# Stormwater, Wastewater and Erosion Management Plan for Bloemsmond 4

Report Prepared for

## Bloemsmond Solar 4 (Pty) Ltd

Report Number 548199/2

Report Prepared by

srk consulting

June 2019

# Stormwater, Wastewater and Erosion Management Plan for Bloemsmond 4

# Bloemsmond Solar 4 Pty (Ltd)

**101, Block A, West Quay Building,**
**7 West Quay Road, V & A Waterfront, Cape Town, Western Cape**
**Tel: +27 (0) 21 418 2596**

**SRK Consulting (South Africa) (Pty) Ltd.**
The Administrative Building
Albion Spring
183 Main Rd
Rondebosch 7700
Cape Town
South Africa

Tel: +27 (0) 21 659 3060
Fax: +27 (0) 21 685 7105

e-mail: capetown@srk.co.za
website: www.srk.co.za

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**Compiled by:**

Seabelo Seroalo
Engineer

Email: xadams@srk.co.za

**Peer Reviewed by:**

Bruce Engelsman, Pr. Eng, Pr. CPM
Partner

**Authors:**

Xanthe Adams; Seabelo Seroalo

# Executive Summary


This report documents the stormwater, wastewater and erosion management plan (referred to as the SWMP) for Bloemsmond 4, a proposed solar power generation facility planned in the Northern Cape of South Africa. The facility will include a substation, offices, a control room, a workshop, a warehouse, internal roads, powerlines, solar panel arrays and inverters. The SWMP aims to facilitate protection of surface water resources and covers the project development area and the access road as indicated in Figure 1.

The first step in the SWMP development is an analysis of the site and the proposed facilities. The analysis found that the proposed facilities are likely to have an intrinsically low impact on the surface water resources because:

- The vegetation, soil and topography will remain mostly undisturbed;
- The site and roads are well placed such that they lie mostly outside of the natural watercourses (Figure 1) and most river crossings will have low flows;
- Water use at the site, with the potential to generate runoff, such as solar panel washing, is negligible in volume compared to stormflows;
- Sewage and landfill waste will be taken offsite for disposal;
- Rainfall in the area is low and few steep gradients exist.

Despite the low impact on surface water resources, some potential impacts are possible including:

- Dirty areas will exist which could contribute to contamination including:
    - Transformers which could leak oil;
    - The workshop which may store oils or lubricants that could contaminate wash down water;
    - The sewage conservancy tank which could leak or overflow.
- Erosion where stormwater drains discharge to the natural environment or around stockpiles – estimated stormflows indicate that erosion could be significant in such localised areas without proper detailed design;
- Road crossings (Figure 4-1), which could exacerbate erosion without proper design, were identified – four of these crossed relatively large drainage lines;
- Disruption of flow, and possibly erosion, where solar panels are located within water courses and flood prone areas.

Based on the potential impacts, as well as legal requirements and best practice guidelines, specific objectives were developed for stormwater and erosion management. A plan was then developed to address each objective to protect surface water resources. The objectives, as well as the plan, are shown in **Table 1: Summary of the operational SWMP plans** for the operational phase of the project, and in **Table 2: Summary of the SWMP for construction** for the construction phase of the project.

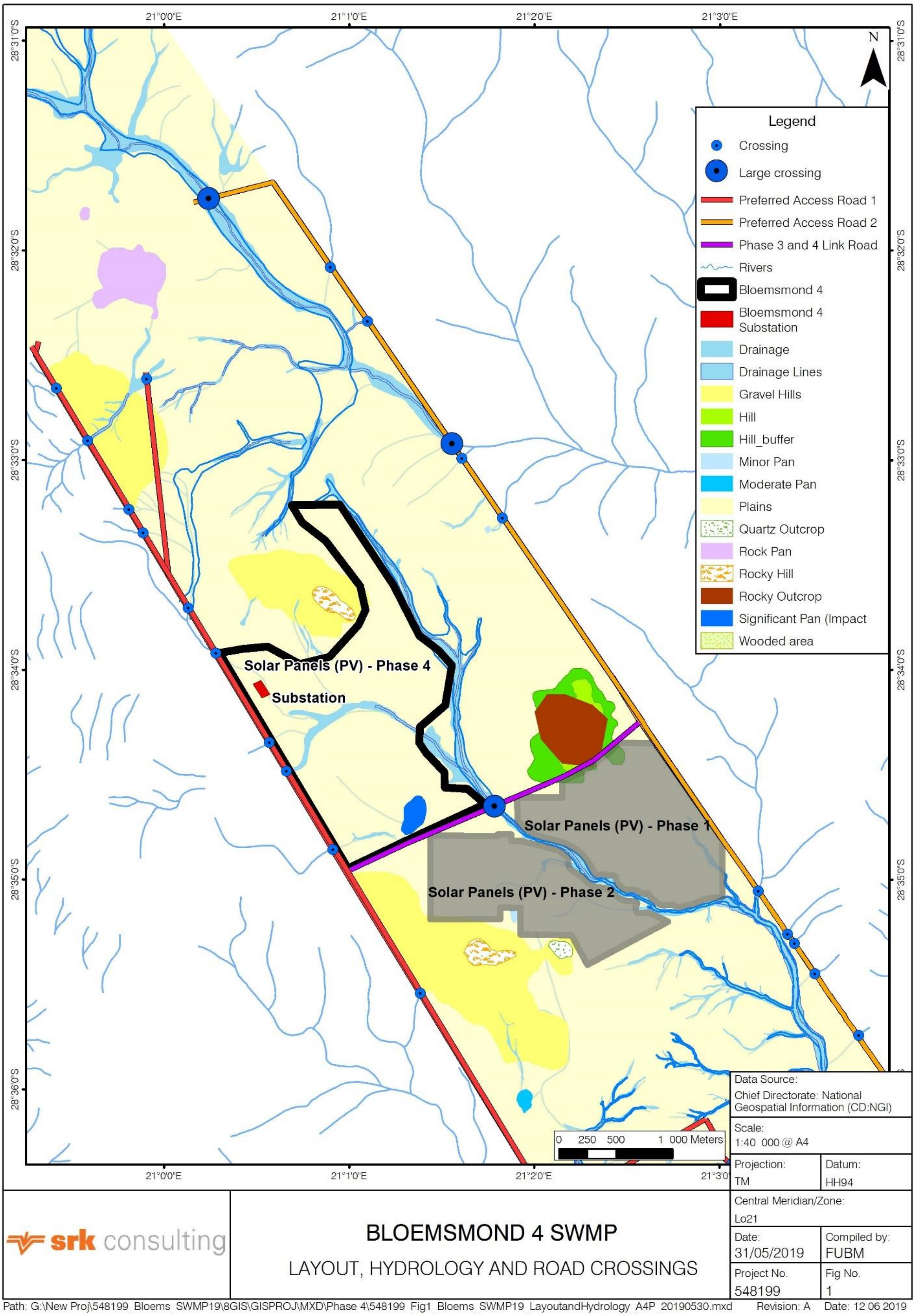


**Figure 1: Layout, hydrology and road crossings**

**Table 1: Summary of the operational SWMP plans**

| Objective | Plan to meet objective |
|---|---|
| Keep clean water clean | Construct stormwater drains or bunds to divert clean runoff around the workshop, transformers and wastewater conservancy tank |
| Collect and treat any dirty water (waste water management) | Bund transformers and contaminants in the workshop;<br>Include an oil and grease trap for any wash water exiting the workshop area;<br>Capture and treat oil and grease from the workshop and oil from the transformers offsite;<br>Dispose and treat wastewater by collection in a conservancy tank (with overflow tank) and transport to municipal treatment works. |
| Do not impede natural surface or subsurface flows | Minimise dirty area footprints by placing clean water diversions as close to these as possible;<br>Ensure any engineered drainage delivers clean stormwater to the natural receiving drainage line. |
| Control erosion and dissipate stormwater | Design channels such that 1:50 year flows do not present undue erosion risks;<br>Design proper sediment transport controls from any stockpiles from piling spoils;<br>Design crossings (concrete drifts for larger crossings) such that 1:50 year flows do not present undue erosion risks;<br>Dissipate energy effectively at stormwater drainage outlets. |
| Monitor and manage erosion, wastewater and stormwater | Inspect the site for erosion, leaks or spills and oil and grease trap capacity every 3 months in the first 2 years of operation and annually thereafter;<br>Install a rain gauge, collect rain data and inspect the site for erosion after any rainfall event exceeding a 10-year return period storm or where damage has been noticed;<br>Install a float switch alarm system on wastewater conservancy tank to prevent overflow;<br>Annual refresher training of staff and incorporation of well-placed signage, to facilitate reporting. |
| General | Ensure no infrastructure, except roads, solar panels and solar panel supports are within 300 m of a water course. In particular, ensure no dirty areas, that may contain pollutants, are within 300 m of the water course<br>o Review and improve the stormwater management plan every 5 years. |

**Table 2: Summary of the SWMP for construction**

| Objective | Plan to meet objective |
|---|---|
| Keep clean water clean | Excavate clean water diversion channels to direct clean runoff around dirty/disturbed areas such as stockpiles and laydown areas. |
| Collect and treat dirty water | Construct silt fences or berms to prevent the sediment transport into rivers;<br>Dispose of general waste, oils and other contaminants off site;<br>Supply and maintain chemical toilets;<br>Construct temporary bunds to contain potential contaminants. |
| Do not impede natural surface or subsurface flows | Minimise laydown areas and stock piles and do not place near watercourses;<br>Ensure that any temporary stormwater drains or diversion berms direct water towards the natural receiving drainage line. |
| Control erosion and dissipate stormwater | Disturb the natural topography, soil or vegetation as little as possible;<br>Design drains such that velocities do no exceed 1 m/s in a 1 in 5 year event;<br>Build roads and road crossings, including any dissipaters, before other infrastructure. |
| Monitor and manage erosion, wastewater and stormwater | Regularly inspect the site for leaks and the onset of erosion;<br>Install a rain gauge and inspect the site for erosion after rain events and remediate when necessary.<br>Brief training for all construction staff including who to contact if erosion or leaks are found. |
| General | Do not place laydown areas, stockpiles or other materials within 300 metres of a water course |

The report concluded that stormwater impacts can be managed at the site in a practical way that will protect water bodies and minimise erosion. It is recommended that the stormwater management plan be further developed with detailed designs that have sufficient detail to realise conceptual plans. The plan will be incorporated into an environmental specification for use during construction, and be implemented during operation of the facility.

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# Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by Bloemsmond Solar 4 Pty (Ltd). The opinions in this Report are provided in response to a specific request from Bloemsmond Solar 4 Pty (Ltd) to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

# 1 Introduction

This report documents the stormwater, wastewater and erosion management plan (referred to as the SWMP) to be implemented at the Bloemsmond 4 facility, a proposed solar power generation facility in the Northern Cape of South Africa. It is a conceptual level plan, based on practical considerations, regulations and best practice guidelines, and is developed to manage stormwater at the site during construction and operation of the proposed facility.

# 2 Objectives and scope of the report

## 2.1 Objectives

The objective of this report is to document a SWMP that protects the surface water resources, manages erosion risks and complies with the regulations and guidelines for the construction and operational phases of the Bloemsmond 4 facility.

## 2.2 Scope

This report covers the following scope:

- The site covered by the report lies in the Northern Cape of South Africa about 30 km South-West of Upington;
- The report covers the site and catchments draining to the site;
- The report covers both the proposed development area as well as the roads accessing the site;
- The report covers both the construction and operation phases of the proposed project;
- The SWMP is conceptual at this stage, as detailed survey is outstanding, however, the conceptual designs have been developed specifically for the project’s needs.

# 3 Supporting information

This section summarises all the information and assumptions upon which the SWMP is based. This is done to highlight how the plan was developed: by matching regulations and guidelines to the specific needs of the project in the local natural conditions at the site, and hence the information is key to understanding the plan. The relevant information can be divided into:

- Project information;
- Guidelines and regulations;
- Natural characteristics at the site.

## 3.1 Program information

The site information was obtained from the Bloemsmond Project Information Document provided by the client, and information for the area in general, from the studies related to phase 1, 2, 3 and 4 was obtained from the Background Information Document (Savannah Environmental, June 2015) and the Final Scoping Report (Savannah Environmental, July 2015). Further site information was provided by the client in the form of electronic maps. The layout of the site is shown in Figure 3-1. The development area of the proposed facility is anticipated to be approximately 306 hectares.

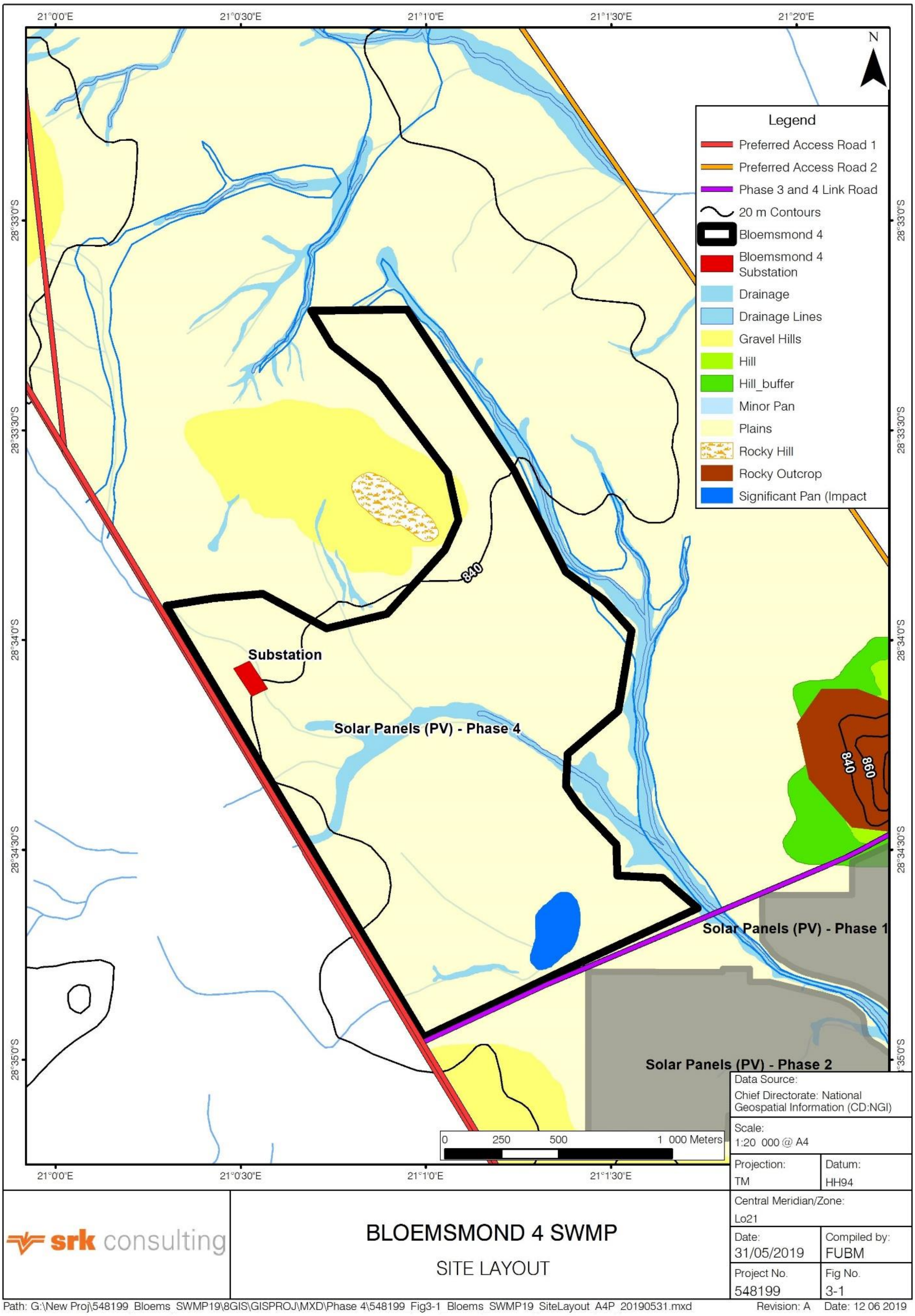



**Figure 3-1: Phase 4 Site Layout**

The proposed site infrastructure and the associated potential pollutants are as follows:

- A security entrance with a small toilet and a conservancy tank for wastewater;
- An electrical substation including transformers containing oil
- On-site inverters located between the panels to step up power;
- Photovoltaic cells with mounting structures. These will be washed about twice a year with municipal water. The volume of wash water is approximately 3 l/m$^2$ per wash for each 1.95 m$^2$ panel and it is expected that 270 000 to 300 000 panels will be installed. No additives will be used in the wash water;
- Cabling between the projects components is to be laid underground where practical;
- A new single circuit 132kV power line from Bloemsmond 4 substation / switching station to the Bloemsmond Collector Substation;
- Fencing around the development area;
- Internal Access Roads:
    - Existing roads will be used as access roads where possible;
    - Existing roads will be extended to create access to the Solar 4 facility.
- During construction, a temporary laydown area and a workshop will be added;
- During operation, a chemical storage area will be built.

Fuel and acids (generally considered high risk contaminants to stormwater) have been ruled out as potential threats as neither will be stored or used on site. General waste will only be stored temporarily and taken off site regularly for disposal to landfill.

## 3.2 Legislation and guidelines

Stormwater management plans are generally required as part of Environmental Management Plan (EMPr) and for Water Use License Applications.

The SWMP was developed based on the guidelines in the Best Practice Guidelines (DWAF, 2006). The plan was also developed in compliance with regulation 704 of the National Water Act, 1998 (Act No.36 of 1998) which applies to mining and associated activities, but includes principles that should be applied at all sites. Municipal regulations, which usually lay down specific standards for each municipality, but still adhere to the overall principles of the regulations and guidelines above, will be consulted during detailed design.

## 3.3 Natural conditions

### 3.3.1 Climate

The site lies in an arid to semi-arid climatic region with average rainfall below 200 mm per year.

### 3.3.2 Design rainfall

The design rainfall data used in the phase 1 and 2 portions of Bloemsmond is assumed as these sites are in close proximity of each other and the rainfall characteristics of portion 3, 4 and 5 will not differ significantly (from 1 and 2). The design rainfall data was extracted from the Design Estimation Flow Software (Gorven, 2002) and is shown in Table 3-1.The values were interpolated from the six closest rainfall stations, all of which have a long record of 30 to 96 years. The closest station, Geelkop 0283098W, is less than 6 km away.

**Table 3-1: Design rainfall (mm) data interpolated from the six closest stations**

| Design Rainfall Data (mm) interpolated from six closest stations | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mean annual rainfall | 152 | mm | Latitude | -28.587237 | | degrees | |
| Altitude | 775 | mamsl | Longitude | 21.040049 | | degrees | |
| **Storm Duration** | **Return Period (Years)** | | | | | | |
| | **2** | **5** | **10** | **20** | **50** | **100** | **200** |
| 5 minutes | 5.9 | 9.3 | 11.8 | 14.4 | 18.1 | 21.1 | 24.4 |
| 15 minutes | 11.1 | 17.3 | 22 | 26.8 | 33.7 | 39.3 | 45.4 |
| 1 hour | 16.5 | 25.9 | 32.9 | 40.1 | 50.3 | 58.8 | 67.9 |
| 1.5 hours | 18.6 | 29.2 | 37 | 45.1 | 56.6 | 66.1 | 76.4 |
| 2 hours | 20.2 | 31.7 | 40.2 | 49 | 61.6 | 71.9 | 83 |
| 8 hours | 26.2 | 41.2 | 52.1 | 63.3 | 79.9 | 93.3 | 107.7 |
| 24 hours | 32.2 | 50.6 | 64.1 | 78.2 | 98.2 | 114.6 | 132.4 |
| 5 day | 36.8 | 57.8 | 73.2 | 89.3 | 112.2 | 131 | 151.3 |

### 3.3.3 Landforms and stream morphology

Landforms influence runoff because steeper areas generate more stormflow and high velocity stormflow, whereas runoff water flows slower in flatter areas, thus allowing more opportunity for infiltration. The typical landscape of the site is open plains, with low rocky hills in a few areas (see Figure 3-2 and Figure 3-3). The topographical contours indicate a slope of less than 3% over most of the area. The drainage lines and stream morphology in the area consists of ephemeral washes with deep sandy soil and indistinct channels (Figure 3-4). For the purposes of stormflow estimation, the mostly flat topography with localised steeper areas was accounted for.

**Figure 3-2: Low rocky plains that dominate the area (Photo taken near Bloemsmond 4)**

**Figure 3-3: Low hills that exist in the area (Photo taken near Bloemsmond 4)**

**Figure 3-4: Empheral drainage line showing deep sandy soils and little channelization (Photo taken near Bloemsmond 4)**

### 3.3.4 Soil

Soil type influences soil permeability which in turn influences how much water will infiltrate in a storm event. The soil type and permeability was obtained from the agricultural study which investigated the general characteristics of soils in the area (Savannah Environmental, Draft 2015). From a hydrological point of view, most of the site and the catchments contributing to the site are covered by well-drained sandy-soil, although a small portion of the northern part of the farm includes soils that are sandy to loamy. This soil characterisation was substantiated by photographs from the site shown in Figure 3-5. Based on this, and erring on the side of caution, the overall soil condition was considered to be medium permeability for the purposes of stormflow estimation.

**Figure 3-5: Soil in the area (Photo taken near Bloemsmond 4)**

### 3.3.5 Land use and vegetation

The main land use in the area around the site if for stock grazing. This will have some (minor) impact on the runoff of stormwater from the catchment as livestock tend to partially compact near surface soils. The vegetation in the area is mostly shrubby grassland (Savannah Environmental, July 2015). Photographs of the typical vegetation are shown in Figure 3-2 to Figure 3-6. Note the very sparse vegetation in some areas.

**Figure 3-6: Typical vegetation in the area (Photo taken near Bloemsmond 4)**

Note that Figure 3-2 to Figure 3-6 are not specific to phase 4 of Bloemsmond but are of the general area of Bloemsmond.

# 4 Program Results

## 4.1 Step 1: Development of specific objectives

The specific objectives were developed based on the laws and guidelines mentioned in Section 3.2

The specific objectives are as follows:

- Keep clean water clean by constructing diversions or bunds. This prevents any clean runoff from entering any potentially dirty areas. The bunds or diversions should be designed for a 1 in 50-year event.
- Collect and treat discharge water or runoff from any dirty areas. Dirty water should not spill into clean water systems more than once every fifty years;
- Bund any areas housing hazardous substances or pollutants, including any oils as per regulations;
- Do not impede surface or subsurface water flows:
  - Minimise disturbed areas such that surface and subsurface movement of water along the drainage lines is not reduced;
  - Ensure any engineered clean stormwater drainage directs water to the naturally receiving drainage line.
- Erosion control:
  - Prevent erosion in general, and minimize the potential for erosion in large storm events of 1 in 50 years or greater;
  - Dissipate stormwater energy at all drainage outlets to velocities that are unlikely to cause erosion (i.e. <1 m/s).
- Monitoring and management:
  - Include an erosion monitoring plan that ensures that the onset of erosion is detected and rehabilitated within 6 months, and any acute erosion due to large storm events is detected within two weeks;
  - Include a monitoring system for spills and leaks such that they are detected and remediated as soon as practically possible.
- General:
  - Ensure no infrastructure, except road crossings, solar panels and solar panel supports are built within the water courses
  - Do not build infrastructure containing potential pollutants within 300 metres of natural drainage lines;
  - Review and improve stormwater management plan regularly.

## 4.2 Step 2: Technical situation analysis and evaluation

### 4.2.1 Analysis of potential stormwater, wastewater and erosion impacts

An overall analysis of the available data and the development plans reveal the following potential impacts:

- The facility presents a very low risk to adversely impacting surface water resources because:
    - The development will leave the natural vegetation, soil conditions and topography largely undisturbed;
    - The site and roads have been well placed such that they lie mostly outside of the natural water ways and most river crossings are over very small rivers characterised with small catchments and low flows;
    - Sewage and landfill waste will be disposed off site;
    - Rainfall in the area is low and few steep slopes exist to generate high flow velocities.
- Some potential impacts do exist including:
    - Possible contamination of stormwater by:
        - Oil leaks from the transformers;
        - Oil and lubricant in wash down water from the workshop;
        - Overflow of wastewater from the conservancy tanks.
    - Potential for erosion:
        - Where any stormwater drains discharge into rivers or onto the natural land surface;
        - At river / road crossing.
    - Potential exists to impede and disrupt flow if infrastructure is placed within water courses;
    - Potential exists to damage infrastructure and exacerbate erosion if infrastructure is places within areas that are inundated in floods.

### 4.2.2 Delineation of clean water and dirty areas

The site was divided into clean and dirty water areas as follows:

- Dirty areas:
    - The workshop where oils and lubricants may be stored and used. The workshop will only be temporary (during the construction phase). A chemical storage area will be constructed for the operational phase of the project;
    - The medium-voltage 40 transformers (at the inverter stations) placed around the site as these will contain oil;
    - Transformers at the substation as they will contain oil;
    - The conservancy tanks because they will contain sewage.
- Clean areas are deemed to be all areas outside of those stated above as dirty areas.

### 4.2.3 Delineation of catchments and identification of road crossings

Road crossings were identified for all the roads that will be upgraded or built as part of the project. Note that the road / river crossings are conceptual at this stage, and their locations are approximate. It is extremely unlikely that minor modifications in road position will change the assessments and conclusions in this report. Also note that most of the road crossings are over minor natural drainage lines near the source of their flow. The relevant roads are the preferred access road 1 and 2 and the Phase 3 and 4 Link Road as shown on Figure 4-1. More crossings may be necessary for the internal roads in the solar panel areas, but layouts for these roads will only be available at a later stage. Any internal road crossings will be minor and conceptual designs provided in this report can be used as a basis for such crossings. The crossings are shown in Figure 4-1, and their locations provided in Table 4-1 below. Note that the drainage lines in the figure are, wherever possible, delineated during the scoping study (Savannah Environmental, July 2015).

**Table 4-1: River crossings with approximate latitude and longitude**

| Name | Type | Latitude | Longitude |
|---|---|---|---|
| 2 | Crossing | 21,05458037050 | -28,61021828900 |
| 3 | Crossing | 21,05311938140 | -28,60830520230 |
| 4 | Crossing | 21,05174881190 | -28,60676331160 |
| 6 | Crossing | 21,05102988690 | -28,60601091040 |
| 7 | Crossing | 21,03853665970 | -28,60767080260 |
| 8 | Crossing | 21,02976478700 | -28,57751342760 |
| 10 | Crossing | 21,01521464720 | -28,58093459920 |
| 11 | Crossing | 21,01104899710 | -28,57471842180 |
| 12 | Crossing | 21,00950729060 | -28,57242671010 |
| 13 | Crossing | 21,00467975120 | -28,56533661340 |
| 14 | Crossing | 21,00220538210 | -28,56175568890 |
| 15 | Crossing | 20,99814940370 | -28,55577544140 |
| 16 | Crossing | 20,99685158590 | -28,55391330170 |
| 17 | Crossing | 20,99316117780 | -28,54843424560 |
| 18 | Crossing | 20,99032265680 | -28,54428011730 |
| 19 | Crossing | 20,99845593000 | -28,54354270750 |
| 20 | Crossing | 21,06252794660 | -28,59569906320 |
| 21 | Crossing | 21,05859757480 | -28,59079227710 |
| 22 | Crossing | 21,05674413360 | -28,58840135880 |
| 23 | Crossing | 21,05613517180 | -28,58765557610 |
| 24 | Crossing | 21,05349633630 | -28,58422487510 |
| 25 | Crossing | 21,03047421660 | -28,55459030650 |
| 26 | Crossing | 21,02682279160 | -28,54986416630 |
| 28 | Crossing | 21,01832652660 | -28,53897570600 |
| A | Larger Crossing | 21,07494580230 | -28,61188859500 |
| B | Larger Crossing | 21,02976478700 | -28,57751342760 |
| C | Larger Crossing | 21,02593027290 | -28,54871842140 |
| D | Larger Crossing | 21,00402938180 | -28,52924019670 |

The following catchments were delineated:

- Conceptual stormwater catchments of the development areas – for these, the area was divided into sections depending on the nearest receiving watercourse (Figure 4-2);
- Catchments of the major rivers where they cross any of the upgraded roads (A, B, C and D in Figure 4-3);
- The receiving catchment close to where it discharges to the Orange River complex.

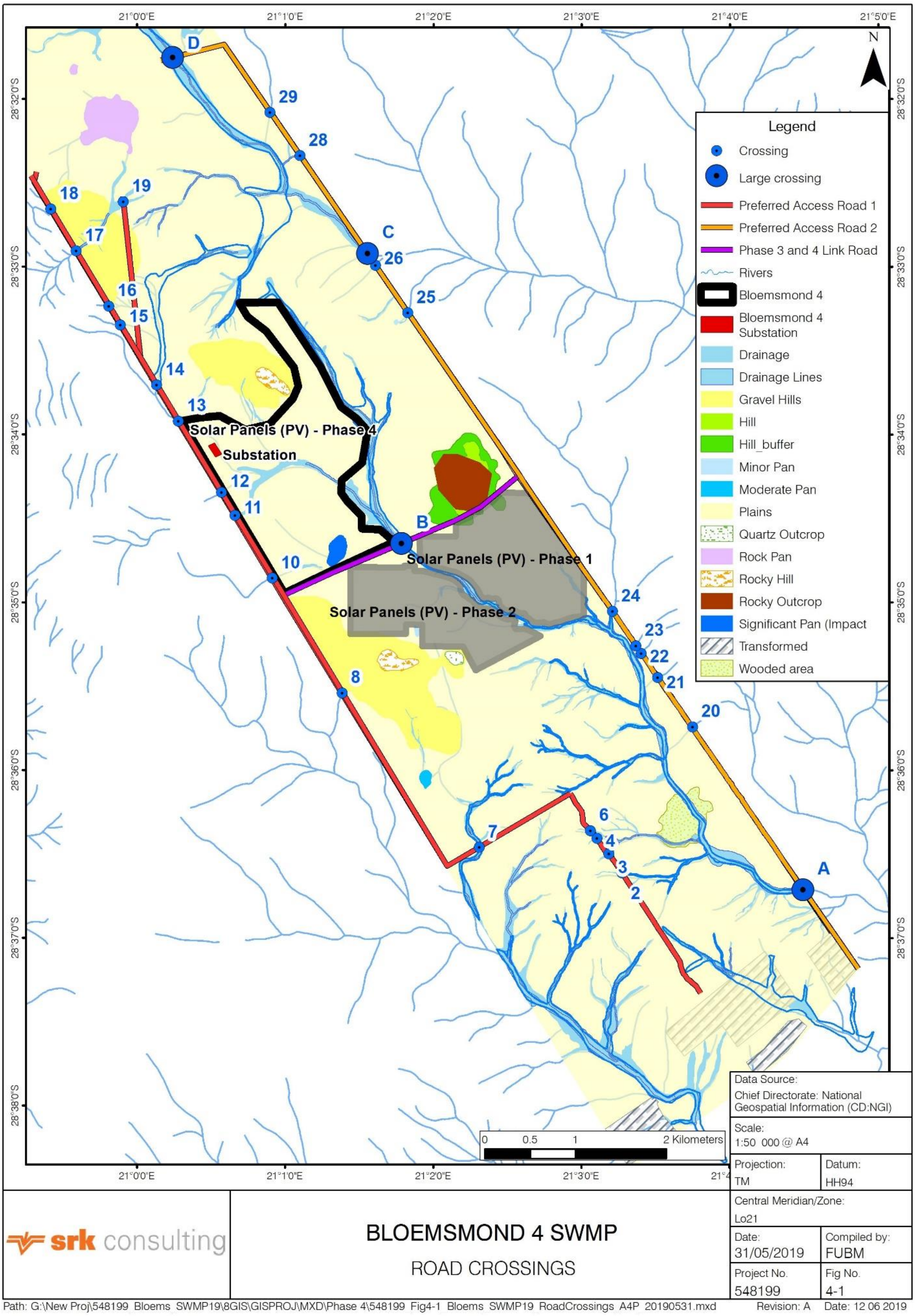



**Figure 4-1: Road crossings**

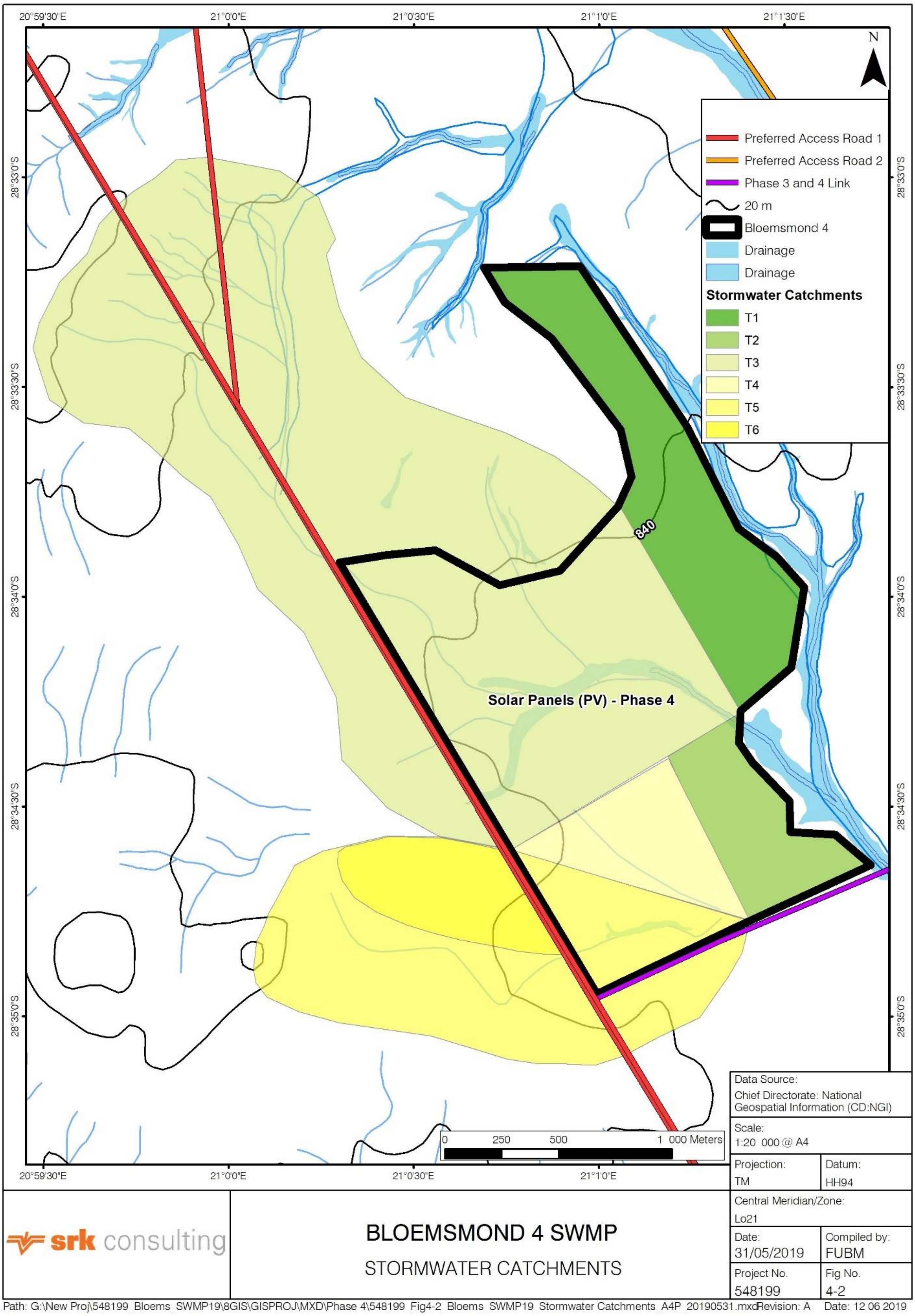



**Figure 4-2: Stormwater Catchments**

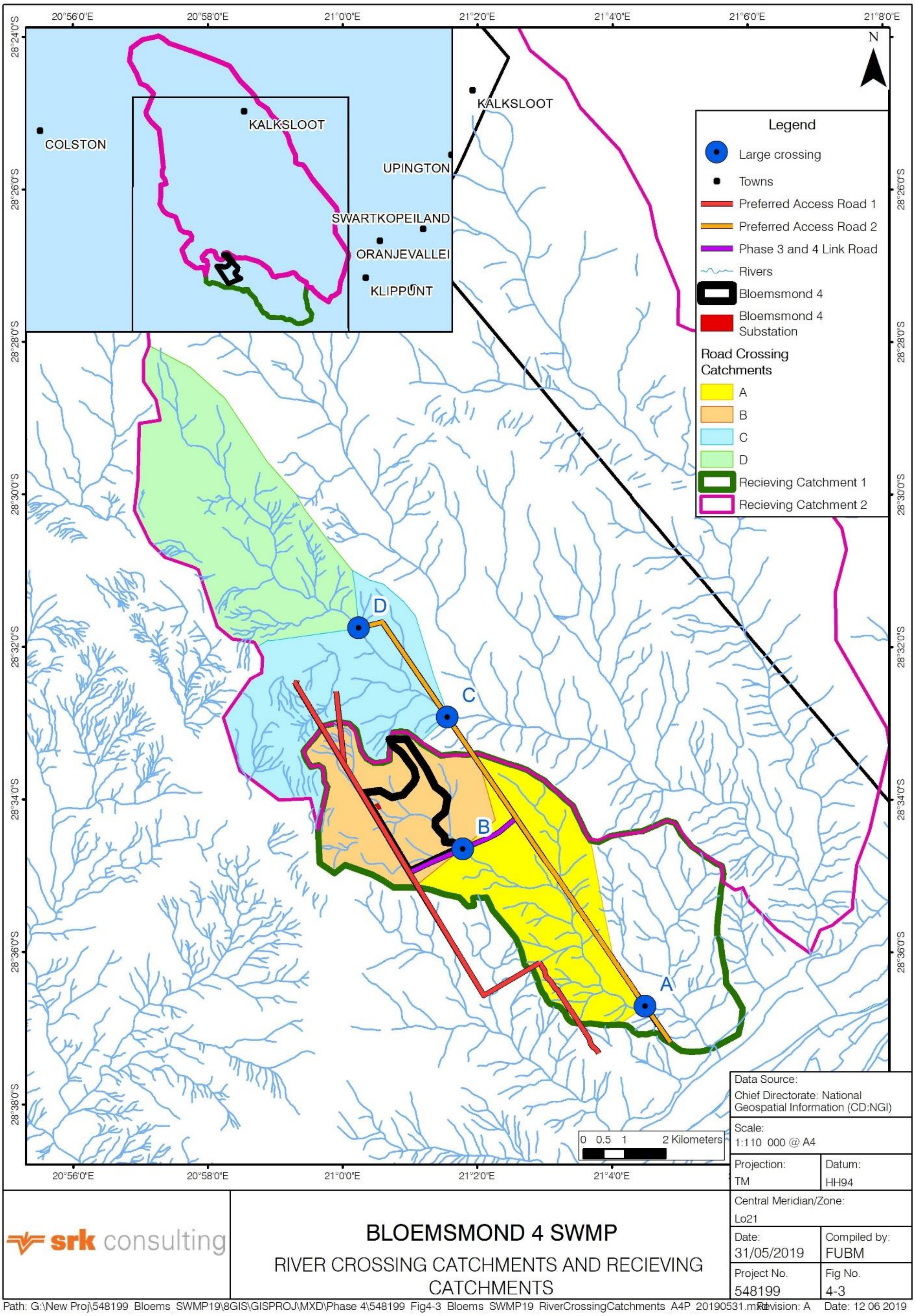



**Figure 4-3: River crossing catchments and receiving catchments**

### 4.2.4 Storm peaks

Storm peaks were calculated for the catchments shown in Figure 4-2 and Figure 4-3. Peaks were calculated using only the rational method, because the SWMP is currently only conceptual. The rational method is considered conservative, and detailed contour data was not available and thus peaks themselves are currently conceptual. The peaks, along with the input parameters for each peak, are given in Table 4-2. The peaks are both pre-development and post-development scenarios because the vegetation, topography and soil conditions will largely be the same, except where the main buildings are placed and this accounts for a negligible portion of the site from a surface area viewpoint.

Note that the wash water was not considered in the storm peaks because solar panel washing is unlikely to be done in the rainy season, and it will be negligable in comparison to storm volumes. The volume of wash water is approximately 3 l/m$^2$ per wash for each 1.95 m$^2$ panel and it is expected that between 270 000 to 300 000 panels will be installed.

**Table 4-2: Peak flows for receiving catchments, major crossings and stormwater catchments**

| **C Values for all catchments** | | | 0.13 | 0.14 | 0.15 | 0.17 | 0.21 | 0.25 |
|---|---|---|---|---|---|---|---|---|
| **Receiving catchments** | | | | | | | | |
| **Catchment name** | **Catchment Area (km$^2$)** | **Tc (Hours)** | **Stormpeaks (m$^3$/s)** | | | | | |
| | | | **1:2** | **1:5** | **1:10** | **1:20** | **1:50** | **1:100** |
| 1 | 41.2 | 4.3 | 12.2 | 21.0 | 29.1 | 39.6 | 61.6 | 86.7 |
| 2 | 321 | 8.7 | 14.4 | 45.4 | 74.6 | 105.8 | 150.2 | 221 |
| **Major road crossings** | | | | | | | | |
| **Catchment name** | **Catchment Area (km$^2$)** | **Tc (Hours)** | **Stormpeaks (m$^3$/s)** | | | | | |
| | | | **1:2** | **1:5** | **1:10** | **1:20** | **1:50** | **1:100** |
| A | 27.8 | 2.95 | 6.8 | 11.7 | 16.2 | 22.0 | 34.2 | 48.2 |
| B | 12.2 | 1.26 | 5.8 | 9.9 | 13.8 | 18.7 | 29.1 | 41.0 |
| C | 37.0 | 3.86 | 7.3 | 12.5 | 17.4 | 23.6 | 36.7 | 51.7 |
| D | 21.2 | 2.24 | 6.4 | 11.1 | 15.3 | 20.9 | 32.5 | 45.7 |
| **Stormwater catchments - Preferred development area** | | | | | | | | |
| **Catchment name** | **Catchment Area (km$^2$)** | **Tc (Minutes)** | **Stormpeaks (m$^3$/s)** | | | | | |
| | | | **1:2** | **1:5** | **1:10** | **1:20** | **1:50** | **1:100** |
| T1 | 0.76 | 49.8 | 0.5 | 0.8 | 1.2 | 1.6 | 2.5 | 3.5 |
| T2 | 0.33 | 37.8 | 0.3 | 0.4 | 0.6 | 0.8 | 1.3 | 1.8 |
| T3 | 4.28 | 79.9 | 1.9 | 3.3 | 4.6 | 6.3 | 9.8 | 13.7 |
| T4 | 0.32 | 17.9 | 0.4 | 0.7 | 1.0 | 1.3 | 2.1 | 2.9 |
| T5 | 1.57 | 50.5 | 1.0 | 1.7 | 2.4 | 3.2 | 5.0 | 7.1 |
| T6 | 0.32 | 12.2 | 0.5 | 0.9 | 1.2 | 1.7 | 2.6 | 3.6 |

The above peaks may be reduced using other calculation methods such as SCS during detailed design. The implications of the storm peaks calculated, and their impact on the SWMP, are discussed in Section 4.3.

## 4.3 Conceptual design and review

This section should be read in conjunction with the stormwater, wastewater and erosion management plan in Section 5. This section provides detail on why management approaches were selected, any alternatives that should be considered, and further steps required to confirm or improve the conceptual plan.

### 4.3.1 Channels, diversions and dissipaters

It is recommended that channels be placed on the upgradient side of any roads to control erosion as well as around any of the dirty areas to divert clean water. Note that in most cases diversions will not be required around dirty areas because bunds will "keep clean water clean". Solar panel areas are not considered dirty but where practical upgradient stormwater can be diverted around them (e.g. Catchment T6). In some cases, stormwater should not be diverted as it would have an negative impact by reducing flows to natural drainage lies (e.g. Catchment T3)

Using the conceptual infrastructure layout plans and regional contours, high-level conceptual designs were developed (i.e. typical drain and dissipater types). These were based on the following preliminary conclusions:

- Peak flows for the stormwater catchments are low;
- Most of the area is under 2% grade, and it is potentially possible to design earth or gravel drains rather than concrete drains because low erosion potential exists at these low flow gradients;
- Even though engineering designs might achieve low velocity flows in the drains, dissipaters are recommended at any outlets to control the transition of water from concentrated channel flow to overland dispersed flow or in-river flow – in addition, it is possible that outlets (e.g. adjacent to road/river crossings) could be locally steep.

Typical generic conceptual designs, based on the above discussions, were compiled as shown in Figure 5-1.

### 4.3.2 Waste and wastewater management

Waste will be disposed of at a registered landfill site and domestic wastewater at a licensed wastewater treatment plant (i.e. waste will be treated off site), hence, the SWMP only focuses on temporary storage on site.

Domestic waste should be stored out of the rain and wind, collected (and disposed of) regularly as is currently proposed for the development. Conceptual design of the wastewater (sewage) conservancy tank was not within the scope of this report, however, the current conceptual plan was evaluated in terms of the risks that this may pose to stormwater. Management of the tank is the main risk because the system could fail if the tank is not emptied regularly resulting in overflows. Consequently, a float switch controlled alert system is recommended.

Oil and lubricants in the workshop, and oil from the transformers must be bunded (See Section 4.3.5 for bunding requirements) as per legal requirements and hence, this was recommended without any alternatives.

### 4.3.3 Road crossings

Using the conceptual infrastructure layout plans and regional contours, high-level conceptual designs were developed. These were based on the following preliminary conclusions:

- Most crossings are small and on areas with low gradients, and thus the roads are well-placed to generally avoid erosion at crossings;
- Drifts would be the best crossing design from a practical, economic and environmental point of view for the road crossings;
- The catchments of the four larger road crossings (A, B, C and D on Figure 4-1 are relatively large, with relatively large peaks of 19 $m^3/s$ for a 1 in 50 year storm. Conceptually, these are likely to spread widely during flooding, given the flat terrain in the area and the morphology of the rivers. Hence, the delineation of floodlines is strongly recommended and this should be done as part of the detailed design.
- Note that the preliminary time of concentration (Tc) is 2.95, 1.26, 3.86 and 2.24 hours for the four larger crossing catchments, A, B, C, D respectively and floods last about 3 times as long as the Tc as a rule of thumb. Consequently, culverts could be considered to allow access during storms at Crossing A, B, C and D, particularly for emergency vehicles. Any decision should be based on:
  - The floodline;
  - Confirmed Tc values using more detailed contour data;
  - The frequency of floods that would prevent access;
  - Whether alternative access routes are available;
  - The exact location of the main buildings at the site.

Typical conceptual designs, based on the above discussions, were compiled for information purposes and are shown in Figure 5-1.

### 4.3.4 Erosion and sediment transport

The main erosion risks are drain outlets (Section 4.3.1), road crossings (Section 4.3.3) and stockpiles. Permanent stockpiles should be avoided. However, material excavated during piling of the panels might be significant (cumulatively). In that case, a suitable area should be selected for the stockpile such that it is unlikely to erode and result in sediment transport. Sediment traps and diversion drains should also be designed for the stockpile.

During construction, stockpiles will be necessary. A suitable area should be selected for such stockpiles. Temporary silt fences and diversion drains should also be designed for the stockpiles.

### 4.3.5 Bunding

Requirements for bunding of potential contaminants are specified in detail in the National Norms and Standards for the Storage of Waste (Notice 926 of 29 November 2013, Department of Environmental Affairs, National Environmental Management: Waste Act 2008, Act No.29 of 2008). The specification, which will apply to the site, reads as follows:

"….bunds having a capacity which can contain at least 110% of the maximum contents of the waste storage facility. Where more than one container or tank is stored, the bund must be capable of storing at least 110% of the largest tank or 25% of the total storage capacity, whichever is greater (in the case of drums the tray or bund size must be at least 25% of total storage capacity)."

### 4.3.6 Monitoring and management

Monitoring and management are key to the success of a SWMP. The following are therefore included as a key aspect of SWMP:

- Frequent inspections until the success of the design and any unexpected problems are resolved/confirmed;
- Review of the plan after a few years to improve, where possible, its practicality, cost-effectiveness or efficacy;
- Alerts that do not rely on a fulltime environmental manager at the site (which may not be feasible) including:
    - Automatic alert systems for the wastewater conservancy tank (e.g. a float driven switch alert system);
    - Brief, annual refresher training that should not take more than half an hour of time for each staff member;
    - Well placed signs that allow reporting as soon as possible and reduce the likelihood that forgetfulness or confusion will prevent reporting.

# 5 Stormwater, wastewater and erosion management plan (SWMP)

The SWMP, including waste water management, is summarised in Table 5-1, Table 5-2 and Figure 5-1. Supporting information and discussions of alternatives, where relevant, is provided in Sections 3 and 4.

**Table 5-1: Operational SWMP of Bloemsmond 4**

| General principle | Specific objective | Ref No. | Focus area | Action* | When | By whom |
|---|---|---|---|---|---|---|
| Keep clean water clean | Keep clean water clean by constructing diversions or bunds. This prevents any clean runoff from entering any potentially dirty areas. The bunds or diversions should be designed for a 1 in 50 year event | 1 | The workshop<br>The wastewater conservancy tank<br>Transformers | **Clean water diversions or bunds:** Construct stormwater drains or bunds to divert clean runoff around the workshop, transformers and wastewater conservancy tank. The bund or diversion should be designed for a 1 in 50 year event | Constructed prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |
| Collect and treat dirty water (waste water management) | Collect and treat discharge water or runoff from any dirty areas. Dirty water should not have the potential to spill into clean water systems more than once every fifty years (where influenced by stormwater) | 2 | Workshop | **Workshop collection drain with oil and grease trap:** Construct a small concrete drain collecting all water, potentially containing oils and lubricants, from workshop floor and directing it through an oil and grease trap before discharge (or removing to offsite facility). Floor to be sloped such that all water will collect in drains. | Constructed prior to operation | |
| | | 3 | Workshop | **Clean the oil and grease trap:** the oil and grease trap is to be inspected and, when necessary, cleaned and waste taken to offsite facility | Inspect every 3 months for first 2 years and then revise | |
| | | 4 | Transformers | **Dispose of transformer oil offsite:** Dispose of any oil removed from transformers during maintenance to a registered facility | Constructed prior to operation | |
| | | 5 | The sewage conservancy tank | **Transport sewage to municipal works:** Collect sewage in a conservancy tank that will regularly be emptied and disposed to the municipal sewage treatment plant. | Constructed prior to operation | |
| | Bund any hazardous substance or pollutant storage areas (including any oils) as per regulations | 6 | Workshop | **Small trays for workshop chemicals:** Bund any containers with oils and lubricants by placing them in plastic trays that is at least 100% of the volume of the container If all containers are stored together the bund will store at least 110% of the largest container or 25% of the total storage capacity, whichever is greater. Suitability of the bund must be investigated whenever a new substance is added to the bund | During operation: as and when containers are purchased | **Workshop manager** and assurance by **environmental manager** |
| | | 7 | Transformers | **Transformer bunds:** All transformers will be bunded with bund capacity of at least 110% of the maximum volume of oil in the transformer. Transformers and bund will be protected from rainfall by small covers or roof or housing in containers. | Constructed prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |
| | | 8 | The sewage conservancy tank | **Sewage conservancy bund:** The sewage conservancy tank will be a closed tank with an automatic alert system. | Constructed prior to operation | |
| Do not impede surface and subsurface flow along drainage lines | Minimise dirty areas such that surface and subsurface movement of water along the drainage lines is not impeded | 9 | The workshop, transformers, waste water conservancy tank | **Diversion channels placed to minimised dirty areas:** Place diversion channels directly beside dirty areas such that dirty areas are minimized in footprint | Constructed prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |

| General principle | Specific objective | Ref No. | Focus area | Action* | When | By whom |
|---|---|---|---|---|---|---|
| | Ensure any engineered clean stormwater drainage directs water to the naturally receiving drainage line | 10 | Along roads, the workshop, transformers, waste water conservancy tank | **Drains to follow natural topography:** Ensure outlets drain towards the natural drainage line that would originally have received flow from that area | Constructed prior to operation | |
| Control erosion | Prevent erosion in general | 11 | All areas | **Maintain natural topography:** Do not disturb the natural topography or vegetation between the solar panel installations | Constructed prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |
| | | 12 | All areas | **No stockpiles if possible:** Do not stockpile (during operation). If spoil from pilings is likely to be significant, a dedicated stockpile location must be identified and stormwater protection measures designed when detailed layouts are available. | During operation | Assurance by **environmental manager** |
| | Minimize erosion in large storm event of 1 in 50 years or greater | 13 | All drains | **Engineer low velocity drains:** Drains sloped and sized such that velocities do no exceed 1 m/s | Constructed prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |
| | | 14 | Road crossings | **Engineered drifts:** Line all major drifts on road crossings with concrete to protect from traffic damage and high flow velocities (For smaller drifts gravel might suffice). Place a section of rip-rap (larger rocks) underlain by gravel and with gravel on either side to facilitate a smooth flow transition. Detailed modelling and design of road crossings such that erosion is controlled to be a feature of the detailed design. | Constructed prior to operation | |
| | Dissipate stormwater at all drainage outlets to velocities unlikely to cause erosion in natural soils for a 1 in 50 year storm event | 15 | All drains | **Dissipaters:** At drain outlets widen the channel and use rip-rap (can be sourced from spoil during construction) or reno matresses to dissipate stormwater flows | Constructed prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |
| | | 16 | Road crossings | **Dissipation at road crossings:** Detailed modelling and design of road crossings including rip-rap (can potentially be sourced from spoil during construction) or reno-matresses. | Constructed prior to operation | |
| Monitor and manage erosion | Ensure that any chronic erosion is detected and rehabilitated within 6 months | 17 | PV cell blocks<br>Drains<br>Outlets of all drains<br>All natural drainage lines that cross the access road<br>All natural drainage lines that run through the site | **Inspect and remediate noticeable erosion:** Inspect all focus areas for erosion. If erosion is found, remediate and redesign the drainage in the area. If erosion is found in a natural drainage line, conduct an assessment and determine the cause. Develop a plan to prevent future erosion. | Every 3 months for the first 2 years and annually thereafter | **Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager |
| | Ensure that any acute erosion due to large storm events is detected within two weeks. | 18 | | **Inspect and remediate acute erosion:** Inspect all focus areas for erosion. If erosion is found remediate and redesign the drainage in the area. If erosion is found in a natural drainage line conduct and assessment and determine the cause and develop a plan to prevent future erosion. | After a rain event of greater than 65 mm In one day (a 10 year rain event) or when staff notice flood damage. | |
| | | 19 | Main office | **Install a rain gauge** that can measure greater than 115 mm (100 year, 24 hour event) | Construction prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |

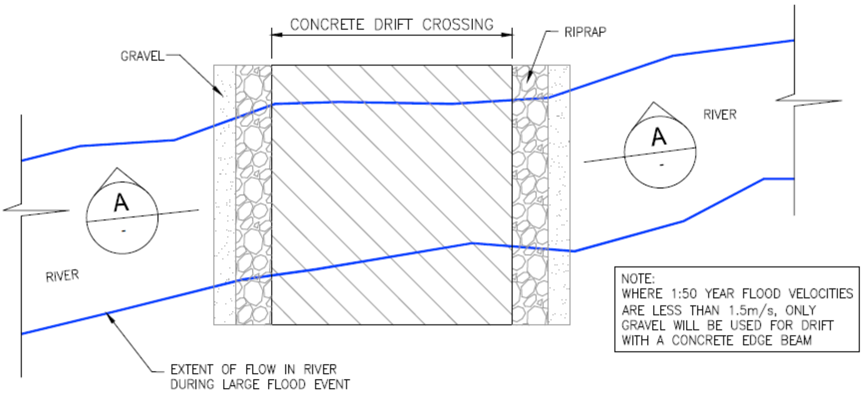
| General principle | Specific objective | Ref No. | Focus area | Action* | When | By whom |
|---|---|---|---|---|---|---|
| | | 20 | All | **Set up rain data system:** Build or buy a basic rain program, preferably electronic, that allows site staff to enter rain data from the rain gauge. Ideally the system should alert the environmental manager and site manager when a rainfall event in excess of 65 mm per day is entered. | Design and development prior to operation | **Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager |
| | | 21 | Main office | **Record rain data:** Read and record rain gauge daily; | | Onsite staff member tasked by the **Environmental manager** |
| | | 22 | Main office | **Signs at main office to aid problem reporting:** Ensure that a sign providing the following is posed in the reception area, the control room, on each transformer and in the workshop:<br>The name, telephone number and email address of the environmental manager. The sign should state: "If you notice any leaks or spills or erosion anywhere on the property please phone or email the environmental manager on ……." | Update annually in case of staff change | **Environmental manager** |
| | Training | 23 | All | **Training:** Provide a very short briefing to all staff on stormwater management including erosion and leaks that covers at least:<br>• How to identify erosion;<br>• How to identify a leak, including car leaks;<br>• Where to find contact details of the environmental manager in case of leaks or erosion. | Annually | **Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager |
| Monitor and manage stormwater system | Include a monitoring system for spills and leaks such that they are detected as soon as possible. | 24 | All | **Leak inspection:** regularly check for leaks and for any breaches or evidence of spills or any other problems that would indicate that it is not in adherence to this plan. All cars should also be checked for oil leaks during the inspection. Any leaks found should be stopped immediately, the cause of the leak sought, the problem remediated such that no further leaks occur and any contaminated soil or water assessed and remediated. | Every 3 months for the first 2 years and annually thereafter | **Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager |
| | | 25 | All | **Data capture, training and signs:** see 19,20,21,22 & 23 | Continuous | **Environmental manager** and staff in general |
| | | 26 | The sewage conservancy tank | **Sewage conservancy tank alert system:** Install a float switch controlled alarm that will alert the control room when the conservancy tank has less than 2 weeks of capacity remaining. | Construction prior to operation | Included in detailed designs of **design engineer** and carried out by contractor appointed for construction |
| | | 27 | Transformers | **Signs at transformers:** Post a sign on transformers stating "If you notice any leaks or spills or erosion anywhere on the property please phone reception on ……and report it" | Construction prior to operation | |
| General | Do not build infrastructure in watercourses | 28 | All | Ensure no infrastructure except roads, solar panels and solar panel supports are built within 300 metres of a water course. I particular, ensure no dirty areas, that may contain pollutants, are within 300 metres of the water course<br>Alter any designs that result in potentially polluting infrastructure (transformers, workshop, conservancy tank), lying within 300 metres of the watercourse (currently none are proposed) | Detailed design | **Design engineer** or engineer appointed by the design engineer |
| | Do not build infrastructure containing potential pollutants in any of the natural drainage lines. | 29 | All | Ensure that final infrastructure plans **do not** propose **any potentially polluting infrastructure, such as transformers, workshops or conservancy tanks in the natural drainage** lines (currently none are proposed) | Detailed design | **Design engineer** or engineer appointed by the design engineer |

| General principle | Specific objective | Ref No. | Focus area | Action* | When | By whom |
|---|---|---|---|---|---|---|
| | Review and improve stormwater management plan regularly. | 30 | All | **Review and improve** the stormwater plan | Once every 5 years | **Environmental manager** or engineer appointed by the environmental manager |

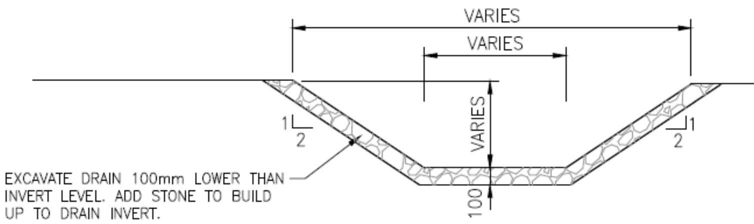
**Table 5-2: SWMP details for construction of Bloemsmond 4**

| General principle | Specific objective | Ref No. | Focus area | Action* | When | By whom |
|---|---|---|---|---|---|---|
| Keep clean water clean | Keep clean water clean by diverting any clean runoff around any potentially dirty areas. The diversion should be designed for a 1 in 5 year event | 1 | Stockpiles<br>Laydown areas<br>Any other area likely to generate sediment during a storm event or contain contaminants | **Clean water diversions:** Excavate clean water diversion channel to direct clean runoff around dirty areas. Channel to be sized for 1 in 5 year event. Typical design will be an excavated earth channel or berms. | During site establishment | Construction contractor's **onsite environmental officer/representative** |
| Collect and treat dirty water | Collect and treat discharge water or runoff from any dirty areas. Dirty water should not have the potential to spill into clean water systems more than once every fifty years (where influenced by stormwater) | 2 | Stockpiles | **Construct silt fences or berms:** to prevent the sediment transport into rivers. | Before stockpiles are deposited | |
| | | 3 | Waste | **Dispose of landfill, oils and other contaminants offsite** | Throughout construction | |
| | | 4 | Sewage | **Supply chemical toilets** | During site establishment | |
| | Bund any hazardous substance or pollutant storage areas (including any oils) as per regulations | 5 | General | Construct **temporary bunds for any chemicals** such as oils or fuel stored on sited during construction. Bunds must contain at least 100% of the volume of the container. If all containers are stored together the bund must store at least 110% of the largest container or 25% of the total storage capacity, whichever is greater. Suitability of the material of bund must be investigated whenever a new substance is added to the bund | Throughout construction | |
| Do not impede surface and subsurface flow along drainage lines | Minimise dirty areas the such that surface and subsurface movement of water along the drainage lines is not impeded | 6 | Laydown areas<br>Stockpiles | **Minimise laydown areas and stock piles**. | Throughout construction | Construction contractor's **onsite environmental officer/representative** |
| | Ensure any engineered clean stormwater drainage directs water to the naturally receiving drainage line | 7 | All drains | Ensure that any temporary **stormwater drains** or diversion berms direct water **towards the drainage line to which it would naturally flow** | Throughout construction | |
| Control erosion | Prevent erosion in general | 8 | All | **Maintain natural topography and vegetation:** Do not disturb the natural topography or vegetation where possible | Constructed prior to operation | Construction contractors **onsite environmental officer/representative** |
| | Minimize erosion in large storm event of 1 in 5 years or greater | 9 | All drains | **Engineer low velocity temporary drains:** Drains sloped and sized such that velocities do no exceed 1 m/s in a 1 in 5 year event | Throughout construction | |
| | | 10 | Road crossings | **Engineered temporary drifts:** Build roads and road crossings before other infrastructure. | Early in construction | |
| | Dissipate stormwater at all drainage outlets to velocities that | 11 | All drains | **Dissipaters at drain outlets**, where necessary, widen the channel and use rip-rap from construction spoil to dissipate stormwater flows | Constructed prior to operation | |

| General principle | Specific objective | Ref No. | Focus area | Action* | When | By whom |
|---|---|---|---|---|---|---|
| | are unlikely to cause erosion in for the natural soils for a 1 in 5 year storm event | | | | | |
| | | 12 | Road crossings | **Dissipation at road crossings:** Build roads and road crossings before other infrastructure. | Constructed prior to operation | |
| Monitor and manage erosion | Ensure that any erosion is detected and rehabilitated | 13 | All | **Inspect the site for erosion after rain events.** If erosion is found, remediate and redesign the drainage in the area. If erosion is found in a natural drainage line, conduct an assessment to determine the cause and develop a plan to prevent future erosion. | After rain events | **Contractors environmental officer/representative** |
| | | 14 | | **Install a rain gauge** that can measure greater than 115 mm (100 year, 24 hour event). This rain gauge will also be used during operation. | During site establishment | |
| | | 15 | | **Training:** Provide a short briefing to all construction staff on the dynamics of erosion and leaks that covers at least:<br>• How to identify erosion;<br>• How to identify a leak, including car leaks;<br>Where to find contact details of the environmental officer/representative in case of leaks or erosion. | During site establishment | |
| Monitor and manage stormwater system | Include a monitoring system for spills and leaks such that they are detected as soon as possible. | 16 | All | **Leak inspection:** regularly check for leaks and for any breaches or evidence of spills or any other problems not in adherence to this SWMP. All cars should also be checked for oil leaks and any leaks found should be stopped immediately, the cause of the leak identified, the problem remediated such that no further leaks occur and any contaminated soil or water assessed and remediated. | Once every two weeks | **Contractors environmental officer/representative** |
| General | Review and inspect | 17 | All | **Inspect the site to ensure adherence to the stormwater management plan** | Once every two months depending on the construction schedule | **Clients environmental representative or Engineer** |
| | Do not place stockpiles or other potentially polluting construction items within 300 metres of the water course | 18 | All | **Do not place laydown areas, stockpiles within 300 metres of the water course** | Detailed design and throughout construction | **Design engineer** or engineer appointed by the design engineer |
| | Do not build infrastructure within water courses, and potential pollutants within 300 metres of a water course | 19 | All | **Do not place laydown areas, stockpiles** or any other materials or equipment within 300 metres of the water course | Throughout construction | **Design engineer** or engineer appointed by the design engineer |
| | General | 20 | | Develop a specific **environmental specification for any construction** including, but not limited to, the actions in this stormwater management plan and its principles | Detailed design | **Clients environmental representative or specialist** |

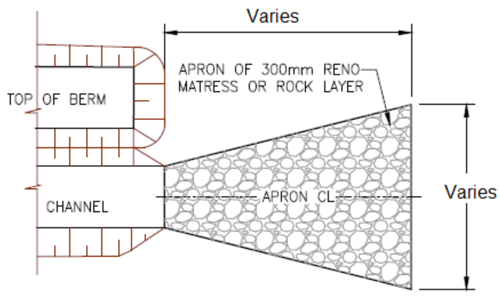



TYPICAL PLAN OF
DRIFT CROSSING




TYPICAL CROSS SECTION THROUGH
THROUGH DIVERSION CHANNEL

NOTE:
WHERE 1:50 YEAR FLOOD VELOCITIES ARE LESS THAN 1m/s, STONE LINING WILL BE EXCLUDED




TYPICAL PLAN OF
DISSIPATER AT END OF CHANNEL

| srk consulting | **Bloemsmond Solar 4 SWMP**<br>Typical conceptual designs of stormwater infrastructure<br>(to be confirmed in detailed design) | Project No.<br>495722 |
|---|---|---|

**Figure 5-1: Typical conceptual designs of stormwater infrastructure**

# 6 Conclusions and Recommendations

In conclusion:

- The proposed facility, will have an intrinsically low impact on surface water resources;
- The potential stormwater impacts that do exist can be managed in a practical way;
- The plan is conceptual because no detailed contour data is available and only conceptual infrastructure layouts are available.

It is recommended that the SWMP be developed further during detailed design by:

- Delineating floodlines for major rivers and assessing any safety requirements due to flooding;
- Conducting a detailed topographic survey;
- Developing a stormwater layout and conceptual designs based on the above information and infrastructure layout plan;
- Developing conceptual designs into detailed designs with sufficient detail to support construction.

The plan should be incorporated into an environmental specification for use during construction. The plan should be incorporated into the operational environmental management of the site;

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Seabelo Seroalo

Engineer

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Xanthe Adams, Pr. Eng.

Principal Engineer

**Project Partner**

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Bruce Engelsman, Pr. Eng, Pr. CPM

Partner

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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