REPORT

Annual Rehabilitation Plan for Grootegeluk Coal Mine - Revision 1

Exxaro Resources Limited

Submitted to:

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Executive Summary

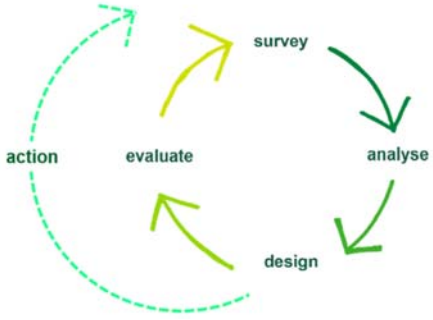
Golder Associates was appointed to assist Grootegeluk with an update of closure planning documentation compiled in 2014, to align to the requirements of the Financial Provisioning Regulations, 2015 (GN R.1147 of 20 November 2015) (as amended). This update includes the compilation of an annual rehabilitation plan, according to stipulations of Appendix 3 of these regulations, with the aim of:

- Planning for and conducting concurrent rehabilitation throughout the operational phase;
- Enhancing the integration of closure and rehabilitation planning with overall mine and operational planning; and thus
- Ensuring that rehabilitation of defunct / superfluous surface infrastructure and non-operational / available mining areas is undertaken conscientiously throughout the operational period, thereby minimising financial provisioning for closure and gradually achieving the desired end land use.

Due to this being the *first draft* of the mine's annual rehabilitation plan, the objectives and content stipulations (GN R.1147) have been addressed to the extent possible. Rehabilitation commitments / activities and related costs cannot be extracted for the past 12 months for evaluation, as per the requirements of GN R.1147. As the mine becomes GN R.1147 compliant by the current stipulated deadline of February 2020, and more information becomes available, the outstanding objectives and requirements will be addressed as part of routine annual update of the plan.

Approach

The approach adopted with closure planning at Grootegeluk is founded on the application of an iterative process according to four key stages, as graphically represented below. This iterative process underpins the principle that planning for closure should occur throughout the life of the mine, with solutions continually being refined via a cyclical process of survey, analysis, design and evaluation. Concurrent rehabilitation planning adopts a similar strategy, including an "action" for implementation of designs, which should be monitored and assessed to determine success.



Timeframe for plan implementation

The rehabilitation action plan contained in this report addresses rehabilitation activities for the short and medium term:

- Short term: annual, 12-month period (January – December 2020); and
- Medium term: 5-year period (January 2020 – December 2024).

Rehabilitation vision

The following vision was formulated to assist in identifying appropriate objectives for the current rehabilitation to be conducted at Grootegeluk:

To facilitate the rehabilitation of the Grootegeluk site to a wilderness state that is stable, safe, non-contaminating and aesthetically appropriate

To create non-contaminating, secure and physically stable landforms and rehabilitated areas that contribute to the bio-diversity of the area and which are aesthetically acceptable

Of particular relevance to this first annual rehabilitation plan – to establish a solid / robust rehabilitation focused knowledge base that is founded on survey, analysis, design and evaluation, via the testing of design concepts via trials and monitoring, to enable future effective implementation of rehabilitation

Rehabilitation conducted to date

It should be noted that rehabilitation activities at Grootegeluk have been focused on improved operations, via the mine's commitment to implement an integrated planning approach, that have an influence on rehabilitation practices, such as the placement of discard in the pit. The following developments, although not purely rehabilitation focused, have been undertaken to achieve this objective:

- The main effort regarding concurrent rehabilitation is focused on the in-pit backfilling system where the aim is the fill the pit areas that has already been mined with discard that is sealed with overburden so as to reach natural ground level (NGL) so that the final cover, top soiling and revegetation of this area can commence and continue as with roll-over mining where final rehabilitation is done as one with mining; however, until the backfill reaches this level this is not possible:
  - The placement of interburden in the pit, thus eliminates contamination of greenfields / undisturbed areas;
  - The placement of plant discard in the pit is pro-active rehabilitation of the current pit; and
  - To date approximately 5 ha have been brought back up to 900 m above sea level (NGL).
- Designs and test / trial work has commenced on the old Dump 4 & 5, to determine a sustainable rehabilitation method;
- Extension of the cement slab of the salvage reclamation yard, with the commissioning of a new separator, on the site of an old laydown area for stores, thereby providing an impenetrable surface that will limit hydrocarbon contamination and the like;
- Construction and commissioning of the cyclic ponds, which displays a fundamental shift in the method of managing slimes;
- Limiting the disturbance of greenfields / undisturbed areas for new developments / mine extensions, e.g.:
  - Two previously disturbed areas cleaned and converted to new contractor's laydown areas; and
  - Utilisation of the slimes dam 3 footprint for the construction of the cyclic ponds.

- Covering / sealing of the open pit discard backfill with overburden and red-sand to limit the occurrence of spontaneous combustion.

GN R.1147 requires the following portrayal of rehabilitation-focused data for planning purposes:

Total area of the MRA (ha):	22,054 ha Refer to Figure 2
The total area disturbed by infrastructure and mining to date (ha):	3,800 ha
The area disturbed by mining (ha):	2,416.5 ha Calculation includes open pit (also stripped / cleared area, new disturbed areas around pit as at Dec 2018), dumps, slimes dams, cyclic ponds, stockpile areas

The area of mined land rehabilitated (ha):	There are currently no areas that can be seen as finally rehabilitated / areas where no more mining activities will take place. Some areas have been remediated and filled, however these areas will in time be used as laydown / new construction areas. Efforts towards readiness / preparation for final rehabilitation activities, although considered as mining / operational activities, include: ■ Topsoil stripping (ahead of pit mined out area); ■ Topsoil stockpiling; ■ Topsoil placed in final position; ■ Discard placement on dumps in final position, to achieve final landform design; ■ Overburden removal; ■ Overburden stockpiling; ■ Pit backfilling with overburden, interburden and discard to achieve original ground level; and ■ Overburden placement in final position on dumps, construction areas and in constructing pit ramps.
Future area (with current LOM plan) to be disturbed by mining (ha) etc.:	3,250 ha

Planned rehabilitation

Rehabilitation-focused activities have been planned for infrastructure, mining areas (open pit backfill areas, dumps and slimes) and general surface rehabilitation according to the five steps / stages of the approach: survey – analyse – design – evaluate – action. The majority of the planned activities fall within the "design" category, to allow for adequate planning and decision making going forward; the key actions (implementation) planned for the short and medium term are as follows:

Short term: ANNUAL **January to December 2020**	**Medium term: 5-YEAR** **January 2020 to December 2024**
Open pit backfill areas	
■ Continue with backfilling of lower and upper systems, as per the current mine plan; and ■ Cover backfilled discard with overburden, as necessary and according to placement timeframes, to curb the occurrence of spontaneous combustion.	
Dump 4&5	
■ Commence with the formulation / design of a phased implementation strategy to undertake dump rehabilitation over a 10-year period, once authorization is approved. ■ Approval of the proposed Rehabilitation Methodology as par tart of the Grootegeluk Rehabilitation BAR and WL application process that started in October 2019.	■ Commence with implementation of the phased implementation strategy to put the final dump rehabilitation plan into effect.
Cyclic ponds	
-	■ Implement the approach / methodology to improve the cover and vegetate the slopes of the cyclic ponds, as per findings of 2019 work.
General surface rehabilitation: soil resource management	
■ Continue with current practice of stripping topsoil ahead of mining. ■ Development and formalization of the soil stripping schedule that considers the material required for the rehabilitation of Dump 4 & 5 and future areas.	■ Informed by the materials balance and associated use prioritisation, undertake planned soil stripping, stockpiling and replacement, along with required amelioration / improving fertility; and ■ Due to the difficulty in obtaining large quantities of organic material, initiate a composting project aligned to concurrent rehabilitation and clearing activities
General surface rehabilitation: vegetation establishment	
-	■ Establish vegetation on available areas.

Short term: ANNUAL January to December 2020	Medium term: 5-YEAR January 2020 to December 2024
General surface rehabilitation: wetland reinstatement	
■ Commence with proof of concept work as it relates to the possible creation of pans within the future rehabilitated area footprint.	■ Continue with the planned trials and monitor their success rate over time; and ■ Integrate the proven methodology for the reinstatement of pans into the overall open pit top system rehabilitation methodology.
General surface rehabilitation: vegetation establishment	
-	■ Commence with implementation of the eradication programme as soon as possible. This will reduce the negative impact, both in extent and severity, on the eventual establishment of vegetation.

Cost of planned rehabilitation

The costs of the planned rehabilitation are determined as at December 2019, coming to:

- Short term (Jan – Dec 2020): R 152,267,754
- Medium term (Jan 2020 – Dec 2024): R 1,174,613,068

Cost aspects for the 2020 work are primarily focused on the categories of “survey, analyse and design”, as per the approach described in section 3.0 of this report (these costs are primarily reflected in the “additional allowances” section of the cost estimate), with actions limited to planned backfill operations of the open pit.

The 5-year rehabilitation plan includes a number of anticipated “actions”, with estimates on work to be conducted derived from percentage-based estimates from the existing unscheduled closure cost estimate for Grootegeluk and budgets associated to planned backfill operations.

A number of costs have been excluded due to these assumed to be allocated to Grootegeluk’s mining / operational budget.

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1.0 INTRODUCTION

Grootegeluk Coal Mine (Grootegeluk), a subsidiary of Exxaro Resources Limited (Exxaro), is an open pit mine that produces 18.8 Mt/annum final coal products, using a conventional truck and shovel mining method. The mine has an estimated minable coal reserve of 2 800 Mt and a total measured coal resource of 4,600 Mt, from which semi-soft coking coal, thermal coal and metallurgical coal are produced.

Golder Associates (Golder) was appointed to assist Grootegeluk with an update of closure planning documentation compiled in 2014, to align to the requirements of the Financial Provisioning Regulations, 2015 (GN R.1147 of 20 November 2015) (as amended). This update includes the compilation of an annual and 5-year rehabilitation plan, according to stipulations of Appendix 3 of these regulations, with the aim of:

- Planning for and conducting concurrent rehabilitation throughout the operational phase;
- Enhancing the integration of closure and rehabilitation planning with overall mine and operational planning; and thus
- Ensuring that rehabilitation of defunct / superfluous surface infrastructure and non-operational / available mining areas is undertaken conscientiously throughout the operational period, thereby minimising financial provisioning for closure and gradually achieving the desired end land use.

Due to this being the *first draft* of the annual rehabilitation plan (ARP) for Grootegeluk, the objectives and content stipulations (GN.R. 1147) have been addressed to the extent possible. Rehabilitation commitments / activities and related costs cannot be extracted for the past 12 months for evaluation, as per the requirements of GN R.1147. As the mine becomes GN R.1147 compliant by the current stipulated deadline of February 2020, and more information becomes available, the outstanding objectives and requirements will be addressed as part of routine annual update of the plan.

2.0 PROJECT AND REPORTING INFORMATION

2.1 Proponent

Table 1: Proponents contact details

Name of company:	Exxaro Resources Limited
Name of Mine:	Grootegeluk Coal Mine
Name of project:	Annual rehabilitation plan for Grootegeluk Coal Mine, as per the requirements of Appendix 3 of the National Environmental Management Act (NEMA, Act No. 107 of 1998) GN R.1147, dated 20 November 2015
Contact:	Filomaine Swanepoel
Postal address:	PO Box 178, Lephalale, 0555
Telephone number:	+27 14 763 9288

2.2 Consultant

Golder was appointed by Exxaro as an external environmental and engineering consultancy with specialist closure planning and costing experience to undertake the closure planning for Grootegeluk.

Table 2: Consultant / specialist contact details

Name of company:	Golder Associates
Contact:	Nadine Coetzee / Johan Bothma
Physical address:	Podium at Menlyn, Second Floor, 43 Ingersol Road, Menlyn, 0181
Postal address:	PO Box 6001 Halfway House 1685
Telephone number:	+27 12 254 4800

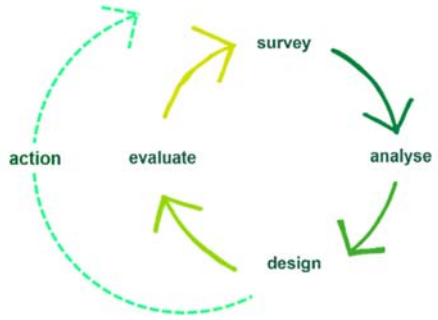
The core specialists who contributed to this rehabilitation plan, and their relevant professional registrations and experience, are provided in Table 3.

Table 3: Details of specialists

Specialist	Task	Professional registrations/experience
Jennifer Botha	Site visit, compilation of rehabilitation plan	PrLArch (SACLAP) BSc (LArch), BL(Hons), ML(Prof) 14 years' experience
Mark Aken	Site visit, technical / specialist inputs and review	PhD (Botany; Phycology) SACNASP (400001/92) 33 years' experience
Anthony Lamb	Report review	BSc Hons 22 years' experience

3.0 APPROACH

The approach adopted with closure planning at Grootegeluk is founded on the application of an iterative process according to four key stages, as graphically represented below. This iterative process underpins the principle that planning for closure should occur throughout the life of the mine, with solutions continually being refined via a cyclical process of survey, analysis, design and evaluation. Concurrent rehabilitation planning adopts a similar strategy, including an "action" for implementation of designs, which should be monitored and assessed to determine success.



The approach adopted with compilation of this report is as follows:

- Provide planning and report approach;
- Review and comment on the key legislative requirements (objectives and content) of this plan;
- Stipulate the planning timeframe;
- Collate and review supporting information[1] to inform the rehabilitation planning, including:
  - Providing a brief mine description;
  - Reviewing the environmental context, and particularly the key implications for rehabilitation and closure;
  - Providing comment on the results of monitoring of risks identified in the final rehabilitation, decommissioning and mine closure plan (closure plan) with a view to informing rehabilitation and remediation activities; and
  - Aligning rehabilitation planning to the latest views on the envisioned end land use.
- Conceptualise an appropriate rehabilitation vision and associated objectives;
- Summary of and comment on rehabilitation conducted to date;
- Formulate the planned rehabilitation according to the stipulated timeframes to align to overall closure planning, within the following categories:
  - Infrastructure;
  - Mining areas; and
  - General surface rehabilitation.
- Compile a preliminary schedule of key actions;
- Determine the anticipated cost to implementation the annual and 5-year rehabilitation plan actions;
- Provide monitoring and aftercare plan, including monitoring objectives, measures, demonstration period, etc.; and
- Formulate a concluding statement.

[1] Refer to APPENDIX B for the list of information reviewed, both with the original 2014 work and the current update

4.0 OBJECTIVES AND CONTENTS OF THE REHABILITATION PLAN

The primary focus and content of an ARP is to identify and address those operational aspects that would contribute to achieving the closure objectives as stipulated in the latest mine closure plan. Generally, the rehabilitation plan does not address routine environmental matters and considerations arising from operations, as these are covered in the environmental management plan (EMP) and are implemented through the mine's environmental management system (EMS) and supporting standards and procedures.

Given that Grootegeluk is currently in the process of becoming compliant with GN R.1147, the objectives of the ARP, as set out in Appendix 3 of GN R.1147, have been addressed to the extent possible, as indicated in Table 4. As the mine becomes GN R.1147 compliant and more information becomes available, the outstanding objectives will be addressed as part of routine annual updates of the plan.

Table 4: Purpose and objective of the Annual Rehabilitation Plan

Purpose and Objectives	Status	Reason / motivation
a) Review concurrent rehabilitation and remediation activities already implemented.	Not addressed	Due to this being the first official ARP, compiled according to the stipulations of GN R.1147, there is no formal review of the previously planned rehabilitation activities.
b) Establish rehabilitation and remediation goals and outcomes for the forthcoming 12 months, which contribute to the gradual achievement of the post-mining land use, closure vision and objectives identified in the holder's final rehabilitation, decommissioning and mine closure plan	Commenced, not complete	Broad rehabilitation objectives are provided per aspect in section 12.0. This rehabilitation plan references the vision and objectives formulated in the latest closure plan. Due to the current status of the mine plan and operations, limited tangible rehabilitation actions are envisioned for the next 12 months (Jan – Dec 2020). This plan is thus largely focused on setting the framework and baseline via assessments (survey and analysis) and designs, including trials / proofs to further the rehabilitation focused knowledge base for future plan updates.
c) Establish a plan, schedule and budget for rehabilitation for the forthcoming 12 months		Refer to section 12.0 for planned rehabilitation, including survey, analysis, design, action and evaluation steps. Preliminary implementation schedule to be completed once the closure plan and associated costings, according to the requirements of Appendix 4 of GN.R. 1147, is approved by Exxaro / Grootegeluk's management team. Cost estimate provided in section 13.0.

Purpose and Objectives	Status	Reason / motivation
d) Identify and address shortcomings experienced in the preceding 12 months of rehabilitation	Not addressed	Due to this being the first official ARP, compiled according to the stipulations of GN.R. 1147, there is no formal review of the previously planned rehabilitation activities.
e) Evaluate and update the cost of rehabilitation for the next 12-month period and for closure, for purposes of supplementing the financial provision guarantee or other financial provision instrument	Pending	Not applicable – first formal / official ARP.

The ARP is aligned to the requirements of Appendix 3 of GN R.1147, as documented in Table 5:

Table 5: Content of annual rehabilitation plan (Appendix 3 of GN R.1147)

No.	Content of an annual rehabilitation plan	Inclusion / application in this report
(a)	*Details of -*	
(i)	*The person or persons that prepared the plan;*	Refer to section 2.2 of this report.
(ii)	*The professional registrations and experience of the preparers;*	Refer to section 2.2 of this report.
(iii)	*Timeframes of implementation of the current, and review of the previous rehabilitation activities.*	Refer to section 5.0 of this report for the broad plan timeframe. Detailed scheduling to be included once the rehabilitation costs are finalised. Due to this being the first official ARP, compiled according to the stipulations of GN R.1147, there is no formal review of the previously planned rehabilitation activities; however, section 11.0 of this report does provide a succinct summary of recent rehabilitation activities undertaken.
(b)	*The pertinent environmental and project context relating directly to the planned annual rehabilitation and remediation activity;*	Refer to section 6.0 of this report for the general mine description, including locality, resource, mining method, product, mine residue and life of mine. Refer to more specific contextual site data included in the sub-sections of section 12.0. Refer to section 7.0 for specific and relevant information on the environmental context.

No.	Content of an annual rehabilitation plan	Inclusion / application in this report
(c)	*Results of monitoring of risks identified in the final rehabilitation, decommissioning and mine closure plan with a view to informing rehabilitation and remediation activities;*	Not applicable at this stage, to be completed with next update of the ARP.
(d)	*An identification of shortcomings experienced in the preceding 12 months;*	Due to this being the first official ARP, compiled according to the stipulations of GN.R. 1147, there is no formal review of the previously planned rehabilitation activities; however, section 11.0 of this report does provide a summary of recent rehabilitation activities undertaken.
(e)	*Details of the planned annual rehabilitation and remediation activities or measures for the forthcoming 12 months, including those which will address the shortcomings contemplated in (d) above or which were identified from monitoring in the preceding 12 months, and including -*	Refer to section 12.0 of this report for planned rehabilitation.
(i)	*If no areas are available for annual rehabilitation and remediation concurrent with mining, an indication to that effect and motivation why no annual rehabilitation or remediation can be undertaken;*	Due to current status of the mine plan and operations, this aspect is largely relevant to Grootegeluk; however, this plan provides largely for the undertaking of assessments (survey and analysis) and designs, including trials/proofs to further the rehabilitation focused knowledge base for future plan updates.
(ii)	*Where areas are available for annual rehabilitation and remediation concurrent with mining, annual rehabilitation and remediation activities related to previous disturbance or expected planned impacts and disturbance, as per the mine works programme, in the period under consideration, which should be tabulated and must indicate, but not necessarily be limited to, -*	As above, due to current status of the mine plan and operations, no specific areas will be made available for rehabilitation during the next 12 months (other than the open pit backfill operations detailed in section 12.2.1); however, rehabilitation planning will be focused on assessments (survey and analysis) and designs, including trials and proofs to be evaluated for success and further implementation going forward.
(aa)	*Nature or type of activity and associated infrastructure;*	Included in sections 12.1 and 12.2.
(bb)	*Planned remaining life of the activity under consideration;*	
(cc)	*Area already disturbed or planned to be disturbed in the period of review;*	

No.	Content of an annual rehabilitation plan	Inclusion / application in this report
(dd)	*Percentage of the already disturbed or planned to be disturbed area available for concurrent rehabilitation and remediation activities;*	
(ee)	*Percentage of the already disturbed or planned to be disturbed area available as per (dd) and on which concurrent rehabilitation and remediation can be undertaken;*	
(ff)	*Notes to indicate why total available or planned to be available area differs from area already disturbed or planned to be disturbed;*	
(gg)	*Notes to indicate why concurrent rehabilitation will not be undertaken on the full available or planned to be available area;*	
(hh)	*Details of rehabilitation activity planned on this area for the period of review;*	
(ii)	*The pertinent closure objectives and performance targets that will be addressed in the forthcoming year, which objectives and targets are aligned to the final rehabilitation, decommissioning and mine closure plan;*	
(jj)	*Description of the relevant closure design criteria adopted in the annual rehabilitation and remediation activities and the expected final land use once all rehabilitation and remediation activities are complete for the activity or aspect; and*	Preliminary land use plan provided in section 9.0. Measures provided in 12.0.
(iii)	*A site plan indicating at least the total area disturbed, area available for rehabilitation and remediation and the area to be rehabilitated or remediated per aspect or activity;*	The general mine plan is indicated - Figure 3, providing a view of the total area disturbed.

No.	Content of an annual rehabilitation plan	Inclusion / application in this report
(f)	*A review of the previous year's annual rehabilitation and remediation activities, indicating a comparison between activities planned in the previous year's annual rehabilitation and remediation plan and actual rehabilitation and remediation implemented, which should be tabulated and as a minimum contain -*	Due to this being the first official ARP, compiled according to the stipulations of GN.R. 1147, there is no formal review of the previously planned rehabilitation activities; however, section 11.0 of this report does provide a succinct summary of recent rehabilitation activities undertaken.
(aa)	*Area planned to be rehabilitated and remediated during the plan under review;*	
(bb)	*Actual area rehabilitation or remediated; and*	
(cc)	*If the variance between planned and actual exceeds 15%, motivation indicating reasons for the inability to rehabilitate or remediate the full area; and*	
(g)	*Costing, including -*	To be completed once the closure plan, according to the requirements of Appendix 4 of GN R.1147, is approved by Exxaro.
(i)	*An explanation of the closure cost methodology;*	
(ii)	*Auditable calculations of costs per activity or infrastructure;*	
(iii)	*Cost assumptions; and*	
(iv)	*Monitoring and maintenance costs likely to be incurred both during the period of the annual rehabilitation plan and those that will extend past the period of the final rehabilitation, decommissioning and mine closure plan, on condition that the monitoring and maintenance costs included in previous annual rehabilitation plans must be accumulated into subsequent versions of the annual rehabilitation plan until such time as the monitoring and maintenance obligation is discharged.*	

The operational ARP and its annual updates should be read together with the following reports:

- The current Final Rehabilitation, Decommissioning and Mine Closure Plan (closure plan) aligned with Appendix 4 of the NEMA Financial Provisioning Regulation (GN R.1147); and
- Environmental Risk Assessment (compiled in terms of Appendix 5 of the above NEMA Regulations) that covers *inter alia* plans and financial provisioning for post closure residual and latent impacts, included as part of the mine closure plan.

5.0 TIME FRAME FOR PLAN IMPLEMENTATION

The rehabilitation action plan contained in this report addresses rehabilitation activities for the short and medium term:

- Short term: annual, 12-month period (January – December 2020); and
- Medium term: 5-year period (January 2020 – December 2024).

6.0 MINE DESCRIPTION

6.1 Locality

Grootegeluk (the mine) is located within the boundaries of the Lephalale local municipality, in close proximity to the mining suburb of Onverwacht in the Limpopo Province (refer to Figure 1). It is situated 18 km west of the town, covering a surface area of approximately 3,758 hectares (ha).

The mine is accessed from the west *via* a sealed tarmac road, linking it with Onverwacht, which in turn is connected with the rest of the bushveld towns i.e. Thabazimbi (120 km to the south), Modimolle (150 km to the south-east) and Mokopane (160 km east-south-east) *via* tar roads. A portion of the mine's product that is not directed to the mine-associated power stations (Matimba and Medupi), is railed from site by a single-gauge railway line that extends southward to Thabazimbi.

6.2 Resource

The mine falls within the Waterberg Coal Fields, which extend 88 km east to west and 40 km north to south in South Africa, as well as further into Botswana. The coalfields are bounded by fault lines on the north and south. The Daarby fault, with a near vertical displacement of 250 m, has divided the coalfields into two areas, a shallow western portion and a deep eastern portion. The fault also forms the east boundary of the mine as it defines the boundary from where coal can be mined on surface, i.e. in the shallow coal fields (Jones and Wagener, 2011).

The coal fields are a typical multi-seam deposit consisting of coal inter-bedded with carbonaceous shales and sandstones. The coal seams ranges from a few centimetres to more than 1 m thick. The deposit mined at Grootegeluk, is divided based on geological contacts, into a number of 14 benches that is mined in succession to one another. Current mining is carried out up to Bench 11 (Jones and Wagener, 2011); however, the mining of Bench 13 is also currently being explored.

Table 6: Typical succession of mining benches (Jones & Wagener, 2011)

Bench	Thickness (m)		Bench description	
1	16.5	110.2	Overburden	Upper Ecca
2	13.5		Bright coal	
3	16.0		Bright coal	
4	16.0		Bright coal	

Bench	Thickness (m)		Bench description	
5	16.7		Bright coal	
6	4.2		Dull coal	Middle Ecca
7A	5.7		Interburden carbonaceous shale	
7B	1.6		Dull coal	
8	3.9		Interburden carbonaceous shale	
9A	2.8		Dull coal	
9B	5.3		Dull coal	
10	3.9		Interburden sandstone	
11	4.1		Dull coal	
12	12-15		Interburden sandstone	
13**	1,5		Dull coal (Used for excavation of in-pit sumps)	

** *Note the full-scale mining of Bench 13 is currently being explored*

6.3 Mining method

Mining at Grootegeluk is conducted by means of the conventional truck and shovel method. The open pit is located to the west of the plant and is being developed in a westerly direction. Extraction of the Volksrust Formation and Vryheid Formation differs. The Volksrust coal horizons are mass mined whilst the Vryheid Formation zones are mined selectively.

The primary loading equipment consists of both rope and hydraulic shovels. The rope shovels are used on the five upper benches and the hydraulic shovels for the selective mining of Benches 6 to 13. Topsoil is removed prior to mining new areas and either stockpiled or transported directly to areas at the mine requiring rehabilitation. The fleet of haul trucks consists of 181-, 200- and 250-ton rear dump trucks, which transport 54 million tons annually. The dump trucks are diesel-electrically driven and equipped with pantograph systems, making it possible to use electrical power when driving up the ramp and out of the pit. In this way diesel consumption is minimized, productivity is increased, and noise and air pollution are reduced. Diesel driven rotational drills are used to drill the blast holes, before they are primed and blasted.

The overburden bench is approximately 16 m thick and consists of weathered and blue shale. The topsoil and weathered material are stripped with the aid of a hydraulic shovel. The rest of the overburden is drilled with a 172 mm rotary drill and blasted. This material, together with the blue shale, is loaded into haul trucks by a rope shovel and transported to the waste dumps.

Coal is either temporarily stored on stockpiles or fed directly into the tipping bins for use and processing in the plant. The coal is transported via conveyor from the tipping bins to the plants. There are also various workshops across the plant and mining area where equipment is maintained and serviced on a scheduled basis.

The current mining operations cover a surface area of approximately 1 094 ha and the current depth of mining in the open pit is 132 m. It is estimated that the pit will reach its most western extent in 2028 at which time haul distances to the processing plant will be the greatest.

After reaching its western most extent, mining will continue back in an easterly direction to recover coal in the north and south of the pit (refer to Figure 9 for the total LoM mine plan and Figure 10 for the current 10-year mine plan).

Exxaro is currently in the process of expanding the mining area into the next 10-year mine plan area. This proposed expansion area, as well as the remaining LoM area, already forms part of the Grootegeluk mining rights area (MRA) and as such, is addressed and approved in the environmental management programme (EMPr) / environmental authorisation for the mine. However, the mine has recently discovered some seasonal pans within this area, which requires authorisation under the National Water Act (1998) (Golder, 2018).

6.4 Product

Grootegeluk is considered to be the largest coal washing facility of its kind in the world. The majority (81% i.e. 25 million tons per annum) of Grootegeluk's production (from 9 beneficiation plants) is in the form of power station coal, which is supplied to Eskom's Matimba and Medupi Power Stations. These power stations produce approximately 25% of South Africa's power. In addition, semi-soft coking coal (10%) and metallurgical coal (9%) is produced, which is exported and also sold to Mittal SA and other local industries (Golder, 2018).

6.5 Mine Residue

Three types of mine residue are defined for the mine, each is indicated along with the broad management approach:

Overburden is defined as the materials contained in Bench 1, which overlies the exploitable coal seams. The overburden contains carbonaceous materials in places which are, when mined, subject to spontaneous combustion and designated as fresh coal. In the areas described as weathered coal the carbonaceous materials have been weathered and are considered non-combustible. The fresh coal is not suitable for sealing and rehabilitation and needs to be treated similar to what has been proposed for the interburden (see below) (Jones & Wagener, 2011).

Interburden occurs in Benches 7A, 8 and 10. The material consists of shales and sandstones that are subject to spontaneous combustion. Interburden needs to be sealed as part of the planned pit backfill operations (Jones & Wagener, 2011).

Discard is produced as part of the coal beneficiation process and is, in terms of volume, the major residue stream originating from the plant. The material is subject to spontaneous combustion and needs to be sealed as part of the planned backfill operations (Jones & Wagener, 2011). Until both the upper and lower backfill systems of the open pit are fully operational (refer to section 12.2.1 for information on the backfilling), a portion of the discard is still being placed on Dump 4 & 5 and sealed with red sand, as required by the approved EMPr.

6.6 Life of mine

Grootegeluk has been operational since 1982. Grootegeluk has the world's largest coal beneficiation complex with a production capacity of 8 000 tonnes per hour of run-of-mine (ROM) at eight plants. About 24 Mtpa of thermal coal is transported to Eskom's Matimba and Medupi power stations via overland conveyors. An additional 1.99 Mtpa of metallurgical coal is sold domestically to the metals and other industries on short term contracts. Grootegeluk produces 2.45 Mtpa of semi-soft coking coal, the bulk of which is railed to Mittal SA under a long-term supply agreement. Approximately 1 Mtpa of semi-soft coking coal and thermal coal is exported through Richards Bay Coal Terminal or sold domestically.

As of end 2018 the estimated remaining life of mine was found to be more than 30 years based on all reserves according to the latest Resource and Reserve Statement of December 2018. The remaining approved mining authorisation for this mine is 22 years.

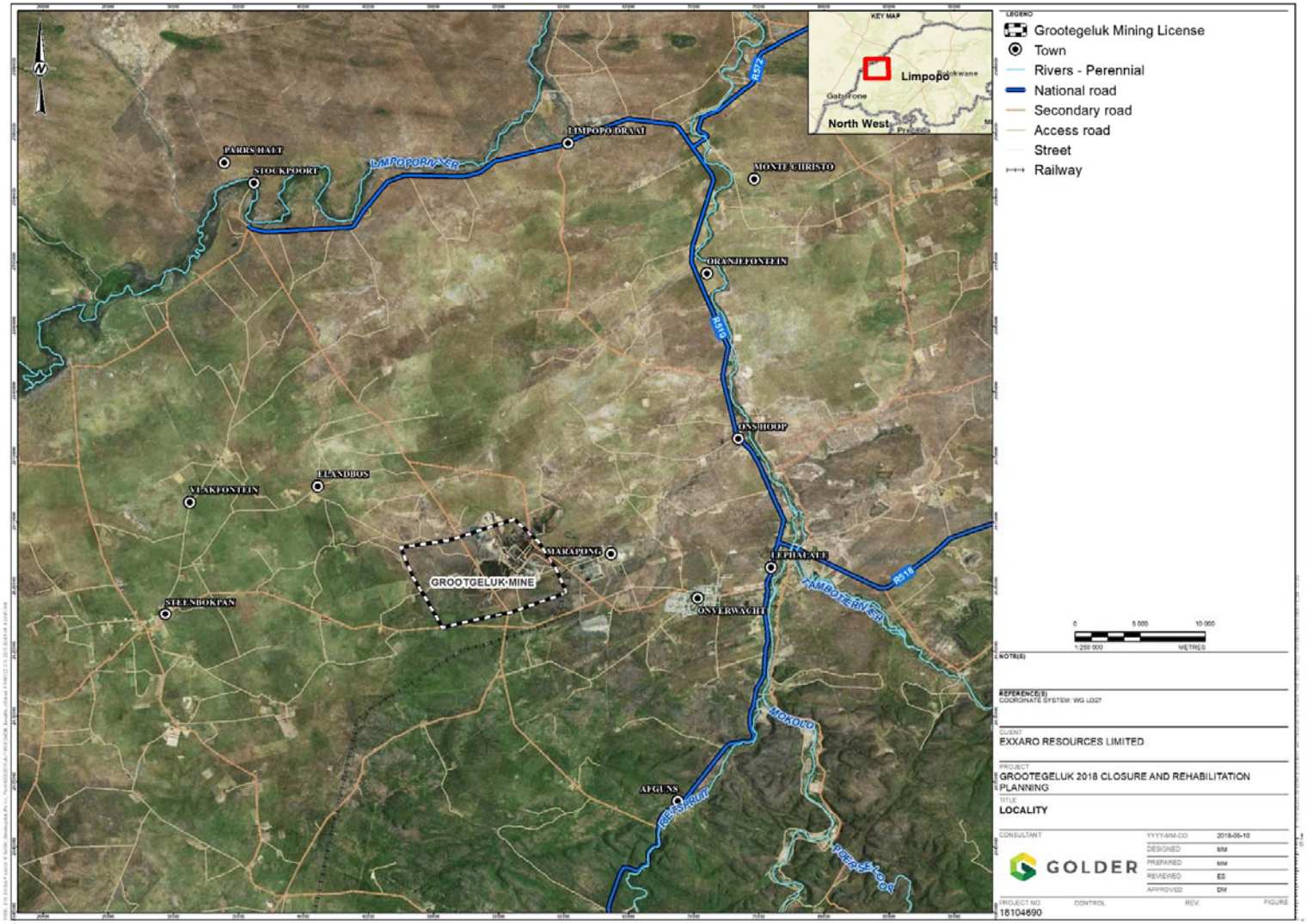


Figure 1: Locality

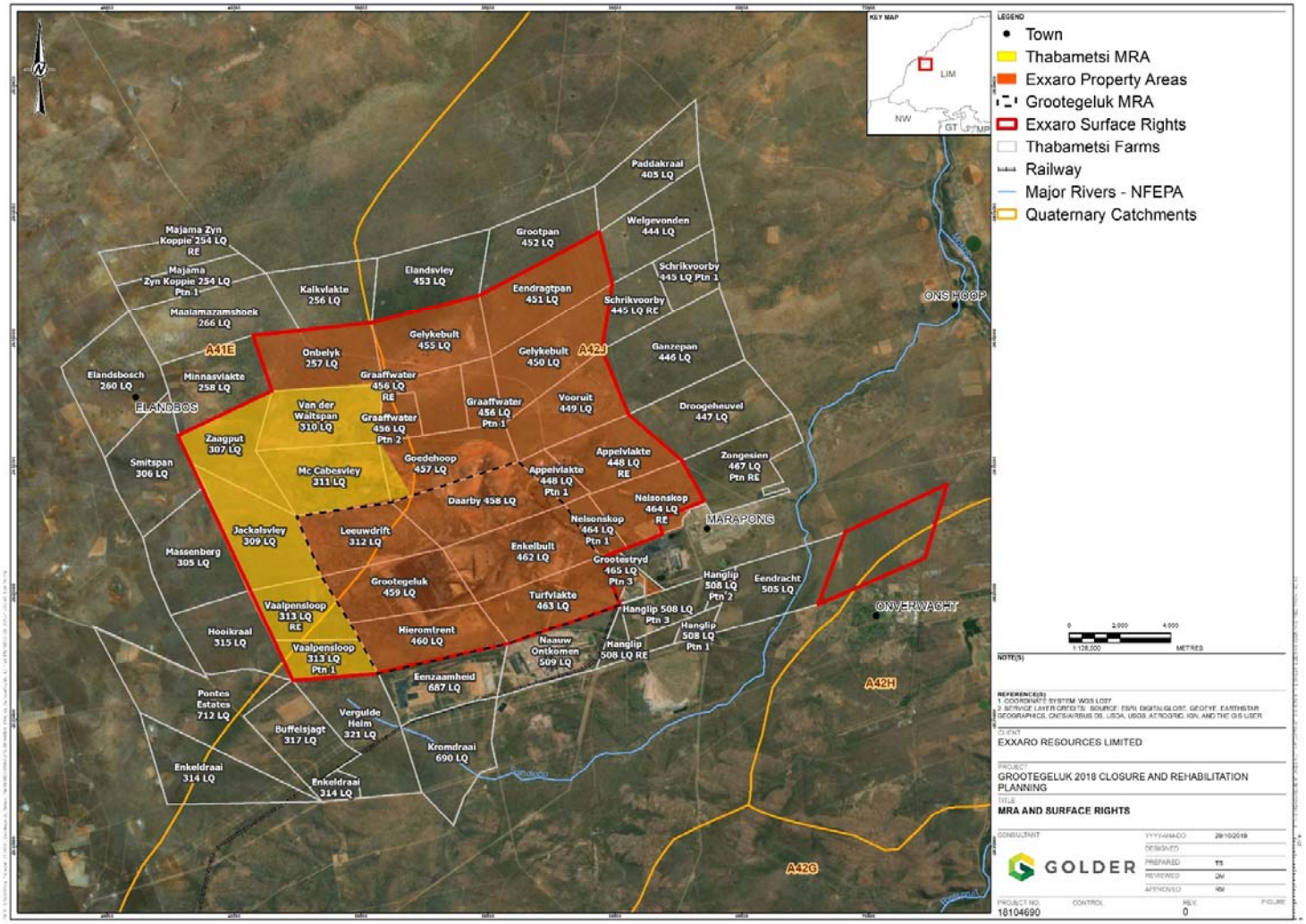


Figure 2: Exxaro Mining rights and surface rights including the remainder of the Thabametsi farms

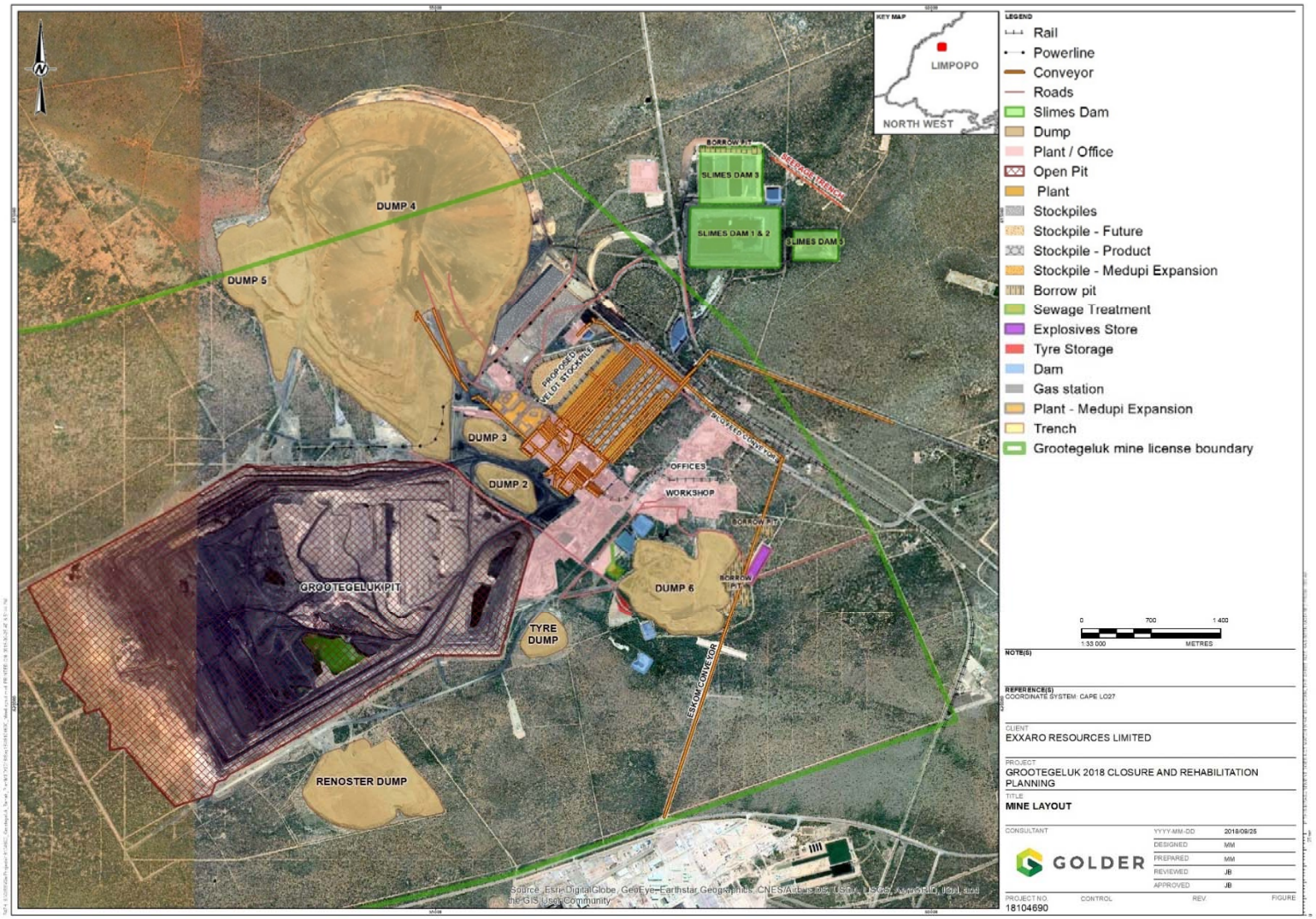


Figure 3: General arrangement plan of the Grootegeluk operation

7.0 ENVIRONMENTAL CONTEXT

The key implications for rehabilitation and closure planning with respect to the local environmental context were derived from the closure knowledge base report compiled for Grootegeluk (Golder, 2013a), the site visit undertaken on 07 August 2018, as well as more recent information made available (refer to APPENDIX B). These considerations have fed into the development of appropriate rehabilitation measures, as well as the scoping of additional investigations, studies and trials to refine current rehabilitation planning.

Aspect	Effect / consideration for rehabilitation planning
Climate	■ The mine is located in what is generally termed the “dry bushveld” within the north-western portion of the RSA. This has a major bearing on the rehabilitation measures devised, especially in terms of surface rehabilitation and the vegetation incorporated/ established as part of this rehabilitation; ■ The mean annual evaporation exceeds the mean annual precipitation by about fourfold, which favours the following: ▪ Application of evaporative covers over facilities with a potential for contamination; and ▪ Long term in-pit water balance that limits the possible accumulation of in-pit water that can potentially lead to the rising to levels that could affect the shallower groundwater levels and/or under extreme conditions could decant to surface; however, this needs to be confirmed. ■ The hot wet summers offer a good growing season for rehabilitated areas; however, extreme climatic events (e.g. intense rainfall, droughts) could adversely affect the short to medium term success of the rehabilitation; ■ With the identification and selection of vegetation for surface rehabilitation, consideration will have to be given to hardy and drought resistant species (grasses, herbs, shrubs and trees); ■ The climate of the area is not conducive to dry land crop production and/or pasture grazing. Currently, these agricultural practices are applied under irrigation. Most likely extensive, low intensity land use options, such as game farming are more viable; and ■ The predominant wind directions are key for the location and configuration of cross walls on the upper surfaces of Dumps 4 and 5 to limit possible dust generation after dump closure.
Geology	■ The faults have direct effects on groundwater flows as they form aquicludes to the north and south of the existing open pit. This has a notable influence on the possible / predicted pit groundwater inflows post closure. Work is currently underway to confirm the predicted post closure inflows; ■ The faults directly influence mine planning and the siting of surface infrastructure and mining facilities; ■ Groundwater mounding to the north of the Daarby Fault occurs. Dedicated abstraction is currently conducted to reduce this mound and it effect on the structural integrity of footings and foundations, as well as to curb the contaminant plume spreading to adjacent areas due to this mounding; and ■ The above mounding could also result in surface expressions that will drain to low lying areas within the affected zone. This has to recognised and addressed in the closure planning and reflected in the eventual abandonment criteria.

Aspect	Effect / consideration for rehabilitation planning
Topography	■ Until the mining areas and associated facilities are rehabilitated appropriately, these areas are aesthetically obtrusive. Grootegeluk contributes to the negative visual appeal of the area. This is further exacerbated by the presence of the two large Eskom power stations; and ■ Closure and rehabilitation measures are to respond to the existing / pre-mining topographical character of the site, so as to rehabilitate unavoidable mining residues (tailings dams and waste rock dumps) to blend in with the surrounding landscape as far as possible.
Soils	■ Boscia Environmental Solutions (Boscia, 2018) undertook a soil sampling reconnaissance to inform appropriate rehabilitation measures associated with soils and vegetation establishment: ▪ A total of 13 soil samples were taken (1) outside the mining area i.e., reference soil, that represents a natural veldt condition, (2) areas with poor to bare vegetation establishment i.e., N and NW, (3) a site that is considered to be fairly rehabilitated i.e., Tire-dump, (4) various soil formations to be used for rehabilitation and (5) area where Acacia trees and debris were stored or dumped. See Figure 1 for site localities and **Table 1** for site and sample description; ▪ Three composite samples were indiscriminately collected from each of the 13 sampling sites. The sampling sites comprised of identified vegetation groups within each of the soil formations and specific ecosystem environments. These composite samples consisted of three subsamples taken from the top 15 cm of soil. The samples were taken to a laboratory, homogenised and kept refrigerated at 4°C to keep their field-moisture and preserve biological characteristics pending analyses; ▪ Soil electrical conductivity (EC) and pH were determined using the saturation paste extract EC and saturation paste pH method. Electrical conductivity (EC) and pH values were determined simultaneously by means of saturated substrate paste with a calibrated pH/EC multi-meter. For all enzymes assayed controls were done by substrate addition after the incubation period, i.e., blank controls (Alef & Nannipieri, 1995). Soil moisture content was determined after air-drying substrate samples. Soil enzymatic activity was assayed in accordance to Alef and Nannipieri (1995); Dick et al. (1996) and Tabatabai (2000); ▪ The site visit observations reveal that there are a great diversity of trees and shrubs present on the undisturbed areas with a variety of density, species richness and soil types present. The main input of the undisturbed soils was mainly planted litter, decaying aerial parts and roots and rhizomes which remain in the soil. The Boom-dump (BO) represented an area where Acacia trees and debris were stored or dumped, this area's soils had a higher %C due to partially decayed Acacia tree within the soil. Seed distribution was identified to be mainly from wind and wildlife. The wildlife's distribution of plant seeds seems widespread i.e., from one soil unit to another unit; ▪ The results of soil enzymatic activities indicated variability in microbial activity in the different soils units and vegetation groups. This variability in the microbial activity may be attributed to the specific soil units and vegetation group's characteristics. For example, the Clovelly's soil unit with predominantly Acacia trees (CVA) had a much higher urease activity perhaps attributable to the nitrogen fixation properties

Aspect	Effect / consideration for rehabilitation planning
	of Acacia trees. Consequently, these Acacia trees positively contribute towards soil fertility and soil health (microbial activity); and ▪ A direct measurement of the microbial population is the dehydrogenase activity, which was higher in the vegetated areas than in the bare soil of NW. Some exceptions pertaining to microbial activity do exist due to the physical and chemical characteristics of the soil units. Based on the results obtained, it is evident that the dominant microbial characteristics of the soil units varied significantly between sites. Both CV2A and BO dehydrogenase strongly correlates with the soils pH and % carbon (C). This correlation indicating a positive relationship between the dehydrogenase activity, %C content and soil pH. ■ Measures / method statements related to soil management, as informed by the reconnaissance survey, or provided in APPENDIX C.
Surface water	■ The post closure environment is not expected to have any impact on surface water quality of the Mokolo River resource; ■ Rehabilitation and closure measures will need to be devised to prevent contamination from potential sources (dump 4/5 and the slimes dams), to reinstate surface drainage lines aligned to existing surface topography and to ensure free drainage; ■ Pit water make post closure is to be limited to regional groundwater recharge and direct rainfall; ■ Drainage channels will need to be cleaned and the silt disposed of appropriately; and ■ Sewage sludge, containing high levels of organic material can be beneficially used as a soil ameliorant.
Groundwater	■ With the high evaporation rate (final pit void), no surface decanting is expected and the groundwater cone of depression 100 years after mine closure; ■ Confirm the predicted long-term groundwater flows into the open pit voids post closure. Existing information reflects a vast disparity on this matter; ■ Aligned to the above, obtain agreement on the predicted long-term groundwater drawdown affecting groundwater, most likely to the west of the existing pit; ■ Given the above inflows and the agreed in-pit water make-up, compile a dedicated long term in-pit water balance. This water balance has to provide information on at least the following: ▪ Long term in-pit water level; ▪ In-pit water level amplitude; ▪ Effect of routing superfluous surface runoff as part of post closure surface water management into the pit, thereby using the pit as a final sink; and ▪ Likelihood of water level interaction with the surrounding exploitable groundwater aquifers. ■ Utilise the existing groundwater modelling to guide on the nature and extent of post closure water interception, abstraction and treatment to arrest and recede the already developed contaminated groundwater plumes; ■ Limit the mobilisation and ingress of waste loads from the sources of contamination via appropriate covering and/or rehabilitation;

Aspect	Effect / consideration for rehabilitation planning
	■ Based on available information, it appears that the potential for AMD is low. However, salt leach will still manifest and this will have to be taken into account with the formulation of closure measures and remediation; and ■ Adapt and or change the existing groundwater monitoring network to confirm the appropriateness of long-term water quality and yield predictions, as well as effectiveness of closure and rehabilitation measures into the post closure phase.
Air quality	■ The rehabilitation plan should consider the fact that the activity takes place in a priority area (Waterberg- Bojanala Priority Area). However, a regional approach to air quality management is recommended as the other activities such as the industrial activities (power stations, brick making); ■ Air pollution generated from vehicle emissions and dust control will need to be managed during the active rehabilitation and closure activities (both initial as well as LoM closure); and ■ Devise appropriate measures related to the dumps (particularly Dump 4 & 5) to minimise dust and to curb / mitigate the occurrence of spontaneous combustion.
Flora	■ Rehabilitation planning, as well as end land use planning, is to take account of the site-specific vegetation, along with the soils required to reintroduce appropriate species; ■ Endemic vegetation species should, as far as possible, be utilised with rehabilitation and coverage of dumps, thereby facilitating the achievement of biodiversity and visual/aesthetic objectives for mine closure; and ■ This rehabilitation plan is to address measures for the eradication and management of alien invasive species.
Fauna	■ Biodiversity objectives are to be established with closure planning and appropriate measures formulated to facilitate achievement of performance criteria; and ■ Depending on the final land-use objectives selected, the NSS study as well as a wildlife management plan could inform conservation measures and animal stocking.
Wetlands	According to a recent wetland assessment undertaken by GroundTruth (GroundTruth, 2018a) (Figure 4): ■ No perennial streams and fringe habitat wetlands occur within the mine's boundaries; ■ The mine area does have an expansive number of pans varying in size from 0.004 ha to 2.3 ha; ■ The majority of the systems are under 0.1 ha in extent, and in some instances are interlinked by a dendritic drainage network; however, these dendritic drainage networks are only preferential flows paths within the landscape and not actual streams (i.e. are not characterised by the presence of alluvial material and vegetation distinctly different from adjacent terrestrial vegetation); ■ All of the identified wetlands, regardless of how temporary in nature the systems were, contained invertebrates, thus providing an additional level of evidence to the presence of wetland conditions resulting in a biotic response; ■ Of the sixty-three (63) systems assessed in the study area, 41 pans and 2 artificial systems will be lost during the next 30 years, with the remaining 22 to be lost when the remaining extent of the reserve is mined (refer to Figure 9); ■ The proposed mitigation of this impact will be three-fold:

Aspect	Effect / consideration for rehabilitation planning
	▪ Conservation / protection, wherever possible; ▪ Offsetting, according to the SANBI Offset Guidelines (the artificial systems were excluded from any assessments due to their artificial nature, and therefore, do not contribute to the offset mitigation requirements); and ▪ Reinstatement on rehabilitated areas (creation of pans / depressions). *Note: The mine is currently waiting for the approval of the IWUL linked to these uses and the mitigation measures and time frames indicated in the ARP will be influenced by the issuance of the IWUL and the conditions therein.* ■ Extremely high egg densities observed in the egg bank (upper sediments of temporary wetlands), coupled with the unique hatching traits of temporary wetland fauna raises the possibility that sediments can be harvested and relocated to areas where artificial wetlands can be created as part of an offset strategy – this in the case where temporary wetland areas have been earmarked for development. The harvesting and relocation of sediments should allow for offsets to successfully enable recolonization of artificial temporary wetlands by associated flora and fauna, though several factors would however have to be carefully considered and planned.

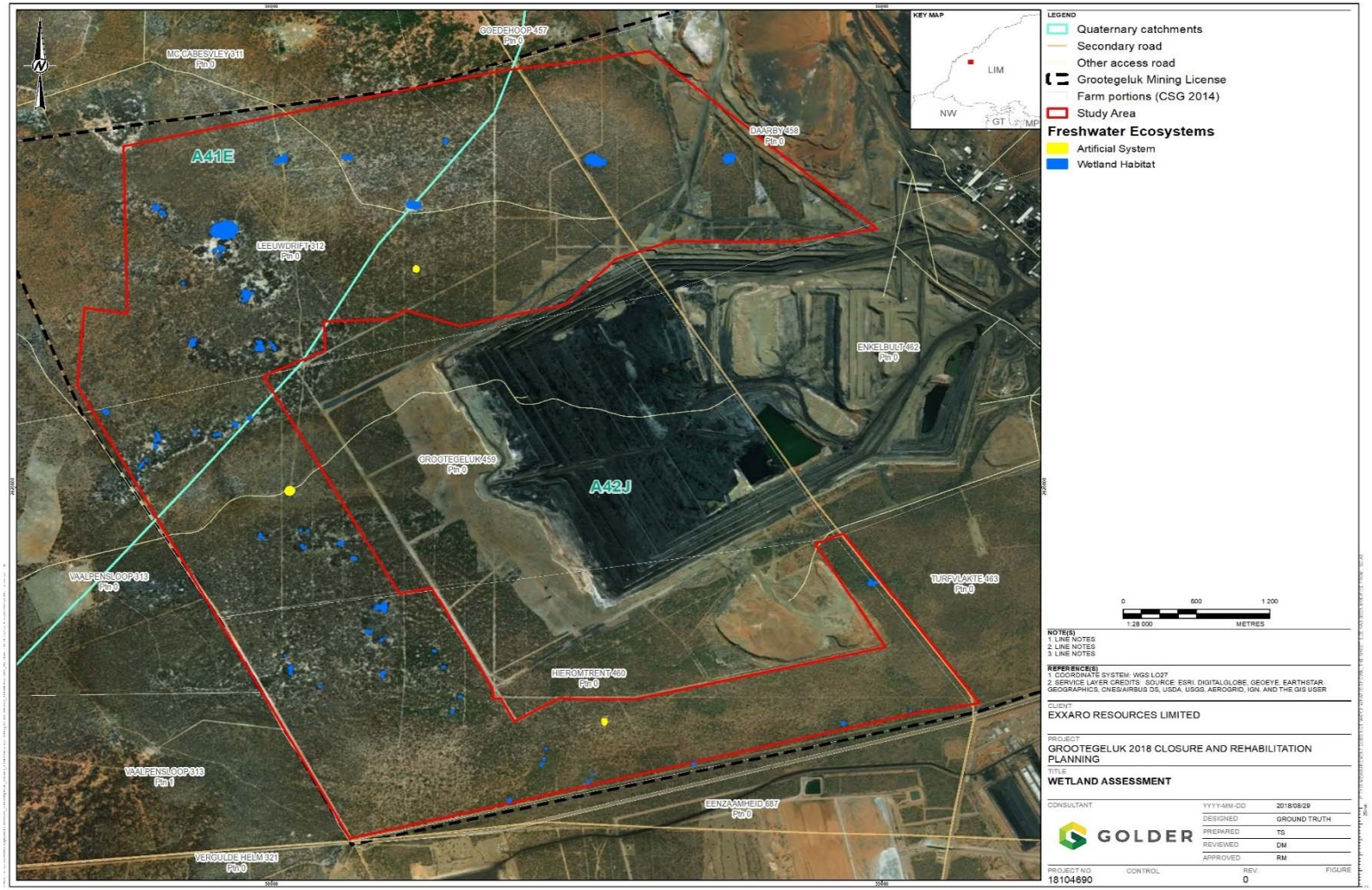


Figure 4: Wetland assessment

8.0 RISK MONITORING

This section of the ARP should report on the results of monitoring of risks identified in the closure plan with a view to informing rehabilitation and remediation activities. This reporting is not possible with this first plan, as the mine closure plan, according to the requirements of Appendix 4 of GN R.1147, as well as the associated environmental risk assessment, according to the requirements of Appendix 5 of GN R.1147 are being finalised for mine management and corporate approval.

The initial key closure-related risks identified during the 2014 closure planning work are summarised below for consideration (Golder, 2014c).

Open pit

- Safety concerns due to unauthorised access and exposure to vertical faces and drops;
- Long term prolonged groundwater drawdown effecting water resource yield to the west of the pit;
- Spontaneous combustion on exposed banks and in pit backfilled areas;
- Long term sump capability for contaminated stormwater runoff with associated in pit water balance;
- Unknown/undefined/incorrect long-term safe break back line resulting in the failure of closure and rehabilitation measures and posing severe safety risks; and
- ***New:*** *loss of unique habitats due to the location of a number of seasonal pans within the approved mine plan and mining right area.*

Dumps

- Spontaneous combustion and associated explosions resulting in erosion of the side slopes of the dump and impacting on the long-term stability of the dump;
- The potential for spontaneous combustion on flat (horizontal) upper surfaces;
- Water ingress into the dump resulting in seepage and eventual soil, surface water and groundwater contamination; and
- Incorrect cover configuration with available soil resources, resulting in failure of the dump cover (seepage, erosion, not achieving desired biodiversity objectives and visual impact).

Slimes dam

- Instability[2] of the facility (slimes dam 1 & 2) during rehabilitation with the risk of possible failure of the facility and liquification of slimes, thus:
  - Making the recovery of the material before closure impossible; or
  - Leading to only partial recovery of dry material that can be safely recovered.
- Further seepage from the slimes dams 1 & 2 resulting in soil, surface water and groundwater contamination and inadequate containment of the contaminant plume; and
- Incorrect cover configuration with available soil resources, resulting in failure of the dump cover (seepage, erosion, not achieving desired biodiversity objectives and visual impact).

[2] Monitored by Grootegeluk's engineers

Infrastructural areas

- Contamination of soils, surface water and groundwater due to hydrocarbon spillages and salt leach, exacerbated due to poor management practices during the operational period resulting in the development of a contaminant plume, with a key risk at closure being inadequate containment of the contaminant plume(s);
- The occurrence of discard material or other contaminants in dumps 1, 2 and 3 to be utilised for the pseudo terrace; and
- The routing of contaminated stormwater to the pit, along with the possible constraints on routing bottlenecks.

Legal aspects

- Not obtaining regulatory approval for the devised rehabilitation measures and/or developing borrow pits to source cover material, with resultant financial impacts.

9.0 END LAND USE

The ARP is aligned to the most recent end land use plan compiled by Golder in 2014, and the latest closure plan updated by Golder in 2018-2019 to align to the requirements of GN R.1147.

9.1 Land use vision

To facilitate the rehabilitation of the Grootegeluk site to a state that is stable, safe, non-contaminating and aesthetically appropriate, by integrating rehabilitated wilderness areas and permanent post-mining landforms with the surrounding biosphere reserve; and to establish end land uses that maximize socio-economic opportunities where possible, that are self-sustaining and that are socially acceptable to stakeholders.

9.2 Proposed end land use zones

Based on the established end land use vision and on the needs and constraints assessment conducted as part of the land use planning (Golder, 2013e), the following potential end land uses of the site have been identified and evaluated in terms of their likely feasibility, as summarised in Table 7. Note that the majority of the land uses identified below would have to be further investigated in terms of their financial, technical and operational/logistic feasibility.

- ***Likely:*** Primary or anchoring end land uses, likely to be functionally self-sufficient;
- ***Possible:*** Secondary or supporting land uses, land uses reliant on likely uses or other external factors; and
- ***Unlikely:*** Undesirable end land uses, land uses that are unlikely to be sustainable or contextually inappropriate.

Table 7: Potential end land uses of Grootegeluk site (Golder, 2014a)

Likely	Possible	Unlikely
Conservation	Adventure sports.	Extensive agriculture ■ Intensive irrigation schemes; and ■ Dry-land farming.

Likely	Possible	Unlikely
Eco-tourism	Conferences and other functions.	Urban residential development.
Game farming and trophy hunting	Mining heritage tourism.	Commercial or retail development.
No access “wilderness” zones	Alternative power generation (solar, photovoltaic).	Waste disposal (landfill / hazardous).
	Intensive agriculture: ■ Vegetable tunnelsl and ■ Greenhouses.	Industrial redevelopment.
	Intensive livestock: ■ Beef feedlots; and ■ Poultry (chickens, ostriches).	
	Wildlife rehabilitation centre.	

Figure 5 provides indicative zones for the envisaged end land uses as described above.

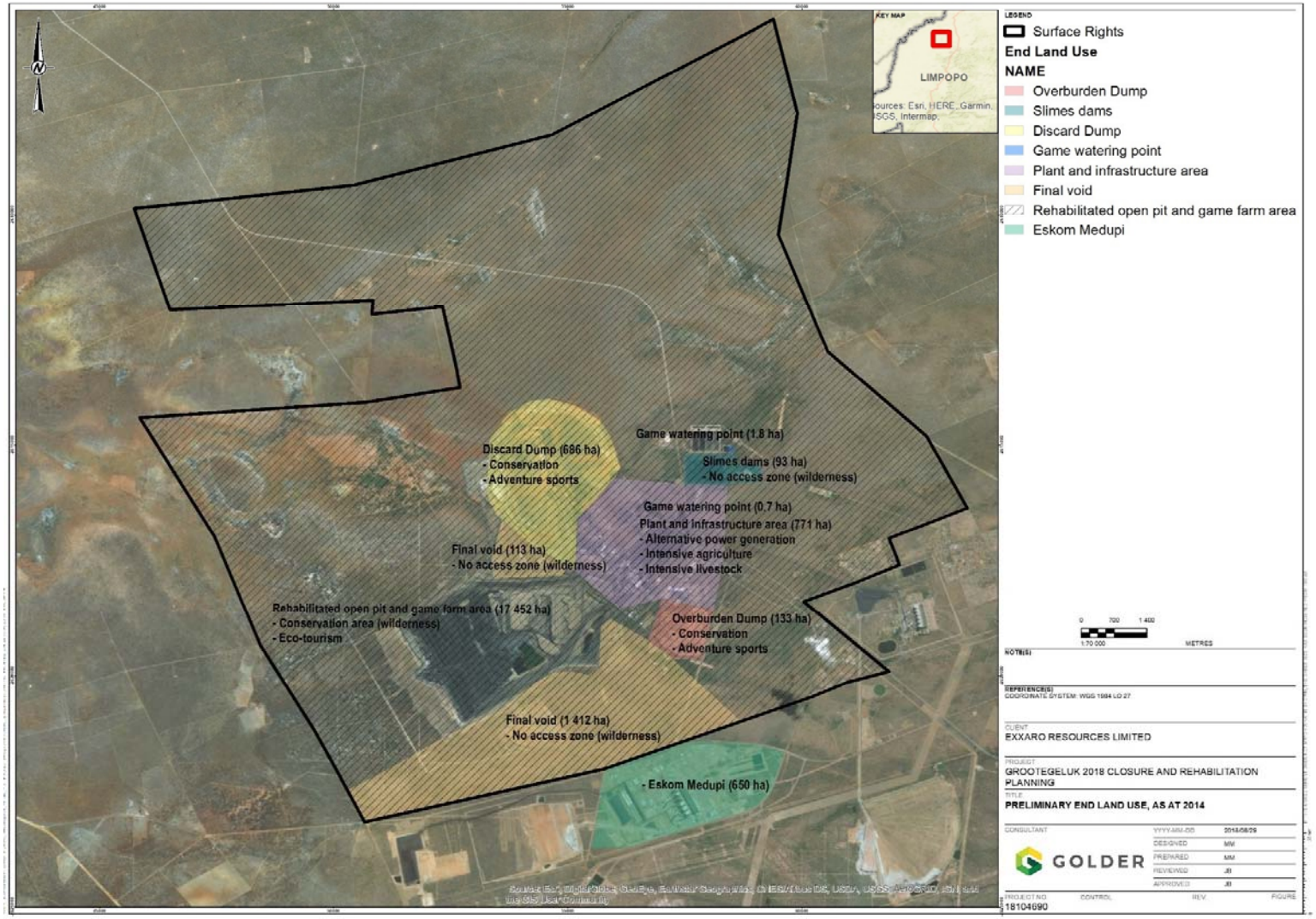


Figure 5: End land use (Golder, 2014a)

10.0 REHABILITATION VISION AND OBJECTIVES

The following vision was formulated to assist in identifying appropriate objectives for the current rehabilitation to be conducted at Grootegeluk:

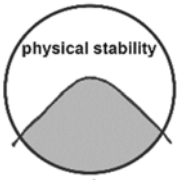
To facilitate the rehabilitation of the Grootegeluk site to a wilderness state that is stable, safe, non-contaminating and aesthetically appropriate

To create non-contaminating, secure and physically stable landforms and rehabilitated areas that contribute to the bio-diversity of the area and which are aesthetically acceptable

Of particular relevance to this first annual rehabilitation plan – to establish a solid / robust rehabilitation focused knowledge base that is founded on survey, analysis, design and evaluation, via the testing of design concepts via trials and monitoring, to enable future effective implementation of rehabilitation

Based on the above vision the following broad rehabilitation objectives were identified:

Table 8: Rehabilitation objectives

Aspect	Objective
	■ Removing defunct infrastructure, fugitive rubble and demolition waste and to rehabilitate the resultant footprints, as well as any existing disturbed area. These areas are to be integrated with the surrounding topography so that all landforms are stable and able to accommodate high rainfall events without notable erosion; ■ Stabilising the upper surfaces and outer slopes of the remnant dumps by means of shaping and the provision of suitable covers to limit water ingress, the occurrence of spontaneous combustion and resultant erosion; ■ Rehabilitating borrow pits (if applicable), dams and ponds to have stable slopes and, aligning to the planned end land use (potential game farm watering holes); and ■ Ensuring that the rehabilitated mine site is free draining.
	■ Cleaning up of sources of possible surface water contamination present on the mine site to protect the downstream receiving environment; ■ Appropriately rehabilitating sources of possible contamination (dumps and slimes dams) to minimise to ensure that these do not pose an unacceptable contamination potential to shallow groundwater; ■ Cleaning-up and rehabilitating contaminated soil areas, especially at high potential areas such as workshops, fuels bays, etc; ■ Ensuring that the rehabilitated project site is free-draining, as follows: ▪ Routing clean runoff to local / natural drainage lines as far as possible; ▪ Ensuring that, if proven feasible to recreate, the reinstated pan structures are designed to provide seasonal pockets of surface water and do not result in increased water ingress to rehabilitated areas; ▪ Routing potentially contaminated runoff to the remaining open pit void as a final sink; and ▪ Ensuring that the drainage lines created on the rehabilitated surfaces will not scour and be sources of erosion.

Aspect	Objective
	■ Limiting the possible health and safety threats to humans and where relevant animals entering the rehabilitated areas; ■ Ensuring that, if proven feasible to recreate, the reinstated pan structures are designed to not be potential sources of contamination; ■ Ensuring that the rehabilitated portions of the project sites are safe and stable in the long-term; and ■ Limiting dust generation on the rehabilitated mine site and / or individual facilities that could cause nuisance and / or health effects to the surrounding landowners / communities.
	■ Achieving a stable situation in terms of land capability over the site in the short to medium term, to eventually achieve the final land capability in the longer term and achieve the desired post-mining land uses ■ Cleaning-up and rehabilitation of contaminated soil areas; ■ Limiting the possible loss of topsoil and the application of the available topsoil to key pre-determined rehabilitation areas (selective materials handling) – primarily during operations; and ■ Ensuring that the drainage lines created on the rehabilitated surfaces will not scour and be sources of erosion.
	■ Creating a suitable vegetation cover over the rehabilitated areas that is largely self-sustaining in the short to medium term and long term, to limit surface erosion and dust generation; ■ Establishing rehabilitated slopes that will preserve vital resources such as growth medium and nutrients, as far as possible, and stabilising disturbed areas to prevent erosion in the short- to medium-term until a suitable vegetation cover has established; ■ Ensuring that the rehabilitated mine site is free draining and that disturbed areas are suitably prepared for the natural establishment of vegetation; however, ensuring that the drainage lines created on the rehabilitated surfaces will not scour and be sources of head cuts; ■ Placing suitable growth medium of sufficient depths and/or suitably ameliorating disturbed areas to sustain vegetation growth; ■ Ensuring that the growth medium has the required organic content and the potential to sustain microbial activity to ensure infiltration, limit runoff and improved soil stability; ■ Establishing or allowing for the natural establishment, as applicable, of viable self-sustaining vegetation communities (keystone pioneer vegetation species), and thus the preparation of ecosystem processes, productivity and services via natural succession; ■ Assessing whether the rehabilitated areas, with limited intervention and change, could be adapted to provide suitable habitats for small mammals, improving the overall biodiversity, while also identifying those aspects/obstacles once site rehabilitation has been completed which could inhibit and/or deter animal life from returning to the rehabilitated project sites;

Aspect	Objective
	■ Reinstating lost surface and habitat features as far as feasible, according to tested concept designs; and ■ Monitoring and suitably eradicating invasive alien vegetation that hinders the success of indigenous vegetation establishment deters from the environmental quality of the rehabilitated site.

11.0 REHABILITATION CONDUCTED TO DATE

The ARP, as per GN.R. 1147 stipulations, should routinely provide a review of the previous years' annual plan implementation. As this is the first formally aligned GN.R. 1147 aligned plan, this level of assessment will be provided with the next update, thus, to review the success of the activities planned for the plan's short-term focus (January – December 2020).

It should be noted that rehabilitation activities at Grootegeluk have been focused on improved operations, via the mine's commitment to implement an integrated planning approach, that have an influence on rehabilitation practices, such as the placement of discard in the pit. The following developments, although not purely rehabilitation focused, have been undertaken to achieve this objective:

- The main effort regarding concurrent rehabilitation is focused on efforts towards readiness / preparation for final rehabilitation activities. These efforts are considered mining / operational activities, including:
  - Topsoil stripping ahead of the pit mined out area, topsoil stockpiling and direct placement (where possible);
  - Overburden removal and stockpiling;
  - Discard placement on dumps in final position in order to achieve the final landform design prior to final rehabilitation taking place;
  - Overburden placement in final position on dumps, construction areas and in constructing pit ramps; and
  - In-pit backfilling system where the aim is the fill the pit areas that has already been mined with discard that is sealed with overburden so as to reach natural ground level (NGL) so that the final cover, top soiling and revegetation of this are can commence and continue as with roll-over mining where final rehabilitation is done as one with mining; however, until the backfill reaches this level this is not possible:
    - The placement of interburden in the pit, thus eliminates contamination of greenfields / undisturbed areas;
    - The placement of plant discard in the pit is pro-active rehabilitation of the current pit; and
    - To date approximately 5 ha have been brought back up to 900 m above sea level (NGL).
- Designs and test / trial work has commenced on the old Dump 4 & 5, to determine a sustainable rehabilitation method;
- Extension of the cement slab of the salvage reclamation yard, with the commissioning of a new separator, on the site of an old laydown area for stores, thereby providing an impenetrable surface that will limit hydrocarbon contamination and the like;

- Construction and commissioning of the cyclic ponds, which displays a fundamental shift in the method of managing slimes;
- Limiting the disturbance of greenfields / undisturbed areas for new developments / mine extensions, e.g.:
  - Two previously disturbed areas cleaned and converted to new contractor's laydown areas; and
  - Utilisation of the slimes dam 3 footprint for the construction of the cyclic ponds.
- Covering / sealing of the open pit discard backfill with overburden and red-sand to limit the occurrence of spontaneous combustion.

Table 9: Grootegeluk mine size and rehabilitation status

Total area of the MRA (ha):	22,054 ha (Refer to Figure 2)
The total area disturbed by infrastructure and mining to date (ha):	3,800 ha
The area disturbed by mining (ha):	2,416.5 ha Calculation includes open pit (also stripped / cleared area, new disturbed areas around pit as at Dec 2018), dumps, slimes dams, cyclic ponds, stockpile areas

The area of mined land rehabilitated (ha):

There are currently no areas that can be seen as finally rehabilitated / areas where no more mining activities will take place.

Some areas have been remediated and filled, however these areas will in time be used as laydown / new construction areas.

Efforts towards readiness / preparation for final rehabilitation activities, although considered as mining / operational activities, include:

- Topsoil stripping (ahead of pit mined out area);
- Topsoil stockpiling;
- Topsoil placed in final position;
- Discard placement on dumps in final position, to achieve final landform design;
- Overburden removal;

	■ Overburden stockpiling; ■ Pit backfilling with overburden, interburden and discard to achieve original ground level; and ■ Overburden placement in final position on dumps, construction areas and in constructing pit ramps. The total volume of material movement within each of the above categories, as at December 2018, is provided in Table 10.
Future area (with current LOM plan) to be disturbed by mining (ha) etc.:	3,250 ha

Table 10: Rehabilitation statistics as at October 2019

Aspect	Volume (m^3)	Description
Topsoil stripping	6 605 001	Pit mined out area x 0.5 m thickness
Topsoil stockpiled	233 323	Topsoil dump north and south
Topsoil placed in final position	3 351 430	Where possible until final design elevation achieved with the backfilling of the pit
Discard placed in final position	359 864 259	Dump 4
Overburden removed (ex-pit)	100 244 994	B1A and B1B
Overburden stockpiled	85 254 745	Dumps 1, 2, 3, 5, 6, Tyre dump, Renoster dump, construction areas and pit ramp
Discard backfill in pit	224 184 845	Overburden, interburden and discard
Overburden placed in final position	232 984 730	Dumps 1, 2, 3, 5, 6, construction areas and pit ramp

12.0 PLANNED REHABILITATION

Rehabilitation-focused activities have been planned for infrastructure, mining areas (open pit backfill areas, dumps and slimes) and general surface rehabilitation according to the five steps / stages of the approach, as described in section 3.0: survey – analyse – design – evaluate – action. Each sub-section of this chapter includes:

- Current status;
- Rehabilitation performance objectives;
- Annual rehabilitation summary (aligned to GN R.1147 requirements); and
- Planned rehabilitation steps for the short term (2020) and medium term (2020 – 2024).

12.1 Infrastructure

With optimising operations and financial provisioning for closure, operationally defunct surface infrastructure should be removed, and disturbed footprint areas rehabilitated as far as possible.

The rehabilitation performance objectives for defunct / superfluous infrastructure are to ensure that:

- All defunct surface infrastructure, including buildings and access roads are removed and/or appropriately rehabilitated to allow for achievement of the desired end land use on these areas during operations and minimising financial provisioning for eventual closure;
- The mine site is clear of fugitive demolition waste, rubble, etc.;
- The rehabilitated sites are free draining and integrate with surrounding surface topography as far as possible; and
- Viable self-sustaining vegetation communities are established via appropriate ecosystem processes, productivity and services via natural succession.

Annual rehabilitation summary: infrastructure	
Planned remaining life of the activity:	Full LoM - >30 years, estimated at 50
Area (A) already / planned to be disturbed in period of review:	Full infrastructural area, [3]231.1 ha
Percentage of area (A) available for concurrent rehabilitation / remediation activities (B):	0%
Percentage of area (B) on which concurrent rehabilitation and remediation can be undertaken:	0%
Why total available or planned to be available area differs from area already disturbed or planned to be disturbed:	All infrastructure currently still in use / not considered defunct. Company and mine-wide studies and policies in this regard to be put in place
Why concurrent rehabilitation will not be undertaken on the full available or planned to be available area:	Not applicable

[3] Calculated infrastructure footprint area, including 10% contingency

Table 11: Infrastructure planned rehabilitation-focused activities

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
Defunct infrastructure	NA	No infrastructural areas currently available for inclusion in annual rehabilitation.	Design	■ Determine company-wide policy and engagement on the philosophy of "making good" and generating infrastructure inventories; ■ Compile and continually update the infrastructure inventory (Asset Register) to include new infrastructure, while identifying and assessing infrastructure considered defunct, potentially to be removed with footprint areas rehabilitated during operations (examine establishing a site-wide GIS database); ■ Integrate the above inventory planning with: ▪ End land use planning; ▪ Update of the site Waste Management Plan ▪ Development and design of a rehabilitation / closure plan for the general waste site on dump 6 is utilised for demolition waste; ▪ The mine's survey and mapping system; and ▪ The strategy and timing to be adopted with rehabilitation of slimes dam 1 & 2, specifically with respect to focus on the recovery of this facility as product. ■ Identify projects either to reinstate / restore infrastructure, thus making useful, aligned to mine infrastructural requirements, or to demolish and/or rehabilitated disturbed surface areas, aligning to the mine's end land use plan and stakeholder requirements, as required; ■ Obtain company (Exxaro) and mine (Grootegeluk) sign-off on demolition and rehabilitation projects; ■ Devise infrastructure-specific demolition and rehabilitation plans, including risk assessments and health and safety plan for demolition of buildings / structures, as well as appropriate disposal of hazardous waste; and ■ Confirm and obtain necessary legal authorisations for demolition of structures, as required.

12.2 Mining areas

12.2.1 Open pit backfill areas

The pit that has been mined since 1980 is well advanced and currently extends approximately 3.2 km east-west in the direction of development, with the mining front approximately 2.5 km wide. In order to expose sufficient pit floor for mining to proceed, mine residue produced was placed out of pit. A number of overburden dumps, as well as notable coarse discard and coal fine disposal facilities from coal beneficiation, have been created.

Current mining is carried out up to bench 12, which is typically at an average elevation of 110 m below natural ground level. This pit floor, at bench 12, slopes generally from west to east with the highest point at 824 meters above mean sea level (mamsl) in the central section. Two distinct low-lying areas are formed in the north and south section at 763 mamsl and 755 mamsl respectively (Jones & Wagener, 2011).

Advanced / pre-stripping of shallow topsoil for expansion of the pit takes place roughly 300 to 500 m ahead of the advancing high wall in a westerly direction. The stripped topsoil is stockpiled for later use as growth medium during mine rehabilitation, while overburden is used for on-site road building and off-site community projects.

The current mine site surface is situated on a localised watershed with a highpoint of 915 mamsl. Natural drainage occurs towards the north-west at a slope of 1:200 and south-east at a slope of 1:300.

Backfilling

The pit floor has been exposed for some time and the mine has developed and tested a method by which coal discard and interburden can be backfilled and sealed/isolated in compartments to prevent the discard and inter-burden from spontaneously combusting. Spontaneous combustion will be prevented by limiting oxygen ingress by a combination of the following (Jones & Wagener, 2011):

- Maintaining a sufficient advance rate of materials placement thereby limiting the time of exposure to the atmosphere; and
- Sealing the backfill in compartments at various intervals as backfilling takes place with available overburden material.

Large scale backfilling commenced in 2014 from the east of the pit towards the west, by means of a truck and shovel operation for the interburden and a two-tier stacking system for the coal discard. The mining operation will continue west up to the mining limits, thereafter the mining will continue back simultaneously along the north and south sections (Jones & Wagener, 2011).

The interburden material will be backfilled according to the Grootegeluk Standards in compartments to prevent spontaneous combustion. The discard material will be backfilled on top of the interburden material using two conveyor systems (face never sealed to form a compartment). The discards layouts consist of a pre-build berm, followed by side seal and top cover which must be placed in advance or within 8 weeks after discards have been placed (Jones & Wagener, 2011).

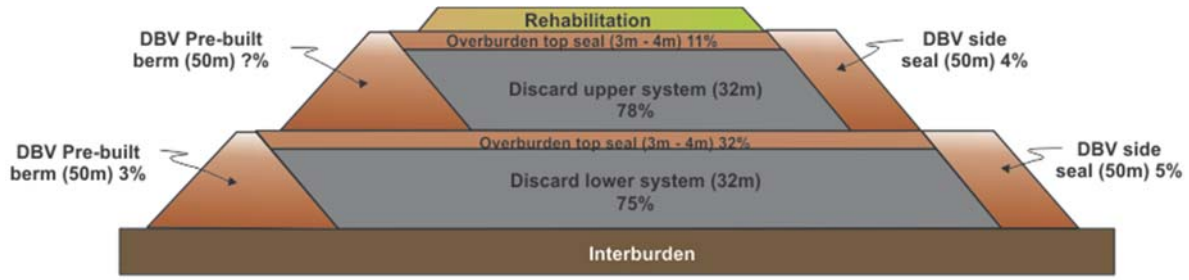


Figure 6: Backfill sealing compartments and layout (Jones & Wagener, 2011)

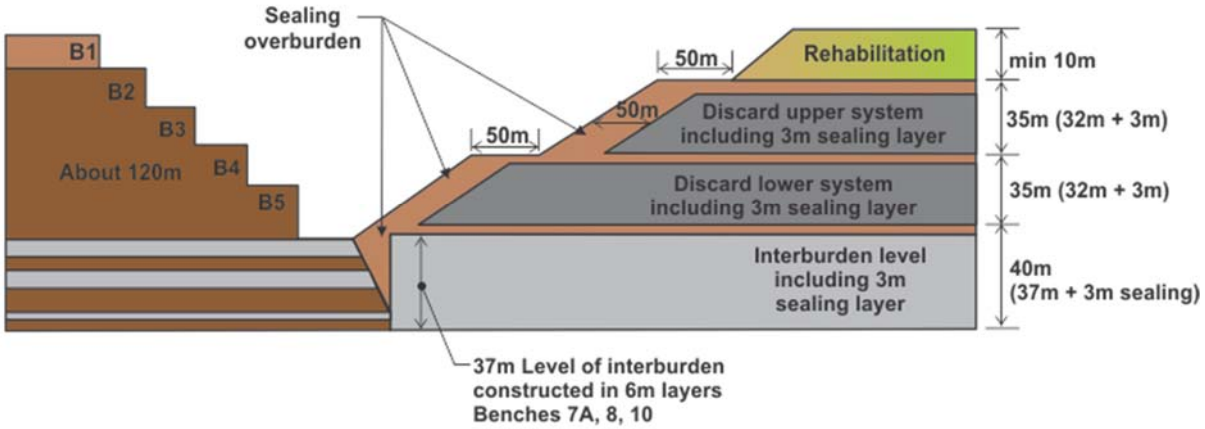


Figure 7: Backfill sealing compartments (north-south section) (Jones & Wagener, 2011)

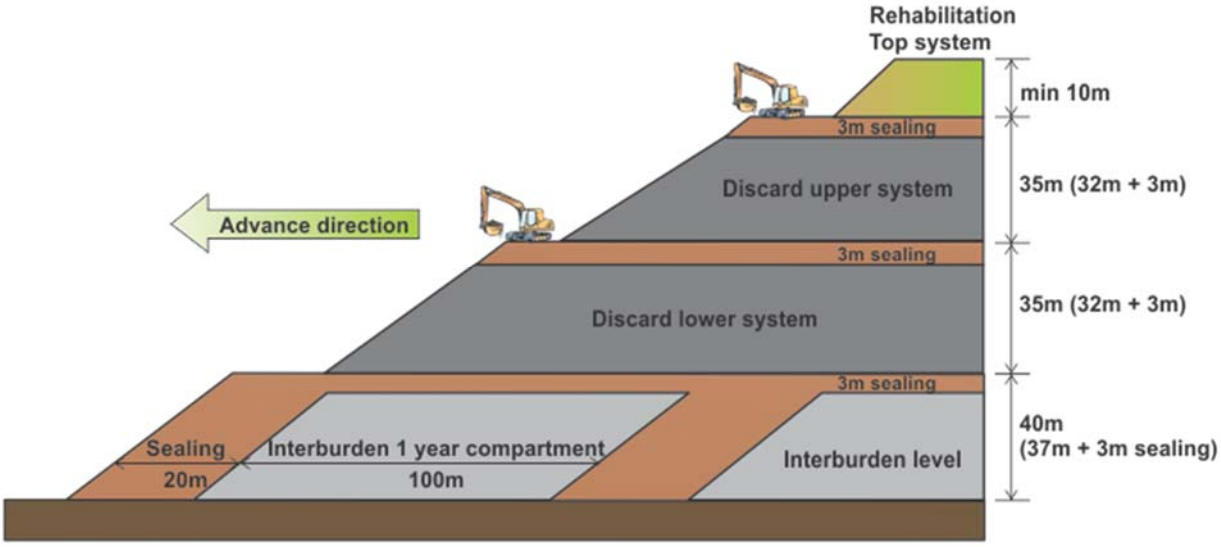


Figure 8: Backfill sealing compartments (east-west section) (Jones & Wagener, 2011)

The current mine plan allows for the development of two final voids, a smaller (100 ha) northern one and an extensive (1010 ha) southern one.

The performance objectives for the rehabilitation of the backfilled open pit are to:

- Start with the process of creating a final rehabilitated landform that:
  - Is safe and physically stable in the long term;
  - Facilitates drainage, by diverting clean-run-off around the area to reduce the probability of infiltration into the rehabilitated areas with subsequent ponding. In addition, these measures also form part of the dirty/clean water separation during operations; and
  - Emulates the surroundings topography, landscape character and natural vegetation cover, as far as possible.
- Limit water infiltration, and thus the operational and post closure pit water make; and
- Establish long term ecological stability and biodiversity on the rehabilitated surface area.

Annual rehabilitation summary: open pit	
Planned remaining life of the activity:	Full LoM, continuous open pit mining, refer to current 10-year and 30-year mine plan and the remaining extent of the coal reserve that makes out the 50-year reserve.
Area (A) already / planned to be disturbed in period of review:	1,097 ha
Percentage of area (A) available for concurrent rehabilitation / remediation activities (B):	0% of surface area available for final rehabilitation to achieve post closure land use; however, pit backfilling with overburden, interburden and discard to achieve original ground level to enable final rehabilitation of the open pit area will continue. It is anticipated that a volume of approximately 20.4 million tonnes will be placed during 2020[4].
Percentage of area (B) on which concurrent rehabilitation and remediation can be undertaken:	0%; refer to comment above
Why total available or planned to be available area differs from area already disturbed or planned to be disturbed:	Due to the extent of the Grootegeluk mining operation, pit backfilling, as described above, has not yet progressed to a stage where the top system rehabilitation can commence

[4] Sourced from GG backfill figures – 2020 budget (Exxaro – Grootegeluk)

	It is anticipated that top system rehabilitation will potentially only start up towards 2021
Why concurrent rehabilitation will not be undertaken on the full available or planned to be available area:	Refer to comment above

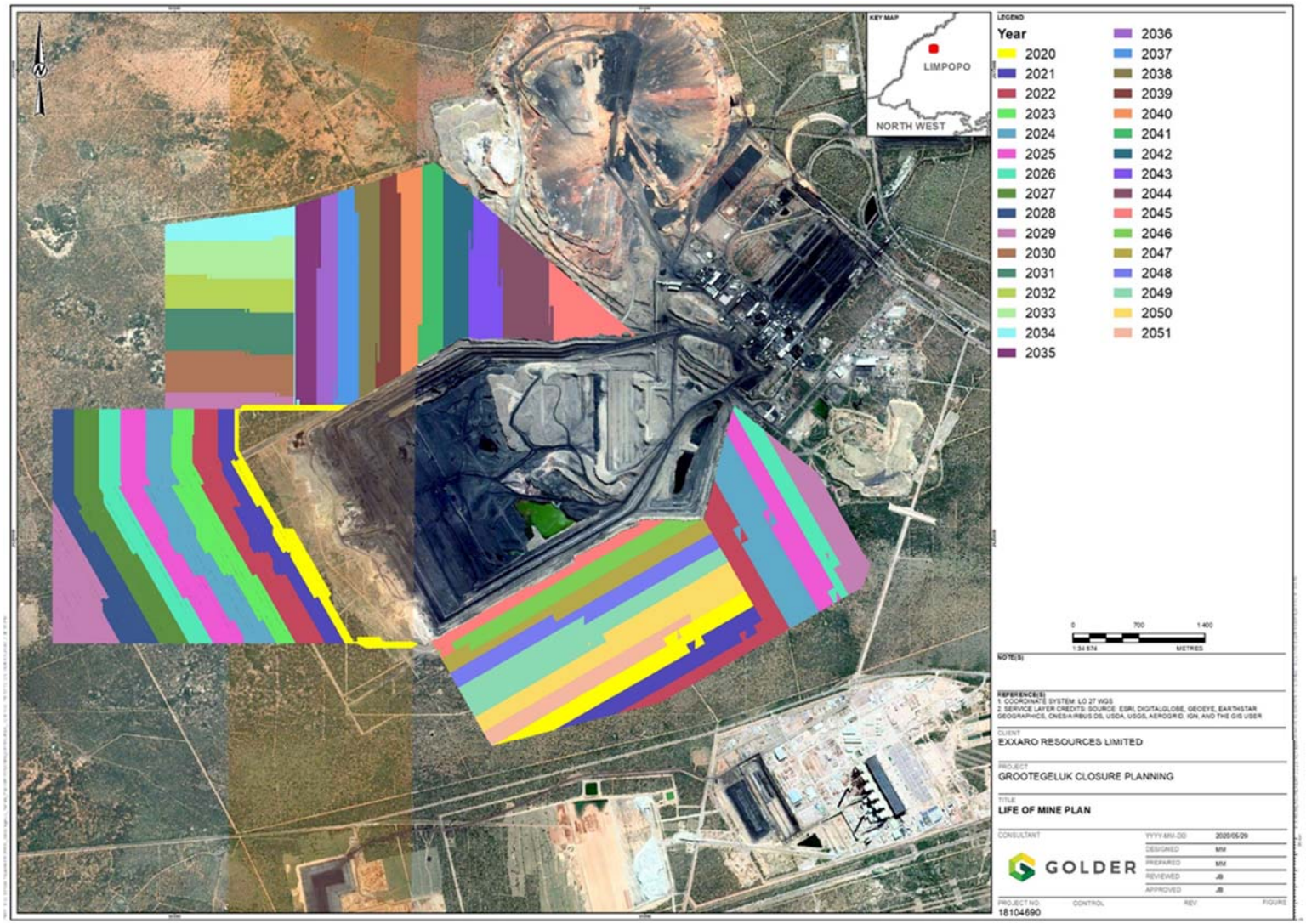


Figure 9: Grootegeluk LoM plan

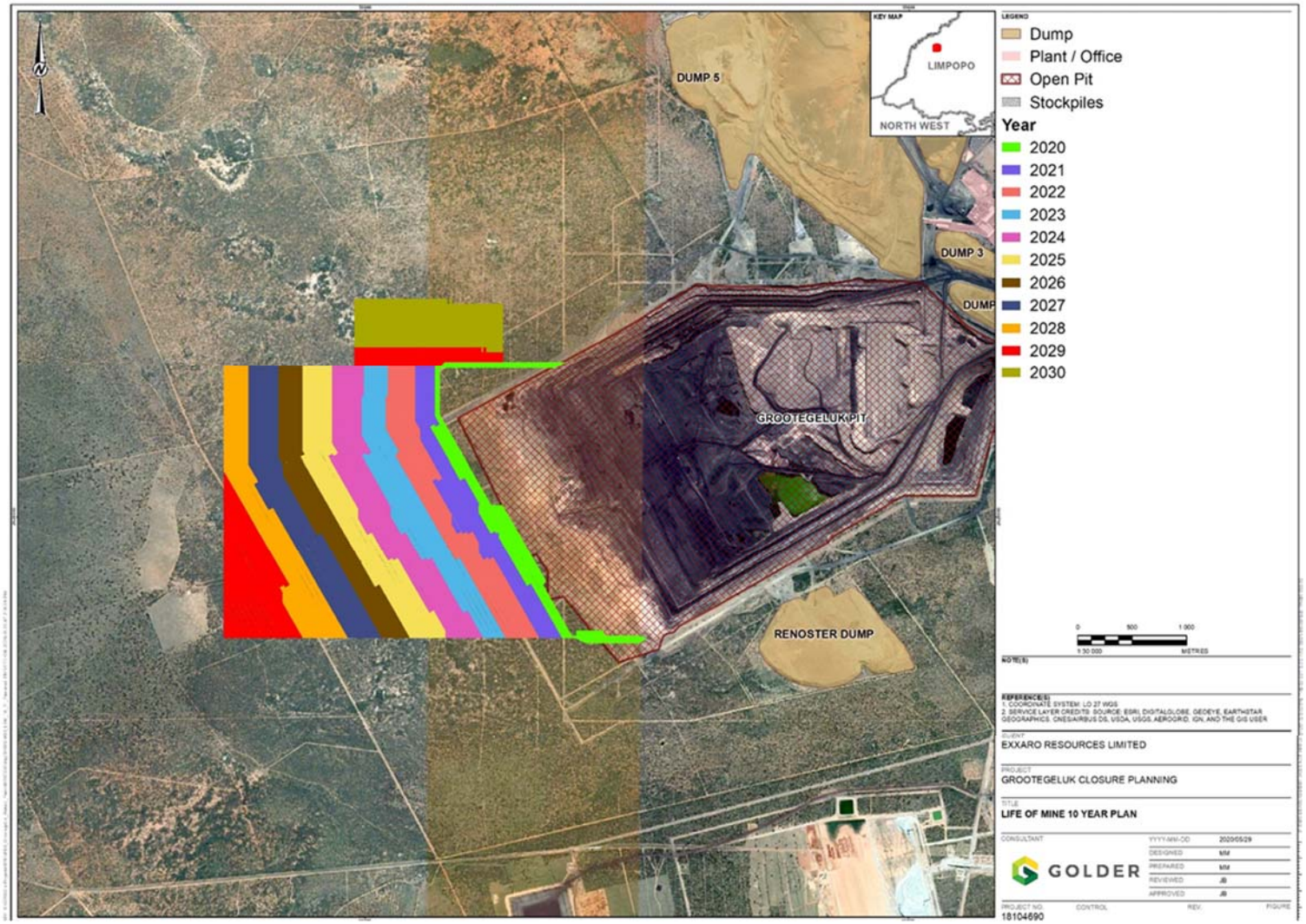


Figure 10: Grootegeluk next 10-year mine plan

Table 12: Open pit planned rehabilitation-focused activities

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
Backfilled landform	Action (normal operations)	■ Continue with efforts towards readiness / preparation for final rehabilitation activities, even though considered as mining / operational activities, including: ▪ Topsoil stripping (ahead of pit mined out area); ▪ Topsoil stockpiling; ▪ Overburden removal; ▪ Overburden stockpiling; ▪ Pit backfilling with overburden, interburden and discard to achieve original ground level; and ▪ Overburden placement in final position (pit ramps). ■ Cover backfilled discard with overburden, as necessary and according to placement timeframes, to curb the occurrence of spontaneous combustion.	Action (normal operations)	■ Continue with efforts towards readiness / preparation for final rehabilitation activities, even though considered as mining / operational activities, including: ▪ Topsoil stripping (ahead of pit mined out area); ▪ Topsoil stockpiling; ▪ Overburden removal; ▪ Overburden stockpiling; ▪ Pit backfilling with overburden, interburden and discard to achieve original ground level; and ▪ Overburden placement in final position (pit ramps). ■ Cover backfilled discard with overburden, as necessary and according to placement timeframes, to curb the occurrence of spontaneous combustion.
Surface profile and capping (rehabilitation top system)	Design	Nothing planned for 2020.	Design	■ Commence with: ▪ The process of obtaining clarity on the desired final profile of the in-filled portions of the pit. If the pit upper surface is to be paddocked and runoff will remain on the pit, a less material-demanding and cost “friendly” final dished surface can be created. Alternatively, if runoff under extreme events is required, then the “wavy” final surface

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
				following the overall drainage gradient could be more appropriate; ▪ The compilation of an initial (Phase 1) detailed surface profiling / landform design of the backfilled open pit[5] to ensure that the landform to be developed will be free draining (refer to conceptual measures devised in this regard – APPENDIX C); ▪ The planning associated to the rehabilitation top system, including: – Capping material, including sourcing and associated materials balance; – Soil amelioration; and – Vegetation establishment. ■ Commence with detailed post-mining landform for the pit rehabilitation, taking account of the levels achieved with the pit backfilling project, the probability of subsidence, available materials, and aligned/integrated with the mine's stormwater management planning, to ensure that progressive rehabilitation of the open pit is conducted in a manner that will achieve the desired outcomes, limiting subsequent excessive corrective action;

[5] *Due to two final voids remaining at closure, it can be assumed that the final backfilled landform is to be developed to natural ground level (NGL), incorporating a 10m top rehabilitation capping system, as illustrated in Figure 6 to Figure 8.*

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
				■ Undertake a defensible material balance, taking cognisance of the rehabilitation methodology proposed for the discard and overburden dumps. The final composition of the growth medium will depend on final available volumes and qualities of media. It may be necessary to construct the deep growth medium with a mixture of clean overburden and red sand; ■ Investigate the following in more details in terms of the above materials balance to be undertaken: ▪ Confirm the volumes of red sand and other potential suitable material based on the current understanding of the distribution by undertaking a site-wide soil survey addressing both the re-vegetation as well as the hydraulic conductivity properties of the available soils. This work has to build on the soils related work already conducted, while including dump 6, Renoster dump and Tyre dump as potentially sources of material; ▪ Confirm the preliminary store and release capacity of the maximum and minimum capping system needs by undertaking a detailed unsaturated flow model in combination with field trials. Focus should be on the minimum cap; and ▪ Determine innovative ways of using the different materials that will be produced during the operations. ■ Ensure that the rehabilitation of the backfilled open pit is continually aligned and integrated with: ▪ Current mine planning; ▪ Backfill project;

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
				▪ Changing materials balance; and ▪ Operational and post closure stormwater and drainage designs/systems. ■ Determine what approval(s) from the relevant statutory departments is/are required for the above open pit rehabilitation methodology, particularly with reference to obtaining agreement on the percentage of recharge to the rehabilitated area, and the associated in pit water make-up operationally and post closure.
Wetland / pan reinstatement	Refer to 12.3 – General surface rehabilitation.			

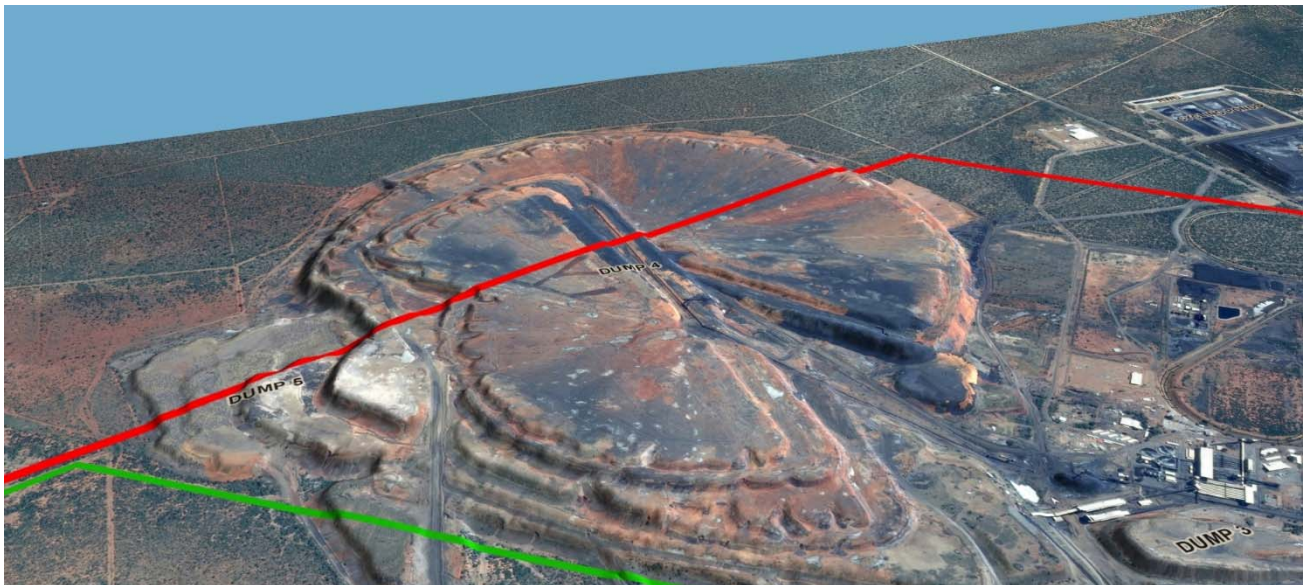
12.2.2 Dumps

Dump 4 & 5

Dump 4 (discard) & 5 (discard and overburden) is located north of the open pit and is characterised as follows:

- A remnant unfilled wedge with a double conveyor line leading to two benches, i.e. the lower 1300 system and the upper 1400 system (combined height of 82 m);
- Outer slopes generally at the angle of repose (34 degrees);
- Spontaneous combustion occurring on the outer slope lip of both benches (overburden, interburden, as well as Kalahari sands and overburden are dumped on top of the dump to seal it off from air ingress in order to reduce the occurrence of spontaneous combustion);
- Significant explosion and erosion scars visible on outer slopes due to spontaneous combustion;
- Constructed with limited compaction from the reclaimers and equipment used to seal each layer placed;
- Earth bund walls are constructed alongside all the gravel roads and on the edges of the upper surface areas of these dumps as a safety measure and also as a means of controlling storm water; and
- Overburden dump 5 is situated directly adjacent and to the west of discard dump 4. This overburden dump has been “polluted” with discard and displays areas of burning.

The lower system was completed in 2015, with the upper system nearing completion (planned for 2019 / 2020).



Dump 6

Dump 6, with an extent of 89.5 ha and a current height of 35 m, is situated to the south of the open pit and the surface infrastructural area. This material was stockpiled during the initial box cut of the Grootegeluk Pit in the early 1980s. With construction no formal compaction of the dump was carried out, except that which was done by the trucks as the material was placed. An earth wall was constructed around the top edge of the dump to prevent erosion by storm water running down the slopes. This dump displays areas of spontaneous combustion, while hosting an authorised general waste site on the upper surface. Some areas of the dump do not display good vegetation coverage, as indicated on the figures below.

Although largely considered an interburden dump, a waste assessment is currently underway to determine the exact nature and classification of the full dump contents. The results of the material characterisation will inform the rehabilitation and / or utilisation options for Dump 6 which are to be considered as part of a site-wide feasibility study.

Due to the above studies that are underway to inform the way forward with respect to rehabilitation and / or utilisation of the dump material, Dump 6 has been excluded from this rehabilitation plan. As the studies become available, the outcomes will be integrated into short- and medium-term planning, as relevant.

Dump 1, 2 & 3

Dumps 1 & 2 (overburden), with an extent of 17.4 ha and height of 41 m is situated east of the open pit directly adjacent to the northern ramp, while dump 3 (mostly overburden with interburden capping), with an extent of 17 ha and height of 41 m is situated north-east of the open pit directly adjacent to the northern ramp.

These dumps are not currently available for rehabilitation as they are used as a base for some of the mine's infrastructure, including:

- Lookout area;
- Tipping bins for process plants; and
- Various haul roads leading in and out of the pit have been constructed on these dumps, as part of the mining haul road system.

Renoster dump

The Renoster dump (primarily overburden), with an extent of 88 ha and height of 22 m is situated to the south of the open pit. With construction no formal compaction was applied to the side slopes, but some compaction has occurred on the surface due to earth moving equipment traversing the surface. The material in the dump has been partially recovered for use by Eskom in the expansion of the Medupi Power Station. An earth wall was constructed on the top edge to prevent water from running down the side slopes and causing erosion.

This dump is not currently available for rehabilitation due to its location within an area to be mined in future. Removal of the material, with likely in-pit disposal, will be aligned to mine planning.

Tyre dump

The semi-rehabilitated tyre dump (overburden and interburden), with an extent of 16 ha and height of 13 m, is situated between dump 6 and the open pit. With construction no formal compaction was applied on the side slopes, but the top surface has been compacted by the earth moving equipment transporting the material onto it. The overburden deposition was historically used to limit spontaneous combustion; however, some isolated patches of spontaneous combustion are evident on the dump. An earth wall was constructed on the top edge to prevent water from running down the side slopes and causing erosion.

As per the Renoster dump, the Tyre dump is not currently available for rehabilitation due to its location within an area to be mined in future. Removal of the material, with likely in-pit disposal, will be aligned to mine planning.

The objectives for the rehabilitation of dumps are to ensure that:

- Materials movement is optimised to conduct dump re-configuration as economically as possible;
- The dump's final landform is safe and physically stable in the long term, while blending in with the surrounding landscape, as far as possible, to be aesthetically acceptable;
- The dump's outer and upper surfaces are free-draining, and that infiltration and ponding is negated;
- The potential for and continued spontaneous combustion is curbed;
- The dump does not pose an unacceptable contamination potential to local soils, surface water, groundwater or air quality;
- Rehabilitated slopes will preserve vital resources such as growth medium and nutrients are established, as far as possible, and that appropriate temporary stabilisation is implemented stabilise to prevent erosion in the short- to medium-term until a suitable vegetation cover has established;
- Develop a cover that is stable, aesthetically pleasing, provides a suitable land capability and fulfils the requirements of DWS;
- Appropriate and sustained vegetation growth is established, that allows for functioning of the placed cover, while being aesthetically acceptable and aligned to the desired end land use and surrounding natural landscape character, enhancing biodiversity and natural vegetation cover;
- Drainage lines are connected with site-wide drainage; and
- The final end land-use of the rehabilitated and closed dump is "maximised".

Annual rehabilitation summary: Dump 4 & 5	
Planned remaining life of the activity:	End 2020
Area (A) already / planned to be disturbed in period of review:	731 ha (current dump footprint)
Percentage of area (A) available for concurrent rehabilitation / remediation activities (B):	75% (approximately 548.25 ha)
Percentage of area (B) on which concurrent rehabilitation and remediation can be undertaken:	10% (approximately 54.8 ha)
Why total available or planned to be available area differs from area already disturbed or planned to be disturbed:	Discard placement on upper system is still underway

Why concurrent rehabilitation will not be undertaken on the full available or planned to be available area:	The initiation of rehabilitation work on Dump 4&5 is constrained by hot spots / areas of burning, influencing where and how to begin. Furthermore, prior to commencing with full rehabilitation, the work methodology to implement the rehabilitation design needs to be tested via appropriate trials to ensure effectivity, practicality and safety

Table 13: Dumps planned rehabilitation-focused activities

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
Dump 4 & 5	Action	■ Approval of the proposed Rehabilitation Methodology as paart of the Grootegeluk Rehabilitation BAR and WL application process that started in October 2019; and ■ Continue with efforts towards readiness / preparation for final rehabilitation activities, although considered as mining / operational activities, including overburden and discard placement on dumps in final position, to achieve final landform design.	Action	■ Continue with efforts towards readiness / preparation for final rehabilitation activities, although considered as mining / operational activities, including overburden and discard placement on dumps in final position, to achieve final landform design.
	Design	■ Commence with the formulation / design of a phased implementation strategy to undertake dump rehabilitation over a 10-year period, once authorization is approved.	Design	■ Compile a standard operational procedure (SOP) for the rehabilitation program based on the approved methodology; ■ Update rehabilitation design and work methodology, as required, as per findings / learnings of the rehabilitation trials; ■ Obtain authorisation for the rehabilitation of this facility (water license and environmental authorisation); and ■ Update the phased implementation strategy.
	Action	■ Rehabilitation trail that was conducted in 2019 proved that the proposed methodology is sound in respect to: ▪ Practicality; ▪ Stability;	Action	■ Commence with implementation of the phased implementation strategy to put the final dump rehabilitation plan into effect.

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
		▪ Effects on and of burning / spontaneous combustion; and ▪ Health and safety. ■ 2020 the establishment of natural regrowth from the 700m cover placed on the trial areas will be assessed to determine if any further steps will be required – refer to APPENDIX C for the method statements related to vegetation establishment.		

12.2.3 Slimes

12.2.3.1 Slimes dam 1 & 2

The existing slimes dam (1 & 2), with an extent of approximately 56 ha and current height of 38 m, reaching its final height is situated north-east of the infrastructure. This slimes dam has the following physical characteristics:

- 1:3 / 1:4 day-walling outer slopes;
- Obvious outer slope erosion setting in;
- Heavily saturated, with a tendency to become unstable if deposition of slimes and the operation of the penstock is not closely monitored and controlled to ensure the required free-board. The most recent professional engineering report indicated that the facility is stable and well operated;
- A penstock system with beach and penstock pool; and
- Limited toe protection with a very shallow perimeter collection drain.

Currently dam 1 & 2 is still operational and the intent is to remine it in future; however, studies relating to how this will be achieved still need to be conducted. If remining does not prove feasible, the facility will be capped / recovered.

12.2.3.2 Other / historic slimes dams

Slimes previously deposited into slimes dam 4 have been completely recovered (the fine dry coal recovered from the slimes dam was trucked to the existing stockpile areas near the beneficiation plant where it was mixed in with the Eskom product, before being fed to the Eskom stockpiles via the conveyor system).

Slimes from historic dam 3 have been completely recovered, with the footprint of this facility now covered by the Cyclic Ponds facility.

Slimes dam 5 is no longer in used, deposition on this dam ceased in the 1980s and reclamation started at the same time as on dam 3. The footprint of the dam is 13 ha. Dam 5's footprint will either be removed and rehabilitated or removed and lined for future use so as not to disturb greenfields areas for future expansions / developments (e.g. conventional slimes dam facility for super fines). In the interim it is being used for placing of material from the cyclic ponds until it can be taken back to the plant and added to the Eskom product.

Within the above context, none of the other / historic slimes dams will require rehabilitation during the foreseeable future and have thus been excluded from this round of rehabilitation planning.

12.2.3.3 Cyclic ponds

To increase the efficiency of the reclamation process, a cyclic pond system was constructed and commissioned in 2015, consisting of four parallel compartments on the footprint of the existing slimes dam 3.

The cyclic ponds will remain fully operational for the foreseeable future with no obvious rehabilitation currently required.

The performance objectives for the rehabilitation of the slimes dam are to ensure that:

- The dam's final landform is safe and physically stable in the long term, while blending in with the surrounding landscape, as far as possible, to be aesthetically acceptable;
- The outer and upper surfaces are free-draining, and that infiltration and ponding is negated;
- The facility does not pose an unacceptable contamination potential to local soils, surface water, groundwater or air quality;
- Rehabilitated/created slopes will preserve vital resources such as growth medium and nutrients are established, as far as possible, and that appropriate temporary stabilisation is implemented stabilise to prevent erosion in the short- to medium-term until a suitable vegetation cover has established; and
- Appropriate and sustained vegetation growth is established to be aesthetically acceptable and aligned to the desired end land use and surrounding natural landscape character.

Annual rehabilitation summary: slimes dams 1 & 2	
Planned remaining life of the activity:	Once it reaches capacity, date uncertain
Area (A) already / planned to be disturbed in period of review:	56 ha
Percentage of area (A) available for concurrent rehabilitation / remediation activities (B):	0%
Percentage of area (B) on which concurrent rehabilitation and remediation can be undertaken:	0%
Why total available or planned to be available area differs from area already disturbed or planned to be disturbed:	Not yet at capacity, decision to be made with respect to remining or rehabilitating
Why concurrent rehabilitation will not be undertaken on the full available or planned to be available area:	Not applicable

Annual rehabilitation summary: cyclic ponds	
Planned remaining life of the activity:	LoM
Area (A) already / planned to be disturbed in period of review:	37.2 ha

Percentage of area (A) available for concurrent rehabilitation / remediation activities (B):	0%
Percentage of area (B) on which concurrent rehabilitation and remediation can be undertaken:	0%
Why total available or planned to be available area differs from area already disturbed or planned to be disturbed:	Upper surface operational Design (approach and methodology) to be put in place for side slopes
Why concurrent rehabilitation will not be undertaken on the full available or planned to be available area:	Not applicable

Table 14: Slimes planned rehabilitation-focused activities

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
Slimes dam 1 & 2	Analyse	■ Commence with investigations on alternative uses for slimes.	Analyse	■ Continue with investigations on alternative uses or remining / reclamation of the slimes once it reaches its full capacity.
Cyclic ponds	Design	■ Determine an approach and methodology to improve the cover and vegetate the slopes of the cyclic ponds that were hydroseeded after construction was completed.	Action	■ Implement the approach / methodology to improve the cover and vegetate the slopes of the cyclic ponds, as per findings of 2020 work.

12.3 General surface rehabilitation

The aspects/components of general surface rehabilitation to be addressed include:

- Contaminated land management;
- Soil management;
- Vegetation establishment; and
- Invasive species management.

The rehabilitation objectives for general surface rehabilitation are to ensure that:

- The threshold levels of salts, metals and other potential contaminants over the rehabilitated site are acceptable and that no possible surface and/or groundwater contaminant sources remain on the rehabilitated sites that could pose health and safety threats;
- The possible loss of topsoil and sub-soils is limited, with the application of the available materials to key pre-determined rehabilitation areas;
- Rehabilitated areas are safe and physically stable, integrating with surrounding topography and landscape character as far as possible, and free-draining (unless area-specific not required);
- Suitable growth medium of sufficient depths, with appropriate amelioration and prepared to sustain microbial activity are re-created, that will subsequently sustain vegetation growth;
- Appropriate vegetation species to allow for development of viable self-sustaining vegetation communities (keystone pioneer vegetation species), and thus the preparation of ecosystem processes, productivity and services via natural succession;
- Exxaro is enabled to attain the functional offset target for pans / wetlands lost due to mining operations; and
- Ensuring that the impacts associated with the proposed mining activities are appropriately addressed via augmenting the level of functioning of the pans within the landscape.

Table 15: General surface rehabilitation planned rehabilitation-focused activities

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
Soil resource management	Survey Analyse	■ Development and formalization of the soil stripping schedule that considers the material required for the rehabilitation of Dump 4 & 5 and future areas; and ■ Update the site-wide materials balance study to further inform balancing and prioritisation of materials required for site wide rehabilitation actions / projects.	Action	■ Informed by the materials balance and associated use prioritisation, undertake planned soil stripping, stockpiling and replacement, along with required amelioration / improving fertility; and ■ Formulate a plan to source and utilise woody debris as a valuable rehabilitation material[6]. Refer to APPENDIX C for the topsoil stripping and replacement procedure compiled by Rehab Green. Although this procedure was focused at the Dump 4 & 5 rehabilitation, it is relevant to site-wide soil management and rehabilitation practices.
	Action (operational)	■ Continue with current practice of stripping topsoil ahead of mining.		
Organic material	-	Nothing planned for 2020.	Action	■ Due to the difficulty in obtaining large quantities of organic material, initiate a composting project aligned to concurrent rehabilitation. Sources of organic material that can be considered include: ▪ All vegetation that is cleared for new mining (trees can be chipped); ▪ Organic waste from residential areas (larger growing towns like Lephalale, i.e. domestic and garden waste); and ▪ Sewage bio-solids, etc.

[6] Creation of microsites which increase germination and emergence of in situ propagules and seeds; Creation of localised changes in soil moisture; Creation of habitat for small animals and soil fauna; Addition of organic matter and release of nutrients to soil via vegetation decay; Erosion control.

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
Vegetation selection and sourcing	-	Nothing planned for 2020.	Design	■ Select specific vegetation to align to key rehabilitation/closure measures and as informed by site-specific conditions (refer to proposed species list in APPENDIX C); ■ Investigate how to effectively harvest or acquire other indigenous species that occur locally and include in the planting / vegetating mixes, as guided by a rehabilitation specialist ecologist; ■ Investigate the feasibility of transplanting small specimen trees and shrubs prior to mining to areas available for rehabilitation / within nursery (as per below investigation); and ■ Investigate the establishment of an *in-situ* nursery to cultivate woody species vegetatively. This method provides an easy means of establishing semi-mature plants in a short space of time. Whole trees/shrubs of a few species transplant easily, and the nursery can serve as a suitable holding facility for large numbers of such species.
Vegetation establishment	-	Nothing planned for 2020.	Action, as applicable	■ Establish vegetation on available areas (refer to APPENDIX C for the proposed sequence of rehabilitation procedures for information pertaining to vegetation establishment ((Boscia, 2018). Although this procedure was focused at the Dump 4 & 5 rehabilitation, it is considered relevant to site-wide rehabilitation practices).
Wetland reinstatement	Survey Analyse Design	■ WUL 07/A42J/CICI/6418 was approved 18 Oct 2019.	Action	■ Start with the implementation and roll-out of the wetland offset plan, wetland rehabilitation activities, management and monitoring programme.

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
		■ Finalize the phase 2 wetland reinstatement study: *detailed wetland offset plan, wetland rehabilitation activities, management and monitoring programme*, including: ▪ Utilise the offset targets, as described in the GroundTruth assessment (GroundTruth, 2018a), as the basis from which this study will be undertaken, i.e.: – Wetland functionality target: 5.6 ha; – Ecosystem conservation target: 1.2 ha; and – Species of conservation concern target: not applicable as no species of special concern were identified. ▪ Include specific pans within the Manketti biosphere, which have been identified as preliminary candidate wetlands to address the offset targets, as the basis for this study, along with the proposed creation of pans to the south and east of the Grootegeluk LOM.		
	Design	■ Finalize the design of the planed trials for proof of concept: translocation / creation of pans in the short term, as aligned to the findings / amendments to the concept	Action	■ Continue with the planned trials and monitor their success rate over time (anticipated to commence in 2020 – into 2023). *NOTE: the creation of these pans on backfilled areas will only be implemented if it is proven not to negatively impact on the integrity*

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
		design from the phase 2 wetland reinstatement study. It is anticipated that the following components would be required to translocate/create pans within the identified areas: ▪ A suitably excavated area at the proposed location of pan; and ▪ Harvested wetland material from the LOM area, separating the materials into the necessary layers (invertebrate, topsoil and subsoil). ■ Start with the implementation of the planned trails towards the 3rd Quarter of 2020.		*of the planned rehabilitation cover. The development of a "proof of concept" is thus very important.*
			Design	■ Continuation and monitoring of the trails for proof of concept; and ■ Update concept designs to final designs based on findings of trials.
Invasive species management	Design	■ Compile a site-specific invasive species eradication programme to remove invader species such as *Pennisetum setaceum* (Category I invader), *Nicotiana glauca, Solanum spp and Melia azedarach* from the dumps and disturbed areas. According to legislation any category 1 invader must be eradicated. This will reduce the competition between species and improve chances for desired vegetation establishment;	Action	■ Commence with implementation of the eradication programme as soon as possible. This will reduce the negative impact, both in extent and severity, on the eventual establishment of vegetation.

Aspect	Short term: ANNUAL – January to December 2020		Medium term: 5-YEAR – January 2020 to December 2024	
	Category	Activity	Category	Activity
		■ Include recommendations on application of one or or a combination of the following basic methods of control, according to species of concern: ▪ Physical (mechanical) consisting of – – Uprooting (hand pulling); – Cutting back; – Hand pulling, chopping, slashing and felling; and – Ring-barking (girdling). ▪ Chemical, by means of herbicides as follows: – Foliar application; – Stem notching and application; – Stump treatment; and – Soil treatment. ■ Biological, which involves the use of host-specific natural enemies of weeds or invaders from the plant's country of origin, to either kill or remove the invasive potential of these plants.		

13.0 COST OF ANNUAL REHABILITATION

The cost of annual rehabilitation for the respective rehabilitation components is set out below. It is noted that some of the costs were already determined and were adopted from other specialist reports / quotations.

13.1 Methodology

The closure cost determination was conducted with the aid of spreadsheets configured / set-up to align to the requirements of GN R.1147. Each category of the planned rehabilitation, as per section 12.0 of this report, is represented in the costing spreadsheets within the following categories:

- Infrastructure aspects;
- Mining aspects;
- General surface rehabilitation;
- Water management;
- Additional allowances; and
- Monitoring and aftercare.

Two sets of costs were determined, one for the annual rehabilitation to be conducted (January 2020 to December 2020), and the second for the five-year rolling rehabilitation costs covering the period January 2020 to December 2024.

13.2 Unit rates

The unit rates for general rehabilitation and closure measures and activities were obtained from Golder's existing database that has been compiled in consultation with demolition and earthworks contractors, as well as with rehabilitation practitioners. Golder undertakes a thorough review of its unit rate database twice per annum, as follows:

- Minor unit rates are adjusted with standard inflation with confirmation at least twice a year;
- Key rates for the dismantling of infrastructure are benchmarked by a specialised demolition contractor, to ensure that it remains market-related and take account of the latest dismantling and demolition techniques. It is noted that as these technologies improve, these rates in real terms are trending downwards;
- Earthworks rates are benchmarked against recent tenders available to Golder as well as benchmarking in discussion with earthwork contractors; and
- Aggregated rates dependent on base infrastructure or earthworks related rates are recalculated given

"additional allowances" section of the cost estimate), with actions limited to planned backfill operations of the open pit;

- The 5-year rehabilitation plan includes a number of anticipated "actions", with estimates on work to be conducted derived from percentage-based estimates from the existing unscheduled closure cost estimate for Grootegeluk and budgets associated to planned backfill operations;
- A number of costs have been excluded due to these assumed to be allocated to Grootegeluk's mining / operational budget; and
- The allowances adopted for P&Gs is in the order of 12% and for Contingencies is 10%, aligned to the overall closure cost determination for Grootegeluk.

13.4 Annual and five-year rehabilitation costs

A summary of the annual and five-year rehabilitation costs is presented in Table 16. The costs have been determined as at December 2019.

Table 16: Annual and five-year rehabilitation costs

Rehabilitation Components		Annual Rehabilitation Plan (Jan - Dec 2020)	5-Year Rehabilitation Plan (Jan 2020 - Dec 2024)
1 to 4	**Demolition and rehabilitation costs**		
1	Infrastructural aspects	R 0	R 0
2	Mining aspects	R 151 217 754	R 1 162 021 370
3	General surface rehabilitation	R 800 000	R 54 946 967
4	Water management	R 0	R 0
	Sub-Total 1	**R 152 017 754**	**R 1 166 968 337**
5	**Additional allowances**		
5.1	Preliminaries and general	R 0	R 593 636
5.2	Contingencies	R 0	R 494 697
5.3	Additional studies	R 250 000	R 2 350 000
5.4	Socio-economic mitigation measures	R 0	R 0
	Sub-Total 2	**R 250 000**	**R 3 438 333**
6	**Monitoring and Aftercare**		
6.1	Monitoring	R 0	R 273 435
6.2	Care and maintenance	R 0	R 3 932 964
		R 0	**R 4 206 399**
	Grand Total Excl. VAT. (Sub-total 1 +2 + 3)	**R 152 267 754**	**R 1 174 613 068**

14.0 REHABILITATION PERFORMANCE MONITORING AND CORRECTIVE ACTION

Monitoring is vital during the operational period, not only to identify potential risks requiring remediation but to also provide a baseline for monitoring post closure.

Without managing and monitoring driven on a system where responsible persons sign off key performance tasks, the procedures will fail, resulting in failure of proper functioning of the rehabilitation actions (Rehab Green, 2018).

14.1 Demonstration period

It is envisaged that a five-year demonstration period will be required to confirm success of rehabilitation, however at present allowance was made to conduct rehabilitation monitoring and aftercare over the operationally rehabilitated areas for a 10-year period. Following the completion of earthworks and vegetation establishment a visual inspection will be undertaken to inform corrective action required, if needed. Thereafter ongoing monitoring and corrective action as per Table 17, will be undertaken.

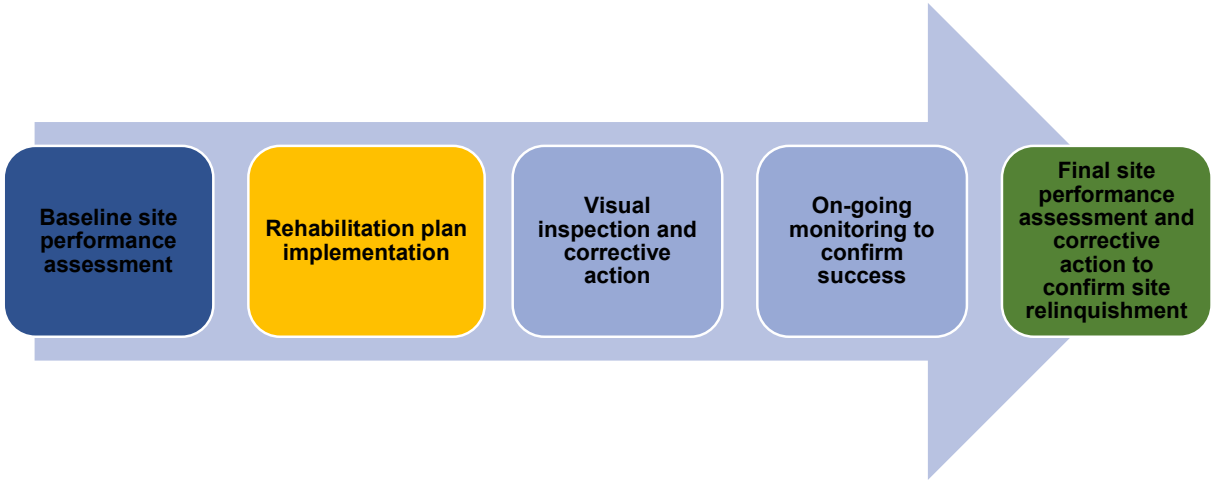


Figure 12: Rehabilitation plan roll out and performance monitoring

14.2 Baseline environmental site performance assessment

A baseline site performance assessment (largely based on existing information and supplemented by a dedicated site walkover) must be conducted prior to rehabilitation implementation. The aim of the environmental site performance assessment is to establish the *status quo*/baseline and knowledge base against which results of monitoring conducted after rehabilitation will be measured.

14.3 Monitoring and corrective action

The rehabilitation performance / progress will be documented in a dedicated annual rehabilitation performance report to be submitted to the relevant Authority until the set criteria are met. The report should reflect on the outcomes of monitoring undertaken, rehabilitation performance and corrective action required. The monitoring objectives, network, sampling routine and analysis methodology is provided in Table 17.

14.4 Final site performance assessment

Following completion of rehabilitation and/or the demonstration period of three (3) years a final performance assessment should be undertaken to document the success of rehabilitation and the corrective action undertaken. The final site performance assessment will be used to document the success of rehabilitation for record keeping.

14.5 Monitoring objectives

The broad objectives for monitoring are to:

- Determine whether the rehabilitation measures implemented during operations successful, require improvement / amendment, and whether they will be suitable to apply at closure;
- Identify and guide further intervention measures as required;
- Gather and bank baseline site data, particularly with respect to indicating a progressive improvement in site conditions; and
- Guide the success of care and maintenance, along with the more accurate determination of success criteria and related timelines.

14.6 Monitoring measures

The measures are structured as follows:

- Component / aspect;
- Monitoring, including methodology and scheduling (frequency);
- Performance objectives; and
- Corrective action (care and maintenance).

It should be noted that these criteria are indicative only and need to be updated and refined as closure and rehabilitation planning at Grootegeluk progresses. Post closure reclamation and land management should be adaptive. It is important that the data obtained during monitoring is used to gauge the success of management interventions, and that such interventions are modified and improved should as necessary.

Table 17: Rehabilitation monitoring

Component / aspect	Monitoring		Performance / success criteria	Corrective action
	Method	Frequency		
Topography and erosion	■ Conduct a visual assessment to determine areas of potential erosion; ■ Identify incidences of rill and gully erosion and/or excessive siltation in a specific area; and ■ Rehabilitate impacted areas in terms of at least progressive in-filling of voids, shaping, topsoiling and grassing.	Bi-annual	■ Concurrent surface rehabilitation that is aligned to rehabilitation planning; ■ Backlog is limited and addressed as a matter of priority; ■ No evidence of significant erosion is present; ■ Implemented landform is aligned to designed land form; and ■ Self-sustaining vegetation establishment occurs.	■ Adjust earthworks and construction practices to achieve and maintain the desired side and cross slopes; ■ Institute corrective action if backlog occurs; ■ Improve vegetation where erosion occurs; ■ Install energy dissipation measures if improved vegetation is not sufficient; ■ At excessive slope lengths and signs of sheet erosion, construct contour drainage berms that intercept the overland flow; and ■ In areas of runoff concentration, create dedicated surface runoff pathways that are appropriately vegetated.
Vegetation (dump 4 & 5 rehabilitation)	■ Take approximately 10 representative samples from the flat surface and 10 on the slopes/edges. The samples should be taken of the upper 200 mm of the soil cover; and ■ Analyse soil samples as specified in APPENDIX C.	Annually	■ Soil analysis results comply with remediation targets at a 95-percentile level.	■ Soil chemical results should be interpreted by a soil specialist and a fertilizer maintenance program should be compiled based on the soil analyses. The fertiliser program should stretch over a period of 3 years and quantities should annually be amended based on soil analyses. It is though essential that soil fertility targets mimic natural undisturbed areas, as over fertilization is unsustainable; ■ The annual maintenance program should consist of 2 applications of which the first should be after the first reasonable rain event and the second in midseason;

Component / aspect	Monitoring		Performance / success criteria	Corrective action
	Method	Frequency		
				■ Trafficking on the rehabilitated surface should be permanently prohibited and should be confined to well-planned access routes. Signs prohibiting access and trafficking on the rehabilitated surface should be placed at all access points; ■ Erosion prevention structures should be constructed on access routes where required. Erosion on these routes should be inspected after each rain event and erosion should be rectified where required; ■ The vegetation cover should be monitored annually during midseason using techniques such as near infra-red analysis. Erosion and bare patches should be identified; and ■ Eroded sections should be stabilised and the cause of bare patches should be determined by a soil specialist if possible. Possible causes should be rectified, and bare patches should be re-seeded with the same vegetation mixture.
Vegetation establishment (general)	■ Determine whether concurrently established vegetation provides an effective cover and aids in controlling erosion, by undertaking the following: ▪ Inspect rehabilitated areas to assess vegetation establishment and early	Monthly after planting / seeding of areas Quarterly after establishmen	■ No evidence of significant erosion is present; ■ Self-sustaining vegetation establishment occurs; and ■ Presence of exotic invasive species as well as bush encroachment species is effectively controlled.	■ Re-vegetate poorly established rehabilitated areas; ■ Re-seed bare patches, as required; and ■ Apply additional fertiliser and/or organic matter, depending on the condition of the vegetation and the initial organic material application.

Component / aspect	Monitoring		Performance / success criteria	Corrective action
	Method	Frequency		
	detection of erosion in recently planted/seeded areas (monthly); and ▪ Conduct evaluation of rehabilitated areas by means of field inspections. During these assessments' measurement of growth performance and species abundance will be carried out to determine: – Plant basal cover and species abundance in the grassed areas; – Estimates of average vegetation canopy and ground cover heights; – Distribution, densities, growth, and survival of woody species; – Dominant plant species (woody and herbaceous); – Presence of exotic invasive as well as bush encroachment species, and degree of encroachment; and	t is confirmed.		

Component / aspect	Monitoring		Performance / success criteria	Corrective action
	Method	Frequency		
	– Occurrence of erosion, noting aspects such as type, severity, degree of sediment build-up.			
Invasive alien species	■ Visually inspect areas where invasive species have been previously eradicated and areas prone to invasive species (e.g. eroded/degraded areas, along drainage lines, etc.) ■ Undertake surveys on relevant sites where bush encroachment has previously been identified, to determine the status quo of invasive vegetation.	Annually, aligned to eradication programme	■ Establishment of Category 1, 2 and 3 invader species is limited and/or prevented; ■ Extended threat to ecosystems, habitats or locally occurring species is minimised; ■ Increased potential for natural systems to deliver goods and services is maintained; and ■ Economic and environmental harm or harm to human health is minimised.	■ Revisit mitigation measures and adjust as required; and ■ Continue control and management.
Surface water quality	■ Undertake monitoring of the surface water quality during the operational period according to monitoring programmes.	Monthly during the operational period.	■ Acceptable threshold levels of salts, metals and other potential contaminants are maintained; and ■ The applicable thresholds do not pose a threat to surrounding land uses or land users.	■ As reflected in relevant IWWMP.
Ground water monitoring	■ Undertake monitoring of the ground water quality during the	Bi-annually	■ Acceptable threshold levels of salts, metals and other potential contaminants are maintained; and	■ As reflected in relevant IWWMP.

Component / aspect	Monitoring		Performance / success criteria	Corrective action
	Method	Frequency		
	operational period according to monitoring programmes.		■ The applicable thresholds do not pose a threat to surrounding land uses or land users.	

15.0 CONCLUSION

This initial ARP consolidates the outcomes of various dedicated physical and bio-physical specialist investigations and recommendations and as such provides the “first cut” GN R.1147 aligned plan for Grootegeluk, as part of the staged approach to closure compliant planning being conducted for the mine.

The operational rehabilitation measures reflected in this report are intended as a planning tool for Grootegeluk, to prioritise and subsequently execute on-going rehabilitation actions over the coming twelve-month period, and to structure future short-to medium term rehabilitation. The plan was developed based on current conditions and site requirements and should be reviewed and updated annually. The rehabilitation planned to be undertaken in this report will also be reviewed in the next iteration of the annual rehabilitation plan.

This plan does not make allowance for or scope the full suite of statutory authorisations that may be triggered by rehabilitation activities, e.g. establishment of borrow pits for cover material.

Future updates will review progress of the past 12 months and look at annual planning and costing for the subsequent 12 months. To demonstrate compliance to the regulations, it is of essence that Grootegeluk displays progression in planning and implementation of rehabilitation actions with each update.

Signature Page

Golder Associates Africa (Pty) Ltd.

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APPENDIX A

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GOLDER ASSOCIATES AFRICA (PTY) LTD

APPENDIX B

Available Background Information

Document title	Compiled by	Date	Reference
2014			
Grootegeluk Groundwater Baseline (2009) Final Report	Environmental Resource Management	2012a	0103516
Grootegeluk Colliery: Backfill Project Materials Classification	Earth Science Solutions	2010	
Grootegeluk Mine. Consolidated Environmental Management Programme Report	Exxaro Coal (Pty) Ltd	2013	10313055
Spontaneous combustion of the organic matter in discards from the Witbank coalfield.	Falcon, R.M.	1986	86(7), 243-250
Grootegeluk Stormwater Management Plan	Golder Associates	2012	10613055-11622-4
Grootegeluk Coal Mine Ecological Scan	Natural Scientific Services CC	2009	1291
Grootegeluk Coal Mine Terrestrial Ecological Scan	Natural Scientific Services CC	2011	1295
Integrated Report 2012	Exxaro Coal (Pty) Ltd	2012	
Slimes dam stability analysis	Jones & Wagener	2012	D337
Grootegeluk Coal Mine Backfill Rehabilitation – Conceptual Design Aspects	Jones & Wagener	2011	JW131/11/B791-Rev A
Grootegeluk Colliery Backfill Project Materials Classification	Synergistics Environmental Services	2010	
Vegetation / Rehabilitation Proposal for the Backfilling Project of Grootegeluk Coal Mine	Synergistics Environmental Services	2009	00223
Closure Knowledge Base Report for Grootegeluk Coal Mine	Golder Associates	2013a	12614858-12244-1
Initial Closure Plan for Immediate Closure Situation – Grootegeluk Coal Mine	Golder Associates	2013b	12614858-12270-2
Review and Update of Unscheduled Closure Cost for Grootegeluk Coal Mine as at June 2013	Golder Associates	2013c	12614528-12322-2

Document title	Compiled by	Date	Reference
Review and Update of Unscheduled Closure Costs for Full Scale Closure (Base Case) of Grootegeluk Coal Mine as at June 2013	Golder Associates	2013d	12614858-12321-1
2018 – 2019			
Preliminary Land Use Plan for Grootegeluk Coal Mine	Golder Associates	April 2014	12614858-12414-5
Site Wide Rehabilitation Plan for Grootegeluk Coal Mine	Golder Associates	May 2014	12614858-12767-8
Life of Mine (LoM) Closure Plan for Grootegeluk Coal Mine	Golder Associates	June 2014	12614858-12856-7
Compilation of the Integrated Water and Waste Management Plan for 63 pans within Grootegeluk area - 2018	Golder Associates	October 2018	1405692-321355-13
Wetland Study within the Exxaro Grootegeluk Complex	GroundTruth	June 2018a	GTW726/140618/01
Grootegeluk Complex – Non-perennial Pans: Creation, design methodology and detailed offset study (quotation)	GroundTruth	July 2018b	GTW726/240718
Procedures and guidelines for topsoil stripping and capping of the discard facility at Grootegeluk Mine (Draft Technical Memorandum)	Rehab Green	August 2018	RG/2018/08/29/1
Final rehabilitation report for Grootegeluk Dump 4 and 5 and sequence of rehabilitation procedures	Boscia Environmental Solutions	August 2018	G-GG-18-02
Exxaro Grootegeluk Complex: Non-perennial pan creation & conceptual pan rehabilitation	GroundTruth	September 2018	GTW726/110918/01
Dump Report July 2018 (Microsoft Excel format)	Exxaro – Grootegeluk	Received: Dec 2018	-
Rehab Stats 2018 – Q4 (Microsoft Excel format)	Exxaro – Grootegeluk	Received: Mar 2019	-
Backfill Costs (Budget 2018 – 2023) (Microsoft Excel format)	Exxaro – Grootegeluk	Received: Apr 2019	-

APPENDIX C

Conceptual / Preliminary Rehabilitation Measures and Method Statements

OPEN PIT BACKFILLED AREAS

- Conduct detailed surface profiling of the backfilled open pit[7] to ensure that the landform to be developed will be free draining. Conceptual measures have been devised as follows:
  - Develop dished drainage lines / corridors, as backfilling of the pit progresses, from south-west to north-east, splitting each mining area (current and northern) into two drainage areas, as illustrated o Figure 13, and aligning to the capping measures described below;
  - Link these drainage lines, and route to the east by developing an appropriately sized drainage corridor, as per/aligned to operational stormwater management plans, to follow natural topography;

Figure 13: Backfilled open pit conceptualised surface profiling and drainage (not to scale)

  - Develop the base / bottom of the dished area to be approximately 1.5 m above NGL, draining from upper crests at 3 m above NGL, as illustrated on Figure 14;

[7] *Due to two final voids remaining at closure, it can be assumed that the final backfilled landform is to be developed to natural ground level (NGL), incorporating a 10m top rehabilitation capping system*

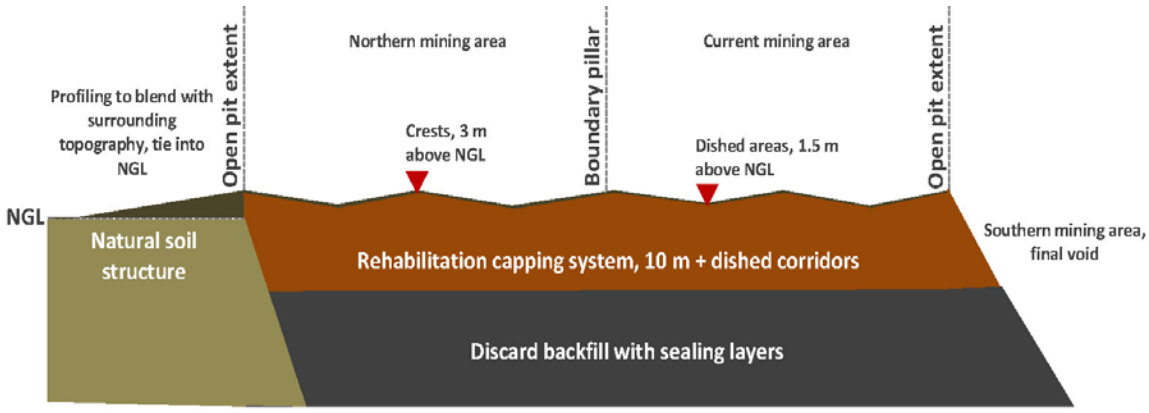

Figure 14: Conceptual section indicating drainage valleys

- Construct the 10 m (plus additional fill required to develop the proposed valleys) rehabilitation capping system once the landform has been profiled/shaped, as described above, as follows:
  - Apply a layer of fill material (between 8.5 and 10 m thickness), allowing for 1 m subsidence, onto the in-filled discard / interburden as well as infill remaining voids/cavities not backfilled with discard material, using available overburden material, dump 6 material, Renoster dump material, Tyre dump material;
  - Create in situ plinthic layer, compacted to approximately 92-93 % Proctor – just under the final growth medium layer;
  - Layer 3 m growth medium – potentially a mixture of red sand and overburden material (to be confirmed); and
  - Apply directly a layer (approximately 100 mm) of fresh sand that contains an active seed bed – sourced from upfront mine expansions.

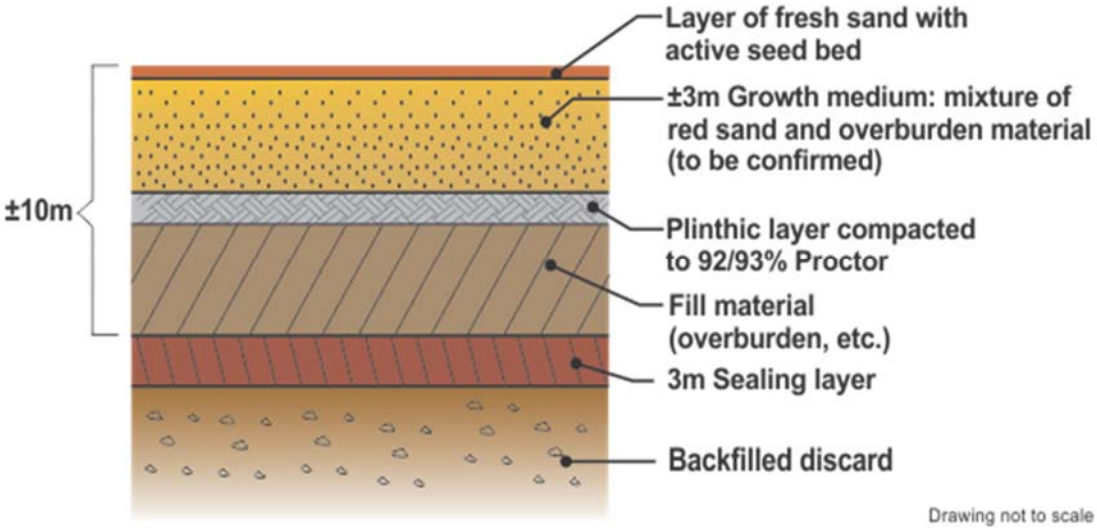

Figure 15: Backfilled open pit capping system

- Finally, ensure that the created final surface emulates the devised valleys that drains from the inter-valley highs to the valley beds, within and overall west to east direction.

PANS TO BE TRANSLOCATED / CREATED WITHIN THE SHORT-TERM

Source: (GroundTruth, 2018c)

Excavation of the new pan site

Based on the HECRAS modelling suitable sites will be selected for the translocation/creation of wetland habitat. As described above in **Section 4.1**, the site will be selected based on varying aspects including topography, vegetation composition and proximity to road networks. Other than the close proximity of these systems to road networks, it is essential that there is a variety of terrestrial habitats surrounding the created/translocated pan, i.e. shrubs and trees versus barren landscape. The diversity of habitats surrounding the pan will provide a suite of habitats for the various invertebrate species and potentially contribute towards maintaining the diversity of invertebrates within a system.

In order to function similarly to 'natural' wetlands, a suitably sized area will have to be excavated for the placement of the harvested wetland material. It is recommended that a minimum of 50cm$_8$ is excavated from ground level, leaving a depression in the landscape.

Harvesting of the wetland substrate from the LOM area

The following guidelines should be adopted when carrying out the harvesting of the wetland materials within the LOM plan area. All excavations should ideally be carried out in the winter months when the rainfall is at its lowest.

- The proposed wetland from which material will be harvested should be clearly demarcated, i.e. the area around the wetland, including the adjacent working area. It is essential that the working area is located at a suitable distance from the pans to avoid any potential contamination of the soils associated with fuel/oil spills etc. Depending on the location of the source material in relation to the proposed mining plan, the impact area surrounding the wetland should be kept to a minimum, i.e. should the mine activities only commence a substantial time following the harvesting of the wetland materials the working footprint should be kept to a bare minimum to ensure the impacts on the surrounding vegetation is nominal. This is also applicable for the proposed newly created wetland area;
- The pans should be excavated in the following sequence:
  - The vegetation (if applicable) should be carefully removed by hand in sods and suitably stored for replanting upon the completion of the creation activities;
  - The top 20-30cm (invertebrate layer) should be carefully harvested and stockpiled separately from the underlying layers;
  - The remaining topsoil 20-40cm (depending on the size and depth of this layer) should be removed and stockpiled separately; and
  - The subsoil layer – 30-70cm – should be removed and also stockpiled separately from the previous two layers.
- The excavation of these layers should be carried out immediately prior to the translocation of the materials to the new site, in order to minimise the time soils are exposed to the elements, e.g. wind; and to ensure the new proposed excavated areas do not remain open for an extended period; and
- Should an extended delay be envisaged, then the excavated material should be protected from erosion. The stockpiles should not be located beyond the boundary of the new proposed pan, keeping the three layers separate.

Backfilling of the proposed new pan

The following methods should be followed for the backfilling of the proposed new pan:

- As described above, the working area should be kept to a minimum particularly since the new pans are located within relatively undisturbed areas. Any areas set aside as designated working areas must be suitably rehabilitated upon completion of the said activities;
- Ideally, the backfilling of the recently excavated area should be carried out immediately after the materials have been harvested;
- The excavated materials from the wetland within the LOM should be returned in the same order that it was removed, i.e. the subsoil replaced first, followed by the topsoil material, and the invertebrates closer to the surface;
- The subsoil layer should be well moistened and compacted in 150mm layers to ensure that a natural impermeable layer is created across the entire width of the pan. In the event that the soils cannot be suitably compacted a little bentonite should be added to the subsoil layer to ensure that an impermeable layer is created; and
- The topsoil layer should also be well moistened and compacted in 150m layers. This is followed by the replacement of the uppermost soil profile containing the invertebrates. Care should be taken when replacing the invertebrate layer to ensure that not too many of the invertebrates are placed towards the bottom of the profile, but rather that these are located within the upper-most portion of the soil profile. This layer may also be slightly compacted to reduce the loss of this layer through wind dispersal.

Revegetation and erosion control measures

Erosion control methods should be implemented to ensure that erosion of the disturbed areas is kept to a minimum, particularly in the working areas. The following recommendations should be implemented to prevent erosion and the generation of sediment into the pans (especially since the formation of the pans is associated with the deflation of sediments):

- If wetland vegetation was harvested, it should be replanted within the deepest parts of the pan. In the adjacent disturbed areas, an approved local indigenous grass seed mixture should be applied;
- The grass should be watered on a regular basis until the vegetation has established and adequate cover is achieved;
- Bio-degradable erosion control blankets should be considered to stabilise the disturbed areas on the steeper approaches to the pans where the risk of erosion of the soils is higher. The erosion control blankets should be implemented according to the supplier’s specification; and
- Fencing off these systems may be considered as an initial control measure, thereby protecting the systems from herbivory and allowing the vegetation within and around these systems to establish.

Timing

The harvesting and creation of the pans should be carried out in winter (June-August) when the area is driest. Where possible, the harvesting/backfilling should make use of machinery, preferably a tracked bulldozer or excavator, to carry out the required earthworks. This would ensure that activities are implemented quickly minimising the amount of time that the wetland soil is exposed. It should be noted, that using earthmoving

machinery to undertake the necessary works, will potentially create a larger working footprint and thus may require additional terrestrial rehabilitation of the affected areas.

SEQUENCE OF REHABILITATION PROCEDURES FOR DUMP 4 & 5

Source: (Boscia, 2018)

1) Write a Standard Operational Procedure (SOP) for an entire rehabilitation program;

2) Start with a compost program;

3) Undertake soil depth mapping and horizon identification of the area where the cover material will be stripped;

4) Write a SOP with special reference to avoid unsuitable soil forms and soil horizons as described by the soil stripping and stockpile procedure by Rehab Green cc.;

5) Harvest litter layer underneath the trees and shrubs:

   Collecting / harvesting organic litter layer (undecomposed organic material) underneath the trees and shrubs from the area where the soil stripping will eventually take place, by means of vacuum harvesters or raking. This procedure can take place two years prior to stripping the vegetation from the soil strip are. Application of litter material should be at least 100 kg/ha on the slopes and 50 kg/ha on the top flat areas. The organic litter should be stockpiled in ventilated bags in a cool dry place until seeding time. The quality will go down if stored for longer than two years.

6) Cut and fill sloping of Dump 4 & 5 to 1:5 slope as specified by the landscape model;

7) Apply lime on discard material according to nett acid potential (lime requirement) to avoid future sub-surface ARD on the interface of the discard and the cover material;

8) Strip topsoil / cover material (and stockpiling if not used directly as a cover material) as per procedure by Rehab Green cc.;

9) Place cover material (topsoil) on the slope as specified by soil stripping as replacing procedure Rehab Green cc.;

10) Evaluate cover soil depths criteria of cover material by means of auger observations on a 50 x 50 m grid basis (by a soil specialist). Spatial maps to provide by soil specialist to indicate cover soil depth and noncompliant sections;

11) Sample the cover material for chemical analyses in order to determine soil amelioration requirements with special reference to the lime application of the cover material / topsoil;

12) Place tree and shrub stripped vegetation windrows on contour at 20 m interval at approximately 2 m wide rows and 50-100 cm high (dead trees and shrubs);

13) Ameliorate cover material:

   - Well decomposed compost/kraal manure application 30 m^3 /ha. If no compliance with this procedure, the core focus and objectives of the rehabilitation plan will fail;
   - In cases where the cover material/topsoil have a pH <5, it is recommended that site-specific lime requirements are executed to obtain the correct nutrient balance and ratios;
   - 350 kg/ha KNO_3 prior to seeding; and
   - 250 kg Superphosphate/ha prior to seeding.

14) Apply bio-stimulant:

- Apply 30 litres of K-humate concentrate at 100l water per hectare
- 15l Fungimax concentrate (mix with 100l water) per ha
- 15l Molasse concentrate (mix with 100l water) per ha
- (K-humate, Fungimax and Molasse could be mixed together with 200l water per application per ha)
- An additional application of above on moribund windrows at 1.0l per meter length

15) Rip on contour (30 cm deep with a 50 cm interval). Ensure ripper lines are behind dozer or wheel tracks;

16) Prepare seed (Trichoderma):
    - 25 grams of Excalibur™ Gold Trichoderma is to be applied to every 10 Kg of grass seed; and
    - 25 grams of Graph-Ex SA™ is to be applied to 10 kilograms of seed for legume seed.

17) Seed with coated and uncoated seed (per ha) on the ameliorated surface as well as on the tree and shrub windrows and 50% less on the top flat areas:
    - Anthphora pubescens (2 coated and 1 kg uncoated);
    - Cynodon dactylon (4 kg coated and 2 kg uncoated);
    - Cenchrus ciliaris (5 kg coated and 1 kg uncoated);
    - Digitaria eriantha (5 kg coated and 1 kg uncoated);
    - Eragrostis curvula (2 kg coated and 1 kg uncoated);
    - Panicum maximum (5 kg coated and 1 kg uncoated) and
    - Eragrostis teff (1 kg uncoated).

18) Add the litter layered retrieved from the organic top soil at 100 kg/ha on the slopes and 50 kg/ha on the top flat areas;

19) Cover with mulch to obtain a 40-60% shade cover;

20) Monitor:
    - Landscape functional analyses (LFA) by end of the growth season;
    - Erosion index and establish cause where occur;
    - Erosion modelling and field index together with LFA;
    - Soil analyses are required once a year by the end of growth season (April- May) and interpretation and recommendations by a qualified soil scientist. The standards and norms for these soil quality criteria should be developed by a soil scientist after careful interpretation of site-specific conditions i.e. climate, soil characteristics, surface conditions, vegetation cover and ultimate goal and objectives of the rehabilitation program as well as end land use and mine closure objectives:
        - Exchangeable cations (K, Ca, Na, Mg);
        - Cation exchange capacity;
        - pH 1:2.5 water solution;

- Electrical conductivity (saturated paste);
- Lime and nutrient requirements where necessary;
- Organic carbon content; and
- Dehydrogenase, urease and phosphatase activity.

21) Keep a record of soil analytical data to make conclusive recommendations with respect to maintenance programs, budgets for ongoing maintenance, and also to make use of the data to get facts to convince Authorities to apply for mine closure when necessary and applicable;

22) Maintain:

- Rectify the negative results of the monitoring results;
- Fertiliser program: 250 kg/ha 2:3:2 (23) after first rain event > 15 mm of each season for three successive years or as required according to soil analyses;
- Establish cause of poor germination, rectify if possible and reseed with the same mixture as above if poor germination is experienced;
- Continue with maintenance program and data processing until mine closure is obtained; and
- Identify potential post-closure maintenance and monitoring programs.

TOPSOIL STRIPPING AND REPLACEMENT PROCEDURE

Source: (Rehab Green, 2018)

A competent person should be appointed to oversee all steps of the soil stripping and replacement procedure and all steps and monitoring procedures should be signed off after inspection and/or completion of such steps and/or procedures. Such a person is referred to as the “Project Supervisor”.

Detailed soil assessment

A detailed soil assessment needs to be done by a soil specialist who is familiar with the required soil properties for the 70cm single layer cover. The assessment should adhere to the following:

- Auger observations at a density of 100 x 100m;
- Suitable soil depth and soil texture should be noted at each auger point and the occurrences of unsuitable underlying material such as soft and hard plinthic or structured horizons and clay layers should be noted;
- Auger cores at each observation point should be photographed;
- A soil map to be compiled containing a labelled 100 x 100 m block grid specifying the refined stripping depth for each block with an accompanying table specifying the cumulative soil volumes. This map is to refer to as the “Soil Stripping Guide Map” further on is this report;
- A brief report should be compiled containing only:
  - The Soil Stripping Guide Map with 100 X 100 m block grid and block numbers;
  - Accompanying soil volume tables;
  - Tables providing the coordinates of each stake with survey system specified (refer to Section 6.2); and
  - The field description sheets as an appendix.
- Compliance of the report to be evaluated by the Project Supervisor and should be amended if the Project Supervisor deemed necessary.

Site demarcation

- In order to facilitate the contractor, each 100 x 100 m block should be staked and numbered, and each stake should contain the block number and stripping depth:
  - Numbers on stakes should be engraved rather than using permanent ink markers;
  - Stakes should be properly planted to prevent stakes falling over and get lost; and
  - Stakes should preferably consist of PVC material rather than wood.
- The stakes may not be removed during the stripping operation and should remain on an approximate 2 x 2 m core which can be removed at the end of the stripping operation. This will facilitate a continuing reference of the stripping depth as the stripping action progresses; and
- The stakes should be put out by the soil specialist or the mine surveyor.

Topsoil stripping

- Stripping should preferably take place in the dry season. Stripping may not take place within 1 day after a rain event exceeding 15 mm and within 2 days exceeding 25 mm of rain;

- The stripping depth of each specific block should be verified by the Project Supervisor and communicated to the excavator operator on a daily basis;
- The excavator operator should always be in possession of the Soil Stripping Guide Map;
- Stripping should take place by an excavator preferably positioned on the upper surface and not on the excavated floor level;
- Soil should be stripped and immediately transported by trucks to the prepared discard dump surface;
- Trucks should access the stripping area via the excavated floor surface and avoid trafficking on the natural surface as far as possible;
- Soils may not be stockpiled/stored at the stripping area in order to preserve the natural seed source and to ensure that any germination of seeds occurs after soils are tipped and levelled on the discard dump surface;
- Soil stripping should be coordinated with available prepared sections on the discard dump. Soil stripping should immediately be halted by the Project Supervisor if final prepared surfaces on the discard dump are not available; and
- The Project Supervisor should sign off each block when completely stripped and confirm that the block was stripped at the specified depth.

Final preparation of the discard dump surface

- No topsoil may be stockpiled/stored on unprepared sections of the discard dump. Topsoil should be tipped directly on final prepared surfaces in order to ensure that germinating seeds are not destroyed by later removal of soils;
- Topsoil should only be tipped on sections that are compliant with surface elevation and slope criteria of Golder's landform model (Model reference), and which is signed off by the Project Supervisor, mine surveyor or responsible person;
- Tipping and levelling of topsoil on incorrect discard surfaces can hamper or completely disable proper functioning of the designed store and release cover; and
- It should be born in mind that a frequent undulation or a very rough discard surface will cause frequent variation in the levelled cover soil depth and will cause frequent points not qualifying to the minimum depth requirement.

Soil replacement on final prepared discard dump surface

- Topsoil should be tipped in quantities per square unit that will result in a minimum of 750 mm initial thickness after levelling but preferably 800 mm. This is to compensate for the initial expansion during stripping and replacement and later settling of the soil profile;
- A guideline to achieve this are as follows:
  - Determine the load volume of trucks bringing topsoil to the discard dump;
  - Calculate the required soil volume of a 20m^2 footprint on the dump i.e. (20 x 20 x 0.75 = 300m^3). If 1 truck contains 10m^3 then 30 trucks should be tipped within a 20 x 20 m footprint. Adapt this calculation to practical measurements based on truck volumes; and

- Place 2 ropes (100 m in length) parallel on the discard surface, 20 m apart, in order to serve as measurement to coordinate the number of loads per 20m2 footprint. Move one of the ropes as tipping progresses.

- A dedicated person, controlling and managing the placement of heaps tipped on the discard should be present at all times; and
- The Project Supervisor should inspect the density of topsoil heaps and sign off each section before levelling of the section may commence.

Levelling of topsoil

- Levelling of topsoil should commence immediately after the Project Supervisor inspected a tipped section and confirmed that the tipping density is correct;
- Topsoil may not be levelled in a wet state, directly after rain events. After rain events topsoil should be left to dry out for approximately 2 to 3 days and levelling can only commence once topsoil is fairly dry as determined by the Project Supervisor;
- The topsoil heaps should be levelled with chain track equipment to avoid compaction as far as possible;
- Topsoil may not be spread over distances apart from levelling actions. Levelling of topsoil which is tipped in correct / sufficient quantities, as described above (soil replacement) will result in the correct depth and spreading will not be necessary;
- Final levelling can be done by a road grader;
- Prohibit any trafficking on levelled topsoil apart from what is needed for soil amelioration and the seeding process. Signs prohibiting access on levelled surfaces should be put up; and
- A levelled section should, after inspected, be signed off by the Project Supervisor and declared ready for an independent depth evaluation.

Monitoring of replaced topsoil depth

- The replaced topsoil depth should be monitored by and independent third party, preferably a soil specialist by means of auger observations at 50 x 50 m grid density, which translates to 4 observations per ha;
- The soil depth results should be reported by means of a soil depth map indicating the soil depth at each auger point. Auger points should be colour coded to indicate shortfalls at increments of 100 mm. This map is referred to as the “Replaced Soil Depth Map” further in this report;
- The first evaluation should commence after the 1st 10-15 ha was levelled. This evaluation will serve as a test section to evaluate all applied procedures. If shortfalls occur the cause should be identified and procedures that are not adhered to should be rectified or adapted to ensure that that the specified depth is reached at 100% of the evaluation points;
- Shortfalls should be avoided to all costs, because rectification of points where shortfalls occur will hardly be possible and will probably result in the following:
  - Heavy trucks will probably get stuck in fairly loose replaced topsoil before reaching points where additional topsoil is required; and
  - Topsoil that are dozed up to points where shortfalls occur will result in compacted layers below the surface which will result in impeded root penetration and development which should be avoided at all cost.

- If all procedures are in place, evaluation of the topsoil depths should take place progressively after each 20 to 30 ha;
- It is important that monitoring takes place on a continuing basis in order to timeously identify deviations of procedures that may result in under or over achievement of the specified topsoil depth;
- The Project Supervisor should in time inform the soil specialist of completed sections that needs to be evaluated;
- The soil specialist should provide the depth results within 1 week by means of the Replaced Soil depth Map with the date of survey as part of the map heading; and
- The Replaced Soil Depth Map should be updated progressively. All rectified points should have a unique colour code and new depth label.

Soil sampling and analyses

- Soil samples should be taken by the soil specialist during the time of the soil depth evaluation;
- Soil samples should be taken at the initial levelled sections at a density of 1 sample per 4 ha. Samples can be taken at a lower density as soil levelling progresses i.e. 1 sample per 20 ha. No composite samples may be taken;
- Samples should be taken of the upper 200 mm of the replaced soil layer;
- Samples should be analysed for at least the following:
  - pH (water);
  - Acid saturation percentage (if pH is below 5.5);
  - Extractable cations: Ca, Mg, K and Na (ammonium acetate method);
  - Cation exchange capacity (CEC) – can be done for initial sections and excluded later if general values are established;
  - Phosphorus (P-Bray 1);
  - Resistance; and
  - Electrical conductivity (Saturate soil paste; only if sodic or saline conditions is expected).
- The soil analyses should be interpreted by the soil specialist. The soil specialist and vegetation specialist should evaluate existing, preliminary soil amelioration recommendations and adapt it according to soil analysis results; and
- Final soil amelioration recommendations should be compiled and provided to the Project Supervisor.

Preliminary soil amelioration

- The soil chemical status should be determined after topsoil was finally levelled on the prepared discard surface. This should be done by representative sampling and analysis as described above;
- A preliminary soil amelioration guideline is provided by (Boscia, 2018) as follows:
  - 30m^3/ha – well decomposed compost/kraal manure;
  - 350 kg/ha KNO_3;

- 250 kg/ha super phosphate (10.5); and
- The elements should be applied on the surface and worked into the soil to a depth of 100-200mm preferably by disking actions.

- The guideline above should be evaluated and adapted based on soil analyses subsection and a final fertiliser recommendation should be compiled.

Bio-stimulants

- The application of bio-stimulants is recommended by Van Deventer 2018 (section 12, Table 4).

Seeding

- A grass seed mixture for the edges of the discard dump is recommended by as follows:
  - *Anthphora pubescens* (2 coated and 1 kg uncoated);
  - *Cynodon dactylon* (4 kg coated and 2 kg uncoated);
  - *Cenchrus ciliaris* (5 kg coated and 1 kg uncoated);
  - *Digitaria eriantha* (5 kg coated and 1 kg uncoated);
  - *Eragrostis curvula* (2 kg coated and 1 kg uncoated);
  - *Panicum maximum* (5 kg coated and 1 kg uncoated); and
  - *Eragrostis teff* (1 kg uncoated).
- The seed mixture should be reduced with 50% for the flat surfaces on top of the discard dump;
- Placing of windrows, a litter layer and mulch cover should be according to specifications by Boscia (Boscia, 2018); and
- The Project Supervisor should ensure that contractors responsible for the seeding process adhere to the proposed seed mixture and specified quantities. If some of the recommended species are not available, the mixture should be adapted in co-ordinance with the vegetation specialist.

GENERAL SURFACE REHABILITATION: VEGETATION SPECIES

- It is proposed that woody species (trees and shrubs) be deliberately established, particularly on flat areas, while grass should be established on all areas. A good grass cover is especially needed on sloped areas, while trees and shrubs should also be established on the flat areas of terraces of the final void, if applicable, to increase the biodiversity and to act as wind breaks (Redco, 2009); and
- Basal cover of the natural veldt hardly exceeds 3 – 4%, therefore a basal cover of more than that cannot be expected of the rehabilitated area. The woody species will be less, and grass species will be the dominant vegetation on the rehabilitated areas. It is possible that during the first few seasons the basal cover will be higher due to the domination by annual species, but it usually declines in time. Another aspect with regard to the establishment of trees to consider and study in more depth in future, is the potential to view this as carbon capture or offset in the larger scheme of activities of the client. This may require e.g. the establishment of a higher density of trees than the natural surrounding environment (Redco, 2009).

Grass species:
The following commercially available perennial species are to be utilised as the basis of the grass mixture (Redco, 2009):

Scientific name	Common name	Ratio (kg/ha)
Anthphora pubescens	Borseltjie grass	1
Cenchrus ciliaris	Blue buffalo grass / Bloubuffelsgras	5
	Rhodes grass / Rhodesgras	1
Cynodon dactylon	Couch grass / Kweekgras	3
Digitaria eriantha	Smuts finger grass / Smutsvingergras	4
Eragrostis curvula		0.5
Panicum maximum	Buffalo grass / Buffelsgras	4
Total:		**18.5**

Note: one of the challenges in achieving successful vegetation establishment is the lack in availability of indigenous grass seed. There are only a few species suitable for the Limpopo Province that are commercially available.
The following commercially available annual specie is to be utilised (Redco, 2009):

It is strongly encouraged to incorporate the harvesting of locally adapted species in the rehabilitation programme as far as possible; however it must be remembered that germination rates of locally sourced/harvested seeds are lower than that of commercial species. The following local annual species is currently recommended (Redco, 2009):

Scientific name	Common name	Ratio (kg/ha)
Chloris virgata	Feather finger grass/Feather windmill grass	

- Woody species:

- Establish herbaceous and woody species mainly by seeds and planting of seedlings of selected species;
- Establish trees and shrubs simultaneously to grass establishment, otherwise there is a chance for lower success and more aftercare will be needed because grass out-competes trees;
- Create an environment where as wide as possible diversity of species would be tolerant and form a stable and sustainable environment, rather than creating different habitats for specific species;
- Spread kraal manure (50 kg/ha) from selected grazing areas to introduce certain species;
- Plant untreated seeds of species that germinate readily;
- Plant treated (to overcome dormancy) seeds of selected species in pockets and keep grass short around clusters until trees are established;
- Plant trees from a locally established nursery of selected trees if required for bio-diversity or specific land use. This will include species that are scarce or vulnerable, difficult to propagate and requires more experience and guidance from specialists (such as *Boscia albitrunca*);
- Due to bulbous and succulent plants being long-lived and slow to establish, all bulbous and succulent plants are to be removed (generally during the rainy season) from areas prior to mining and maintained under artificial conditions in a nursery until such time as they can be reincorporated into rehabilitation programmes of suitable habitat or with concurrent rehabilitation, replanted immediately. These species are generally shallow-rooted and are easily transplanted from their natural environment;
- When planting in the field, place emphasis on re-creating various micro climates that are important for the establishment of many species. Clumping of a variety species that simulates the natural bush clumps is particularly important; and
- Establish *Harpagophytum procumbens* (Devil's claw) within the proposed nursery. This species is a procumbent creeper that was identified in the near vicinity and an important medicinal plant species that is also a protected species, on sandy soils in the study area.

The following table lists a summary of herbaceous and woody species that can be considered in the rehabilitation programme (Redco, 2009):

Scientific name	**Common name**
Establishment with manure	
Acacia tortillas	Haak-en-steek
**Dichrostachys cinerea*	Sekelbos
**Acacia meliffera*	Swarthaak
Note: Experience shows that these species establish readily with this method with no maintenance, while supporting the ecological stability of the rehabilitated areas); however, they do show a tendency to invade disturbed areas and therefore these species will have to be controlled during maintenance not to form thickets. This can be done quite effectively and should not place an unreasonable impact on a rehabilitation maintenance programme. It was found that if a good grass cover is established at the same time, that this control excessive encroachment of these species.	

** All of these species are fast growing and hardy species. Acacia mellifera will form an impenetrable thicket, although people and animals will be able to pass through below them and thus, for this reason, Dichrostachys cinerea is proposed to be planted to form the same kind of impenetrable barrier at a lower level.*	
Untreated seeds	
Combretum apiculatum	Rooibos
Combretum imberbe (protected tree under NFA)	Hardekool
Combretum zeyheri	Raasblaar
Commiphora spp (plant vegetative also)	Kanniedood
Grewia spp. (remove pulp)	Rosyntjiebos
Terminalia sericea	Sandgeelhout
Treated seeds	
Acacia erioloba (and other Acacias) (protected tree under the National Forests Act - NFA)	Kameeldoring
Bauhinia petersiana	Koffie Beesklou
Sclerocarya birrea (protected tree under NFA)	Marula
Uclea spp.	Ghwarrie
Trees from nursery	
Adenium oleifolium (Protected)	Impala lily
Boscia albitrunca (Protected under NFA)	Shepherd tree
Schinziophyton rautanenii (Protected)	Manketti tree
Spirostachys africana (protected tree under NFA)	Tamboti
Bulbous species and succulents	
Note: The establishment of these species normally requires more management, because water and weed control will be needed for some time after planting to ensure success. The creation of a more specific habitat may also be required for success. In the case where seedlings are planted, a water truck should be used to water the seedlings for a period of 3 weeks at a rate of 4 mm per day for 4 days a week. The watering can then be reduced, but should continue until the roots are deep enough to support the moisture needs. From experience it is known that watering may have to continue for at least six months or more depending on the season to ensure survival of the seedlings from the nursery. A mixture of grass and branch mulch should be used to produce a shade cover of 80 %. This will protect the seedlings from wind abrasion and prevent quick evaporation from the soil surface.	

APPENDIX D

Annual Rehabilitation Plan and 5-Year Plan Cost Estimate

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