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Assessment of the impact of sand mining on agricultural potential on Portion 8 of Farm number 440, Vryegunst, near Windmeul

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1 Introduction and brief

Johann Lanz was appointed to conduct a soil survey on Portion 8 of Farm number 440, Vryegunst, near Windmeul. 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 14 May 2019. A total of 11 test pits were investigated across the area. The location of the farm is shown in Figure 1. Data from the test pits is provided in Appendix 1, and the positions of test pits are shown in Figure 2.

Figure 1. *Location of the investigated farm.*

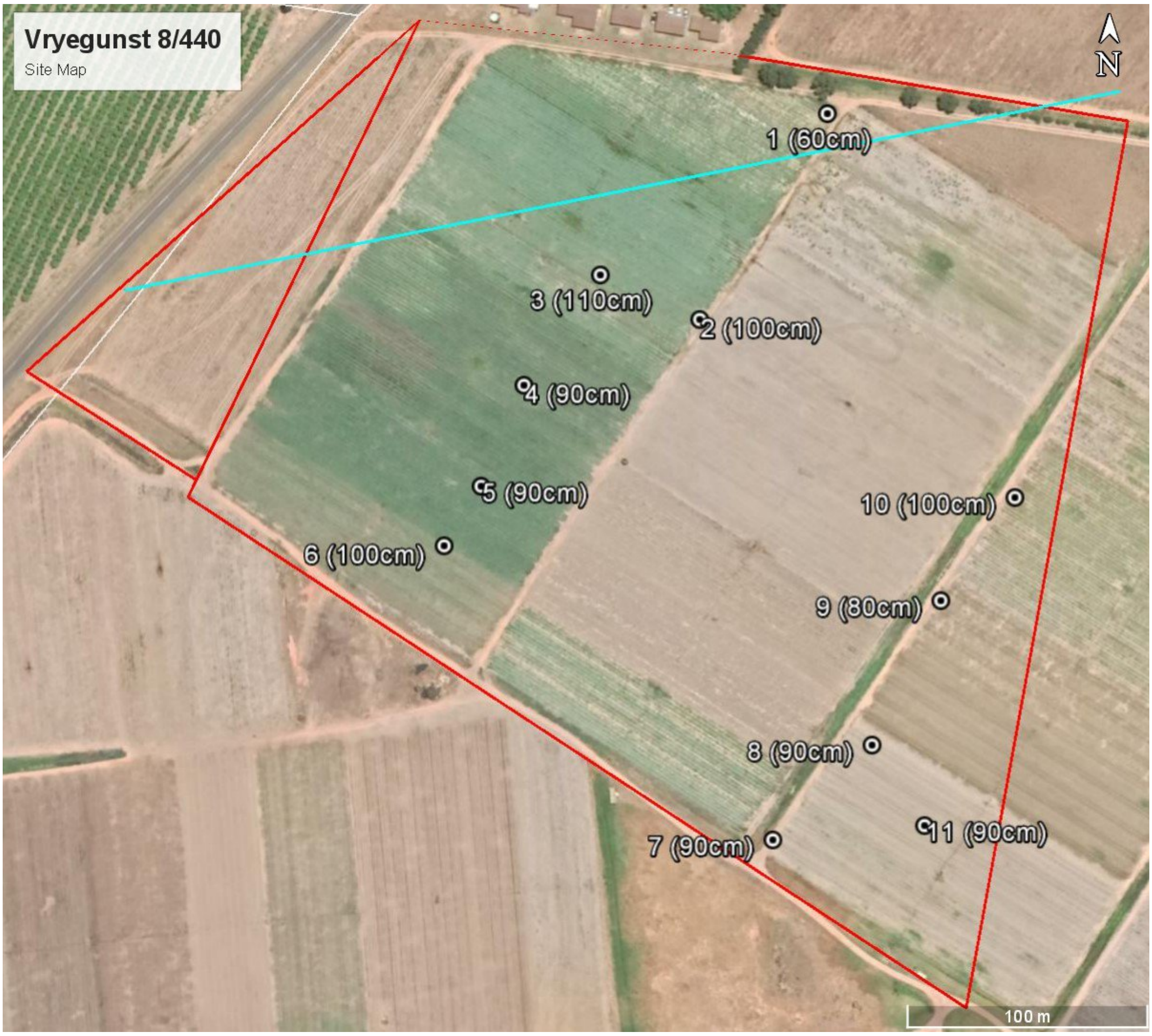

Figure 2. *Satellite image showing all investigated test pits with sand depths (image date: 15/12/2018).The power line route across the investigated area is shown in blue.*

2 Soils and agricultural potential

The underlying geology of the area is mainly Quaternary quartz sand of the Springfontein Formation, largely covering greywacke and phyllite of the Moorreesburg Formation, Malmesbury Group. Occasional granite outcrops and ferricrete occur. The soils are generally deep sands overlying clay. The soils have a slightly darker topsoil horizon underlain by bleached, light coloured sand, and are of the Kroonstad 1000 soil family, as classified by the South African soil classification system. The depth below surface to the clay, across the investigated area, varies from 60 cm to 110 cm.

Photographs of soils and site conditions are shown in Figures 3 and 4.

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. As a result they have a low to medium agricultural potential, and are rated between 4 and 5 out of 10 according to the system used by Western Cape soil scientists. The land capability of the investigated area varies between land capability evaluation values of 8 and 9. The site is suitable for cultivation but is limited by the low water holding capacity of the sandy soil. Although wine grapes are cultivated in the area, the particular soils of the application area are not considered to have sufficient potential for quality wine production. They are too leached and sandy, and therefore do not have sufficient buffer capacity and water holding capacity for quality wine production.

The future agricultural potential of the zone, Cape Town Winelands is rated as remaining high as long as dams fill up.

3 Agricultural land use

The investigated area is currently used for the production of vegetable crops under irrigation. The landowner farms citrus on the neighbouring farm (see Figure 5), in similar soils that have previously been mined. He intends to plant citrus on this farm as well, after sand mining. The motivation to change from vegetables is due to water scarcity. He sees the deep sandy soils as being less water efficient than shallower sands where water is not as easily lost below the root zone. The citrus are planted on ridges to reduce wetness.

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

Mining can have 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.

4.1 Indirect impacts

The following potential indirect impacts are identified

Figure 3. *View of typical site conditions.*

Figure 4. *Typical Kroonstad 1000 soil profiles of the investigated area.*

Figure 5. *Neighbouring citrus orchards on similar soils, that have been mined.*

4.1.1 Alteration of the agricultural sense of place

Mining is an intrusive activity of an industrial nature that, during its operational phase, can alter the agricultural sense of place in a farming area and impact on agritourism potential and therefore on the agricultural economy However the surrounding area considered in this report already has activities in close proximity which include sand mining and battery chicken farming. It is not an area with high agritourism potential. The significance of this impact is therefore not likely to be high. It is however very difficult to assess the significance of such impacts. An important indication of their significance would be provided by the response of neighbouring and surrounding land owners to the mining application.

The intrusive nature of mining may have some lifestyle impact on surrounding residents. However, the focus and defining question of an agricultural impact assessment is assessing the extent to which the development will cause a loss of future agricultural production. Such lifestyle impacts do not necessarily impact agricultural production and are therefore a social issue that is beyond the relevance and scope of an agricultural impact assessment, and should rather be addressed within a social impact assessment.

4.1.2 Dust deposition on surrounding crops

Mining can result in dust on surrounding crops. There are dust sensitive agricultural crops, including vineyards and orchards adjacent to the mining area. Dust will therefore need to be mitigated by means of damping down surfaces when required. The significance of this impact with mitigation is not high.

4.2 Direct impacts

Direct impacts are viewed in the context of the agricultural potential of the area, which is suitable for cultivation.

Mining will change the existing soil profile through the removal of all sandy material below the upper 50 cm. The impact of mining occurs by way of 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.

4.2.1 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 to medium agricultural potential of the land and the fact that the duration of mining will be limited, the significance of this impact is low.

4.2.2 Reduction in soil depth

Removal of sand from the soil profile will decrease the depth of suitable rooting material and the total soil moisture reservoir, above a depth limiting clay layer in the sub soil. The retention of at least 50cm depth of sandy rooting material (as recommended under mitigation) will be necessary to ensure that sufficient rooting depth and moisture reservoir is retained for crops. As discussed above, the farmer sees a reduction in soil depth as an advantage for water efficiency in citrus orchards.

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

In these soils, a temporary water table above the clay layer occurs periodically during rainy times. Reduction in the soil depth above the clay layer will mean that the temporary water table will occur closer to the soil surface and therefore impact more on the root zone.

Furthermore, the creation of surface and/or subsurface depressions that are not free draining, has the potential to also cause water logging in the potential root zone. The slope across the mining area is gradual (approximately 2%), so special care will need to be taken to control mining depths to ensure drainage, especially through the bottom edge of the mine. The retention of at least 50cm depth of sandy rooting material above the clay, ensuring that depressions are free-draining, and re-creating drainage trenches after mining (all recommended under mitigation) will be essential to keep this impact of low significance.

The land is currently drained by ditches that run between the fields. Similar systems of ditches will need to be re-established during rehabilitation to ensure that drainage is adequate.

4.2.4 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.

4.2.5 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 but erosion risk still exists. Mitigation of significant impact is highly dependent on effective erosion management during mining and during the rehabilitation phase.

4.2.6 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 levelling during rehabilitation.

4.2.7 Alien vegetation encroachment

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

4.2.8 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.

5 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 is the sequence of recommended rehabilitation steps:

1. The upper 50 cm of the soil across the entire mining area must be stripped and stockpiled before mining.
2. 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.
3. Topsoil stockpiles should be protected against losses by water and wind erosion. Stockpiles should be positioned so as not to be vulnerable to erosion by wind and water. 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.
4. 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.
5. To ensure minimum impact on drainage, it is essential that no depressions are left in the mining floor. A surface slope (even if minimal) must be maintained across the mining floor in the drainage direction, so that all excavations are free draining. This means that mining depths will need to be controlled on the down-slope side of the mine, so that the mining floor remains free-draining and above the low point for drainage out of the mining area.
6. After mining, any steep slopes at the edges of excavations, must be reduced to a minimum and profiled to blend with the surrounding topography.
7. The stockpiled topsoil must then be evenly spread over the entire mining area, so that there is a minimum 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.
8. Topsoil spreading should only be done at a time of year when moisture is available for vegetation growth so that vegetation cover can be established as quickly as possible after spreading. This is to minimize erosion of returned topsoil by both rain and wind, before vegetation is established.
9. Similar systems of ditches to the existing ones, must be re-established to ensure that drainage of the entire area is adequate.
10. A cover crop must be planted and established immediately after spreading of topsoil, to stabilise the soil and protect it from erosion. The cover crop should be fertilized for optimum biomass production, and any soil chemical deficiencies must be corrected, based on a chemical analysis of the re-spread soil. A chemical analysis from an agricultural laboratory will include a recommendation of the appropriate quantities of chemical ameliorants (for example lime, phosphate etc) that should be applied to optimize the soil chemistry for the relevant crop. 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 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.

6 Conclusions

This assessment has found that there are adequate reserves of sand on site for mining and rehabilitation. Soils are sandy with low water holding capacity which results in low to medium agricultural potential. The soils are too leached and sandy to be good for quality wine production. The site is suitable, but somewhat marginal, for cultivation of pasture crops.

There are both indirect and direct potential impacts of sand mining on agriculture. The indirect impacts are:

1. Change to the agricultural sense of place, which can damage the agritourism potential of the area.
2. Dust deposition on surrounding crops.

The direct potential impact of mining on the land is to reduce its agricultural potential by way of different identified mechanisms:

1. Loss of agricultural land for duration of mining
2. Reduction in soil depth
3. Impaired soil drainage
4. Loss of topsoil and fertility during mining and stockpiling
5. Erosion
6. The creation of steep slopes and uneven surfaces
7. Alien vegetation encroachment
8. Soil contamination from fuel spills

Of the above the most important impact is impaired soil drainage through the creation of surface depressions.

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. All the recommended steps must be well managed and effectively implemented in order for rehabilitation to be successful, especially ensuring that all excavations are free draining after rehabilitation.

If rehabilitation is successful, it will allow the land to be utilised for on-going agricultural production. 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 impacts of high significance, which destroy the capacity of the land for any agricultural production.

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 and soil surface has been sufficiently smoothed to allow cultivation;
2. that the slope has not been steepened anywhere by mining excavations to the extent that it is problematically steep for cultivation;
3. that topsoil has been spread on the surface;
4. 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;
5. 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;
6. That the drainage trenches have been re-established and are working effectively to drain water from the lands;
7. 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;
8. 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.

The sand thickness is total sand thickness, from which 50cm must still be subtracted for rehabilitation.

Test pit no.	GPS Position Lat/Lon hddd.ddddd° WGS84		Total sand thickness
	latitude	longitude	(cm)
1	-33.6421777122	18.8240626361	60
2	-33.6439996026	18.8245720044	80
3	-33.6431938503	18.8227005769	90
4	-33.6435716227	18.8225081284	90
5	-33.6448948737	18.8238178845	90
6	-33.6445399839	18.8242632151	90
7	-33.6448412295	18.824498998	90
8	-33.6429479253	18.8234896492	100
9	-33.6437943298	18.8223422505	100
10	-33.6436138675	18.8249045145	100
11	-33.6427812092	18.8230435643	110