



26 April 2011

Technical Services Manager  
Oceana Gold (New Zealand) Limited  
PO Box 5442  
DUNEDIN 9058

Attention: Marty Hughes

Dear Marty,

**Review of Golder Associates (NZ) Ltd Report 1078301051: "Top Tipperary TSF: Active fault hazard assessment". Electronic file: 1078301051-R100E.pdf, supplied by Golder Associates, 21 February 2011**

Dunedin Research Centre  
764 Cumberland Street  
Private Bag 1930  
Dunedin  
New Zealand  
T +64-3-477 4050  
F +64-3-477 5232  
www.gns.cri.nz

### *Background*

In June 2010, GNS Science was engaged by Oceana Gold (New Zealand) Limited to provide independent review of a Golder Associates (NZ) Ltd investigation of geological fault rupture hazards associated with the Macraes Fault, east Otago. GNS Science input has included discussions with Golder staff during the planning of field investigations, on-site inspection of exploratory trenches, and review of preliminary draft reports. This letter presents our review of the final report, dated February 2011.

### *Assessment of the report*

The report contains a thorough presentation of information on the Macraes Fault relevant to active fault hazard, with an invaluable set of new data from the exploratory trenches. The investigation has done as good a job of investigating the fault as could reasonably be expected given the geological situation of the fault. The landscape of the Macraes Flat area contains little in the way of geologically-young landforms and near-surface deposits. Without widespread age 'markers', the opportunities for obtaining conclusive facts on the history of an active fault are limited.

The excavation of exploratory trenches spanning the width of the area in which the fault must lie has shown, by exclusion, that no geologically-young ground-surface rupture can be demonstrated by available evidence. The evidence for no ground-surface fault rupture deformation since the loess layer was formed, assumed on reasonable and conservative lines of inference to be older than 11,500 years, is compelling.

Review of subsurface geological data from the mine, in companion with relevant published studies, provides strong reinforcement that the Macraes Fault has a very low level of prehistoric activity. The comparison of topographic features to the nearby, significantly active, Ostler Fault, and the clear lack of mutual similarity, is also valuable

### **DISCLAIMER**

This report has been prepared by the Institute of Geological and Nuclear Sciences Limited (GNS Science) exclusively for and under contract to Oceana Gold (New Zealand) Limited (OGL). Unless otherwise agreed in writing by GNS Science, GNS Science accepts no responsibility for any use of, or reliance on any contents of this Report by any person other than OGL and shall not be liable to any person other than OGL, on any ground, for any loss, damage or expense arising from such use or reliance.

qualitative evidence. Indeed, there are grounds for suggesting that the Macraes Fault is not necessarily an active fault, and its topographic expression may instead be the result of erosion, rather than offset of the land surface. However, this argument for inactivity, although compatible with some independent lines of evidence, is ultimately too inconclusive to be a robust basis for engineering design decisions.

We applaud the pragmatic solution of running a 'what if' scenario that, assuming the Macraes Fault to be an active fault, what are the possible consequences? The derived estimate of ground-surface offset of as much as 1.4 m vertical and 1.4 m horizontal in a single rupture event, based on published empirical data, appears to us to be a reasonable value for quantitative engineering. Further, the fact that the Macraes Fault is expressed in the subsurface bedrock as a zone of deformation rather than a single fault, highlights that this estimate is of a 'worse-case' nature, because the deformation associated with any future ground-surface rupture is likely also to be distributed across a zone of faulting and folding, rather than concentrated on a single slip plane.

### *Summary*

The report presents a sound documentation of an active fault investigation that we consider to have been fit for the purpose of defining, as well as is possible based on prehistoric geological evidence, the activity and ground-surface rupture characteristics of the Macraes Fault. By chance, the characteristics of the natural landforms and near-surface geological deposits in the vicinity of the Macraes Fault are such that they do not provide a definitive record of past fault activity. However, the conclusion that the Macraes Fault has a low rate of activity is reasonable, based on several lines of evidence. Furthermore, the reasoning used to estimate that should a ground-surface rupture occur on the fault, offset is likely to be as much as 1.4 m vertically and 1.4 m horizontally is an appropriate worse-case scenario for engineering purposes, in relation to the proposed tailings storage facility.

Yours sincerely



David J.A. Barrell  
Senior Scientist (geology and geomorphology)  
Russ J. Van Dissen  
Senior Scientist (earthquake geology)



Nicola J. Litchfield (Reviewer)  
Senior Scientist (tectonic geomorphology and earthquake geology)