BTE RENEWABLES (PTY) LTD

ESIZAYO 132KV POWERLINE

HYDROLOGICAL ASSESSMENT

29 MARCH 2022

ORIGINAL

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BTE RENEWABLES (PTY) LTD

ORIGINAL

PROJECT NO.: 41103481
DATE: MARCH 2022

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1 INTRODUCTION

WSP in Africa (WSP), a wholly owned affiliate of WSP Global Inc., was commissioned to undertake a hydrological assessment, which is required for the Basic Assessment (BA) process for the new Esizayo 132kV powerline. The development of a 132kV overhead power line is required to connect the Esizayo Wind Energy Facility (WEF) Energy Facility to the national grid via the existing Eskom Komsberg substation. The powerline is approximately 6.5 km long. The project is situated north of the town of Matjiesfontein in the Karoo Hoogland Local Municipality and the Laingsburg Local Municipality in the Northern Cape Province and Western Cape Provinces respectively.

The desktop Hydrological Assessment aimed to assess the impacts of the proposed powerline on the receiving surface water environment and implications to downstream surface water users. The outcomes of the Hydrological Assessment were utilised to develop an erosion management plan. The plan incorporated the monitoring as well as the rehabilitation of soils in the event of an erosion event. The objectives of the assessment were as follows:

— Desktop study;
— Site walkover;
— Erosion management plan;
— Impact assessment.

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2 SITE DESCRIPTION

The Esizayo Site is located within the Western Cape Province, approximately 28 km north-west of the town of Laingsburg, (**Figure 2-1**). Other nearby towns include Matjiesfontein and Sutherland. The site falls within the Central Karoo District Municipality DC5 and stretches over three farm properties viz. Aurora 285, Aanstoot 1/72 and Joseph's Kraal 84, occupying a total area of 61km^2. The R354 district road serves at the primary access route to the Esizayo Site from the N1 at Matjiesfontein (Figure 1). The 132kV grid connection crosses the following properties:

— Farm Standvastigheid 210 Remainder; and
— Farm Aurora 285

The overhead-line will be a 132kV steel single or double structure with kingbird conductor (between 15 and 20m in height, above ground level). Standard overhead line construction methodology will be employed, which consists of drilling holes (typically 2 – 3m in depth), planting poles and stringing conductors. It is not envisaged that any large excavations and stabilized backfill will be required, however this will only be verified on site once the geotechnical study has been undertaken at each pole position (as part of construction works).

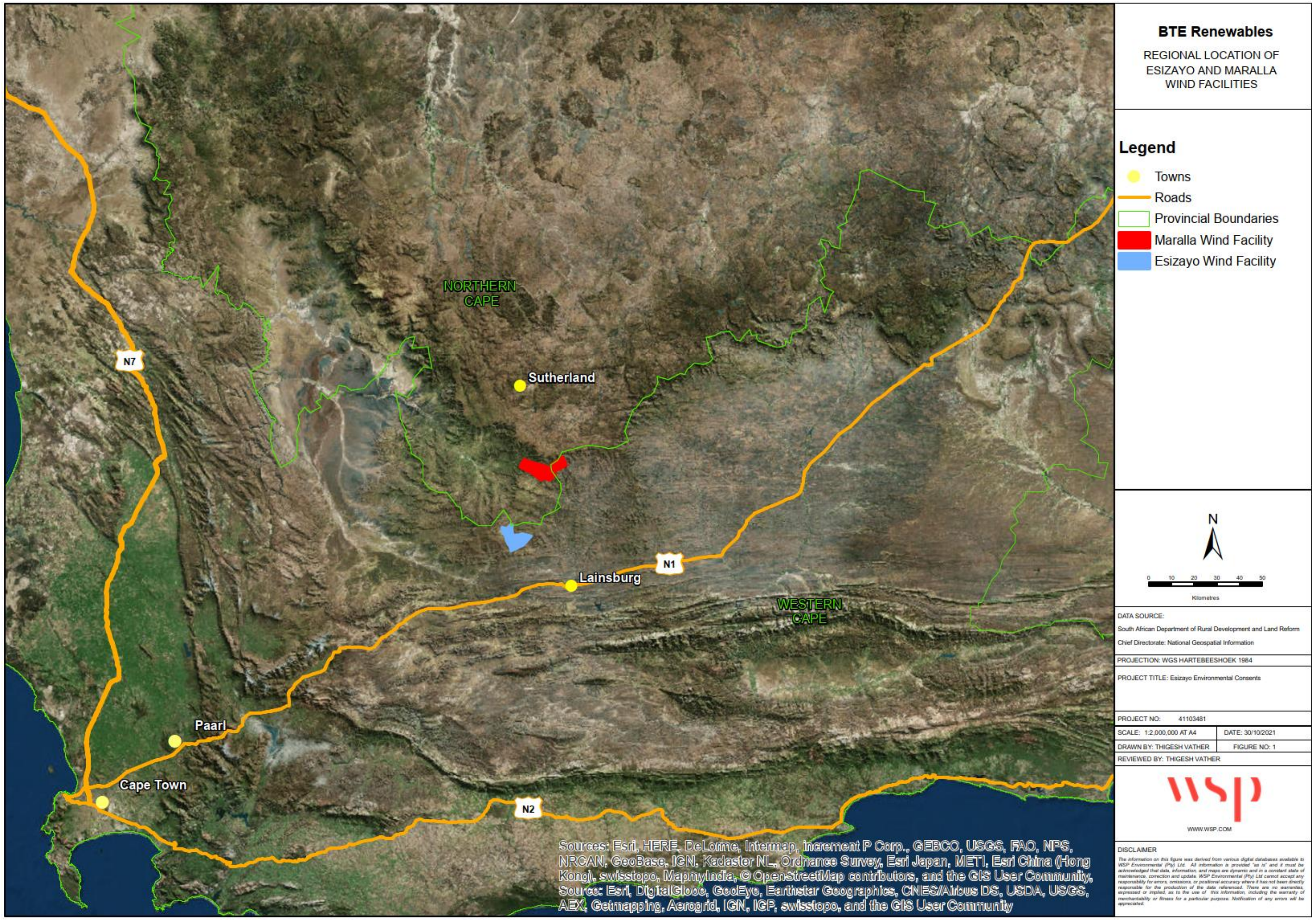


Figure 2-1: Regional Setting of the Esizayo Powerline

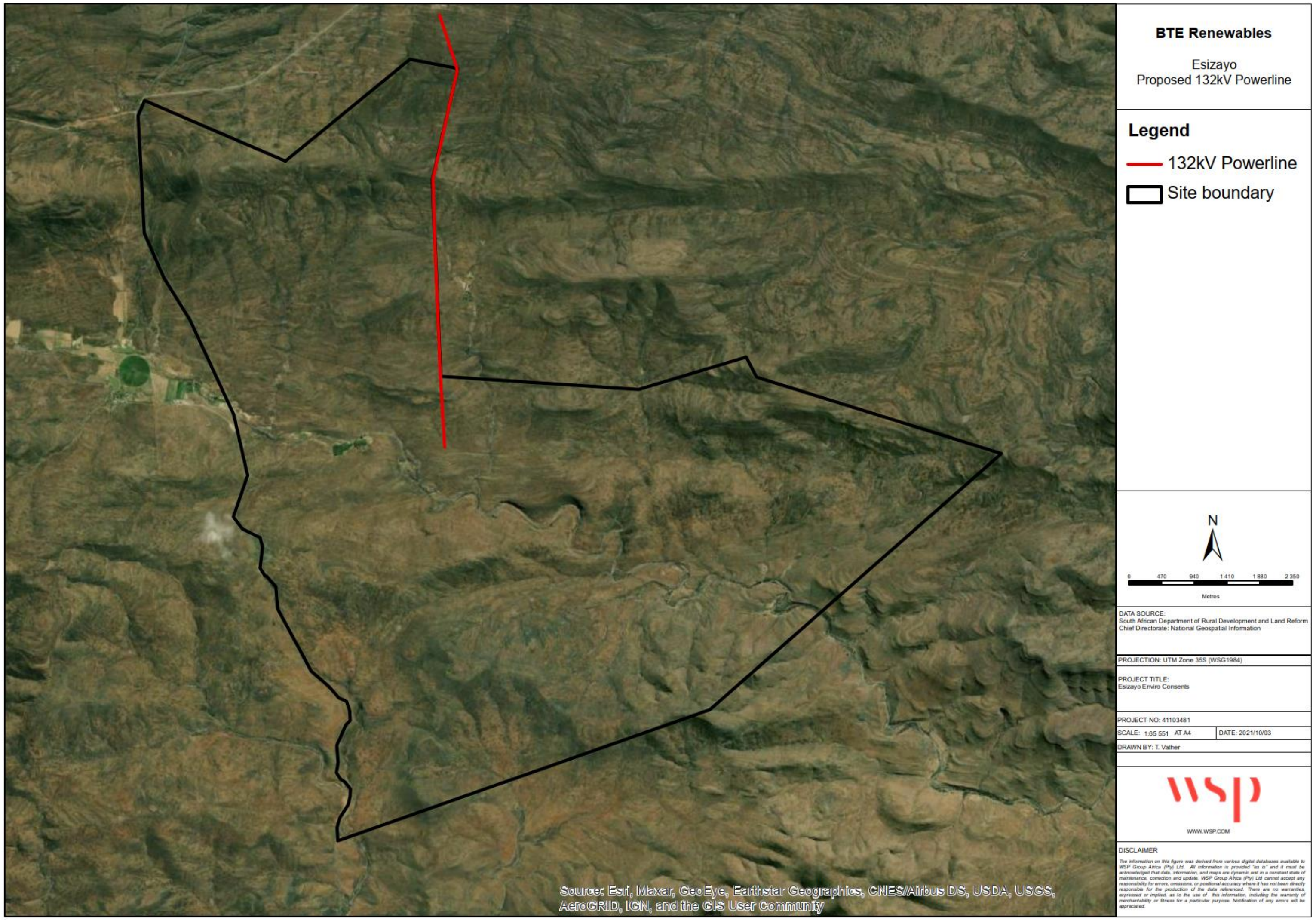


Figure 2-2: Proposed Esizayo powerline

3 LEGAL CONTEXT

The objective of the hydrological assessment is to limit any potential impacts on the surface water and groundwater resources associated with the power station. The South African National Water Act (NWA) was used as the guidance document to meet this objective.

The preamble to the NWA recognises that the aim of water resource management is to achieve sustainable water use for the benefit of all users and that the quality of these resources are protected to ensure ongoing sustainability. The purpose of the NWA is stated, as inter alia:

- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development;
- Protecting aquatic and associated ecosystems and their biological diversity;
- Reducing and preventing pollution and degradation of water resources; and
- Meeting international obligations.

The NWA presents strategies to facilitate sound management of water resources, provides for the protection of water resources, and regulates use of water by means of Catchment Management Agencies, Water User Associations, Advisory Committees and International Water Management.

4 BASELINE RECEIVING ENVIRONMENT

This section describes the baseline environment of the power station, which provided the fundamental understanding of the hydrological assessment.

4.1 CLIMATE

The climate of the region is arid to semi-arid. Rainfall is low and occurs throughout the year but predominantly in the winter months between March and August. Mean annual precipitation is approximately 290mm, ranging from 180 – 410mm rainfall per year. The region experiences dry hot summers and the warmest month of the year is February which averages 23.4°C. The lowest average temperatures in the year occur in July, averaging approximately 9.3°C. The region experiences steady, strong winds between December and April; however, the winds calm between the months of June and October.

4.2 LAND COVER

Based on the Mucina and Rutherford (2006) natural vegetation classification map, the area is mostly Central Mountain Shale Renosterveld, with a minor contribution of Koedoesberge-Moordenaars Karoo. The Department of Agriculture, Forestry and Fisheries (DAFF) define the land use within the Site, as predominantly Shrubland and Low Fynbos (DAFF, 2012).

During the site visit, the vegetation was identified as mostly shrub-like vegetation and Fynbos, which is primarily used for sheep grazing. Indigenous antelope (Springbok) were also present within the site boundary.

4.3 GEOLOGY AND SOILS

Based on the information included in the land type maps of South Africa (AGIS, 2007) the soils in the region are mostly classified as the Glenrosa and/or Mispha forms with lime generally present in the landscape and miscellaneous land classes, rocky areas with miscellaneous soils.

The general geological description of the area is based on the 1:1 000 000 geological map for the Northern Cape Province, published by the Trigonometrical Survey Office in 1970 (Schifano *et.al*.,1970). The Site is nested in the Roggeveld Mountains range, in the Larger Cape Fold belt system. The site is located on the Beaufort Series which forms part of the Karoo system. The rock type for the series comprises of shale, mudstone, sandstone and limestone (Schifano et al., 1970). During the site visit it was observed that shale and mudstone were the dominant rock type for the area.

4.4 TOPOGRAPHY

The topography of the area comprises of mountainous hillslopes (part of the Roggeveld Mountain Range) with small patches of open rocky ground in between, and numerous watercourses and drainage channels. The hillslopes have an average gradient of 34.4 % and 1.1% on the open flat ground. The elevation of the area ranges from 984 m to 1 379 m above mean sea level (amsl).

4.5 QUATERNARY CATCHMENTS

The Powerline lies within tertiary catchment J11D. The J11D tertiary hydrological characteristics are summarised in **Table 4-1**, including catchment area, Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE) and Mean Annual Runoff (MAR). The MAE largely exceeds the MAP, reinforcing the arid conditions of the region.

Table 4-1: Quaternary J11D Hydrological Characteristics

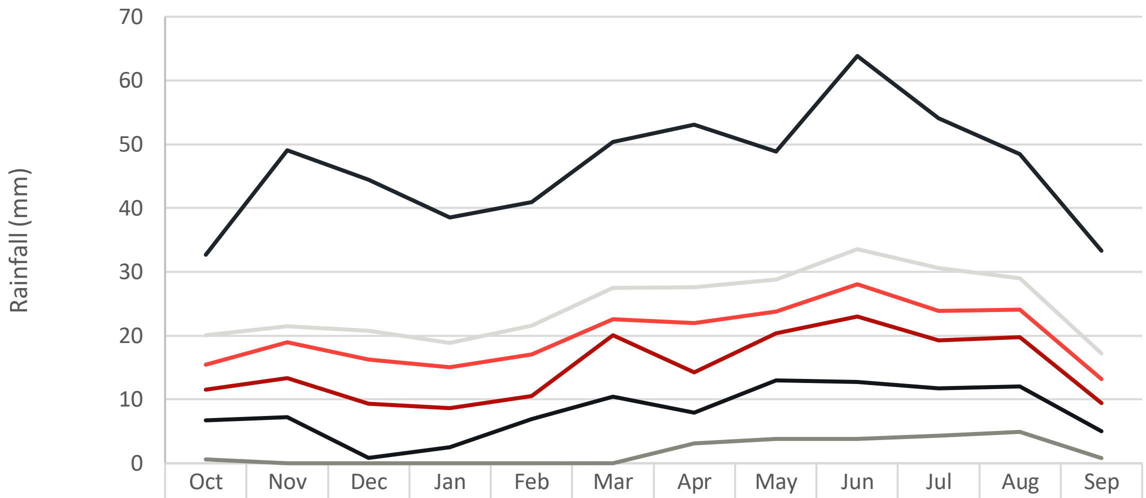
QUATERNARY	CATCHMENT AREA (km^2)	MAP (mm)	MAE (mm)	MAR (mcm)
J11D	801	240	2000	5.58

Source: WRC/DWA, 2012

During the site visit there were several watercourses/drainage channels present within the area, the main river being the Roggeveld, which is south of the powerline. However, a few of the watercourses that were visited within the area were dry. Given the arid climatic condition of the region, the majority of the watercourses are ephemeral and are likely to only convey water during infrequent high rainfall events.

4.5.1 PRECIPITATION

The site falls within rainfall zone J1A associated with quaternary J11D, with an MAP of 240mm. The monthly rainfall distribution is represented in **Figure 4-1**. The 'E' values show the probability of non-exceedance, so highlight the likelihood that the specific rainfall event will not be exceeded.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average	15	19	16	15	17	23	22	24	28	24	24	13
E10	33	49	44	38	41	50	53	49	64	54	48	33
E30	20	21	21	19	22	27	28	29	34	31	29	17
E50	12	13	9	9	11	20	14	20	23	19	20	9
E70	7	7	1	3	7	10	8	13	13	12	12	5
E90	1	0	0	0	0	0	3	4	4	4	5	1

Figure 4-1: Monthly Rainfall for Quaternary J1A (WR2012, 2021)

4.5.2 EVAPORATION

Evaporation data for the site was extracted from the WR2012 (WRC, 2021) database. The evaporation zone representative of the site is 24A with an MAE of 2 000 mm. The MAE is clearly considerably higher than the MAP, making this a dry area. The monthly evaporation distribution is presented in **Figure 4-2**.

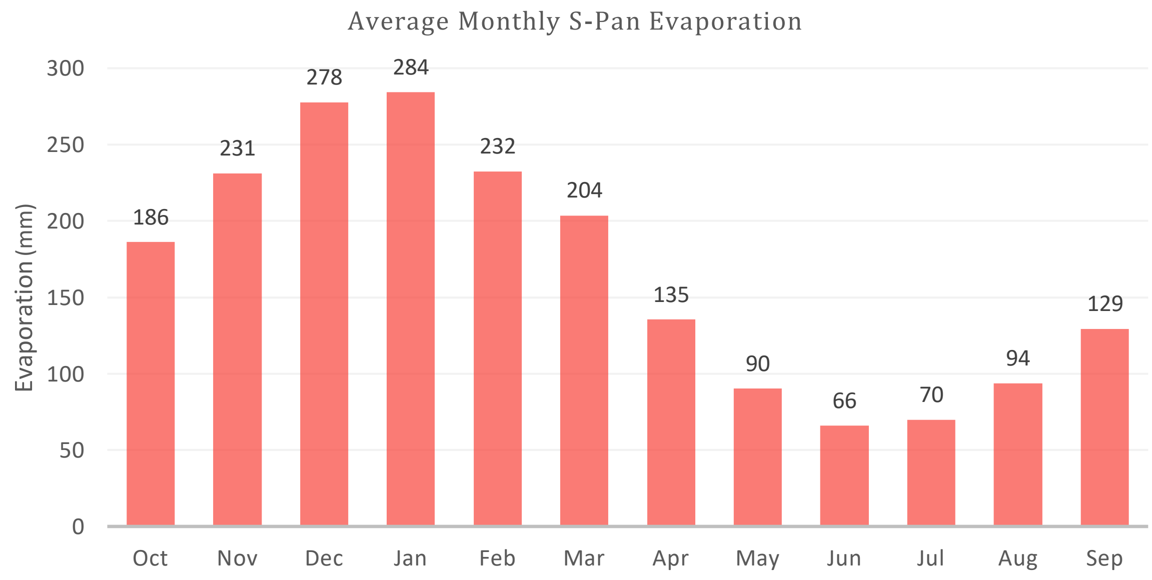
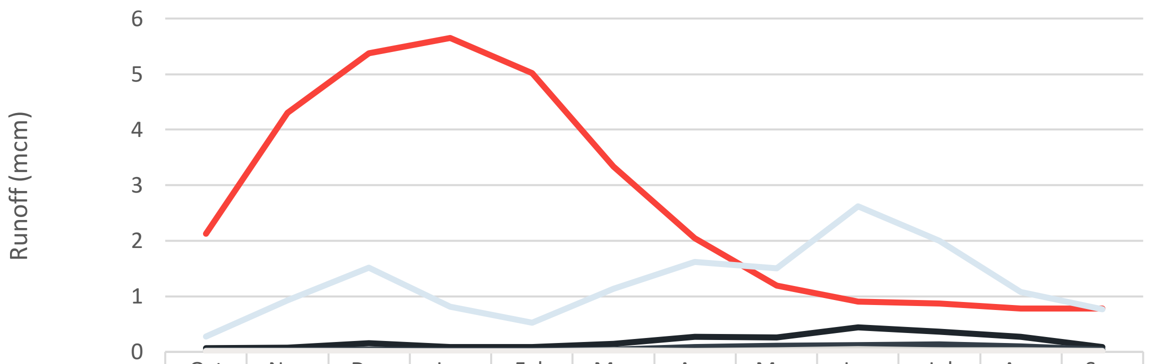


Figure 4-2: Monthly S-Pan Evaporation for Evaporation Zone 12A (WR2012, 2020)

4.5.3 NATURALISED RUNOFF

WR2012 (WRC, 2019) simulates average runoff of this quaternary at 5.58mcm per annum. The monthly runoff is presented in **Figure 4-3**. The 'E' values show the probability of non-exceedance.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average	2.13	4.3	5.37	5.65	5.02	3.33	2.05	1.19	0.9	0.87	0.78	0.78
E10	0.276	0.933	1.521	0.818	0.524	1.138	1.623	1.5	2.62	1.998	1.076	0.762
E30	0.067	0.08	0.154	0.09	0.087	0.147	0.274	0.257	0.441	0.367	0.267	0.09
E50	0.03	0.03	0.04	0.03	0.03	0.04	0.09	0.105	0.12	0.135	0.1	0.04
E70	0.02	0.02	0.02	0.01	0.01	0.03	0.02	0.03	0.05	0.03	0.03	0.02
E90	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.011	0.01	0.01	0.01

Figure 4-3: Naturalised Runoff for Quaternary Catchment C12K (WR2012, 2019)

4.5.4 SITE SPECIFIC DATA

The Daily Rainfall Extraction Utility, developed by the Institute for Commercial Forestry Research (ICFR) in conjunction with the School of Bio-resources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, Pietermaritzburg, was used to obtain summary data for all rainfall stations within the vicinity of the site **(Table 4-2)**. This data was assessed in terms of length of record, completeness of the data set, MAP and location of the rainfall station with respect to the site and the catchment.

Table 4-2: Rainfall Gauging Station Summary (Kunz, 2003)

Rainfall Station	Station Number	Latitude	Longitude	Distance from site (km)	Record (years)	Reliable data (%)	MAP (mm)
LAINSBURG SAAIPLAAS	0066204 W	32.901	20.617	9.242	3	98.9	221
DWARS-IN-DIE-WEG	0045184 W	33.067	20.584	9.753	122	64.3	156
DUMURE	0066027 W	32.951	20.517	10.053	120	56.5	259
SAAIPLAAS	0066668 A	32.884	20.617	11.090	5	84.8	222

The DWARS-IN-DIE-WEG rain gauge station (0045184 W) was considered representative of the area, which was primarily due to the reliability of the dataset, the distance of the station from the site and the record length. This dataset is presented in **Figure 4-4** for the period 1878 to 2002.

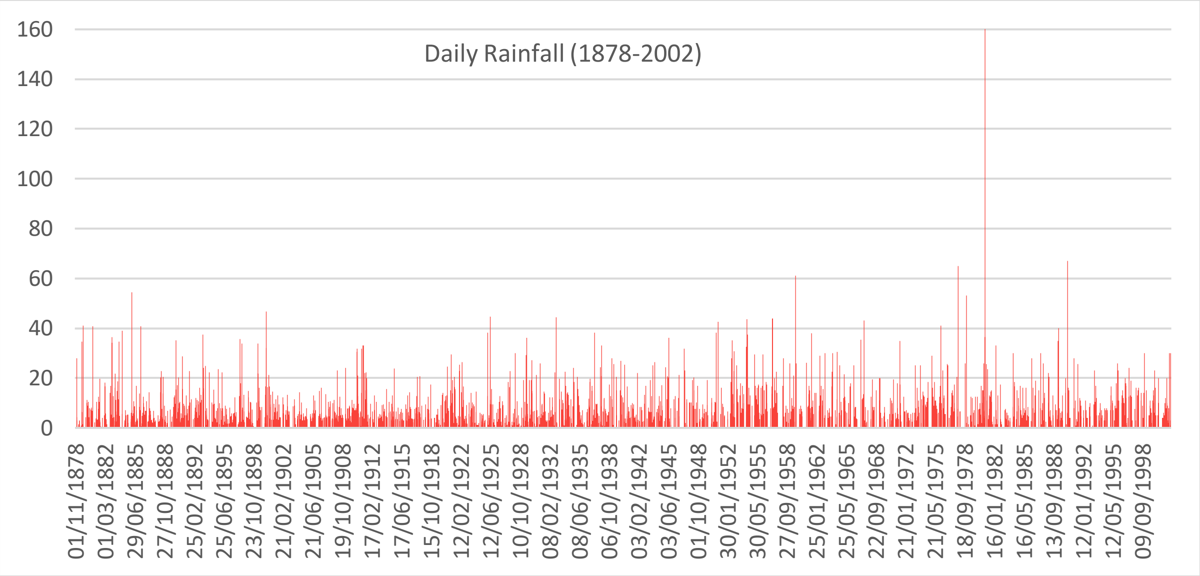


Figure 4-4: Daily Rainfall plot of the DWARS-IN-DIE-WEG Rain Gauge

4.6 HYDROLOGY

The hydrology of the area is shown in **Figure 4-5.** There are numerous dry natural channels which drain the area of water from a westerly to easterly direction. The water courses are generally ephemeral in nature which seldom shows evidence of surface water runoff due to the arid conditions of the area. The area within the footprint of the powerline drains into the Maintjiesplaas and Roggeveld Rivers, which flow into the Buffels River.

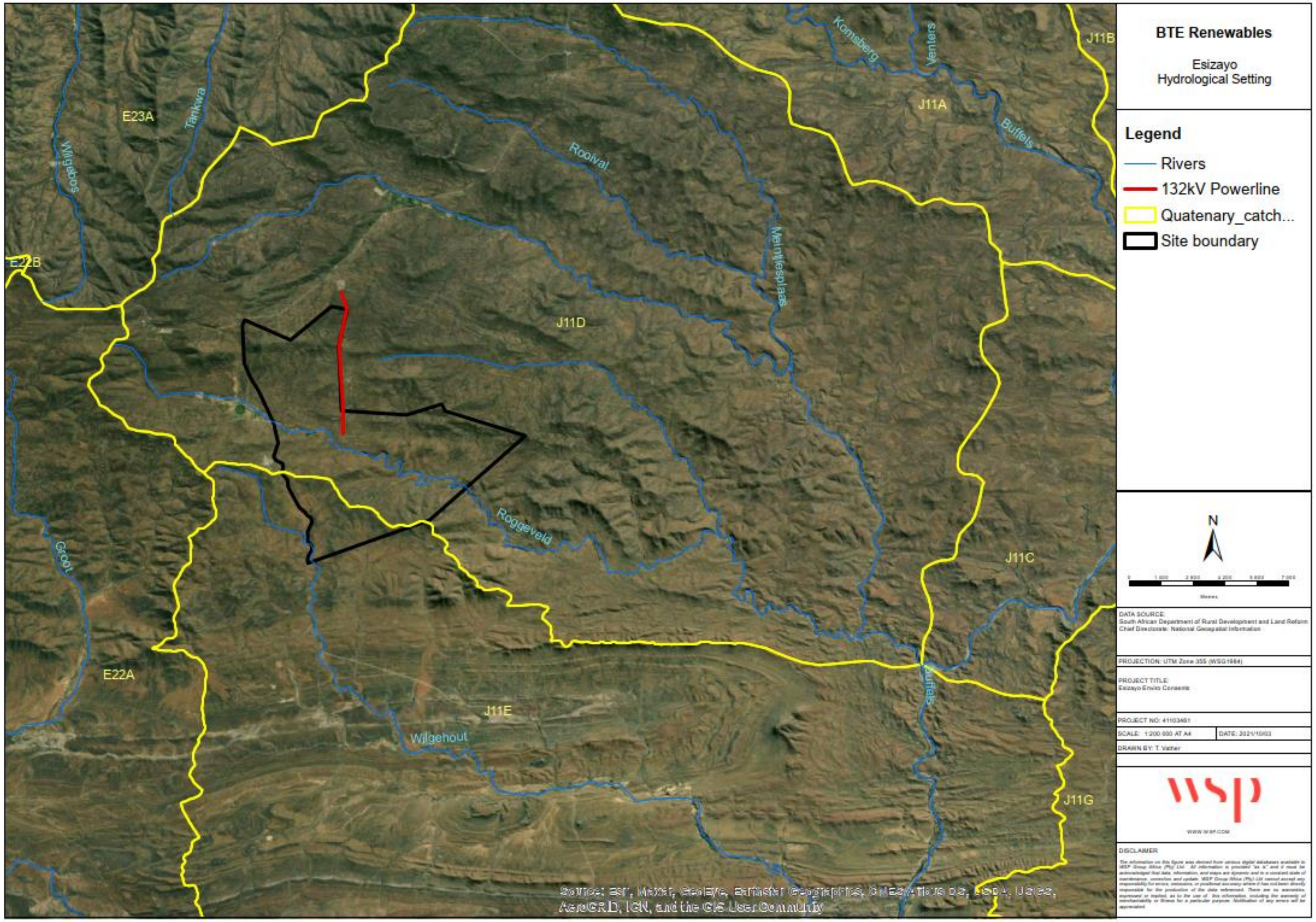


Figure 4-5: Hydrological Setting of the Esizayo Powerline

5 SITE WALKOVER

A site walkover was undertaken by WSP on the 7th of September 2021 to determine the site characteristics. A photographic log highlighting the main features of the site visit is shown in **Table 5-1** and expanded on below:

- Photograph 1 shows a drainage line which crosses the proposed powerline
- Photograph 2 shows a drainage line which crosses the proposed powerline
- Photograph 3 shows the river channel, 3km south east of the southern portion of the powerline
- Photograph 4 shows signs of erosion, roughly halfway along the powerline route.

Table 5-1: Photographic Log of the Site Assessment

Photograph 1 	Photograph 2 
Photograph 3 	Photograph 4 

6 EROSION MANAGEMENT

6.1 INTRODUCTION

Erosion is a form of land degradation that poses major environmental and ecological problems. It may occur at an alarming rate causing serious topsoil loss. Erosion may lead to progressive inability of vegetation and soil to regenerate. Developments tend to result in numerous disturbances, which leave a site vulnerable and susceptible to soil erosion. Large areas of hardened surface created by a development will generate significant volumes of runoff during storm events and this will also pose a potential erosion hazard to the runoff receiving areas. Erosion preventative mechanisms must be implemented throughout the construction phase and monitoring during the operational phase. Erosion resulting from the development should be appropriately rehabilitated to prevent further habitat deterioration.

The aim of an Erosion Management Plan is to provide a framework for the management of soil erosion during the construction and operation of the 132kV powerline, by implementing avoidance and mitigation measures to reduce the erosion potential and impact of erosion.

The broad objectives of this erosion management plan are to:

— Introduce measures to reduce the erosion potential;
— Reduce the susceptibility of the area;
— Develop and implement monitoring and rehabilitation measures;
— Manage runoff and reduce the impact on sensitive areas;
— Achieve long-term stabilisation of all disturbed areas and
— Promote the natural re-establishment and planting of indigenous species to reduce erosion.

6.2 EROSION BACKGROUND

Erosion is the detachment of soil particles and transportation of these particles by erosive agents (water and wind). The removal of vegetation is the major cause of soil detachment since it exposes the soil to these erosive agents. There are several types of erosion which include raindrop impact, sheet erosion, rill erosion, gully erosion and wind erosion. Erosion may be influenced by several factors simultaneously, such as rainfall intensity, antecedent soil moisture content, slope steepness and land use/land cover.

6.3 EROSION CONTROL PRINCIPLES

In the design phase, various stormwater management principles should be considered, including:

— Protect the land surface from erosion.
— Minimise the area of exposure of bare soils to minimise the erosive forces of wind, water and all forms of traffic.
— Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations. This applies particularly during construction.
— Avoid situations where slopes may become saturated and unstable (during and after construction process).
— All roads and other hardened surfaces should have runoff control features which redirect water flow and dissipate any energy in the water which may pose an erosion risk.
— Regular monitoring for erosion after construction to ensure that no erosion problems have developed as result of the disturbance.
— All erosion problems observed should be rectified as soon as possible, using the appropriate erosion control structures and re-vegetation techniques.
— A cover of indigenous species should be established in disturbed areas to bind the soil and prevent erosion.

- Construction activities must be restricted and carefully monitored to keep disturbance to a minimum and disturbed areas must be appropriately rehabilitated and managed.
- Planting of vegetation should commence as soon as possible after construction is completed to minimise the potential for erosion.
- Progressive rehabilitation is an important element of the rehabilitation strategy and should be implemented where feasible. Re-vegetation of disturbed surfaces must occur immediately after construction activities are completed
- Once revegetated, areas should be protected to prevent trampling and erosion.
- No construction equipment, vehicles or unauthorised personnel should be allowed onto areas that have been vegetated

  Regular audits and maintenance programmers to ensure that plants are growing and serving the purpose for which they were planted. This erosion control can be achieved by:
  - Integrating project design with site constraints.
  - Planning and integrating erosion and sediment control with construction activities.
  - Minimising the extent and duration of disturbance.
  - Using erosion controls to prevent on-site damage.

6.3.1 ON-SITE EROSION MANAGEMENT

General factors to consider regarding erosion risk at the site includes:

- Any eroded areas observed should be rehabilitated as soon as possible.
  - Reinstate as much of the eroded area to its pre-disturbed geometry.
  - Install protective works (gabions, reno-mattresses) to stabilise and protect unstable banks.
  - Earthen berms or plugs, rock packs or gabions can be used for the plugging of erosion gullies.
  - The area should then be allowed to re-vegetate itself.
  - Any activities within these areas should be avoided as far as possible.
- Soil loss will be greater on steeper slopes. Ensure that steep slopes are not de-vegetated unnecessarily and subsequently becomes hydrophobic, which will increase erosion potential.
- All bare areas should be revegetated with appropriate locally occurring species, to bind the soil and limit the erosion potential.
- Gabions and other stabilisation features should be used on steep slopes and other areas vulnerable to erosion minimise the erosion risk as far as possible.

6.3.2 EROSION CONTROL MECHANISMS

The following mechanisms may be used to combat erosion when necessary:

- Reno mattresses
- Slope attenuation
- Hessian material
- Shade catch nets
- Gabion baskets
- Silt fences
- Storm water channels and catch pits
- Soil binding
- Geofabrics
- Hydroseeding and/or re-vegetating
- Mulching over cleared areas
- Boulders and size varied rocks
- Tiling

6.4 MONITORING REQUIREMENTS

To monitor the impact of construction activities, follow-ups and rehabilitation efforts, monitoring must be undertaken. This section provides a description of a possible monitoring programme that will provide assessment of the erosion on site as well as an assessment of the success of the management programme.

In general, the following principles apply for monitoring:

- Photographic records must be kept of areas to be cleared prior to work starting and at regular intervals during initial clearing activities. Similarly, photographic records should be kept of the area from immediately before and after follow-up clearing activities. Rehabilitation processes must also be recorded.
- The cause of soil erosion must be determined.
- Simple records must be kept of daily operations (location cleared and labour units).
- It is important that, if monitoring results in detection of invasive alien plants, that this leads to immediate action.

The following monitoring should be implemented to ensure erosion management during the construction phase:

Table 6-1: Erosion management monitoring during construction

Monitoring Action	Indicator	Timeframe
Identification of drainage lines which may be impacted by the development	Hydrological map	Preconstruction & monthly
Monitor cleared areas for erosion problems	Recording the monitoring site, issues encountered and remedial actions implemented	3 Monthly and following the significant rainfall events
Monitor vegetation clearance in sensitive areas	Activity log of monitoring actions and any mitigation and avoidance measures implemented	3 Monthly and following the significant rainfall events
Monitor re-vegetated and stabilised areas	Recording the monitoring site, issues encountered and remedial actions implemented	3 Monthly and following the significant rainfall events

The following monitoring should be implemented to ensure erosion management during the operation phase:

Table 6-2: Erosion management monitoring during operation

Monitoring Action	Indicator	Timeframe
Monitor for the development of new erosion problems across the site	Map erosion problem areas	Quarterly
Document erosion control measures implemented & success rate achieved	Records of control measures and their success	Quarterly
Document the extent of erosion and site rehabilitation measures implemented and success achieved in problem areas	Decline in erosion and vulnerable bare areas over time	Biannually

7 IMPACT ASSESSMENT

The objective of this section of the report is to assess the risk posed by the activity-related processes to the hydrological environment.

7.1 CONSTRUCTION

The following activities will be carried out during the construction of the 132kV powerline.

— Drilling of holes (typically 2-3m in depth);
— Planting of poles;
— Stringing of conductors, and
— Possible excavations and stabilized backfill.

Table 7-1: Construction phase impact assessment

<table>
<tr><th>Impact</th><th>Drainage alteration</th></tr>
<tr><td>Impact description</td><td>Construction activities will result in alterations of flow regimes of watercourses</td></tr>
<tr><td>Mitigation</td><td>Construction of the powerlines should, where feasibly possible, occur during the dry season and the site rehabilitated before major rainfall events occur. Cables must only cross perpendicular to a watercourse and the chosen alignment must endeavour that the span across the watercourse is minimalised.</td></tr>
<tr><td>Ease of mitigation</td><td>Moderate</td></tr>
<tr><td>Significance rating</td><td>
<table>
<tr><td colspan="6">Pre-Mitigation</td><td colspan="6">Post-Mitigation</td></tr>
<tr><td>(M+</td><td>E+</td><td>R+</td><td>D)x</td><td>P=</td><td>S</td><td>(M+</td><td>E+</td><td>R+</td><td>D)x</td><td>P=</td><td>S</td></tr>
<tr><td>4</td><td>2</td><td>3</td><td>2</td><td>4</td><td>44</td><td>2</td><td>2</td><td>1</td><td>2</td><td>3</td><td>21</td></tr>
<tr><td colspan="6">N3 - Moderate</td><td colspan="6">N2 - Low</td></tr>
</table>
</td></tr>
<tr><td>Impact</td><td>Soil erosion and sedimentation</td></tr>
<tr><td>Impact description</td><td>Construction activities will result in soil disturbance, resulting in a higher potential for soil erosion and sedimentation</td></tr>
<tr><td>Mitigation</td><td>Areas of construction should be (where practical) limited to the extent of the footprint, and activities outside of the footprint should be kept to a minimum. Traffic of construction vehicles should be kept to a minimum to reduce soil compaction and limited to existing or proposed roadways where practical. Any soil excavated during construction, should be appropriately stored in stockpiles which are protected from erosion. Wind erosion is dominant for the region. Water erosion action is considered limited, however backfilling with soil and use of gabions or Reno Mattresses should be used where evidence of erosion is present.</td></tr>
</table>

Ease of mitigation	Moderate

Significance rating

Pre-Mitigation						Post-Mitigation					
(M+	E+	R+	D)x	P=	S	(M+	E+	R+	D)x	P=	S
4	2	3	2	3	33	2	1	1	2	2	12
N3 - Moderate						N2 - Low					

Impact	Water quality degradation
Impact description	Potential spillage of hazardous substances such as oils, fuel, grease from construction vehicles and machinery.
Mitigation	The proper handling and storage of hazardous materials, the use of hardstanding in storage areas of hazardous substances and where spillages are possible. The use of drip trays on machinery and vehicles.
Ease of mitigation	Moderate

Significance rating

Pre-Mitigation						Post-Mitigation					
(M+	E+	R+	D)x	P=	S	(M+	E+	R+	D)x	P=	S
2	2	3	2	2	18	1	1	1	2	1	5
N2 - Low						N1 - Very Low					

Impact	Loss of wetland and riparian functionality
Impact description	Temporary degradation of wetland/riparian habitat due to the positioning of the powerlines
Mitigation	The detailed freshwater habitat assessment must be used to determine the most suitable placement of the powerline poles.
Ease of mitigation	Moderate

Significance rating

Pre-Mitigation						Post-Mitigation					
(M+	E+	R+	D)x	P=	S	(M+	E+	R+	D)x	P=	S
4	2	3	2	4	44	4	1	1	2	3	24
N3 - Moderate						N2 - Low					

7.2 OPERATION

Table 7-2: Operation phase impact assessment

Impact	**Soil erosion and sedimentation**											
Impact description	The overall increase in soil disturbance results in a higher potential for soil erosion and sedimentation. The increase in compaction post construction phase will result in more runoff. Routine monitoring and maintenance of the powerline infrastructure will further compact the soil.											
Mitigation	Erosion control management procedures should be implemented to monitor and rehabilitate erosion.											
Ease of mitigation	Moderate											
Significance rating	Pre-Mitigation						Post-Mitigation					
	(M+	E+	R+	D)x	P=	S	(M+	E+	R+	D)x	P=	S
	4	2	3	2	3	33	2	1	1	2	2	12
	N3 - Moderate						N2 - Low					
Impact	Water quality degradation											
Impact description	Potential spillage of hazardous substances such as oils, fuel, grease from vehicles and machinery.											
Mitigation	The proper handling and storage of hazardous materials, the use of hardstanding in storage areas of hazardous substances and where spillages are possible. The use of drip trays on machinery and vehicles.											
Ease of mitigation	Moderate											
Significance rating	Pre-Mitigation						Post-Mitigation					
	(M+	E+	R+	D)x	P=	S	(M+	E+	R+	D)x	P=	S

	2	2	3	2	2	18	1	1	1	2	1	5
	N2 - Low						N1 - Very Low					

8 CONCLUSION

The development of the 132kV Esizayo powerline may result in numerous negative impacts on the environment. To reduce these impacts, proper mitigation and management procedures are to be adhered to. Erosion is a predominant negative impact associated with the development. If adequate erosion control measures are implemented correctly during and after the construction of the 132kV powerline, the risk of erosion may be minimized. Implementation of these measures is not only good practice to ensure the minimisation of degradation, but also necessary to ensure further compliance with the necessary legislative requirements.