



# Correnso/SUPA/MDDP Stability 2017 Annual Report



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**A - Modified Avoca Technique (graphic)**

**B - Surface Drillholes Intersecting Workings**



## 1. PURPOSE

The purpose of the OceanaGold Waihi (OGW) Correnso/SUPA Surface Stability Annual Report is to comply with the requirements of the following Hauraki District Council (HDC) consent conditions:

- LUC 202.2012 (Correnso) Condition 25 – Surface Stability
- LUC 202.2016 (SUPA) Condition 19 – Surface Stability.
- LUC 202.2017 (MDDP) Condition 25 – Surface Stability

Please note that the anniversary for the Correnso report was originally 20 December, the date in 2013 when the first blast was initiated in the Correnso Consent Area. In agreement with HDC, this anniversary was revised to 31 December to coincide with other calendar year data collation and reporting. The agreed anniversary for the SUPA and MDDP stability reports was also agreed to be 31 December to allow the information from the three linked projects to be amalgamated into one combined report.

### 1.1 AS REQUIRED BY CONDITION 25 OF LUC 202.2012 (CORRENZO)

25. *The consent holder shall provide to the Council on an annual basis (within one month of the agreed anniversary) a report:*
- Describing the location, depth height and volume (m<sup>3</sup>) of stopes; and a summary of the data required by Condition 26 regarding unfilled stope voids; and*
  - Describing the lengths of development that, due to the encountered geotechnical conditions where multiple levels overlap, will require backfilling prior to mine closure; and*
  - Describing the backfilling and compaction associated with each stope; and*
  - Describing the ground conditions revealed by the mine excavations; and*
  - Describing the monitoring and measures adopted to ensure ground surface stability, particularly as provided for in Condition 23 and the outcomes of such measures; and*
  - Describing the location and depth of exploratory drives;*
  - Confirming that the extent of the mining works is confined to CEPPA, as defined in Figure 1.*

### 1.2 AS REQUIRED BY CONDITION 19 OF LUC 202.2016 (SUPA)

19. *The consent holder shall provide to the Council an annual report (within one month of the agreed anniversary established in condition 4 or as otherwise agreed in writing by the Council):*
- Describing the location, depth height and volume (m<sup>3</sup>) of stopes; and a summary of the data required by Condition 20 regarding unfilled stope voids; and*
  - Describing the lengths of development that, due to the encountered geotechnical conditions where multiple levels overlap, will require backfilling prior to mine closure; and*
  - Describing the backfilling and compaction associated with each stope; and*
  - Describing the ground conditions revealed by the mine excavations; and*
  - Describing the monitoring and measures adopted to ensure ground surface stability, particularly as provided for in Condition 15 and the outcomes of such measures; and*
  - Describing the location and depth of exploratory drives;*
  - Confirming that the extent of the mining works is confined to SUPA, as defined in Figure 1.*

*These reports may be prepared in conjunction with similar reports prepared in accordance with the consent conditions applying to the Correnso Underground Mine.*

### **1.3 AS REQUIRED BY CONDITION 25 OF LUC 202.2017 (MDDP)**

25. *The consent holder shall provide to the Council an annual report (within one month of the agreed anniversary established in condition 4 or as otherwise agreed in writing by the Council):*

- a) Describing the location and depth of the exploratory drives and any intentional interceptions of historic development, rises and access drives; and*
- b) Describing the lengths of development that, due to the encountered geotechnical conditions or where multiple levels overlap, will require backfilling prior to MDDP closure; and*
- c) Describing the ground conditions revealed by the MDDP excavations using key identification criteria as defined by an independent geotechnical specialist and*
- d) Describing the monitoring and measures adopted to ensure ground surface stability, particularly as provided for in condition 21 and the outcomes of such measures; and*
- e) Confirming that the extent of the underground works is confined to the MDDP area as defined in Figure 1.*

**Advice Note:**

*These reports may be prepared in conjunction with similar reports prepared in accordance with the consent conditions applying to the CEPPA and SUPA.*

## **2. LOCATION, DEPTH, HEIGHT AND VOLUME OF STOPE**

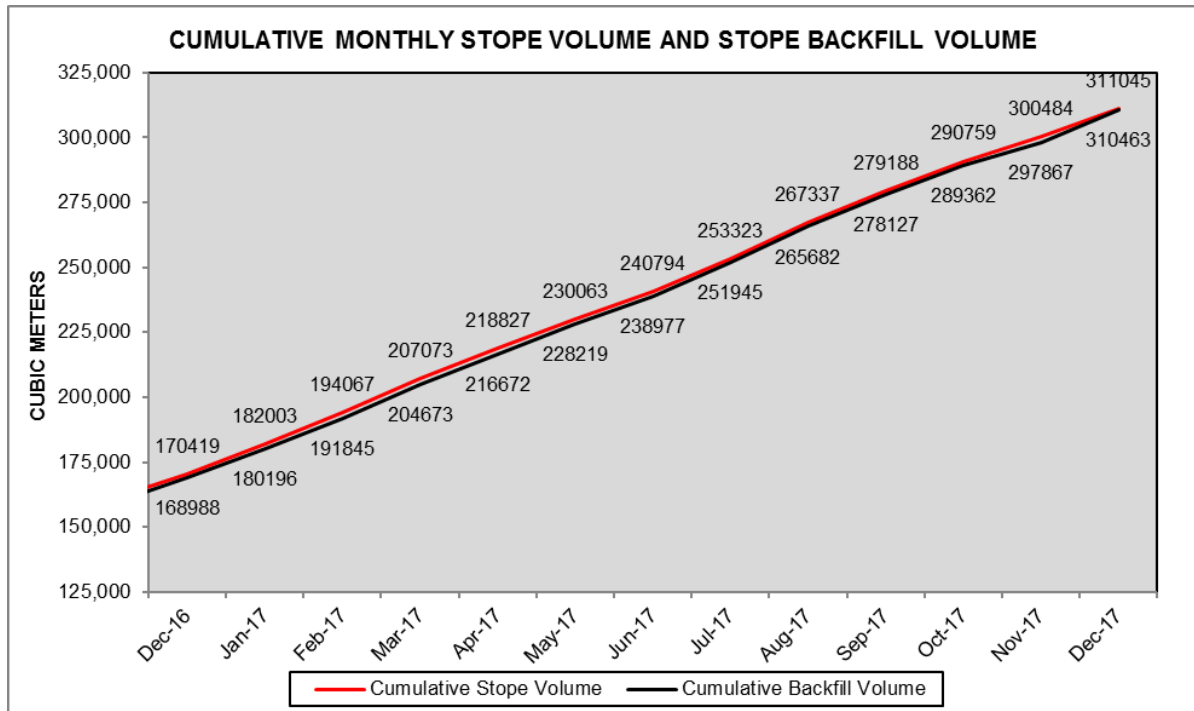
*(Consent conditions: Correnso c.25a, SUPA c.19a)*

The stoping methodology for Correnso is Modified Avoca (refer to Appendix A for a graphical representation). This method requires a 'bottom-up' mining technique, whereby each successively higher stope is mined out by driving on the surface of the previously laid backfill of underlying stopes. This technique also requires the development to the extremities of the ore body, then mining back towards the access points. Schematics of Correnso mining operations for the period are presented in Figures 2 to 4.

Stope extraction began in mid-2015, with production continuing throughout 2016 and 2017. At any one time, multiple stopes are in various states of the production cycle (drilling, blasted stocks, bogging, and backfilling). This means that some stopes may have open voids at the end of the month. By the end of the reporting period, 311,045m<sup>3</sup> of stope volume had been extracted, with 31,046m<sup>3</sup> backfilled (Figure 1) and mining had reached the 915 level.

Stope design during the period consisted of 5m drives with up to 10m stope panels between the drives. The 10m stope height was the maximum during the year; no stopes were greater, a few were less. This results in an effective maximum void height of 20m; made up of the 10m stope and two 5m drives (one above and one below the stope).

While most of the mine development is along the main vein, mining of minor offshoot 'splay' veins is undertaken when viable. These are in various states of extraction (Figures 2 to 4) and are annotated in Figure 5.



**Figure 1: Cumulative monthly stope voids and backfill volumes 2017**

### 3. DEVELOPMENT & EXPLORATION DRIVES

*(Consent conditions: Correnso c.25b&f, SUPA c.19b&f, MDDP c.25a)*

Figures 5 to 7 indicate development progress across the operations as at 31 December 2017.

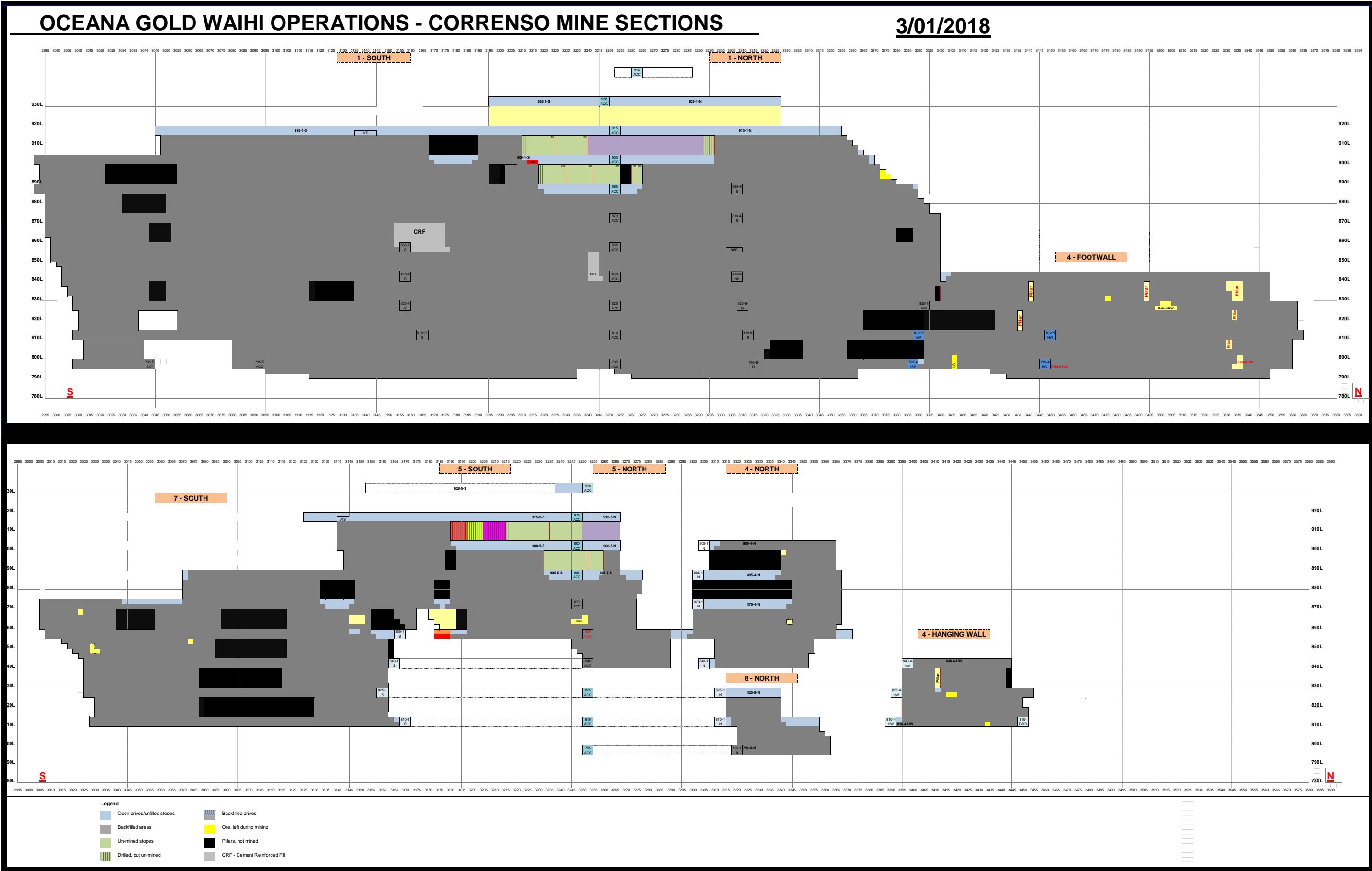


Figure 2: Schematic Long Section of Correnso Veins



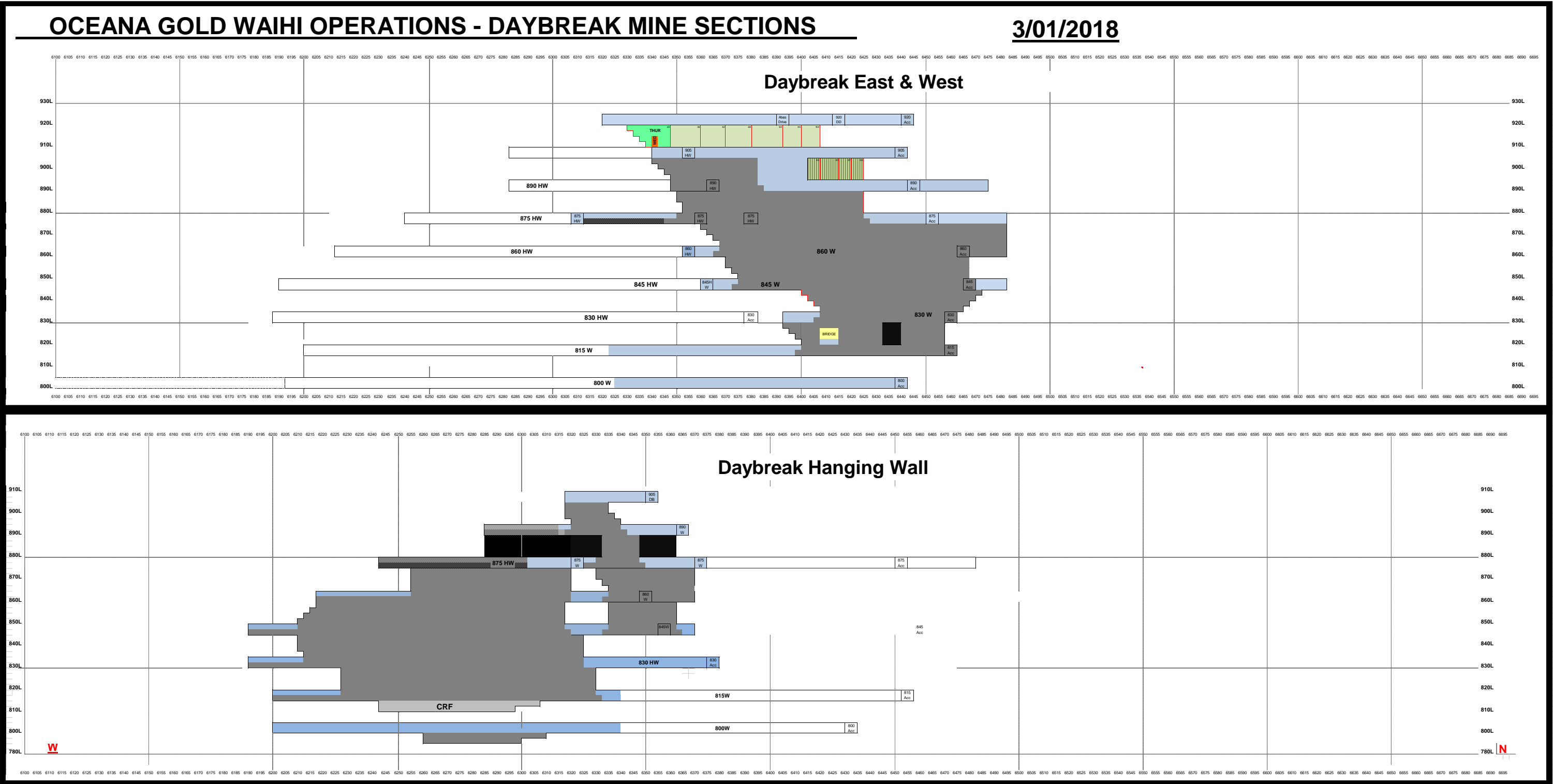
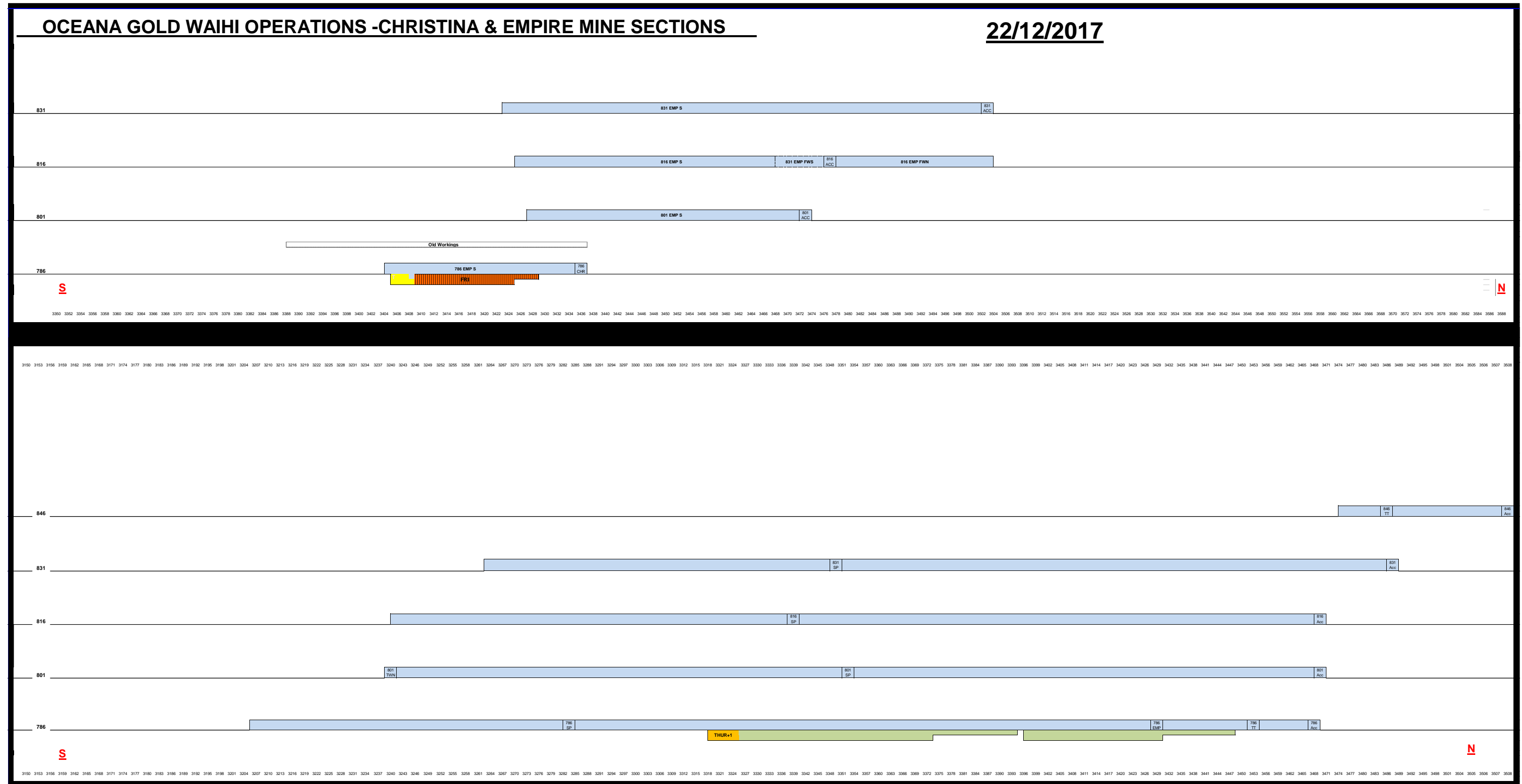


Figure 3: Schematic Long Section of Daybreak Veins



**Figure 4: Schematic Long Section of Christina & Empire Veins**

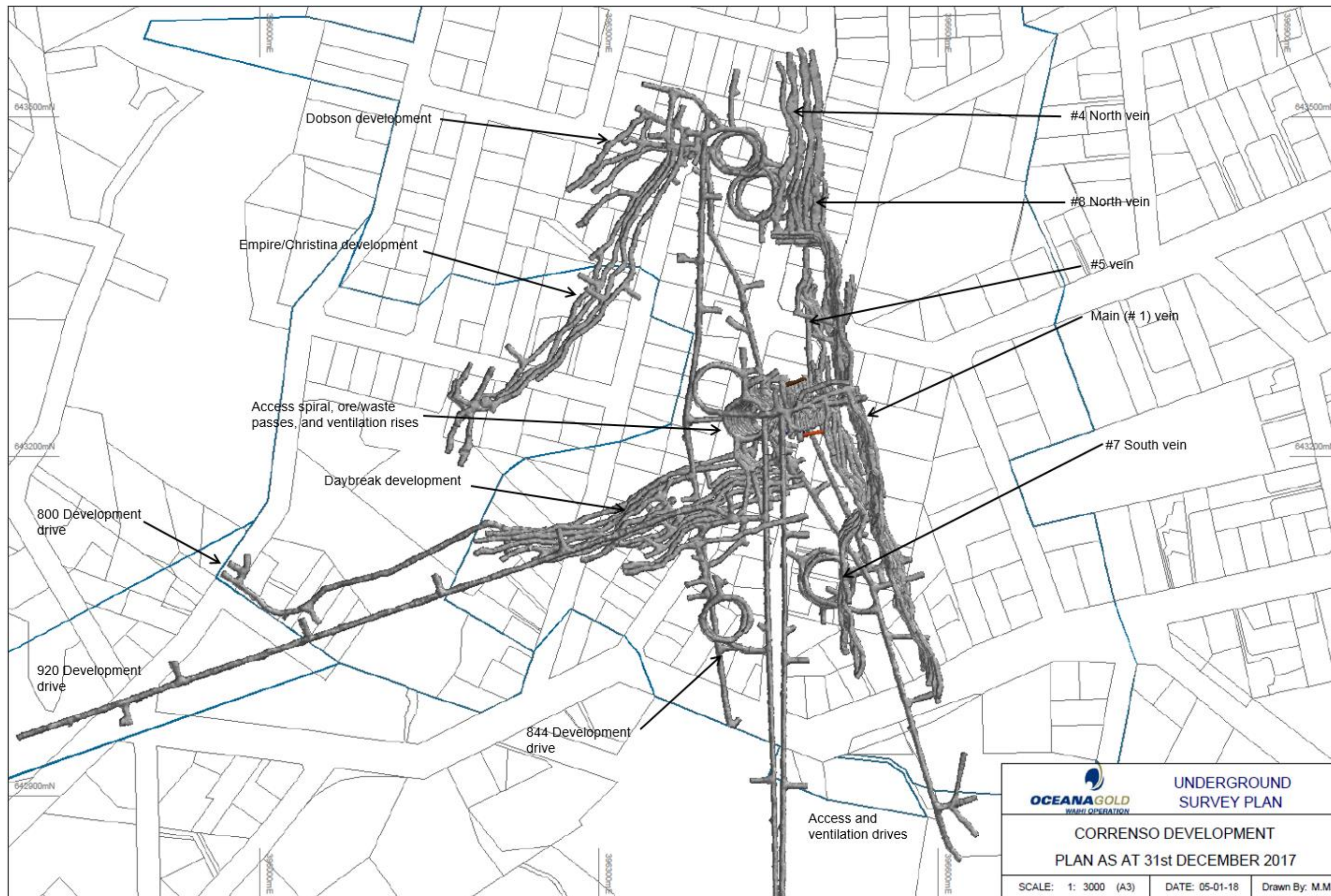


Figure 5: Correnso Development – Plan View (overlying property boundaries)



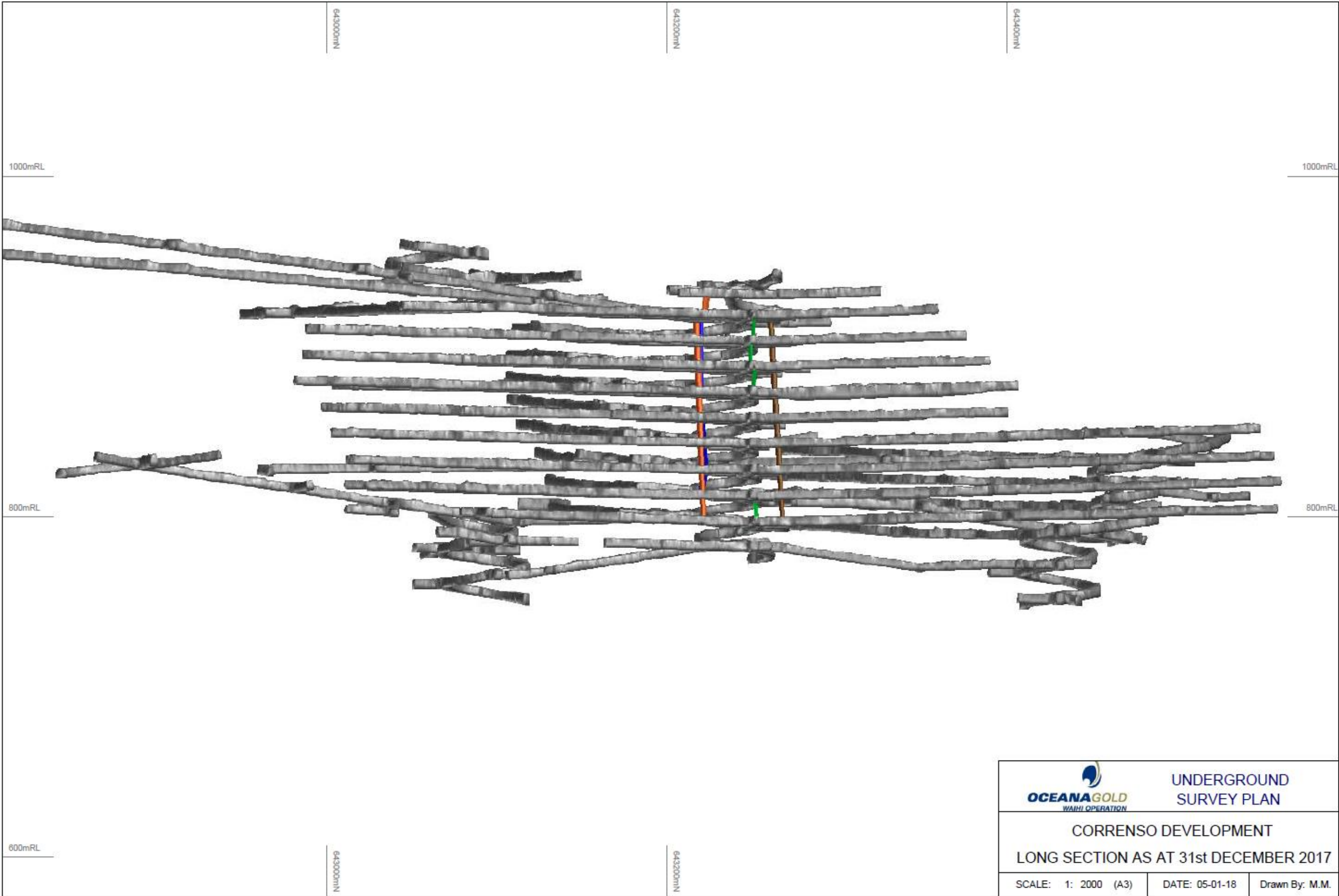


Figure 6: Correnso Development – Long Section View (left to right: south to north)

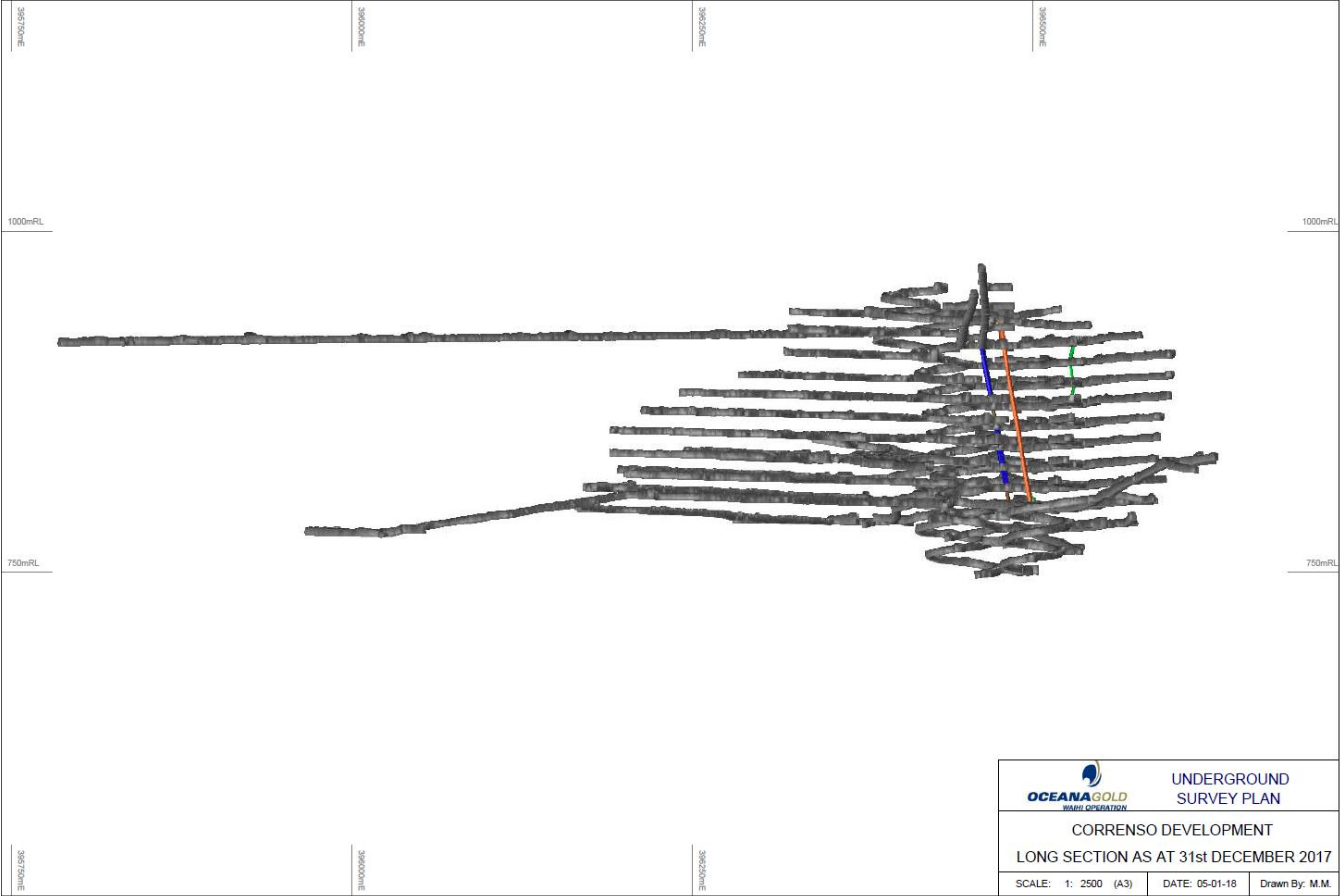


Figure 7 Correnso Development – Long Section View (left to right: east to west)

#### **4. BACKFILLING AND COMPACTION**

*(Consent conditions: Correnso c.25c, SUPA c.19c, MDDP c.25b)*

All stopes extracted to date are backfilled as is dictated by the mining method and conditions. Compaction occurs during backfilling by the machine placing the fill in the stope, then continues with subsequent operations of heavy machinery on top of the backfill. Historically this gives good compaction and the high clay-content of the fill provides a good binding medium.

Extensions of Daybreak and Correnso Drives beyond stoped areas were also backfilled.

No stoping occurred in the SUPA area during 2017. Once production commences the voids will be backfilled and machine compacted as referenced above.

Development of the 920 Drill Drive commenced during 2017 and extended into the Martha Drill Drive Permit area (MDDP). The primary purpose of the development is for underground exploration drilling. This was the only development into the MDDP area during 2017. At this stage, there are no plans to backfill the drive.

#### **5. GROUND CONDITION REVEALED BY EXCAVATIONS**

*(Consent conditions: Correnso c.25d, SUPA c.19d, MDDP c.25c)*

Ground conditions for Correnso are mostly as expected. Q-value estimates are from 1 to 80 representing rock mass categories Poor to Very Good according to Barton's (1974) ground support guidelines. Localised areas of poorer ground are encountered relating to intersecting structures and converging veins.

The most consistently problematic area was the northernmost extents of Correnso due the relatively shallow-dipping veining and sheared hanging wall contacts. Potential local stability issues were managed by a combination of additional ground support and conservative panel lengths. Mining was successfully completed in this area in the early part of 2017 with most of the ore extracted despite challenging conditions and the voids, drives and accesses tight-filled.

Mining during 2017 extracted the lower levels of Correnso which are now backfilled and closed off. (Figure 2). The upper levels of Correnso have overall steeper to sub-vertical vein orientations in relatively good ground conditions. Very few problematic areas have been encountered apart from areas of converging veins where both veins are extracted. These has been successfully managed through appropriate mine sequencing, additional reinforcement and prioritising back-filling.

Daybreak ground conditions are not dissimilar to Correnso. The veining overall dips at a slightly shallower angle than Correnso and localised areas of HW shearing are encountered. Very short panel lengths with prompt back-filling proved a successful management strategy through the sheared areas. Elsewhere there were very few issues.

Development continued in the SUPA area on the Christina and Empire veins during 2017. Ground conditions are overall Good to Very Good (Barton 1974) and there has been almost no requirement for additional support beyond the routine mine standards. Empire is a relatively shallow-dipping vein (50 – 60 degrees) but the strike extent is limited and hanging wall country-rock conditions are favourable.

Development drives on Christina intersected historical exploration tunnels in two locations (as planned) revealing the tunnels to be in very good condition with no evidence of any ground instability,

even with firings having occurred to break into the tunnels. Cavity surveys of proximal historic tunnels using CALS instrumentation (a cavity laser scanning tool) into probe holes also showed the historic tunnels to be in very good condition.

## **6. MONITORING AND MEASURES FOR STABILITY**

*(Consent conditions: Correnso c.25e, SUPA c.19e, MDDP c.25d)*

Multipoint Borehole Extensometers (MPBX) were installed during the early stages of mine development on the 795, 810, 825, 855 and 900 levels. The instruments were all installed in the intersections between the access and the main (#1-vein) ore-drives as representing the widest openings on the vein, as well as being the areas expected to see the most induced stresses as mining retreats towards the accesses. The MPBXs are inserted and grouted into up-hole boreholes and measure micro-displacements as low as 0.1 mm between “anchors”. The MPBXs utilised at Correnso have anchors at 1, 2, 3, 4, 6 and 8 m up the drillholes.

Additionally, five 2-anchor “clock-it” extensometers are installed into the backs of the 915 level with anchors set at 2.5 m and 6 m up the holes.

None of the above instruments showed any indications of significant ground movement or stress concentrations. As stoping has progressed upwards the MPBXs on the 795, 810 and 825 and 855 levels have been lost, as expected. Readings prior to the MPBXs being destroyed indicated overall stable conditions.

The 900 MPBX, which is the instrument likely to see the greatest stress increase has remained stable as has the 915 tell-tale clock-its. Visual inspections show no indications of any stress-related damage. The access intersections with the ore-bodies are all shotcreted and cracks in the shotcrete provide an early visual indicator of damage. The shotcrete liners all remain intact.

An MPBX is now installed in an upper level of Daybreak. Readings are also stable.

A micro-seismic monitoring system is installed (as per consent conditions: Correnso c.23d, SUPA c.15d, & MDDP c.21c) to provide additional reassurance that mining activity would not be causing instability. Micro-seismicity can be basically described as micro-earthquakes less than 0 magnitude, too small to be felt on surface but detectable by sensitive equipment located underground.

The purpose of the seismic system is to monitor regional stability and the rock mass response to mining activities in the critical areas. Given the shallow depth of stoping and a relatively benign stress regime, the seismic system is not expected to record many non-blasting related seismic events. The maximum horizontal stresses pre-mining at 300 m depth are measured at 22 MPa; maximum vertical stresses (from the weight of the overlying rock) are around 15 MPa. These stresses are well below the 60 to 120 MPa average range of measured strengths of the rock mass that hosts the Correnso ore body.

It is generally accepted in industry that event magnitudes of:

<b>Magnitude</b>	<b>Potential impact</b>
$mL \leq 0.0$	does not impact on operations
$0.0 < mL \leq 0.5$	could potentially impact on operations, but typically marginally.
$0.5 < mL \leq 1.0$	could impact on operations and even cause damage if sufficiently close to workings.
$1.0 < mL \leq 2.0$	could require special energy absorbent support systems
$mL > 2$	definitely requires special energy absorbent support systems.

The agreed critical magnitude for Correnso is a conservative  $ML = -0.5$ . Any seismic event of  $ML = -0.5$  and above are thus defined as an "anomalous result", and has to be reported to the HDC on a monthly basis and the following details are required:

- Event magnitude and location coordinates.
- Image plot of the seismic events that includes existing openings and significant geological structures.
- Explanation of the probable cause of the seismic events.

Levels of seismicity are overall low and there have only been very few reportable events during the year. The reportable events above  $mL-0.5$  do not show any clustering or trends and most of the readings are well away from mine activity. There have been no volumes of unusual activity reported by the seismologists who monitor the data, nor any volumes of unusual magnitude events.

The seismic system is to be upgraded in early 2018 to give coverage of the new mining areas.

## **7. MINING CONFINED TO CONSENT BOUNDARIES**

*(Consent conditions: Correnso c.25g, SUPA c.19g, MDDP c.25e)*

Figure 8 displays the current mine development overlying an aerial projection, with the consent boundaries superimposed. All current works are entirely within the consent boundaries.

Surveying methodology has been previously audited and found to be well within the standards prescribed. This accuracy has been utilised to ensure that works stay conservatively within consent boundaries.



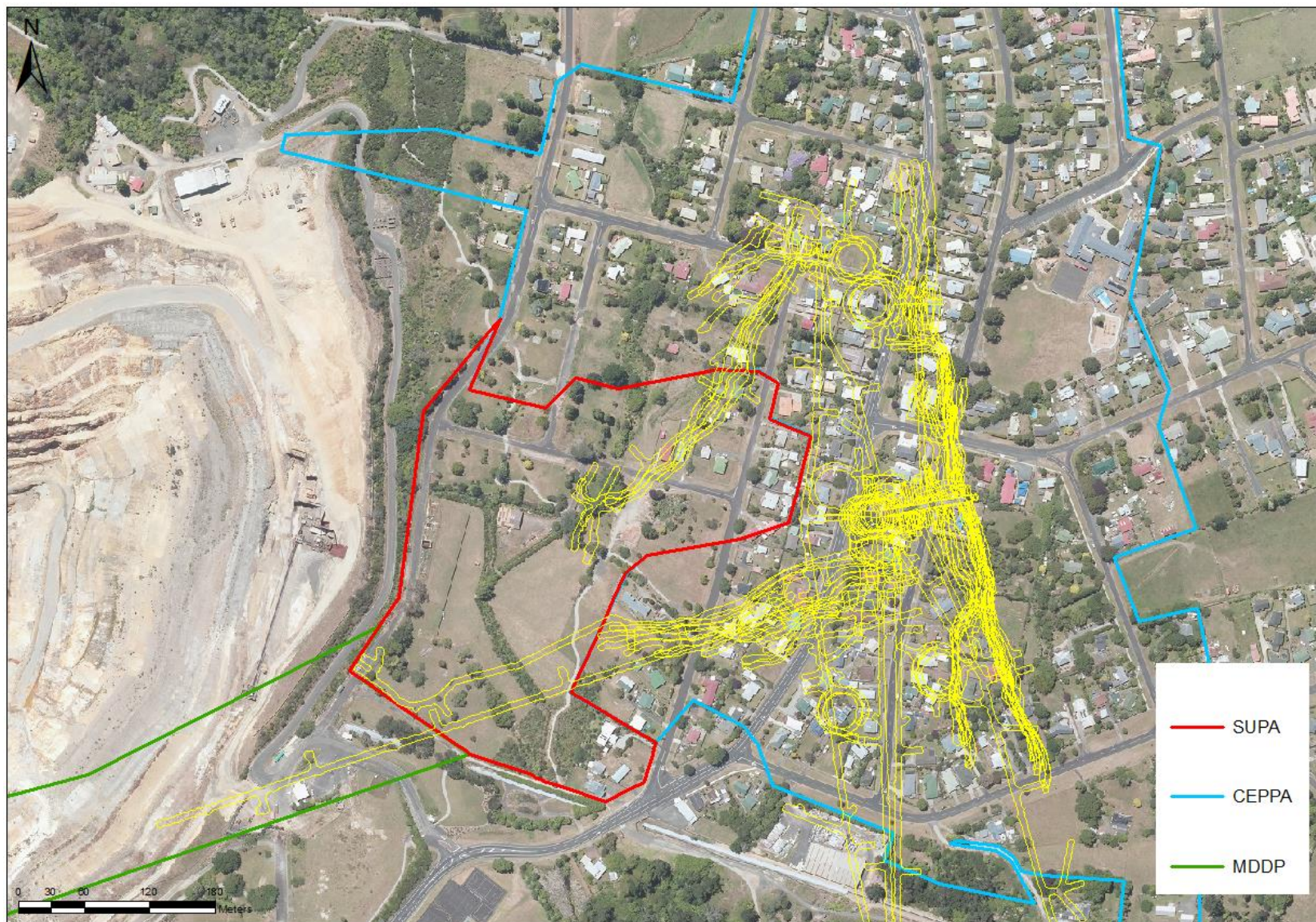


Figure 8: Correnso Development – Plan View (with CEPA, SUPA & MDDP boundaries)

## **8. REVIEW OF CONSENT CONDITION REQUIREMENTS**

- a) Mining methods used require stope voids to be backfilled  
All stopes are backfilled as is required for the Avoca mining method (pictorial representation in Appendix A).
- b) Limits to upper levels of stoping  
The uppermost level on which stoping has been carried out by the end of 2017 was the 915 (900 – 915).
- c) Backfilling where required by geotechnical conditions  
Refer Section 5.
- d) Seismic monitoring and rock movement monitoring  
Refer Section 7 above for monitoring systems.
- e) Grouting of surface-drilled holes  
No surface-drilled exploration has been undertaken over Correnso during the reporting period.
- f) Interception of surface-drilled holes with water flows, and their treatment  
There were no surface drillholes intercepted with any significant water-flows during 2017 (refer Appendix B).
- g) Works confined within consent boundaries  
Refer Section 8 for work locations.

## **9. CONCLUSION**

OceanaGold believes it has fully complied with Conditions 25 (of HDC LUC 202.2012), 19 (of HDC LUC 202.2016) and 25 (of HDC LUC 202.2017) and that the risk of ground surface instability is extremely low due to the geology of the area and best practice underground mining methodologies which have been employed.

Please note also that the 6 monthly tilt surveys have continued to show there is no evidence of mining induced surface instability.

## **10. REFERENCES**

Dunn, M. 2014. Correnso Stage 2B Geotechnical Study. NEM013. Internal Newmont Report prepared by SRK Consulting (Australasia).

Barton et al (1974). Barton, N., Lien, R. and Lunde, J. 1974. Engineering classification of rock masses for the design of tunnel support. Rock Mech., May. 189-236.

CKL (Pagan M), June 2015. Correnso Mine Waihi Report. Survey Verification Report for Hauraki District Council.

Mining One (Fuller, P), February 2015. Verification of CEPA underground mine workings relative to cadastral boundaries on the surface. Report for Hauraki District Council.

OceanaGold NZ Ltd, Jan 2018. Notification of Tilt, Nov 2017. Letter report to Hauraki District Council.



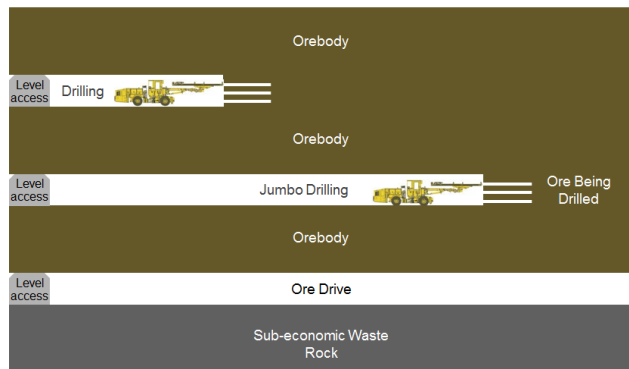
## **Appendix A**

### **Modified Avoca Technique**

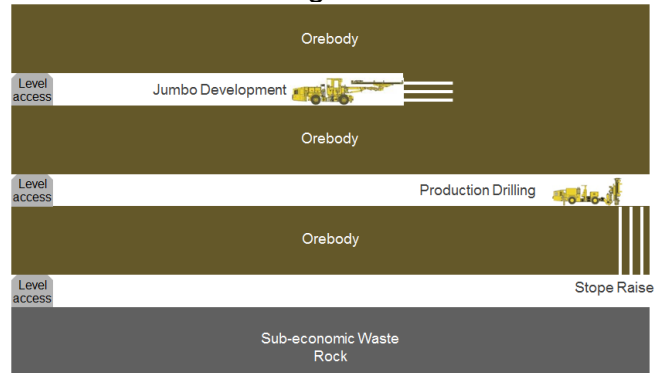


## Schematic of Modified Avoca Technique

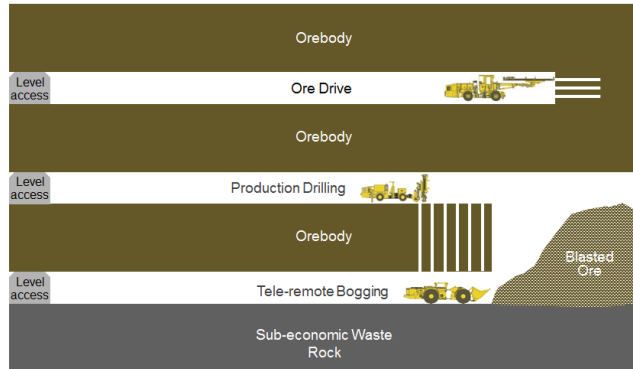
### 1 Drill drive access



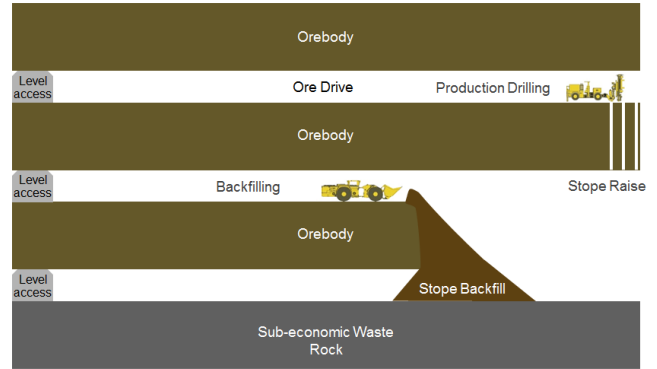
### 2 Production drilling



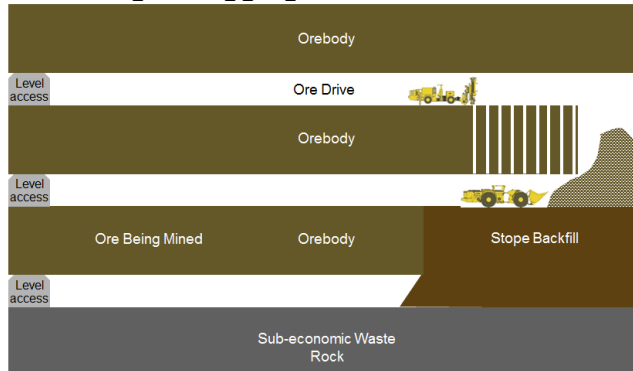
### 3 Production blasting & bogging



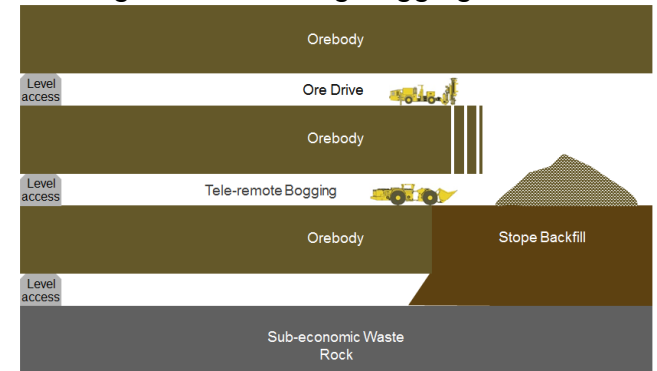
### 4 Backfilling



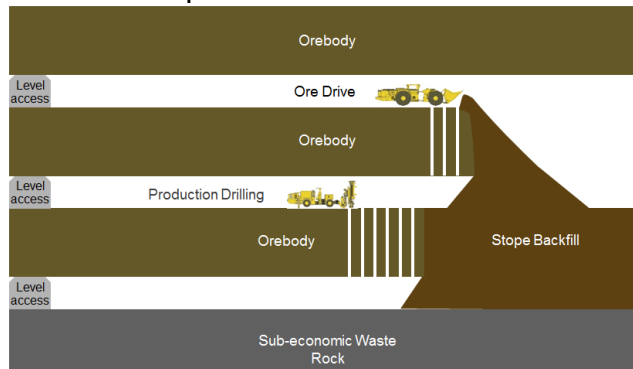
### 5 Blasting & bogging over backfill



### 6 Progressive blasting/bogging



### 7 Multi-level production/backfill



## **Appendix B**

### **Surface Drillholes Intersecting Workings**

Hole ID	Level	Drive	E	N	m.R.L	Date intersected	Pickup	Grouting status	Comments
<b>CGD008</b>	810	C4-FW	396488.5	643473.4	821.4	13/06/2015	Estimated	Not grouted	Hole dry - no evidence of being a water conduit at this level: no Fe staining
<b>UW320</b>	912	ACC	396431.997	643265.11	917.774	13/04/2015	Surveyed	Not grouted	Hole dry
<b>UW348</b>	900	C1-N	396520.5	643263.45	907.62	14/12/2015	Estimated	Grouted	Trickling water which ceased within a day - grouted 16/12/2015
<b>UW358A</b>	900	C1-S	396586.70	643035.20	910.55	25/07/2016	Estimated	Grouted	Low flow, originally grouted within 12 hours, re-grouted after 36 hours. Surrounding split sets grouted as were acting as a conduit. Flow was approximately 1ltr/min
<b>UW365</b>	810	C4-FW	396488.4	643474.8	821.4	9/06/2015	Estimated	Not grouted	Hole dry
<b>UW368</b>	825	C7-S	396515.304	643114.23	833.067	26/08/2015	Surveyed	Grouted	Minor flow - hole re-grouted 16/12/2015
<b>UW386</b>	915	ORE PASS	396482.291	643218.53	914.937	4/02/2015	Surveyed	Not grouted	Hole dry - now in ore pass
<b>UW390</b>	840	C1-S	396541.39	643198.97	844.082	25/03/2015	Surveyed	Not grouted	Hole dry - no evidence of being a water conduit at this level: no Fe staining
<b>UW393</b>	840	C4-HW	396472.922	643416.31	851.398	16/08/2015	Estimated	Not grouted	Hole dry
<b>UW402</b>	953	CDD	396449.3	643126.9	930.5	17/12/2014	Surveyed	Grouted	Hole was producing minimal water for only a few hours
<b>UW402</b>	855	C7-S	396515.03	643092.42	864.645	18/10/2015	Surveyed	Not grouted	Dry - second time intersecting hole with development - was grouted on the 953
<b>UW374</b>	860	DB-HWW	396237.72	643120.73	871.896	16/12/2016	Surveyed	Not grouted	Hole was dry, no indication of previous water - i.e. no Fe staining, etc.
<b>CGD003</b>	942	ACC	396486.76	643260.62	941.1	12/03/2017	Estimated	Not grouted	Only a very light trickle and ceased completely within 24 hours
<b>UW339</b>	~775	Dobson RAD	396489.45	643296.31	778.239	10/06/2017	Surveyed	Not grouted	Hole intercept in backs dry but producing water from the floor due to being below the current water table. Floor intercept plugged 26/6/17 but no need to plug the backs intercept.

Below is a plan view section showing development on Correnso, Daybreak and Empire mine areas. Surface drillholes which intersect development, along with their pierce points, are shown; green points indicate the drillhole collars in the view while the red points indicate the approximate intersection point of surface drillholes with development (no surface holes have yet been intersected by Empire development).

