
PROPOSED ABERDEEN SOLAR FACILITY, EASTERN CAPE PROVINCE

DEA Ref No: 14/12/16/3/3/1/552

CONSTRUCTION & OPERATION DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

Submitted as part of the Draft Basic Assessment Report
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PROJECT DETAILS

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DEFINITIONS AND TERMINOLOGY

Alternatives: Alternatives are different means of meeting the general purpose and need of a proposed activity. Alternatives may include location or site alternatives, activity alternatives, process or technology alternatives, temporal alternatives or the 'do nothing' alternative.

Cumulative impacts: Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities (e.g. discharges of nutrients and heated water to a river that combine to cause algal bloom and subsequent loss of dissolved oxygen that is greater than the additive impacts of each pollutant). Cumulative impacts can occur from the collective impacts of individual minor actions over a period and can include both direct and indirect impacts.

Direct impacts: Impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity (e.g. noise generated by blasting operations on the site of the activity). These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable

'Do nothing' alternative: The 'do nothing' alternative is the option of not undertaking the proposed activity or any of its alternatives. The 'do nothing' alternative also provides the baseline against which the impacts of other alternatives should be compared.

Endangered species: Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included here are taxa whose numbers of individuals have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

Endemic: An "endemic" is a species that grows in a particular area (is endemic to that region) and has a restricted distribution. It is only found in a particular place. Whether something is endemic or not depends on the geographical boundaries of the area in question and the area can be defined at different scales.

Environment: 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.

Environmental impact: An action or series of actions that have an effect on the environment.

Environmental impact assessment: Environmental Impact Assessment (EIA), as defined in the NEMA EIA Regulations and in relation to an application to which scoping must be applied, means the process of collecting, organising, analysing, interpreting and communicating information that is relevant to the consideration of that application.

Environmental management: Ensuring that environmental concerns are included in all stages of development, so that development is sustainable and does not exceed the carrying capacity of the environment.

Environmental management programme: An operational plan that organises and coordinates mitigation, rehabilitation and monitoring measures in order to guide the implementation of a proposal and its ongoing maintenance after implementation.

Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act of 2000).

Indigenous: All biological organisms that occurred naturally within the study area prior to 1800

Indirect impacts: Indirect or induced changes that may occur as a result of the activity (e.g. the reduction of water in a stream that supply water to a reservoir that supply water to the activity). These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.

Interested and affected party: Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups, and the public.

Photovoltaic cell: Semiconductors which absorb solar radiation to produce electricity

Photovoltaic effect: Electricity can be generated using photovoltaic panels (semiconductors) which are comprised of individual photovoltaic cells that absorb solar energy to produce electricity. The absorbed solar radiation excites the electrons inside the cells and produces what is referred to as the Photovoltaic Effect.

Rare species: Taxa with small world populations that are not at present Endangered or Vulnerable, but are at risk as some unexpected threat could easily cause a critical decline. These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range. This category was termed Critically

Rare by Hall and Veldhuis (1985) to distinguish it from the more generally used word "rare."

Red data species: Species listed in terms of the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species, and/or in terms of the South African Red Data list. In terms of the South African Red Data list, species are classified as being extinct, endangered, vulnerable, rare, indeterminate, insufficiently known or not threatened (see other definitions within this glossary).

Renewable energy feed-in tariff: REFITs are used to promote renewable energy and have been adopted in over 36 countries worldwide. The establishment of the REFIT in South Africa provides the opportunity for an increased contribution towards the sustained growth of the renewable energy sector, and to promote competitiveness between renewable and conventional energies in the medium and long-term. Under the National Energy Regulator Act (Act No. 40 of 2004), the Electricity Regulation Act (Act No. 4 of 2006), and all subsequent relevant amendment acts, the National Energy Regulator of South Africa (NERSA) has the mandate to determine the prices at and conditions under which electricity must be supplied by licence.

Significant impact: An impact that by its magnitude, duration, intensity, or probability of occurrence may have a notable effect on one or more aspects of the environment.

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PROJECT DETAILS

CHAPTER 1

BioTherm Energy (Pty) Ltd is proposing the establishment of a commercial solar energy facility (using either photovoltaic or concentrated photovoltaic technology) for electricity generation of up to 20 MW in capacity. The facility is proposed on Portion 1 on Farm Wildebeest Poorje located approximately 17 km southwest of Aberdeen along the N9 national road in the Eastern Cape Province of South Africa (refer to Figure 1.1).

The purpose of the proposed facility is to sell the electricity to Eskom as part of the Renewable Energy Independent Power Producers (IPP) Procurement Programme. The IPP Procurement Programme has been introduced by the Department of Energy (DoE) to promote the development of renewable power generation facilities by IPPs. Selling of electricity according to the IPP Procurement Programme has the advantage of giving developers long-term stability and predictability, as well as providing the opportunity for the South African Government to introduce renewable energy into the power generation technology mix within the country.

The facility is expected to require an area of less than 20 ha within which the following infrastructure will be established (refer to Figure 1.1).

- » Photovoltaic (PV) panels or Concentrated photovoltaic (CPV) panels with an installed capacity of up to 20MW.
- » A new on-site substation to evacuate the power from the facility into the Eskom grid via the Aberdeen Substation located adjacent to the proposed development site.
- » Mounting structure to be either rammed steel piles or piles with pre-manufactured concrete footings to support the PV/CPV panels.
- » Cabling between the project components, to be laid underground where practical.
- » Internal access roads and fencing.
- » Workshop area for maintenance, storage, and offices

The proposed project will be referred to as **Aberdeen Photovoltaic (PV)/ Concentrating Photovoltaic (CPV) Solar Energy Facility**.

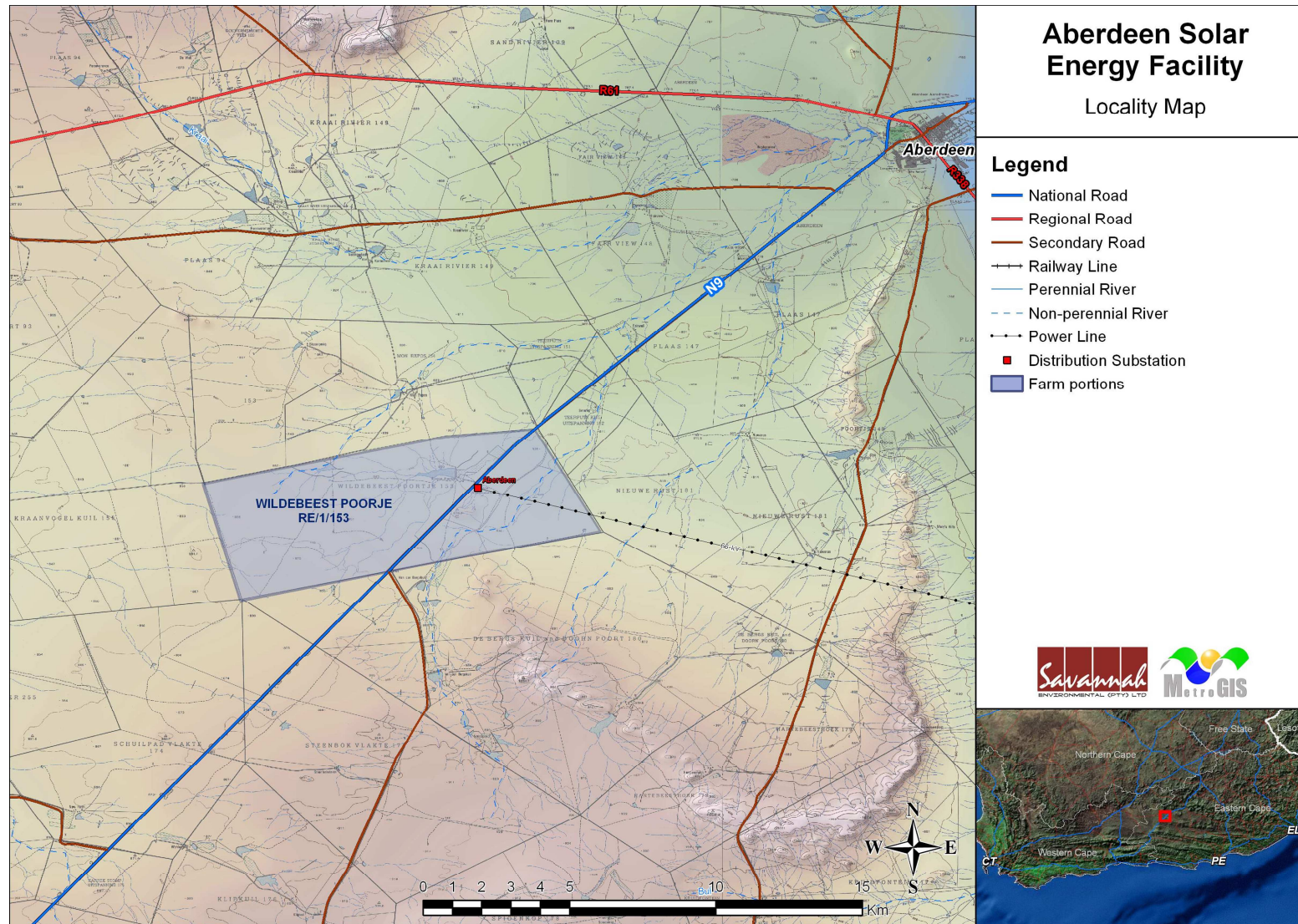


Figure 1.1: Locality map showing the proposed 20 MW PV plant on Portion 1 on Farm Wildebeest Poorje

1.1. Project Location

The Aberdeen PV/CPV Facility is located on Portion 1 on Farm Wildebeest Poorje which is located in the Camdeboo Local Municipality (CLM) area (Cacadu District Municipality) in the Eastern Cape Province of South Africa. The site is easily accessible from the N9. i.e. approximately 17 km southwest of Aberdeen along the N9 national road.

1.2. Technology

The proposed facility will either utilise Photovoltaic (PV) technology or Concentrated Photovoltaic (CPV) technology.

1.2.1. Photovoltaic (PV) Technology

Solar energy facilities, such as those using PV panels use the energy from the sun to generate electricity through a process known as the Photovoltaic Effect. This effect refers to photons of light colliding with electrons, and therefore placing the electrons into a higher state of energy to create electricity. The Solar PV facility will comprise of the following components:

The **Photovoltaic Cell**

Individual PV cells are linked and placed behind a protective glass sheet to form a photovoltaic panel. Other technologies that can be used include thin film

The **Inverter**

The photovoltaic effect produces electricity in direct current. Therefore an inverter must be used to change it to alternating current.

The **Support Structure**

The PV panels will be attached to a support structure approximately 2 meters off the ground set at an angle so to receive the maximum amount of solar radiation. The angle of the panel is dependent on the latitude of the proposed facility and the angles may be adjusted to optimise for summer or winter solar radiation characteristics.

The PV panels are designed to operate continuously for more than 20 years, unattended and with low maintenance.



Figure 1.2: Illustration of a photovoltaic solar facility

Concentrated Photovoltaic (CPV) Technology

Concentrated photovoltaic (CPV) technology uses optics such as lenses to concentrate a large amount of sunlight onto a small area of solar photovoltaic materials to generate electricity.

The Concentrated Photovoltaic Cell

The light energy from the sun is concentrated through lenses onto the individual CPV cells. This serves to increase the efficiency of the CPV panels (i.e. up to 29% efficiency), as compared to conventional PV technology (i.e. 8 % – 18% efficiency) (refer to Figure 1.3).

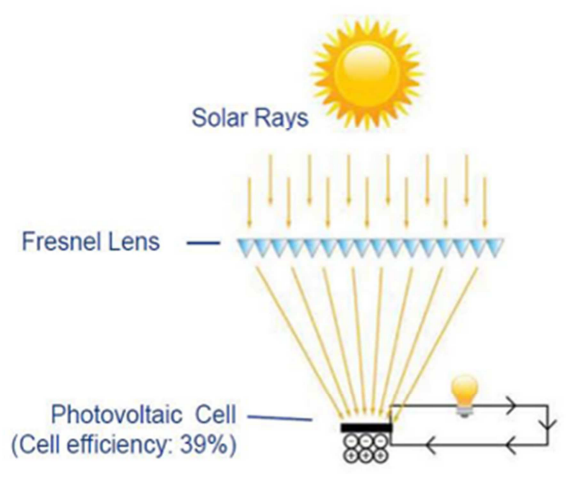


Figure 1.3: The efficiency of the CPV panels is increased through the use of Fresnel Lenses which concentrates the amount of light entering the CPV cells (Source: AmonixTM)

The **Inverter**

An inverter is used to convert the electricity which is produced as direct current into alternating current for the purpose of grid connection. In order to connect a large solar facility to the national grid, numerous inverters will be arranged in several arrays to collect, and convert the produced power.

The **Support Structure**

The CPV Modules will be elevated up to 2m above ground level by a support structure and have a total height of up to 20m. The modules will be able to track the path of the sun during the day, thereby increasing the efficiency of the panels (refer to Figure 1.4).

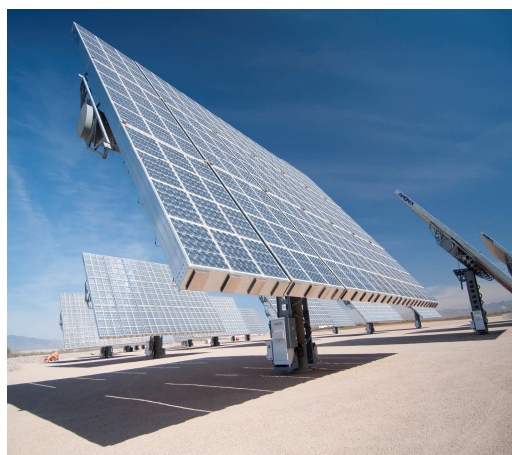


Figure 1.4: The support structures elevate the panels and allow for dual axis tracking of the sun for increased efficiency (Source: AmonixTM)

Each panel will be approximately 22 m wide and 12.5 m high. As such when the tracking panel is vertical the structure will be a maximum height of approximately 20m.

1.3. Activities and Components associated with the PV/CPV Plant

The main activities/components associated with the Aberdeen PV/CPV plant are detailed in Table 1.1.

Table 1.1: Activities Associated with Planning, Construction, Operation and Decommissioning of the PV/CPV Plant

Main Activity/Project Component	Components of Activity	Details
Planning		
Conduct technical surveys	<ul style="list-style-type: none"> » Geotechnical survey by geotechnical engineer. » Site survey and confirmation of the infrastructure micro-siting footprint. 	<ul style="list-style-type: none"> » Geotechnical survey – a geotechnical survey will be required in order to detail the geology and topography of the study area. The geotechnical study will also consider flood potential, foundation conditions, and the potential for excavations. This study will serve to inform the Engineering, Procurement, and Construction (EPC) Contractors regarding soil conditions, required to specify foundations required for the support structures, and the extent of earthworks and compaction required in the establishment of any internal access roads. » Site survey – this will be required to finalise the design layout of the PV/CPV solar field and other associated infrastructure. The finalisation will need to be confirmed in line with the Environmental Authorisation issued for the facility.
Construction		
Undertake site preparation	<ul style="list-style-type: none"> » Clearance of vegetation at the infrastructure footprints. » Where required, some levelling of the land may occur. » Excavation of trenches for underground cables. 	<ul style="list-style-type: none"> » Site preparation activities will include clearance of vegetation at the footprint of the following infrastructure within the development footprint: <ul style="list-style-type: none"> * Support structure/pedestals for the PV/CPV panels (panel dimensions 2000x1000x50 consisting of up to 80 000 panels). * Switchgear * Transformers * Workshop

Main Activity/Project Component	Components of Activity	Details
		<ul style="list-style-type: none"> * Trenches for the underground cabling. » These activities may require the stripping of topsoil which will need to be stockpiled, backfilled and/or spread on site.
Construction of internal access roads	<ul style="list-style-type: none"> » Construct a 3 to 5 m wide gravel roads around the site. 	<ul style="list-style-type: none"> » The project development site is accessible from the N9 » Temporary access roads may be required during the construction phase; however these are likely to be single track gravel roads of less than 6 m wide
Construct infrastructure foundations	<ul style="list-style-type: none"> » Mounting structures will either be pile driven, screwed or pre-cast concrete footings 	<ul style="list-style-type: none"> » To be confirmed once the geotechnical study has been completed
Transport of components and equipment to site	<ul style="list-style-type: none"> » Trucks will be used to transport all components to site: * The normal civil engineering construction equipment for the civil works (e.g. trucks, graders, compaction equipment, cement mixers, etc.). 	<ul style="list-style-type: none"> * The components will be transported to site via the N9. * In addition, civil engineering construction equipment will be required on site (e.g. excavators, trucks, ready mix cement trucks, etc.) as well as components required for the establishment of the switchgear.
Establishment of PV panels	<ul style="list-style-type: none"> » PV/CPV panels are transported in containers. » The steel structures will be assembled on site. 	<ul style="list-style-type: none"> » A support structure unit will be erected by excavating an area for the foundation. » Ready mix cement will be used to stabilise the foundation. Ready-mix cement will be prepared off-site and transported from the closest centre to the development. » A service cage will be erected around the foundation unit to allow for the establishment of the electrical and hydraulic infrastructure). This

Main Activity/Project Component	Components of Activity	Details
		includes the inverter. » A drive head will be positioned on top of the foundation unit as a connection point for the PV/CPV panel which allows for the dual axis tracking. » The CPV mega module will be lifted via a crane onto the drive head. » The installation of the underground cables between the PV/CPV panels, the transformers, the switchgear, and the new Substation will require the excavation of trenches of approximately 1 m deep within which they can then be laid.
Connection of PV/CPV panels to the substation	» The PV panels will be connected to the on-site substation via underground cabling (where practical).	» The installation of these underground cables will require the excavation of trenches of approximately 400 mm – 1000 mm cm deep within which they can then be laid.
Connect substation to the grid	» The electricity is proposed to be evacuated into the Aberdeen substation.	» The electricity generated at the site will run through underground cables through and will connect to Eskom’s substation.
Undertake site rehabilitation	» Remove all construction equipment from the site. » Rehabilitation of temporarily disturbed areas where practical and reasonable.	» Once construction is complete and all construction equipment is removed, the site must be rehabilitated where practical and reasonable. » On full commissioning of the facility any access points to the site which are not required during the operational phase must be closed and prepared for rehabilitation.
Operation		
Operation	» PV/CPV panels. » Associated infrastructure.	» The PV/CPV panels will convert the light energy from the incoming radiation into electrical energy

Main Activity/Project Component	Components of Activity	Details
		(i.e. as direct current). » The transformers will change the power to alternating current, where after the electricity will be conveyed to the switchgear, the underground cables and then to the existing Aberdeen Substation » An estimated 220 000 litres of water per annum would be required for cleaning of the panels , 2 200 litres for offices and workshops and an estimated 1.5 million litres of water would be required for the construction of the plant.
Maintenance & Security	» Maintenance during the life cycle of the facility would include emergency repairs, routine panel maintenance, routine maintenance of medium voltage equipment and maintenance of the site.	» Each component within the solar energy facility will be operational except under circumstances of mechanical breakdown, unfavourable weather conditions, or routine maintenance activities. » As the CPV units use tracking technology the hydraulic oil may need to be supplemented occasionally.
Decommissioning		
Site preparation	» Preparation of the site. » Mobilisation of construction equipment.	» Depending on the economics of the development following the operational period, the plant will either be decommissioned or the operational phase will be extended. If it is deemed financially viable to continue, existing components may be disassembled and replaced with technology/ infrastructure available at that time. However, if the decision is made to decommission the facility the following activities will form part of the project scope.

Main Activity/Project Component	Components of Activity	Details
Disassemble panels	» The panels will be disassembled and removed.	» The components of the plant will be disassembled and removed. Thereafter they will be reused and recycled (where possible) or disposed of in accordance with regulatory requirements.

1.4. Environmental Process

In terms of the Environmental Impact Assessment (EIA) Regulations published in terms of Section 24(5) of the National Environmental Management Act (NEMA, Act No. 107 of 1998), authorisation is required from the National Department of Environmental Affairs (DEA) (in consultation with the Eastern Cape Department of Economic Development and Environmental Affairs), for the establishment of the proposed installation. In terms of sections 24 and 24D of NEMA, as read with the EIA Regulations of GNR543 - GNR546, a Basic Assessment process is required to be undertaken for the construction of the proposed facility. This project has been registered with National DEA under reference number **14/12/16/3/3/1/552**.

Savannah Environmental has been appointed as the independent environmental consultants to undertake the Environmental Basic Assessment to identify and assess any potential environmental impacts. As part of these environmental studies, interested and affected parties (I&APs) have been actively involved through a public involvement process.

In terms of the findings of the Basic Assessment, various planning, construction, and operation-related environmental impacts were identified, including:

- » Potential impacts on heritage resources
- » Potential impacts on soil and agricultural potential
- » Ecological disturbances
- » Visual Impacts
- » Social Impacts

The main findings of the Basic Assessment include:

- » The overall impact on ecology is likely to be of a low significance, provided the recommended mitigation measures are implemented. From an ecological perspective, the site is largely favourable for the development of a solar energy facility. With the appropriate avoidance of identified sensitive areas and mitigation measures in place, the risk of significant ecological impact at the site would be minimised. The plains of the site are homogenous and development within this area could proceed with little ecological risk. Disturbance during the construction phase should be kept to a minimum as the rehabilitation or revegetation of disturbed sites in the karoo can be difficult, and such areas would be prone to alien plant invasion for many years. The flat nature of the site is likely to be an enabling factor which would allow development to take place with minimal disturbance and it is recommended that the construction approach be one based on a philosophy of minimal impact. As with all semi-arid ecosystems, the site is likely to maintain a

much higher degree of resilience if vegetation cover is allowed to persist as far as possible through the construction process.

- » The overall impact on soils is likely to be of **low negative significance** with the implementation of recommended mitigation measures. The most significant potential negative impacts are that of soil degradation and erosion. It is likely that the negative impacts will be out-weighted by the positive impact of a reduction in the rate of demand for non-renewable energy sources on a national scale.
- » The agricultural potential of the site is considered to be low and limited to extensive grazing by small stock and game. The carrying capacity is low (estimated at ± 6 hectares per small stock unit (SSU)), rainfall is low and erratic and soils are shallow with low water holding capacities. Irrigation water is not available for use on the proposed site which is limited by the shallow soils and other inherent soil restraints. Irrigation is therefore not considered a viable option. Impacts on agricultural potential is therefore expected to be of **low significance**.
- » The overall heritage impact is likely to be of **low significance** with the implementation of mitigation measures. No sites of heritage significance were found during the survey. However, the larger area is known for its fossil record and the paleontological component of the project needs to be addressed as per the recommendations contained in this report.
- » The overall visual impact is likely to be of a **low to moderate significance** with the implementation of appropriate mitigation measures. The on-site verification from the selected Key Observation Points and the view sheds generated from the latter points indicated that the project site is indistinguishable from most observation points. The findings of the Visual Impact Assessment for the proposed Aberdeen PV Plant therefore found that the proposed activity will have a low impact from the middle and background and a moderate impact from the foreground (<1km). It should be noted that users of the N9 (the most sensitive visual receptor within the 1km zone) would only see the activity for a short period of time as they drive by the project site. The activity will therefore not have a lasting visual impact.
- » The overall social impact is likely to be of a predominantly **low significance** with the implementation of appropriate mitigation and enhancement measures. The findings of the SIA undertaken for the proposed BioTherm Aberdeen solar facility indicate that the development will create employment and business opportunities for locals during both the construction and operational phase of the project. The establishment of a Community Trust also creates an opportunity to support local economic development in the area. The proposed development also represents an investment in clean, renewable energy infrastructure, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

-
- » The establishment of the facility will have positive benefits as the integration of an additional 20 MW may alleviate the pressure on the local grid to a small extent and would contribute (albeit small) to the national target for renewable energy.

Based on the findings of the studies undertaken, in terms of environmental constraints identified through the Environmental Basic Assessment process, no environmental fatal flaws were identified to be associated with the establishment of the proposed BioTherm Energy Aberdeen Solar Facility and associated infrastructure.

1.4.1. Site Sensitivity Assessment

The ecological sensitivity map of the BioTherm Aberdeen Solar Facility is depicted below in Figure 1.5. The plains of the site are classified as Medium Sensitivity, while the rocky hill and slope are classified as High and Medium-High Sensitivity respectively. Given the high plant diversity of the rocky hill and the presence of a number of listed plant species in this area, it is recommended that the rocky hill is avoided by the development. The extent of the Medium sensitivity area is 28 ha which should be sufficient to accommodate the development. Given the low slope and homogenous nature of this area, development could proceed within this area with little ecological risk and there were no features present within this area that would need to be avoided.

The EMP has been developed based on the findings of the Draft Basic Assessment, and must be implemented to protect sensitive on-site and off-site features through controlling construction and operation activities that could have a detrimental effect on the environment, and through avoiding or minimising potential impacts.

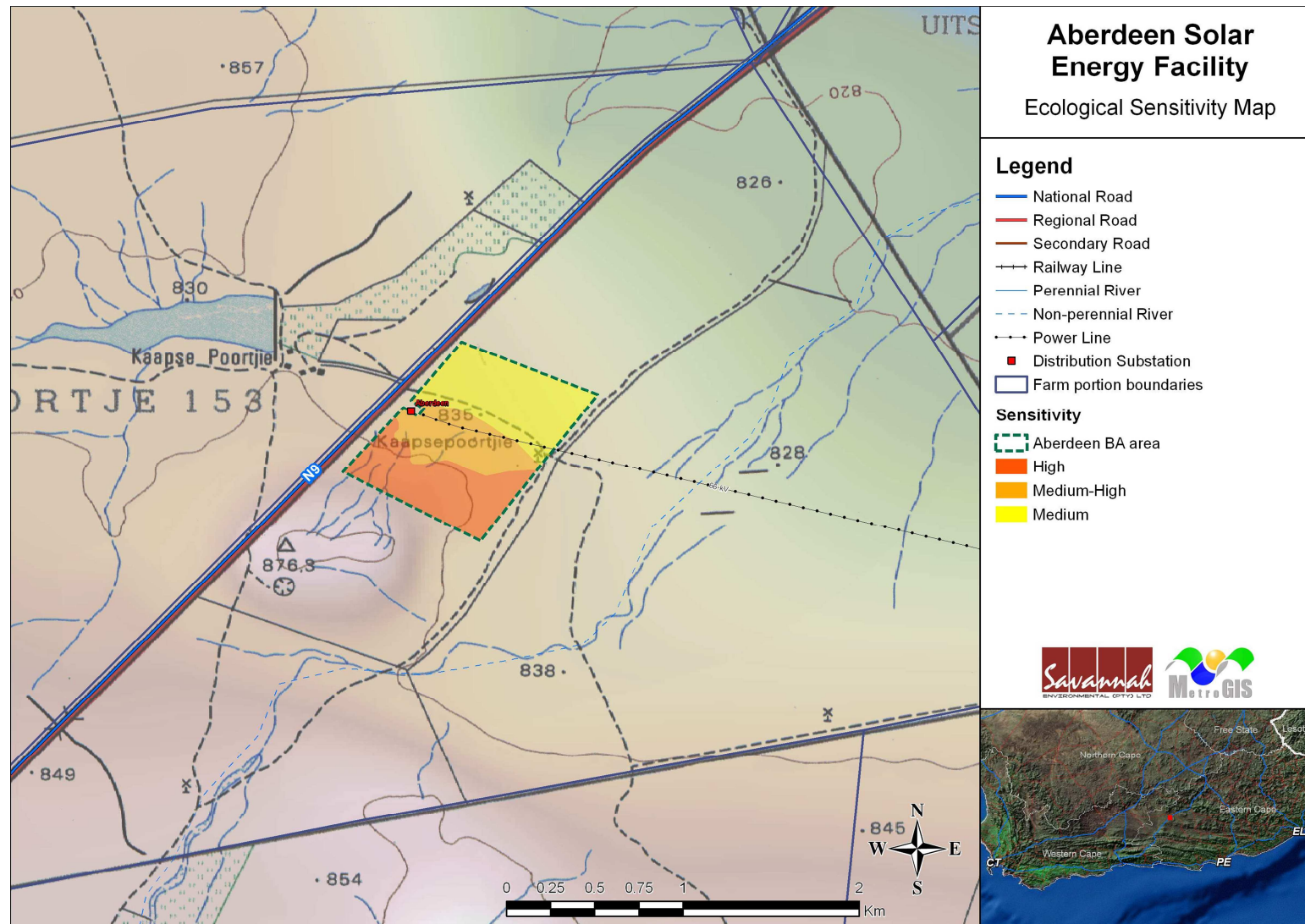


Figure 1.5: Identified sensitive areas of the study area

PURPOSE & OBJECTIVES OF THE EMP

CHAPTER 2

An Environmental Management Programme (EMP) is defined as “an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented or mitigated, and that the positive benefits of the projects are enhanced”¹. The objective of this EMP is to provide consistent information and guidance for implementing the management and monitoring measures established in the permitting process and help achieve environmental policy goals. The purpose of an EMP is to help ensure continuous improvement of environmental performance, reducing negative impacts and enhancing positive effects during the construction and operation of the PV plant. An effective EMP is concerned with both the immediate outcome as well as the long-term impacts of the project.

The EMP provides specific environmental guidance for the construction and operation phases of a project, and is intended to manage and mitigate construction and operation activities so that unnecessary or preventable environmental impacts do not result. These impacts range from those incurred during start up (site clearing and site establishment) through those incurred during the construction activities themselves (erosion, noise, dust) to those incurred during site rehabilitation (soil stabilisation, re-vegetation) and operation.

The EMP has been developed as a set of environmental specifications (i.e. principles of environmental management for the proposed Aberdeen PV/CPV), which are appropriately contextualised to provide clear guidance in terms of the on-site implementation of these specifications (i.e. on-site contextualisation is provided through the inclusion of various monitoring and implementation). During its lifecycle, projects journey through four distinctive phases, i.e. construction, rehabilitation, operation, and decommissioning. The EMP is accordingly separated into measures dealing with the various project phases.

The EMP has the following objectives:

- » To outline mitigation measures and environmental specifications which are required to be implemented for the planning, construction, rehabilitation, and operation phases of the project in order to minimise the extent of environmental impacts, and to manage environmental impacts associated with the PV/CPV Plant.

Provincial Government Western Cape, Department of Environmental Affairs and Development Planning:
Guideline for Environmental Management Plans. 2005

- » To ensure that the construction and operation phases do not result in undue or reasonably avoidable adverse environmental impacts, and ensure that any potential environmental benefits are enhanced.
- » To identify entities who will be responsible for the implementation of the measures and outline functions and responsibilities.
- » To propose mechanisms and frequency for monitoring compliance, and preventing long-term or permanent environmental degradation.
- » To facilitate appropriate and proactive responses to unforeseen events or changes in project implementation that was not considered in the Basic Assessment process.

The mitigation measures identified within the Basic Assessment process are systematically addressed in the EMP, ensuring the minimisation of adverse environmental impacts to an acceptable level.

BioTherm Energy (Pty) Ltd must ensure that the implementation of the project complies with the requirements of any environmental authorisations and permits, and obligations emanating from other relevant environmental legislation. This obligation is partly met through the development and the implementation of the EMP through its integration into the contract documentation. Since this EMP is part of the Basic Assessment process undertaken for the proposed Aberdeen PV/CPV, it is important that this document be read in conjunction with the Basic Assessment Report, as well as the Environmental Authorisation (once issued). This will contextualise the EMP and enable a thorough understanding of its role and purpose in the integrated environmental management process. This EMP for construction and operation activities has been compiled in accordance with Section 33 of the EIA Regulations and will be further developed in terms of specific requirements listed in any authorisations issued for the proposed project.

To achieve effective environmental management, it is important that Contractors are aware of the responsibilities in terms of the relevant environmental legislation and the contents of this EMP. The Contractor is responsible for informing employees and sub-contractors of their environmental obligations in terms of the environmental specifications, and for ensuring that employees are adequately experienced and properly trained in order to execute the works in a manner that will minimise environmental impacts. The Contractor's obligations in this regard include the following:

- » Ensuring that employees have a basic understanding of the key environmental features of the construction site and the surrounding environment.
- » Ensuring that a copy of the EMP is readily available on-site, and that all site staff are aware of the location and have access to the document. Employees will be familiar with the requirements of the EMP and the environmental specifications as they apply to the construction of the facility.
- » Ensuring that, prior to commencing any site works, all employees and sub-contractors are given some form of Environmental Awareness Training. This training

must provide the site staff with an appreciation of the project's environmental requirements, and how they are to be implemented.

- » Ensuring awareness of any other environmental matters, which are deemed necessary by the Environmental Control Officer (ECO).

The EMP is a dynamic document, which must be updated when required. It is considered critical that this draft EMP be updated to include site-specific information and specifications as required throughout the life-cycle of the facility. This will ensure that the project activities are planned and implemented taking sensitive environmental features into account.

STRUCTURE OF THIS EMP

CHAPTER 3

The first two chapters provide background to the EMP and the proposed project. The chapters which follow consider the:

- » Planning and design activities
- » Construction activities
- » Operation activities
- » Decommissioning activities

These chapters set out the procedures necessary for BioTherm to achieve environmental compliance. For each of the phases of implementation for the photovoltaic plant project, an over-arching environmental **goal** is stated. In order to meet this goal, a number of **objectives** are listed. The management programme has been structured in table format in order to show the links between the goals for each phase and their associated objectives, activities/risk sources, mitigation actions monitoring requirements and performance indicators. A specific environmental management programme table has been established for each environmental objective. The information provided within the EMP table for each objective is illustrated below:

OBJECTIVE: Description of the objective, which is necessary in order to meet the overall goals; these take into account the findings of the environmental impact assessment specialist studies

From the specialist investigations undertaken for the proposed photovoltaic (PV) and concentrated photovoltaic (CPV) plant development site, the sensitive areas for development on the proposed farm portion is indicated on Figure 1.5. The plains of the site are classified as Medium Sensitivity, while the rocky hill and slope are classified as High and Medium-High Sensitivity respectively. Given the high plant diversity of the rocky hill and the presence of a number of listed plant species in this area, it is recommended that the rocky hill is avoided by the development

Project component/s	List of project components affecting the objective, i.e.: » PV/CPV panels » Ancillary infrastructure
Potential Impact	Brief description of potential environmental impact if objective is not met
Activity/risk source	Description of activities which could impact on achieving objective
Mitigation: Target/Objective	Description of the target; include quantitative measures and/or dates of completion

Mitigation: Action/control	Responsibility	Timeframe
List specific action(s) required to meet the mitigation target/objective described above.	Who is responsible for the measures	Time periods for implementation of measures

Performance Indicator	Description of key indicator(s) that track progress/indicate the effectiveness of the management Programme.
Monitoring	Mechanisms for monitoring compliance; the key monitoring actions required to check whether the objectives are being achieved, taking into consideration responsibility, frequency, methods and reporting.

The objectives and EMP tables are required to be reviewed and possibly modified whenever changes, such as the following, occur:

- » Planned activities change (i.e. in terms of the components and/or layout of the facility).
- » Modification to or addition to environmental objectives and targets.
- » Relevant legal or other requirements are changed or introduced.
- » Significant progress has been made on achieving an objective or target such that it should be re-examined to determine if it is still relevant, should be modified, etc.

3.1. Project Team

This draft EMP was compiled by:

	Name	Company
EMP Compilers:	Umeshree Naicker	Savannah Environmental
	Jo-Anne Thomas	Savannah Environmental
Specialists:	Simon Todd	Simon Todd Consulting
	Iain Paton	Outeniqua Geotechnical Services Cc
	Jaco van der Walt	Heritage Contracts and Archaeological Consulting CC
	Tony Barbour	Tony Barbour Consulting
	Johan Claassen	Zone Land Solutions

The Savannah Environmental team have extensive knowledge and experience in environmental impact assessment and environmental management, having been involved in EIA processes over the past ten (10) years. They have managed and drafted Environmental Management Programmes for other power generation projects throughout South Africa, including numerous renewable energy facilities.

MANAGEMENT PROGRAMME FOR THE PV PLANT: PLANNING & DESIGN

CHAPTER 4

4.1. Goal for Planning and Design

Overall Goal for Planning and Design: Undertake the planning and design phase of the PV/CPV plant in a way that:

- » Ensures that the design of the facility responds to the identified environmental constraints and opportunities.
- » Ensures that adequate regard has been taken of any landowner concerns and that these are appropriately addressed through design and planning (where appropriate).
- » Ensures that the best environmental options are selected for the project, including the power line alignment.
- » Enables the solar facility construction activities to be undertaken without significant disruption to other land uses in the area.

In order to meet this goal, the following objectives have been identified, together with necessary actions and monitoring requirements.

4.2. Objectives

OBJECTIVE: Ensure that the design of the facility responds to the identified environmental constraints and opportunities

Project component/s	Project components affecting the objective: <ul style="list-style-type: none"> » PV/CPV panels » Access roads » Ancillary infrastructure
Potential Impact	Design fails to respond optimally to the identified environmental considerations
Activities/risk sources	Site layout (Figure 1.5 - Sensitivity Map)
Mitigation: Target/Objective	To ensure that the design of the facility responds to the identified environmental constraints and opportunities

Mitigation: Action/control	Responsibility	Timeframe
Consider design level mitigation measures recommended by the specialists, especially with	Engineering Design Consultant, and	Design phase

Mitigation: Action/control	Responsibility	Timeframe
respect to Biodiversity, as detailed within the Basic Assessment report and relevant appendices.	BioTherm	
A detailed geotechnical investigation is required for the design phase.	BioTherm	Design phase
Compile a comprehensive stormwater management plan for hard surfaces as part of the final design of the project.	Engineering design consultant	Design phase
Access roads within the site to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement, and compaction of soil.	Engineer	Pre-construction, and construction
Balance technical and financial considerations against environmental constraints and opportunities in finalising the design of key elements.	BioTherm	Tender design, and design review stage

Performance Indicator	<ul style="list-style-type: none"> » Design meets objectives and does not degrade the environment. » Design and layouts respond to the mitigation measures and recommendations in the Basic Assessment report.
Monitoring	Ensure that the design implemented meets the objectives and mitigation measures in the Basic Assessment report through review of the design by the Project Manager, and ECO prior to the commencement of construction.

OBJECTIVE: To ensure effective communication mechanisms

On-going communication with affected and surrounding landowners is important to maintain during the construction and operational phases of the solar energy facility. Any issues and concerns raised should be addressed as far as possible in as short a timeframe as possible.

Project component/s	List of project components affecting the objective <ul style="list-style-type: none"> » Solar energy facility
Potential Impact	» Impacts on affected and surrounding landowners and land uses
Activity/risk source	<ul style="list-style-type: none"> » Activities associated with solar energy facility construction » Activities associated with solar energy facility operation
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Effective communication with affected and surrounding landowners » Addressing of any issues and concerns raised as far as possible in as short a timeframe as possible

Mitigation: Action/control	Responsibility	Timeframe
Compile and implement a grievance mechanism procedure for the public to be	BioTherm Energy	Pre-construction (construction

Mitigation: Action/control	Responsibility	Timeframe
implemented during both the construction and operational phases of the facility. This procedure should include details of the contact person who will be receiving issues raised by interested and affected parties, and the process that will be followed to address issues.		procedure) Pre-operation (operation procedure)
Develop and implement a grievance mechanism for the construction, operational and closure phases of the project for all employees, contractors, subcontractors and site personnel. This procedure should be in line with the South African Labour Law.	BioTherm Energy Contractor	Pre-construction (construction procedure) Pre-operation (operation procedure)
Liaison with landowners is to be undertaken prior to the commencement of construction in order to provide sufficient time for them to plan agricultural activities.	BioTherm Energy Contractor	Pre-construction

Performance Indicator	» Effective communication procedures in place.
Monitoring	» An incident reporting system should be used to record non-conformances to the EMP.

MANAGEMENT PROGRAMME FOR THE SOLAR FACILITY: CONSTRUCTION

CHAPTER 5

5.1. Overall Goal for Construction

Overall Goal for Construction: Undertake the construction phase of the PV facility in a way that:

- » Ensures that construction activities are properly managed in respect of environmental aspects and impacts.
- » Enables the construction activities to be undertaken without significant disruption to other land uses in the area, in particular concerning farming practices, traffic and road use, and effects on local residents.

5.2. Institutional Arrangements: Roles and Responsibilities for the Construction Phase of the PV/CPV Plant

As the Proponent, BioTherm South Africa must ensure that the implementation of the PV/CPV facility complies with the requirements of all environmental authorisations and permits, and obligations emanating from other relevant environmental legislation. This obligation is partly met through the development of the EMP, and the implementation of the EMP through its integration into the contract documentation. BioTherm will retain various key roles and responsibilities during the construction of the PV facility. These are outlined below.

OBJECTIVE: To establish clear reporting, communication and responsibilities in relation to environmental incident

Formal responsibilities are necessary to ensure that key procedures are executed. Figure 5.1 provides an organogram indicating the organisational structure for the implementation of the EMP.

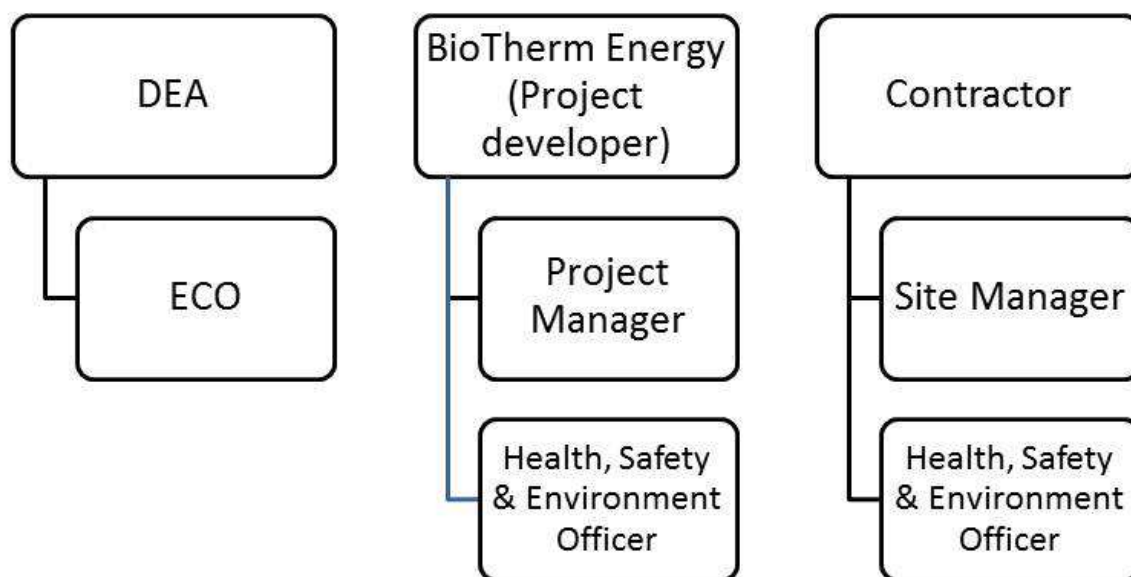


Figure 5.1: Organisational structure for the implementation of the EMP

Specific responsibilities of the Project Manager; Site Manager; Environmental Control Officer and Contractor for the construction phase of this project are as detailed below.

The **Project Manager** will:

- » Ensure of all specifications and legal constraints specifically with regards to the environment are highlighted to the Contractor(s) so that they are aware of these.
- » Ensure that BioTherm Energy and its Contractor(s) are made aware of all stipulations within the EMP.
- » Ensure that the EMP is correctly implemented throughout the project by means of site inspections and meetings. This will be documented as part of the site meeting minutes.
- » Be fully conversant with the Environmental Impact Assessment for the project, the EMP, the conditions of the Environmental Authorisation (once issued), and all relevant environmental legislation.

5.2.1. Site Manager

The **Site Manager** (BioTherm Energy's On-site Representative) will:

- » Be fully knowledgeable with the contents of the Environmental Impact Assessment.
- » Be fully knowledgeable with the contents and conditions of the Environmental Authorisation (once issued).
- » Be fully knowledgeable with the contents of the Environmental Management Plan.
- » Be fully knowledgeable with the contents of all relevant environmental legislation, and ensure compliance with these.
- » Have overall responsibility of the EMP and its implementation.
- » Conduct audits to ensure compliance to the EMP.

- » Ensure there is communication with the Project Manager, the Environmental Control Officer and relevant discipline Engineers on matters concerning the environment.
- » Ensure that no actions are taken which will harm or may indirectly cause harm to the environment, and take steps to prevent pollution on the site.
- » Confine activities to the demarcated construction site.

5.2.2. Safety, Health and Environment Representative

The **Safety, Health and Environment Representative** (SHE officer) will:

- » Develop and compile environmental policies and procedures.
- » Direct and liaise with the Environmental Control Officer (ECO) regarding monitoring and reporting on the environmental performance of the construction phase.
- » Conduct internal environmental audits and co-ordinate external environmental audits.
- » Liaise with statutory bodies on environmental performance and other issues as required.

5.2.3. Environmental Control Officer

An independent **Environmental Control Officer** (ECO) must be appointed by BioTherm Energy prior to the commencement of any authorised activities. The ECO will be responsible for monitoring, reviewing and verifying compliance by the Contractor with the environmental specifications of the EMP and the conditions of the Environmental Authorisation. Accordingly, the ECO will:

- » Be fully knowledgeable with the contents with the Environmental Impact Assessment.
- » Be fully knowledgeable with the contents with the conditions of the Environmental Authorisation (once issued).
- » Be fully knowledgeable with the contents with the Environmental Management Plan.
- » Be fully knowledgeable with the contents with all relevant environmental legislation, and ensure compliance with them.
- » Ensure that the contents of this document are communicated to the Contractor site staff and that the Site Manager and Contractor are constantly made aware of the contents through discussion.
- » Ensure that the compliance of the EMP is monitored through regular and comprehensive inspection of the site and surrounding areas.
- » Ensure that if the EMP conditions or specifications are not followed then appropriate measures are undertaken to address this.
- » Monitoring and verification must be implemented to ensure that environmental impacts are kept to a minimum, as far as possible.
- » Ensure that the Site Manager has input into the review and acceptance of construction methods and method statements.

- » Ensure that activities on site comply with all relevant environmental legislation.
- » Ensure that a removal is ordered of any person(s) and/or equipment responsible for any contravention of the specifications of the EMP.
- » Ensure that the compilation of progress reports for submission to the Project Manager, with input from the Site Manager, takes place on a regular basis, including a final post-construction audit.
- » Ensure that there is communication with the Site Manager regarding the monitoring of the site.
- » Ensure that any non-compliance or remedial measures that need to be applied are reported.
- » Keep record of all activities on site, problems identified, transgressions noted and a task schedule of tasks undertaken by the ECO.

As a general mitigation strategy, the Environmental Control Officer (ECO) should be present for the site preparation and initial clearing activities to ensure the correct demarcation of no-go areas, facilitate environmental induction with construction staff and supervise any flora relocation and faunal rescue activities that may need to take place during the site clearing (i.e. during site establishment, and excavation of foundations). Thereafter weekly site compliance inspections would probably be sufficient, decreasing in frequency as construction proceeds, provided that compliance with the EMP is maintained. However, in the absence of the ECO there should be a designated environmental officer present to deal with any environmental issues that may arise such as fuel or oil spills. The ECO shall remain employed until all rehabilitation measures, as required for implementation due to construction damage, are completed and the site handed over for operation.

5.2.4. Contractors and Service Providers

All contractors (including sub-contractors and staff) and service providers are ultimately responsible for:

- » Ensuring adherence to the environmental management specifications.
- » Ensuring that Method Statements are submitted to the Site Manager (and ECO) for approval before any work is undertaken. Any lack of adherence to this will be considered as non-compliance to the specifications of the EMP.
- » Ensuring that any instructions issued by the Site Manager on the advice of the ECO are adhered to.
- » Ensuring that a report is tabled at each site meeting, which will document all incidents that have occurred during the period before the site meeting.
- » Ensuring that a register is kept in the site office, which lists all transgressions issued by the ECO.
- » Ensuring that a register of all public complaints is maintained.

- » Ensuring that all employees, including those of sub-contractors receive training before the commencement of construction in order that they can constructively contribute towards the successful implementation of the EMP (i.e. ensure their staff are appropriately trained as to the environmental obligations).

5.3. Objectives

In order to meet the goal detailed in Section 5.1 above, the following objectives have been identified, together with necessary actions and monitoring requirements.

OBJECTIVE: Site establishment and securing the site

Site establishment is the first activity which is to be undertaken within the construction phase. The Contractor must take all reasonable measures to ensure the safety of the public in the surrounding area. Where the public could be exposed to danger by any of the works or site activities, the Contractor must, as appropriate, provide suitable flagmen, barriers and/or warning signs in English, Afrikaans and any other relevant local languages, all to the approval of the Site Manager.

Project component/s	Project components affecting the objective: » PV/CPV panels and ancillary infrastructure
Potential Impact	» Hazards to landowners and public » Security of materials
Activities/risk sources	Movement of construction vehicles in the area and on-site
Mitigation: Target/Objective	To secure the site against unauthorised entry To protect members of the public/landowners/residents

Mitigation: Action/control	Responsibility	Timeframe
Secure site, working areas and excavations in an appropriate manner, as agreed with the ECO.	Contractor	Erection: during site establishment Maintenance: for duration of contract
Where necessary to control access, fence and secure area.	Contractor	Erection: during site establishment Maintenance: for duration of contract

Mitigation: Action/control	Responsibility	Timeframe
Fence and secure Contractor's equipment camp.	Contractor	Erection: during site establishment Maintenance: duration of contract
Identify disturbance areas and restrict construction activity to these areas.	ECO / Contractor	Pre-construction, and construction
Establish the necessary ablution facilities with chemical toilets. Provide adequate sanitary facilities and ablutions for construction workers (1 toilet per every 15 workers) at appropriate locations on site.	Contractor	Erection: during site establishment Maintenance: duration of contract
Ablution or sanitary facilities should not be located within 100 m from a 1:100 year flood line including water courses, wetlands or within a horizontal distance of less than 100 m, whichever is applicable.	Contractor	During site establishment, construction and maintenance
Supply adequate numbers of waste collection bins in appropriate locations on the site where construction is being undertaken.	Contractor	Erection: during site establishment Maintenance: for duration of contract within a particular area
All unattended open excavations shall be adequately demarcated and/or fenced). Adequate protective measures must be implemented to prevent unauthorised access to the working area and the internal access/haul routes.	Contractor	Erection: during site establishment Maintenance: for duration of contract

Performance Indicator	<ul style="list-style-type: none"> » No unnecessary environmental impacts associated with site established. » Site is secure and there is no unauthorised entry. » No members of the public/ landowners injured.
Monitoring	<ul style="list-style-type: none"> » An incident reporting system will be used to record non-conformances to the EMP. » ECO to monitor all construction areas on a continuous basis until all construction is completed; immediate report backs to site manager in terms of non-conformances recorded.

OBJECTIVE: Objective: Limit faunal impacts

Of the species which are known to occur in the area, only the Honey Badger (Endangered) and Leopard (Near Threatened) are listed. No listed reptile species are known from the area and given the small extent of the development, the impact on reptiles is likely to local in extent and of a generally low significance. The site lies within the distribution range of six amphibian species. The only species of conservation concern which may occur at the site is the Giant Bullfrog which is listed as Near Threatened. The site is however at the margin of the species' distribution and it is not likely that it occurs at the site as the habitat was not broadly suitable. As there is little specialised amphibian habitat at the site, impacts on amphibians are likely to be low magnitude.

Project component/s	All components which create disturbance during construction, as well as security fencing and transmission lines
Potential Impact	<ul style="list-style-type: none"> » Loss of habitat and landscape connectivity for terrestrial fauna. » Negative impacts on avifauna.
Activities/risk sources	<ul style="list-style-type: none"> » Habitat transformation during construction; » site fencing, » presence of construction and operation personnel.
Mitigation: Target/Objective	Low faunal impact during construction and operation.

Mitigation: Action/control	Responsibility	Timeframe
Environmental induction for all staff	Management/ECO	Construction
Ensure bird-friendly design of transmission infrastructure	Management/ECO	Design Construction
Use low UV lighting at night to avoid attracting insects.	Management/ECO	Design Construction
ECO on duty during the site clearing	Management/ECO	Construction
Permeable fencing at strategic places	Management/ECO	Design Construction
No electric fencing within 30cm of the ground	Management/ECO	

Performance Indicator	<ul style="list-style-type: none"> » Limited mortality of fauna during construction » Limited mortality of avifauna during operation
Monitoring	<ul style="list-style-type: none"> » Monitoring for compliance during the construction phase » Monitoring for avifaunal impacts by searching under transmission infrastructure for dead birds » Records of all incidents and mitigation measures implemented at sites where repeated impacts occur.

OBJECTIVE: Limit alien plant invasion

All alien plants present at the site should be controlled annually using the best practice methods for the species present.

Project component/s	All components which create disturbance during construction
Potential Impact	Alien plant invasion leading to habitat degradation, loss of ecosystem services and loss of biodiversity
Activities/risk sources	Construction related disturbance
Mitigation: Target/Objective	Low abundance of alien plant species at the site

Mitigation: Action/control	Responsibility	Timeframe
Clear alien plants on a bi-annual basis.	Contractor ECO BioTherm Energy	Construction & operation

Performance Indicator	Low abundance of alien plant species at the site.
Monitoring	<ul style="list-style-type: none"> » Bi-annual monitoring for the presence of alien species at the site » Records of clearing activities and the species involved

OBJECTIVE: Limit disturbance of site during construction

Project component/s	PV or CPV arrays and their support structures; access and maintenance roads; buildings.
Potential Impact	Loss of plant cover leading to erosion as well as loss of faunal habitat
Activities/risk sources	Construction & site clearing activities
Mitigation: Target/Objective	Maintain a ground layer to protect the site from erosion and reduce faunal impacts.

Mitigation: Action/control	Responsibility	Timeframe
Areas to be cleared must be clearly marked on-site to eliminate the potential for unnecessary clearing.	Contractor ECO	Construction
Clear woody vegetation with least possible impact to ground layer, or re-establish ground layer after clearing	Contractor ECO	Construction
The extent of clearing and disturbance to the natural vegetation must be kept to a minimum so that impact on flora and habitats is restricted.	Contractor	Site establishment & duration of contract
Construction activities must be restricted to demarcated areas so that impact on flora and sensitive habitats is restricted.	Contractor	Site establishment & duration of contract
Unnecessary impacts on surrounding natural vegetation must be avoided, e.g. driving around in the veld. Use demarcated access roads only.	Contractor	Site establishment & duration of contract
Ensure erosion control structures are in place in areas of water movement	Contractor ECO	Construction

Performance Indicator	» Ground layer cover after construction has been completed
Monitoring	<ul style="list-style-type: none"> » Document pre- and post- construction cover of the ground layer. » Document revegetation actions taken and their success » Document erosion problems and the control measures implemented

OBJECTIVE: Maximise local employment and business opportunities associated with the construction phase.

Project component/s	Construction and establishment activities associated with the establishment of the solar facility, including infrastructure etc.
Potential Impact	The opportunities and benefits associated with the creation of local employment and business should be maximised.
Activity/risk source	The employment of outside contractors to undertake the work and who make use of their own labour will reduce the employment and business opportunities for locals. Employment of local labour will maximise local employment opportunities.
Mitigation: Target/Objective	BioTherm, in discussions with the Camdeboo Local Municipality, should aim to employ a minimum of 80% of the low-skilled workers from the local area. This should also be made a requirement for all contractors. BioTherm should also develop a database of local BEE service providers

Mitigation: Action/control	Responsibility	Timeframe
Employment and business policy document that sets out local employment targets to be in place before construction phase commences.	BioTherm & contractors	Pre-construction
As far as possible, ensure that the majority of low-skilled workers are sourced from the local area.	BioTherm & contractors	Construction
Where required, implement appropriate training and skills development programmes prior to the initiation of the construction phase to ensure that the local employment target is met.	BioTherm Contractors	Pre-construction Construction
Skills audit to be undertaken to determine training and skills development requirements;	BioTherm	Pre-construction
Develop a database of local BEE service providers and ensure that they are informed of tenders and job opportunities;	BioTherm	Pre-construction
Identify potential opportunities for local businesses	BioTherm	Pre-construction

Performance Indicator	<ul style="list-style-type: none"> » Employment and business policy document that sets out local employment and targets completed before construction phase commences. » Majority of semi and unskilled labour locally sourced. » Database of potential local BEE services providers in place before construction phase commences. » Skills audit to determine need for training and skills development programme undertaken within 1 month of commencement of construction phase.
Monitoring	<ul style="list-style-type: none"> » BioTherm and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OBJECTIVE: Avoid the potential impacts on family structures and social networks associated with presence of construction workers from outside the area

Project component/s	Construction and establishment activities associated with the establishment of the PV facility, including infrastructure etc.
Potential Impact	The presence of construction workers who live outside the area and who are housed in local towns can affect family structures and social networks.
Activity/risk source	The presence of construction workers can affect negatively on family structures and social networks, especially in small, rural communities.
Mitigation:	To avoid and or minimise the potential impact of construction workers on

Target/Objective	the local community. This can be achieved by maximising the number of locals employed during the construction phase and minimising the number of workers housed on the site.
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Mitigation: Action/control	Responsibility	Timeframe
Attempt to ensure that the majority of the low-skilled workers are sourced from the local area. This should be included in the tender documents. Construction workers should be recruited from the local area.	BioTherm contractors	Construction
Identify local contractors who are qualified to undertake the required work.	BioTherm	Pre-construction
Develop a Code of Conduct to cover the activities of the construction workers housed on the site.	BioTherm	Pre-construction
Ensure that construction workers attend a brief session before they commence activities. The aim of the briefing session is to inform them of the rules and regulations governing activities on the site as set out in the Code of Conduct.	BioTherm and contractors	Pre-construction
Ensure that all workers are informed at the outset of the construction phase of the conditions contained on the Code of Conduct.	BioTherm contractors	Pre-construction
Ensure that construction workers who are found guilty of breaching the Code of Conduct are dismissed. All dismissals must be in accordance with South African labour legislation.	Contractors	Construction
Provide opportunities for workers to go home over weekends. The cost of transporting workers home over weekends and back to the site should be borne by the contractors.	Contractors	Construction
On completion of the construction phase all construction workers must be transported back to their place of origin within two days of their contract ending. The costs of transportation must be borne by the contractor	Contractors	Construction

Performance Indicator	<ul style="list-style-type: none"> » Employment policy and tender documents that sets out local employment and targets completed before construction phase commences; » majority of semi and unskilled labour locally sourced; » Local construction workers employed have proof that they have lived in the area for five years or longer; » Tender documents for contractors include recommendations for construction camp; » Code of Conduct drafted before commencement of construction phase;
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	» Briefing session with construction workers held at outset of construction phase;
Monitoring	» BioTherm and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OBJECTIVE: To avoid and or minimise the potential risk of increased veld fires during the construction phase.

The natural vegetation in the study area is known to be at risk of fire. The increased presence of people on the site could increase the risk of veld fires, particularly in the dry season.

Project component/s	Construction and establishment activities associated with the establishment of solar facility, including infrastructure etc.
Potential Impact	Veld fires can pose a personal safety risk to local farmers and communities, and their homes, crops, livestock and farm infrastructure, such as gates and fences.
Activity/risk source	The presence of construction workers and their activities on the site can increase the risk of veld fires.
Mitigation: Target/Objective	To avoid and or minimise the potential risk of veld fires on local communities and their livelihoods.

Mitigation: Action/control	Responsibility	Timeframe
Ensure that open fires on the site for cooking or heating are not allowed except in designated areas.	BioTherm and contractors	Construction
Provide adequate fire fighting equipment on-site.	BioTherm and contractors	Construction
Provide fire-fighting training to selected construction staff.	BioTherm and contractors	Construction
Compensate farmers / community members at full market related replacement cost for any losses, such as livestock, damage to infrastructure etc.	Contractors	Compensate Farmers within 1 month of claim being verified
Join Fire Protection Agency	BioTherm Energy	Pre-construction

Performance Indicator	<ul style="list-style-type: none"> » Designated areas for fires identified on site at the outset of the construction phase. » Fire fighting equipment and training provided before the construction phase commences. » Compensation claims settled within 1 month of claim being verified.
Monitoring	» BioTherm and or appointed ECO must monitor indicators listed above

to ensure that they have been met for the construction phase.

OBJECTIVE: To avoid and or minimise the potential impacts of safety, noise and dust and damage to roads caused by construction vehicles during the construction phase.

Project component/s	Construction and establishment activities associated with the establishment of the solar facility, including infrastructure etc.
Potential Impact	<ul style="list-style-type: none"> » Heavy vehicles can generate noise and dust impacts. » Movement of heavy vehicles can damage roads.
Activity/risk source	The movement of heavy vehicles and their activities on the site can result in noise and dust impacts and damage roads.
Mitigation: Target/Objective	To avoid and or minimise the potential noise and dust impacts associated with heavy vehicles, and minimise damage to roads.

Mitigation: Action/control	Responsibility	Timeframe
Implement dust suppression measures for heavy vehicles such as wetting roads on a regular basis and ensuring that vehicles used to transport sand and building materials are fitted with tarpaulins or covers.	Contractors	Construction
Ensure that all vehicles are road-worthy; drivers are qualified and are made aware of the potential noise, dust and safety issues.	Contractors	Construction
Ensure that drivers adhere to speed limits. Vehicles should be fitted with recorders to record when vehicles exceed the speed limit.	Contractors	Construction
Ensure that damage to roads is repaired before completion of construction phase.	Contractors	Construction

Performance Indicator	<ul style="list-style-type: none"> » Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase commences. » Drivers made aware of the potential safety issues and enforcement of strict speed limits when they are employed. » All heavy vehicles equipped with speed monitors before they are used in the construction phase. » Road worthy certificates in place for all heavy vehicles at outset of construction phase and up-dated on a monthly basis.
Monitoring	<ul style="list-style-type: none"> » BioTherm and/or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OBJECTIVE: To avoid and or minimise the potential impact on current and future farming activities during the construction phase.

Project component/s	Construction phase activities associated with the establishment of the solar facility and associated infrastructure.
Potential Impact	The footprint of the solar energy plant and associated infrastructure will result in a loss of land that will impact on farming activities on the site.
Activity/risk source	The footprint taken up by the solar energy plant and associated infrastructure.
Mitigation: Target/Objective	To minimise the loss of land taken up by the PV facility and associated infrastructure and to enable farming activities to continue where possible, specifically grazing.

Mitigation: Action/control	Responsibility	Timeframe
Minimise the footprint of the solar facility and the associated infrastructure.	Contractor BioTherm	Pre-construction
Rehabilitate disturbed areas on completion of the construction phase. Details of the rehabilitation programme should be contained in the EMP	ECO Contractors	Construction

Performance Indicator	» Footprint of solar facility included in the Construction Phase EMP. » Meeting/s held with farmers during construction phase.
Monitoring	» ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OBJECTIVE: To minimise the potential impact on safety and security

Criminals could also use the opportunity due to “outsiders” being in the area to undertake their criminal activities. Materials and goods would be stored on site in some type of storage facility for the duration of the construction period, and this in itself can lure criminals to the area. The negative impacts associated with the inflow of workers could, however, be limited should a local labour force be used.

Project component/s	» Solar facility. » Associated infrastructure.
Potential Impact	Outside workers are involved in criminal activities.
Activities/risk sources	» Safety of individuals and animals are at risk. » Theft of construction material.
Mitigation:	Employment of local labour should be maximised and strict security

Target/Objective measures should be implemented at the construction site.

Mitigation: Action/control	Responsibility	Timeframe
Employing local community members could minimise the potential for criminal activity or perceived perception of an increase in criminal activity due to the presence of an outside workforce.	Contractor	Pre-construction Construction
Screening of workers that apply for work could be useful to lessen perceived negative perceptions about the outside workforce.	Contractor	Pre-construction
Construction workers should be easily identifiable by wearing uniforms and even identity tags.	Contractor	Construction
Local community members and property owners should be informed of the presence of the outside workforce, the construction schedule, and movement of workers.	BioTherm	Construction
Property owners, their workers, as well as local communities should be motivated to be involved in crime prevention by reporting crimes to the appropriate authorities.	BioTherm, and local communities	All phases of project
The construction site should be fenced and access to the area controlled.	BioTherm, and contractor	All phases of project
Workers should preferable not be allowed to be accommodated on site. From a social perspective it is preferred that no workers should thus be accommodated on site at night. Should this, however, be considered, the developer should be obliged to consult the neighbouring property owners in this regard and to address their concerns.	BioTherm & EPC Partner	Construction

Performance Indicator	» No criminal activities and theft are reported to be linked with the construction force.
Monitoring	» Project proponent, and appointed ECO must monitor indicators listed above to ensure that they have been implemented.

OBJECTIVE: Minimise negative impact on soil degradation and agricultural potential

Soil degradation including erosion (by wind and water) and subsequent deposition elsewhere is of a concern in areas which are underlain by fine grained soil which can be mobilised when disturbed, even on relatively low slope gradients (accelerated erosion).

Uncontrolled run-off relating to the construction activity (excessive wetting, uncontrolled discharge, etc.) will also lead to accelerated erosion and possible sedimentation along natural drainage lines or catchment areas.

Degradation of the natural soil profile due to excavation, removal or topsoil, stockpiling, wetting, compaction, pollution and other construction activities will affect soil forming processes and associated agricultural potential.

Project Component/s	<ul style="list-style-type: none"> » PV/CPV arrays and foundations to support them. » Access roads. » Underground cabling. » Storage and maintenance facilities and foundations to support them. » Overhead power lines and substation linking the facility to the electricity grid.
Potential Impact	<ul style="list-style-type: none"> » Soil removal. » Soil mixing, wetting, stockpiling, compaction. » Soil pollution. » Increased run-off and erosion. » Increased siltation along drainage lines. » Dust pollution.
Activity/Risk Source	<ul style="list-style-type: none"> » Earthworks & transportation across site. » Rainfall and concentrated discharge causing water erosion of disturbed areas. » Wind - erosion of disturbed areas.
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Minimise soil degradation (removal, excavation, mixing, wetting, compaction, pollution, etc.). » Minimise erosion. » Minimise sediment transport downstream (siltation). » Minimise dust pollution.

Mitigation: Action/Control	Responsibility	Timeframe
Identify areas of high erosion risk (drainage lines/watercourses, existing problem areas). Only special works to be undertaken in these areas to be authorised by ECO	ECO	At design stage.
Identify construction areas for general construction work and restrict construction activity to these areas.	ECO/ Contractor	At design stage and during construction
Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling)	ECO/ Contractor	During construction
Access roads to be carefully planned and constructed to minimise the impacted area and prevent unnecessary degradation of soil. Special attention to be given to roads that cross drainage lines and roads on steep slopes (to prevent unnecessary cutting and filling operations).	ECO/ Contractor	At design stage and during construction
Dust control on construction site through wetting or covering of cleared areas.	Contractor	Daily during construction

Mitigation: Action/Control	Responsibility	Timeframe
Minimise removal of vegetation which aids soil stability.	ECO/ Contractor	Continuously during construction
Rehabilitate disturbance areas as soon as an area is vacated.	Contractor	Continuously during and after construction
Soil conservation - stockpile topsoil for re-use in rehabilitation phase. Protect stockpile from erosion.	Contractor	Continuously during construction
Erosion control measures- run-off control and attenuation on slopes (sand bags, logs), silt fences, stormwater channels and catch-pits, shade nets, soil binding, geofabrics, hydroseeding or mulching over cleared areas.	Contractor/ECO	Erection: Before construction Maintenance: Duration of contract
Where access roads cross natural drainage lines, culverts must be designed to allow free flow. Regular maintenance must be carried out	ECO/ Contractor	Before construction and maintenance over duration of contract
Control depth of excavations and stability of cut faces/sidewalls	ECO Contractor	Before construction and maintenance over duration of contract
Compile and implement a stormwater management plan	BioTherm Energy Contractor	Before construction and maintenance over duration of contract

Performance Indicator	<ul style="list-style-type: none"> » Only authorised activity outside construction areas » No activity in no-go areas. » Acceptable level of activity within construction areas, as determined by ECO. » Acceptable level of soil erosion around site, as determined by ECO. » Acceptable level of sedimentation along drainage lines, as determined by ECO. » Acceptable level of soil degradation, as determined by ECO. » Acceptable state of excavations, as determined by ER & ECO.
Monitoring	<ul style="list-style-type: none"> » Monitoring inspections of the site by the ECO.

	<ul style="list-style-type: none"> » Monthly inspections of sediment control devices by the ECO. » Inspections of surroundings, including drainage lines by the ECO. » Immediate reporting of ineffective sediment control systems by the ECO. » An incident reporting system will record non-conformances.
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OBJECTIVE: Minimising the impact on heritage sites

The construction of the PV/CPV array could impact on unidentified sites of archaeological importance..

Project component/s	PV /CPV Array, power lines, roads and construction camps
Potential Impact	<ul style="list-style-type: none"> » Heritage objects or artefacts found on site are inappropriately managed or destroyed » Disturbance to fossil resources
Activity/risk source	<ul style="list-style-type: none"> » Site preparation and earthworks » Foundations or plant equipment installation » Mobile construction equipment movement on site
Mitigation: Target/Objective	<ul style="list-style-type: none"> » To ensure that any heritage objects found on site are treated appropriately and in accordance with the relevant legislation

Mitigation: Action/control	Responsibility	Timeframe
Training of personnel to recognise heritage/archaeological/fossil finds.	Contractor in consultation with Specialist	Pre-construction
Monitoring of any excavation activities during the construction phase of the project.	ECO	During excavations associated with the construction phase
If a heritage object is found work in that area must be stopped immediately, and appropriate specialists brought in to assess to site, notify the administering authority of the item/site, and undertake due/required processes.	BioTherm Energy /Contractor in consultation with Specialist	Duration of contract
On uncovering a possible grave or burial site it is imperative that construction be ceased immediately. The area should be marked and a heritage practitioner be informed immediately.	ECO	Duration of construction

Performance Indicator	<ul style="list-style-type: none"> » Zero disturbance outside of designated work areas » All heritage items located are dealt with as per the legislative guidelines » A record is kept of all instances of accidental disturbance of heritage material, as well as post construction review of impacts on landscape context.
Monitoring	<ul style="list-style-type: none"> » Supervision of all clearing and earthworks by ECO throughout construction phase

OBJECTIVE: Mitigate the possible visual impact associated with the construction phase.

Project component/s	PV /CPV Array, power lines, roads and construction camps
Potential Impact	<ul style="list-style-type: none"> » Visual impact of general construction activities and associated impacts.
Activity/risk source	<ul style="list-style-type: none"> » Potential impact on sensitive receptors within 1 km of the facility.
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Minimal visual intrusion by construction activities and general acceptance and compliance with Environmental Specifications.

Mitigation: Action/control	Responsibility	Timeframe
Design buildings to reflect the local architecture and sense of place.	BioTherm / contractor	Pre-construction
Keep disturbed areas to a minimum.	BioTherm / contractor	Throughout construction
Identify suitable areas within the construction site for fuel storage, temporary workshops, eating areas, ablution facilities and washing areas.	BioTherm / contractor	Throughout construction

Performance Indicator	<ul style="list-style-type: none"> » Construction site is confined to the demarcated areas identified on the Development Plan
Monitoring	<ul style="list-style-type: none"> » Monitoring to be undertaken by an appointed Environmental Control Officer who will enforce compliance with the Environmental Specifications.

OBJECTIVE: Appropriate handling and storage of chemicals, hazardous substances and waste

The construction phase of the PV/CPV facility may involve the storage and handling of a variety of chemicals including adhesives, abrasives, oils and lubricants, paints and solvents. The main wastes expected to be generated by the construction of the facility will probably consist of some construction and general solid waste. A guideline for integrated management of construction waste is included as Appendix A of this EMP.

Project component/s	<ul style="list-style-type: none"> » Storage and handling of chemicals, and waste. » Maintenance of vehicles and planning of vehicle service areas.
Potential Impact	<ul style="list-style-type: none"> » Release of contaminated water from contact with spilled chemicals. » Generation of contaminated wastes from used chemical containers. » Pollution of the surrounding environment through inappropriate waste management practices. » Litter or contamination of the site or water through poor waste management practices. » Pollution of water and soil resources. » Oil, fuel and other hydrocarbon pollution.
Activity/risk source	<ul style="list-style-type: none"> » PV panel construction activities. » Building construction activities. » Packaging and other construction wastes. » Hydrocarbon use and storage. » Spoil material from site preparation. » Poor maintenance of vehicles and poor control over service areas.
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons. » Ensure that the storage and maintenance of machinery on-site does not cause pollution of the environment or harm to persons. » Comply with waste management guidelines. » Minimise production of waste. » Ensure appropriate waste handling, storage, and disposal. » Avoid environmental harm from waste disposal. » Adequate maintenance and control over service areas

Mitigation: Action/control	Responsibility	Timeframe
Compile and implement an emergency preparedness plan during the construction phase.	Contractor	Duration of Contract
Spill kits must be made available on-site for the clean-up of spills and leaks of contaminants.	Contractor	Duration of contract
Corrective action must be undertaken immediately if a complaint is made, or potential/actual leak or spill of	Contractor	Duration of contract

Mitigation: Action/control	Responsibility	Timeframe
polluting substance identified. This includes stopping the contaminant from further escaping, cleaning up the affected environment as much as practically possible and implementing preventive measures.		
In the event of a major spill or leak of contaminants, the relevant authorities should be notified as per the notification of emergencies/incidents, as per the requirements of NEMA.	Contractor	Duration of contract
Spilled cement must be cleaned up as soon as possible and disposed of at a suitably licensed waste disposal site.	Contractor	Duration of contract
Routine servicing and maintenance of vehicles must not take place on-site outside of designated areas (except for emergencies). If repairs of vehicles must take place on site, an appropriate drip tray must be used to contain any fuel or oils.	Contractor	Duration of contract
All stored fuels to be maintained within a bunded area and on a sealed surface. The bunded area must be provided with a tap-off system through which spillages and leakages that might occur will be removed without any spillage outside the bunded area.	Contractor	Duration of contract
Construction machinery must be stored in an appropriately sealed area.	Contractor	Duration of contract
The storage of flammable and combustible liquids such as oils will be in designated areas which are appropriately bunded, and stored in compliance with MSDS files.	Contractor	Duration of contract
Any storage and disposal permits/approvals which may be required must be obtained, and the conditions attached to such permits and approvals will be complied with.	Contractor	Duration of contract
Construction contractors must provide specific detailed waste management method statements to deal with all waste streams.	Contractor	Pre-construction
Specific areas must be designated on-site for the temporary management of various waste streams, i.e. general refuse, construction waste (wood and metal scrap), and contaminated waste. Location of such areas must seek to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, seepage, and vermin control.	Contractor	Duration of contract
Where possible, construction and general wastes on-site must be reused or recycled. Bins and skips must be available on-site for collection, separation, and storage of waste streams (such as wood, metals,	Contractor	Duration of contract

Mitigation: Action/control	Responsibility	Timeframe
general refuse etc.).		
Disposal of waste must be in accordance with relevant legislative requirements, including the use of licensed contractors.	Contractor	Duration of contract
No waste may be buried or burnt on site	Contractor	Duration of contract
Hydrocarbon waste must be contained and stored in sealed containers within an appropriately bunded area.	Contractor	Duration of contract
Waste and surplus dangerous goods must be kept to a minimum and must be transported by approved waste transporters to sites designated for their disposal.	Contractor	Duration of contract
Documentation (waste manifest) must be maintained detailing the quantity, nature, and fate of any regulated waste. Waste disposal records must be available for review at any time.	Contractor	Duration of contract
The sediment control and water quality structures used on-site must be monitored and maintained in an operational state at all times.	Contractor	Duration of contract
Upon the completion of construction, the area must be cleared of potentially polluting materials.	Contractor	Completion of construction
Maintenance of service areas, regular clean-up	Construction team and engineer	Duration of contract

Performance Indicator	<ul style="list-style-type: none"> » Implement an effective monitoring system to detect any leakage or spillage of all hazardous substances. » No chemical spills outside of designated storage areas. » No water or soil contamination by spills. » No complaints received regarding waste on site or indiscriminate dumping. » Internal site audits ensuring that waste segregation, recycling and reuse is occurring appropriately. » Provision of all appropriate waste manifests for all waste streams. » Assessment number and extent of spillages on a regular basis.
Monitoring	<ul style="list-style-type: none"> » Observation and supervision of chemical storage and handling practices and vehicle maintenance throughout construction phase. » A complaints register must be maintained, in which any complaints from the community will be logged. » Complaints will be investigated and, if appropriate, acted upon. » Observation and supervision of waste management practices throughout construction phase. » Waste collection to be monitored on a regular basis. » Waste documentation completed. » A complaints register will be maintained, in which any complaints from the community will be logged. » An incident reporting system will be used to record non-conformances

to the EMP.
» Monitor construction and service sites.

OBJECTIVE: Ensure disciplined conduct of on-site contractors and workers

In order to minimise impacts on the surrounding environment, Contractors must be required to adopt a certain Code of Conduct and commit to restricting construction activities to areas within the development footprint. Contractors and their sub-contractors must be familiar with the conditions of the Environmental Authorisation (once issued), the BA Report, and this EMP, as well as the requirements of all relevant environmental legislation.

Project component/s	All components and activities occurring during the construction phase.
Potential Impact	Pollution/contamination of the environment. Disturbance to the environment.
Activity/risk source	Contractors are not aware of the requirements of the EMP, leading to unnecessary impacts on the surrounding environment.
Mitigation: Target/Objective	To ensure appropriate management of actions by on-site personnel in order to minimise impacts to the surrounding environment.

Mitigation: Action/control	Responsibility	Timeframe
The terms of this EMP and the Environmental Authorisation (once issued) will be included in all Contractors contracts.	BioTherm	Tender process
An ECO must be permanently on site during any construction close to drainage lines and wetlands and at other times should visit the site at least once a week.	BioTherm	Duration of construction
Contractors must use chemical toilets/ablution facilities situated at designated areas of the site; no abluting will be permitted outside the designated area. These facilities must be regularly serviced by appropriate contractors.	Contractor, and sub-contractors	Duration of contract
Cooking/meals must take place in a designated area; no firewood or kindling may be gathered from the site or surrounds.	Contractor, and sub-contractors	Duration of contract
All litter must be deposited in a clearly marked, closed, animal-proof disposal bin in the construction area; particular attention needs to be paid to food waste.	Contractor, and sub-contractors	Duration of contract
No one other than the ECO or personnel authorised	Contractor, and	Duration of

Mitigation: Action/control	Responsibility	Timeframe
by said individual may disturb flora or fauna outside of the demarcated construction area/s.	sub-contractors	contract
Contractors must ensure that all workers are informed at the outset of the construction phase about the consequences of stock theft and trespassing on adjacent farms.	Contractor, and sub-contractors	Construction
Develop and implement a grievance mechanism for the construction, operational and closure phases of the project for all employees, contractors, subcontractors and site personnel. This procedure should be in line with the South African Labour Law.	BioTherm Energy Contractor	Pre-construction

Performance Indicator	<ul style="list-style-type: none"> » Compliance with specified conditions of Environmental Authorisation, (once issued), EIA report, and the EMP. » No complaints regarding contractor behaviour or habits. » Code of Conduct drafted before commencement of construction phase. » Briefing session with construction workers held at outset of construction phase.
Monitoring	<ul style="list-style-type: none"> » Observation and supervision of Contractor practices throughout construction phase. » A complaints register will be maintained, in which any complaints from the community will be logged. Complaints will be investigated and, if appropriate, acted upon. » An incident reporting system will be used to record non-conformances to the EMP.

5.4. Detailing Method Statements

OBJECTIVE: Ensure all construction activities/practices/procedures are undertaken with the appropriate level of environmental awareness to minimise environmental risk, in line with the specifications of the EMP

The environmental specifications are required to be underpinned by a series of Method Statements, within which the Contractors and Service Providers are required to outline how any identified environmental risks will practically be mitigated and managed for the duration of the contract, and how specifications within this EMP will be met. That is, the Contractor will be required to describe how specified requirements will be achieved through the submission of written Method Statements to the Site Manager (and ECO).

A Method Statement is defined as "a written submission by the Contractor in response to the environmental specification or a request by the Site Manager, setting out the plant,

materials, labour and method the Contractor proposes using to conduct an activity, in such detail that the Site Manager is able 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 must 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, and
- » Any other information deemed necessary by the Site Manager.

The Contractor may not commence the activity covered by the Method Statement until it has been approved by the Project Manager, except in the case of emergency activities and then only with the consent of the Site Manager. Approval of the Method Statement will not absolve the Contractor from their obligations or responsibilities in terms of their contract. Failure to submit a method statement may result in suspension of the activity concerned until such time as a method statement has been submitted and approved.

The ECO should monitor the construction activities to ensure that these are undertaken in accordance with the approved Method Statement.

5.5. Awareness and Competence: Construction Phase of the PV/CPV Plant

OBJECTIVE: Ensure all construction personnel have the appropriate level of environmental awareness and competence to ensure continued environmental due diligence and on-going minimisation of environmental harm

To achieve effective environmental management, it is important that Contractors and employees are aware of the responsibilities in terms of the relevant environmental legislation and the contents of this EMP. The Contractor is responsible for informing employees and sub-contractors of their environmental obligations in terms of the environmental specifications, and for ensuring that employees are adequately experienced and properly trained in order to execute the works in a manner that will minimise environmental impacts. The Contractors obligations in this regard include the following:

- » Employees must have a basic understanding of the key environmental features of the construction site and the surrounding environment.
- » Ensuring that a copy of the EMP is readily available on-site, and that all site staff are aware of the location and have access to the document. Employees will be familiar with the requirements of the EMP and the environmental specifications as they apply to the construction of the facility.
- » Ensuring that, prior to commencing any site works, all employees and sub-contractors have attended an Environmental Awareness Training course. The course must provide the site staff with an appreciation of the project's environmental requirements, and how they are to be implemented.
- » Basic training in the identification of archaeological sites/objects, paleontological sites, and protected flora and fauna that may be encountered on the site.
- » Awareness of any other environmental matters, which are deemed to be necessary by the ECO.
- » Ensuring that appropriate communication tools are used to outline the environmental "do's" and "don'ts" (as per the environmental awareness training course) to employees.
- » Records must be kept of those that have completed the relevant training.
- » Refresher sessions must be held to ensure the contractor's staff are aware of their environmental obligations.

Therefore, prior to the commencement of construction activities on site and before any person commences with work on site thereafter, adequate environmental awareness and responsibility are to be appropriately presented to all staff present onsite, clearly describing their obligations towards environmental controls and methodologies in terms of this EMP. This training and awareness will be achieved in the following ways:

5.5.1. Environmental Awareness Training

Environmental Awareness Training must take the form of an on-site talk and demonstration by the ECO before the commencement of site establishment and construction on site. The education/awareness programme should be aimed at all levels of management and construction workers within the contractor team. A record of attendance of this training must be maintained by the ECO on site.

5.5.2. Induction Training

Environmental induction training must be presented to all persons who are to work on the site – be it for short or long durations; Contractor's or Engineer's staff; administrative or site staff; sub-contractors or visitors to site.

This induction training should include discussing the developer's environmental policy and values, the function of the EMP and Contract Specifications and the importance and reasons for compliance to these. The induction training must highlight overall do's and don'ts on site and clarify the repercussions of not complying with these. The non-conformance reporting system must be explained during the induction as well. Opportunity for questions and clarifications must form part of this training. A record of attendance of this training must be maintained by the SHE Officer on site.

5.5.3. Toolbox Talks

Toolbox talks should be held on a scheduled and regular basis (at least twice a month) where foremen, environmental and safety representatives of different components of the Works and sub-consultants hold talks relating to environmental practices and safety awareness on site. These talks should also include discussions on possible common incidents occurring on site and the prevention of reoccurrence thereof. Records of attendance and the awareness talk subject must be kept on file.

5.6. Monitoring Programme: Construction Phase of the PV/CPV Plant

OBJECTIVE: Monitor the performance of the control strategies employed against environmental objectives and standards

A monitoring programme must be in place not only to ensure conformance with the EMP, but also to monitor any environmental issues and impacts which have not been accounted for in the EMP that are, or could result in significant environmental impacts for which corrective action is required. The period and frequency of monitoring will be stipulated by the Environmental Authorisation (once issued). Where this is not clearly dictated, BioTherm Energy will determine and stipulate the period and frequency of monitoring required in consultation with relevant stakeholders and authorities. The Project Manager will ensure that the monitoring is conducted and reported to the ECO.

The aim of the monitoring and auditing process would be to routinely monitor the implementation of the specified environmental specifications, in order to:

- » Monitor and audit compliance with the prescriptive and procedural terms of the environmental specifications
- » Ensure adequate and appropriate interventions to address non-compliance
- » Ensure adequate and appropriate interventions to address environmental degradation
- » Provide a mechanism for the lodging and resolution of public complaints

- » Ensure appropriate and adequate record keeping related to environmental compliance
- » Determine the effectiveness of the environmental specifications and recommend the requisite changes and updates based on audit outcomes, in order to enhance the efficacy of environmental management on site
- » Aid communication and feedback to authorities and stakeholders.

The ECO will ensure compliance with the EMP, and to conduct monitoring activities. The ECO must have the appropriate experience and qualifications to undertake the necessary tasks. The ECO must report any non-compliance or where corrective action is necessary to the Site Manager and/or any other monitoring body stipulated by the regulating authorities. The following reports will be applicable:

5.6.1. Non-Conformance Reports

All supervisory staff including Foremen, Resident Engineers, and the ECO must be provided the means to be able to submit non-conformance reports to the Site Manager. Non-conformance reports will describe, in detail, the cause, nature and effects of any environmental non-conformance by the Contractor. Records of penalties imposed may be required by the relevant authority.

The non-conformance report will be updated on completion of the corrective measures indicated on the finding sheet. The report must indicate that the remediation measures have been implemented timeously and that the non-conformance can be closed-out to the satisfaction of the Site Manager and ECO.

5.6.2. Monitoring Reports

A monitoring report will be compiled by the ECO on a monthly basis and must be submitted to DEA for their records. This report should include details of the activities undertaken in the reporting period, any non-conformances or incidents recorded, corrective action required, and details of those non-conformances or incidents which have been closed out.

5.6.3. Final Audit Report

A final environmental audit report must be submitted to DEA upon completion of the construction and rehabilitation activities. This report must indicate the date of the audit, the name of the auditor and the outcome of the audit in terms of compliance with the environmental authorisation conditions and the requirements of the EMP.

MANAGEMENT PROGRAMME FOR THE SOLAR FACILITY: CHAPTER 6 REHABILITATION OF DISTURBED AREAS

6.1. Overall Goal for the Rehabilitation of Disturbed Areas

Overall Goal for the Rehabilitation of Disturbed Areas: Undertake the rehabilitation measures in a way that:

- » Ensures rehabilitation of disturbed areas following the execution of the works, such that residual environmental impacts are remediated or curtailed

6.2. Objectives

In order to meet this goal, the following objective, actions and monitoring requirements are relevant:

OBJECTIVE: Ensure appropriate rehabilitation of disturbed areas following any executions such that residual environmental impacts are remediated or curtailed

Areas requiring rehabilitation will include all areas disturbed during the construction phase and that are not required for regular maintenance operations. Rehabilitation should be undertaken in an area as soon as possible after the completion of construction activities within that area.

Project component/s	<ul style="list-style-type: none"> » PV/CPV facility. » Internal access roads (i.e. those not required for operation and maintenance).
Potential Impact	<ul style="list-style-type: none"> » Environmental integrity of site undermined resulting in reduced visual aesthetics, erosion, compromised land capability and the requirement for on-going management intervention.
Activity/risk source	<ul style="list-style-type: none"> » Temporary access roads/tracks. » Other disturbed areas/footprints.
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Ensure and encourage site rehabilitation of disturbed areas. » Ensure that the site is appropriately rehabilitated following the execution of the works, such that residual environmental impacts (including erosion) are remediated or curtailed.

Mitigation: Action/control	Responsibility	Timeframe
All temporary facilities, equipment, and waste materials must be removed from site as soon as practically possible after construction is complete.	Contractor	Following execution of the works

Mitigation: Action/control	Responsibility	Timeframe
All temporary fencing and danger tape must be removed once the construction phase has been completed.	Contractor	Following completion of construction activities in an area
Necessary drainage works and anti-erosion measures must be installed, where required, to minimise loss of topsoil and control erosion.	Contractor	Following completion of construction activities in an area
Disturbed areas must be rehabilitated/re-vegetated with appropriate natural vegetation and/or local seed mix. Re-use of native/indigenous plant species removed from disturbance areas in the rehabilitation phase.	Contractor, and rehabilitation specialist	Following completion of construction activities in an area
Re-vegetated areas may have to be protected from wind erosion and maintained until an acceptable plant cover has been achieved.	BioTherm, and rehabilitation specialist	Post-rehabilitation
On-going alien plant monitoring and removal must be undertaken on all areas of natural vegetation on an annual basis.	BioTherm, and rehabilitation specialist	Post-rehabilitation

Performance Indicator	<ul style="list-style-type: none"> » All portions of site, including construction equipment camp and working areas, cleared of equipment and temporary facilities. » Topsoil replaced on all areas and stabilised. » Disturbed areas rehabilitated and acceptable plant cover achieved on rehabilitated sites. » Completed site free of erosion and alien invasive plants.
Monitoring	<ul style="list-style-type: none"> » On-going inspection of rehabilitated areas in order to determine effectiveness of rehabilitation measures implemented. » On-going alien plant monitoring and removal should be undertaken on an annual basis.

MANAGEMENT PROGRAMME FOR THE SOLAR FACILITY: OPERATION

CHAPTER 7

7.1. Overall Goal for Operation

Overall Goal for Operation: To ensure that the operation of the PV/CPV plant does not have unforeseen impacts on the environment and to ensure that all impacts are monitored and the necessary corrective action taken in all cases. In order to address this goal, it is necessary to operate the PV/CPV facility in a way that:

- » Ensures that operation activities are properly managed in respect of environmental aspects and impacts.
- » Ensures the operation activities are undertaken without significant disruption to other land uses in the area, in particular with regard to farming practices, traffic and road use, and effects on local residents and other receptors in terms of visual impacts.

7.2. Objectives

In order to meet this goal, the following objectives have been identified, together with necessary actions and monitoring requirements.

OBJECTIVE: To establish clear reporting, communication and responsibilities in relation to environmental incident

Formal responsibilities are necessary to ensure that key procedures are executed. Specific responsibilities of the Power Station Manager, and Environmental Manager for the operation phase of this project are detailed below.

The **Power Station Manager** will:

- » Ensure that adequate resources (human, financial, technology) are made available and appropriately managed for the successful implementation of the operational EMP.
- » Conduct annual basis reviews of the EMP to evaluate its effectiveness.
- » Take appropriate action as a result of findings and recommendations in management reviews and audits.
- » Provide forums to communicate matters regarding environmental management.

The **Environmental Manager** will:

- » Develop and implement an Environmental Management System (EMS) for the solar energy facility and associated infrastructure.
- » Manage and report on the facility's environmental performance.
- » Maintain a register of all known environmental impacts and manage the monitoring thereof.
- » Conduct internal environmental audits and co-ordinate external environmental audits.
- » Liaise with statutory bodies such as the National and Provincial Department of Environmental Affairs (DEA) on environmental performance and other issues.
- » Conduct environmental training and awareness for the employees who operate and maintain the solar energy facility.
- » Compile environmental policies and procedures.
- » Liaise with interested and affected parties on environmental issues of common concern.
- » Track and control the lodging of any complaints regarding environmental matters.

OBJECTIVE: Maintenance of rehabilitated areas

In order to ensure the long-term environmental integrity of the site following construction, maintenance the areas rehabilitated post-construction must be undertaken until these areas have successfully re-established. Fire breaks should be established, where appropriate, to limit both incoming and outgoing veld fires.

Project component/s	<ul style="list-style-type: none"> » PV/CPV facility. » Ancillary buildings.
Potential Impact	Environmental integrity of site undermined resulting in reduced visual aesthetics, erosion, compromised land capability and the requirement for on-going management intervention.
Activity/risk source	<ul style="list-style-type: none"> » Foundations. » Other disturbed areas.
Mitigation: Target/Objective	Ensure and encourage site rehabilitation of disturbed areas.

Mitigation: Action/control	Responsibility	Timeframe
Fire breaks should be established and maintained, where appropriate.	BioTherm	Operation
Maintenance of erosion control measures.	BioTherm	Operation
Implementation of a storm water management plan.	BioTherm	Operation
Appoint an environmental manager during operation whose duty it will be to minimise impacts on	BioTherm	Operation

Mitigation: Action/control	Responsibility	Timeframe
surrounding sensitive habitats.		

Performance Indicator	Successful rehabilitation of disturbed areas.
Monitoring	On-going alien plant monitoring and removal should be undertaken on an annual basis.

OBJECTIVE: Mitigate the possible visual impact associated with the operational phase.

Project component/s	Photovoltaic 'string' of panels or CPV plant with tower structure and infrastructure such as a security building, workshop and offices.
Potential Impact	Potential visual intrusion in the area and damage to the natural environment.
Activity/risk source	Potential impact on sensitive receptors within 1 km of the site.
Mitigation: Target/Objective	A facility that fits in with the landscape, that is well maintained and managed.

Mitigation: Action/control	Responsibility	Timeframe
Maintain the general appearance of the facility as a whole (i.e. the PV panels, buildings and associated infrastructure, roads and natural environment).	BioTherm / operator	Throughout operational phase
Maintain access roads to prevent scouring and erosion, especially after rains.	BioTherm / operator	Throughout operational phase

Performance Indicator	<ul style="list-style-type: none"> » Well maintained facility that has a small footprint on the environment. Natural processes continuing to occur unhindered. » All actions to be measured against the Operational Phase Environmental Management Plan.
Monitoring	<ul style="list-style-type: none"> » Environmental manager to undertake on-going monitoring after construction has been completed to ensure compliance with mitigation measures.

OBJECTIVE: Maximise local employment and business opportunities associated with the operational phase.

Project component/s	Day to day operational activities associated with the PV facility, including maintenance etc.
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Potential Impact	The opportunities and benefits associated with the creation of local employment and business should be maximised
Activity/risk source	The operational phase of the PV facility will create approximately 20-25 full time employment opportunities.
Mitigation: Target/Objective	In the medium to long term employ as many locals as possible to fill the full time employment opportunities.

Mitigation: Action/control	Responsibility	Timeframe
The workforce of 20-25 permanent staff is likely to be based in Aberdeen. BioTherm should commit to implementing a 5-year training and skills development and training programme. The initial local content target is 30%; however, after 5 years the objective is to have all the employment opportunities taken up by locals.	BioTherm / operator	Prior to commencement of operation
Identify local members of the community who are suitably qualified or who have the potential to be employed full time.	BioTherm / operator	Prior to commencement of operation

Performance Indicator	<ul style="list-style-type: none"> » 5 year training and skills development programme developed and designed before construction phase completed. » Potential locals identified before construction phase completed.
Monitoring	<ul style="list-style-type: none"> » BioTherm must monitor indicators listed above to ensure that they have been met for the operational phase.

OBJECTIVE: Appropriate handling and storage of chemicals and hazardous substances for the substation.

The operational phase of the PV facility may involve handling and management for appropriate handling and storage of chemicals and hazardous substances for the substation for the substation.

Project component/s	Storage and handling of chemicals, and waste.
Potential Impact	<ul style="list-style-type: none"> » Release of contaminated water from contact with spilled chemicals. » Generation of contaminated wastes from used chemical containers. » Pollution of the surrounding environment through inappropriate waste management practices. » Oil, fuel and other hydrocarbon pollution.
Activity/risk source	<ul style="list-style-type: none"> » Hydrocarbon use and storage. » Maintenance of the substation.
Mitigation:	<ul style="list-style-type: none"> » Ensure that the storage and handling of chemicals and hydrocarbons

Target/Objective	<p>on-site does not cause pollution to the environment or harm to persons.</p> <ul style="list-style-type: none"> » Ensure that the storage and maintenance of the substation does not cause pollution of the environment or harm to persons. » Comply with waste management guidelines. » Minimise production of waste. » Ensure appropriate waste handling, storage, and disposal. » Avoid environmental harm from waste disposal. » Adequate maintenance and control over service areas
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Mitigation: Action/control	Responsibility	Timeframe
Implement an emergency preparedness plan during the operation and maintenance phase.	BioTherm Energy	Operation
Spill kits must be made available on-site for the clean-up of spills and leaks of contaminants.	BioTherm / operator	Operation
Corrective action must be undertaken immediately if a complaint is made, or potential/actual leak or spill of polluting substance identified. This includes stopping the contaminant from further escaping, cleaning up the affected environment as much as practically possible and implementing preventive measures.	BioTherm / operator	Operation
In the event of a major spill or leak of contaminants, the relevant authorities should be notified as per the notification of emergencies/incidents, as per the requirements of NEMA.	BioTherm / operator	Operation
All stored fuels to be maintained within a bunded area and on a sealed surface.	BioTherm / operator	Operation
The storage of flammable and combustible liquids such as oils will be in designated areas which are appropriately bunded, and stored in compliance with MSDS files.	BioTherm / operator	Operation
Any storage and disposal permits/approvals which may be required must be obtained, and the conditions attached to such permits and approvals will be complied with.	BioTherm / operator	Operation
Hydrocarbon waste must be contained and stored in sealed containers within an appropriately bunded area.	BioTherm / operator	Operation
Waste and surplus dangerous goods must be kept to a minimum and must be transported by approved waste transporters to sites designated for their disposal.	BioTherm / operator	Operation
Documentation (waste manifest) must be maintained detailing the quantity, nature, and fate of any regulated waste. Waste disposal records must be available for review at any time.	BioTherm / Operator	Operation

Performance Indicator	» No chemical spills outside of designated storage areas. » No water or soil contamination by spills. » No complaints received regarding waste on site or indiscriminate dumping. » Assessment number and extent of spillages on a regular basis.
Monitoring	» Observation and supervision of chemical storage and handling practices and vehicle maintenance throughout operational phase.

**MANAGEMENT PROGRAMME FOR THE SOLAR FACILITY: CHAPTER 8
 DECOMMISSIONING**

The infrastructure which will be utilised for the proposed PV/CPV facility is expected to have a lifespan of up to 20 years (with maintenance). Equipment associated with this facility would only be decommissioned once it has reached the end of its economic life. It is most likely that decommissioning activities of the infrastructure of the facility would comprise the disassembly and replacement of the infrastructure with more appropriate technology/infrastructure available at that time.

Should the activity ever cease or become redundant, the applicant shall undertake the required actions as prescribed by legislation at the time and comply with all relevant legal requirements administered by any relevant and competent authority at that time.

8.1. Site Preparation

Site preparation activities will include confirming the integrity of the access to the site, preparation of the site (e.g. lay down areas, construction platform) and the mobilisation of construction equipment.

8.2 Disassemble and Replace Existing Infrastructure

All components will be reused, recycled, or disposed of in accordance with regulatory requirements.

OBJECTIVE: To avoid and or minimise the potential impacts associated with the decommissioning phase

Decommissioning of the solar facility would result in job losses and this could impact negatively on those employed at the facility.

Project component/s	Decommissioning phase of the PV facility.
Potential Impact	» Decommissioning will result in job losses, which in turn can result in a number of social impacts, such as reduced quality of life, stress, depression etc. However, the number of people affected (20-25) is relatively small. Decommissioning is also similar to the construction phase in that it will also create temporary employment opportunities..
Activity/risk source	Decommissioning of the PV/CPV facility

Mitigation:	To avoid and or minimise the potential social impacts associated with decommissioning phase of the PV/CPV facility.
Target/Objective	

Mitigation: Action/control	Responsibility	Timeframe
Retrenchments should comply with South African Labour legislation of the day	BioTherm	When PV/CPV facility is decommissioned

Performance Indicator	» South African Labour legislation relevant at the time
Monitoring	» BioTherm and Department of Labour

**ON-GOING UPDATE OF THE
ENVIRONMENTAL MANAGEMENT PROGRAMME**

CHAPTER 9

The EMP is a dynamic document, which must be updated when required. It is considered critical that this EMP be updated to include any additional site-specific information and specifications following the final walk-through survey by specialists just prior to the commencement of construction. This will ensure that the construction and operation activities are planned and implemented taking sensitive environmental features into account.

**APPENDIX A:
GUIDELINES FOR INTEGRATED MANAGEMENT OF
CONSTRUCTION WASTE**

GUIDELINE FOR INTEGRATED MANAGEMENT OF CONSTRUCTION WASTE

Waste is broadly defined by the Department of Water Affairs in 1994 as: 'an undesirable or superfluous by-product, emission, residue or remainder of any process or activity'. An integrated approach to waste management on site is needed. Such an approach is illustrated in the figure below.

The Integrated Waste Management Approach to Waste



Source: <http://www.enviroserv.co.za/pages/content.asp?SectionId=496>

1. Waste Assessment

A detailed waste assessment is necessary to understand the waste types and volumes being produced. In order to achieve this, construction practices must be measured and analysed.

2. Waste Plan

A waste plan must be developed to provide appropriate solutions for managing the entire waste stream on site. The objective of the plan should be to reduce the volumes of waste to disposal and thereby to reduce the cost of management of the waste stream without compromising environmental standards. The plan should include recovery, re-use and recycle recommendations.

Construction Waste Management is the practice of reducing the actual waste that goes to the landfill site. Waste reduction is best met by recycling, and construction wastes offer several opportunities in this regard. In fact, 80% of the wastes found in construction waste piles are recyclable in some form or another. Wood, concrete, bricks, metals, glass and even paint offer several options for recycling.

There are three basic steps for construction waste management, i.e. Reduce, Reuse, and Recycle. **Reduce** is the prevention of the waste from arising and optimising material usage. Waste avoidance and waste reduction can be achieved through improved education and training - by improving efficiencies and by making staff environmentally aware.

Reuse is using existing materials instead of throwing these away. Reusing does not mean that it needs to be reused on the same construction site. Selling or donating waste materials to a third party is one option of construction waste management.

Recycle is somewhat limited since it only allows for those items that can be used on-site. The most important step for recycling of construction waste is on-site separation. Initially, this will take additional effort and training of construction personnel. Targets should be set for the levels of recycling. Once separation habits are established, on-site separation can be done at little or no additional cost.

3. What to Recycle

Before recycling construction waste, identify who will accept it. This is important in designating type of waste to separate, and in making arrangements for drop-off or delivery of materials. Materials that can be recycled include:

- » Cardboard and Paper
- » Wood

- » Metals
- » Plastics
- » Glass
- » Paints, Stains, Solvents and Sealants
- » Oil

4. Materials Separation

Successful recycling requires good clean uniform collections of single waste types. This is most effectively achieved by separating the waste streams close to source rather than at the landfill site. Containers for material recycling must be set up on site and clearly labelled. Construction personnel must be trained in material sorting policy, and bins must be monitored periodically to prevent waste mixing as a result of construction employees throwing rubbish into the bins.

Some materials will require bins or storage that protect these from rain. Other bins may be locked to prevent tampering.

5. Recycling and Waste Minimisation Guidelines

- » *Wood*
 - * Optimise building dimensions to correspond to standard wood dimensions in order to reduce the need for cutting.
 - * Store wood on level blocking under cover to minimize warping, twisting and waste.
- » *Metals*
 - * During construction, separate metals for recycling, including copper piping, wire, aluminium, iron and steel, nails and fasteners, galvanized roofing. It is critical to keep lead out of landfills because it could leach into groundwater.
- » *Cardboard and Paper*
 - * Avoid excessively packaged materials and supplies. However, be sure packaging is adequate to prevent damage and waste.
 - * As far as possible, use recyclable packaging.
 - * Separate cardboard waste, bundle, and store in a dry place.
 - * Minimise the number of blueprints and reproductions necessary during the design and construction process.
- » *Plastic*
 - * Avoid excessively packaged materials and supplies. However, be sure packaging is adequate to prevent damage and waste.
 - * As far as possible, use recyclable packaging.

Since more than 60 different types of plastic resins exist, the Plastics Federation of South Africa has adopted a voluntary number coding system for each category of plastics to aid in their sorting by material type for recycling (Bruyns et al, 2002). The most common resin types are itemised in Table 1.

Table 1: Identification System for Plastic

Id Number	Plastic Resin Type
1	PET (polyethylene terephthalate)
2	HDPE (high-density polyethylene)
3	PVC (polyvinyl chloride) or V (vinyl)
4	LDPE (low-density polyethylene)
5	PP (polypropylene)
6	PS (polystyrene)
7	Other (laminates, etc.)

» *Paints, Stains, Solvents and Sealants*

* Unused materials should be taken to a hazardous waste collection facility.

6. On-site Management

Good supervision of the waste management programme on site is critical to success. Management of the entire on-site program is critical to ensure smooth operations.

7. Auditing and Control

The success of the waste plan is determined by measuring criteria such as waste volumes, cost recovery from recycling, cost of disposal. Recorded data can indicate the effect of training and education, or the need for education. It will provide trends and benchmarks for setting goals and standards. It will provide clear evidence of the success or otherwise of the plan. Finally, good record keeping and control, becomes a continuous waste assessment process, allowing the waste plan to be improved and adjusted as required.

8. Useful contacts:

<http://www.transpaco.co.za/page5.htm>

Transpaco, a manufacturing and distribution company operating extensively in the plastics and packaging industries, conducts plastic reclamation and recycling.

<http://www.jclenterprises.co.za/>

JCL Enterprises for plastic sales of quality recycled plastic materials as well as the recycling of plastic.

<http://www.rosefoundation.org.za/>

The Rose Foundation specialises in the collection and recycling of used motor (engine) oil.

Information Sources:

<http://www.greenbuilder.com/sourcebook/ConstructionWaste.html#Guidelines>

<http://www.enviroserv.co.za/pages/Content.asp?SectionID=587>

<http://www.enviroserv.co.za/pages/content.asp?SectionId=496>

Programme for the Implementation of the National Waste Management Strategy. DEAT,
May 2000

Residential Construction Waste Management Demonstration and Evaluation. Prepared
for U.S. Environmental Protection Agency by NAHB Research Center, May 2, 1995