BEFORE COMMISSIONERS APPOINTED BY WAIKATO REGIONAL AND HAURAKI DISTRICT COUNCILS

UNDER	the Resource Management Act 1991 (**RMA**)
AND	
IN THE MATTER	of an application for resource consents to extend the Waihi Gold Mine via underground and open pit mining methods known as Project Martha
BY	**OCEANA GOLD (NEW ZEALAND) LIMITED**
	Applicant

SYNOPSIS OF TECHNICAL REPORT (s42A) AND RESPONSE TO EVIDENCE BY

Dr Peter Fuller

FOR THE HAURAKI DISTRICT COUNCIL

Geotechnical and Surface Stability

19 November 2018

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1. INTRODUCTION

1.1. My full name is Peter Gilmour Fuller and my role concerning the Project Martha Application has been as technical adviser to the Hauraki District Council (HDC) on matters relating to geotechnical aspects and surface stability.

1.2. I have reviewed the Application and the appended technical expert reports covering the MP4 pit, the underground mine, the interaction between the MP4 pit and the underground mine, the groundwater assessment and the surface settlement assessment. I have also reviewed the various responses to questions that I raised after reading draft versions of those reports and the submissions received by the HDC in which geotechnical and surface stability matters were raised.

1.3. The overall finding from my review of the technical reports and responses is that the separate technical assessments are all of the highest standard possible given the current preliminary status of the proposed underground mining part of the project.

1.4. My findings on the stability aspects of future mining are that:

1.5. Martha pit and its new MP4 design to cutback the north wall and mine remaining ore in the base to 875mRL have been extensively analysed and the conclusion that the MP4 design will be stable, particularly if old mined stope voids 30m below the floor are backfilled, is well founded;

1.6. Analysis of the proposed underground mine has focussed on critical dimensions for individual stopes to achieve local stability, and stability of the pillar between the surface and the top mined level in the new Rex lode. It has been inferred that lodes are laterally separated for each to be mined without interaction from others and that intervening pillars between essentially parallel lodes will remain stable. However, if additional lodes are found and separations become small, more investigation will be needed to confirm the adequacy of what are effectively regional support pillars for the area. This matter is addressed later in paragraphs 2.4 and 3.4 of my evidence;

1.7. Stoping of wide areas of previously unmined portions of lodes and remnant mining of previously mined areas will need to be sequenced to ensure that back (roof) spans are not excessive and there is no increased risk of backs becoming unstable;

1.8. The need for proper backfilling of mined stopes has been recognised as the major control against the risk of the underground area becoming unstable and impacting the stability of the surface. This has been proven worldwide to be effective. An essential requirement is that each mined stope will need to be backfilled before stope blasting commences in any adjacent stope. This requirement has been included as proposed consent condition 71 a.

1.9. It is noted that for remnant mining of unfilled historic voids in a top – down sequence, initial backfilling of the voids is to occur with either cemented aggregate fill (CAF) or rockfill but it is unclear from the Application whether this means filling the total stope void or part thereof. Nevertheless, prior backfilling of old stope voids before remnant stoping is essential otherwise it will be necessary for remnant stoping to start at the top level of the old stope.

1.10. My findings relating to the surface – underground interaction study are that:

1.11. Interaction between underground, and MP4 pit and the surface has been examined in considerable detail with a 3D model representation of the main underground workings and proposed new stoping as well as a 2D model of Rex lode workings and the surface close to the centre of Waihi. Both are appropriate for checking for interactive effects. The extra work with the 3D modelling to check the sensitivity of results to input parameters including the amount of underground mining has provided a useful guide to the location, areal extent and amount of mining related surface movement which is likely to occur;

1.12. Maximum vertical settlement of about 100mm is predicted in the central zone of the SE wall of MP4 and spreading out onto the surface around the SE rim where the settlement prediction is about 25mm, gradually reducing to zero about 200m east of the rim. These values should be regarded as indicative only as they depend on the assumptions made in the model. Mining in the Rex lode is predicted to cause about 10mm of reasonably uniform settlement across a 150m wide zone immediately south of the S rim of MP4. Movements

of the magnitudes predicted have occurred in the past within the Martha pit and as such, are not regarded as any undue cause for concern regarding pit stability; and

1.13. Settlement due to mining the main part of Martha underground has been shown to be quite sensitive to the size of mined zones and to the backfilling of stope voids. Placement of CAF in voids 30m below the base of MP4 is predicted to have a beneficial effect of reducing both the extent and magnitude of displacement and strain and the consultants concluded that the possibility of local crushing at the base of the wall will be reduced by backfilling those voids with CAF. Since this is likely to have a beneficial effect on both short and long-term stability of MP4, rather than leaving it to be considered at some later stage, it should be an essential requirement for the project and should occur as soon as a suitable and safe access for backfill placement becomes available. It is preferable that it occurs well before the final stage of the N wall cutback in MP4. The necessity for this to occur differs from the Applicant's view and this is discussed further in paragraphs 2.2 and 3.2 of my evidence.

1.14. My findings related to groundwater conditions and their impact on surface settlement are that:

1.15. Predictions of the effect of lowering the groundwater level to 500mRL seem to be well founded and are based on extensive experience of previous dewatering to progressively lower levels at Waihi. Importantly, the effect on the near surface and essentially isolated groundwater system is likely to be minimal with only very minor seepage from the upper system considered a possibility in the uppermost mined levels in the Rex and Royal lodes;

1.16. No substantial increase in the area of dewatering is anticipated which seems reasonable, given that the Lower Quartz Andesite below 700mRL has been found to have lower permeability than at levels above and drawdown will tend to be steep close to the lodes; and

1.17. Surface settlement due to additional dewatering (which will be additional to mining induced settlement discussed in paragraph 1.12.) has been assessed based to a large extent on the extensive experience with settlement prediction and the response to previous dewatering in the Waihi area to date. Some

increases in settlement are anticipated and the area around the pit has been rezoned based on the predictions. Trigger levels for settlement have been revised and will need to be included in a monitoring plan that will require certification before project commencement. No increase in the likelihood of excessive differential settlement has been predicted.

1.18. In relation to geotechnical and surface stability matters raised in submissions to the HDC, my opinion is that:

1.19. Stability related concerns expressed in some submissions will be mitigated by the consent conditions 71 a. and b. relating to the placement of backfill in all stopes. The issue of intersecting a previously unknown stope void at least partially filled with water will be addressed in a Void Management Plan (VMP) required to be certified by the HDC before underground mining commences. Concerns about the likelihood of another N wall failure occurring have been covered by the detailed examination of ground conditions in the N wall and behind the cutback wall position, and analyses show the cutback wall to be stable. Further assurance of that will result from the early filling of unfilled stope voids.

2. COMMENTS ON THE EVIDENCE PROVIDED PRIOR TO THE HEARING

2.1. Having reviewed the evidence for the Applicant relating to geotechnical points, there are three matters of disagreement between me and some of the Applicant's experts. These are:

- the essential need for old open historic stope voids within 30m of the MP4 pit base (presumed to be the pit toe) to be backfilled with CAF,
- the requirement to commence mining the first remnant stope at the top of an historic stope; and
- the requirement for any new lodes to be mined between those included in the Application to be investigated for their impact on stability to the satisfaction of the HDC prior to that mining commencing.

2.2. In relation to the first matter in paragraph 2.1., I have reviewed Mr Sullivan's evidence and note that in paragraph 21, comment b) he states that a positive of Project Martha is that the underground mining component will stabilise many of the existing openings immediately below MP4. While that may be so,

the results of the modelling of the combined MP4 – underground mining in Run 1 indicate in Figures 1 and 2.

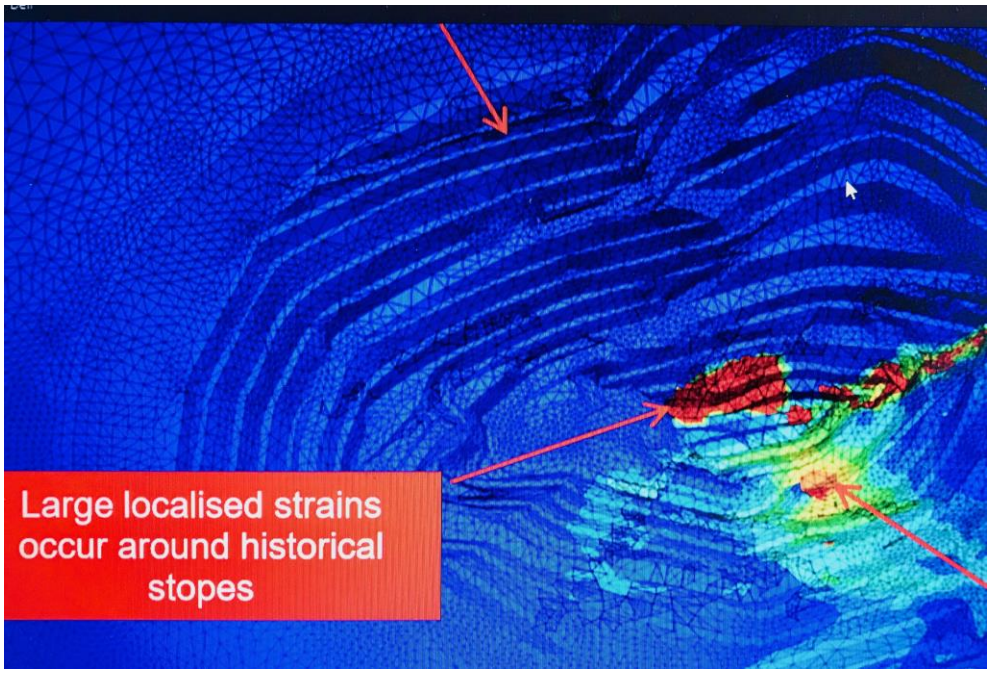

Figure 1. Extract from Figure 24 of AEE Appendix P1 – shear strain at base of north wall after completion of MP4 and underground mining without backfill in old stopes below the MP4 base

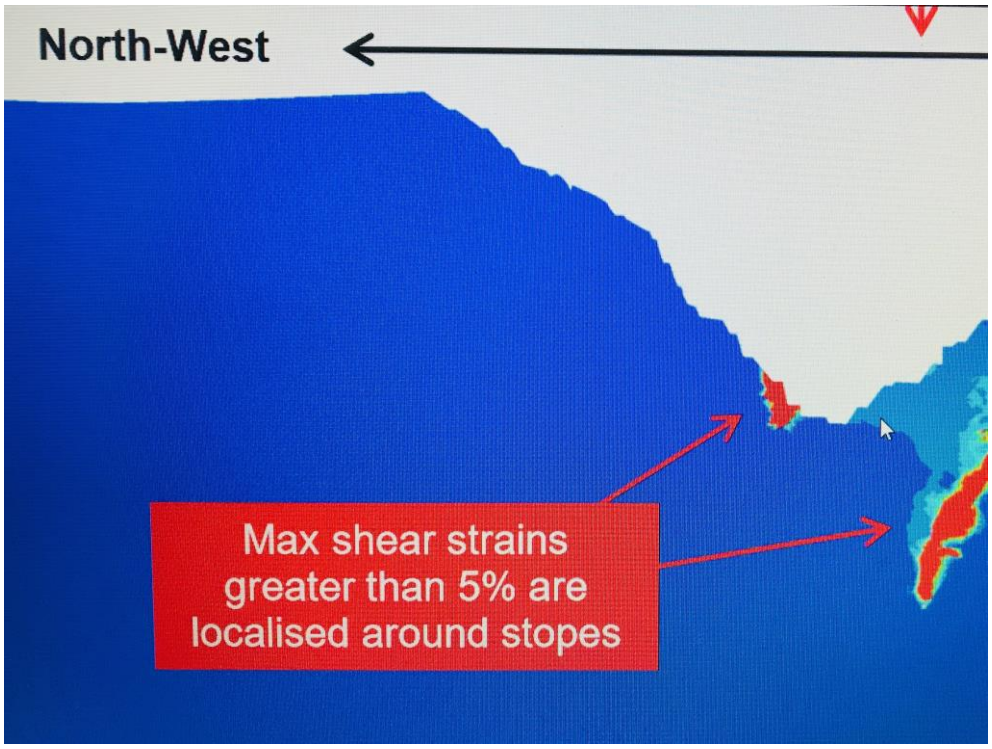

Figure 2. Extract from Figure 25 of AEE Appendix P1 – shear strain at base of north wall after completion of MP4 and underground mining without backfill in old stopes below the MP4 base

that a zone of greater than 5% shear strain remains at the base of the completed MP4 North wall. In my opinion this level of shear strain is indicative of rockmass failure and maintaining strength in this zone is critical to minimising the risk of pit wall failure. Run 6 of the modelling included prior backfilling of unfilled historic stope voids with CAF within the zone 30m below the base of MP4 and the equivalent results to those in Figures 1 and 2 are shown in Figures 3 and 4.

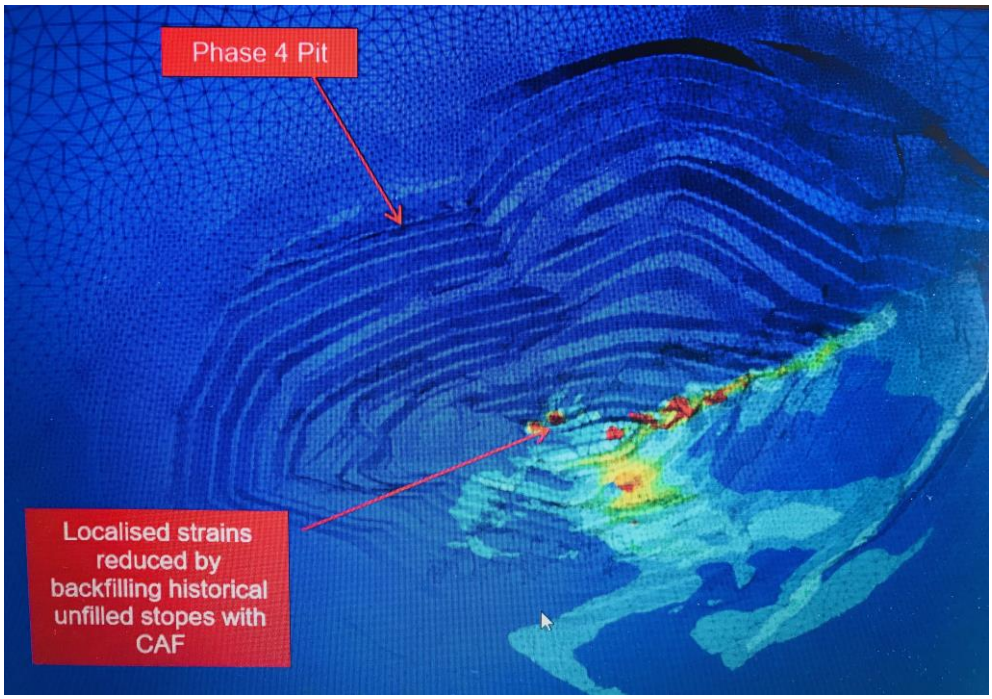

Figure 3. Extract from Figure 43 of AEE Appendix P1 – shear strain at base of north wall after completion of MP4 and underground mining with CAF backfill in old stopes below the MP4 base

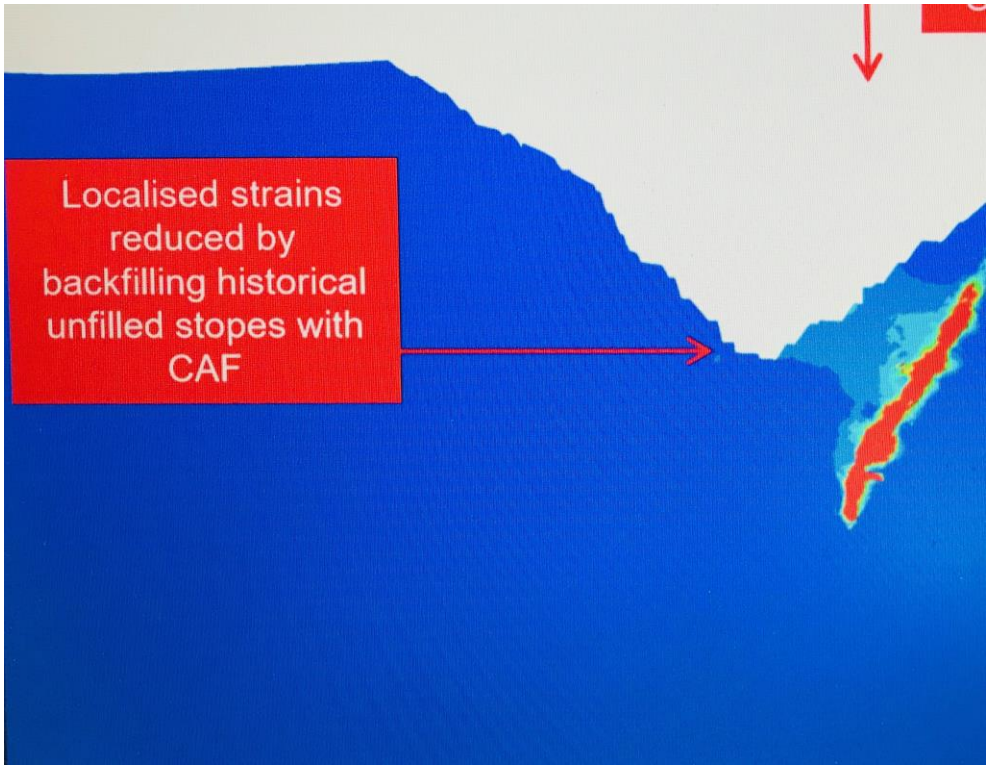

Figure 4. Extract from Figure Appendix G7 of AEE Appendix P1 – shear strain at base of north wall after completion of MP4 and underground mining with CAF backfill in old stopes below the MP4 base

CAF backfilling has virtually eliminated the high shear strain zone leaving the rockmass at the base of the N wall relatively unaffected. A reduction in displacement from around the toe (from greater than 1m to some 30mm) can be seen by comparing results in Figures 5 and 6 for the analyses

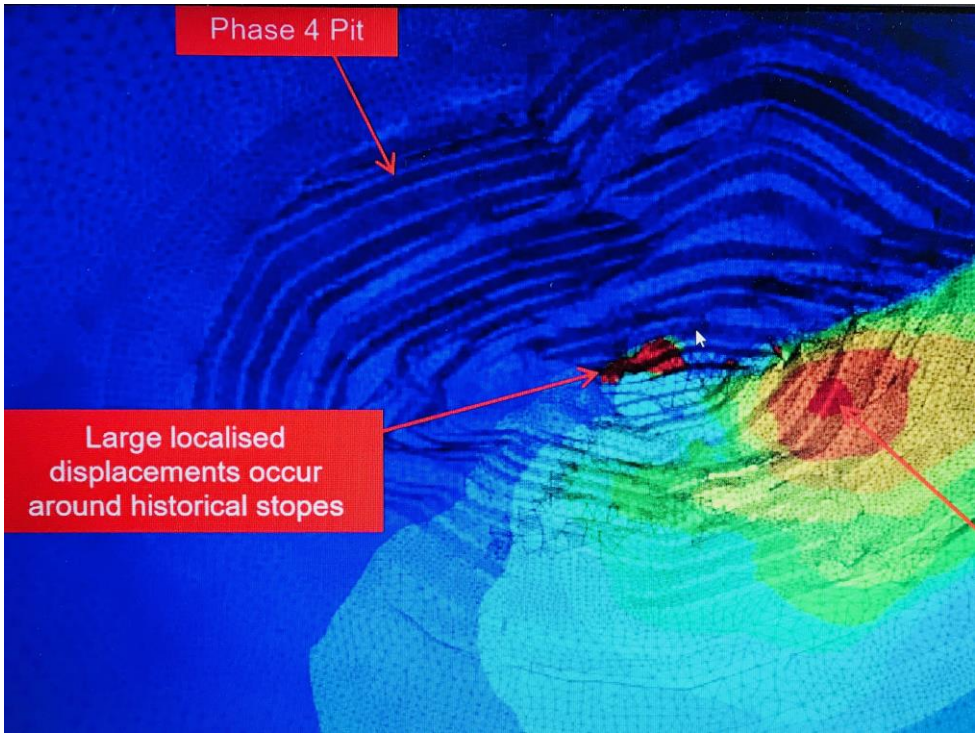

Figure 5. Extract from Figure 18 of AEE Appendix P1 – displacement at base of north wall after completion of MP4 and underground mining without backfill in old stopes below the MP4 base

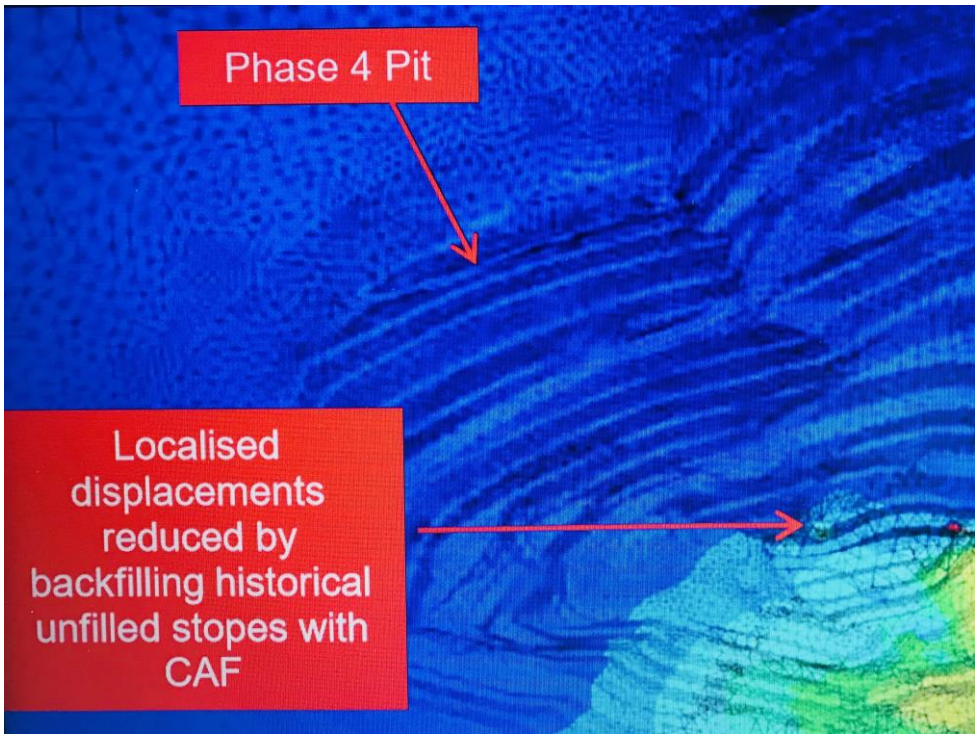

Figure 6. Extract from Figure 42 of AEE Appendix P1 – displacement at base of north wall after completion of MP4 and underground mining with CAF backfill in old stopes below the MP4 base

without and with prior CAF placement 30m below the MP4 pit base. Based on these model findings, my opinion is that prior backfilling of historic stope voids within the zone 30m below the base of MP4 as soon as it is practical and safe to do so should be a requirement of consent condition 70 to ensure that the MP4 design remains stable and a competent buffer exists between the pit and the uppermost underground mining. While the use of CAF for that backfilling is my preferred option because of its superior stiffness and strength to limit strain and displacement, other forms of backfill including cemented rock fill (CRF) or rockfill will still be beneficial to maintaining stability of the toe and walls of the MP4 pit. I note that Mr Sullivan advocates a “wait and see” approach in his evidence and that any backfill placement in this zone should depend on pit wall behaviour and conditions exposed and be a remedial treatment rather than the pro-active one which I recommend. In my opinion this would, in all likelihood, be too late to be effective, may be too risky to undertake, and is unlikely to be completed quickly.

2.3. The second matter of disagreement concerning the need for remnant stoping of unfilled historic voids to commence at the top was considered by Mr O’Leary in paragraph 49 of his evidence to be too restrictive. While I am sympathetic to this point, unless there is a requirement for all such voids to be fully backfilled with sufficiently competent material prior to the commencement of remnant stoping in the walls or pillars of that previously mined lode, my opinion is that the above condition should remain. Otherwise, remnant mining could occur near the bottom of an open historic stope void by undercutting either the hangingwall or footwall and potentially induce a progressive failure in walls of the unfilled portion which could propagate a considerable distance upwards and impact either the pit walls or the surface depending on its location. Mr Sandy, in paragraph 70 of his evidence, points out that short and long term local and regional stability underground can only be assured if a high degree of backflling is achieved and in paragraph 81 he covers the requirement for backfilling unfilled historic voids. The addition I recommend is that such backfilling needs to occur prior to the commencement of remnant stoping around the particular old stope. If this occurs, there is no need for remnant stoping to commence at the top level.

2.4. The third matter of disagreement relates to the stability of pillars between existing and new lodes and the requirement that this be investigated prior to commencing mining in the new lodes. I understand that this could be seen as being restrictive to future mine planning and method selection and I agree with Mr Turner that it can be dealt with under the Void Management Plan (VMP). For Project Martha, in my opinion the VMP should be regarded as the plan covering all voids, historic and present and not just the need to be aware of and manage the stability and interaction with historic voids.

3. ADDITIONAL COMMENTS ON THE EVIDENCE PRESENTED AT THE HEARING

3.1. Just prior to and during the hearing I was able to discuss these three points of disagreement with Messrs Sullivan and Sandy.

3.2. On the first matter, I agreed that any form of backfill (not just CAF) will be beneficial in limiting displacement at the toe of MP4 and Mr Sullivan agreed that the proactive approach which I advocate will achieve the best result in terms of maintaining both short and long term stability of the MP4 pit. However, such backfilling will need to be done from the base of the pit and we have agreed that it must be both practical and safe. Consent condition 70 a. has been added to cover the agreed requirement.

3.3. Regarding the second matter of prior backfilling unfilled historic voids before starting any adjacent remnant stoping, Mr Sandy and I referred to paragraph 81 of his evidence and agreed that the intent of that would address my concerns. That paragraph has been duly reworded and included as consent condition 71 b.

3.4. The third matter was discussed with Mr Sandy and agreed that with the preliminary conceptual stage of underground mining, it has not been possible to assess the specific need for separation pillars to ensure regional scale stability. It was therefore mutually agreed that this matter be addressed as part of the VMP by a combination of consent conditions 72 g. and 72 h.

3.5. In conclusion, the application of backfill in old unfilled stope voids and all new stopes created as part of Project Martha will ensure that stability underground is properly controlled and hence that the underground operations will not affect the stability of the surface. It is predicted that the SE wall of the MP4 pit

will experience mining induced settlement from the underground mine but from past monitoring of wall movements and experience, the magnitude of these has been assessed by the Applicant's expert to not lead to any pit wall failure of any consequence to either the operation of the mine or long-term pit stability. I have no reason to doubt that conclusion.

3.6. Each year I have been commissioned by the HDC to audit OGNZL against current underground and surface stability related conditions for consented underground mining and development in the Waihi area. The results have been 100% compliance and OGNZL have demonstrated that maintaining both local and regional stability receive extremely high priority. For Project Martha, with compliance with consent conditions 70 to 75 as drafted, I am confident that surface stability for Project Martha will be maintained.

19th November 2018