.
6. The rated capacity of tanks shall provide sufficient capacity to permit expansion of the product contained therein by the rise in temperature during storage.

{bunds/storage areas}

1. Tanks shall be situated in a bunded area the volume of which shall be at least 110% of the volume of the largest tank. The floor of bund shall be smooth and impermeable constructed of concrete or plastic sheeting with impermeable joints with a layer of sand over to prevent perishing. The bund walls shall be formed of well-packed earth with the impermeable lining extending to the crest. The floor of the bund shall be sloped towards an oil trap or sump to enable any spilled fuel and/or fuel-soaked water to be removed.
2. A bacterial hydrocarbon digestion agent that is effective in water approved by the Engineer shall be installed in the sump.
3. The tanks and bunded areas shall be covered by a roofed structure as detailed on drawing ?? to prevent the bunded area from filling with rain water. This structure shall be constructed in such a way, and to the approval of the Engineer, to ensure that it is wind resistant.

4. Any water that collects in the bund shall not be allowed to stand and shall be removed within one day and taken off Site to a disposal site approved by the Engineer, and the bacterial hydrocarbon digestion agent shall be replenished.

{*Refer to figures at end of this Detailed Environmental Specification*}

{empty containers}

1. Only empty and externally clean tanks may be stored on the bare ground. All empty and externally dirty tanks shall be sealed and stored on an area where the ground has been protected.

{filling/dispensing methods}

1. Any electrical or petrol-driven pump shall be equipped and positioned so as not to cause any danger of ignition of the product.
2. If fuel is dispensed from 200 litre drums, the proper dispensing equipment shall be used. The drum shall not be tipped in order to dispense fuel. The dispensing mechanism of the fuel storage tank shall be stored in a waterproof container when not in use.
3. Adequate precautions shall be provided to prevent spillage during the filling of any tank and during the dispensing of the contents.

{method statements}

1. A method statement is required for the filling of and dispensing from storage tanks

Shutter oil operations

1. Shutter oils are to be applied under controlled conditions to avoid accidental and incidental spillage. Proper brush or roller tools shall be provided for the application of shutter oils and the use of rags or makeshift items will not be allowed.
2. Small or appropriately sized containers shall be provided for the application of decanted oil in order to minimise accidental spillage.

Eating areas

1. The Contractor shall designate eating areas at the following location {*either provide verbal description of potential eating area sites or indicate them on the site plan*}
2. The feeding, or leaving of food, for baboons and other animals is strictly prohibited.

Toilet and ablution facilities

{Provision}

1. Provision shall be made for employee facilities including: shelter, toilets and washing facilities.
2. Toilet facilities supplied by the Contractor for the workers shall occur at a maximum ratio of 1 toilet per 30 workers (preferred 1:15).

{Location}

1. The exact location of the toilets shall be approved by the Engineer prior to establishment.
2. Sanitation facilities shall be located within 100 m from any point of work, but not closer than 50 m to any water body. {distances can be modified depending on the nature of the project}
3. Toilets shall be within the Contractor's Camp and at work areas more than 50m from the Contractor's Camp.

{Construction/design}

1. All temporary/ portable toilets shall be secured to the ground to the satisfaction of the Engineer to prevent them toppling due to wind or any other cause.
2. The Contractor shall ensure that the entrances to toilets are adequately screened from public view.
3. Combinations of urinal and pan type units shall be carefully considered.

{Use/Operation}

1. These facilities shall be maintained in a hygienic state and serviced regularly. Toilet paper shall be provided.
2. The Contractor shall ensure that no spillage occurs when the toilets are cleaned or emptied and that the contents are removed from Site.
3. Discharge of waste from toilets into the environment and burial of waste is strictly prohibited.
4. The Contractor shall ensure that toilets are emptied before the builders' holidays.

13.3.2 Solid waste management

General

1. The Contractor shall set up a solid waste control and removal system and a Method Statement is required in this regard.
2. Bins shall be emptied on a daily basis.
3. The system shall comply with the following detailed requirements:

Dumping

1. Receipts for hazardous waste disposal shall be copied to the Engineer.
2. Any proposal to dispose of vegetation cuttings, tree trunks or building waste products such as rubble or asphalt or similar such products as part of backfill or landscape shaping shall require a Method Statement.

Litter and refuse

1. Waste and litter shall be disposed of into scavenger- and weather proof bins. The Contractor shall then remove the refuse collected from the working areas, from Site at least once a week.

2. Refuse must be disposed at a site approved by the Engineer.
3. The Contractor shall make provision for workers to clean up the Contractor's camp and working areas at least once a week.

Recycling

1. Wherever possible, materials used or generated by construction shall be recycled.
2. Containers for glass, paper, metals and plastics shall be provided. Office and camp areas are particularly suited to this form of recycling process.
3. Where possible and practical, such as at stores and offices, waste shall be sorted for recycling purposes. Recycling protocols shall sort materials into the following categories:
    a. Paper / cardboard
    b. Aluminium
    c. Metals (other than aluminium)
    d. Organic waste
    e. Glass

Litter and oil traps

1. Refuse screens and oil traps shall be installed at runoff concentration points from large parking facilities, wash bays, storm water outlets, inlets to detention ponds, workshop forecourt drainage points, ablution and eating areas. These facilities shall be serviced and monitored at the discretion of the Engineer.

13.3.3 Contaminated water

General

1. The Engineer's approval will be required prior to the discharge of contaminated water to the Municipal sewer system.
2. The Contractor shall prevent discharge of any pollutants, such as cements, concrete, lime, chemicals and fuels into any water sources.
3. Water from kitchens, showers, laboratories, sinks etc. shall be discharged into a conservancy tank for removal from the site.
4. Runoff from fuel depots/workshops/truck washing areas and concrete swills shall be directed into a conservancy tank and disposed off at a site approved by the Engineer and Local Authority.
5. The contaminated water, contaminated run-off, or effluent may also require analysis prior to disposal. Cape Metropolitan Council Scientific Services may provide this function, and the relevant South African Water Quality Guidelines implemented by DWAF apply.

Washing areas

1. Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater, are not polluted.
2. A Method Statement shall be required for all wash areas where hydrocarbon and hazardous materials, and pollutants are expected to be used. This includes, but is not limited to, vehicle washing, workshop wash bays, paint wash and cleaning.
3. Wash areas for domestic use shall ensure that the disposal of contaminated “grey” water is sanctioned by the Engineer.

13.3.4 Dust

1. The Contractors shall be solely responsible for the control of dust arising from the Contractor’s operations and for any costs against the Employer for damages resulting from the dust.
2. The Contractor shall take all reasonable measures to minimise the generation of dust as a result of construction activities to the satisfaction of the Engineer.
3. Removal of vegetation shall be avoided until such time as soil stripping is required and similarly exposed surfaces shall be re-vegetated or stabilised as soon as is practically possible.
4. Excavation, handling and transport of erodible materials shall be avoided under high wind conditions or when a visible dust plume is present.
5. During high wind conditions, the Engineer will evaluate the situation and make recommendations as to whether dust-damping measures are adequate, or whether working will cease altogether until the wind speed drops to an acceptable level.
6. Where possible, soil stockpiles shall be located in sheltered areas where they are not exposed to the erosive effects of the wind. Where erosion of stockpiles becomes a problem, erosion control measures shall be implemented at the discretion of the Engineer.
7. Vehicle speeds shall not exceed 40km/h along dust roads or 20km/h when traversing unconsolidated and non-vegetated areas. {*modify speed limits depending on the nature of the project*}
8. Appropriate dust suppression measures shall be used when dust generation is unavoidable, e.g. dampening with water, particularly during prolonged periods of dry weather in summer. Such measures shall also include the use of temporary stabilising measures (e.g. chemical soil binders, straw, brush packs, chipping etc.).
9. Straw stabilisation shall be applied at a rate of one bale/ 10m² and harrowed into the top 100 mm of top material, for all completed earthworks.

13.3.5 Lights

1. Where the Engineer has authorised night work, low flux and frequency lighting shall be used. {*applicable in areas where entomology concerns have been identified – a specialist would need to be consulted with respect to determining the appropriate flux and frequency levels*}

13.3.6 Workshop, equipment maintenance and storage

Construction camp maintenance

1. The construction camp shall be kept neat and clean at all times.
2. Refuse and waste storage areas shall be positioned away from buildings

Drip trays and bunding

1. Drip trays shall be inspected and emptied daily, and serviced when necessary. In particular drip trays shall be closely monitored during rain events to ensure that they do not overflow.
2. All repairs done on machinery using hydrocarbons as fuels or lubricants shall have a drip tray placed strategically to avoid incidental spillage.
3. All static plant shall be located within a bunded area. The bunded area shall have a smooth impermeable surface (plastic) with an earth bund. The impermeable material shall extend to the crest of the earth bund. The floor of the bunded area shall be sloped towards an oil trap or sump to enable incidental spillage to be removed.

13.3.7 Noise

1. Noise levels exceeding 85dB shall only be permitted where approved by the Engineer or during an emergency situation.

13.4 CONSTRUCTION

13.4.1 Method Statements

The following Method Statements shall be provided by the Contractor 14 days after receipt of the Letter of Acceptance:

{Add in only those Method Statements relevant to the particular project}

Other Method Statements that shall be required during the course of construction include:

{Add in only those Method Statements relevant to the particular project}

{List of method statements from which the relevant ones must be chosen}:

13.4.2 Access routes

- Upgrading and construction of access routes.
- Rehabilitation of temporary access routes.
- Location of proposed access routes.

13.4.3 Alien plant clearing

- Method of control to be used for the eradication or control of alien vegetation.

13.4.4 Anchors

- Use of rock or ground anchors (epoxy and grouting chemical/safety data sheets to also be provided)

13.4.5 Blasting

- Details of all methods and logistics associated with blasting.

13.4.6 Bunding

- Method of bunding for static plant.

13.4.7 Camp establishment

- Layout and preparation of the construction camp.
- Method of installing fences required for “no go” areas, working areas and construction camp areas
- Preparation of the working area.

13.4.8 Cement/concrete batching

- Location, layout and preparation of cement/ concrete batching facilities including the methods employed for the mixing of concrete including the management of runoff water from such areas.

Contaminated water

- Contaminated water management plan, including the containment of runoff and polluted water.

13.4.9 Demolition

- Proposed method(s) of demolition.

13.4.10 Dredging

- Proposed methods and compounds to treat spills.
- Methods of refuelling dredger.

13.4.11 Drilling and jack hammering

- Method of drill coring with water or coolant lubricants.

- Methods to prevent pollution during drilling operations.

13.4.12 Dust

- Dust control.

13.4.13 Earthwork

- Method for the control of erosion during bulk earthwork operations.
- Method of undertaking earthworks, including hand excavation and spoil management.

13.4.14 Emergency

- Emergency construction method statements.

13.4.15 Environmental awareness course

- Logistics for the environmental awareness course for all the Contractors employees.
- Logistics for the environmental awareness course for the Contractors management staff.

13.4.16 Erosion control

- Method of erosion control, including erosion of spoil material

13.4.17 Exposed aggregate finishes

- The method of control, treatment and disposal with respect to exposed aggregate finishes.

13.4.18 Fire, hazardous and poisonous substances

- Handling and storage of hazardous wastes.
- Emergency spillage procedures and compounds to be used.
- Emergency procedures for fire.
- Use of herbicides, pesticides and other poisonous substances.
- Methods for the disposal of hazardous building materials including asbestos, fibre claddings, refrigerants and coolants.

13.4.19 Fuels and fuel spills

- Methods of refuelling vehicles.
- Details of methods for fuel spills and clean-up operations.
- Refuelling of construction vehicles in high flow areas [or in the 1 in 50 year floodplain].

- Method of refuelling dredger during dredging operations.

13.4.20 Piling, jacking and thrust boring

- The method of piling operation (e.g. driven or bored) or in situ casting or pre-cast pile structures.

13.4.21 Rehabilitation

- Rehabilitation of disturbed areas and re-vegetation after construction is complete.
- Retaining walls and gabions.
- Method for construction and installation of retaining walls/ gabion baskets.

13.4.22 Riverine corridors

- Method of diverting the river during construction.
- Details of methods to control downstream sedimentation.
- Details of methods to control in stream and floodplain erosion.
- Details of methods to cross rivers or streams during construction activities.
- Details of the release of any construction related effluent water into any natural stream of river.
- Method for all construction activities within the 1 in 50 year floodplain.
- Method of laying the pipeline across the {*lagoon*}, including details of methods to control sedimentation.

13.4.23 Rock breaking

- Details of chemical applications to be used for rock breaking.

13.4.24 Settlement ponds and sumps

- Layout and preparation of settlement ponds and sumps.

13.4.25 Solid waste management

- Solid waste control and removal of waste from Site.
- Methods for the disposal of vegetation cuttings, tree trunks and or building materials.

13.4.26 Sources of materials

- Details of materials imported to the site (where applicable).

13.4.27 Sensitive environments

- Proposed construction methods within any sensitive environments {*these include but are not limited to wetlands, intertidal zones and estuaries*}

13.4.28 Traffic

- Traffic safety measure for entry/ exit onto/ off public roads.

13.4.29 Vegetation clearing

- Method of vegetation clearing during site establishment.

13.4.30 Wash areas

- Location, layout, preparation and operation of all wash areas, including vehicle wash, workshop washing and paint washing and clearing.

13.4.31 Wastewater treatment works

- Emergency procedures for accidental leaks, spillage or overflow of raw wastewater, semi-treated wastewater, sludge or final effluent. The Method Statement shall include the following:
    a. a comprehensive list of available equipment (*e.g.* pipes and pumps) in the event of a spill
    b. the location of all emergency equipment
    c. the individual(s) responsible for the upkeep and maintenance of the emergency equipment
    d. an indication of how regularly the emergency equipment will be checked to ensure that it is working properly
    e. the location of any and all temporary emergency sumps, including old sludge ponds, clarifiers, low lying areas *etc*.
    f. the size of spillage which the emergency procedures could contain
    g. where and how any spilled material will be returned to the wastewater works system
    h. who shall be notified in the event of an emergency, including contact numbers for the relevant local authority
- Methods to isolate any section of the wastewater infrastructure for construction or maintenance purposes.
- Methods to connect new structures or reconnect old structures to the wastewater treatment infrastructure.

13.4.32 Water abstraction

- Methods of abstraction and utilisation of water from natural water resources.
- Details of any well point provision.

13.5 Environmental awareness training

{requirement}

1. All the Contractors employees and Sub-Contractors employees and any suppliers employees that spend more than 1 day a week or four days in a month on site, must attend an Environmental Awareness Training course presented by the Contractor the first of which shall be held within one week of the Commencement Date. Subsequent courses shall be held as and when required.

{given by whom}

1. The Engineer will provide the Contractor with the course content for the environmental awareness training course, and the Contractor shall communicate this information to his employees on the site, to any new employees coming onto site, to his subcontractors and to his suppliers.
2. The Engineer or suitably qualified representative will present the environmental awareness training course to the Contractors employees on the site, to any new employees coming onto site and to the Contractors subcontractors and suppliers.

{logistics}

1. No more than 20 people shall attend each course and the cost, venue and logistics for this/ these course/s shall be for the Contractor's responsibility. The cost for each individual course shall be R…..
2. Within seven days from the Commencement Date the Contractor shall ensure that the first course/s is/are held for as many of the employees that are available at this time.
3. The Contractor shall supply the Engineer with a monthly report indicating the number of employees that will be present on site during the following month and any changes in this number that may occur during the month.

{method statement}

1. The Contractor shall submit a Method Statement detailing the logistics of the environmental awareness training course.

13.6 Site division

Construction camp location

1. The construction camp shall be located at an easily accessible point and within an area of low environmental sensitivity. The location shall be identified in consultation with the Engineer.
2. No site establishment shall be allowed within 15 m of a drainage channel or water body unless otherwise approved by the Engineer.

Routing of services

1. Main bulk service providers such as Telkom and Eskom shall be advised of the construction activities as well as the requirements of this specification and the Contractor shall be responsible for their activities within their work areas.
2. All routes for service infrastructure shall take cognisance of any special features on Site and shall be re-routed around “no go” areas.
3. Where possible, service infrastructure shall be located in the same trench.

Site establishment

1. To facilitate the necessary monitoring, the Contractor shall inform the Engineer of the intended actions and programme for site establishment.
2. The site layout shall take cognisance of access for deliveries and services, and future works. Likely disturbance to neighbours as well as security implications shall be considered.

13.7 Site demarcation

{General}

1. The boundaries of the proposed construction camp and working areas are shown in Drawing ????. The site shall be fenced ***by means of/as shown on*** {*insert appropriate specification from list below*}.
2. No-Go areas shall be fenced ***by means of/as shown on*** {*insert appropriate specification from list below*}.
3. areas shall be fenced ***by means of/as shown on*** {*insert appropriate specification from list below*}.

{Differing functional areas shall be listed separately with the appropriate fencing specification clearly shown}

4. The Contractor shall maintain in good order all demarcation fencing and barriers for the duration of construction activities, or as otherwise instructed.

{Specification}

a. a diamond mesh or bonnix fence with a minimum height of 1,8 m shall be erected around the Site.

b. metal or wooden standards at 20 m centres, with three wooden droppers between the standards. A minimum of 3 plain wire strands shall be tensioned horizontally, the lowest strand being at a height of 500 mm above average ground level and the highest being at 1.2 m. Mesh or bonnix type fencing, of 1.2 m in height, shall be secured to the wire strands and posts.

c. wooden or metal posts at 3 m centres with 2 plain wire strands tensioned horizontally at 300 mm and 900 mm from ground level. Commercially available extruded plastic mesh fencing shall be secured to these wire strands and posts. The plastic mesh shall be in a clearly seen and visible colour (orange or red). The minimum height shall be 1.2m {*check on standard available sizes*}

d. wooden or metal posts at 3 m centres with 1 plain wire strand tensioned horizontally at 900 mm from ground level. Commercially available danger tape shall be wrapped around the wire strand. The Contractor shall maintain the fence for the duration of the contract and ensure that the danger tape does not become dislodged and cause litter. {*Refer to figures at end of this Detailed Environmental Specification*}

e. Rocks and/ or droppers at 50 m intervals shall be placed along the Site boundary and painted white. The Contractor shall maintain these markers and ensure that they are removed at the end of the Contract.

f. Drawing 8450 CT6 *{Refer to figures at end of this Detailed Environmental Specification}*.

13.8 "No go" areas

General

1. A "no go" area shall extend …. {*indicate location and extent of all "no go" areas*}
2. The Contractor shall ensure that all "no go" areas are demarcated according to the following specifications {*either refer to one of the diagrams or outline demarcation method using specifications given in "Site demarcation"*}.
3. No unauthorised entry, stockpiling, dumping or storage of equipment or materials shall be allowed within the demarcated "no go" areas.

{*Refer to figures at end of this Detailed Environmental Specification*}

Tree protection

1. All trees, which are to be retained, are to be clearly indicated on a site plan and demarcated.

2. Trees to be demarcated shall be clearly marked under the supervision of the Engineer. Marking techniques include danger tape, paint (be aware of long term aesthetics), strapping and pegs. Tagging by exclusion shall be considered, i.e. where the number of trees to be cleared is fewer than those to be retained then mark trees for felling and all other trees shall automatically be retained.
3. Demarcation shall remain in place for the duration of works on site. If damaged, demarcation shall be repaired or replaced immediately.

{*Refer to figures at end of this Detailed Environmental Specification*}

Natural/ special features

1. Special features shall be marked on a site layout plan prior to any works commencing on site. These areas may be designated “No go” areas.
2. Outcrops, rock faces, trees and natural vegetation or any other natural or special features inside and outside the Site, shall not be defaced, painted for benchmarks for survey or any other purposes or otherwise damaged in any way without the prior approval of the Engineer. These features shall be demarcated as “no go” areas and shall be fenced or similarly protected, as determined by the Engineer.

{*Refer to figures at end of this Detailed Environmental Specification*}

13.9 Access routes/ haul roads

{Routes}

1. Access to the construction camp and works area is shown on Drawing No ????
2. Haul routes are shown on drawing No ????
3. Access to the Campsite and works area shall utilise existing roads or tracks where possible.
4. Upgrading of the access roads shall be undertaken within the existing confines of the road, unless otherwise agreed with the Engineer.

{control}

1. The Contractor shall erect and maintain marker pegs along the boundaries of the working areas, access roads, haul roads or paths, to the satisfaction of the Engineer, before commencing any other work.
2. The movement of any vehicles and/ or personnel outside of the designated working areas shall not be permitted without the written authorisation of the Engineer.
3. Should the Contractor not exercise sufficient control to restrict all work to the area within the marker boundaries, then these on instruction of the Engineer shall be replaced by fencing the additional cost of which shall be borne by the Contractor.
4. Dust control measures such as dampening with water shall be implemented where necessary, as indicated by the Engineer.

{construction/ maintenance/ rehabilitation}

1. Access and haul roads shall be maintained by the Contractor.
2. Maintenance includes adequate drainage and side drains, dust control and restriction of edge use.
3. All temporary access routes shall be rehabilitated at the end of the contract to the satisfaction of the Engineer.
4. All public roads shall be kept clear of mud and sand. Mud and sand that has been deposited through construction activities shall be cleared regularly.
5. Any materials used for layer works shall be approved by the Engineer prior to the activity commencing.
6. Damage to the existing access roads as a result of construction activities shall be repaired to the satisfaction of the Engineer, using material similar to that originally used. The cost of the repairs shall be borne by the Contractor

{safety}

1. Traffic safety measures, to the satisfaction of the Engineer, shall be considered in determining entry / exit onto public roads.
2. All users of haul roads shall not exceed 45 kph (cars)/ 15 kph (trucks) {note that the standard spec places a site speed limit of 45 kph for all vehicles}
3. Appropriate traffic warning signs shall be erected and maintained.
4. Trained and equipped flagmen shall be used where the access road intersects with any public roads.
5. Attention shall be paid to minimising disruption of the flow of traffic and reducing the danger to other road users and pedestrians.

{method statements}

Method statements are required for the following:-

1. Traffic safety measures with regard to entry and exit on public roads and the control of construction traffic.
2. Proposed route for new access roads, tracks, or haul roads; the proposed construction of new roads, and the method of upgrading existing roads; and the proposed methods of rehabilitation on completion.

{*include definition of working area where applicable*}

13.10 Construction personnel information posters

1. An A3 construction personnel information poster must be laminated and erected in the eating area. The Specifications for the posters are presented in Drawing ???? {*include copy of the construction personnel information poster in the tender document*}

2. The Contractor shall ensure that the construction personnel information poster is not damaged in any way, and shall replace it if any part of it becomes illegible.

{*Refer to figures at end of this Detailed Environmental Specification*}

13.11 Fire control

1. The Contractor shall take all reasonable and active steps to avoid increasing the risk of fire through their activities on Site. No fires may be lit except at places approved by the Engineer.
2. The Contractor shall ensure that the basic fire-fighting equipment is to the satisfaction of the Local Fire Services.
3. The Contractor shall supply all living quarters, site offices, kitchen areas, workshop areas, materials, stores and any other areas identified by the Engineer with tested and approved fire fighting equipment.
4. Fire and “hot work” shall be restricted to a site approved by the Engineer.
5. A Braai facility may be considered at the discretion of the Engineer. The area shall be away from flammable stores. All events shall be under management supervision and a fire extinguisher shall be immediately available. “Low smoke” fuels shall be used. Smoke free zoning regulations shall be considered.
6. Fires within National Parks, Nature Reserves and natural areas are prohibited. Cooking shall be restricted to bottled gas facilities under strict control and supervision.
7. The Contractor shall take precautions when working with welding or grinding equipment near potential sources of combustion. Such precautions include having a suitable, tested and approved fire extinguisher immediately at hand and the use of welding curtains.

13.12 Emergency procedures

Wastewater treatment works

1. A Method Statement shall be drawn up by the Contractor, in consultation with the wastewater plant manager, on the protocols to be followed, and contingencies in place, in the event of an accidental leak, spillage or overflow of raw wastewater, semi-treated wastewater, sludge or final effluent, as a direct or indirect result of construction activities. The Method Statement shall include the following:
    a. a comprehensive list of available equipment (*e.g.* pipes and pumps) in the event of a spill
    b. the location of all emergency equipment
    c. the individual(s) responsible for the upkeep and maintenance of the emergency equipment
    d. an indication of how regularly the emergency equipment will be checked to ensure that it is working properly

e. the location of any and all temporary emergency sumps, including old sludge ponds, clarifiers, low lying areas *etc*.

f. the size of spillage which the emergency procedures could contain

g. where and how any spilled material will be returned to the wastewater works system

h. who shall be notified in the event of an emergency, including contact numbers

2. The Contractor shall ensure that his staff and the staff of Subcontractors are aware of the procedure to be followed for dealing with spills and leaks, which shall include notifying the Engineer and the relevant local authorities. The Contractor shall ensure that the necessary materials and equipment for dealing with spills and leaks are present on Site at all times. The clean-up of spills and any damage caused by the spill or leak shall be for the Contractor's account.

Hydrocarbon spills

1. An approved Method Statement for spillage treatment is required.
2. The site shall have a supply of absorbent material readily available to absorb any emergency hydrocarbon spills, and where possible is designed to encapsulate minor hydrocarbon spillage. The quantity of such materials shall be able to absorb / deal with a minimum of 200 l of hydrocarbon liquid spill.
3. There are a number of products on the market, which are designed and suitable to absorbents and encapsulate. The following are examples of those products used to contain incidental spillage:
    a. Spill-Sorb – oil and chemical absorbent & encapsulating products
    b. Drizzat Pads
    c. Enretech Powder – Absorbent & encapsulation
    d. Peat moss
4. Treatment and remediation of spill areas shall be undertaken to the satisfaction of the Engineer
5. Treatment and remediation shall require a Method Statement. Examples of products used for treatment and remediation include:
    a. Chemcap – aqueous silicate, releases and encapsulates
    b. Bio-Systems B110 Series
    c. Enretech products
6. The source of the spillage shall be isolated.
7. The contractor shall contain the spillage using sand berms, sandbags, pre-made booms, sawdust or absorbent materials.
8. Cordon off and ensure safety of the spillage area.
9. Notify the Engineer and the City of Cape Town Pollution Control Inspectorate.

13.13 Special environments

{*method statements should be requested for all construction activities within these sensitive areas*}

13.13.1 Intertidal zones and estuaries

1. No vehicle shall be permitted onto a beach without a permit having first been obtained from the Relevant Authority concerned.
2. Any works to be carried out below the high water mark of the sea for which a permit has not been obtained from the Relevant Authority in terms of the Sea Shore Act (21 of 1935) is illegal and shall render the offender to a prison sentence of up to two years and a fine.
3. The removal of any material from below the high water mark of the sea without the necessary permit is an offence and attracts a jail term of up to two years and a fine.
4. Additionally, a court may order the removal of any illegal works carried out below the high water mark of the sea at the offender's expense and further order the rehabilitation and repair of any damage to the sea shore caused by the illegal works.

13.13.2 Rivers and streams

1. The Contractor shall minimise the extent of any damage to the flood plain to that necessary to complete the works, and shall not pollute the river system as a result of construction activities. The Contractor shall not cause any physical damage to any aspects of a watercourse, other than that necessary to complete the works as specified and in accordance with the accepted method statement.
2. Construction activities shall not permanently alter the surface or subsurface flow of water through the flood plain area. No construction materials shall be stockpiled on the flood plain.
3. Any excavation within the lagoon and flood plain shall be by hand. The Contractor shall ensure that all construction activities within the flood plain and lagoon, including the removal of vegetation, stockpiling of top material, excavating of pipeline route, laying of pipeline, backfilling of excavations and rehabilitation occur within a maximum of a three week period.
4. Baseline water quality of any rivers, streams, wetlands on the Site shall be established prior to onset of any construction activities. These baseline values (total Suspended Solids, pH, conductivity, nitrates, nitrites, ammonia and temperature) shall not be adversely affected by construction-related activities. {*Baseline water quality and monitoring requirements should be established with the City of Cape Town's Scientific Services prior to commencement of construction*}
5. The Contractor shall submit a method statement for review 14 days prior to commencing construction within the 1 in 50 year flood line. The method statement shall highlight (but not be confined to) the following issues:
    a. detailed plan for any crossings, including pipe protection works;

b. how water flow will be diverted during construction (if applicable);

c. containment of contaminated runoff and contaminated water;

d. width of working servitude (if not already detailed in project specification);

e. final expected profile of river/ stream banks;

f. reinstatement and rehabilitation of river/ stream banks.

6. All temporary and permanent fill used adjacent to, or within, the river / streambed shall be of clean sand or larger particles. Silts, clays, granitic sands and boulders shall not be permitted in the fill.
7. Plastic sheeting, sandbags or geofabric approved by the Engineer shall be used to prevent the migration of fines through the edges of the fill into the river.
8. Banks shall be suitably stabilised incrementally immediately after construction allows. Upkeep of stabilisation facilities shall be continuously maintained.
9. The Contractor shall remove herbaceous riparian vegetation as directed by the Engineer, with their root ball intact. This vegetation shall be kept moist by means of placing it in the shade, covered with moistened hessian cloth until it is replanted.
10. The Contractor shall not modify the banks or bed of a watercourse.
11. Rocks for use in gabion baskets/ reno mattresses shall not be obtained from a watercourse.
12. The Contractor shall not cause any physical damage to any aspects of a watercourse, other than that necessary to complete the works as specified and in accordance with the accepted method statement.
13. The introduction of any construction related effluent water into any natural stream or river requires a Method Statement to be approved by the Engineer.

{*Refer to figures at end of this Detailed Environmental Specification*}

13.13.3 Wetlands

1. Damage to the wetland areas shall be minimised. The Engineer shall approve demarcation of work area extent. All potential wetland areas shall be marked clearly on the plan and the Contractor shall submit a Method Statement for review at least 14 days prior to commencing construction in a wetland.
2. Construction may not permanently alter the surface or subsurface flow of water through the wetland.
3. The Contractor shall remove all wetland vegetation, as indicated by the Engineer, with their root ball intact. This vegetation shall kept moist at all times and shall be placed in the shade and covered with moistened hessian cloth until replanting.
4. No construction materials shall be stockpiled in any wetland areas.
5. The post-construction profile of the wetland shall be returned to one similar to that before construction, with no created “ridge or channel” features present.

13.14 Protection of archaeological and palaeontological remains

If remains or artefacts are discovered on Site during earthworks, work shall cease and the Contractor shall immediately inform the Engineer and contact the relevant authority, which in this case is the South African Heritage Resources Agency (SAHRA).

13.15 Erosion and sedimentation control

1. During construction the Contractor shall protect areas susceptible to erosion by installing necessary temporary and permanent drainage works as soon as possible and by taking other measures necessary to prevent the surface water from being concentrated in streams and from scouring the slopes, banks or other areas.
2. A Method statement shall be developed and submitted to the Engineer to deal with erosion issues prior to bulk earthworks operations commencing.
3. Any runnels or erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored to a proper condition.
4. Stabilisation of cleared areas to prevent and control erosion shall be actively managed. The method of stabilisation shall determine in consultation with the Engineer. Consideration and provision shall be made for the following methods (or combination): {*choose appropriate method*}

Brush cut packing

Mulch or chip cover

Straw stabilising (at the rate of one bale/m² and rotated into the top 100mm of the completed earthworks)

Watering

Planting / sodding

Hand seeding sowing

Hydro seeding

Soil binders and anti-erosion compounds

Mechanical cover or packing structures

i. Gabions & mattresses
ii. Geofabric
iii. Hessian cover
iv. Armourflex
v. Log / pole fencing

vi. Retaining walls

5. Traffic and movement over stabilised areas shall be restricted and controlled, and damage to stabilised areas shall be repaired and maintained to the satisfaction of the Engineer.
6. Anti-erosion compounds shall consist of an organic or inorganic material to bind soil particles together and shall be a proven product able to suppress dust and erosion. The application rate shall conform to the manufacturer's recommendations. The material used shall be of such a quality that grass and “fynbos” seeds may germinate and not prohibit growth.

{*Refer to figures at end of this Detailed Environmental Specification*}

13.16 Storm water controls

1. The Contractor shall take reasonable measures to control the erosive effects of storm water runoff.
2. The Contractor shall use silt screens to prevent overland flowing water from causing erosion.
3. The use of straw bales as filters, which are placed across the flow of overland storm water flows, shall be used as an erosion protection measure.
4. The ploughing-in of straw offers limited protection against storm water runoff-induced erosion and shall be used as an erosion protection measure.
5. The Contractor shall be liable for any damage to downstream property caused by the diversion of overland storm water flows.

13.17 Aesthetics

1. The Contractor shall be required to visually screen the site.
2. Visual screening shall be aesthetically pleasing and shall be erected by the Contractor prior to commencing any activities.
3. Visual screening shall be maintained by the Contractor for the duration of the Contract.
4. Visual screening may be of the following types:
    a. Shade cloth
    b. Hessian
    c. Berms

13.18 Community relations

Adjoining sites

1. The adjoining site is used by the community as a sports field/ soccer pitch. The Contractor shall ensure that his operations do not in any way prejudice or interrupt the safe use of this facility by members of the public.

2. Operations that are likely to be noisy, dusty or otherwise disruptive shall only be commenced after due notice and consultation with the community likely to be affected has been carried out. The following procedure shall be adhered to:- *{insert here procedure which should be dictated by the relevant recommendations of the EMP}*

3. Access to the site will be allowed through the adjoining site only if the access route is clearly marked and demarcated as described in clause **. Particular care shall be taken by all drivers while negotiating this route and all rules laid down in clauses in this regard elsewhere in this Specification shall be strictly adhered to.

{*It must be established whether the Contractor is to be given the responsibility of community relations. If not then the employer must undertake the actions outlined below, and these instructions would not be included in the Project Specification*}

1. The Contractor shall erect an information board containing background information for the construction activity and listing the relevant contact details for complaint. {*the number and location of information boards for each project must be determined when drawing up the tender document*}

13.19 For a project for which an Environmental Impact Assessment process has been undertaken]

2. The Contractor shall distribute letters to all interested and affected parties identified during the Environmental Impact Assessment process, notifying them of the onset of the construction activities and providing the relevant contact details for complaint.

13.20 For a project for which no previous Environmental Impact Assessment process has been undertaken}

2. The Contractor shall undertake a mail drop to residents in the immediate vicinity of the proposed activity, notifying them of the onset of the construction activities and providing the relevant contact details for complaint.

{Information boards}

3. A2 posters, to be placed on the information boards, printed on vinyl, shall be supplied to the Contractor. The Contractor shall mount the poster on a 0,6 mm white chromodek backing with a 50 mm by 50 mm by 1,6 mm square tube frame. This frame shall be mounted on a 100 mm diameter wooden pole 1,5 m above the ground as directed by the Engineer. The Contractor shall be responsible for making up and erecting the information boards at the locations indicated above and for maintaining them to the satisfaction of the Engineer.

13.20.1 Access to site

1. The Contractor shall ensure that access to the Site and associated infrastructure and equipment is off-limits to the public at all times during construction. Additional areas restricted to the public and suggested detours shall be clearly marked on the information boards to the satisfaction of the Engineer.

13.20.2 Anchors

1. Rock or ground anchors are normally associated with unstable or special engineering circumstances and a Method Statement, approved by the Engineer, shall be required for these processes.
2. Epoxy and grouting Chemical/safety data sheets to be provided as part of Method Statement.

{*Refer also to Drilling, Protection of natural features, Noise*}

13.20.3 Asphalt, bitumen and paving

1. Over spray of bitumen products outside of the road surface and onto roadside vegetation shall be prevented using a method approved by the Engineer.
2. Bitumen drums / products shall be stored in an area approved by the Engineer. This area shall be indicated on the construction camp layout plan. The storage area shall have a smooth impermeable (concrete or thick plastic covered in sand) floor. The floor shall be bunded and sloped towards a sump to contain any spillages of substances.
3. When heating of bitumen products, the Contractor shall take cognisance of appropriate fire risk controls.
4. Stone chip / gravel excess shall not be left on road / paved area verges. This shall be swept / raked into piles and removed to an area approved by the Engineer.
5. Milled or cut out bitumen shall be removed to an area approved by the Engineer.
6. Water quality from runoff from newly /fresh bitumen surfaces shall be monitored by the Engineer and remedial actions taken where necessary.
7. Heating of bitumen products shall only be undertaken using LPG or similar zero emission fuels.
8. Appropriate fire fighting equipment shall be readily available.

13.20.4 Blasting

1. A current and valid authorisation shall be obtained from the relevant authorities and copied to the Engineer prior to any blasting activity.
2. A Method Statement shall be required for any blasting related activities.
3. All Laws and Regulations applicable to blasting activities shall be adhered to at all times.
4. A qualified and registered blaster shall supervise all blasting and rock splitting operations at all times.
5. The Contractor shall ensure that appropriate pre blast monitoring records are in place (i.e. photographic and inspection records of structures in close proximity to the blast area).
6. The Contractor shall allow for good quality vibration monitoring equipment and record keeping on Site at all times during blasting operations.

7. The Contractor shall ensure that emergency services are notified, in writing, a minimum of 24 hours prior to any blasting activities commencing on Site.
8. The Contractor shall take necessary precautions to prevent damage to special features and the general environment, which includes the removal of fly rock. Environmental damage caused by blasting / drilling shall be repaired at the Contractors expense to the satisfaction of the Engineer.
9. The Contractor shall ensure that adequate warning is provided immediately prior to all blasting. All signals shall also be clearly given.
10. The Contractor shall use blast mats for cover material during blasting. {*topsoil may not be used as blast cover*}
11. During demolition the Contractor shall ensure, where possible, that trees in the area are not damaged.
12. Appropriate blast shaping techniques shall be employed to aid in the landscaping of blast areas, and a Method Statement to be approved by the Engineer, shall be required in this regard.
13. At least one week prior to blasting, the relevant occupants/owners of surrounding land shall be notified by the Contractor and any concerns addressed. Buildings within the potential damaging zone of the blast shall be surveyed preferably with the owner present, and any cracks or latent defects pointed out and recorded either using photographs or video. Failing to do so shall render the Contractor fully liable for any claim of whatsoever nature, which may arise. The Contractor shall indemnify the Employer in this regard.

13.20.5 Borrow pits and quarries

1. All borrow pit sites shall be clearly indicated on plan.
2. Prior to the onset of any quarrying or borrow pit activities the Contractor shall establish from the Engineer whether authorisation has been obtained, both in terms of the Minerals Act (No 50 of 1991)(via the compilation of an Environmental Management Programme Report) and in terms of the Environment Conservation Act (No 73 of 1989) (via an Environmental Impact Assessment process). No excavation or blasting activities shall commence before the necessary authorisations are in place. {*ensure that necessary authorisations are being processed well in advance of activity going out to tender*}.
3. Borrow pits shall at all times be operated according to the regulations promulgated in terms of the Minerals Act (No 50 of 1991); Mine Health and Safety Act (No 29 of 1996) and Noise and Nuisance Regulations of the Environment Conservation Act (No 73 of 1989)
4. Only single lane access for construction vehicles shall be provided at borrow pit and quarry sites. New access roads require approval by the Engineer.
5. Storm water and groundwater controls shall be implemented
6. Machinery, fuels and hazardous materials vulnerable to flooding shall be stored out of flood risk areas.

7. Vehicles leaving borrow pits shall not deposit/shed mud, sand and debris onto any public road.
8. All loads shall be covered with a tarpaulin or similar to prevent dangers and nuisance to other road users.
9. Trees and debris shall not be permitted to fall outside of the clearing limits. Trees shall be cleared or felled so as not to damage other trees or vegetation
10. Borrow pits shall be fenced to prevent unauthorised persons and vehicles from entering the area. Fences shall also be stock and game proof.
11. Rehabilitation and re-vegetation of borrow pits sites shall be as detailed in the Specification ER.
12. The contractor shall ensure that blasted faces of the pit shall be shape-blasted to the approval of the Engineer.
13. Where required, dust and fly-rock prevention methods shall be detailed in a Method Statement to be approved by the Engineer.
14. During the rehabilitation of borrow bits, the slope of the borrow pit shall be graded to blend with the natural terrain and be stabilised to prevent erosion.

13.20.6 Bridges and culverts

1. The Contractor shall ensure that provision is made to facilitate continuity of base water flow at all times during construction of these features
2. Reduction of baseline water quality by construction actions/activities shall be prevented (for example coffer dams, silt traps or plastic lining).
3. Water quality monitoring regimes shall be established prior to the onset of any construction activities within watercourses. {*Baseline water quality and monitoring requirements should be established with the City of Cape Town's Scientific Services prior to commencement of construction*}
4. No watercourse or stream may be diverted, dammed or modified without the approval of the Engineer.
5. Where stream diversion is required, the Contractor shall submit a Method Statement to the Engineer for approval prior to commencing construction. Following construction, all diverted streams shall be reinstated to the satisfaction of the Engineer

{*Refer to figures at end of this Detailed Environmental Specification*}

13.20.7 Cement and concrete batching

Location

1. Concrete shall not be mixed directly on the ground.
2. The concrete batching activity shall be located in an area of low environmental sensitivity to be identified and approved by the Engineer.

3. The permitted location of the batching plant (including the location of cement stores and sand and aggregate stockpiles) shall be indicated on the Site layout plan and approved by the Engineer. A Method Statement indicating the layout and preparation of this facility is required in this regard.

Maintenance

1. All wastewater resulting from batching of concrete shall be disposed of via the wastewater management system.
2. The cement/ concrete batching works shall be kept neat and clean at all times. No batching activities shall occur on unprotected substratum of any kind.
3. All runoff from batching areas shall be strictly controlled, and cement-contaminated water shall be collected, stored and disposed of at a site approved by the Engineer. Dagga boards, mixing trays and impermeable sumps shall be used at all mixing and supply points. Contaminated water shall be disposed at a waste disposal site approved by the Engineer.
4. Contaminated water storage facilities shall not be allowed to overflow and appropriate protection from rain and flooding shall be implemented.
5. Contaminated water treatment on Site shall require a method statement approved by Engineer.
6. Unused cement bags are to be stored so as not to be effected by rain or runoff events.
7. Used bags shall be stored in weather proof containers to prevent windblown cement dust and water contamination. Used bags shall be disposed of on a regular basis via the solid waste management system, and shall not be used for any other purpose.
8. Concrete transportation shall not result in spillage.
9. Cleaning of equipment and flushing of mixers shall not result in pollution of the surrounding environment: Care shall be taken to collect contaminated wash water from cleaning activities and dispose of it in a manner approved by the Engineer. To prevent spillage onto roads, ready mix trucks shall rinse off the delivery shoot into a suitable sump prior to leaving Site.
10. Suitable screening and containment shall be in place to prevent windblown contamination associated with bulk cement silos, loading and batching.
11. With respect to exposed aggregate finishes, the Contractor shall collect all contaminated water & fines and store it in sumps for disposal at an approved waste site.
12. All visible remains of excess concrete shall be physically removed on completion of the plaster or concrete pour section and disposed of. Washing the remains into the ground is not acceptable. All excess aggregate shall also be removed.

13.20.8 Pipelines

1. Cleaning/flushing of pipelines shall not impair (down grade) downstream baseline water quality. The water quality of receiving waters shall be monitored by the Contractor during cleaning/ flushing operations. {*Baseline water quality and monitoring requirements should*

be established with the City of Cape Town's Scientific Services prior to commencement of construction}

2. Materials used in the sterilisation of pipelines, *viz.* chlorine solutions shall be treated as hazardous substances and disposed of at an approved landfill site.
3. Litter traps shall be installed and maintained at the outflow of all pipelines.
4. The Contractor shall lay the pipeline within the river and flood plain by hand. No diversion or alteration of the normal river or tidal flow of either the lagoon or flood plain shall occur during the excavation, laying and backfilling of the pipeline.
5. Pressurised air shall be used to ensure that the pipeline section and associated concrete anchors along the bed of the river are buried below the bed surface. However, appropriate measures shall be taken to minimise the disturbance and sedimentation caused during this process. A geotextile curtain shall be erected within the water column on either side of the pipeline route during these excavation operations to minimise downstream sedimentation. These curtains shall be removed at the end of each working day and replaced at the start of each working day.

13.20.9 Crane operations

1. Drive plants shall be well maintained and drip trays shall be positioned at potential leak areas.
2. Over-greasing of crane cables shall be avoided.
3. The positioning and direction of lighting associated with crane operations shall not cause a nuisance to the surrounding communities or users of the area.
4. The movement and lifting of hazardous materials shall be undertaken such that they do not cause pollution, spillage or safety risk (in particular where concrete buckets are in use). Where necessary, a method statement is required in this regard.

13.20.10 Crushing

1. Main crusher box and conveyor belt heads are to be fitted with fine jet sprinkler heads to minimise dust, and pre- and post- crush stockpiles shall be managed to minimise dust.
2. The positioning of the crusher plant shall take cognisance of noise nuisance.
3. All crushing plant machinery shall have drip trays and all fuels and oils required for the crusher infrastructure shall be stored in the fuel store, if one is present on Site, or in an appropriately bunded and secured area.
4. The site of the crusher shall be fenced and sign-posted, and access to all unauthorised persons and vehicles shall be strictly prohibited.

{*Refer also to dust and noise}*

13.20.11 Demolition

1. Hazardous building materials, including asbestos shall be identified prior to demolition of any buildings and dealt with in accordance with the safety and health legislation. A Method Statement, outlining the proposed approach to the disposal of these materials, must be supplied for approval by the Engineer.
2. Hazardous and non-hazardous materials shall be separated at site and disposed of in a manner approved by the Engineer.
3. All buildings older than 60 years require a permit from South African Heritage Resources Agency in terms of the National Heritage Resources Act (no. 25 of 1999).
4. A demolition permit is also required from the local authority in terms of the National Building Regulations {*this applies to the demolition all buildings, irrespective age*}
5. Municipal and other services shall be isolated prior to any demolition occurring.
6. Hazardous building materials (e.g. asbestos, fibre claddings, refrigerants, coolants, substation cooling oils) shall be identified prior to demolition of the building and dealt with in accordance with the safety and health legislation. A Method Statement shall be supplied for approval by the Engineer.
7. Safety legislation shall be strictly adhered to in demolishing buildings and structures.
8. A Safety officer shall be appointed to oversee the safe demolition of buildings and structures.
9. Demolition sites shall be kept in a neat, tidy and safe condition.
10. Hazardous and non-hazardous materials shall be separated on Site and disposed off at appropriate licensed disposal sites. The Contractor shall supply the Engineer with a certificate of disposal.
11. Prior to demolition taking place, the Contractor shall ensure that suitable anti-rodent measures are implemented at any building requiring demolition.

13.20.12 Dredging

1. All craft and equipment used in dredging operations shall be well maintained and free of grease, oil, fuel or other hazardous contaminant leaks. Any incidents of spillage shall be reported to the Engineer immediately, and appropriate remedial measures, as approved by the Engineer, implemented.
2. The Contractor shall ensure that no pollutants such as oil are discharged into the water during maintenance work on the dredger.
3. Appropriate spill treatment facilities or compounds shall be readily available. Such measures shall be detailed in a Method Statement, to be approved by the Engineer.
4. Any craft or equipment lost overboard or which sinks shall be recovered.
5. The Contractor shall ensure that refuelling of the dredger is undertaken in such a manner that fuel does not spill into the water. A Method Statement for the refuelling of the dredger

during dredging operations shall be supplied and approved by the Engineer prior to any dredging operations commencing.

13.20.13 Drilling and jackhammering

1. The Contractor shall submit a Method Statement detailing his proposals to prevent pollution during drilling operations. This shall be approved by the Engineer prior to the onset of any drilling operations.
2. The Contractor shall take all reasonable measures to limit dust generation as a result of drilling operations.
3. Noise and dust nuisances shall comply with the applicable standards.
4. The Contractor shall ensure that no pollution results from drilling operations, either as a result of oil and fuel drips, or from drilling fluid.
5. All affected parties shall be informed at least one week prior to the onset of the proposed drilling/ jackhammering operations, and their concerns addressed.
6. Drill coring with water or coolant lubricants shall require a Method Statement approved by the Engineer.
7. Any areas or structures damaged by the drilling and associated activities shall be rehabilitated by the Contractor to the satisfaction of the Engineer.

13.20.14 Earthworks

1. The excavation of any material on Site shall be done in accordance with SABS 1200 D or DB and PSD or PSDB, as applicable.
2. Prior to Earthworks (including site clearance) starting on site, a search and rescue operation for bulbs and other indigenous plants of value, as detailed in the Re-vegetation Specification shall be undertaken.
3. All earthworks shall be undertaken in such a manner so as to minimise the extent of any impacts caused by such activities.
4. Defined access routes to and from the area of operation as well as around the area of operation shall be detailed in a Method Statement for approval by the Engineer.
5. No equipment associated with the activity shall be allowed outside of these areas unless expressly permitted by the Engineer.

13.20.15 Piling, jacking and thrust boring

1. Piling operations require a Method Statement, which shall detail the type of piling operation as well as *in situ* casting or pre-cast pile structures. In *situ* piles shall take cognisance of possible groundwater impacts.

2. The Contractor shall take preventative measures, such as screening, muffling, dust control, timing. Pre-notification of affected parties shall be implemented to minimise complaints regarding dust, noise and vibration nuisances.
3. The area shall be adequately fenced and warning signs erected.

13.20.16 Power tools

1. The Contractor shall take preventative measures, such as screening, muffling, dust control, timing and pre-notification of affected parties shall be implemented to minimise complaints regarding dust, noise and vibration nuisances.

13.20.17 Pumping and sumping

1. Pumps shall be placed over a drip tray in order to prevent fuel spills and leaks from contaminating the water in the pumped area.
2. Contaminated water may not be discharged into existing watercourses or streams and a Method Statement for discharge of this contaminated water shall be required.
3. Silt-laden water shall be cleaned by using a perforated 200l drum containing sand and stone separated by geotextile fabric with a central delivery water pipe
4. Silt-laden water shall be cleaned by ensuring that the overland flow of water disperses widely through vegetation.
5. Silt-laden water shall be cleaned by tying a geotextile sock on the delivery pipe of the pump. Other filtration methods may be used and shall be approved by the Engineer.

13.20.18 Settlement ponds

1. The Contractor shall submit a Method Statement proposal in connection with settlement ponds prior to the construction of any such ponds. The Contractor shall size settlement ponds in accordance with the envisaged scale of operation.
2. Suspended solids and contaminants including oils shall be removed and disposed of by the Contractor at frequent intervals at a site approved by the Engineer.

13.20.19 Retaining walls and gabions

1. A Method Statement, approved by the Engineer, shall be required to deal with these structures.
2. Rocks for use in gabion baskets/ reno mattresses shall be obtained from a source approved by the Engineer
3. Rocks for use in gabion baskets/ reno mattresses shall not be obtained from a watercourse.

13.20.20 Rock breaking

1. Mechanical methods of rock breaking, including Montabert type breakers, jackhammers and “boulder busting”, have noise and dust impacts that shall be addressed. Boulder buster use requires that blasting protocols shall be followed.
2. Residents shall be notified at least one week prior to these activities commencing, and their concerns addressed.
3. Chemical breaking shall require a Method Statement approved by the Engineer.

13.20.21 Stream diversion

1. The Contractor shall not divert, dam or modify any watercourse or stream without the approval of the Engineer.
2. The Contractor shall submit a method statement to the Engineer for approval prior to commencing construction.
3. Diverted streams shall be reinstated to the satisfaction of the Engineer.

{*Refer to figures at end of this Detailed Environmental Specification*}

13.20.22 Stream crossing

1. This activity requires a Method Statement for approval by the Engineer.
2. Temporary bridges shall be built in order for the Contractor to cross rivers and, where appropriate, the structure of the bridge shall be such that there is nothing placed in the water (i.e. the bridge shall be “bank-to-bank” in a single span).
3. The fording of rivers by machinery and vehicles shall be undertaken at slow speed and with clean vehicles (i.e. no oil leaks, etc.) and along a single track. The methodology of vehicle crossings via fording shall be detailed in a Method Statement.

{*Refer to figures at end of this Detailed Environmental Specification*}

13.20.23 Trenching

1. Trenching for services shall be undertaken in accordance with the engineering specifications (SABS 1200DB) with the following environmental amplifications, where applicable:
2. Trenching shall be kept to a minimum through the use of single trenches for multiple service provision.
3. The planning and selection of trench routes shall be undertaken in liaison with the Engineer and cognisance shall be given to minimising the potential for soil erosion.
4. Trench routes with permitted working areas shall be clearly defined and marked with painted stakes prior to excavation.

5. The stripping and separation of topsoil shall occur as stipulated by the Engineer. Soil shall be excavated and used for re-filling trenches using the rollover method, i.e. soil from the first trench section shall be stockpiled. Thereafter, soil excavated from subsequent trench lengths shall be used to backfill the trench behind it once the services have been laid. The final trench length shall be re-filled using the soil stockpiled from the first length.
6. Trench lengths shall be kept as short as practically possible before backfilling and compacting.
7. Trenches shall be re-filled to the same level as (or slightly higher to allow for settlement) the surrounding land surface to minimise erosion. Excess soil shall be stockpiled in an appropriate manner.
8. Immediately after re-filling, trenches and associated disturbed working areas shall be planted with a suitable plant species and regularly watered. Where there is a particularly high erosion risk, a fabric such as Geojute (biodegradable) shall be used in addition to planting.

13.20.24 Water abstraction from stream and groundwater

1. Abstractions from natural water resources require a Method Statement for prior approval by the Engineer.

13.20.25 Well points

1. Well point provision requires a Method Statement for the approval by the Engineer.

13.20.26 Temporary site closure

In the event of temporary site closure the Contractor's Safety Officers (as defined by the Occupational Health and Safety Act) shall check the site, ensure that the following conditions pertain and report on compliance with this clause;

Fuels / flammables / hazardous materials stores

Fuel stores are as low in volume as practicable.

1. There are no leaks.
2. The outlet is secure and locked.
3. The bund is empty.
4. Fire extinguishers are serviced and accessible.
5. The area is secure from accidental damage through vehicle collision and the like.
6. Emergency and contact numbers are available and displayed.
7. There is adequate ventilation in enclosed spaces.
8. There are no stores or containers within the 1:50 year flood line.

Safety

1. Site safety officer checks have been carried out in accordance with the Occupational Health and Safety Act (No. 85 of 1993) prior to site closure.
2. That there is an inspection schedule and log for use by security or contracts staff.
3. All trenches and manholes are secured.
4. Fencing and barriers in place in accordance with the Occupational Health and Safety Act (No. 85 of 1993).
5. Applicable notice boards are in place and secured.
6. Emergency and Management contact details are prominently displayed.
7. Security personnel have been briefed and have the facilities to contact or be contacted by relevant management and emergency personnel.
8. Night hazards such as reflectors, lighting, traffic signage etc have been checked.
9. Fire hazards identified and the local authority notified of any potential threats e.g. large brush stockpiles, fuels etc.
10. Pipe stockpiles are wedged / secured.
11. Scaffolds are secure.
12. Structures vulnerable to high winds secure.

Erosion

1. Wind and dust mitigation measures such as straw, brush packs, irrigation etc are in place.
2. Excavated and filled slopes and stockpiles are at a stable angle and capable of accommodating normal expected water flows
3. Re-vegetated areas have a water schedule and the supply to such areas is secured.
4. There are sufficient detention ponds or channels in place.

Water contamination and pollution

1. Hazardous fuel stores are secure.
2. Cement and materials stores are secured
3. Toilets are empty and secured
4. Refuse bins are empty and secured
5. Bunding is clean and treated e.g. Spill Sorb or Enretech #1 powder or similar approved product
6. Drip trays empty & secure

TOLERANCES

13.21 Fines

Fines

Fines will be issued for the transgressions listed below. Fines may be issued per incident at the discretion of the Engineer. Such fines will be issued in addition to any remedial costs incurred as a result of non-compliance with the Environmental Specifications. The Engineer will inform the Contractor of the contravention and the amount of the fine, and will deduct the amount from monies due under the Contract.

Fines for the activities detailed below, will be imposed by the Engineer on the Contractor and/or his Sub-contractors.

A	Any persons, vehicles, plant, or thing related to the Contractors operations within the designated boundaries of a “no-go” area	4,000
B	Any vehicle driving in excess of designated speed limits	1,000
C	Any vehicle being driven, and items of plant or materials being parked or stored outside the demarcated boundaries of the site	2,000
C	Persons walking outside the demarcated boundaries of the site	500
E	Persistent and un-repaired oil leaks from machinery. The use of inappropriate methods of refuelling such as the use of a funnel rather than a pump	3,000
F	Litter on site	1,000
G	Deliberate lighting of illegal fires on site	5,000
H	The eating of meals on site outside the defined eating area. Individual not making use of the site ablution facilities	1,000
I	Dust or excess noise on or emanating from site	1,000
J	Any person, vehicle, item of plant, or anything related to the Contractors operations causing a public nuisance	2,000

For each subsequent similar offence the fine may, at the discretion of the Engineer, be doubled in value to a maximum value of R50,000.

The Engineer shall be the judge as to what constitutes a transgression in terms of this clause, subject to the provisions of Clause 60(1) of the General Conditions of Contract. In the event that transgressions continue the Contractors attention is drawn to the provisions of Sub-clause 58(1)(b)(vi) of the General Conditions of Contract under which the Engineer may cancel the Contract.

13.22 Penalties

1. Where the Contractor inflicts non-repairable damage upon the environment or fails to comply with any of the environmental specifications, he shall be liable to pay a penalty fine over and above any other contractual consequence. {*In terms of the Conventional Penalties Act (1962) a creditor is not entitled to recover both the penalty and damages. Accordingly, were a Contractor causes damage, the Employer can either enforce a penalty or make the Contractor make good the damage, but not both.*}
2. The Contractor is deemed NOT to have complied with the this Specification if:
    a. within the boundaries of the site, site extensions and haul/ access roads there is evidence of contravention of the Specification
    b. environmental damage ensues due to negligence
    c. the Contractor fails to comply with corrective or other instructions issued by the Engineer with in a specific time
    d. the Contractor fails to respond adequately to complaints from the public
3. Payment of any fines in terms of the contract shall not absolve the offender from being liable from prosecution in terms of any law.
4. An Environmental Performance Guarantee of 5% of Contract Value shall be deposited by the Contractor with the Engineer. This fund shall be used in the event of penalties or rehabilitation costs for non-conformance or contraventions of the EMP. The balance shall be given back to the Contractor at Contract closure.
5. The following penalties are suggested for transgressions:

a.	Erosion	A penalty equivalent in value to the cost of rehabilitation plus 20%
b.	Oil spills	A penalty equivalent in value to the cost of clean-up operation plus 20%
c.	Damage to indigenous vegetation	A penalty equivalent in value to the cost of restoration plus 20%.
d.	Damage to sensitive environments	A penalty equivalent in value to the cost of restoration plus 20%.
e.	Damage to cultural sites	A penalty to a maximum of R 100 000 shall be paid for any damage to any cultural/ historical sites
f.	Damage to trees	A penalty to a maximum of R100 000 shall paid for each tree removed without prior permission, or a maximum of R5 000 for damage to any tree, which is to be retained on site.
g.	Penalties for removing or damaging trees:	

	Girth of trunk (1m above ground level)	Replacement value per tree

	0 – 15 mm	R100.00
	16 – 30 mm	R200.00
	31 – 50 mm	R500.00
	51 – 75 mm	R1 000.00
	76 – 100 mm	R2 500.00
	101 – 150 mm	R5 000.00
	150 – 300 mm	R10 000.00
	Larger than 300 mm	R15 000.00 to R100 000.00

13.23 MEASUREMENT AND PAYMENT

13.23.1 Environmental awareness training

1. The organisation and attendance of the education course will be measured as a sum.
2. The tender sum shall cover the time cost of all personnel attending the course, the provision of the venue and for any other operation necessary to comply with the requirements of the environmental awareness courses to the satisfaction of the Engineer.

13.23.2 Refuse removal

1. The unit of measurement shall be a sum for the removal of refuse.
2. The rate shall include the collection of refuse, for providing, maintaining and running the refuse vehicles, refuse bins and special refuse enclosures, and for all loading, unloading and double handling as required.

13.23.3 Site demarcation

1. The supply, installation and removal at the end of the construction of all temporary fences shall be measured by length for each type of fence scheduled.

13.23.4 Dust control

1. The unit of measurement shall be a sum for watering and/ or straw stabilisation.
2. The rate shall include the cost of obtaining, transporting and applying the water and/ or straw stabilisation including supplying and maintaining suitable water bowsers.

13.23.5 Pumping

1. The unit of measurement shall be a sum for pumping water into or out of settlement ponds.
2. The tendered rate shall include full compensation for supplying, installing, operating and maintaining the pumps and pump hoses.
3. In the event of the contents of a settlement pond being removed by a suction tanker such removal shall be deemed to be allowed for.

13.23.6 Supply and erection of public information boards

1. The supply and erection of public information boards shall be measured by number.
2. xx A2 copy(ies) of the poster for the board shall be supplied to the Contractor. The rate shall cover the cost of securing the posters to the backing boards, the cost of all labour, materials, plant and equipment necessary for the erection, maintenance and removal on completion.

13.23.7 Supply and erection of construction personnel information boards

1. The supply and erection of construction personnel information boards shall be measured by number.
2. The tendered rate shall cover the cost of all printing, labour, materials, plant and equipment, necessary for the erection, maintenance and removal on completion.

13.23.8 Speed limit and route marker signs

1. The supply and erection of speed limit signs and signs to indicate the route up the access road to the site shall be measured as a sum.
2. The tendered rate shall cover the cost of all labour, materials, plant and equipment, necessary for the erection, maintenance and removal on completion.

13.23.9 Fire control

1. The compliance with fire control requirements shall be measured as a sum.
2. The tendered rate shall cover the cost of all labour, materials, equipment and any other operation or thing necessary to comply with the requirements including maintenance and replacement of defective or damaged equipment, and refilling.

13.23.10 “No go” area demarcation

“No go area demarcation Unit: m

1. “No go” area fencing will be measured by length for each type of fence scheduled.

2. The tender rate shall cover the cost of all labour, materials, plant and equipment necessary for the supply, installation and removal of the fences, including for all excavation, temporary strutting, backfilling of holes with earth, finishing and trimming and for any other operation necessary to complete the work to the satisfaction of the Engineer.

13.23.11 All other requirements of the environmental management specification

1. All other work not measured elsewhere, associated with complying with any requirement of the environmental management programme shall be measured as a sum.
2. The tendered rate shall cover any cost associated with complying with the environmental management specification and shall include for all materials, labour and plant required to execute and complete the work as specified, described in the Schedule of Quantities or shown on the drawing(s).