STORMWATER AND DRAINANGE MANAGEMENT PLAN

Batho-Batho PV Solar Facility

Client	Sinetech
Original Project Name	Batho-Batho PV Facility
Project Number	1523
Description	Stormwater and Drainage Management Report Rev 1
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PROJECTS & INDUSTRIAL ENGINEERING (Pty) Ltd

SUMMARY SHEET

Study	Stormwater and Drainage Management Plan
Location	Mareetsane, Northwest, South Africa
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File Name	M:\##PiEng\1523#Batho- Batho PV Facility - Kentz\5DOCUMENTS GENERATED\Projects and Industrial\Doc003_CK_SW&DrainageManPlan_25Sept2013

EXECUTIVE SUMMARY

Floodlines for the Batho- Batho Solar Photovoltaic (PV) Facility were calculated based on first principals. Batho- Batho Solar PV Facility is classified as a sheet flow stormwater catchment area and has no properly defined watercourses. Stormwater will reach a maximum depth of 150mm for storm intensities with a return period of 1:100 year flood and 130mm for a 1:50 year flood. Stormwater poses some risk within the solar facility but with the necessary precautionary measurements most of the risk could be mitigated.

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1. INTRODUCTION

Kgatelopele Private Equity and Venture Capital (Pty) Ltd (herein after referred to as KPEVC) proposes to develop a site to the south of Mareetsane in the North West province for a Solar PV facility. Project and Industrial Engineering (Pty) Ltd (PIE) was approached by Sinetech, the principle consultant to the client, to act on their behalf to produce and execute several preliminary studies including a Stormwater Management Plan and Drainage Management Plan. These studies are captured in this report. See below the proposed site layout as received from Strategic Environmental Focus (Pty) Ltd (SEF).

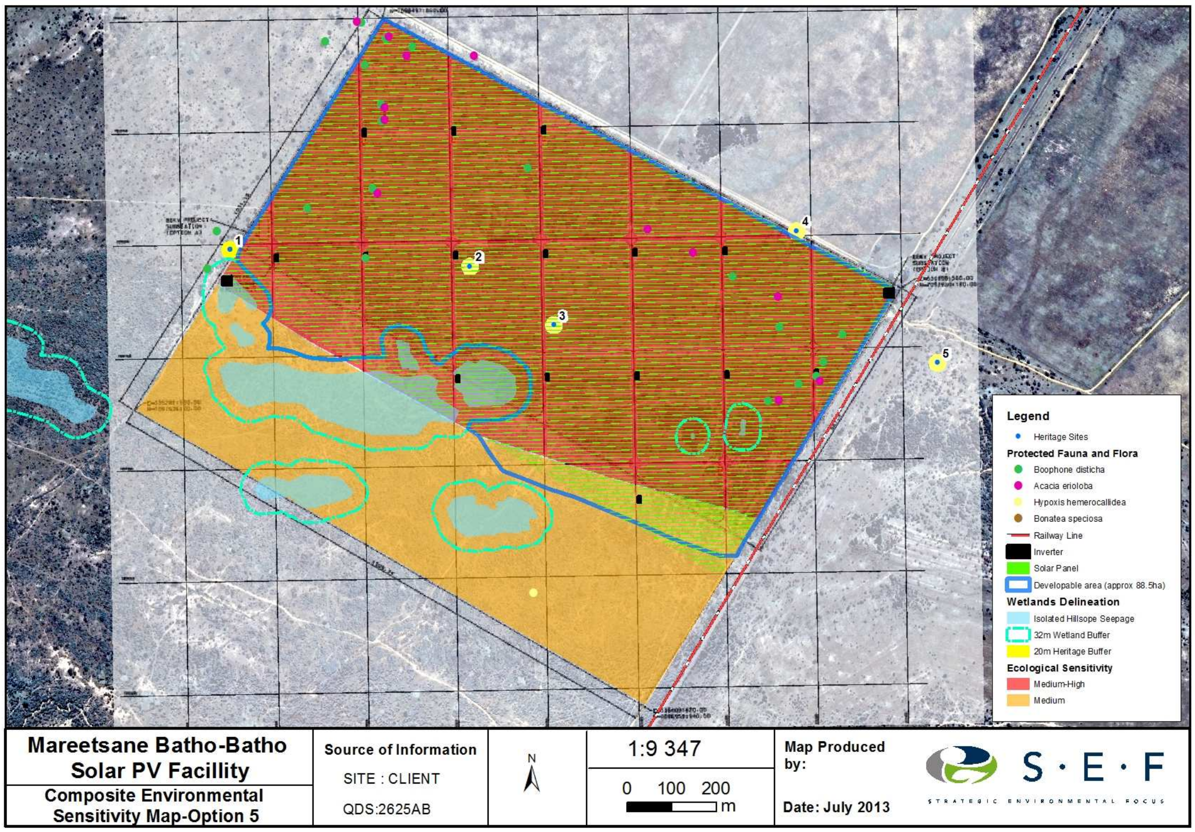

Figure 1: Proposed facility layout.

2. LOCALITY

The site is situated in the Setlagole Native Reserve, approximately 11 km south of Mareetsane in the North West Province. A national Transnet railway line runs parallel to the site bordering the south eastern perimeter. There is a rural train station situated near the south east corner of the proposed solar facility, named Badibua. It is situated less than one kilometre from the proposed site but however is currently not operational. Morokwa settlement lies south west of the proposed facility in addition to a native graveyard bordering both the settlement and the newly proposed developmental site. Please see figure 2 below.

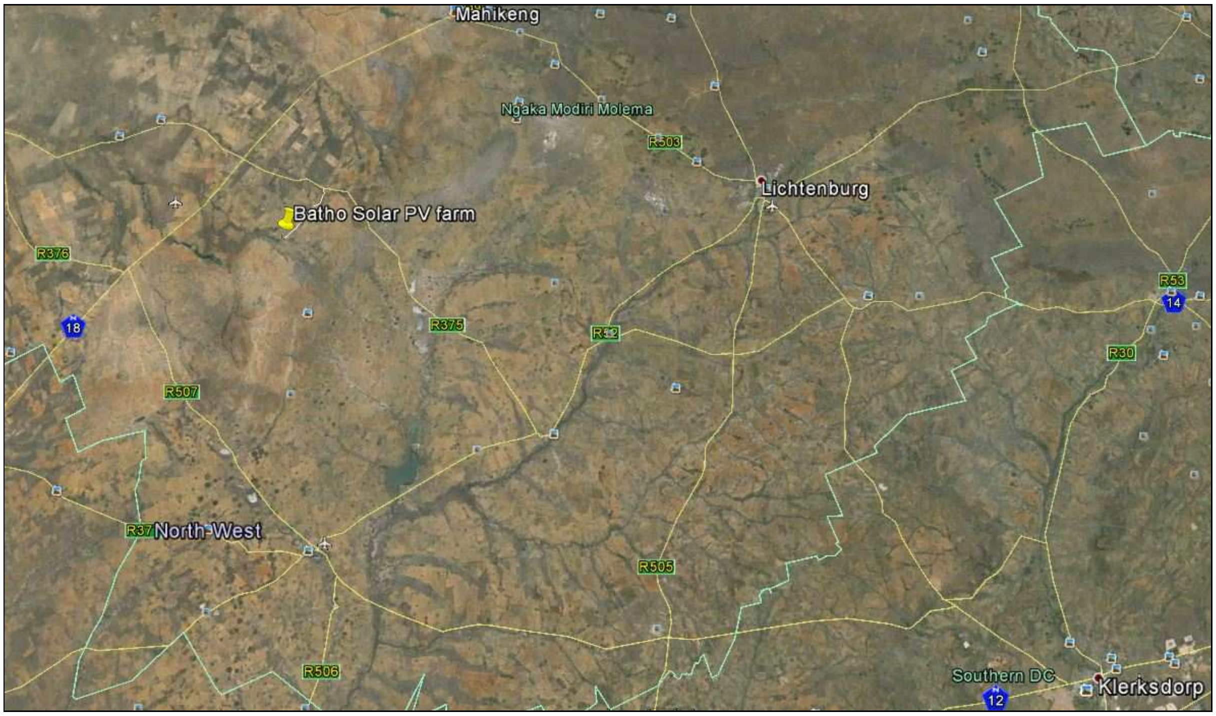

Figure 2: Locality photo

3. PROPOSED DEVELOPMENT

The proposed Batho PV solar Facility will generate 30MW of electricity and will consist of more than 80 000m^2 of solar panels. Solar panels will be mounted on steel columns and secured *in situ* into the soil. As per industry norms, all solar plant equipment will be raised 200mm above natural ground level to combat stormwater erosion. The solar facility will consist of an internal road network which will provide access throughout the site. The solar facility will be built in one phase, with a total construction period of 12 months. The solar facility is spread over an 88 hectare area. .

4. SCOPE OF SUPPLY

PIE conducted a site visit to the Batho- Batho PV Facility and investigated flood lines and storm intensities in the vicinity of the facility. This report will determine the severity a storm would have on the solar facility and surrounding structures. The scope of work included examining orthophotos, contour plans, and analysing potential floodlines for a 1 in 20 year, 1 in 50 year and 1 in 100 year storm return period.

There are no defined water courses on the site and precautionary action is not required. However please refer to the mitigation chapter for stormwater design guidelines.

The conclusion will include the compilation of a conceptual Stormwater Management Plan. The Stormwater Management Plan will be implemented during the construction and operation phases of the facility. The plan will ensure compliance with applicable regulations and prevent off-site contaminated stormwater or increased soil erosion. The plan will include the construction of appropriate design measures that will allow surface and subsurface movement of water along drainage lines so as not to impede natural surface and subsurface flows. Drainage measures will promote the dissipation of stormwater runoff.

The second section of the scope of work will be to estimate the solid waste generated during the construction and operations phase of the project. This section will include refuse removal, where PIE will indicate how sewage will be treated during the operational phase.

5. METHODOLOGY

Orthophotos and contour plans were studied to determine possible problem areas. Areas where flood lines were observed were marked up and examined. Contour plans received from the client confirmed possible watercourses at the Batho- Batho PV farm. By using the rational method, as stipulated in the drainage manual, stormwater flows were determined in the proposed water courses. Manning's equation was used to estimate the depth of the flood lines. Three floods with intensities ranging from a 1:20 year, 1:50 year and 1:100 year return periods were considered for this study.

The depth of a flood line would determine whether or not structures within the vicinity of that flood path would be damaged. Information from the client indicated that structures were developed to withstand a flood depth of 150mm. By raising structures, the magnitude of the *safe* flood depth would increase. This report will recommend alternative heights in designated areas on the Batho-Batho PV Facility. It is stated in chapter nine of this report (Mitigation Measures), that all structures on the Batho PV Facility must be 200mm above natural ground level. Concrete foundations will be erected with foundation plinths 200mm above natural ground level. From that level all steel work and solar equipment may be constructed.

6. TOPOGRAPHY

The Facility has an even topography and a slight south western slope. Find below the orthophoto of the Batho- Batho Solar PV Facility. From the photo it is clear that stormwater has not eroded a drainage channel through the Facility, but the existing road layout encourages the concentration of stormwater. It is thus probable that defined watercourses will be present during a storm on the roads and in time will cause erosion. This area was carefully examined to determine the severity of the watercourse, please refer to chapter nine (Mitigation Measures) for proposed remedial action.

Figure 3, Batho- Batho PV Facility

From contour lines, one can easily confirm whether defined watercourses will be present on a site. A defined watercourse could be explained as a portion of land where natural topography forces water to concentrate and form a temporary or permanent stream.

From the drawing “Topographical Survey of a Portion of Setlagoli Reserve” (as received from

Sinetech), it is confirmed that sheet flow or overland flow will dominate the Batho- Batho PV Facility. In other words, natural topography will not concentrate water and as a result rainwater will spread evenly throughout the site. Stormwater will enter the site from the north and will discharge into the wetlands south of the site.

7. CATCHMENT AREA

The catchment area is defined as the area in which the topography is shaped as to allow all stormwater to intersect the site. The catchment area is not limited to the site itself but includes external farms and areas. The catchment area could be influenced by external developments namely; roads, perimeter walls, railway tracks etc. The original topographical catchment area is illustrated below.

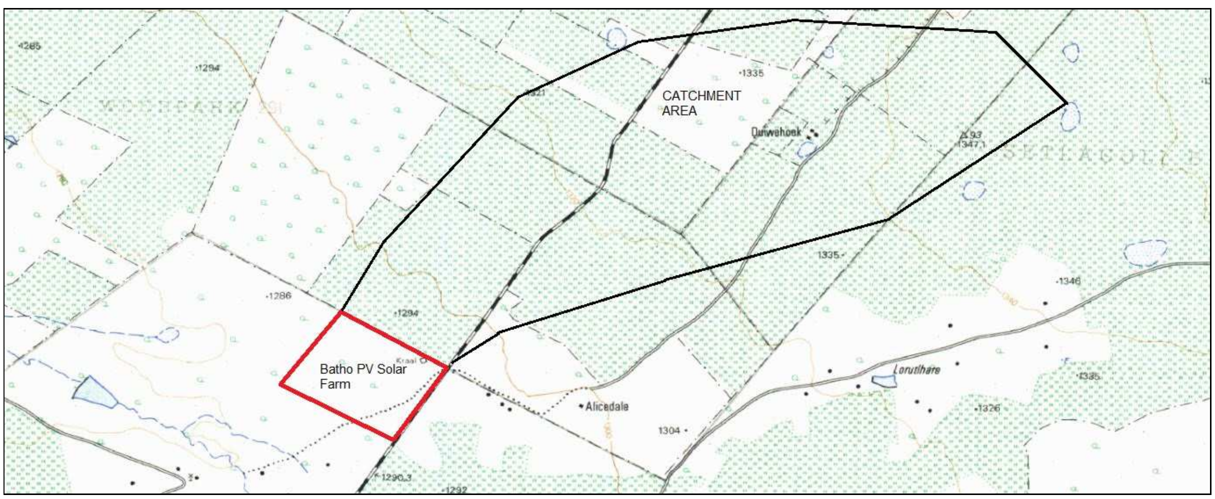

Figure 4: Catchment area

The size of the original catchment area is 11.36km². It can be seen from the figure above that the railway track divides the catchment area in two sections. Stormwater falling on the “right” side of the railway track will not breach the railway track as it was design to withstand a 1:100 year storm intensity. Stormwater will thus flow downwards past the site to a railway culvert south of the site. The catchment area is thus reduced to 3.61km².

8. STORMWATER GENERATED

From the rational method as stipulated in the *Drainage manual* “The South African Roads Agency”

– 5th edition, the following was calculated when based on a mean annual rainfall of 560mm/ year as per Mafikeng region. The catchment area is defined as follows;

- Flat areas with an average slope of 3%;
- Light bush and Facility lands; and
- Semi-permeable.

The study will focus on the 1:20, 1:50 and 1:100 year floods, total stormwater generated for the flood intensities are 9.9m³/s, 14.14m³/s and 17.7m³/s respectively. Stormwater will enter the facility from the northern boundary and will flow through the site and exit the site near the south western corner.

To determine a storm flow depth on the Batho- Batho PV Facility, an absolute worst case scenario was identified and flow depths were determined as such. Find below a figure indicating the absolute worst case scenario. The worst case scenario is defined as the point with the largest catchment area and topography most likely to concentrate water.

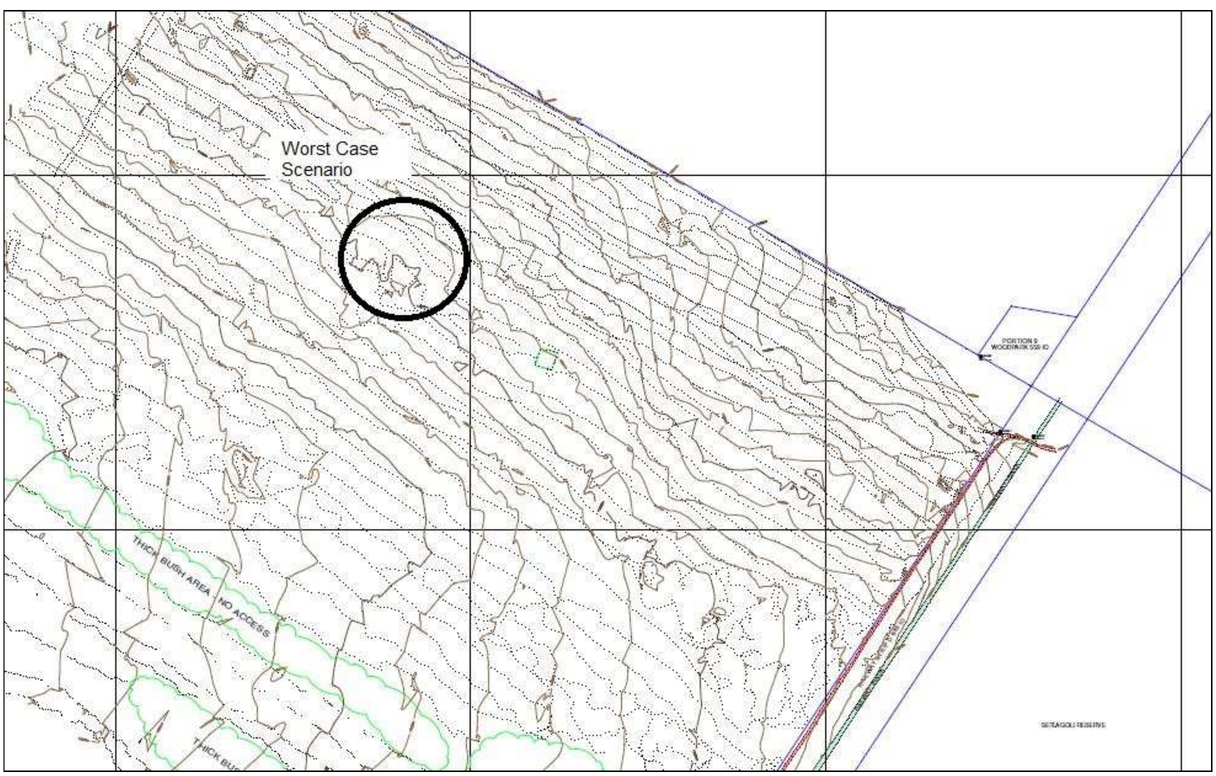

Figure 5: Contour map of Batho- Batho PV Facility indicating worst case scenario.

Floods and flow depths were calculated at this point and summarised in the table below. From the table, it can be seen that a 1:100 year flood will produce sheet flow throughout the facility with a depth of 150 mm and a 1:50 year flood was determined to have a depth of 140 mm. Structures in the proposed solar facility will be raised to 200mm above natural ground level to combat the 1:100 year intensity storm.

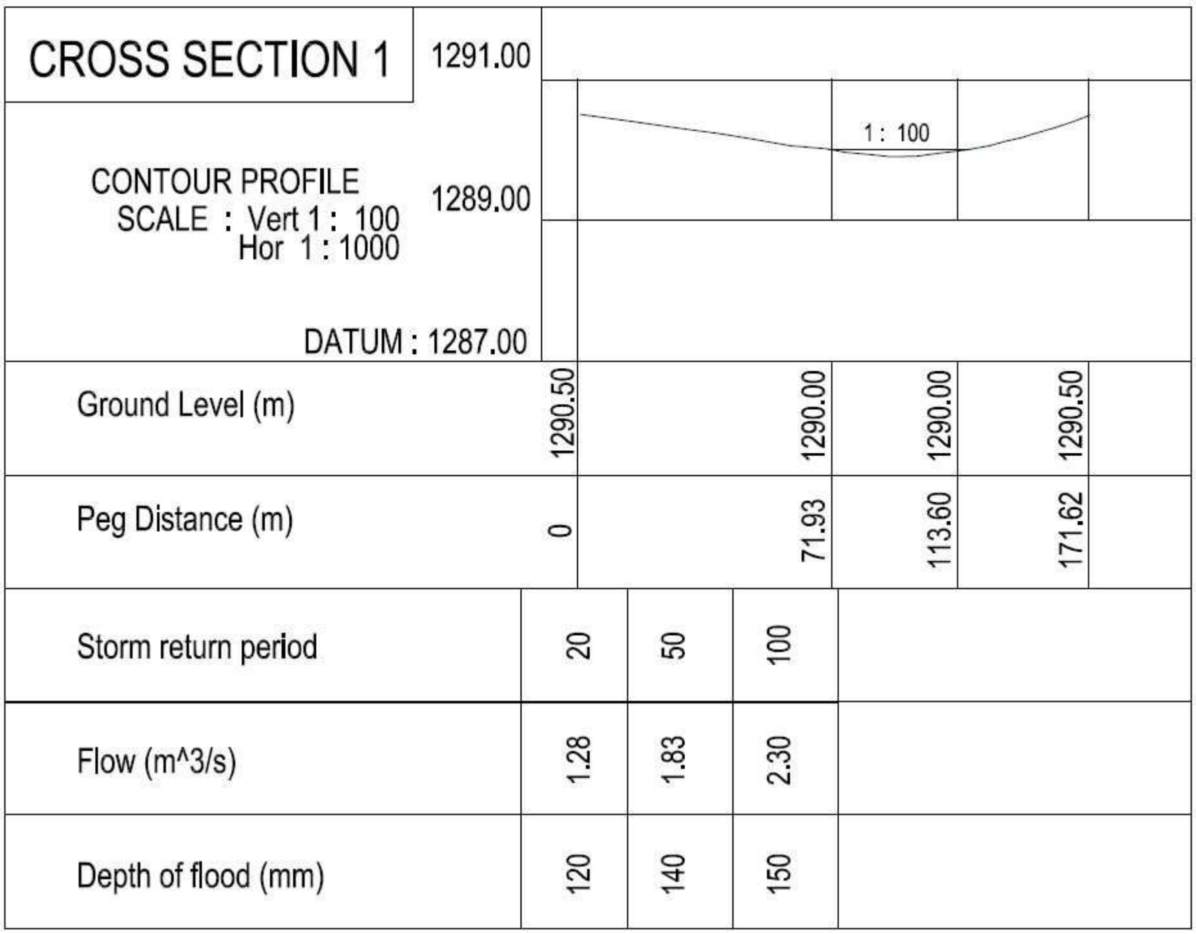

Figure 6: Batho- Batho PV Facility worst case scenario

9. MITIGATION MEASURES

Stormwater generated by the Batho-Batho PV Facility will have a low runoff factor. The post-development flood will not increase significantly due to the fact that the existing ground surface will be left undisturbed. Solar panels will capture rain droplets but droplets will fall onto undisturbed in situ soil with the same characteristics as per the pre-development flood. Thus, stormwater runoff will be influenced mainly by the internal road network and mitigation measures will focus on limiting the effect the internal road network will exert on the post-development flood.

In general, the main objective of the stormwater management plan is to ward off the accumulation of runoff. If runoff is spread over larger areas (sheet flow) instead of concentrated in confined spaces (channel flow), the potential damage in scouring of land is greatly reduced. In order to prevent erosion on the Batho-Batho PV Facility and to prolong the lifespan of the internal road network, careful attention must be given to design road levels within the Batho- Batho PV Facility.

Stormwater must not be allowed to dam on roads, roads must thus not act as drainage channels. Roads must also be kept 'dry' as far as possible. Stormwater must therefore be removed from gravel roads as soon as possible. In general, this can be achieved by constructing the wearing course at a slightly higher level than the adjacent natural ground level. A camber profile must also be created in order that stormwater drains to either side of the road. Where roads run parallel to contours, run-off from the higher laying land will dam against the road. Where low run-off volumes are foreseen, the level of the wearing course can be made level with the adjacent natural ground level which will allow the run-off to pass safely over the road. Where higher volumes are however foreseen, the road will be damaged if preventative measures are not taken. Strategically placed pipes can be used in order to safely convey the run-off underneath the roads, but concrete lined drifts might be a more practical solution.

Each situation must be considered at detail design stage. Where roads run perpendicular to contours, limited run-off onto the roads can be expected. However, in order to prevent scouring alongside the roads, cut-off side drains must be constructed which drain away from the road. These drains will break the accumulation of runoff. Roads perpendicular to contours should be kept to an absolute minimum.

Due to the existing even topography stormwater generated on site will consist mainly of sheet flow. Sheet flow will not present any areas of concern; however, all structures must be constructed 200mm above natural ground level as per industry norms.

Permanent structures on the Batho-Batho PV Farm will include a control room structure. It is proposed that a gutter system be installed to capture all stormwater on the control structure roof and directed into a 2000 litre stormwater attenuation tanks, (a JoJo tank is recommended). The control room stormwater can be used for irrigation.

In order to mitigate all stormwater runoff from the Batho- Batho Facility a berm must be constructed along the south western perimeter of the site to intercept all stormwater. The berm will transfer 17.7m³/s of stormwater to an attenuation dam. From the topographical drawing the slope of the berm is calculated to be 0.0049m/m. To safely displace 17.7m³/s of stormwater at a 0.0049m/m slope the berm must be 500mm high. The water depth in the berm will be 300mm deep and will span 107meters. Development will not be allowed in the imposed flood line.

A five minute storm will accumulate 5 310m³ of stormwater. The attenuation dam will be situated in the south western corner of the site. The dam will have a cross sectional area of 3 540m² with an average depth of 1.5m. Stormwater in the attenuation dam will gradually seep into the ground and evaporate. Storms with intensities larger than 1:100 year flood and storms with 1:100 year storm duration longer than 5 minute will be diverted into an overflow system which leads into the wetland. See figure 7 below.

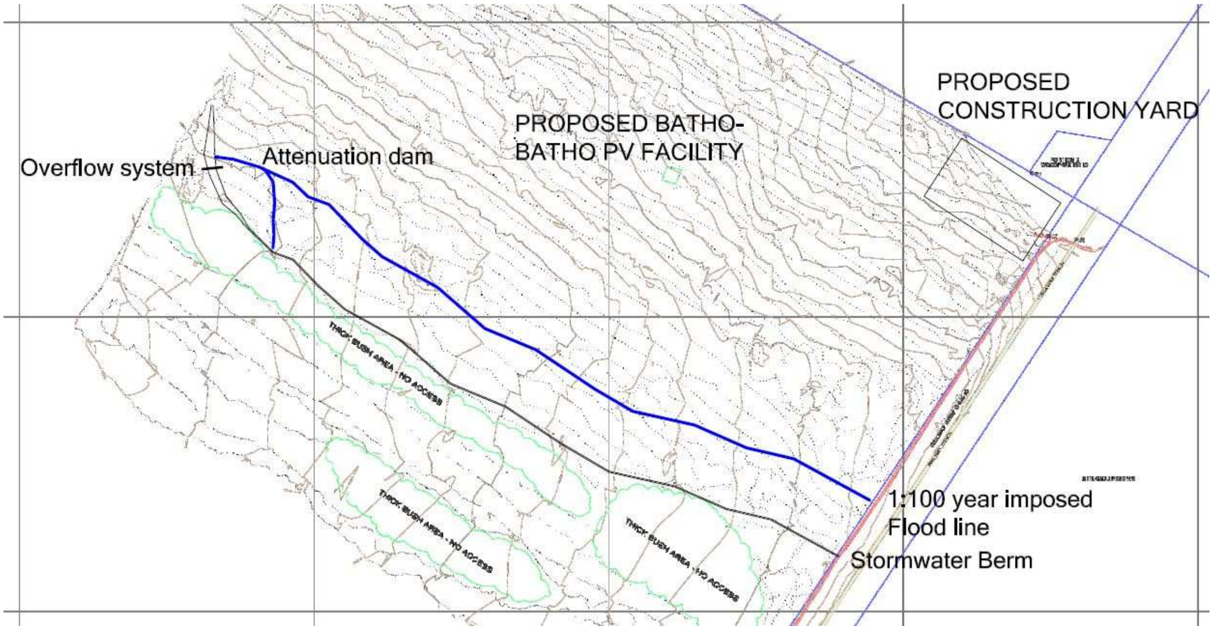

Figure 7: Conceptual Stormwater Plan

Find below a typical layout of the construction yard.

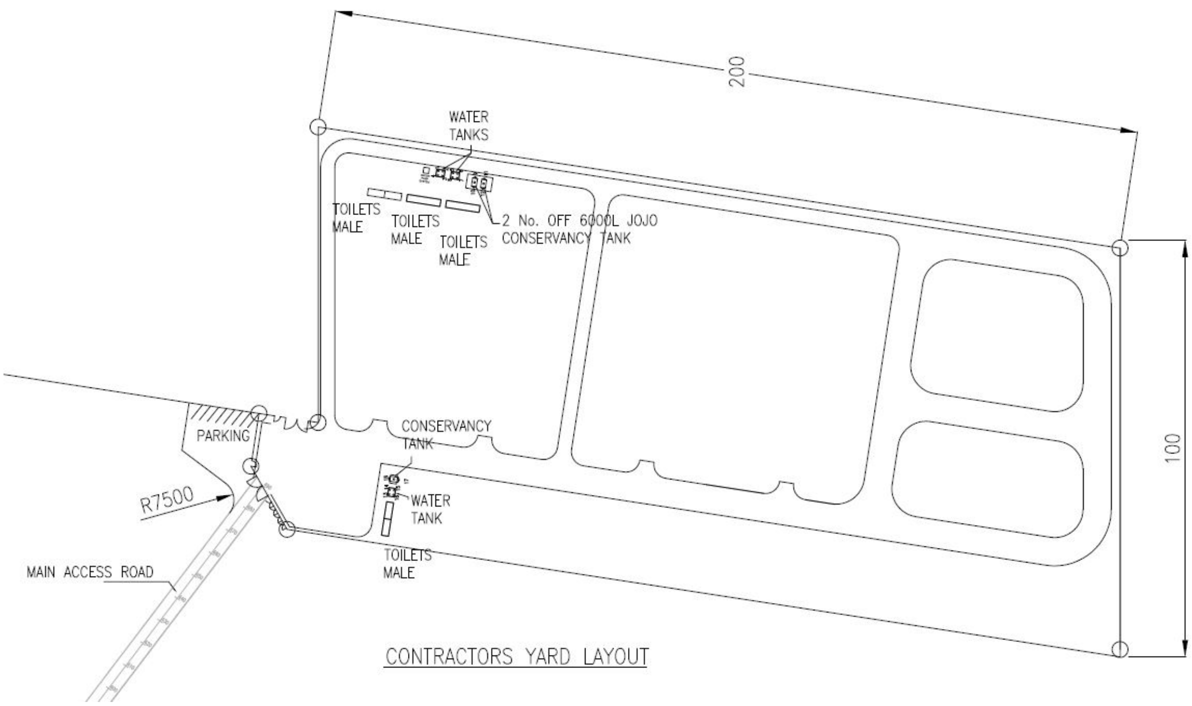

Figure 8: Typical contractor's yard layout

10. SEWAGE AND SOLID WASTE

This report focused on two aspects of the project; the construction phase and the operational phase.

During the construction phase of the project, it is expected that more than 300 workers will be employed to oversee the construction of the solar facility. From the SANS 10252-2 Table B.1 it is stipulated that the amount of effluent generated per person per day is 25 litre per person per day for toilet waste. An extra 20 litres per person per day will be added for permanent staff. This accumulates to 7.5 kilo litres per day during construction and 1,1kilo litres per day during the operational phase.

Conservancy tanks will be installed to contain human effluent during the construction and operational phases of the project. The tanks will be emptied and disposed of at the nearest sewage treatment plant, Mahikeng. The level in the conservancy tank will be monitored by permanent staff to prevent overloading. As per SANS 10252-2 waste generated during construction stage and during operational stage will accumulate to 7.5 kilo litres and 1.1 kilo litres respectively. Eight 6000 litre tanks will be installed during construction and two 6000 litre tanks will be installed during operational phase. A vacuum tanker will convey the effluent on a weekly basis.
See figure below of general arrangement of conservancy tanks.

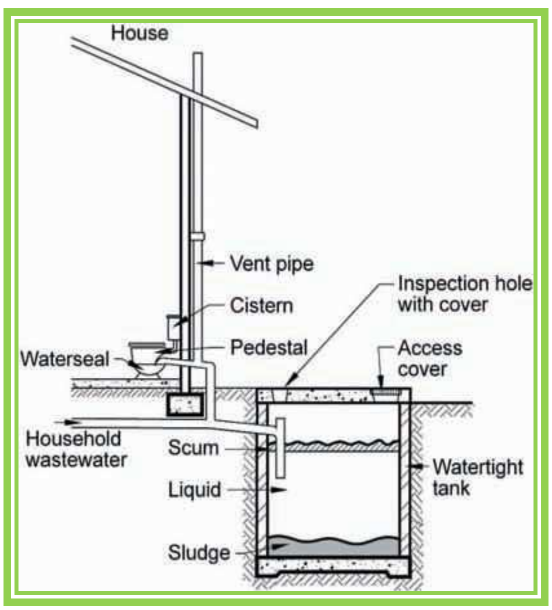

Figure 9: General conservancy tank arrangement

Construction waste generated is expected to include solar panel packaging, cable drums and contaminated soil. Packaging includes plastic wrapping, cardboard boxes and wooden pallets. Based on experiences from past projects, it is estimated that at least 5000 boxes and wooden pallets will be generated by the proposed Batho- Batho PV Facility project. This will equal to 50 ton boxes and 150 ton wooden pallets.

Soil contamination due to diesel spillage is also a factor to be considered. In order to contain the contamination of soil it is proposed that the following structure is constructed for the diesel tank area. See figure 10 below.

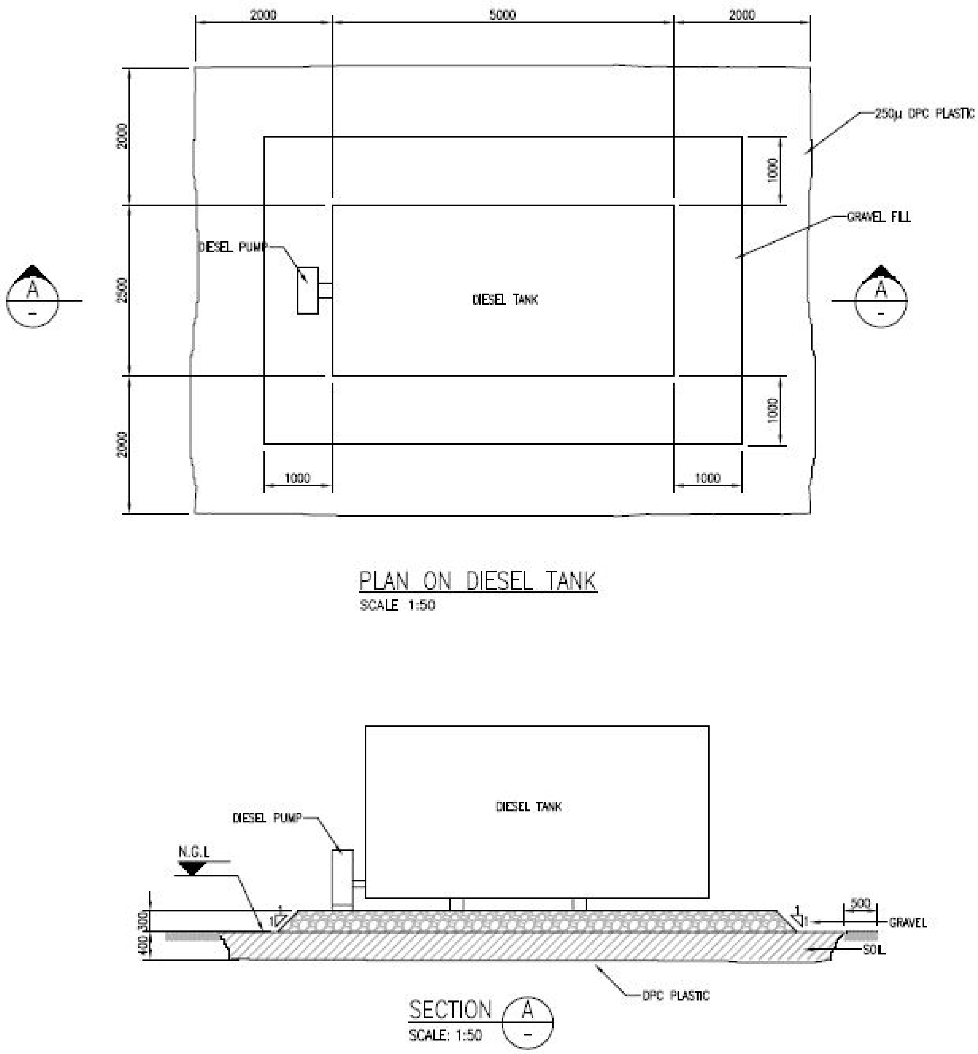

Figure 10: General arrangement of diesel tank area.

It is estimated that the soil will be replaced when the construction phase concludes. The total amount of contaminated soil is thus 18.5m³.

All waste (construction and human) generated on the site will be disposed of in collaboration with the local authority. Waste will be transported to a registered waste treatment facility and dispose of properly. Compliance certificates are issued by waste treatment vendors to prove compliance thereof.

11. CONCLUSION

PIE was appointed to confirm whether or not structures on the solar Facility would be at risk during high storm intensities. This report concludes that the Batho- Batho PV Facility has no defined watercourses. The main focus of the stormwater master plan report was to determine the anticipated runoff towards- and on the site. From the figures indicated in the report, critical areas were identified. The entire site should comply with the mitigation requirements as set out in this report.

Yours Faithfully

Chris Kleinhaus BEng Honours **Stuart Hoy** PrEng

for Projects & Industrial Engineering (Pty) Ltd