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Assessment of the impact of sand mining on agricultural potential on Portion 2 of Farm number 1242 near Kraaifontein

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1 Introduction and brief

Johann Lanz was appointed to conduct a soil survey on Portion 2 of Farm number 1242 near Kraaifontein. This assessment report uses data from the soil survey to determine sand depths for suitability of mining and rehabilitation, to determine agricultural potential, to assess the impact of mining on that potential, and to provide recommended mitigation measures and rehabilitation guidelines for all the identified impacts caused by mining.

The soil investigation was conducted on 15 June 2017. A total of 12 test pits were investigated within the area of deepest sand reserves. The location of the proposed mine is shown in Figure 1. Data from the test pits is provided in Appendix 1, and the positions of all test pits are shown in Figure 2.

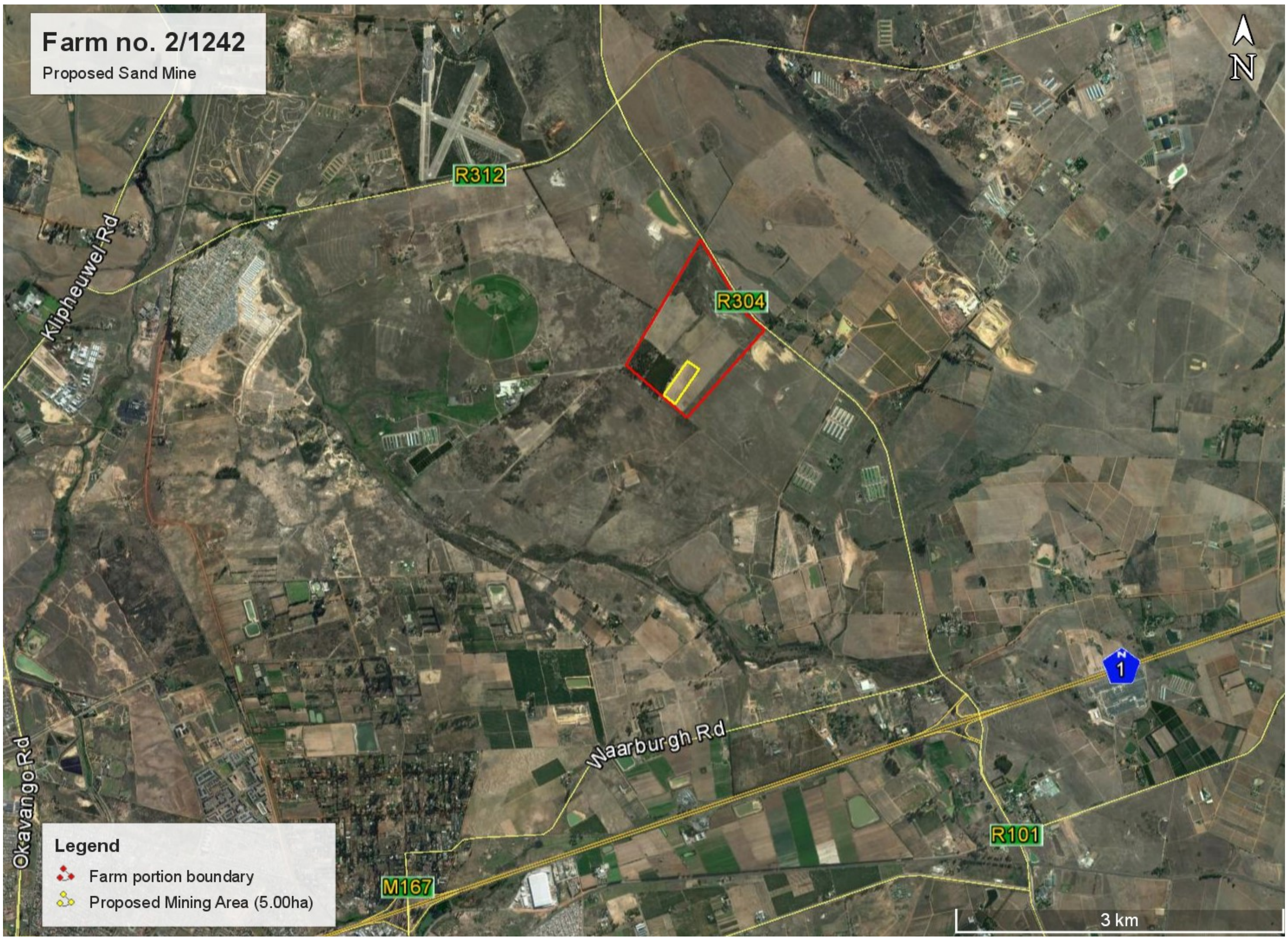

Figure 1. *Location of the proposed mine.*

2 Soils and agricultural potential

The geology of the area is mainly surficial cover formed in situ on Malmesbury rocks as well as greywacke, phyllite, and quartzitic sandstone of the Tygerberg Formation, Malmesbury Group. Granite and deposits of the weathering products of granite, Cape Granite Suite as well as occasional ferricrete also occur.

The soils are generally fairly deep, medium grade sands overlying clay or gravel. They are bleached, grey coloured sands, and are mostly of the Kroonstad soil form and Kd1000 soil family, as classified by the South African soil classification system. The depth below surface to the clay varies between 50 cm and 160 cm. A typical soil profile is illustrated in Figure 3.

Figure 2. *Satellite image showing all investigated test pits (image date: 13 May 2017).*

Figure 3. *Typical soil profile from site. Kroonstad 1000 soil family (test pit 1).*

The soils are limited by the low clay content and leaching of the upper soil horizons and therefore have a low water and nutrient holding capacity. They also have drainage limitations due to the underlying, largely impermeable clay. As a result they have a low to medium agricultural potential, and are rated as 4 out of 10 according to the system used by Western Cape soil scientists. The site is classified on Cape Farm Mapper as land capability class IV, which is marginal potential arable land. The specific limitations of the site, render the soil very marginal for cultivated crops.

3 Agricultural land use

The proposed mining area is on land which is cultivated to planted pastures.

4 Estimated sand reserves

The average total sand depth across the proposed 5.00 hectare mining area (as indicated in Figure 1) is 126 cm. The average mine-able depth is 50cm less (required for rehabilitation). This gives a mine-able sand volume of approximately 38,000 m^3. Note that this is an estimate only, based on the measured test pits.

5 Identification and assessment of the impacts of mining on agricultural resources and production

Mining has both direct and indirect impacts on agricultural potential. Direct impacts are those that change the soil potential on site in terms of growing agricultural crops. Indirect impacts are those that do not directly affect on-site crop growth, but that might impact the success of agricultural enterprises in the general area of the proposed mine.

5.1 Indirect impacts

Indirect impacts can include the alteration of the agricultural sense of place, which may impact on agri-tourism potential. They can also include dust deposition on surrounding crops. Indirect impacts are not considered to be significant, given that the area does not have particular value as having agricultural sense of place, or high potential for high value crops such as vines. Surrounding land uses already include historical and existing sand mining operations as well as battery chicken farms.

5.2 Direct impacts

Direct impacts are viewed in the context of the agricultural potential of the site, which is marginal for cultivated crops, and limited by sandy soils with low water holding capacity. The low agricultural potential of the site limits the significance of agricultural impacts.

Mining will change the existing soil profile through the removal of all sandy material below the upper topsoil. The impact of mining occurs by way of eight different identified mechanisms, listed below. All these mechanisms impact on the agricultural potential. For the purposes of this report, the overall impact, namely reduction in agricultural potential, as a result of the interaction of these different mechanisms, is assessed. Each mechanism is discussed below. Details of mitigation measures are provided in the following section.

The following direct impacts are identified.

5.2.1 Loss of agricultural land for duration of mining

All mining areas will be lost to agricultural production for the duration of mining activity on them. Given the low agricultural potential of the land and the limited duration of a mining permit, the significance of this impact is low.

5.2.2 Reduction in soil depth

Removal of sand from the soil profile will decrease the depth of suitable rooting material and the soil moisture reservoir, above a depth limiting clay layer in the sub soil. The retention of at least 50cm depth of rooting material (as recommended for rehabilitation) will mean that the loss of rooting depth is not significant to agricultural use, under the soil and agricultural potential that exists on site (that is suitability for shallow-rooted, annual crops only).

5.2.3 Impaired soil drainage resulting in water logging in potential root zone

In these soils, lateral water movement down-slope above the clay layer occurs periodically after rain. Reduction in the soil depth above the clay layer will mean that the lateral water movement will occur closer to the soil surface and therefore impact more on the root zone.

The creation of surface and/or subsurface depressions that are not free draining, will also cause water logging in the potential root zone. The retention of at least 50cm depth of sandy rooting material above the clay and ensuring that depressions are free draining (as recommended under mitigation) will keep this impact of low significance. The proposed mining area is positioned at the high point of the rise, with gentle slopes of about 2% running away from it in two directions, to the south west and north east. This position will allow for adequate drainage and for mining to be done without creating a depression.

5.2.4 Loss of topsoil and of topsoil fertility during mining and stockpiling

Poor topsoil management during mining may result in the loss of topsoil for rehabilitation through burial or erosion from stockpiles. Also, disturbance and dilution of topsoil can cause loss of fertility as a result of reduced organic carbon and biological activity. The significance of this impact is highly dependent on the effectiveness of topsoil management during mining and during the rehabilitation phase. The natural topsoil does have low natural fertility, and the significance of the impact is therefore unlikely to be high.

5.2.5 Erosion

Downslope erosion during the operational phase can be caused by run-off accumulation from the mining excavations. When topsoil is re-spread, on completion of mining, the newly rehabilitated land will also be prone to erosion. Slopes are not steep and so the erosion risk is not high, but it is always present and requires effective management. Mitigation of significant impact is highly dependent on effective erosion management during mining and during the rehabilitation phase.

5.2.6 The creation of uneven surfaces or steep slopes

Mining excavations can create an uneven surface or steep slopes (usually on the edge of the mining excavation) that would prevent or hinder future agricultural land use. This can be completely mitigated by effective slope reduction during rehabilitation.

5.2.7 Alien vegetation encroachment

Soil disturbance can result in alien vegetation encroachment after rehabilitation. This can be controlled with effective environmental management of alien removal.

5.2.8 Soil contamination due to fuel spills

The presence of heavy machinery in the mining area may result in contamination from fuel spills. This can be prevented or ameliorated with effective environmental spill management.

6 Recommended mitigation and rehabilitation plan

A very important factor affecting the success of rehabilitation, and consequently the significance of all direct impacts, is the level of care that is taken to rehabilitate effectively. This is dependent on the level of environmental management of all mining activities that can impact on rehabilitation, both during the mining process and during the rehabilitation phase.

The following are the sequence of recommended rehabilitation steps:

1. During mining, the outflow of run-off water from the mining excavation must be controlled to prevent any down-slope erosion. This must be done by way of the construction of temporary banks and ditches that will direct run-off water. These should be in place at any points where overflow out of the excavation might occur.
2. The upper 50 cm of the soil must be stripped and stockpiled before mining. Mining can then be done down to the clay layer (or other depth limiting layer).
3. Topsoil is a valuable and essential resource for rehabilitation and it should therefore be managed carefully to conserve and maintain it throughout the stockpiling and rehabilitation processes.
4. Topsoil stripping, stockpiling and re-spreading must be done in a systematic way. The mining plan should be such that topsoil is stockpiled for the minimum possible time by rehabilitating different mining blocks progressively as the mining process continues.
5. Topsoil stockpiles should be protected against losses by water and wind erosion. Stockpiles should be positioned so as not to be vulnerable to erosion. The establishment of plants (weeds or a cover crop) on the stockpiles will help to prevent erosion. Stockpiles should be no more than 2 metres high.
6. To ensure minimum impact on drainage, it is important that no surface depressions remain after mining. A surface slope (even if minimal) must be maintained across the mining area, and out of it on the down-slope side.
7. After mining, any steep slopes at the edges of excavations, must be reduced to a minimum and profiled to blend with the surrounding topography. Profiling of the bottom mining boundary should be extended beyond the mining area to minimise any depression and resultant damming effect.
8. The stockpiled topsoil must then be evenly spread over the entire mining area, so that there is a depth of 50cm of sandy topsoil above the underlying clay. The depth should be monitored during spreading to ensure that coverage is adequate and even.

9. Topsoil spreading should only be done at a time of year when vegetation cover can be established as quickly as possible afterwards, so that erosion of returned topsoil by both rain and wind, before vegetation is established, is minimised. The best time of year is at the end of the rainy season, when there is moisture in the soil for vegetation establishment and the risk of heavy rainfall events is minimal.
10. A cover crop must be planted and established immediately after topsoil spreading. This is to stabilise the soil and protect it from erosion. The cover crop should be fertilized for optimum production. It is important that rehabilitation is taken up to the point of cover crop stabilisation. Rehabilitation cannot be considered to be complete until the first cover crop is well established.
11. The rehabilitated area as well as the land down slope of it must be monitored for erosion, and appropriately stabilised if any erosion occurs.
12. On-going alien vegetation control must keep the area free of alien vegetation after mining.

7 Conclusions

This assessment has found that there are adequate reserves of sand on site for mining and rehabilitation. Soils are sandy and the agricultural potential across the site is low to medium. The soils are marginal for cultivation.

Successful rehabilitation will allow the land to be utilised at a similar level of agricultural production as the pre-mining land use. With effective mitigation, the reduction in agricultural potential is therefore assessed as having low significance. Without mitigation or with ineffective mitigation it can result in the reduction of the agricultural potential of the site.

Mitigation measures and a rehabilitation plan are provided in this report. Successful mitigation and rehabilitation of impacts is highly dependent on maintaining a sufficient level of environmental management. Mine management must be held accountable for well managed and effectively implemented rehabilitation. The specific, measurable rehabilitation outcomes against which the effectiveness of completed rehabilitation must be measured are:

1. that the topography has been sufficiently smoothed without steep excavation edges to allow for cultivation;
2. that topsoil has been spread on the surface;
3. that there is a potential rooting depth of at least 50 cm above the clay, of non-compacted soil material, which is suitable for root growth, across the entire mining area
4. that there are no non free-draining depressions across the surface and that the depth of mining has not created an effective sub-surface dam, that is lower than the low point for drainage out of the mining area;
5. that there is no visible erosion across the area, or down-slope of it as a result of mining, and that no part of the area has been left unacceptably vulnerable to erosion;
6. that a successful cover crop has been established across the entire area.

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Appendix 1: Measured depths in all investigated test pits.

Test pit no.	GPS Position Lat/Lon hddd.ddddd° WGS84		Total depth from surface to base of sand layer
	latitude	longitude	(cm)
1	-33.7927076407	18.7615136895	150
2	-33.7934660353	18.7611555308	150
3	-33.7940400280	18.7619166076	140
4	-33.7946858536	18.7625550572	110
5	-33.7937178276	18.7630090211	50
6	-33.7930968963	18.7635903060	70
7	-33.7926697545	18.7639237382	80
8	-33.7925987598	18.7630521040	70
9	-33.7931127381	18.7624061946	90
10	-33.7915933505	18.7626614235	160
11	-33.7905296870	18.7634431198	90
12	-33.7909748498	18.7641865108	90

Note: The table gives total sand thickness. Mine-able thickness of sand would need to subtract the 50cm that will be required for rehabilitation, from the total sand thickness.