MEMO

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SUBJECT: **Response to WR-22 – Hydraulic gradients near block cave at closure**

DATE: **April 22, 2020**

INTRODUCTION

In preparation of the Resolution Copper Final Environmental Impact Statement (FEIS), the United States Forest Services (USFS) and its subcontractor SWCA arranged a series of meetings with the USFS Groundwater Working Group to address public comments received following publication of the Draft EIS (DEIS). The USFS Groundwater Working Group meetings consisted of the same agencies, representatives, and associated consultants previously assembled during the DEIS process.

During the latest meeting, held on March 26th 2020, a question about the regional groundwater model was raised and recorded as action item WR-22. The question centered on the hydraulic containment of groundwater near the block cave after closure of the Resolution Mine, and the assertion that it would behave as a sink into the future. This memo will focus directly on answering this question and provide graphical output from the predictive model to demonstrate the hydraulic containment of the groundwater through the years after mine closure.

MODEL RESULTS

The predictive regional groundwater model is run in transient mode through the 51-year Life of Mine (LoM), simulating mine development, propagation of the block cave, and associated dewatering. Thereafter, the model simulates the post-closure period and water level recovery of the block cave after mining and associated dewatering has ceased. Details of the predictive regional groundwater model and associated model setup is available in report *Resolution Copper Groundwater Flow Model Report (WSP 2019)*.

To answer the question of hydraulic containment (documented as action item WR-22), a series of model results are presented, illustrating the hydraulic gradients and flow vectors near the block cave through the post-closure period. The figures show model results in both plan and cross-sectional views to present horizontal and vertical flow directions, respectively. The cross-sectional view for presentation of model results corresponds with section A-A' provided in *Resolution Copper Groundwater Flow Model Report* (WSP 2019) and model row 82. The plan view for

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presentation corresponds with model layer 35 and captures the area of interest, including the future extent of block cave, fault graben, and surrounding HGUs of the deep groundwater system.

Figure 1 outlines the general configuration and key features utilized for reference on the following model result snapshots, including:

- HGUs and faults
- Extent of block cave zone
- Underground workings (historic Magma and future Resolution)
- Subsidence crater

Figures 2-5 show snapshots of the predictive model results at model years 200, 500, 950 and 975. Model results are shown as groundwater flow vectors and the zero-pressure contour in cross-sectional view and groundwater flow vectors and total head contours in plan view.

At model year 200 (150 years post-closure; Figure 2), strong inward gradients remain developed around the graben and indicate flow toward the high hydraulic conductivity (K) block cave, representing hydraulic sink conditions and containment (plan view). The east-west cross-section shows a consistent hydraulic field with flow directions downwards and inwards towards the low pressures within the block cave.

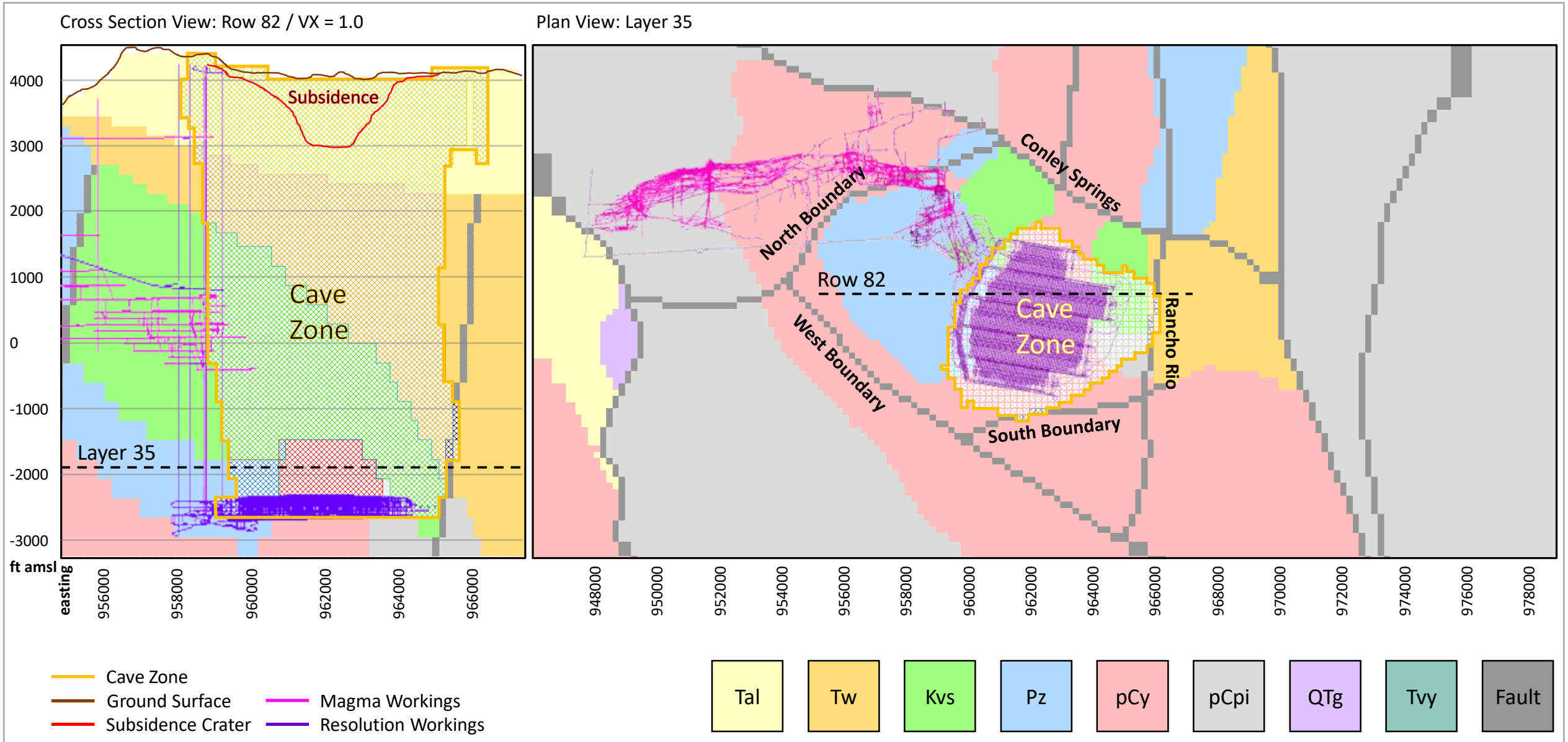
At model year 500 (450 years post-closure; Figure 3), water levels have recovered to approximately 0 ft amsl but remain more than 3000 ft below the bottom of the subsidence crater. Strong hydraulic gradients remain developed around the graben and block cave with all groundwater flow towards the low-pressure system within the cave, representing hydraulic sink conditions and containment at 500 years into the future.

The strength of hydraulic gradients continues to subside over time as the caved zone is filled, but hydraulic sink conditions remain in place far into the future and don't change until the period between 950 and 975 years of the predictive model. At 950 years, the block cave sink has considerably weakened, shown by larger spaced contours indicating lower gradients, but groundwater flow is still inwards toward the graben and block cave (Figure 4). However, at year 975, hydraulic gradients and groundwater flow vectors indicate that hydraulic containment subsides and a throughflow system is established, allowing groundwater flow from east-to-west across the North Boundary fault and west towards the Queen Creek watershed (Figure 5). Groundwater levels remain below the bottom of the estimated subsidence crater.

In summary, the figures and accompanying discussion indicate that hydraulic containment of groundwater within the block cave will be established for a very long period into the future. Although model results have inherent uncertainty, this evaluation demonstrates that the block cave and surrounding groundwater system indicate hydrogeologic conditions of a hydraulic sink past the period in which the USFS Groundwater Working Group and DEIS deemed reasonably foreseeable.

REFERENCES

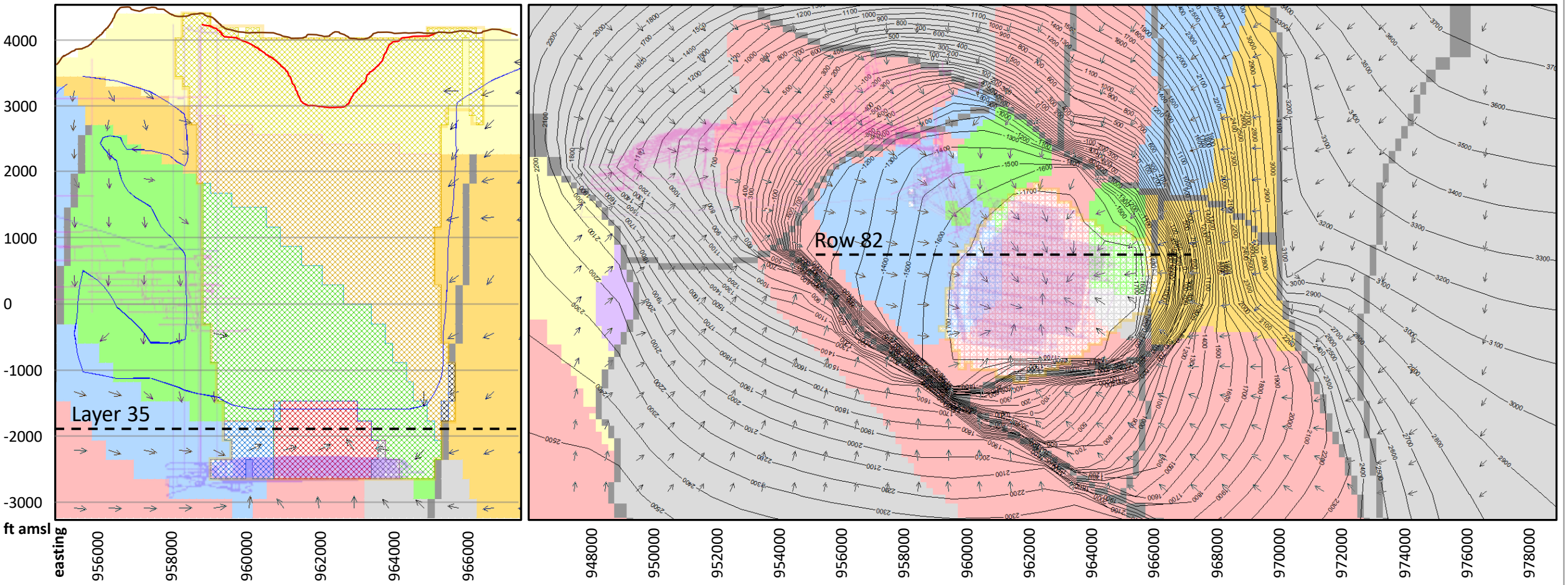
WSP USA. 2019. *Resolution Copper Groundwater Flow Model Report*. Project No.: 31400968. Greenwood Village, Colorado: WSP USA. February 15.



Post-Closure Hydraulic Gradient Assessment - Cross Section & Plan View Basemap	
PROJECT: WR-22	FIGURE: 1
CLIENT: Resolution Copper	PROJECT #: 31400968.002
DRAWN: CP	DATE: April 2020

Cross Section View: Row 82 / VX = 1.0

Plan View: Layer 35



Cave Zone
Ground Surface
Subsidence Crater
Magma Workings
Resolution Workings
Zero Pressure
Head Contour

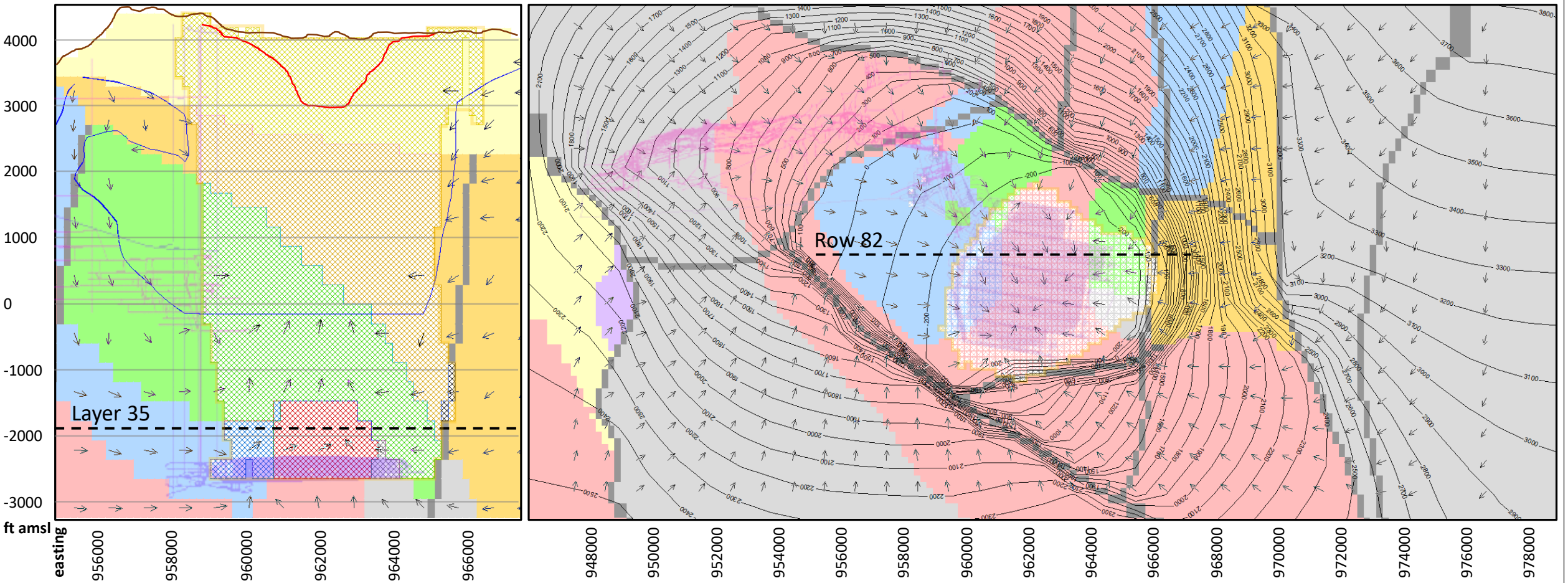
Tal | Tw | Kvs | Pz | pCy | pCpi | QTg | Tvy | Fault

Post-Closure Hydraulic Gradient Assessment – Model Results Year 200

PROJECT: WR-22	FIGURE: 2
CLIENT: Resolution Copper	PROJECT #: 31400968.002
DRAWN: CP	DATE: April 2020

Cross Section View: Row 82 / VX = 1.0

Plan View: Layer 35



Cave Zone
Ground Surface
Subsidence Crater
Magma Workings
Resolution Workings
Zero Pressure
Head Contour

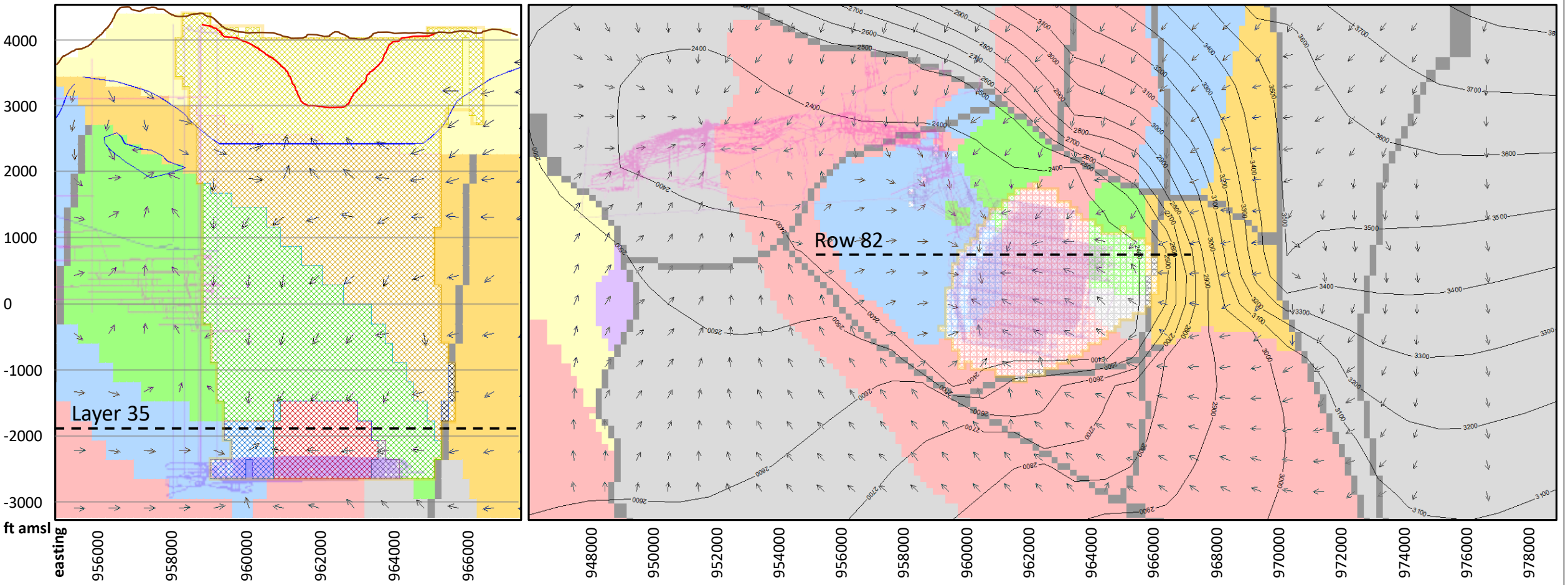
Tal | Tw | Kvs | Pz | pCy | pCpi | QTg | Tvy | Fault

Post-Closure Hydraulic Gradient Assessment – Model Results Year 500

PROJECT: WR-22	FIGURE: 3
CLIENT: Resolution Copper	PROJECT #: 31400968.002
DRAWN: CP	DATE: April 2020

Cross Section View: Row 82 / VX = 1.0

Plan View: Layer 35



Cave Zone
Ground Surface
Subsidence Crater
Magma Workings
Resolution Workings
Zero Pressure
Head Contour

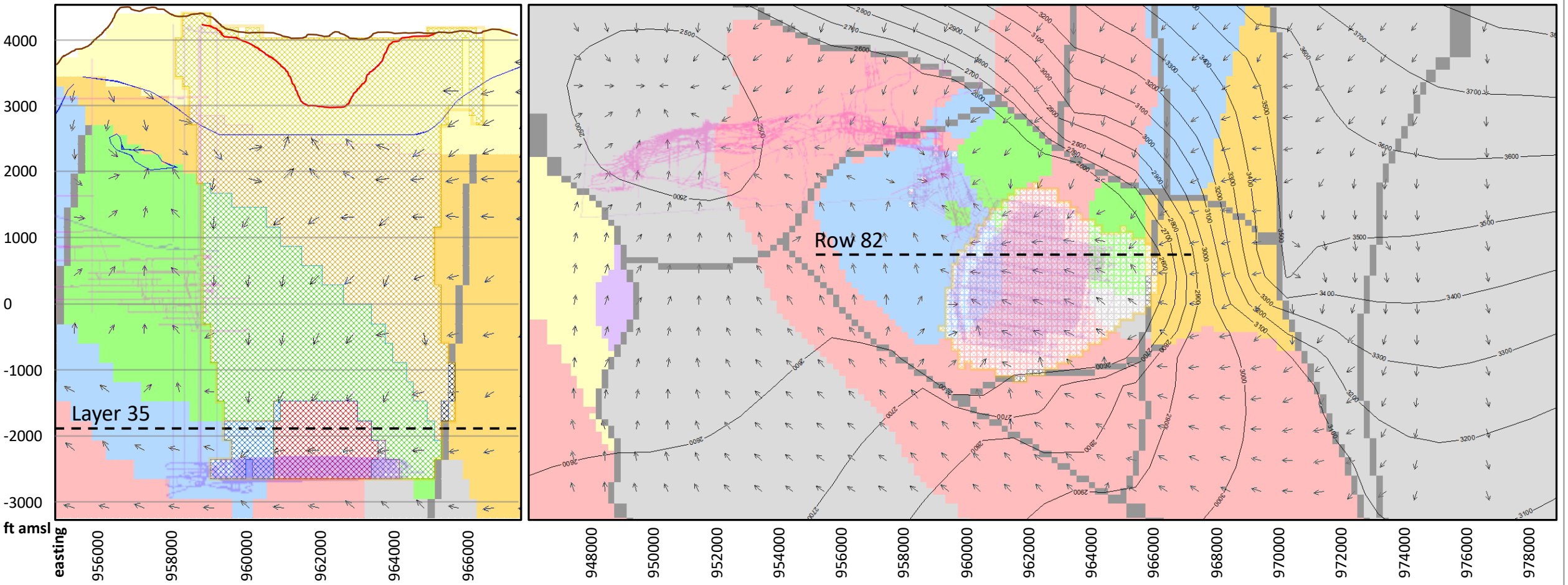
Tal | Tw | Kvs | Pz | pCy | pCpi | QTg | Tvy | Fault

Post-Closure Hydraulic Gradient Assessment – Model Results Year 950

PROJECT: WR-22	FIGURE: 4
CLIENT: Resolution Copper	PROJECT #: 31400968.002
DRAWN: CP	DATE: April 2020

Cross Section View: Row 82 / VX = 1.0

Plan View: Layer 35



Cave Zone
Ground Surface
Subsidence Crater
Magma Workings
Resolution Workings
Zero Pressure
Head Contour

Tal | Tw | Kvs | Pz | pCy | pCpi | QTg | Tvy | Fault

Post-Closure Hydraulic Gradient Assessment – Model Results Year 975

PROJECT: WR-22	FIGURE: 5
CLIENT: Resolution Copper	PROJECT #: 31400968.002
DRAWN: CP	DATE: April 2020