ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPr): WATERVAL SOLAR FARM

Draft: 24 March 2014

EON Consulting

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Glossary

Construction phase:

The activities pertaining to the preparation for and the physical construction of the proposed development.

Contractor:

The organisation(s) contracted by the Employer to carry out some of the pre-construction and construction of the solar farm

Employer:

The Employer is Waterval Solar

Environmental Manager (EM):

Person/organisation appointed by the Employer to oversee the work of all consultants, sub-developers, contractors, residents and visitors.

Environment:

The environment is defined in terms of the National Environmental Management Act, No 107 of 1998, as the surroundings within which humans exist and that are made up of – the land, water and atmosphere of the earth; micro-organisms, plant and animal life; any part or combination of (i) and (ii) and the interrelationships among and between them; and the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

Environmental management program (EMPr):

The EMPr is a detailed plan for the implementation of the mitigation measures to minimise negative environmental impacts during the life cycle of a project. The EMPr contributes to the preparation of the contract documentation by developing clauses to which the Contractor must adhere for the protection of the environment. The EMPr specifies how the construction of the project is to be carried out and includes the actions required to ensure that all the environmental impacts are adeqautly managed.

Pre-construction phase:

The period prior to commencement of the construction phase, during which various activities associated with the preparation for the construction phase will be undertaken.

Rehabilitation:

Rehabilitation is defined as the return of a disturbed area to a state which approximates the state (where possible) in which it was before disruption. Rehabilitation for the purposes of this specification is aimed at post-reinstatement revegetation of a disturbed area and the assurance of a stable land surface. Revegetation should aim to accelerate the natural succession processes so that the plant community develops in the desired way, i.e. promotes rapid vegetation establishment.

Site Manager:

The person, representing the Contractor, responsible for all the Contractor's activities on the site including supervision of the construction staff and activities associated with the construction phase. The Site Manager will liaise with the Principal Agent in order to ensure that the project is conducted in accordance with the environmental management plan.

Abbreviations

AEL	Air emission licence
EIAR	Environmental Impact Assesment report
C	Contractor
CEMP	Construction environmental management plan
CMS	Construction method statement
EMPL	Employer
DWS	Department of Water Affairs and Sanitation
EA	Environmental authorisation
ECO	Environmental Control Officer
EIA	Environmental impact assessment
EMPr	Environmental management program
I & AP	Ineterested and affected party
EPCM	Engineering, procurement and construction management
GA	General authorisation
MSDS	Material safety data sheets
OHSA	Occupational Health and Safety Act, Act 85 of 1993
PM	Project Manager
RE	Resident Engineer
SABS	South African Bureau of Standards
SAHRA	South African Heritage Resourses Agency
SANS	South African National Standards
SM	Site Manager

1. Introduction

This environmental management plan (EMPr) should be implemented during the pre-construction phase, construction and operational and decommissioning phase of the development to ensure that any environmental impacts that could occur during construction, are mitigated or prevented.

The EMPr is compiled by the environmental assessment practitioner (EAP) who did the EIA: Adri Venter; PrSci Nat from EON Consulting (CV attached as Annexure). The EAP has an MSc Geography and Environmental Studies and more than 15 years' experience in environmental management.

2. Site location

The map below represents a superimposed version of the project activities (infrastructure and structures) on the environmental sensitivities onsite as well as areas that must be avoided during the construction and operational phase.

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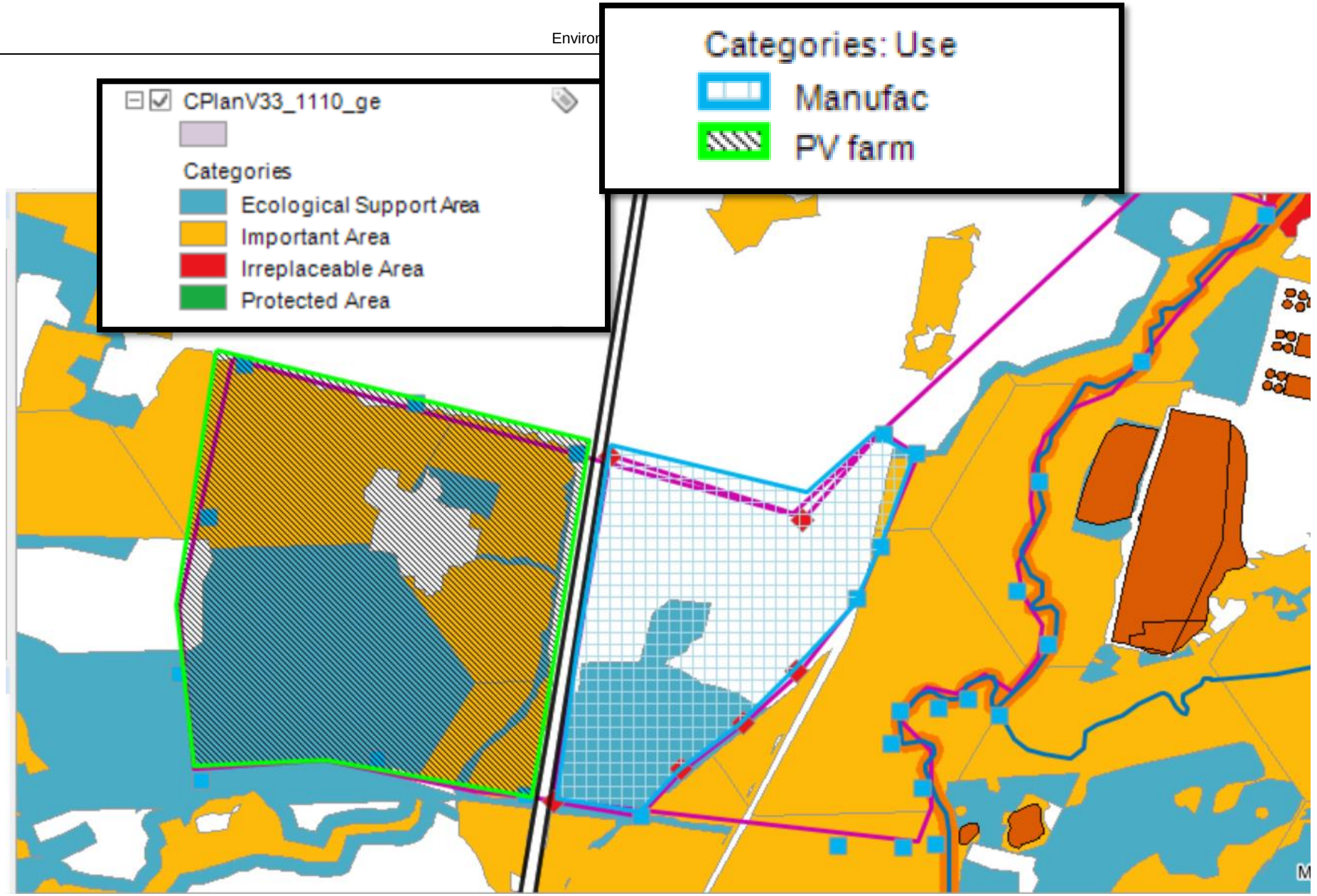

Figure 1: The area that is not colored by a grid, are the ecological important area that may not be entered by the construction personnel or developed.

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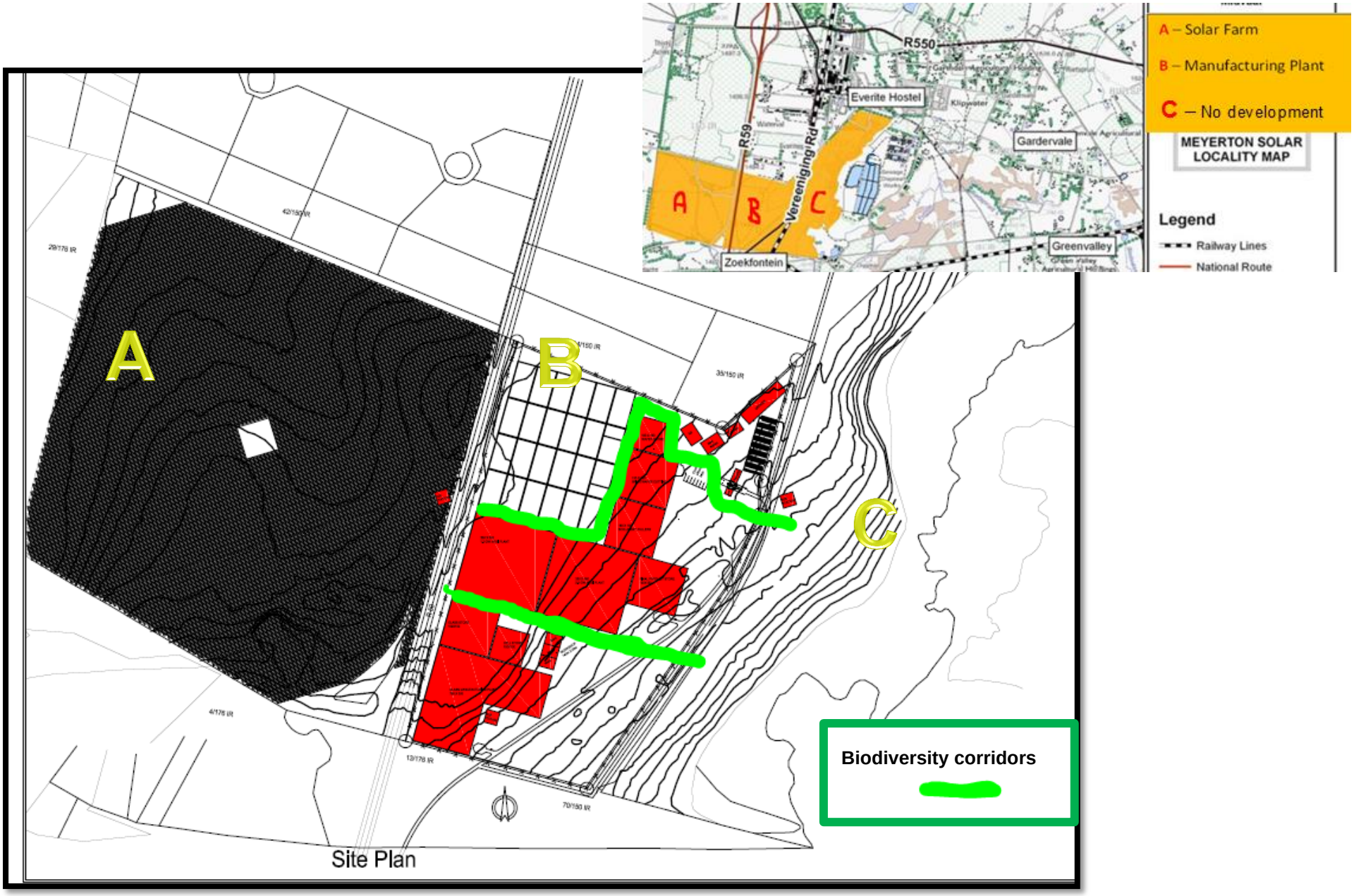

A – Solar Farm
B – Manufacturing Plant
C – No development
MEYERTON SOLAR LOCALITY MAP
Legend
Railway Lines
National Route
R550
Everite Hostel
Gardervale
Greenvalley
Zoekfontein
R59
Vereeniging Rd
A
B
C
Biodiversity corridors
Site Plan

Figure 2: Site Plan

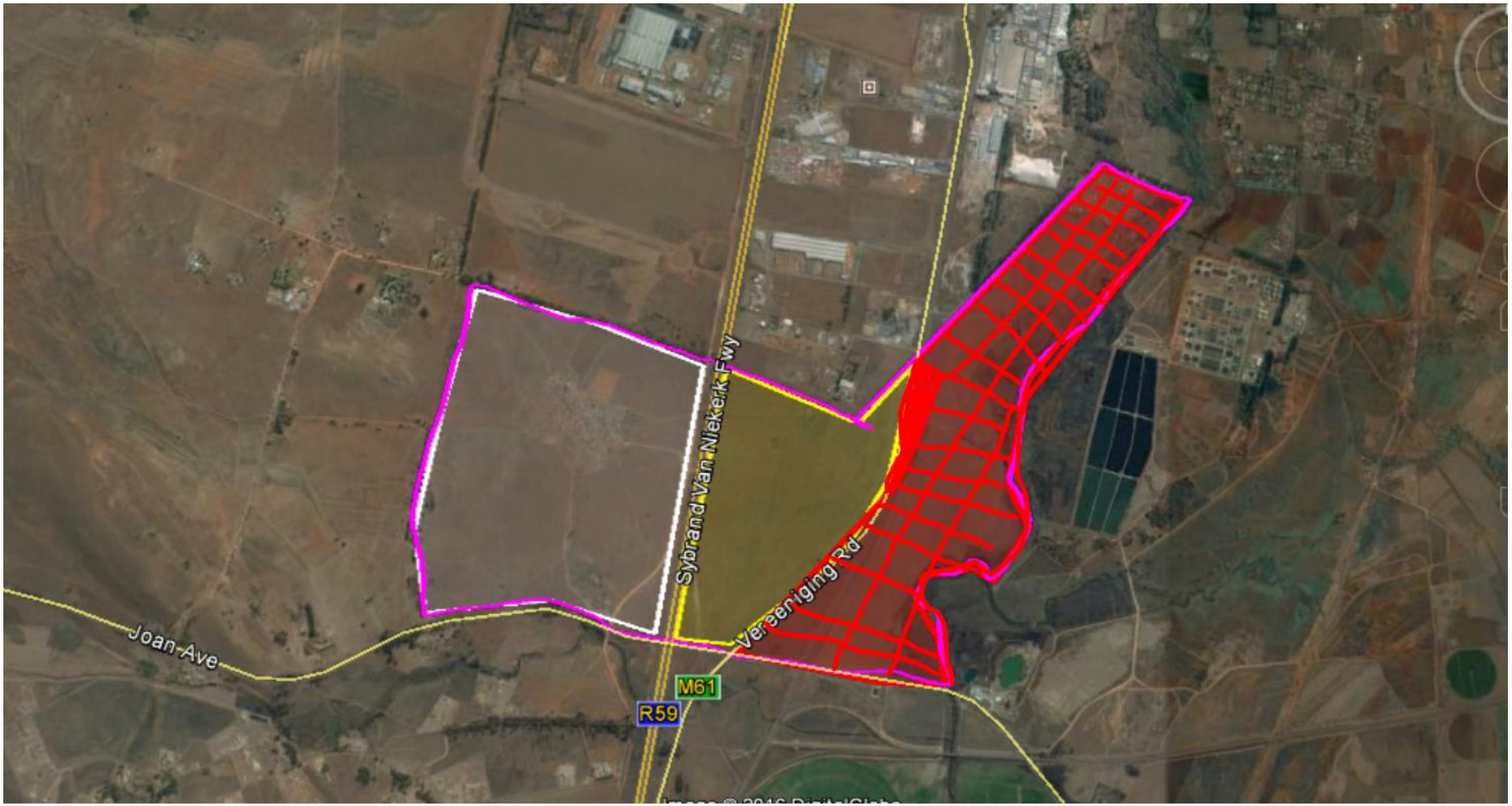


Figure 3: The area indicated by the red-lined grid is the no-go area.

3. Detailed description of the aspects of the activities covered by the EMPr

The proposed activity will consist of 3 aspects, namely:

1) Glass manufacturing
2) Silicon manufacturing
3) Photovoltaic installation to generate electricity

The aluminium frames and silver grid which forms part of the PV cells is pre-manufactured on another site.

The complex will include an office building and ablution facilities for workers. Water will be directly obtained from Rand Water (main pipeline runs along the property boundary and a connection will be made which will be below the thresholds for an environmental authorisation).

In terms of sanitation services no sewage connection is available and therefore an onsite treatment facility (mobile package plant) will be installed and all effluent from the treatment facility will be re-used in the manufacturing plant.

Office waste will be disposed of at a registered landfill site.

3.1. Glass manufacturing

Glass will be manufactured onsite as part of the parts of the photovoltaic panels that will be manufactured onsite.

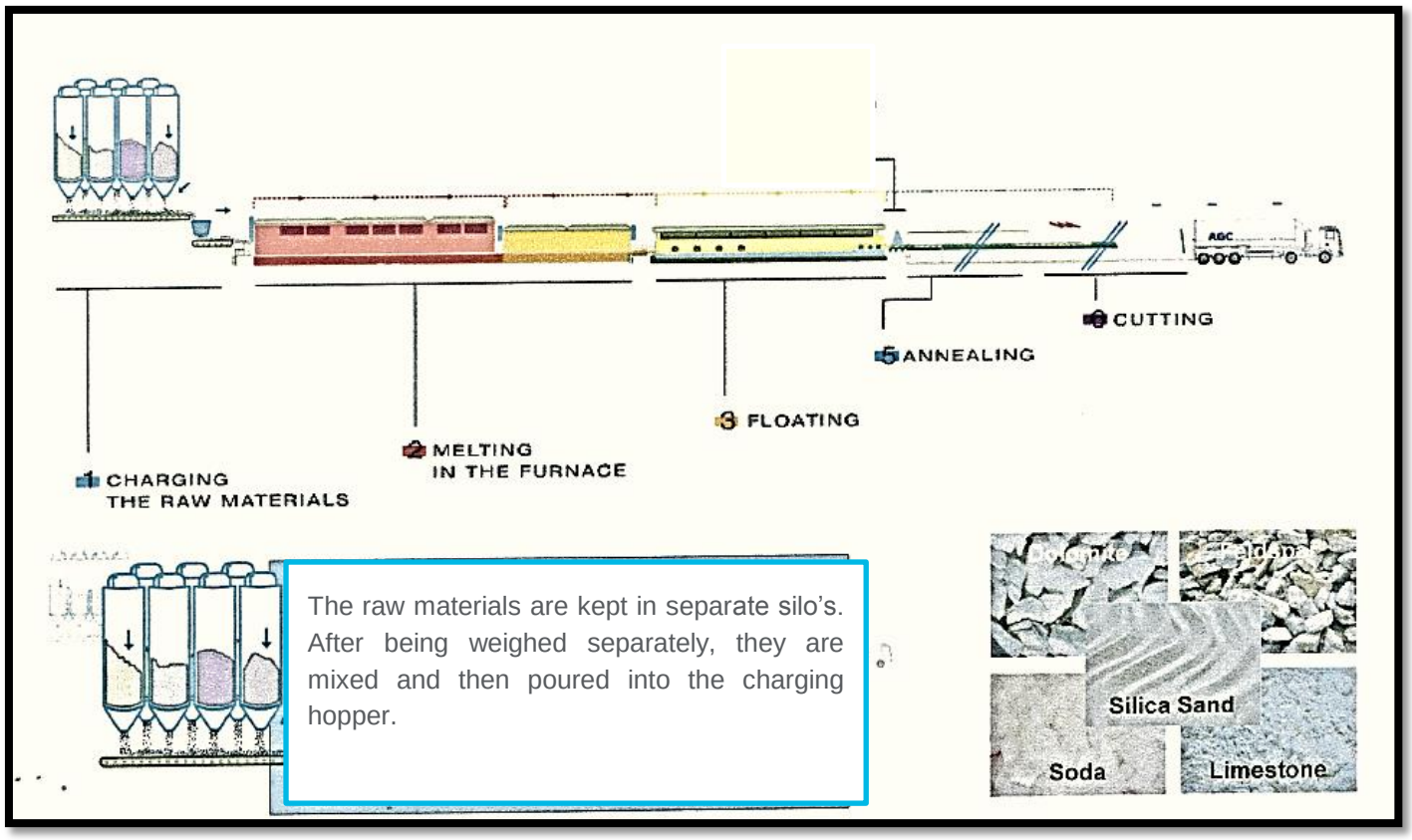
3.1.1. Raw materials:

The following raw materials are used to produce glass:

- Silica
- Soda (Na_2CO_3)
- Lime Stone
- Dolomite
- Feldspar
- Filter cake – originating from the treatment of gaseous emissions and returned to the raw materials used in the melting process
- Waste Glass – from the production process is returned as raw materials to the melting process

Raw materials will be delivered via enclosed cylinder tankers and will be transferred to on-site silos via a vacuum pump.

3.1.2. Process steps for floating glass

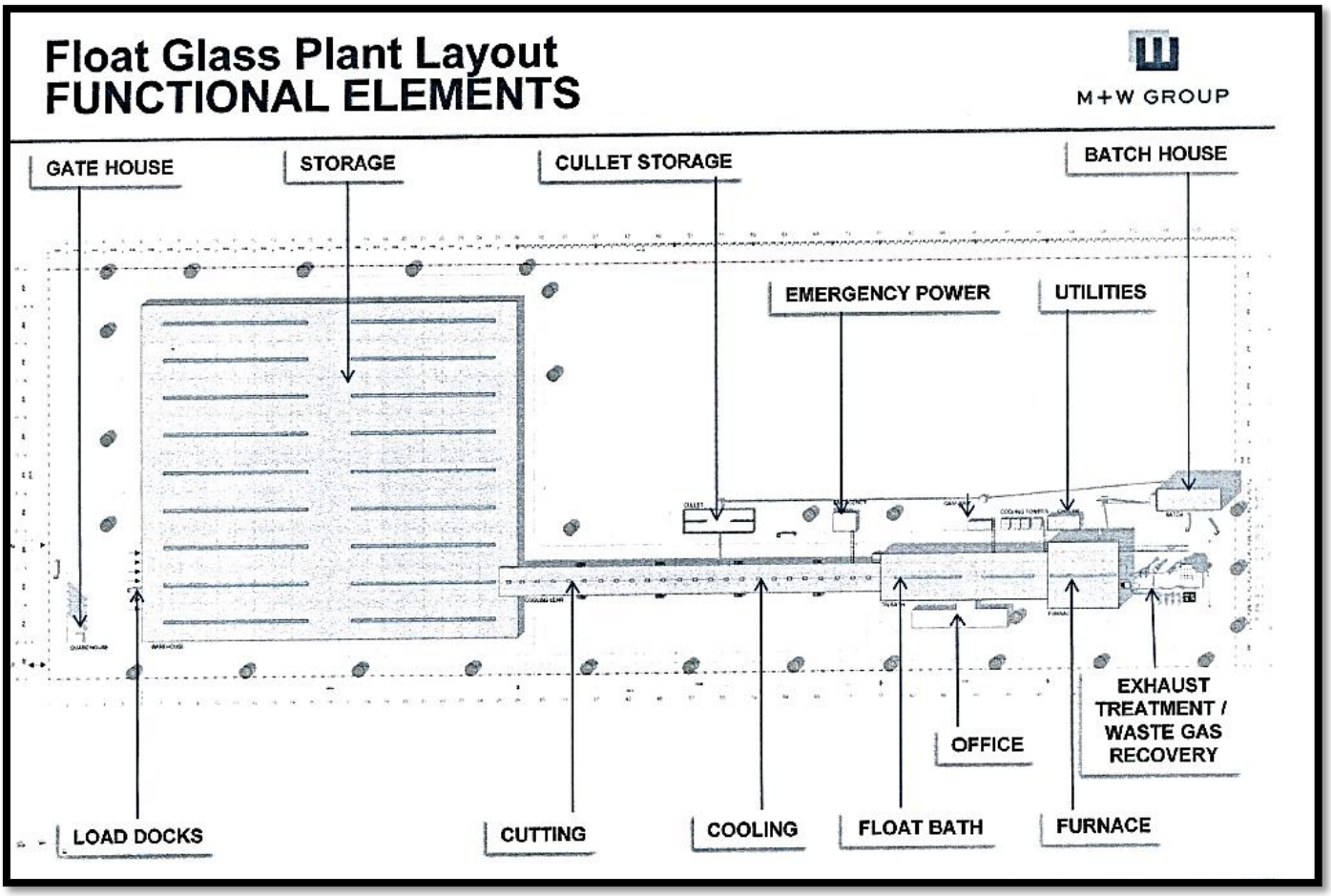


Melting in the furnace: Temperatures are 1550^{o}C. The molten glass is kept at high temperature for several hours, allowing bubbles of trapped air to escape.

Floating: As the product comes out of the furnace, the molten glass is poured onto a bath of liquid, where a sheet of glass is formed by flotation. Rollers on either side of the bath draw out the glass to roll it into the required thickness and width.

Annealing: Once the glass emerges from the floating bath it is led by a roller conveyer to an annealing tunnel where the glass is gradually cooled to ensure the glass remain perfectly flat and ready for cutting at ambient temperature.

Cutting: After annealing, the glass strip is inspected by an optical laser and then automatically cut into the required sizes.



Gas will be used to heat the melting furnace. Gas will be obtained directly from a Sasol gas pipeline on the edge of the property. The gas pipeline will be inside the industrial complex, and will not exceed 1000 metres in length.

Potential Environmental impacts associated with glass manufacturing process:

- Air quality impacts from loading and mixing of raw materials as well as from the furnace, and float bath.
- Noise impacts from the mixers, roller conveyers and cutting
- Air quality impacts in the case of emergency venting from the pipeline
- Clearing of vegetation for the construction of the plant

3.2. Silicon manufacturing

The process consists of three main production units:

- Hydro chlorination unit

- Monosilane Disproportionation Unit

- CVD Polysilicon Deposition

The process is characterized by a process structure which leads to reduced energy consumption in comparison to conventional Polysilicon production technologies like, for example, the Siemens process. This provides manufacturers with remarkable operating cost saving.

Monosilane gas (SiH_4) is a basic feedstock for the photovoltaic industry. It is used as an anti-reflective for solar cell coatings, as basis material for thin film solar cells, flat-screen displays (TFT) and semiconductors for the electronics industry. The monosilane-based process facilitates purification to the degree of electronic-grade high purity polysilicon. In the hydrochlorination in two parallel reactions, both STC (Tetrachlorsilane) and metallurgical silicon respectively are converted into TCS (Trichlorosilane). Then the TCS is fed to a disproportionation reactor, where purified TCS is processed to monosilane gas. The monosilane gas is then directly fed to the CVD reactor, where polysilicon deposition finally occurs on heated slim rods. The monosilane process makes possible an unprecedented silicon conversion rate of 98%.For example, the oxidation of monosilane is strongly influenced by moisture, since SiH4 is relatively easily hydrolyzedii: $SiH_4 + 2H_2O > SiO_2 + 4H_2$; high humidity will reduce the risk of ignition. On the other hand, there is a positive aspect about silane leaks for any plant operating with monosilane: there are no “hidden leaks”. Almost every silane leak is found quickly, because even most tiny silane leaks make a “popping” sound, or are disclosed by a small flame and a dust cloud instantly. That means, silane leaks are unlikely to accumulate, which prevents vapor clouds that would explode with large impact (as would happen with CH_4 or H_2). The risk of delayed ignition is higher, the larger the difference between line pressure and ambient pressure is, or when abrupt changes in pressure occur. Then, there is the point of air flow: the most dangerous places for monosilane are small, confined spaces like gas cabinets in buildings. The best location for monosilane operating is outdoors, or in large buildings like polysilicon CVD rooms if they have appropriate air flow. Sources of monosilane incidents were in most cases corroded cylinder caps or physically stressed/ incorrectly used material. Most significant silane industrial accidents have occurred in this context, and not in monosilane production plants. These risks can be managed by good design of equipment and proper handling by trained operators. Toxicity: Silane is not as highly a toxic gas as TCS, STC, DCS, HCl, or Cl_2. The byproducts of a silane leak and fire would be SiO_2 (dust) and H_20 – all not toxic or harmful gases. In contrast, the byproducts of a TCS, STC, DCS, HCl, or Cl^2 release to the atmosphere include highly toxic hydrochloric acid. While such a release of chlorine containing gas can create a toxic cloud that might travel far with the wind and have negative impacts outside plant boundaries, the hazards of monosilane are typically confined to the production facility itself, and provide no risk to the environment. *(Schmid Silicon Technology GmbH Robert-Bosch-Str. 32-36 Phone: 0049 7441 538-454 Fax: 0049 7441 538-260 72250 Freudenstadt Germany info@schmid-silicon.com www.schmid-silicon.com, undated)*

Monosilane is produced from metallurgical grade silicon in a two-step process. In the first step, powdered silicon is reacted with *hydrogen chloride* at about 300 °C to produce *trichlorosilane*, $HSiCl_3$, along with *hydrogen* gas, according to the *chemical equation*:

$$Si + 3\ HCl \rightarrow HSiCl_3 + H_2$$

At room temperature, silane is a gas, and is pyrophoric — it undergoes spontaneous combustion in air, without the need for external ignition.
Above 420 °C, silane decomposes into silicon and hydrogen; it can therefore be used in the chemical vapor deposition of silicon.

Silane is fairly toxic: the lethal concentration in air for rats (LC_{50}) is 0.96% (9,600 ppm) over a 4-hour exposure. In addition, contact with eyes may form *silicic acid* with resultant irritation. In Japan, in order to reduce the danger of silane for amorphous silicon solar cell manufacturing, several companies began to dilute silane with *hydrogen* gas. This resulted in a symbiotic benefit of making more stable *solar photovoltaic* cells as it reduced the *Staebler-Wronski Effect*.

In regards to occupational exposure of silane to workers, the US *National Institute for Occupational Safety and Health* has set a *recommended exposure limit* of 5 ppm (7 mg/m^3) over an eight-hour time-weighted average.

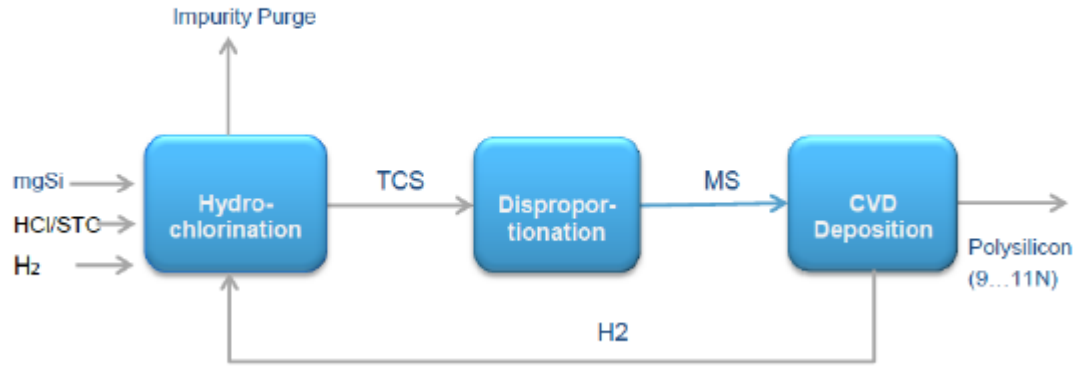
Properties	
Chemical formula	H_4Si
Molar mass	32.12 g·mol^{-1}
Appearance	Colourless gas
Odor	repulsive[1]
Density	1.342 g dm^{-3}
Melting point	−185 °C (−301.0 °F; 88.1 K)
Boiling point	−112 °C (−170 °F; 161 K)
Solubility in water	Reacts slowly
Vapor pressure	>1 atm (20°C)[1]
Structure	
Molecular shape	tetrahedral r(Si-H) = 1.4798 angstroms
Dipole moment	0 D
Thermochemistry	
Std molar entropy ($S^{\ominus}_{298}$)	204.6 J mol^{-1} K^{-1}
Std enthalpy of formation ($\Delta_f H^{\ominus}_{298}$)	34.31kJ/mol
Hazards	
Main hazards	Extremely flammable, pyrophoric in air
Safety data sheet	ICSC 0564
EU Index	Not listed
NFPA 704	
Flash point	Not applicable, pyrophoric gas.
Explosive limits	1.37–100%
US health exposure limits (NIOSH):	
PEL (Permissible)	none[1]
REL (Recommended)	TWA 5 ppm (7 mg/m^3)[1]

Hydrochloric acid is used in the rector to generate silicon from metallurgical silica. Hydrochloric acid is a clear, colorless, highly pungent solution of hydrogen chloride (HCl) in water. It is a highly corrosive, strong mineral acid. The main risk associated with HCL is its high corrosively and causing chemical burns during contact. Exhaust ventilation or other engineering controls are required to keep the airborne concentrations of vapors below their respective threshold limit value

(Source: Wikipedia, 2016)

Storage facilities of all hazardous materials will have to comply with SANS 310-1:2007, Storage tank facilities for hazardouschemicals: Part 1: Above-ground storage tank facilities for non-flammable chemicals.

Silica raw material will be delivered by a rotary truck (similar to a ready mix cement truck) and pumped with air pressure directly into the silo. From the silo, raw material will be pumped directly to the reactor by means of air pressured pipes. As such, during normal operations no silica will be released into the environment as part of this process.



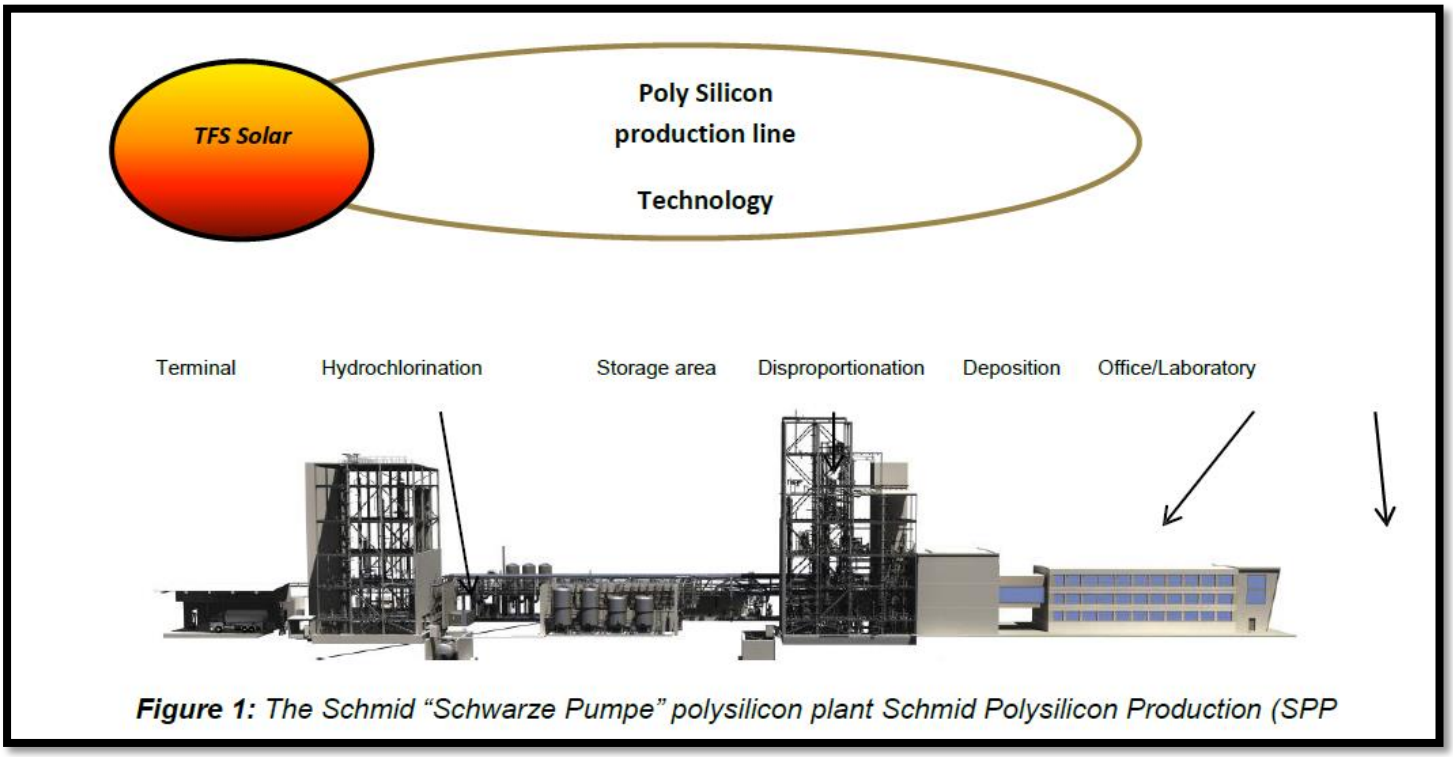


Figure 1: *The Schmid "Schwarze Pumpe" polysilicon plant Schmid Polysilicon Production (SPP*

Figure 4: An example of a CVD Reactor Installation

3.2.1. Process description - Hydrochlorination Unit

The SST Hydrochlorination Unit combines four individual process steps in one unit.

Step 1:
A highly sophisticated fluidized bed reactor is employed for Hydrochlorination of metallurgical Silicon with hydrogen and STC. The product of Hydrochlorination which is also called conversion, is TCS.

Chemical reaction inside the FBR:

(1) Hydrogenation of STC (SiCl4): SiCl4 + H2 SiHCl3 + HCl
(2) Chlorination of mg-Si: mg-Si + 3 HCl SiHCl3 + H2

Typically no external HCl is required for the SST Hydrochlorination. HCl forms only as an intermediate product inside the FBR, wherein HCl is fully converted into TCS. High processing temperature ensures the maximum conversion rate of >=25% (this number represents the concentration of TCS in mol-% in the liquid phase stream emerging from the FBR).

Step 2:
The SST Quench System downstream of the FBR is cooling down the product stream emerging from the FBR and removing traces of Si-fines and impurities like metal chlorides. Thus, fouling in the downstream equipment can be eliminated.

Step 3:
In the following SST Condensation System the gaseous STC/TCS mixture coming from the Quench system is condensed and fed to the STC/TCS –split column.

Step 4:
The STC/TCS –split column removes the non-converted STC from the TCS-product stream. The separated STC is recycled back to the FBR.

The reactor is fitted with a silicon dust filter.

3.2.2. SST Disproportionation Technology

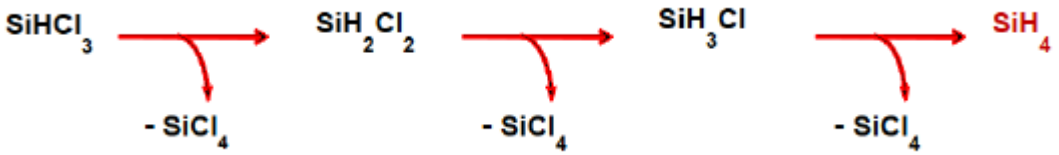
The SST Disproportionation Units shows the state of the art for converting Trichlorosilane to Monosilane of highest purity based on so called reactive distillation. Within a wide operation window this technology utilizes only about 10% of the energy compared to the conventional two step disproportionation process.
The SST Disproportionation Technology provides Monosilane Gas which can be fed via the monosilane buffer storage either to the MS Deposition Unit or to a Monosilane filling and loading station.

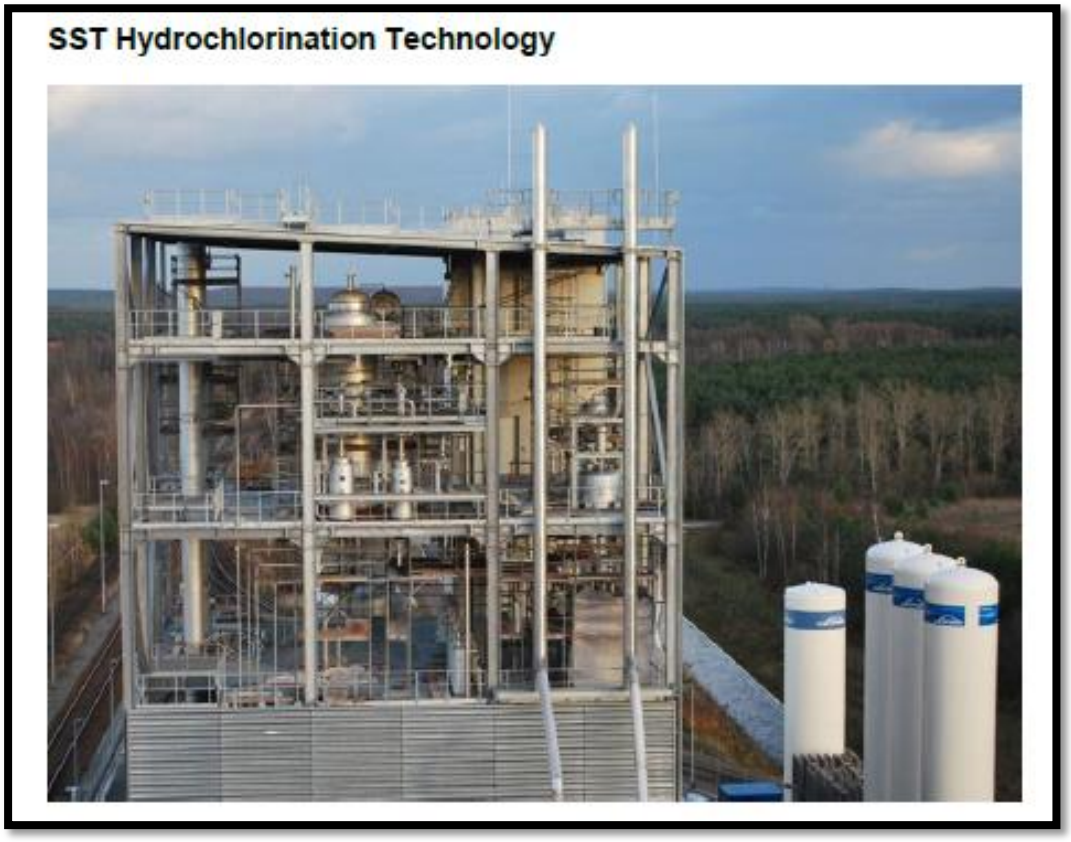
In comparison to the common TCS-Purification Process using a multiple stage Distillation Unit, the SST Disproportionation is easy to operate and guarantees a consistently high product quality of Monosilane Gas as well as Polysilicon. Because Dichlorosilane gets converted in the disproportionation to Monosilane there is no need for an extra Dichlorosilane recovery and conversion unit. Adding an additional Monosilane Purification Unit to the Disproportionation Unit UHP (UHP = Ultra High Purity) - Monosilane Gas can be produced.

The SST Hydrochlorination unit features the state-of-the-art technology of the Hydrochlorination process utilized at advanced Polysilicon production plants. Operated at a low pressure and high temperature level it achieves an outstanding conversion rate of >=25mol %. (STC=>TCS).

3.2.3. Process description – Disproportionation Unit

SST´s combination of TCS via hydrochlorination and Monosilane via disproportionation creates the lowest number of impurities and makes them easier to remove. Pure Monosilane can be obtained most easily through the disproportionation reaction of Trichlorosilane in the presence of a catalyst.





The manufacturing area (inclusive of glass and silica manufacturing will have a footprint of 74Ha.

Potential Environmental impacts associated with the silicon manufacturing process:

- Air quality impacts from loading and mixing of raw materials as well as from the reactor, storage area and disproportion unit in the event of an incidence
- Noise impacts from the roller conveyers
- Clearing of vegetation for the construction of the plant
- Accidental spillages from the chemical tank farm leading to ground and water pollution
- Waste water generation from the SST Quench system containing impurities
- Accidental releases from HCL vapour clouds and Monosilane causing air pollution and human health hazards
- Disposal of dust filters
- Disposal of material used to clean up spillages

3.3. Photovoltaic installation to generate electricity

The footprint of the PV panels onsite will be 154Ha.

The ground slope is usually kept below 5%, by grading, if necessary. Given the relative flatness of the site grading will not be required. After installation of the solar panels, the vegetation will be periodically cut to prevent shading of the panels, which limits vegetation height to below 1 m height. Inverters, transformers, and collector boxes are built for every 1 MW of panels, and are placed on concrete pads sized at roughly 5 × 5 m.

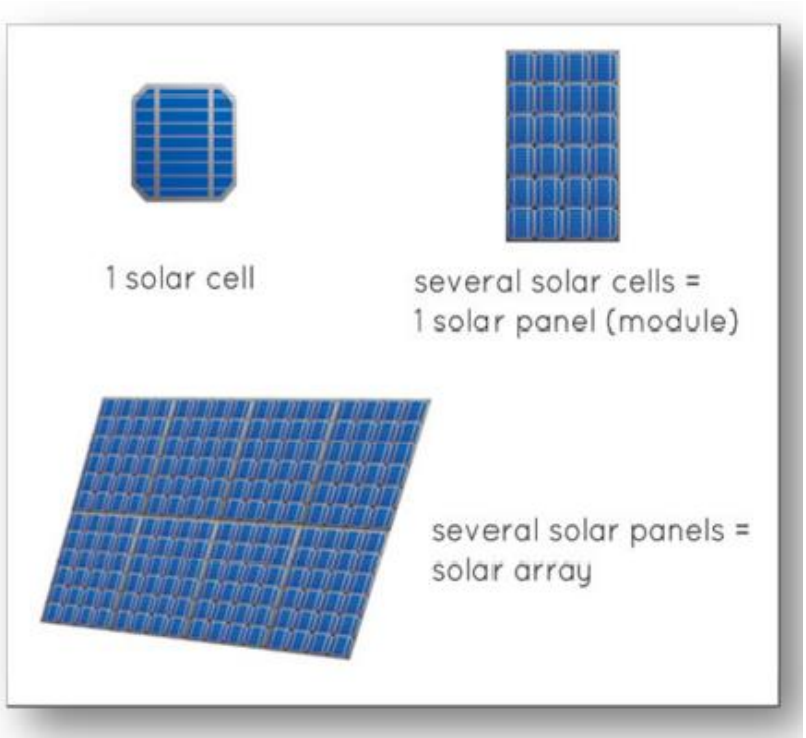


Figure 1: The generic composition of the solar panel arrays

3.3.1. Mounting system

The height of the arrays will be 4m high. Single axis tracking system will be used. The tracking system follows the sun to ensure maximum exposure to sunlight leading to efficient energy generation

Trenching for electrical and communications cables is required.

The panels require washing, which uses water at a rate of roughly 500–1000 gallons per MW of panels per year. Rainfall events will reduce the need for washing. No soap will be used, only pure water. Wash water will therefore not create any environmental impacts but will infiltrate into the soil and evaporate from the panels. Maintenance vehicles travel the access roads between the panels for washing and mowing. Dust suppression measures will be implemented on dirt roads.

Redox Flow Batteries will be used and will be stored in a normal store building. Redox flow batteries, and to a lesser extent hybrid flow batteries, have the advantages of flexible layout (due to separation of the power and energy components), long cycle life (because there are no solid-to-solid phase transitions), quick response times, no need for "equalisation" charging (the overcharging of a battery to ensure all cells have an equal charge) and no harmful emissions. They offer easy state-of-charge determination (through voltage dependence on charge), low maintenance and tolerance to overcharge/over discharge.

Flow batteries are rather complicated in comparison with standard batteries as they may require pumps, sensors, control units and secondary containment vessels.

Potential environmental impacts associated with the PV plant:

- Land-use
- Water use for washing
- significant alteration to the vegetation onsite due to construction and the creation of shadows by the panels
- erosion of topsoil, increase of sediment load or turbidity in local streams,
- the reduction of groundwater recharge due to the creation of impermeable surfaces
- fencing around the site will limit the movement of animals
- Flow batteries require secondary containment to prevent spillages
- Dust from vehicles travelling on dirt roads between the panels for maintenance purposes
- Avifaunal disturbance

3.4. Description of the associated structures and infrastructure related to the development

3.4.1. Power lines:

No new power line is required because the Eskom powerline is already running close by. A substation will be installed to draw power from the existing line. This will only serve as a back-up in the event of inadequate energy provision from the solar farm due to long term overcast weather. Several 1MW substations will be installed on the solar farm.

Potential environmental impacts associated with electricity infrastructure:

- Electromagnetic interference

3.4.2. Roads

No internal roads will be built - Only an access road from Joan Avenue. The roads are less than 8m wide and will be surfaced to prevent dust generation.

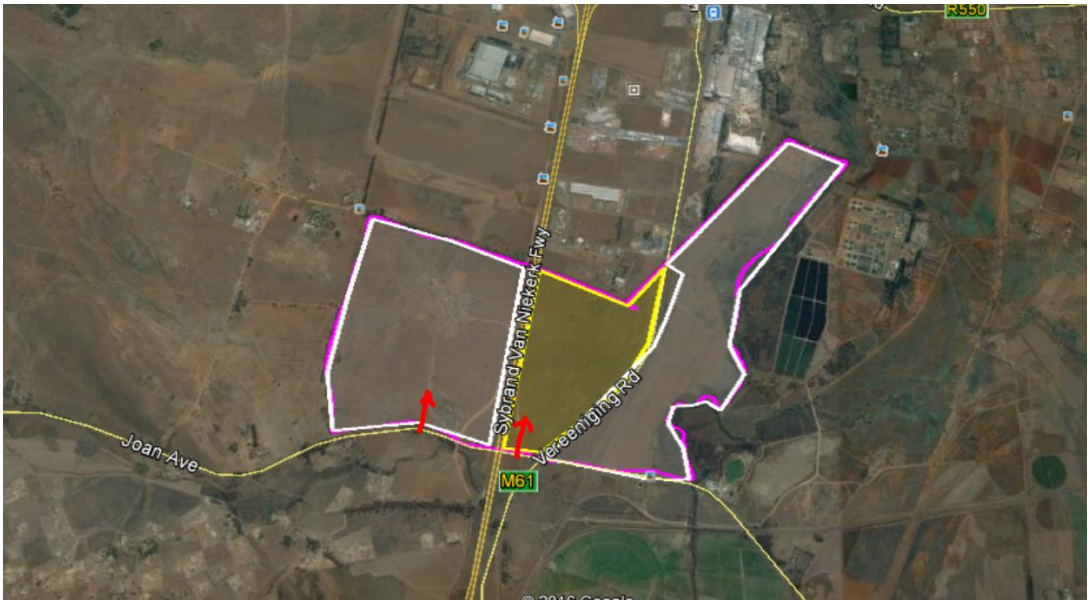


Figure 2: Position of the access roads

Potential environmental impacts associated with new access road:

- Dust

3.4.3. Sanitation facilities

A mobile package waste water treatment works will be used on-site.

The Bannow Boxer is a pre-fabricated package sewage treatment plant suitable for population equivalents of 5 - 50 domestic residents. The Boxer can be used for single houses, small buildings, construction sites, small housing developments, hotels, golf courses, holiday resorts and leisure developments in areas that are not connected to mains sewers. The Boxer has been designed specifically for nutrient removal as that has become increasingly important in many areas.

The Boxer system is one of the most compact “all in one” systems available and is manufactured to ISO 9002 quality standard. The civil works are minimal, consisting of a flat concrete support slab the plan area of the unit which can be at ground level if the Boxer is installed on grade or roughly 2m below ground if the Boxer is to be buried. The Boxer is completely enclosed with manhole access for maintenance. It is a modular unit that lends itself to future expansion or relocation.

The Bannow Boxer comprises the following 5 sections all of which are accommodated within one Fibre Reinforced Plastic (FRP) tank which is built on a steel frame:

- Primary Settlement & Sludge Storage
- Anaerobic Treatment
- Anoxic Zone
- Aerobic Biological Treatment

a. Primary Settlement & Sludge Storage
Raw effluent flows into the primary settlement zone where 75% of solids are removed using lamella (parallel) plates for more efficient settlement. This is also the sludge storage area. It incorporates lamella or parallel plates to enhance efficiency and utilisation of space. This zone is maintenance free and contains no moving mechanical or electrical devices. Lockable FRP covers with easy man access and sufficient ventilation are provided.
All-in-one package
Quick to install and commission - no long lead times and minimal civil works
Compact
Takes up the least amount of room
Unobtrusive
No unsightly open tanks or lagoons - normally buried to deck level with locked lids
Simple to Operate
Can be operated by non-technical staff.
Nutrient Removal
All important nowadays.
Easy Maintenance
Simple maintenance functions
Modular
Additional units can be installed as required if the usage increases
Relocatable
The investment is not locked in concrete - the Boxer can be traded in for a larger size or moved to another site at a later date if necessary
b. Anaerobic zone
The settled effluent entering the treatment plant mixes with recycled flow from the aeration zone. The recycle ratio can vary and is variable depending on the effluent discharge standards and the incoming flow strength (usually between 2 and 4 times incoming flow). This combined flow enters the Anaerobic zone. The anaerobic zone provides sufficient residence time for any residual dissolved oxygen to dissipate. It also provides a surface area on which anaerobic bacteria propagate. This results in the digestion of some of the solids in the effluent.
c. Anoxic zone
Effluent from the Anaerobic Zone enters the Anoxic zone from above. The Anoxic Zone is composed of plastic media that provides a surface on which the denitrifying bacteria adhere. The denitrifying bacteria convert the Nitrate (NO3) from the recycled flow to Nitrogen (N2) Gas. The BOD in the incoming effluent provides the carbon that is required for the bacteria to grow. This also has the advantage of reducing the BOD load to the aeration zone by approximately 20%.
d. Aerobic Treatment

An air lift pumps feeds effluent from the Anoxic Zone to the Aerobic Zone at a constant rate. Air is supplied to the Aeration zone from a small air blower. The air is fed to the base of the tank via special diffusers. Small media balls are provided in the Aeration Zone. These media balls enhance the area available on which the bacteria can grow and provides a highly efficient means of oxygen transfer. This results in a smaller aeration reactor while minimizing the power requirements. An aeration spurge cycle is activated on a timer a number of times a day to ensure there is no sludge build-up within the aeration zone.

e. Final Settlement

The clarifier or final settlement area uses lamella plates for efficient removal of solids, with a Saran filter and sludge return.

The Final Settlement or Humus Tank is a discrete compartment denying ingress of untreated or partially treated liquor. The design is similar to the Primary Settlement Tank on an upward flow basis. This zone has frequent automatic removal of sludge to sludge storage by means of a timed submersible pump.

To cater to low BOD5, TSS & COD effluent requirements, an optional Saran Membrane Filter can be fitted on top of the lamella plates in this Final Settlement Tank. The Saran Filter entraps finely divided particles and eliminates any sludge carry-over which can, in the absence of the filter, occur naturally from time to time.

f. Sludge Storage

Sludge Storage is provided in the base of the units. Depending on the load applied there is approximately 12 weeks capacity provided. Normally desludging is carried out by suction-tanker.

4. Materials and Construction

The Bannow Boxer is a single tank system supplied in multiple modules if necessary. The outside of the tank is steel reinforced FRP and can be free standing or buried up to deck level without the necessity of a concrete surround. All internal surfaces in contact with sewage are FRP. Lifting hooks are provided. The tank and internal components are accessed by a series of lockable FRP covers capable of being lifted by one person. These can be manufactured in a colour of the client's choice to enhance the visual impact of the location.

a. Electrical

In order to minimise power consumption and maintenance, the Boxer unit has two small blowers. The Boxer 40 has a 160W and a 54W Blower.

b. Control Panels & Alarms

The Bannow Boxer is supplied with a separate control panel with all the necessary starters and controls. The panel can be mounted on the Boxer or supplied loose to be installed mounted in a separate housing. The system comes with the Bannow Pumpwatch monitoring system which will Optional alarms can be fitted in the form of volt free contacts in the control panel, which can be wired to the building management system. High level float switches in the pump sump tank and the Blivets will provide a simple yet effective warning which will indicate any malfunction or overloading of the system.

d. Quality Control

The Bannow licensed factory in China is certified to ISO 9002 quality standard. All watertight compartments are hydraulically tested before leaving the factory. Quality certificates can be provided with each unit. Copies of certificates of conformity for all major component materials are available for inspection.

5. Installation & Civil Works

The required civil works consist simply of providing a suitable base support slab in 20N reinforced concrete for the Boxer. Installation consists of lifting the plant onto the slab and making one inlet & one outlet pipe connection and one electrical power supply connection per unit. The Boxer can be above ground or buried in the ground to deck level such that only the lockable covers are showing.

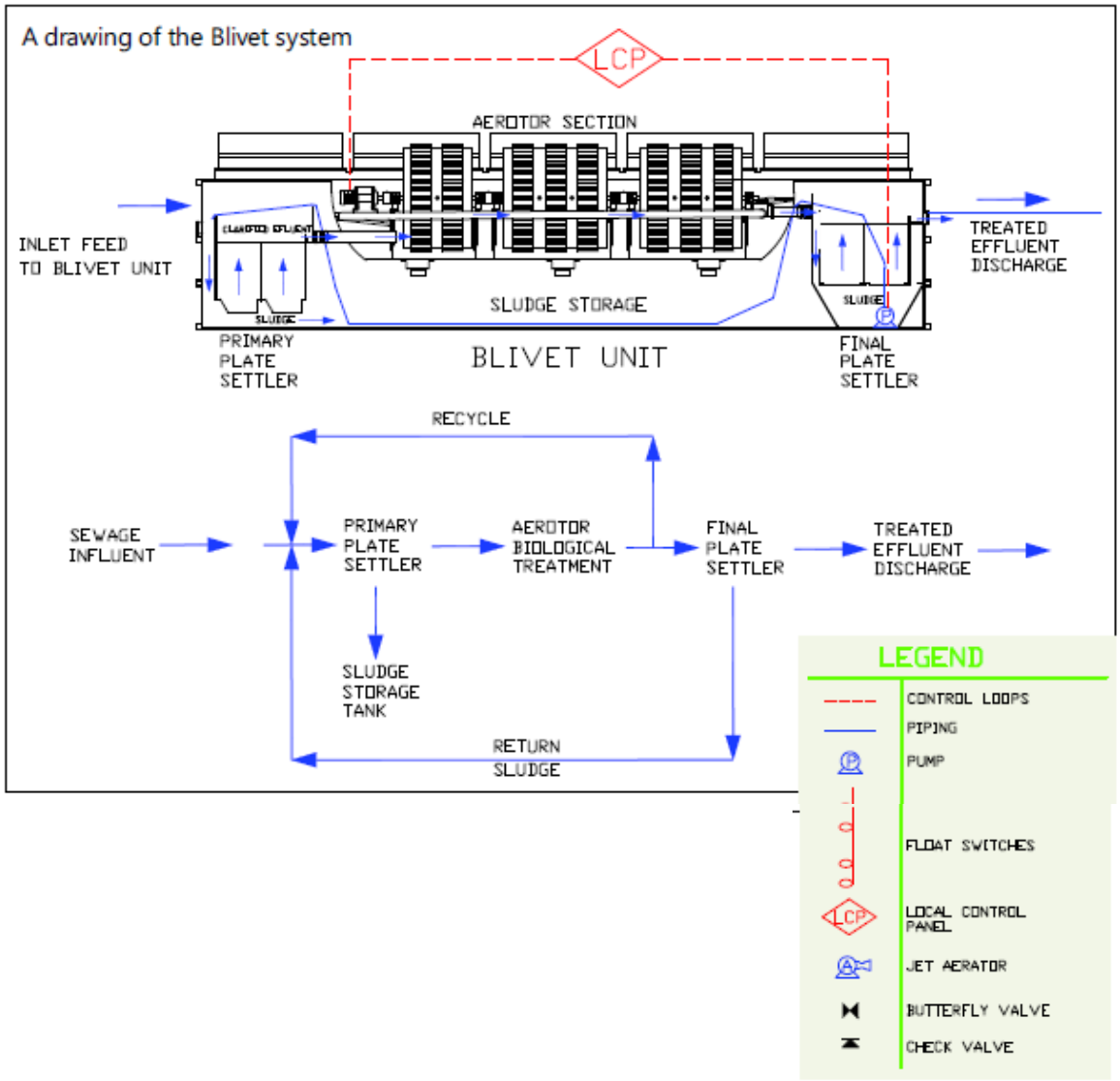
a. Supervisor & Training:

Bannow or their distributors can provide an engineer who will supervise the installation, commission the plant and train the client's operators. The client's staff can be fully trained in operation and maintenance of the plant during the commissioning period.

7. Operation & Maintenance Requirements

The Bannow Boxer requires very little routine maintenance and supervision compared to other plants. All the maintenance tasks (and operation) can be carried out by a maintenance operator and do not need a highly skilled technician. A maintenance contract can be offered by our local representative.

Figure 3: The package plant, which has been operating at the Nedbank Olwazini Training Centre in Muldersdrift for the past eight years, received a Green Drop award in 2012



The treated effluent will be re-used onsite in the manufacturing process. The effluent will be fed into the demineralization plant. No effluent will be released into the environment. The re-use of the effluent will support water conservation onsite.

In terms of environmental impacts, the only potential impacts are leaking pipes which may lead to ground, water and ground water pollution. Safe disposal of sewage sludge is also required.

3.4.4. Storage of Dangerous Goods

Input	Storage facilities description	Transport and onsite utilization description	Quantities/Volume

Metallurgical Silicon	MgSi will be stored in Concrete Silos, similar to current cement storage silos. Totally enclosed with opening at the bottom with an auto / manual feed control mechanism.	Transportation from the supplier will be with trucks, similar to the concrete delivery trucks. Upon arrival it will be unloaded directly into the concrete silo from the top via automated / manual feed control access / belt conveyor. To access the MgSi it will simply be loaded again with smaller loading vehicles / or with dedicated automatic belt conveyors. This method will only be decided once final design engineering has been agreed.	7200 tons per annum : 7200/365days = 19.72 tons per day *(Est. Conversion fig) 1m³=2.41T* **8m³ per day**
Hydrochloric acid	Hydrochloric acid will be stored in specially Vertically Hydrochloric acid storage tanks, and according to Industrial standards and properly vented. These hydrochloric acid storage tanks are made using quality HDPE & PP and are acknowledged for durability, resistance to corrosion and decay from concentrated chemicals. A pressure / vacuum relief device will be in place to regulate pressure. All requirements on storage of Hydrochloric acid will be strictly complied with. These storage area and storage facilities / drum containers will be properly barricaded with all the necessary health and safety regulations in place and as per the necessary requirements and the requirements as per the Suppliers MSDS (Material	Hydrochloric acid will be transported with the suppliers' specified Hydrochloric acid tank trucks carrying this Hydrochloric acid in tightly sealed containers. An automated pump system or compressed air system will be used and a pipeline and joint will be used from the truck container to the storage container with valves. An automatic transferring system will be implemented whereby the transferring process is simplified by simply connecting the pipe to the tank. When liquid is withdrawn from the	3250 tons per annum: 3250 / 365days = 8.9 tons per day *(Est. Conversion fig) 1m³=2.41T* 5 to 8m3 per tank truck **3.69m³ per day**

	Safe Data Sheet). Proper PPE (Personal Protective clothing) shall be worn in these storage areas, and all necessary requirements, including signs, information, requirements, MSDS will be adhered to and all necessary requirements will be complied with. These steel containers / drums will have proper release valves and pipes for loading and off-loading Hydrochloric acid will be kept in a tightly closed containers and stored in chemical area that is compatible with other chemicals. It will also be stored in a secure, well-ventilated area, that is well marked, and away from the general work population.	tank, an equal volume of air will be regulated by valve system. A pipe system will be fixed to the tank in order to feed the MgSi Plant.	
Nitrogen	Nitrogen will be stored in specially Nitrogen storage vessels, specifically a cryogenic storage tank, one or more vaporizers, and a pressure and temperature control system. The cryogenic tank is constructed like, in principle, a vacuum bottle. It is designed to keep heat away from the liquid that is contained in the inner vessel. Vaporizers convert the liquid nitrogen to its gaseous state classed as pressure vessels and meet the industrial requirements and according to SABS	Nitrogen will be supplied with a dedicated Nitrogen pipe line to the property and directly to the point of storage (vessel). The usage of Nitrogen will be automated and released as per A pressure control manifold which controls the pressure air which the gas is fed to the process. In other words, a liquid transfer line is used to safely remove liquid product (Nitrogen). For cryogenic liquid cylinders, the transfer line is connected to the cylinder's liquid withdrawal valve. Liquid product is typically removed	12 200 tons per annum: 12200/365days = 33.42 tons per day *(Est. Conversion fig)* *1m³=2.41T* in 40m3 vertical liquid nitrogen vessels **13.8m³ per day**

		through insulated withdrawal lines to minimize the loss of liquid product to gas. Insulated flexible or rigid lines are used to withdraw product from storage tanks.	
Hydrogen	Metal hydride tank is a container loading with hydrogen storage alloy powder, heat exchange parts, and gas transport components. The container body materials are generally aluminium alloy or stainless steel. Our hydrogen storage vessels will be based on AB5 metal hydride alloys. Hydrogen being stored at low pressure in the vessel, they provide a safe and reliable energy storage, particularly for portable applications, in-house and in-board storage. An indoor storage facility will be available for this Hydrogen.	Hydrogen will be supplied by the Hydrogen supplier, in these high pressure containers, similar to Oxygen and Acetylene containers, by road transport. Where these small quantities will be required it will be transported by LDV to the required point. A connection will be made directly to the container, and the Hydrogen is then released by means of a valve.	0.053 tons per annum: 0.053/365 days = 0.0001452 tons per day *(Est. Conversion fig)* *1m³=2.41T* **0.0000602m³ per day**
Argon	Since argon is inert, special materials of construction are not required. However, materials of construction will be selected to withstand the low temperature of liquid argon. Vessels and piping will be designed to. A typical system will consists of the following components: a cryogenic storage tank, one or more vaporizers, a pressure control system, and all of the piping required for fill, vaporization. The cryogenic tank is constructed, in principle, like a vacuum bottle. It is designed to keep heat away from the liquid that is contained in the inner vessel.	Although used more commonly in the gaseous state, argon will commonly be stored and transported as a liquid, affording a more cost-effective way of providing product supply. By means of a valve a direct pipe line will be connected to the tank for usage and as required by the process.	3.110 tons per annum: 3.110/365 days = 0.0085 tons per day *(Est. Conversion fig)* *1m³=2.41T* **0.0035m³ per day**

	Vaporizers convert the liquid argon to its gaseous state. A pressure control manifold controls the pressure at which the gas is fed to the process.		

The main potential impacts associated with the storage of dangerous goods are spillages and accidental releases of gas and dust which may lead to ground, ground water, surface water and air pollution.

4. PROJECT PHASES AND ASSOCIATED ACTIVITIES

The project can be divided into three main phases:

i. Construction Phase
ii. Operational Phase
iii. Decommissioning Phase.

Each activity undertaken as part of the above phases may have environmental impacts and has therefore been assessed by the specialist studies. In addition, management and mitigation measures required to address all the impacts are included in the EMPr. The Environmental Authorisation is required for the construction and operational phases of the project.

A description and identification of impact management outcomes associated with the project are indicated in the table below:

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P = Positive impact

Category of environment	Description of environmental issues and risks: leading to environmental impacts	Volume	Toxicity	Social	Ecological	Intensity	Duration	Extent	SEVERITY	PROBABILITY	Pre-mitigation significance	Mitigation Rating	Post mitigation and final significance rating	Mitigation description	Nature of impact: Reversible	Nature of impact: irreplaceable loss of resources	Nature of impact: avoided/ mitigated / managed
Hydrology	The increase in concrete and impermeable surfaces will increase runoff from the site and increase erosion	5	1	1	3	10	5	5	20	5	100	4	25	Storm water management plan and artificial wetland to attenuate flow and increase ground water infiltration			
	Excavation and construction may lead to soil washing away and increasing sediment loads in surface runoff during construction	3	1	1	3	8	1	3	12	3	36	4	9	Stormwater management plan for construction activities			
Noise	Increase in ambient noise levels in the area due to construction activities, increase in traffic and operations	5	1	5	3	14	5	3	22	3	66	4	17	Construction timing limited to between 7 and 18:00 per day			

	Increase in ambient noise levels due to manufacturing processes	5	1	5	3	14	3	3	20	5	100	3	33	Noise measurement to be done once manufacturing commences. If noise levels at the site boundaries exceed allowable limits, engineering controls will be implemented			
Air quality	Increase in dust emissions during construction	3	1	3	3	10	3	3	16	3	48	2	24	Dust suppression measures to be implemented during construction. Method statement to be compiled by contractor and approved by ECO			
	Increase in localized emissions of particulate matter	5	5	5	3	18	5	5	28	5	140	4	35	Emission control equipment and delivery, storage and utilization in an enclosed environment (vacuum pumping)			
	Increase in dust and diesel exhaust fumes from increased truck movement to and from the site, delivering raw materials	3	3	3	1	10	5	3	18	3	54	2	27	Dust suppression and servicing of vehicles			

	Accidental releases of HCL vapors and Monosilane	3	5	5	5	18	3	3	24	2	48	2	24	Engineering control measures and health and safety measures as well as identification of potential problems			
	Emissions from the manufacturing process of glass (furnace, floating bath, metal oxide coatings) and silicon (reactor, disproportionation and deposition units).	3	3	5	5	16	5	5	26	3	78	4	20	Emission control equipment			
	Reduced carbon emissions associated with energy from a renewable source					0			0		0		P				
	Storage of raw materials	3	3	3	3	12	5	5	22	3	66	4	17	storage and utilisation in an enclosed environment (vacuum pumping)			
Solid and liquid Waste	Waste produced during construction may impact on the surrounding land	3	1	1	3	8	1	1	10	2	20	4	5	Waste management plan and measures to be compiled and approved by ECO			
	Increase in the volumes of general office waste generated on site due to the increased number of people present on site	3	1	1	1	6	5	1	12	5	60	4	15	Waste management plan , recycling and removal of waste to registered landfill site			
	Increase in the volumes of sewage generated on site due to the increased number of people present on site	3	3	3	3	12	5	3	20	5	100	4	25	Local package plant to be installed and waste water risk			

														abatement plan to be compiled. Participation in Green Drop certification			
Flora	Alien species may establish due to disturbance during construction and operation of the solar farm	2	3	1	1	7	5	3	15	3	45	4	11	Alien species control plan to be compiled and approved by ECO			
	Removal of vegetation during construction	3	1	1	5	10	5	1	16	5	80	4	20	Search and rescue			
	Presence of medicinal plants on site which may be disturbed during construction	3	1	1	5	10	5	1	16	5	80	4	20	Search and rescue			
Fauna	Presence of fauna on site may be disturbed or killed during construction	3	1	1	3	8	1	1	10	2	20	3	7	Search and rescue plus environmental awareness			
	Restricted movement of animal species due to fencing of the site	3	1	1	3	8	5	3	16	3	48	2	24	biodiversity corridors onsite			
Avifauna	Collision with PV panels at night	3	1	1	3	8	5	1	14	3	42	3	14	Panels to be faced downwards at night			
	Disturbance of red data species	1	1	1	1	4	5	1	10	1	10	1	10	No red data species currently onsite. Monitoring will continue during construction and operation			
Ecological integrity	Impacts on the wetland area and sensitive ecological area	1	1	1	1	4	1	1	6	1	6	4	2	No activities in this area. Environmental			

														awareness and training				
Heritage	Destruction of heritage objects	1	1	1	1	4	1	1	6	1	6	2	3	No heritage objects on site. However, should heritage objects be uncovered, construction will be stopped and an archaeologist will be send to site				
Employment	Increase in local employment opportunities.					0			0		0		**P**					
Economic	Positive impacts on local economic development through the increase in regional domestic product					0			0		0		**P**					
Electricity supply	Positive impact on the amount of electricity available in SA					0			0		0		**P**					
Renewable energy	Positive impact on the availability of renewable energy					0			0		0		**P**					
						0			0		0		**P**					
						0			0		0		**P**					
Visual impact	Visual impacts on motorists and surrounding residential areas	3	1	3	1	8	5	3	16	3	48	2	24	High boundary wall, buildings constructed in a manner to reduce visual impact				

Use of non-renewable resources	The use of non-renewable resources during construction	5	1	1	3	10	1	3	14	5	70	2	35	Minimise wastage			
Spills	Pollutants such diesel fuel and hydrochloric acid may lead to soil pollution and infiltrate groundwater.	3	3	1	5	12	5	3	20	2	40	3	13	Bunding and engineering controls plus emergency management plan			
Emergencies	Leakages of monosilane, HCL vapours and exposure of monosilane to ambient temperatures may lead to explosions	3	5	5	5	18	1	3	22	2	44	2	22	Engineering controls and early detection measures			
Agricultural potential	Reduction in availability and utilisation of soils with high agricultural potential	1	1	3	1	6	5	1	12	2	24	4	6	In terms of the specialist study, limited impacts. The largest area with high potential agricultural soils will not be affected			
Waste water	Waste water from the manufacturing plant to pollute soil, surface and ground water	3	3	1	3	10	5	1	16	5	80	4	20	Waste water will be recycled. Effluent during the cleaning of filter membranes will be stored in bunded containers and removed by a registered waste handler to a licensed disposal site			
	Waste water from the sewage package plant pollute soil and ground water	2	3	3	2	10	5	3	18	3	54	4	14	Waste water from the package plant			

														will be recycled into the manufacturing process			
Sewage sludge	Sludge from the package plant to pollute soil and ground water	1	3	3	3	10	5	3	18	5	90	4	23	To be removed by a suction truck and disposed of at a sewage plant			
Flow batteries	Soil and ground/surface water pollution during spillage incidences	1	5	3	5	14	1	1	16	2	32	3	11	Bunding around batteries. Situated on impermeable surfaces. Emergency management pan. Spill prevention procedure during re-filling.			
Cleaning of PV panels	Water use	1	1	1	1	4	1	1	6	5	30	1	30	Panel cleaning procedure will be compiled to limit wastage of water. No soap will be used			
Fire	Burning of surrounding areas due to starting of fire on site	3	3	3	3	12	1	3	16	2	32	3	11	Fire management plan to be compiled. Firefighting equipment to be stored and readily accessible on site. Training of employees to do firefighting on site. Engineering			

														controls to prevent fires		
Electromagnetic interference		1	1	1	1	4	5	1	10	1	10	4	3	Due to the low voltage and isolation of substations, no electromagnetic interference. During the operational phase, a specific study will be undertaken.		

Impact management objectives relevant to the different project phases:

Impact management	Planning and design	Preconstruction	Construction	Operation	Decommissioning
Storm water control and erosion control management plans	■	■	■	■	
Noise level controls			■	■	
Dust emission control			■	■	
Air pollution control (Emissions from the manufacturing process of glass)				■	
Accidental releases of HCL vapors and Monosilane,				■	
Storage of raw materials			■	■	
Waste management			■	■	■
Alien species management		■	■	■	■
Search and rescue of sensitive fauna and flora		■			
Biological corridors	■	■	■	■	■
Avifaunal protection	■	■	■	■	

Impact management	Planning and design	Preconstruction	Construction	Operation	Decommissioning
Heritage objects			■		
Visual impacts management	■		■	■	
Hazardous substance control			■	■	
Waste water management			■	■	
Sewage and sludge management			■	■	
Incident management			■	■	
Fire management		■	■	■	■
Electromagnetic interference			■	■	
Water use			■	■	
Sensitive area to be avoided and protected	■	■	■	■	■
Hazardous waste management			■	■	■
Traffic management			■	■	■
Environmental awareness and training			■	■	
Reporting to the authorities as per conditions stated in AEL and EA			■	■	

4.1. Construction Phase

Construction is planned to start in 2016 as soon as the Environmental Authorisation has been obtained. It will take up to 6 months due to the fact that most units are mobile units that will be installed in the buildings that are to be erected.

The main activities that will form part of the construction phase are:

i. Vegetation clearing in the areas required for building infrastructure and brush cutting in the solar field area where the panels will be installed;
ii. Excavations for infrastructure and associated infrastructure;
iii. Establishment of a laydown area for equipment;
iv. Construction of internal gravel access roads;
v. Stockpiling of soil and vegetation removal;
vi. Traffic generation from construction trucks delivering materials to site and workers coming to site
vii. Construction of buildings

4.2. Operational Phase

The main activities to be undertaken during the operational phase include:

PV panel manufacturing
The manufacturing plant will manufacture silicon and glass which will be used to build PV panels. The PV panels will be sold and some will be used to create energy on-site.

Energy generation
The operational phase of the facility includes the operation of the solar facility whereby power is generated from the sunlight. The electricity generated will be stored in the flow batteries and used in the manufacturing plant.

Panel maintenance and cleaning
The accumulation of dust on the panels affects the productivity of the proposed solar power facility, and as a result, the panels require regular cleaning. It is planned that cleaning will take place on a monthly basis using only water.

The duration of the Environmental Authorisation is required for the total operational period which does not have a final date at this stage. Closure is not foreseen.

4.3. Decommissioning Phase

Decommissioning will involve removing the solar panels, manufacturing plant and associated infrastructures, and covering the concrete footings with soil to a depth sufficient for natural vegetation re-growth.

Buildings will not be demolished, but may be utilized for other purposes such as offices or housing or other manufacturing facilities.

Decommissioning however is not foreseen as part of the project phases.

4.4. Overview of the proposed project impacts

The EMPr will be strictly implemented during the construction phase of the project and will be consulted regularly during the **pre-construction and construction phases** of the project.

The EMPr specifies mitigation measures for the following environmental aspects:

4.4.1. Planning and design

- Planning and site layout: The sensitive area next to the Klipriver is not included in the lay-out plan and may not be developed.
- Design of buildings and infrastructure must comply with the visual impact assessment's requirements
- Solar panels must be able to face downwards at night to prevent avifaunal collisions

4.4.2. Pre-construction phase

- Search and rescue of fauna and flora – relocation to the area that will remain undeveloped.
- Identification of construction camp area that is not located inside the sensitive area that may not be developed.
- Identification of storage facilities for construction material: not located inside the sensitive area that may not be developed.

4.4.3. Construction phase

- Site clearing
- Site establishment
- Construction traffic and access
- Construction camp
- Specialised construction methods
- Soils and geology
- Erosion control
- Groundwater and surface water pollution
- Hydrology and storm water
- Air pollution
- Dust pollution
- Oil leakages and spillages
- Noise
- Flora

- Fauna
- Waste generation and littering
- Cultural and heritage artefacts
- Search and rescue for fauna and flora
- Veld fires
- Accidental Spillages and releases of hazardous materials into the environment
- Avifaunal impacts
- Noise impacts
- Storm water impacts
- Avifaunal impacts

4.4.4. Post Constructional phase

- Removal of building rubble to licensed landfill site
- Landscaping in accordance with approved landscaping plan (by the Midvaal Municipality)
- Avifaunal impacts
- Reporting to the authorities as per the conditions stated in the Environmental Authorisation

4.4.5. Operational Phase

- Air pollution from manufacturing
- Dust pollution from roads
- Growth of alien vegetation
- Veld fires
- Accidental Spillages and releases of hazardous materials into the environment
- Avifaunal impacts from solar panels
- Noise impacts
- Storm water impacts
- Electromagnetic interference
- Waste generation
- Sewage sludge generation
- Reporting to the authorities as per the Air Emission Licence and conditions stated in the Environmental Authorisation

5. Applicable legislation and guidelines governing the EMPr

The plant will be operated and maintained according to several national and international standards, including but not limited to:

- National Fire Protection Association (NFPA) standards
- International Standards Organization (ISO) 9000/2000 Quality Systems
- South African standards, codes and regulations, which include:
    - South African Occupational Health and Safety Act (OHASA) Act 85 of 1993
    - South African National Standard (SANS) 10089 (pertaining to the building industry)
    - South African National Standard (SANS 310) pertaining to hazardous material storage tanks
    - National Environmental Management Act, Act 107 of 1998
    - National Water Act, Act36 of 1998
    - Constitution of South Africa, Act 108 of 1996
    - National Heritage Resources Act, Act 25 of 1999
    - Protected species – provincial ordinances
    - Conservation of Agricultural Resources Act, Act 103 of 1997
    - National Environmental Management: Biodiversity Act, Act 10 of 2004
    - National Environmental Management: Air Quality Act, Act 39 of 2004
    - Hazardous Substances Act, Act 15 of 1973
    - National Environmental Management: Waste Act, Act 59 of 2008.

6. Applicable documentation

The following documents should be read in conjunction with this EMPr.

- Environmental impact assessment (EIA)
- Environmental Authorisation: conditions
- Air Emission licence

7. Project Responsibilities

Several professionals will form part of the construction team. The most important from an environmental perspective are the Project Manager (PM), the Environmental Control Officer (ECO), the Contractor and the Employer. The Employer will appoint an independent Environmental Auditor.

The PM is responsible for the implementation of the EMPr on the site during the **pre-construction** and **construction** phases of the project.

The ECO is responsible for monitoring the implementation of the EMPr during the design, **pre-construction** and **construction** phases of the project.

The Contractor is responsible for abiding by the mitigation measures of the EMPr which are implemented by the Project Manager during the **construction** phase.

7.1. Project Manager

The PM is responsible for overall management of project and EMPr implementation. The following tasks will fall within his/her responsibilities:

- Be aware of the findings and conclusions of the EIA report and the conditions stated within the environmental authorisation.
- Be familiar with the recommendations and mitigation measures of this EMPr, and implement these measures.
- Monitor site activities on a daily basis for compliance.
- Conduct internal audits of the construction site against the EMPr.
- Confine the construction site to the demarcated area.
- Rectify transgressions through the implementation of corrective action.

7.2. Environmental Control Officer

The ECO is responsible for the implementation of the EMPr during the construction phase. The ECO will liaise and report to the Employer, Contractor, landowners and authorities. The following tasks will fall within his/her responsibilities:

- Be aware of the findings and conclusions of the environmental impact assessment and the conditions stated within the environmental authorisation.
- Be familiar with the recommendations and mitigation measures of this EMPr.
- Conduct weekly/monthly audits of the construction site according to the EMPr and environmental authorisation.
- Educate the Contractor about the management measures of the EMPr and environmental authorisation.
- Liaise regularly with the construction team and the PM.
- Recommend corrective action for any environmental non-compliance incidents on the construction site.
- Compile a regular report highlighting any non-compliance issues as well as good compliance with the EMPr.
- All negotiations for any reason shall be between the ECO, the affected parties, the Employer and the Contractor. No verbal agreements shall be made. All agreements shall be recorded in writing and all parties shall co-sign the documentation.
- The affected parties shall always be kept informed about any changes to the construction programme should they be involved. If the ECO is not on site, the Contractor should keep the

affected parties informed. The contact numbers of the Contractor and the ECO shall be made available to the affected parties. This will ensure open channels of communication and prompt responses to queries and claims.

Liaising with the Employer, Contractor, landowners and authorities by the ECO will take place in the following manner:

- Weekly inspections will be conducted by the relevant ECO in all areas. These audits will be conducted randomly (within the week) and will not require prior arrangement with the Contractor.
- Daily and weekly inspections (refer to the above) will take the form of completed audit checklists and photographic checklists. These weekly audit checklists will be appended to, and inform, the monthly consolidated audit report.
- Compilation of a monthly audit report with a consolidated rating of the compliance with the EMPr. The monthly audit report will be delivered before the end of the relevant month, to the Engineer and copied to the Contractor for necessary corrective action. The audit report will be submitted to the competent authority ten days after the end of the month.
- The only liaison with authorities will be the submission of monthly reports.

7.3. Contractor

The Contractor is responsible for the implementation of and compliance with recommendations and conditions of the EMPr. The following tasks will fall within his/her responsibility:

- Ensure compliance with the EMPr at all times during construction.
- Maintain environmental registers which keep a record of all incidents that occur on site during construction. These incidents include:
    - Public involvement/complaints
    - Health and safety incidents
    - Hazardous materials stored on site
    - Non-compliance incidents.

8. The Environmental Management Program (EMPr)

This EMPr seeks to manage and keep to a minimum the negative impacts of a development while enhancing the positive and beneficial impacts.

8.1. 3.1 Objectives of an EMPr

The objectives of the EMPr are to:

- Identify a range of mitigation measures which could reduce and mitigate the potential impacts to minimal or insignificant levels.

- Identify measures that could optimize beneficial impacts.
- To create management structures that addresses the concerns and complaints of I & APs with regards to the development.
- Establish a method of monitoring and auditing environmental management practices during all phases of development.
- Ensure that the construction and operational phases of the project continue within the principles of integrated environmental management.
- Detail specific actions deemed necessary to assist in mitigating the environmental impact of the project.
- Ensure that the safety recommendations are complied with.
- Propose mechanisms for monitoring compliance with the EMPr and reporting thereon.
- Specify time periods within which the measures contemplated in the environmental management plan must be implemented, where appropriate.

8.2. Issues highlighted by the EMPr

The EMPr seeks to highlight the following:

- Avoiding impacts by not performing certain actions.
- Minimising impacts by limiting aspects of an action.
- Rectifying impacts through rehabilitation, restoration, etc. of the affected environment.
- Compensating for impacts by providing substitute resources or environments.
- Minimising impacts by optimising processes, structural elements and other design features.
- Provide ongoing monitoring and management of environmental impacts of a development and documenting any digressions/good performances.

The EMPr is a legally binding document of which all parties involved in the project must be aware.

8.3. Environmental monitoring

A monitoring programme will be implemented for the duration of the project's construction phase. This programme will include:

- Bi-weekly audits during first month, where after monthly audits will be conducted by the Environmental Control Officer, which are according to the EMPr and environmental authorisation's conditions. These audits can be conducted randomly and do not require prior arrangement with the Project Manager.
- Compilation of an audit report with a rating of the compliance with the EMPr. This report will be submitted to the relevant authorities.

The ECO shall keep a photographic record of any damage to areas outside the demarcated site area. The date, time of damage, type of damage and reason for the damage shall be recorded in full to ensure the responsible party is held liable. All claims for compensation emanating from damage should be directed to the ECO for appraisal. The Contractor shall be held liable for all unnecessary damage to the environment. A register shall be kept of all complaints from the landowner or community. All complaints/claims shall be handled immediately to ensure timeous rectification/payment by the responsible party.

A formal monitoring protocol will be included within the Contractor Environmental Management System Manual, as detailed in specific procedures outlined in the EMS.

8.4. Compliance with the EMPr and associated documentation

A copy of the EMPr must be kept on site during the construction period at all times. The EMPr will be made binding on all contractors operating on the site and must be included within the *Contractual Clauses*. It should be noted that, in terms of the National Environmental Management Act, No. 107 of 1998 (Section 28), those responsible for environmental damage must pay the repair costs to the environment, human health as well as the preventative measures to reduce or prevent further pollution and/or environmental damage (i.e. the polluter pays principle).

The Contractor is deemed not to have complied with the EMPr if:

- Within the boundaries of the site, site extensions and haul/access roads there is evidence of contravention of clauses
- Environmental damage ensues due to negligence
- The Contractor fails to comply with corrective or other instructions issued by the ECO or authorities within a specified time
- The Contractor fails to respond adequately to complaints from the public.

The Employer is deemed not to have complied with the EMPr if:

- Within the boundaries of the site there is evidence of contravention of clauses
- Environmental damage ensues due to negligence
- The Employer fails to respond adequately to complaints from the public.

8.5. Layout of the EMPr

The EMPr is separated into two phases. Each phase has specific issues unique to that period of the development and operation of the project and associated infrastructure. The phases of the development are:

- Pre-construction phase
- Construction phase and associated rehabilitation of affected environment
- Operational phase
- Decommissioning phase.

8.6. Training and awareness

8.6.1. Training of construction workers

Construction workers must receive basic training in environmental awareness, including the storage and handling of hazardous substances, minimisation of disturbance to sensitive areas, management of waste, and prevention of water pollution. They must be informed how to recognise historical/archaeological artefacts that may be uncovered during construction excavation. They must also be informed of the EMPr's requirements.

8.6.2. Training of operational employees

Employees must receive basic training in environmental awareness, including the storage and handling of hazardous substances, minimisation of disturbance to sensitive areas, management of waste, and prevention of water pollution as well as implementation and maintenance of all environmental management plans.

8.7. Contractor performance

The Contractor must ensure that the conditions of the environmental management program are adhered to. Should the Contractor require clarity on any aspect of the EMPr, the Contractor must contact the Environmental Control Officer for advice.

8.8. Environmental Management Program: Pre-Construction Phase

EMPr requirements for the pre-construction phase are:

- Sensitive areas must be demarcated and cordoned off to prevent access by the construction team.
- Proper and continuous liaison must be maintained between the Employer, the Contractor and surrounding landowners to ensure all parties are appropriately informed at all times.
- The surrounding landowners must be informed of the starting date of construction as well as the phases in which the construction shall take place.
- The Contractor must adhere to all conditions of contract including those of the environmental management plan.
- Adequate planning of the construction programme to allow for disruptions due to rain and very wet conditions.
- All manmade as well as natural (vegetation) structures outside the boundary of the servitude in proximity to the construction site shall be protected against damage at all times and any damage shall be rectified with all due haste.
- Proper documentation and record keeping of all complaints and actions taken.
- Appointment of an Environmental Control Officer on behalf of the Employer to implement this EMPr as well as deal with all landowner related matters.
- Regular site inspections by the ECO and good control over the construction process throughout the construction period.

8.8.1. Compilation of plans before construction commences and submitted for approval:

- A storm water control plan must be compiled and approved by the ECO before construction commences
- A re-vegetation and habitat rehabilitation plan must be compiled and approved by the ECO before construction commences.
- A fire management plan must be compiled and approved by the ECO before construction commences
- A plant rescue and protection plan must be compiled by a vegetation specialist and approved by the ECO before construction commences
- An open space management plan must be compiled and approved by the ECO before construction commences
- A transportation plan for the transportation of components, cranes and large pieces of equipment must be compiled and approved by the ECO before construction commences
- A traffic management plan for the site access roads to ensure that no hazards would results from increased traffic and increased traffic would not influence current traffic flow must be compiled and approved by the ECO before construction commences
- An alien invasive plant management plan must be compiled and approved by the ECO before construction commences

- An erosion management plan for the prevention, monitoring and rehabilitation of erosion must be compiled and approved by the ECO before construction commences
- A management plan for the effective monitoring of leakages and early detection of leakages/spillages during transportation , storage, handling and usage must be compiled and approved by the ECO before construction commences
- Environmental sensitive areas (wetlands. Riparian zones etc.) must be delineation and temporary fenced off to prevent any access by machinery/traffic/workers.

Table 1: Preconstruction Phase

IMPACT	**PRE-CONSTRUCTION PHASE** This section deals with the preparation of the site and actions that need to be implemented before construction commences	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
PHASE	**PRE-CONSTRUCTION**	**Employer / ECO**	**Weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
General	1. Appoint an Environmental Control Officer (ECO). 2. Before construction commences, all areas that are to be developed and avoided must be clearly demarcated with fencing or orange construction barriers where applicable. 3. Search and rescue of indigenous species must take place. Rescued plant species must be maintained in a temporary nursery on site and re-established after the completion of construction in a suitable area on site. Animal species must be relocated to a suitable area in conjunction with the ECO. 4. The Contractor and ECO must ensure compliance with conditions described in the environmental authorisation. 5. Provide a layout plan to the ECO indicating site access and haulage routes; eating areas;, ablution facilities; material storage and handling areas; construction offices and workshops; vehicle service areas; topsoil and stockpile storage areas; and storm water control systems. Note that no permanent structures may be erected. 6. A waste area is to be established. Skips and other waste containers must be stored on an impermeable surface. Waste bins and skips must be enclosed to prevent rain water ingress.	**Employer / ECO / Contractor**	

IMPACT	PRE-CONSTRUCTION PHASE This section deals with the preparation of the site and actions that need to be implemented before construction commences	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	7. Confirm, with ECO, suitable sites for the construction camps (equipment and batching etc.) and storage areas for materials. 8. All construction equipment must be stored within this construction camp. 9. All servicing must take place within this camp on a sealed surface such as a concrete slab or else off site if necessary. 10. Training of site staff • Environmental awareness training for construction staff concerning the prevention of accidental spillage of hazardous chemicals and oil, pollution of water resources (both surface and groundwater), air pollution and litter control, and identification of archaeological artefacts. • Project Manager shall ensure that the training and capabilities of the Contractor's site staff are adequate to carry out the designated tasks. • Staff who operates equipment (such as excavators, loaders, etc.) shall be adequately trained and sensitised to any potential hazards associated with their tasks as well as avoidance of sensitive areas as demarcated. • Staff should be educated as to the need to refrain from indiscriminate waste disposal and/or pollution of local soil and water resources. • Staff should receive the necessary safety training. 11. A Standard operating procedure regarding the handling of hazardous material and waste must be compiled by the		

IMPACT	PRE-CONSTRUCTION PHASE This section deals with the preparation of the site and actions that need to be implemented before construction commences	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	Contractor, for approval by the ECO. 12. A record of all hazardous material that will be kept on site must be compiled and submitted to the ECO. 13. A temporary refuelling bay must be established. The area must have an impermeable surface, a bund wall able to contain 110% of the stored fuel capacity. The area must also be equipped with a spill kit. 14. A photographic record of the flora on site and any fauna found on site must be made before construction starts. 15. Ablution facilities must be provided in the form of chemical toilets. The Contractor must provide toilet paper and arrange for the regular cleaning and emptying of the toilets.		
Emergency procedures	16. An emergency procedure in the event of spillages, fires and environmental pollution must be compiled. The plan must include measures to identify emergencies, notification of the relevant authorities, containment measures as well as rehabilitation and monitoring, and evaluation of the effectiveness of all intervention measures. 17. In the event of soil contamination, the emergency procedure must make provision for the excavation of contaminated soil to a depth where all contaminated material is removed, as well as the safe storage and removal to a designated landfill site.	**Employer / ECO / Contractor**	
Fencing and security	18. Security measures must be implemented to prevent unauthorised access to the site	**Employer / Contractor**	

8.9. Environmental Management Program: Construction Phase

8.9.1. Site clearing

Site clearing must take place in a phased manner, in accordance with the accepted construction programme, as and when required. Areas which are not to be used for construction within a reasonable period must not be cleared, to reduce erosion risks. The area to be cleared must be clearly demarcated and this footprint strictly maintained. Spoil that is removed from the site must be removed to an approved spoil site or licensed landfill site. The necessary silt fences and erosion control measures must be implemented in areas where these risks are more prevalent, such as run-off into wetlands and sensitive biodiversity areas. Topsoil from the construction area must be neatly stockpiled ready for backfill when required.

8.10. Site establishment

Site establishment shall take place in an orderly manner and all required amenities shall be installed at the campsite before the main workforce moves onto site. The construction camp shall have the necessary ablution facilities with chemical toilets. The Contractor shall inform all site staff to make use of supplied ablution facilities and under no circumstances shall indiscriminate sanitary activities be allowed.

The Contractor shall supply waste collection bins where such is not available and all solid waste collected shall be disposed of at a registered landfill. A certificate of disposal shall be obtained by the Contractor and kept on file. Where a registered waste site is not available close to the construction site, the Contractor shall provide a method statement with regard to waste management. The disposal of waste shall be in accordance with all relevant legislation. Under no circumstances may solid waste be burnt on site.

Table 2: Construction traffic and access

IMPACT	CONSTRUCTION TRAFFIC AND ACCESS This section deals with the impact that construction traffic and access has on the site and surrounds	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**Contractor / ECO**	**Weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
Construction traffic	1. Construction routes and required access roads must be clearly defined. 2. Access of all construction and material delivery vehicles should be strictly controlled, especially during wet weather, to avoid compaction and damage to the topsoil structure. 3. Vehicles and equipment shall be serviced regularly to avoid the contamination of soil from oil and hydraulic fluid leaks etc. 4. On-site maintenance e.g. oil changes and servicing of equipment will be allowed provided that adequate preventative measures are implemented (e.g. use of drip trays and other spill prevention/response measures in particular). Dedicated locations for servicing/maintenance/oil changes should be prepared using impermeable liners. Soils compacted	**Contractor/ ECO / Employer**	**Weekly**

IMPACT	CONSTRUCTION TRAFFIC AND ACCESS This section deals with the impact that construction traffic and access has on the site and surrounds	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	by construction shall be deep ripped to loosen compacted layers and re-graded to even running levels. 5. Temporary access roads to be rehabilitated prior to the contractor leaving the site.		
Access	6. Strategic positioning of entry and exit points to ensure as little effect as possible on public traffic. 7. The main routes to the site must be clearly signposted and printed delivery maps must be issued to all suppliers and sub-contractors. 8. Planning of access routes to the site for construction purposes shall be coordinated between the Contractor, the Employer (Local Authority) and the landowner. All agreements reached should be documented and no verbal agreements should be made. The Contractor shall clearly mark all access roads. Roads not to be used shall be marked with a “NO ENTRY for construction vehicles" sign.		
Road maintenance	9. Where necessary, suitable measures shall be taken to rehabilitate damaged areas. In the event of rehabilitation work being required on private roads, such work will be done to the original or better	**Contractor / ECO**	**Weekly**

IMPACT	CONSTRUCTION TRAFFIC AND ACCESS This section deals with the impact that construction traffic and access has on the site and surrounds	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	condition of the private road. 10. Mud deposited on tarred roads by construction vehicles must be removed to prevent run-off into storm water systems and resultant siltation of surrounding water resources. 11. Contractors must ensure that access roads are maintained in good condition by attending to potholes, corrugation and storm water damages as soon as these develop. 12. If necessary, staff must be employed to clean surfaced roads adjacent to construction sites where materials have spilt.		
General	13. The Contractor shall meet safety requirements under all circumstances. All equipment transported shall be clearly labelled as to their potential hazards according to specifications. All the required safety labelling on the containers and trucks used shall be in place. 14. The Contractor shall ensure that all the necessary precautions against damage to the environment and injury to persons are taken.	**Contractor**	**Weekly**

Table 3: Construction Camp

IMPACT	CONSTRUCTION CAMP This section deals with the impacts relating to the construction camp (equipment and batching camp)	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**Contractor / ECO**	**weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
Site of construction camp	1. Choice of site for the Contractor's camp requires the construction manager and ECO's permission and must take into account location of local residents and/or ecologically sensitive areas, including flood zones and slip/unstable zones. A site plan must be submitted to the construction manager and the ECO for approval. 2. The construction camp may not be situated within the 1:100 year flood line or on slopes greater than 1:3. 3. The size of the construction camp should be minimized (especially where natural vegetation has to be cleared for its construction). 4. Adequate parking must be provided for site staff and visitors. This should not inconvenience or pose a nuisance to neighbours. 5. The Contractor must attend to drainage of the camp	**Contractor / ECO**	**Weekly**

IMPACT	CONSTRUCTION CAMP This section deals with the impacts relating to the construction camp (equipment and batching camp)	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	site to avoid standing water and/or sheet erosion. 6. Suitable control measures must be implemented over the contractor's yard, plant and material storage to mitigate any visual impact of the construction activity.		
Storage of materials (including hazardous materials)	7. Dedicated buffer zones will be identified and allocated where appropriate. Where a flood line is unknown, no development is permitted within 50 m/100 m of a watercourse. Choice of location for storage areas must take into account prevailing winds, distances to water bodies, general onsite topography and water erosion potential of the soil. Impervious surfaces must be provided where necessary. 8. Storage areas must be designated, demarcated and fenced if necessary. 9. Storage areas should be secure so as to minimize the risk of crime. They should also be safe from access by unauthorised persons i.e. children/animals etc. 10. Fire prevention facilities must be present at all storage facilities. 11. Proper storage facilities for the storage of oil, paint,	**Contractor / ECO**	**Weekly**

IMPACT	CONSTRUCTION CAMP This section deals with the impacts relating to the construction camp (equipment and batching camp)	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	grease, fuel, chemicals and any hazardous materials to be used must be provided to prevent the migration of spillage into the ground and groundwater regime around the temporary storage area(s). These pollution prevention measures for storage should include a bund wall high enough to contain at least 110% of any stored volume, and this should be sited away from drainage lines in a site with the approval of the engineer in charge. 12. These storage facilities (including any tanks) must be on an impermeable surface that is protected from the ingress of storm water from surrounding areas in order to ensure that accidental spillage does not pollute local soil or water resources. 13. Material safety data sheets (MSDSs) shall be readily available on site for all chemicals and hazardous substances to be used on site. Where possible, the available MSDSs should additionally include information on ecological impacts and measures to minimise negative environmental impacts during accidental releases or escapes. 14. Storage areas containing hazardous		

IMPACT	CONSTRUCTION CAMP This section deals with the impacts relating to the construction camp (equipment and batching camp)	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	substances/materials must be clearly signposted. 15. Staff dealing with these materials/substances must be aware of their potential impacts and follow the appropriate safety measures. 16. An approved waste disposal contractor must be employed to remove waste oil. These wastes should only be disposed of at licensed landfill sites designed to handle hazardous wastes. A disposal certificate must be obtained from the waste disposal contractor. 17. The contractor must ensure that its staff is made aware of the health risks associated with any hazardous substances used and provide them with the appropriate protective clothing/equipment in case of spillages or accidents, and that they have received the necessary training. 18. All excess cement and concrete mixes are to be contained on the construction site prior to disposal off site. 19. Any spillage which may occur shall be investigated and immediate action must be taken. In the event of significant spills (> 35 litres) of any hazardous substance, these must also be recorded and reported		

IMPACT	CONSTRUCTION CAMP This section deals with the impacts relating to the construction camp (equipment and batching camp)	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	to the ECO, DWS and the local/provincial authorities where necessary.		
Drainage of construction camp	20. Run-off from the camp site must not lead to contamination of sedimentation of neighbours' properties, roads or into adjacent wetlands, rivers, streams or sensitive environmental areas. The Contractor must employ measures to prevent storm water pollution such as silt barriers.	**Contractor / ECO**	**Weekly**
End of construction	21. Once construction has been completed on site and all excess material has been removed, the storage area shall be rehabilitated. If the area was badly damaged, seeding shall be done. Such areas shall be rehabilitated to their natural state. Any spilled concrete shall be removed, and soil compacted during construction shall be ripped, levelled and vegetated. 22. Only designated areas must be used for storage of construction materials, soil stockpiles, machinery and other equipment. 23. Specific areas must be designated for cement batching plants. Sufficient drainage for these plants must be in place to ensure that soils do not become	**Contractor / ECO**	**Weekly**

IMPACT	CONSTRUCTION CAMP This section deals with the impacts relating to the construction camp (equipment and batching camp)	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	contaminated. 24. The construction camp must be kept clear of litter at all times. 25. Spillages within the construction camp need to be cleaned up immediately and disposed of in the hazardous skip bin for correct disposal. 26. No open fires are allowed within the construction camp and no wood from surrounding vegetation may be used to create a fire.		

Table 4: Environmental education and training

IMPACT	**ENVIRONMENTAL EDUCATION AND TRAINING** This section deals with the environmental training of construction employees who will work on the Solar Park construction site	**RESPONSIBILITY**	**FREQUENCY MONITORING REQUIREMENTS**
PHASE	**CONSTRUCTION**	**ECO / Main contractor**	**Monthly**
ENVIRONMENTAL MANAGEMENT PLAN			
	MITIGATION / METHOD STATEMENT		
Environmental training	1. Ensure that all site personnel have a basic level of environmental awareness training. The Contractor must submit a proposal for this training to the ECO for approval. Topics covered should include:; • What is meant by "environment"? • Why the environment needs to be protected and conserved • How construction activities can impact on the environment • What can be done to mitigate against such impacts • Awareness of emergency and spills response provisions • Social responsibility during construction e.g. being considerate to local residents. 2. It is the Contractor's responsibility to provide the site	**ECO / Contractor**	**Monthly**

IMPACT	ENVIRONMENTAL EDUCATION AND TRAINING This section deals with the environmental training of construction employees who will work on the Solar Park construction site	RESPONSIBILITY	FREQUENCY MONITORING REQUIREMENTS
	foreman with no less that 1 hour's environmental training and to ensure that the foreman has sufficient understanding to pass this information onto the construction staff. 3. Training should be provided to the staff members in the use of the appropriate fire-fighting equipment. Translators are to be used where necessary. 4. Environmental awareness posters should be used on site. 5. The need for a "clean site" policy also needs to be explained to the workers. ***6.*** Staff operating equipment (such as excavators, loaders, etc.) shall be adequately trained and sensitised to any potential hazards associated with their tasks.		
Monitoring of environmental training	7. The Contractor must monitor the performance of construction workers to ensure that the points relayed during their environmental induction have been properly understood and are being followed.	**Contractor / ECO**	**Monthly**

Table 5: Construction

IMPACT	This section deals with the impacts relating to the construction of the upgraded sections of the Solar Park	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
PHASE	**CONSTRUCTION**	**Contractor / Employer / Engineer**	**Weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
General construction	1. Construction should be limited to daylight hours (06h00–18h00) in sensitive areas such as residential areas. Where construction is required after hours in order to avoid traffic interruptions, notification is to be sent out to all potentially affected landowners. *2.* Notification must also be issued when essential services such as water or electricity are to be affected by the construction process.	**Contractor / Engineer / Employer**	**Weekly**
Welding	3. All welding of pipelines must undergo a rigorous series of quality control testing to avoid leakages.	**Contractor / Approved Inspection Authority**	

IMPACT	This section deals with the impacts relating to the construction of the upgraded sections of the Solar Park	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
Backfilling	4. Topsoil must be segregated from subsoil. The subsoil is replaced first and then the topsoil.	**Contractor**	
Reinstatement	5. The impacted areas must be deep ripped to loosen the soil. 6. The area must then be rehabilitated according to the construction methodologies outlined in various tables of this EMPr.	**Contractor**	
Construction near Houses	7. The Employer and Contractor shall consult all affected neighbouring houses that are adjacent or in close proximity to the construction areas, e.g. within 100 m of the construction site, 2 months prior to construction activities commence. The purpose of this engagement will be to discuss what homeowners' concerns are with respect to construction activities and how these can be addressed. Applicable legislation in terms of construction are captured in the construction regulations as part of the Occupational, Health and Safety Act (OSH Act), the National Building Regulations, and SANS 1200 Section A, Standardized Specification for Civil Engineering Construction. 8. Unnecessary noise must be avoided, for example use	**Employer / Engineer / Contractor**	**2 months prior to construction**

IMPACT	This section deals with the impacts relating to the construction of the upgraded sections of the Solar Park	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	of hooters, excessive noise by construction workers, use of radio's etc.		
Dewatering of excavations	9. The Contractor compiled a method statement regarding disposal of water found underground. The method statement must be adhered to.	**Employer / Engineer / Contractor/ECO**	

Table 6: Specialised Construction Methods

IMPACT	SPECIALISED CONSTRUCTION METHODS This section deals with the impacts relating to the unique construction methods that are utilised in construction of a Solar Park	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**Contractor / Employer / Engineer**	**Bi weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
General	1. Contractor to submit detailed procedures for review to ensure any environmental issues are mitigated. The method statement will clearly outline: a. Timing of the activity b. Materials to be used c. Equipment and staffing requirements d. Proposed construction procedure designed to comply with environmental specifications e. System to be implemented to comply with environmental specifications f. Other information deemed necessary by the ECO. 2. Method statements shall be submitted 14 days prior	**Contractor**	

IMPACT	SPECIALISED CONSTRUCTION METHODS This section deals with the impacts relating to the unique construction methods that are utilised in construction of a Solar Park	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	to implementation to allow for signed approval by the ECO. 3. All modifications to method statements must be submitted in writing to the resident engineer and the ECO for approval. 4. The method statements require, but are not limited to, the following: a. Location, layout and preparation of the construction camp site and materials storage areas b. Location, layout and preparation of the concrete batching/mixing facility as well as management of the runoff from the area c. Emergency plans for hazardous substance spills and the clean-up methods to be employed d. Implementation of environmental awareness training and toolbox talks for all contractor staff members and management team		

IMPACT	SPECIALISED CONSTRUCTION METHODS This section deals with the impacts relating to the unique construction methods that are utilised in construction of a Solar Park	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	e. Solid waste management.		

Table 7: Soils and Geology

IMPACT	**SOILS AND GEOLOGY** This section deals with the impact that the proposed development will have on soils and geology	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
PHASE	**CONSTRUCTION**	**ECO / Contractor**	**Weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
	MITIGATION / METHOD STATEMENT		
Topsoil	1. The contractor should, prior to the commencement of earthworks, determine the average depth of topsoil, and agree on this with the ECO. The full depth of topsoil should be stripped from areas affected by construction and related activities prior to the commencement of major earthworks. This should include the building footprints, working areas and storage areas. Topsoil must be reused where possible to rehabilitate disturbed areas. 2. Care must be taken not to mix topsoil and subsoil during stripping. 3. Should any topsoil become polluted, the contractor must remove the polluted soil to the full depth of pollution and replace it at his own expense with	**ECO / Contractor**	**Weekly**

IMPACT	SOILS AND GEOLOGY This section deals with the impact that the proposed development will have on soils and geology	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	approved topsoil which should be at least equal to approved topsoil specifications. 4. Removed polluted topsoil should be transported to a licensed landfill site.		
Soil stripping	5. No soil stripping must take place on areas within the site that the Contractor does not require for construction works or areas of retained vegetation. 6. Subsoil and overburden in all construction and lay down areas should be stockpiled separately to be returned for backfilling in the correct soil horizon order. 7. Construction vehicles must only be allowed to utilised existing tracts or pre-planned access routes.	**ECO / Contractor**	**Weekly**
Stockpiles	8. Stockpiles should not be situated such that they obstruct natural water pathways. 9. Stockpiles should not exceed 1.5 m in height unless otherwise permitted by the Engineer. 10. Stockpiles are to be protected by installing adequate protection barriers to minimize loss of soil where practicable due to windy conditions or heavy rain, depending on the duration of the project. Dust mitigation and erosion protection measures will be	**ECO / Contractor**	**Weekly**

IMPACT	SOILS AND GEOLOGY This section deals with the impact that the proposed development will have on soils and geology	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	implemented. 11. Stockpiles should be kept clear of weeds and alien vegetation growth by regular weeding. 12. Where contamination of soil is expected, analysis must be done prior to disposal of soil to determine the appropriate disposal route. Proof of disposal from an approved waste disposal site where contaminated soils are dumped if and when a spillage/leakage occurs, should be forwarded to the GDARD.		
Fuel storage	13. Topsoil and subsoil to be protected from contamination. 14. Fuel and material storage must be away from stockpiles. 15. Provisions should be made to contain spillages or overflows into the soil. 16. Any storage tanks containing hazardous materials must be placed in bunded containment areas with sealed surfaces. The bund walls must be high enough to contain 110% of the total volume of the stored hazardous material. 17. Contaminated soil must be contained and disposed	**ECO / Contractor**	**Weekly**

IMPACT	SOILS AND GEOLOGY This section deals with the impact that the proposed development will have on soils and geology	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	of off-site at an approved landfill site. Records of disposal to be forwarded to GDARD.		
Concrete mixing	18. The concrete batching plant must be contained within a bunded area. 19. Concrete mixing must only take place within designated areas. 20. Ready mixed concrete must be utilised where possible. 21. No vehicles transporting concrete to the site may be washed on site. 22. If a batching plant is necessary, run-off should be managed effectively to avoid contamination of other areas of the site. Untreated run-off from the batch plant must not be allowed to get into the storm water system or any rivers, streams, wetlands or existing erosion channels / dongas.	**ECO / Contractor**	**Weekly / Monthly**
Earthworks	23. All earthworks must be adequately controlled and managed. 24. Soils compacted during construction should be deeply ripped to loosen compacted layers and re-graded to even running levels. Topsoil should be re-spread over landscaped areas. According to	**ECO / Contractor**	**Weekly**

IMPACT	SOILS AND GEOLOGY This section deals with the impact that the proposed development will have on soils and geology	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	specifications by the developer's landscape architect the area should be re-vegetated upon completion of construction activities		
Herbicides / pesticides	25. Herbicides should not be used excessively and slow release fertilizers and organic products should be used in preference to highly soluble and inorganic fertilizers. 26. The use of herbicides and pesticides and other horticultural chemicals should be carefully controlled wherever these are used. Where feasible, 'environmentally friendly' products should be utilised.	**ECO / Contractor**	**Weekly**

Table 8: Erosion Control

IMPACT	EROSION CONTROL This section deals with the impact that the proposed development will have with regards to potential erosion	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**ECO / Contractor**	**Bi Monthly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
General	1. Wind screening and storm water control should be undertaken to prevent soil loss from the site. 2. The use of silt fences and sand bags must be implemented in areas that are susceptible to erosion. 3. Other erosion control measures that can be implemented are as follows: • Brush packing with cleared vegetation • Mulch or chip packing • Planting of vegetation • Hydroseeding / hand sowing. 4. Sensitive areas need to be identified prior to construction so that the necessary precautions can be implemented. 5. All erosion control mechanisms need to be regularly maintained. 6. Retention of vegetation where possible to avoid soil	**ECO / Contractor**	**Bi Monthly**

IMPACT	EROSION CONTROL This section deals with the impact that the proposed development will have with regards to potential erosion	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	erosion 7. Vegetation clearance should be phased to ensure that the minimum area of soil is exposed to potential erosion at any one time. 8. Re-vegetation of disturbed surfaces should occur immediately after construction activities are completed. 9. No impediment to the natural water flow other than approved erosion control works and DWS approved wetland management is permitted. 10. To prevent storm water damage, the increase in storm water run-off resulting from construction activities must be estimated and the drainage system assessed accordingly. A drainage plan must be submitted to the Project Manager for approval and must include the location and design criteria of any temporary installations. 11. Stockpiles not used in three (3) months after stripping must be seeded to prevent dust and erosion, only if natural seeding does not occur.		

Table 9: Ground and surface water pollution

IMPACT	GROUNDWATER AND SURFACE WATER POLLUTION This section deals with the impact that the construction and operation of the development could have on Ground and surface water pollution	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**ECO / Contractor**	**Weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
Sanitation	1. Adequate sanitary facilities and ablutions must be provided for construction workers (1 toilet per every 15 workers). 2. The facilities must be regularly serviced to reduce the risk of surface or groundwater pollution.	**ECO / Contractor**	**Weekly**
Hazardous materials	3. Use and/or storage of materials, fuel and chemicals which could potentially leak into the ground must be controlled. 4. All storage tanks containing hazardous materials must be placed in bunded containment areas with sealed surfaces. The bund walls must be high enough to contain 110% of the total volume of the stored hazardous material with an additional allocation for potential storm water events.	**ECO / Contractor**	**Weekly**

IMPACT	GROUNDWATER AND SURFACE WATER POLLUTION This section deals with the impact that the construction and operation of the development could have on Ground and surface water pollution	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	5. Any hazardous substances must be stored at least 50 m from any of the water bodies on site. 6. The ECO should be responsible for ensuring that potentially harmful materials are properly stored in a dry, secure, ventilated environment, with concrete or sealed flooring and a means of preventing unauthorised entry. 7. Contaminated wastewater must be managed by the Contractor to ensure existing water resources on the site are not contaminated. All wastewater from general activities in the camp shall be collected and removed from the site for appropriate disposal at a licensed commercial facility.		
Concrete / cement mixing	8. Concrete/cement contaminated water must be detained, settled and pH tested before allowed to enter the water system as this disturbs the natural acidity of the soil and affects plant growth. Only neutral (pH 6-8) water may be allowed to enter water systems.	**ECO / Contractor**	**Weekly**
Waste and waste water	9. Food preparation areas should be provided with	**ECO / Contractor**	**Weekly**

IMPACT	GROUNDWATER AND SURFACE WATER POLLUTION This section deals with the impact that the construction and operation of the development could have on Ground and surface water pollution	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	adequate washing facilities and food refuse should be stored in sealed refuse bins which should be removed from site on a regular basis. 10. The contractor should take steps to ensure that littering by construction workers does not occur and persons should be employed on site to collect litter from the site and immediate surroundings, including litter accumulating at fence lines. 11. No washing of vehicles except at designated sites.		
Water resources	12. Site staff shall not be permitted to use any other open water body or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing. 13. Municipal water (or another source accepted by the ECO and Project manager) should instead be used for all activities such as washing of equipment, dust suppression, concrete mixing, compacting, or for any construction or related activities. 14. Department of Water Sanitation and the ECO as well as other Emergency contact numbers provided by the	**ECO / Contractor**	**Weekly**

IMPACT	GROUNDWATER AND SURFACE WATER POLLUTION This section deals with the impact that the construction and operation of the development could have on Ground and surface water pollution	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	Municipality should be contacted in order to deal with spillages and contamination of aquatic environments.		
SITE SPECIFIC MITIGATION MEASURES			
General	15. Ensure that surface/storm water is diverted away from excavation trenches. 16. Ensure that stream flow can bypass construction site. 17. Ensure that contaminants are safely stored and away from construction site.	**ECO / Contractor**	**Weekly**

Table 10: Hydrology and Storm water

IMPACT	HYDROLOGY AND STORMWATER This section deals with the impact that the construction and operation of the development could have on hydrology and storm water	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**ECO / Contractor**	**weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
General	1. The site must be managed in order to prevent pollution of drains, downstream watercourses or groundwater, due to suspended solids, silt or chemical pollutants. 2. Silt fences should be used to prevent any soil entering the storm water drains. 3. Temporary cut-off drains and berms may be required to capture storm water and promote infiltration. 4. Promote water saving mind-set with construction workers in order to ensure less water wastage. 5. New storm water construction must be developed strictly according to specifications from engineers in order to ensure efficiency.	**ECO / Contractor**	**weekly**

	6. Hazardous substances must be stored at least 20 m from any water bodies on site to avoid pollution. 7. The installation of the storm water system must take place as soon as possible to attenuate storm water from the construction phase as well as the operation phase. 8. Earth, stone and rubble is to be properly disposed of so as not to obstruct natural water path ways over the site. I.e. these materials must not be placed in storm water channels, drainage lines or rivers. 9. There should be a periodic checking of the site's drainage system to ensure that the water flow is unobstructed. 10. If a batching plant is necessary, run-off should be managed effectively to avoid contamination of other areas of the site. Untreated runoff from the batch plant must not be allowed to get into the storm water system or nearby streams, rivers or erosion channels or dongas.		

Table 11: Air Quality

IMPACT	**AIR POLLUTION** This section deals with the impact from air pollution	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
PHASE	**CONSTRUCTION**	**ECO / Contractor**	**Daily**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
Dust control	1. To prevent dust nuisance a maintenance crew will be utilised to clean roads. 2. Retention of vegetation where possible will reduce dust travel 3. Excavations and other clearing activities must only be done during agreed working times and permitting weather conditions to avoid drifting of sand and dust into neighbouring areas. 4. Damping down of all exposed soil surfaces with a water bowser or sprinklers when necessary to reduce dust. 5. Blasting must be carried out in accordance with legislation using optimal and not excessive quantities of explosives. Blasting should where practical be restricted to calm days in order to reduce dust carry. The geotechnical report indicated that the probability of blasting is low.	**ECO / Contractor**	**Daily**

IMPACT	AIR POLLUTION This section deals with the impact from air pollution	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	6. The Contractor shall be responsible for dust control on site to manage potential nuisance caused to the Landowner or neighbouring Communities. 7. Any complaints or claims emanating from the lack of dust control shall be attended to immediately by the Contractor.		
Odour control	8. All construction vehicles must comply with relevant vehicle emissions standards 9. Regular servicing of on-site toilets to avoid potential odours. 10. Allocated cooking areas must be provided. 11. The contractor must make alternative arrangements (other than fires) for cooking and/or heating requirements. LP gas cookers may be used provided that all safety regulations are followed.	**ECO / Contractor**	**Weekly**
Rehabilitation	12. The contractor should commence rehabilitation of exposed soil surfaces as soon as practical after completion of earthworks.	**ECO / Contractor**	**After completion of earthworks**
Fire prevention	13. The contractor must ensure that any grass left in a natural state within 10m of the construction servitude during construction should be cut in order to prevent veld fires, especially during the dry months. 14. No open fires shall be allowed on site under any	**ECO / Contractor**	**Weekly**

IMPACT	AIR POLLUTION This section deals with the impact from air pollution	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	circumstance (The Forest Act, No 122 of 1984). All cooking shall be done in demarcated areas that are safe and cannot cause runaway fires. 15. The Contractor shall have operational fire-fighting equipment available on site at all times. The level of firefighting equipment must be assessed and evaluated through a typical risk assessment process. It may be required to be increase the level of protection during the winter months.		

Table 12: Noise

IMPACT	**NOISE** This section deals with the impact that increased noise will have on surrounding areas	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
PHASE	**CONSTRUCTION**	**Main Contractor /ECO**	**Daily**
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			

IMPACT	**NOISE** This section deals with the impact that increased noise will have on surrounding areas	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
General	1. The construction phase must aim to adhere to the relevant noise regulations and limit noise to within standard working hours in order to reduce disturbance of residential areas in close proximity to the development. 2. Construction site yards, workshops, concrete batching plants, and other noisy fixed facilities should be located where possible away from noise sensitive areas. Once the proposed final layouts are made available by the contractor(s), the sites must be evaluated by the Contractor and specific measures designed in to the system as far as practical. 3. Truck traffic should be routed away from noise sensitive areas, where possible. 4. Noise levels must be kept within acceptable limits. All noise and sounds generated must adhere to SANS 10103 specifications for maximum allowable noise levels for residential areas. No pure tone sirens or hooters may be utilised except where required in terms of SABS standards or in emergencies. 5. Noisy operations should be combined so that they occur where possible at the same time. 6. Blasting operations (if required) are to be strictly controlled as per all safety regulations. Due notification to the public must be made, which provide information on the time, place and date of the blast.	**Main Contractor/ ECO**	**Daily**

IMPACT	**NOISE** This section deals with the impact that increased noise will have on surrounding areas	**RESPONSIBILITY**	**FREQUENCY / MONITORING REQUIREMENTS**
	7. Construction activities are to be contained to reasonable hours during the day and early evening. Night-time activities near noise sensitive areas should not be allowed. 8. With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents on how best to minimise impact, and the local population should be kept informed of the nature and duration of intended activities. 9. As construction workers operate in a very noisy environment, it must be ensured that their working conditions comply with the requirements of the Occupational Health and Safety Act (Act No 85 of 1993). Where necessary ear protection gear should be worn. 10. Noisy activities to take place during allocated construction hours only. 11. Noise from labourers must be controlled. 12. The contractor must take measures to discourage labourers from loitering in the area and causing noise disturbance. Where possible labour shall be transported to and from the site by the contractor or his Sub-Contractors by the contractors own transport.		

Table 13: Flora

IMPACT	FLORA This section deals with the impact that the development will have on flora on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**ECO / Contractor**	**weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
	MITIGATION / METHOD STATEMENT		
Existing vegetation	1. Existing indigenous vegetation must be retained where possible. 2. A follow up vegetation survey should be conducted before site clearing to demarcate vegetation that should remain and remove and relocate any plants of botanical or ecological significance. 3. Vegetation to be removed as it becomes necessary. 4. Materials should not be delivered to the site prematurely which could result in additional areas being cleared or affected. 5. No existing vegetation to be used for firewood on site.	**ECO / Contractor**	**Weekly**
Rehabilitation	6. All damaged areas shall be rehabilitated upon completion of the contract in accordance with design	**ECO / Contractor**	**Weekly**

IMPACT	FLORA This section deals with the impact that the development will have on flora on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	specifications. In accordance with the Conservation of Agricultural Resources Act, Act No 43 of 1983, slopes in excess of 2% must be contoured and slopes in excess of 12% must be terraced. Extra seed shall be sown on disturbed areas as directed by the ECO (see below for specifications). Other methods of rehabilitating disturbed sites may also be used at the discretion of the Contractor; and approved by ECO to comply with the EMPr, e.g. stone pitching, logging, etc. Contour banks shall be spaced according to the slopes. The type of soil shall also be taken into consideration. 7. Rehabilitation must take place as soon as construction is complete to avoid the infiltration of alien species and soil erosion within the site. 8. Rehabilitation process should be monitored and maintained throughout the construction phase and post construction phase until rehabilitation has been successfully completed 9. Appropriate indigenous vegetation must be planted on the site to -attract avi-fauna, reptiles and small mammals back into the area		

IMPACT	FLORA This section deals with the impact that the development will have on flora on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
Permits	10. Permits for removal of any protected species must be obtained from Provincial Nature Conservation should such species be affected.	**ECO / Contractor**	**Weekly**
Demarcation of construction site	11. All natural vegetation not interfering with the site construction shall be left undisturbed, clearly marked and indicated on the site plan. 12. The construction area must be well demarcated and no construction activities must be allowed outside of this demarcated footprint. 13. Areas which are identified by the ECO as being ecologically sensitive and which are adjacent to any construction work are to be suitably demarcated to prevent damage by labour and equipment. 14. Vegetation removal must be phased in order to reduce impact of construction. 15. Construction site office and laydown areas must be clearly demarcated and no encroachment must occur beyond demarcated areas. 16. Where the route passes intact vegetation (but does not impact on it), a buffer zone should be established to ensure that construction activities do not extend into these areas.	**ECO / Contractor**	**Weekly**

IMPACT	FLORA This section deals with the impact that the development will have on flora on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	17. Soils must be kept free of petrochemical solutions that may be kept on site during construction. Spillage can result in a loss of soil functionality thus limiting the re-establishment of flora. 18. Daily environmental auditing must take place		
Utilisation of resources	19. All construction staff are prohibited from gathering of firewood, fruit, muthi plants, or any other natural material onsite or in areas adjacent to the site is prohibited unless with prior approval of the ECO.	**ECO / Contractor**	**Weekly**
Exotic vegetation	20. All exotic vegetation must be removed from site. 21. Alien vegetation on the site will need to be controlled in terms of Government Notice R1048. 22. The contractor should be responsible for implementing a programme of weed control (particularly in areas where soil has been disturbed); and grassing of any remaining stockpiles to prevent weed invasion. 23. The spread of exotic species occurring throughout the site should be controlled.	**ECO / Contractor**	**Weekly**
Herbicides	24. Herbicide use shall only be allowed with the approval of the Employer and according to relevant contract specifications. The application shall be according to	**ECO / Contractor / Employer**	**Weekly**

IMPACT	FLORA This section deals with the impact that the development will have on flora on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	set specifications and under supervision of a qualified technician. The possibility of leaching into the surrounding environment shall be properly investigated and only environmentally friendly herbicides shall be used. 25. The use of pesticides and herbicides within the servitude must be discouraged as this will impact on important pollinator species of indigenous vegetation.		

Table 14: Waste management

IMPACT	WASTE MANAGEMENT This section deals with the impact from waste by the development	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**Main Contactor / ECO**	**Weekly**
ENVIRONMENTAL MANAGEMENT PLAN			
	MITIGATION / METHOD STATEMENT		
Construction rubble	1. All rubble from demolition activities must either be used on site as part of the existing development, or must be taken off the reserve and disposed of at an approved site. 2. Rubble must not be dumped on site but must be placed within a skip bin for regular removal. 3. Construction rubble shall be disposed of in pre – agreed, demarcated spoil dumps that have been approved by the relevant EMM. 4. Construction waste/rubble may not be burned or buried on site.	**Main Contactor / ECO**	**Weekly**
Litter management / housekeeping	5. Refuse bins must be placed at strategic positions to ensure that litter does not accumulate within the construction site. 6. A housekeeping team should be appointed to	**Main Contactor / ECO**	**Weekly**

IMPACT	WASTE MANAGEMENT This section deals with the impact from waste by the development	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	regularly maintain the litter and rubble situation on the construction site. 7. If possible and feasible, all waste generated on site must be separated into glass, plastic, paper, metal and wood and recycled. An independent contractor can be appointed to conduct this recycling. 8. Littering by the employees of the Contractor shall not be allowed under any circumstances. The ECO shall monitor the neatness of the work sites as well as the Contractor campsite. 9. Skip waste containers should be maintained on site. These should be kept covered and arrangements made for them to be collected regularly form the site by the local council. 10. All waste must be removed from the site and transported to a landfill site as approved by the relevant Municipality. 11. Waybills providing disposal at each site shall be provided to the Engineer's and ECO inspection.		
Hazardous waste	12. All waste hazardous materials must be carefully stored as advised by the ECO, and then disposed of offsite at a licensed landfill site.	**Main Contactor / ECO**	**Weekly**

IMPACT	WASTE MANAGEMENT This section deals with the impact from waste by the development	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	13. Contaminants to be stored safely to avoid spillage. 14. Waste contaminated by biological waste must be disinfected before disposal. 15. Machinery must be properly maintained to keep oil leaks in check.		
Sanitation	16. The Contractor shall install mobile chemical toilets on the site. 17. Staff shall be sensitised to the fact that they should use these facilities at all times. No indiscriminate sanitary activities on site shall be allowed. 18. Ablution facilities shall be within 100m from workplaces but not closer than 50m from any natural water bodies or boreholes. There should be enough toilets available to accommodate the workforce (minimum requirement 1: 15 workers). Male and females must be accommodated separately where possible. 19. Toilets shall be serviced regularly and the ECO shall inspect toilets regularly. 20. Toilets should be no closer than 100m or above the 1:100 year flood line from any natural or manmade water bodies or drainage lines or alternatively	**Main Contactor / ECO**	**Weekly**

IMPACT	WASTE MANAGEMENT This section deals with the impact from waste by the development	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	located in a place approved of by the Engineer. 21. Under no circumstances may open areas, neighbours fences or the surrounding bush be used as a toilet facility. 22. Potable water must be provided for all construction staff.		
Remedial actions	23. Depending on the nature and extent of the spill, contaminated soil must be either excavated or treated on-site. 24. Excavation of contaminated soil must involve careful removal of soil using appropriate tools/machinery to storage containers until treated or disposed of at a licensed hazardous landfill site. 25. The ECO must determine the precise method of treatment of polluted soil. This could involve the application of soil absorbent materials as well as oil-digestive powders to the contaminated soil. 26. If a spill occurs on an impermeable surface such as cement or concrete, the surface spill must be contained using oil absorbent material. 27. If necessary, oil absorbent sheets or pads must be attached to leaky machinery or infrastructure.	**Main Contactor / ECO**	**Weekly**

IMPACT	WASTE MANAGEMENT This section deals with the impact from waste by the development	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	28. Materials used for the remediation of petrochemical spills must be used according to product specifications and guidance for use. 29. Contaminated remediation materials must be carefully removed from the area of the spill so as to prevent further release of petrochemicals to the environment, and stored in adequate containers until appropriate disposal.		

Table 15: Cultural and heritage artefacts

IMPACT	CULTURAL AND HERITAGE ARTEFACTS This section deals with the impact that the new development has on potential archaeological artefacts of the site	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**CONSTRUCTION**	**Contractor / ECO**	**Monthly**
ENVIRONMENTAL MANAGEMENT PLAN			
	MITIGATION / METHOD STATEMENT		
General	1. Any finds must be reported to the nearest National Monuments office to comply with the National Heritage Resources Act (Act No 25 of 1999) and to GDARD. 2. Local museums as well as the South African Heritage Resource Agency (SAHRA) should be informed if any artefacts are uncovered in the affected area. 3. The contractor must ensure that his workforce is aware of the necessity of reporting any possible historical or archaeological finds to the ECO so that appropriate action can be taken. 4. Any discovered artefacts shall not be removed under any circumstances. Any destruction of a site can only be allowed once a permit is obtained and the site has	**Contractor / ECO**	**Monthly**

	been mapped and noted. Permits shall be obtained from the South African Heritage Resources Association (SAHRA) should the proposed site affect any world heritage sites or if any heritage sites are to be destroyed or altered. 5. Should any archaeological sites/graves be uncovered during construction, their existence shall be reported to EMM immediately. 6. If grave sites are uncovered during construction, work must immediately be stopped in the area and the find must be reported to SAHRA as well as the South African Police Service for further investigation.		

Operational EMPr

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
PHASE	**Operational**	**Environmental officer (EO)**	
ENVIRONMENTAL MANAGEMENT PLAN			
MITIGATION / METHOD STATEMENT			
Existing vegetation	1. Existing indigenous vegetation must be retained where in terms of the approved lay-out plan	**EO**	**Quarterly**
Exotic vegetation	2. All exotic vegetation must be removed from site. 3. Alien vegetation on the site will need to be controlled in terms of Government Notice R1048. 4. The spread of exotic species occurring throughout the site should be controlled.	**EO**	**Quarterly**
Herbicides	5. Herbicide use shall only be allowed with the approval of the EO and according to relevant contract specifications. The application shall be according to set specifications and under supervision of a qualified technician. The possibility of leaching into the surrounding environment shall be properly	**EO**	**Quarterly**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	investigated and only environmentally friendly herbicides shall be used. 6. The use of pesticides and herbicides within the servitude must be discouraged as this will impact on important pollinator species of indigenous vegetation.		
Air Quality	7. In terms of the requirements of the Air Emission Licence (AEL), air quality monitoring and reporting must be undertaken in terms of the Air Quality Management Act	**EO**	**As per the requirements of the AEL**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.1. **General Waste management**	8. A sufficient number of containers must be strategically placed to handle the amount of litter, waste, rubbish and debris generated by the development. All refuse bins must have a lid secured so that animals and insects cannot gain access. 9. Under no circumstances may any waste be burnt. 10. All waste must be disposed of at a registered site or as otherwise agreed upon with the regulatory authorities. It is the management bodies' responsibility to ensure that the contracted party responsible for waste disposal disposes of the waste in a legal manner. 11. Waste must be segregated to facilitate re-use and recycling. 12. Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess to plant needs. 13. Instituting procurement measures that recognise opportunities to return usable materials such as containers and which prevents the over ordering of materials. 14. Minimising hazardous waste generation by implementing stringent waste segregation to prevent the commingling of non-hazardous and hazardous	**EO**	**weekly**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	waste to be managed.		
8.10.2. Oil and chemicals	15. These substances must be confined to designated, secured areas in a way that does not pose a danger of pollution even during times of high rainfall. The oil and chemical storage areas must be imperviously bunded with adequate containment (at least 110% of the volume of the fuel) for potential spills. 16. Spill kits must be available on site and in all vehicles that transport toxic substances for dispensing. Spill kits must be made up of material/product that is environmentally suitable (Sunsorb^{TM} is a recommended product that is environmentally friendly). 17. All spilled hazardous substances must be contained in impermeable containers for removal to a licensed hazardous waste site, (this includes contaminated soils, and drenched spill kit material). 18. Contaminated/hazardous materials must be disposed of at permitted hazardous landfill site	**EO**	**weekly**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.3. **Storm Water Management**	19. A Storm Water Management Plan should be drawn-up for the operational phase of the project. The Plan must be implemented and the related infrastructure maintained for the life of the operations. Design measures to be considered are: 20. Silt traps 21. Entrainment of particles and debris from ash and biomass storage areas 22. Entrainment of pollution from leaking waste and chemical containment areas 23. Ponding of storm water on site 24. Large scale concentrated run-off from impervious areas onto neighbouring properties, causing secondary problems at that site, as well as erosion channels. 25. Cognisance must be taken of the section on Rain Water Harvesting in this EMPr, when compiling the storm water management plan. 26. The storm water management plan must be implemented in full. A report on the successful implementation and water quality run-off must be submitted to the Competent Authority after the first rain with respect to commencement of operations.	**EO**	**weekly**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.4. **Noise pollution**	27. A noise impact assessment by an independent and qualified person will have to be conducted once the plant is in full operation. Should it be found that excessive levels of noise is being generated, the required engineering controls must be instituted in order to bring noise levels down to acceptable levels. 28. Screening off areas which generate high levels of noise in an environmentally friendly manner may be necessary. It may also be necessary to limit certain activities responsible for excessive noise, to between 7pm and 7 am.	**EO**	**First month after start of operations**
8.10.5. **Safety and Security**	29. An emergency plan (including fire management) must be developed and i**mplemented for maintenance during operations.**	**EO**	**Ongoing**
8.10.6. Stack emissions from the glass manufacturing plant	**a) Control equipment:** The following constituents are expected from stack emissions on site: i. Particulate matter (PM_{10} and $PM_{2.5}$) ii. NOx iii. SOx iv. CO Adequate air quality control equipment has to be	**EO**	**Ongoing**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	installed to ensure that stack emissions comply with the NEMAQA. In the event that the air quality control equipment is non-operational, operation of the furnace must be ceased immediately until the equipment is fully operational. Stack emissions from the collection chamber may not cause secondary pollution or nuisances. Collected fly-ash must be stored in containers with lids. During the collection of fly-ash, personnel must be equipped with appropriate face masks to prevent inhaling of fine particulate matter. Fly-ash must be disposed of to an appropriate licenced landfill site. . All safe disposal certificates will be retained on site. The quantity of fly-ash stored will not exceed $35m^3$ (to be calculated cumulatively with other hazard waste on site) at any time. **b) Monitoring:** Annual isokinetic sampling must be undertaken by a qualified person to ensure that stack emissions comply with the NEMAQA. **c) Operation of the furnace:** An important factor for emission control and reduction are proper fuel preparation and fuel input. To reduce		

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	emissions, the fuel should be fed to the furnace at a constant flow and have a constant (as far as is reasonably possible) calorific value. Operational optimisation is also a critical factor to limit stack emissions. For example the regulation of primary and secondary air flow should be closely monitored. For the purposes of optimal operation of the boiler, a suitably qualified person must be appointed to oversee furnace operations. Shutdown and start-up of the furnaceshould be minimised as far as reasonably possible. **d) Maintenance** An Operation and Maintenance manual must be compiled to ensure optimal functioning of the furnace **e) Stack Height** The stack height must be designed accordingly to avoid excessive ground level concentrations due to downwash, wakes, and eddy effects, and to ensure reasonable diffusion to minimise impacts.		

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.7. **Dust Control**	30. The drop to the ash hopper and ash stockpile should be minimised (or enclosed) to reduce the generation of fugitive dust. 31. Dust control measures must be implemented for the transport of raw materials and final products. 32. Dust suppression measures must be applied to all dirt roads on site 33. Dust and mud should be controlled at vehicle exit and entry points to prevent the dispersion of dust and mud beyond the site boundary. Facilities for the washing of vehicles could be provided at the entry and exit points. 34. A speed limit of 40 km/h should be set for all vehicles travelling over exposed areas. Traffic over exposed areas should be kept to a minimum **35.** During the transfer of material to piles, drop heights should be minimised to control the dispersion of materials being transferred. **36.** Dust fall-out must be measured (in line with the national Dust Control regulations: R 827 of 1 November 2013) to ensure that dust levels remains within legal limits. **i. Vehicle Emissions**	**EO**	**Ongoing**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	37. Maintenance of trucks to prevent inefficient combustion and high emission rates of exhaust gasses, must be done at the required intervals		

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.8. **Conserving water resources**	Water must be conserved through the following measures: 38. Use of a closed circuit dry cooling system for all manufacturing units 39. Use of potable water with high pressure hoses to wash motor vehicles and clean paved areas is prohibited 40. Identification of and repair of condensate leaks, and repair of all failed traps must be undertaken as soon as possible 41. Minimising de-aerator heating 42. Re-use of grey water (fin which only bio-degradable soap has been used) can be used for dust suppression 43. Implementation of rain water harvesting from roofs and impervious areas (where practical) must be investigated and implemented. Water thus harvested may not be used as potable water, but is suitable for dust suppression, ablution. Personnel on site must be made aware that this water is not for drinking purposes. Signs to this effect must be indicated on holding tanks. **44.** Any water leak will be repaired as soon as possible, but within 8 hours.	**EO**	**Ongoing**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.9. **Prevention of water pollution**	• Discharges of process wastewater, sanitary wastewater, and wastewater from utility operations or polluted storm water to surface water will not be allowed, unless authorisation has been obtained to do so. Discharges should not result in contaminant concentrations in excess of local or national ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality, or as defined by conditions attached to an authorization. 45. Land application of waste water may not be undertaken, unless permission from the competent authority has been obtained.	**EO**	**Ongoing**
8.10.10. **Secondary Containment**	46. Secondary containment (bunding) must be maintained around all hazardous liquids. The bunding must be able to contain 110% of the volumes stored.	**EO**	**Ongoing**
8.10.11. **Traffic safety**	It is envisaged that traffic volumes will increase on the roads in the immediate vicinity of the plant. The following measures must be implemented: • Driver road safety awareness – including other motorised road users, pedestrians and animals • Signage should indicate slow moving vehicles	**EO**	**Ongoing**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	such as tractors on roads frequented by such vehicles • Regular vehicle maintenance		

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.12. **Re-fuelling of vehicles**	Should refuelling of vehicles takes place on site, the following measures must be implemented: • Re-fuelling must take place in a designated area on an impervious concrete surface • The re-fuelling area must allow for spill containment • Spill kits must be kept in the re-fuelling area	**EO**	**Ongoing**
8.10.13. **Cleaning solution of membrane filter media**	Cleaning solution will be contained in spill-proof, impermeable containers stored in a concrete bunded area. The bunded area will be able to hold 110% of the volumes stored and will be protected from rain water ingress by a roof structure. The containment area will be an integral part of the water conditioning plant to prevent the conveyance of the solution over a longer distance. The cleaning solution will be decanted from the conditioning water treatment plant via a direct pipe connection to the storage containers. The decanting and storage infrastructure will all be housed on a bunded concrete floor under a roof structure to prevent rainwater ingress. 47. The cleaning solution will be removed by a company registered to transport hazardous material. Removal	**EO**	**Ongoing**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
	for disposal will take place to a registered hazardous waste site. All safe disposal certificates will be retained on site. The quantity of solution stored will not exceed 35m^3 (to be calculated cumulatively with other hazard waste on site) at any time.		

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.14. Environmental Pollution incidents	An emergency response protocol must be drawn up. The protocol must make provision for different levels of incidences/emergencies and prescribe the actions that have to be taken. All environmental incidents must be reported immediately to the EO. In the event of a spillage, the required containment measures must be instituted immediately. The EO must investigate the incidence as soon as possible and ensure that the required containment/mitigatory measures have been taken. The EO must investigate the site after the incident has been contained and recommend clean-up and rehabilitation measures if required and ensure that these are implemented. The EO may issue instructions to stop any activity which leads to environmental degradation or which are outside the scope of the environmental authorisation. All incidences must be recorded and described in an incidence/emergency register. Close-out of the incident must be monitored by the EO. All major incidences (as per Section 30 of NEMA) must be reported to the relevant authorities within 14 days.	**EO**	

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.15. Operation of sewage package plant	48. The package plant must be paced on an impermeable concrete surface within a bund wall. 49. Pipelines to and from the package plant must be installed above ground, and tested for integrity before being used. 50. A flow meter should be installed at the outflow chamber as well as in the receiving chamber of the demin plant. The flow meters should be compared to test the water balance to identify any effluent losses in the pipeline. The pipelines should be checked on a daily basis to identify leakages. 51. The effluent and pipelines should be clearly marked with signage to indicate that the effluent is not suitable for drinking water purposes.	**EO**	**Daily**
8.10.16. Environmental audits	The new Regulations (R982 of 4 December 2014) require the execution of external compliance audits regarding adherence to the EMPr and submission of audit reports to the Environmental Department. The Environmental Authorisation will specify the required frequency of the environmental audits.	**EO**	**As per the legal requirements specified in the Environmental Authorisation**
8.10.17. Environmental Management System (EMS)	52. An EMS must be developed for the site with the aim of ISO 14001 certification	**EO**	**Ongoing**

IMPACT	This section deals with the impact that the development will have on site and in the surrounding areas	RESPONSIBILITY	FREQUENCY / MONITORING REQUIREMENTS
8.10.18. Occupational health and safety (OHS)	53. An OHS system must be developed for the manufacturing plant with the aim of ISO 18000 certification	**EO**	**Ongoing**

Decommissioning

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Should it become evident that operations are to be discontinued, a decommissioning plan must be complied in order to ensure: • The safety of the structures that is left behind • That all hazardous materials are removed from site • That all combustible materials are removed from site	Safety and Pollution prevention	No safety incident and no environmental pollution	Site manager or delegated person	On closure

• That all ash is removed from site • That all waste is safely disposed • That boreholes are securely closed to prevent accidents • That storm water containment structures are dismantled to allow for the free flowing of water on par with pre-construction conditions • That all residual polluted areas are adequately rehabilitated • That all disturbed areas are re-vegetated with suitable specie.				

9. Working Documents

Environmental Incident Log

DATE	ENVIRONMENTAL CONDITION	COMMENTS (Include any possible explanations for current condition and possible responsible parties. Include photographs, records etc. if available)	CORRECTION ACTION TAKEN	SIGNATURE

METHOD STATEMENT

CONTRACT:…… **DATE**:…….

WHAT WORK IS TO BE UNDERTAKEN (give a brief description of the works):

WHERE ARE THE WORKS TO BE UNDERTAKEN (where possible, provide an annotated plan and a full description of the extent of the works):

START AND END DATE OF THE WORKS FOR WHICH THE METHOD STATEMENT IS REQUIRED:

Start Date:…….. **End Date:**…….

HOW ARE THE WORKS TO BE UNDERTAKEN (provide as much detail as possible, including annotated sketches and plans where possible): * Note: please attach extra pages if more space is required

DECLARATIONS for Method Statement [ ]

1) ENGINEER

The work described in this Method Statement, if carried out according to the methodology described, is satisfactory to prevent or control environmental harm and is thus approved:

_____ _____

(Signed) (Print name)

Dated:._____

2) CONTRACTOR

I understand the contents of this Method Statement and the scope of the works required of me. I further understand that this Method Statement may be amended on application to and with approval by the Engineer, and that the SHE Coordinator, Construction Manager and ECO will audit my compliance with the contents of this Method Statement

_____ _____

(Signed) (Print name)

_____

Dated: _____

Complaints Record Sheet

COMPLAINTS RECORD SHEET	File Ref: Page …. of ….	DATE:……
COMPLAINT RAISED BY:		
CAPACITY OF COMPLAINANT:		
COMPLAINT RECORDED BY:		
COMPLAINT:		
PROPOSED REMEDIAL ACTION:		

ECO: _____ Date: _____
NOTES BY ECO:
ECO: _____ Date: _____ Site Manager: _____ Date: _____

9.1. Environmental Audit reports

10. AUDIT CHECKLIST PROFORMA

AUDIT NO…… **AUDIT DATE……/……./……**

ITEM REFERENCE NO.	SPECIFIC SYSTEM/PROCEDURE REQUIREMENT	COMPLY YES/NO	COMMENTS

Environmental Audit Checklist

Auditee: Environmental Auditor:

Location of Audit: Date:

	#Item Ref. No.	Requirement	*Compliance	Comment
1				
2				
3				
4				
5				
6				
7				

8				

[#]Refers to the reference number in the contract documentation (Eg. EMPr Pt 3.8.1; Specie Pt 150 'General').

*C = Compliance; NC = Not Complying; PC = Partial Compliance

Other evidence

Include any photos or other evidence obtained whilst conducting the audit. Ensure these are referred to in the text of the report.

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