GEMSBOK SOLAR PV2,5,6

MULILO TOTAL COEGA

Conceptual Flood Impact & Stormwater Management Plan

MULILO RENEWABLE PROJECT DEVELOPMETS

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1 EXECUTIVE SUMMARY

The site is generally flat to gentle sloping and annual rainfall is low – the design considers the data obtained from the pluviometric map of South Africa for a 20 year return period. The site is located away from the ecologically sensitive "no-go" areas including a buffer area greater than 50m; all possible wetland (including pans) and riparian (including ephemeral drainage lines) features fall outside of the work area. Access roads are to be positioned in such a way that no clearing within no-go areas is required and definite drainage areas are avoided wherever possible.

"Irish Bridges" will be distributed strategically at several points to allow for the continuity of the natural flow and water passage. The Irish Bridge will consist of a concrete platform that permits the continuity of the rain flow over the designed roads; the elevation in these areas will be lower to allow the water to flow easily across the roads. Surface runoff will be collected by a system of drainage swales, but additional drainage ditches may be required in locations where there are no proposed roadways to conduct flow to the Irish Bridge flow passages.

- Should any drainage pipes be required, a standard riprap lined ditch for erosion control is to be installed for the end-of-pipe energy dissipation.
- Degradation or erosion as a result of leaking pipes, spills, muddy conditions, or washaways shall be taken into account when designing any water abstraction points. Any leaks identified must be repaired immediately.
- Cleared areas and stockpiles of aggregates or soil is to be protected in such a way that erosion or sediment inputs to ecologically sensitive areas during rainfall is prevented.
- Access to wet areas after rainy periods is to be avoided until such a time as the soil has dried out.
- Water is to be recycled during the construction phase wherever possible.

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2 INTRODUCTION

The site which has been selected is within the project development area identified as the "Nieuwehoop cluster" where the Project Company has focused its site prospecting.

The area presents the following characteristics:

- The solar irradiance in the region is favourable;
- Proximity to transmission grid infrastructure and a direct access to the National electricity grid through a Main Transmission Substations (MTS) within the identified clusters;
- The identified cluster offers potential for cost advantage due to an economy of scale.

In addition to the above the land availability, site accessibility, topography and environmental considerations have also been evaluated. These points are discussed in further detail in subsequent sections of the feasibility study.

Figure 1: Solar Panels (Image: Mulilo Prieska PV)

Facility	**Nieuwehoop Solar PV Facility**
Proposed site location	located approximately 30 km northeast of Kenhardt, Northern Cape
Locality Map	

Figure 2: Location of Nieuwehoop Solar PV Facility (Google Earth)

Access	via regional road R359
Co-ordinates	29°8'4.12"S; 21°20'49.30"E and 29°6'25.82"S; 21°25'22.87"E
Generation	Solar Photovoltaic, single axis tracking
Storage	N/A
Installed capacity	216 MWp
Export capacity	180 MW

The areas of interest are identified in the site cluster diagram (Figure 2) as follows:

- Gemsbok Solar PV2
- Gemsbok Solar PV5
- Gemsbok Solar PV6

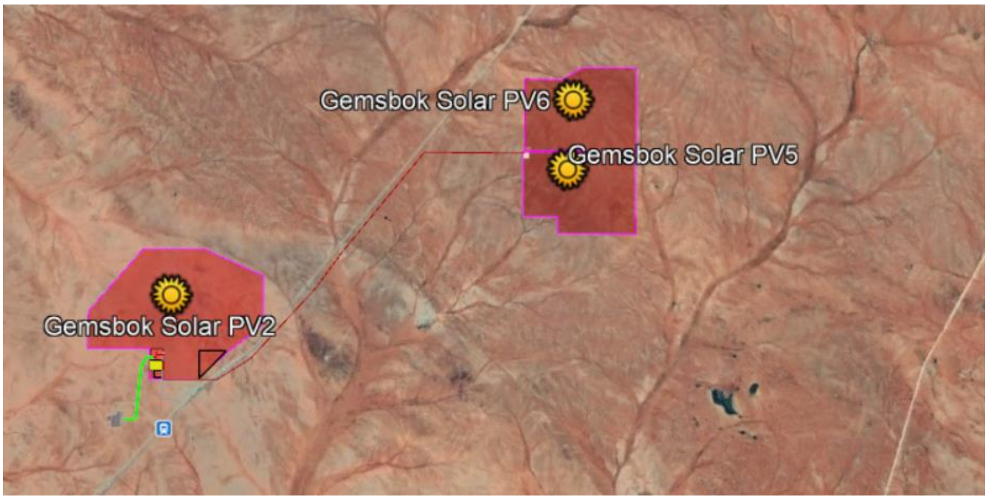


Figure 3: Nieuwehoop Cluster (Google Earth)

In terms of solar PV development and site capacity, an initial high-level assessment was done to determine the energy potential for the respective areas. The maximum installed capacity for each area is indicated in Table 3 below:

Table 1: Detail of site suitability in terms of Solar PV capacity

PV Cluster	#	Site name	Location	Contracted capacity MW	Installed capacity MWp	Site Area (Ha)
NIEUWEHOOP CLUSTER	1	Gemsbok Solar PV2	Portion 3 of Farm 120 Gemsbok Bult Kenhardt	75	90	400
	2	Gemsbok Solar PV5	Portion 8 of Farm 120 Gemsbok Bult Kenhardt	55	66	240
	3	Gemsbok Solar PV6	Portion 8 of Farm 120 Gemsbok Bult Kenhardt	50	60	240
Total				180	216	880

3 HYDROLOGY AND FLOOD ASSESSMENT

3.1 DESIGN HYDROLOGY

For the rain design it has been checked the pluviometric map of South Africa for twenty years of return period, wherein a 70mm value is given for Prieska rains data. This value is taken for evaluate the maximum rainfall for the calculation. With the rain data it´s been followed the Rational Method in order to get the flow in the different watersheds that will be captured by the superficial drainage.

3.1.1 Basin Area Delineation and Land-use Determination

The contributing drainage areas have been delineated based on the master plan and topographic map drawings. The basin area delineation has been made using the proposed site grading, building block elevation, and roadway designs. The land use factor coefficients were selected using guidance documentation, a presential field data collection, and engineering judgment. None of the drainage system contributing areas individually exceeds the hectares of cumulative area that are required for the use of Hydrology Rational Method criteria.

3.1.2 Precipitation: Basic Rainfall of Calculation

The design storm for this project is expected to recur every 20 years on average. The value of rainfall intensity determined in the analysis performed using the rainfall data of 70mm from the map below where it’s shown the maximum daily rainfall distribution across southern Africa, which is appropriate for the storm drainage system design in this project.

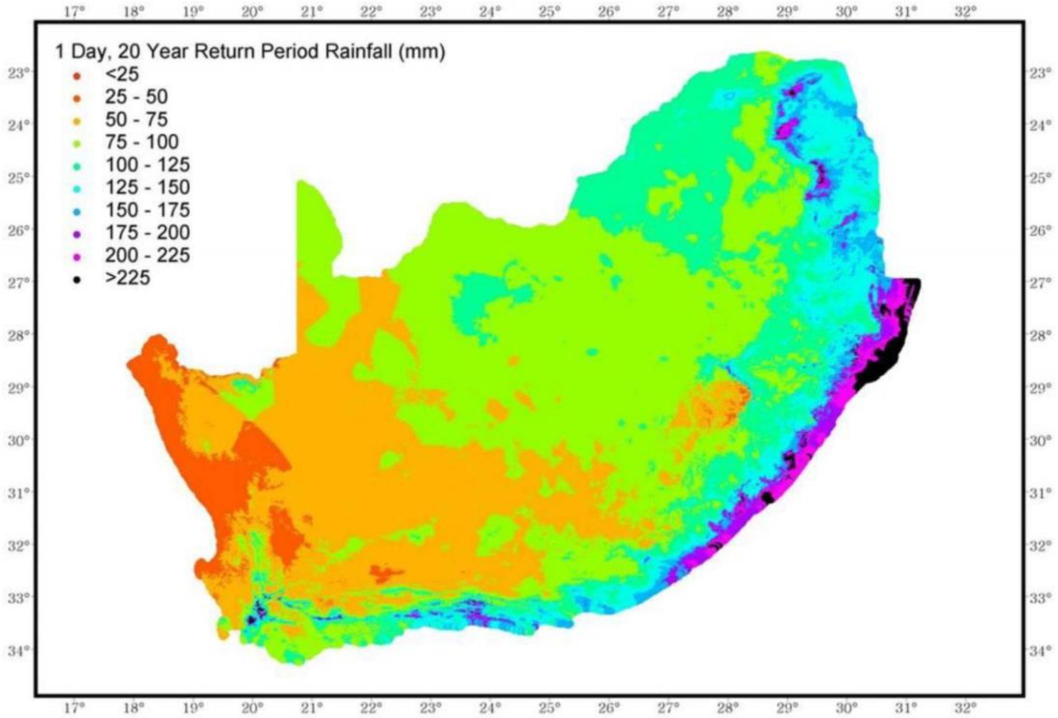


Figure 4: South Africa 20 year return period rainfall

The value related to the precipitation in Nieuwehoop has been considered as 70mm for a 20 year back flowing period. In order to increase the security of the foundation and roads, this rainfall is used as basic rainfall in the verification of the drainage system by the Rational Method for ten years return period.

3.1.3 Topography:

A preliminary terrain topography analysis was performed to study the suitability of the terrain for the construction of a photovoltaic plant. The North-South and East-West slopes were calculated and are shown in Figure 5.

The grid resolution of the elevation data is 30.0 m (North-South and East-West directions). This data was provided by Google Earth (SRTM-30).

The analysis of the terrain slopes results in three differentiated areas:

- Zones where the slope is lower than 5.00 %.
- Zones where the slope is between 5.00 % and 10.00 %.
- Zones where the slope is greater than 15.00 %.

NOTE: The slopes measured on site when performing a detailed topographical analysis could be greater than the slopes obtained using this analysis.

The map shown in the Figure 5 represents the slopes of the terrain, with the following colors representing:

- Slopes <5.00 %
- Slopes >5.00 % and <10.00 %
- Slopes >10.00 % and <15.00 %
- Slopes >15.00 %

Using the previously mentioned elevation data, the position of the mounting structures in the terrain was calculated. The slope of the terrain in the North-South and East-West directions under the structures was calculated. The position of the structure posts was also calculated, including ground elevation and post height.

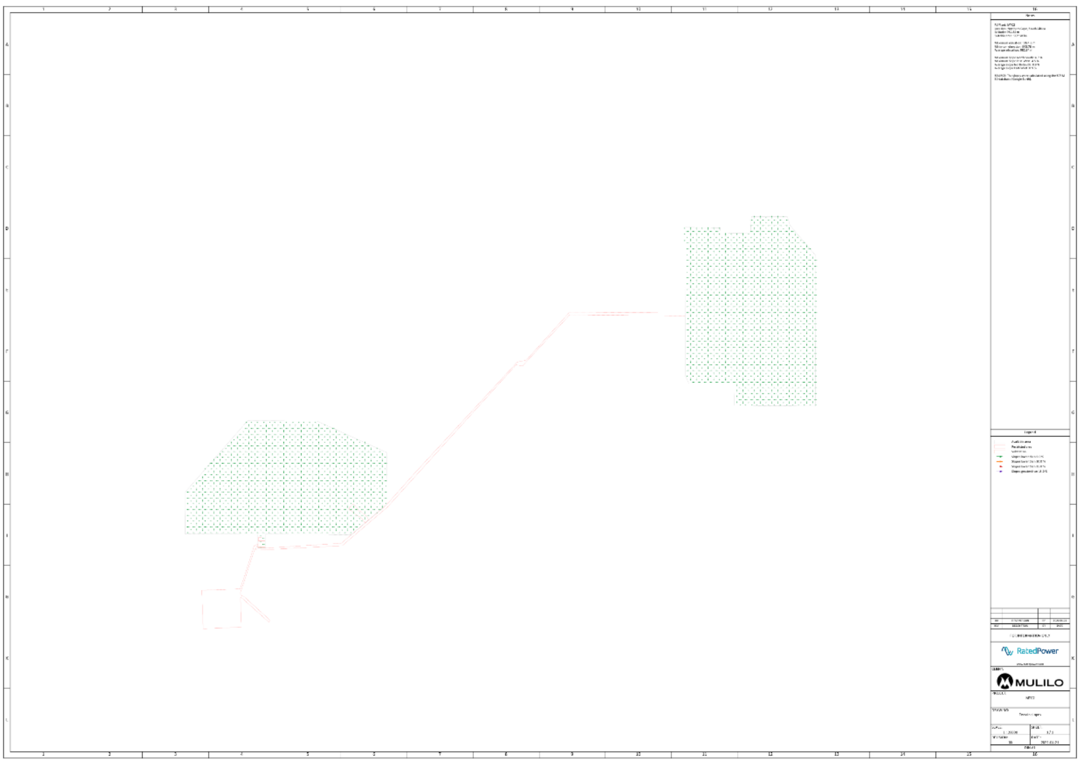


Figure 5: Slopes of the plot areas

The site is generally flat to gentle sloping and annual rainfall is low - the design considers the data obtained from the pluviometric map of South Africa for a 20 year return period. The site is located away from the ecologically sensitive "no-go" areas including a buffer area greater than 50m; all possible wetland (including pans) and riparian (including ephemeral drainage lines) features fall outside of the work area. Access roads are be positioned in such a way that no clearing within no-go areas is required and definite drainage areas are avoided.

From a hydrology point of view the facility area can be looked at as two distinct zones namely that of Gemsbok Solar PV2 and then then that of Gemsbok Solar PV5 and Gemsbok Solar PV6. Each zone is discussed in the sections which follow.

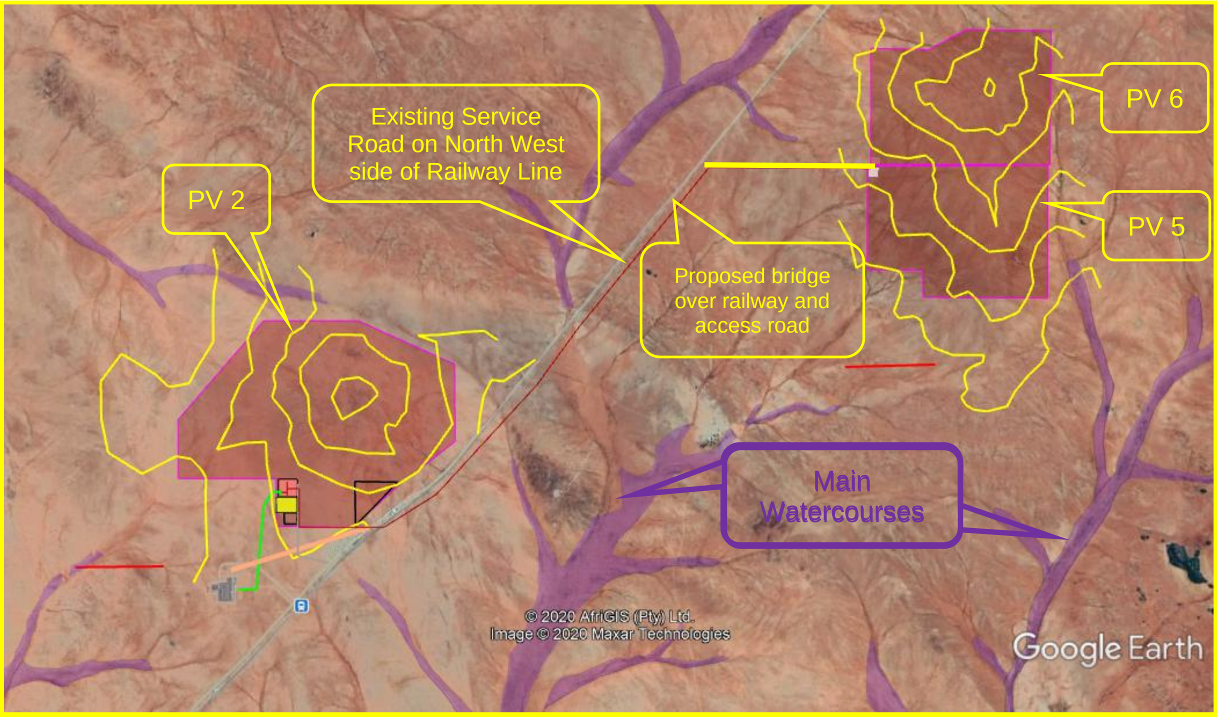


Figure 6: Nieuwehoop sites (Google Earth)

3.2 Zone 1 – Gemsbok Solar PV2

3.2.1 Catchment areas and flow paths

As mentioned above and shown in Figure 3 and in Figure 4, the PV2 site is situated to the east of the gravel service road for the Sishen Saldanha Railway.

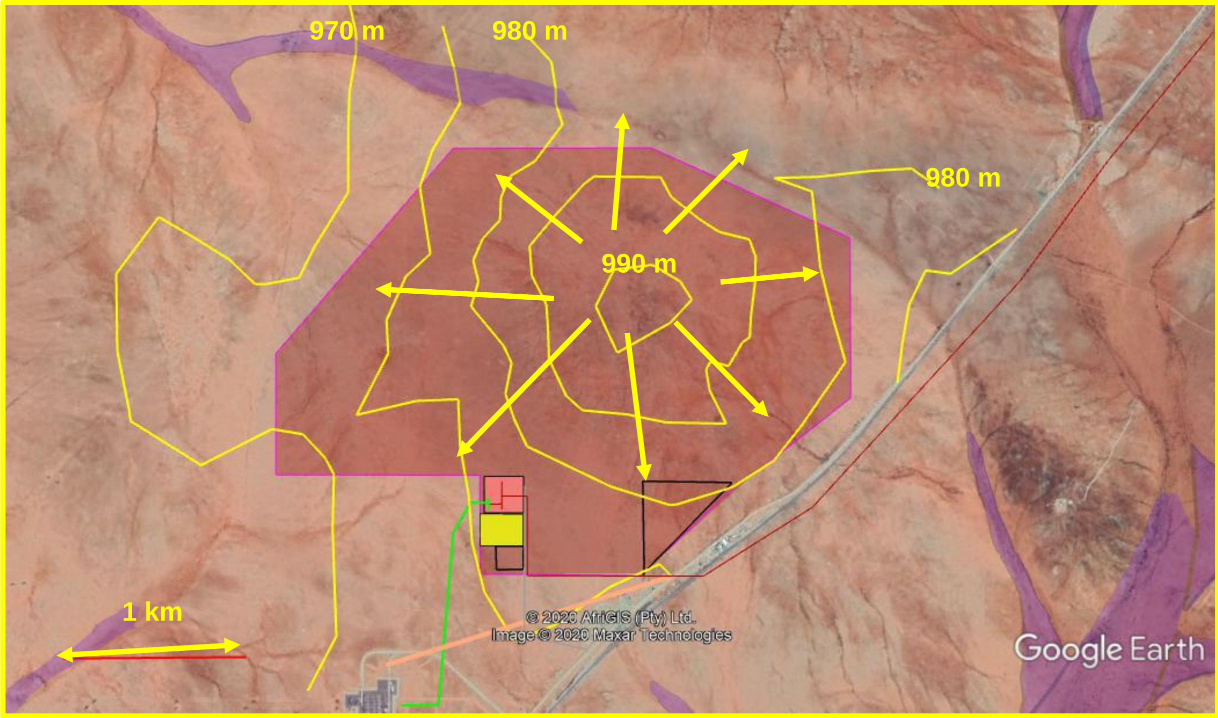


Figure 7: Contours of Gemsbok Solar PV2 Site (Google Earth)

The approximate contours shown in Figure 4 were determined from Google Earth. These contours show that as the flow will discharge radially from the crest of the hill it is unlikely to cause erosion on account of the catchment areas. However, there may be existing drainage paths where flows are more concentrated which have not been identified.

3.3 HYDRAULIC DESIGN

3.3.1 Runoff Collection

Surface runoff will be collected by a system of drainage swales, generally along proposed roadways, but additional drainage ditches could be required at locations where there are no proposed roadways, as shown on the drawings. It was assumed that no significant surface runoff flows into the site from outside the project limits.

3.3.2 6.2 Runoff Conveyance

Runoff is collected in roadway ditches and additional ditches and conveyed to rip-rap dissipaters. Several different discharges points have been made in order to reduce the erosion that only one and unique discharge could produce. Each roadway crossing was screened to determine if a low water crossing could be substituted to reduce the amount of conduit required.

Energy dissipation would still be required at all of the above locations, the standard riprap lined ditch currently proposed for the end-of-pipe energy dissipation is to be installed concurrent with commencement of grading activities to provide protection during construction.

The storm drain system shown on the attached drawings and calculations is designed based on the project understanding and assumptions described above. If substantive changes are made to those understandings and assumptions, the designs, drawings and calculations will need to be reviewed and may require revision.

3.4 Flood risk

For a project lifetime of 20 years, the risks of floods with recurrence intervals of 1 in 20 years, 1 in 50 years and 1 in 100 years occurring are 64%, 33% and 18% respectively.

3.5 Need for flood protection measures

As the catchment areas for flows down the sides of the hill are very small as is evident from Figure 9 and if on site investigations show that little or no erosion has occurred then it may not be necessary to provide erosion protection other than around the panel bases which are typically as shown in Figure 10.

On the other hand, if there is evidence of erosion then it may be necessary to provide a number of small herringbone drainage systems around the hill with some erosion protection to the downhill channels.

As there are no significant water courses no major flood protection measures would be required.

3.6 Zone 2 – Gemsbok Solar PV5 and Gemsbok Solar PV6

3.6.1 Catchment areas and flow paths

As mentioned above and shown in Figure 8 above and in Figure 11 below, the Gemsbok Solar PV5 and PV6 sites are adjacent to each other and are situated about 2 km to the east of the gravel service road for the Sishen Saldanha Railway.

As also mentioned above it would probably be necessary to construct a bridge over the Sishen Saldanha Railway, as for all other road crossings of this Railway, and a 2 km access road to the sites.

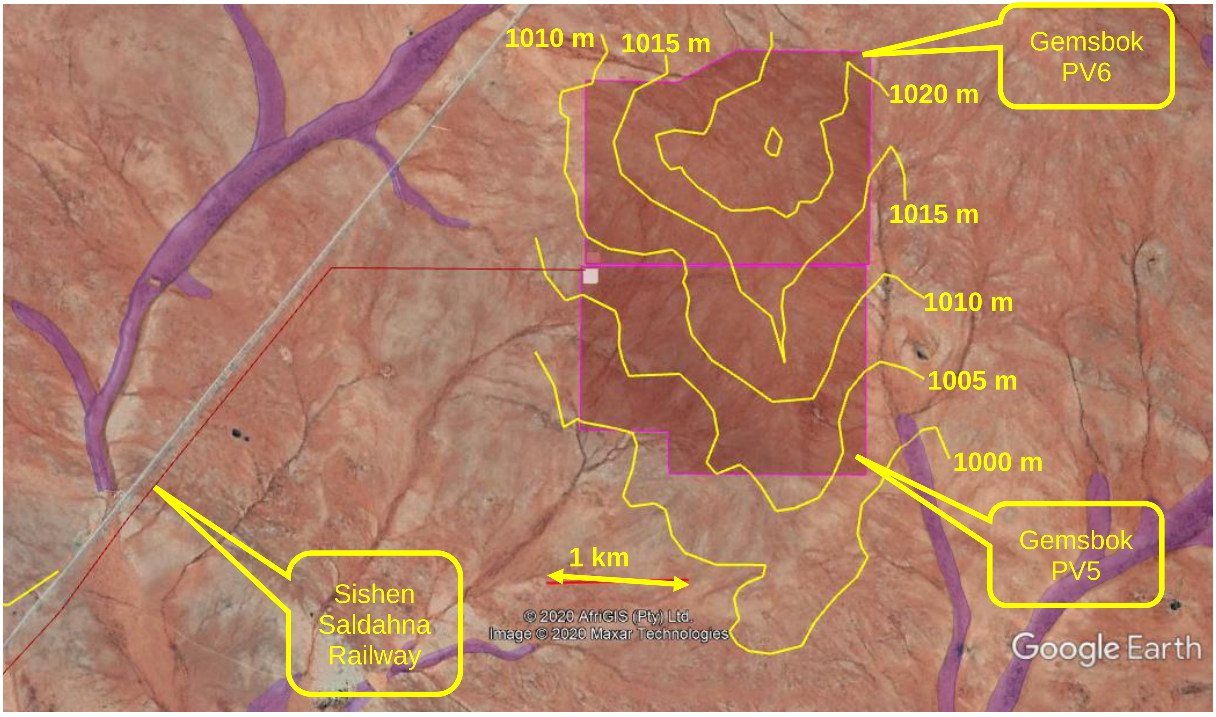


Figure 8:Contours of Zone 2 (Google Earth)

4 FLOOD RISK

For a project lifetime of 20 years, the risks of floods with recurrence intervals of 1 in 20 years, 1 in 50 years and 1 in 100 years occurring are 64%, 33% and 18% respectively.

4.1 Need for flood protection measures

The approximate contours determined from Google Earth as shown in Figure 11 indicate that storm runoff currently discharge from the sites as follows:

- For Gemsbok Sites PV5 and PV6 storm runoff also discharges radially from the crest of the hill, also with limited erosion potential on account of the relatively small catchment areas.
- On the other hand there appears to be some evidence possible minor erosion in the south west of Gemsbok Solar PV5 perhaps due to local concentration of the flow on account of the local contours.

As the catchment areas for flows down the sides of the hill are very small, and if site investigations show that little or no erosion has occurred then it may only be necessary to provide panel layouts that do not concentrate the flow and that do not erode the panel bases.

On the other hand, if there is evidence of erosion then it may be necessary to provide local drainage measures such as a small herringbone drainage systems.

As there are no significant water courses no major flood protection measures would be required.

5 PROPOSED MEASURES FOR STORMWATER MANAGEMENT

5.1 General

The existing drainage patterns and characteristics will be preserved to a large extent, which will include the use of the natural ponding areas - endorheic pans.

“Irish Bridges” will be distributed strategically at several points to allow for the continuity of the natural flow and water passage. The Irish Bridge will consist of a concrete platform that permits the continuity of the rain flow over the designed roads; the elevation in these areas will be lower to allow the water to flow easily across the roads.

5.2 DRAINAGE SYSTEM ELEMENTS

Taking into consideration the aforementioned concept, it can be evaluate as a good option the execution of drainage elements that allow the passage of the rainfall flow in the specific points of flow concentration.

Surface runoff will be collected by a system of drainage swales, but additional drainage ditches may be required in locations where there are no proposed roadways to conduct flow to the Irish Bridge flow passages.

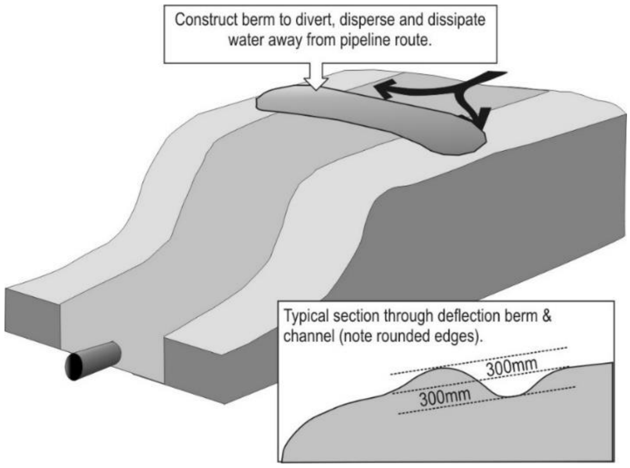


Figure 9: Typical application of a deflection berm to avoid erosion of a pipeline route

5.2.1 Side Drains

In general it was decided to provide open drains along the proposed roads or between PV Panels where no other options were possible.

The open drains would be gravel drains with concrete protection at crossings where required.

5.2.2 Irish Bridge

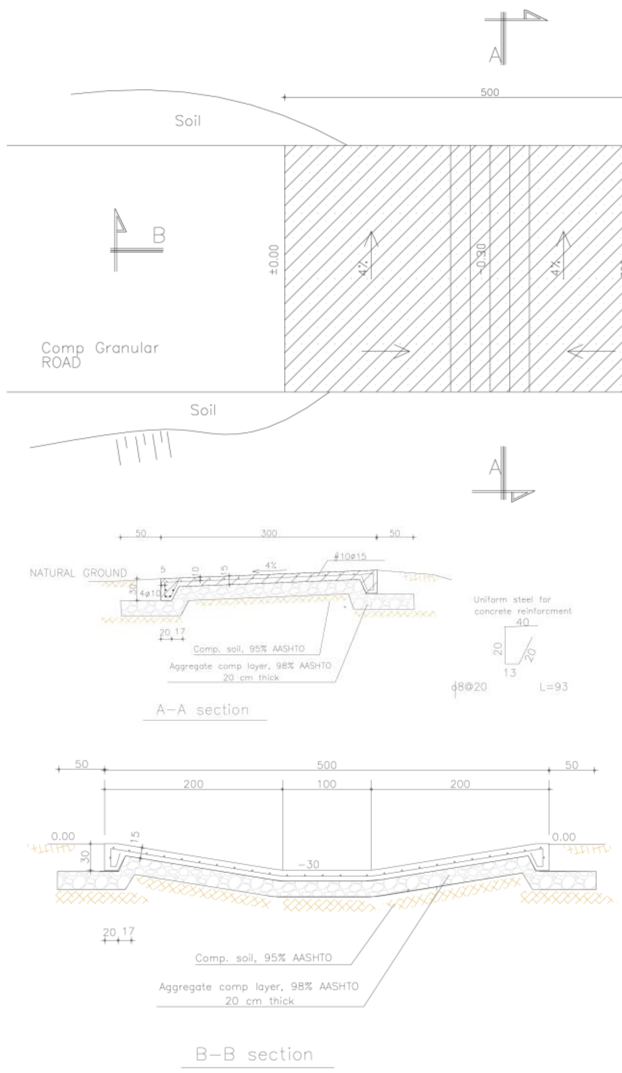
Instead of the execution of typical ditches all along the designed roads, it would be effective design a main drainage composed by several “flow access” by Irish Bridge execution in there points that an important flow is interrupted.

Those “Irish Bridge” will be allocated in several points of the site, so they allow the continuity of the normal flow and the water passage.

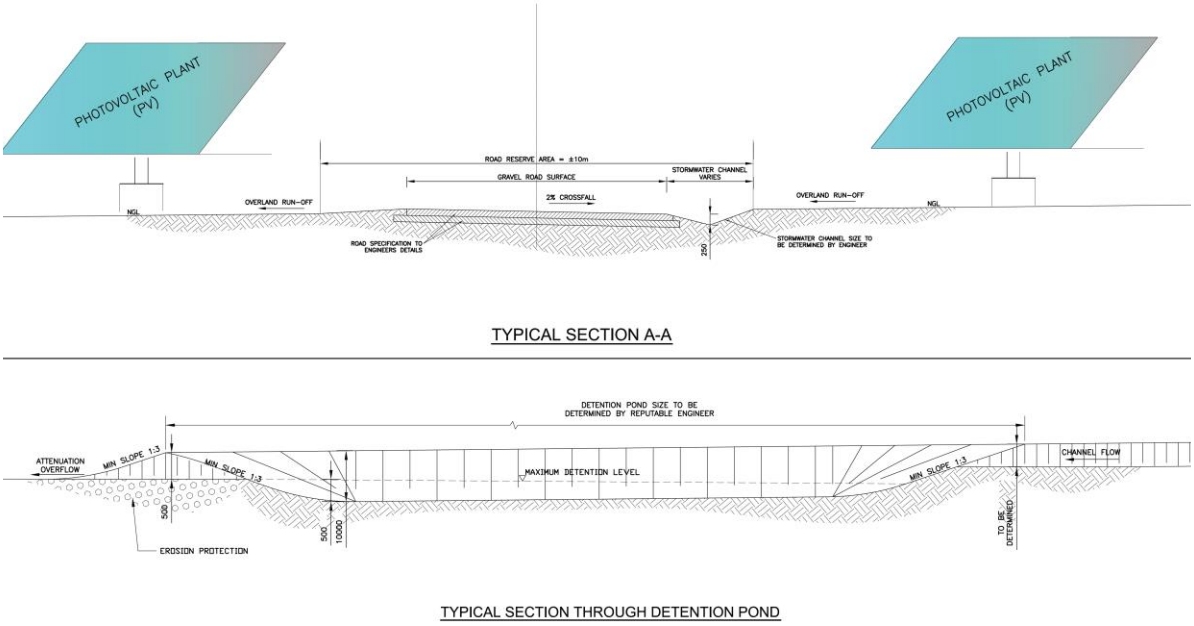
The Irish Bridge would consist of a concrete platform that permit the continuity of the rain flow over the designed roads. The elevation of the road in those points where the Irish Bridge would be designed, should be lower than the previous elevation of it to do easy the rain flow crossing over the road.

Once the lower point of the Irish Bridge is overcome, the road increases the elevation until reach the standard elevation which would have been projected for.

Below is attached the Irish Bridge drawing where can be checked the details of it.



5.2.3 PV Area



Drainage Elements for PV Area

5.2.4 Access road

It is assumed that the bulk of the terrace roads and the main access road to the plant will be gravel roads.

To assist with the stormwater run-off, these gravel roads should typically be graded and shaped with a 2% crossfall back into the slope, allowing stormwater to be channelled in a controlled manor towards the sites, natural drainage lines and to assist with any sheet flow on the site.

Where any proposed roads, intersect the natural, defined drainage lines, it is suggested that either suitably sized pipe culverts or drive through causeways are installed / constructed and should take into account the hydrology criteria for a selected major storm

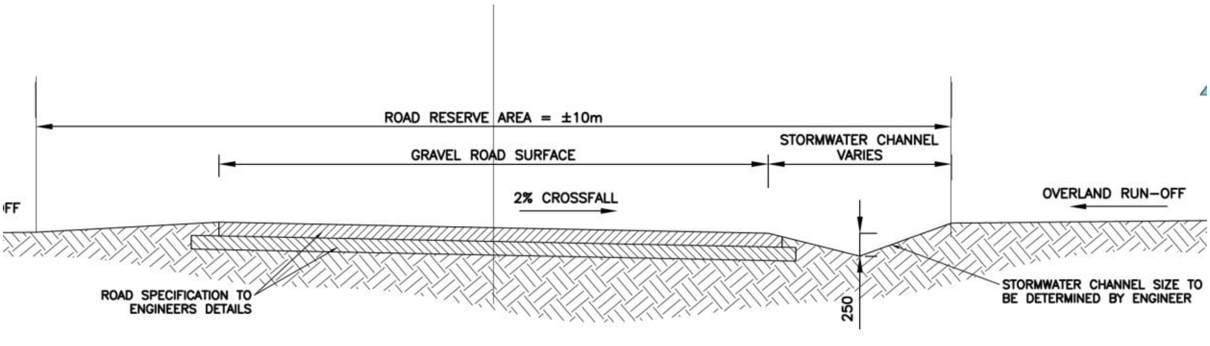
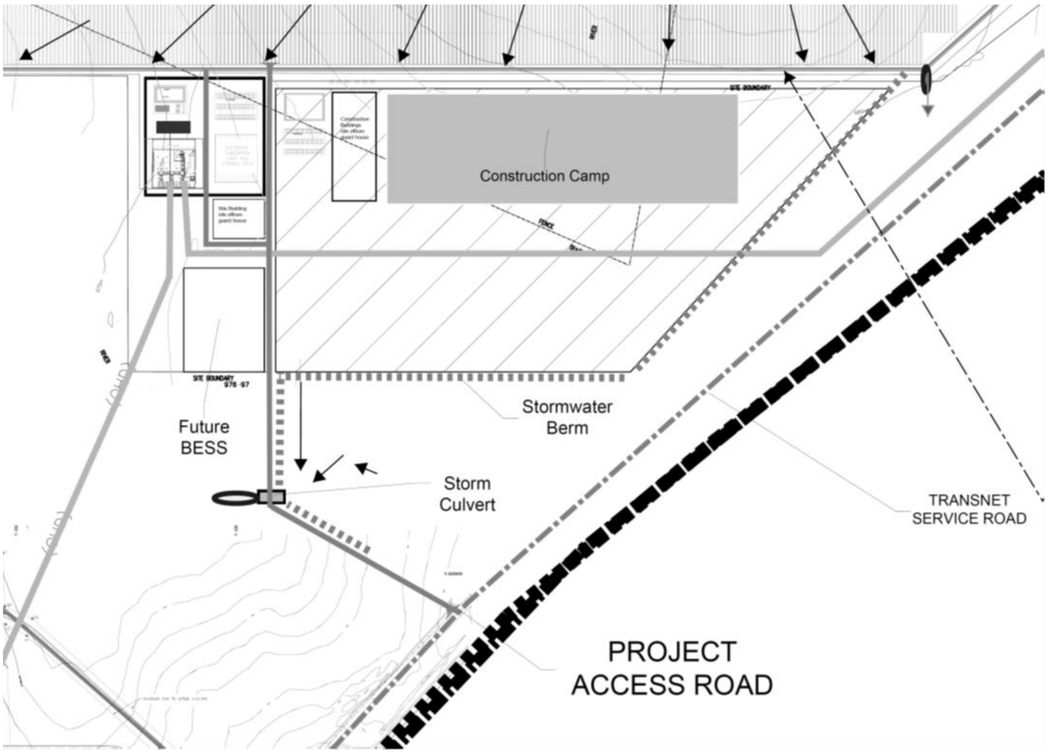
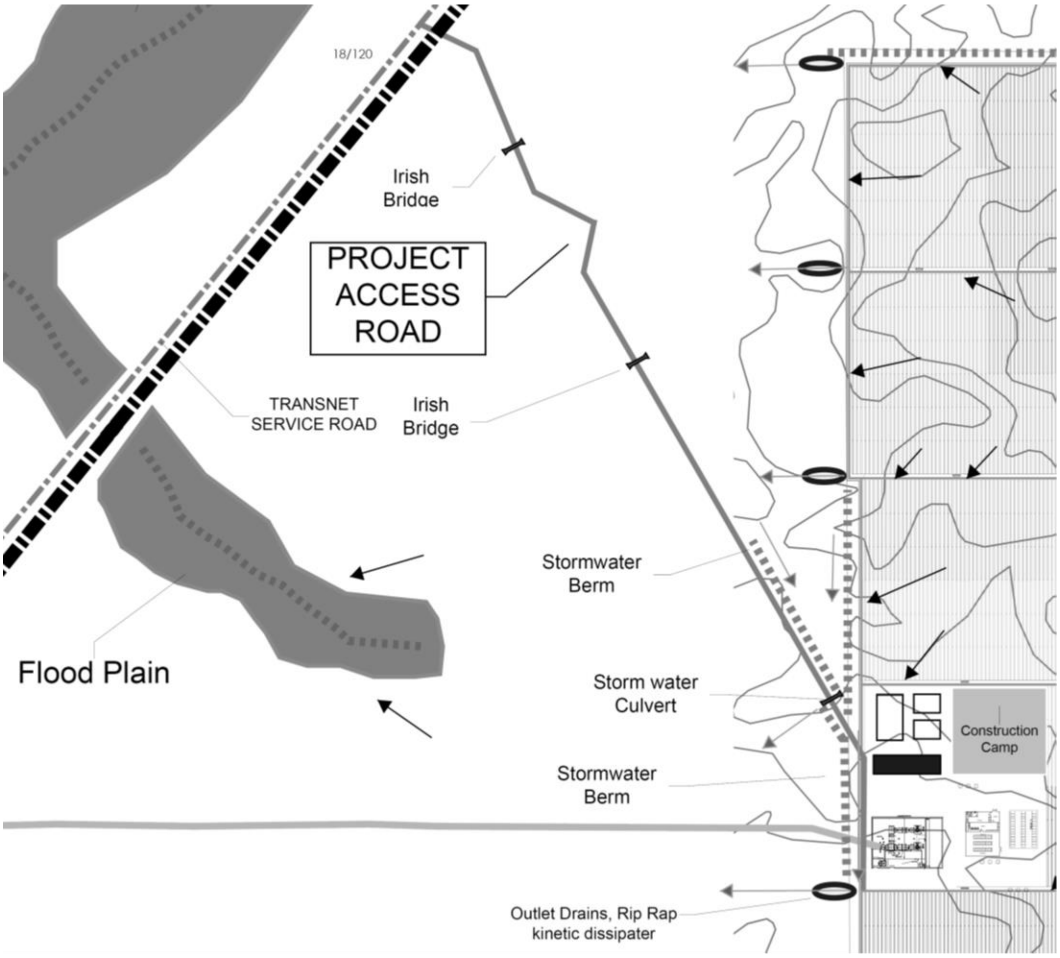


Figure 12: Drainage Elements for Access Road



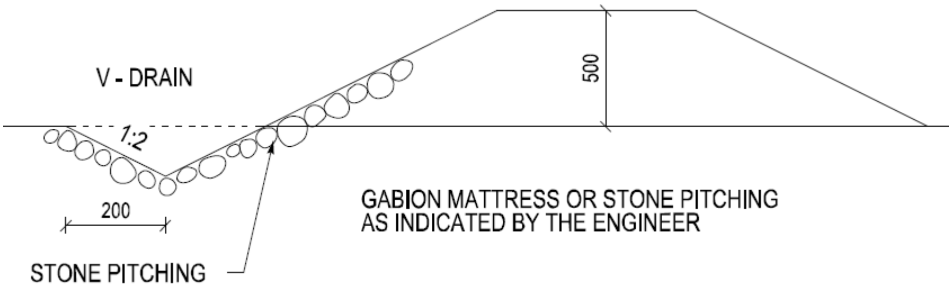
PV2 Access Detail

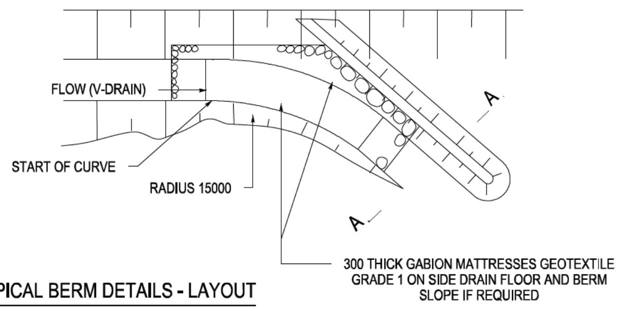


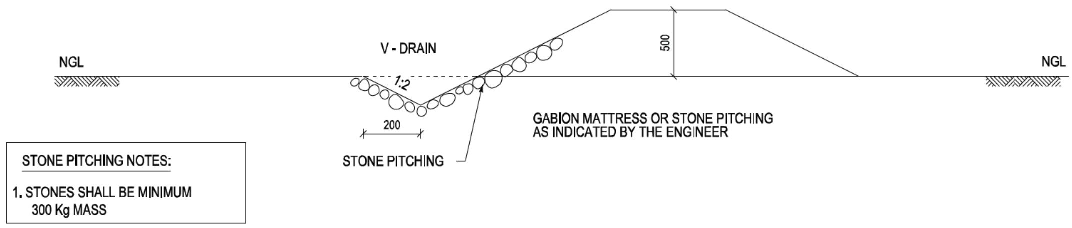
PV56 Access Detail

5.2.5 Berms

Berms are proposed to prevent external water from entering the PV Area and directing flow to suitable areas of release.







5.2.6 Outlets

All culverts located on the access road have concrete outlets with erosion protection as detailed in the typical detail drawing. Side drain outlets should be terminated as per typical detail with a widening and erosion protection to reduce the velocity and flow depth.

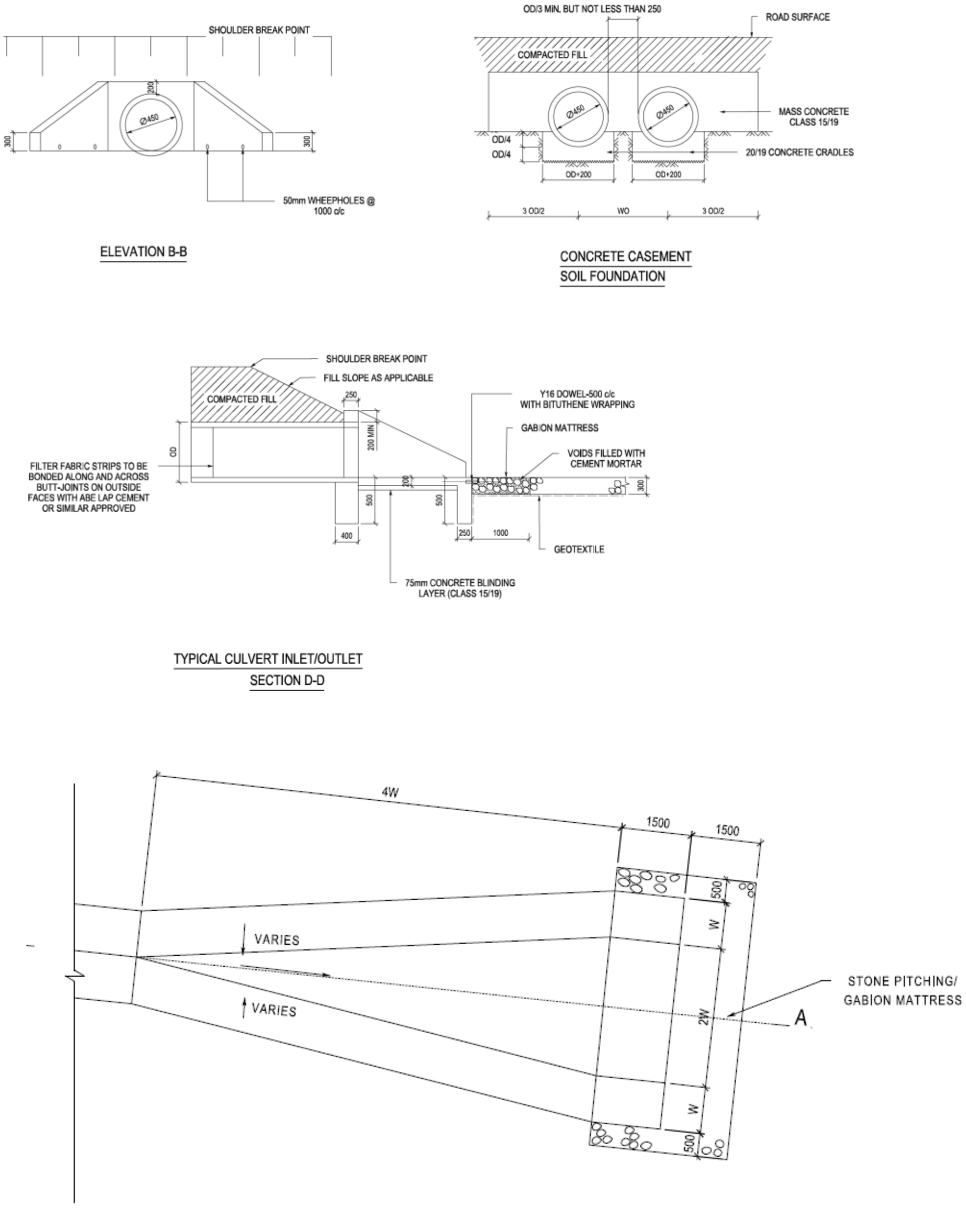


Figure 14: Typical Detail - Outlet with Erosion Protection

6 CONCLUSIONS AND RECOMMENDATIONS

Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes or along pipeline routes without erosion protection measures being in place. Line overflow and scour channels with stone pitching along their length and at their points of discharge to prevent soil erosion. The point of discharge should preferably be at a point where there is dense natural grass cover.

Ensure that channels do not discharge straight down the contours. These must be aligned at such an angle to the contours that they have the least possible gradient. Locate any point of overland discharge at least 50m away from any river, stream, or drainage way. Where possible, undertake river diversions outside of the rainy season. Should any drainage pipes be required, a standard riprap lined ditch for erosion control is to be installed for the end-of-pipe energy dissipation.

Degradation or erosion as a result of leaking pipes, spills, muddy conditions, or washaways shall be considered when designing any water abstraction points. Any leaks identified must be repaired immediately. Cleared areas and stockpiles of aggregates or soil is to be protected in such a way that erosion or sediment inputs to ecologically sensitive areas during rainfall is prevented. Access to wet areas after rainy periods is to be avoided until such a time as the soil has dried out.

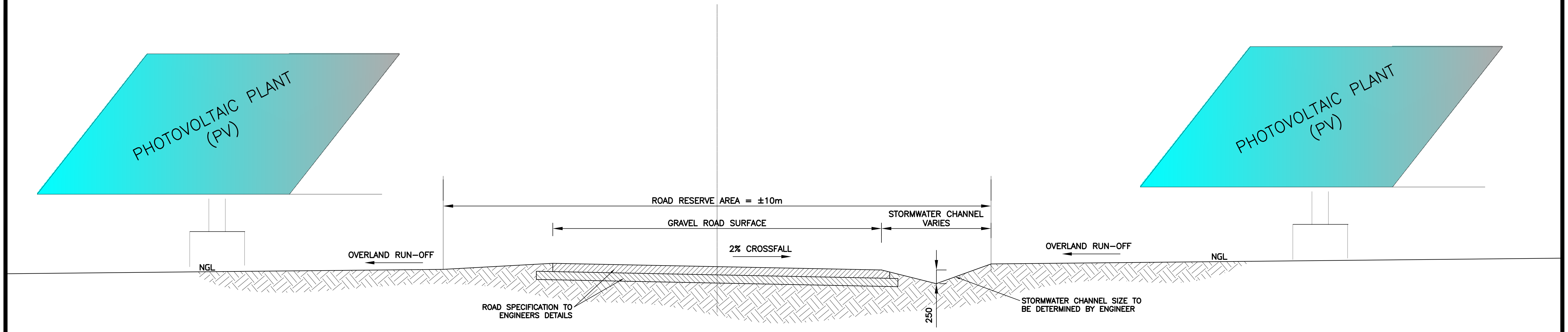
Ensure that Reserve releases (i.e. for sustained downstream ecological requirements and basic human needs) are catered for throughout the construction of dams and impoundments. The minimum requirement is that the Reserve be released during and after construction.

For long term construction sites, accommodate 1:10 year floods in all temporary infrastructure (i.e., drifts, diversions etc.). Where possible, only initiate impoundment once all environmental work within the dam basin has been completed.

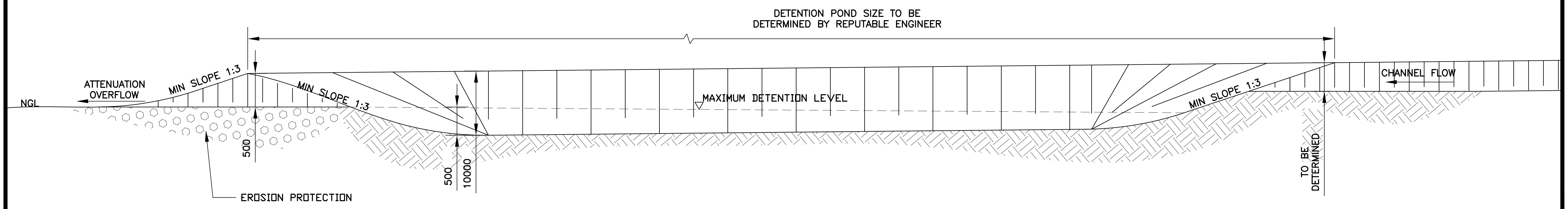
Site PV2 is sited on an isolated hill and contiguous sites PV5 and PV6 are sited on another hill. As the catchment areas at all three sites are exceedingly small it would only be necessary to provide local drainage to safely convey the flows through the site, such as a herringbone drainage system with limited erosion protection to the main channels.

As there are no significant water courses no major flood protection measures would be required.

ANNEX A– Indicative Drawings



TYPICAL SECTION A-A



TYPICAL SECTION THROUGH DETENTION POND

PROJECT

Mulilo Total Coega

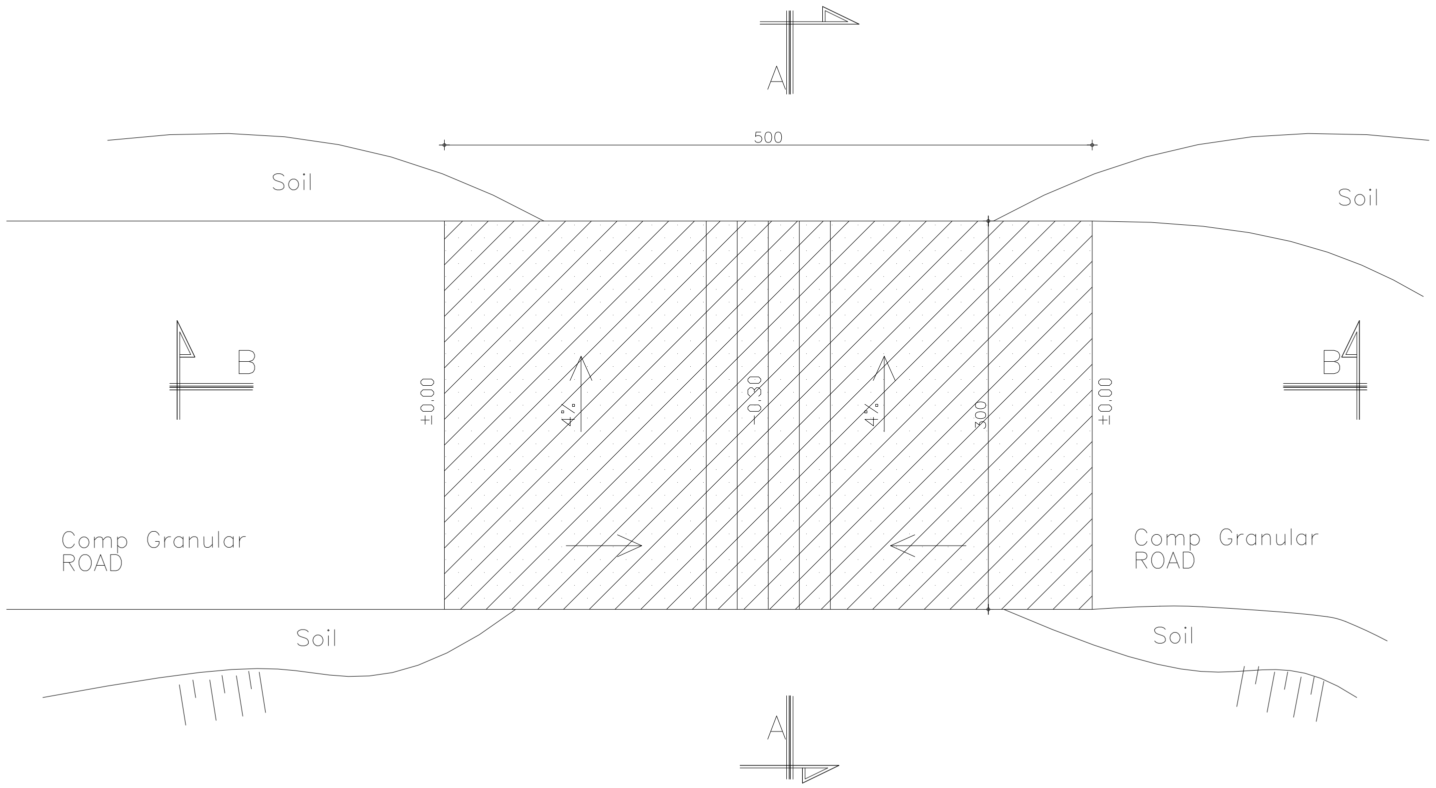
MULILO

DWG. TITLE

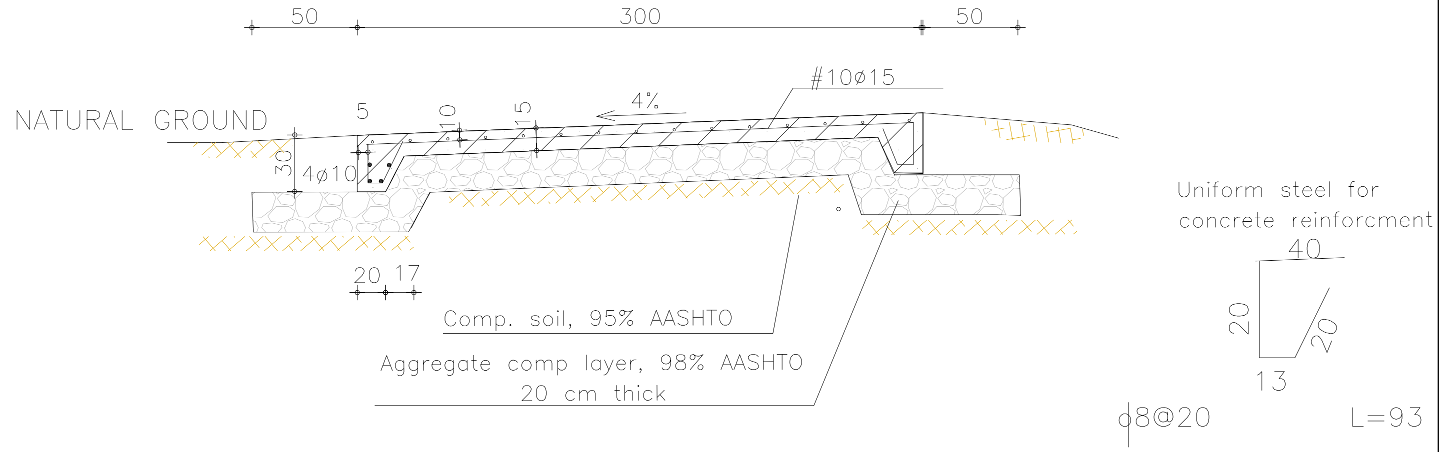
PROPOSED STORMWATER DETAILS

DRAWN	DATE	DESIGNED	DATE	SCALE	
*	*	*	*	VERTICAL	*
APPROVED				HORIZONTAL	NTS
ENGINEER				DRG. No.	REV.
Pr Eng No					
SIGNATURE					

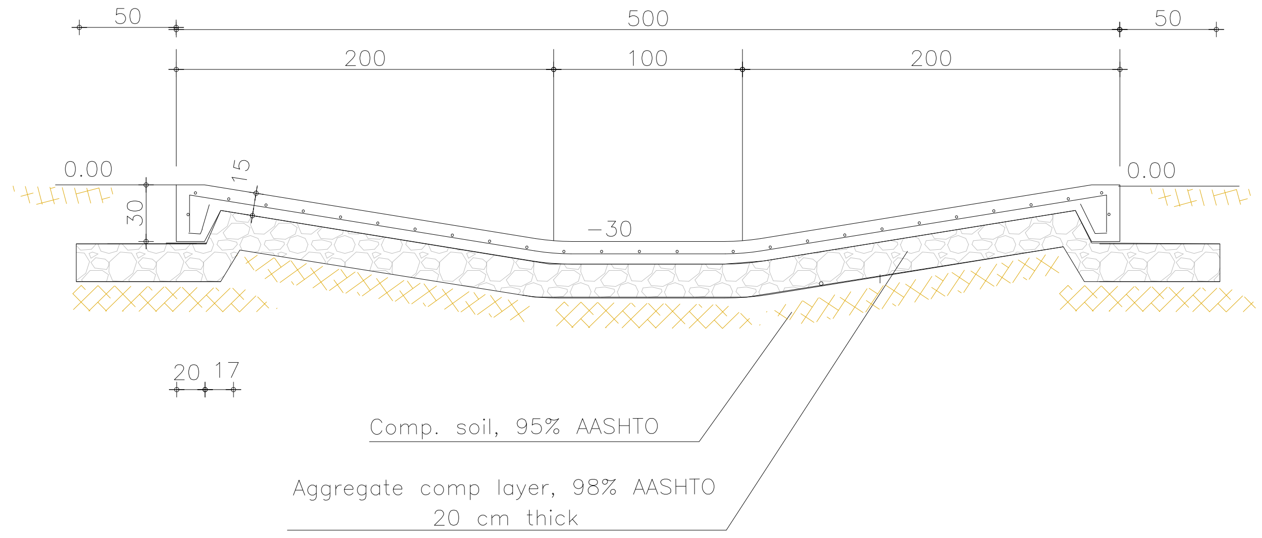
CONCRETE IRISH BRIDGE PLAN



CONCRETE IRISH BRIDGE SECTIONS



A–A section



B–B section

MULILO

CLIENT

Mulilo Total Coega

REV	DATE	REVISION DETAILS	APPROVED

DRAWN | DESIGNED

CHECKED

APPROVED

DATE

PROJECT

MULILO TOTAL COEGA - GEMSBOK PV

TITLE

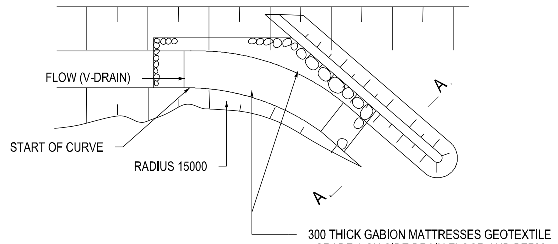
TYPICAL DRAINAGE DETAILS - SIDE DRAINS

FOR DISCUSSION ONLY

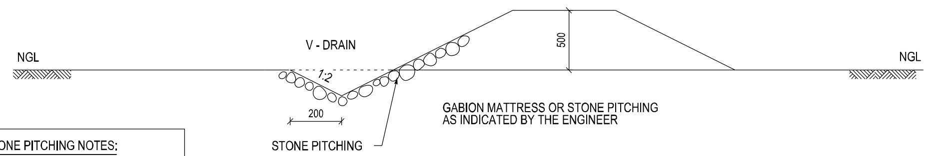
PROJECT No.

SCALE | SIZE

DRAWING No. | REV



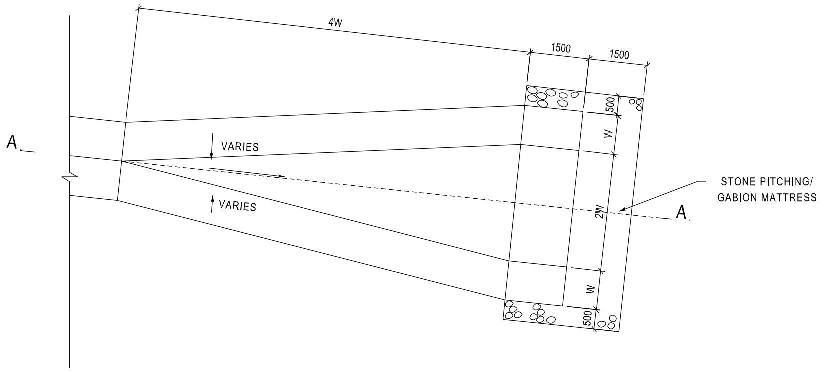
TYPICAL BERM DETAILS - LAYOUT



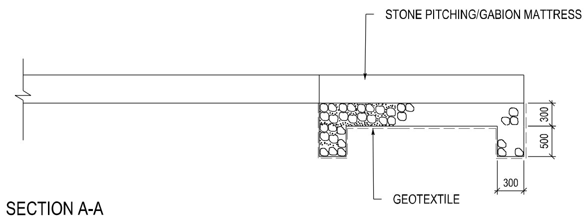
STONE PITCHING NOTES:

1. STONES SHALL BE MINIMUM 300 Kg MASS

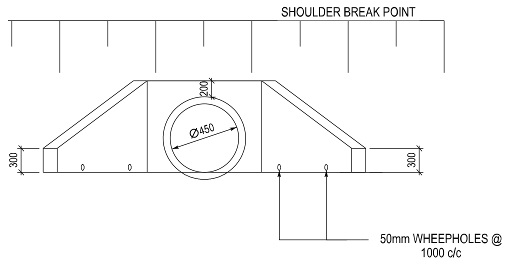
TYPICAL BERM DETAILS - SECTION A-A



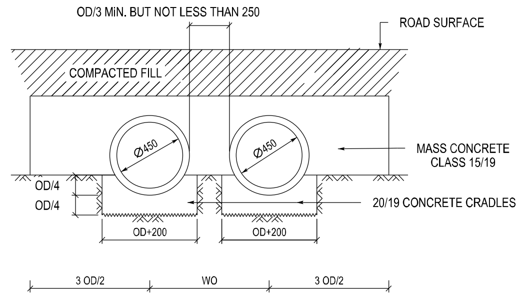
SIDE DRAINS OUTLET



SECTION A-A

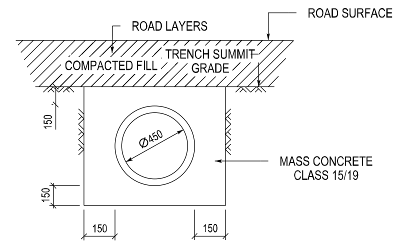


ELEVATION B-B

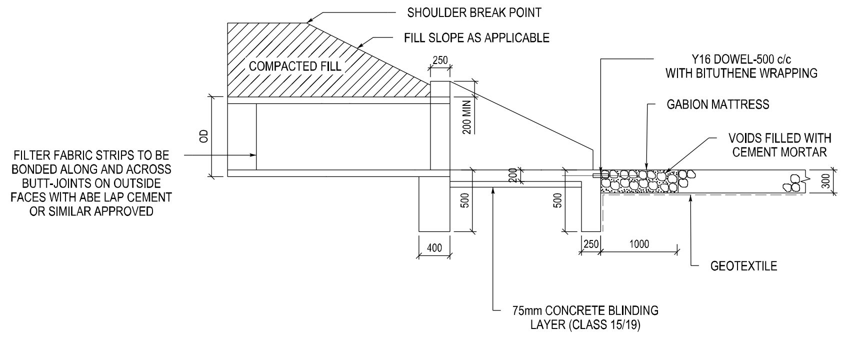


CONCRETE CASEMENT

SOIL FOUNDATION

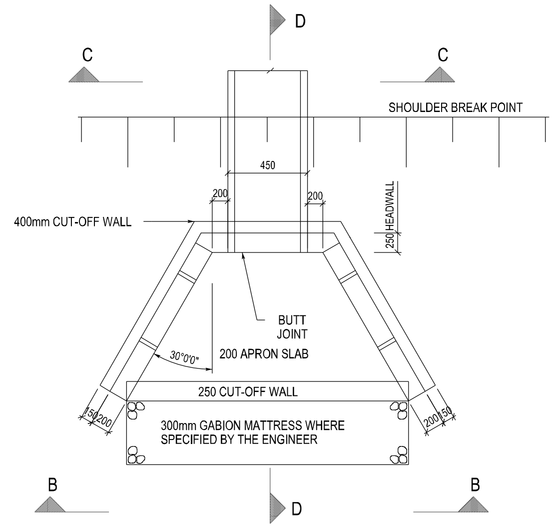


SECTION C-C

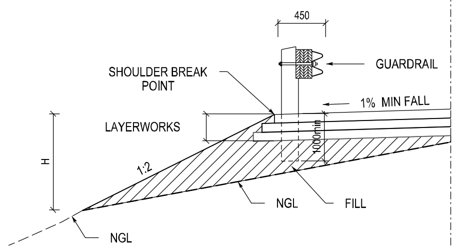


TYPICAL CULVERT INLET/OUTLET

SECTION D-D



PLAN - SQUARE CULVERT OUTLET



NOTE:

1. WHERE H > 3m, INSTALL GAURDRAILS ON HARDSTAND PLATFORM

TYPICAL GAURDRAIL INSTALLATION

GUARDRAIL NOTES

1. GAURDRAILS TO BE PLACED ON EDGE OF HARDSTAND/TURNAROUND POINTS WHERE FILL 3m.
2. GAURDRAILS SHALL NOT BE PLACED IN POSITIONS THAT WILL OBSTRUCT THE ASSEMBLY OF TURBINES. WHERE GAURDRAILS OBSTRUCTS THE ASSEMBLY OF ROTAR, THEY SHALL BE TEMPORARILY REMOVED.
3. WHERE HARDSTAND AREAS ARE TO BE REHABILITATED, GAURDRAILS SHALL BE MOVED TO NEW POSITIONS AS DECIDED ON SITE.

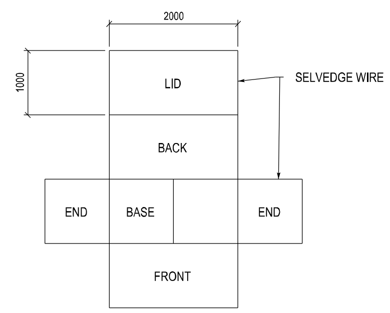


FIGURE 1

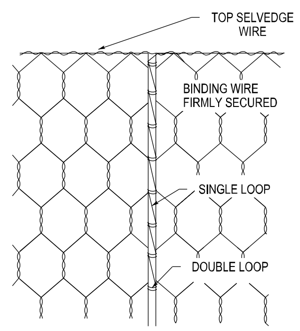


FIGURE 3

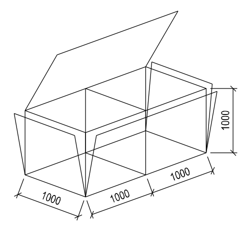


FIGURE 2

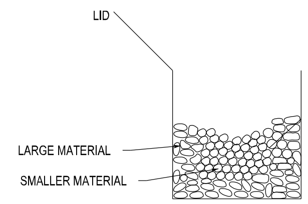


FIGURE 4

GABION BOX DETAILS

GABION NOTES:

1. GABION BOXES : (80x100) WIRE MESH
   MESH WIRE : 2.7mm AND PVC COATED
   SELVEDGE WIRE : 3.4mm AND PVC COATED
   BINDING WIRE : 2.2mm AND PVC COATED
2. FILLING STONE NOT LARGER THAT 250mm AND NOT SMALLER THAT THE SIZE OF THE MESH

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REV	DATE	REVISION DETAILS	APPROVED

DRAWN | DESIGNED

CHECKED

APPROVED

DATE

PROJECT

MULILO TOTAL COEGA - GEMSBOK PV

TITLE

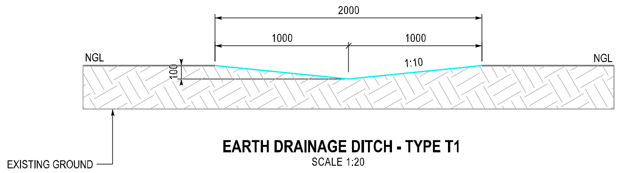
TYPICAL DETAIL DRAWINGS
GENERAL DETAILS

FOR DISCUSSION ONLY

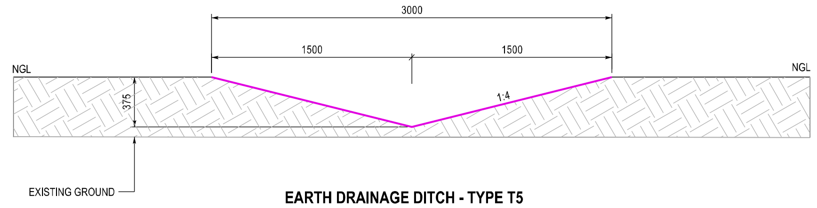
PROJECT No.

SCALE: AS SHOWN | SIZE: A0

DRAWING No. | REV: A



EARTH DRAINAGE DITCH - TYPE T1
SCALE 1:20



EARTH DRAINAGE DITCH - TYPE T5
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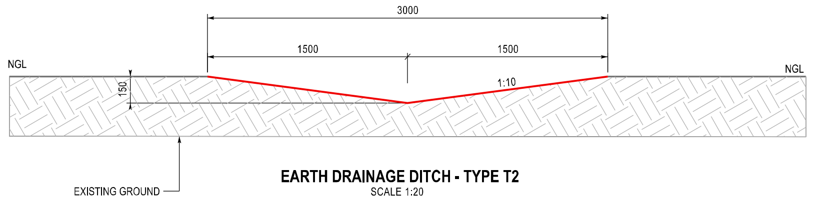
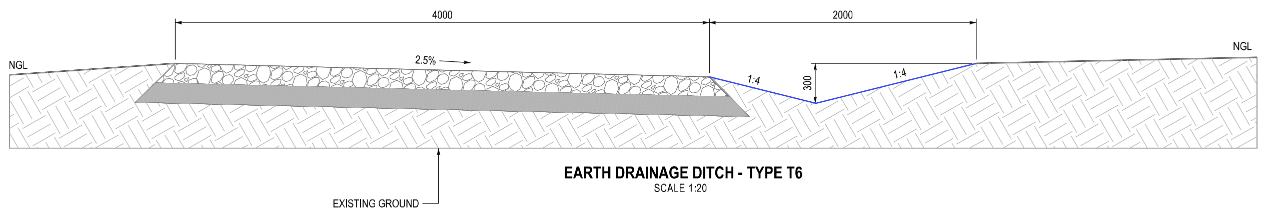
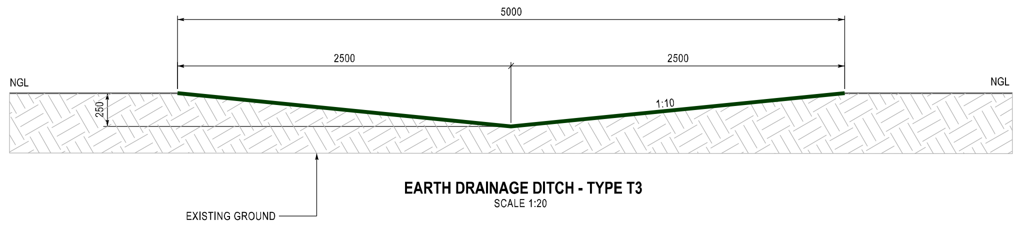


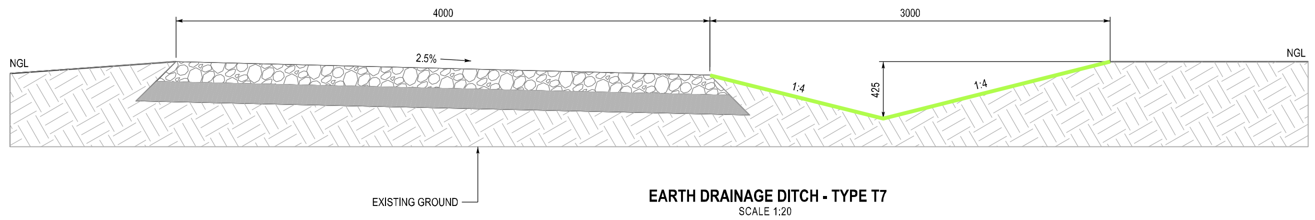
EARTH DRAINAGE DITCH - TYPE T2
SCALE 1:20



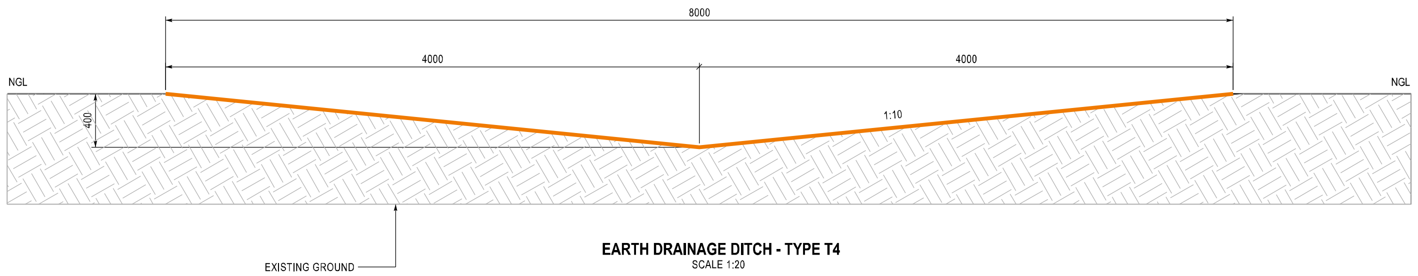
EARTH DRAINAGE DITCH - TYPE T6
SCALE 1:20



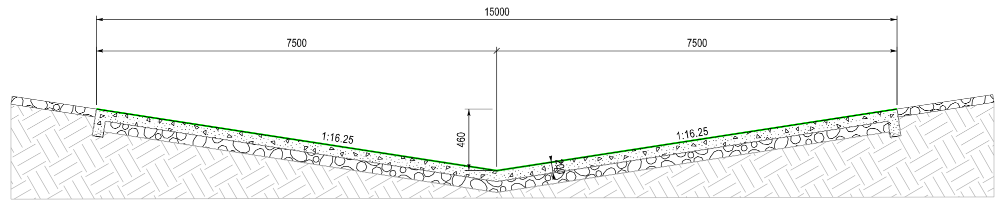
EARTH DRAINAGE DITCH - TYPE T3
SCALE 1:20



EARTH DRAINAGE DITCH - TYPE T7
SCALE 1:20



EARTH DRAINAGE DITCH - TYPE T4
SCALE 1:20



CONCRETE DRIFT CROSSING
SCALE 1:50

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REV	DATE	REVISION DETAILS	APPROVED

DRAWN	DESIGNED
CHECKED	
APPROVED	
DATE	

PROJECT
MULILO TOTAL COEGA - GEMSBOK PV

TITLE
TYPICAL DRAINAGE DETAILS - SIDE DRAINS

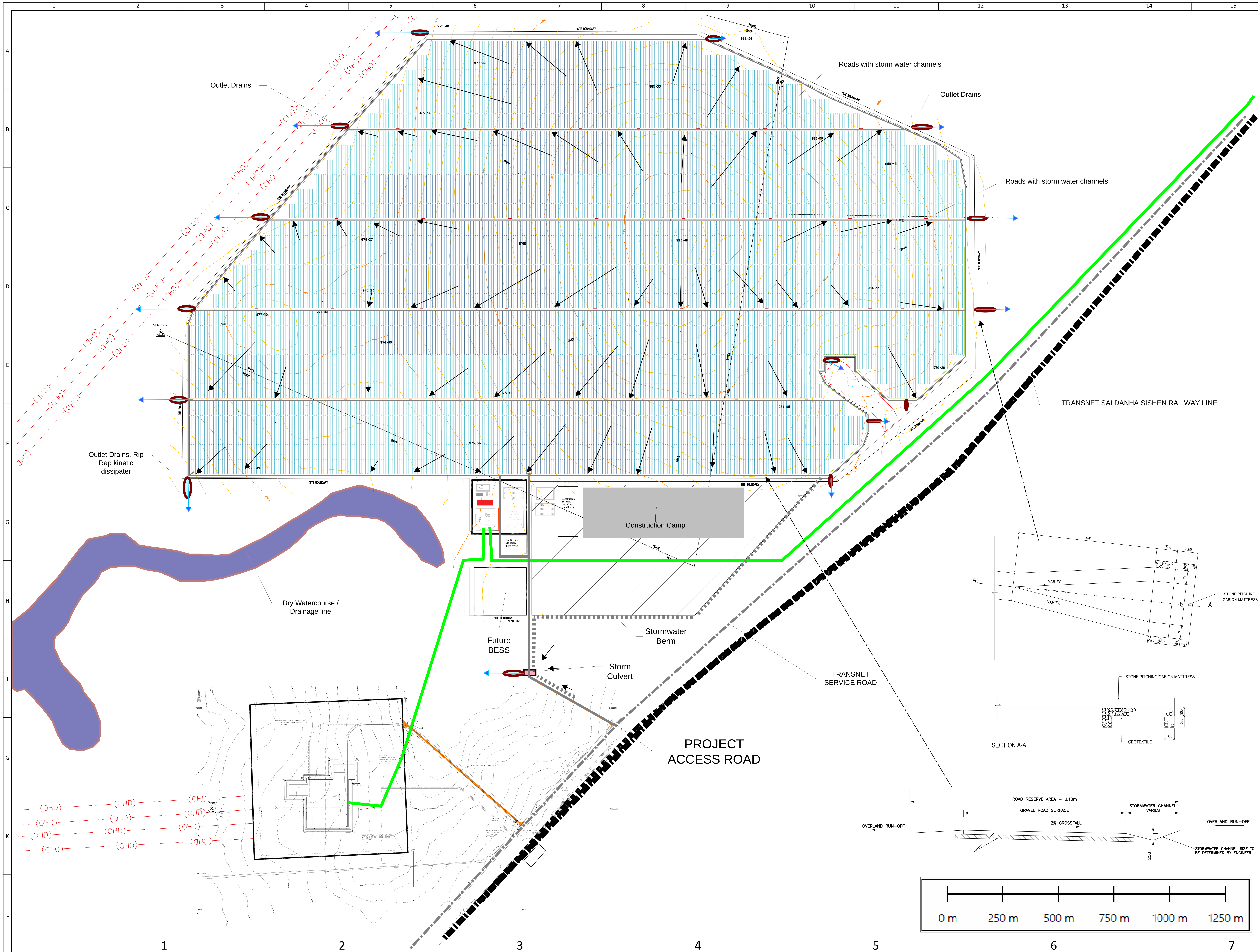
FOR DISCUSSION ONLY

PROJECT No.

SCALE | SIZE

DRAWING No. | REV

ANNEX B– Storm Water Conceptual Plan



Notes

PV Plant: MULILO TOTAL COEGA FACILITY B - GEMSBOK SOLAR 256

Location: Northern Cape, South Africa
UTM convergence: -0.1861
Altitude: 982.84 m

Rated Power: 75 MW
Peak Power: 90 MW
Ratio DC/AC: 1.2
Structure: Single Axis Tracking, 1V Portrait
PV Module: 450 W - 610 W Bifacial Mono PERC
Inverter: Huawei 2000 185kva

Power Station: 5920.0 kVA, 0.8/33.0kV
Pitch distance: 7.2 m
Modules per string: 28

Legend

- Available area
- Restricted area
- Substation
- Power station
- Colors indicate solar field connection to each power station
- Mounting structure
- Roads
- Medium voltage trenches
- Fences
- Medium voltage lines
- String cables
- O&M Building
- Auxiliary Backup Generators
- 132 KV Overhead Power-line (twin Tern Steel Monopole)
- Existing Power-line
- Laydown Area
- 6 Bay Switching station & IPP Substation
- Water Tanks

REV	DESCRIPTION	BY	DATE
00	FIRST VERSION	WMORSE	2021-04-06

FOR INFORMATION ONLY

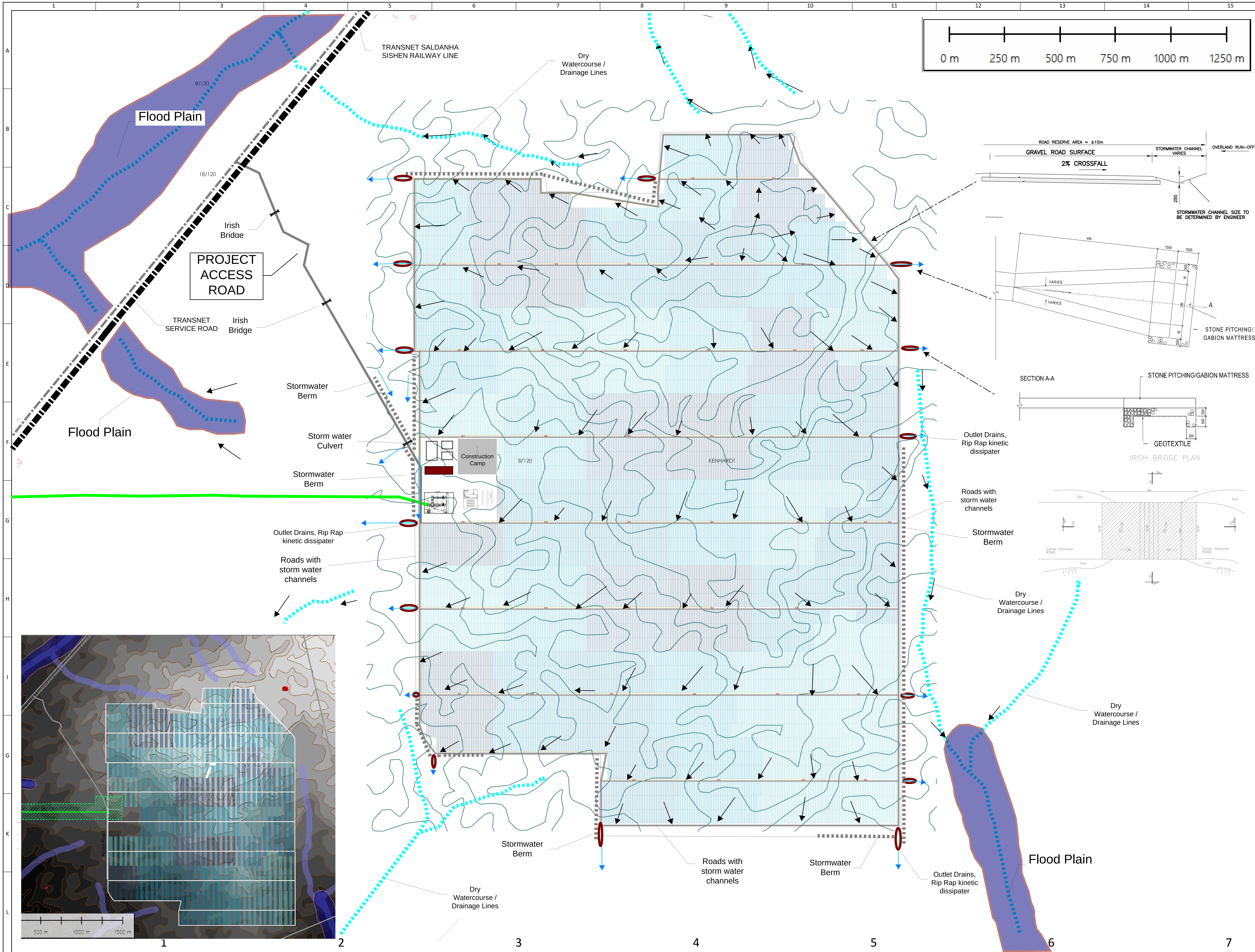
CLIENT: Mulilo Total Coega Project

PROJECT: MULILO TOTAL COEGA - FACILITY B (GEMSBOK SOLAR PV2)

DRAWING: STORMWATER MANAGEMENT PLAN

SCALE: 1 : 20000	SHEET: 1 / 1
REVISION: 00	DATE: 2021-04-06

DIN A1



Notes

PV Plant: MULILO TOTAL COEGA FACILITY B - GEMSBOK SOLAR 256

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- Colors indicate solar field connection to each power station
- Mounting structure
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- Medium voltage lines
- String cables
- O&M Building
- Auxiliary Backup Generators
- 132 KV Overhead Power-line (twin Tern Steel Monopole)
- Existing Power-line
- Laydown Area
- 6 Bay Switching station & IPP Substation
- Water Tanks

REV	DESCRIPTION	BY	DATE
00	FIRST VERSION	WMORSE	28 April 2021

FOR INFORMATION ONLY

MULILO

CLIENT: Mulilo Total Coega Project

PROJECT: MULILO TOTAL COEGA - FACILITY B (GEMSBOK SOLAR PV5 & PV6)

DRAWING: STORMWATER MANAGEMENT PLAN

SCALE:	SHEET:
1 : 20000	1 / 1
REVISION: 00	DATE: 2021-04-06

DIN A1