Before a joint hearing of the

Otago Regional Council | **RM 20.024**

Waitaki District Council

Under	the Resource Management Act 1991
In the matter of	applications by Oceana Gold (New Zealand) Limited for resource consents for the Deepdell North Stage III Project

Statement of evidence of Dr Robert Bertuzzi for Oceana Gold (New Zealand) Limited

4 August 2020

QUALIFICATION AND EXPERIENCE

1 My name is Robert Bertuzzi.

2 I am a Principal Geotechnical Engineer at Pells Sullivan Meynink.

3 I graduated from the University of Sydney in 1985 with a bachelor's degree in mining engineering, and the university medal. I completed my master's degree in research in rock mechanics at the university of Sydney in 1989. I received my PhD from the UNSW for my thesis "Rock mass properties for tunnelling".

4 In 1991 I joined Coffey Partners as senior geotechnical engineer. I joined Pells Sullivan Meynink (PSM) as senior consultant in 1994 and was Managing Director between 2007 - 2016. I have worked on over 100 mining and tunnelling projects, from feasibility design to planning implementation and remedial work.

5 In addition to consulting I have acted as technical expert witness on projects across Australia, in Laos, Philippines and Chile. From 1999 to present, I have given lectures on Rock Engineering for Underground Structures and the subject component, Rock bolting for slopes, at the University of New South Wales Master of Engineering Science course. I assisted NSW Workcover in preparing its 2007 Code of Practice, AustRoad in its Tunnelling Guidelines in 2010 and Queensland's TMR in its tunnelling guidelines between 2015 - 2017.

6 My Professional affiliations include:

a. Member Australasian Institute of Mining and Metallurgy
b. Member Institute of Engineers
c. Chartered and Registered Professional Engineer (1453618)
d. Registered Professional Engineer of Queensland (9231) (Civil & Mining)
e. Registered APEC Engineer (Civil)
f. Member of Australian Geomechanics Society
g. Member of Australasian Tunnelling Society.

7 I confirm that I am the primary author of the following reports which relate to the geotechnical aspects of the proposed Deepdell Stage 3 open pit:

a. 16 February 2018 PSM71-224R

b. 19 November 2018 PSM71-229M

c. 12 June 2019 PSM71-238L

d. 12 February 2020 PSM71-244L

e. 05 March 2020 PSM71-245L

8 I confirm that I have reviewed the above reports. These reports and the modelling were carried out under my direction and I agree with the results and conclusions.

9 The reports are summarised in the following paragraphs.

EXECUTIVE SUMMARY

10 The reports presented relate to the geotechnical aspects of the proposed Deepdell Stage 3 open pit and include consideration of:

a. the interaction between the pit and waste rock stack

b. slope stability analyses for the expected conditions during and post-mining

c. the impacts of earthquakes.

11 The results of the analyses for the proposed pit during mining and closure are in keeping with the acceptance criteria.

12 The risks of landslides triggering a wave-overtopping event post-mining and of flood risk in the Golden Point Historic Reserve are negligible.

GEOTECHNICAL REVIEW OF DEEPDELL PIT STAGE 3 DESIGN

13 Report PSM71-224R dated 16th February 2018.

14 This report presents a geotechnical stability assessment for the proposed Deepdell Stage 3 pit development during the following phases.

a. Operational conditions during excavation - This assumes the water table is drawn down below the ultimate pit floor to approximately 372 mRL

b. Closure planning Scenario 1 – A pit lake forms to the lowest intersection point with the topography at the southern end of the pit, approximately 445 mRL

c. Closure planning Scenario 2 – A pit lake fills to the lowest intersection point at the northern end of the pit, approximately 475mRL.

15 The typical slope design for Deepdell Stage 3 comprises:

a. North and east walls comprising 15 m high, 60° batters and 4.3 to 7.5 m wide berms producing and 90 to 125 m high, 40 to 48° inter-ramp slopes

b. West wall (orientated towards 090°) comprising variable batter and berm configurations, producing a 145 m high, 23 to 38° inter-ramp slopes

16 Geotechnical stability assessments undertaken have shown to have a minimum factor of safety (FoS) ≥ 1.5. This exceeds the general acceptance level for mine slope stability. A sensitivity analysis was carried out on the east wall to test the design for seismic loading. A horizontal load of 0.13g (equivalent to a M 4.5 earthquake 0 km from the mine) was applied in the analysis. The resultant factor of safety = 1.2 indicating that the design would remain stable under the earthquake.

DEEPDELL NORTH – RESPONSE TO COMMENTS

17 Report PSM71-229M dated 19th November 2018.

18 This memorandum addresses the comments raised by Tonkin and Taylor in its review on behalf of Otago Regional Council [(1)]. The relevant aspects are summarized in the following paragraphs.

19 A static Factor of Safety (FoS) of 1.5 is commonly accepted for pit closures as listed in table 9.9 of Read & Stacey 2009, Open Pit Slope Design [(2)].

20 The waste rock stack is only a minor part of the pit stability analysis such that adopting conservative Mohr-Coulomb parameters of c' = 1 kPa and ϕ' = 35° for its shear strength did not impact on the pit design.

21 To evaluate the earthquake effect on the pit walls two scenarios were assessed.

a. Scenario 1 - M5.0 earthquake at 30 km from the mine.

b. Scenario 2 - M4.5 earthquake on the Billy's Ridge Fault – Macraes Fault. This scenario is hypothetical and conservatively worse case, as it assumes an earthquake on the Macraes Fault occurring at the mine (i.e. at a distance of 0 km).

22 Ground motion models developed for New Zealand by McVerry et al. (2006) and from tectonic regions similar to New Zealand (i.e. NGA West 2 models, 2012) were used to estimate the peak ground accelerations (PGA) at the mine site associated with the two considered earthquake scenarios. Scenarios 1 and 2 resulted in a PGA of 0.04g and 0.13g, respectively.

23 The post-closure slope with the filling pit lake, still has a FoS > 1.0 under the 0.13g PGA. Hence, large scale movement of the slope is not expected. No wave is expected.

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(1) *Proposed Deepdell North Stage III Project – Section 92 Requests for Additional Information*, Tonkin+Taylor, Job No. 51640.0280, 1 August 2018. Received by PSM in an email from Pieter Doelman dated 16th November 2018.

(2) *Guidelines for open pit slope design,* Ed. Read & Stacey, CRC Press, 2009.

GEOTECHNICAL REVIEW OF UPDATED DEEPDELL PIT STAGE 3

24 Report PSM71-238L dated 12th June 2019.

25 This letter presents a geotechnical review of the proposed Deepdell Stage 3 Pit which had been slightly revised since the PSM71-224R study. This letter supplements that work which is presented in Paragraphs 11-15.

26 The geotechnical review of the Deepdell Stage 3 pit design includes:

a. the interaction between the pit and waste rock stack.

b. slope stability for the expected conditions during mining as well as conditions post mining. This includes two pit lake levels.

c. the impacts of a 1 in 150-year seismic event occurring during mining and of a 1 in 2500-year seismic event occurring post-mining were assessed.

27 The results of the analyses suggest that should a 1 in 2500-year earthquake effect Deepdell, then permanent displacement in the order of 100 cm will occur but the slopes will remain stable.

28 The risk of landslides triggering a wave-overtopping event in the pit lake is negligible because the open pit rock slopes are stable under earthquake events.

29 The results of the analyses for the proposed pit during mining and closure are in keeping with the acceptance criteria.

DEEPDELL STAGE III – RISK OF FLOODING FROM THE PIT

30 Report PSM71-244L dated 12th February 2020.

31 This letter reviews the risk of flooding of Deepdell Creek from the post-closure pit and confirms that the risk is negligible.

32 The previous analyses (presented in Paragraphs 14 to 30) had adopted a theoretical lake level of 475 mRL. Subsequent revisions to the pit design

reduced the maximum lake level to 465 mRL [3]; the overflow level. The previous stability analyses will therefore be slightly conservative.

33 Further, water balance studies concluded that the long-term lake level will actually not reach the overflow level but is likely to stabilise at about 430 mRL [3]. This means there will be a 35 m freeboard between the overflow and the lake level.

34 The review concluded that the risk of landslides triggering a wave-overtopping event in the pit lake of Deepdell Stage III pit is negligible because of several factors.

a. The open pit rock slopes are stable

b. The slopes are stable under a 1 in 2500-year earthquake event

c. The results of the stability analyses are slightly conservative as the maximum lake level is 40 m less than that assumed in the analyses; 430 mRL cf. 475 mRL.

d. There is 35 m freeboard above the lake level.

35 The flood risk caused to the Golden Point Historic Reserve in the event of unforeseen wave-overtopping of the pit lake is therefore also negligible.

36 No additional risk avoidance or reduction measures are needed.

DEEPDELL STAGE III – ADDITIONAL INFORMATION

37 Report PSM71-245L dated 5th March 2020.

38 This letter presents the additional information requested by the Otago Regional Council (ORC) [4] in regard to strength parameters and the potential

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(3) GHD, Deepdell North Stage III Project, Groundwater Assessment, 125/028848, January 2020.

(4) Emails from Louie Herrero to Robert Bertuzzi dated 27th February and 2nd March 2020.

for block failure. This letter confirms that appropriate consideration has been given to these aspects in the stability analyses.

Strength parameters

39 Firstly, intact rock is much stronger than waste rock and backfill. The waste rock / backfill comprises broken rock that is transported by truck and dumped. It rills at slope angles of between 34 to 38°, slightly lower for oxidised schist, but overall typically 37°. Figure 1 shows a few typical examples.

40 Conversely, intact rock mass is stable at much steeper angles. The poorest rock masses at Macraes can form stable 60° slopes, the better rock masses can be cut vertically, i.e. 90°. Figure 2 shows typical examples.

41 The strength parameters adopted for stability assessments comprised those shown in Table 1.

Table 1 – Adopted rock mass strength properties

Material	Unit Weight (kN/m^3) mean ± sd, range	Cohesion (kPa) mean ± sd, range	Friction Angle (°) mean ± sd, range
Waste rock	20	1	35
Weathered schist	25	120	35
Inter-shear pelite	25 -3 +2, 22 - 27	180 -15 +25, 170 – 205	43 -5 +2, 38 – 45

Figure 1: **Examples of waste rock and backfill.**

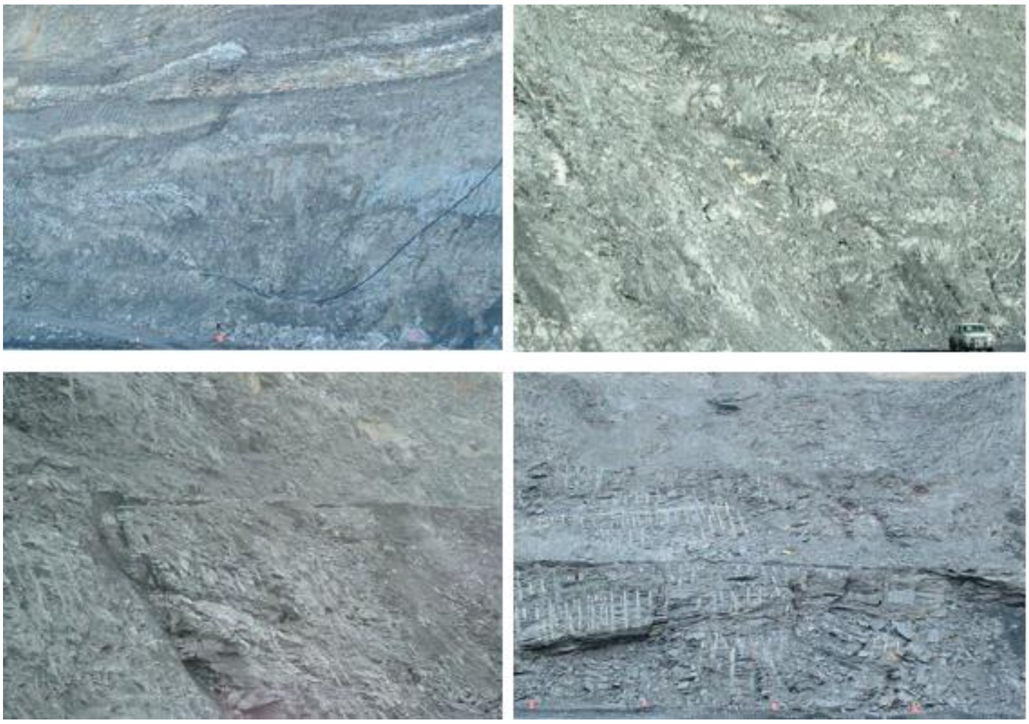

Figure 2: **Examples of intact rock slopes ranging from the better rock mass in the top left to the poorer rock mass in the bottom right.**

42 The rock mass strength assumptions/calculations are based on the following sources and accord with accepted geotechnical methods for such work.

a. A comprehensive undertaking of laboratory testing on intact rock and defect shear strength was undertaken for mine design studies carried out in 1997 (5). This comprised:

i. Point load strength

ii. Unconfined compressive strength

iii. Direct shear

iv. Ring shear

v. Comparison with data from Clyde and Maniototo projects.

b. The widely accepted GSI (6) / Hoek-Brown classification method. This method uses a classification rating to factor the intact rock strength down to a rock mass strength.

c. Back-analyses of the pit slope performance at Macraes over the past 30 years, which includes slope failures

43 In addition, variability is introduced by way of normal distributions based on the mean ± standard deviation to cater for uncertainty in the rock mass strength.

Potential for block failure

44 Block failures (planar sliding, wedge failure and toppling) that occur while the Deepdell Stage III pit is in operation will be dealt with during mining.

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(5) PSM, Mine geotechnical design studies, PSM71.R8, 20 November 1997.

(6) Geological Strength Index.

45 Block failures that could occur post pit closure are implicitly included in the seismic analysis of the overall slope that is presented in our previous report (presented in Paragraphs 14 to 30).

CONCLUSION

46 The reports presented herein relating to the geotechnical aspects of the proposed Deepdell Stage 3 open pit include consideration of:

a. the interaction between the pit and waste rock stack

b. slope stability analyses for the expected conditions during mining as well conditions post mining which includes two pit lake levels

c. the impacts of a 1 in 150-year seismic event occurring during mining and of a 1 in 2500-year seismic event occurring post-mining.

47 The results of the analyses for the proposed pit during mining and closure are in keeping with the acceptance criteria.

a. FoS ≥ 1.2 as commonly accepted for mining applications

b. FoS ≥ 1.5 for pit closures

c. FoS ≥ 1.0 under earthquake loading

48 The results indicate that should a 1 in 2500-year earthquake effect Deepdell, then permanent displacement in the order of a metre will occur but the slopes will remain stable.

49 The risk of landslides triggering a wave-overtopping event in the post-closure pit lake is negligible because the open pit rock slopes are stable under earthquake events.

50 The flood risk caused to the Golden Point Historic Reserve in the event of unforeseen wave-overtopping of the pit lake is therefore also negligible.

51 Overall I am satisfied that the geotechnical aspects of the proposed Deepdell Stage 3 open have been appropriately considered at this stage in the design process, and there are no known geotechnical matters that mean there is reason to think the proposed pit cannot be safely mined and rehabilitated.

Robert Bertuzzi

4 August 2020