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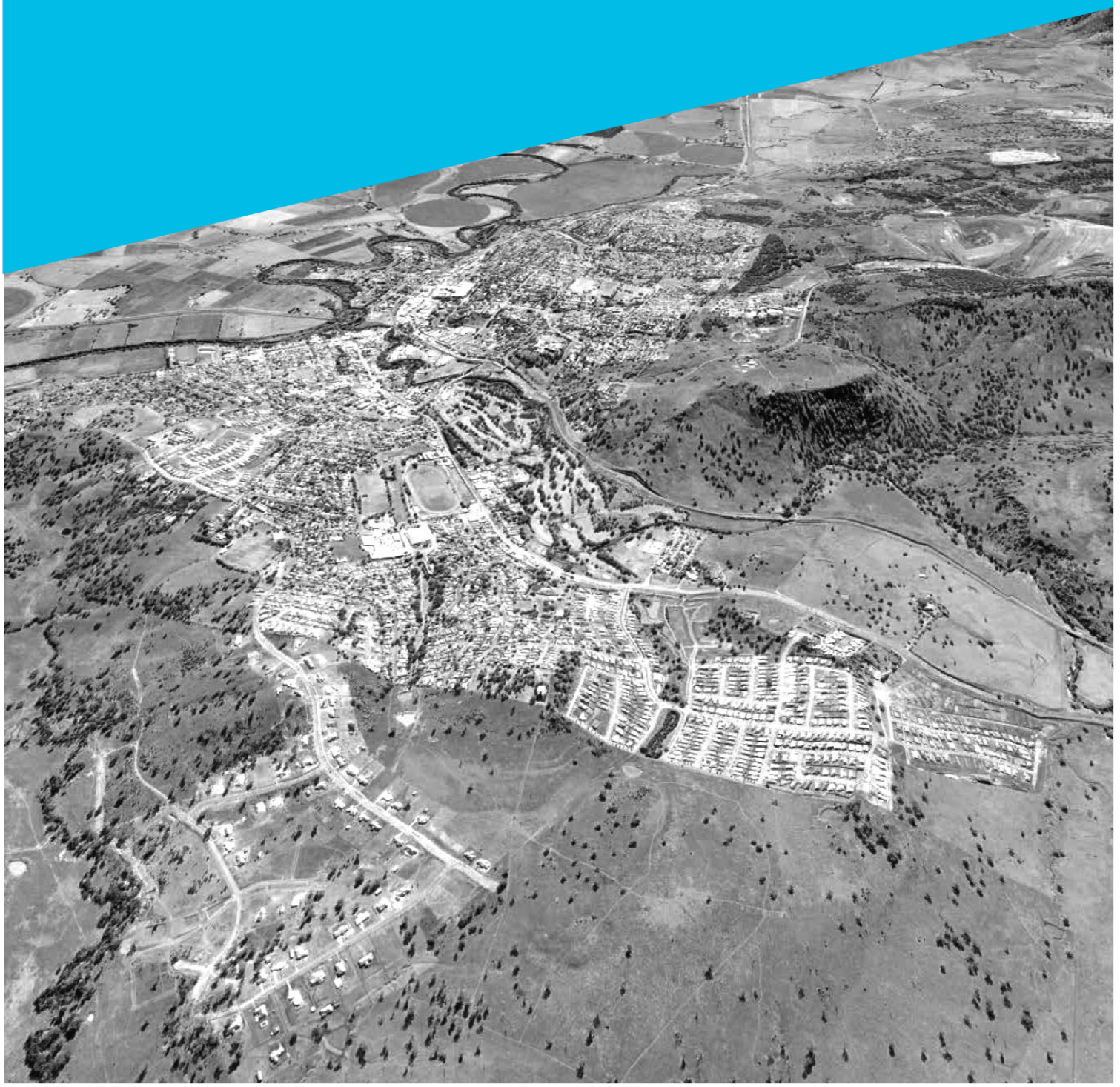
Muswellbrook Bypass Concept Phase
Transport for NSW
10-Sep-2021

Mining Assessment Report

Muswellbrook Bypass Concept Phase



Mining Assessment Report

Muswellbrook Bypass Concept Phase

Client: Transport for NSW

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Executive summary

AECOM Australia Pty Ltd (AECOM) has been engaged by Transport for NSW (Transport) to undertake the concept design and environmental assessment for the Muswellbrook Bypass Concept Phase (MBCP) project. This report provides an assessment of the potential impacts of the former underground mine workings on the performance of the proposed bypass. The assessment has been carried out to facilitate the approval process with Subsidence Advisory NSW (SA NSW) for construction of the section of the bypass over the former underground mine workings.

The proposed bypass is located to the east of Muswellbrook township within the Muswellbrook Shire Council local government area. The bypass is about 9 km long with a section (around 1.5 km long) north of Coal Road passing over former mine workings and waste placements owned by Muswellbrook Coal Company (MCC) including a short section over the former underground workings about 70 m long and a former open cut.

Geotechnical investigations were carried out as part of a program of works for the alignment concept design. As part of this work a number of investigations were carried out targeting the former underground workings in the Muswellbrook, St Heliers and Lewis seams. These are listed below:

- Geotechnical boreholes to intercept the Muswellbrook and St Heliers seams and the Lewis Seam workings
- Sonar survey where BH28_UG intercepted the Lewis Seam workings
- Review of mine tracings
- Assessment of pillar stability in the Lewis Seam.

The investigations indicate that the underground workings in the Muswellbrook and St Heliers are too far removed from the alignment to have any impact on the road and these workings have not been considered further.

The assessment concluded that no further works were required to stabilise workings in the Lewis Seam. It is proposed to construct a full depth asphalt pavement supported by a load transfer platform (LTP) over the former open cut immediately to the south of the underground workings and this pavement type should be extended for the alignment over the former Lewis Seam workings.

1.0 Introduction

1.1 Project overview

Transport have been investigating a bypass of the New England Highway at Muswellbrook since 2000. The New England Highway is part of the National Land Transport Network and is a major freight and commuter route.

Currently, New England Highway traffic passes through six traffic lights, a roundabout, a school zone, under a narrow railway overpass, and through a flood prone section of highway at Muscle Creek. All these items impact on the total travel time for both local commuters and through traffic. Additionally, the narrow railway underpass poses limitations for over-size over-mass (OSOM) vehicles which are required to use alternate routes around the town.

There is presently considerable interaction between local, though, pedestrian and bicycle traffic, causing safety concerns and overall slower traffic movements. This leads to a poor scenario for future infrastructure developments around the CBD. Projected increases in population and subsequently traffic in the Muswellbrook area and adjacent regions, will result in increased strain on the existing New England Highway infrastructure that passes through Muswellbrook.

A bypass of the town centre would remove conflicts between local and through traffic, improve local amenity and improve the efficiency of heavy vehicle movements along the New England Highway. Overall, this would ensure that the future growth in the region is matched with appropriate infrastructure

Route options were initially displayed in 2000, after which the Australian Government announced a preferred option for the Muswellbrook bypass in 2005. Muswellbrook Shire Council reserved the road corridor of the preferred option in their 2009 Local Environment Plan (LEP). After further consideration of project constraints and costs in 2015, the 2005 preferred option was no longer considered economically viable.

Transport has continued identifying an economically viable option for a bypass including consideration of in-town routes and refinements on the 2005 preferred option. Further option assessments were completed in 2017 to clarify a preferred project design that is most suitable given the updated investigations.

In early 2019, the NSW Government announced they would fully fund the $266 million Muswellbrook bypass as part of a key election promise. Along with this announcement was expectation of construction to commence in 2022, placing significant time constraints on the project.

The current work being undertaken by AECOM Australia Pty Ltd (AECOM) will focus on the development of the concept design and environmental assessment of the New England Highway bypass of Muswellbrook.

1.2 Project objectives

The objectives of the New England Highway Muswellbrook bypass project are to focus on the development of the concept design and environmental assessment while considering the following:

- Improve network efficiency on the New England Highway, particularly travel times for long haul freight movements
- Improve safety for all road users in the town centre, particularly relating to heavy and light vehicle interactions
- Improve amenity of Muswellbrook township.

1.3 Extent of proposal area

The bypass proposal area broadly identifies the area to be considered for a bypass corridor (refer Figure 1 below). This area is being assessed as part of an REF.

The bypass proposal area includes a southern and northern connection with the existing New England Highway, a central connection with Coal Road and a large section of property owned by MCC.

A portion of the preferred bypass route, predominately at the northern and southern connection, has been designated for transport infrastructure as part of the Muswellbrook Shire Council (Council) Local Environmental Plan 2009. Additionally, there are portions of the preferred corridor that pass over individual landowner properties, including those owned by Ausgrid.

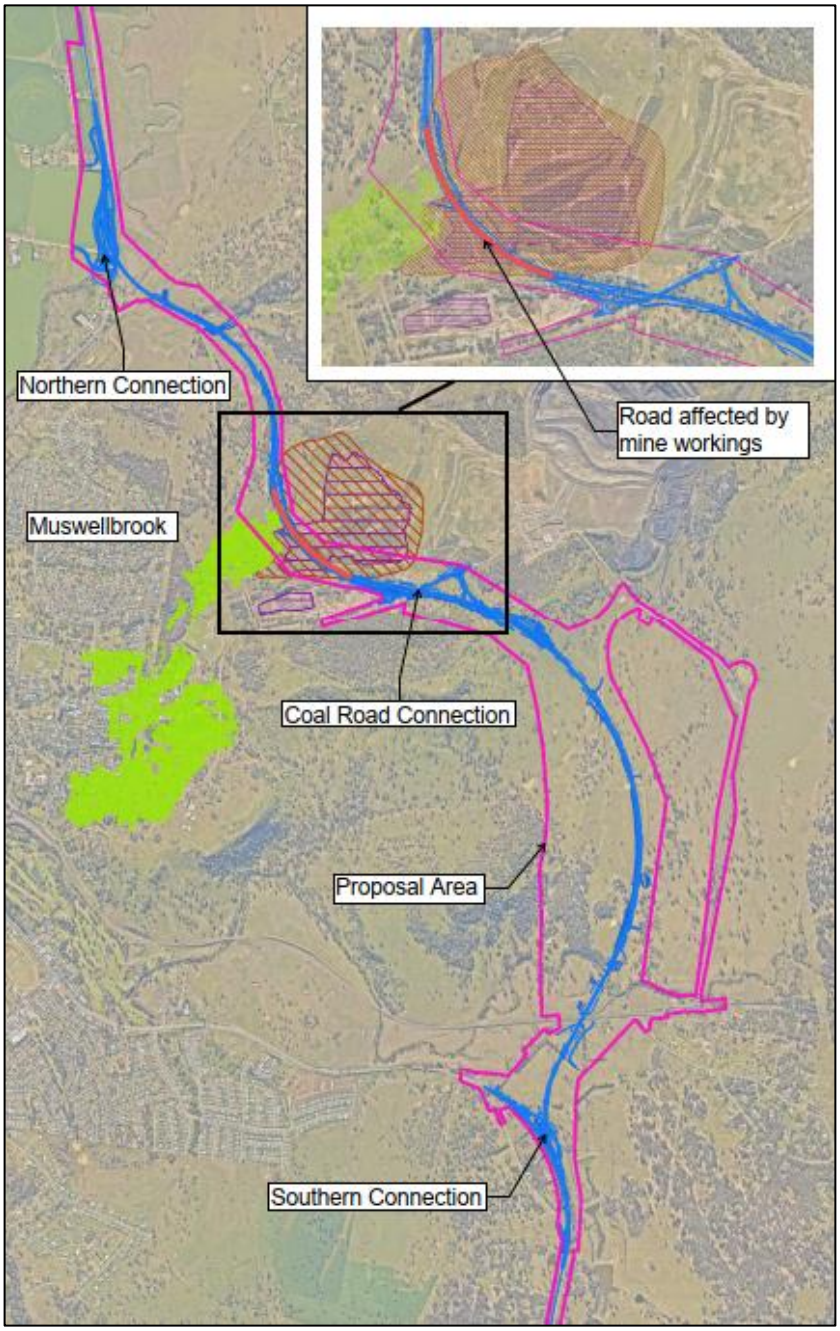

Figure 1 Project proposal area

2.0 Project Background

Numerous reports have been completed that are relevant to the project area, specifically with regard to the optioneering and initial environmental investigations. To appreciate the development of the project the following reports and key points are referred to:

- 2000 – Initial Options Report
  - Assessed eleven different possible routes.
- June 2002 – Coal Mining Constraints on Potential Muswellbrook Bypass Route
  - All routes were additionally reviewed with 'Route E' considered most appropriate given the complex geology
  - The proposed 'Route E' was identified to pass over open cut overburden spoils and various highwalls that would result in potential differential settlement of structures
- June 2003 - Muswellbrook Bypass Geotechnical Investigations of Open Cut Area of Modified Option E
  - Reviewed the geotechnical concerns previously highlighted for 'Route E'
  - Mentioned geotechnical concerns could be overcome on the updated route with conventional design methods.
- June 2005 – Announcement of preferred option Modified Option E
  - The Federal Government announced the preferred option, Modified Option E, which was displayed between October to November 2005.
- 2009 – Project footprint included in Local Environment Plan (LEP)
  - The Modified Option E was included in the Muswellbrook Council LEP in 2009.
- December 2013 – Muswellbrook Bypass Preliminary Socio-Economic Assessment
  - Highlighted that minimal adverse socio-economic factors would occur based upon the construction of the proposed route for the general Muswellbrook community.
  - Suggested that the bypass should ensure connectivity with the key infrastructure points of the Muswellbrook Coal Mine, landfill sites, and the railway network.
  - Recommended a "moderate" assessment level of socio-economic impact assessment be undertaken during the next phase of the assessment process.
- December 2013 – Preliminary Environmental Investigations for Muswellbrook Bypass
  - Indicated potentially significant impacts upon a range of native flora and fauna based upon the location of the preferred route.
  - Impacts on existing surface flow patterns and drainage capacity due to an incremental increase of impervious surface area.
  - Route may impact areas of moderate and high archaeological potential for Aboriginal sites.
  - Positive and negative socio-economic effects resulting from the bypass of through traffic.
  - Landscape character and visual impacts associated with introduction of the bypass in predominately rural landscape.
- February 2015 – Review of Geotechnical Issues Relating to Feasibility of Design Alignment Options
  - Geotechnical review of three possible routes which cross mine-affected ground associated with Muswellbrook Coal Mine.
  - Highlighted the risk of spontaneous combustion related to the previously placed mine spoil and recommends further planning investigations.

  - Recommended a detailed list of further geotechnical investigations dependent upon route selection.

- October 2016 – New England Highway Draft Corridor Strategy
  - Set out a 20 year plan to manage and guide development of the New England Highway corridor to improve safety, traffic efficiency and sustainability. (Not a project specific document)
- October 2016 – New England Highway Urban Design Framework
  - Overviews the suggested Urban Design options for entire New England Highway (Not a project specific document).
- December 2016 – Preliminary Environmental Investigations for Muswellbrook Bypass
  - Suggestions made for managing the complex heritage, biodiversity, hydrological, soil contamination, noise, air quality and landscape issues identified through a desktop review, field investigation and constraint mapping.
- April 2018 – Muswellbrook Bypass Traffic and Option Modelling Report
  - Developed a microsimulation traffic model based on two sets of origin-destination traffic survey data both from 2016.
  - Developed future traffic growth scenarios for the Muswellbrook area for the 20 year period between 2024 and 2044, based on population and traffic growth rates.
  - Assessed a ‘do-nothing’ option alongside three full bypass route options, and three staged bypass route options.
- July 2018 – Muswellbrook Bypass Options Report
  - Assessed five different routes based primarily on traffic and economic performance, with consideration of environmental constraints. The “Blue Route” that had the highest benefit cost ratio (BCR) and was the preferred route option.
  - The preferred route option provided one of the highest time savings (peak hours), along with the lowest out-turn costs.
- November 2018 – Muswellbrook Bypass Strategic Business Case
  - Reinforced the selection of a the “Blue Option” as the preferred route.
  - Outlined the project objectives, expected benefits and project program/milestones.
  - More detail provided to justify the project economically.
- September 2018 – Royal Haskoning DHV Floodplain Risk Management Study
  - Completed flood study for the Hunter River and lower Muscle Creek on behalf of Muswellbrook Council and The NSW Office of Environmental and Heritage (OEH) (Not a project specific document)
  - The report aims to ascertain the risk to life and property, develop risk management / reduction options, whilst considering opportunities for environmental enhancement.
  - The results of the assessment appear to exclude the upstream area of Muscle Creek (near the southern connection) and Sandy Creek (near the northern connection).
- July 2019 – Muswellbrook Bypass –Preliminary Biodiversity Investigation
  - Desktop review of relevant sources and a field survey were completed to identify preliminary ecological constraints within the study area.
  - Several potential flora and fauna constraints were identified; however, it was recommended that the project is unlikely to have significant impact on listed threatened species or ecological communities.
  - Recommendations of further targeted seasonal surveys.

3.0 Proposed development

3.1 Infrastructure

The proposed bypass infrastructure includes a paved highway constructed to Transport road standards. Associated infrastructure, in the vicinity of mine affected area, will include relatively low cuts and fills constructed with maximum 2:1(H:V) batters, road signs and surface drainage.

The alignment passes over former underground workings of the Lewis seam. The solutions discussed in the Pavement Options Report for the active mining area will also be applied here to mitigate any residual risk of subsidence.

The pavement construction will consist of full depth asphalt (FDA), the preferred pavement solution where there is a risk of mine subsidence or significant differential settlements. A FDA pavement is a flexible pavement that has a low modulus at the low rates of strain associated with mine subsidence and settlement, but high modulus at high transient strain rates associated with traffic. The pavement is therefore able to deform to accommodate ground movements whilst retaining its traffic carrying capacity. Repairs to this type of pavement are also relatively straight forward, generally comprising a mill and resheet, the depth of milling controlled by the pavement condition. FDA's ductile and gradual deformation also makes it a significantly safer pavement where there is a risk of large settlements.

The pavement over the former open cut will be supported on a load transfer platform (LTP). This LTP will be extended over the former underground workings to provide an extra measure of resilience for the road construction. The LTP consists of an earthworks zone over the width of the pavement constructed using selected fill and reinforced with high strength geotextile. The LTP attenuates differential settlements over short distances and can span subsidence bowls or potholes up to around two metres in diameter. A typical detail of a pavement supported on an LTP is provided in Figure 2 below.

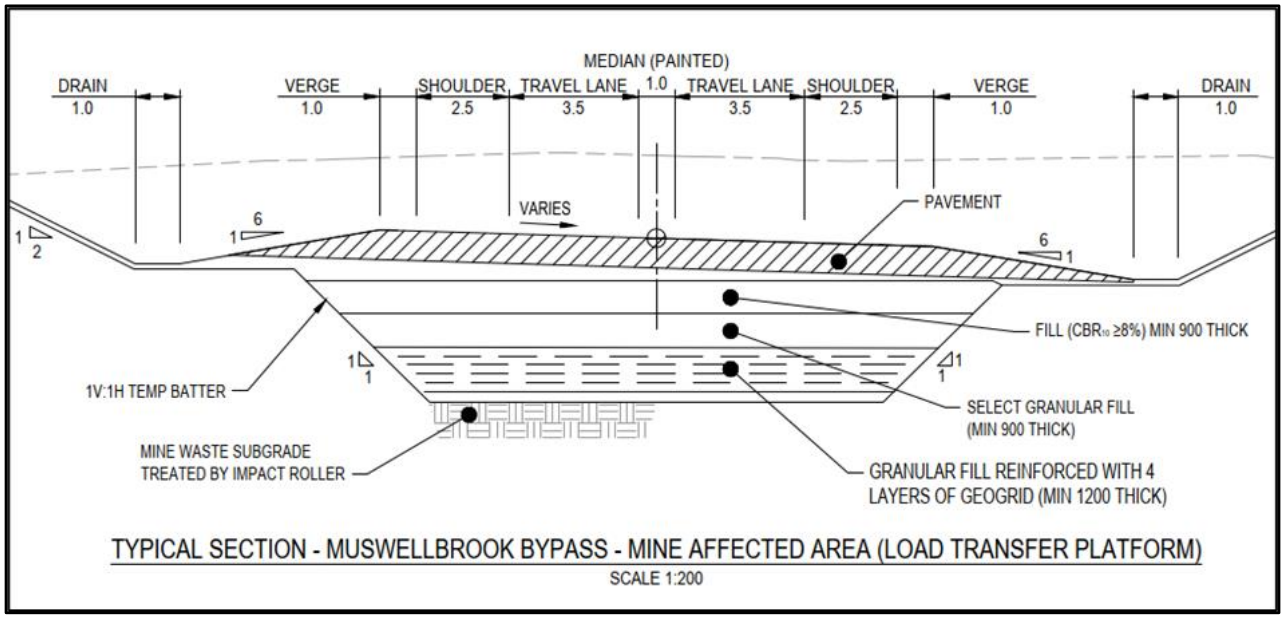

Figure 2: Typical Section - Pavement with load transfer platform

3.2 Geometry

A plan showing the proposed alignment relative to the underground workings is presented in Figure 3.

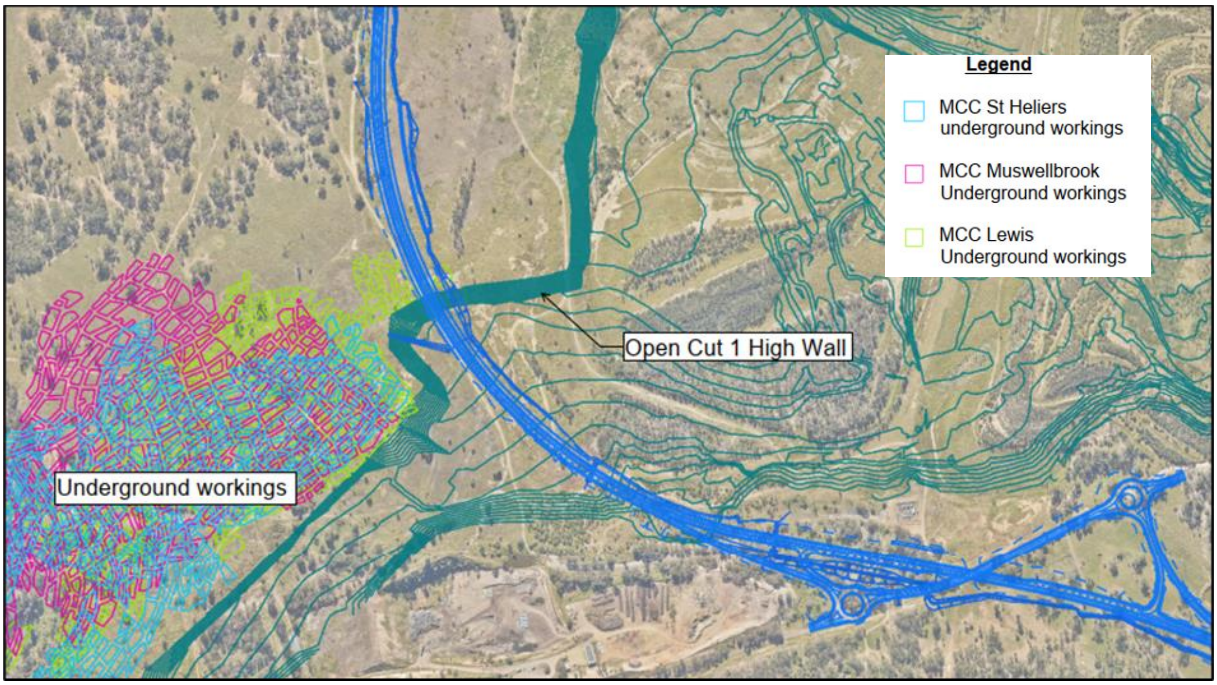

Figure 3: Bypass alignment relative to underground workings.

4.0 Mine assessment

4.1 Purpose

The purpose of this report is to provide an assessment of the potential impacts of the former underground mine workings on the performance of the proposed Muswellbrook bypass. The assessment is being carried out to facilitate the approval process with Subsidence Advisory NSW (SA NSW) for construction of the section of the bypass over the former underground mine workings. SA NSW is in the process of obtaining clarification of their approvals jurisdiction in relation to works over the former open cut. Hence for the purposes of this report it has been assumed that the jurisdiction of SA NSW is for approval of works that may be affected by underground workings only.

Design of the alignment over the former MCC open cut is the subject of separate investigations and studies by Transport and AECOM. Design measures will be developed to reduce the impact of ground movements on the alignment in the open cut together with consideration of modified maintenance regimes during operation of the road.

4.2 Scope

The scope of work included the following tasks:

- Review of recent geotechnical investigations carried out by AECOM
- Review of historical mine data, such as mine tracings, and assessment of location and orientation of the underground workings relative to the proposed alignment
- Assessment of pillar stability
- Evaluation of potential impacts of the existing underground workings on the proposed surface road.

5.0 Site description

The proposed Muswellbrook bypass alignment passes over the former Muswellbrook Colliery Open Cut No 1 and the over former underground mine workings of the Lewis Seam. The bypass is about 9 km in length with a section (around 1.5 km long) north of Coal Road passing over ground disturbed by mining activities carried out by MCC. This section has a topography of undulating hills formed by man-made revegetated mine dumps, and sparse vegetation. The alignment in this area is tightly constrained at the southern end between Council's Muswellbrook Waste Management Facility (MWMF) and the MCC power supply substation.

Immediately north of the MWMF, the alignment passes over the former MCC open pit for a distance of about 600 m. Immediately north of the former open cut the alignment passes over former underground workings for a distance of about 70 m. The alignment over the mining area is presented in Figure 4.

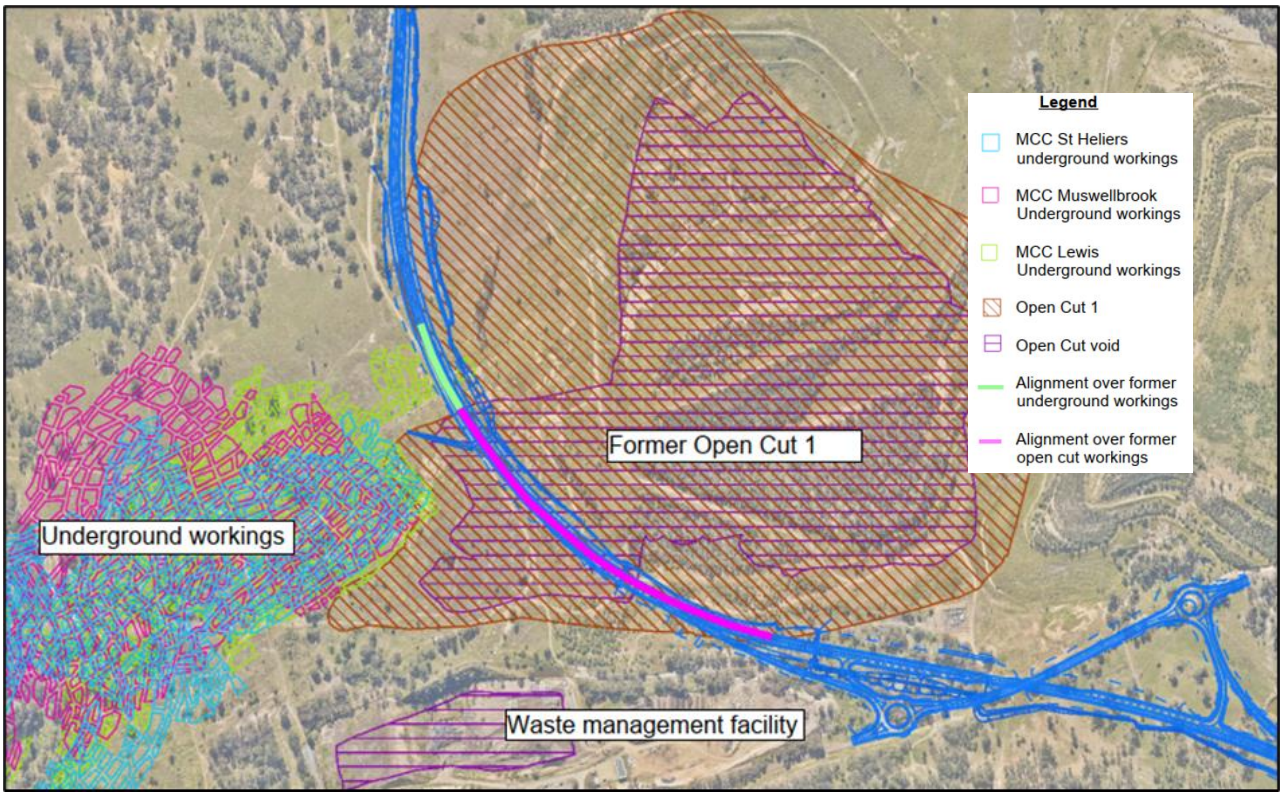

Figure 4: Bypass alignment over former mine workings

6.0 Review of geotechnical investigations

6.1 Regional geology

The regional geology as mapped by the Hunter Coalfield Regional Geology 1:100 000, the Muswellbrook 1:25,000 geological map, and the Singleton 1:250,000 geological sheet SI/56-01 comprises:

- Quaternary Man-made fill described as mine waste including carbonaceous siltstone, sandstone and low-quality coal; overlying
- Branxton Formation (Pmb) described as Sandstone, Siltstone and conglomerate; overlying
- Greta Coal Measures including:
  - Rowan Formation (Pgr) described as sandstone, siltstone, shale and mudstone with intercalated coal seams and subordinate conglomerate
  - Skeletar Formation (Pgk) described as rhyolite, chert and white tuffaceous shale.

An extract from the NSW seamless geology is shown in Figure 5.

The Branxton Formation, Rowan Formation, and Skeletar Formation dip around 5 degrees towards the north west and form the western limb of the Muswellbrook Anticline. A set of NW-SE trending faults are mapped cutting across the western limb of the Muswellbrook Anticline. These are parallel to the fault mapped underground and shown in Figure 5 and Figure 9.

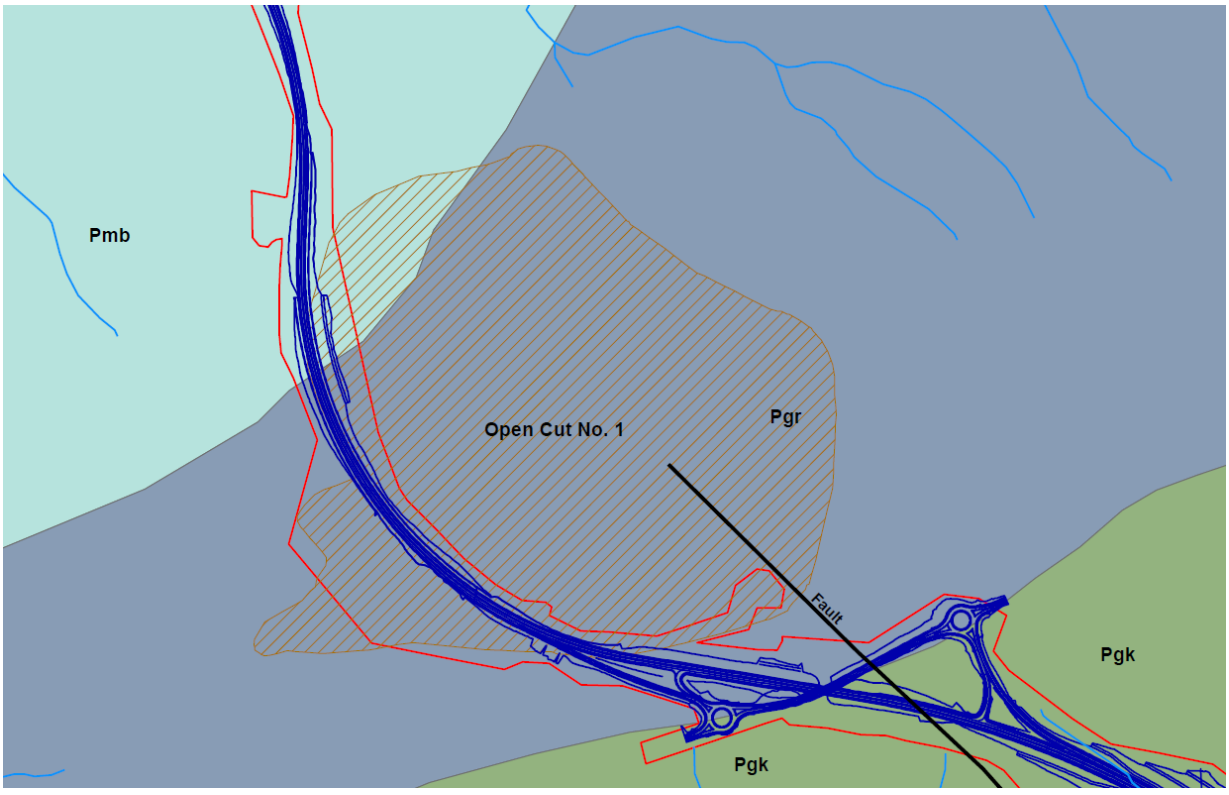

Figure 5 Regional Geology

6.2 Geotechnical investigations

6.2.1 General

Geotechnical investigations were carried out as part of the MBCP, targeting the former underground workings in the Muswellbrook, St Heliers and Lewis seams. The investigations in the vicinity of the former underground mine are listed below:

- Four boreholes were drilled along the alignment to determine the stratigraphy associated with the coal seams and where possible to identify the workings
- Down-hole sonar probing where mine voids associated with the former workings in the Lewis Seam were intercepted to obtain more details of the geometry of the workings in this seam. The sonar survey is discussed further in Section 7.3
- Groundwater levels were recorded in the boreholes to assess groundwater levels at seam level.

6.2.2 Boreholes

One borehole (BH28_UG) was cored from the surface to a depth of 73.1 m (RL 150 mAHD) to record the full stratigraphy from road level to below the floor of the Lewis seam.

The remaining boreholes (BH28A_UG, BH28B_UG, BH28C_UG) were cored from a height of 5 m to 15 m above the Lewis seam to a depth of 0.5 m to 3 m below the floor of the Lewis seam workings. These three boreholes were drilled to provide additional information of the nature of the roof and floor of the workings and to verify the location and orientation of the workings.

The borehole locations are shown in Figure 6 and the detailed borehole logs are in Appendix A.

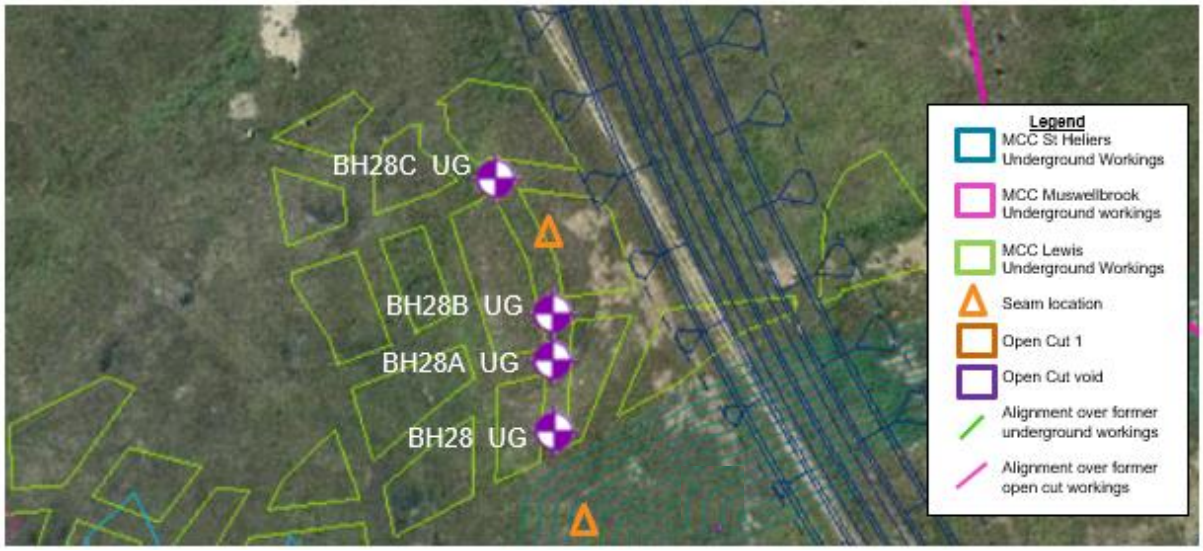

Figure 6: Borehole locations

The boreholes show the presence of solid coal in the Muswellbrook and St Heliers seams respectively. The mine tracings indicate that these boreholes are located about 120 m to 75 m from the Muswellbrook and St Heliers seams respectively. Hence the angles of draw of these seams do not extend into the road alignment unless there are substantial errors in the tracings.

The boreholes indicate a mining void in the Lewis seam of 2.6 m to 3.48 m in boreholes BH28_UG and BH28C respectively. The 2.6 m void depth has been used for the pillar stability calculations as the additional metre height in BH28C_UG is considered to be due to a local roof collapse.

The borehole logs indicate that at the Lewis seam a low to medium strength conglomerate occurs generally in the floor of the workings, but with low to medium strength sandstone in BH28B_UG.

The roof of the workings comprises very low strength coal for up to 2 m above the void. It is this material which may have resulted in a local roof collapse at BH28C_UG. Low to medium strength coal occurs in solid coal at the pillars. Low to medium or medium to high strength sandstone or laminate occurs above the coal.

6.3 Groundwater

Groundwater was measured at 60 to 61.5 m depth when drilling to the underground workings and corresponds to an elevation of 162 to 164 m AHD. This is below the level of the Muswellbrook and St Heliers seams, but above the Lewis Seam workings. This is supported by the findings during the investigations that the Lewis seam was filled with water. MCC are currently lowering groundwater levels as part of their Open Cut No2 operations. It is possible that once these operations cease and groundwater levels stabilise at pre-mining levels, Muswellbrook and St Heliers seams will also be inundated.

7.0 Former underground mining operations

7.1 General

There are former workings in three coal seams below the proposed alignment, the Muswellbrook, St Heliers and Lewis seams. Active underground mining is understood to have occurred from 1907 to 1980, with the Lewis Seam extracted from the 1950s. Only the Lewis Seam workings extend below the proposed alignment, with the workings in the two upper seams being offset from the alignment. Access to the Lewis Seam workings is understood to have been from Coal Road to the south. The seams have been worked cross-dip towards the north east. The seams dip towards the north west at about six degrees.

7.2 Mine stratigraphy

Within the active MCC mining area, there are multiple mine workings associated with the Greta Coal Measures. These include backfilled open cut pits, rehabilitated mine waste dumps and abandoned underground workings in several seams. The focus of this report is on the underground workings.

The mine stratigraphy has been developed based on the boreholes drilled in the vicinity of the underground workings. The general mine stratigraphy is summarised in Table 1 and shown in Figure 7. The values in the table are approximate and are based on limited information.

Table 1 Underground workings - General stratigraphy

Seam	Muswellbrook	St Heliers	Lewis
Depth (Ground to roof) (m)	38	48	70
Rock cover (m)	22	32	54
Seam thickness (m)	3	8	2.5-3.5
Mined thickness	Not known	Not known	3.5
Extends below proposed road	No	No	Yes

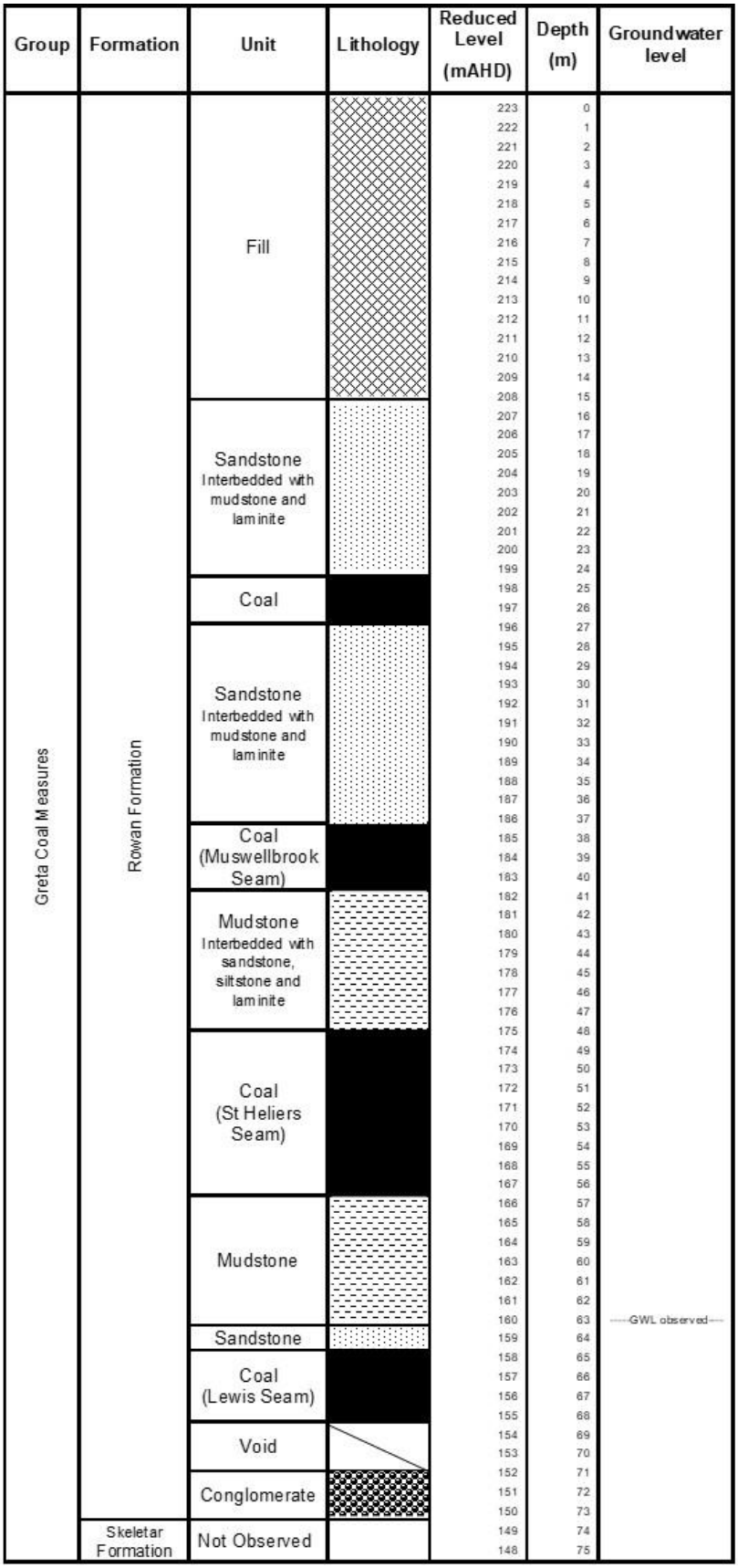

Figure 7: General stratigraphy at underground workings

7.3 Geometry

A typical cross section showing the alignment and offsets from the Muswellbrook, St Heliers and Lewis workings is shown schematically in Figure 8. It can be seen from the figure that the proposed alignment is outside a 30^0 angle of draw for both the Muswellbrook and St Heliers seam workings. The Lewis Seam workings extend beyond the proposed alignment.

A fault mapped in the underground workings trends NW-SE. It appears that the underground workings in the Muswellbrook and St Heliers Seams did not cross this fault, while a small area in the Lewis seam was mined north east of the fault. The fault, with a throw of around 3 m, could have acted as a natural barrier for further development of the Muswellbrook and St Heliers Seams. This fault has not been identified or inferred at the surface during the current geotechnical investigations.

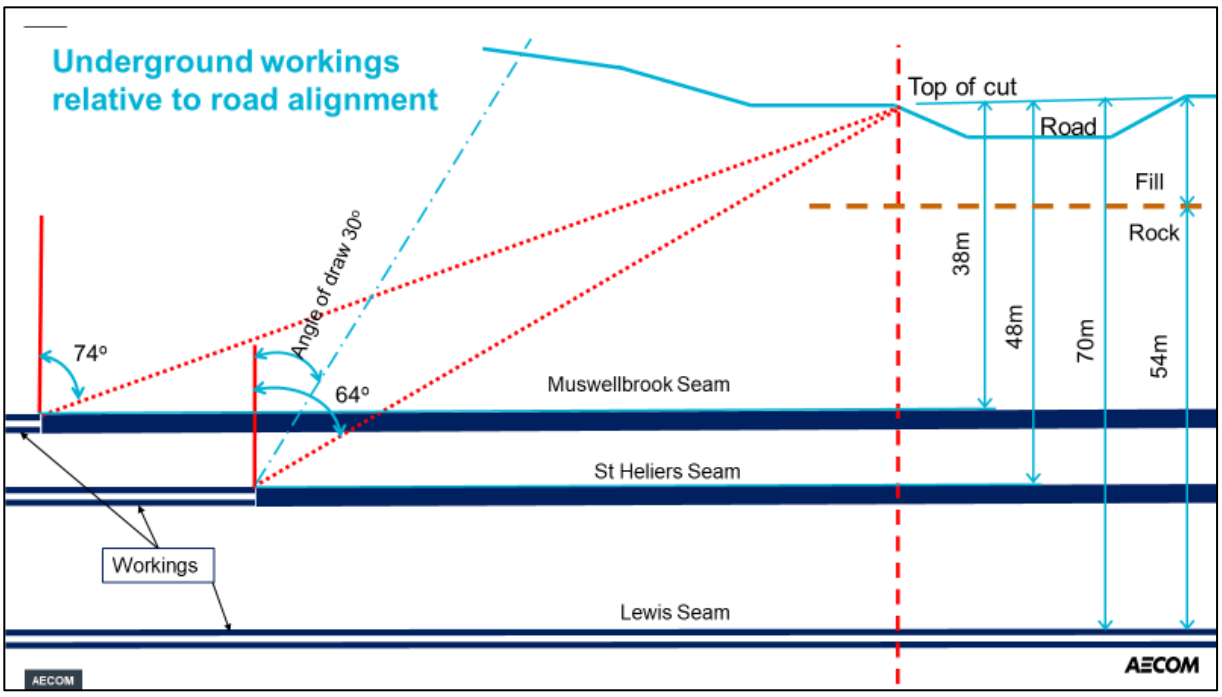

Figure 8: Former underground workings relative to alignment

The proposed alignment relative to the underground workings and the fault at seam level is shown in plan in Figure 9. The indicative location of the high wall have also been plotted on this figure. The Muswellbrook and St Heliers seams do not extend beyond this fault line and it is likely that it presented a barrier to further development of these seams.

The highwall was located to preserve a pillar greater than 25m between the open cut and the underground workings. The kink in the highwall generally follows the line of the seam level fault.

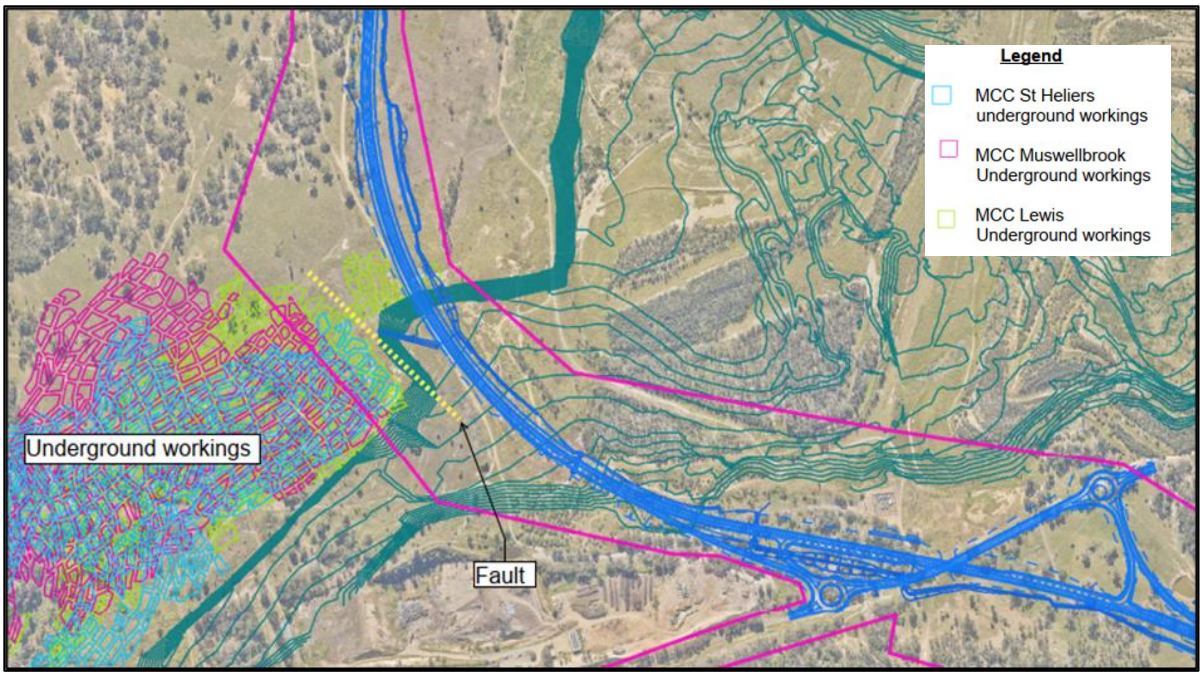

Figure 9: Bypass alignment relative to underground workings.

8.0 Review of mine tracings and downhole surveys

8.1.1 General

Voids were encountered while HQ3 core drilling in BH28_UG and BH28C_UG at depths of 68.53-71.15 m and 67.87-71.5 m respectively. These boreholes were reamed with HWT casing (117 mm diameter) to provide a sufficient opening to complete a downhole survey of the voids.

The downhole survey was completed to provide information on the condition of the underground roadway openings, nature and orientation of rock discontinuities, and delamination in the roof strata of underground workings.

8.1.2 Acoustic televiewer

AECOM engaged Groundsearch Australia to carry out the downhole geophysical survey on 2 July and 20 August 2020 using temperature, colour camera, sonar and televiewer tools. The colour camera could not be used on BH28_UG due to high (70^0C) temperatures in the borehole. Water in BH28C_UG was too murky for imaging, so the camera was not used. The acoustic survey of BH28_UG was limited to below the standing water level at 61.50 m.

The joint spacings recorded in the televiewer at BH28C_UG are in broad agreement with the BH28_UG borehole logs and hence the BH28_UG borehole log has been used to develop the stratigraphy.

8.1.3 3D Cavity sonar survey

A down hole 3d cavity sonar survey was carried out in boreholes BH28_UG and BH28C_UG for a better appreciation of the geometry of the Lewis Seam workings. The work was carried out by Groundsearch Australia and their report is attached in Appendix B of this report. The figures that follow have been extracted from this report.

8.1.4 Borehole BH28_UG

Figure 10 presents a plan view (horizontal section) about 1.5 m above the floor of the workings overlaid on the mine tracings. The roadways and the corners of Pillars P2 and P3 can be identified in the image.

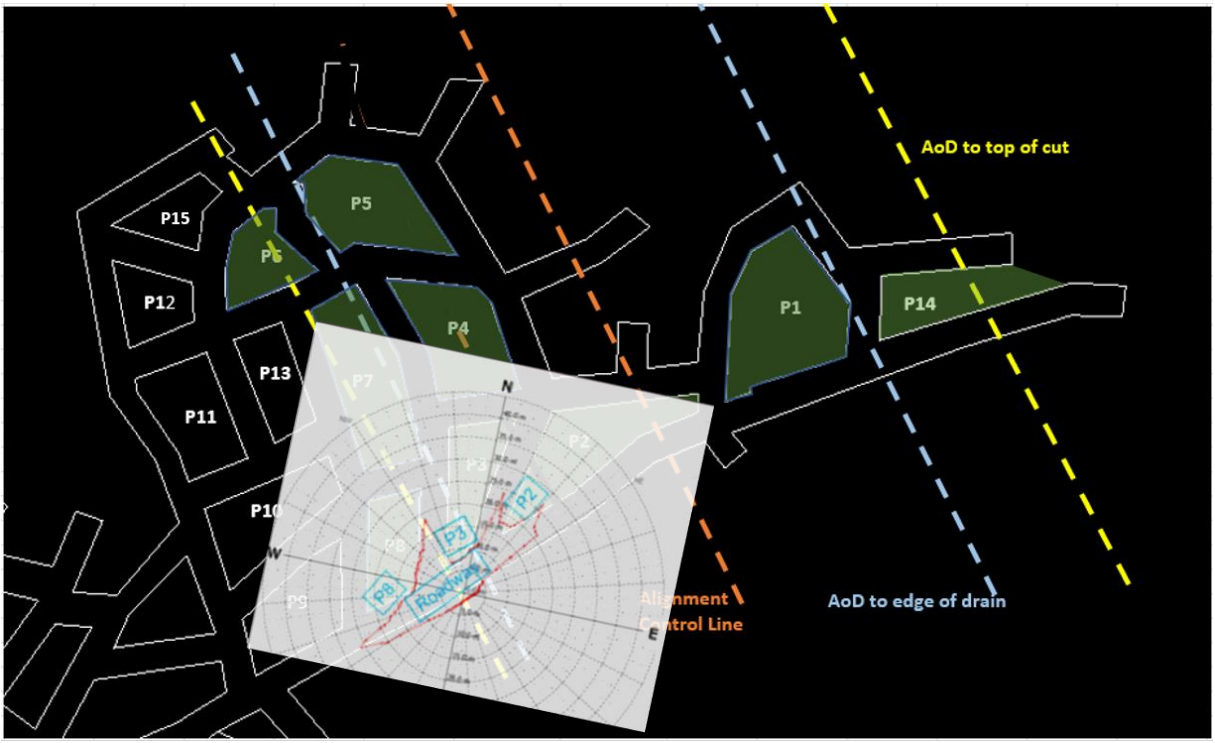

Figure 10: Plan view 1.5 m above floor of workings

The vertical sections in the Groundsearch report (extract in Figure 11 below) indicate a void height of about 2.5 m, consistent with the void height in the borehole log. The imagery in this figure indicates that the roadways have been developed up-dip, probably along the conglomerate/coal interface.

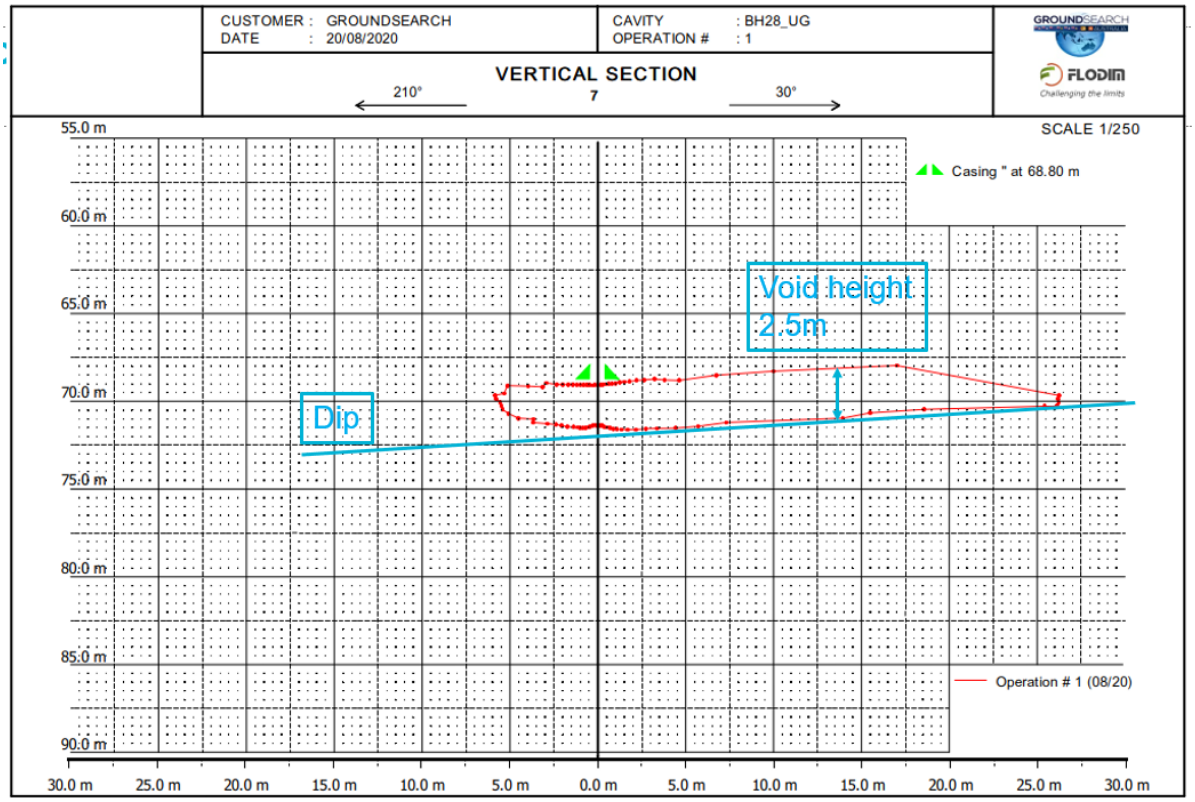

Figure 11: Vertical section

8.1.5 Borehole BH28C_UG

The horizontal sections indicate that there has been a local roof failure with a general void height in the order of 2.5 m, increasing locally to around 3.5 m. and is consistent with the height void identified in the borehole log. Figure 12 shows the geometry of the void at this location.

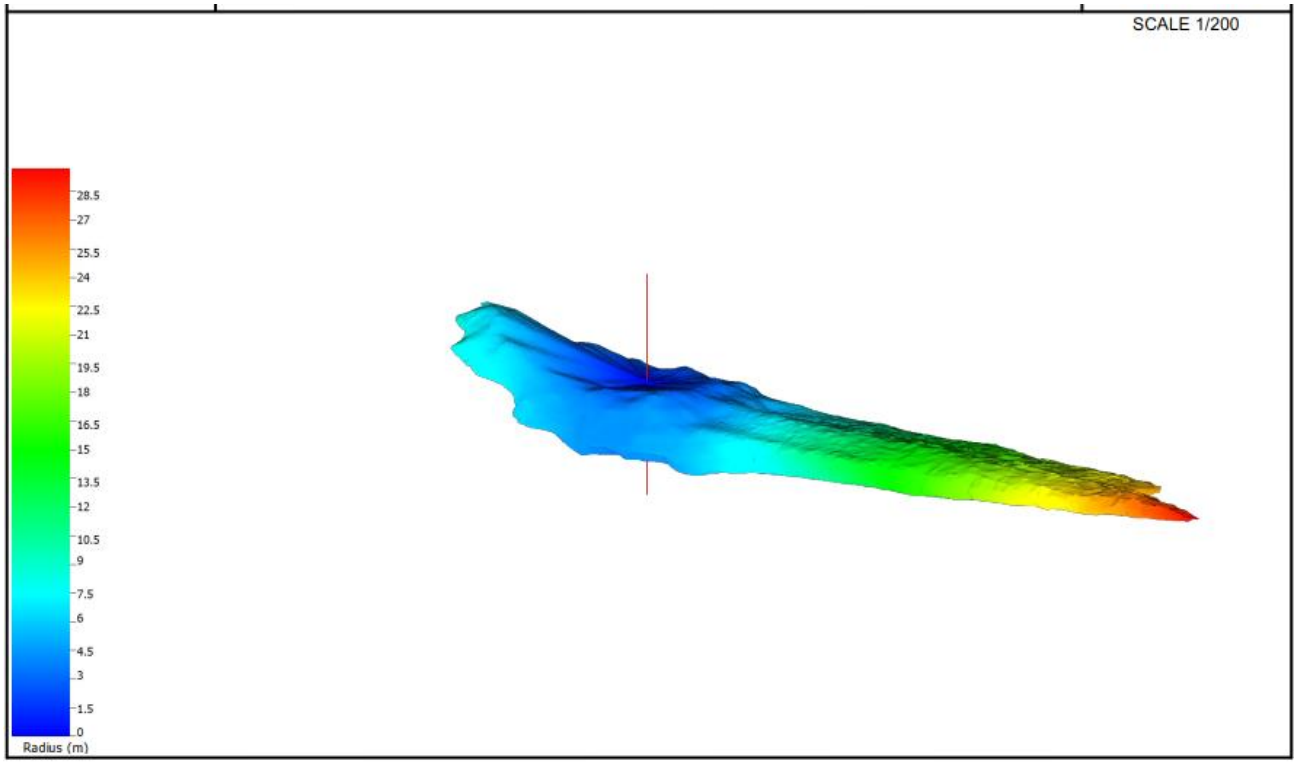

Figure 12: Void at borehole BH28C_UG from the east

9.0 Pillar stability

Pillar strength may be estimated using the Power Law developed by the UNSW and developed in Anderson (1999). In this calculation pillar strength is a function of the pillar dimensions (pillar width and height) as shown below:

- When w/h < 5.0 $\sigma_p = 7.4 \frac{w^{0.46}}{h^{0.66}}$
- When w/h ≥ 5.0 $\sigma_p = 19.24 \frac{\left[0.2372\left[\left(\frac{w}{5h}\right)^{2.5} - 1\right] + 1\right]}{w^{0.1334}\, h^{0.0667}}$

Where:

σ_p = pillar strength (MPa)

w = pillar width (m)

h = pillar height (m)

A factor of safety can then be calculated based on the ratio of pillar strength to the stress in the pillar based on overburden load, pillar dimensions and tributary area.

In view of the distance of the Muswellbrook and St Heliers workings from the alignment, only the stability of the pillars in the Lewis seam workings could impact on the proposed alignment. The angle of draw for the alignment relative to the Lewis Seam pillars and the pillar numbering is presented in Figure 13. Hence the performance of only pillars P1, P2, P3, P4, and P5 can impact the alignment.

Figure 13: Pillar numbering within angle of draw in Lewis Seam

The assessment method is based on the behaviour (failures) of pillars in Australia and South Africa. The analysis relates the probability of failure to pillar geometry and the reference records no pillar failures for pillars with a factor of safety of 2.1 or more calculated in accordance with the method presented in the reference. In addition, sudden failures are considered very unlikely for squat pillars (width/height > 5). Figure 14 below presents the relationship between factor of safety and probability of failure developed in Anderson (1999).

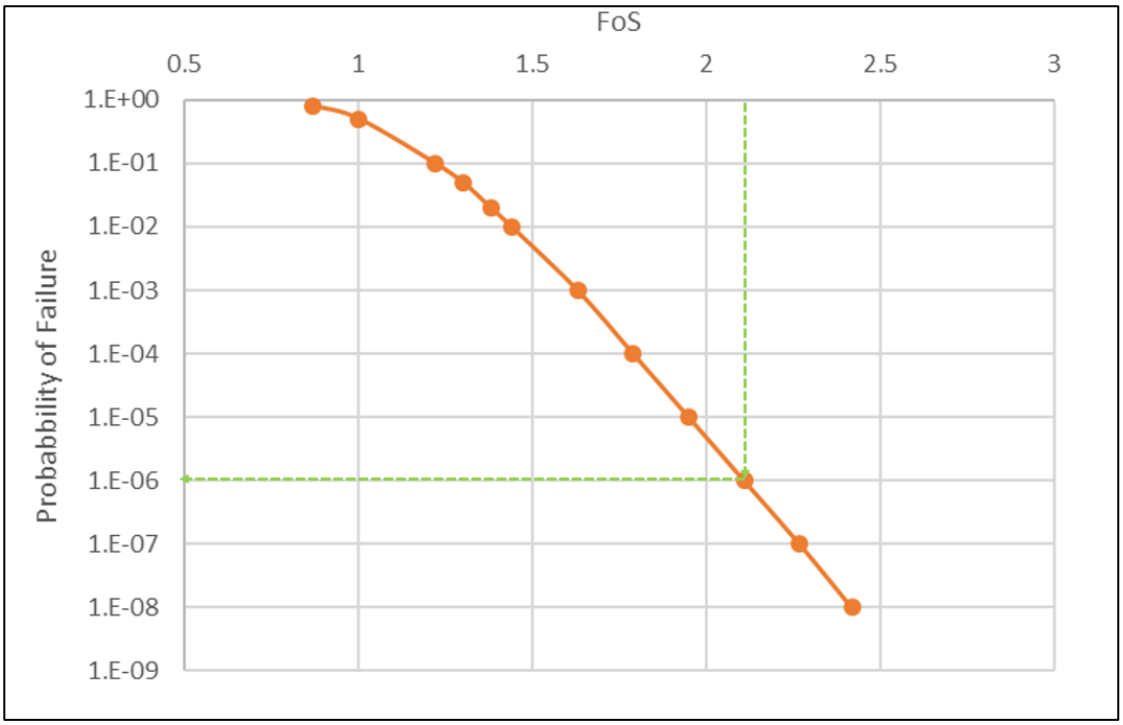

Figure 14: Relationship between Factor of safety and probability of failure

Anderson (1999) suggests that a probability of 1 in 100,000 (10^{-5}) is appropriate for subsidence protection pillars and this equates to a factor of safety of 2.06.

The FoS of the Lewis Seam pillars in Figure 13 have been calculated and are presented in Figure 15 below.

Pillar	w_m (m)	H (m)	h (m)	w_m/h	Squat (Y/N)	θ	Power σ_{ps} (MPa)	w_1	w_2	c_1	c_2	σ_p (MPa)	FOS	Prob. of Failure
P1	24.9	68.5	2.6	9.6	Yes	1.1	49.9	24.9	31.1	31.4	37.6	2.61	**19.1**	<1.0E-8
P2	7.3	68.5	2.6	2.8	No	1.0	10.6	4.6	48.9	11.1	55.4	3.27	**3.2**	<1.0E-8
P3	5.4	68.5	2.6	2.1	No	1.0	9.1	3.8	29.3	10.3	35.8	3.58	**2.5**	<1.0E-8
P4	15.7	68.5	2.6	6.0	Yes	1.2	30.9	15.7	23.5	22.2	30	3.09	**10.0**	<1.0E-8
P5	16.9	68.5	2.6	6.5	Yes	1.2	33.4	16.9	27.3	23.4	33.8	2.94	**11.4**	<1.0E-8
P6	14.9	68.5	2.6	5.7	Yes	1.0	27.0	15.3	14.9	21.8	21.4	3.50	**7.7**	<1.0E-8
P7	12.5	68.5	2.6	4.8	No	1.3	15.8	12.5	36.7	19	43.2	3.1	**4.5**	<1.0E-8
P8	11	68.5	2.6	4.2	No	0.8	12.0	22.5	11	29	17.5	3.5	**3.4**	<1.0E-8
P9	11.7	68.5	2.6	4.5	No	1.1	14.4	11.7	21.7	18.2	28.2	3.46	**4.2**	<1.0E-8
P10	8	68.5	2.6	3.1	No	1.0	11.2	8	28.9	14.5	35.4	3.80	**2.9**	<1.0E-8
P11	12.7	68.5	2.6	4.9	No	1.2	15.3	12.7	23.4	19.2	29.9	3.31	**4.6**	<1.0E-8
P12	7.9	68.5	2.6	3.0	No	1.0	11.0	14.8	7.9	21.3	14.4	4.49	**2.5**	<1.0E-8
P13	10.1	68.5	2.6	3.9	No	1.1	13.1	10.1	22.1	16.6	28.6	3.6	**3.6**	<1.0E-8
P14	13.1	68.5	2.6	5.0	Yes	1.2	28.0	13.1	28	19.6	34.5	3.2	**8.9**	<1.0E-8
P15	7.5	68.5	2.6	2.9	No	1.0	10.8	7.5	16.6	14.0	23.1	4.4	**2.4**	<1.0E-8

Figure 15: Factors of Safety for Lewis Seam pillars

The width of pillars P2 and P3 have been adjusted as shown in Figure 13 so that the narrow tail ends of these pillars have not been considered in the analysis.

The results of the analysis indicate that all pillars have a FoS in excess of 2.1 together with a probability of failure of less than $1:10^{-8}$.

In addition, Pillars P1, P4 and P5 are squat pillars, and (other than Pillars P2 and P3) are the only pillars within a 30^0 angle of draw of the road pavement, so that if any failure of these pillars were to occur, it would be expected to manifest at the surface in the form of gradual subsidence.

The cut slope beyond the pavement on the western side of the alignment is within the 30^0 angle of draw of Pillars P6, P7 and P8. These are not squat pillars but do have FoS in excess of 3. The cut slope beyond the pavement on the eastern side of the alignment is within the 30^0 angle of draw of Pillar P14. This is a squat pillar and has a FoS in excess of 3.

The following factors, not considered in the analyses further enhance the stability of the pillars:

- The squat pillars (P1, P4, P5, P6 and P14) within the angle of draw of the pavement and cut slopes can be expected to gain strength as they deform.
- The span at pillars P2 and P3 (FoS > 2.5, but not squat pillars), is around 35 m between solid coal abutments and squat pillars, and with some 70 m cover to the workings, it is likely that loads would transfer to the abutments and squat pillars, thus causing these pillars to unload if they deform.
- The water table is around 8 m above the roof of the Lewis seam which results in a drop in pillar stress due to the submerged weight of rock over this height. This effect could be enhanced in the longer term as the regional water table rises post mining operations.
- Due to the presence of low to medium strength conglomerate in the floor of the workings failure through the floor is considered very unlikely.
- Low to medium or medium to high strength sandstone or laminate in the roof of the workings. BH28_UG indicates that low to medium strength sandstone or laminate occurs in the interburden between the Lewis and St Heliers seams. Hence it is considered that sudden failure of the roof is unlikely, although BH28_UG indicates that there may be some deterioration in the coal within the roof of the workings.

In view of the above it is considered that the pillars in the Lewis Seam within the angle of draw of the road alignment may be considered stable in the long term and no further measures are required to improve stability.

10.0 Underground fires

The possibility of underground fires in the Lewis Seam workings has been considered by AECOM. However, with the water table about 8 m above the roof level of these workings in the vicinity of the alignment, underground fires are not considered a credible issue in this seam.

Only solid coal was encountered in the boreholes in the Muswellbrook and St Heliers seams, and the mine tracings indicate that the workings in these seams are 100 m or more from the alignment. In addition, the open cut high wall was constructed with a 25 m to 30 m barrier between the open cut and the high wall. This barrier of solid coal will also inhibit the spread of fire between the opencut and the underground workings.

In addition, AECOM installed four soil vapour wells which are also indicators for spontaneous combustion to monitor dangerous gasses (CO, CO2, CH4 and SO2) in the former open cut immediately south of the underground workings. An InSAR survey has recently been carried out over the mine area, with a number of settlement points in this vicinity. These points are stable and show no signs of ongoing settlement that could be attributed to underground fires.

It is therefore considered that there is an insignificant risk of underground fires extending to these seams from either the existing workings or the former open cut.

11.0 Subsidence Advisory NSW

Subsidence Advisory NSW (SA NSW) were contacted early in the concept phase of the Project and various times as part of the State Environmental Planning Policy (Infrastructure) (ISEPP) procedure. A summary of the primary consultation with SA NSW is provided below:

- Minor Works Review of Environmental Factors (MWREF) for geotechnical investigations
  - SA NSW were contacted via an ISEPP letter to provide a proposal outline and summary of upcoming geotechnical investigations for the project – 27 April 2020
  - SA NSW provided a response via letter noting *"significant geotechnical risk in the investigation area"*, including *"poorly defined or potentially unmapped mine workings, as well as a history of mine fires in Muswellbrook, St Heliers and Lewis Coal Seams".* It was recommended Transport consult with SA NSW following geotechnical investigations when more data is available – 15 May 2020
- Review of Environmental Factors (REF)
  - SA NSW were invited to provide advice or comment on the bypass proposal for the purpose of providing mitigation measures which would be included within the REF – 12 March 2021.
- Mine assessment report
  - SA NSW were provided with Revision B of this report for review and comment.
  - SA NSW provided a response via letter noting four recommendations which should be included in this report – 30 March 2021
  - In response to SA NSW letter (30 March 2021) a presentation was prepared by AECOM and meeting held on 10 May 2021 to address their recommendations. The mine assessment report would subsequently be revised by AECOM / Transport and issued to SA NSW.

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12.0 Conclusions

Investigations have been carried out to assess the potential for the former mine workings in the Muswellbrook, St Heliers and Lewis seams to impact on the proposed alignment for the Muswellbrook bypass. The proposed infrastructure potentially impacted by the workings comprises road pavements, cuttings, and drainage. No significant structures are anticipated in this part of the alignment.

The investigations have comprised:

- Geotechnical boreholes to intercept the Muswellbrook and St Heliers seams and the Lewis Seam workings.
- Sonar survey where BH28_UG intercepted the Lewis Seam workings
- Review of mine tracings
- Assessment of pillar stability in the Lewis Seam.

The investigations indicate that the Muswellbrook and St Heliers workings are too far removed from the alignment to have any impact on the road. No further mitigation work is required related to these seams.

The investigations have established that the mine tracings provide a reliable reflection of the geometry of the former workings, and that the georeferencing is suitably accurate with minor adjustments for the purpose of making these assessments.

The investigations indicate that the proposed alignment will directly pass over the Lewis Seam workings over a short distance of about 20 m.

The angle of draw from the workings will affect around 70 m length of the alignment. All Lewis Seam pillars within 80 m of the alignment works (including cut batters) have been assessed and all have factors of safety in excess of 2.1 and can be considered long term stable. Five pillars have an angle of draw that includes the road pavement. All have factors of safety in excess of 2.5 and can be considered long term stable. In addition, three of these five pillars are squat pillars and can be expected to gain strength as they deform. Hence, even if deformation did occur, it is likely to be gradual and would reduce with time.

These pillar assessments have been made using conservative assumptions and have not considered the beneficial effects of the water table level or strength of the floor or roof of the workings.

In view of the above assessments and considering the type of infrastructure proposed for this section of the alignment, no further works are envisaged to stabilise the Lewis Seam underground workings. It is proposed to construct a full depth asphalt pavement supported by a load transfer platform (LTP) over the former open cut immediately to the south of the underground workings. This construction should be extended over the former Lewis Seam workings where they directly underlie the road.

13.0 Important information about this Geotechnical Report

Client details, scope and reliance

AECOM has prepared this report for the use of the Client and for a specific purpose, each as expressly stated in the report. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this report. This report has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM's findings represent its reasonable judgment within the time and budget context of its commission and utilising the information available to it at the time.

No section or element of this report may be removed, reproduced, electronically stored or transmitted in any form by parties other than those for whom the report has been prepared without the written permission of AECOM. All sections in this report must be viewed in the context of the entire report/document including, without limitation, any assumptions made, and disclaimers provided. No section in this report may be excised from the body of the report without AECOM's prior written consent.

Unless explicitly stated in the scope of work, this report does not provide data or advice on the contamination status of the site or adjacent sites.

Standard of care

AECOM has prepared this report using the standard of reasonable skill, care and diligence required of a consultant performing the same or similar Services. The report should be read in full. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

AECOM may have relied on information provided by the Client and third parties (Information Providers) to produce this report and arrive at its conclusions. AECOM has not verified information provided by the Information Providers (unless specifically agreed as part of AECOM's scope of work) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM assumes no responsibility for inaccuracies in reporting by the Information Providers including, without limitation, by the Client's employees or representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the report.

Variability in conditions and limitations of data

Subsurface conditions are formed through a variety of natural processes and can be altered by human activities. The behaviour of the ground, groundwater and contaminants are complex and conditions can vary across a particular site. As a result, subsurface conditions cannot be exhaustively defined by investigations at discrete locations. Therefore, it is unlikely that the results and assessments expressed in this report will represent conditions at any location removed from the specific points of sampling. The precision with which conditions can be inferred depends largely on the uniformity of subsurface conditions and on the frequency and method of sampling as constrained by factors such as project budget and time limitations and physical constraints.

Furthermore, subsurface conditions can change over time, which should be considered when interpreting or using the data within this report.

Verification of opinions and recommendations

The opinions and recommendations in this report apply to the proposed development and the site existing at the time of our investigation and cannot necessarily apply to changes in the proposed development or site changes of which AECOM is not aware and has not had the opportunity to evaluate. Our recommendations should be considered to be preliminary and subject to verification during project implementation. If conditions encountered at the site are subsequently found to differ significantly from those anticipated, AECOM must be notified and be provided with an opportunity to review the recommendations.

Appendix A

Borehole logs

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28_UG**

Sheet: 1 of 10

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	PW	24/6/20 ▽			223.0	0.0			FILL: Clayey SAND: fine to medium grained; brown; with cobbles/boulders of siltstone, 80-250 mm, angular, trace rootlets	M		TOPSOIL FILL
				DS_0.50-0.60		0.5			FILL: Silty SAND: fine to coarse grained; dark grey; with fine to coarse gravels, angular, of sandstone, coal, ironstone and tuffaceous siltstone	D		MINE WASTE FILL
			SPT:5,3,3 N=6	N*_1.00-1.45 (240/450)	222.0	1.0						
				DS_1.80-2.00		1.5						
					221.0	2.0						2.00m: peak temperature 35.7°C
			SPT:3,5,7 N=12 PP=250 kPa	N*_2.50-2.95 (450/450)		2.5			FILL: Silty CLAY: low plasticity; red-brown, yellow-brown and dark grey-brown; with sand, fine to medium grained	w<PL		
				DS_3.00-3.20	220.0	3.0			FILL: silty sandy CLAY: low plasticity; yellow brown and pale grey; sand is fine to medium grained; trace gravel			
						3.5			FILL: Silty CLAY: medium plasticity; dark grey-brown; with fine to coarse grained sand, trace fine to medium gravels, sub-angular, of siltstone, iron-indurated siltstone and coal			
			SPT:2,4,4 N=8	N*_4.40-4.45 (380/450)	219.0	4.0						4.00m: peak temperature 28.1°C
						4.5			FILL: Silty CLAY: medium to high plasticity; dark grey; trace fine to medium gravels, rounded of igneous, sub-angular of siltstone	w~PL		
				DS_5.00-5.20	218.0	5.0						
			SPT:4,3,5 N=8	N*_5.50-5.95 (400/400)		5.5						
						6.0			FILL: Silty GRAVEL: fine to medium grained; dark grey	w<PL		
			PP=350 kPa		217.0	6.5			FILL: silty CLAY: low plasticity; dark grey; with fine to medium grainedsand; with fine to medium gravel of sandstone, siltstone, coal and slag	w~PL		6.00m: peak temperature 159.7°C
			SPT:3,6,6 N=12	N*_7.00-7.45	216.0	7.0						
						7.5			FILL: Silty CLAY: medium plasticity; dark grey; trace medium gravels, of siltstone and weathered sandstone, weathered to sand, medium grained			7.50m: peak temperature 71.2°C
						8.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	PW				215.0				FILL: Silty CLAY: medium plasticity; dark grey; trace medium gravels, of siltstone and weathered sandstone, weathered to sand, medium grained *(continued)*	w~PL		MINE WASTE FILL *(continued)*
						8.5						
			SPT:4,5,6 N=11 PP=250 kPa	N*_8.50-5.95 (450/450)								
					214.0	9.0						9.00m: peak temperature 60.7°C
						9.5						
					213.0	10.0						
WB	HWT		SPT:6,4,4 N=8	N*_10.00-10.45 (330/450)					FILL: Silty gravelly CLAY: low plasticity; yellow-brown and pale grey; angular, of siltstone and weathered sandstone, weathered to sand, medium grained	w<PL		
						10.5						10.50m: peak temperature 82.7°C
						11.0						
			SPT:4,4,5 N=9	N*_11.00-11.45 (350/450)	212.0				FILL: Sandy gravelly CLAY: low plasticity; yellow-brown and grey; sand is fine to medium grained, gravel is fine to coarse, angular to sub-angular, of siltstone, ironstone, sandstone, and sub-angular to sub-rounded igneous gravels			
						11.5						
						12.0						
					211.0							
						12.5						
						13.0						
					210.0							
						13.5						
						14.0						
				N*_14.00-14.45 (250/450)	209.0				FILL: Clayey GRAVEL: fine and coarse grained; red, yellow-brown, grey and dark grey; sub-angular to sub-rounded, of siltstone, ironstone, sandstone, and igneous gravels (river gravel?)	D		
						14.5						
						15.0						
					208.0							
						15.5						
									SANDSTONE: medium grained; pale brown and red-brown, XW- HW, soil-VL *Borehole BH28_UG continued as cored log from 16.00 m.*			BEDROCK
						16.0						

AECOM Cored Engineering Log — Draft

BOREHOLE No. BH28_UG

Sheet: 3 of 10

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
							Continued from non-cored borehole at 16.00 m.	XW/XA HW/HA MW/MA SW/SA FR	soil VL L M H VH EH				
HQ3	Run 1	0% WATER LOSS		207.0			SANDSTONE: medium grained; pale grey and yellow-brown; cross bedded at 0-5°			80 [25]		P, 5°, PL, ro, cn, x2, spaced 10 mm CZ, 20°, IR, ro, GP, 70 mm EW, IR, ML, 160 mm	BEDROCK *(continued)*	
				16.5			from 16.63 m: iron stained					CZ, 10-80°, IR, ro, SM, Fe, 150 mm		
				17.0	206.0		from 17.00 m: heavily iron stained, with carbonaceous laminations					J, 90°, PL, ro, vn, Fe, from 16.87-16.94m		
				17.5			NO CORE: dark grey; from 17.50 m to 17.50 m							1 of 15
	Run 2	0% WATER LOSS	$Is_{50}(A)$= 0.03 MPa $Is_{50}(D)$= 0.24 MPa				MUDSTONE: dark grey; laminated at 0-5°			100 [58]				
				18.0	205.0							J, 10°, PL, sm-ro, cn SZ, IR, sm, vn, CL, 120 mm P, 5°, PL, sm, barrel spun		
				18.5			SANDSTONE: fine to medium grained; pale grey; cross bedded at 0-15°					EW, 50-60°, PL, ro, CL, 90 mm J, 30°, PL, ro, vn, Fe		
				19.0	204.0		from 18.80 m to 19.00 m: intelaminated at 0-5° with mudstone (40%) dark grey					SS, 70°, PL, from 18.79-18.91m, apparent displacement 25mm SS, 75°, PL, from 18.89-19.00m		
							SANDSTONE: medium grained; pale grey and yellow-brown; cross bedded at 0-5°, with carbonaceous laminations							
				19.5								CZ, 10°, PL, ro, GC, Fe, 30 mm P, 0°, PL, ro, vn, Fe,X, barrel spun		
			$Is_{50}(A)$= 0.95 MPa $Is_{50}(D)$= 0.73 MPa				LAMINITE: sandstone (80%) fine grained, pale grey, interlaminated at 0-10° with mudstone (20%): dark grey, undulating beds					P, 0°, PL, ro, vn, Fe,X, barrel spun, x2, spaced 10 mm SS, 70-90°, CU, from 19.74-19.85m P, 5°, UN, ro, vn, X, 1 mm P, 70°, UN, sm-ro, co, CL, X		
				20.0	203.0									
							MUDSTONE: dark grey; occasionally interlaminated at 0-5° with sandstone (5%) pale brown							
				20.5								J, 30°, PL, healed J, 20°, PL, healed SS, 65°, PL, from 20.37-20.43m J, 10°, PL, sm-ro, cn SS, 75°, PL, from 20.45-20.68m J, 10°, PL, sm-ro, cn		
			$Is_{50}(A)$= 0.13 MPa $Is_{50}(D)$= 0.03 MPa	21.0	202.0					100 [56]		J, 30°, PL, sm, co, clay, Fe, 1 mm J, 40°, PL, tight J, 60°, PL, ro, from 21.03-21.17m, healed J, 60°, PL, ro, from 21.25-21.35m		
			$Is_{50}(A)$= 0.05 MPa	21.5			SILTSTONE: pale grey; laminated at 0-10°					P, 0°, PL, sm, cn SS, 70°		
	Run 3	0% WATER LOSS	$Is_{50}(D)$= 0.27 MPa	22.0	201.0							J, 20°, PL, ro, co, Fe P, 0°, PL, ro, co, X, Fe J, 20°, PL, ro, co, X, Fe J, 15°, PL, ro, co, Fe		
			$Is_{50}(D)$= 0.43 MPa UCS= 3.6 MPa	22.5								P, 0°, PL, ro, co, X J, 30°, PL, ro, vn, Fe P, 0-5°, PL, ro, vn		
				23.0	200.0		COAL: black					J, 65°, PL, ro, cn, Fe, from 22.83-22.91m P, 40°, PL, ro, co, X, clay		2 of 15
			$Is_{50}(A)$= 0.28 MPa $Is_{50}(D)$= 0.38 MPa				SANDSTONE: medium grained; dark grey; cross bedded at 0°, occasional siltstone laminations (10%) grey					P, 0°, PL, ro, co, x, Fe J, 70°, PL, ro, vn, Fe		
	Run 4			23.5						81 [32]		J, 60°, PL, ro, vn, Fe, clay J, 60-90°, UN P, 0°, PL, ro, vn, X, Fe P, 10°, PL, ro, vn, X, Fe		3 of 15
				24.0	199.0									

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

AECOM Cored Engineering Log

Draft

BOREHOLE No. BH28_UG

Sheet: 4 of 10

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				Surface:	Grass
				RL:	223 m
				Ver. Datum:	AHD

Field Data							Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 4	20% WATER LOSS	$Is_{50}(A)$= 0.01 MPa $Is_{50}(D)$= 0.16 MPa	199.0	24.5		MUDSTONE: dark grey; occasionally interlaminated at 0-5° with sandstone (10%), fine grained, pale grey	XW/XA HW/HA MW/MA SW/SA FR	soil 0.6 VL 2 L 6 M 20 H 60 VH 200 EH	81 [32]	40 60 100 300 1000	P, 0°, PL, ro, vn, X, Fe J, 90°, PL, ro, vn, Fe, X P, 0°, PL, ro, vn, X, Fe P, 5°, PL, ro, vn, Fe, X P, 5°, PL, ro, co, Fe, X P, 0°, PL, ro, vn, Fe, X CZ, IR, vn, CL, Fe, 80 mm P, 0°, PL, sm-ro, cn P, 0°, PL, sm-ro, vn, SC, Fe, X, x5, spaced 20 mm	BEDROCK *(continued)* *(continued)*	3 of 15
				198.0	25.0		COAL: black							
				197.0	26.0		NO CORE: from 26.03 m to 26.60 m					J, 70°, PL, sm-ro, vn, X P, 0°, PL, sm-ro, vn, X J, 30°, PL, sm-ro, vn, X CZ, IR, GP, X, 150 mm CZ, IR, GP, X, 320 mm		
	Run 5	100% WATER LOSS		196.0	27.0		COAL: black			71 [31]		CZ, IR, GP, X, 270 mm		
							SANDSTONE: medium grained; dark grey; occasionally interlaminated at 0-10° with siltstone (5%); occasional carbonaceous laminations					J, 20°, PL P, 0°, PL, sm, cn P, 5°, PL, sm-ro, cn P, 5°, PL, sm-ro, X, Fe P, 10°, PL, ro, cn		
				195.0	28.0		NO CORE: from 27.60 m to 28.00 m							
	Run 6		UCS= 15 MPa				SANDSTONE: as above from 28.42 m to 28.52 m: cross bedded at 5-15°			81 [29]		P, 0°, PL, ro, vn, X J, 50°, PL, ro, co, CL, 1 mm J, 80°, PL, ro, vn, CL, from 28.05-28.15m J, 60°, PL, ro, cn, from 29.08-29.15m J, 30°, PL, ro, vn, CL P, 5°, PL, ro, cn P, 0°, UN, ro, vn, CL J, 40-50°, UN, ro, tight P, 5°, PL, ro, vn, CL, X J, 30°, PL, ro, vn, CL, X CS, 0-30°, PL, CL, X, 50 mm P, 0°, PL, ro, vn, X J, 50°, PL, ro, tight P, 0°, PL, ro, co, CL, 1 mm		4 of 15
				194.0	29.0									
				193.0	30.0		NO CORE: from 29.5 m to 29.85 m					CS, 5°, PL, ro, SC, 10 mm J, 30°, PL, ro, vn, CL, X		
	Run 7	20% WATER LOSS	$Is_{50}(A)$= 0.66 MPa $Is_{50}(D)$= 0.06 MPa				SANDSTONE: pale grey; cross bedded at 0-10°, with carbonaceous laminations			95 [37]		P, 5°, PL, ro, vn, X P, 0°, IR, sm, cn P, 5°, PL, ro, co, SC, 1 mm, barrel spun J, 75°, PL, ro, vn, X, pyrite, from 30.37-30.58m P, 0°, PL, ro, co, SC, 1 mm P, 0°, PL, sm-ro, vn, CL, X P, 0°, PL, ro, co, SC, 1 mm		
				192.0	31.0		COAL: black							
	Run 8	20% WATER LOSS					SILTSTONE: dark grey; occasionaly interlaminated at 0-5° with sandstone (5%), fine grained, pale grey			100 [97]		P, 5°, PL, sm, vn, pyrite J, 45°, PL, sm, cn		5 of 15
	Run 9			191.0	32.0					100 [44]		P, 0-5°, PL, sm, cn J, 90°, PL, ro J, 20°, PL, sm, cn P, 10°, UN, sm, cn P, 5°, PL, sm, cn		

AECOM Cored Engineering Log — Draft

BOREHOLE No. BH28_UG

Sheet: 5 of 10

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data

Method: HQ3

Core Run: Run 9, Run 10, Run 11, Run 12, Run 13

Ground Water: 20% WATER LOSS

Field Tests

Reduced Level (m) / Depth (m)

Graphic Log

Material Description

MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)

Weathering/ Alteration: XW/XA, HW/HA, MW/MA, SW/SA, FR

Inferred Strength 20 x $Is_{(50)}$ MPa: soil, 0.6, VL, 2, L, 6, M, 20, H, 60, VH, 200, EH

Non-compliant UCS

TCR [RQD] (%)

Defect Spacing (mm): 40, 60, 100, 300, 1000

Comments

Additional Observations, Defect Descriptions.

Depth (m)	RL (m)	Material Description	TCR [RQD] (%)	particular	general	Core Box No.
32.5	191.0	SANDSTONE: fine to medium grained; pale grey; cross bedded at 0-5°, with carbonaceous laminations *(continued)*	100 [44]	J, 10°, PL, ro, cn J, 50°, UN, ro, vn, X, Fe J, 45°, PL, ro, vn, X, Fe	BEDROCK *(continued)*	
				P, 0°, PL, ro, vn, X P, 5°, PL, ro, vn, X J, 80-90°, PL, sm-ro, cn P, 0°, UN, ro, cn J, 70°, sm, cn	*(continued)*	
33.0	190.0	SILTSTONE: dark grey; occasionally interlaminated at 0° with sandstone (10%)	100 [40]			
		COAL: black		J, 85-90°, ST, sm-ro, vn, pyrite, X		
33.5				CS, vn, pyrite, X, coal, 90 mm J, 85°, PL, sm, vn, pyrite, from 33.58-33.71m		5 of 15
34.0	189.0	LAMINITE: siltstone (70-80%) dark grey, interlaminated at 0-5° with sandstone (20-30%) fine grained, pale grey, with carbonaceous laminations		J, 85°, PL, sm, vn, pyrite, from 33.65-33.75m P, 5°, PL, sm-ro, vn, pyrite J, 70°, PL, sm-ro, cn, from 33.78-33.92m J, 0-5°, IR, sm-ro, cn J, 35°, PL, sm-ro, cn J, 60°, PL, sm-ro, cn, from 34.01-34.05m J, 0-30°, UN, sm-ro, cn J, 30°, PL, sm-ro, cn J, 0-30°, UN, sm-ro, cn J, 15°, PL, sm-ro, co, CL, 1 mm J, 15°, PL, sm-ro, cn P, 0°, ST, sm-ro, vn, pyrite		
35.0	188.0	SANDSTONE: medium grained; pale brown to dark brown; cross bedded day 0-5°, with carbonaceous laminations		J, 0-30°, UN, sm-ro J, 80°, PL, sm-ro, cn J, 80°, PL-UN, sm-ro, cn, from 34.85-35.08m		
35.5		MUDSTONE: dark grey; occasionally interlaminated at 0-5° with sandstone (5%)		P, 5°, PL, sm-ro, co, coal P, 0-10°, IR, sm-ro, co, coal CZ, IR, sm-ro, GP, 110 mm J, 75°, PL, sm-ro, from 35.63-35.78m		
36.0	187.0	LAMINITE: siltstone (60%) dark grey, interlaminated at 0-10° with sandstone (30-40%) fine grained, pale grey	100 [37]	P, 5°, PL, sm, cn J, 50°, PL, sm, cn J, 70°, PL, sm, cn, from 36.02-36.15m P, 0°, IR, sm, cn, CL, pyrite, barrel spun P, 10°, PL, sm, cn P, 0°, PL, sm, cn J, 5-10°, UN, tight P, 0°, PL, sm, vn, CL, barrel spun J, 10°, PL, sm-ro, cn J, 60°, PL, sm-ro, vn, CL, from 36.76-36.85m J, 75°, PL, sm-ro, cn J, 10°, UN, sm-ro, cn, from 36.80-37.03m J, 10°, UN, sm-ro, cn J, 75°, PL, sm-ro, cn, X P, 5°, PL, sm-ro, cn P, 5°, PL, ro, cn P, 0°, PL, sm-ro, vn, X, Fe P, 5-10°, UN, ro, vn, X, Fe P, 5°, PL, ro, cn, Fe CZ, 140 mm J, 90°, ST, sm, coal, from 37.71-37.87m		6 of 15
37.5		SANDSTONE: fine to medium grained; grey and yellow-brown; cross bedded day 0-5°, with carbonaceous laminations				
		COAL: black; Muswellbrook Seam				
38.0	185.0		91	CZ, IR, coal, 170 mm P, 0°, PL, sm, coal J, 0°, PL, sm, coal J, 50°, PL, sm, coal CZ, 850 mm J, 50°, PL, sm, coal J, 90°, PL, sm, coal, pyrite, from 38.35-38.45m J, 50°, PL, sm, coal		
38.5						
39.0	184.0	NO CORE: from 38.81 m to 38.90 m	87	J, 70°, PL, sm, coal, pyrite, from 38.50-38.72m CS, IR, GP, 40 mm J, 60°, PL, sm, coal, pyrite, from 35.72-38.81m SZ J, 50-90°, CN J, 50°, CN J, 30°, PL, sm J, 10°, PL, sm		7 of 15
		COAL: black; Muswellbrook Seam				
39.5						
		NO CORE: from 39.77 m to 39.9 m		J, 60°, PL, from 39.61-39.73m J, 25°, PL, sm		
40.0	183.0					

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, VL, L, M, H, VH, EH; 0.6, 2, 6, 20, 60, 200)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 14	20% WATER LOSS	UCS= 35 MPa	183.0			COAL: black; Muswellbrook Seam *(continued)*			90			BEDROCK *(continued)* *(continued)*	
					40.5							CS, IR, sm, GC, X, 40 mm P, 0°, PL, sm, cn J, 80°, PL, sm, vn, pyrite, from 40.40-40.86m J, 10°, PL, sm, cn P, 5°, PL, sm, cn J, 10-40°, CN, sm, cn		
					41.0		NO CORE: from 40.80 m to 40.90 m							
	Run 15	20% WATER LOSS		182.0			MUDSTONE: dark grey; laminated at 0-5°			95 [41]		J, 10°, PL, sm, co, CL, X P, 5°, PL, sm, cn J, 15°, PL, sm, vn, CL P, 0°, PL, sm, vn, CL, X J, 30-70°, UN, sm, vn, pyrite, from 40.54-40.61m		7 of 15
					41.5		LAMINITE: siltstone (50%) dark grey, interlaminated at 0-10° with sandstone (50%) fine grained, pale grey					J, 70°, PL, sm, vn, pyrite J, 25°, PL, cn P, 5°, PL, vn, pyrite J, 30°, PL, vn, pyrite, cross joint		
					42.0		NO CORE: from 41.80 m to 41.85 m					CZ, IR, GP, pyrite, 80 mm, cross joint		
	Run 16	20% WATER LOSS		181.0			LAMINITE: as above			100 [94]		CZ, CR, CP, 20 mm SZ, PL, GC J, 25°, PL, sm, cn SZ, 65-80°, UN, co, X, 1 mm, displacment 6mm P, 5°, PL, sm-ro, cn P, 15°, PL, sm-ro, cn, tight CS, 5°, PL, sm, GC, 10 mm J, 10°, PL, sm, cn P, 10°, PL, sm-ro, cn J, 60°, PL, ro, cn, from 41.97-42.04m P, 0°, PL, ro, cn SS, 60°, PL, to, cn, displacment 3 mm		
					43.0		from 42.80 m to 43.00 m: Sandstone (90%); Mudstone (10%)					P, 3°, PL, sm-ro, cn J, 10°, UN, ro, cn		
				180.0								P, 0°, PL, sm-ro, cn J, 20°, PL, ro, co, GC, 3 mm P, 0°, PL, sm-ro, cn		
					44.0		SANDSTONE: fine to medium grained; pale grey; cross bedded at 0-5°, with mudstone laminations					J, 30°, UN, ro, cn J, 10°, PL, ro, cn P, 0°, PL, ro, cn		
	Run 17	20% WATER LOSS		178.0	45.0		Carbonaceous SILTSTONE: dark grey; laminated at 0°			100 [26]		P, 5°, PL, ro, vn, X, washed out J, 15°, PL, ro, vn, X, washed out P, 0°, PL, ro, cn J, 70°, PL, sm, vn, X P, 0°, PL, sm, vn, X J, 65°, PL, sm-ro, vn, pyrite, from 45.00-45.12m J, 65°, PL, sm, vn, X, pyrite, crushed by drilling P, 10°, from 42.22-45.37m J, 20°, PL, ro, co, GC, X, 2 mm J, 70°, vn, X, from 45.22-45.37m J, 80-90°, CN, ro, co, GC, X, 2 mm, from 45.31-45.61m P, 0°, PL, ro, co, GC, X P, 0°, PL, ro, co, GC, X, pyrite P, 0°, PL, ro, co, GC, X J, 70°, PL, ro, vn, X P, 0-10°, UN, sm-ro, vn, X, pyrite		8 of 15
					45.5		LAMINITE: mudstone (70%) dark grey, interlaminated at 5-10° with sandstone (30%) fine grained, grey							
	Run 18	20% WATER LOSS		177.0	46.0					100 [8]		J, 15°, PL, sm-ro, vn, pyrite P, 0°, UN, ro, cn P, 0°, PL, sm, cn J, 45°, PL, sm, cn P, 0°, PL, sm, cn, barrel spun J, 65°, PL, sm, cn, from 46.31-46.46m P, 0°, barrel spun P, 0°, PL, sm, cn J, 30°, PL, sm, cn P, 0°, PL, sm, cn J, 80-90°, CU, sm, cn, from 46.63-46.71m P, 0°, PL, ro, cn, 2x EW, 0°, PL, ro, co, SC, 30 mm P, 0°, PL, sm-ro, cn J, 5°, PL, ro, cn P, 0°, PL, sm-ro		9 of 15
					47.5		SILTSTONE: dark grey; laminated at 0°							
				175.0	48.0					100				

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data | **Material Description** | **Comments**

Method: HQ3

Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, 0.6, VL, 2, L, 6, M, 20, H, 60, VH, 200, EH)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
Run 19	20% WATER LOSS		175.0	48.5		COAL: black; St Heliers Seam			100		J, 85°, IR, sm, vn, pyrite, tight	BEDROCK	
						SILTSTONE: dark grey; laminated at 0°					J, 10°, PL, sm, vn, CL	*(continued)*	
						COAL: black; St Heliers Seam					J, 40°, PL, sm, co, CL, 1 mm, crushed by drilling	*(continued)*	
											P, 0°, PL, sm, cn		
											J, 90°, IR, sm, vn, pyrite, 2x tight		
											J, 10°, PL, sm, cn		
											J, 20-30°, UN, sm, cn		
											P, 0°, PL, sm, cn		
											P, 0°, PL, sm, vn, CL		
											P, 0°, PL, sm, cn		
			174.0	49.0		SILTSTONE: dark grey; laminated at 0°					P, 5°, PL, sm, cn, from 47.40-47.97m		
						COAL: black; St Heliers Seam					P, 0°, PL		
											J, 10-50°, UN, sm, un		
											J, 50°, PL, sm		
											J, 10-30°, UN, sm, vn		
				49.5							CS, 30°, PL, sm, co, GC, 30 mm, crushed by drilling		9 of 15
Run 20	20% WATER LOSS								100		P, 10°, PL, sm, vn, X		
											J, 15°, PL, sm, cn, GC		
											J, 40°, PL, sm, cn, X		
											J, 50°, PL, sm, cn		
											J, 60°, PL, sm, cn, from 48.51-48.63m		
											J, 30°, PL, sm, cn		
											J, 20°, PL, sm, vn, pyrite		
											P, 0°, PL, sm, cn		
											J, 60°, PL, sm, vn, pyrite		
											P, 5°, PL, sm, cn		
											CZ, coal, 60 mm		
											SZ, PL, vn, vn, pyrite, multiple joints		
											P, 5°, PL, sm, cn, barrel spun		
											J, 60°, PL, vn, vn, pyrite, tight		
											P, 0°, PL, sm, cn		
									100		J, 10°, PL, sm, cn		
											J, 25°, PL, vn, vn, pyrite		
											J, 40°, PL, sm, cn		
											J, 40°, PL, vn, vn, pyrite		
											J, 10°, PL, sm, cn		
											J, 70-90°, CN, vn, vn, pyrite, from 49.93-50.13m		
											J, 85°, PL, vn, vn, pyrite, from 49.93-50.32m		
											P, 5°, PL, sm, cn		
											P, 0°, PL, sm, cn		
											J, 70-90°, CU, sm, cn		
											J, 50°, IR, sm, cn		
											J, 10°, PL, sm, cn		
											J, 40°, PL-IR, sm, cn		
											J, 60°, PL, sm, cn, from 50.72-50.84m		
											J, 70°, PL, sm, cn, from 50.96-51.13m		
											O, 50°, PL, sm, cn		
											CS, coal, 10 mm		
											O, 5°, PL, sm, cn		
											P, 5°, PL, sm, cn, barrel spun		
											J, 45°, PL, sm, cn		
											J, 45°, IR-UN		
											J, 10-70°, UN		
Run 21	20% WATER LOSS										CS, 5°, PL, sm, vn, coal, 10 mm		10 of 15
											CS, 10°, PL, sm, vn, coal, 10 mm		
									100				
											P, 5°, PL, sm, cn		
											SZ, IR, sm, cn		
											P, 0°, PL, sm, cn		
											J, 90°, PL, sm, cn, from 54.47-54.60m		
											J, 10°, PL, sm, cn		
Run 22	20% WATER LOSS										P, 0°, PL, sm, cn		11 of 15
											J, 20°, PL, sm, cn		
											J, 35°, PL, sm, cn		
											J, 75°, PL, sm, cn, from 55.34-55.46m		
											J, 10°, PL, sm, cn		
											P, 5°, PL, sm, cn		
			167.0										

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
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Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x Is(50) MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 22	20% WATER LOSS	2/7/20	167.0			COAL: black; St Heliers Seam *(continued)*	XW/XA HW/HA MW/MA SW/SA FR	soil VL L M H VH EH	100		J, 70-90°, UN, sm, cn, from 56.02-56.17m	BEDROCK *(continued)* *(continued)*	
				56.5								J, 90°, PL, sm, cn, from 65.41-56.54m P, 0°, PL, sm, cn		
	Run 23	20% WATER LOSS		57.0	166.0		SILTSTONE: dark grey; laminated at 0-5°			100 [78]		J, 30°, PL, sm, cn J, 10°, PL, sm, cn, tight J, 40°, PL, sm, cn, tight J, 40°, PL, sm, cn J, 30°, PL, sm, cn J, 20°, PL, sm-ro, cn P, 5°, PL, sm-ro, cn J, 30°, PL, sm-ro, cn		11 of 15
				57.5			LAMINITE: sandstone (70-80%): fine to medium grained, pale grey, interlaminated at 0-15° with siltstone (20-30%), grey					P, 0°, PL, sm-ro, vn, pyrite J, 20°, PL, sm-ro, vn, pyrite J, 30°, PL, sm-ro, vn, pyrite P, 0°, PL, sm-ro, vn, pyrite J, 5°, PL, sm-ro, vn, pyrite J, 60°, PL, sm-ro, cn P, 0°, PL, sm-ro, cn J, 10°, PL, sm-ro, vn, pyrite J, 24°, PL, sm-ro, vn, pyrite		
				58.0	165.0									
				58.5			SANDSTONE: medium grained; grey and yellow-brown; cross bedded at 0-5°, occasional siltstone and carbonaceous laminations					P, 5°, PL, ro, vn, X		
		100% WATER LOSS		59.0	164.0							P, 5°, PL, ro, vn, pyrite, X J, 45°, PL, ro, vn, pyrite, X P, 0°, PL, ro, vn, pyrite, X, x2, spaced 20 mm NF, 30°, UN, ro, co, X, 3 mm P, 5°, PL, ro, co, CL, X, 2 mm		
				59.5								P, 5°, PL, ro, co, X, 2 mm CS, IR, co, GP, X, 70 mm		
	Run 24	82% WATER LOSS		60.0	163.0		INTERBEDDED MUDSTONE/SANDSTONE: mudstone (60%) dark grey, interlaminated at 0-15° with sandstone (40%) fine grained, pale grey			100 [65]		SZ, IR, sm, vn, CL, pyrite J, 10°, PL, sm, co, X, pyrite, 1 mm J, 20°, PL, sm, vnvn, X, pyrite P, 5°, PL, ro, vn, X, pyrite, tight, spaced 10 mm J, 20°, PL, sm, vn, pyrite P, 0°, PL, sm, vn, pyrite P, 0°, PL, sm-ro, vn, pyrite J, CU, sm-ro, cn, from 60.05-60.12m P, 0°, PL, sm-ro, vn, pyrite J, 30°, PL, sm-ro, cn SS, 70°, PL, sm-ro, cn, from 60.11-60.30m, apparent displacement 3mm J, 60°, PL, sm-ro, cn, from 60.28-60.38m J, 5°, PL, sm-ro, cn J, 40°, PL, sm-ro, cn J, 10°, PL, sm-ro, cn J, 15°, PL, sm-ro, vn, X J, 30°, PL, sm-ro, cn J, 90°, PL, sm-ro, cn, from 60.94-61.15m J, 10°, PL, sm-ro, cn P, 0°, PL, sm-ro, cn		12 of 15
				60.5										
				61.0	162.0									
				61.5								J, 30°, PL, sm-ro, vn, X		
				62.0	161.0									
	Run 25	100% WATER LOSS		62.5								J, 30°, PL, sm-ro, cn		
				63.0	160.0					100 [100]		P, 0°, PL, sm-ro, vn, pyrite J, 45°, PL, sm-ro, vn, pyrite		
	Run 26	50% WATER LOSS		63.5						100 [71]		J, 10°, UN, sm-ro, cn P, 5°, PL, sm-ro J, 30°, PL, sm-ro, cn P, 0°, PL, sm-ro, cn, barrel spun J, 10°, PL, sm-ro, vn, X P, 5°, PL, sm-ro, cn		13 of 15
				64.0	159.0									

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
		Inclination:	-90°	**Northing:**	6429533 m
Drill Rig:	Hydrapower Scout VI	**Bearing:**	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data | **Material Description** | **Comments**

Method: HQ3

Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, 0.6, VL, 2, L, 6, M, 20, H, 60, VH, 200, EH)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
		UCS= 35 MPa	159.0									BEDROCK *(continued)* *(continued)*	
Run 26	50% WATER LOSS		64.5			SANDSTONE: medium to coarse grained; pale grey-brown; cross bedded day 0-5°, occasional siltstone and carbonaceous laminations			100 [71]		P, 0°, barrel spun CS, IR, sm-ro, GM, 20 mm P, 10°, PL, ro, co, CL, X, 5 mm P, 5°, PL, ro, co, X, 5 mm P, 10°, PL, ro, vn, X		
			65.0	158.0									13 of 15
			65.5			COAL: dark grey to black; Lewis Seam					P, 10°, PL, ro, co, X, 2 mm P, 10°, PL, coal, pyrite J, 70-85°, UN, sm, vn, pyrite, from 65.28-65.45m P, 0°, PL, sm, co, coal, 1 mm J, 85°, PL, sm, vn, pyrite, from 65.51-65.86m		
Run 27	30% WATER LOSS		66.0	157.0					100		J, 60°, PL, sm, vn, pyrite, from 65.57-65.66m P, 10°, PL, sm, cn P, 5°, PL, sm, vn, pyrite P, 5°, PL, sm, cn J, 20°, PL, sm, cn P, 0°, PL, sm, cn J, 80°, PL, from 66.19-66.25m		
			66.5										
		UCS= 26 MPa	67.0	156.0							P, 50°, PL, sm, cn J, 80°, sm, vn, pyrite J, 70-80°, PL, sm, cn, x3, spaced 20 mm J, 0-20°, CU, sm, cn J, 70-70°, UN, sm, vn, pyrite, from 67.06-67.37m		
			67.5								J, 70°, PL, sm, vn, pyrite, from 67.43-67.61m J, 10-20°, UN, sm, cn J, 70-90°, CU, sm, vn, pyrite, from 67.76-68.27m		
			68.0	155.0									14 of 15
			68.5			VOID: from 68.53 m to 71.15 m							
	100% WATER LOSS		69.0	154.0									
			69.5										
			70.0	153.0									
			70.5								P, 0°, PL, sm-ro, co, SC, 1 mm		
			71.0	152.0									
Run 28	100% WATER LOSS	$Is_{50}(A)$= 0.15 MPa $Is_{50}(D)$= 0.35 MPa	71.5			CONGLOMERATE: pale grey and grey; matrix supported; matrix supported. clasts are fine to medium gravel size, sub-angular to sub-rounded, carbonaceous sandstone and siltstone, pyrite; matrix is cemented silt and sand			100 [43]		P, multiple partings, spaced 10 mm P, 0°, UN, sm, vn, pyrite, X P, 0°, UN, sm, vn, pyrite, X, barrel spun P, 0°, PL, sm, vn, pyrite, X, barrel spun P, 0°, PL, sm, vn, pyrite, X P, 0°, PL, sm, vn, barrel spun P, 5°, PL, sm, cn J, 30°, PL, sm, cn P, 5°, PL, sm, cn, barrel spun J, 10°, PL, sm-ro, cn		15 of 15
			72.0	151.0									

AECOM Cored Engineering Log — Draft

BOREHOLE No. BH28_UG

Sheet: 10 of 10

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	22/06/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	02/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303513 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429533 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, VL, L, M, H, VH, EH; 0.6, 2, 6, 20, 60, 200)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 29	100% WATER LOSS	Is_{50}(A)= 0.12 MPa Is_{50}(D)= 0.02 MPa Is_{50}(A)= 0.13 MPa Is_{50}(D)= 0.36 MPa	151.0 72.5 73.0 150.0			CONGLOMERATE: pale grey and grey; matrix supported; matrix supported. clasts are fine to medium gravel size, sub-angular to sub-rounded, carbonaceous sandstone and siltstone, pyrite; matrix is cemented silt and sand *(continued)*			100 [74]		J, 30°, PL, sm-ro, cn P, 0°, PL, sm-ro, cn, barrel spun P, 0°, PL, sm-ro, cn J, 30°, PL, sm-ro, cn J, 30°, IR, sm-ro, cn J, 60°, PL, sm-ro, cn, from 72.08-72.17m P, 5°, PL, sm-ro, cn P, 0°, PL, sm-ro, cn P, 5°, PL, sm-ro, cn	BEDROCK *(continued)* *(continued)*	15 of 15
					73.0		*BH28_UG terminated at 73.07 m. Achieved Termination Criteria*							
					73.5									
					74.0									
				149.0	74.5									
					75.0									
				148.0	75.5									
					76.0									
				147.0	76.5									
					77.0									
				146.0	77.5									
					78.0									
				145.0	78.5									
					79.0									
				144.0	79.5									
					80.0									
				143.0										

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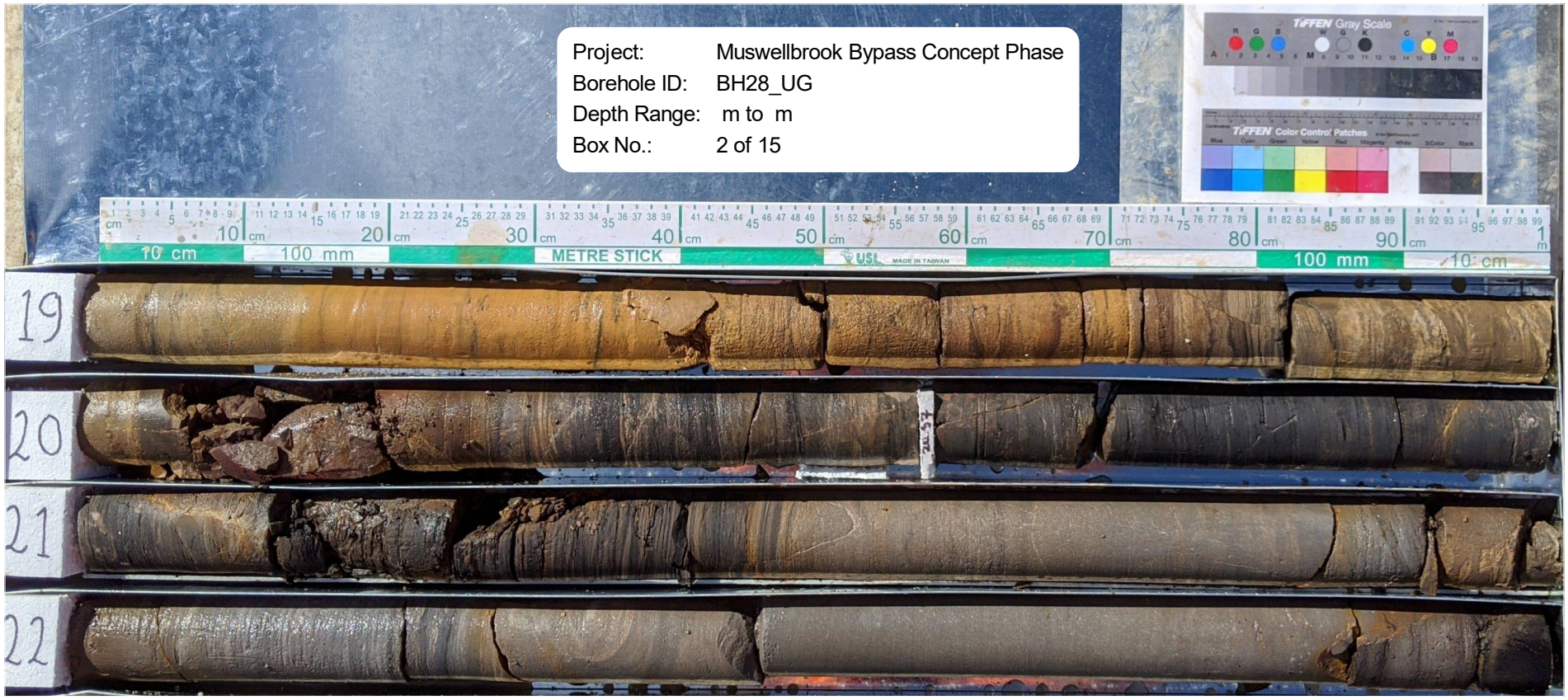
CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 1 of 15



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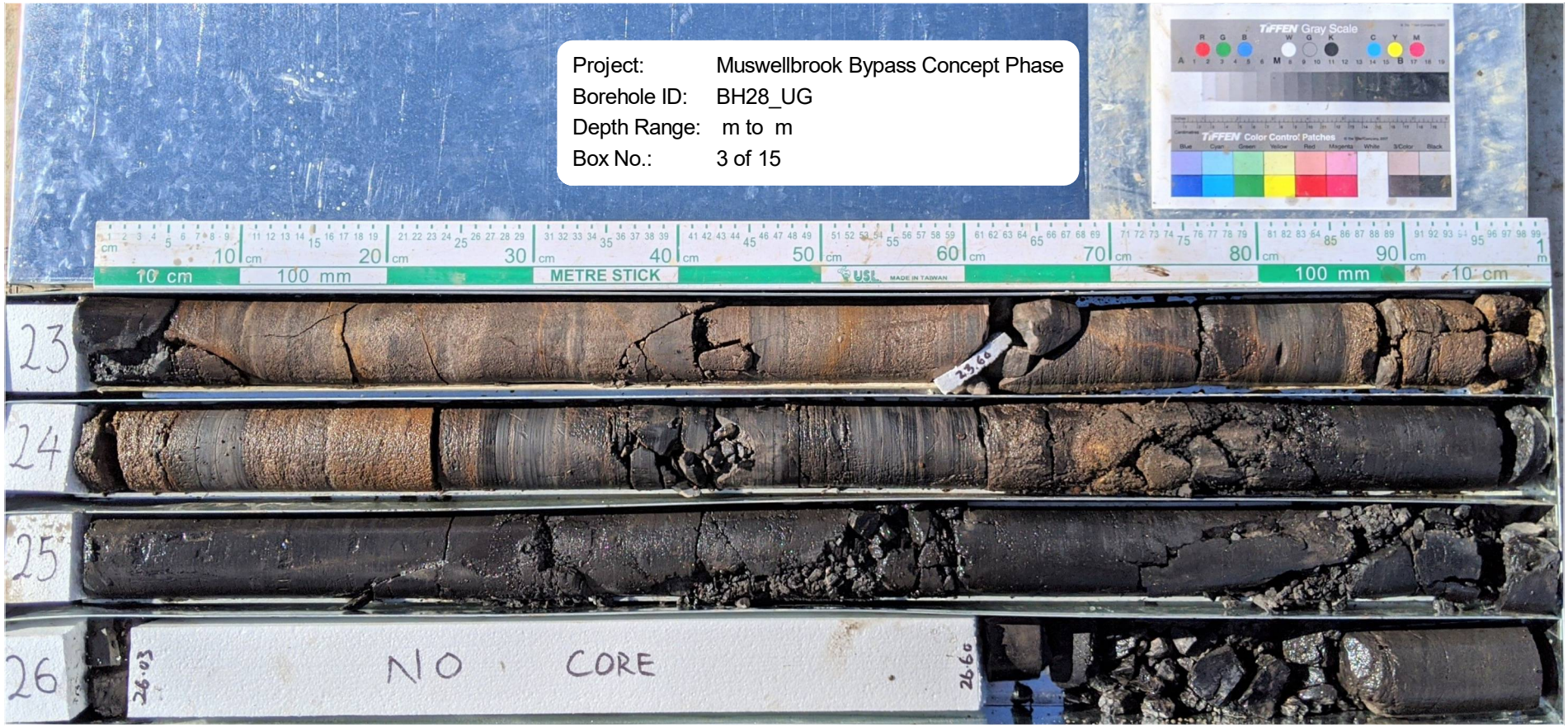
CLIENT: TfNSW	APPROVED:	TR	TITLE: Core Photographs
PROJECT NAME: Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	BOREHOLE NO: BH28_UG
PROJECT No: 60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE: m to m PHOTO NO: 2 of 15

AECOM



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CLIENT:	TfNSW	APPROVED:	TR	TITLE:	Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	BOREHOLE NO:	BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE:	m to m
				PHOTO NO:	3 of 15

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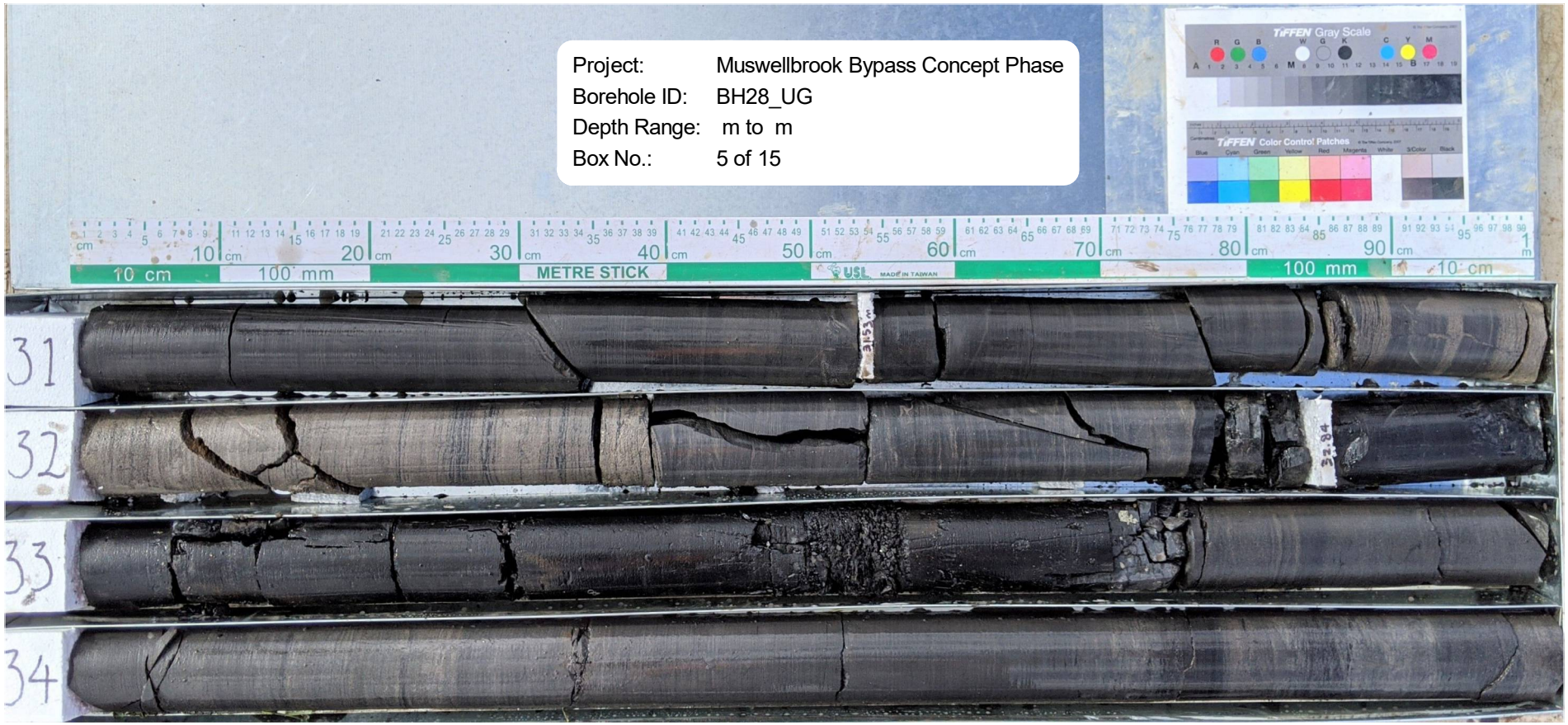
CLIENT: TfNSW	APPROVED:	TR	TITLE: Core Photographs
PROJECT NAME: Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	BOREHOLE NO: BH28_UG
PROJECT No: 60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE: m to m PHOTO NO: 4 of 15



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CLIENT:	TfNSW	APPROVED:	TR		TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	AECOM	BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 5 of 15

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CLIENT:	TfNSW	APPROVED:	TR	TITLE:	Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	BOREHOLE NO:	BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE:	m to m
				PHOTO NO:	6 of 15

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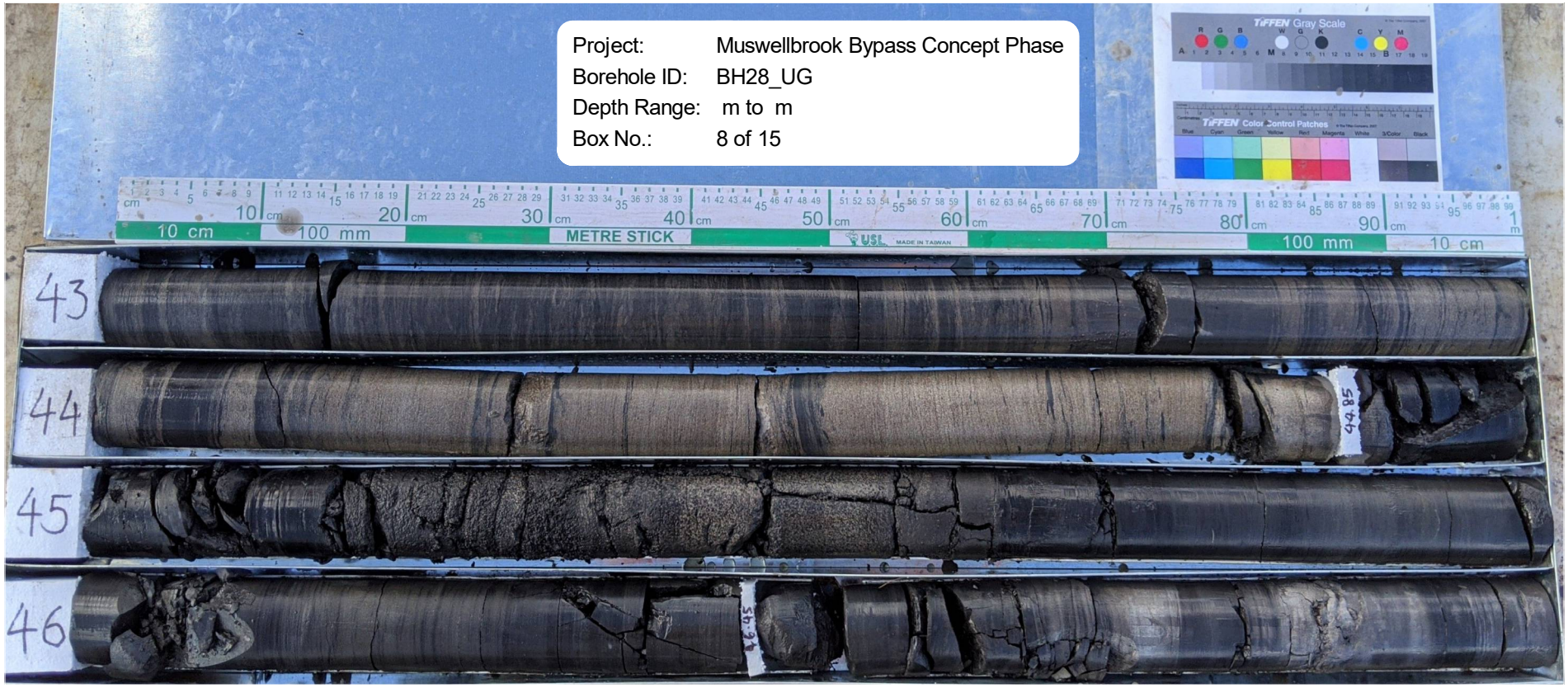
CLIENT:	TfNSW	APPROVED:	TR	TITLE:	Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	BOREHOLE NO:	BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE:	m to m
				PHOTO NO:	7 of 15



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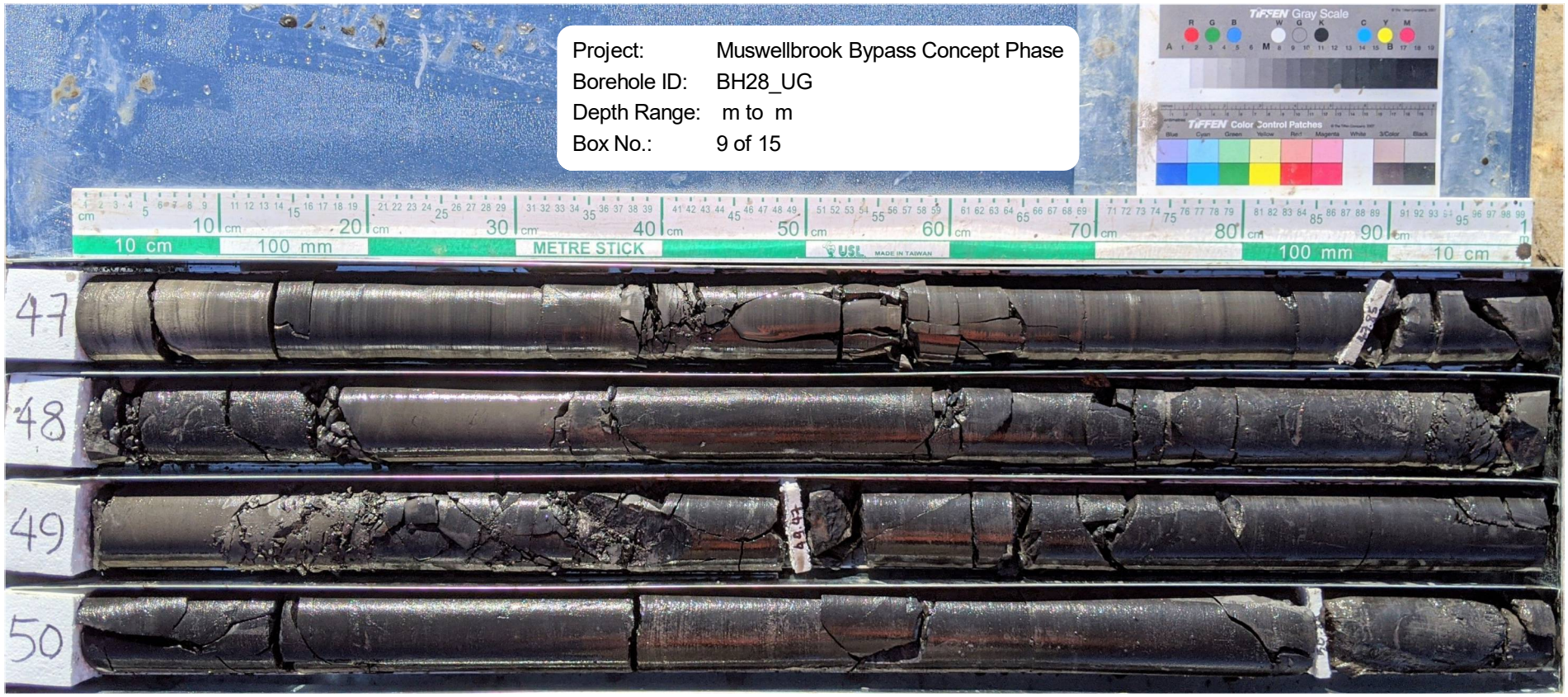
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 8 of 15



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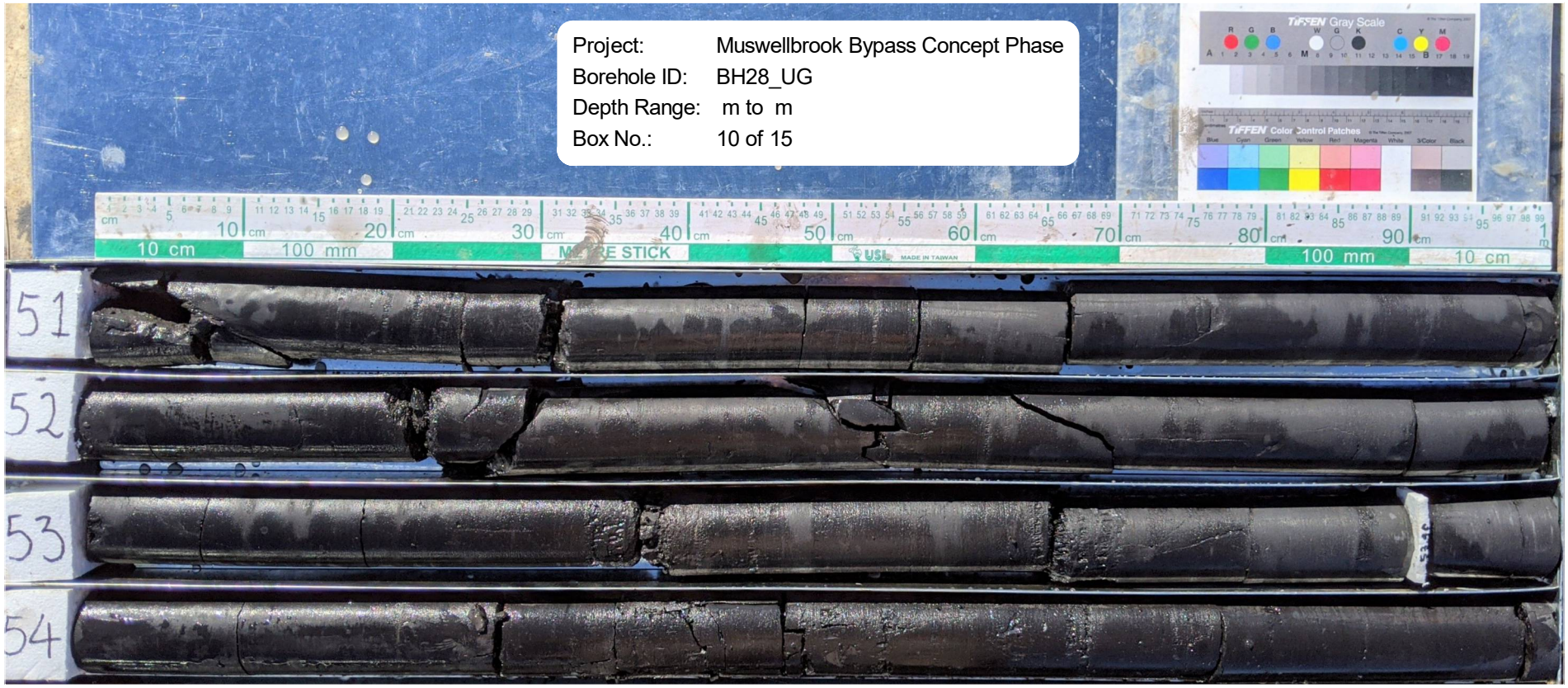
CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 9 of 15



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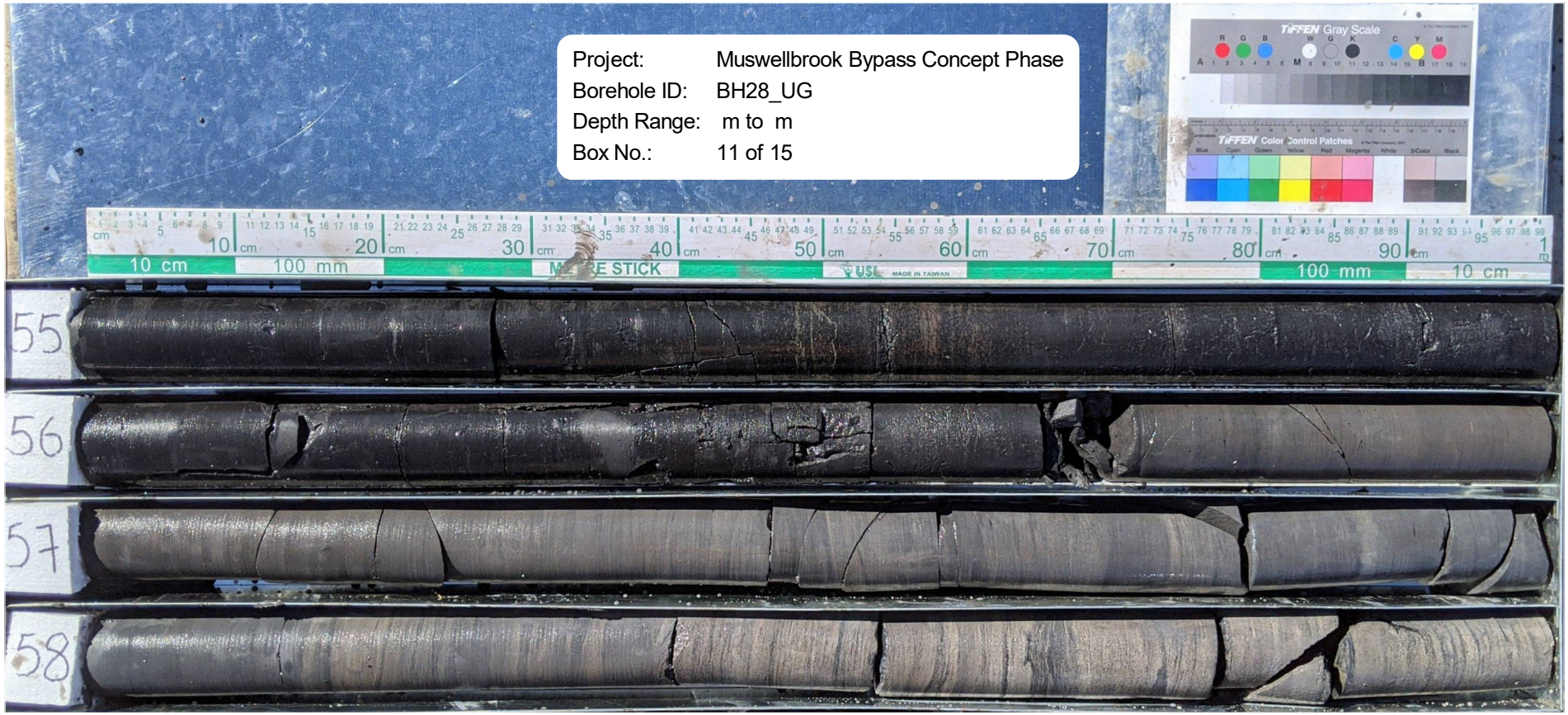
CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 10 of 15



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CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 11 of 15

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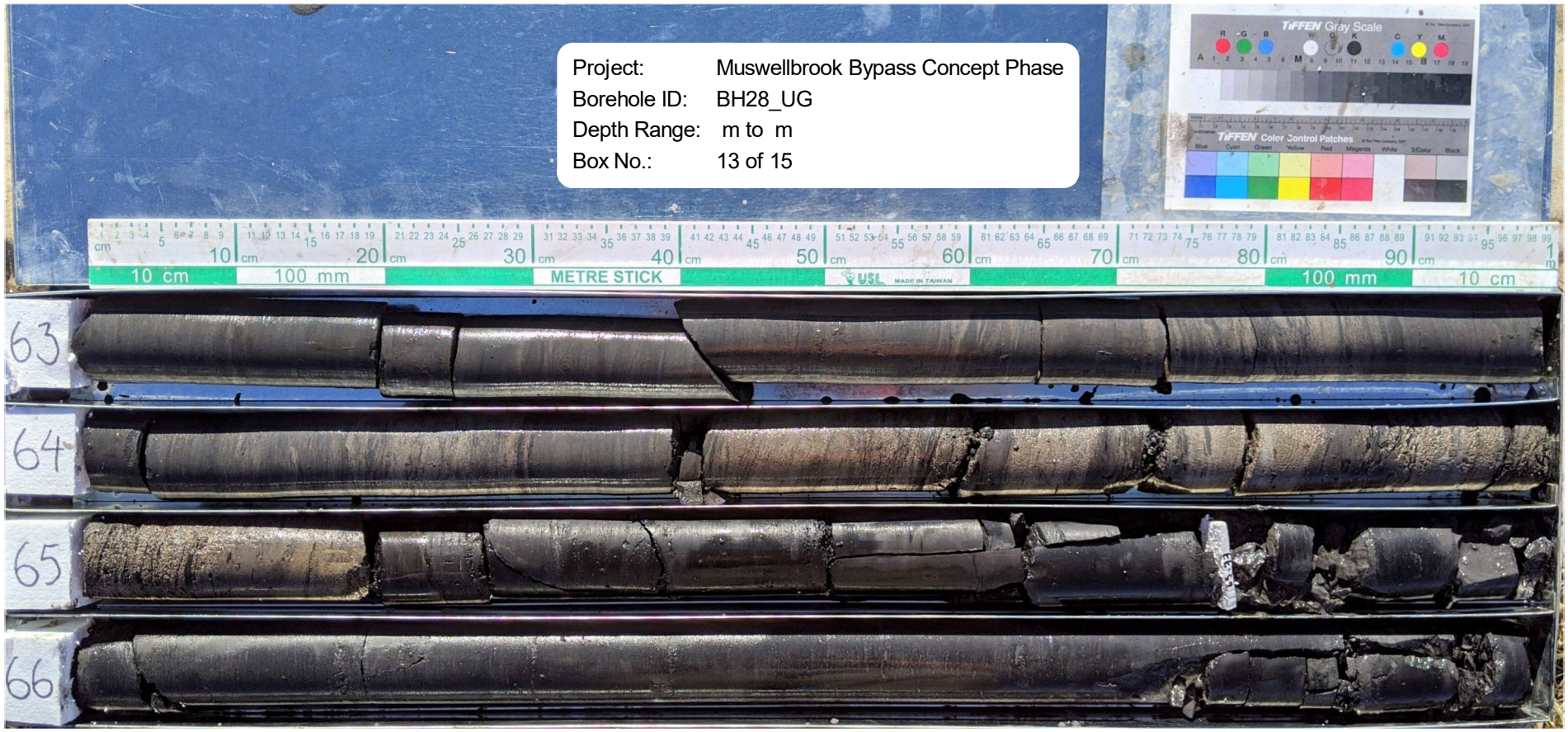
CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 12 of 15



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CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 13 of 15

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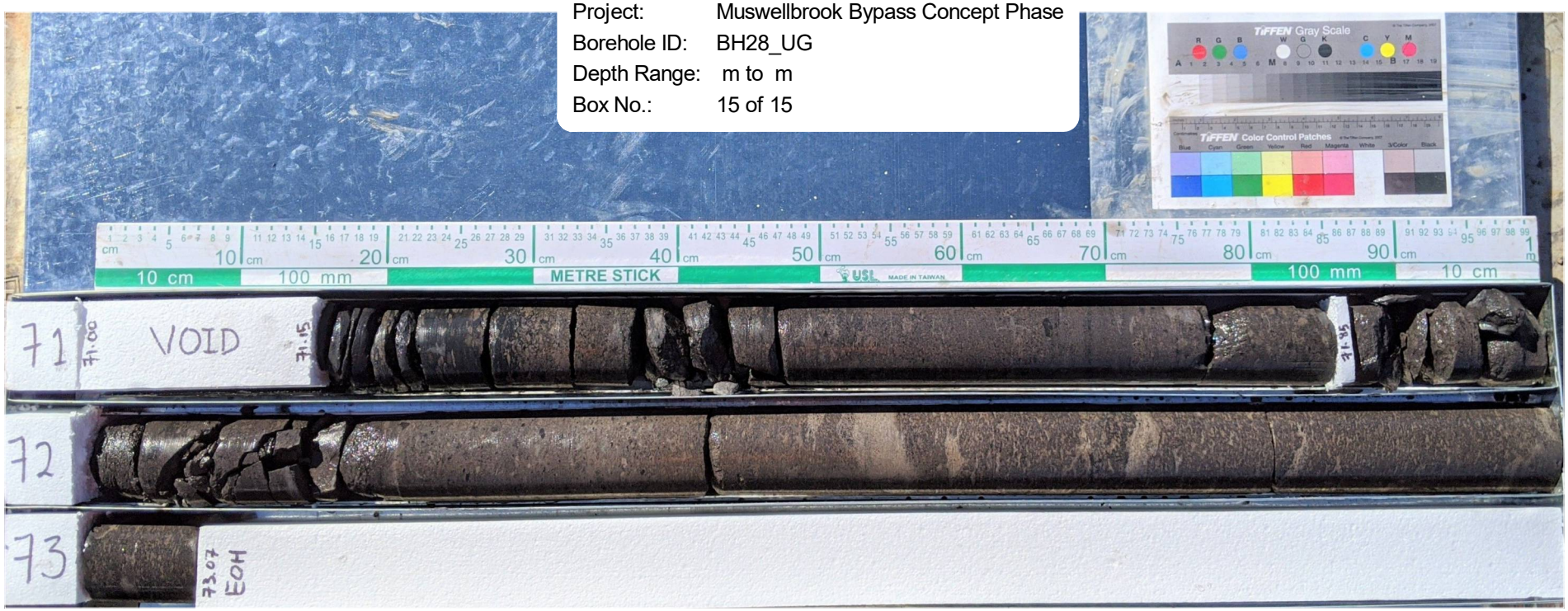
CLIENT: TfNSW	APPROVED:	TR	TITLE: Core Photographs
PROJECT NAME: Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020	BOREHOLE NO: BH28_UG
PROJECT No: 60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE: m to m PHOTO NO: 14 of 15

Project: Muswellbrook Bypass Concept Phase
Borehole ID: BH28_UG
Depth Range: m to m
Box No.: 15 of 15



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CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	24/06/2020		BOREHOLE NO: BH28_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: m to m PHOTO NO: 15 of 15

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28A_UG**

Sheet: 1 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	U				224.0	0.0			FILL: MIXTURE OF COBBLES/BOULDERS AND SOIL, soil comprises silty SAND: fine to coarse grained; dark brown; cobbles of siltstone, coal, sandstone, 60-90 mm, sub-angular	M		FILL
						0.5			FILL: gravelly SAND: fine to coarse grained; brown-grey; gravels is angular to sub-angular, of siltstone, sandstone and coal, with silt			
					223.0	1.0			FILL: SAND: fine to medium grained; dark grey; with silt, with fine to medium gravel, angular, of tuffaceous siltstone, carbonaceous siltstone and coal	D		
						1.5			FILL: sandy GRAVEL: fine to medium grained; angular to sub-angular; black, dark grey, red-brown and white; of tuffaceous siltstone, ironstone, sandstone and coal, sand is fine to medium grained, grey-brown			
					222.0	2.0			FILL: sandy SILT: non-plastic; yellow-brown and pale grey; sand is fine to medium grained			
						2.5			from 2.50 m: dark grey			
					221.0	3.0			FILL: FILL: Refer to BH28_UG for indicative soil/rock sttatum			3.00-59.10m: Refer to BH28_UG for indicative soil/rock sttatum
WB+RR	HWT					3.5						
					220.0	4.0						
						4.5						
						5.0						
					219.0	5.5						5.00m: water return temperature: 13.6°C
						6.0						
					218.0	6.5						
						7.0						
					217.0	7.5						
						8.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB+RR	HWT				216.0	8.5			FILL: FILL: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			FILL *(continued)*
					215.0	9.0						
						9.5						
					214.0	10.0						
						10.5						
					213.0	11.0						
						11.5						
					212.0	12.0						
						12.5						
					211.0	13.0						
						13.5						
					210.0	14.0						
						14.5						
PCD					209.0	15.0			BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum			BEDROCK
						15.5						
						16.0						

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD					208.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						16.5						
					207.0	17.0						
						17.5						
					206.0	18.0						
						18.5						
					205.0	19.0						
						19.5						
					204.0	20.0						
						20.5						
					203.0	21.0						
						21.5						
					202.0	22.0						
						22.5						
					201.0	23.0						
						23.5						
						24.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD					200.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						24.5						
					199.0	25.0						
						25.5						
					198.0	26.0						
						26.5						
					197.0	27.0						
						27.5						
					196.0	28.0						
						28.5						
					195.0	29.0						
						29.5						
					194.0	30.0						
						30.5						
					193.0	31.0						
						31.5						
						32.0						

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28A_UG**

Sheet: 5 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD					192.0	32.5			BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
					191.0	33.0						
						33.5						
					190.0	34.0						
						34.5						
					189.0	35.0						
						35.5						
					188.0	36.0						
						36.5						
					187.0	37.0						
						37.5						
					186.0	38.0						
						38.5						
					185.0	39.0						
						39.5						
						40.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD					184.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						40.5						
					183.0	41.0						
						41.5						
					182.0	42.0						
						42.5						
					181.0	43.0						
						43.5						
					180.0	44.0						
						44.5						
					179.0	45.0						
						45.5						
					178.0	46.0						
						46.5						
					177.0	47.0						
						47.5						
						48.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD					176.0	48.5			BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
					175.0	49.0						
						49.5						
					174.0	50.0						
						50.5						
					173.0	51.0						
						51.5						
					172.0	52.0						
						52.5						
					171.0	53.0						
						53.5						
					170.0	54.0						
						54.5						
					169.0	55.0						
						55.5						
						56.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD					168.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						56.5						
					167.0	57.0						
						57.5						
					166.0	58.0						
						58.5						
					165.0	59.0						
									Borehole BH28A_UG log continued as cored log from 59.10 m.			
						59.5						
						60.0						
						60.5						
						61.0						
						61.5						
						62.0						
						62.5						
						63.0						
						63.5						
						64.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description					Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular / general	Core Box No.
				168.0									
					56.5								
				167.0	57.0								
					57.5								
				166.0	58.0								
					58.5								
				165.0	59.0		*Continued from non-cored borehole at 59.10 m.*						
HQ3	Run 1	5% WATER LOSS	$Is_{50}(A)$= 0.90 MPa $Is_{50}(D)$= 1.80 MPa		59.5		MUDSTONE: dark grey; occasionally interlaminated at 0-5° with sandstone (10%)			100 [100]		BEDROCK J, 20°, PL, sm, cn P, 5°, PL, sm, cn J, 10°, UN, ro-sm, cn	
				164.0	60.0		SANDSTONE: fine to medium grained; pale brown; cross bedded at 0-10°, with carbonaceous laminations			100 [88]		P, 5°, PL, ro-sm, vn, X	
	Run 2	0% WATER LOSS	$Is_{50}(A)$= 0.99 MPa $Is_{50}(D)$= 2.60 MPa		60.5							P, 5°, PL, ro, vn, pyrite, X	
				163.0	61.0		LAMINITE: siltstone (70%) dark grey, laminated at 0-10° with sandstone (30%), fine to medium grained, grey, 5-20 mm typical spacing					J, 40°, PL, ro, cn P, 0°, PL, ro, cn P, 0°, PL, sm, cn J, 30°, PL, sm, cn J, 10°, PL, sm, cn P, 5°, PL, sm, cn, barrel spun P, 0°, PL, sm, cn, barrel spun P, 0°, PL, ro-sm, vn, X P, 0°, PL, sm, cn, barrel spun	1 of 4
			$Is_{50}(A)$= 0.54 MPa $Is_{50}(D)$= 1.90 MPa		61.5							J, 5°, PL, sm, cn P, 5°, PL, sm, cn	
				162.0	62.0							J, 50°, PL, sm, cn	
					62.5							J, 10°, PL, sm, cn	
			$Is_{50}(A)$= 1.50 MPa $Is_{50}(D)$= 1.90 MPa		63.0							J, 70°, PL, sm, vn, pyrite, from 62.53 m to 62.70 m, tight P, 10°, PL, sm, cn J, 10°, PL, sm, cn	
				161.0								J, 70°, PL, sm, cn, healed, broken by hand	
	Run 3	0% WATER LOSS			63.5		from 63.51 m to 63.53 m: anthracite			100 [91]		J, 65°, PL, ro-sm, cn, discontinuous, from 63.31 m to 63.35 m J, 90°, PL, ro-sm, cn, from 63.28 m to 63.37 m P, 5-10°, PL, ro-sm, vn, pyrite P, 5°, IR, ro-sm, vn, pyrite, barrel spun	2 of 4
			$Is_{50}(A)$= 1.60 MPa	160.0	64.0							P, 5°, PL, ro-sm, vn, pyrite	

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
		Inclination:	-90°	**Northing:**	6429549 m
Drill Rig:	Hydrapower Scout VI	**Bearing:**	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data | **Material Description** | **Comments**

Method: HQ3

Core Run: Run 3 | Run 4 | Run 5 | Run 6

Ground Water: 0% WATER LOSS (Run 3, Run 4, Run 5)

Field Tests: $Is_{50}(D)$= 1.30 MPa; $Is_{50}(A)$= 1.40 MPa; $Is_{50}(D)$= 2.10 MPa; $Is_{50}(A)$= 0.85 MPa; $Is_{50}(D)$= 1.40 MPa; $Is_{50}(A)$= 1.10 MPa; $Is_{50}(D)$= 0.81 MPa; $Is_{50}(A)$= 0.34 MPa; $Is_{50}(D)$= 0.95 MPa; $Is_{50}(A)$= 0.65 MPa; $Is_{50}(D)$= 1.60 MPa; $Is_{50}(A)$= 0.68 MPa; $Is_{50}(D)$= 1.10 MPa

Reduced Level (m) / Depth (m): 160.0 / 0.0; 159.0 / 1.0; 158.0 / 2.0; 157.0 / 3.0; 156.0 / 4.0; 155.0 / 5.0; 154.0 / 6.0; 153.0 / 7.0; 152.0 / 8.0; 64.5; 65.0; 65.5; 66.0; 66.5; 67.0; 67.5; 68.0; 68.5; 69.0; 69.5; 70.0; 70.5; 71.0; 71.5; 72.0

Graphic Log

MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)

LAMINITE: siltstone (70%) dark grey, laminated at 0-10° at with sandstone (30%), fine to medium grained, grey, 5-20 mm typical spacing *(continued)*

SANDSTONE: medium grained; brown; disturbed bedding, occasional siltstone laminations, 10-40 mm typical spacing

COAL: black; Lewis Seam

Weathering/ Alteration: XW/XA, HW/HA, MW/MA, SW/SA, FR

Inferred Strength 20 x $Is_{(50)}$ MPa: soil, 0.6, VL, 2, L, 6, M, 20, H, 60, VH, 200, EH

A● D○ I◆ UCS□ (compliant); A◐ D⊗ I◇ UCS■ (non-compliant)

TCR [RQD] (%): 100 [91]; 100 [72]; 100 [45]; 100 [12]

Defect Spacing (mm): 40, 60, 100, 300, 1000

Additional Observations, Defect Descriptions.

particular	general
P, 10°, PL, ro-sm, cn, barrel spun	BEDROCK *(continued)*
J, 5°, PL, ro-sm, cn	
J, 70°, PL, ro-sm, cn	
P, 0°, PL, ro-sm, cn	
P, 0°, PL, sm-ro, cn	
J, 10°, PL, sm-ro, vn, Pyrite	
P, 0°, PL, sm-ro, cn	
P, 5°, PL, sm-ro, cn	
P, 0°, PL, sm-ro, vn, Pyrite	
P, 5°, PL, sm-ro, cn	
J, 10°, PL, sm-ro, vn, Pyrite	
P, 5°, PL, sm-ro, cn	
J, 35°, PL, sm-ro, vn, X	
EW, 35°, PL, sm-ro, GC, 100 mm	
J, 20°, UN, ro, vn, X	
P, 0°, PL, ro, vn, X	
J, 80°, PL, ro, vn, X, from 66.29 m to 66.39 m	
P, 0°, PL, ro, vn, X, barrel spun	
P, 0°, PL, ro, vn, X	
P, 5°, PL, ro, vn, X	
CS, 0°, PL, ro, vn, GP, X, 30 mm	
P, 0°, PL, ro, vn, X	
P	
J, 85°, PL, sl, from 66.69 m to 67.00 m	
J, 75°, IR, sl, cn, from 67.00 m to 67.17 m	
J, 80°, PL, tight, discontinuous, from 67.30 m to 67.42 m	
P, 0°, PL, sm, cn	
J, 70°, UN, sm, cn, from 68.19 m to 68.47 m	
J, 70°, PL, sm, cn, from 68.47 m to 68.68m	
J, 30°, UN, sm, vn, Pyrite	
J, 45°, PL, sm, vn, Pyrite	
J, 40-70°, IR, sm, cn, multiple J, spaced 50 mm	
J, 10°, PL, sm, cn	
J, 80°, PL-ST, sm, vn, Pyrite, discontinuous, from 70.17 m o 70.27 m	
P, 0°, PL, sm, cn	
J, 40-50°, PL, sm, cn, multiple J, spaced 30 mm	
P, 0°, PL, sm, cn	
J, 80°, PL, sm, vn, Pyrite, Fe, discontinuous, from 70.78 m o 71.00 m	
J, 5°, IR, sm, cn	
J, 10-30°, UN, sm, vn, Pyrite	
CR, 5-45°, IR, ro, cn, 600 mm, spaced 50 mm	

Core Box No.: 2 of 4; 3 of 4; 4 of 4

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

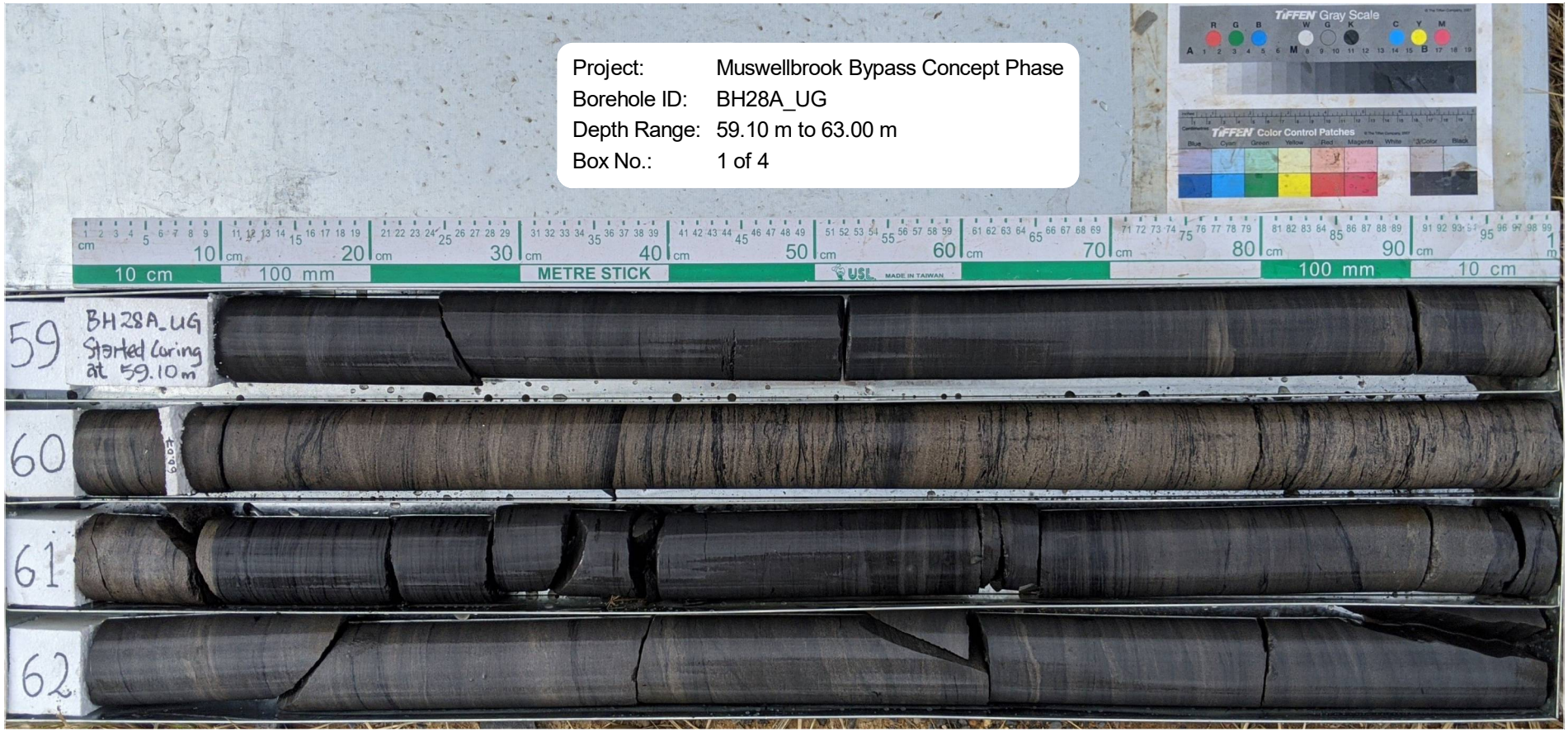
Field Data						Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 6	0% WATER LOSS	Is_{50}(A)= 0.03 MPa Is_{50}(D)= 0.98 MPa	152.0	72.5		COAL: black; Lewis Seam *(continued)*	XW/XA HW/HA MW/MA SW/SA FR	soil VL L M H VH EH	100 [12]	40 60 100 300 1000	J, 70°, PL, sm, vn, Pyrite, Fe, from 72.01 m to 72.23 m J, 70-80°, PL, sm, vn, Pyrite, Fe CR, 10-70°, IR, ro, vn, pyrite, 240 mm, spaced 20 mm P, 0°, PL, sm, cn J, 50°, PL, sm, cn P, 0°, PL, sm, cn J, 50°, PL, sm, cn J, 30°, PL, sm, cn J, 10°, UN, sm, cn	BEDROCK *(continued)*	4 of 4
				151.0	73.0		CONGLOMERATE: pale grey and grey; matrix supported; clasts are fine to medium gravel sized, sub-angular to sub-rounded, polymictic, matrix is cemented silt and sand							
							BH28A_UG terminated at 72.97 m. Achieved Termination Criteria							
				150.0	74.0									
				149.0	75.0									
				148.0	76.0									
				147.0	77.0									
				146.0	78.0									
				145.0	79.0									
				144.0	80.0									

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description					Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, VL, L, M, H, VH, EH; 0.6, 2, 6, 20, 60, 200; A● D○ I◆ UCS□; Non-compliant A◐ D⊗ I◇ UCS■)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular / general	Core Box No.
				144.0								
					80.5							
				143.0	81.0							
					81.5							
				142.0	82.0							
					82.5							
				141.0	83.0							
					83.5							
				140.0	84.0							
					84.5							
				139.0	85.0							
					85.5							
				138.0	86.0							
					86.5							
				137.0	87.0							
					87.5							
				136.0	88.0							

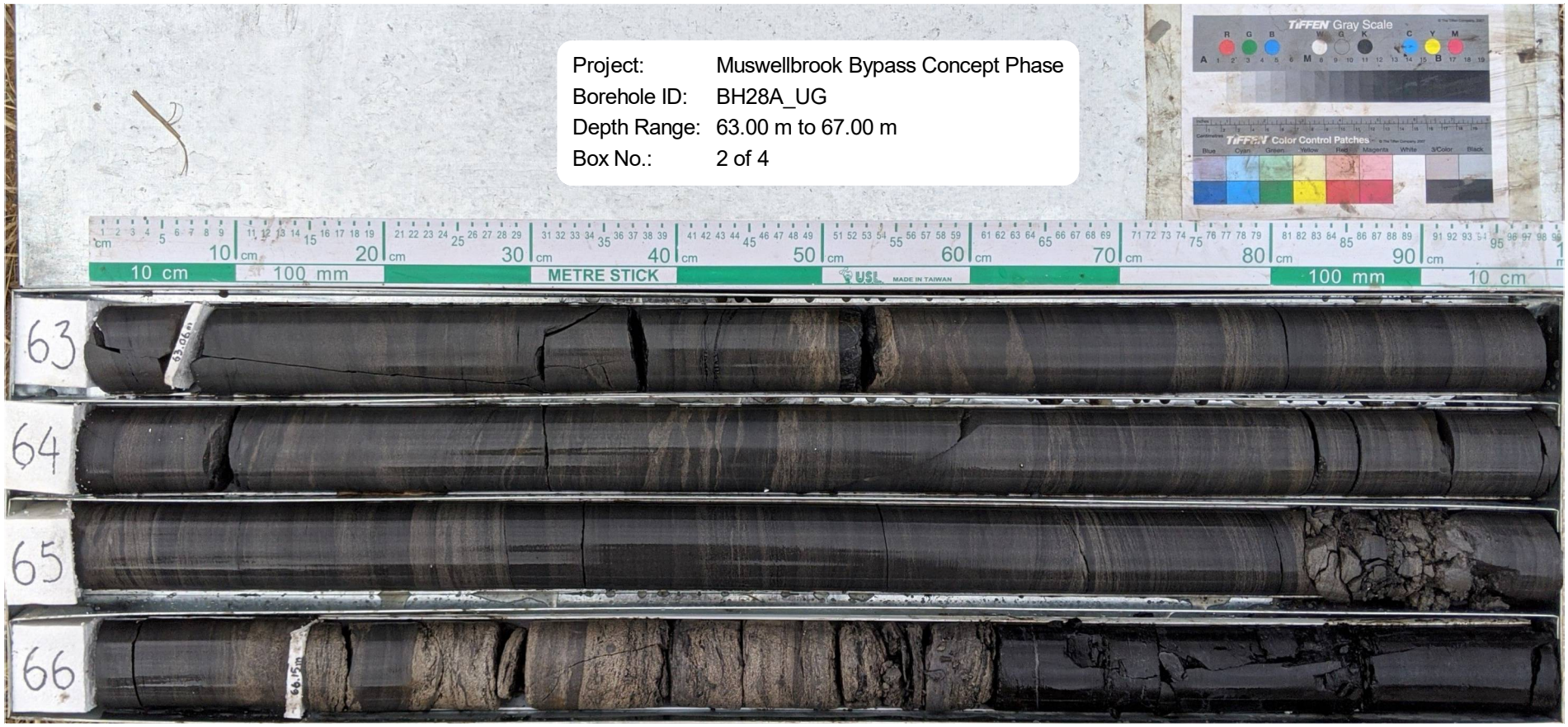
Client:	TfNSW	**Project No:**	60619756	**Start Date:**	10/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	20/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-118 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429549 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description					Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, VL, L, M, H, VH, EH; 0.6, 2, 6, 20, 60, 200)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular / general	Core Box No.
			$Is_{50}(A)$= 0.21 MPa $Is_{50}(D)$= 1.40 MPa	136.0 135.0 134.0 133.0 132.0 131.0 130.0 129.0 128.0	88.5 89.0 89.5 90.0 90.5 91.0 91.5 92.0 92.5 93.0 93.5 94.0 94.5 95.0 95.5 96.0				● ○			



\\AUSYD1FP001.AU.AECOMNET.COM\Projects\606X\60619756\400_TECH\432_GEOTECH\3.0_Geotechnical Investigation\0.6_Field Records\01_Boreholes\BH28A_UG\Core Photos\gINT Core Photos\BH28A_UG_59.10-63.00.jpg printed 28.7.2020

CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	16/07/2020		BOREHOLE NO: BH28A_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 59.10 m to 63.00 m PHOTO NO: 1 of 4



\\AUSYD1FP001.AU.AECOMNET.COM\Projects\606X\60619756\400_TECH\432_GEOTECH\3.0_Geotechnical Investigation\0.6_Field Records\01_Boreholes\BH28A_UG\Core Photos\gINT Core Photos\BH28A_UG_63.00-67.00.jpg printed 28.7.2020

CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	16/07/2020		BOREHOLE NO: BH28A_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 63.00 m to 67.00 m PHOTO NO: 2 of 4

\\AUSYD1FP001.AU.AECOMNET.COM\Projects\606X\60619756\400_TECH\432_GEOTECH\3.0_Geotechnical Investigation\0.6_Field Records\01_Boreholes\BH28A_UG\Core Photos\gINT Core Photos\BH28A_UG_67.00-71.00.jpg printed 28.7.2020

CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	16/07/2020		BOREHOLE NO: BH28A_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 67.00 m to 71.00 m PHOTO NO: 3 of 4

Project: Muswellbrook Bypass Concept Phase
Borehole ID: BH28A_UG
Depth Range: 71.00 m to 72.97 m
Box No.: 4 of 4

\\AUSYD1FP001.AU.AECOMNET.COM\Projects\606X\60619756\400_TECH\432_GEOTECH\3.0_Geotechnical Investigation\0.6_Field Records\01_Boreholes\BH28A_UG\Core Photos\gINT Core Photos\BH28A_UG_71.00-72.97.jpg printed 28.7.2020

CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	16/07/2020		BOREHOLE NO: BH28A_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 71.00 m to 72.97 m PHOTO NO: 4 of 4

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28B_UG**

Sheet: 1 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB+RR	PW				224.0	0.0			FILL: MIXTURE OF COBBLES AND SOIL, soil comprises silty SAND: fine to coarse grained; dark brown; cobbles of siltstone, coal, sandstone, 60-90 mm, sub-angular	M		FILL
						0.5			FILL: gravelly SAND: fine to coarse grained; brown-grey; gravel is fine to coarse, sub-angular to angular, of siltstone, sandstone and coal; with silt			
					223.0	1.0			FILL: SAND: fine to medium grained; dark grey; with silt; with fine to medium gravel, angular, of tuffaceous siltstone, coal, carbonaceous siltstone	D		
						1.5			FILL: sandy GRAVEL: fine to medium grained; angular to sub-angular; black, dark grey, red-brown and white; of tuffaceous siltstone, ironstone, sandstone and coal, sand is fine to medium grained, grey-brown			
					222.0	2.0			FILL: sandy SILT: non-plastic; yellow-brown and pale grey; sand is fine to medium grained			
						2.5			from 2.50 m: dark grey			
					221.0	3.0			FILL: FILL: Refer to BH28_UG for indicative soil/rock sttatum			3.00m: temperature 20.9°C
						3.5						
					220.0	4.0						
						4.5						
					219.0	5.0						5.20m: 100% water loss
						5.5						
					218.0	6.0						6.00m: temperature 25.1°C
						6.5						
					217.0	7.0						
						7.5						
						8.0						

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28B_UG**

Sheet: 2 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description		Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB+RR	PW				216.0				FILL: FILL: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			FILL *(continued)*
						8.5						
					215.0	9.0						9.00m: temperature 18.1°C
						9.5						
					214.0	10.0						
						10.5						
					213.0	11.0						
						11.5						
					212.0	12.0						12.00m: temperature 19.7°C
						12.5						
					211.0	13.0						
						13.5						
					210.0	14.0						
						14.5			BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum			BEDROCK
PCD	HWT											14.50m: temperature 18.1°C
					209.0	15.0						
						15.5						
						16.0						

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD	HWT				208.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						16.5						
					207.0	17.0						
						17.5						
					206.0	18.0						
						18.5						
					205.0	19.0						
						19.5						
					204.0	20.0						
						20.5						
					203.0	21.0						
						21.5						
					202.0	22.0						
						22.5						
					201.0	23.0						
						23.5						
						24.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD	HWT				200.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						24.5						
					199.0	25.0						
						25.5						
					198.0	26.0						
						26.5						
					197.0	27.0						
						27.5						
					196.0	28.0						
						28.5						
					195.0	29.0						
						29.5						
					194.0	30.0						
						30.5						
					193.0	31.0						
						31.5						
						32.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD	HWT				192.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						32.5						
					191.0	33.0						
						33.5						
					190.0	34.0						
						34.5						
					189.0	35.0						
						35.5						
					188.0	36.0						
						36.5						
					187.0	37.0						
						37.5						
					186.0	38.0						
						38.5						
					185.0	39.0						
						39.5						
						40.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD	HWT				184.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						40.5						
					183.0	41.0						
						41.5						
					182.0	42.0						
						42.5						
					181.0	43.0						
						43.5						
					180.0	44.0						
						44.5						
					179.0	45.0						
						45.5						
					178.0	46.0						
						46.5						
					177.0	47.0						
						47.5						
						48.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD	HWT				176.0	48.5			BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
					175.0	49.0						
						49.5						
					174.0	50.0						
						50.5						
					173.0	51.0						
						51.5						
					172.0	52.0						
						52.5						
					171.0	53.0						
						53.5						
					170.0	54.0						
						54.5						
					169.0	55.0						
						55.5						
						56.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
PCD	HWT				168.0				BEDROCK: Refer to BH28_UG for indicative soil/rock sttatum *(continued)*			BEDROCK *(continued)*
						56.5						
					167.0	57.0						
						57.5						
					166.0	58.0						
						58.5						
					165.0	59.0						
						59.5			*Borehole BH28B_UG log continued as cored log from 59.45 m.*			
						60.0						
						60.5						
						61.0						
						61.5						
						62.0						
						62.5						
						63.0						
						63.5						
						64.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
				168.0										
					56.5									
				167.0	57.0									
					57.5									
				166.0	58.0									
					58.5									
				165.0	59.0									
							Continued from non-cored borehole at 59.45 m.							
HQ3	Run 1	0% WATER LOSS	$Is_{50}(D)$= 1.00 MPa		59.5		SANDSTONE: fine grained; pale brown and brown-grey; occasionally interlaminated with siltstone (20%) dark grey			100 [88]			BEDROCK	
			$Is_{50}(A)$= 0.51 MPa	164.0	60.0									
			$Is_{50}(D)$= 1.90 MPa				SANDSTONE: fine to medium grained; pale brown; cross bedded at 0-10°, with discontinuous carbonaceous laminations and lenticular siltstone inclusions			100 [91]				
					60.5									
			$Is_{50}(A)$= 1.10 MPa	163.0	61.0									
			$Is_{50}(D)$= 2.30 MPa											
					61.5		LAMINITE: siltstone (60%): dark grey, laminated at 0-10° with sandstone (40%), fine to medium grained, grey, 5-20 mm typical spacing							1 of 4
	Run 2	0% WATER LOSS	$Is_{50}(A)$= 0.76 MPa		62.0									
			$Is_{50}(D)$= 1.20 MPa	162.0										
					62.5									
			$Is_{50}(A)$= 1.30 MPa											
			$Is_{50}(D)$= 1.30 MPa											
				161.0	63.0									
	Run 3	0% WATER LOSS			63.5					100 [82]				2 of 4
			$Is_{50}(A)$= 0.64 MPa											
			$Is_{50}(D)$= 1.40 MPa	160.0	64.0									

AECOM Cored Engineering Log — Draft

BOREHOLE No. BH28B_UG

Sheet: 10 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data | **Material Description** | **Comments**

Method: HQ3

Core Run / Ground Water: Run 3 — 0% WATER LOSS; Run 4 — 5% WATER LOSS; Run 5 — 100% WATER LOSS; Run 6 — 100% WATER LOSS

Field Tests | Reduced Level (m) | Depth (m) | Graphic Log | MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin) | Weathering/Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR) | Inferred Strength 20 x $Is_{(50)}$ MPa (soil, 0.6, 2, 6, 20, 60, 200; VL, L, M, H, VH, EH; A● D○ I◆ UCS□; Non-compliant A◐ D⊗ I◇ UCS■) | TCR [RQD] (%) | Defect Spacing (mm) (40, 60, 100, 300, 1000) | Additional Observations, Defect Descriptions. particular / general | Core Box No.

Depth (m)	RL (m)	Material / Field Tests	TCR [RQD] (%)	Defect Spacing & Observations	Core Box No.
64.5	160.0	LAMINITE: siltstone (60%): dark grey, laminated at 0-10° with sandstone (40%), fine to medium grained, grey, 5-20 mm typical spacing *(continued)*	100 [82]	BEDROCK *(continued)*	2 of 4
65.0	159.0	$Is_{50}(A)$= 0.98 MPa; $Is_{50}(D)$= 1.40 MPa			
65.5		$Is_{50}(A)$= 0.55 MPa; $Is_{50}(D)$= 0.97 MPa			
66.0	158.0				
66.5		SANDSTONE: fine to coarse grained; pale brown; occasionally interlaminated at 0-10° with siltstone (15%) dark grey	100 [10]	J, 50°, PL, healed P, 0°, PL, ro, cn P, 0°, PL, ro, vn, X	
67.0	157.0	COAL: black; Lewis Seam		P, 0°, PL, sm-ro, vn, X P, 0-15°, UN, ro, vn, X P, 5°, PL, ro, vn, X P, 0°, PL, ro, vn, X P, 0°, UN, sm, cn P, 0°, PL, sl, cn P, 0°, UN, sm, cn, barrel spun J, 80°, PL, sm, cn, discontinuous, from 67.18 m to 67.25 m P, 0°, PL, sm, cn J, 70-90°, IR, sm, vn, Pyrite, discontinuous, from 67.57 m to 67.73 m J, 80°, IR, sm, cn, discontinuous, from 67.73 m to 67.83 m P, 0°, PL, sl, cn	
67.5		$Is_{50}(A)$= 0.41 MPa; $Is_{50}(D)$= 1.40 MPa			
68.0	156.0	$Is_{50}(A)$= 0.18 MPa; $Is_{50}(D)$= 0.56 MPa			
68.5		$Is_{50}(D)$= 1.40 MPa; $Is_{50}(A)$= 0.53 MPa		J, 70°, PL, sl, vn, Pyrite	
69.0	155.0		100 [0]	J, 45°, UN, sm, vn, X EW, 40-45°, PL, Coal, 70 mm CR, IR, sm, Coal, 100 mm J, 80°, PL, sm, cn P, 0°, PL, sm, cn J, 30°, PL, sm, cn J, 65°, PL, sm, cn, from 68.94 m to 69.04 m CR, 10°, PL, Coal, 100 mm J, 15°, PL, sm, cn J, 80°, PL, sm, vn, Pyrite, from 69.05 m to 69.36 m	3 of 4
69.5					
70.0	154.0	$Is_{50}(A)$= 0.72 MPa; $Is_{50}(D)$= 1.30 MPa		J, 30°, UN, sl, vn, Anthracite P, 0°, PL, sm, vn, Anthracite J, 50°, PL, sm, vn, Pyrite CR, 0°, PL, sm, Coal, 50 mm	
70.5		$Is_{50}(A)$= 0.51 MPa; $Is_{50}(D)$= 1.20 MPa		J, 0°, UN, sm, cn	
71.0	153.0		100 [0]	J, 80°, PL, sm, cn CR, IR, sm, Coal, 380 mm	
71.5				J, 70°, PL, sm, vn, Pyrite, Fe J, 15°, PL, sm, cn J, 30°, PL, sm, cn P, 5°, PL, sm, cn J, 65°, PL, sm, vn, Pyrite, from 71.42 m to 71.56 m J, 80°, PL, sm, vn, Pyrite, from 71.38 m to 71.64 m J, 80°, PL, sm, vn, Pyrite, from 71.42 m	4 of 4
72.0	152.0				

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	21/07/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	24/07/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	96-144 mm	**Easting:**	303512 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429560 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	224 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data | **Material Description** | **Comments**

Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration (XW/XA, HW/HA, MW/MA, SW/SA, FR)	Inferred Strength 20 x $Is_{(50)}$ MPa (soil, VL, L, M, H, VH, EH; 0.6, 2, 6, 20, 60, 200)	TCR [RQD] (%)	Defect Spacing (mm) (40, 60, 100, 300, 1000)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 6	100% WATER LOSS	$Is_{50}(A)$= 0.30 MPa $Is_{50}(D)$= 1.60 MPa	152.0			COAL: black; Lewis Seam *(continued)*			100 [0]		to 71.70 m J, 50°, PL, sm, vn, Pyrite, Fe P, 0°, PL, sm, cn J, 80°, PL, sm, vn, Pyrite, Fe, discontinuous, form 71.87 m to 71.94 m CS, 10°, PL, sm, Coal, 80 mm P, 0°, PL, sm, cn P, 0°, PL, sm, vn, Fe P, 0°, PL, sm, cn P, 0°, PL, sm, vn, Pyrite, multiple partings, spaced 20 mm P, 0°, PL, sm, cn P, 0°, PL, sm-ro, vn, X, barrel spun P, 0°, PL, sm-ro, cn J, 15°, PL, sm-ro, cn J, 5°, PL, sm-ro, cn P, 0°, PL, sm-ro, cn, barrel spun J, 80°, PL, sm-ro, cn, healed, broken by hand, from 72.86 m	BEDROCK *(continued)*	4 of 4
	Run 7		$Is_{50}(A)$= 0.08 MPa $Is_{50}(D)$= 0.80 MPa $Is_{50}(D)$= 0.09 MPa	72.5	73.0		SANDSTONE: pale grey and grey; occasionally interlaminated at 0-10° with siltstone (10%); with fine to medium gravel sized clasts (5%), sub-angular to sub-rounded, polymictic			100 [48]				
				151.0			*BH28B_UG terminated at 73.12 m. Achieved Termination Criteria*							
				150.0	74.0									
				149.0	75.0									
				148.0	76.0									
				147.0	77.0									
				146.0	78.0									
				145.0	79.0									
				144.0	80.0									

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CLIENT:	TfNSW	APPROVED:	TR	TITLE:	Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	23/07/2020	BOREHOLE NO:	BH28B_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:		DEPTH RANGE:	59.45 m to 63.00 m
				PHOTO NO:	1 of 4

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CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	23/07/2020		BOREHOLE NO: BH28B_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 63.00 m to 67.00 m PHOTO NO: 2 of 4

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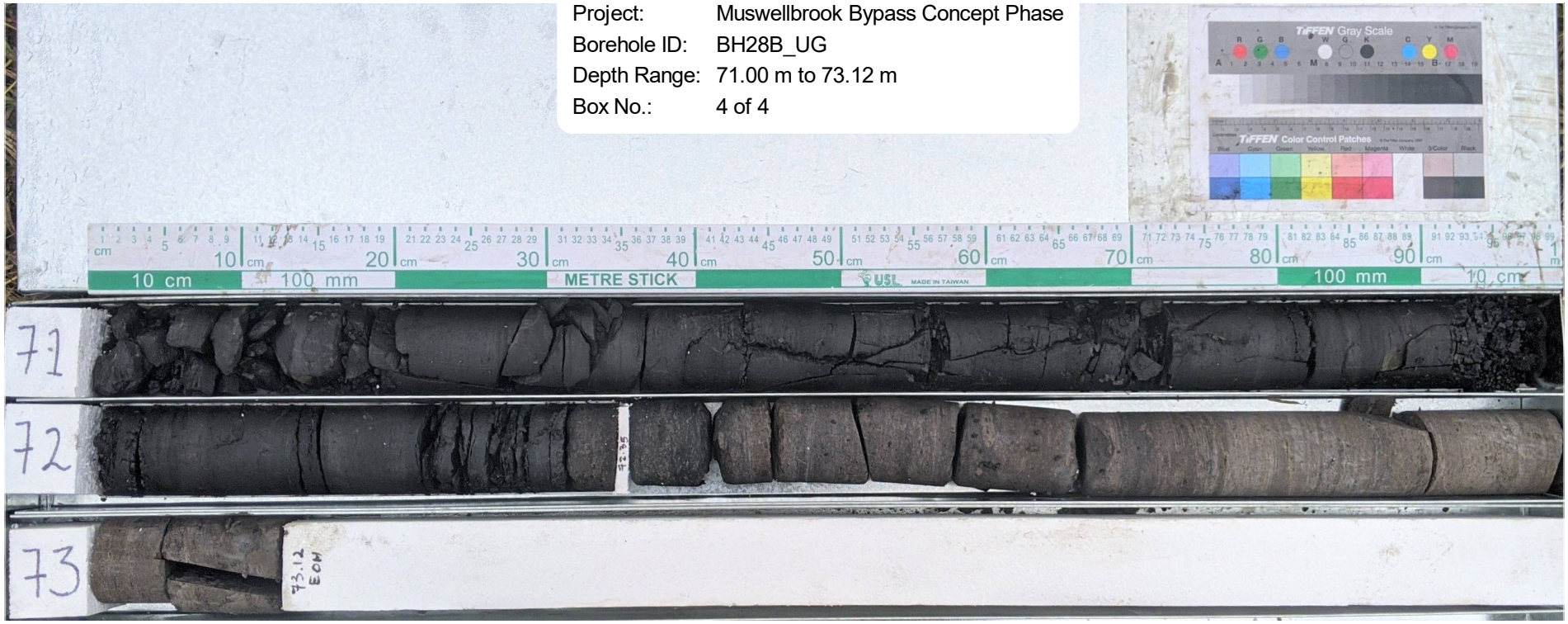
CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	23/07/2020		BOREHOLE NO: BH28B_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 67.00 m to 71.00 m PHOTO NO: 3 of 4



\\AUSYD1FP001.AU.AECOMNET.COM\Projects\606X\60619756\400_TECH\432_GEOTECH\3.0_Geotechnical Investigation\0.6_Field Records\01_Boreholes\BH28B_UG\Core Photos\gINT Core Photos\BH28B_UG_71.00-73.12.jpg printed 10.8.2020

CLIENT:	TfNSW	APPROVED:	TR	AECOM	TITLE: Core Photographs
PROJECT NAME:	Muswellbrook Bypass Concept Phase	PHOTO DATE:	23/07/2020		BOREHOLE NO: BH28B_UG
PROJECT No:	60619756	LEGEND FIELD-INFERRED MECHANICAL BREAK:			DEPTH RANGE: 71.00 m to 73.12 m PHOTO NO: 4 of 4

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28C_UG**

Sheet: 1 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
RR	PW				223.0	0.0			FILL: Refer to BH28_UG for indicative soil/rock stratum			FILL 0.00-59.45m: Refer to BH28_UG for indicative soil/rock stratum
						0.5						
					222.0	1.0						
						1.5						
					221.0	2.0						
						2.5						
					220.0	3.0						
						3.5						
					219.0	4.0						
						4.5						
					218.0	5.0						
						5.5						
					217.0	6.0						
						6.5						
					216.0	7.0						
						7.5						
						8.0						

AECOM **Engineering Log** **Draft** **BOREHOLE No.** **BH28C_UG**

Sheet: 2 of 11

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description		Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
RR	PW				215.0				FILL: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			FILL *(continued)*
						8.5						
					214.0	9.0						
						9.5						
					213.0	10.0						
						10.5						
					212.0	11.0						
						11.5						
					211.0	12.0						
						12.5						
					210.0	13.0						
						13.5			BEDROCK: Refer to BH28_UG for indicative soil/rock stratum			BEDROCK
					209.0	14.0						
						14.5						
WB	HWT				208.0	15.0						
						15.5						
						16.0						

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB	HWT				207.0				BEDROCK: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			BEDROCK *(continued)*
						16.5						
					206.0	17.0						
						17.5						
					205.0	18.0						
						18.5						
					204.0	19.0						
						19.5						
					203.0	20.0						
						20.5						
					202.0	21.0						
						21.5						
					201.0	22.0						
						22.5						
					200.0	23.0						
						23.5						
						24.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB	HWT				199.0	24.5			BEDROCK: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			BEDROCK *(continued)*
					198.0	25.0						
						25.5						
					197.0	26.0						
						26.5						
					196.0	27.0						
						27.5						
					195.0	28.0						
						28.5						
					194.0	29.0						
						29.5						
					193.0	30.0						
						30.5						
					192.0	31.0						
						31.5						
						32.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB	HWT				191.0				BEDROCK: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			BEDROCK *(continued)*
						32.5						
					190.0	33.0						
						33.5						
					189.0	34.0						
						34.5						
					188.0	35.0						
						35.5						
					187.0	36.0						
						36.5						
					186.0	37.0						
						37.5						
					185.0	38.0						
						38.5						
					184.0	39.0						
						39.5						
						40.0						

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB	HWT				183.0				BEDROCK: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			BEDROCK *(continued)*
						40.5						
					182.0	41.0						
						41.5						
					181.0	42.0						
						42.5						
					180.0	43.0						
						43.5						
					179.0	44.0						
						44.5						
					178.0	45.0						
						45.5						
					177.0	46.0						
						46.5						
					176.0	47.0						
						47.5						
						48.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB	HWT				175.0				BEDROCK: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			BEDROCK *(continued)*
						48.5						
					174.0	49.0						
						49.5						
					173.0	50.0						
						50.5						
					172.0	51.0						
						51.5						
					171.0	52.0						
						52.5						
					170.0	53.0						
						53.5						
					169.0	54.0						
						54.5						
					168.0	55.0						
						55.5						
						56.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	MATERIAL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
WB	HWT	13/8/20 ▽			167.0				BEDROCK: Refer to BH28_UG for indicative soil/rock stratum *(continued)*			BEDROCK *(continued)*
						56.5						
					166.0	57.0						
						57.5						
					165.0	58.0						
						58.5						
					164.0	59.0						
						59.5						
					163.0	60.0						
						60.5						
					162.0	61.0						
						61.5						
					161.0	62.0						
						62.5			*Borehole BH28C_UG log continued as cored log from 62.15 m.*			
						63.0						
						63.5						
						64.0						

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 1	0% WATER LOSS	$Is_{50}(A)$= 1.60 MPa $Is_{50}(B)$= 1.90 MPa	167.0	56.5			XW/XA HW/HA MW/MA SW/SA FR soil	0.6 2 6 20 60 200 VL L M H VH EH		40 60 100 300 1000			
				166.0	57.0									
				165.0	57.5									
				164.0	58.0									
				163.0	58.5									
				162.0	59.0									
				161.0	59.5									
					60.0									
					60.5									
					61.0									
					61.5									
					62.0		*Continued from non-cored borehole at 62.15 m.*							
					62.5		SILTSTONE: dark grey; occasionally interlaminated at 0-10° with sandstone (10%), medium grained, brown-grey, 5-10 mm typical spacing; occasional carbonaceous laminations			100 [100]		BEDROCK *(continued)*	
					63.0							J, 15°, PL, sm, cn		
												J, 25°, PL, ro-sm, vn, pyrite		
												P, 0-5°, UN, sm, cn		
												P, 0°, UN, sm, cn		
	Run 2	0% WATER LOSS	$Is_{50}(A)$= 0.70 MPa $Is_{50}(B)$= 2.30 MPa	160.0	63.5					100 [100]				1 of 3
												P, 5°, PL, ro-sm, cn		
				159.0	64.0							J, 80°, PL, healed, from 63.75 m to		

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data							Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 2	0% WATER LOSS	$Is_{50}(A)$= 0.69 MPa $Is_{50}(B)$= 1.90 MPa	159.0	64.5					100 [100]		64.08 m P, 5°, UN, ro-sm, cn P, 5°, UN/CU, ro-sm, cn P, 0-5°, PL, sm, cn	BEDROCK *(continued)* *(continued)*	1 of 3
				158.0	65.0		LAMINITE: Siltstone (60%) dark grey, interlaminated at 5-10° with sandstone (40%), fine to medium grained, grey, 5-20 mm typical spacing					P, 0°, PL, sm, cn		
			$Is_{50}(A)$= 1.70 MPa $Is_{50}(B)$= 2.40 MPa	157.0	65.5 66.0		LAMINITE: Sandstone (70%): fine to medium grained, grey, interlaminated at 5-10°with siltstone (30%), dark grey, 5-10 mm tpical spacing					P, 5°, CU, ro-sm, cn P, 5°, PL, ro-sm, cn		
	Run 3	5% WATER LOSS	$Is_{50}(A)$= 1.70 MPa $Is_{50}(B)$= 2.80 MPa $Is_{50}(A)$= 1.30 MPa $Is_{50}(B)$= 1.50 MPa	156.0	66.5 67.0					100 [49]		P, 5°, IR, ro-sm, vn, X P, 0°, PL, ro, cn		2 of 3
				155.0	67.5 68.0		COAL: black; Lewis Seam VOID: from 67.87 m to 71.35 m					P, 5°, PL, ro-sm, vn, X P, 0°, PL, ro-sm, vn, X P, 10°, PL, ro-sm, vn, X P, 0°, PL, ro, cn P, 0°, PL, sm, vn, x3, spaced 5 mm CR, IR, ro-sm, GP, X, 50 mm P, 0°, PL, sm, cn, x3, spaced 20 mm J, 70°, PL, sl, cn, from 67.53 m to 67.67 m CR, IR, sm, cn, GP, X, 40 mm J, 80°, PL, sl, cn, from 67.73 m to 67.87 m		
				154.0	68.5 69.0									
				153.0	69.5 70.0									
				152.0	70.5 71.0									3 of 3
WB		100% WATER LOSS			71.5		NO CORE: from 71.35 m to 71.50 m							
HQ3	Run 4			151.0	72.0		from 71.70 m to 71.77 m: coal seam, black			100 [38]		CR, IR, ro-sm, vn, Fe, 190 mm, possibly drilling induced P, 0-5°, PL, ro-sm, cn, x5, spaced 20 mm J, 15°, PL, ro-sm, cn		

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

Client:	TfNSW	**Project No:**	60619756	**Start Date:**	05/08/2020
Project:	Muswellbrook Bypass Concept Phase	**Logged by:**	AC	**End Date:**	14/08/2020
Location:	MCC rehabilitation area	**Checked by:**	TR	**Location Meth.:**	hhGPS5
Driller:	Total Drilling	**Hole Diameter:**	118-144 mm	**Easting:**	303498 m
Drill Rig:	Hydrapower Scout VI	**Inclination:**	-90°	**Northing:**	6429591 m
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H
				RL:	223 m
				Ver. Datum:	AHD
				Surface:	Grass

Field Data						Material Description						Comments	
Method	Core Run	Ground Water	Field Tests	Reduced Level (m)	Depth (m)	Graphic Log	MATERIAL NAME: colour, grain size, texture and fabric, structure, bedding dip (soil) moisture, consistency/density (Geological Origin)	Weathering/ Alteration	Inferred Strength 20 x $Is_{(50)}$ MPa	TCR [RQD] (%)	Defect Spacing (mm)	Additional Observations, Defect Descriptions. particular	general	Core Box No.
HQ3	Run 4	100% WATER LOSS	$Is_{50}(D)$= 0.32 MPa $Is_{50}(A)$= 0.04 MPa $Is_{50}(D)$= 0.48 MPa	151.0 72.5 73.0 150.0			CONGLOMERATE: pale grey and grey; matrix supported; clasts are fine to medium gravel sized, sub-angular to sub-rounded, carbonaceous, matrix is cemented silt and sand *(continued)*	XW/XA HW/HA MW/MA SW/SA FR	soil VL L M H VH EH 0.6 2 6 20 60 200	100 [38]	40 60 100 300 1000	P, 0°, PL, ro-sm, cn J, 20°, PL, ro-sm, cn P, 0°, PL, ro-sm, cn, barrel spun J, 15°, PL, ro-sm, cn J, 30°, PL, ro-sm, cn J, 45°, PL, ro-sm, cn J, 30°, PL, ro-sm, cn J, 30°, PL, ro-sm, cn, from 72.78 m to 72.89 m P, 0°, PL, ro-sm, cn, barrel spun, x2, spaced 30 mm J, 80°, PL, ro-sm, cn, from 72.78 m to 73.00 m P, 0°, PL, ro-sm, cn, barrel spun J, 10°, PL, ro-sm, cn, from 72.78 m to 72.89 m P, 0°, PL, ro-sm, cn, barrel spun P, 05°, PL, ro-sm, cn, barrel spun J, 80°, PL, ro-sm, cn, from 73.19 m to 73.39 m	BEDROCK *(continued)* *(continued)*	3 of 3
				73.5 74.0 149.0 74.5 75.0 148.0 75.5 76.0 147.0 76.5 77.0 146.0 77.5 78.0 145.0 78.5 79.0 144.0 79.5 80.0 143.0		*BH28C_UG terminated at 73.39 m. Achieved Termination Criteria*							

Project: Muswellbrook Bypass Concept Phase
Borehole ID: BH28C_UG
Depth Range: 62.15 m to 66.00 m
Box No.: 1 of 3

C:\Users\Chena\Desktop\MBCP\BH28C_UG\Core Photos\gINT Core Photos\BH28C_UG_62.15-66.00.jpg printed 16.10.2020

CLIENT: TfNSW	APPROVED:	TR	AECOM	TITLE:	Core Photographs
	PHOTO DATE:	5/08/2020		BOREHOLE NO:	BH28C_UG
PROJECT NAME: Muswellbrook Bypass Concept Phase	LEGEND			DEPTH RANGE:	62.15 m to 66.00 m
PROJECT No: 60619756				PHOTO NO:	1 of 3

Project: Muswellbrook Bypass Concept Phase
Borehole ID: BH28C_UG
Depth Range: 66.00 m to 70.00 m
Box No.: 2 of 3

C:\Users\Chena\Desktop\MBCP\BH28C_UG\Core Photos\gINT Core Photos\BH28C_UG_66.00-70.00.jpg printed 16.10.2020

CLIENT: TfNSW	APPROVED:	TR	AECOM	TITLE:	Core Photographs
	PHOTO DATE:	5/08/2020		BOREHOLE NO:	BH28C_UG
PROJECT NAME: Muswellbrook Bypass Concept Phase	LEGEND			DEPTH RANGE:	66.00 m to 70.00 m
PROJECT No: 60619756				PHOTO NO:	2 of 3

Project: Muswellbrook Bypass Concept Phase
Borehole ID: BH28C_UG
Depth Range: 70.00 m to 73.39 m
Box No.: 3 of 3

C:\Users\Chena\Desktop\MBCP\BH28C_UG\Core Photos\gINT Core Photos\BH28C_UG_70.00-73.39.jpg printed 16.10.2020

CLIENT: TfNSW	APPROVED:	TR	AECOM	TITLE:	Core Photographs
	PHOTO DATE:	5/08/2020		BOREHOLE NO:	BH28C_UG
PROJECT NAME: Muswellbrook Bypass Concept Phase	LEGEND			DEPTH RANGE:	70.00 m to 73.39 m
PROJECT No: 60619756				PHOTO NO:	3 of 3

Appendix B

Groundsearch Report

AECOM Australia Pty Ltd

Muswellbrook Bypass Project

BH28_UG 3D Cavity Sonar Survey Summary Report

Groundsearch Australia Pty. Limited

Prepared by: John Lea

Issued: 30 September 2020

DISCLAIMER

The data used in this report were obtained using equipment manufactured by the Century Geophysical Corporation. The interpretations given in this report are based on judgement and experience of Groundsearch Australia's personnel. They are provided for AECOM Australia Pty Ltd's sole use in accordance with a specified brief. As such, the interpretation outcomes do not necessarily address all aspects of ground conditions and behaviour on the subject site. The responsibility of Groundsearch Australia is solely to AECOM Australia Pty Ltd and it is not intended that any third party rely upon this report. This report shall not be reproduced either wholly or in part without the written permission of Groundsearch Australia Pty. Limited.

For and on behalf of Groundsearch Australia Pty. Limited

John Lea BSc (Hons) FAusIMM
Principal Geologist
Managing Director

1.0 Summary

The Groundsearch Australia and Flodim partnership provided wireline 3D cavity surveys with a sonar system for two water-filled, abandoned coal mine cavities adjacent to the investigation area for the AECOM Australia Pty Ltd Muswellbrook Bypass Project. The surveys were conducted from a standard Groundsearch logging unit utilising boreholes known as BH28_UG and BH28_UG.

A Flodim sonar survey tool was run to collect data in the water-filled section of BH28_UG on 20 August 2020. The data in this report are from 65.5 to 71.5 mbgl.

The cavity data are recorded in horizontal & tilted survey sections providing full 3D coverage with the data saved as a "point cloud".

The BH28_UG separate surveys are combined into a single model with depth & distance-based data presented as:

- tabulated characteristics
- 2D vertical & horizontal sections
- 2D solid representations

2.0 BH28_UG dimensions

BH28_UG survey data indicate:

- Top of cavity = 68.5 m
- Base of cavity = 72.0 m
- Total volume = 743.0 m^3
- Maximum radius orientation = 235^0 (Magnetic North)
- Maximum distance between points = 56.3 m
- Maximum surface area = 541.6 m^2

Appendix 1 is provided by Flodim and contains:

- Total Volume (m^3) versus Depth graph 1/50
- Partial Volume (m^3) versus Depth each 0.5 m graph 1/50
- Vertical sections superposition between 0° and 175° each 5° profile view 1/250
- Mean Radius profile view 1/100
- Horizontal sections superposition between 68.0 m and 71.5 m plan view 1/500
- Maximum extension plan view 1/500

- View from Above plan view 1/500
- Main characteristics datasheet table – 0.5 m depth intervals
- 36 x vertical sections 5^0 increments profile views 1/250
- 8 x horizontal sections 0.5 intervals from 65.5 m to 71.5 m plan views 1/500
- 2D solid view from North with an overhang of 10°
- 2D solid view from East with an overhang of 10°
- 2D solid view from South with an overhang of 10°
- 2D solid view from West with an overhang of 10°

Appendix 1 Flodim SARL Sonar Survey Data Report

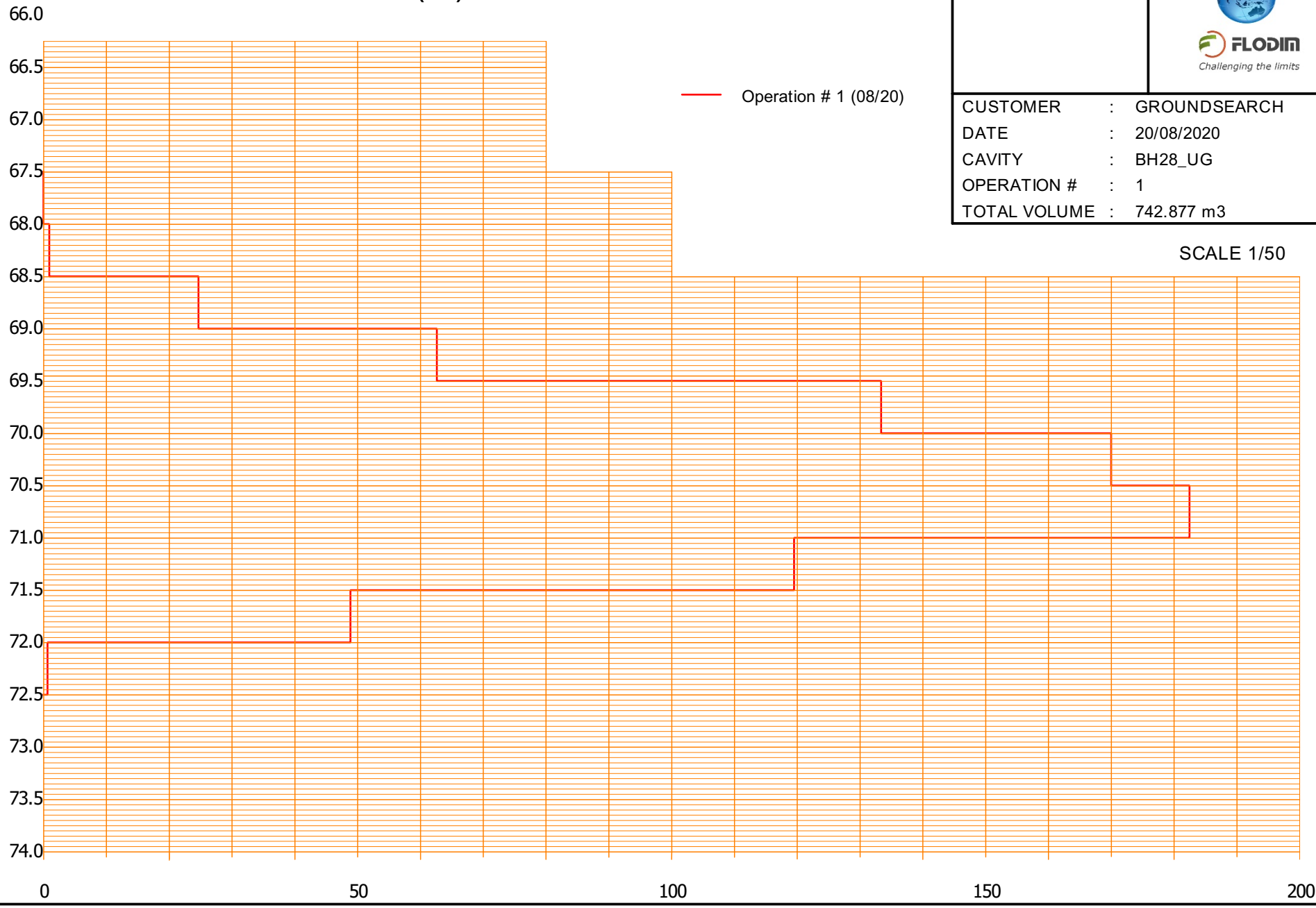
CUSTOMER	GROUNDSEARCH
DATE	20/08/2020
CAVITY	BH28_UG
OPERATION #	1
REPORT #	20-3148

TOTAL VOLUME (m3) VERSUS DEPTH

CUSTOMER	:	GROUNDSEARCH
DATE	:	20/08/2020
CAVITY	:	BH28_UG
OPERATION #	:	1
TOTAL VOLUME	:	742.877 m3

SCALE 1/50

PARTIAL VOLUME (m3) VERSUS DEPTH EACH 0.5 m



GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

CUSTOMER	:	GROUNDSEARCH
DATE	:	20/08/2020
CAVITY	:	BH28_UG
OPERATION #	:	1
TOTAL VOLUME	:	742.877 m3

SCALE 1/50

CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

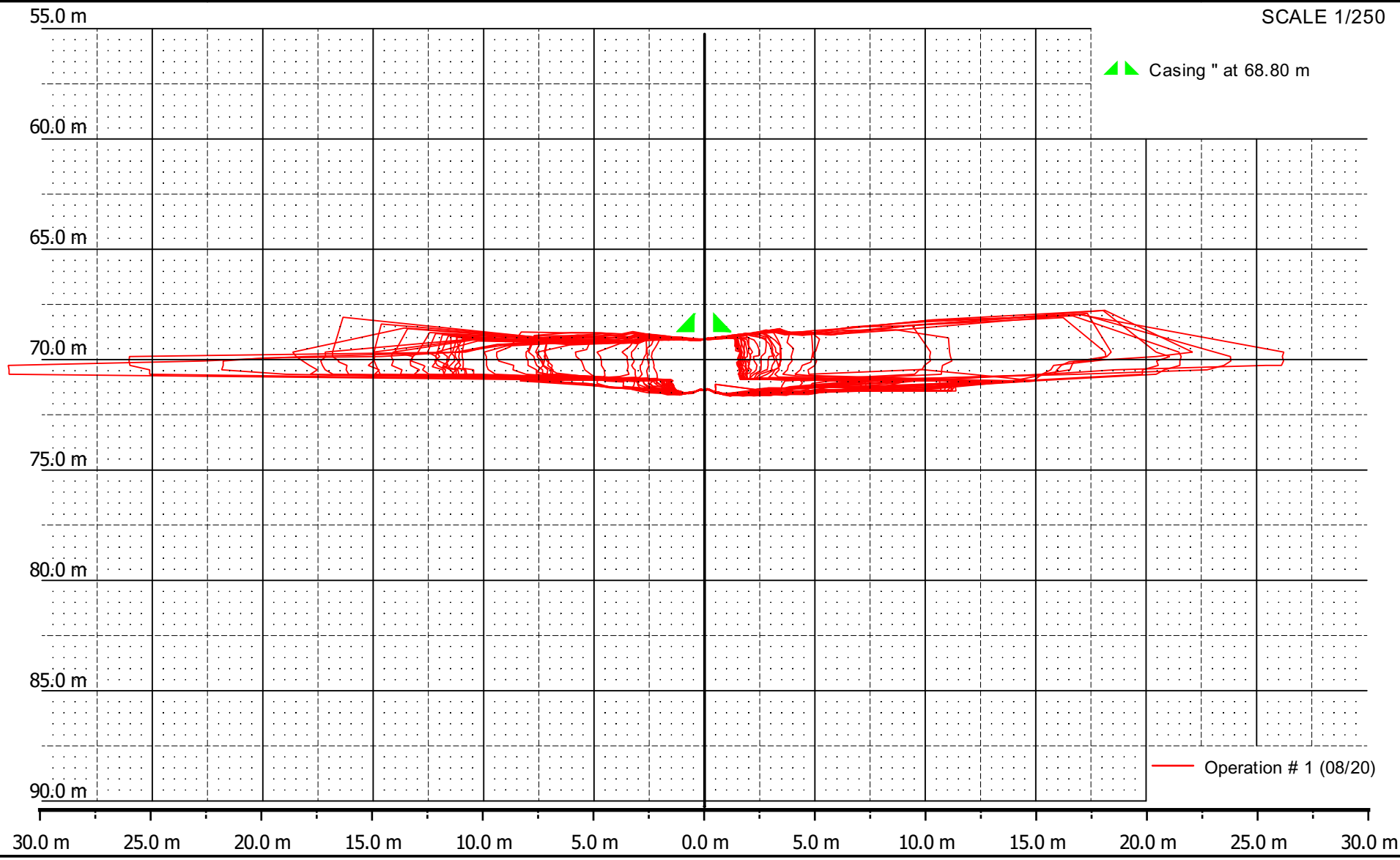
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTIONS SUPERPOSITION

between 0° and 175° every 5°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



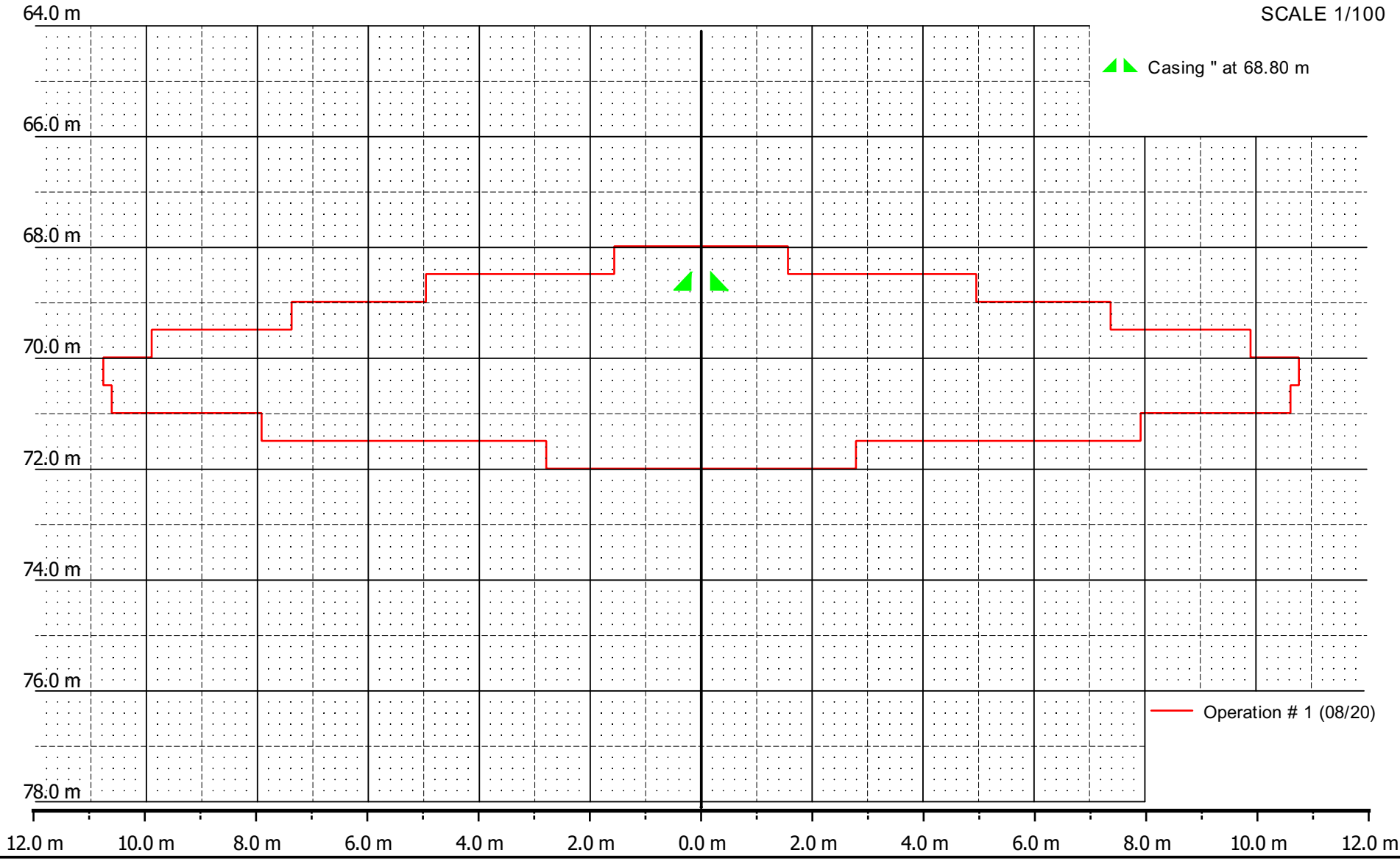
CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28_UG
OPERATION # : 1

MEAN RADIUS

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

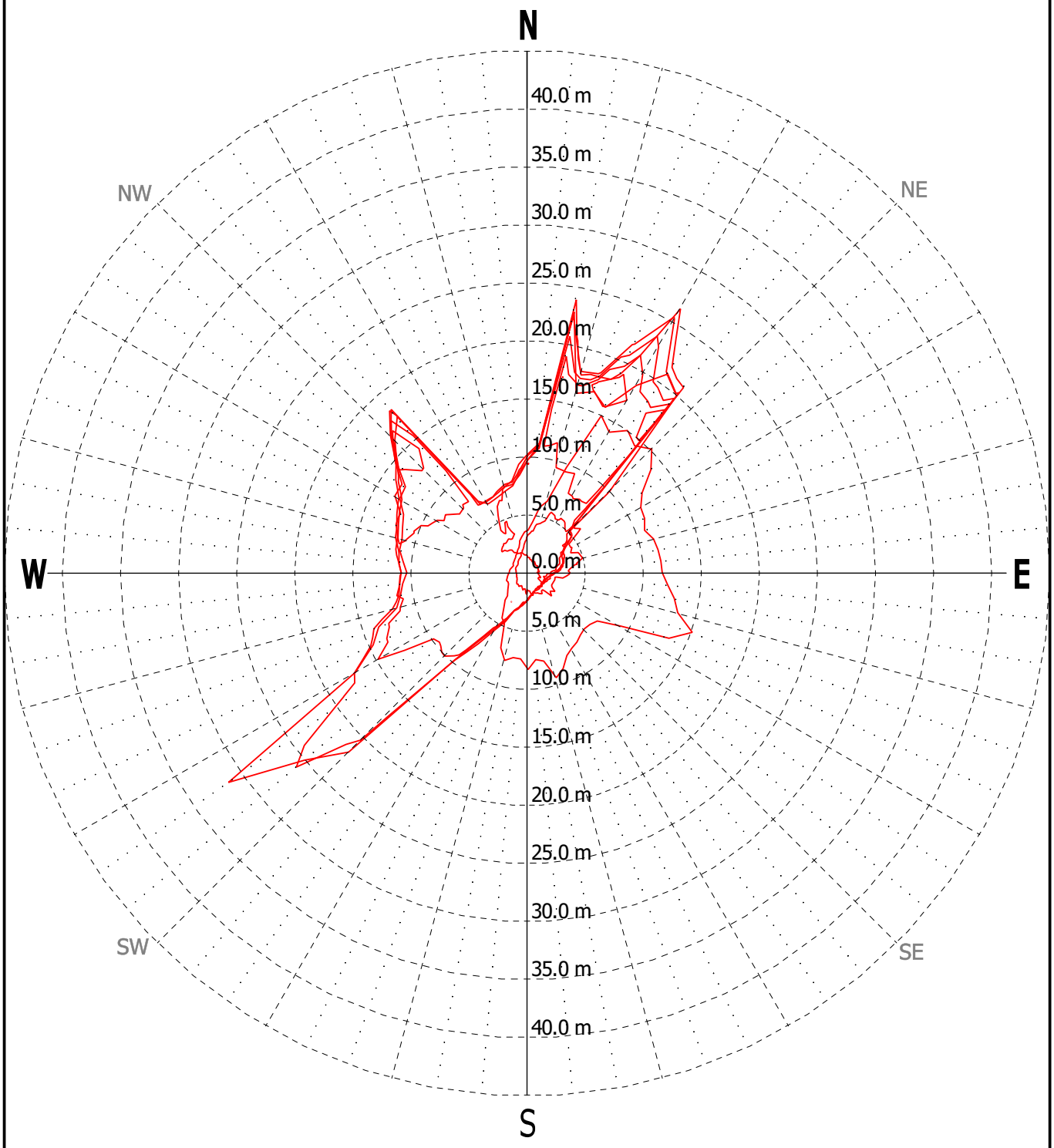


CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTIONS SUPERPOSITION

between 68.0 m and 71.5 m

SCALE 1/500

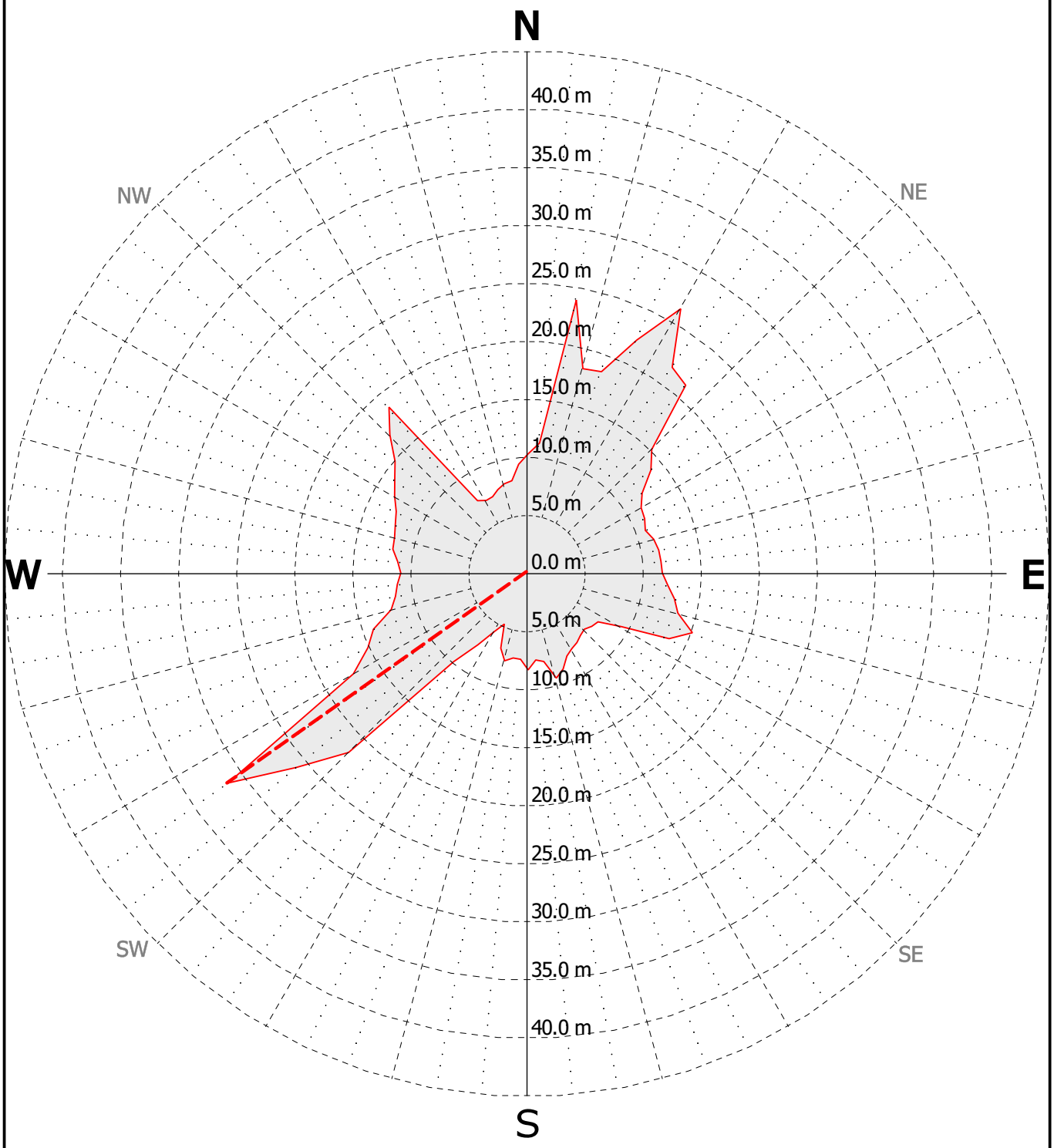


Operation # 1 (08/20)

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

MAXIMUM EXTENSION

SCALE 1/500



Operation # 1 (08/20)

Maximum radius	: 31.43 m
Orientation maxi. radius	: 235 °
Depth maxi. radius	: 70.3 m
Surface	: 541.55 m²
Max distance between points	: 56.26 m

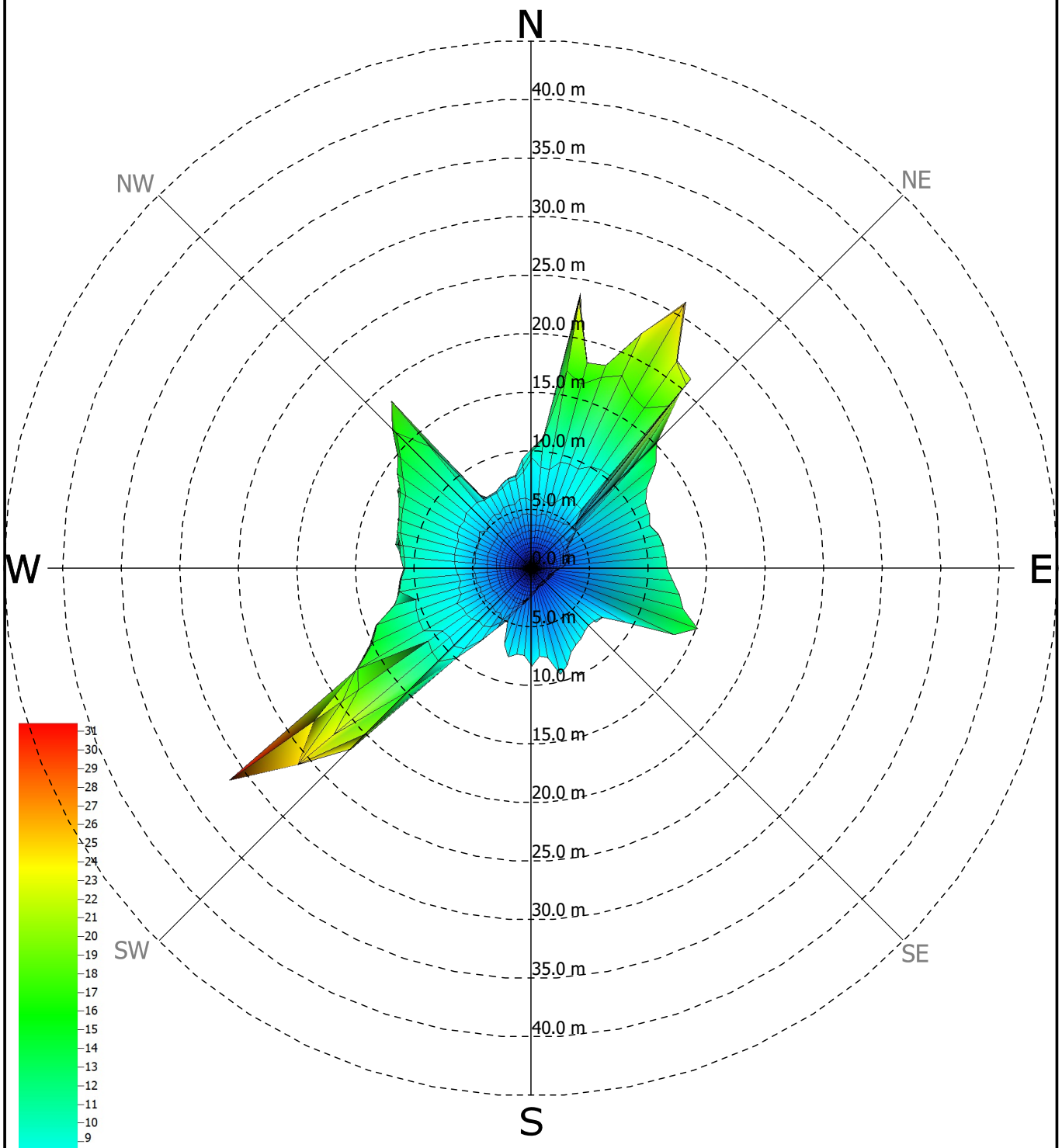
CUSTOMER	:GROUNDSEARCH	CAVITY	:BH28_UG
DATE	:20/08/2020	OPERATION #	:1

VIEW FROM ABOVE

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

SCALE 1/500



Maximum radius	: 31.43 m
Orientation maxi. radius	: 235 °
Depth maxi. radius	: 70.3 m
Surface	: 541.55 m²
Max distance between points	: 56.26 m

CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28_UG
OPERATION # : 1

1

MAIN CHARACTERISTICS DATASHEET

Depth (m)	Cumulated Volume (m3)	Volume Section (m3)	Section Area (m²)	Mean Radius (m)	Mean Diameter (m)	Min Radiu (m)	Max Radius (m)	Max Radius Orientation (°)	Min Diamete (m)	Max Diameter (m)	Max Diam. Orientation (°)
68.00	0.93	0.93	7.66	1.56	3.12	14.78	18.89	25.70	-	-	-
68.50	25.60	24.67	76.86	4.95	9.89	7.42	21.00	27.31	-	-	-
69.00	88.22	62.62	170.21	7.36	14.72	0.77	23.12	28.63	10.47	13.34	110.00
69.50	221.55	133.33	306.43	9.88	19.75	1.44	25.26	29.72	8.60	29.37	40.00
70.00	**391.49**	**169.94**	**362.74**	**10.75**	**21.49**	**1.53**	**26.14**	**30.00**	**8.76**	**30.57**	**40.00**
70.50	573.90	182.41	352.60	10.59	21.19	1.56	31.39	235.00	8.98	35.16	55.00
71.00	693.37	119.47	196.09	7.90	15.80	1.39	15.00	45.00	8.44	19.69	25.00
71.50	742.23	48.86	24.34	2.78	5.57	0.99	5.87	50.00	3.24	6.79	35.00
72.00	742.88	0.65	-	-	-	-	-	-	-	-	-

CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

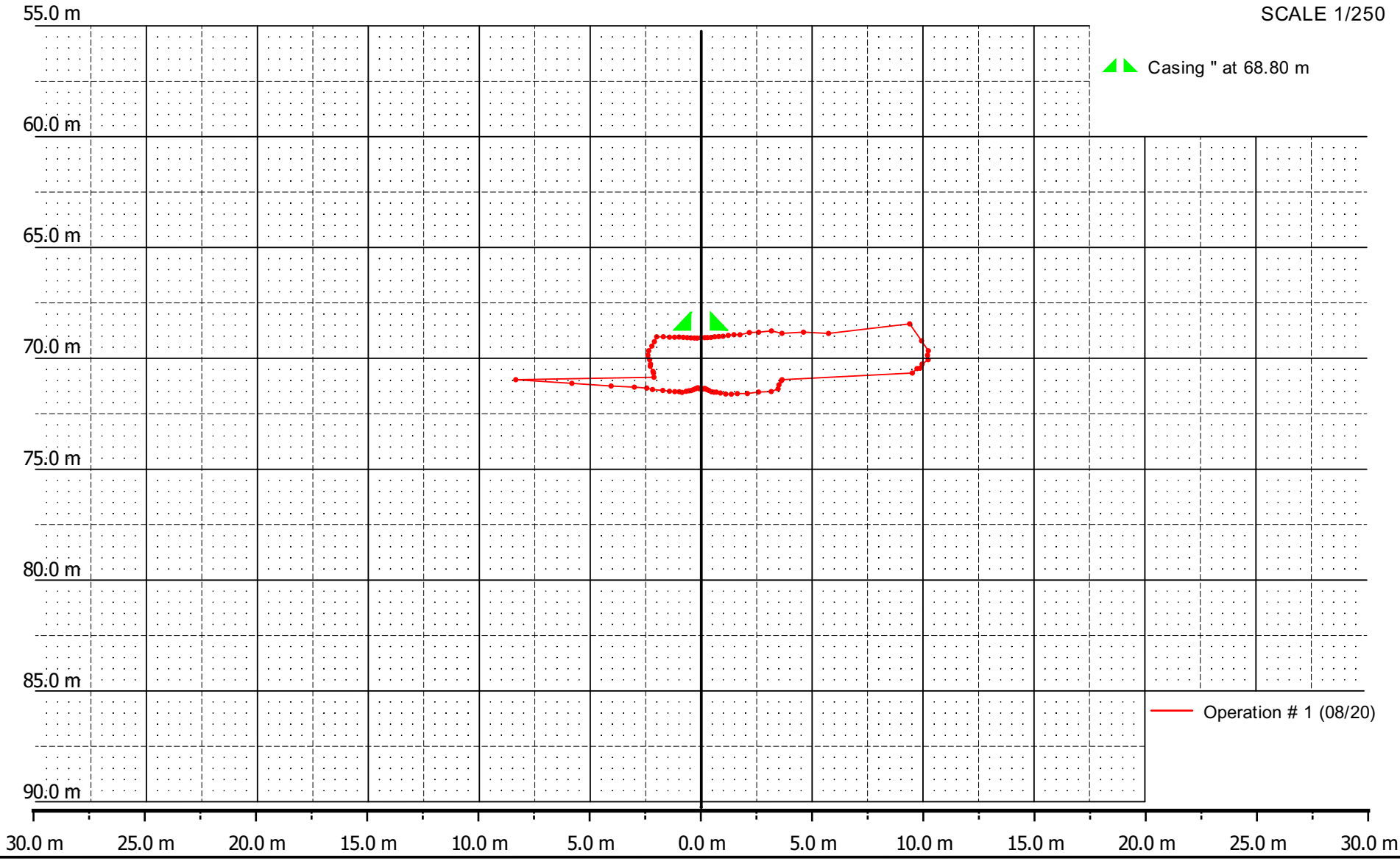
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

180° ← 1 → 0°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

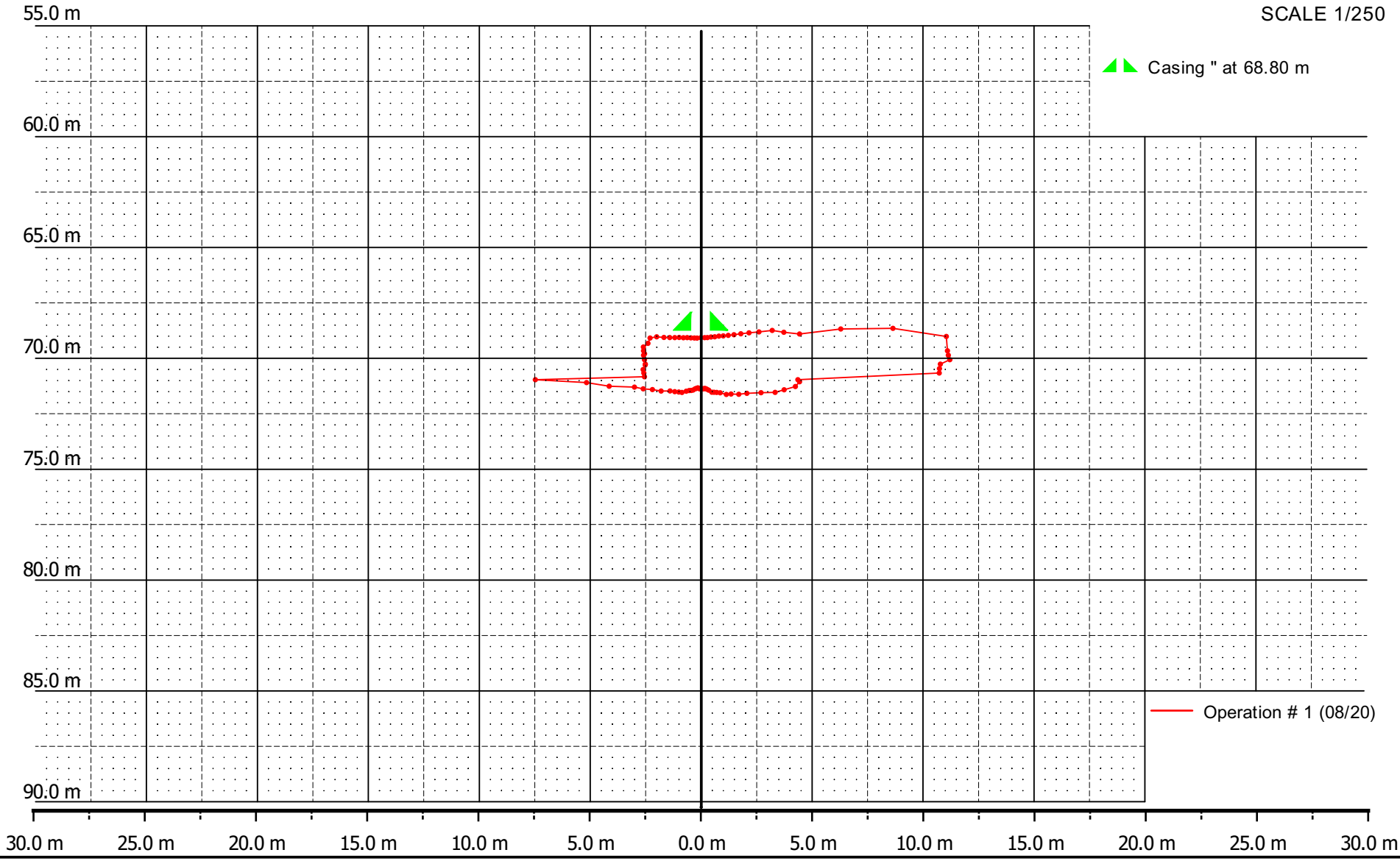
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

185° ← 2 → 5°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

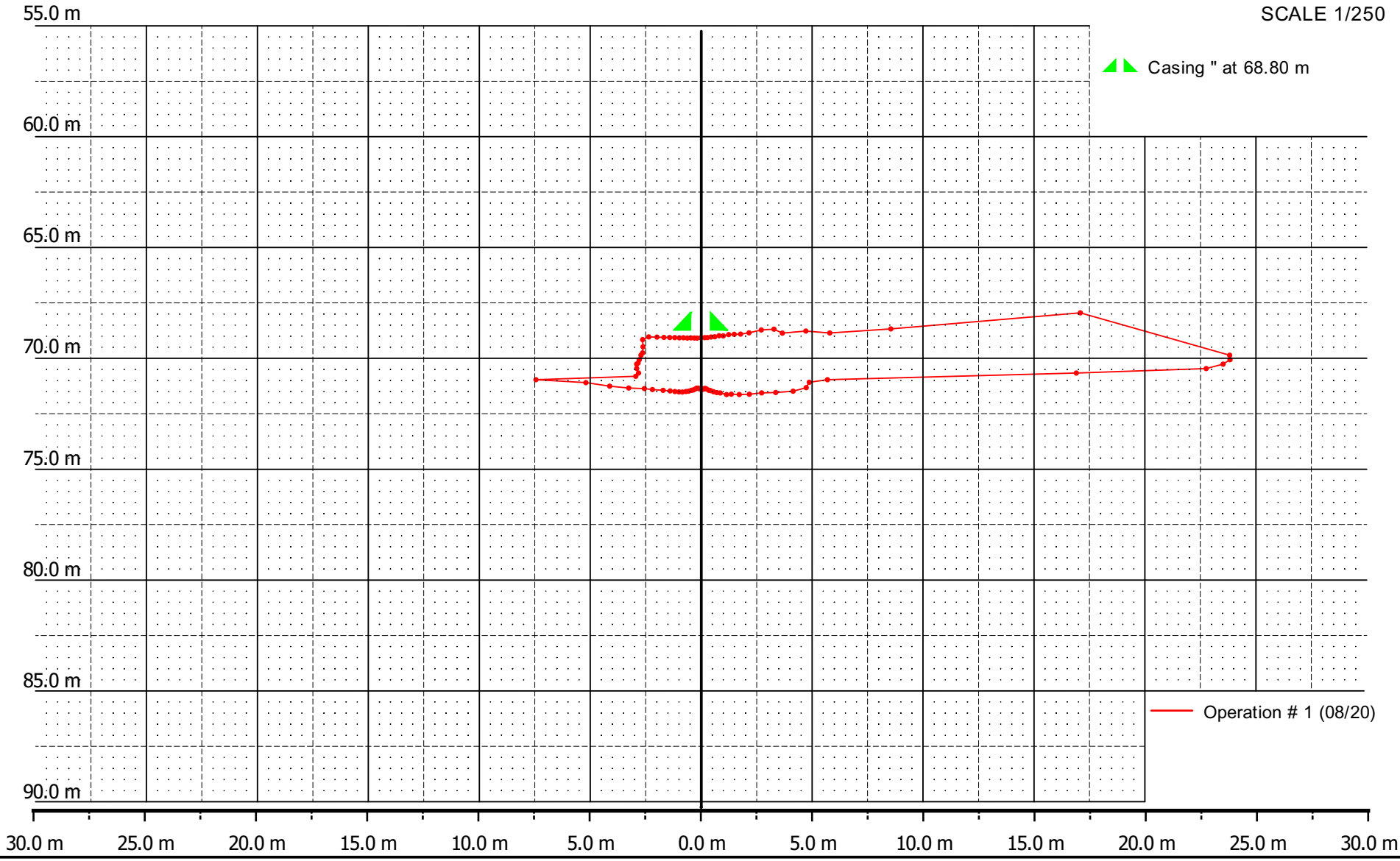
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

190° ← 3 → 10°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

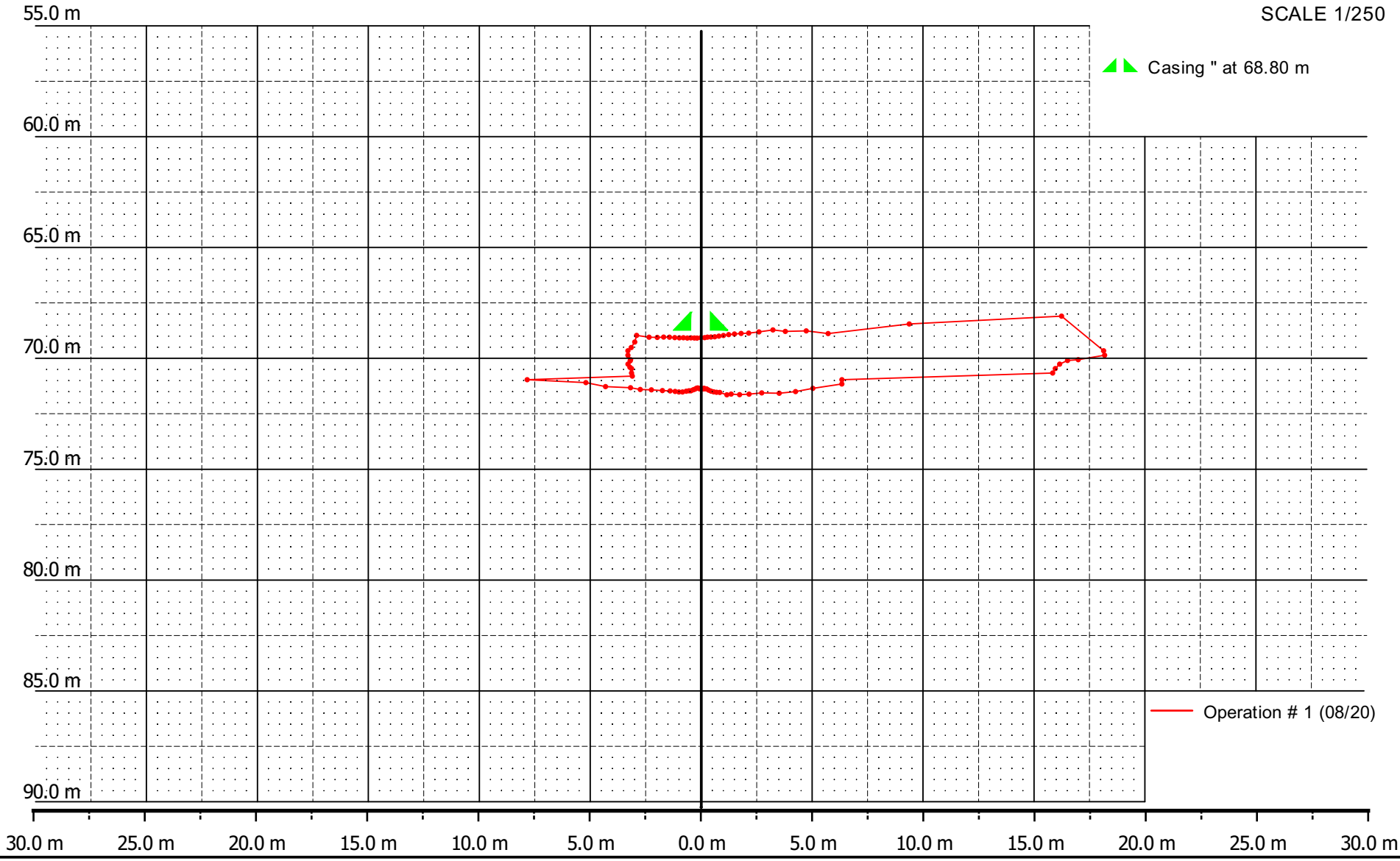
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

195° ← 4 → 15°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

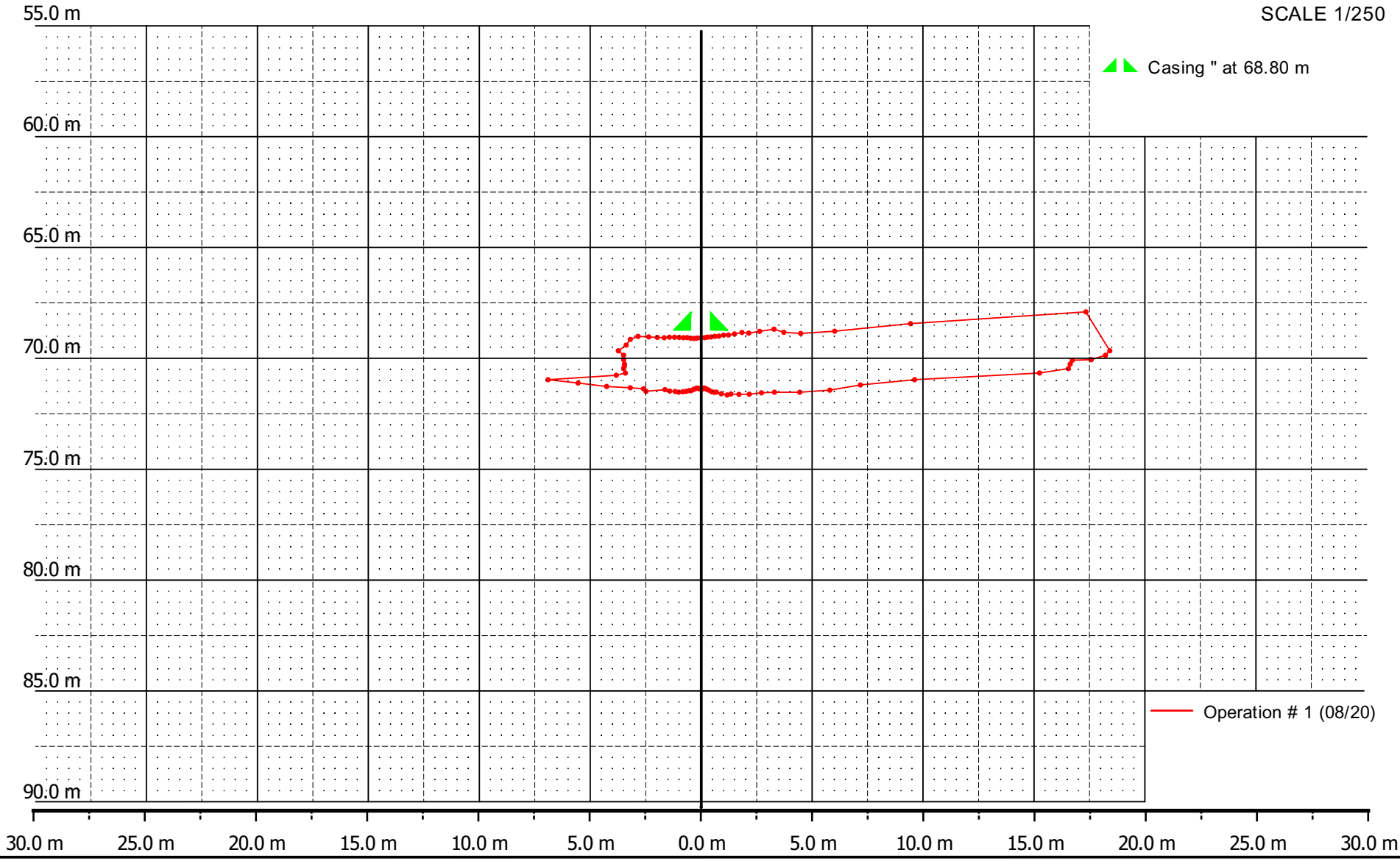
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

200° ← **5** → 20°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

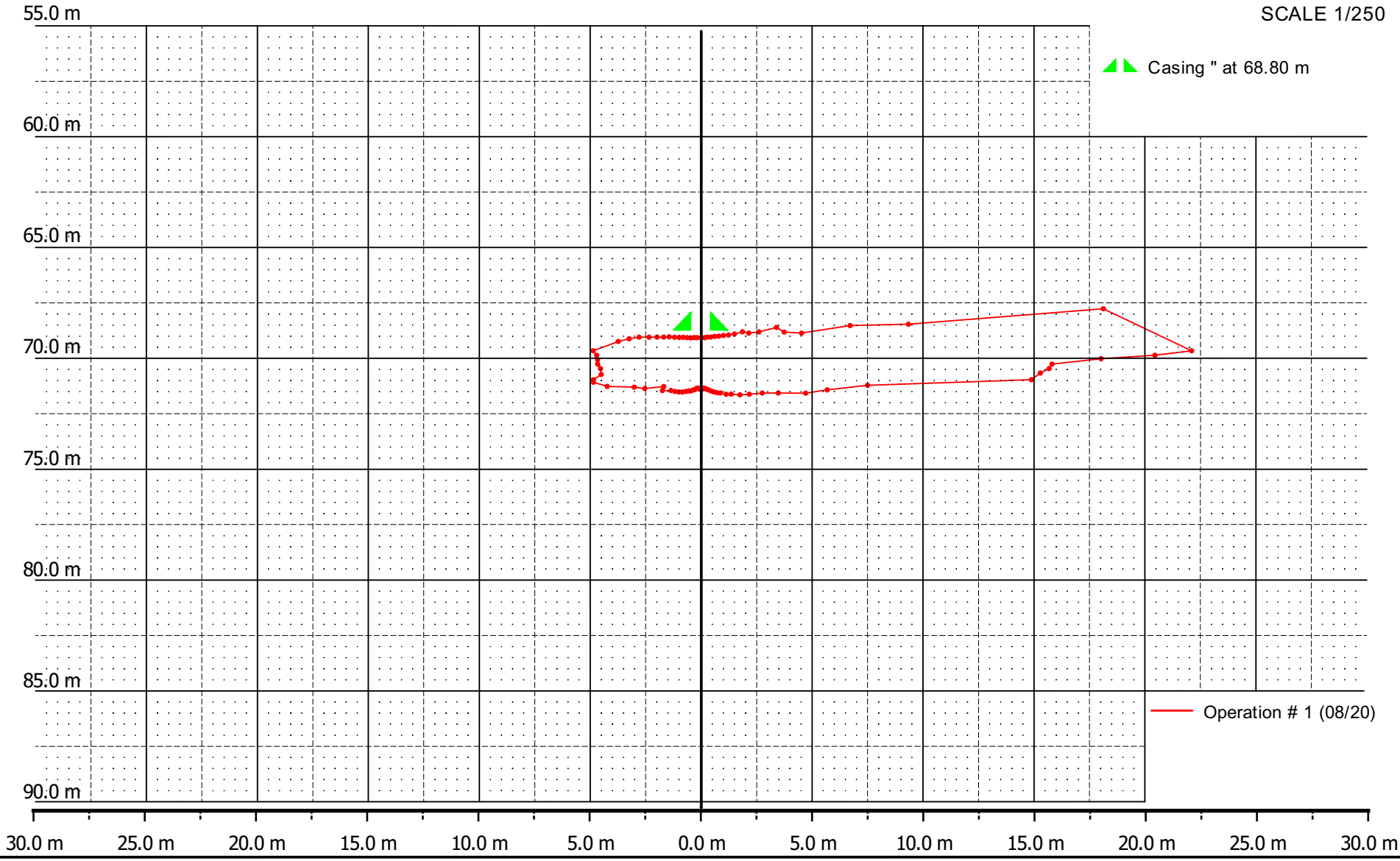
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

205° ← 6 → 25°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

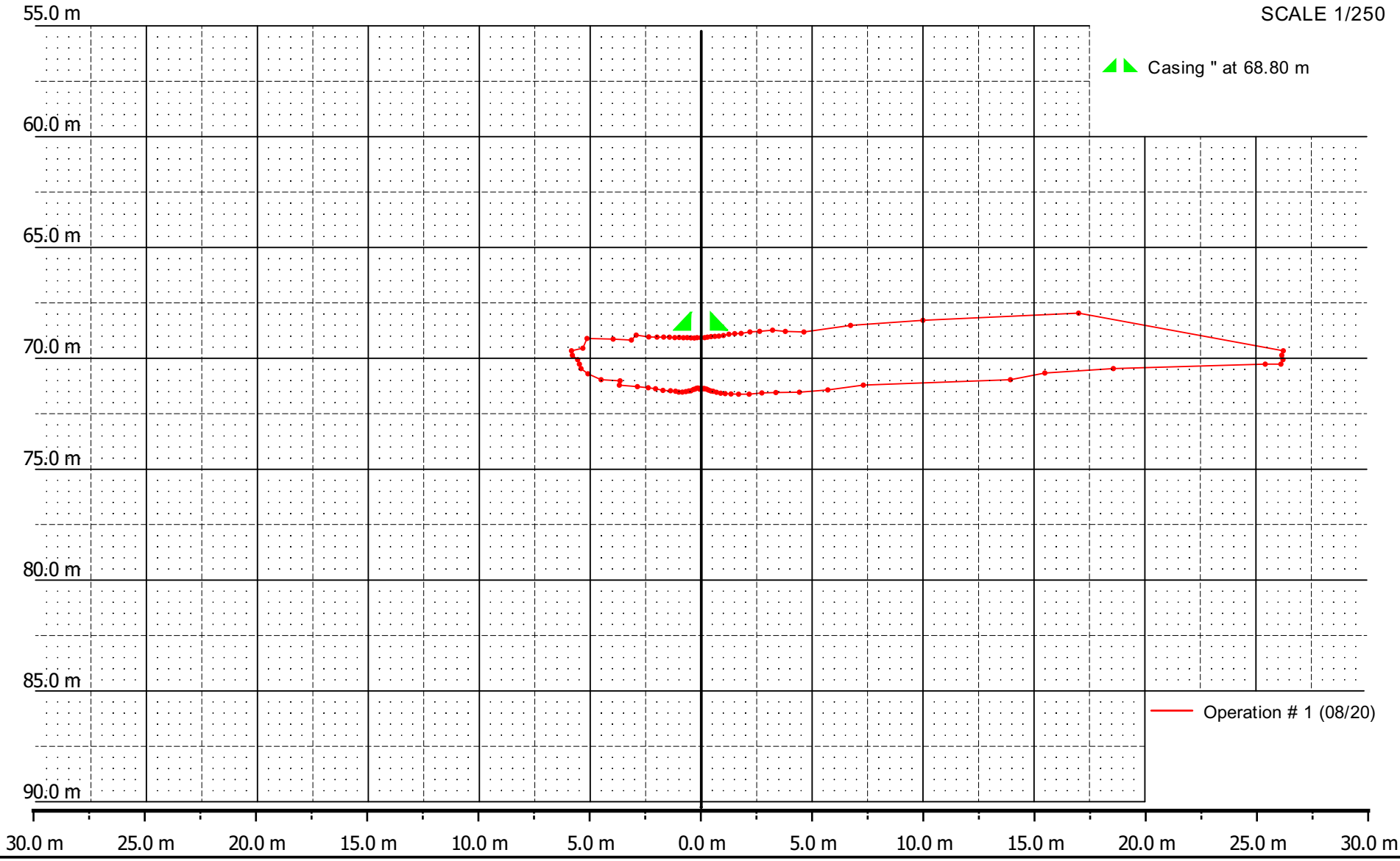
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

210° ← **7** → 30°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

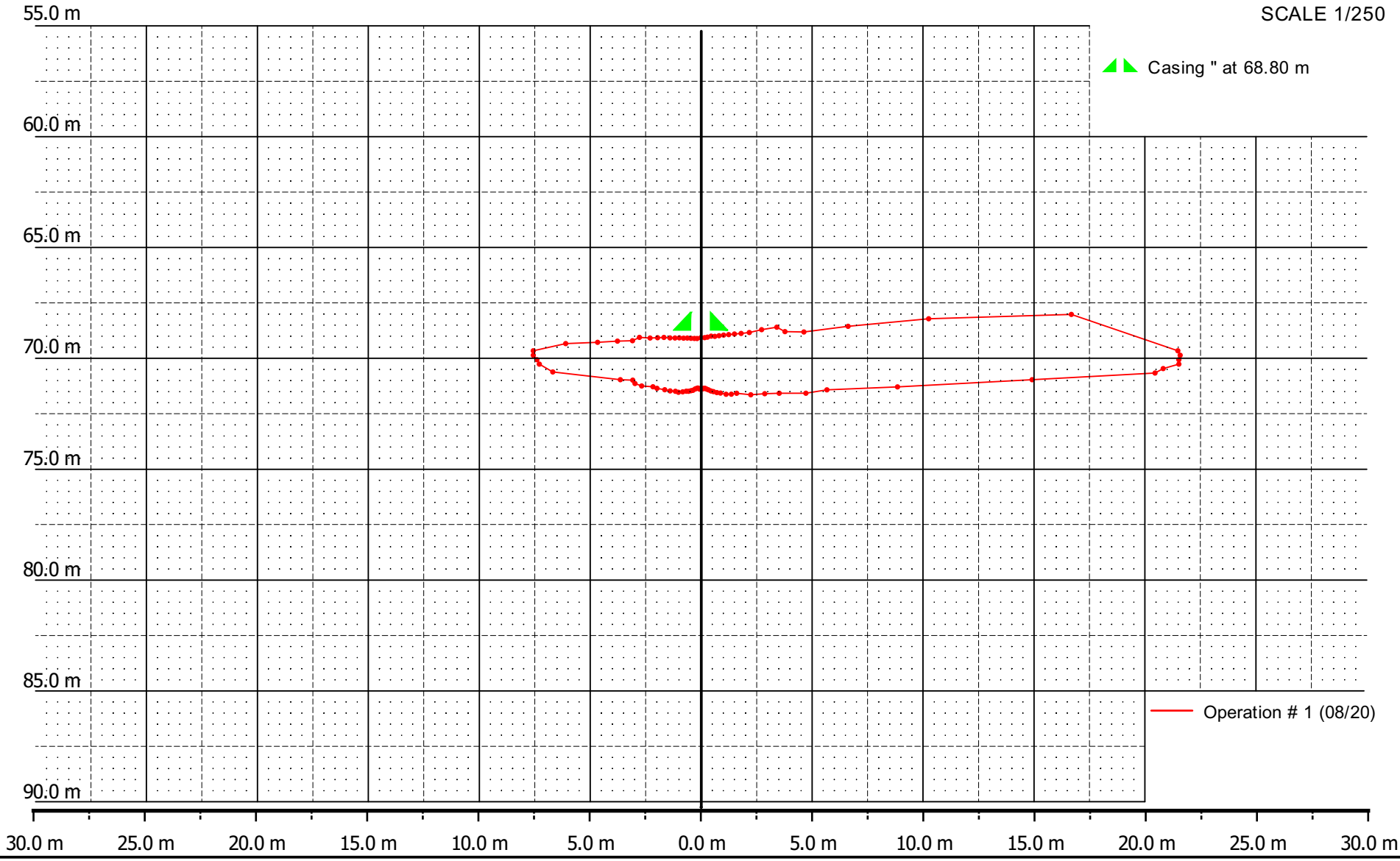
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

215° ← **8** → 35°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28_UG
OPERATION # : 1

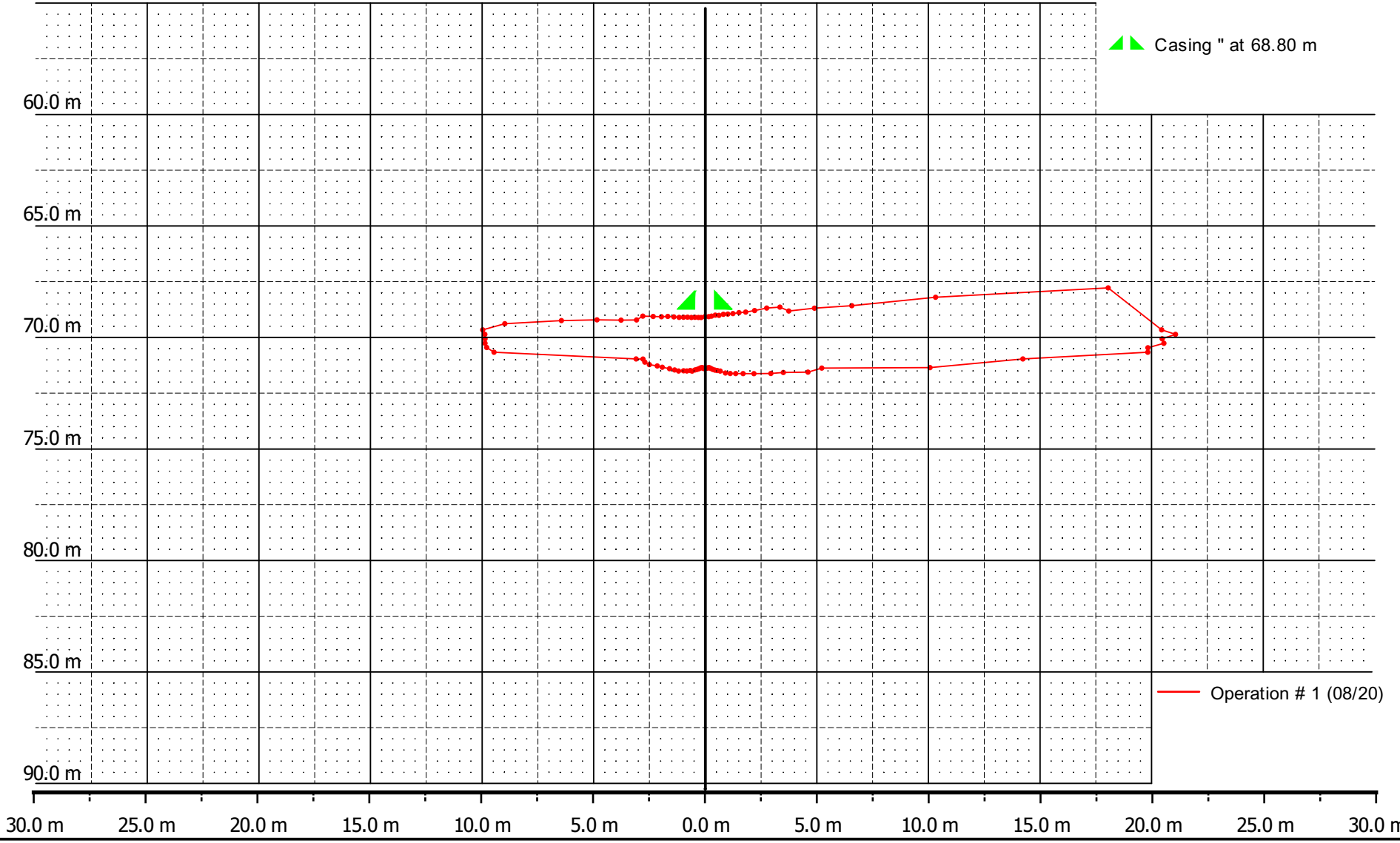
VERTICAL SECTION

220° ← **9** → 40°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

SCALE 1/250



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

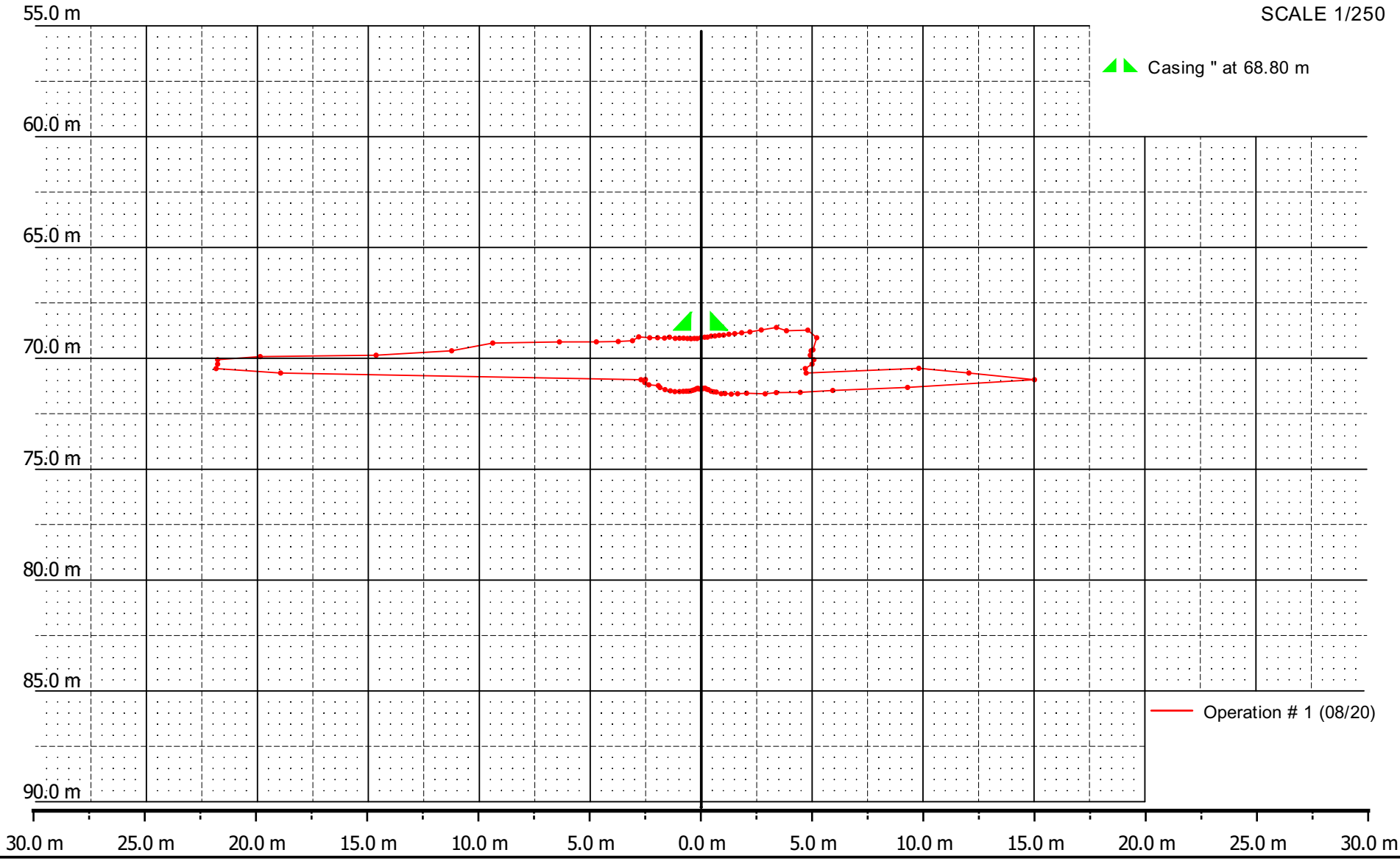
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

225° ← 10 → 45°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

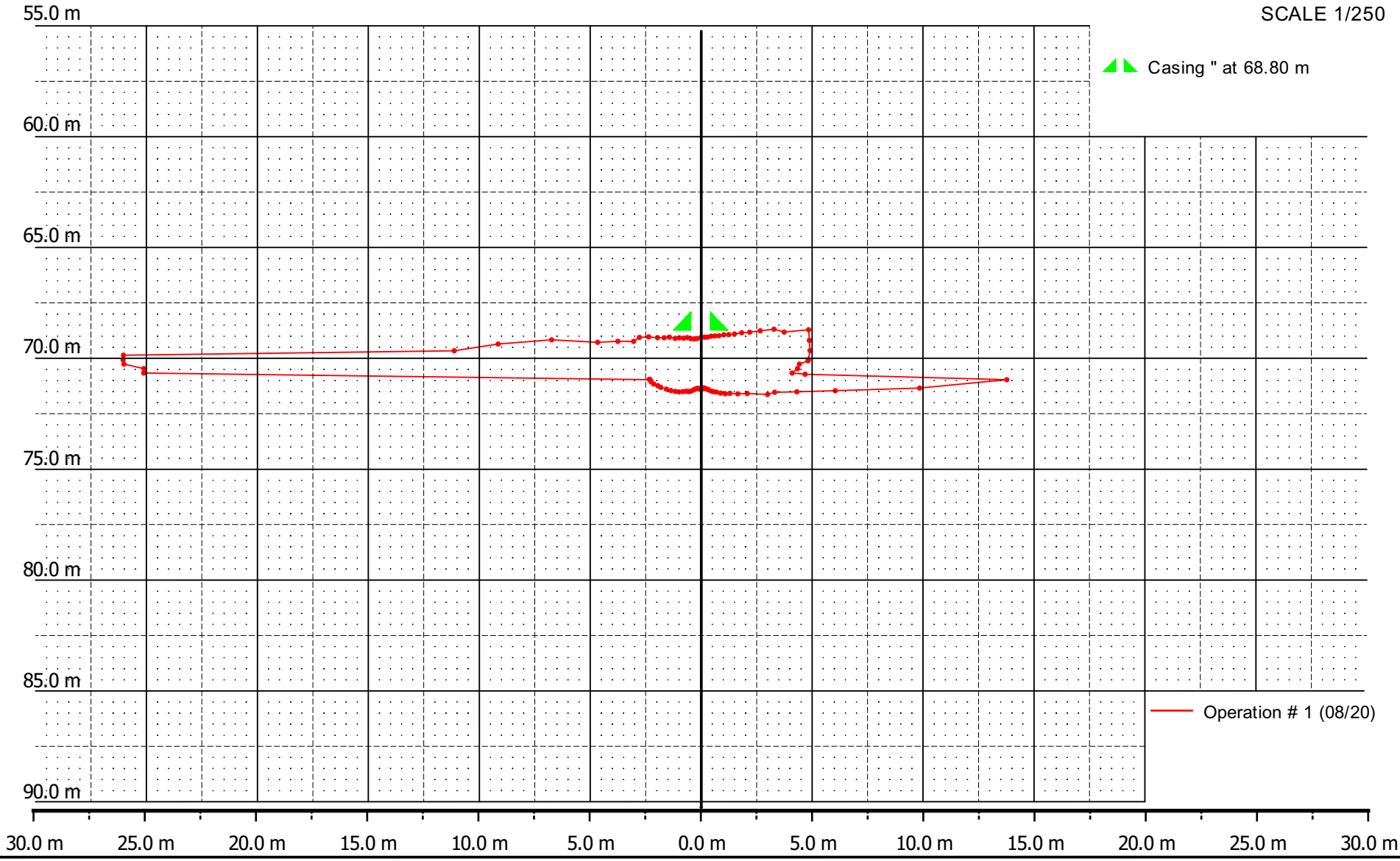
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

230° ← 11 → 50°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

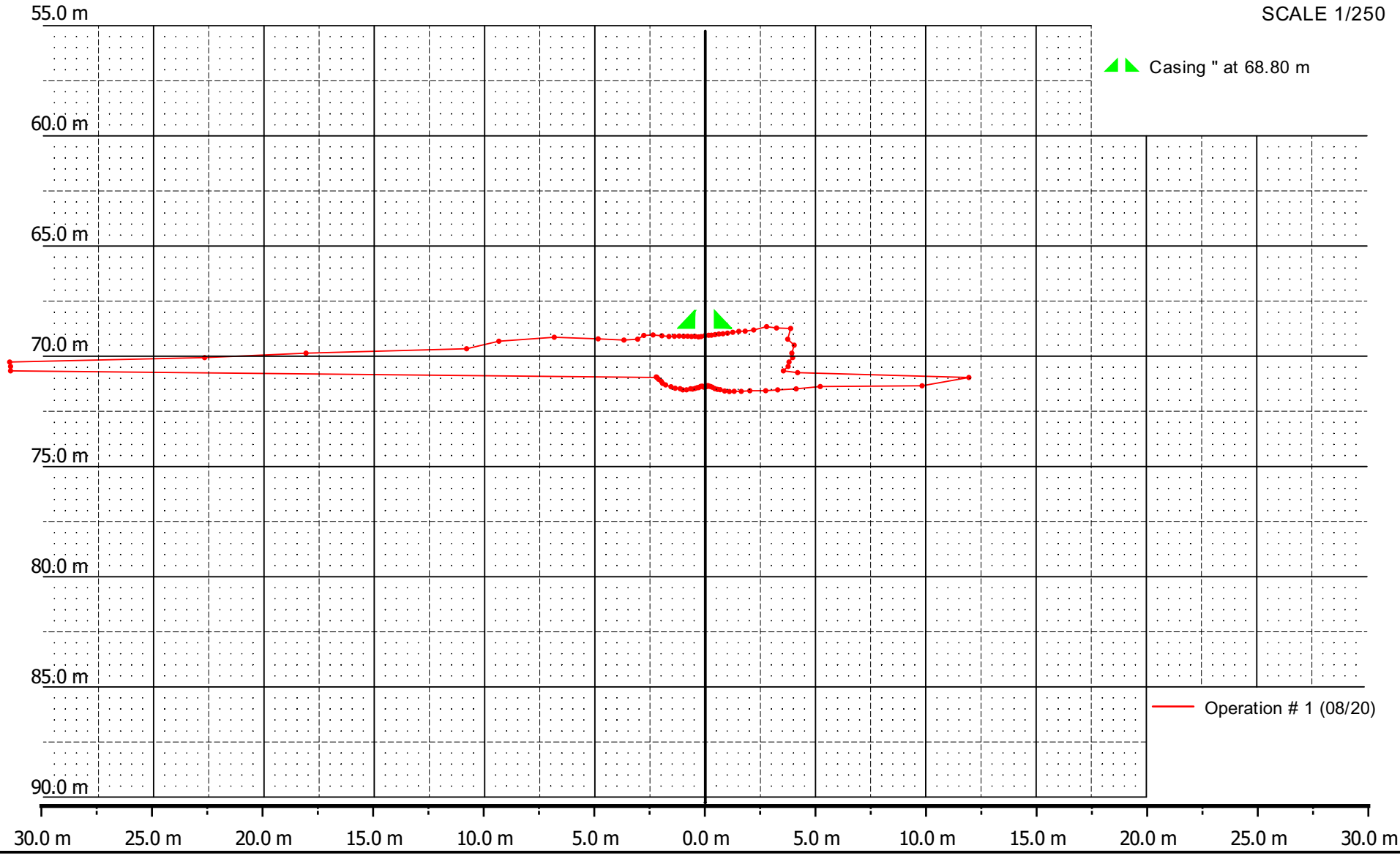
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

235° ← **12** → 55°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

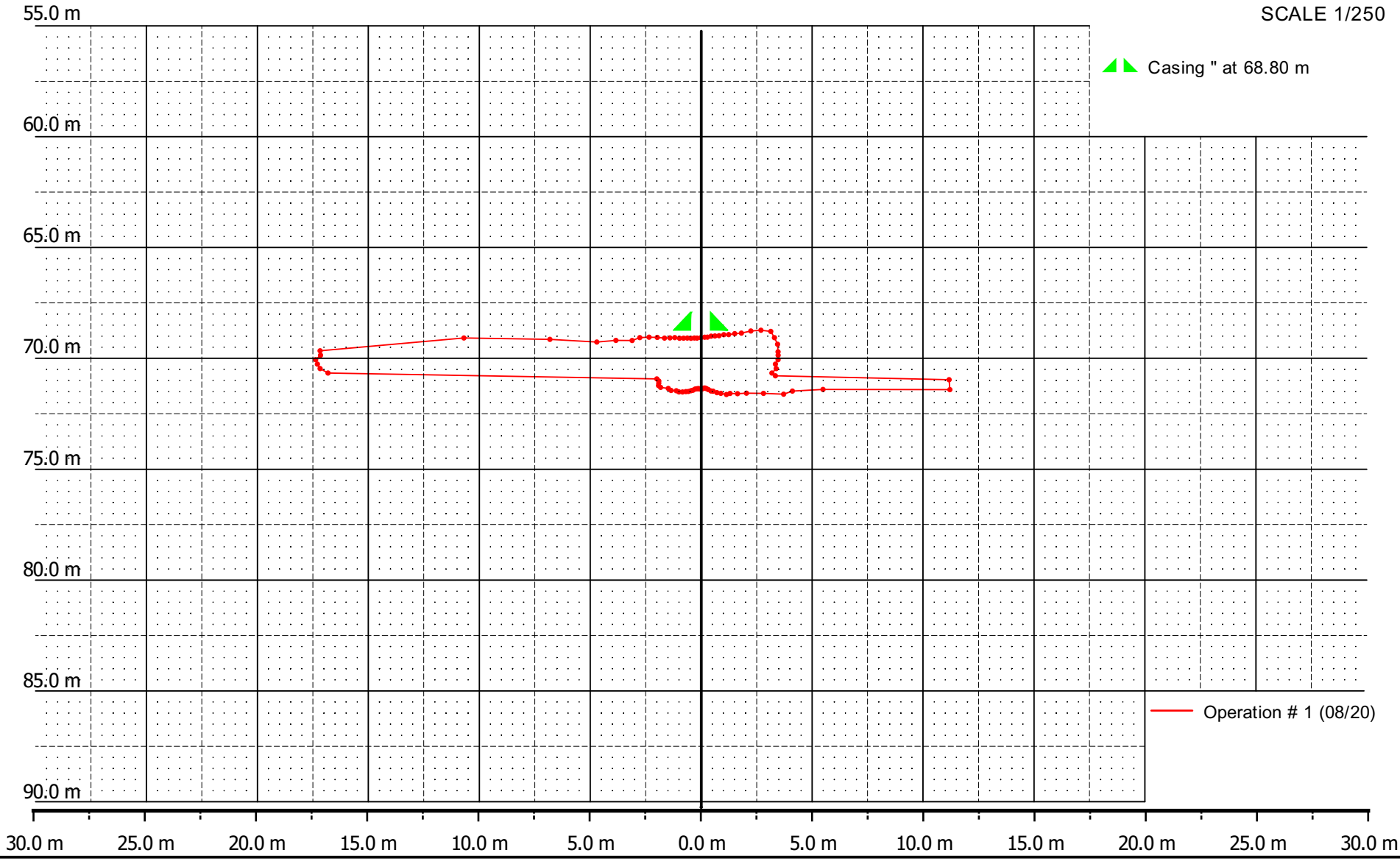
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

240° ← **13** → 60°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

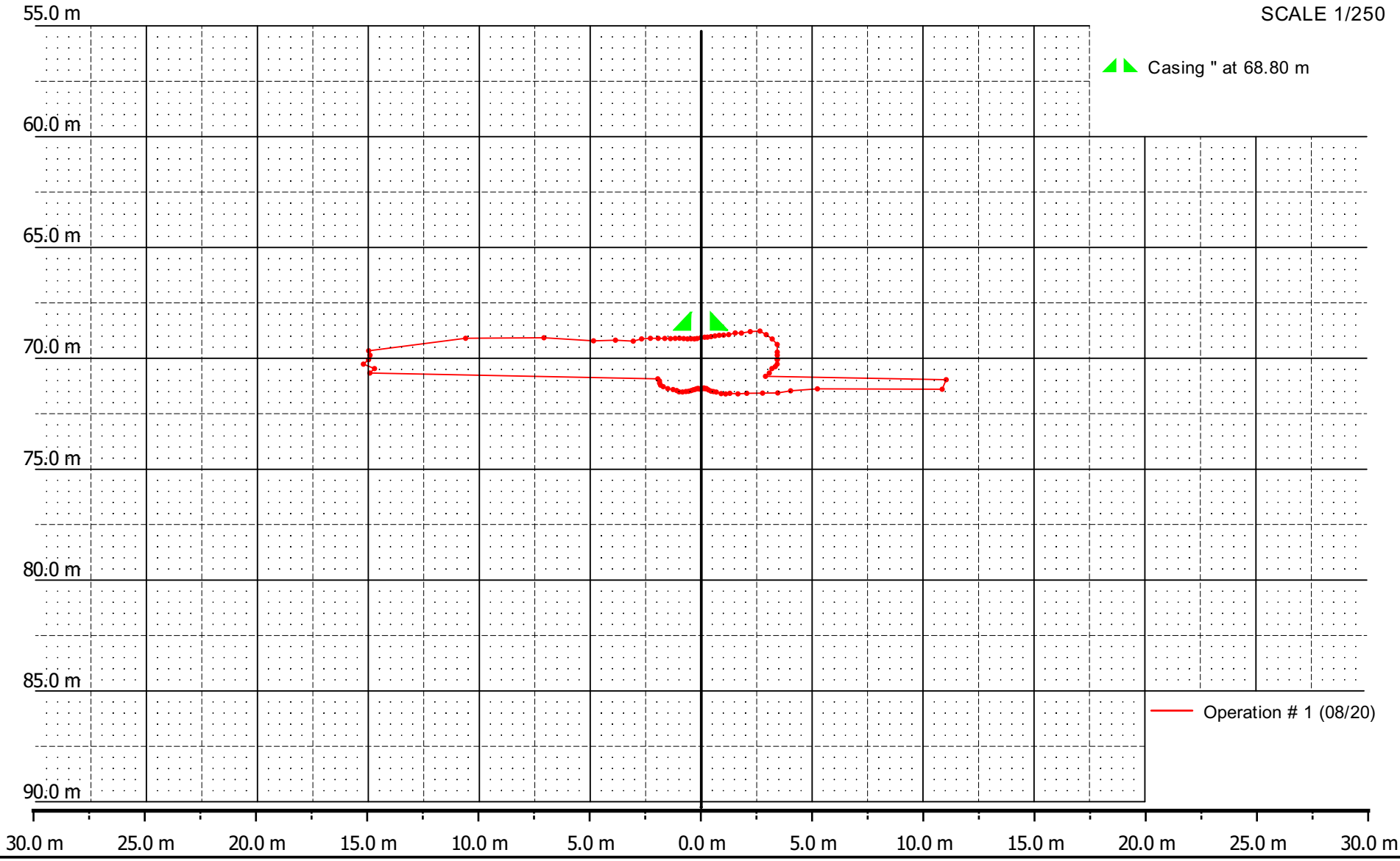
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

245° ← 14 → 65°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

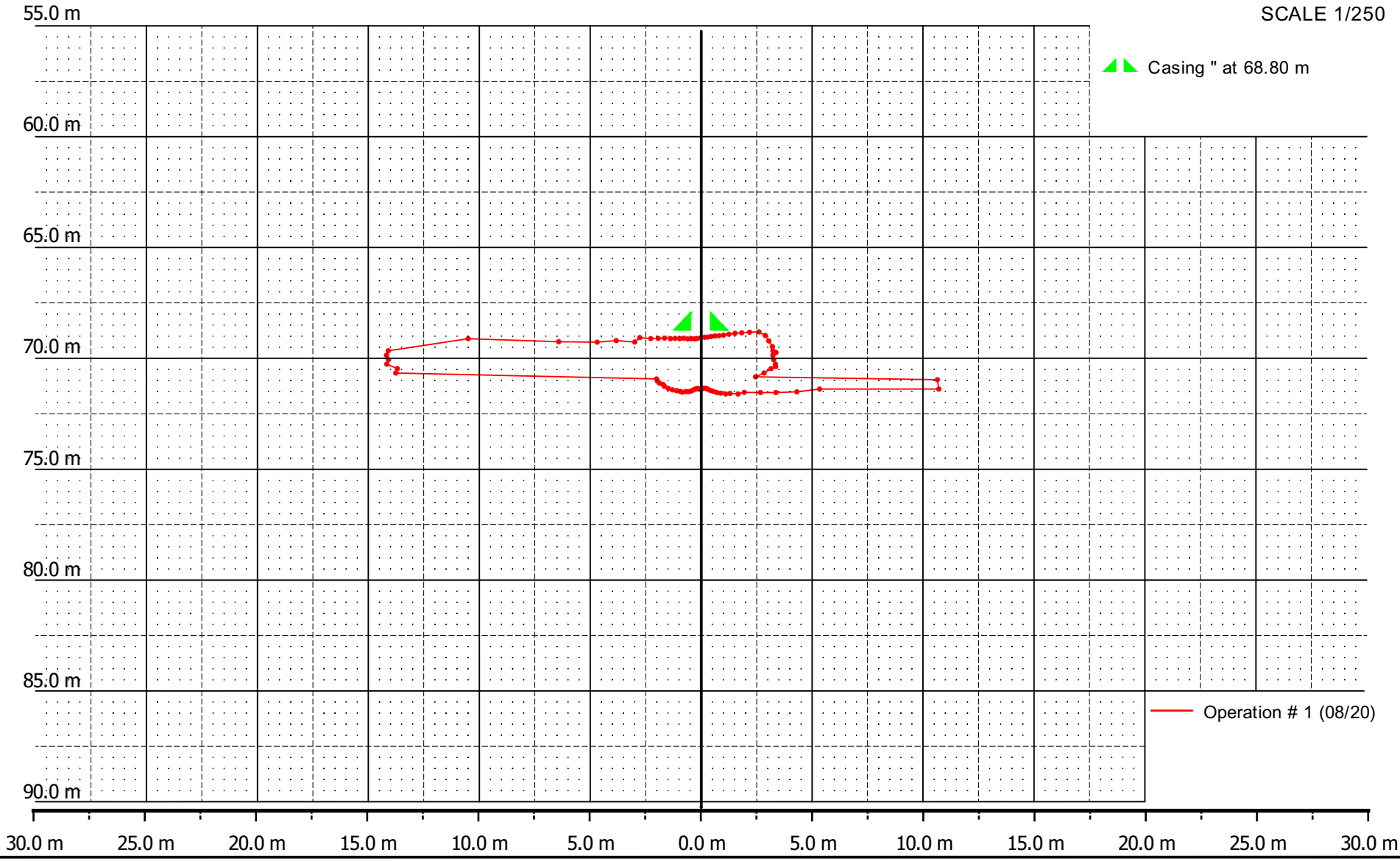
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

250° ← 15 → 70°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

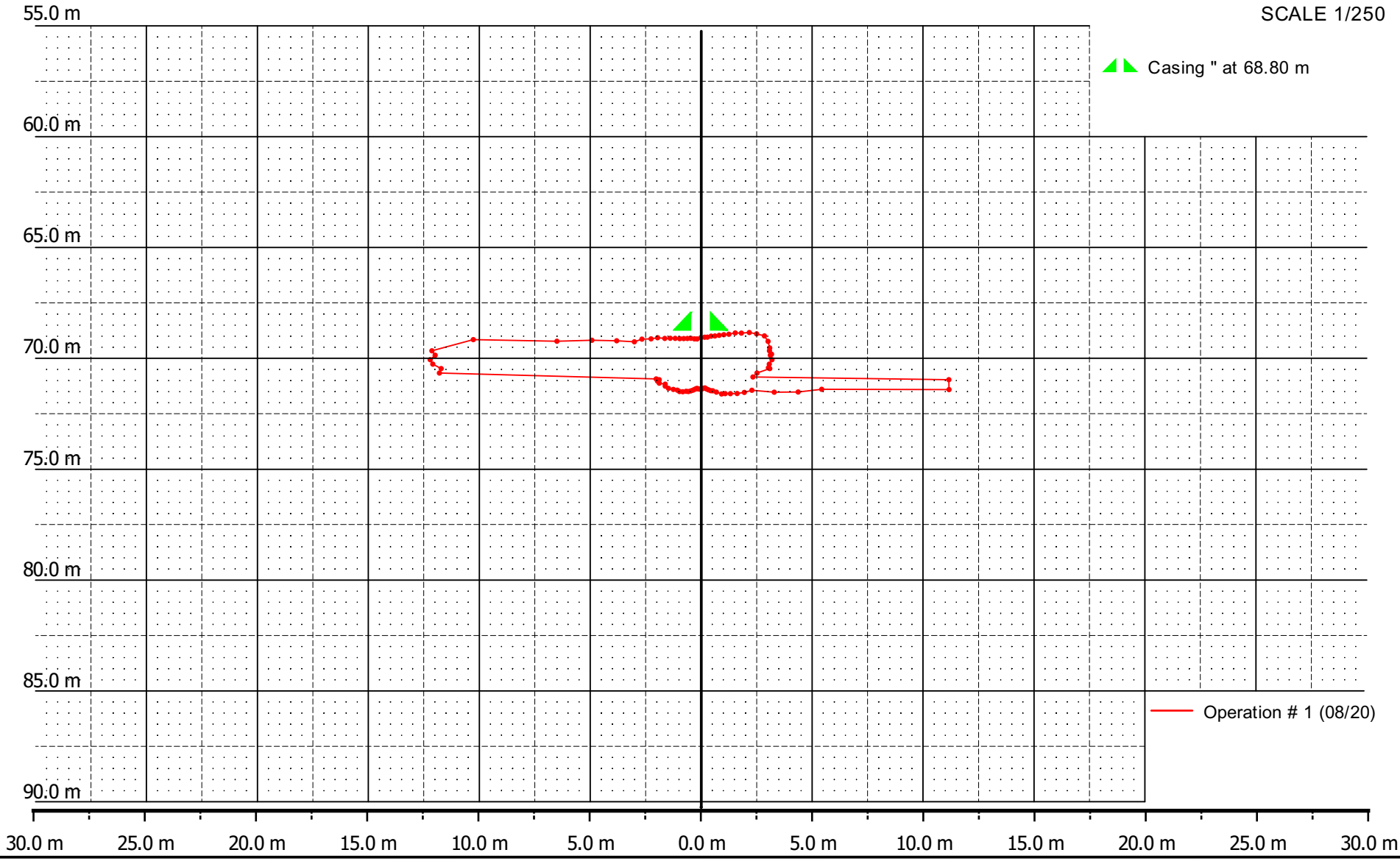
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

255° ← **16** → 75°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

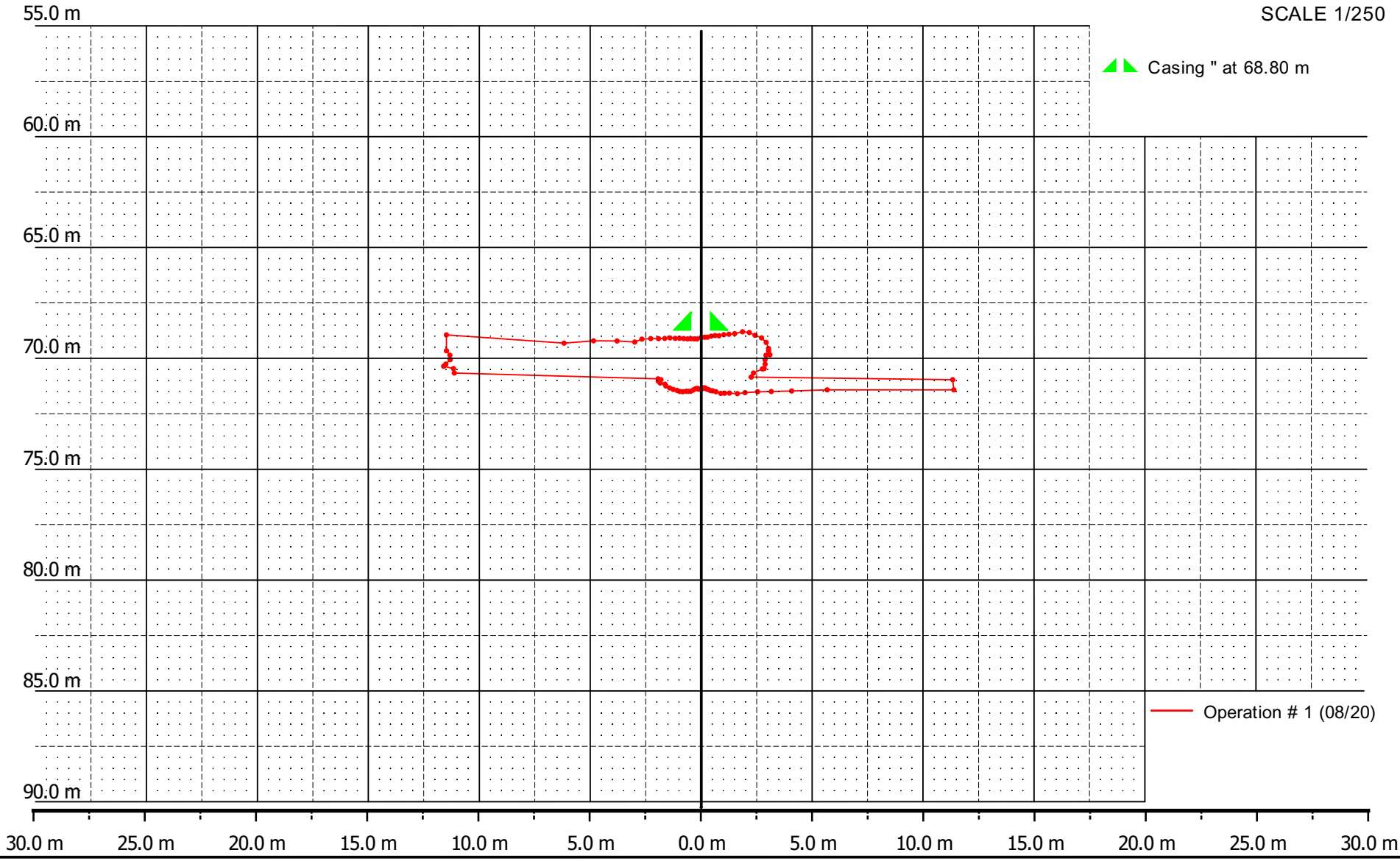
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

260° ← 17 → 80°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

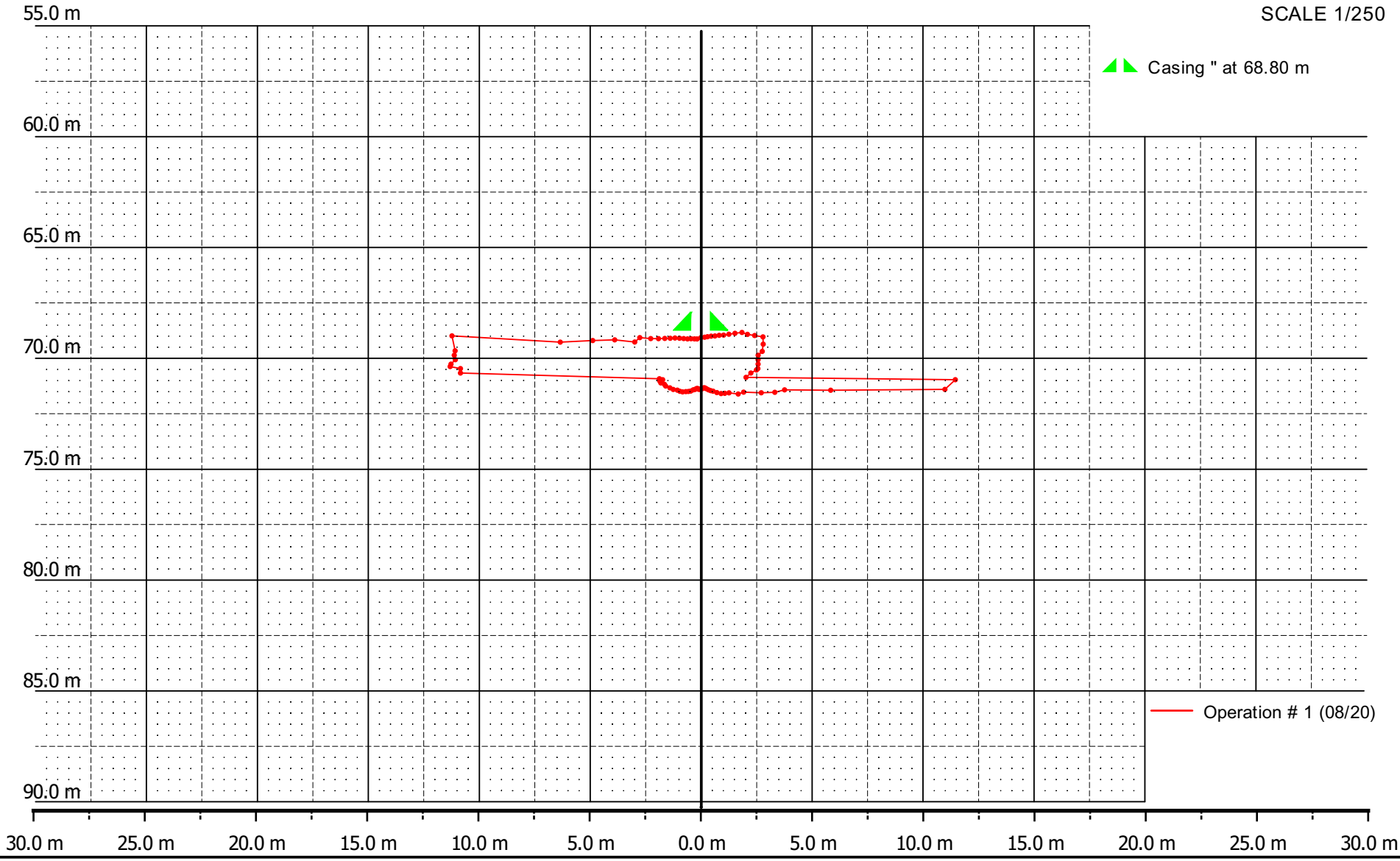
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

265° ← **18** → 85°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

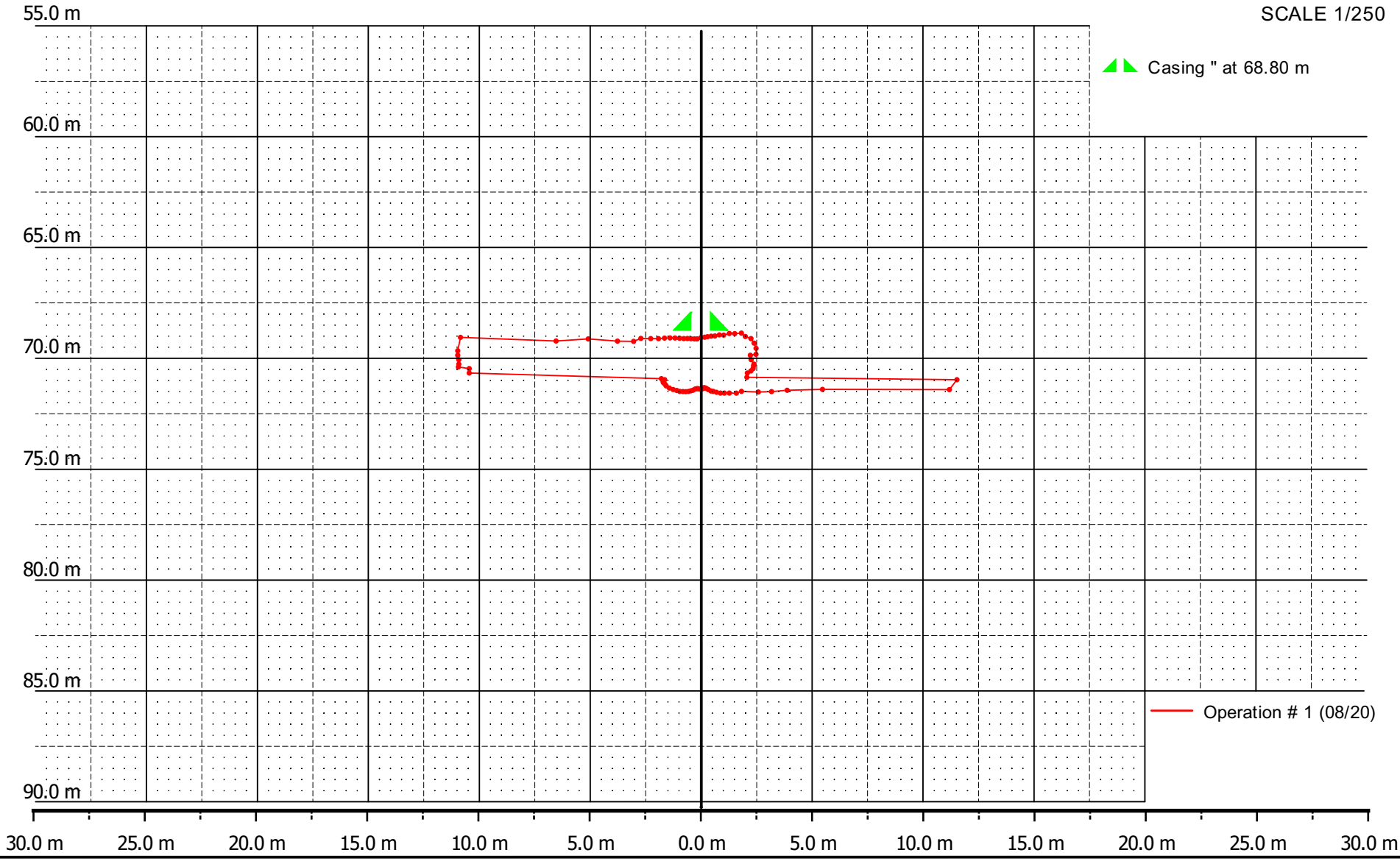
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

270° ← **19** → 90°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

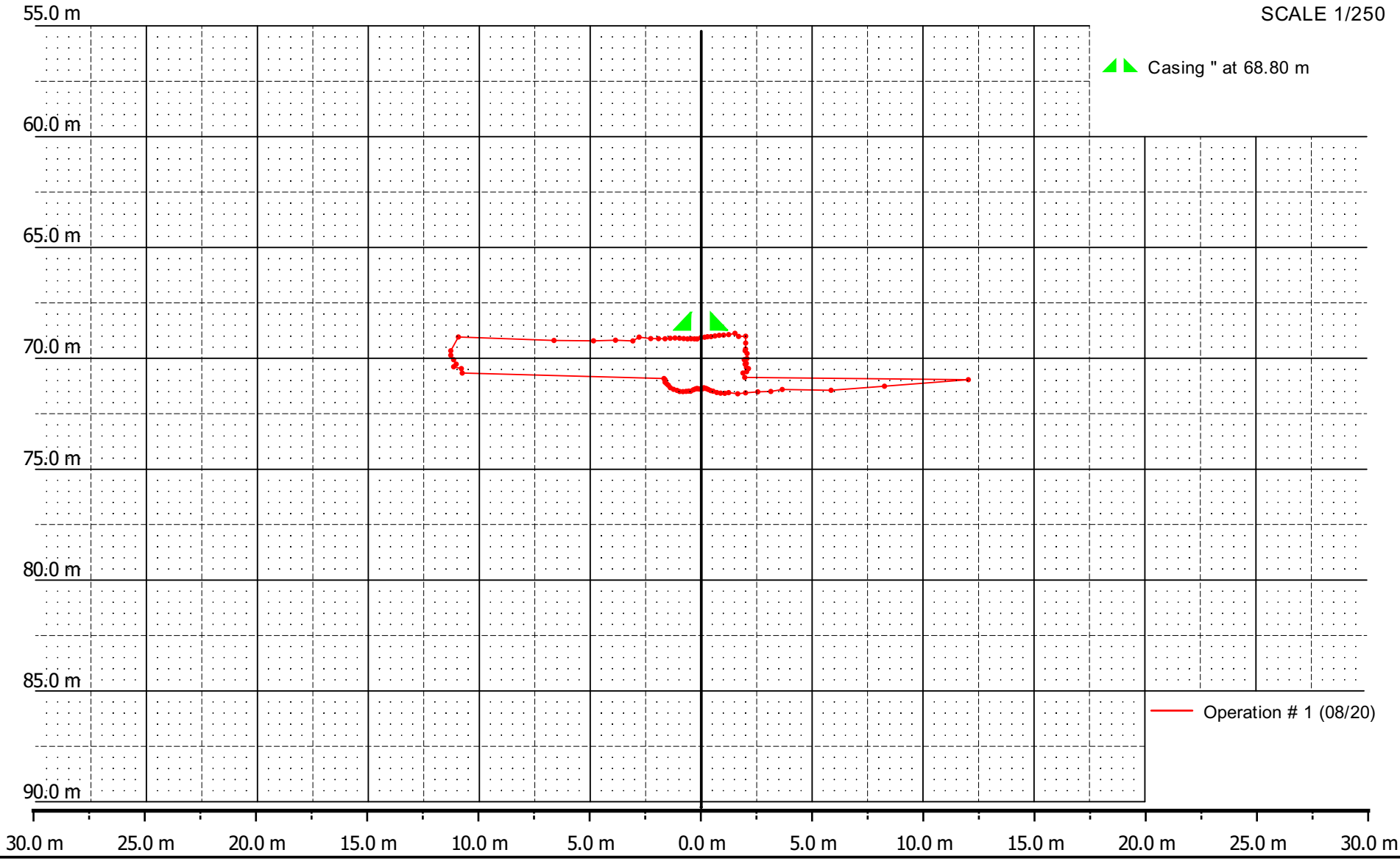
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

275° ← **20** → 95°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

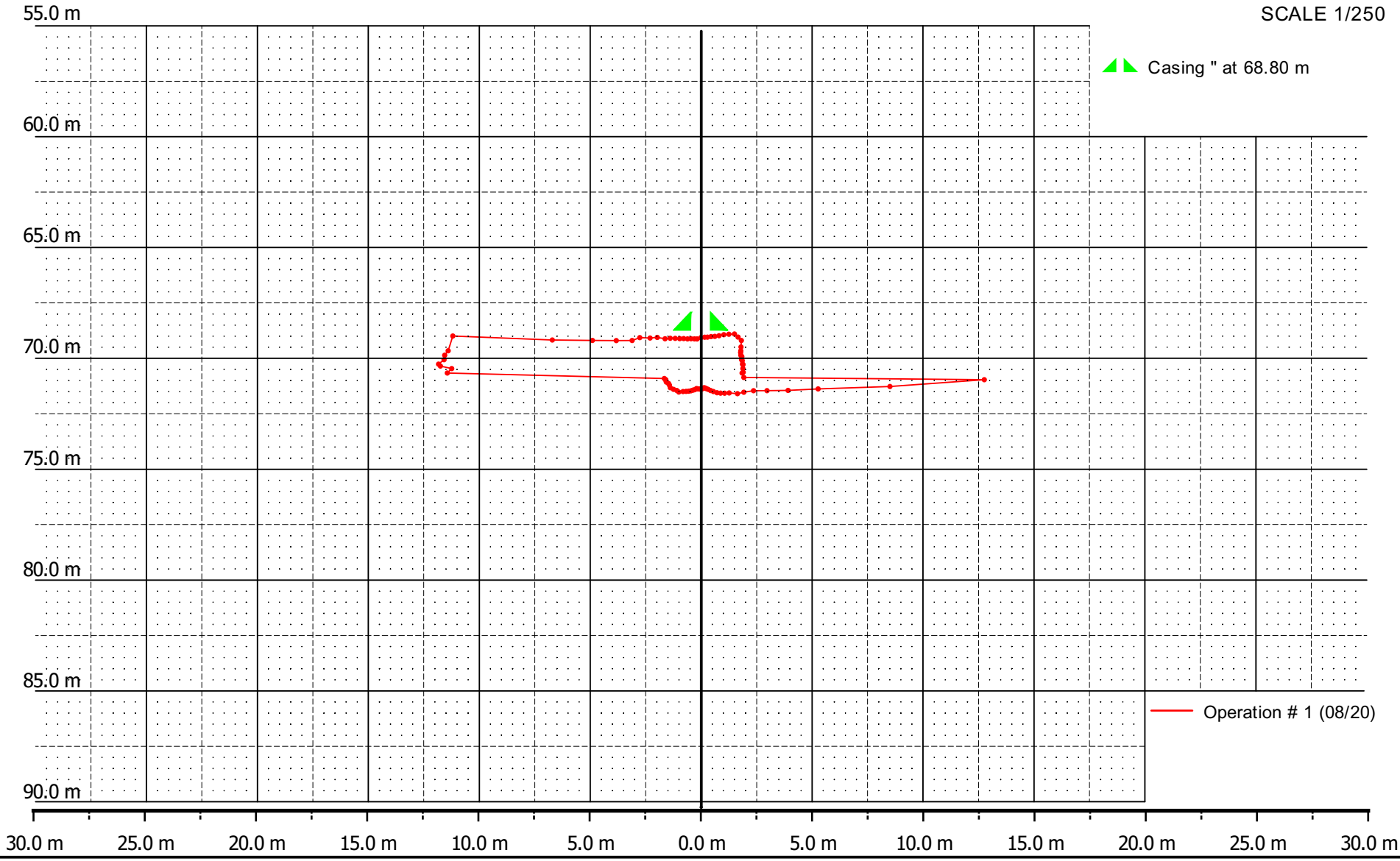


CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

280° ← 21 → 100°



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

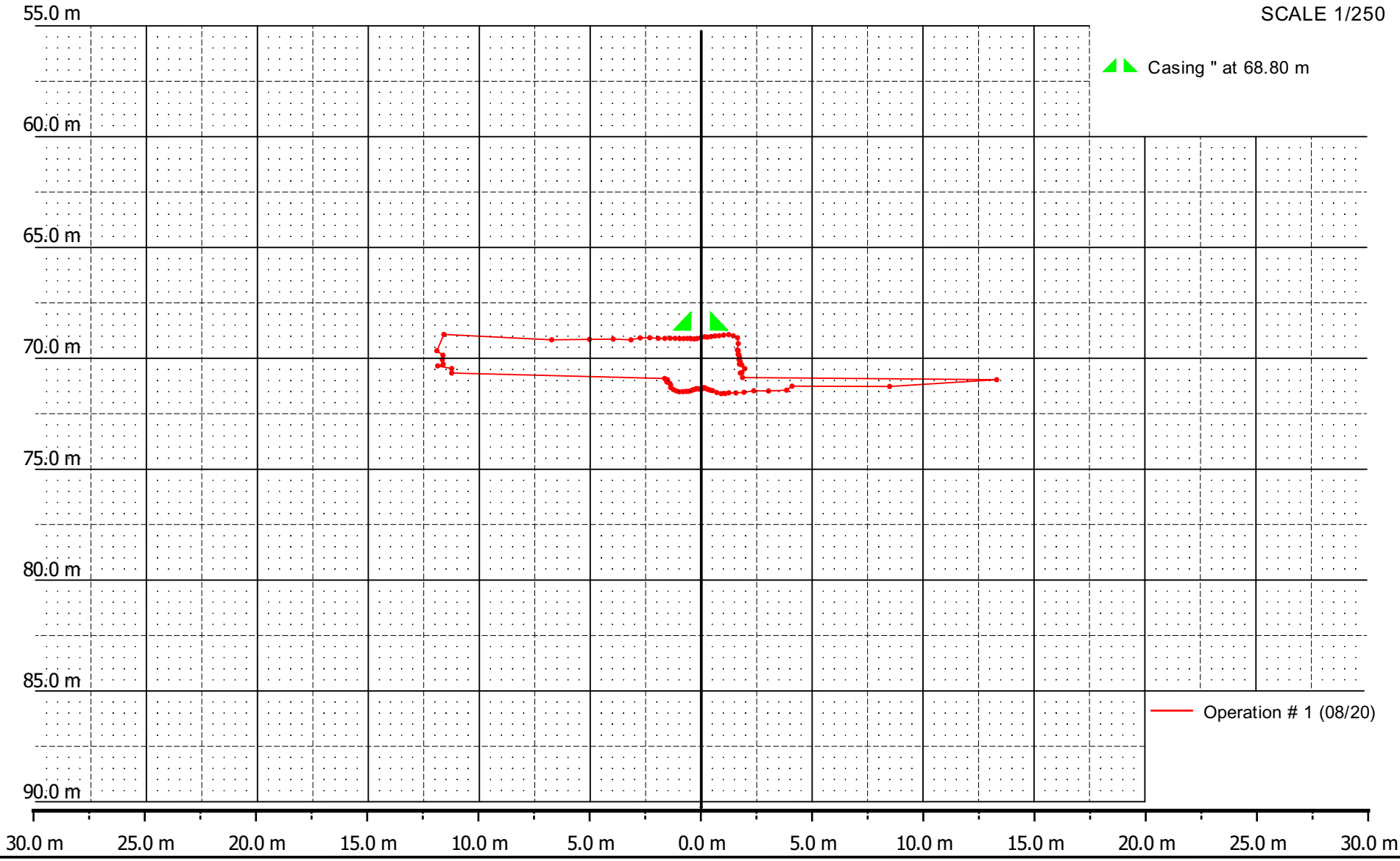
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

285° ← 22 → 105°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

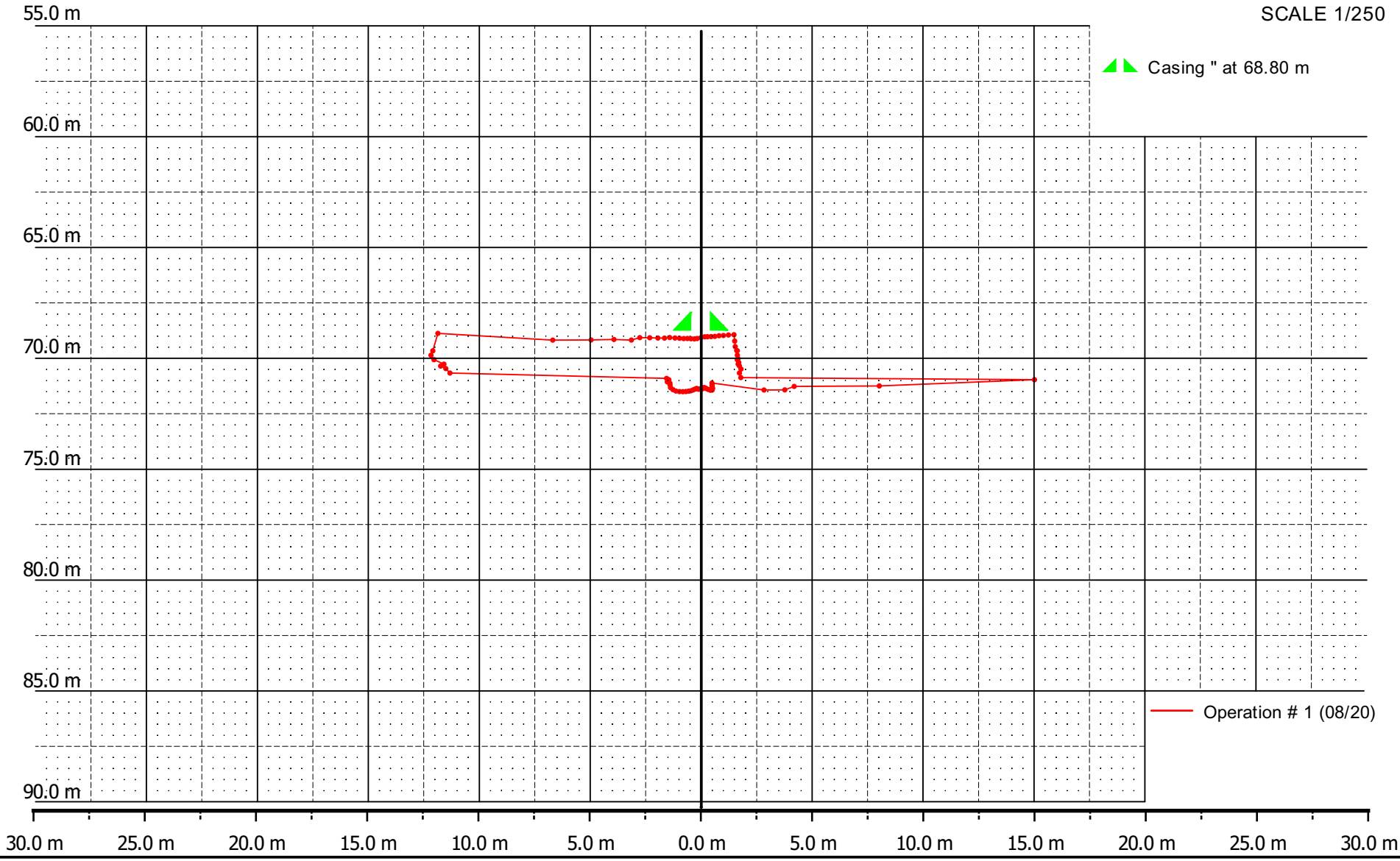
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

290° ← **23** → 110°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

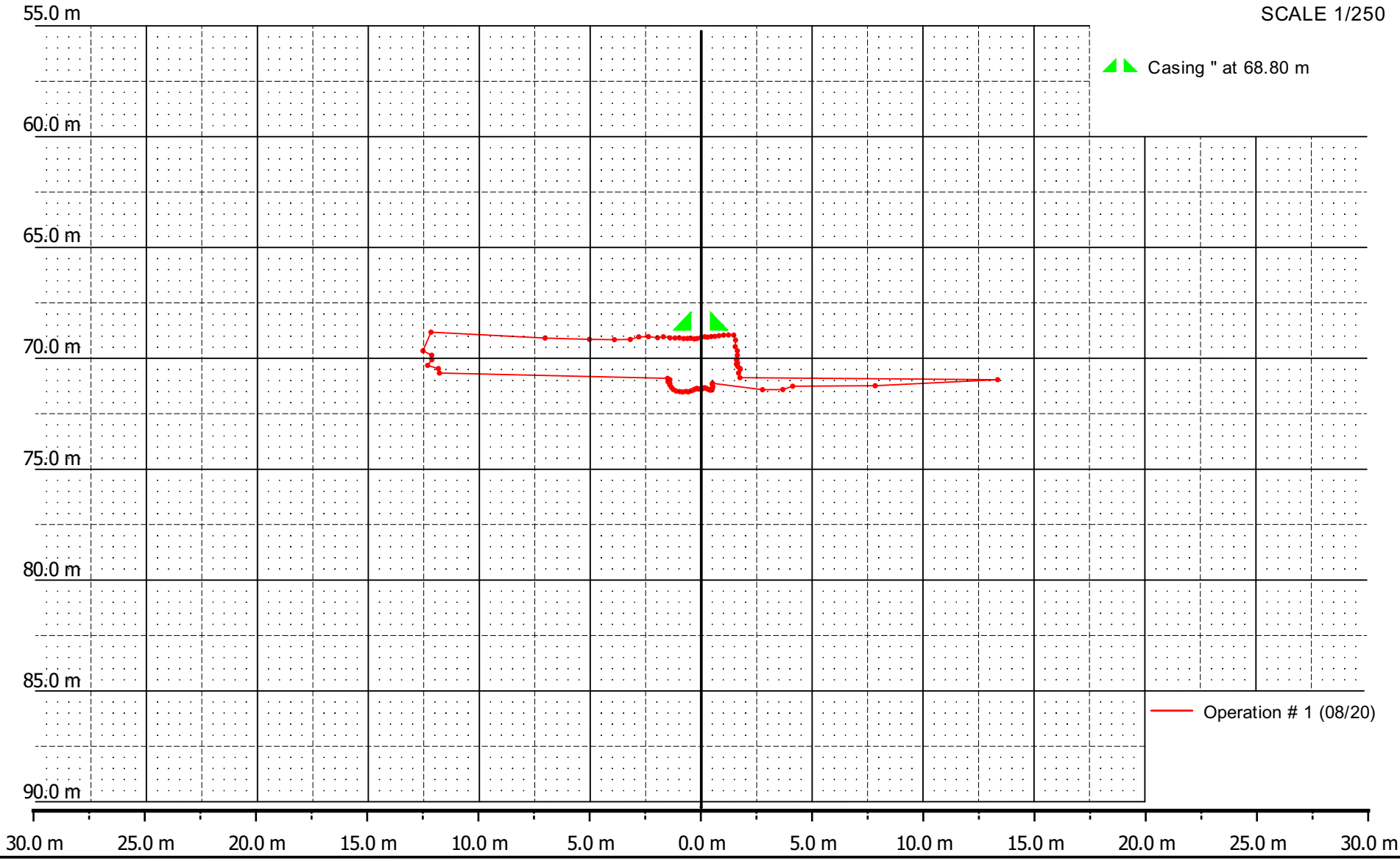
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

295° ← **24** → 115°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

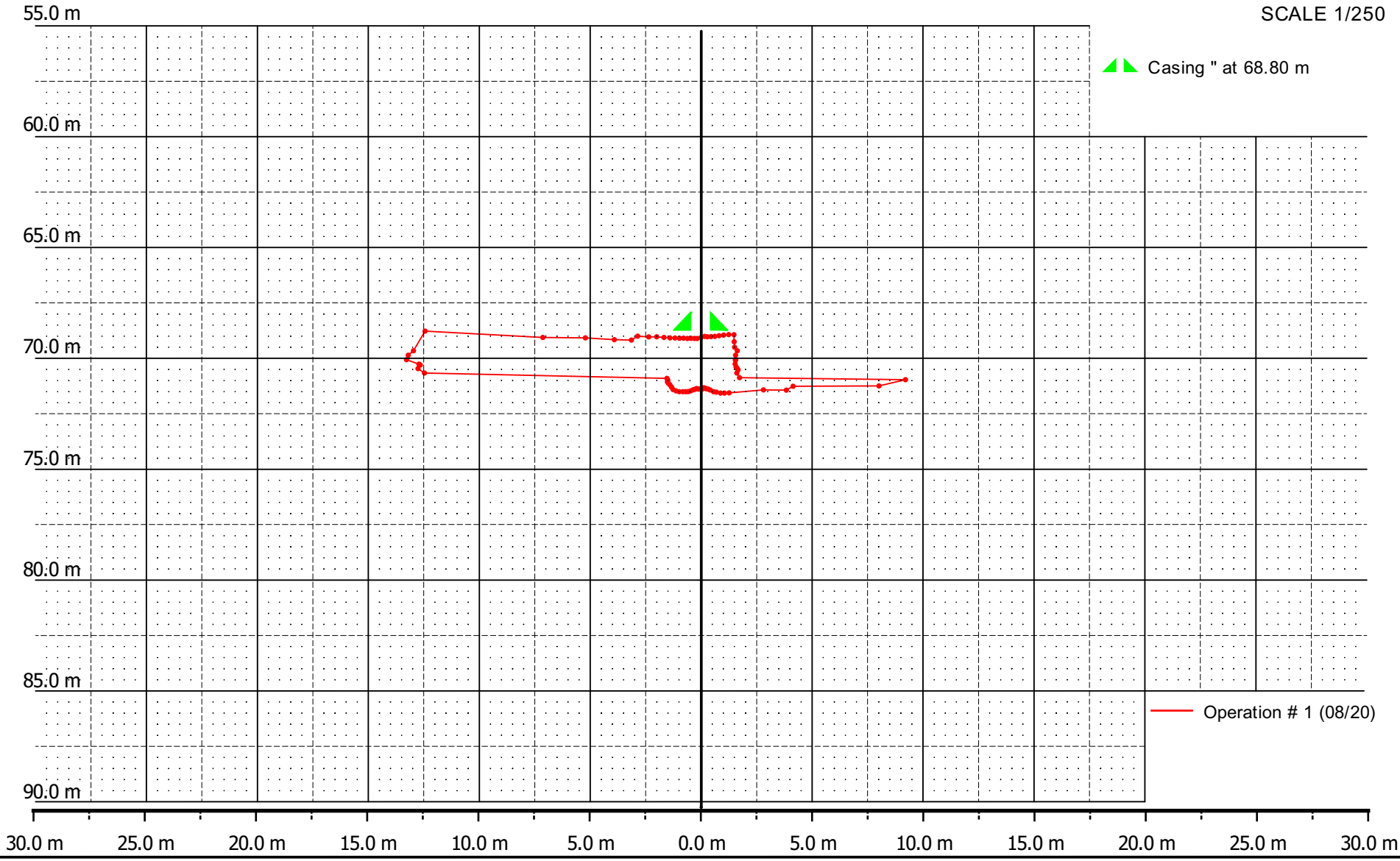
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

300° ← 25 → 120°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

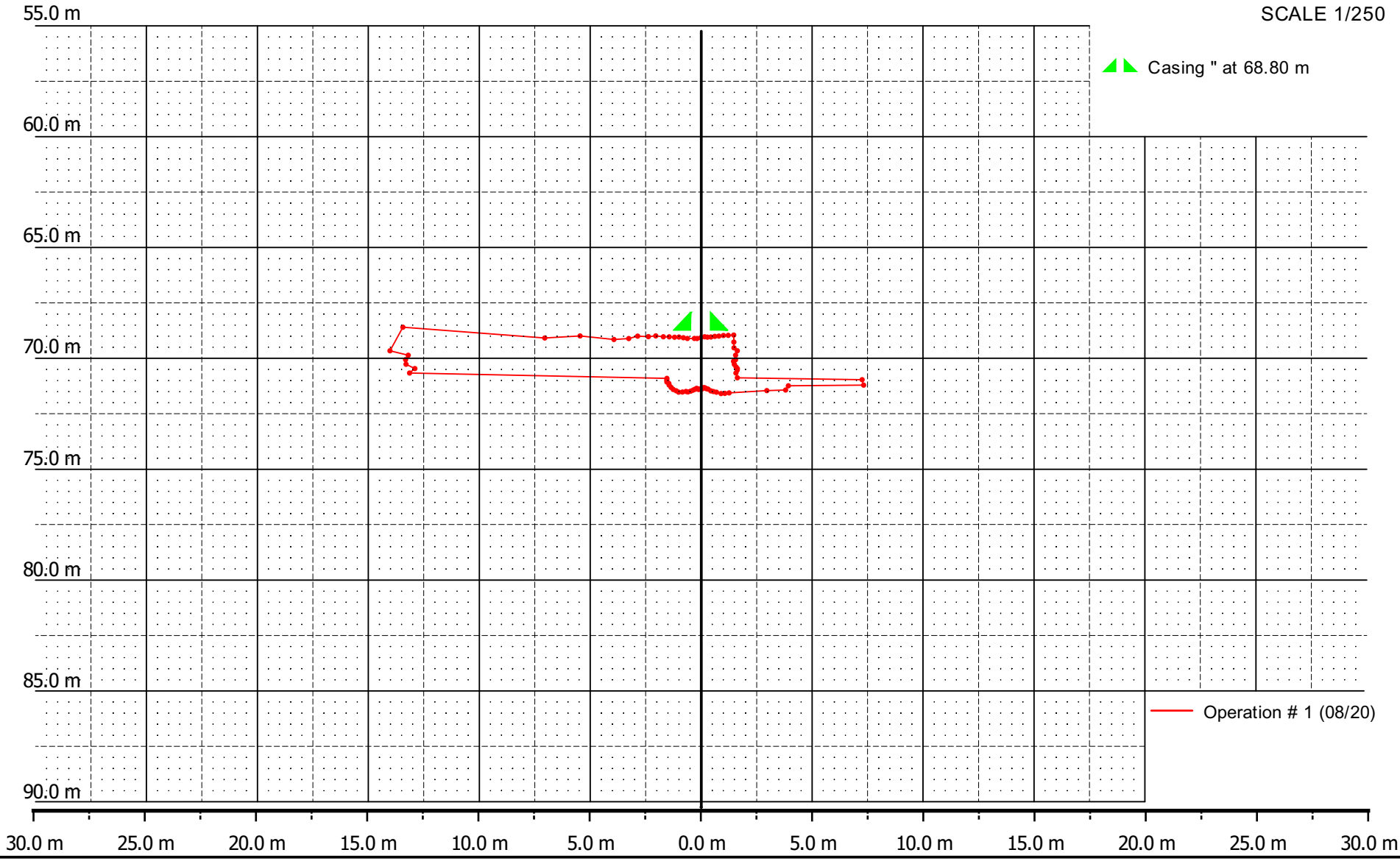
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

305° ← 26 → 125°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

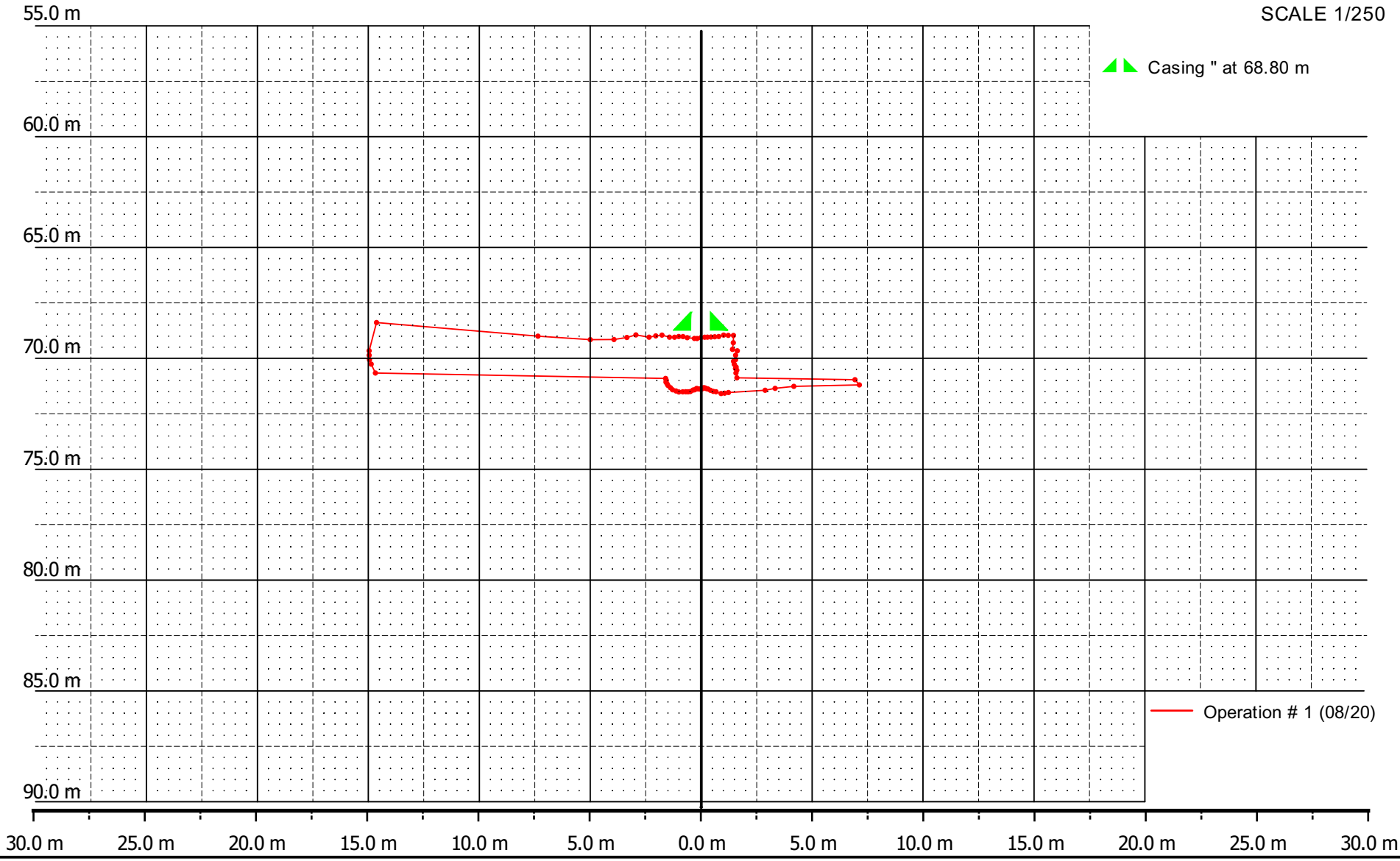
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

310° ← **27** → 130°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

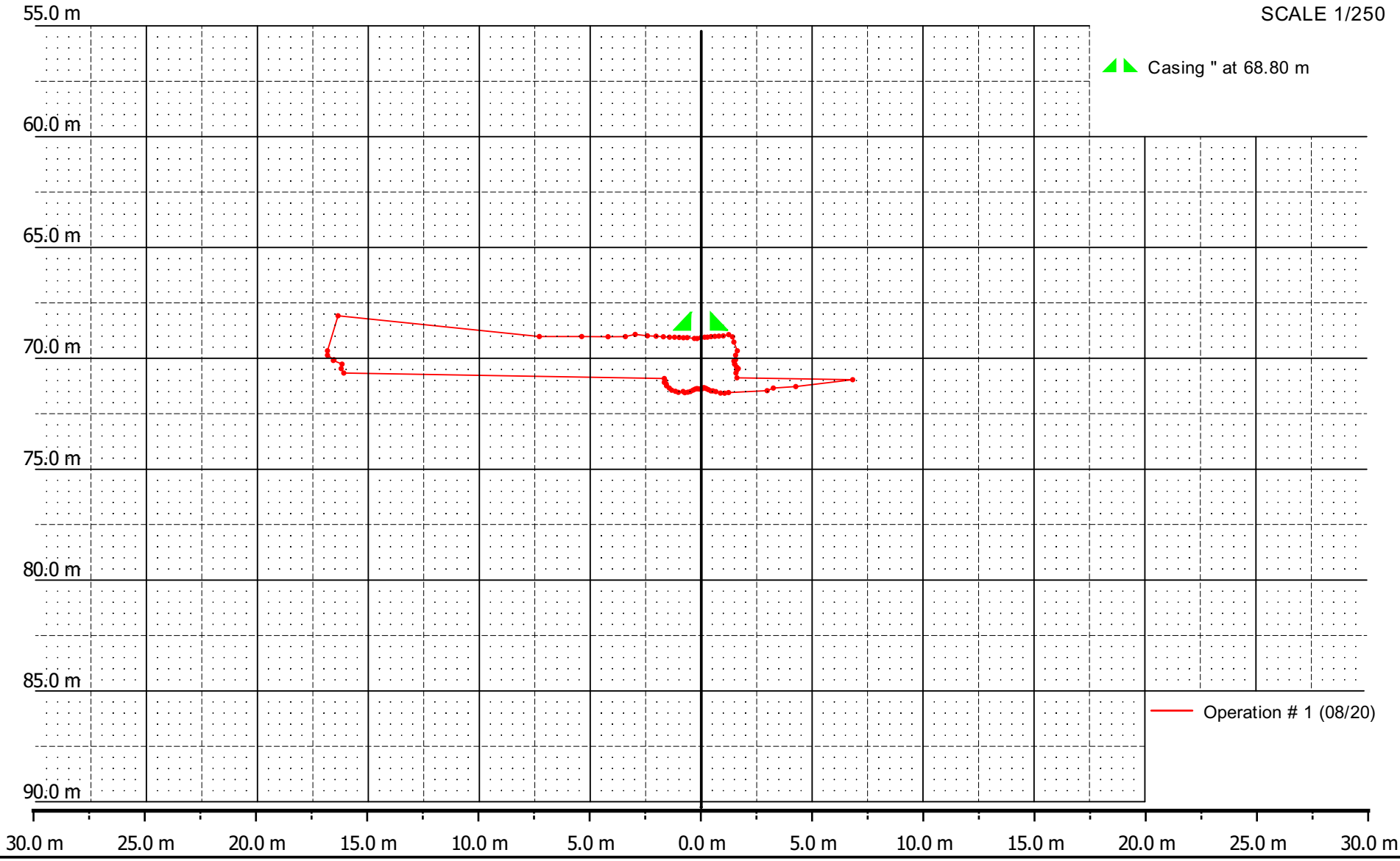
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

315° ← **28** → 135°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

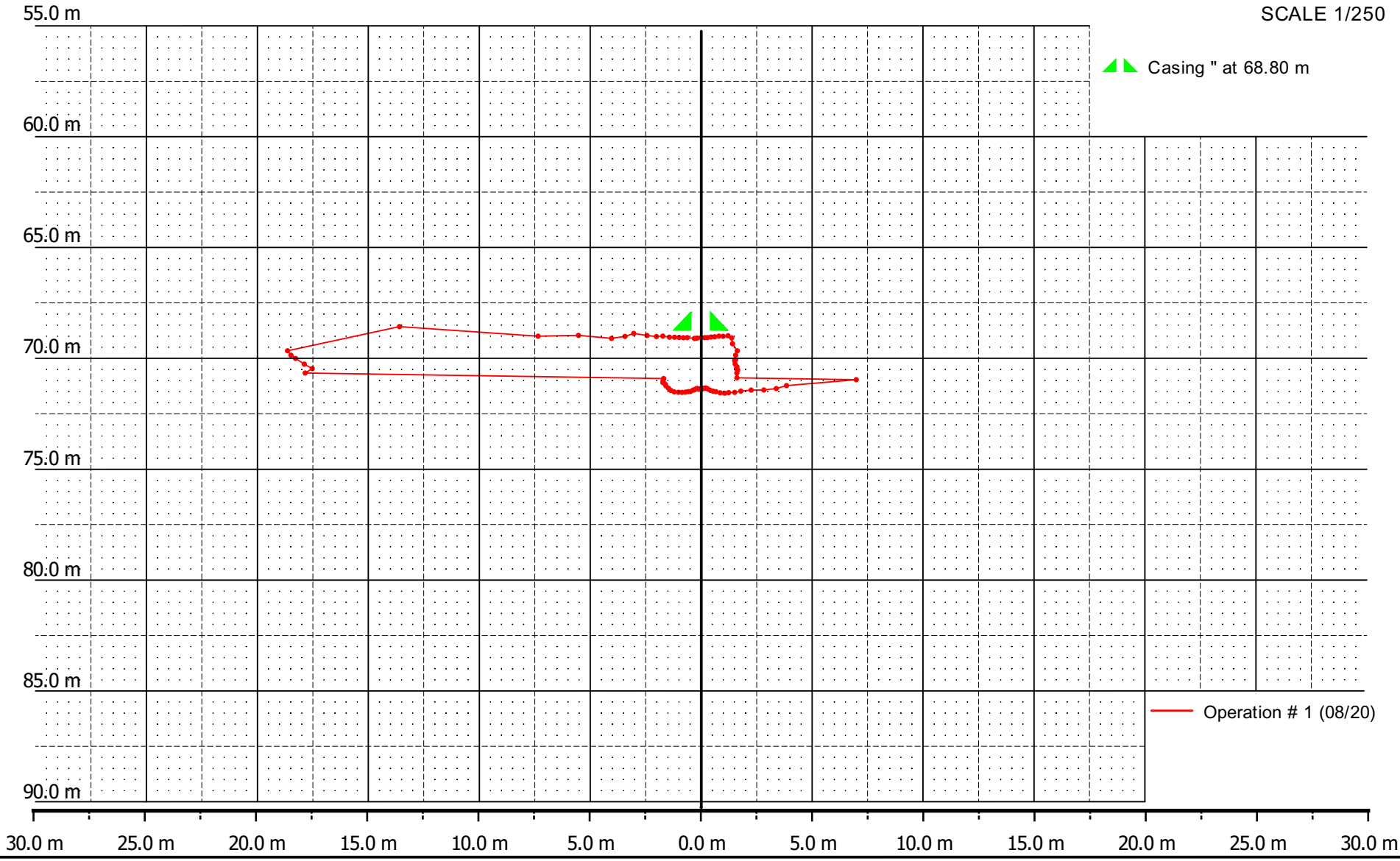
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

320° ← 29 → 140°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

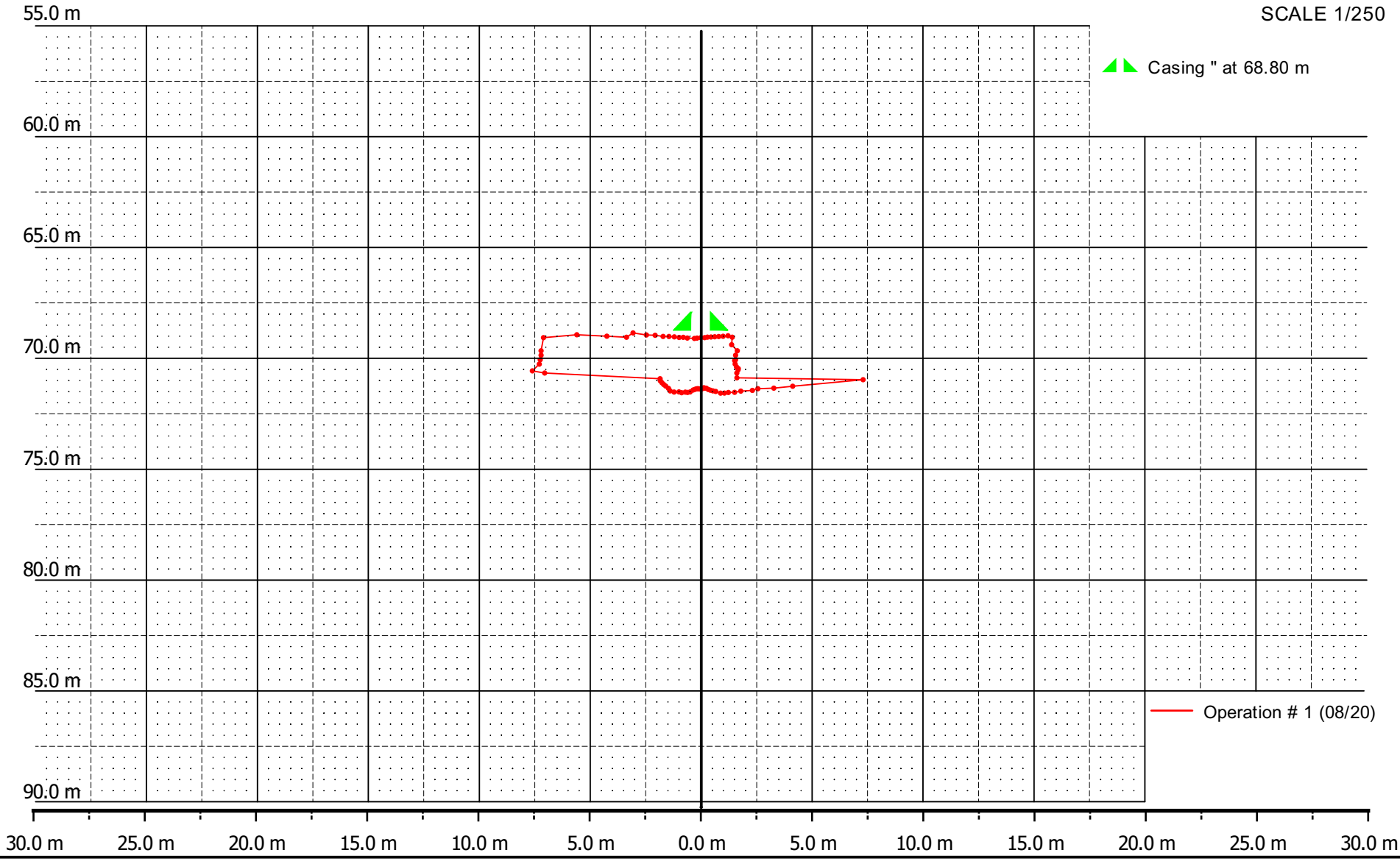
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

325° ← **30** → 145°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

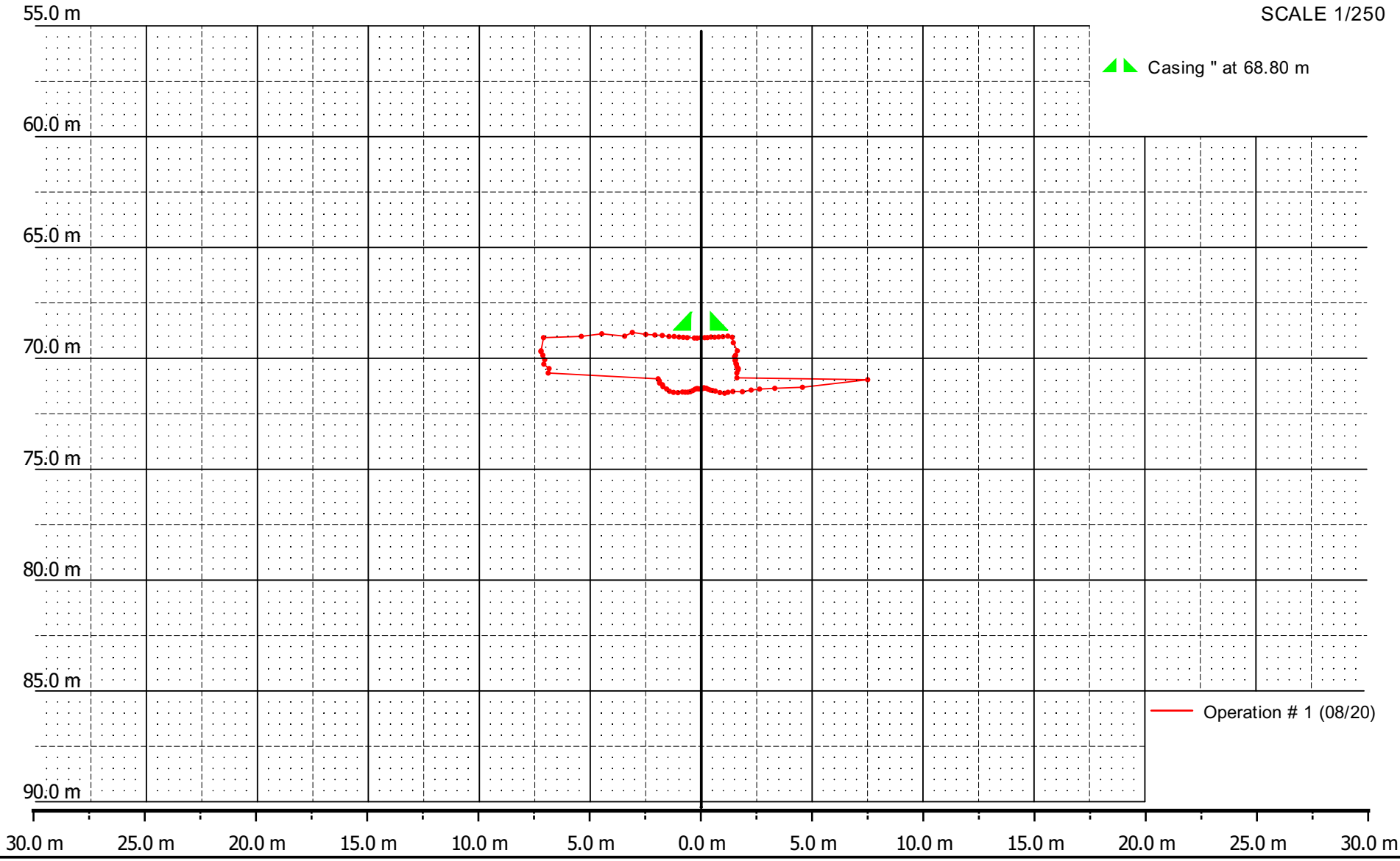
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

330° ← 31 → 150°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

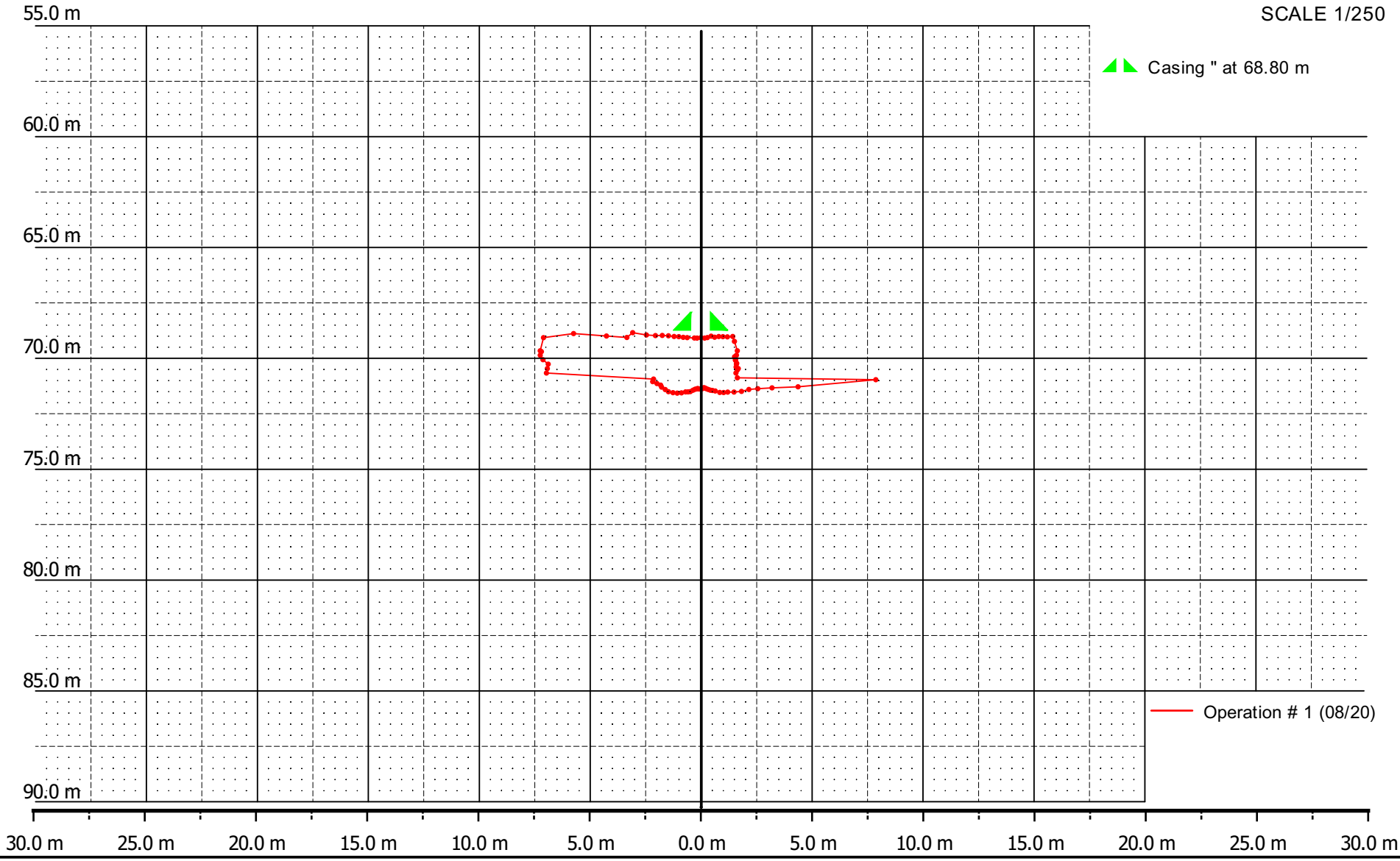
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

335° ← **32** → 155°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

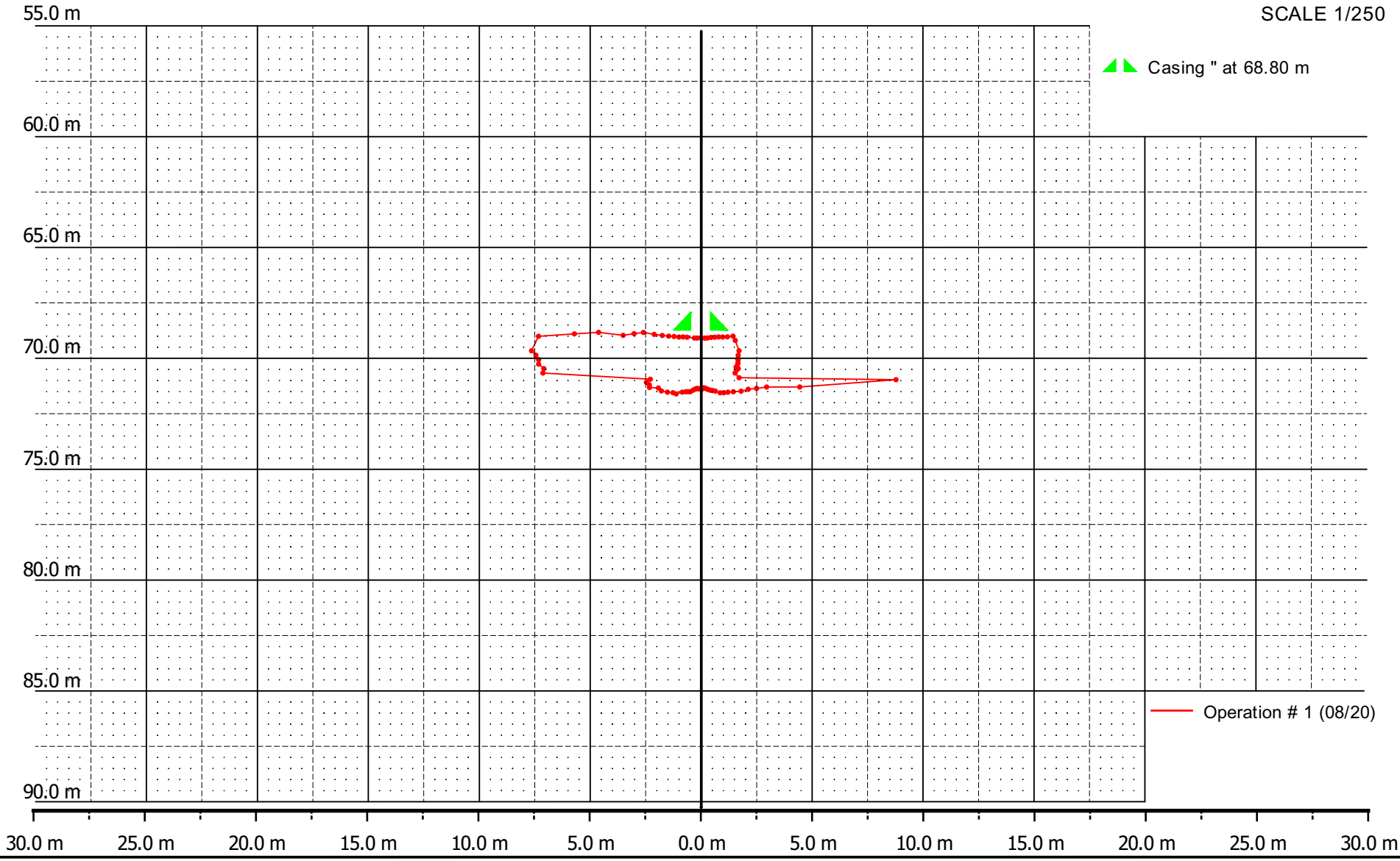
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

340° ← **33** → 160°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

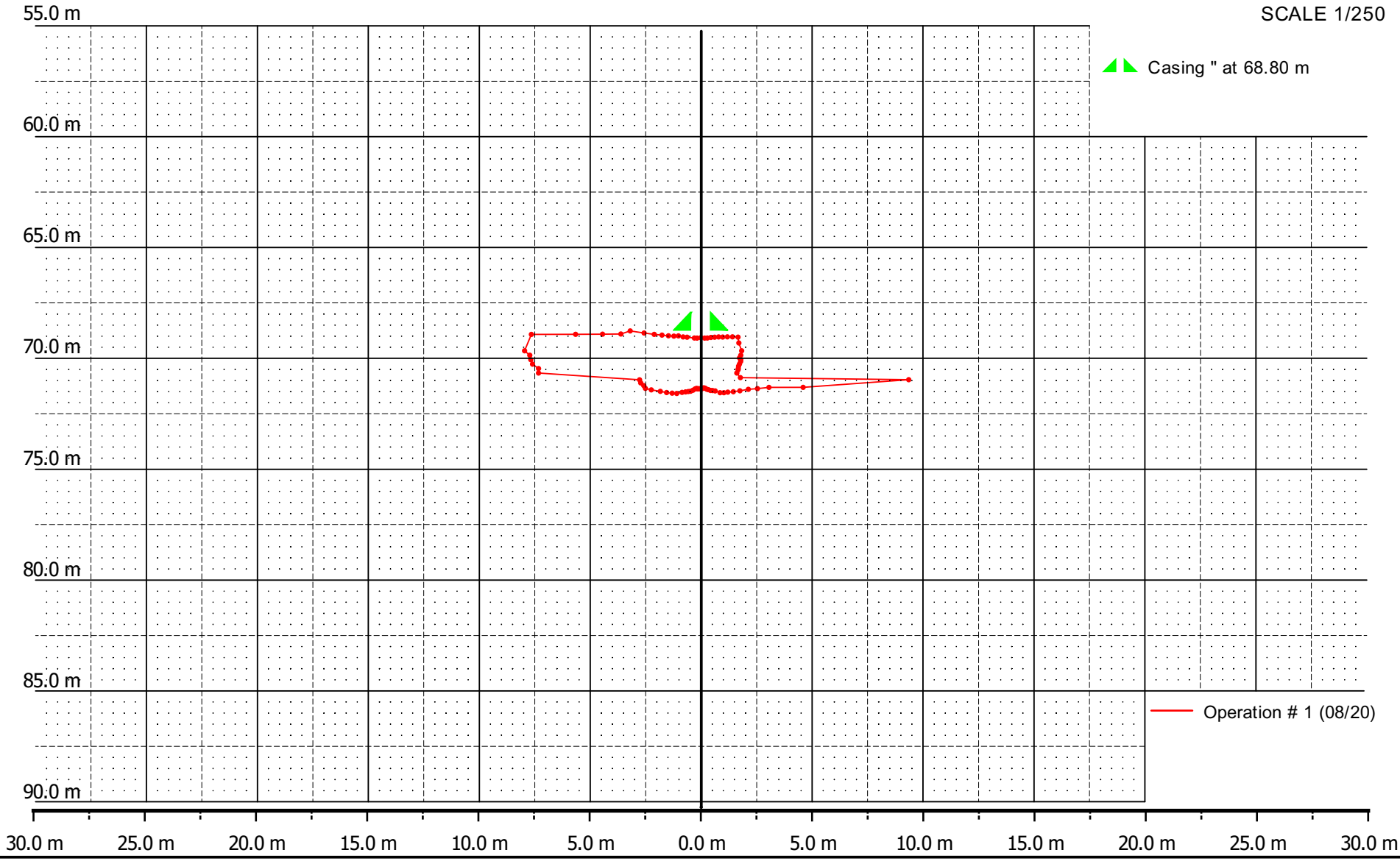
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

345° ← **34** → 165°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

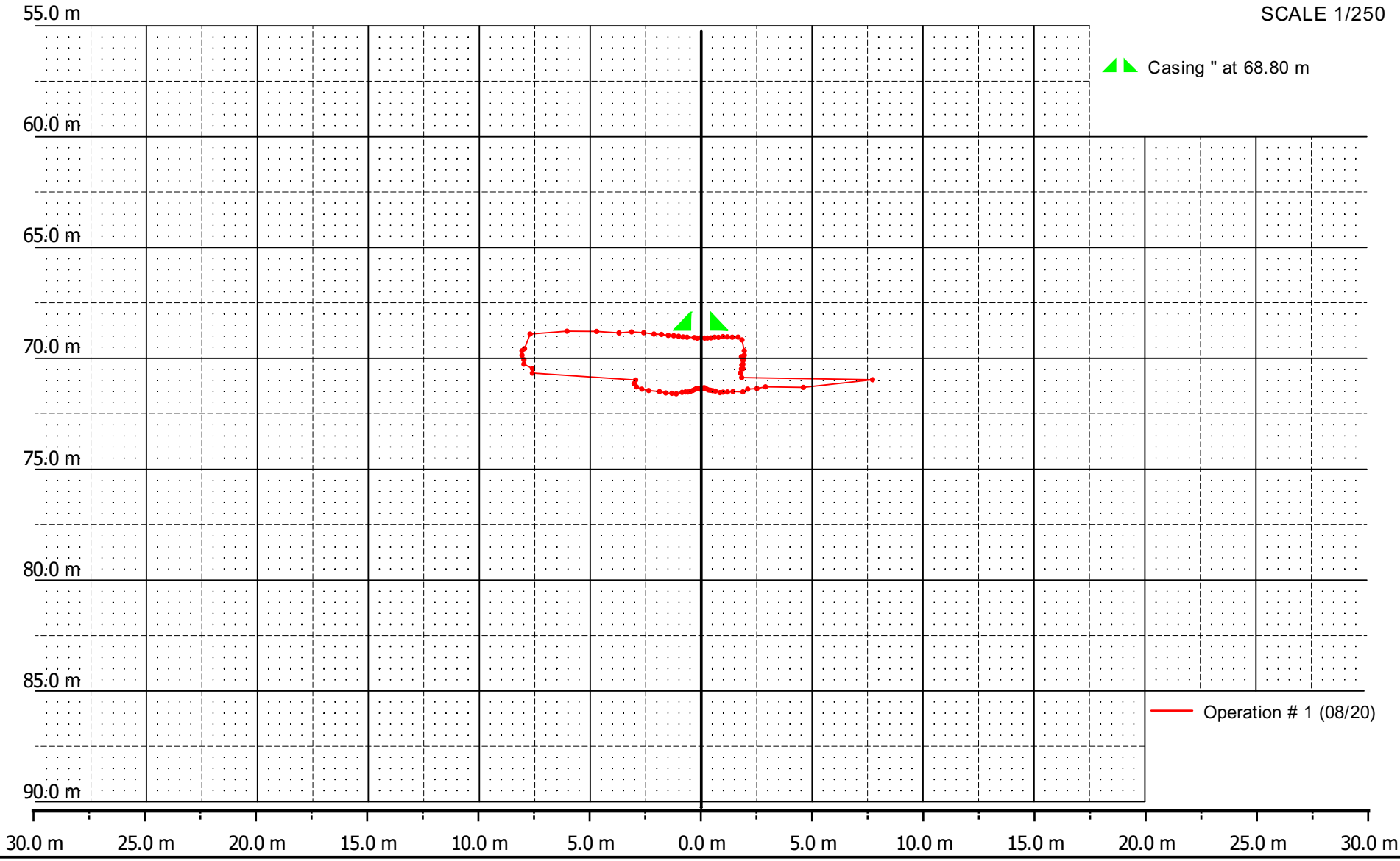
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

350° ← **35** → 170°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

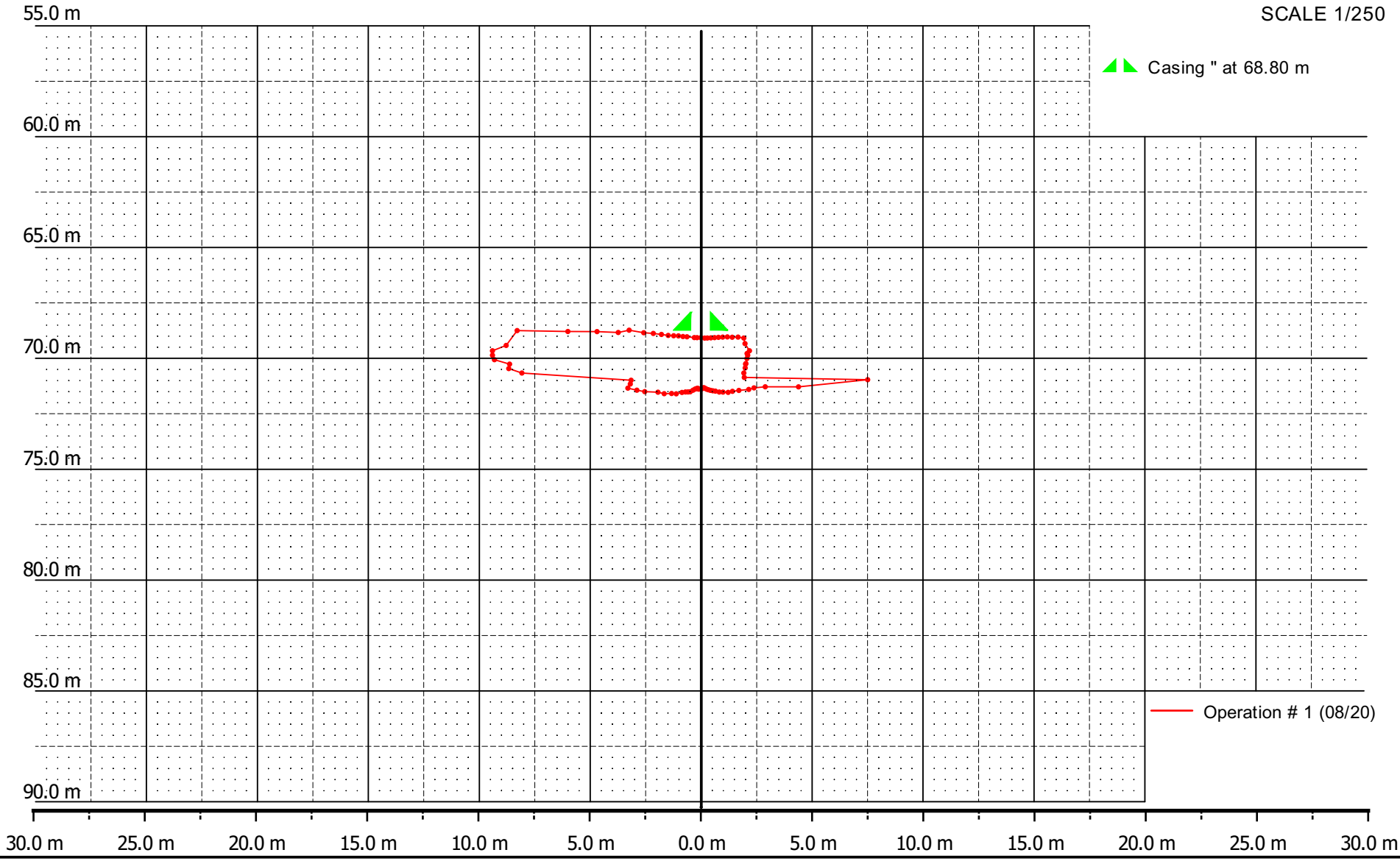
CAVITY : BH28_UG
OPERATION # : 1

VERTICAL SECTION

355° ← **36** → 175°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

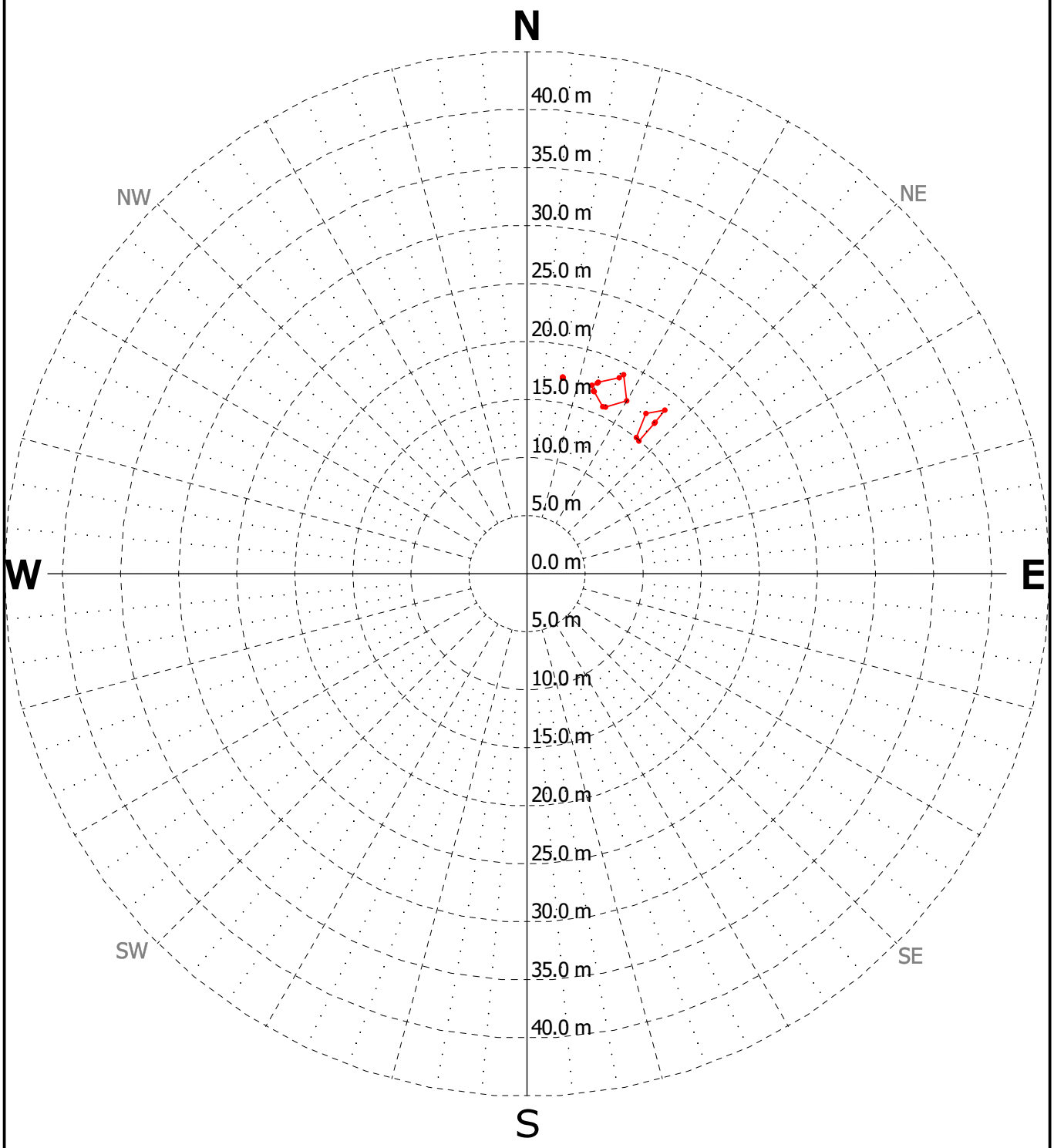


	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

68.0 m

SCALE 1/500



Operation # 1 (08/20)

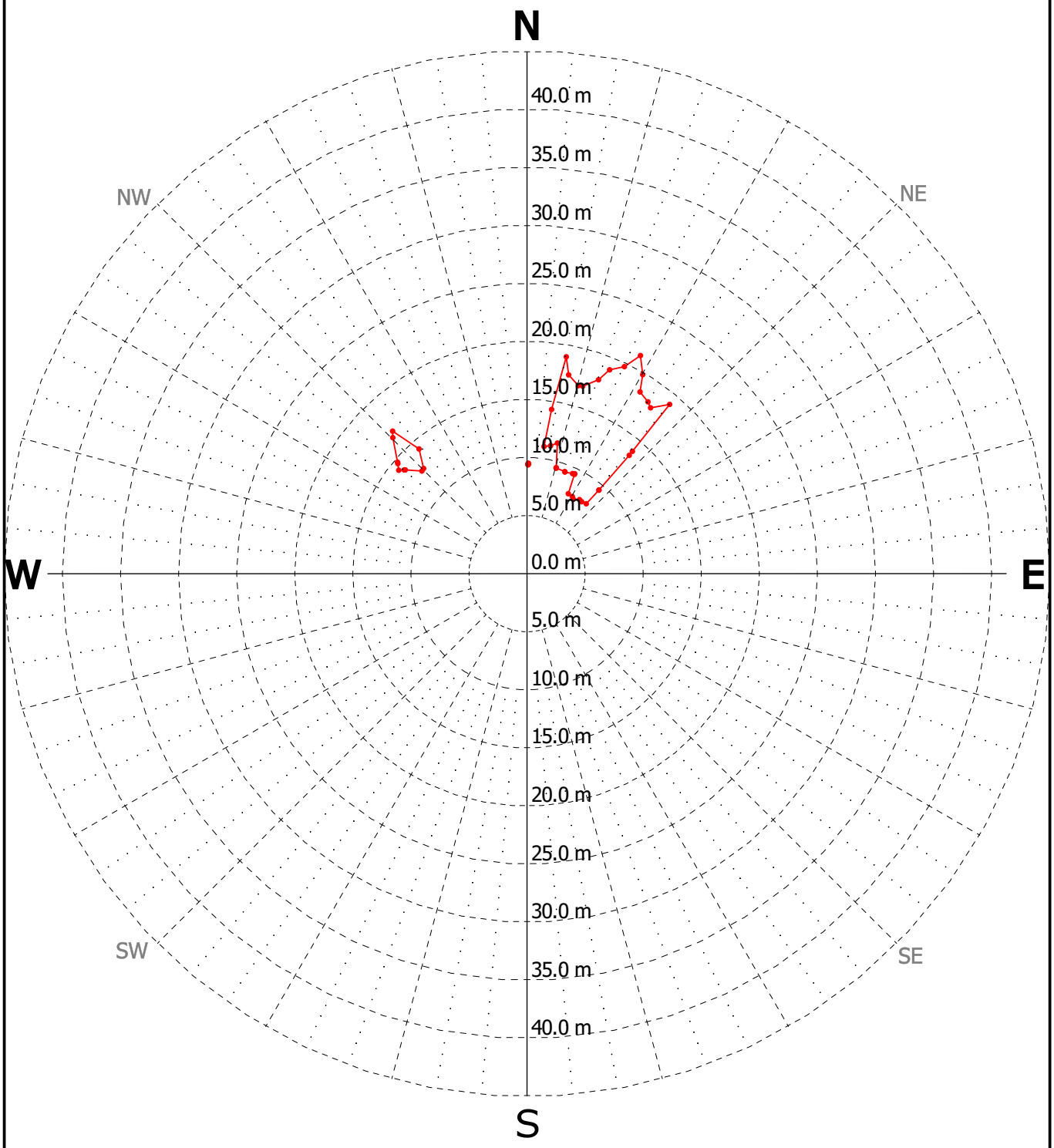
Maximum radius	: 18.89 m
Orientation maxi. radius	: 26 °
Surface	: 7.66 m²
Maximum distance	: 9.21 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

68.5 m

SCALE 1/500



Operation # 1 (08/20)

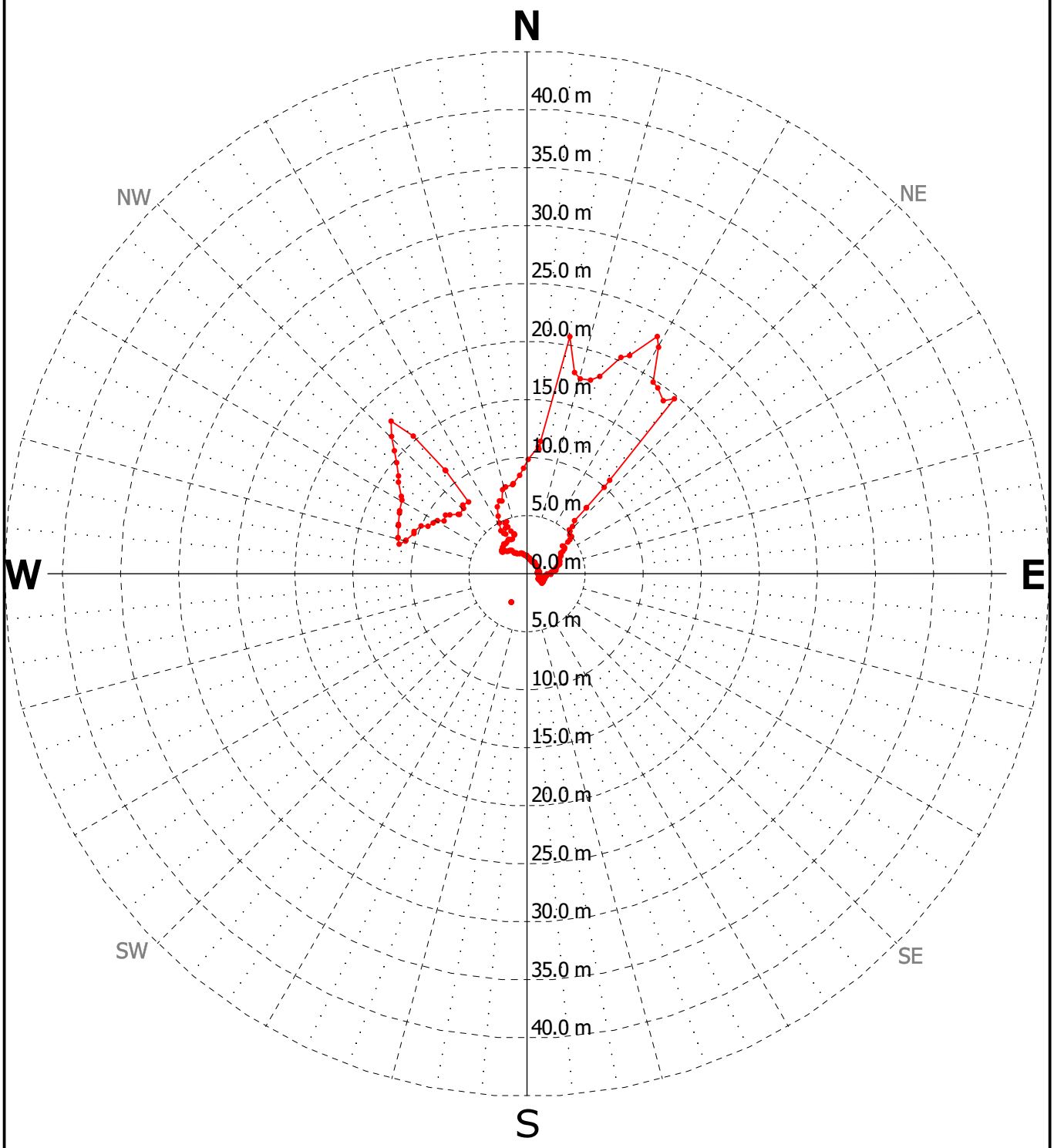
Maximum radius	: 21.00 m
Orientation maxi. radius	: 27 °
Surface	: 76.86 m²
Maximum distance	: 23.92 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

69.0 m

SCALE 1/500



Operation # 1 (08/20)

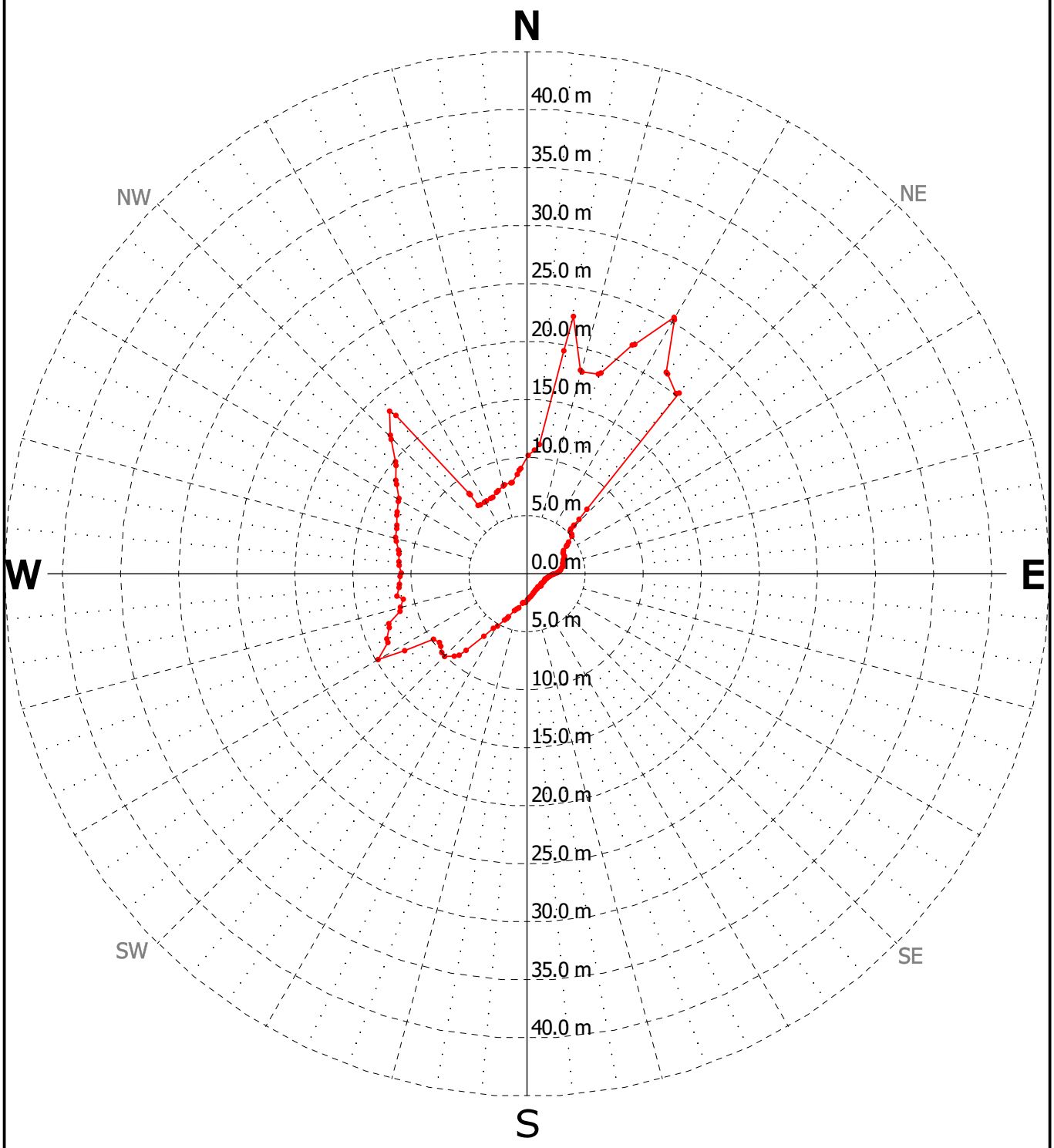
Maximum radius	: 23.12 m
Orientation maxi. radius	: 29 °
Surface	: 170.21 m²
Maximum distance	: 28.43 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

69.5 m

SCALE 1/500



Operation # 1 (08/20)

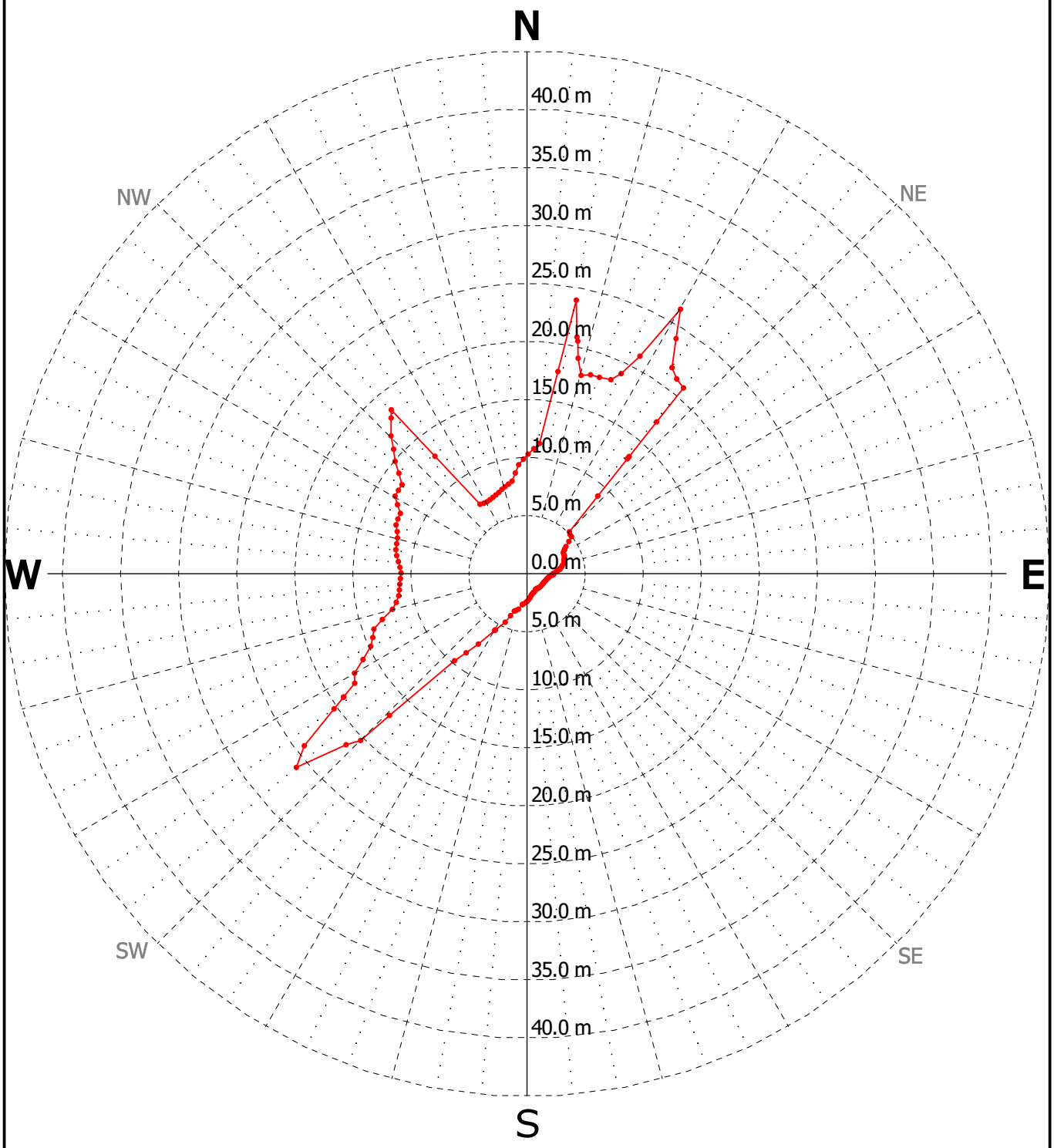
Maximum radius	: 25.26 m
Orientation maxi. radius	: 30 °
Surface	: 306.43 m²
Maximum distance	: 38.83 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

70.0 m

SCALE 1/500



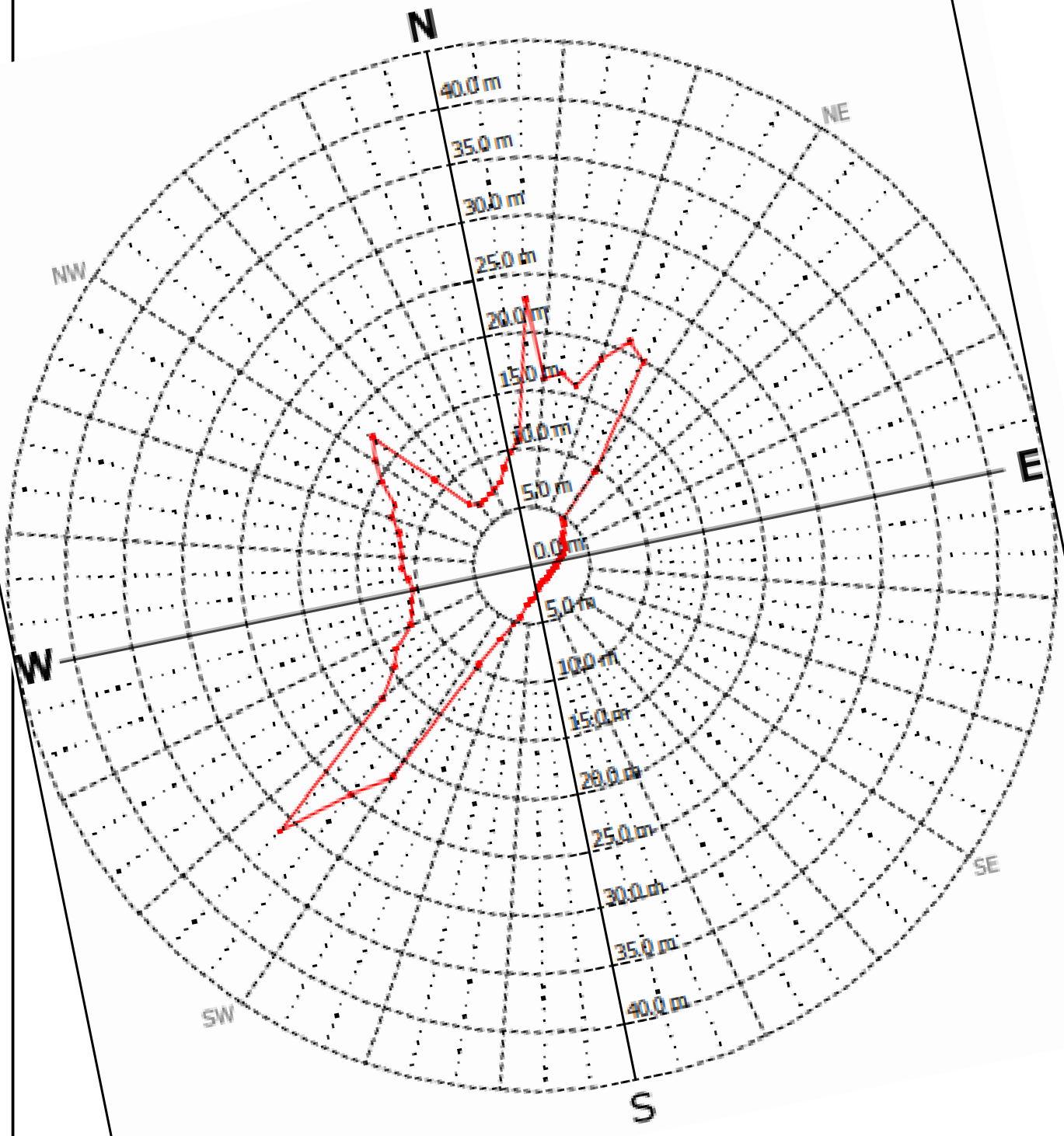
Operation # 1 (08/20)

Maximum radius	: 26.14 m
Orientation maxi. radius	: 30 °
Surface	: 362.74 m²
Maximum distance	: 51.32 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020		CAVITY : BH28_UG OPERATION # : 1	

HORIZONTAL SECTION

70.5 m



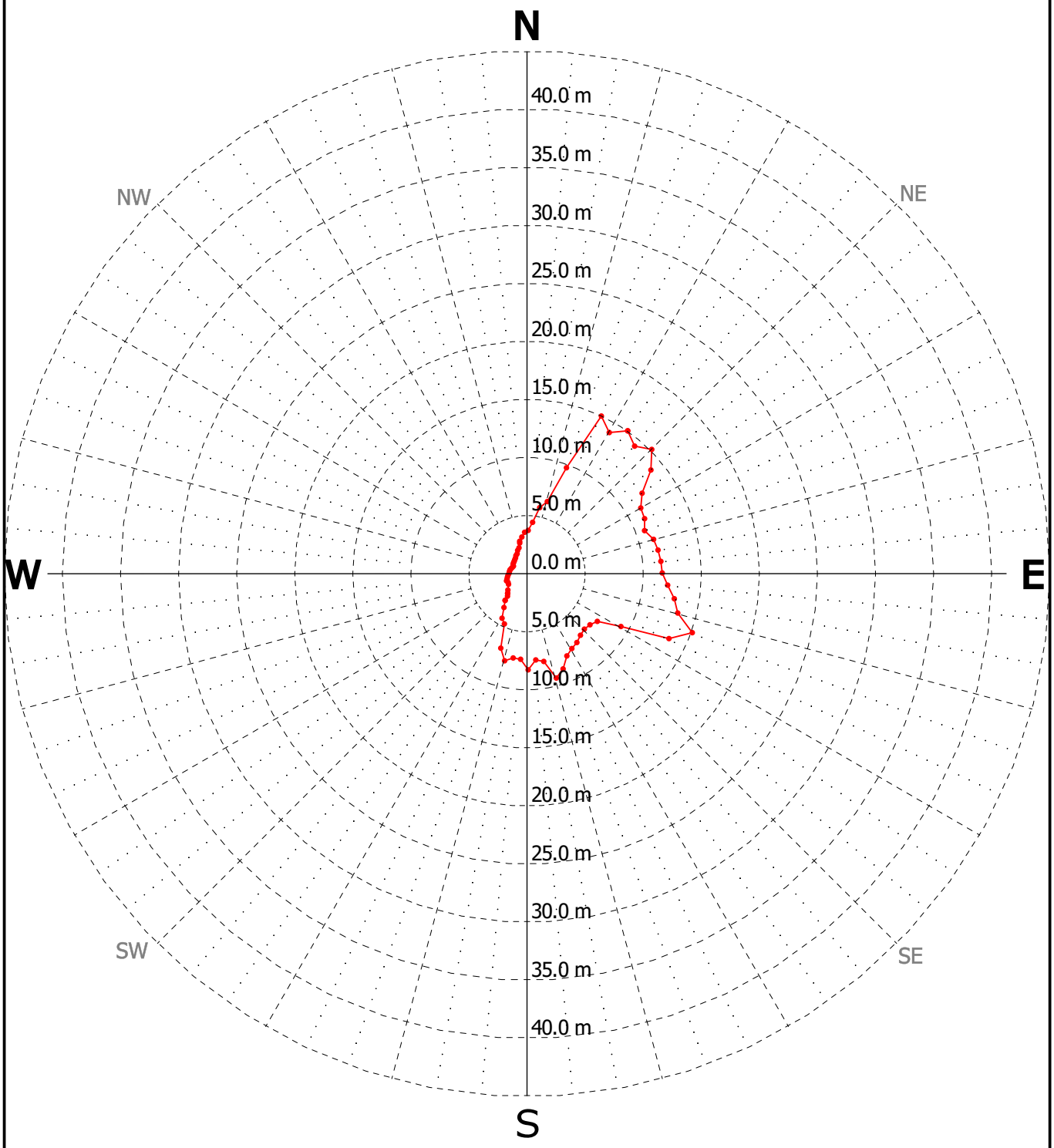
Maximum radius	: 31.39 m
Orientation maxi. radius	: 235 °
Surface	: 352.60 m²
Maximum distance	: 51.42 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

71.0 m

SCALE 1/500



Operation # 1 (08/20)

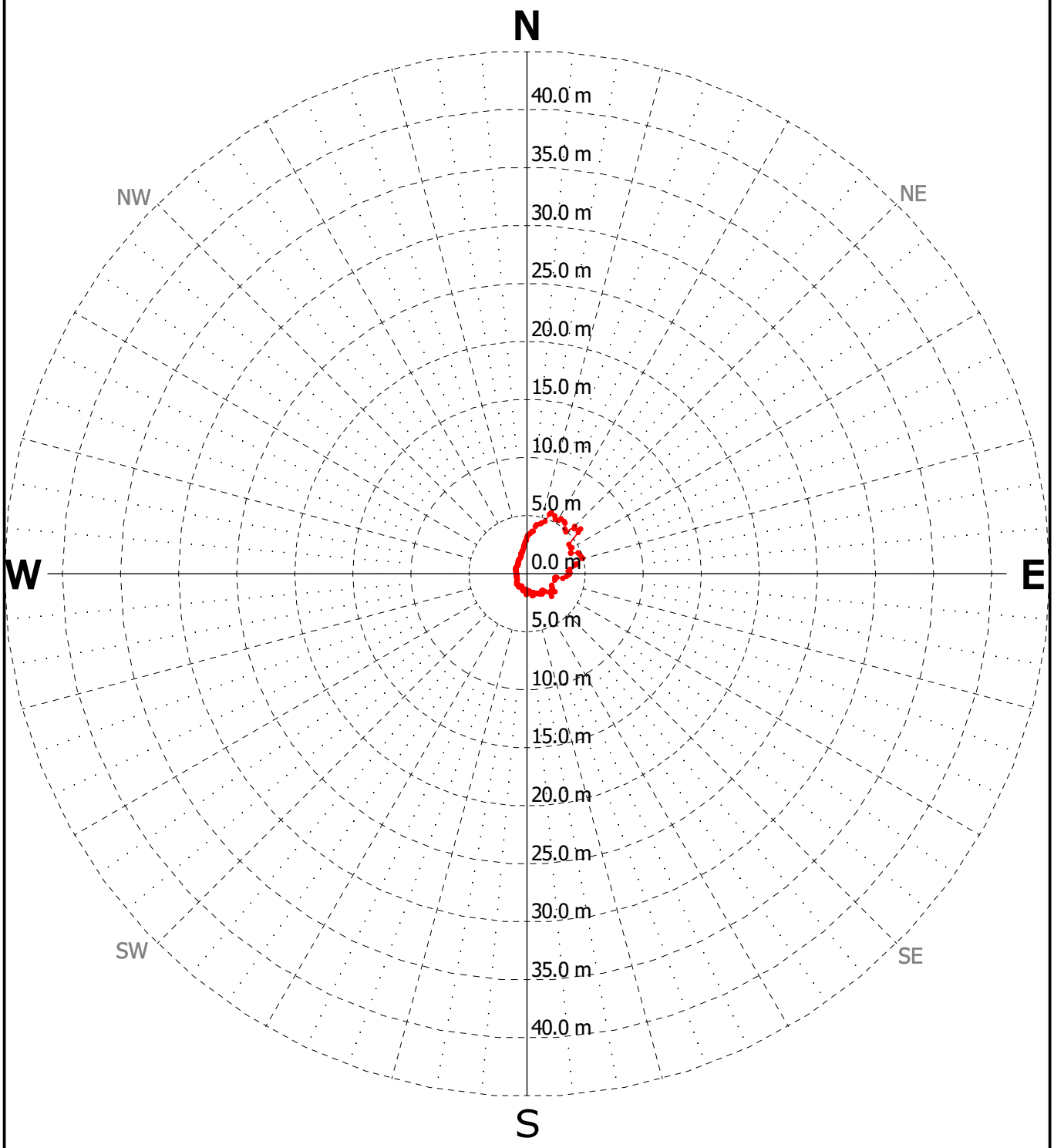
Maximum radius	: 15.00 m
Orientation maxi. radius	: 45 °
Surface	: 196.09 m²
Maximum distance	: 22.82 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

71.5 m

SCALE 1/500



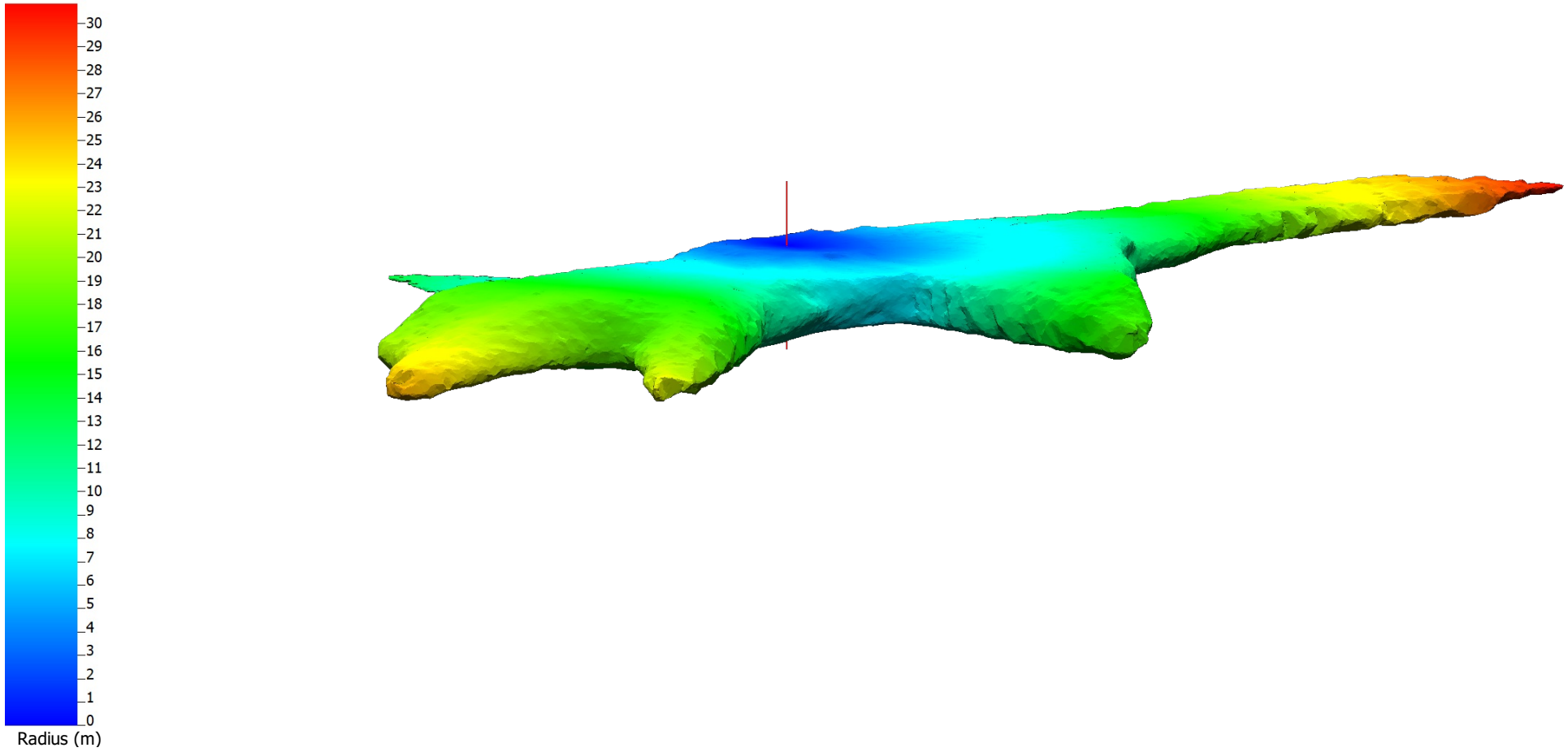
Operation # 1 (08/20)

Maximum radius	: 5.87 m
Orientation maxi. radius	: 50 °
Surface	: 24.34 m²
Maximum distance	: 7.34 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM NORTH

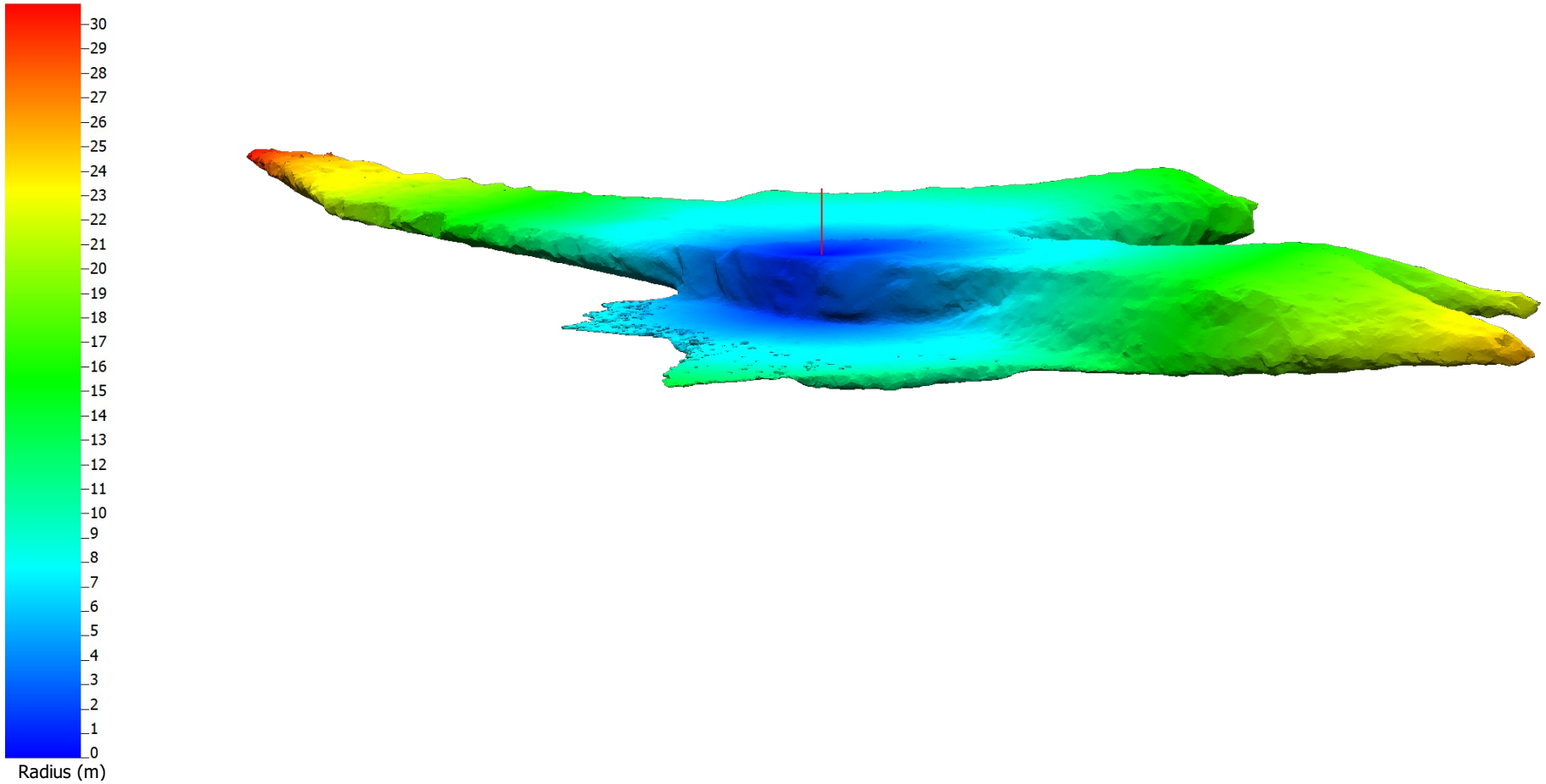
with an overhang of 10°



CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM EAST

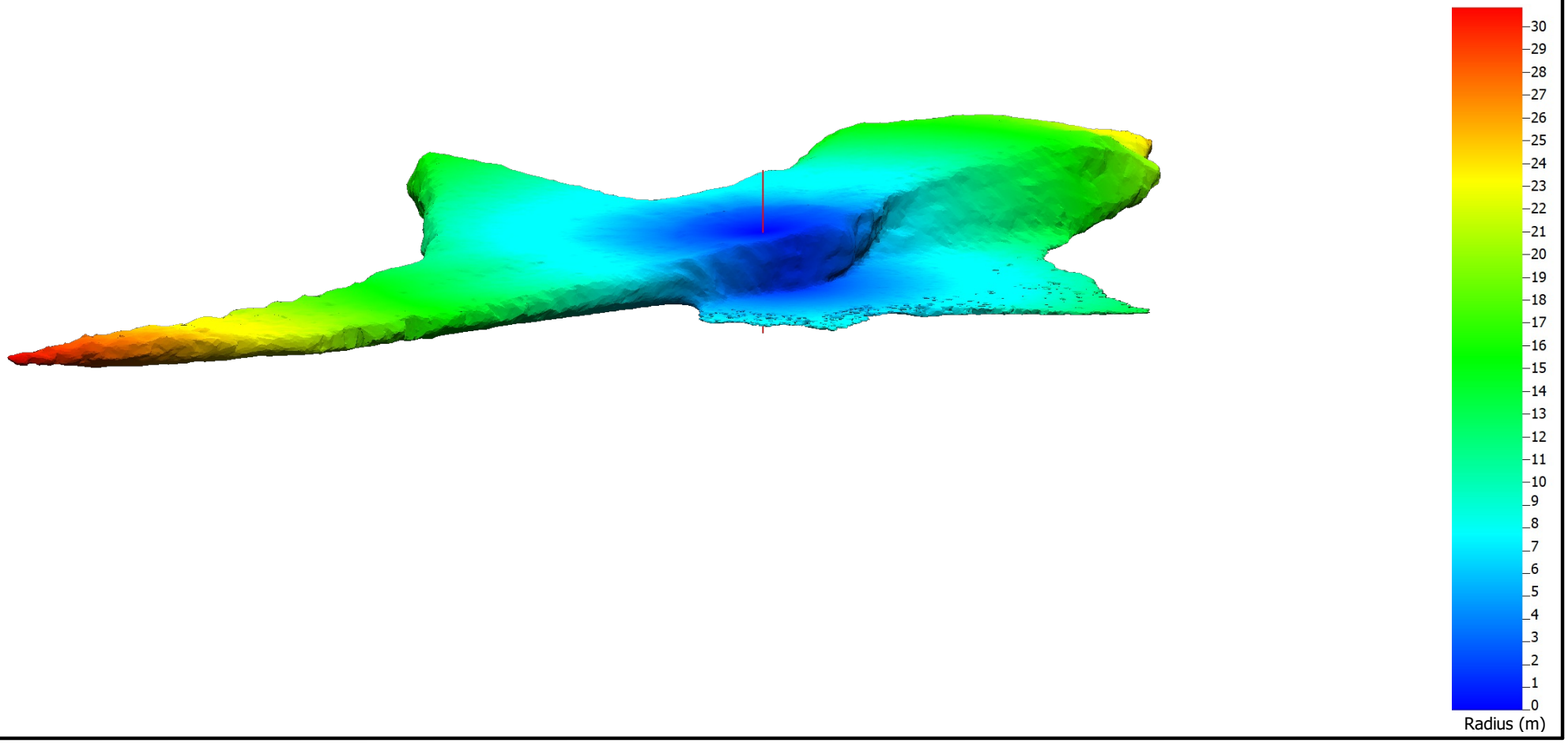
with an overhang of 10°



CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM SOUTH

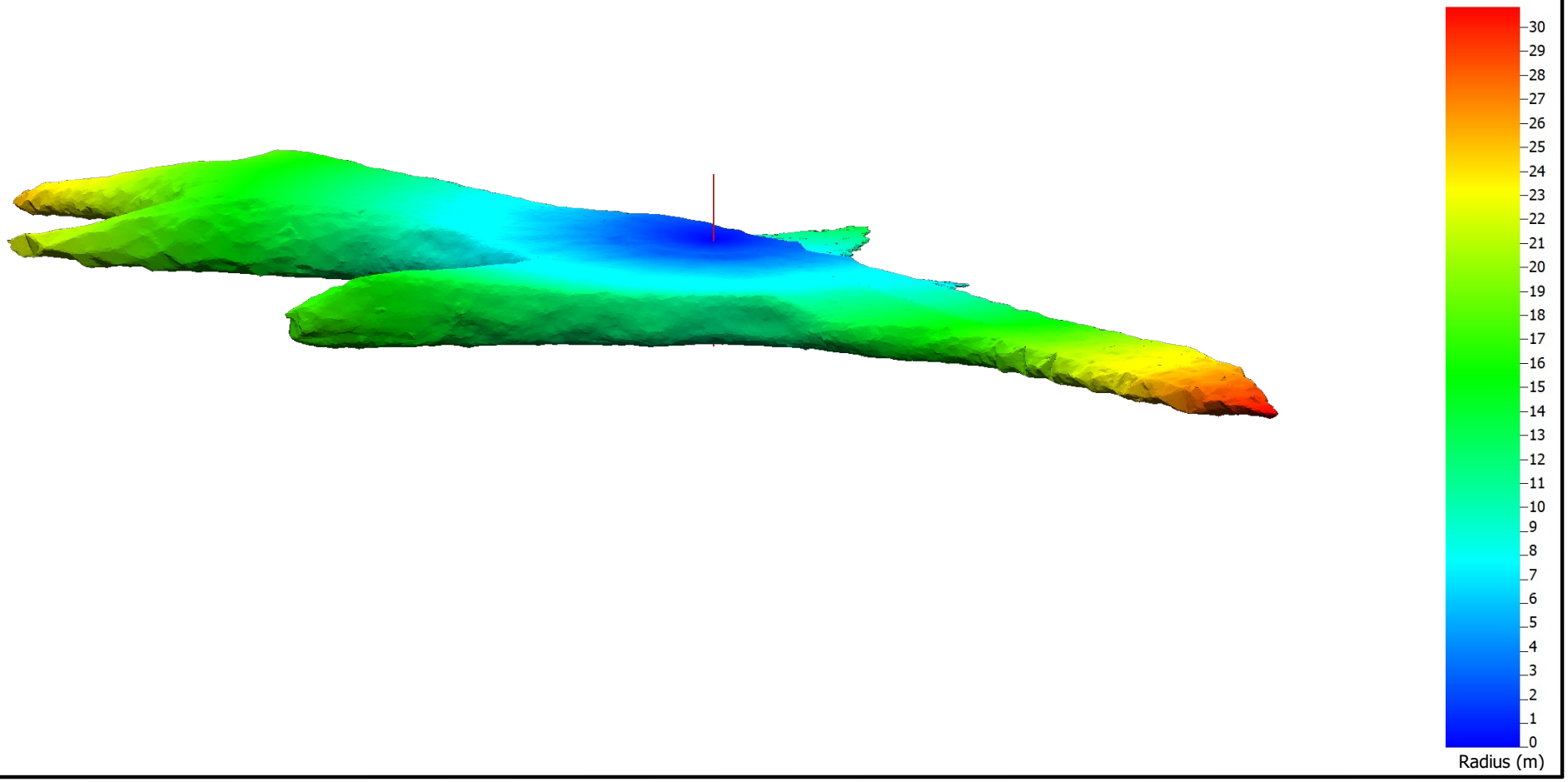
with an overhang of 10°



CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM WEST

with an overhang of 10°



AECOM Australia Pty Ltd

Muswellbrook Bypass Project

BH28C_UG 3D Cavity Sonar Survey Summary Report

Groundsearch Australia Pty. Limited

Prepared by: John Lea

Issued: 30 September 2020

DISCLAIMER

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For and on behalf of Groundsearch Australia Pty. Limited

John Lea BSc (Hons) FAusIMM
Principal Geologist
Managing Director

1.0 Summary

The Groundsearch Australia and Flodim partnership provided wireline 3D cavity surveys with a sonar system for two water-filled, abandoned coal mine cavities adjacent to the investigation area for the AECOM Australia Pty Ltd Muswellbrook Bypass Project. The surveys were conducted from a standard Groundsearch logging unit utilising boreholes known as BH28_UG and BH28C_UG.

A Flodim sonar survey tool was run to collect data in the water-filled section of BH28C_UG on 20 August 2020. The data in this report are from 65.5 to 71.5 mbgl.

The cavity data are recorded in horizontal & tilted survey sections providing full 3D coverage with the data saved as a "point cloud".

The BH28C_UG separate surveys are combined into a single model with depth & distance-based data presented as:

- tabulated characteristics
- 2D vertical & horizontal sections
- 2D solid representations

2.0 BH28C_UG dimensions

BH28C_UG survey data indicate:

- Top of cavity = 65.5 m
- Base of cavity = 71.5 m
- Total volume = 367.0 m^3
- Maximum radius orientation = 40^0 (Magnetic North)
- Maximum distance between points = 40.8 m
- Maximum surface area = 236.6 m^2

Appendix 1 is provided by Flodim and contains:

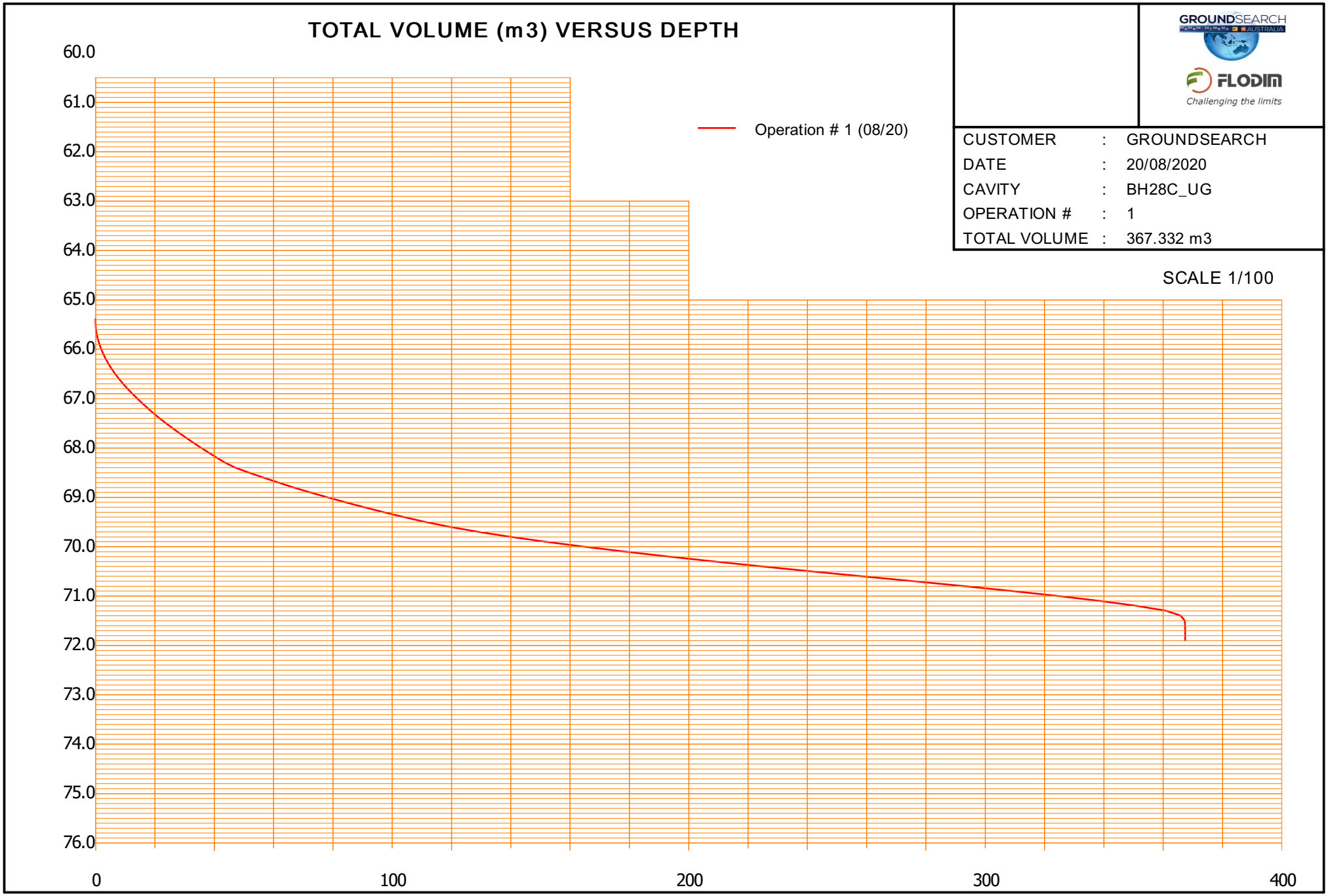
- Total Volume (m^3) versus Depth graph 1/100
- Partial Volume (m^3) versus Depth each 0.5 m graph 1/100
- Vertical sections superposition between 0° and 178° each 5° profile view 1/250
- Mean Radius profile view 1/100
- Horizontal sections superposition between 65.0 m and 71.5 m plan view 1/500
- Maximum extension plan view 1/500

- View from Above plan view 1/500
- Main characteristics datasheet table – 0.5 m depth intervals
- 36 x vertical sections 1 (0 – 180^0) to 18 (170 – 350^0) profile views 1/250
- 13 x horizontal sections 0.5 intervals from 65.5 m to 71.5 m plan views 1/500
- 2D solid view from North with an overhang of 10°
- 2D solid view from East with an overhang of 10°
- 2D solid view from South with an overhang of 10°
- 2D solid view from West with an overhang of 10°

Appendix 1 Flodim SARL Sonar Survey Data Report

CUSTOMER	GROUNDSEARCH
DATE	20/08/2020
CAVITY	BH28C_UG
OPERATION #	1
REPORT #	20-3149

TOTAL VOLUME (m3) VERSUS DEPTH



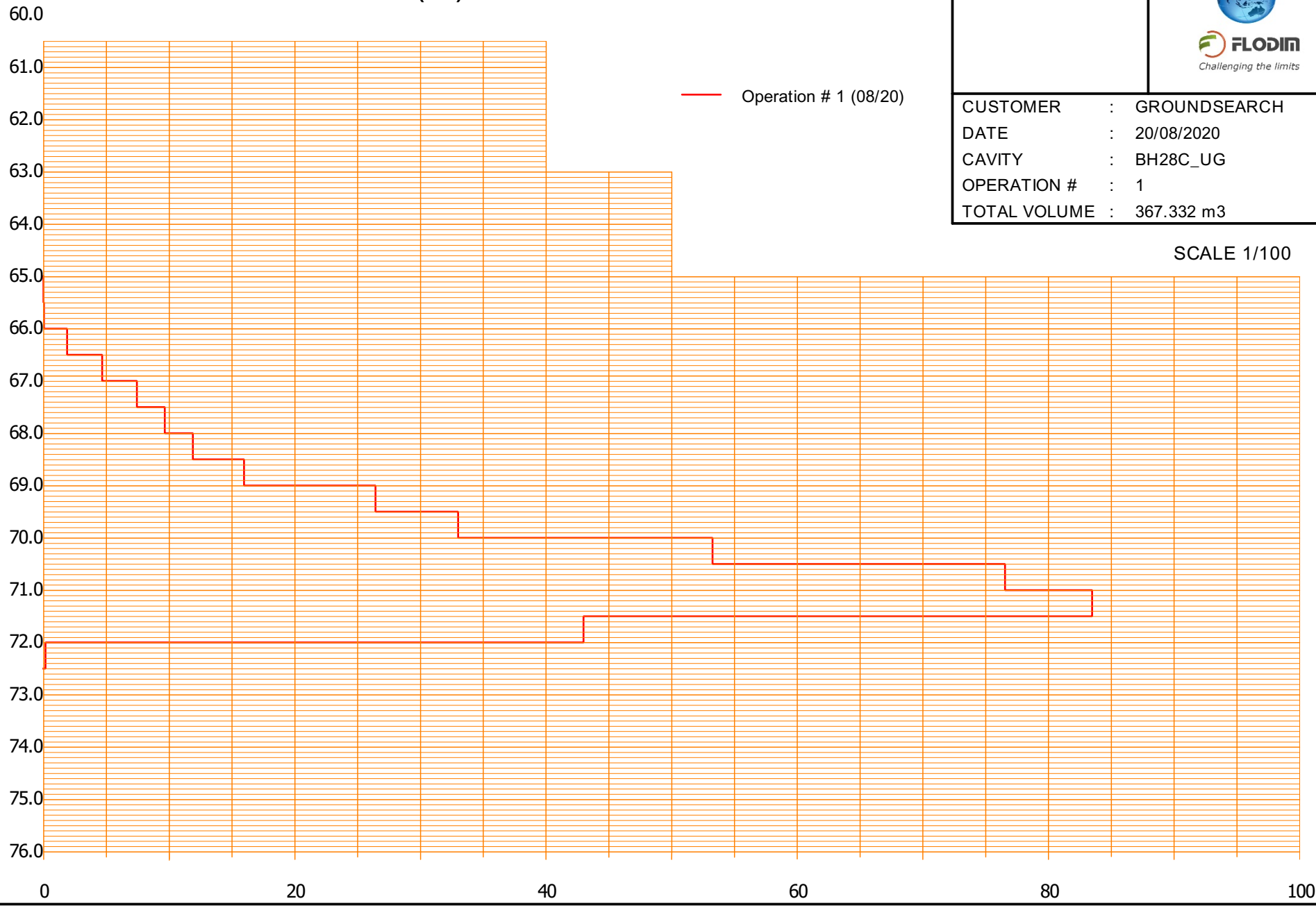
GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

CUSTOMER	:	GROUNDSEARCH
DATE	:	20/08/2020
CAVITY	:	BH28C_UG
OPERATION #	:	1
TOTAL VOLUME	:	367.332 m3

SCALE 1/100

PARTIAL VOLUME (m3) VERSUS DEPTH EACH 0.5 m



CUSTOMER	:	GROUNDSEARCH
DATE	:	20/08/2020
CAVITY	:	BH28C_UG
OPERATION #	:	1
TOTAL VOLUME	:	367.332 m3

SCALE 1/100

CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

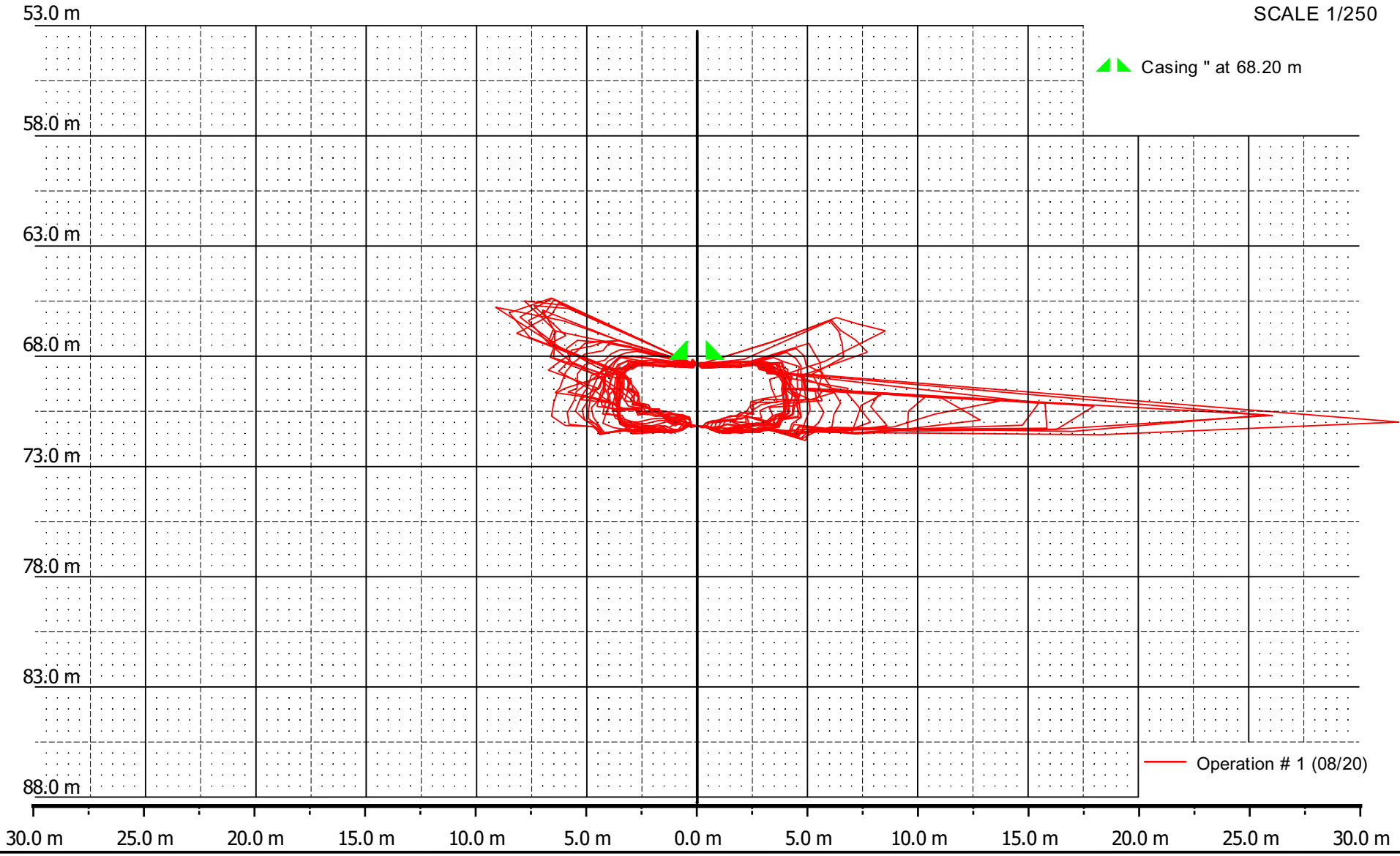
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTIONS SUPERPOSITION

between 0° and 175° every 5°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



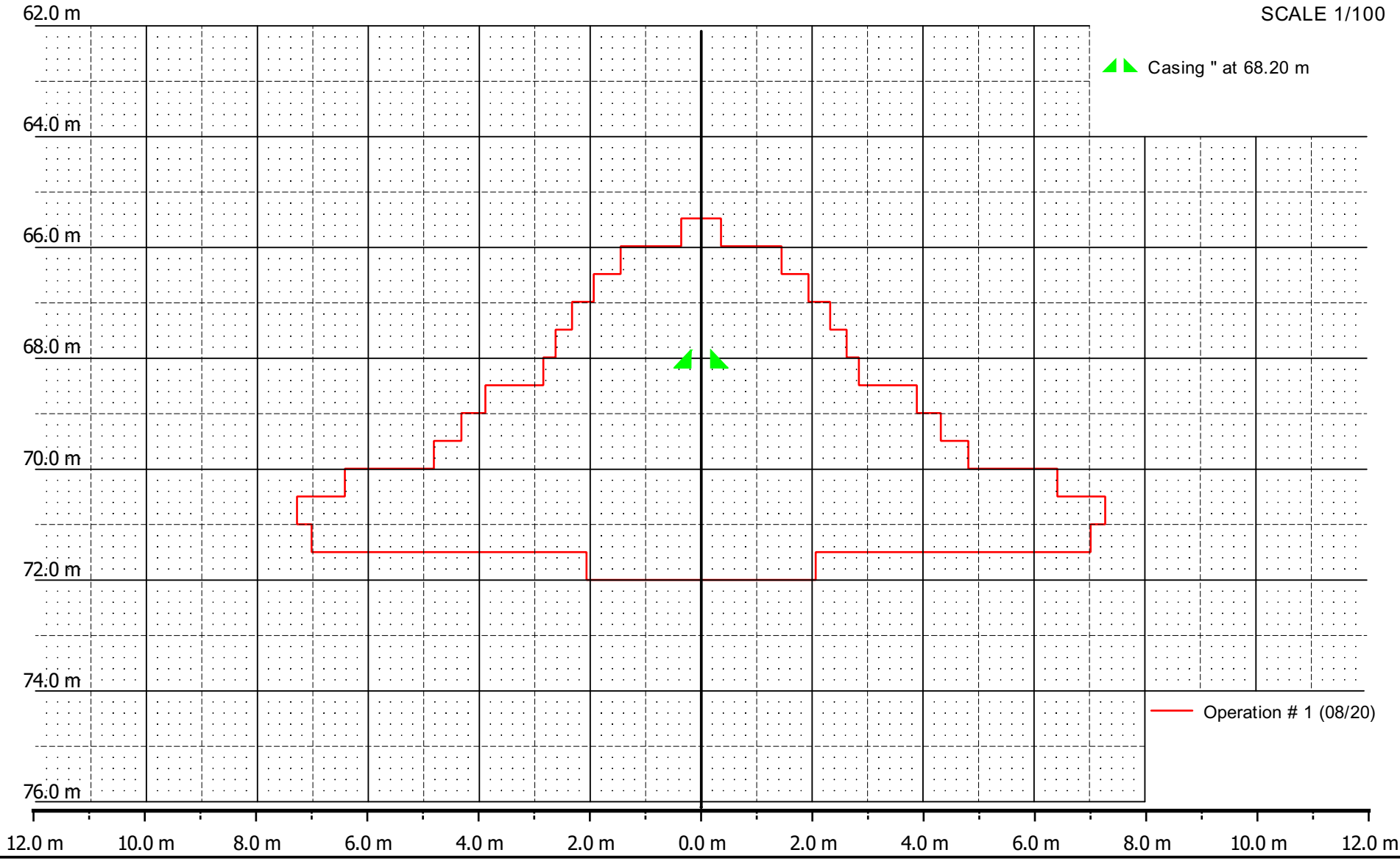
CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

MEAN RADIUS

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

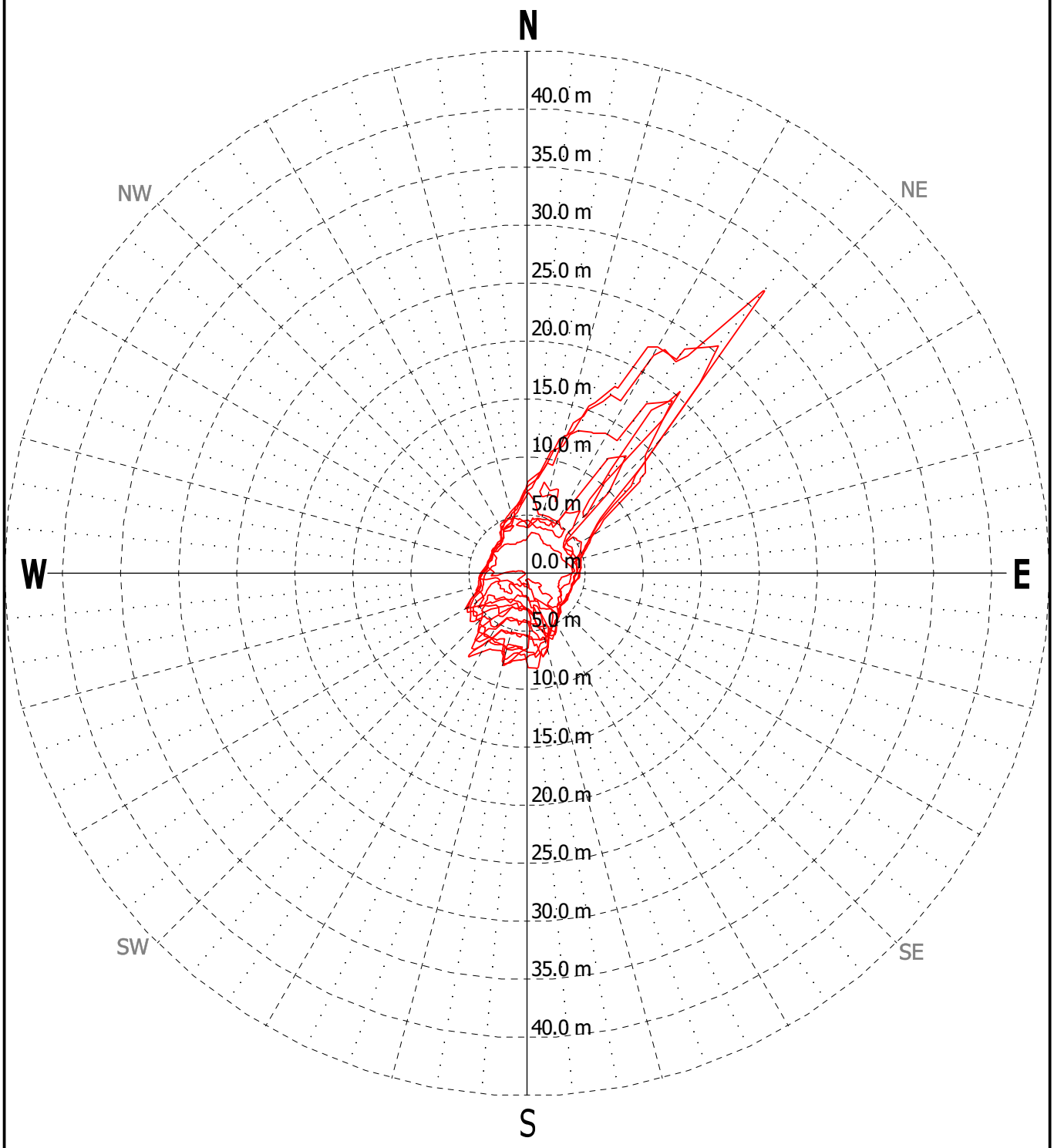


CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTIONS SUPERPOSITION

between 65.5 m and 71.5 m

SCALE 1/500

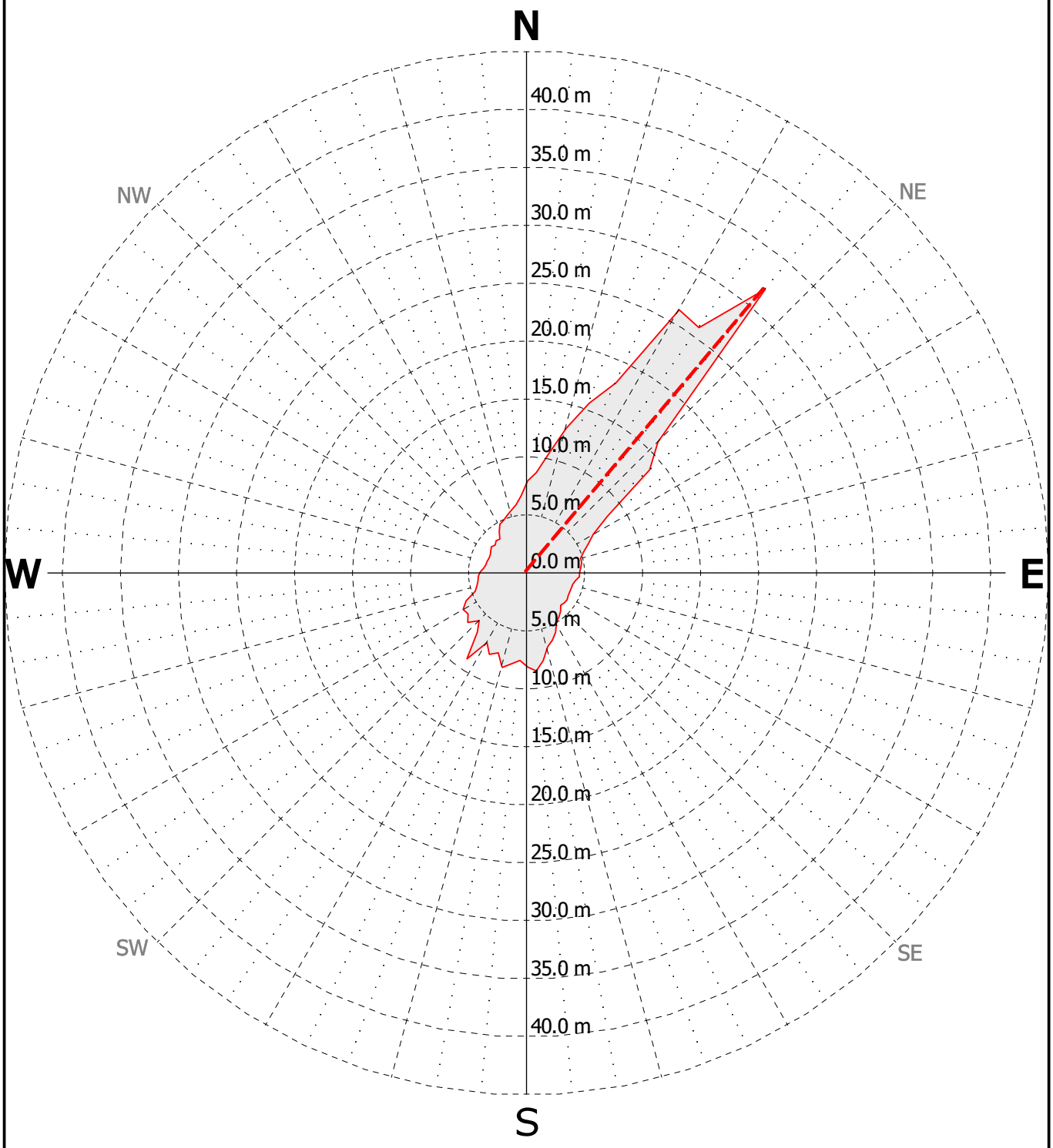


Operation # 1 (08/20)

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

MAXIMUM EXTENSION

SCALE 1/500



Operation # 1 (08/20)

Maximum radius	: 31.75 m
Orientation maxi. radius	: 40 °
Depth maxi. radius	: 71.00 m
Surface	: 236.57 m²
Max distance between points	: 40.83 m

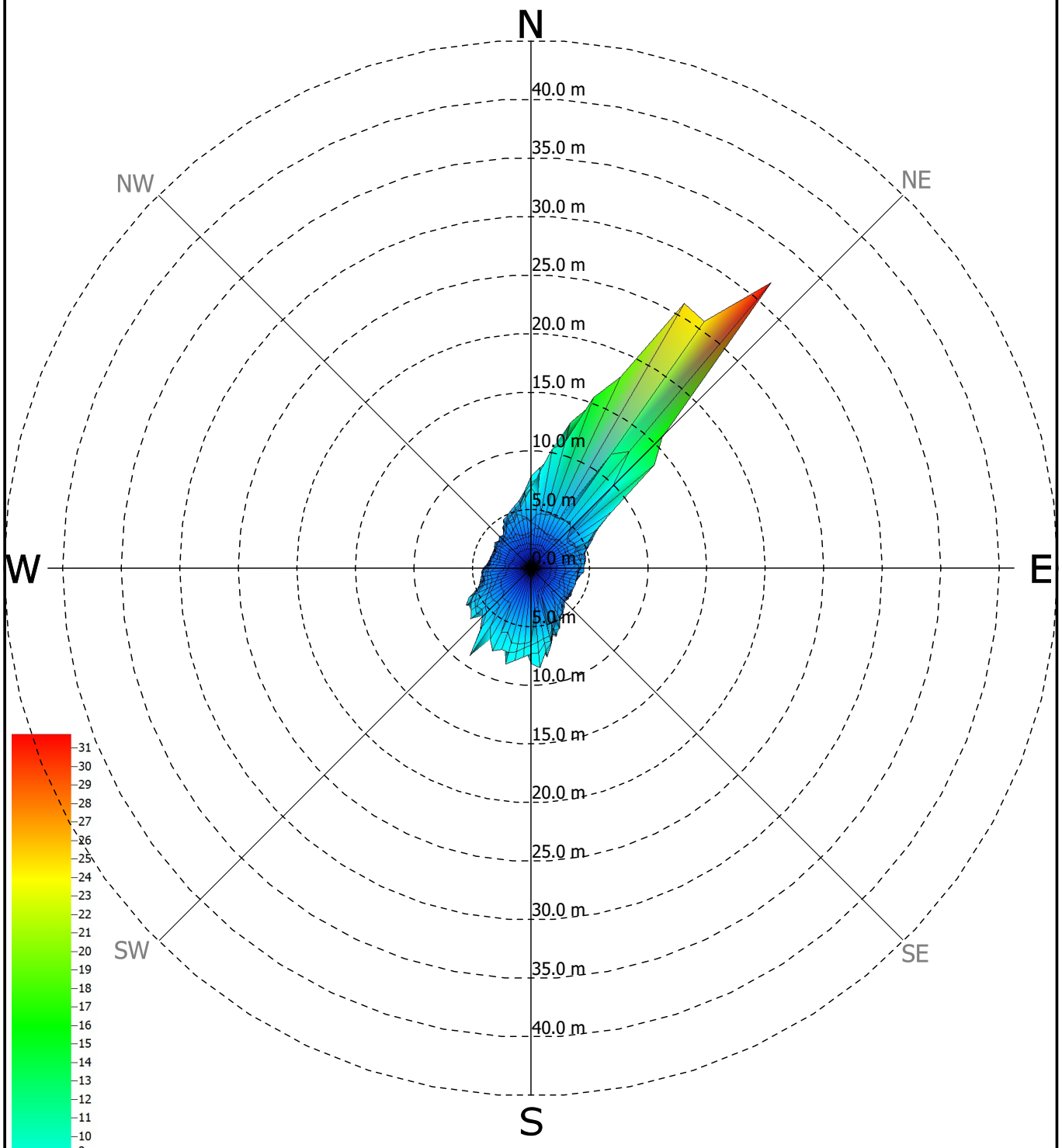
CUSTOMER	:GROUNDSEARCH	CAVITY	:BH28C_UG
DATE	:20/08/2020	OPERATION #	:1

VIEW FROM ABOVE

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

SCALE 1/500



Maximum radius	: 31.75 m
Orientation maxi. radius	: 40 °
Depth maxi. radius	: 71.00 m
Surface	: 236.57 m²
Max distance between points	: 40.83 m

CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

1

MAIN CHARACTERISTICS DATASHEET

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

Depth (m)	Cumulated Volume (m3)	Volume Section (m3)	Section Area (m²)	Mean Radius (m)	Mean Diameter (m)	Min Radiu (m)	Max Radius (m)	Max Radius Orientation (°)	Min Diamete (m)	Max Diameter (m)	Max Diam. Orientation (°)
65.50	0.04	0.04	0.40	0.36	0.72	6.38	6.83	195.00	-	-	-
66.00	1.92	1.88	6.57	1.45	2.89	5.30	8.84	215.42	-	-	-
66.50	6.59	4.67	11.71	1.93	3.86	4.23	8.13	195.00	-	-	-
67.00	14.03	7.44	16.91	2.32	4.64	3.15	8.31	175.00	-	-	-
67.50	23.69	9.65	21.49	2.62	5.23	2.08	7.37	170.00	-	-	-
68.00	35.58	11.89	25.27	2.84	5.67	0.99	7.30	170.00	-	-	-
68.50	51.54	15.96	47.24	3.88	7.76	2.66	6.50	230.00	5.62	9.18	55.00
69.00	77.96	26.42	58.33	4.31	8.62	3.11	6.92	40.00	7.29	10.86	40.00
69.50	110.97	33.00	72.49	4.80	9.61	2.78	13.08	40.00	7.25	16.93	40.00
70.00	**164.21**	**53.25**	**128.82**	**6.40**	**12.81**	**2.60**	**19.25**	**40.00**	**7.38**	**22.21**	**40.00**
70.50	240.74	76.52	165.75	7.26	14.53	1.66	25.41	40.00	7.18	27.76	40.00
71.00	324.19	83.46	154.00	7.00	14.00	0.28	31.58	40.00	3.98	32.60	40.00
71.50	367.17	42.98	13.33	2.06	4.12	3.70	20.31	40.00	-	-	-
72.00	367.33	0.16	-	-	-	-	-	-	-	-	-

CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

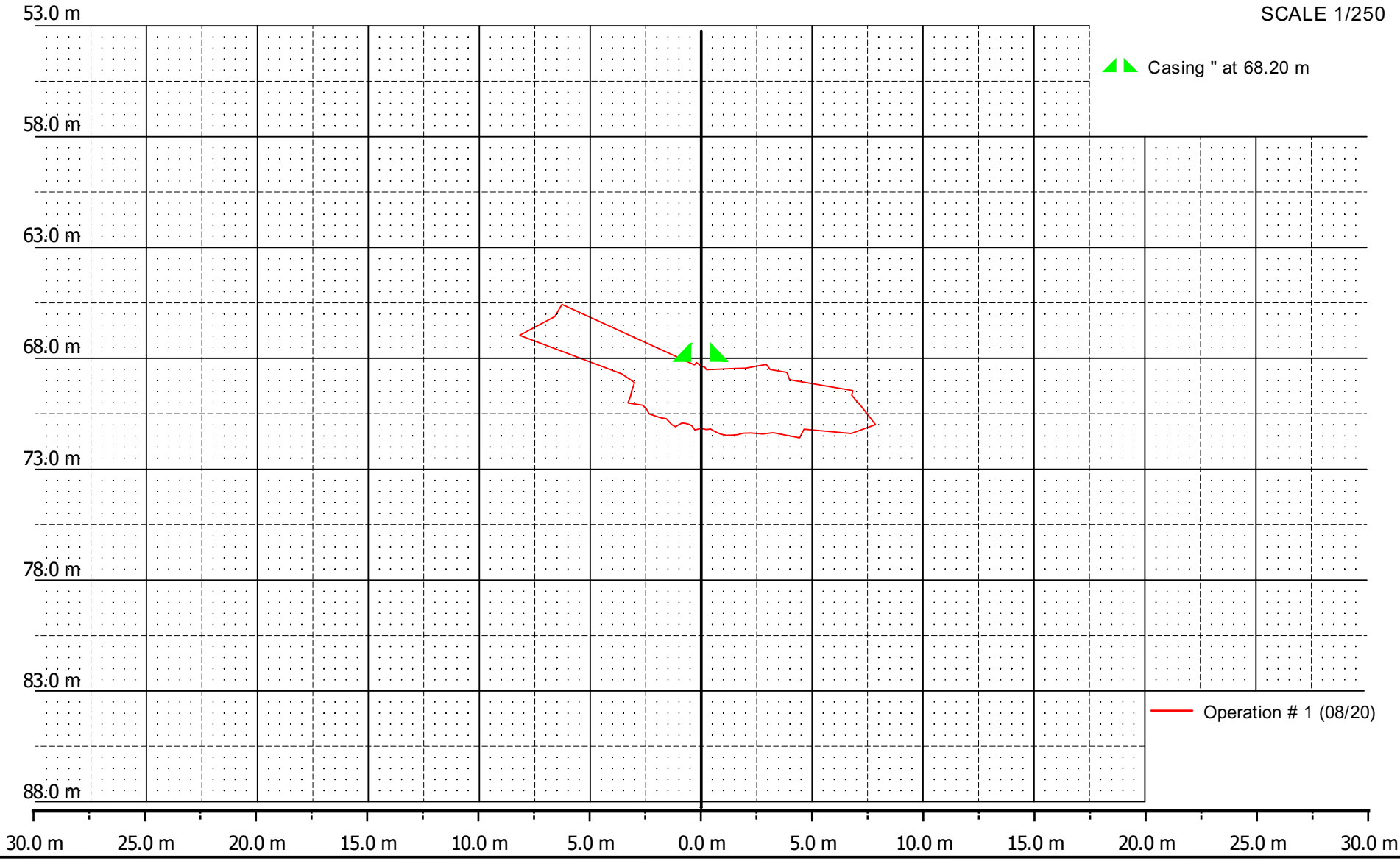
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

180° ← 1 → 0°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

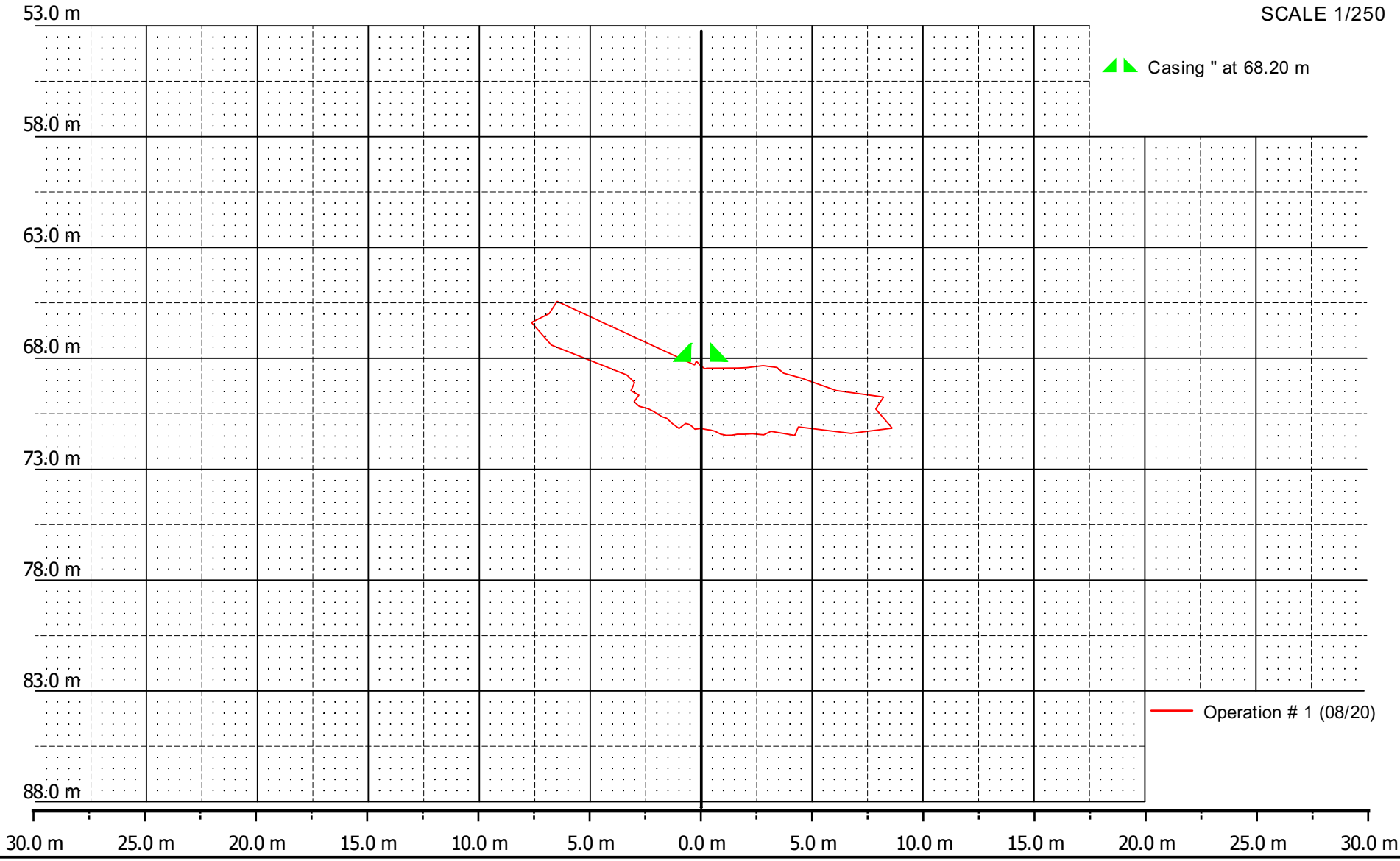
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

185° ← 2 → 5°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

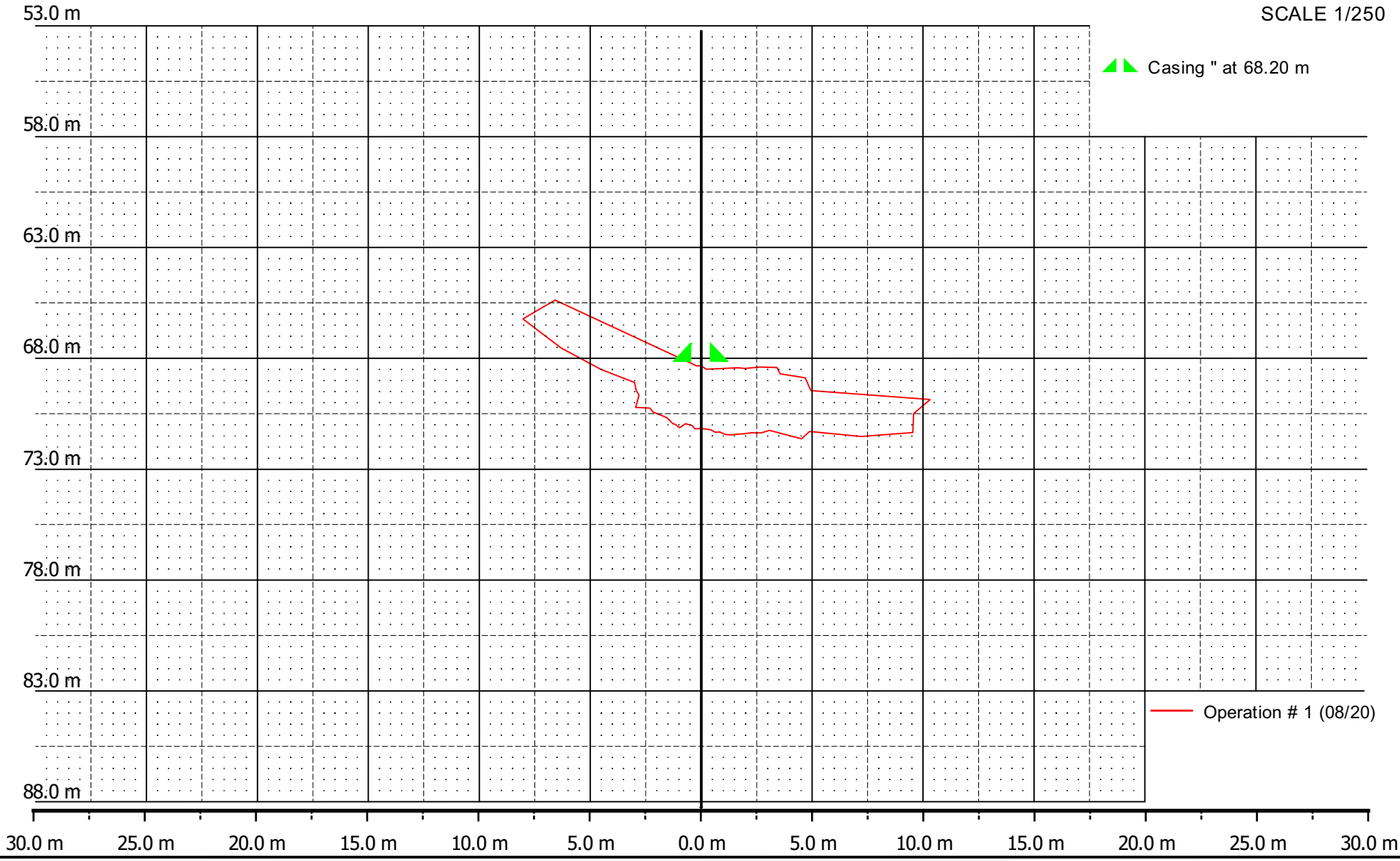
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

190° ← 3 → 10°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



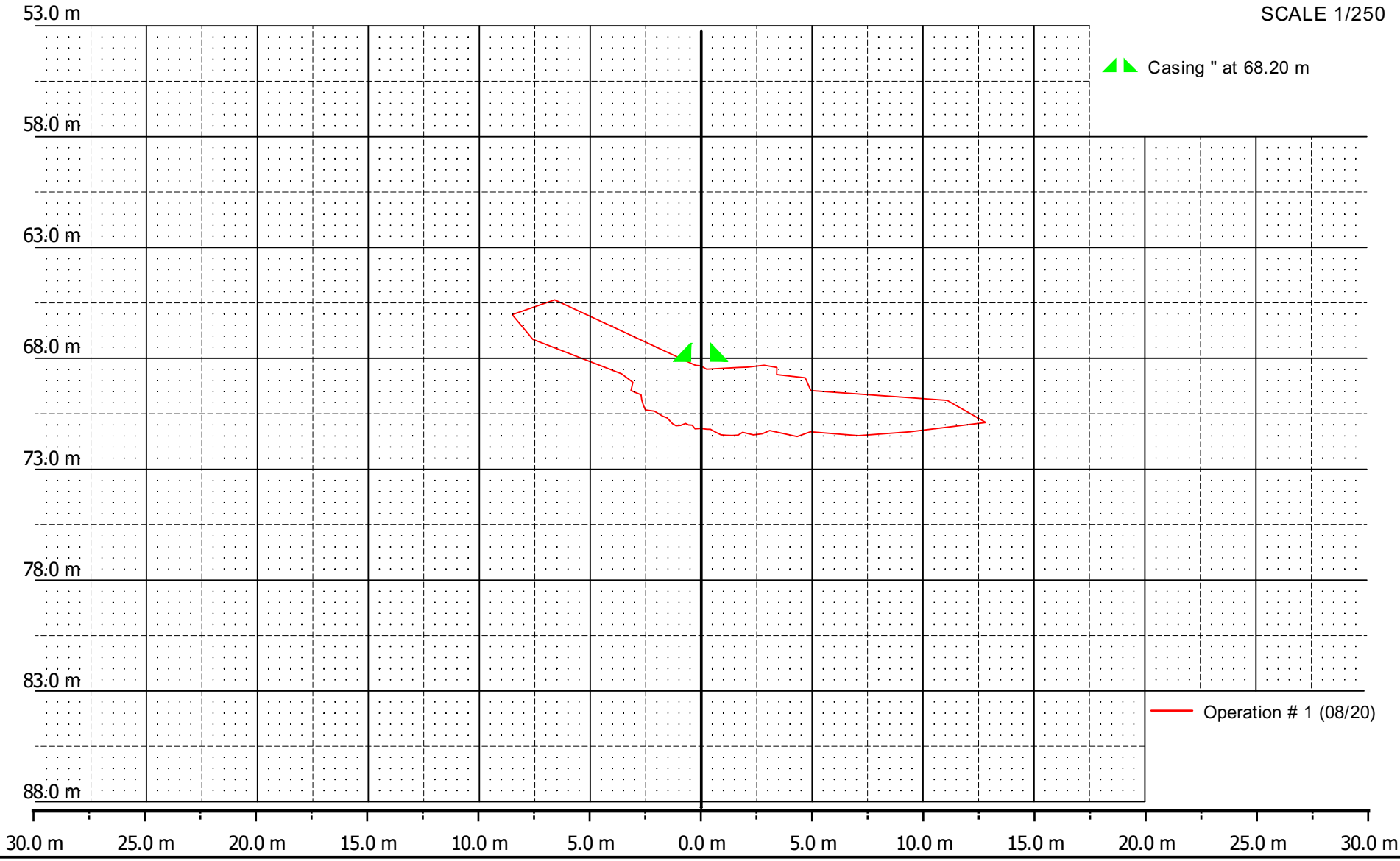
CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

195° ← 4 → 15°

GROUNDSEARCH AUSTRALIA
FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

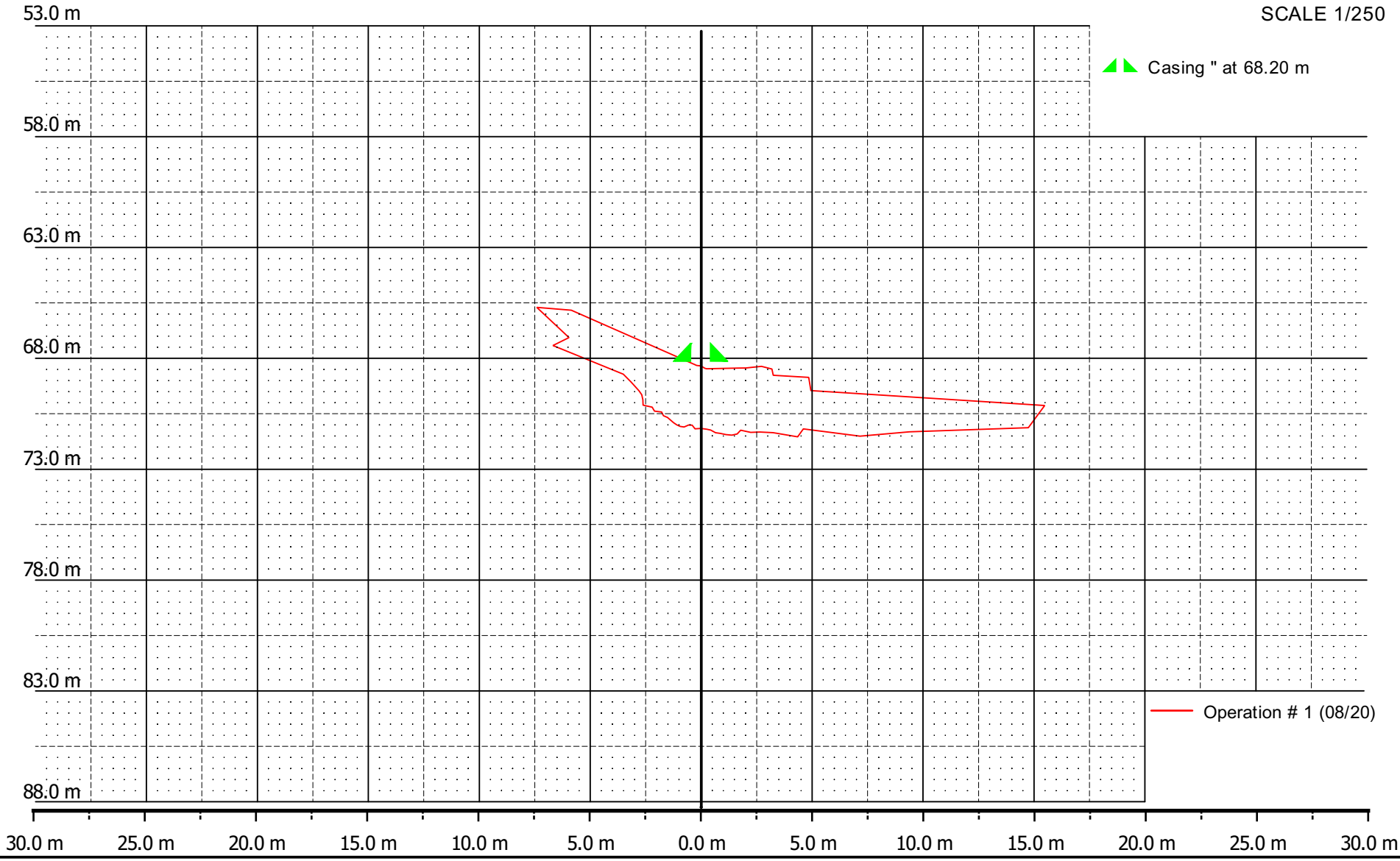
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

200° ← **5** → 20°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



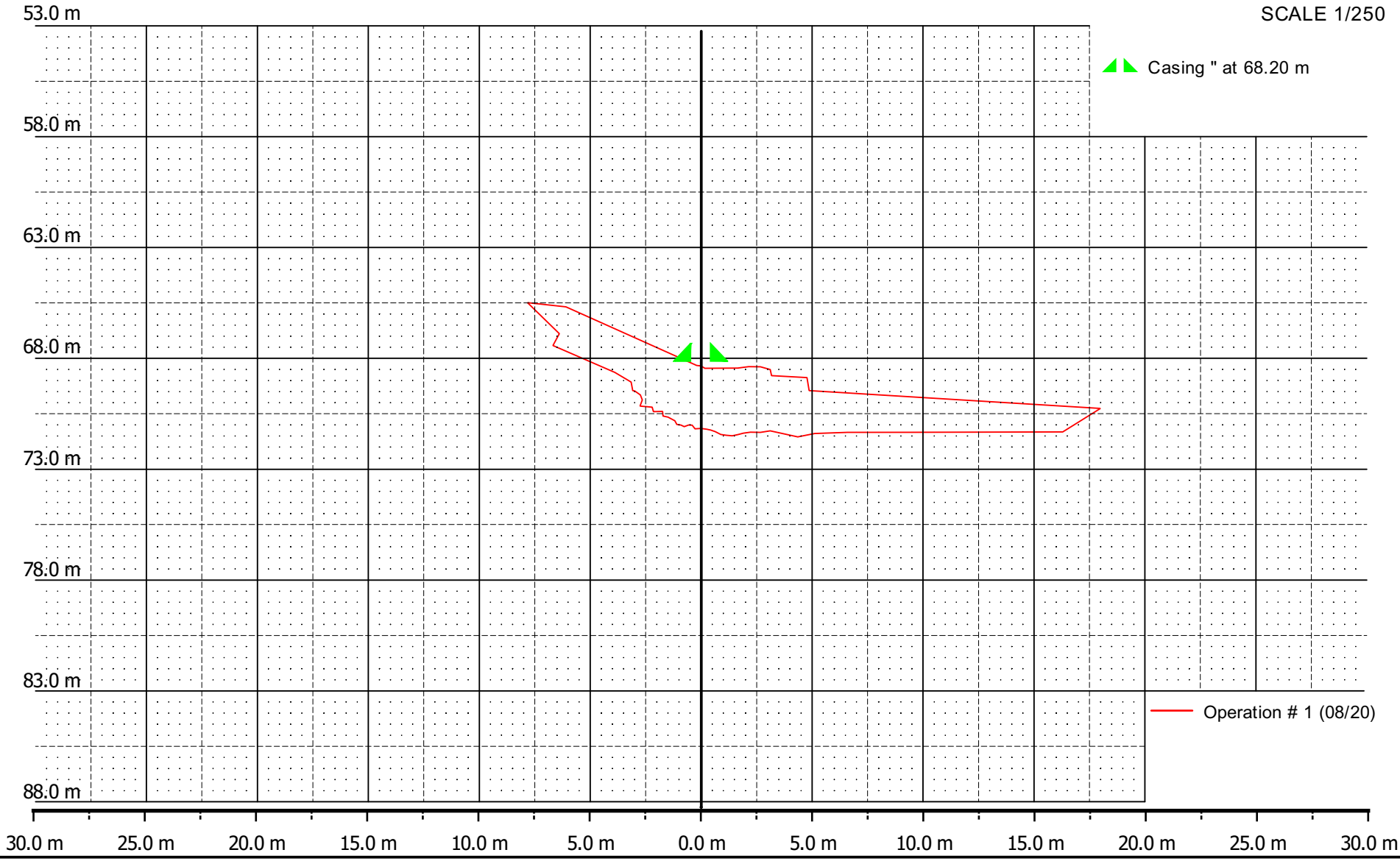
CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

205° ← 6 → 25°

GROUNDSEARCH AUSTRALIA
FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

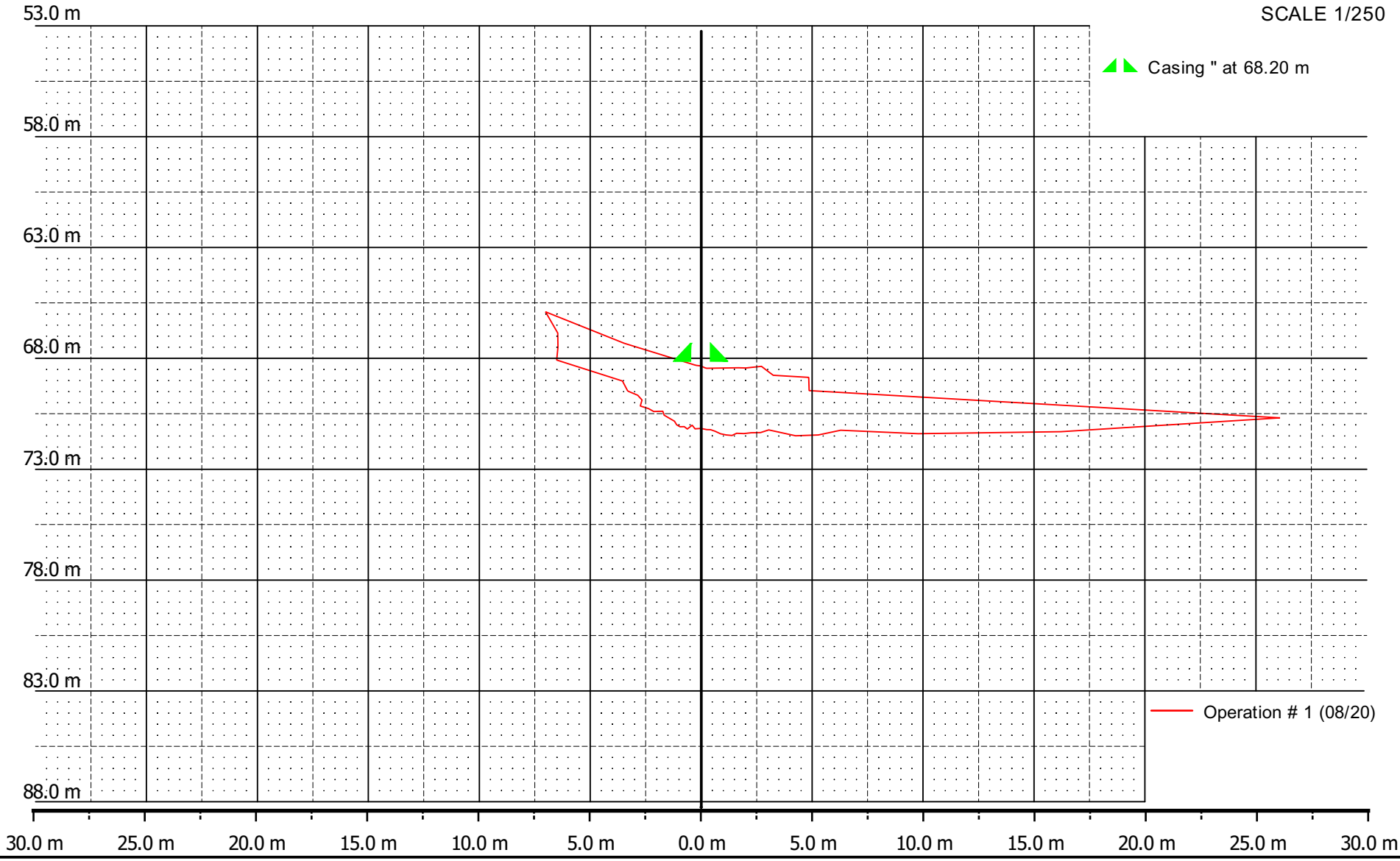
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

210° ← **7** → 30°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

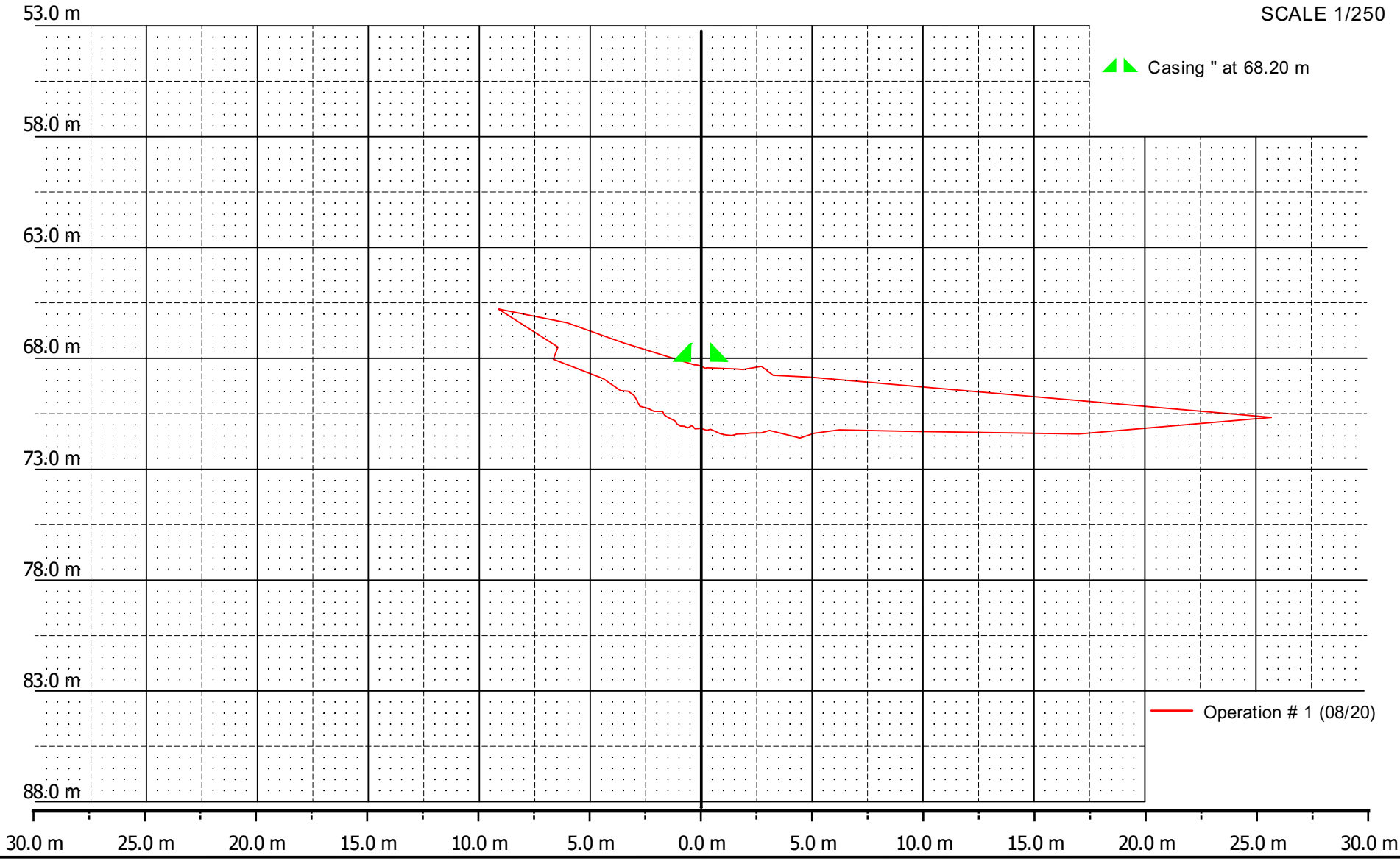
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

215° ← **8** → 35°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



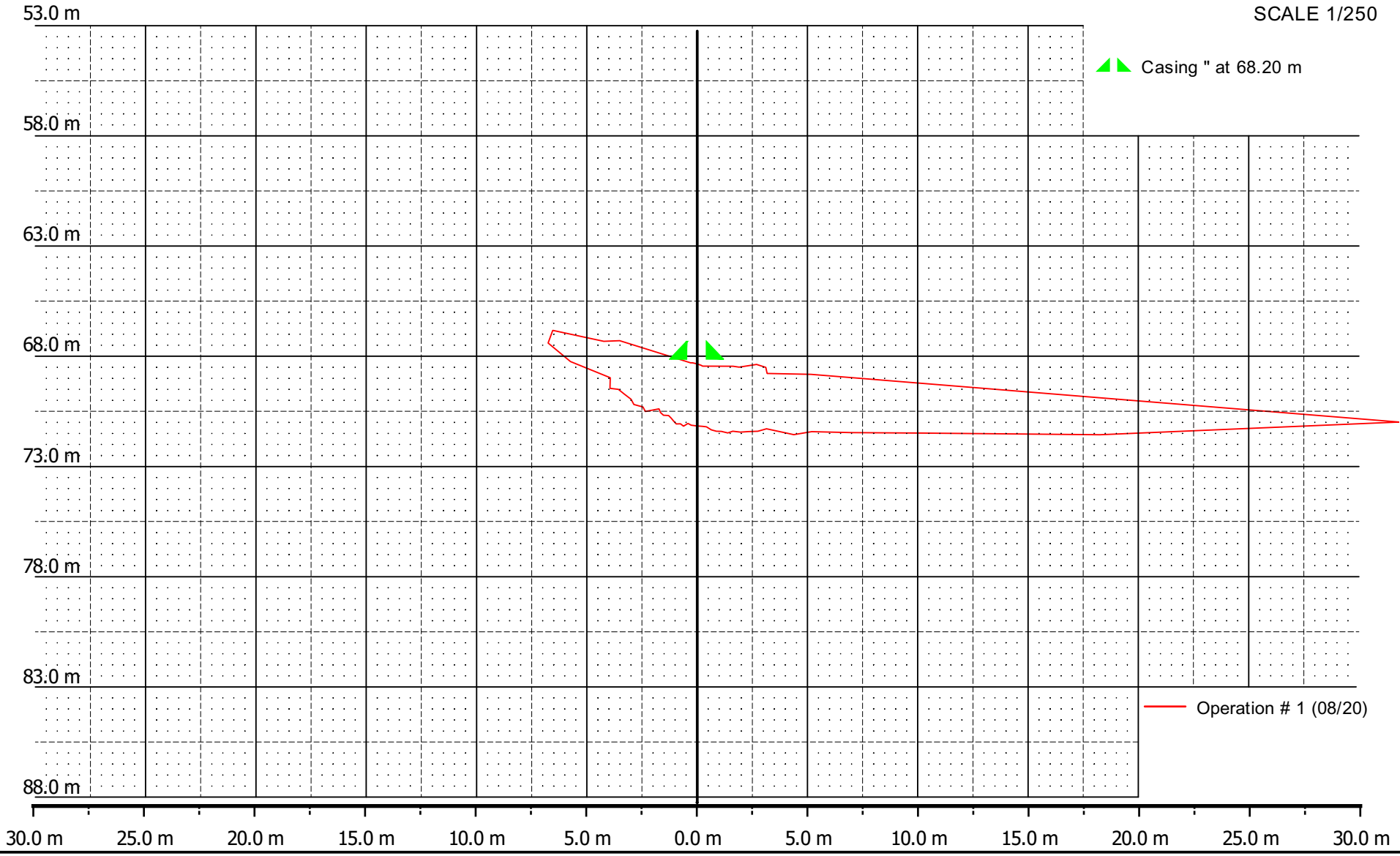
CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

220° ← 9 → 40°

GROUNDSEARCH AUSTRALIA
FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

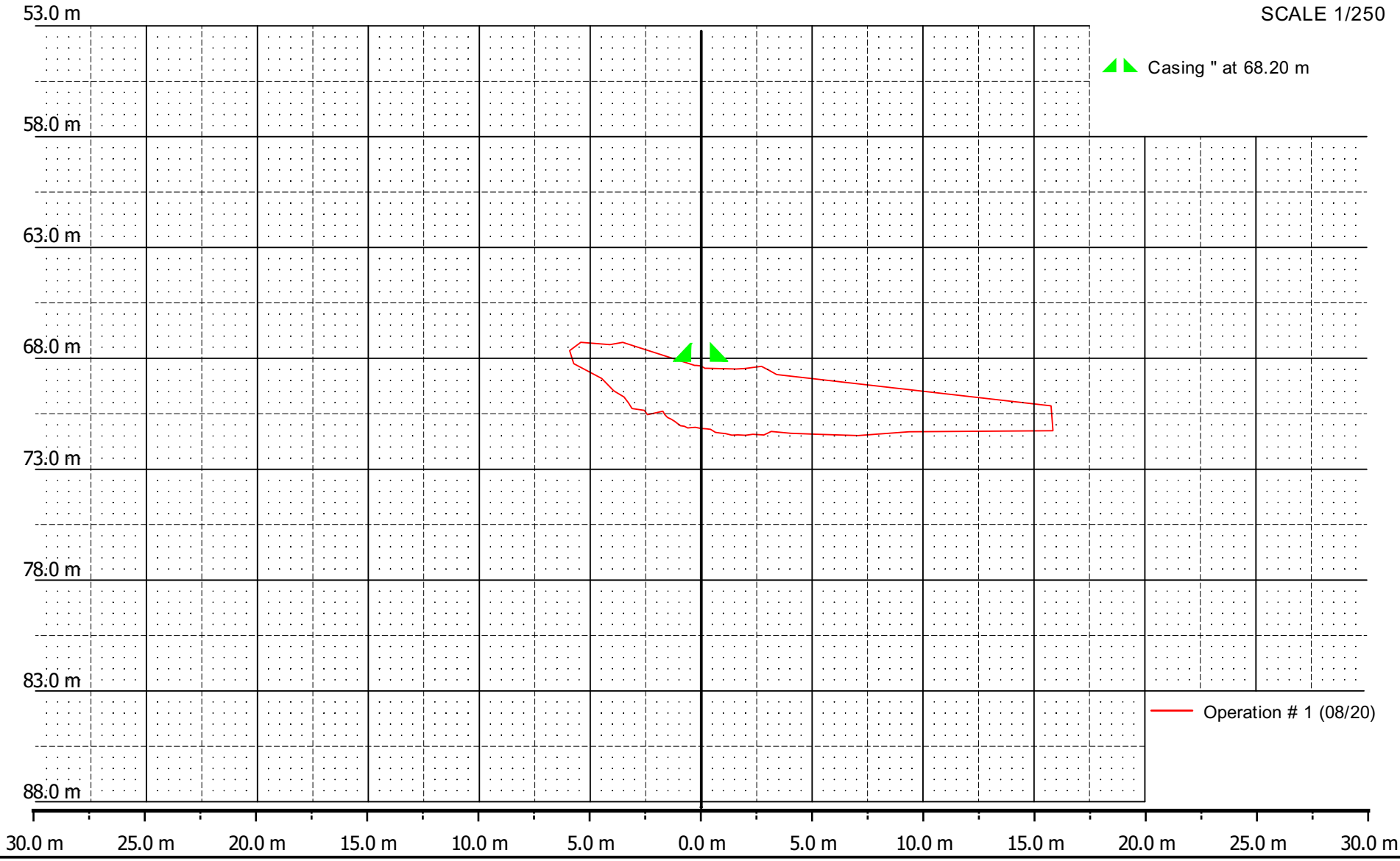
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

225° ← **10** → 45°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

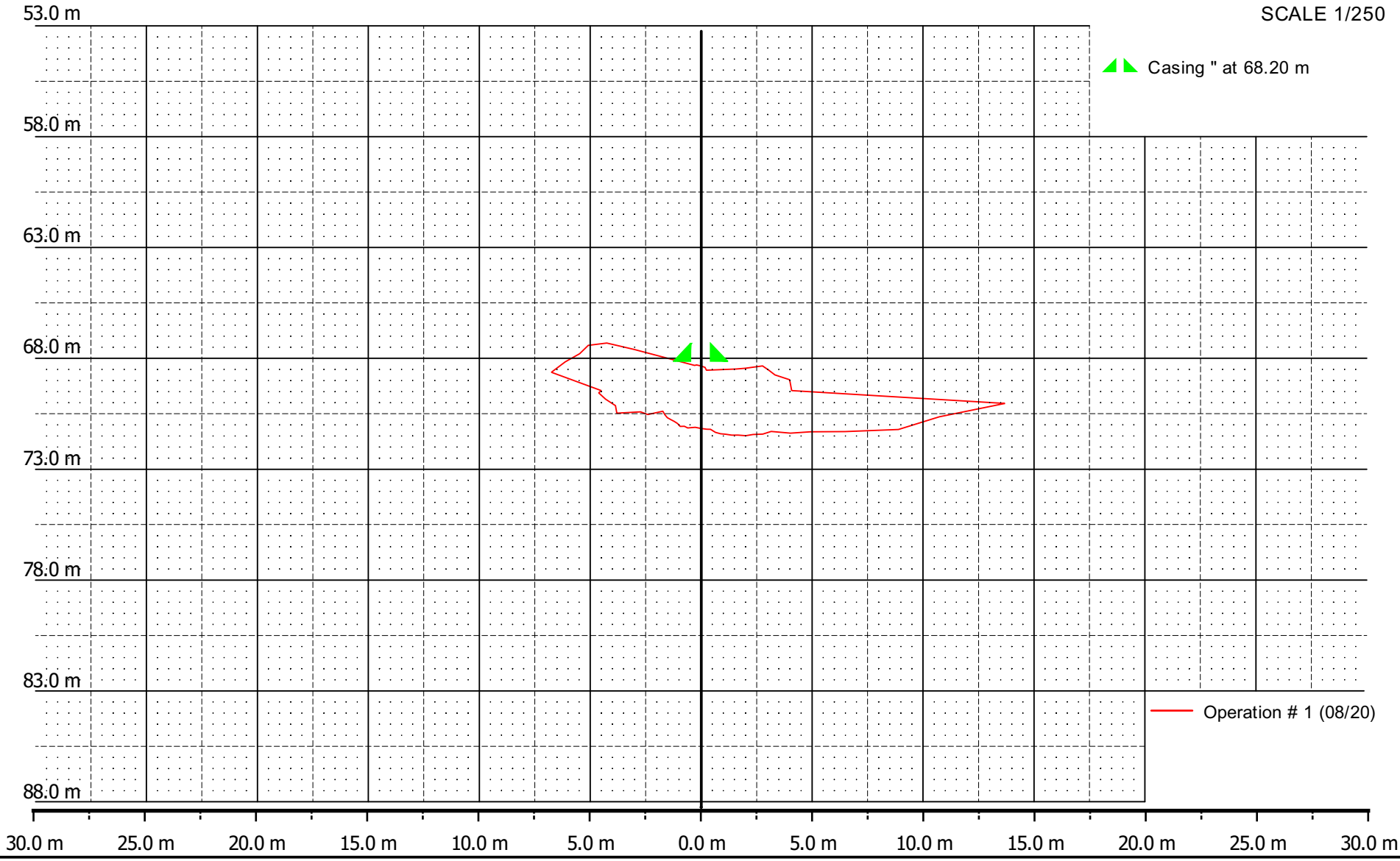
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

230° ← 11 → 50°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

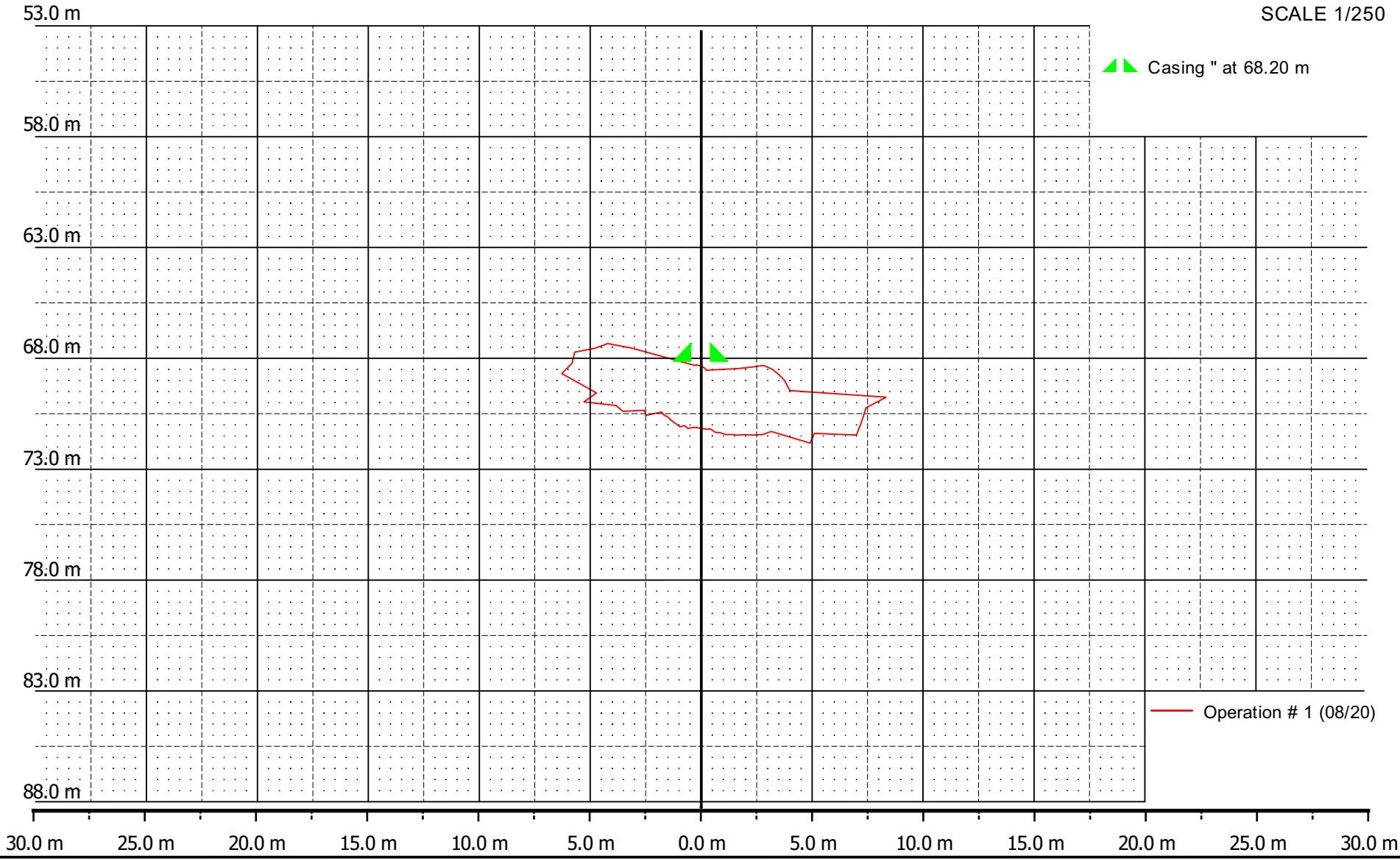
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

235° ← 12 → 55°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

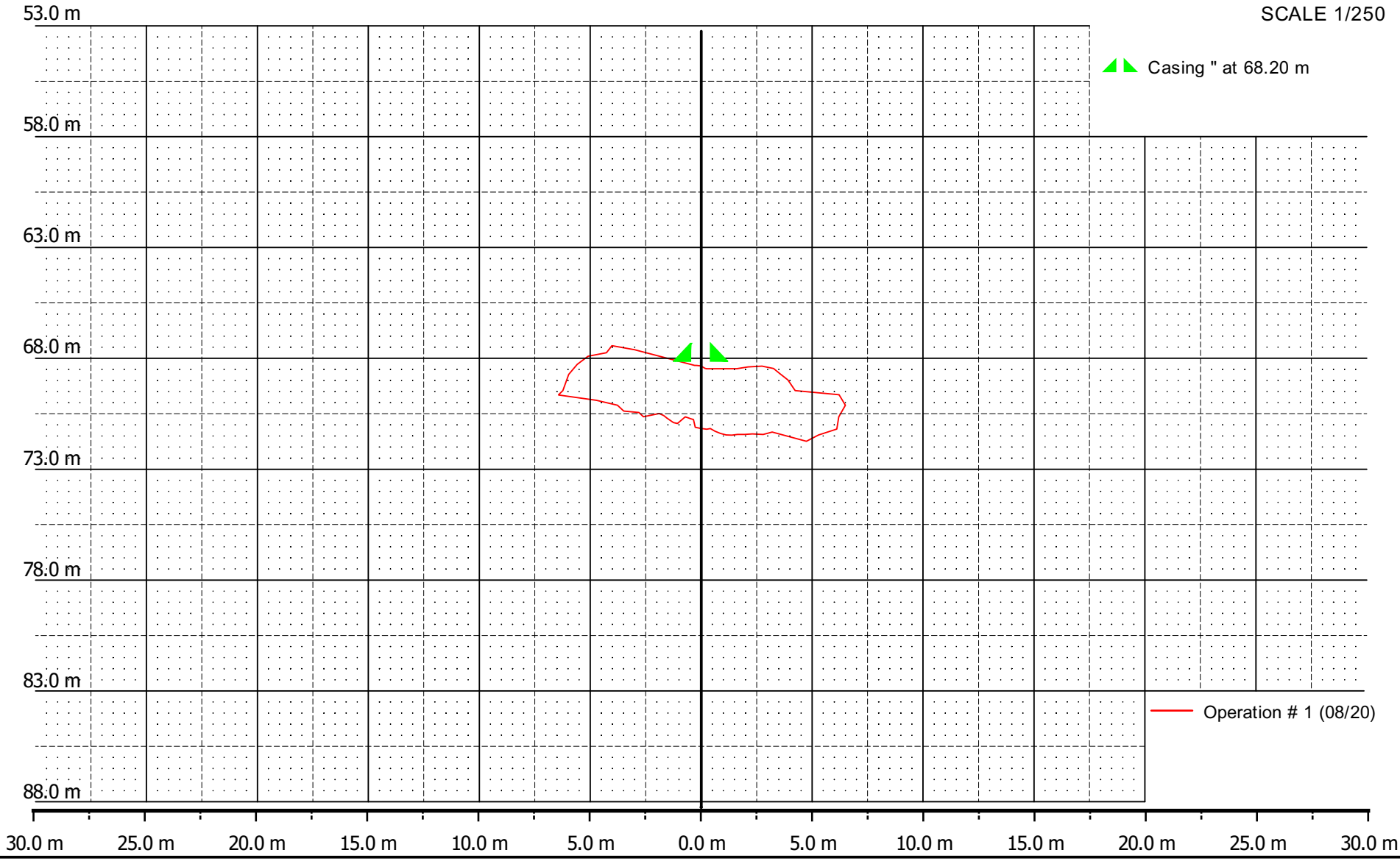
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

240° ← **13** → 60°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

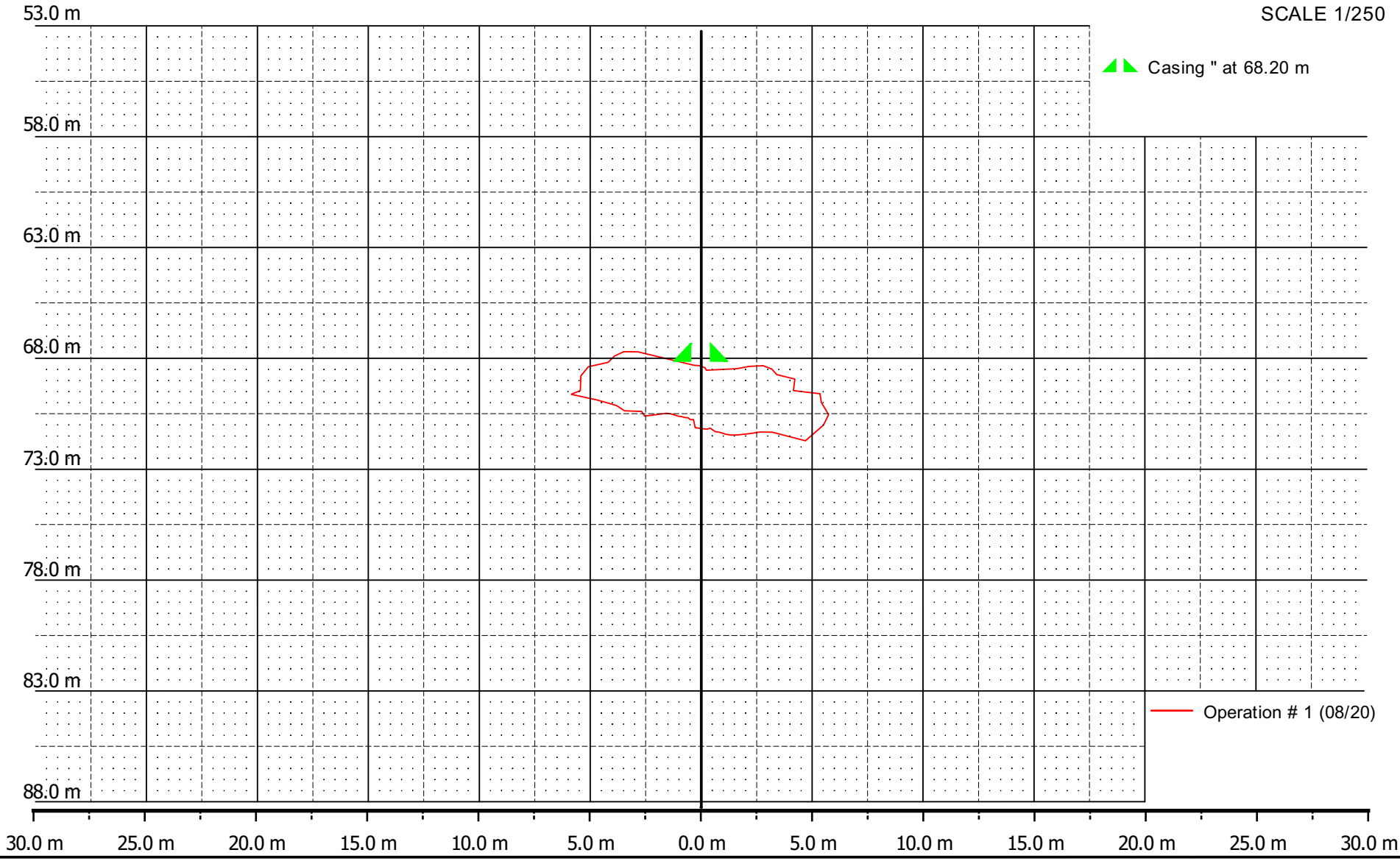
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

245° ← 14 → 65°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

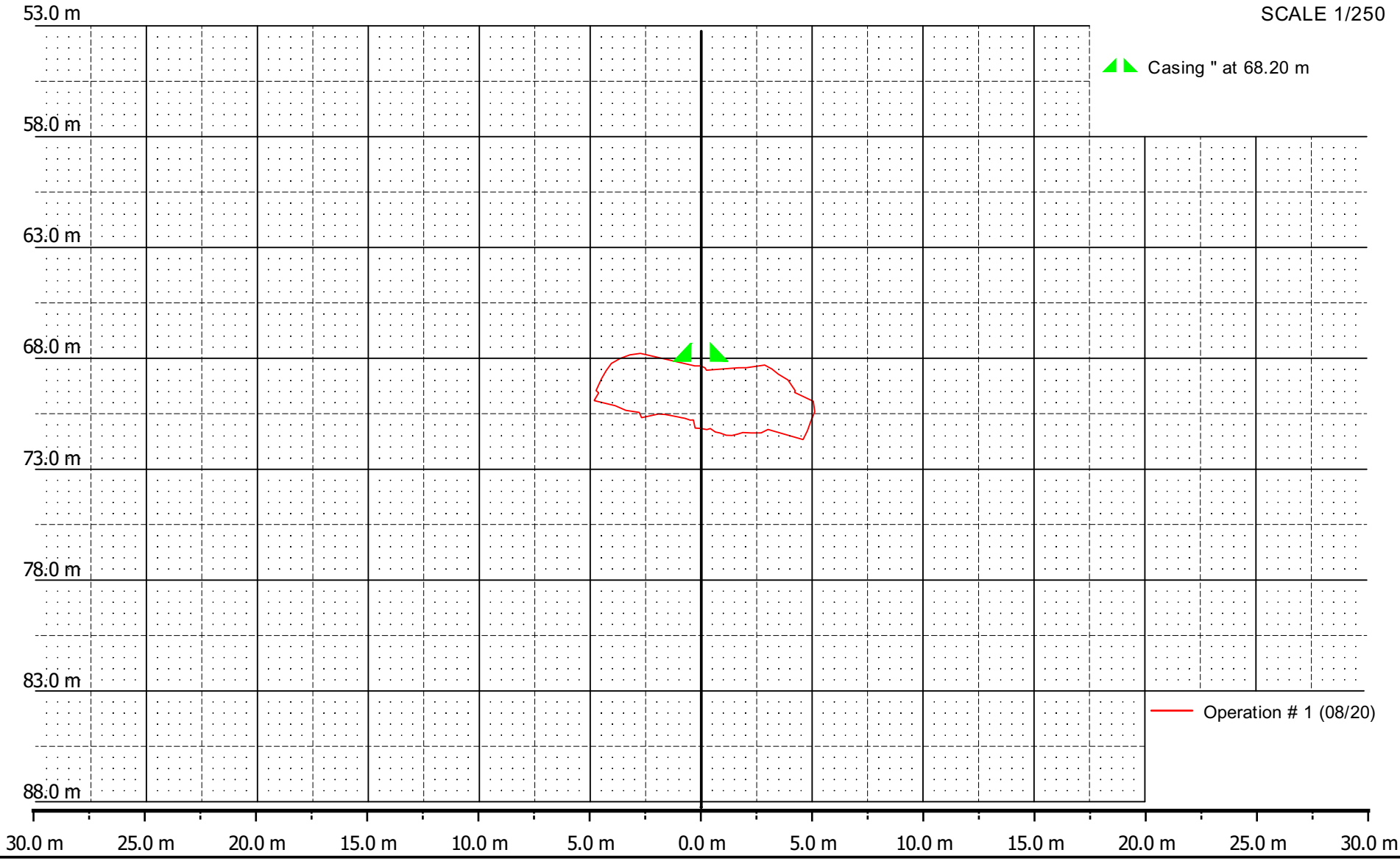
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

250° ← 15 → 70°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

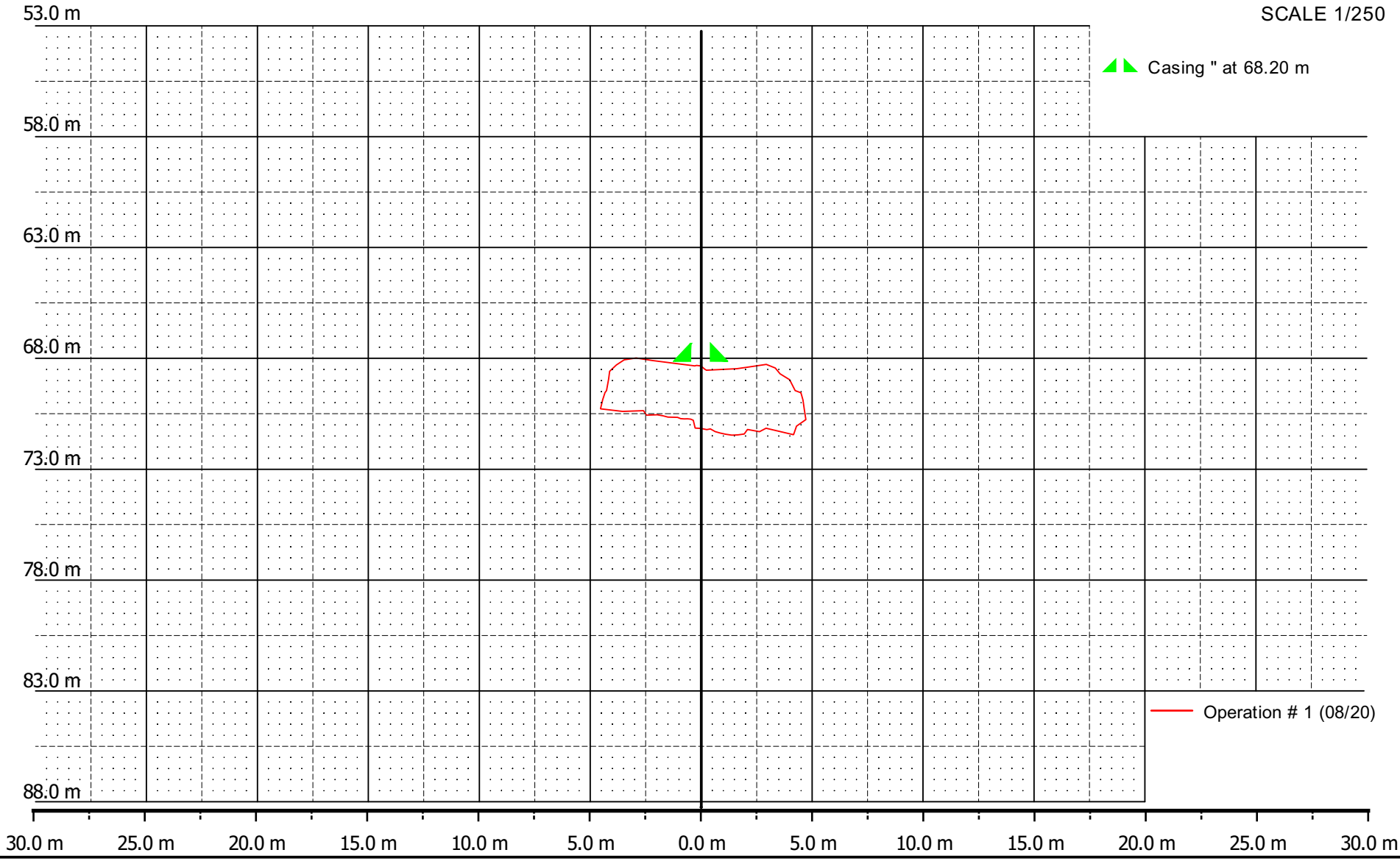
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

255° ← **16** → 75°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

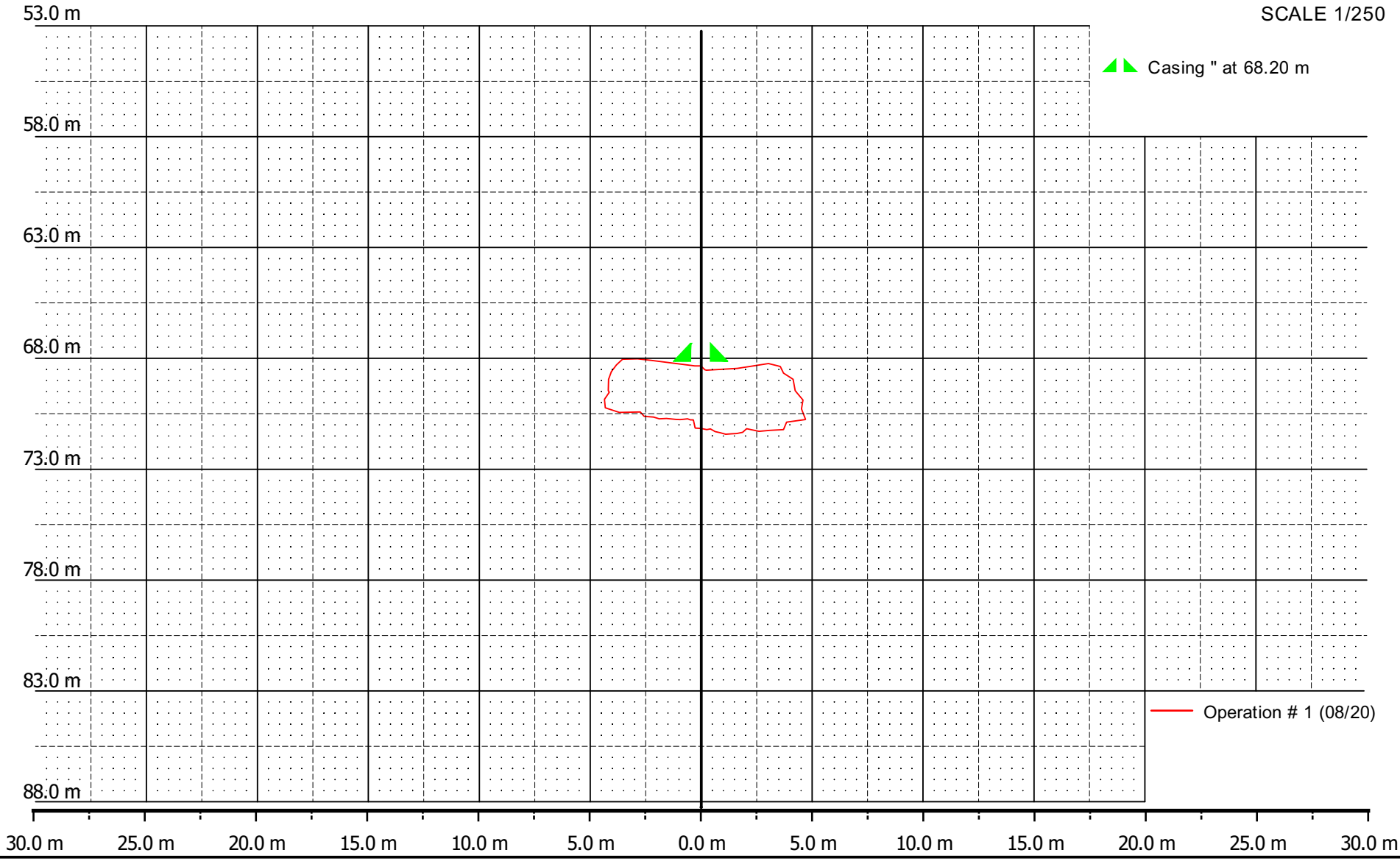
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

260° ← 17 → 80°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

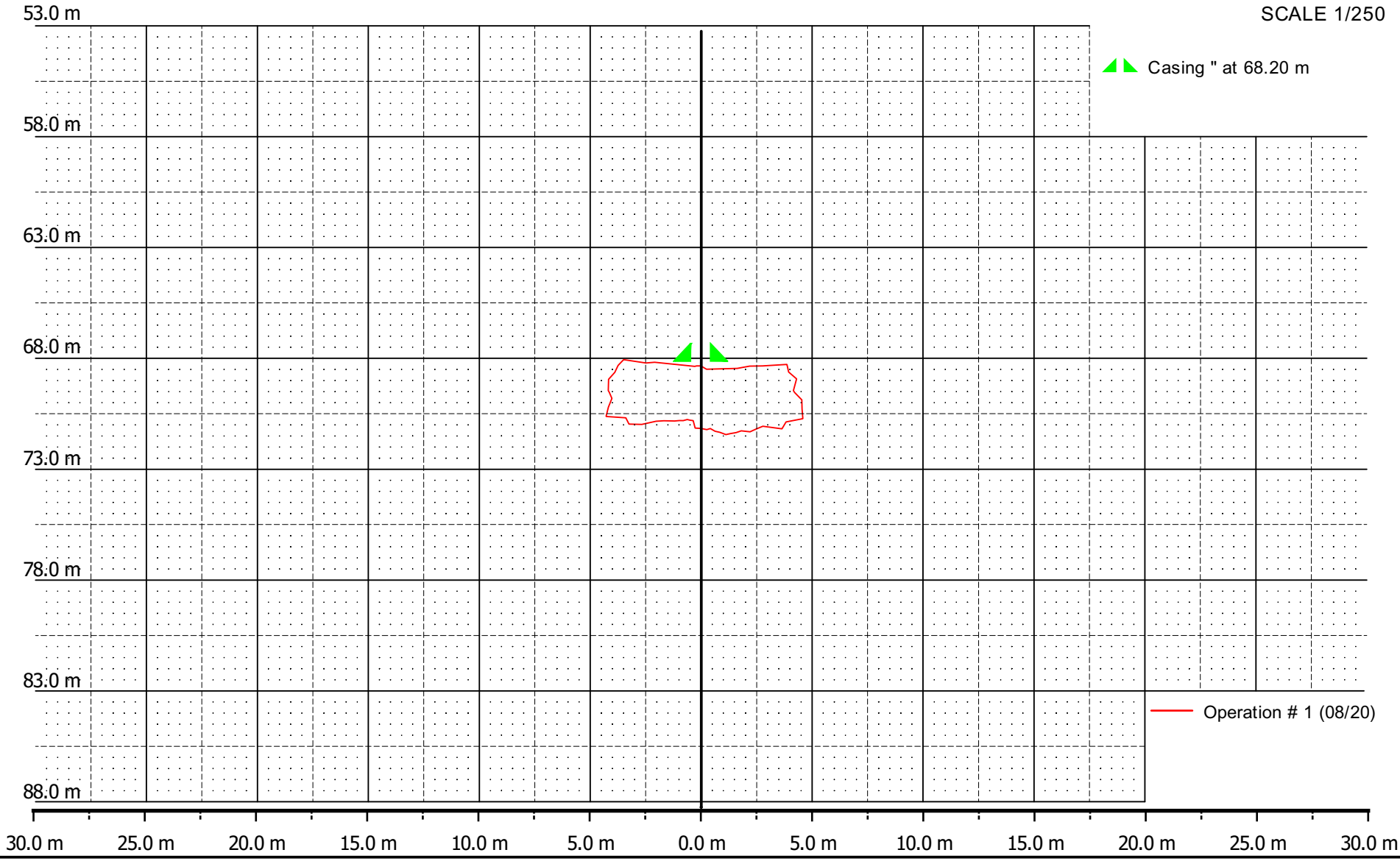
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

265° ← **18** → 85°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

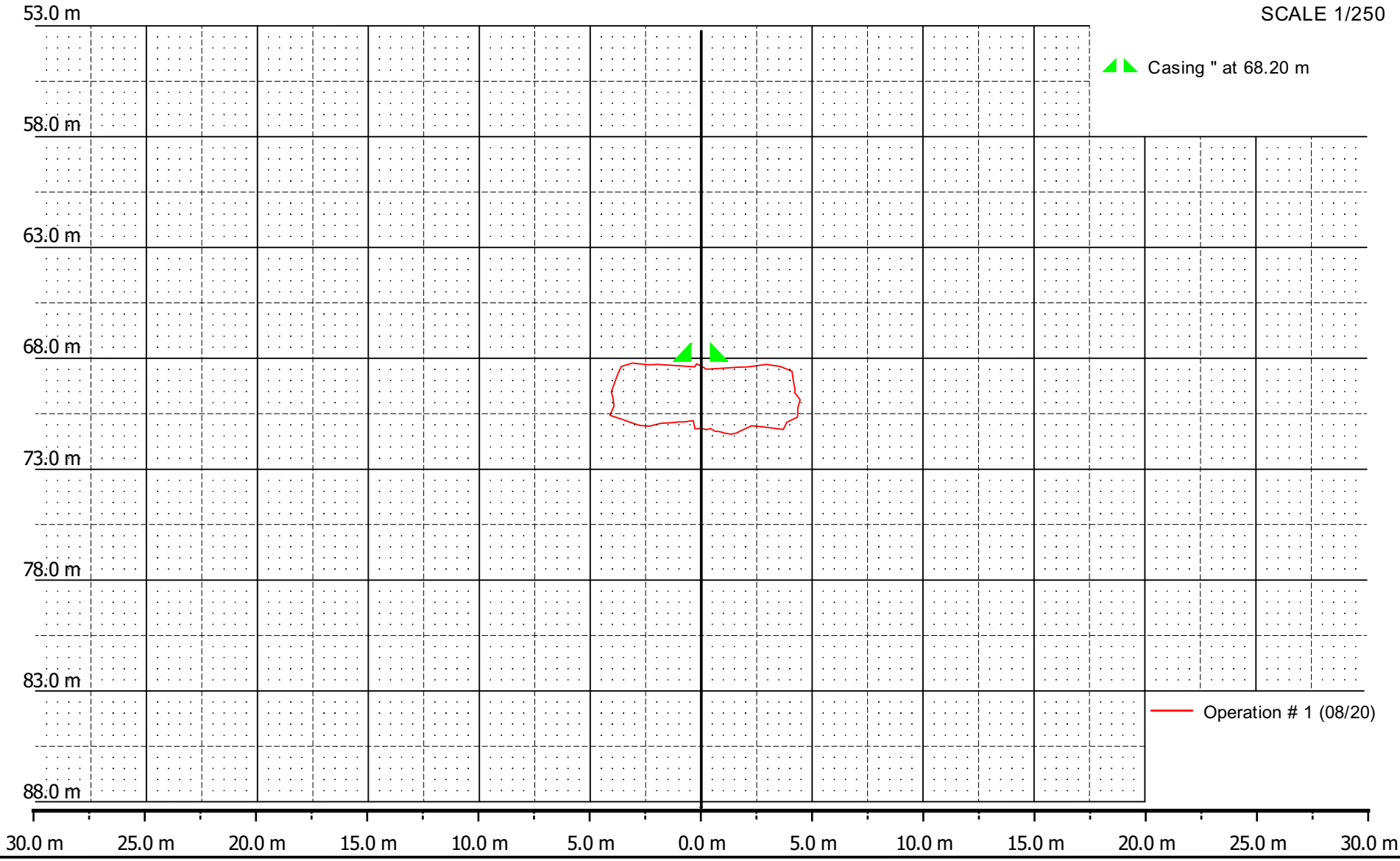
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

270° ← **19** → 90°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

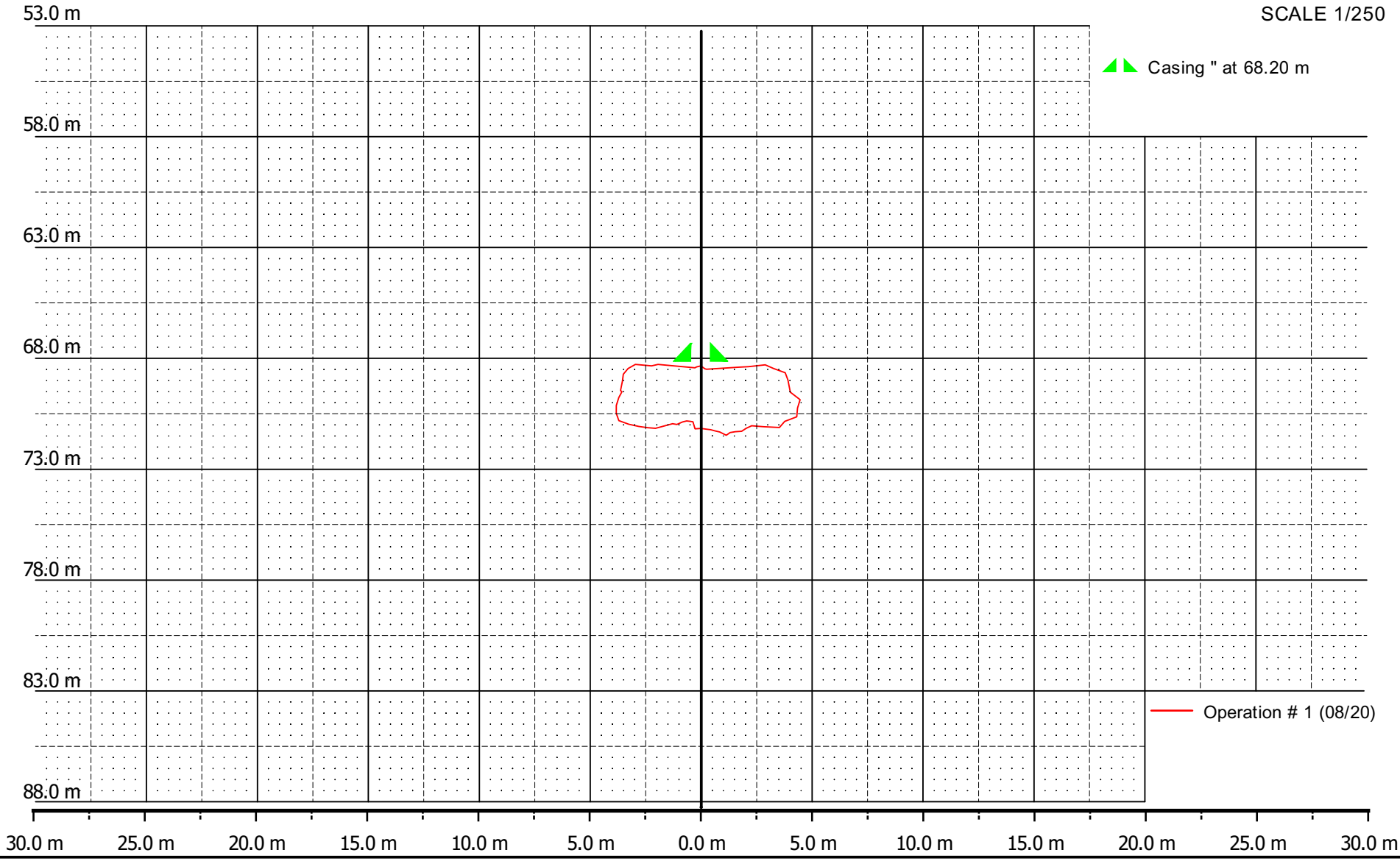
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

275° ← **20** → 95°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

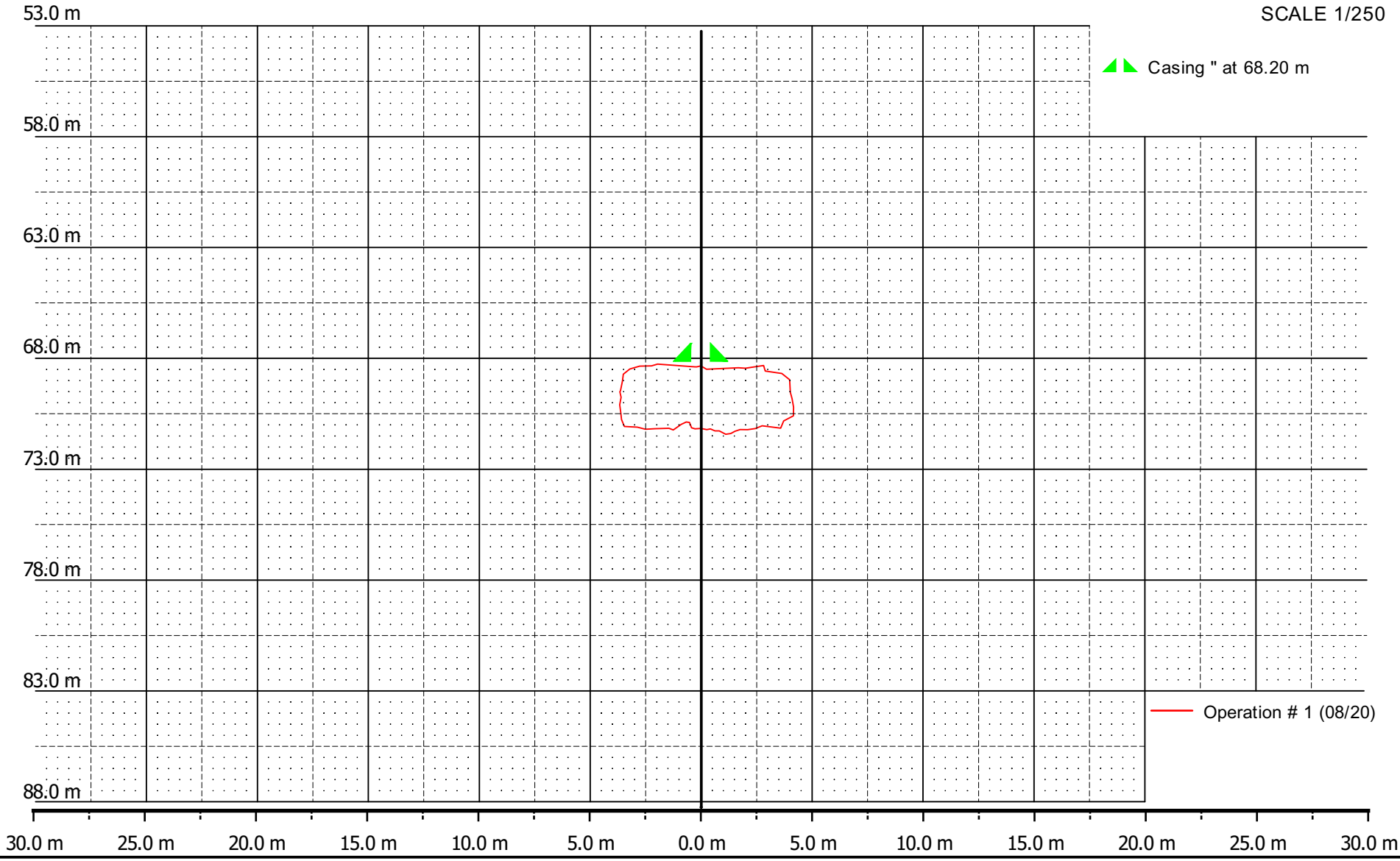
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

280° ← 21 → 100°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

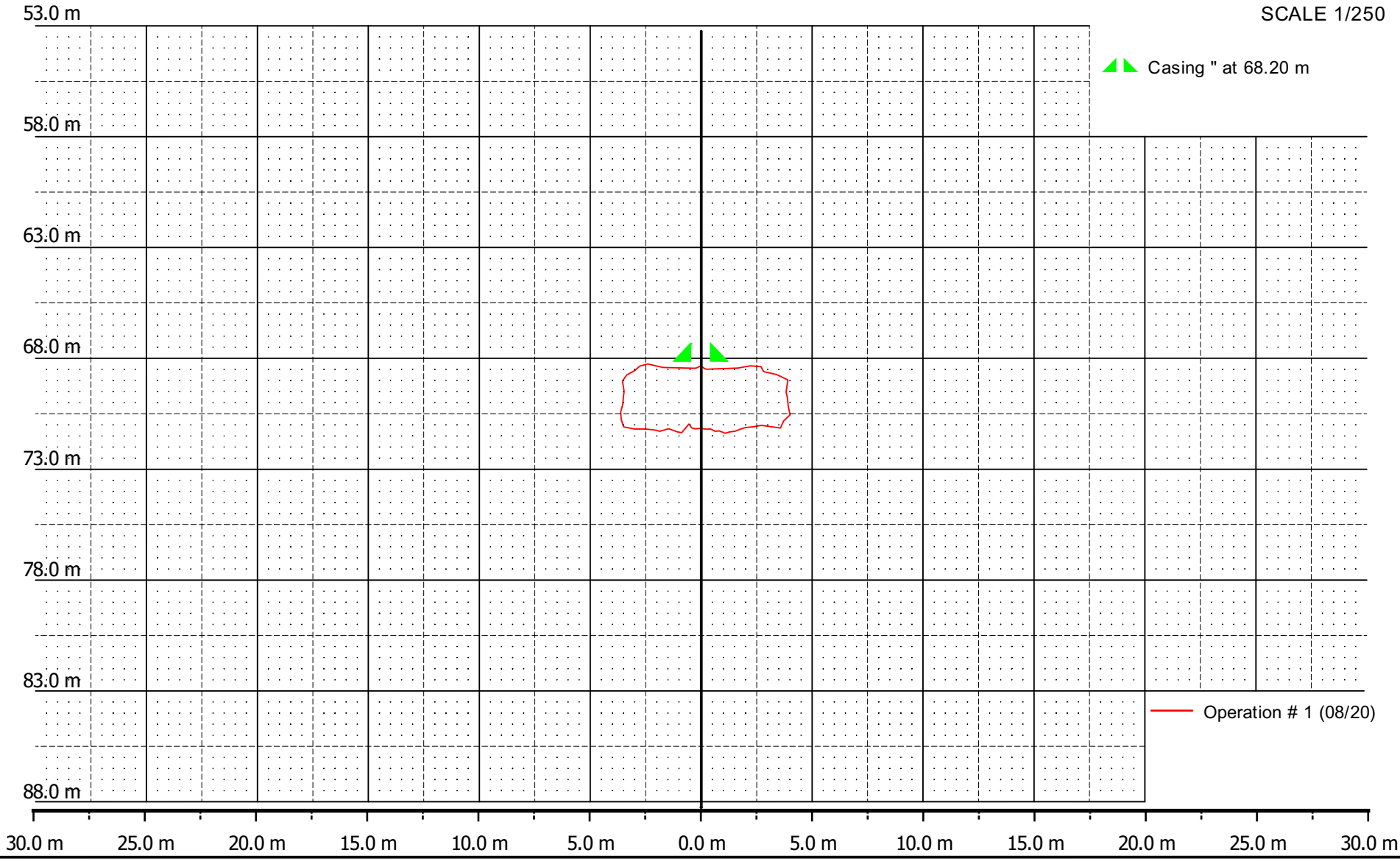
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

285° ← 22 → 105°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

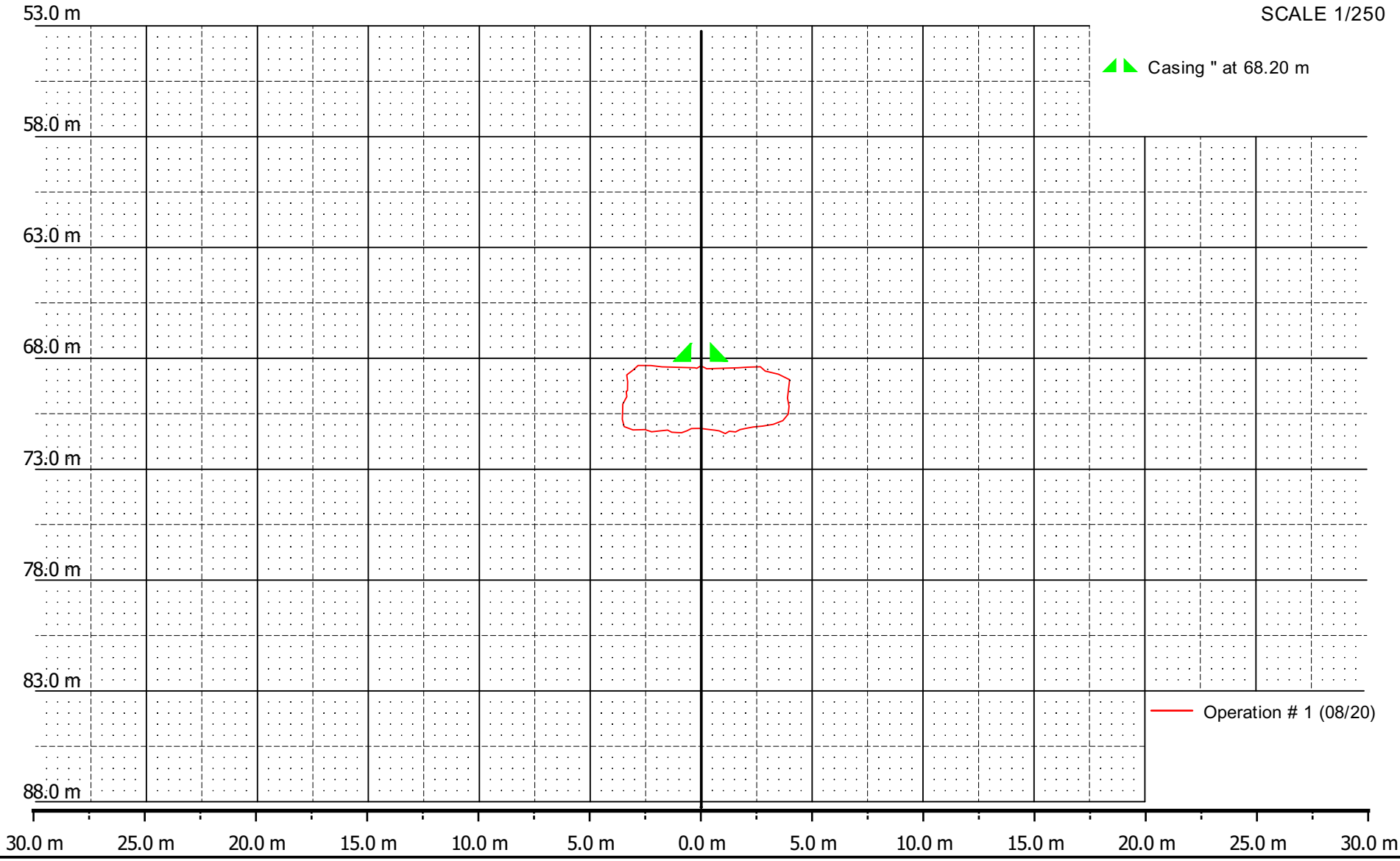
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

290° ← **23** → 110°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

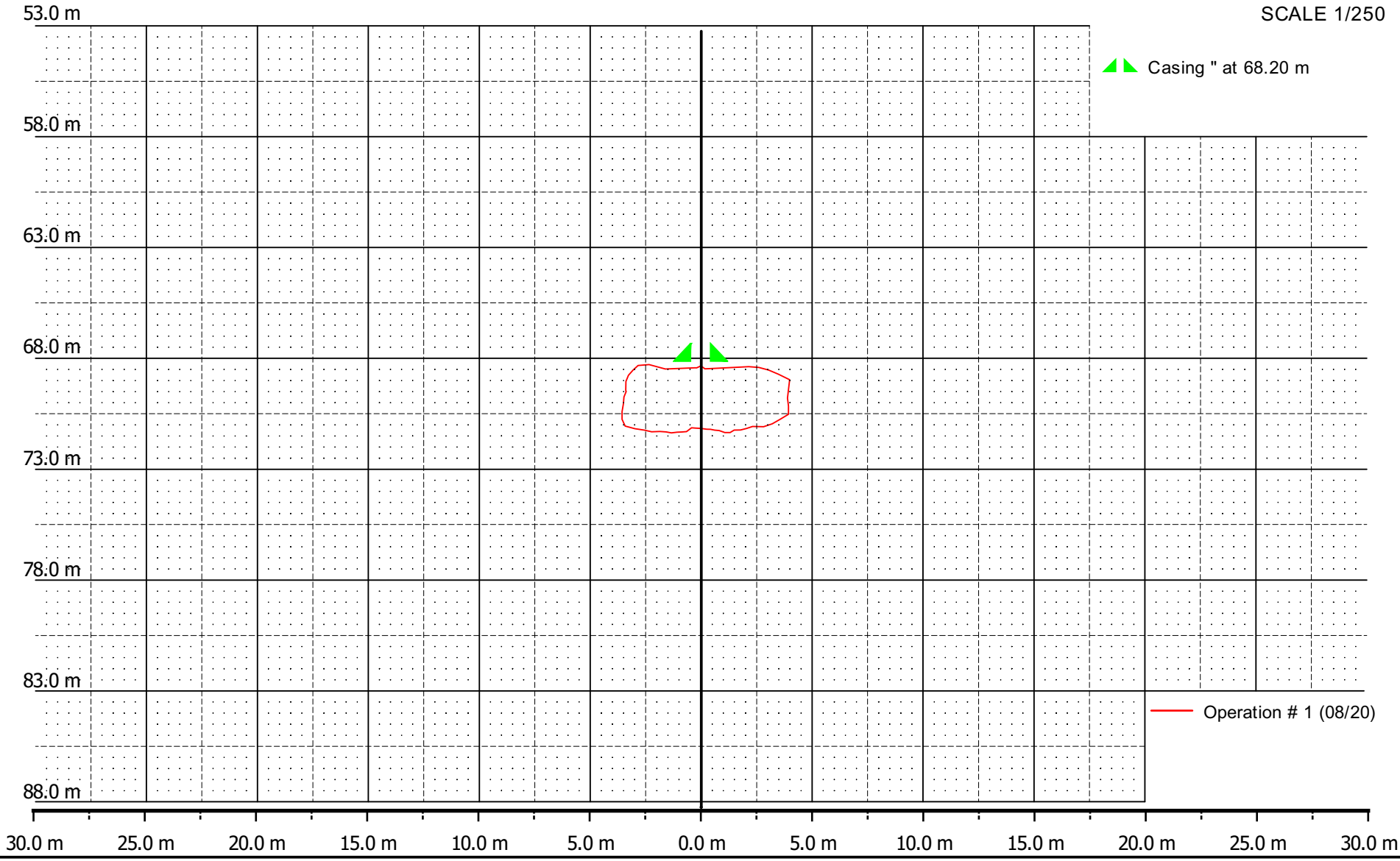
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

295° ← **24** → 115°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

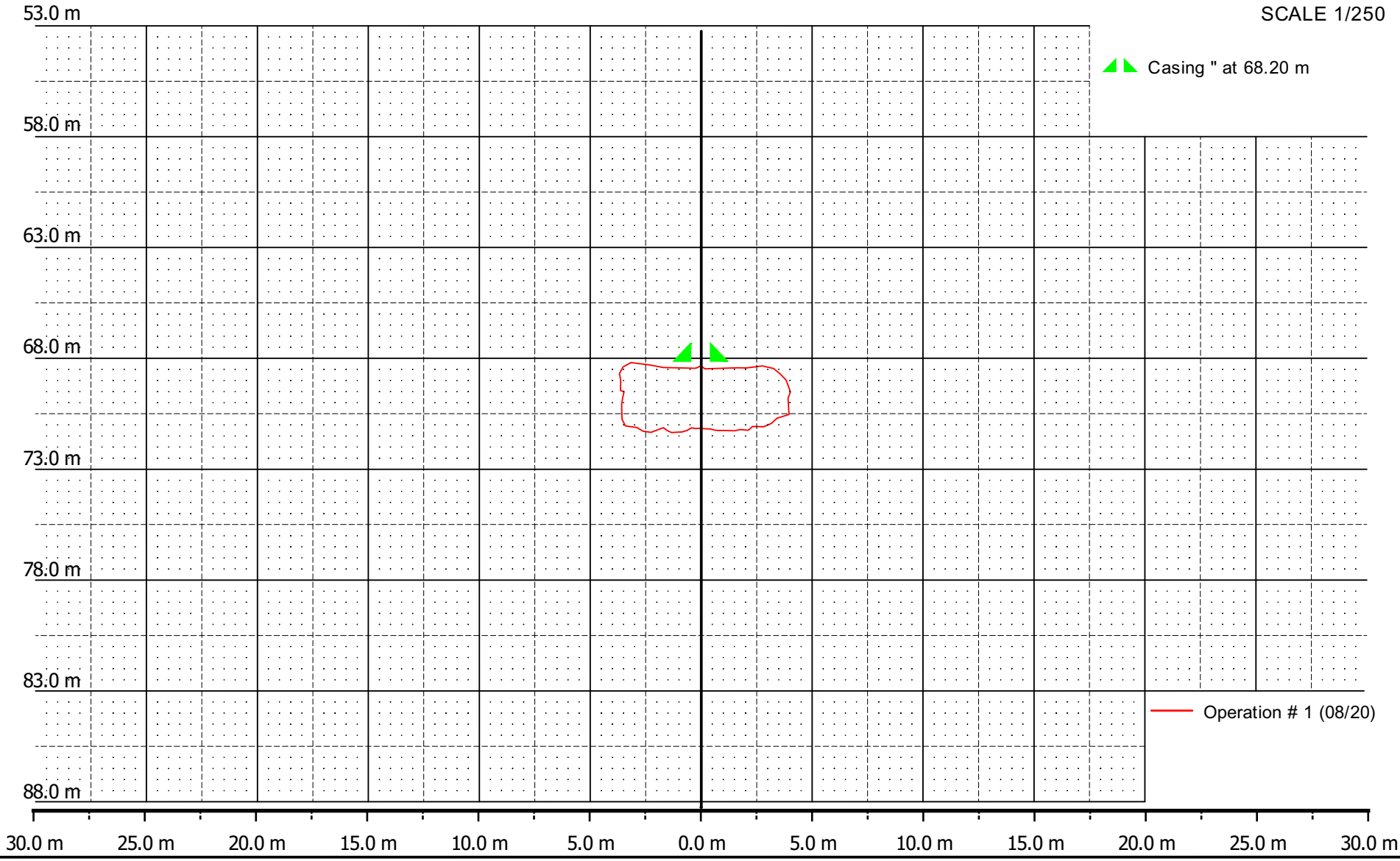
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

300° ← 25 → 120°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

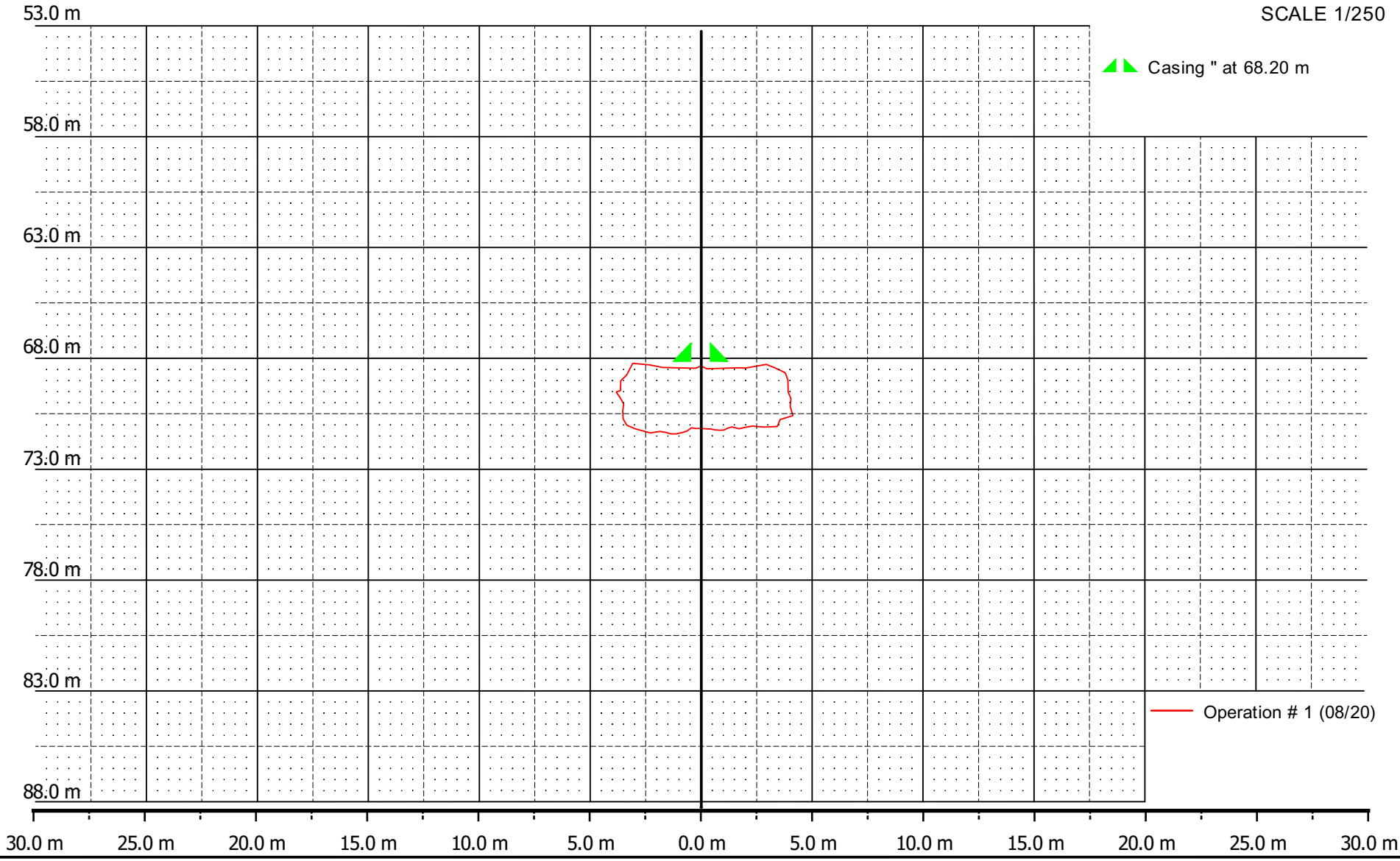
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

305° ← 26 → 125°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

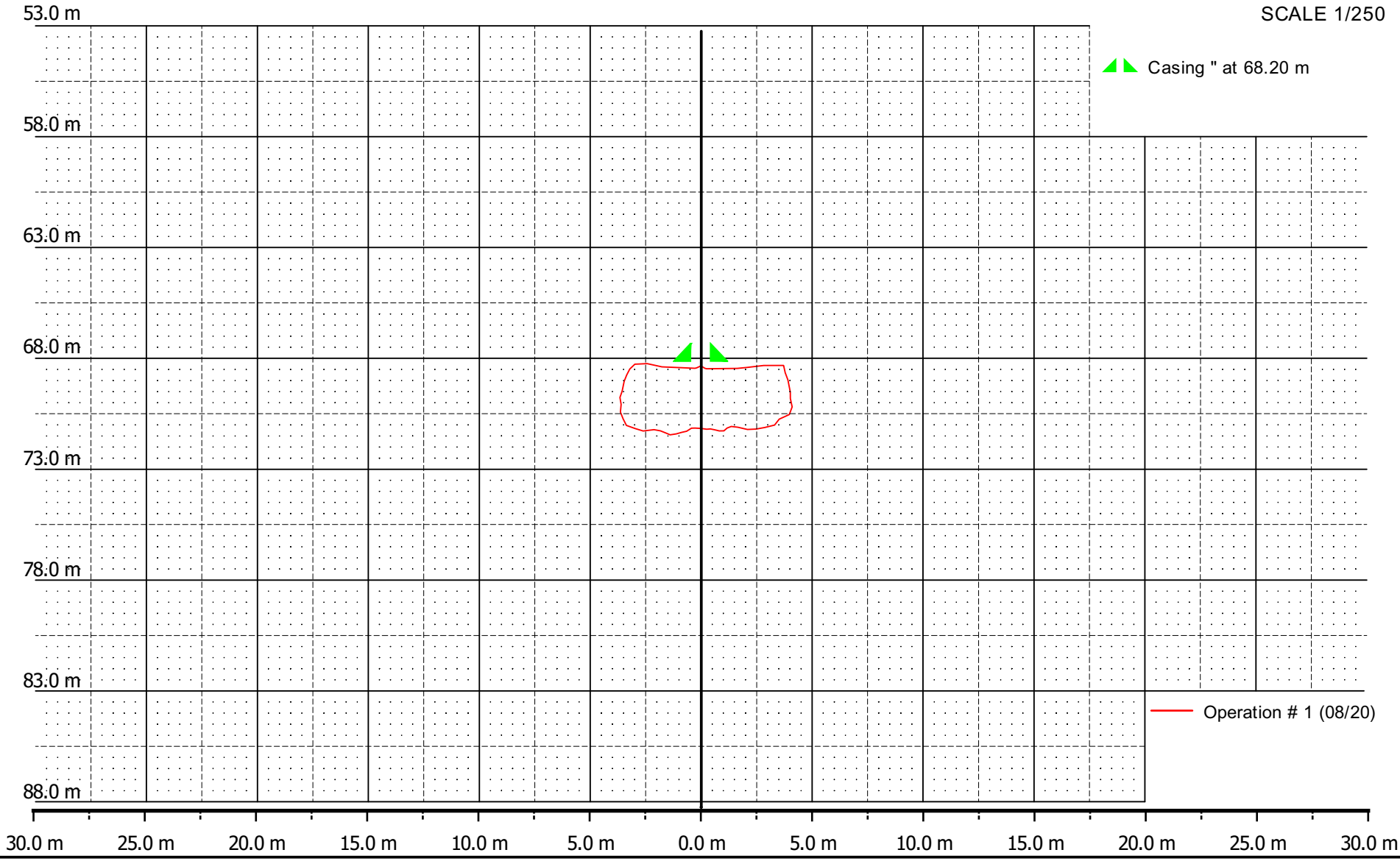
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

310° ← 27 → 130°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

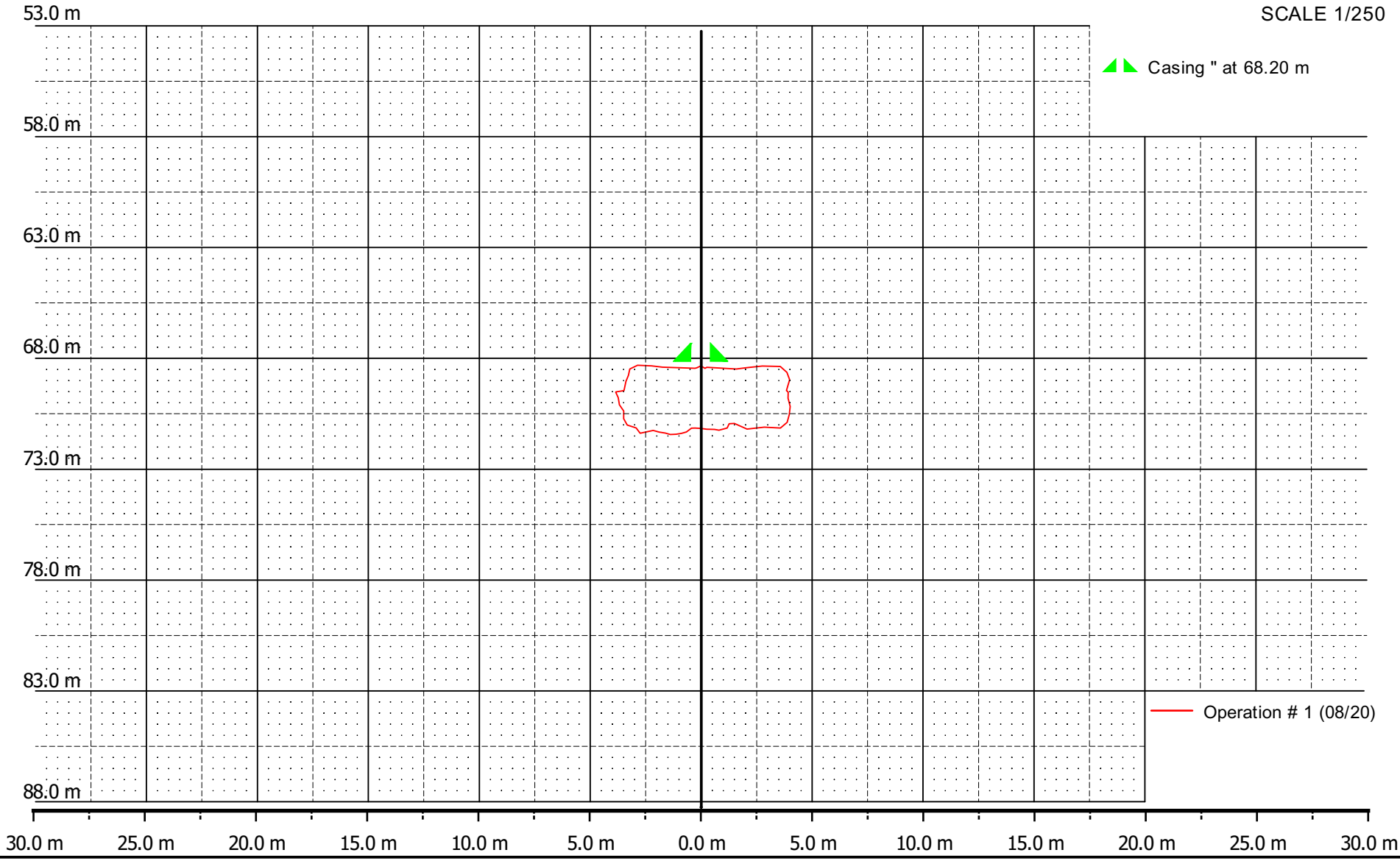
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

315° ← **28** → 135°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

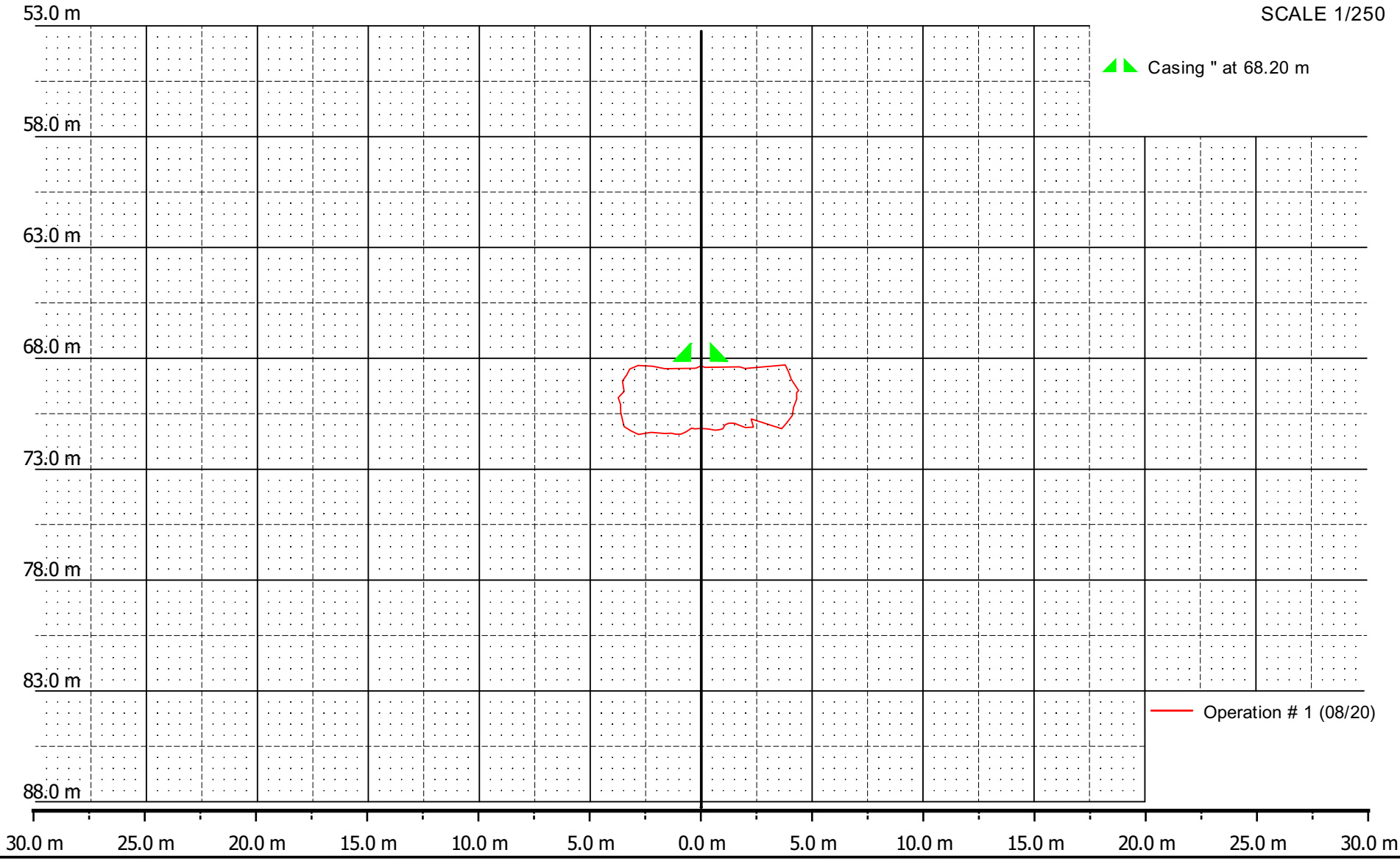
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

320° ← 29 → 140°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

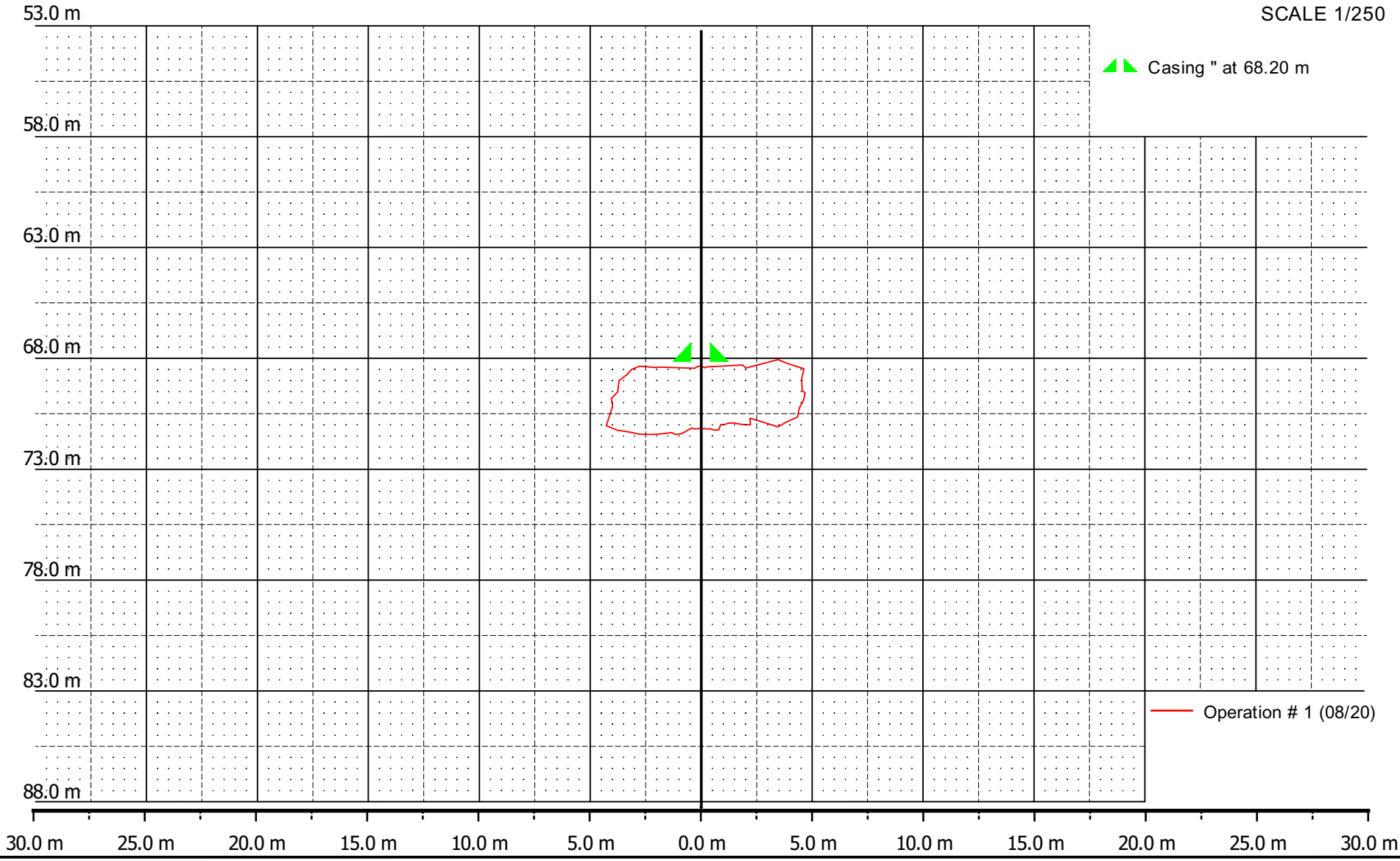
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

325° ← **30** → 145°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

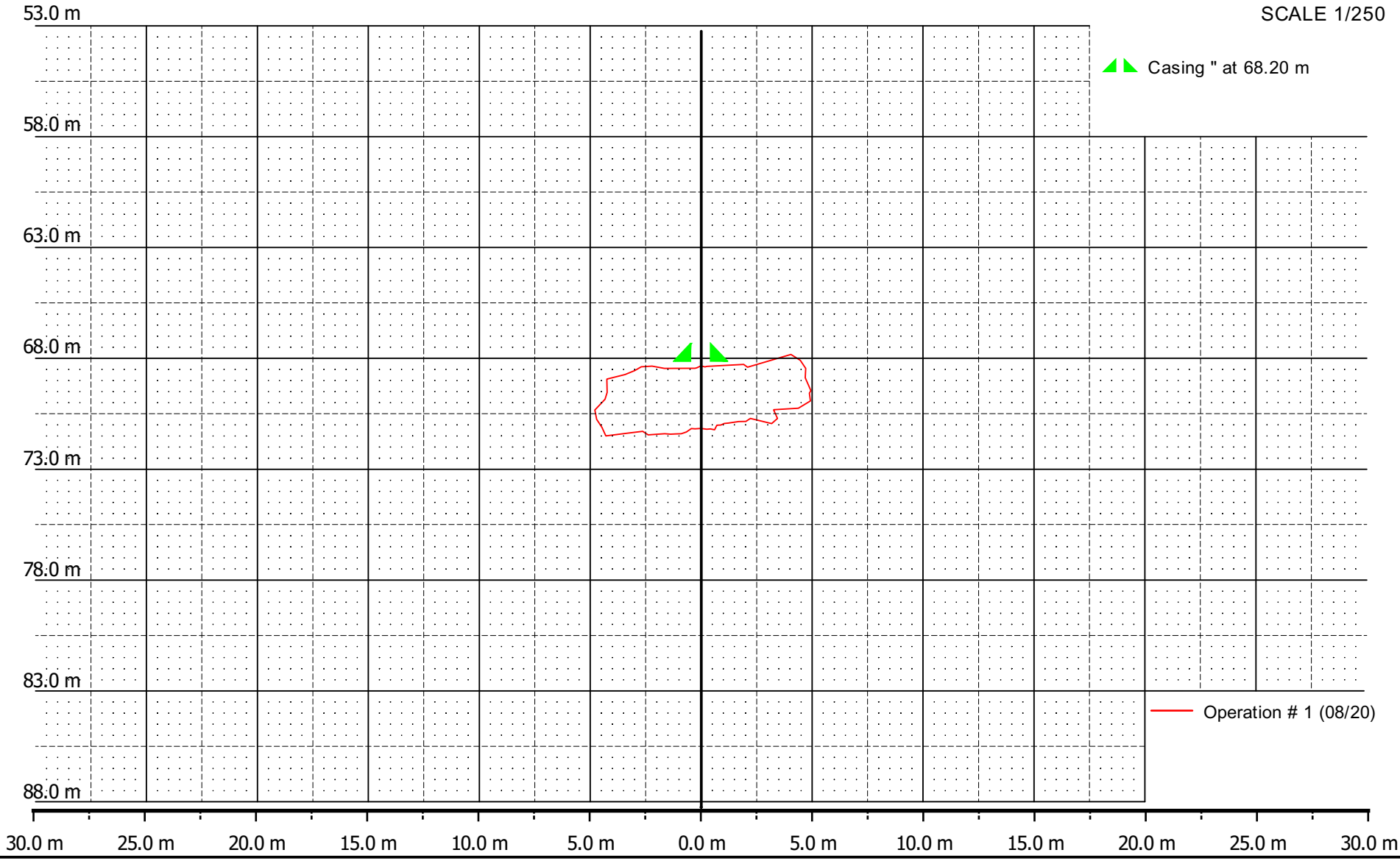


CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

330° ← 31 → 150°



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

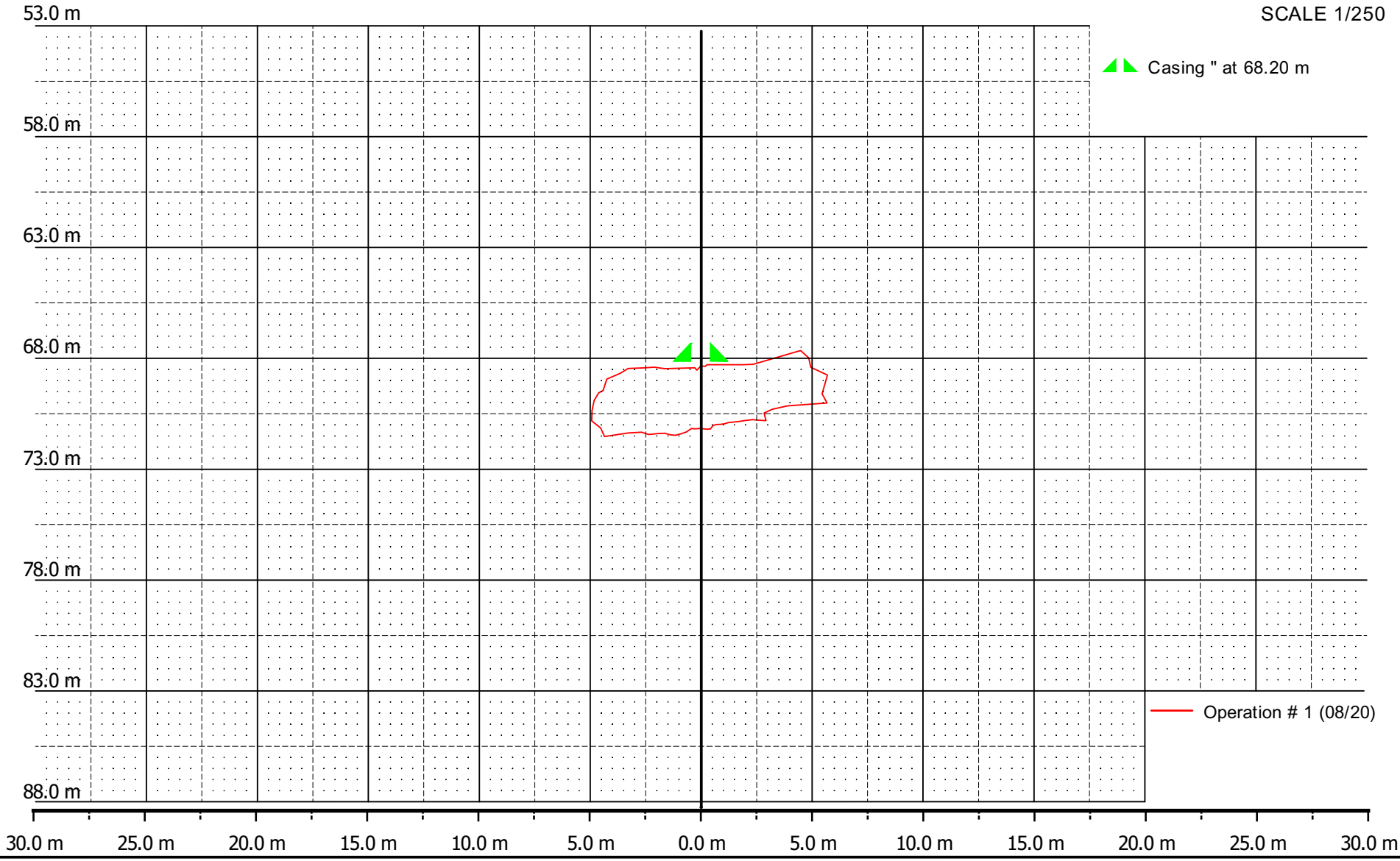
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

335° ← **32** → 155°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

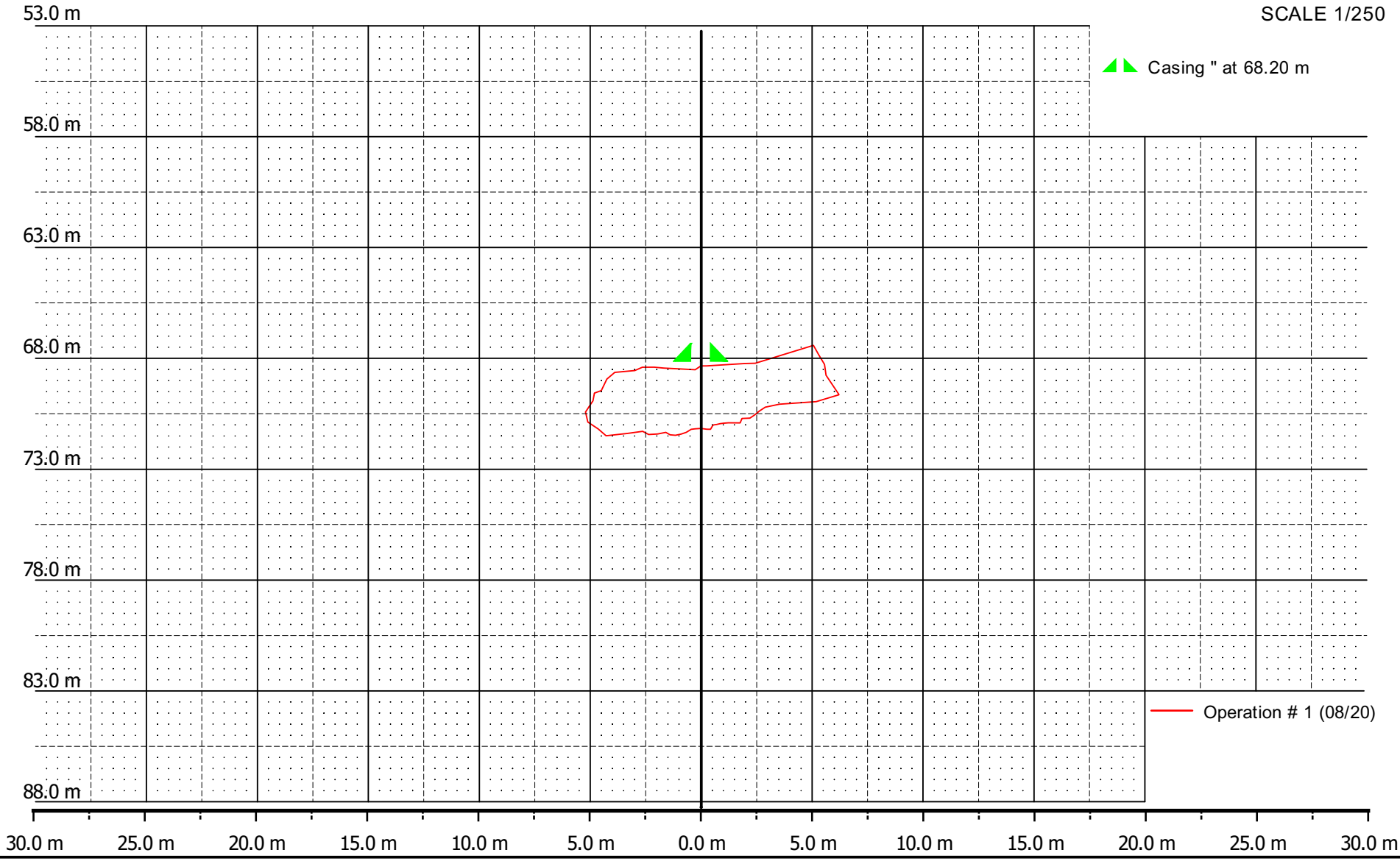
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

340° ← **33** → 160°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



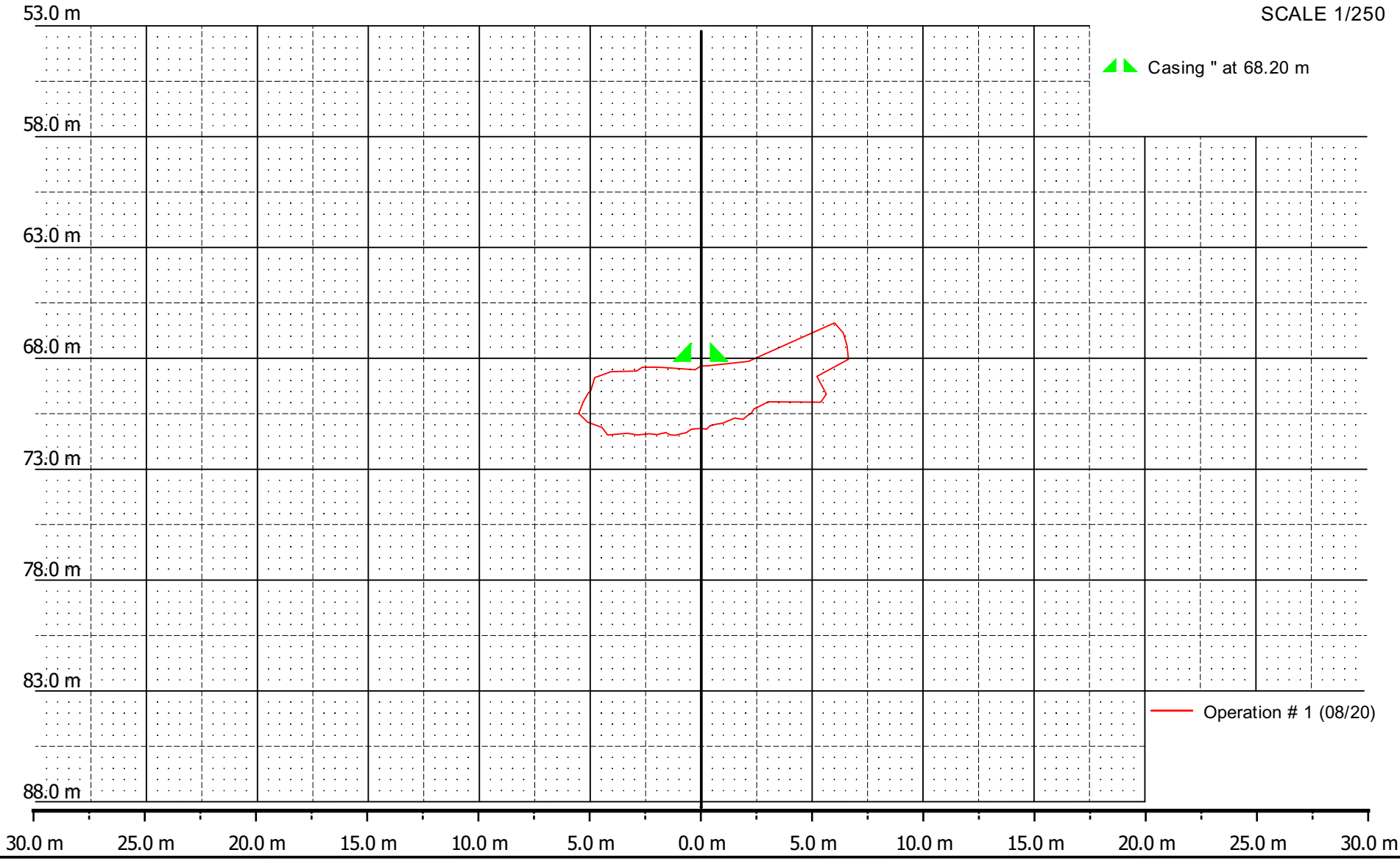
CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

345° ← **34** → 165°

GROUNDSEARCH AUSTRALIA
FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

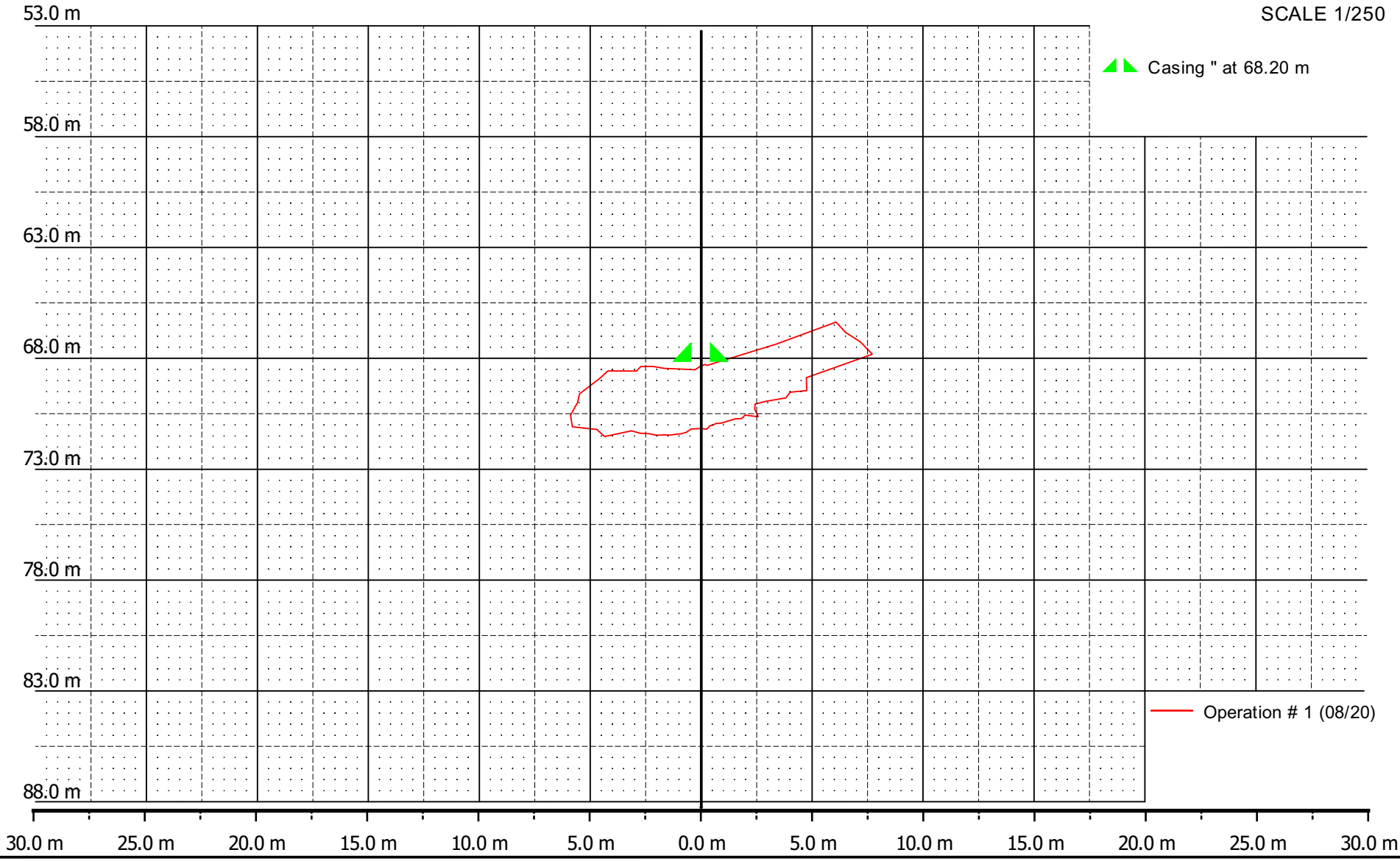
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

350° ← **35** → 170°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits



CUSTOMER : GROUNDSEARCH
DATE : 20/08/2020

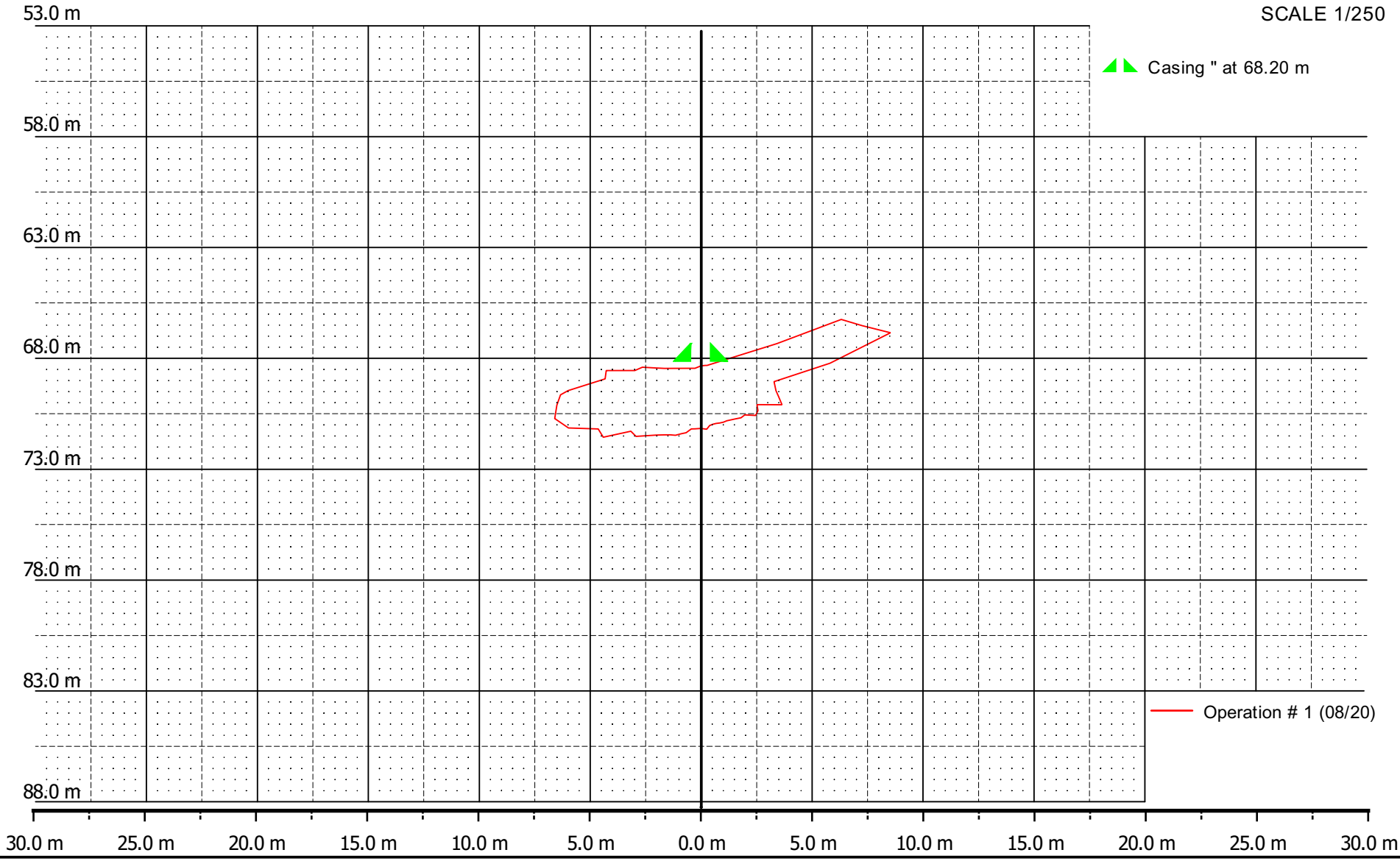
CAVITY : BH28C_UG
OPERATION # : 1

VERTICAL SECTION

355° ← **36** → 175°

GROUNDSEARCH AUSTRALIA

FLODIM
Challenging the limits

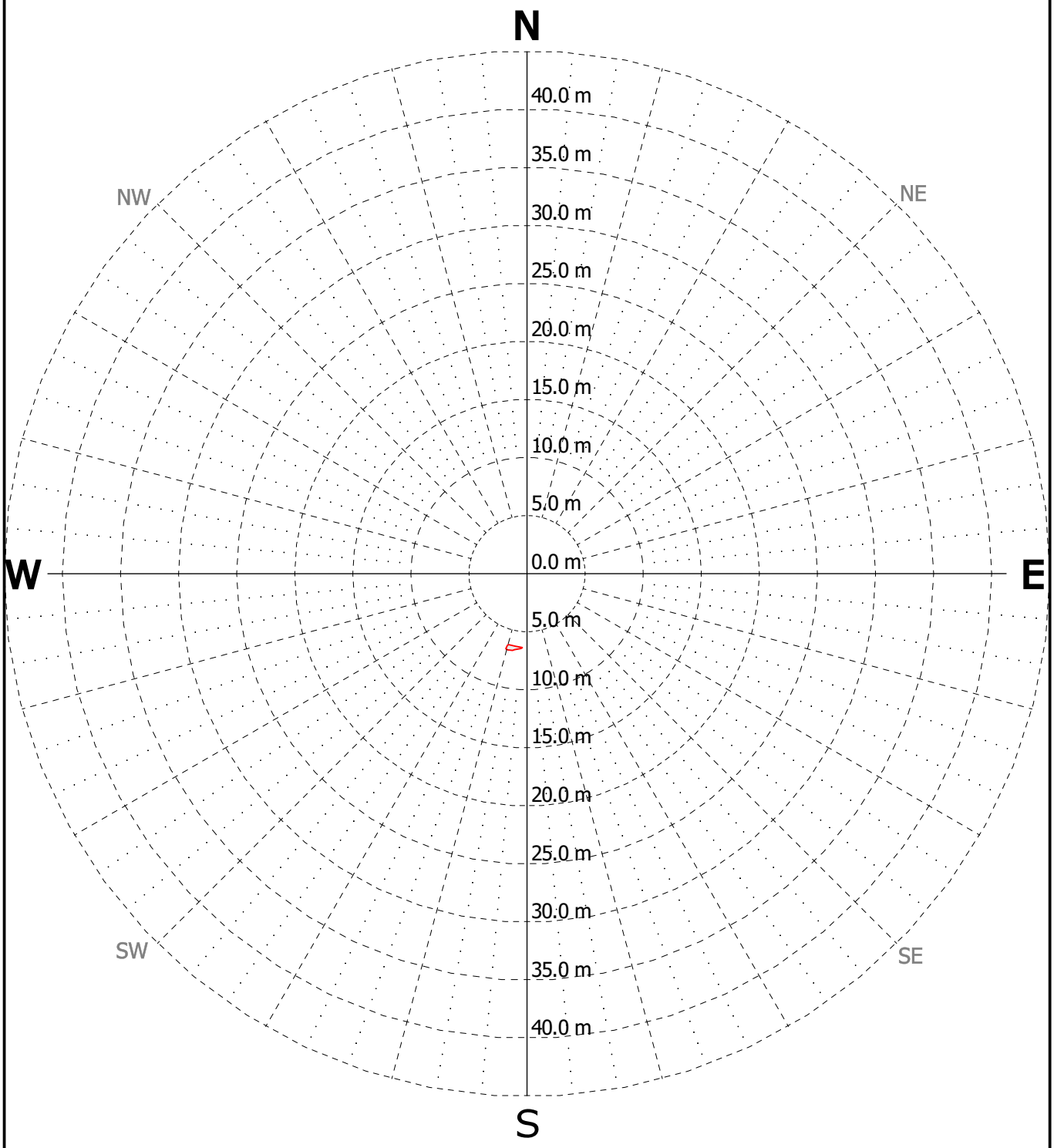


	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

65.5 m

SCALE 1/500



Operation # 1 (08/20)

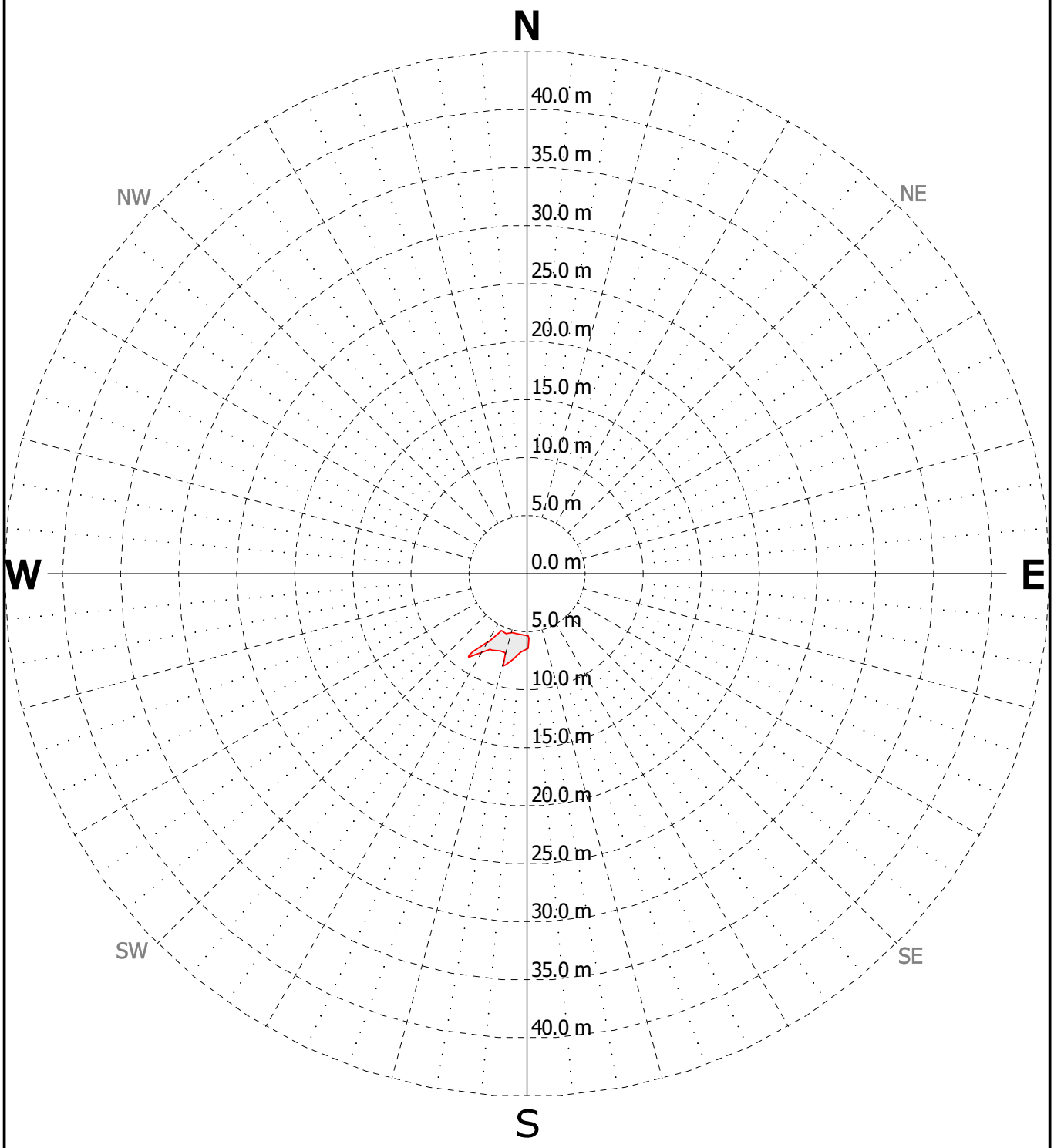
Maximum radius	: 6.83 m
Orientation maxi. radius	: 195 °
Surface	: 0.40 m²
Maximum distance	: 1.45 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

66.0 m

SCALE 1/500



Operation # 1 (08/20)

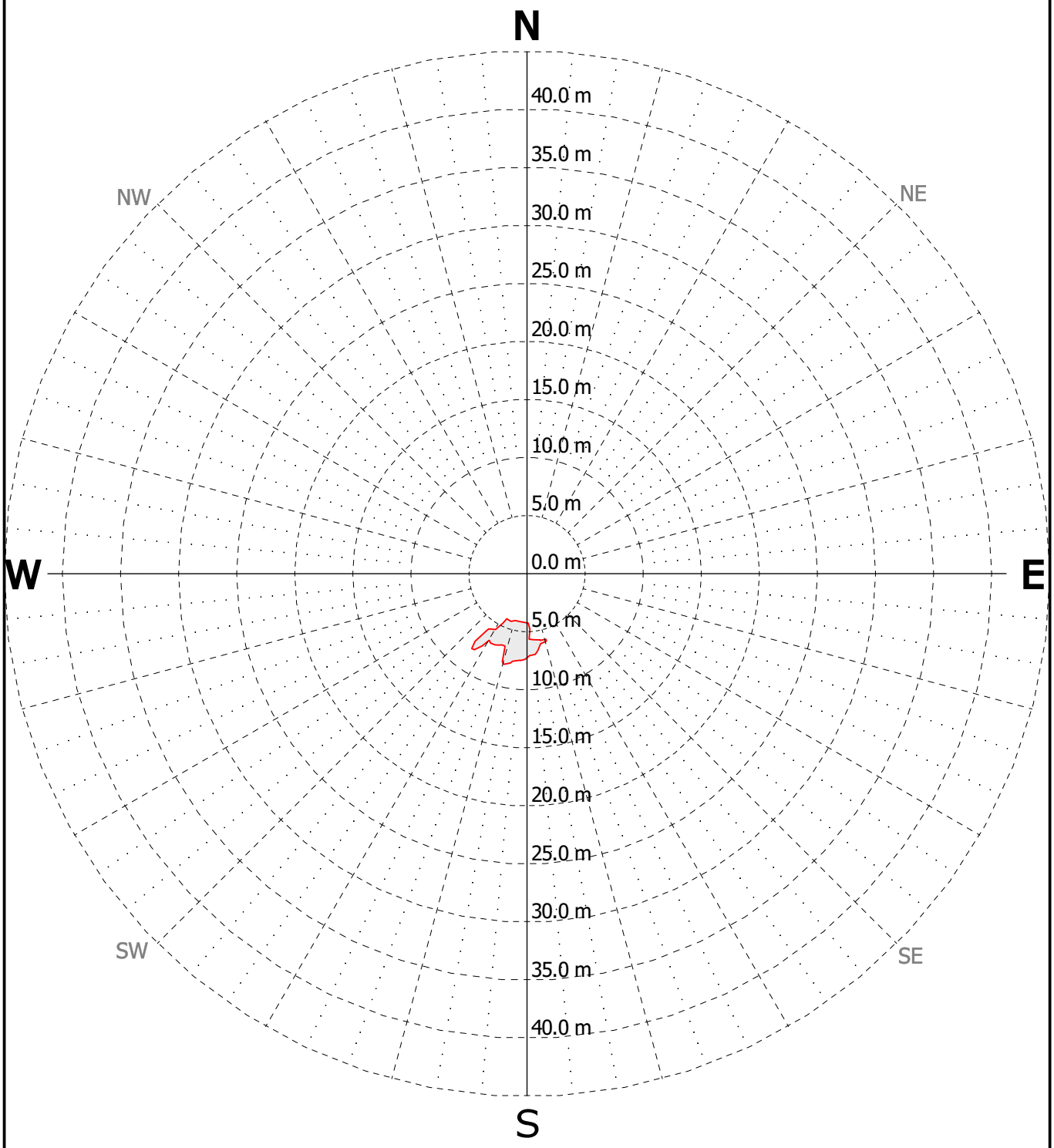
Maximum radius	: 8.84 m
Orientation maxi. radius	: 215 °
Surface	: 6.57 m²
Maximum distance	: 5.43 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

66.5 m

SCALE 1/500



Operation # 1 (08/20)

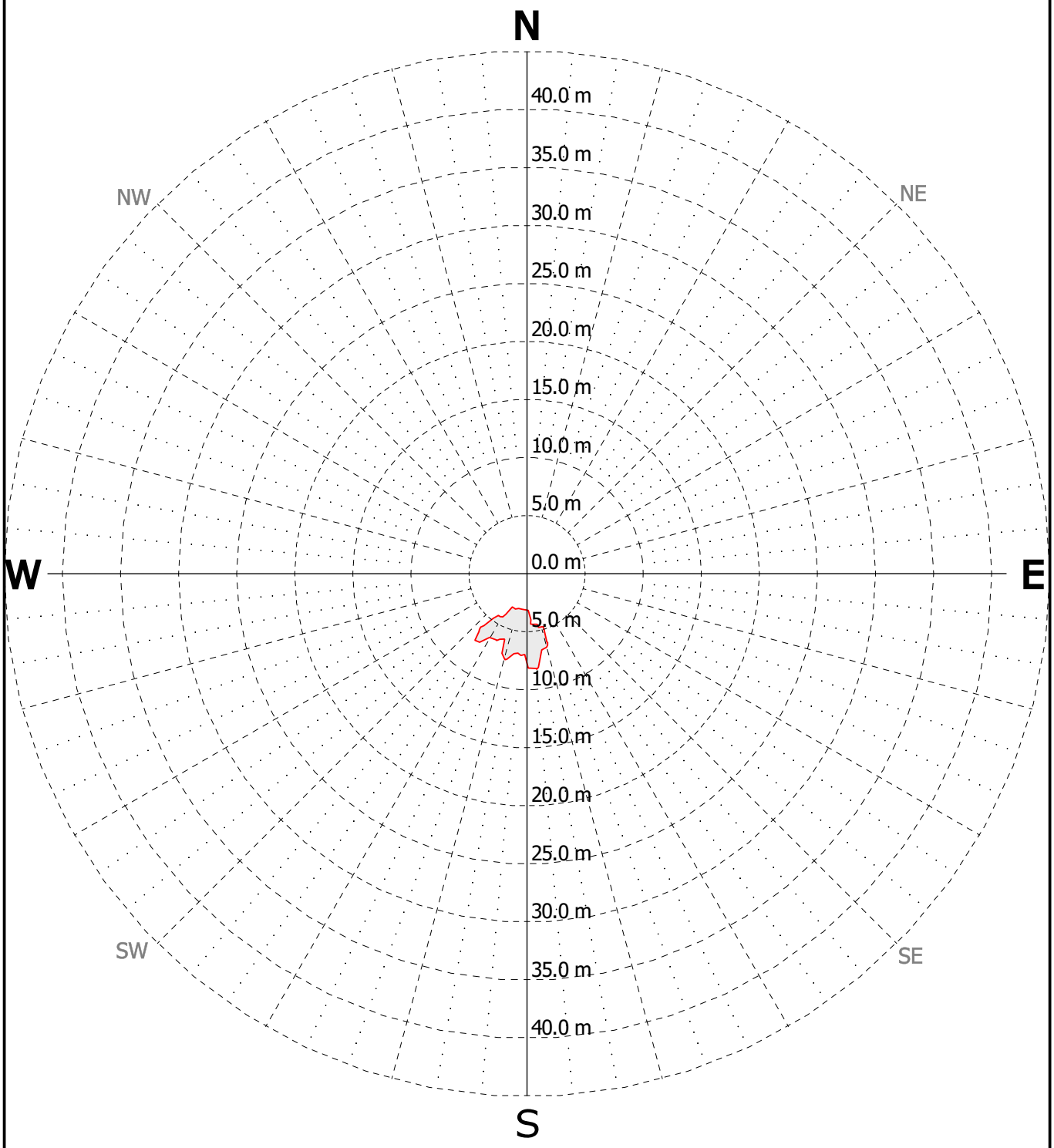
Maximum radius	: 8.13 m
Orientation maxi. radius	: 195 °
Surface	: 11.71 m²
Maximum distance	: 6.45 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

67.0 m

SCALE 1/500



Operation # 1 (08/20)

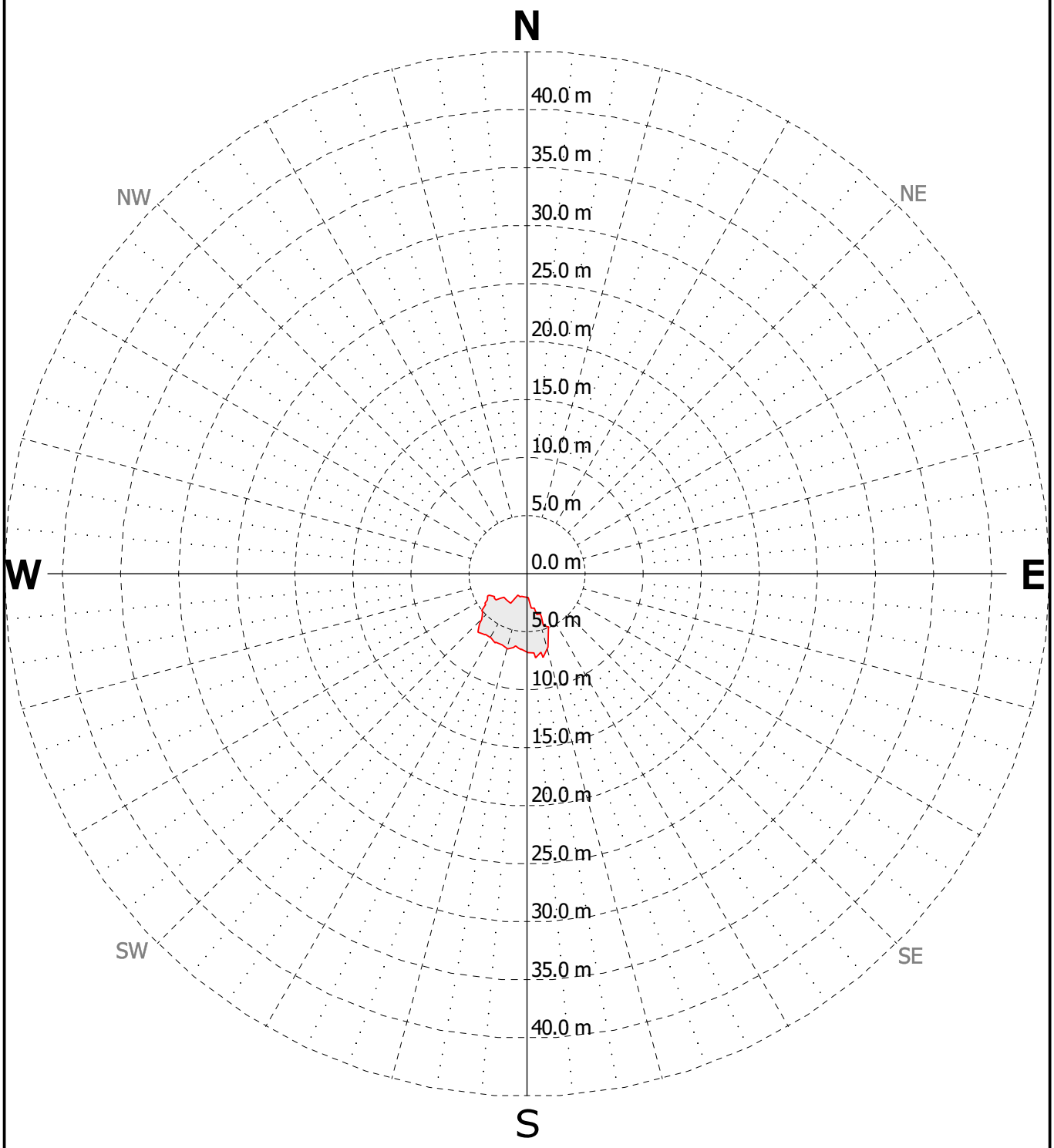
Maximum radius	: 8.31 m
Orientation maxi. radius	: 175 °
Surface	: 16.91 m²
Maximum distance	: 6.25 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

67.5 m

SCALE 1/500



Operation # 1 (08/20)

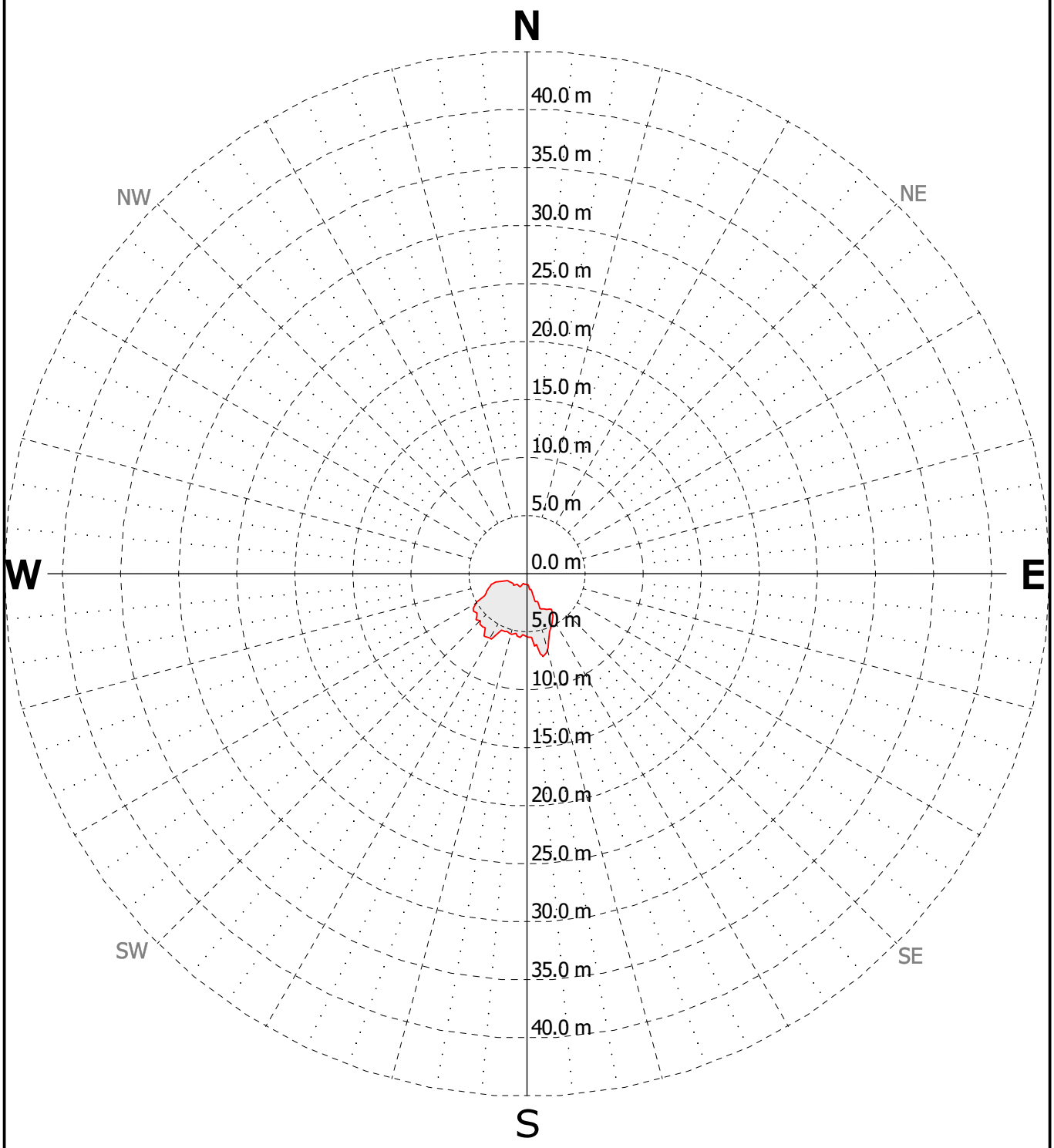
Maximum radius	: 7.37 m
Orientation maxi. radius	: 170 °
Surface	: 21.49 m²
Maximum distance	: 7.10 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

68.0 m

SCALE 1/500



Operation # 1 (08/20)

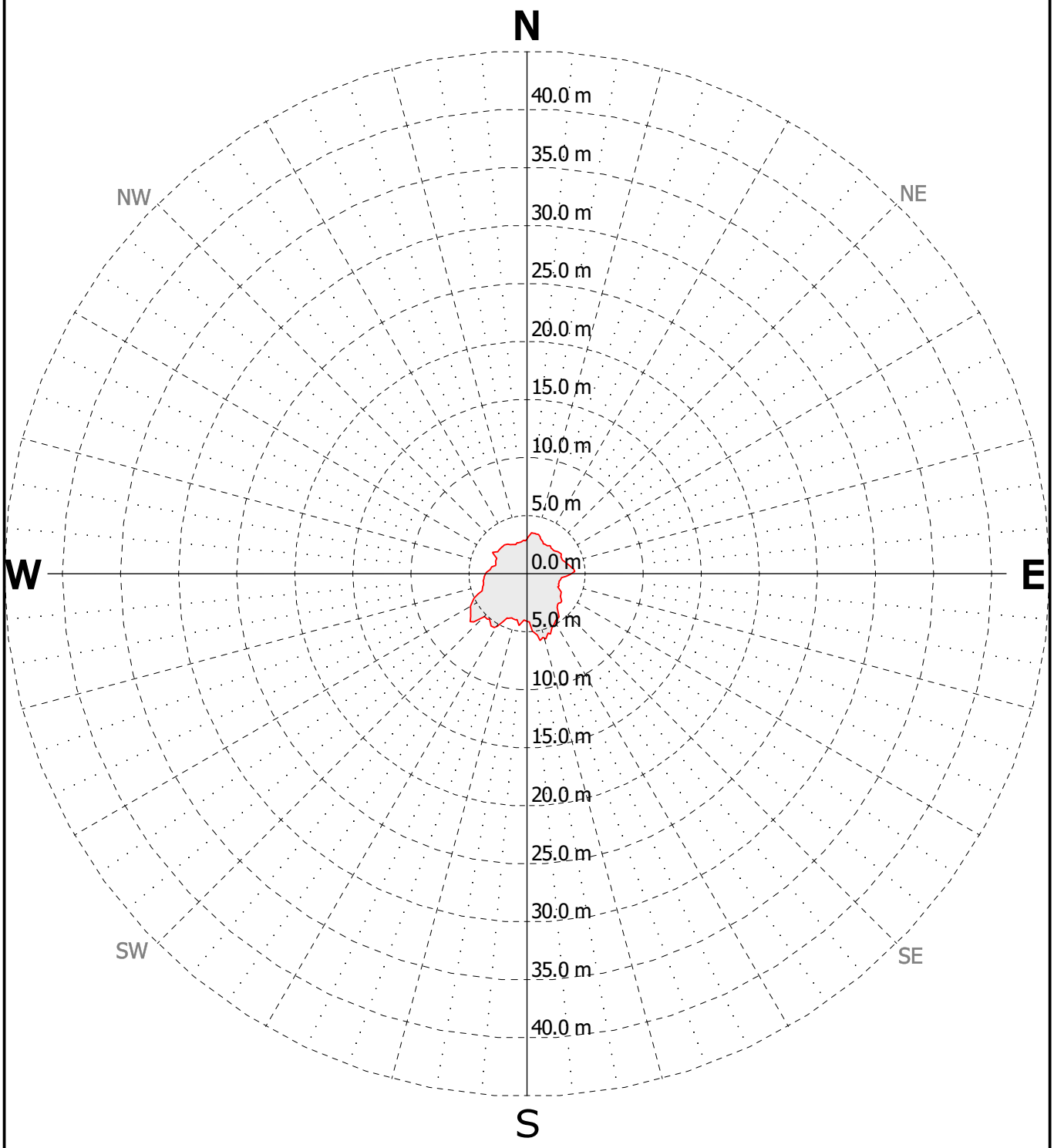
Maximum radius	: 7.30 m
Orientation maxi. radius	: 170 °
Surface	: 25.27 m²
Maximum distance	: 7.63 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

68.5 m

SCALE 1/500



Operation # 1 (08/20)

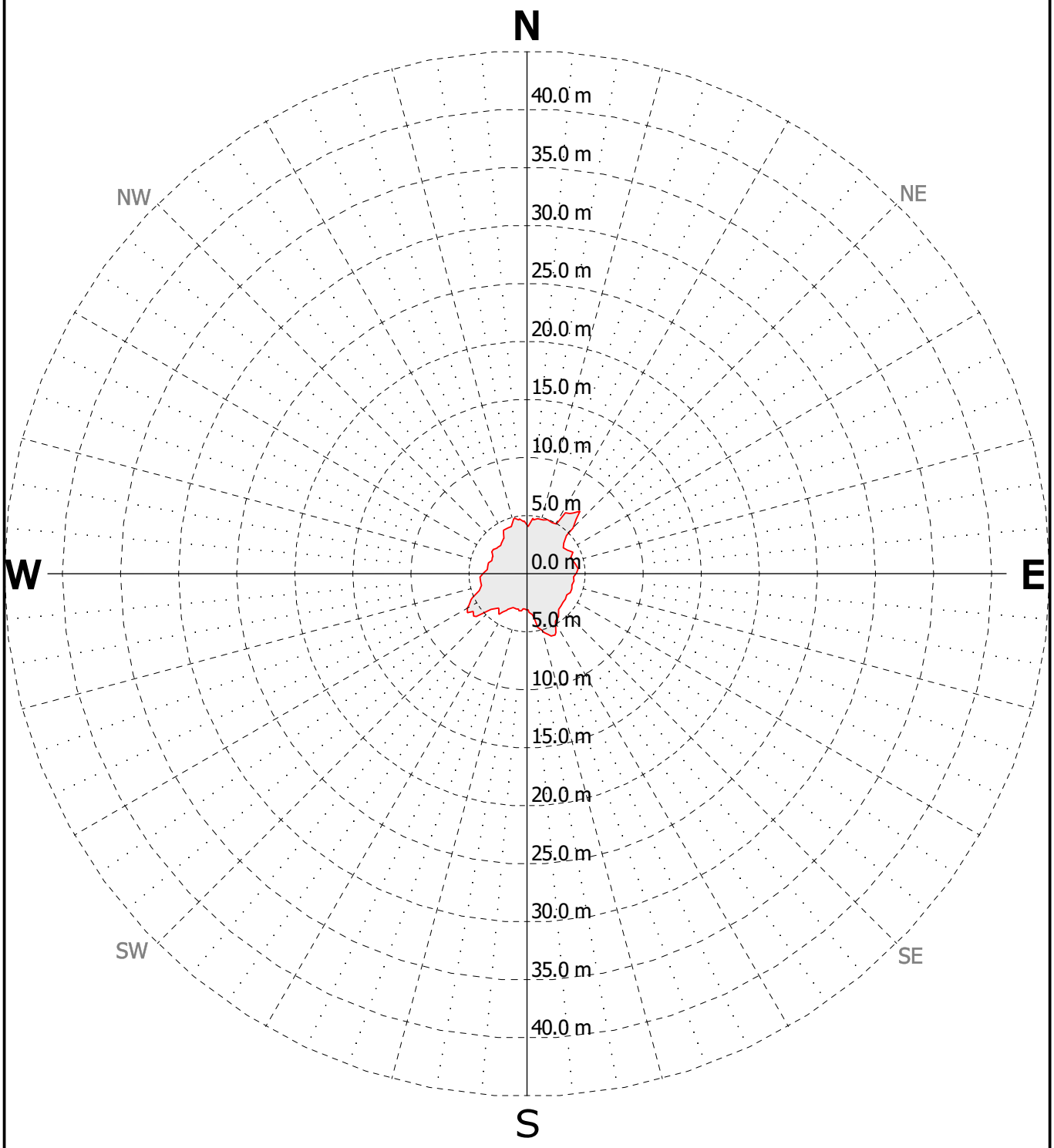
Maximum radius	: 6.50 m
Orientation maxi. radius	: 230 °
Surface	: 47.24 m²
Maximum distance	: 9.96 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

69.0 m

SCALE 1/500



Operation # 1 (08/20)

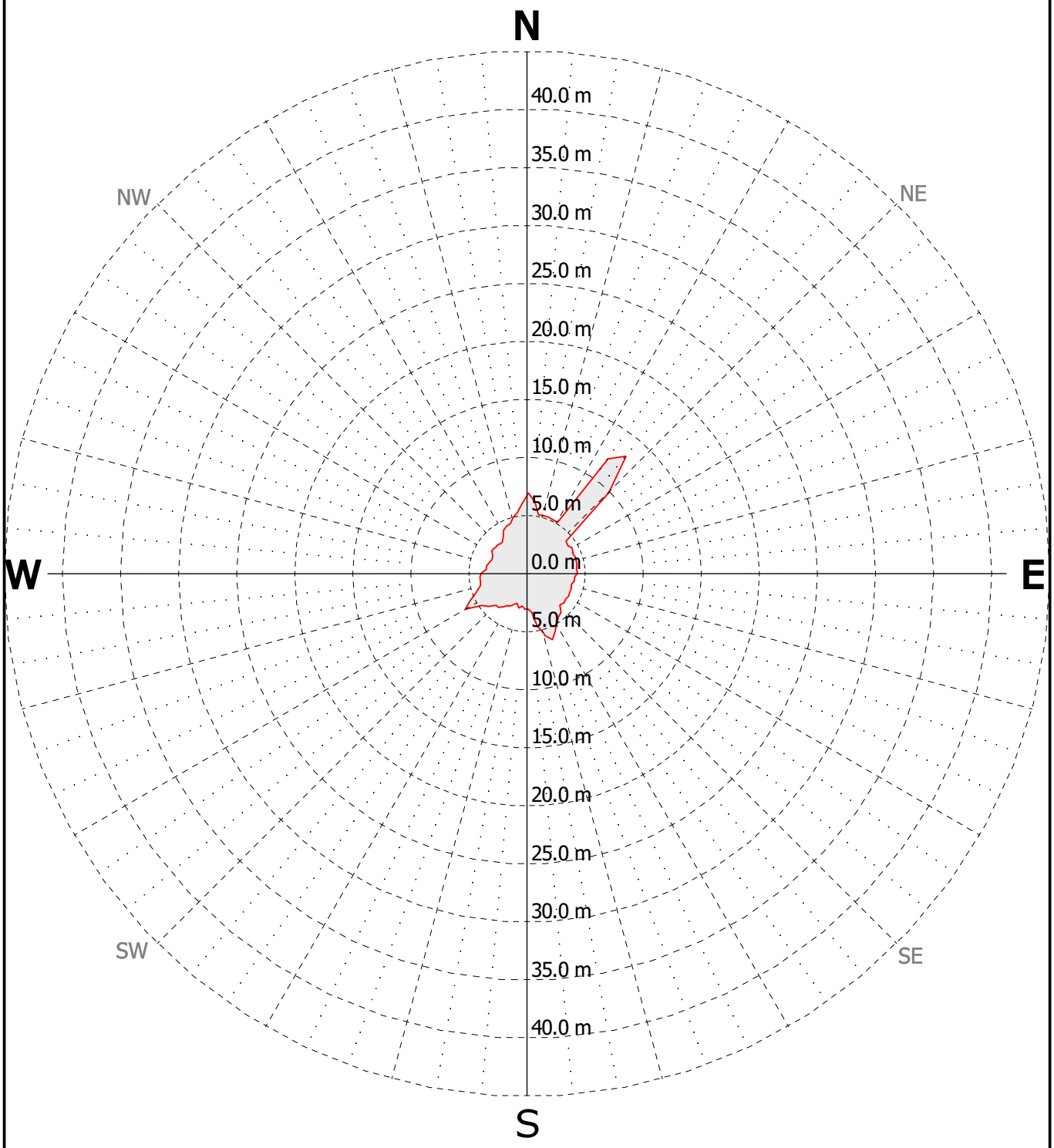
Maximum radius	: 6.92 m
Orientation maxi. radius	: 40 °
Surface	: 58.33 m²
Maximum distance	: 13.01 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

69.5 m

SCALE 1/500



Operation # 1 (08/20)

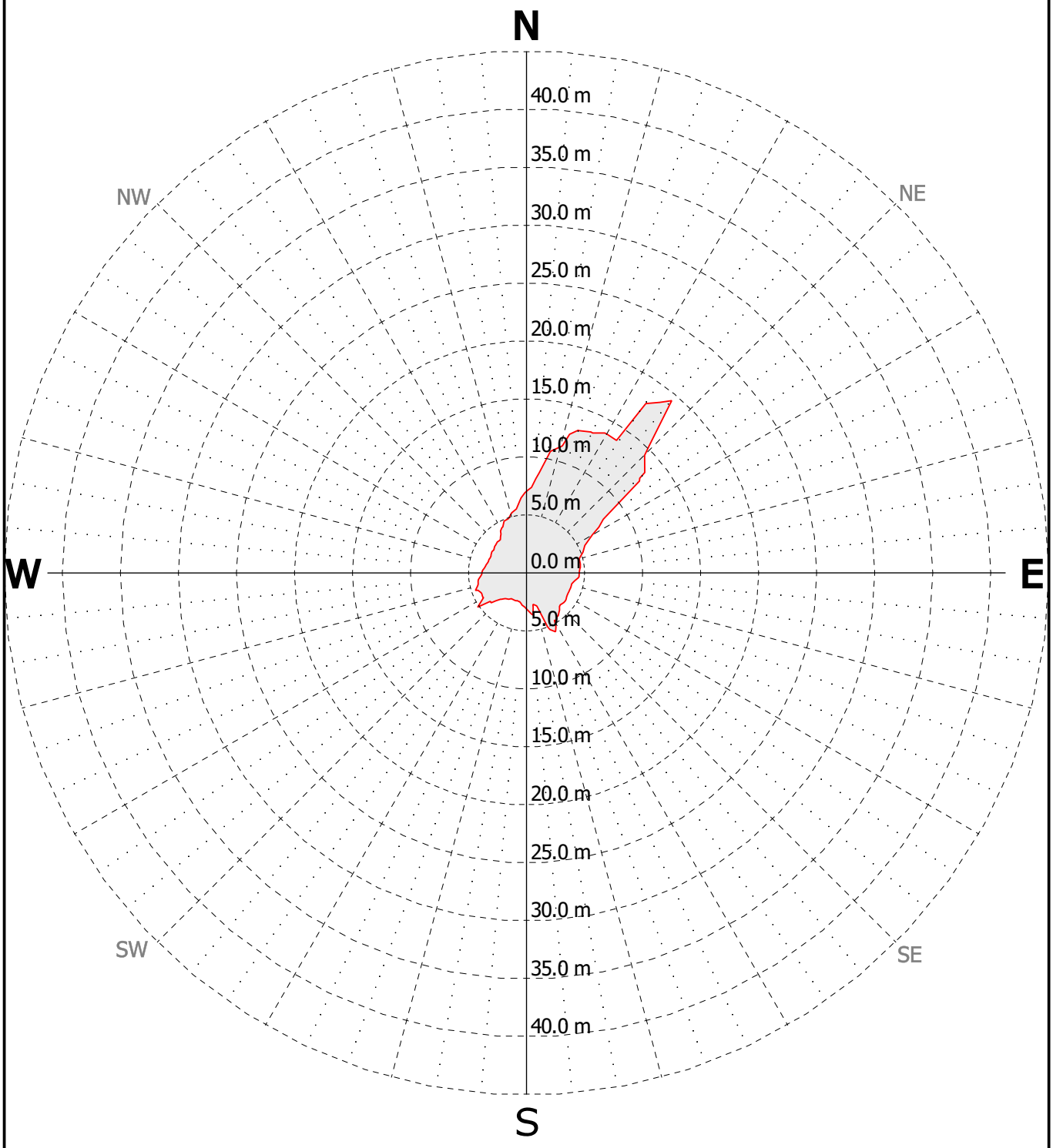
Maximum radius	: 13.08 m
Orientation maxi. radius	: 40 °
Surface	: 72.49 m²
Maximum distance	: 19.04 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

70.0 m

SCALE 1/500



Operation # 1 (08/20)

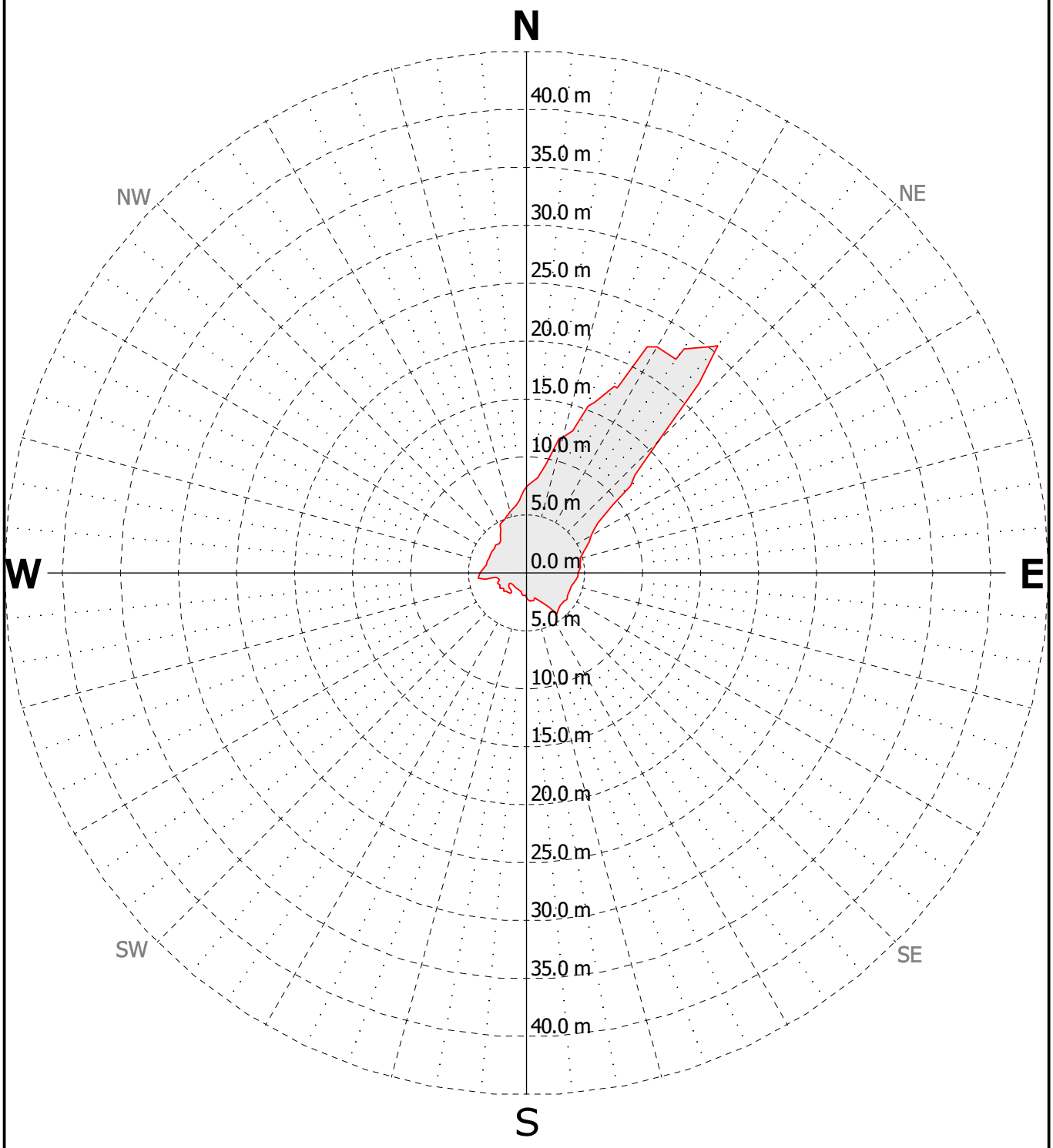
Maximum radius	: 19.25 m
Orientation maxi. radius	: 40 °
Surface	: 128.82 m²
Maximum distance	: 24.33 m

CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

70.5 m

SCALE 1/500



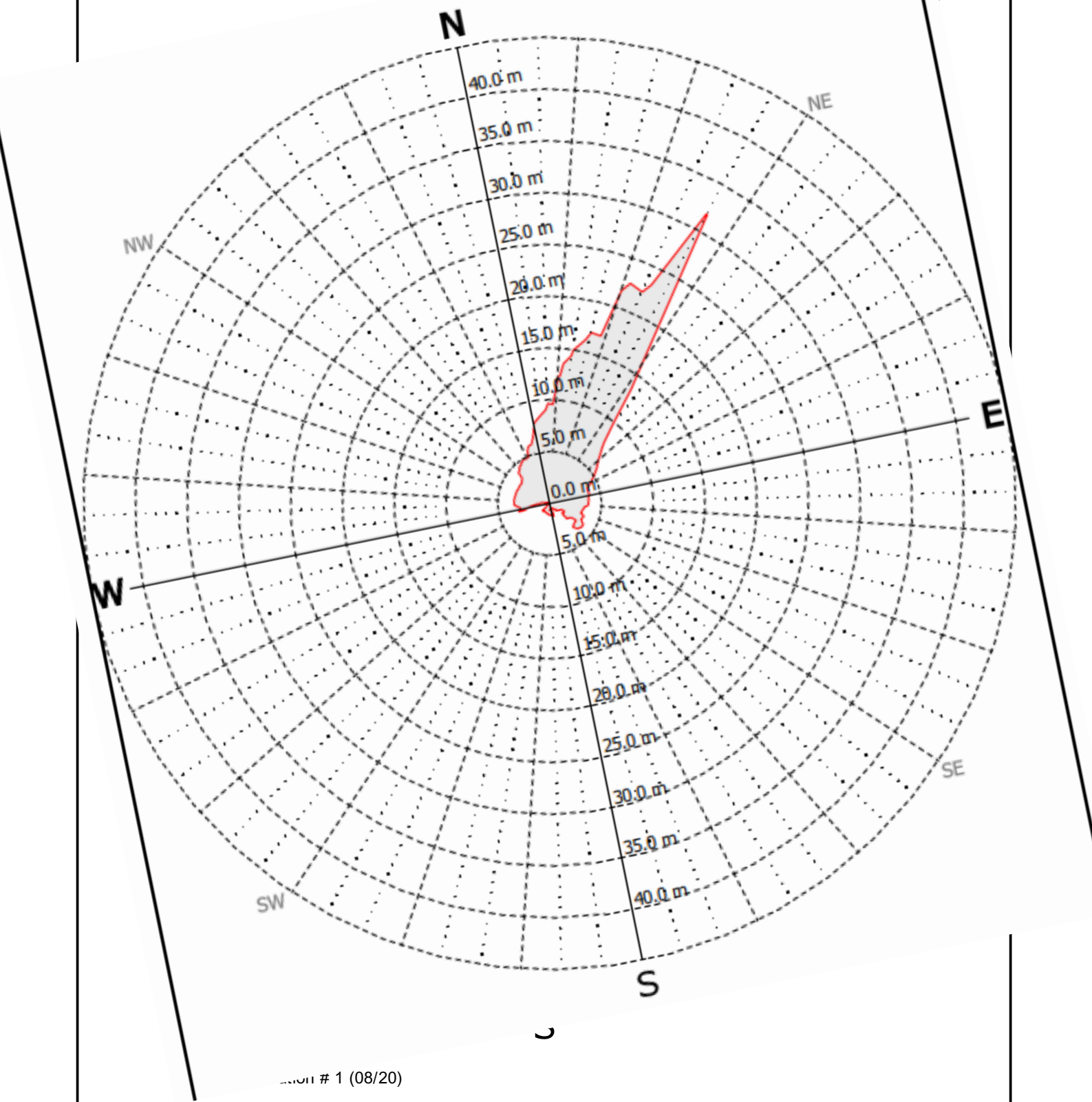
Operation # 1 (08/20)

Maximum radius	: 25.41 m
Orientation maxi. radius	: 40 °
Surface	: 165.75 m²
Maximum distance	: 28.68 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA LODIM g the limits

HORIZONTAL SECTION

71.0 m



ation # 1 (08/20)

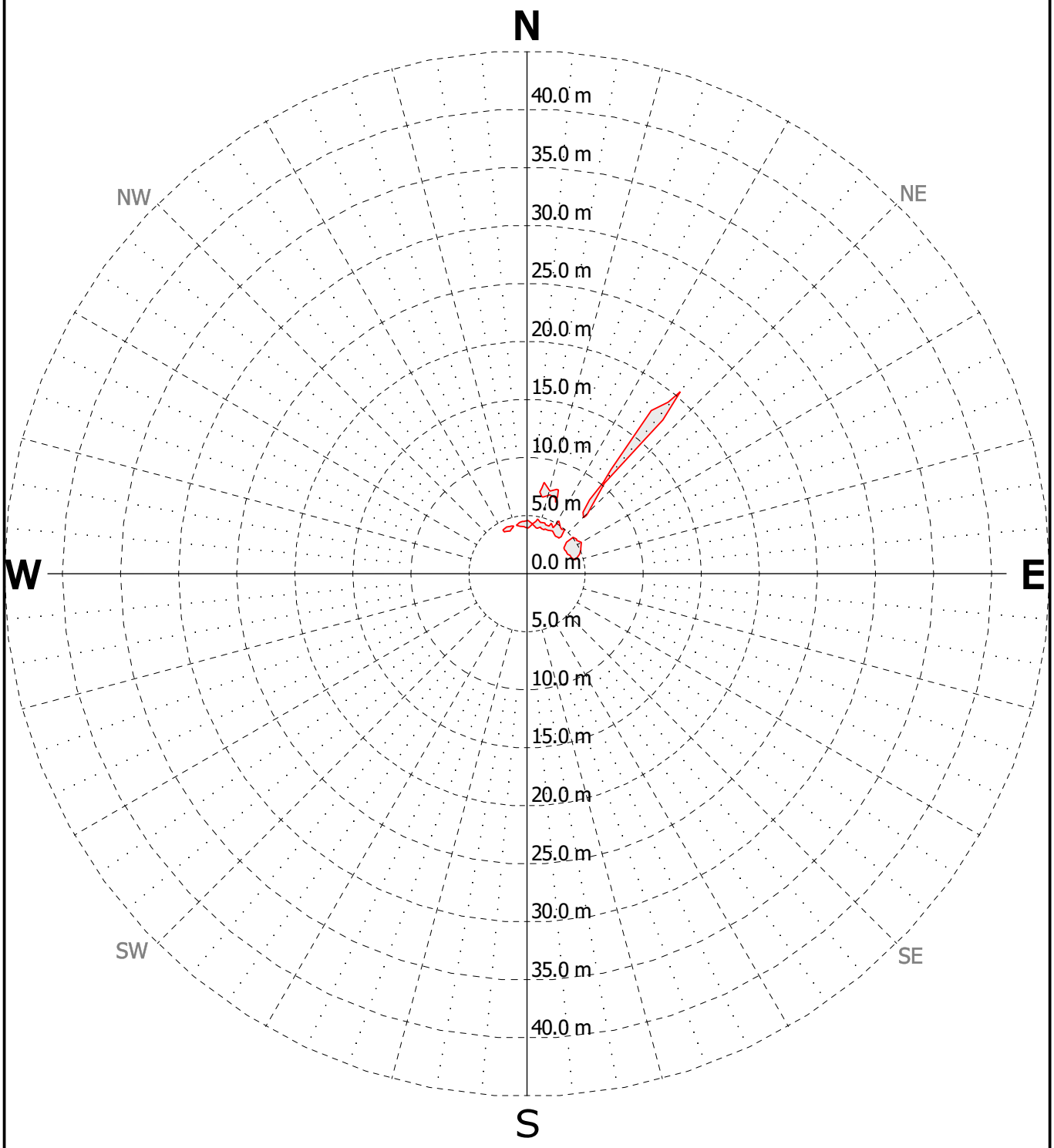
Maximum radius	: 31.58 m
Orientation maxi. radius	: 40 °
Surface	: 154.00 m²
Maximum distance	: 33.90 m

	CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY : BH28C_UG OPERATION # : 1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

HORIZONTAL SECTION

71.5 m

SCALE 1/500



Operation # 1 (08/20)

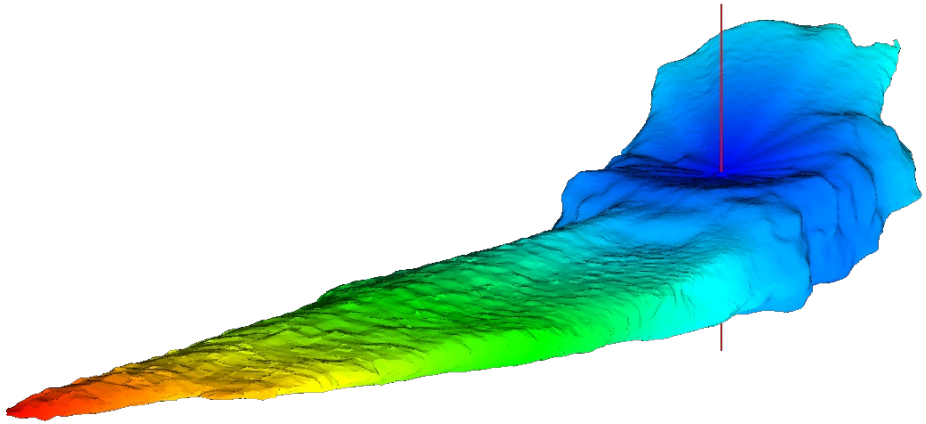
Maximum radius	: 20.31 m
Orientation maxi. radius	: 40 °
Surface	: 13.33 m²
Maximum distance	: 19.31 m

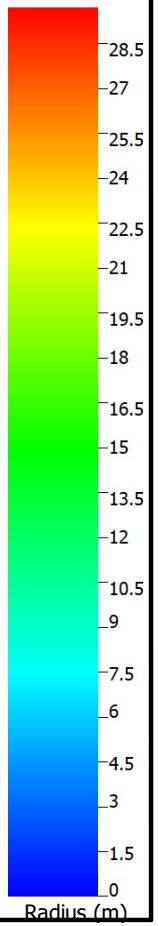
CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28C_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM NORTH

with an overhang of 10°

SCALE 1/200



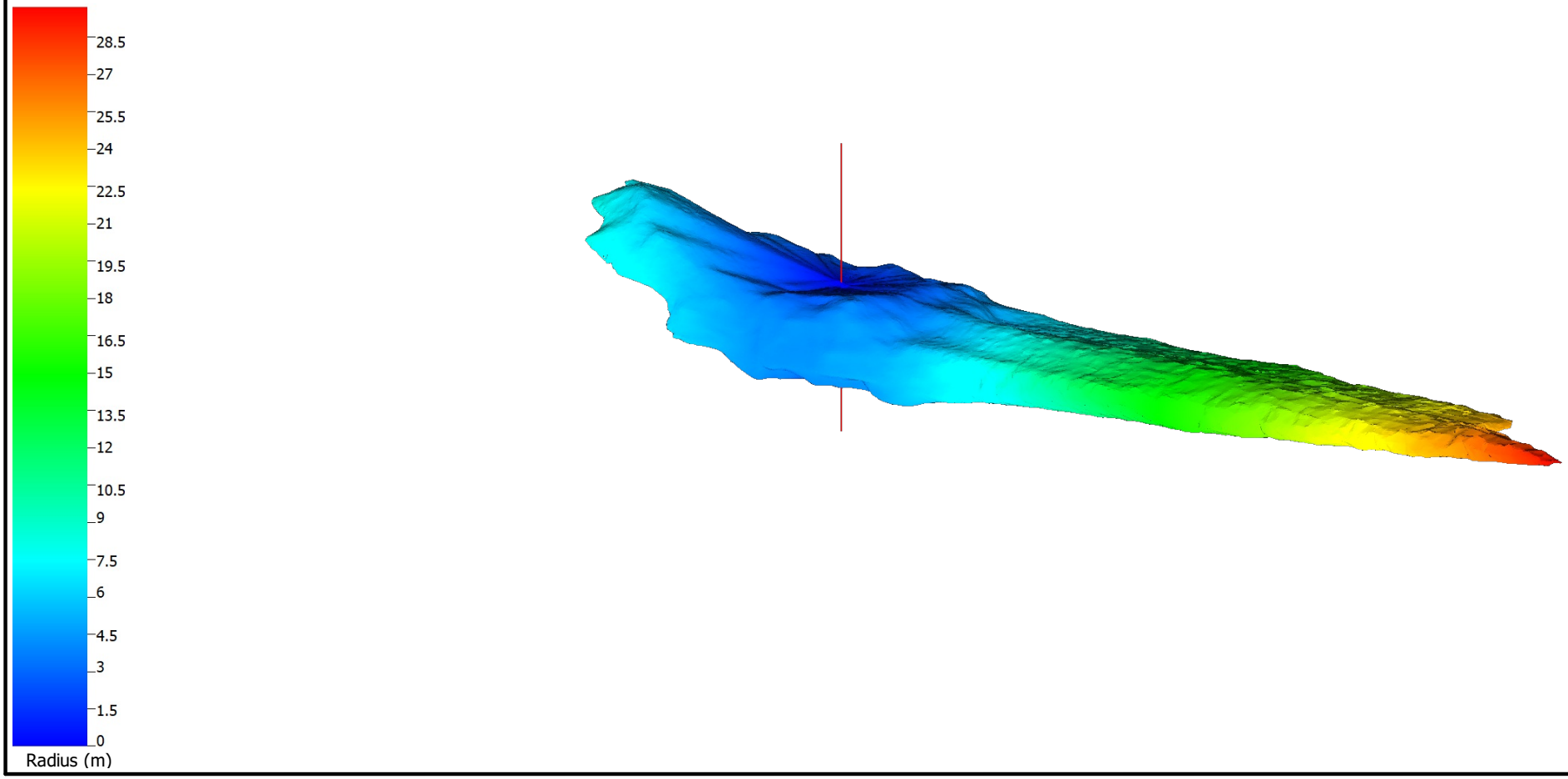


CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28C_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM EAST

with an overhang of 10°

SCALE 1/200

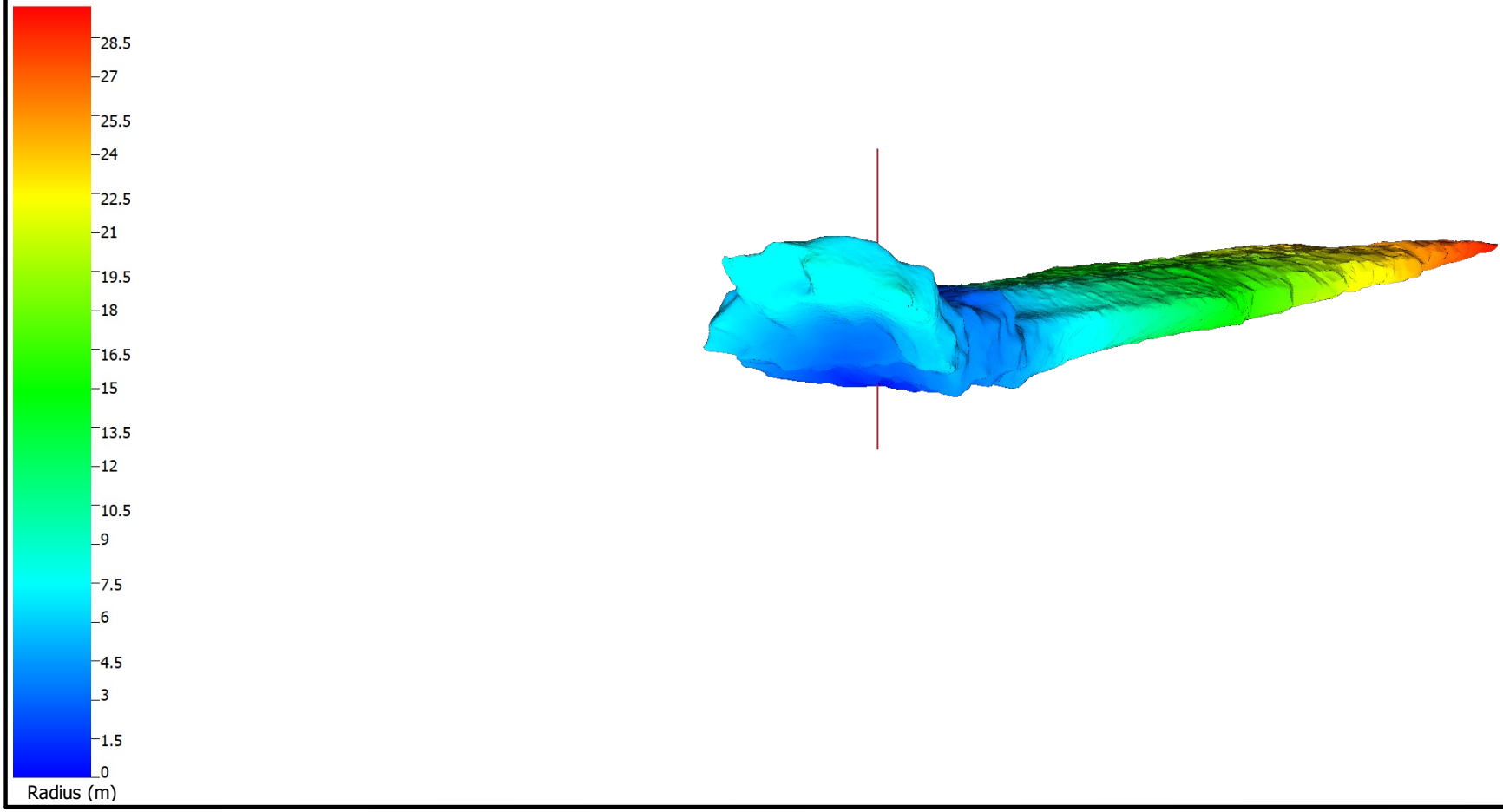


CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28C_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM SOUTH

with an overhang of 10°

SCALE 1/200

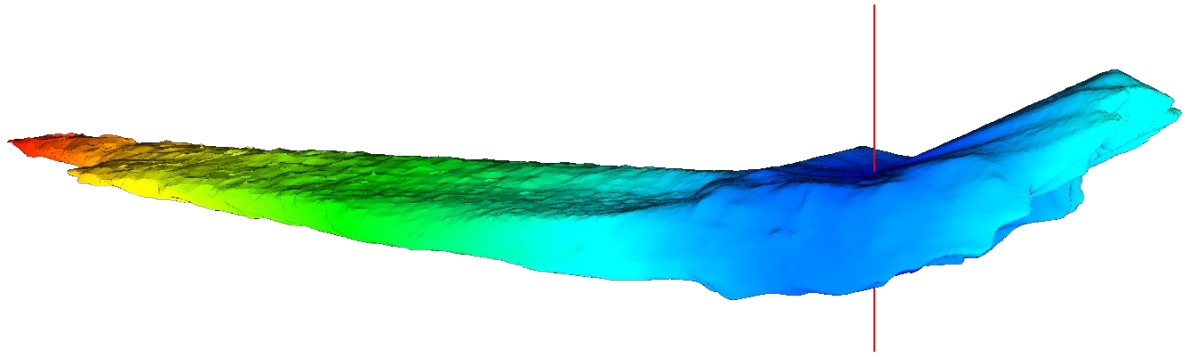


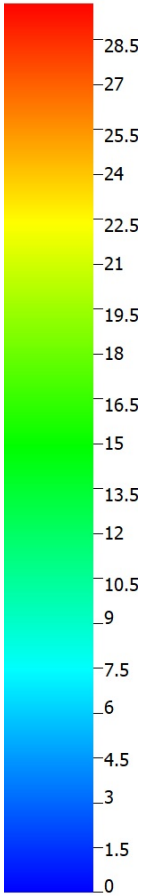
CUSTOMER : GROUNDSEARCH DATE : 20/08/2020	CAVITY :BH28C_UG OPERATION # :1	GROUNDSEARCH AUSTRALIA FLODIM Challenging the limits

VIEW FROM WEST

with an overhang of 10°

SCALE 1/200





AECOM – MUSWELLBROOK BYPASS PROJECT

BOREHOLE BH28_UG Wireline Imaging Report

Groundsearch Australia Pty. Limited

Prepared by: John Lea

Issued: 11 October 2020

DISCLAIMER

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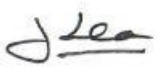
For and on behalf of Groundsearch Australia Pty. Limited



John Lea BSc (Hons) FAusIMM
Principal Geologist
Managing Director

Summary

The data contained in this report were obtained from one, vertical, H-size, cored borehole that was drilled as a component of the 2020 geotechnical investigation programme for the Muswellbrook Bypass Project.

A Century Geophysical Corporation 9804 acoustic televiewer tool (ATV) from 61.45 to 68.65 mbgl was used to collect the borehole data in the field on 2 July 2020.

The total number of features identified is 28 and are the SWL at 61.45 mbgl, bedding planes and fractures.

The ATV tool relies on contrasting sonic properties in borehole wallrocks to produce images that are used for interpretation and presentation.

All data are referenced to True North and represent the feature midpoint depth as mbgl.

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List of Figures

List of Tables

1.0 Background Technical Information

The data contained in this report were obtained from one, vertical, H-size, cored borehole that was drilled as a component of the 2020 geotechnical investigation programme for the Muswellbrook Bypass Project.

A Century Geophysical Corporation 9804 acoustic televiewer tool (ATV) from 61.45 to 68.65 mbgl was used to collect the borehole data in the field on 2 July 2020.

The total number of features identified is 28 and are the SWL at 61.45 mbgl, bedding planes and fractures.

The ATV tool relies on contrasting sonic properties in borehole wallrocks to produce images that are used for interpretation and presentation.

All data are referenced to True North and represent the feature midpoint depth as mbgl.

Analysis software includes colour adjustment, fracture dip and dip direction determination, and classification of features. It allows information to be displayed on the graphical screen, and in report formats.

2.0 Interpretation Methodology

It should be noted that the ATV is a bowspring-centralised tools and are affected by poor wallrock conditions known as rugosity.

The data interpretation procedure is based on the superposition of curves on feature logs directly onto the computer screen by using a subjective, manual; multi-point definition of a feature's top and base to produce a sine curve. The sides of the time and amplitude plots represent magnetic north and magnetic south is in the centre of each plot. The low side, or trough, of the sine curve defines the dip direction of the feature.

The image and structure files are adjusted manually using the site-specific magnetic declination value to present data aligned to True North.

The tadpole data are subsequently processed to transform the features' apparent dip and dip direction to represent the true situation.

This report contains a;

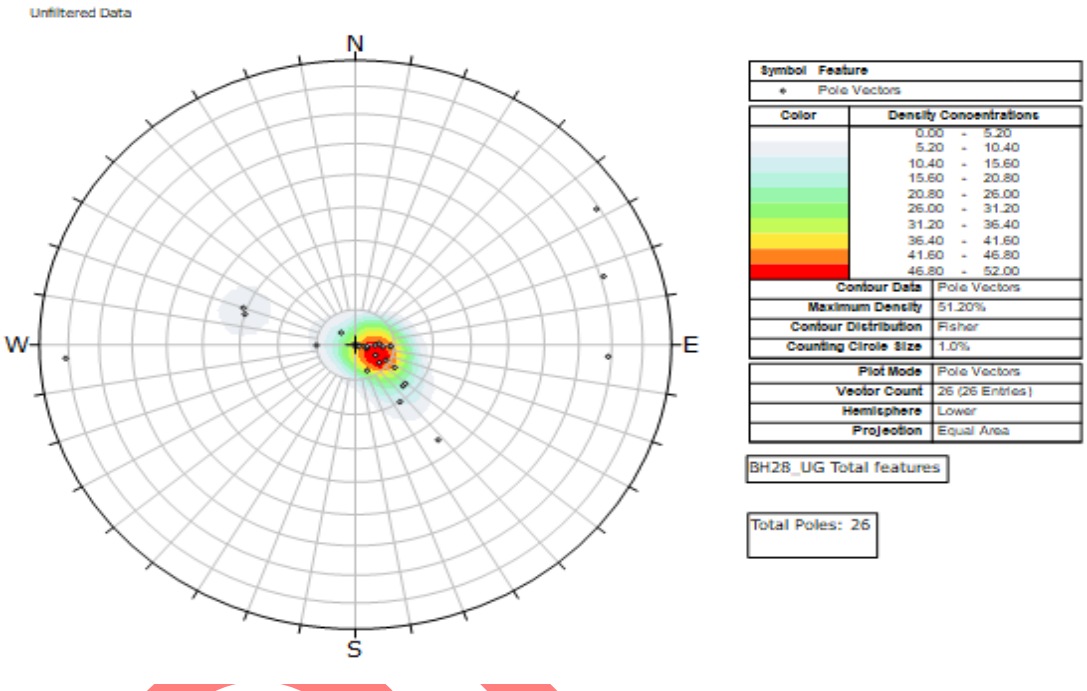
- Text summary of the interpreted features
- Table containing feature midpoint dip angle, dip azimuth and feature description.
- Circular graphic representations of interpreted features
- Logs that show geological features with their subjective curves shown in colour at 1:10 scale. The logs are in standard format whereby the image of the borehole wall is "flattened" onto the plot. The logs have the following additional features to enhance geological interpretations of the strata;
    - Natural gamma
    - TN ATV image from 61.45 to 68.65 mbgl including interpretation curves
    - TN ATV image from 61.45 to 68.65 mbgl without interpretation curves
    - TN structure log plot including interpretation curves
    - TN tadpoles that represent true feature dip and dip direction
    - Slant angle (borehole dip)
    - MN slant angle bearing (borehole dip direction)

3.0 Borehole BH28_UG Interpretations

Table 1 details the variation in the dip angle and dip direction data.

Figure 1 presents the total features' orientation and contoured density.

Figure 1. BH28_UG total data orientation plan – true north

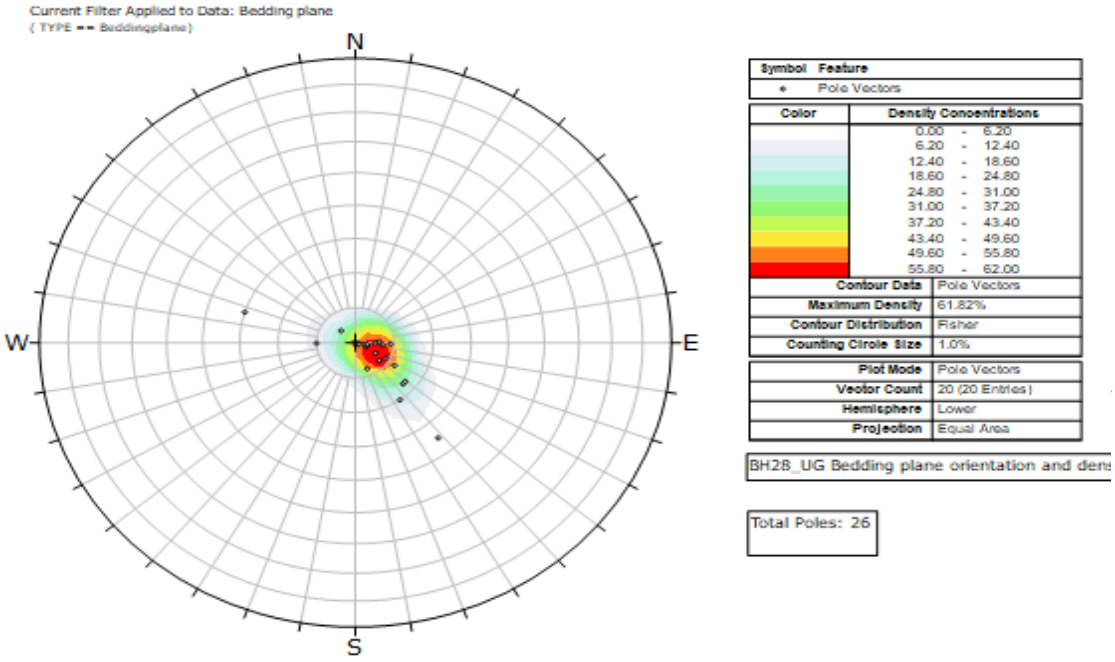


3.1 BH28_UG sedimentary features

The 20 sedimentary features identified appear to be bedding planes with dip angles from flat-lying to 35^0.

Figure 2 presents the sedimentary features' orientation and contoured density.

Figure 2. BH28_UG sedimentary data orientation plan – true north



3.2 BH28_UG fracture features

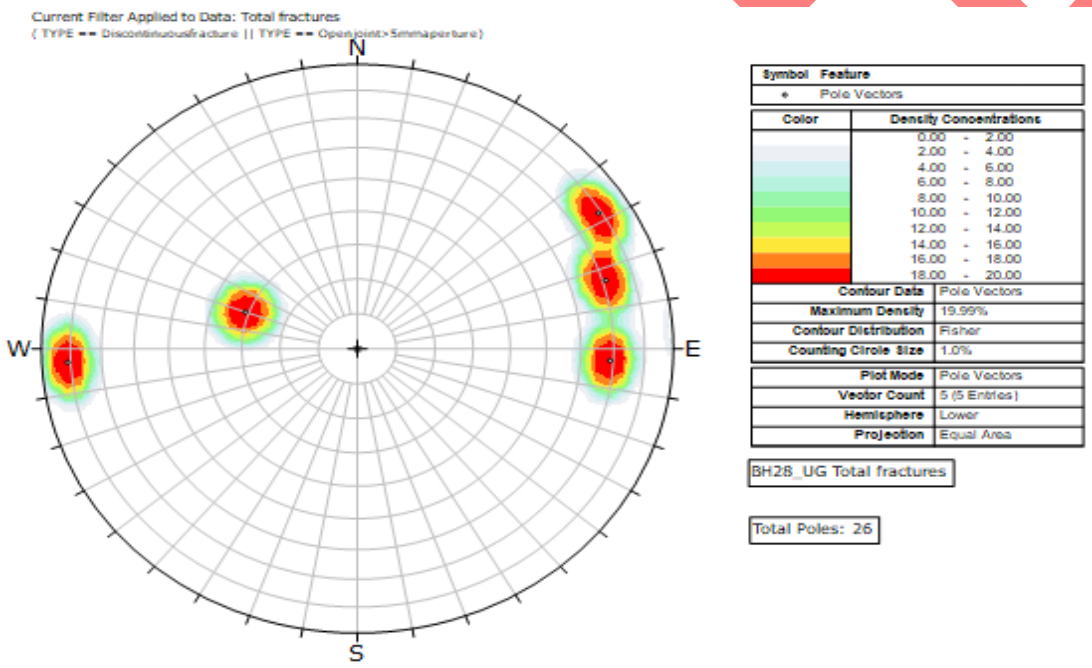
The five fractures identified appear to be:

- 1 x open joint >5 mm aperture
- 4 x discontinuous joints

The dip angles range from 31^0 to 81^0 from the horizontal.

The fracture data orientation density contours for true dip and dip direction are shown in Figure 3.

Figure 3. BH28_UG total fracture data orientation plan – true north



The contour density for each category are show as Figures 4, and 5.

Figure 4. **BH28_UG open joint >5 mm aperture** ***data orientation density contours – true north***

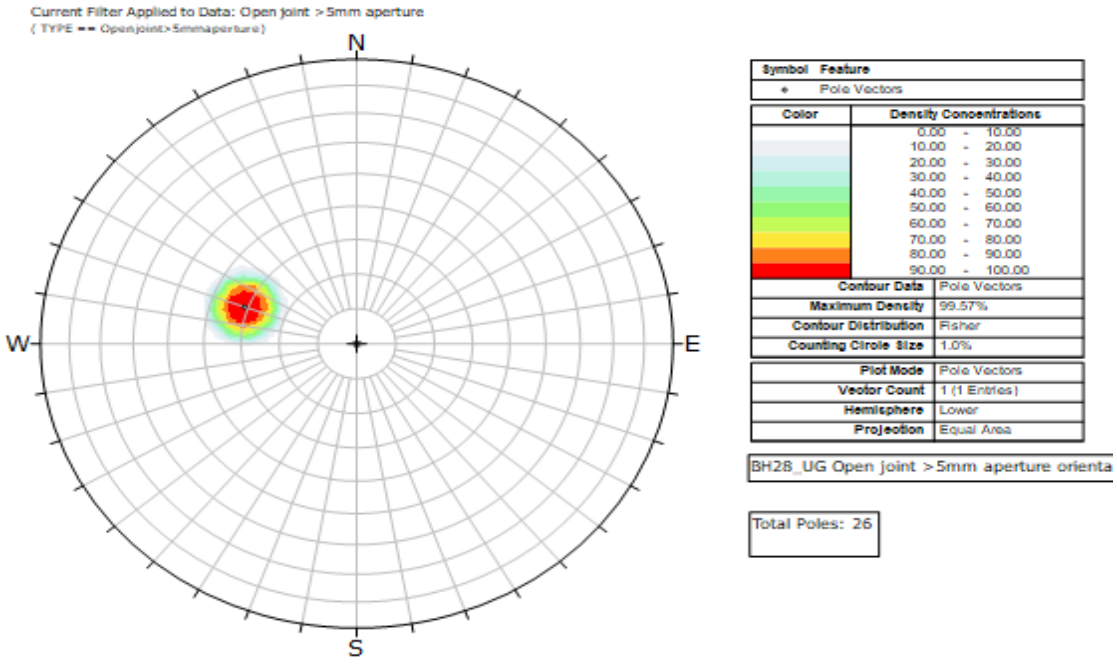


Figure 3. BH28_UG discontinuous fracture data orientation density contours – true north

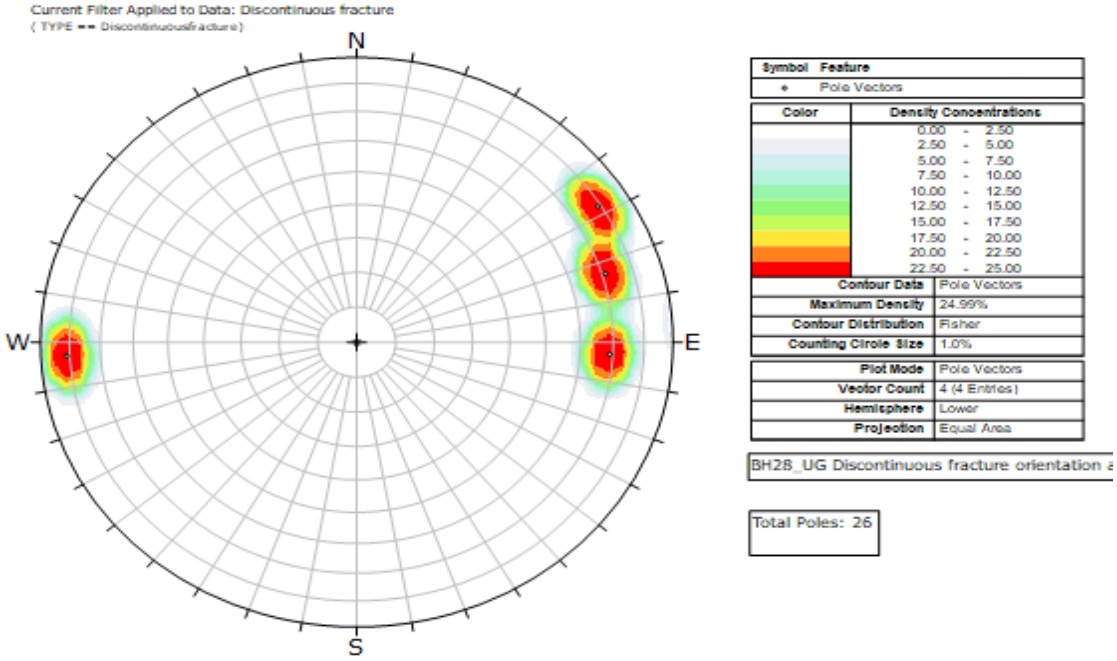


Table 1. Interpreted features data

Depth m	Azimuth deg TN	Dip deg	Interpreted feature description
61.45	0	0	SWL
61.98	89	10	Bedding plane
62.28	133	5	Bedding plane
64.46	310	8	Bedding plane
64.47	338	8	Bedding plane
64.68	314	17	Bedding plane
64.70	311	17	Bedding plane
64.94	322	35	Bedding plane
65.12	325	20	Bedding plane
65.23	107	30	Bedding plane
65.27	110	31	Open joint >5 mm aperture
65.31	274	9	Top of Coal Unit
65.55	305	1	Bedding plane
65.57	272	5	Bedding plane
65.69	291	3	Bedding plane
65.70	289	3	Bedding plane
65.82	275	7	Bedding plane
66.14	280	3	Bedding plane
66.15	273	69	Discontinuous fracture
67.81	87	81	Discontinuous fracture
67.88	253	71	Discontinuous fracture
67.93	300	6	Bedding plane
67.95	299	9	Bedding plane
68.15	238	79	Discontinuous fracture
68.43	267	6	Bedding plane
68.45	272	9	Bedding plane
68.52	303	12	Bedding plane
68.53	306	11	Top of void
Depth m	**Azimuth deg TN**	**Dip deg**	**Interpreted feature description**

Table 2. Interpretation curve and tadpole symbols

	Code	Tadpole	Sine Wave	
1	Seam/zone top FZ			Fractured zone top
2	Seam/zone base FZ			Fractured zone base
3	Seam/zone base			
4	Fracture plane - open			Fracture plane - open
5	Minor open fracture			Minor open fracture
6	Fracture plane - partially open			Fracture plane - partially open
7	Filled fracture			Filled fracture
8	Bedding plane open			Bedding plane open
9	Fracture plane - closed			Fracture plane - closed
10	Top of data			Top of data
11	Induced fracture			Induced fracture
12	SWL			SWL
13	Fault - FT			Level 1
14	Rocktype boundary			Rocktype boundary
15	Bedding separation plane			Bedding separation plane
16	Fracture plane - discontinuous			Fracture plane - discontinuous
17	Partially filled fracture			Partially filled fracture
18	Irregular vein			Irregular vein
19	Unconformity			Unconformity
20	Base of casing			Base of casing
21	Top of Coal Unit			Top of Coal Unit
22	Base of Coal Unit			Base of Coal Unit
23	Base of weathering			Base of weathering
24	Top of breakout			Top of breakout
25	Base of breakout			Base of breakout
26	Top of washout			Top of washout
27	Base of washout			Base of washout
28	Top of open fracture			Top of open fracture
29	Base of open fracture			Base of open fracture
30	Bedding plane partially open			Bedding plane partially open
31	Parting			Parting
32	Shear plane			Shear plane
33	Face cleat			Face cleat
34	Butt cleat			Butt cleat
35	Intrusive contact			Intrusive contact
36	Irregular fracture			Irregular fracture
37	Open joint >5 mm aperture			Level 2
38	Closed joint <5 mm aperture			Level 3
39	Vein			Level 3
40	Filled joint - SN			Level 3
41	Filled joint - VN <1 mm			Level 3
42	Filled joint - CT 1 mm to <10 mm			Level 3
43	Filled joint - FD > 10 mm			Level 3
44	Zone top			Lithozone boundary

Appendix 1

1:10 Interpretation Logs

61.45 to 68.65 mbgl

ABN 11 057 389 152

Well Information

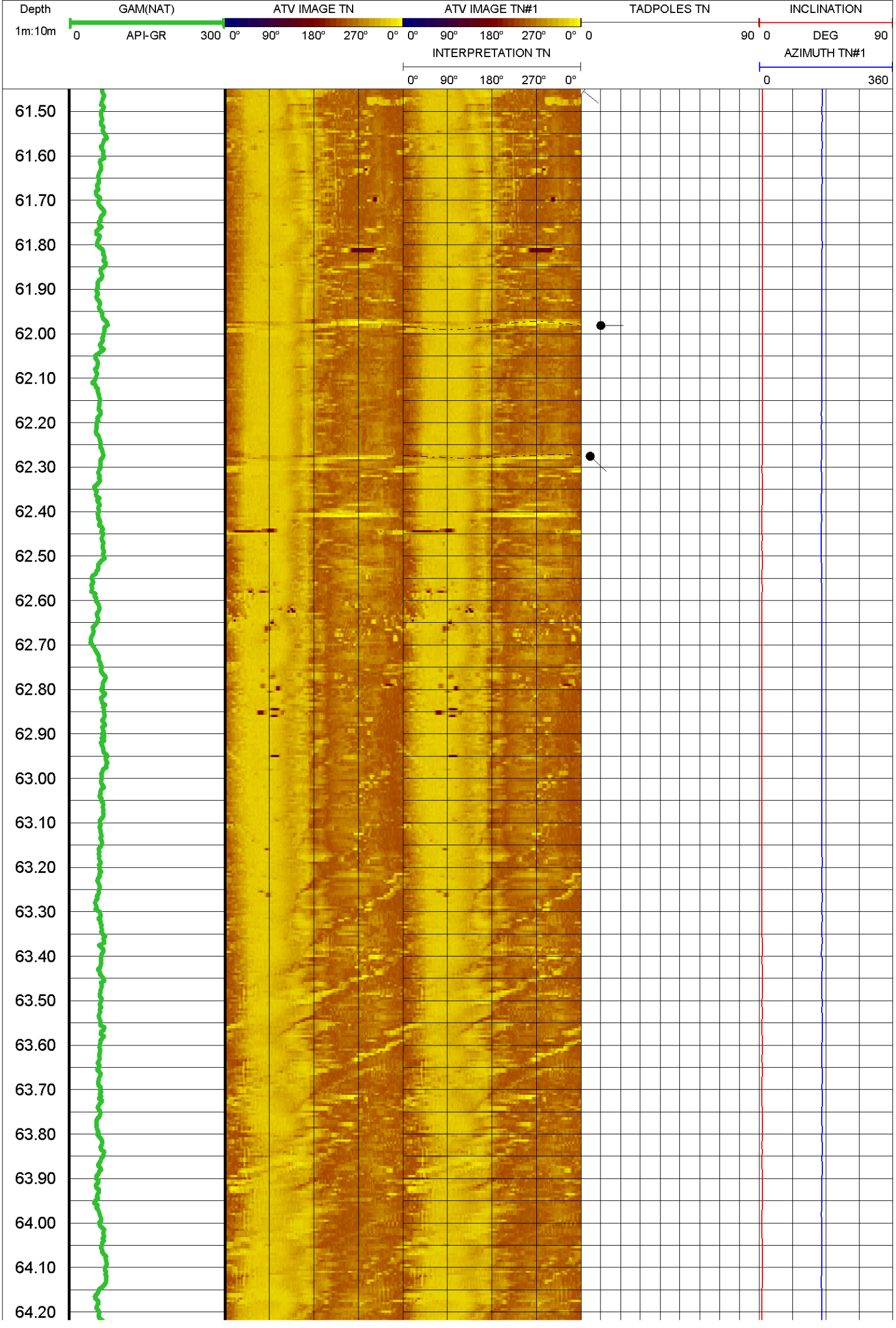
Company	Well Name	Location	Country
AECOM	BH28	Muswellbrook Bypass	Australia
State	**Local Coordinates Referenced To**	**Scale**	**Map Datum**
NSW	Borehole Collar	1:10	
Map Northing	**Map Easting**	**Elevation/RL (m AHD)**	**Grid Convergence (Degrees)**
Unknown	Unknown	Unknown	11.92

Survey Information

Ref Datum	Ground Level	Depth Reference	Depth Above Reference
Ground Level	Same as RL (m AHD)	Ground Level	0.00m
Log Date	**Survey Instrument/s**	**Driller's Depth**	**Log Depth**
2-Jul-20	ATV	68.53	68.65
Logging Unit	**Casing Diameter**	**Casing Bottom**	**Casing Type**
T121	11.4 cm	15.5 m	HW
Bit Size	**Survey Engineer**	**Conveyance Company**	**Conveyance**
9.6cm	C. Jones	Groundsearch Aus	Wireline

Comments

All measurements referenced to True North - unless otherwise stated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ATV IMAGE TN#1
0° 90° 180° 270° 0°
INTERPRETATION TN
0° 90° 180° 270° 0°
TADPOLES TN
0
90
INCLINATION
0
DEG
90
AZIMUTH TN#1
0
360
61.50
61.60
61.70
61.80
61.90
62.00
62.10
62.20
62.30
62.40
62.50
62.60
62.70
62.80
62.90
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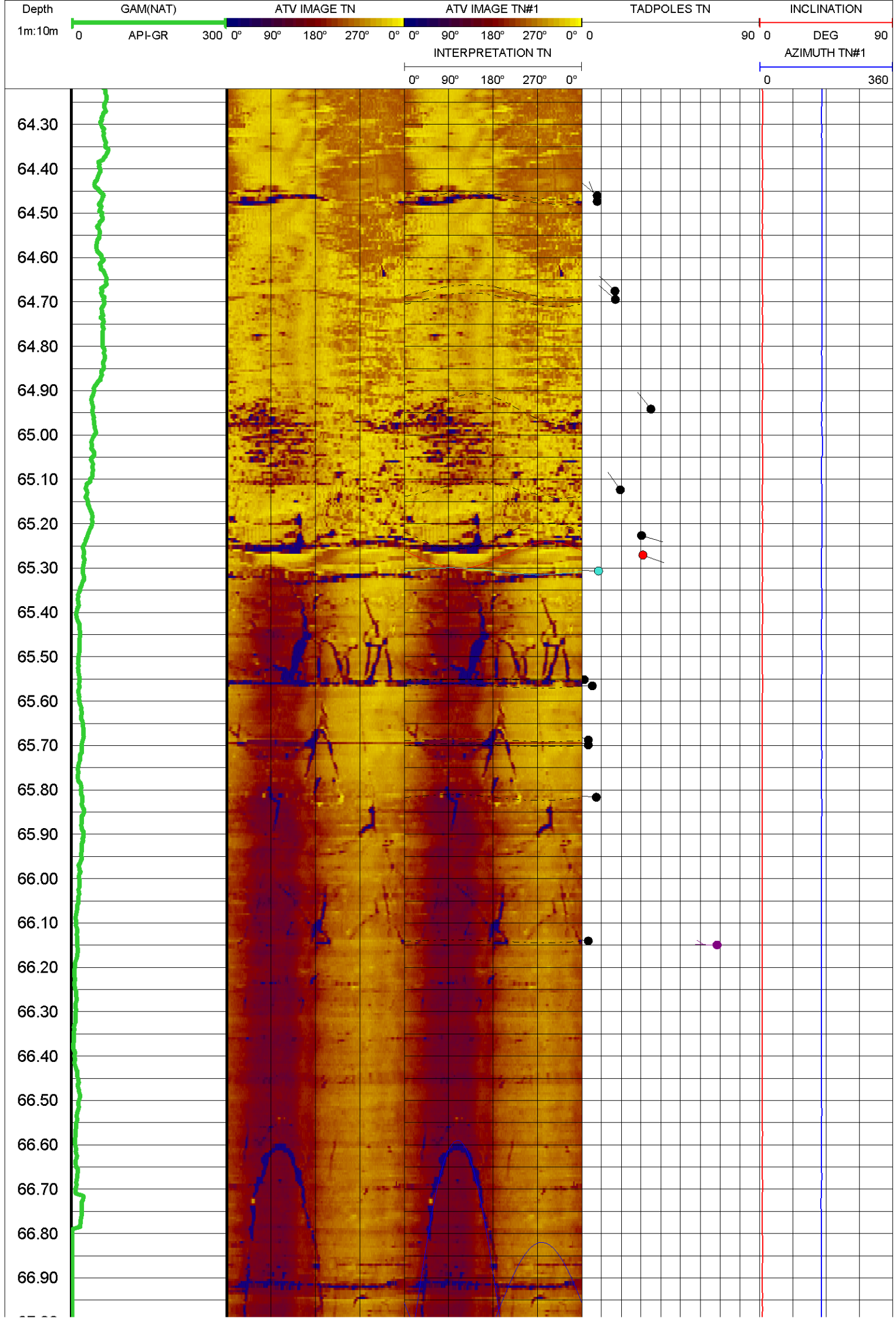
Depth
1m:10m
GAM(NAT)
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API-GR
300
ATV IMAGE TN
0° 90° 180° 270° 0°
ATV IMAGE TN#1
0° 90° 180° 270° 0°
INTERPRETATION TN
0° 90° 180° 270° 0°
TADPOLES TN
0
90
INCLINATION
0
DEG
90
AZIMUTH TN#1
0
360
64.30
64.40
64.50
64.60
64.70
64.80
64.90
65.00
65.10
65.20
65.30
65.40
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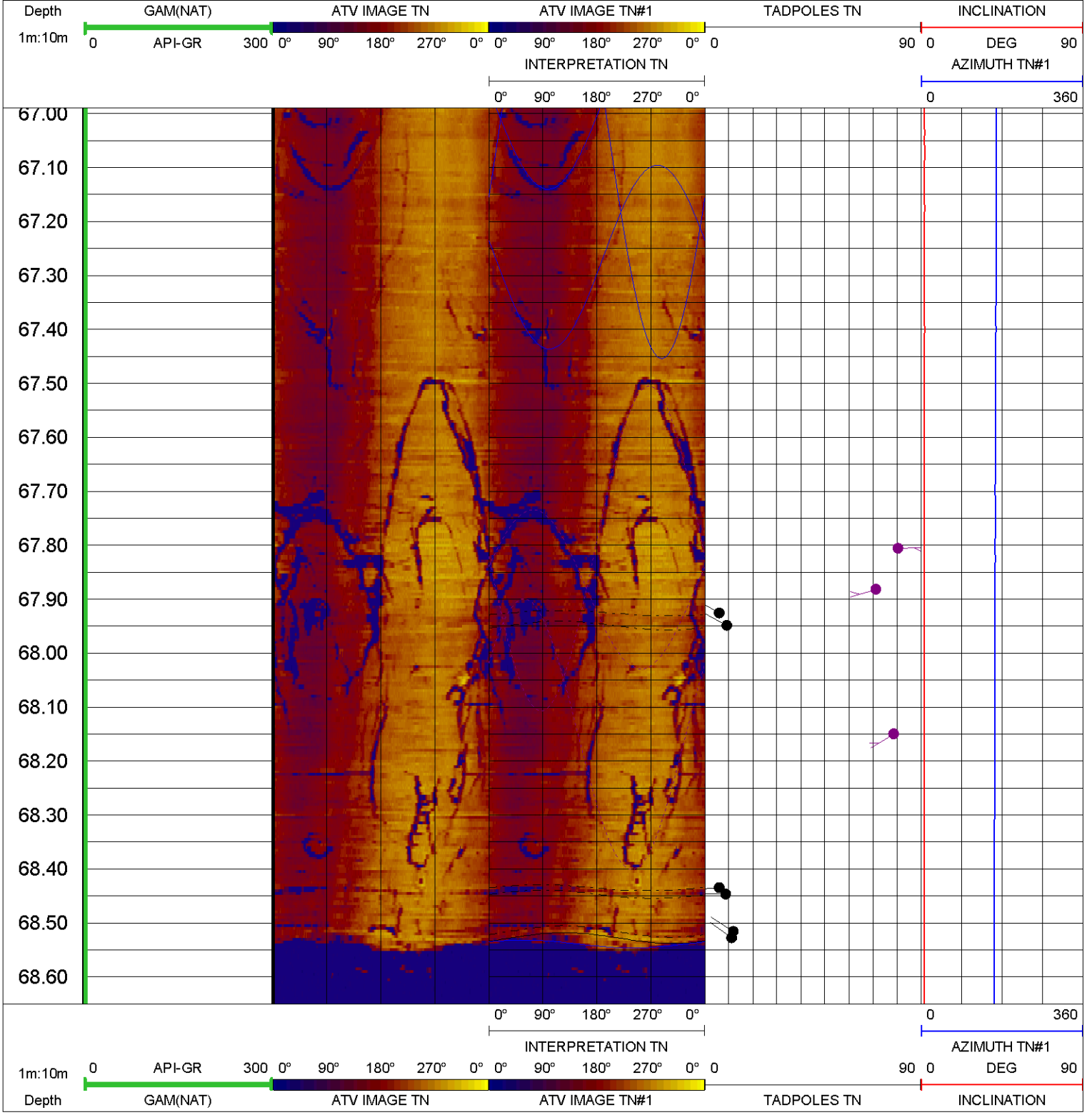
66.70
66.80
66.90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API-GR
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ATV IMAGE TN
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0° 90° 180° 270° 0°
INTERPRETATION TN
0° 90° 180° 270° 0°
TADPOLES TN
0
90
INCLINATION
0
DEG
90
AZIMUTH TN#1
0
360
67.00
67.10
67.20
67.30
67.40
67.50
67.60
67.70
67.80
67.90
68.00
68.10
68.20
68.30
68.40
68.50
68.60

AECOM – Muswellbrook Bypass Project

BOREHOLE BH28C_UG Wireline Imaging Report

Groundsearch Australia Pty. Limited

Prepared by: John Lea

Issued: 11 October 2020

DISCLAIMER

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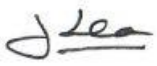
For and on behalf of Groundsearch Australia Pty. Limited



John Lea BSc (Hons) FAusIMM
Principal Geologist
Managing Director

Summary

The data contained in this report were obtained from one, vertical, H-size, cored borehole that was drilled as a component of the 2020 geotechnical investigation programme for the Muswellbrook Bypass Project.

A LIM Logging optical televiewer (OTV) tool (from 12.32 to 61.80 mbgl) and a Century Geophysical Corporation 9804 acoustic televiewer tool (ATV) (from 61.80 to 67.10 mbgl) were used to collect the borehole data in the field on 20 August 2020.

The total number of features identified is 141 and are the SWL at 61.80 mbgl, fractures, lithozone boundaries, washouts and the top of a void.

The OTV relies on contrasting colour tones and ATV tool relies on contrasting sonic properties in borehole wallrocks to produce images that are used for interpretation and presentation.

All data are referenced to True North and represent the feature midpoint depth as mbgl with dip angle and dip direction data plotted as poles in the lower hemisphere.

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List of Figures

List of Tables

1.0 Background Technical Information

The data contained in this report were obtained from one, vertical, H-size, cored borehole that was drilled as a component of the 2020 geotechnical investigation programme for the Muswellbrook Bypass Project.

A LIM Logging optical televiewer (OTV) tool (from 12.32 to 61.80 mbgl) and a Century Geophysical Corporation 9804 acoustic televiewer tool (ATV) (from 61.80 to 67.10 mbgl) were used to collect the borehole data in the field on 20 August 2020.

The total number of features identified is 141 and are the SWL at 61.80 mbgl, fractures, lithozone boundaries, washouts and the top of a void.

The OTV relies on contrasting colour tones and ATV tool relies on contrasting sonic properties in borehole wallrocks to produce images that are used for interpretation and presentation.

All data are referenced to True North and represent the feature midpoint depth as mbgl.

The ATV tool uses high-resolution sound waves to produce a Magnetic North-oriented image of the borehole wallrocks.

This information is used to detect bedding planes, fractures, and other borehole anomalies without the need to have clear fluid filling the boreholes.

All data are referenced to True North and represent the feature midpoint depth as mbgl with dip angle and dip direction data plotted as poles in the lower hemisphere.

Analysis software includes colour adjustment, fracture dip and dip direction determination, and classification of features. It allows information to be displayed on the graphical screen, and in report formats.

2.0 Interpretation Methodology

It should be noted that the OTV and ATV are bowspring-centralised tools and are affected by poor wallrock conditions known as rugosity.

The data interpretation procedure is based on the superposition of curves on feature logs directly onto the computer screen by using a subjective, manual; multi-point definition of a feature's top and base to produce a sine curve. The sides of the time and amplitude plots represent magnetic north and magnetic south is in the centre of each plot. The low side, or trough, of the sine curve defines the dip direction of the feature.

The logging program automatically records the OTV and ATV tool slant angle. These data are used to adjust from apparent to true dip angle and dip direction.

The image and structure files are adjusted manually using the site-specific magnetic declination value to present data aligned to True North.

The tadpole data are subsequently processed to transform the features' apparent dip and dip direction to represent the true situation.

This report contains a;

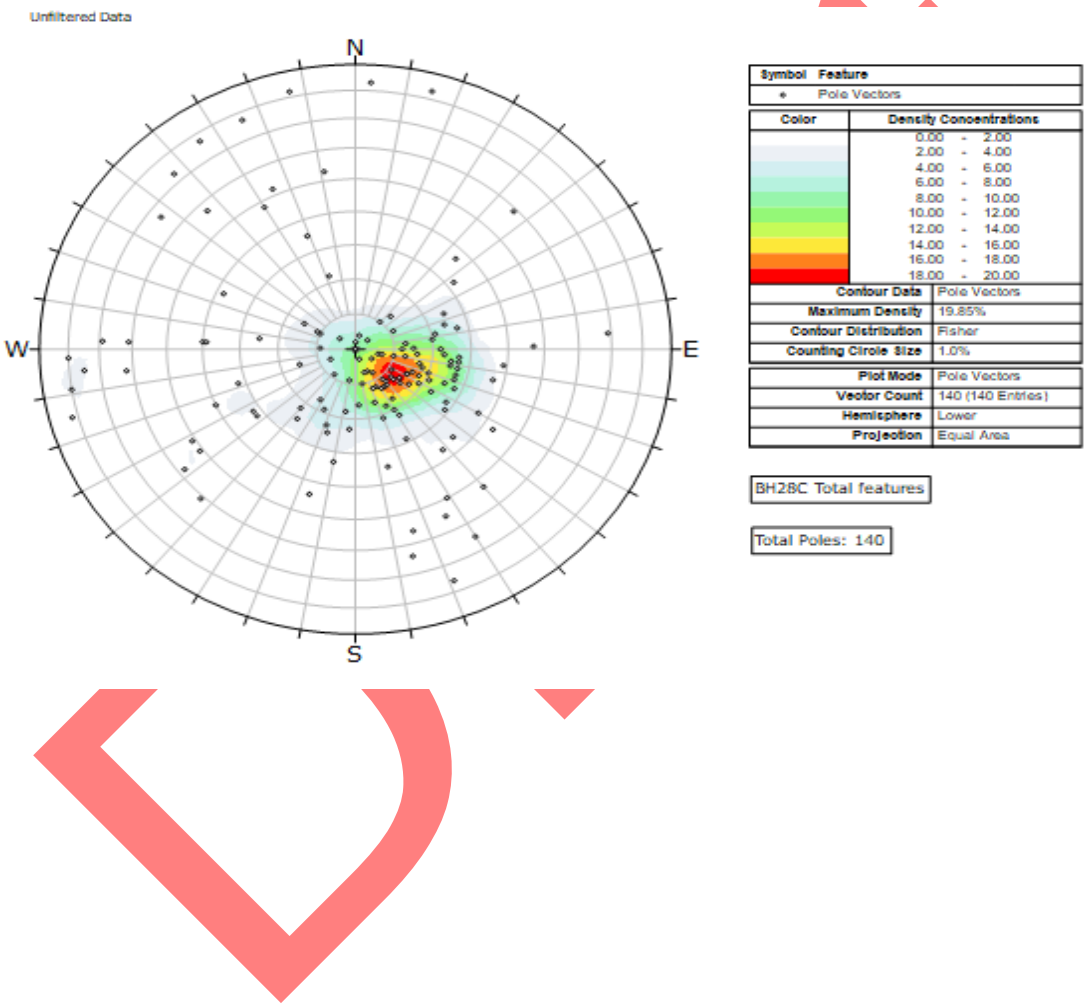
- Text summary of the interpreted features
- Table containing feature midpoint dip angle, dip azimuth and feature description.
- Circular graphic representations of interpreted features
- Logs that show geological features with their subjective curves shown in colour at 1:10 scale. The logs are in standard format whereby the image of the borehole wall is "flattened" onto the plot. The logs have the following additional features to enhance geological interpretations of the strata;
    - Natural gamma
    - TN OTV image from 12.32 to 61.80 mbgl without interpretation curves
    - TN OTV image from 12.32 to 61.80 mbgl including interpretation curves
    - TN ATV image from 61.80 to 67.10 mbgl without curves
    - TN ATV image from 61.80 to 67.10 mbgl without interpretation curves
    - TN structure log plot including interpretation curves
    - TN tadpoles that represent true feature dip and dip direction
    - Slant angle (borehole dip)
    - TN slant angle bearing (borehole dip direction)

3.0 Borehole BH28C_UG Interpretations

Table 1 details the variation in the dip angle and dip direction data.

Figure 1 presents the dip angle and dip direction for all features as poles plotted in the lower hemisphere.

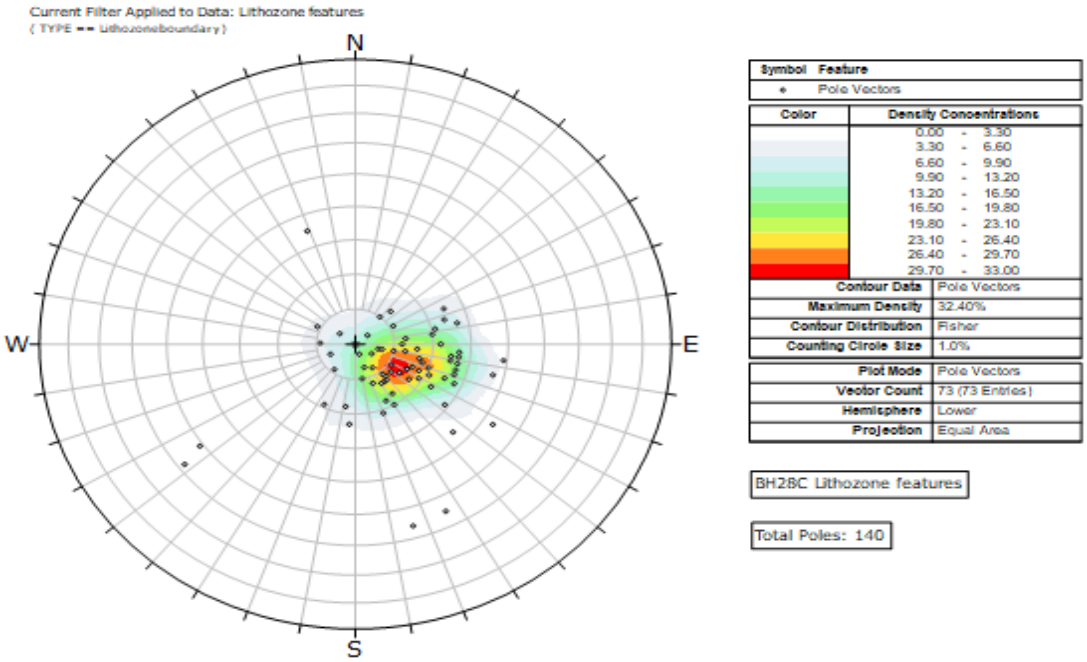
Figure 1. BH28C_UG total data orientation plan – true north



3.1 BH28C_UG sedimentary features

The 73 sedimentary features identified appear to be lithozone boundary planes – possibly bedding planes.

Figure 2. BH28C_UG sedimentary data orientation plan – true north



3.2 BH28C_UG fracture features

The fracture features identified appear to be:

- open joint >5 mm aperture (5%)
- filled joint - CT 1 mm to <10 mm (7%)
- closed joint <5 mm aperture (88%)

The dips angles and dip direction data are presented in Table1 and as contoured density plots in Figure 3.

The dip angles range from 4^0 to 83^0 from the horizontal.

The contour density for each category are show as Figures 4, 5, and 6.

Figure 3 BH28C_UG total fracture data orientation plan – true north

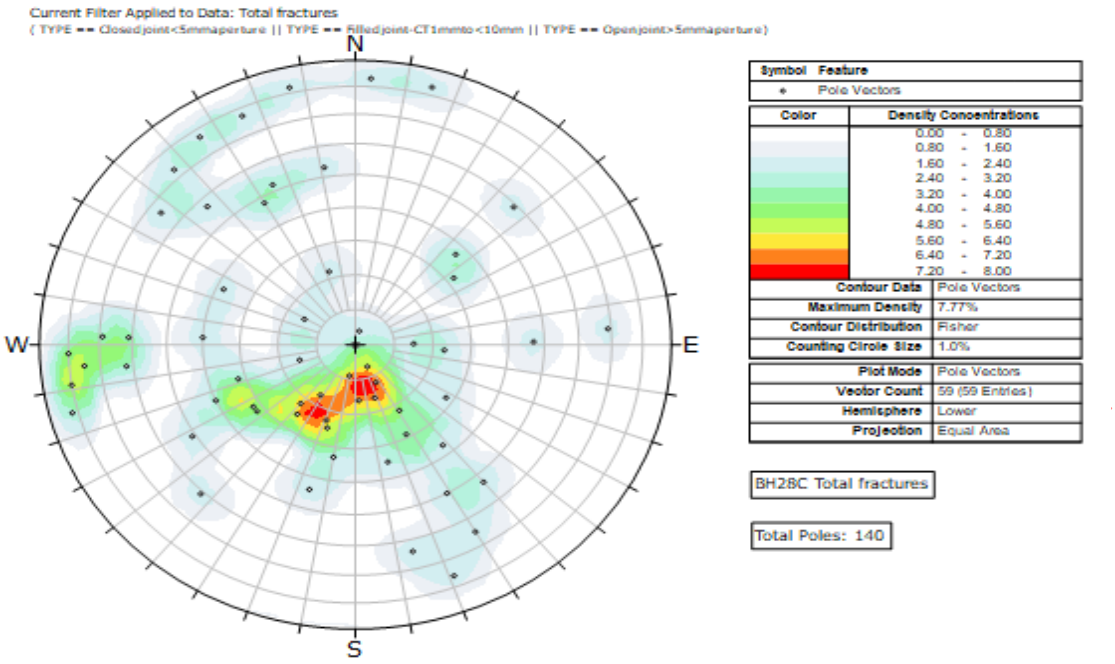


Figure 4.* BH28C_UG open joint >5 mm aperture *data orientation density contours – true north

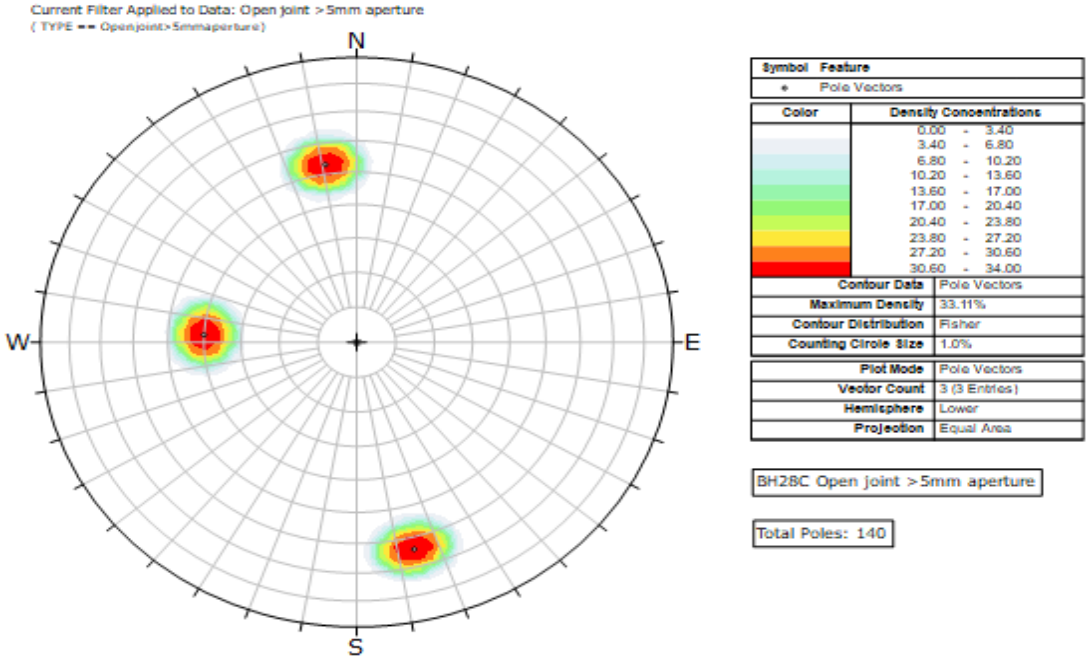


Figure 5. BH28C_UG filled joint - CT 1 mm to <10 mm* aperture *data orientation density contours – true north

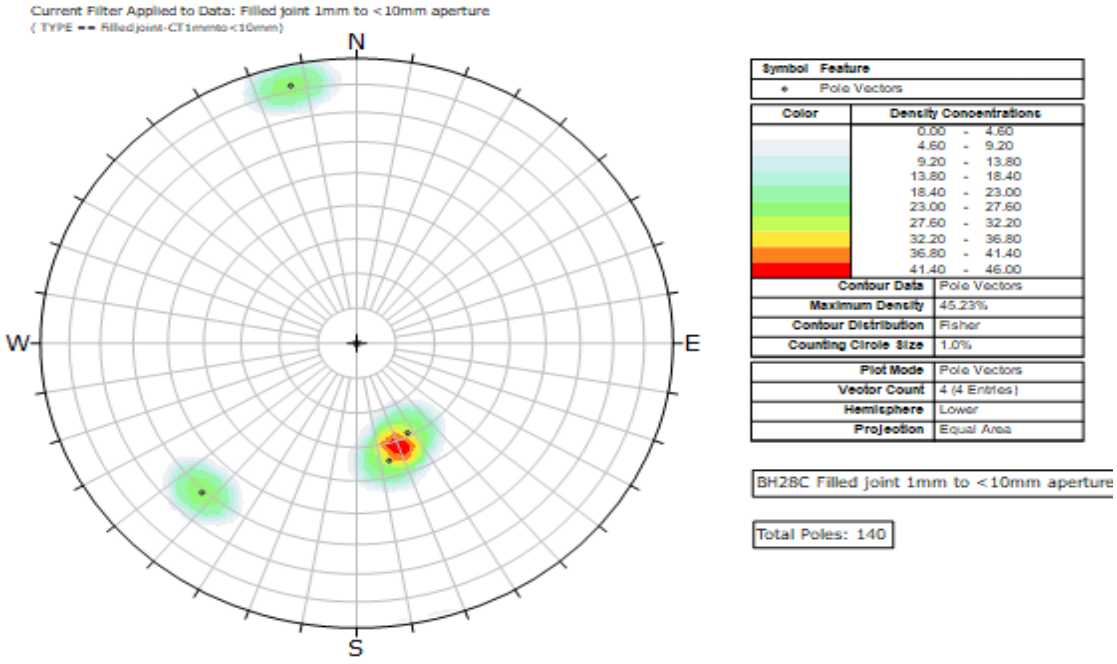


Figure 6. BH28C_UG closed joint <5 mm* aperture *data orientation density contours – true north

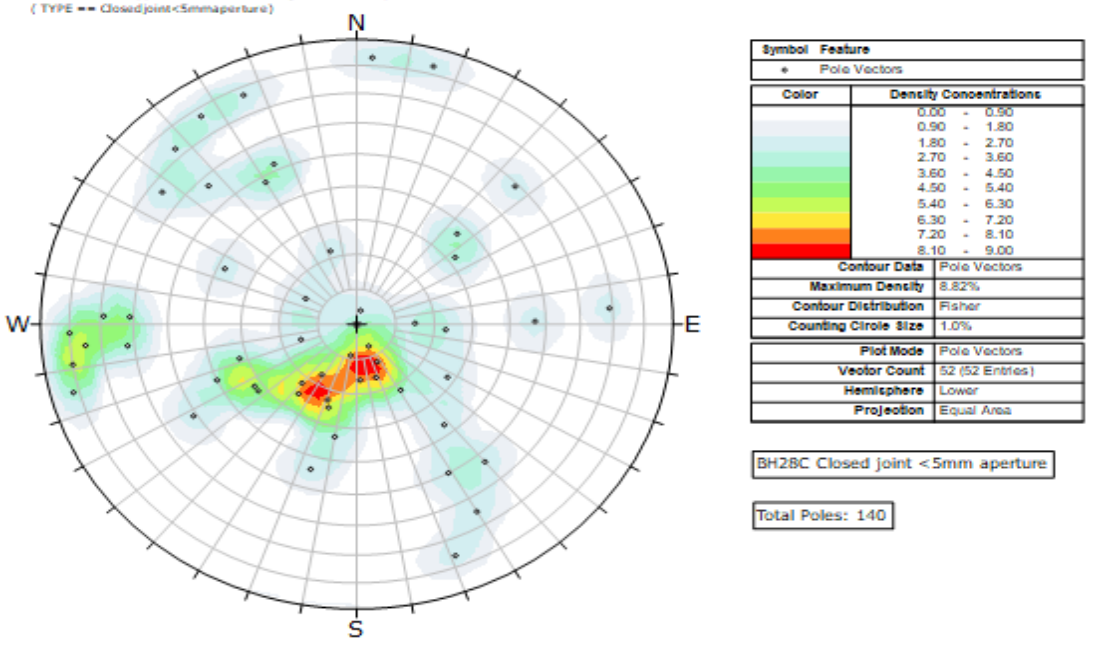


Table 1. Interpreted features data

Depth m	Azimuth deg TN	Dip deg	Interpreted feature description
13.36	54	51	Lithozone boundary
13.83	277	39	Lithozone boundary
14.31	293	25	Lithozone boundary
14.69	330	20	Lithozone boundary
16.02	322	37	Closed joint <5 mm aperture
16.39	37	25	Closed joint <5 mm aperture
16.54	274	23	Closed joint <5 mm aperture
19.18	315	36	Lithozone boundary
19.36	311	13	Top of washout
19.41	310	15	Base of washout
19.69	137	73	Closed joint <5 mm aperture
19.72	300	37	Top of washout
19.84	116	10	Base of washout
20.03	195	83	Closed joint <5 mm aperture
20.37	146	77	Closed joint <5 mm aperture
20.43	329	22	Closed joint <5 mm aperture
20.54	357	16	Closed joint <5 mm aperture
21.35	17	25	Closed joint <5 mm aperture
21.70	156	77	Closed joint <5 mm aperture
21.79	329	13	Lithozone boundary
21.94	294	16	Lithozone boundary
22.59	320	53	Closed joint <5 mm aperture
23.10	127	66	Closed joint <5 mm aperture
23.26	306	17	Lithozone boundary
23.69	339	76	Closed joint <5 mm aperture
23.89	342	16	Closed joint <5 mm aperture
25.27	155	52	Closed joint <5 mm aperture
25.61	325	13	Lithozone boundary
25.70	302	11	Lithozone boundary
26.32	303	28	Closed joint <5 mm aperture
26.78	311	12	Lithozone boundary
27.49	97	25	Top of washout
27.59	225	37	Closed joint <5 mm aperture
27.64	93	40	Open joint >5 mm aperture
27.67	93	39	Base of washout
28.36	10	9	Closed joint <5 mm aperture

28.86	322	13	Lithozone boundary
29.05	266	69	Closed joint <5 mm aperture
29.28	40	22	Closed joint <5 mm aperture
29.34	32	17	Closed joint <5 mm aperture
29.77	281	10	Lithozone boundary
30.13	334	12	Closed joint <5 mm aperture
30.53	269	47	Closed joint <5 mm aperture
30.76	303	5	Lithozone boundary
31.58	115	38	Closed joint <5 mm aperture
31.97	19	23	Closed joint <5 mm aperture
32.13	10	33	Closed joint <5 mm aperture
32.29	319	12	Lithozone boundary
32.58	66	7	Lithozone boundary
32.73	53	32	Closed joint <5 mm aperture
32.94	56	32	Closed joint <5 mm aperture
33.41	331	50	Closed joint <5 mm aperture
33.51	306	14	Lithozone boundary
33.73	294	28	Lithozone boundary
33.79	307	29	Lithozone boundary
33.85	295	18	Lithozone boundary
33.98	290	20	Lithozone boundary
34.00	73	15	Closed joint <5 mm aperture
34.15	298	15	Lithozone boundary
34.27	321	11	Lithozone boundary
34.35	283	6	Lithozone boundary
34.44	298	15	Lithozone boundary
34.72	279	13	Lithozone boundary
34.88	334	7	Closed joint <5 mm aperture
35.76	159	35	Lithozone boundary
36.08	330	65	Closed joint <5 mm aperture
36.20	344	56	Lithozone boundary
36.75	334	55	Lithozone boundary
37.06	346	64	Open joint >5 mm aperture
37.15	171	53	Open joint >5 mm aperture
37.24	326	17	Lithozone boundary
37.57	284	37	Lithozone boundary
37.60	66	40	Closed joint <5 mm aperture
37.79	72	32	Closed joint <5 mm aperture
37.89	301	19	Lithozone boundary
38.50	119	15	Closed joint <5 mm aperture
38.88	16	44	Closed joint <5 mm aperture

40.09	194	4	Closed joint <5 mm aperture
40.61	270	12	Lithozone boundary
40.81	92	9	Lithozone boundary
41.12	117	11	Lithozone boundary
41.65	162	22	Closed joint <5 mm aperture
42.35	242	11	Lithozone boundary
43.63	58	51	Closed joint <5 mm aperture
44.18	262	20	Lithozone boundary
44.37	284	17	Lithozone boundary
44.75	346	35	Filled joint - CT 1 mm to <10 mm
44.90	167	82	Filled joint - CT 1 mm to <10 mm
44.91	333	29	Filled joint - CT 1 mm to <10 mm
45.22	281	25	Lithozone boundary
45.27	282	27	Lithozone boundary
45.51	224	13	Lithozone boundary
45.85	150	48	Closed joint <5 mm aperture
46.30	219	10	Lithozone boundary
46.74	282	7	Lithozone boundary
47.26	269	15	Closed joint <5 mm aperture
48.29	289	27	Lithozone boundary
48.71	226	59	Closed joint <5 mm aperture
49.05	275	27	Lithozone boundary
49.53	52	58	Lithozone boundary
51.40	257	27	Lithozone boundary
51.54	246	25	Lithozone boundary
52.21	286	27	Lithozone boundary
52.48	278	25	Lithozone boundary
52.94	303	43	Lithozone boundary
53.31	258	21	Lithozone boundary
53.39	43	61	Filled joint - CT 1 mm to <10 mm
53.75	295	21	Lithozone boundary
53.84	287	18	Lithozone boundary
53.90	253	24	Lithozone boundary
53.96	270	22	Lithozone boundary
54.01	85	75	Closed joint <5 mm aperture
54.17	88	80	Closed joint <5 mm aperture
54.33	81	80	Closed joint <5 mm aperture
54.58	75	82	Closed joint <5 mm aperture
55.08	92	69	Closed joint <5 mm aperture
55.52	136	57	Closed joint <5 mm aperture
55.71	92	61	Closed joint <5 mm aperture

55.79	84	62	Closed joint <5 mm aperture
56.15	263	13	Lithozone boundary
56.33	302	23	Lithozone boundary
56.40	127	5	Lithozone boundary
58.16	275	16	Lithozone boundary
58.87	278	27	Lithozone boundary
59.30	233	32	Closed joint <5 mm aperture
61.80	127	0	SWL
63.76	183	83	Closed joint <5 mm aperture
65.38	350	10	Lithozone boundary
65.44	231	4	Lithozone boundary
65.55	8	18	Lithozone boundary
65.56	4	23	Lithozone boundary
65.57	25	19	Lithozone boundary
65.66	37	9	Lithozone boundary
65.72	340	21	Lithozone boundary
65.84	338	12	Lithozone boundary
65.85	341	7	Lithozone boundary
65.95	334	18	Lithozone boundary
66.56	327	8	Lithozone boundary
66.64	341	3	Lithozone boundary
67.10	182	2	Top of void
Depth m	**Azimuth deg TN**	**Dip deg**	**Interpreted feature description**

Table 2. Interpretation curve and tadpole symbols

	Code	Tadpole	Sine Wave	
1	Seam/zone top FZ			Fractured zone top
2	Seam/zone base FZ			Fractured zone base
3	Seam/zone base			
4	Fracture plane - open			Fracture plane - open
5	Minor open fracture			Minor open fracture
6	Fracture plane - partially open			Fracture plane - partially open
7	Filled fracture			Filled fracture
8	Bedding plane open			Bedding plane open
9	Fracture plane - closed			Fracture plane - closed
10	Top of data			Top of data
11	Induced fracture			Induced fracture
12	SWL			SWL
13	Fault - FT			Level 1
14	Rocktype boundary			Rocktype boundary
15	Bedding separation plane			Bedding separation plane
16	Fracture plane - discontinuous			Fracture plane - discontinuous
17	Partially filled fracture			Partially filled fracture
18	Irregular vein			Irregular vein
19	Unconformity			Unconformity
20	Base of casing			Base of casing
21	Top of Coal Unit			Top of Coal Unit
22	Base of Coal Unit			Base of Coal Unit
23	Base of weathering			Base of weathering
24	Top of breakout			Top of breakout
25	Base of breakout			Base of breakout
26	Top of washout			Top of washout
27	Base of washout			Base of washout
28	Top of open fracture			Top of open fracture
29	Base of open fracture			Base of open fracture
30	Bedding plane partially open			Bedding plane partially open
31	Parting			Parting

32	Shear plane			Shear plane
33	Face cleat			Face cleat
34	Butt cleat			Butt cleat
35	Intrusive contact			Intrusive contact
36	Irregular fracture			Irregular fracture
37	Open joint >5 mm aperture			Level 2
38	Closed joint <5 mm aperture			Level 3
39	Vein			Level 3
40	Filled joint - SN			Level 3
41	Filled joint - VN <1 mm			Level 3
42	Filled joint - CT 1 mm to <10 mm			Level 3
43	Filled joint - FD > 10 mm			Level 3
44	Zone top			Lithozone boundary

Appendix 1

1:10 Interpretation Logs

12.32 to 67.10 mbgl

ABN 11 057 389 152

Well Information

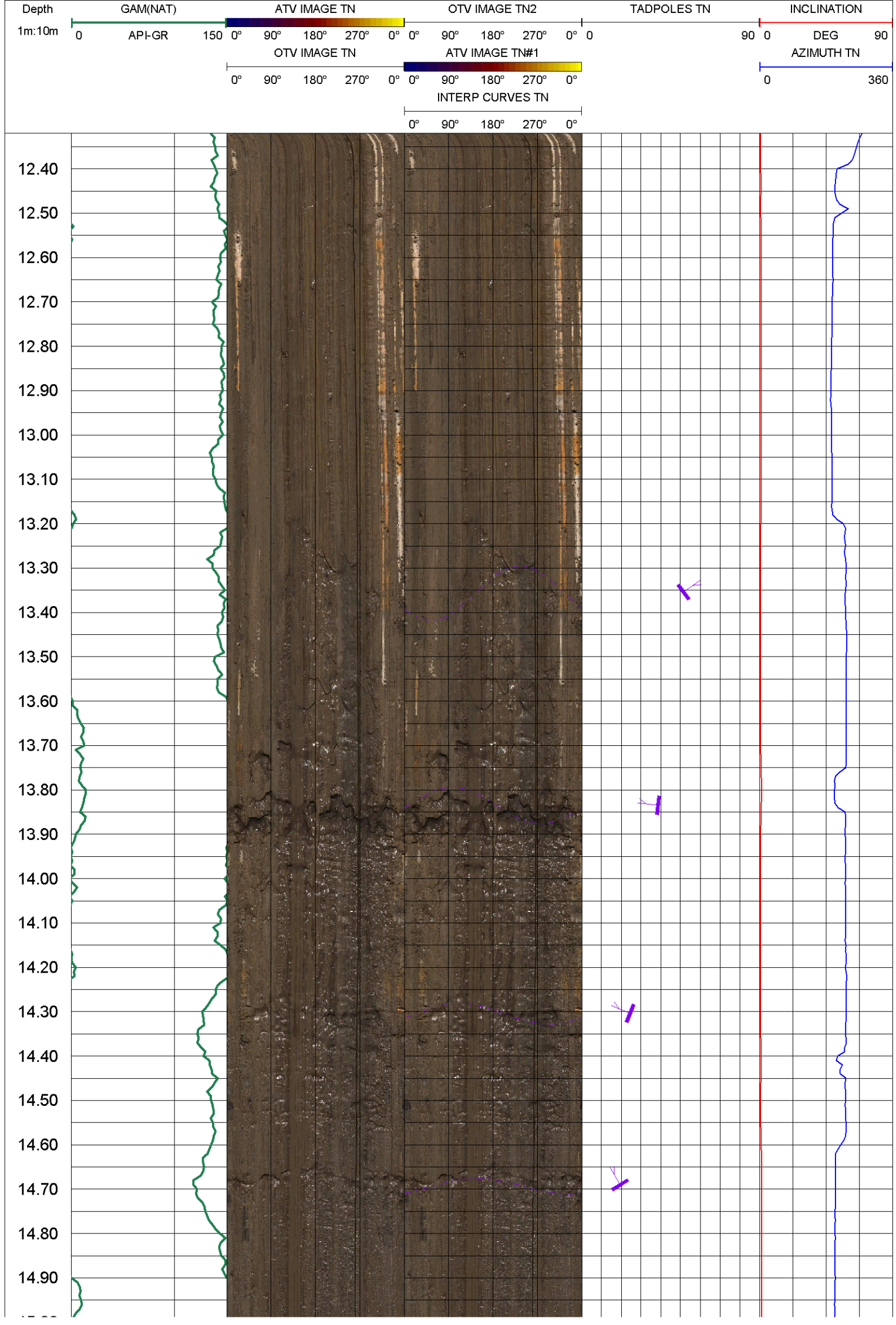
Company	Well Name	Location	Country
AECOM	BH28C	Muswellbrook Bypass	Australia
State	**Local Coordinates Referenced To**	**Scale**	**Map Datum**
NSW	Borehole Collar	1:10	
Map Northing	**Map Easting**	**Elevation/RL (m AHD)**	**Grid Convergence (Degrees)**
Unknown	Unknown	Unknown	11.92

Survey Information

Ref Datum	Ground Level	Depth Reference	Depth Above Reference
Ground Level	Same as RL (m AHD)	Ground Level	0.00m
Log Date	**Survey Instrument/s**	**Driller's Depth**	**Log Depth**
20-Aug-20	OTV/ATV	73.35 m	67.10 m
Logging Unit	**Casing Diameter**	**Casing Bottom**	**Casing Type**
T107	12 cm	11.5 m	HW
Bit Size	**Survey Engineer**	**Conveyance Company**	**Conveyance**
9.6cm	C. Jones	Groundsearch Aus	Wireline

Comments

All measurements referenced to True North - unless otherwise stated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1m:10m
GAM(NAT)
0
API-GR
150
ATV IMAGE TN
0° 90° 180° 270° 0°
OTV IMAGE TN2
0° 90° 180° 270° 0°
TADPOLES TN
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INCLINATION
0
DEG
90
OTV IMAGE TN
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ATV IMAGE TN#1
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AZIMUTH TN
0
360
INTERP CURVES TN
0° 90° 180° 270° 0°
12.40
12.50
12.60
12.70
12.80
12.90
13.00
13.10
13.20
13.30
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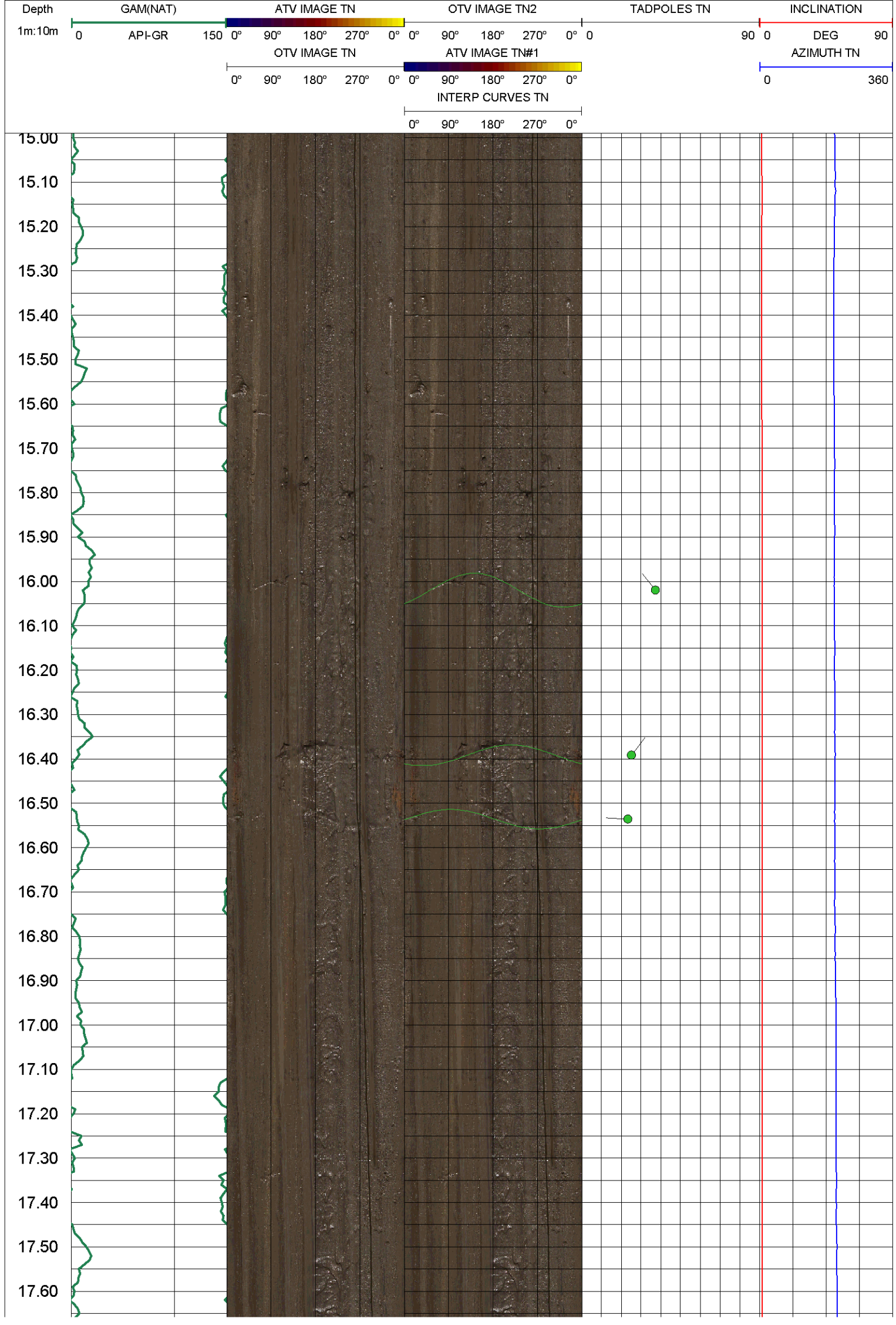
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ATV IMAGE TN#1
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INTERP CURVES TN
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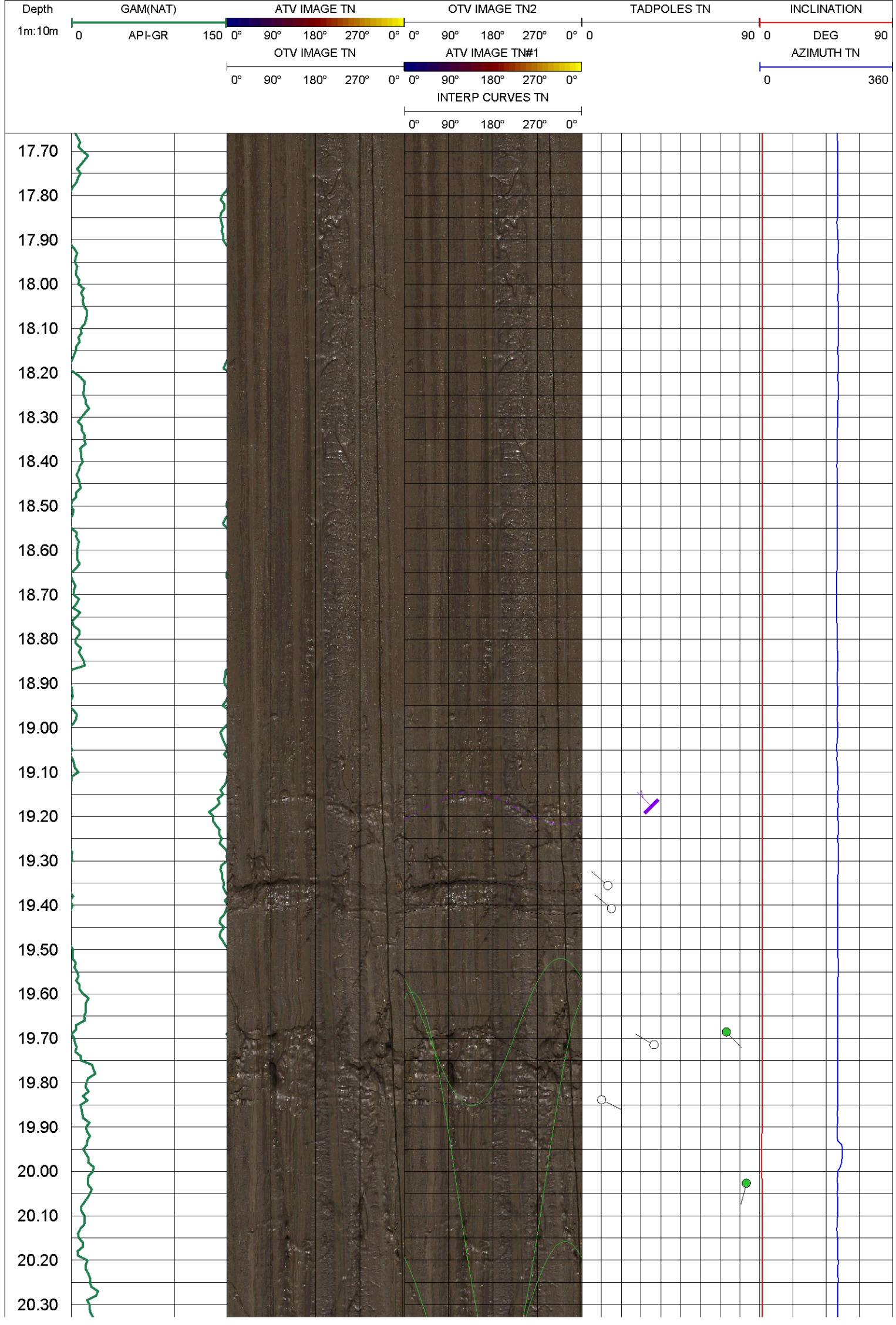
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INCLINATION
0
DEG
90
OTV IMAGE TN
0° 90° 180° 270° 0°
ATV IMAGE TN#1
0° 90° 180° 270° 0°
AZIMUTH TN
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360
INTERP CURVES TN
0° 90° 180° 270° 0°
17.70
17.80
17.90
18.00
18.10
18.20
18.30
18.40
18.50
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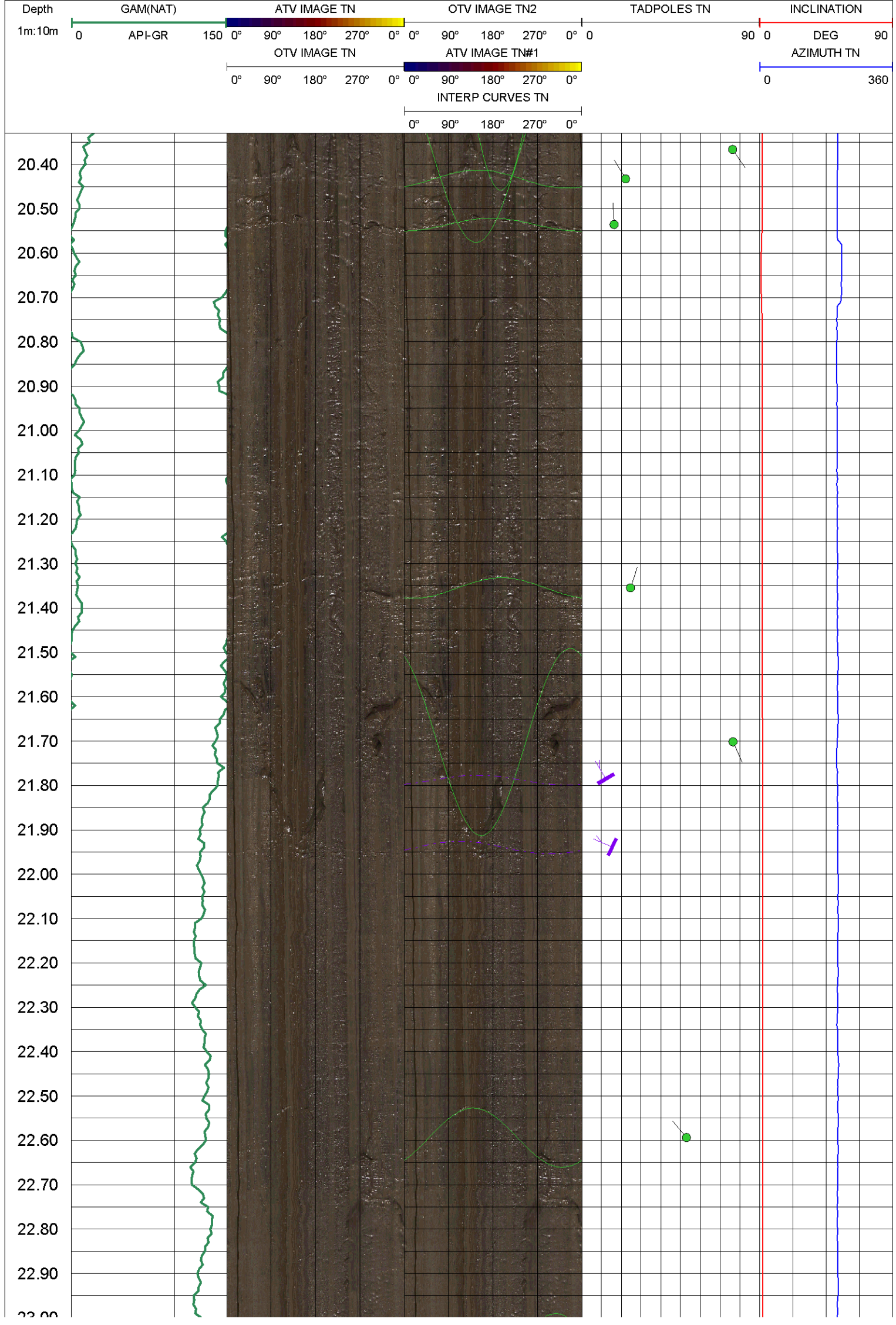
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DEG
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ATV IMAGE TN#1
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AZIMUTH TN
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INTERP CURVES TN
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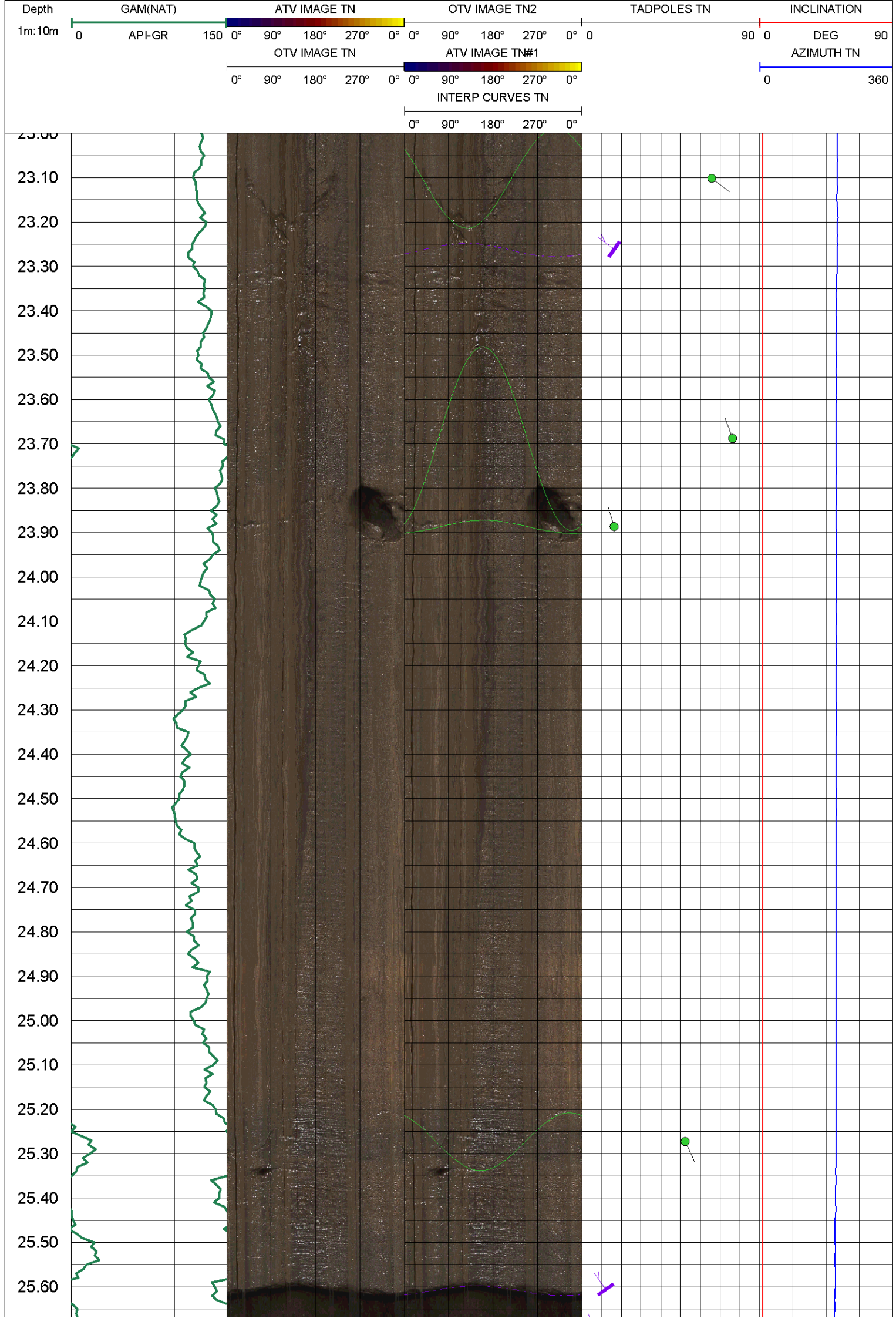
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INCLINATION
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DEG
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OTV IMAGE TN
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ATV IMAGE TN#1
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AZIMUTH TN
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INTERP CURVES TN
0° 90° 180° 270° 0°
23.10
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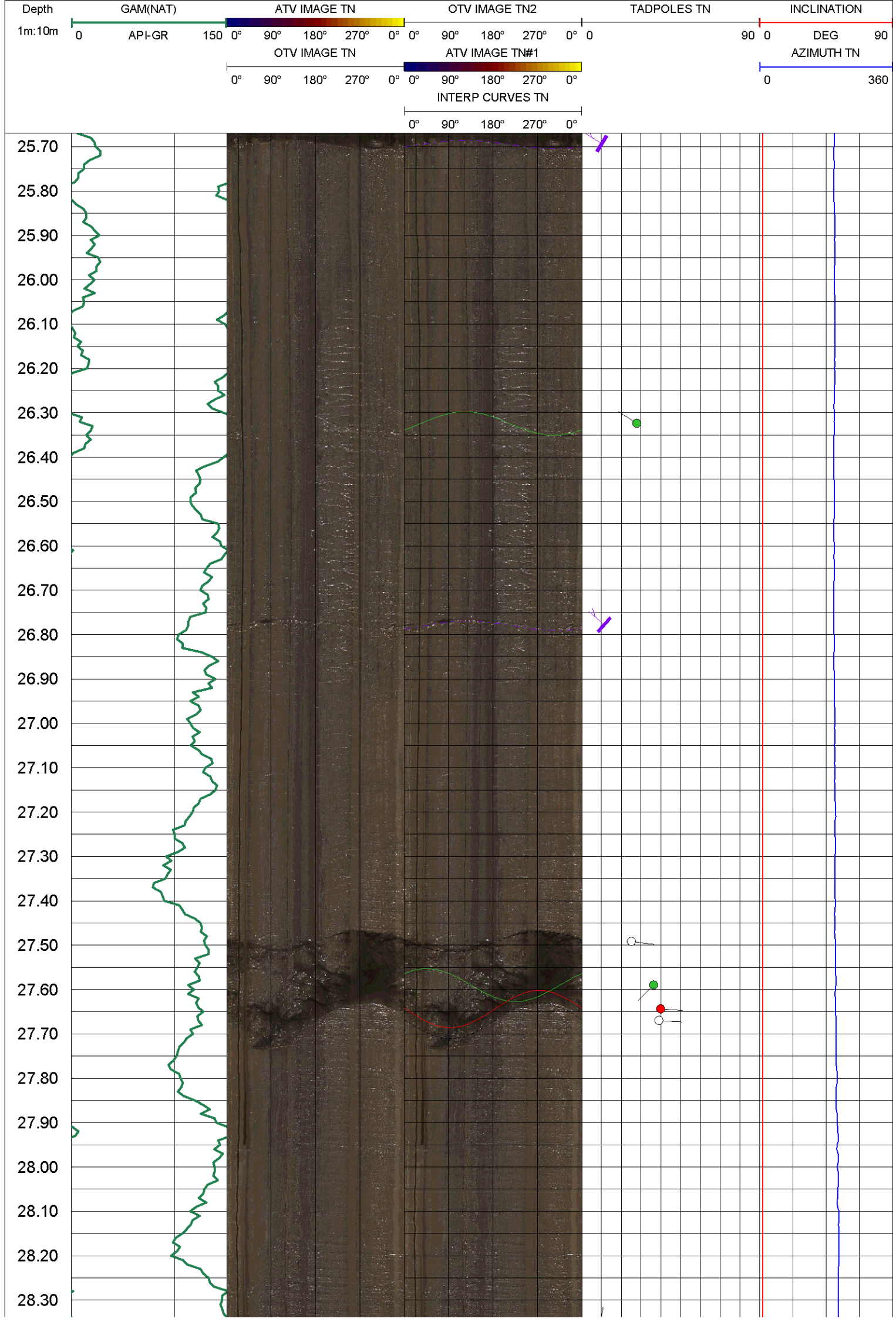
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DEG
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ATV IMAGE TN#1
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AZIMUTH TN
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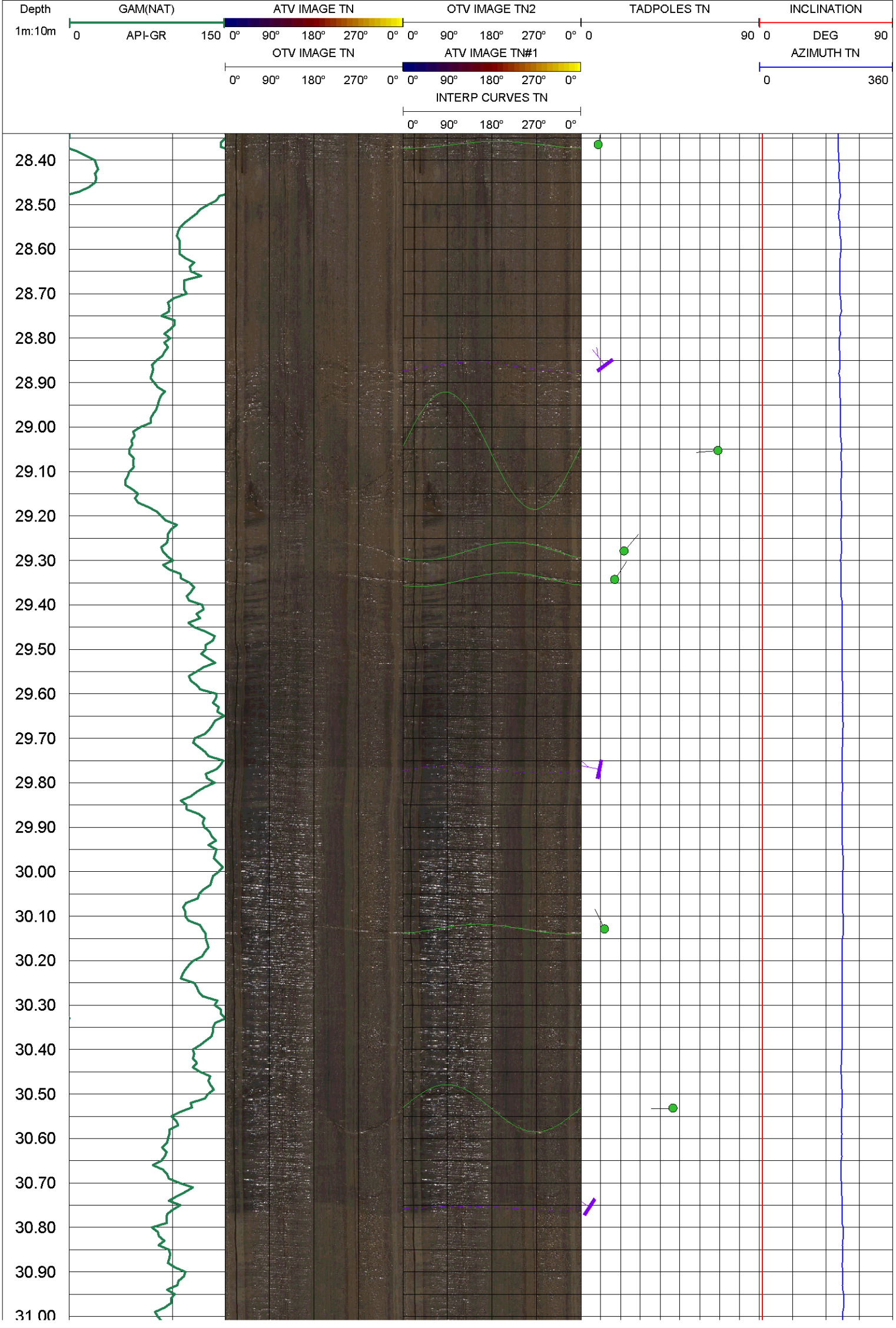
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INCLINATION
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DEG
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ATV IMAGE TN#1
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AZIMUTH TN
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INTERP CURVES TN
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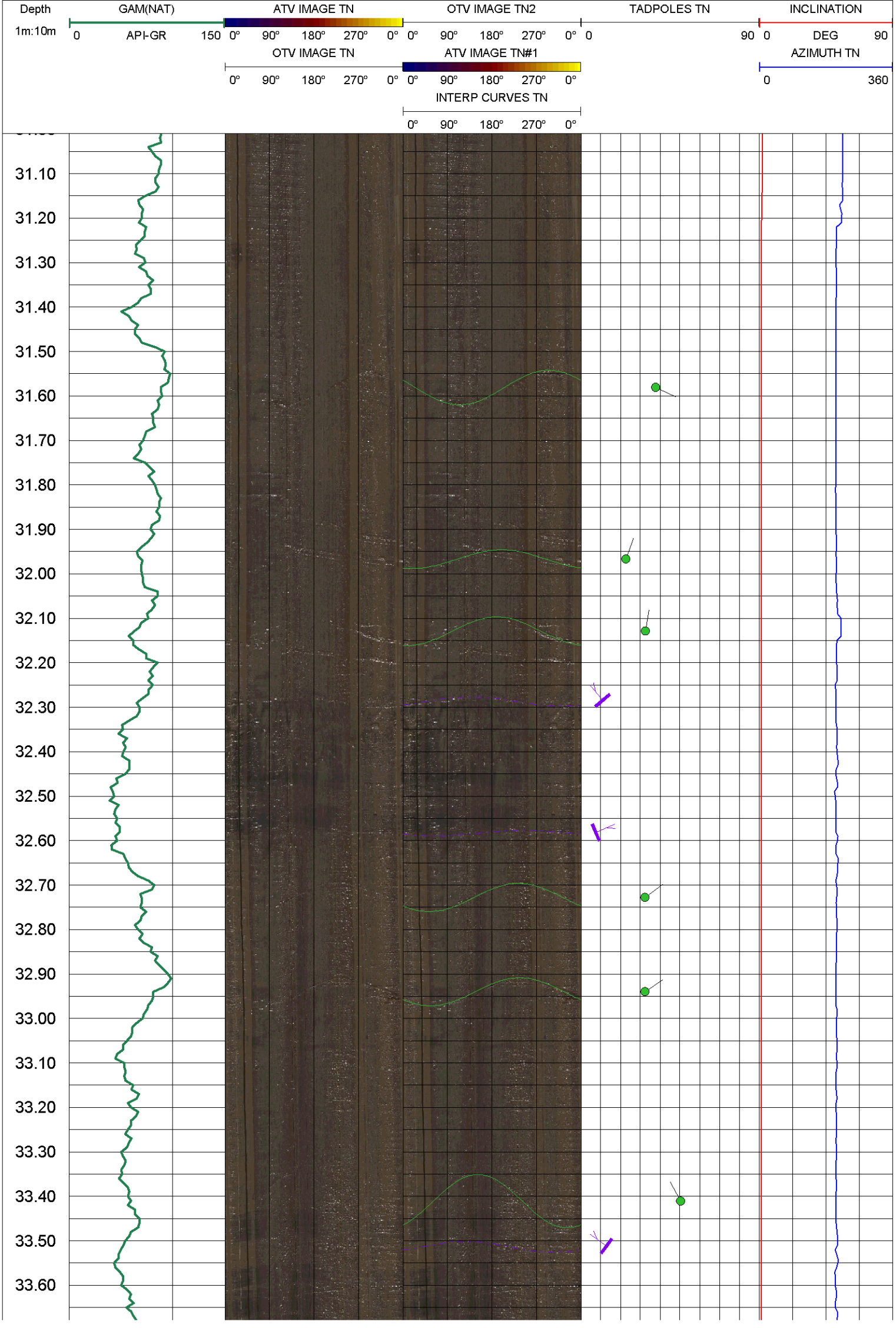
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AZIMUTH TN
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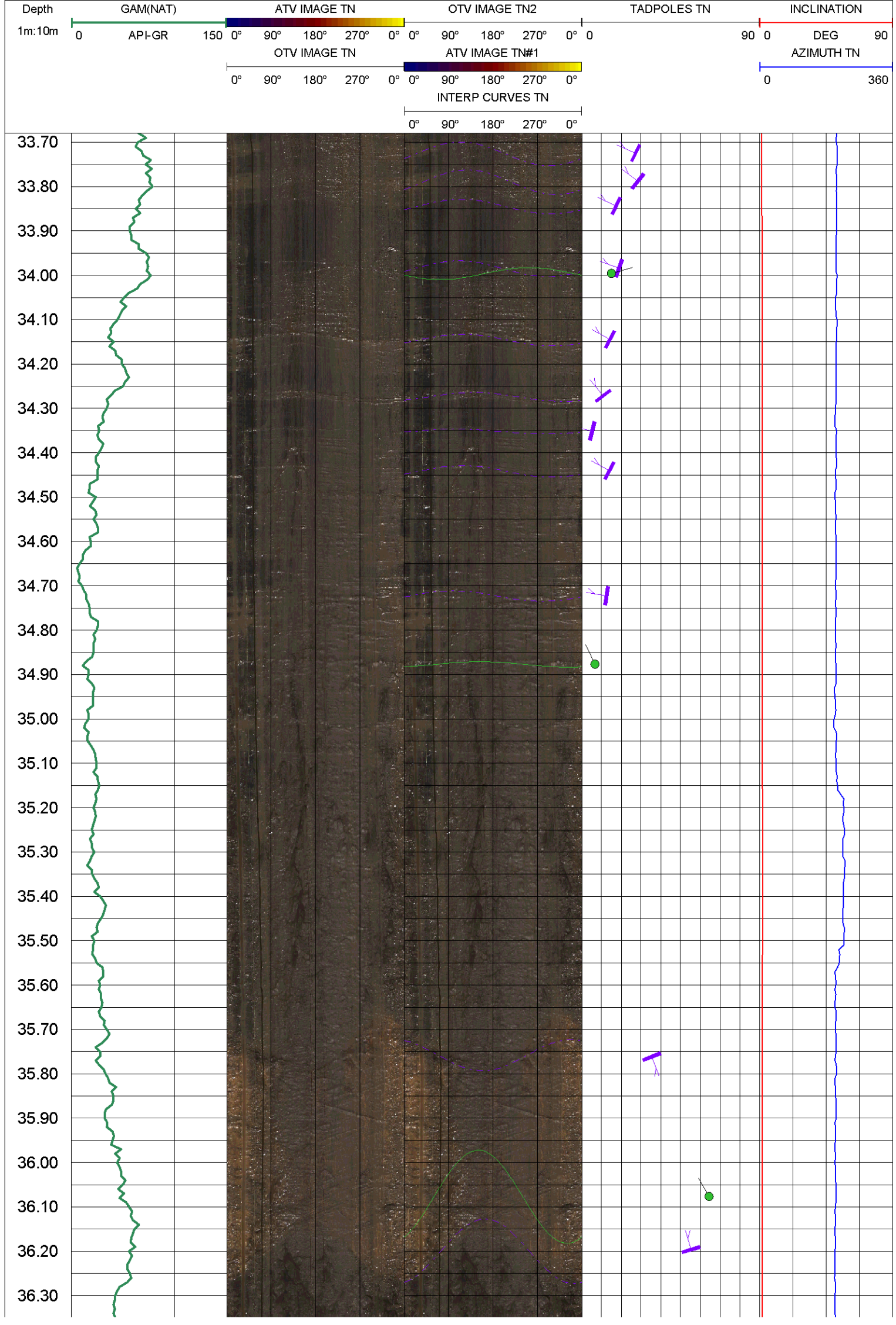
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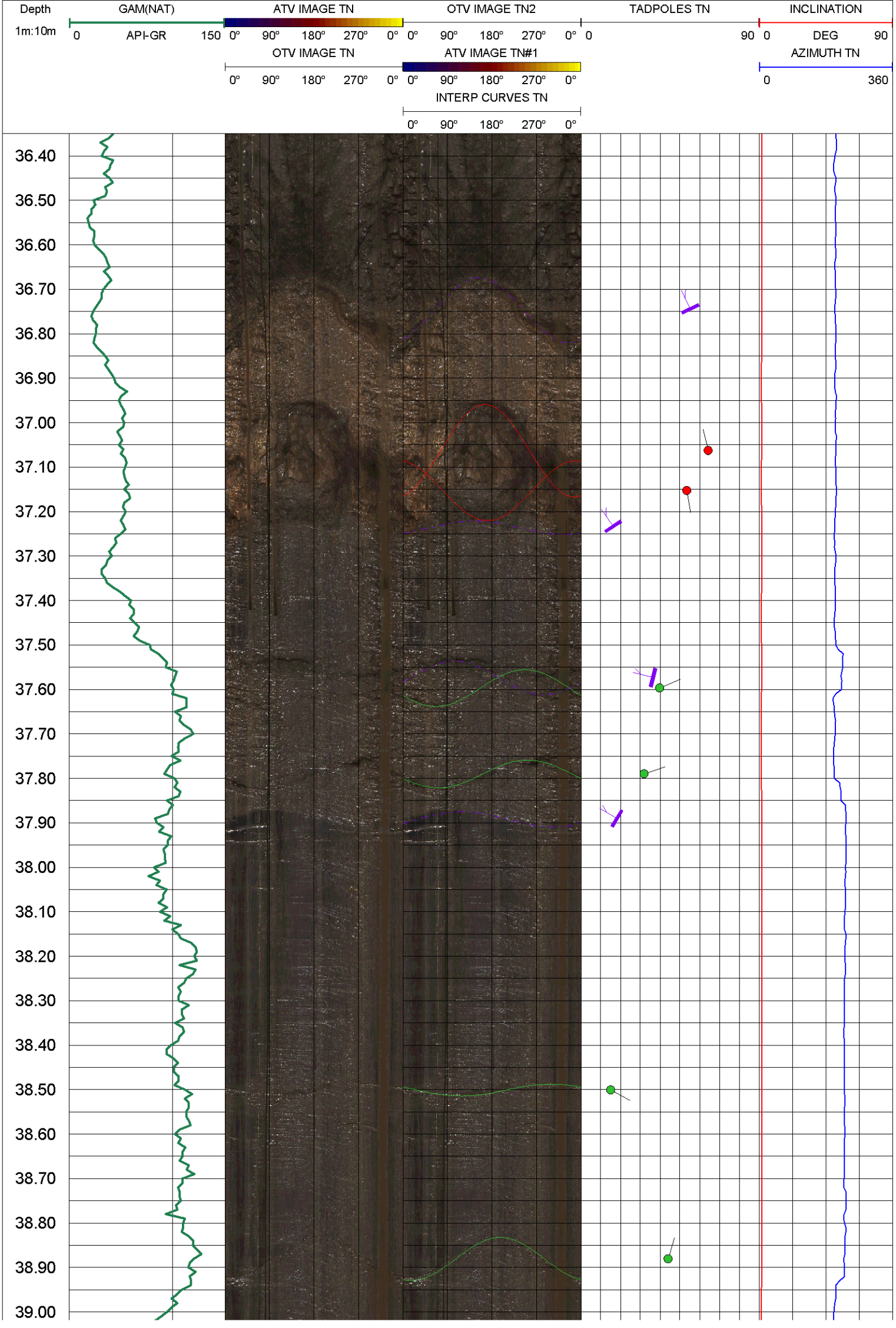
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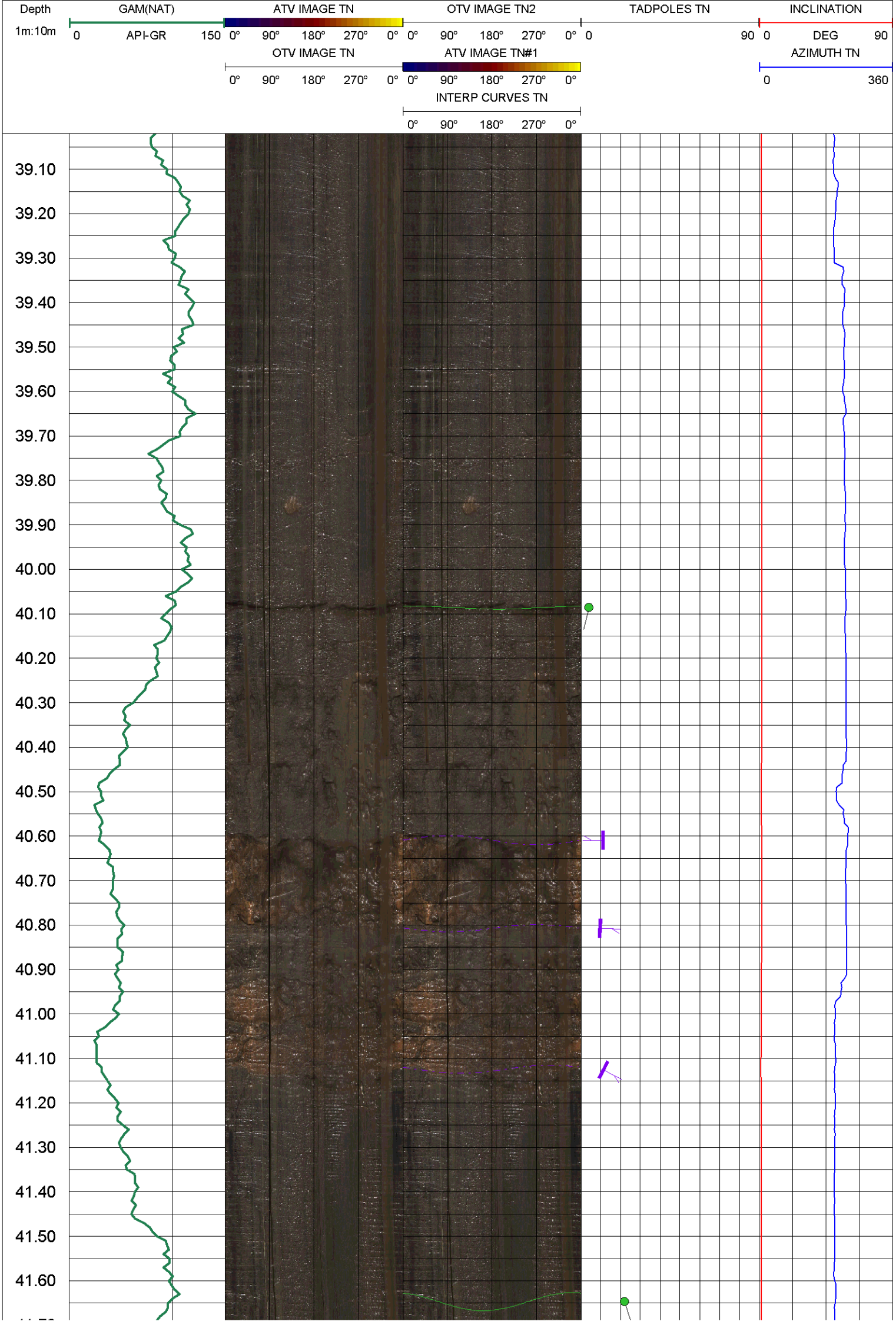
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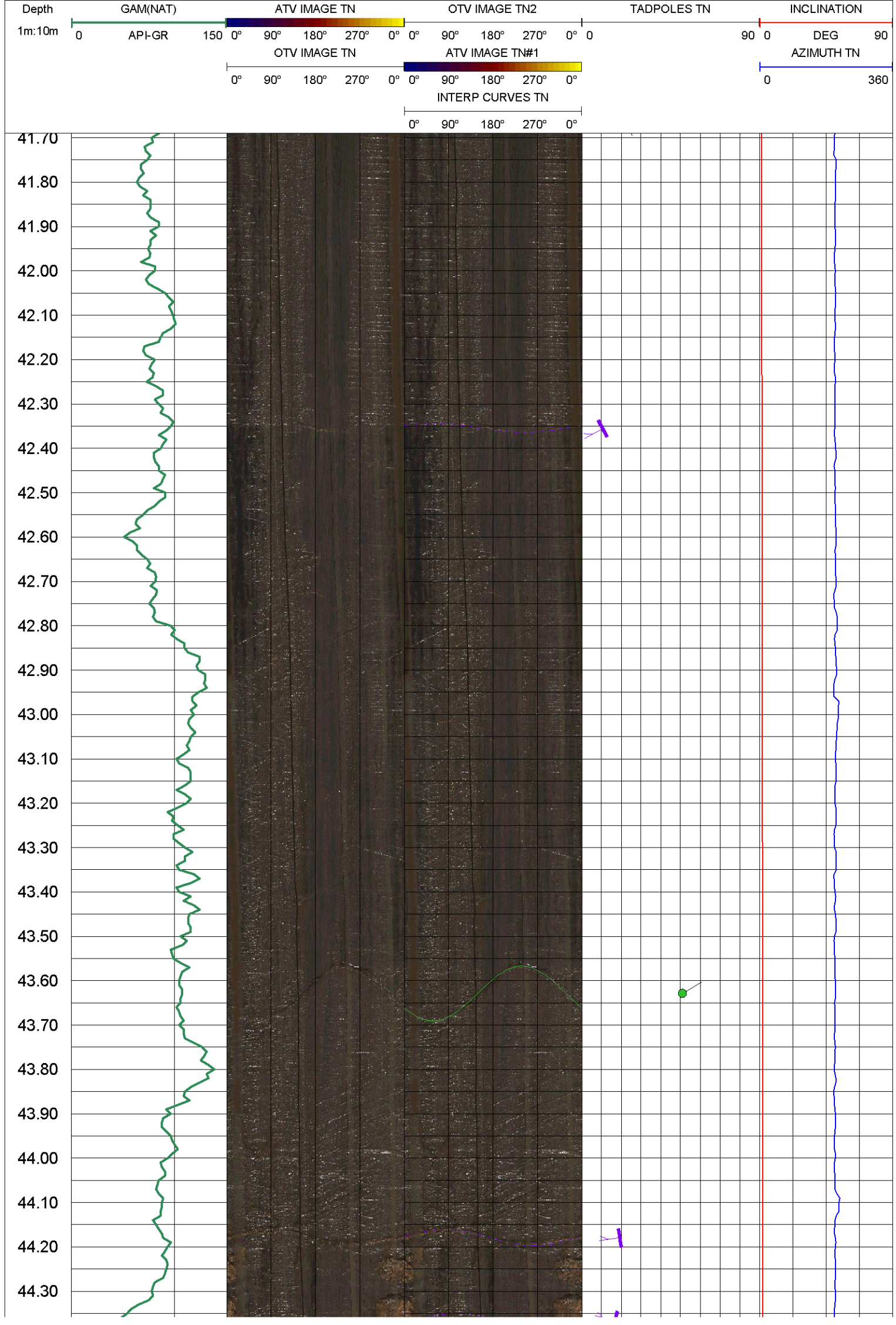
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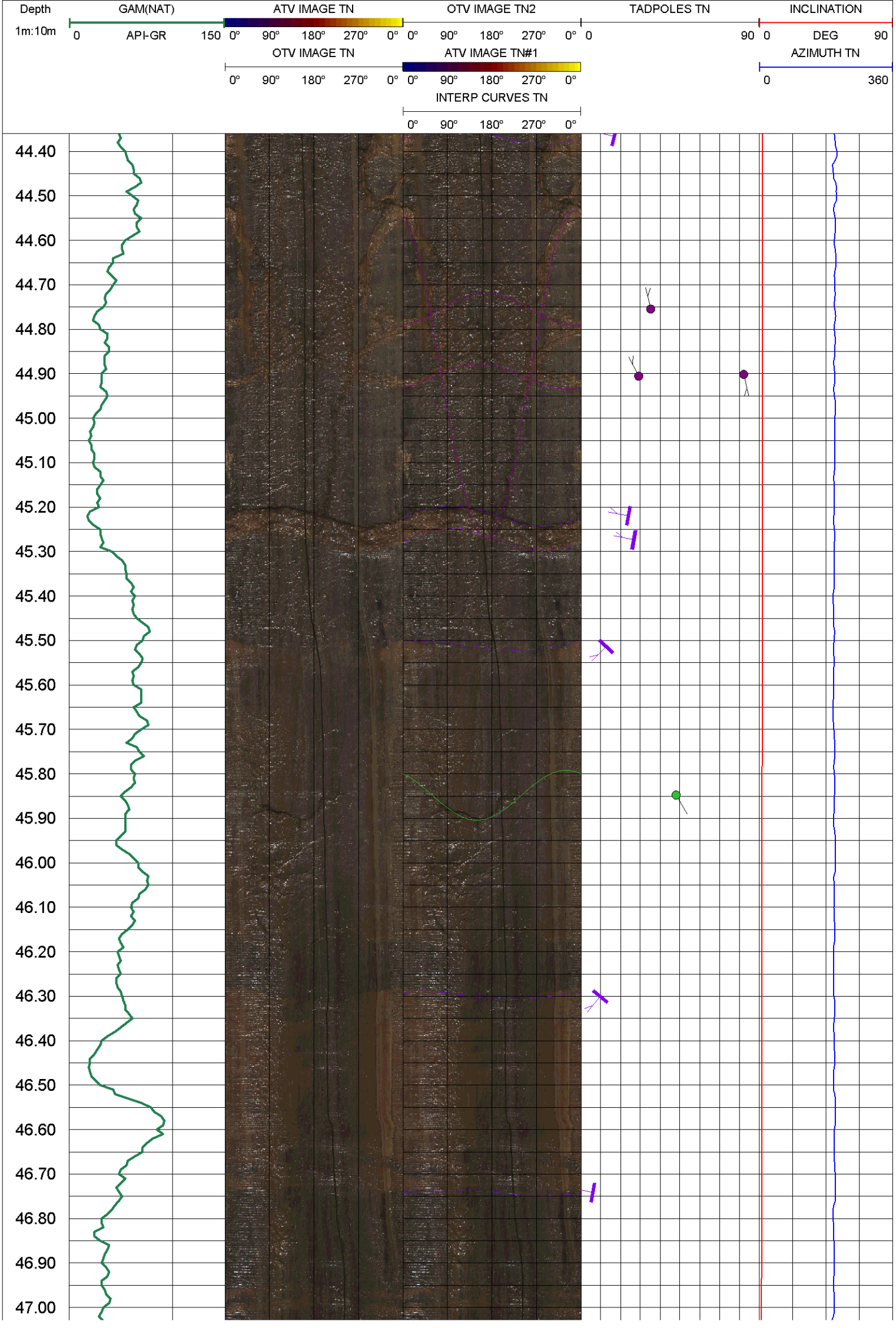
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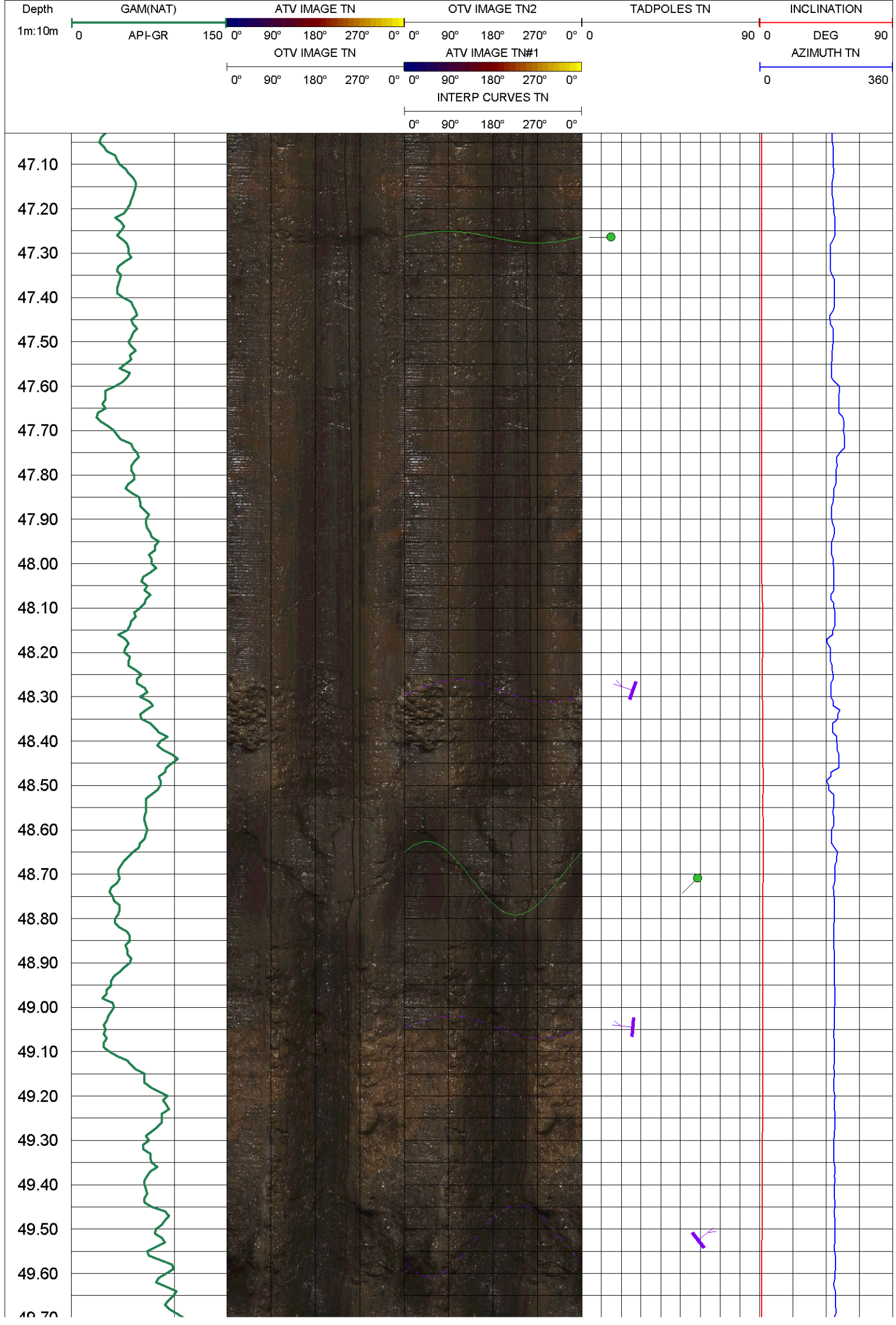
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INTERP CURVES TN
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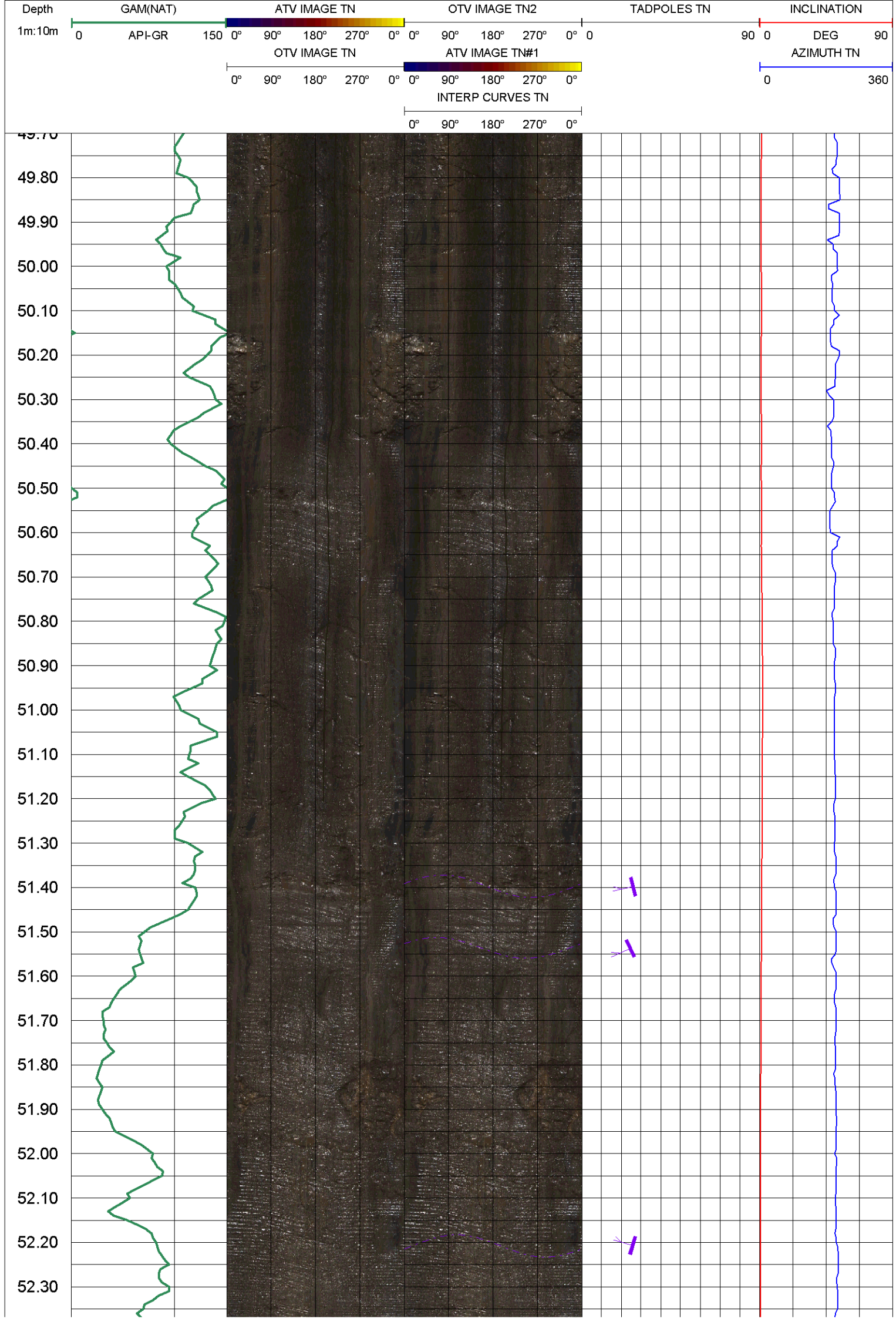
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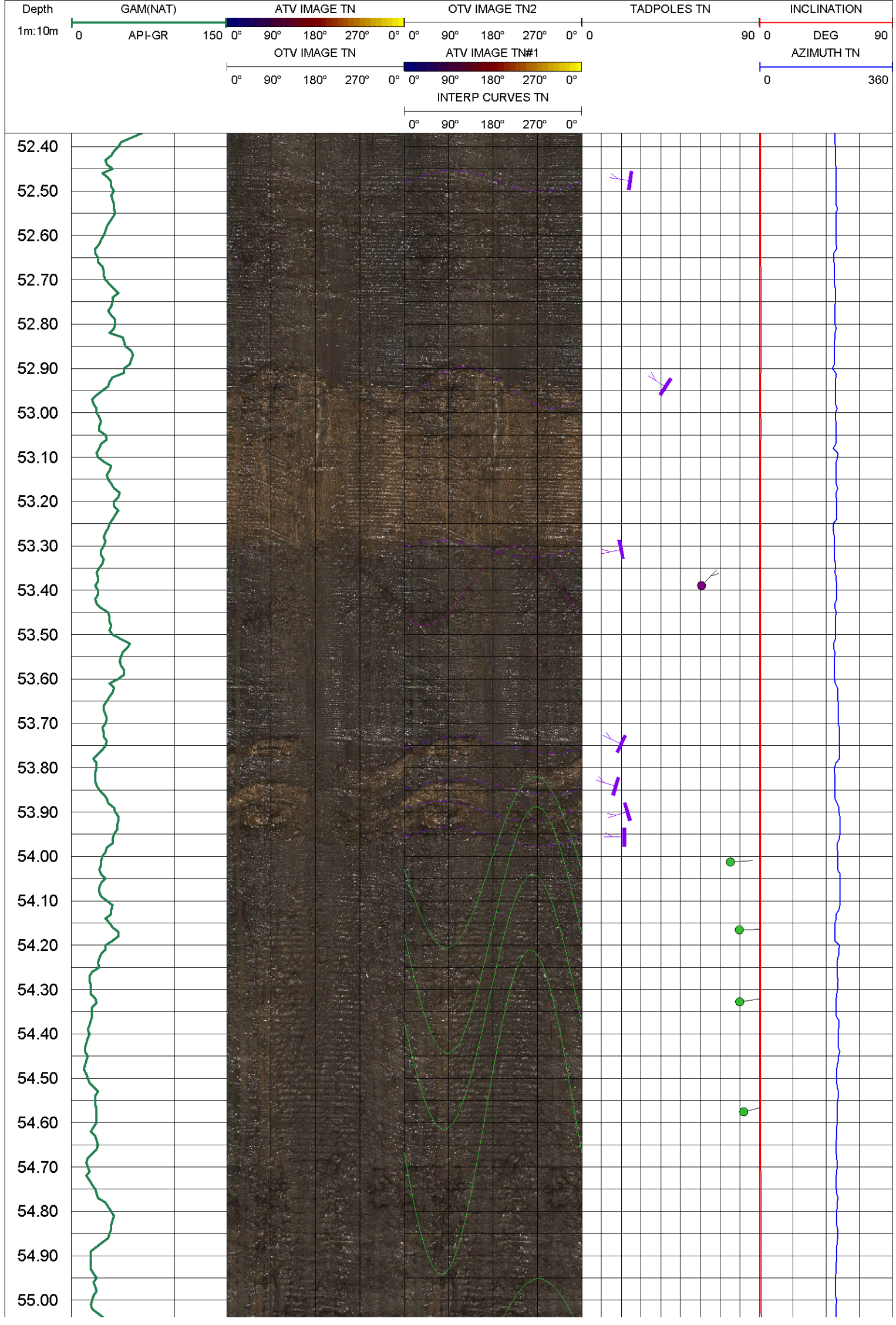
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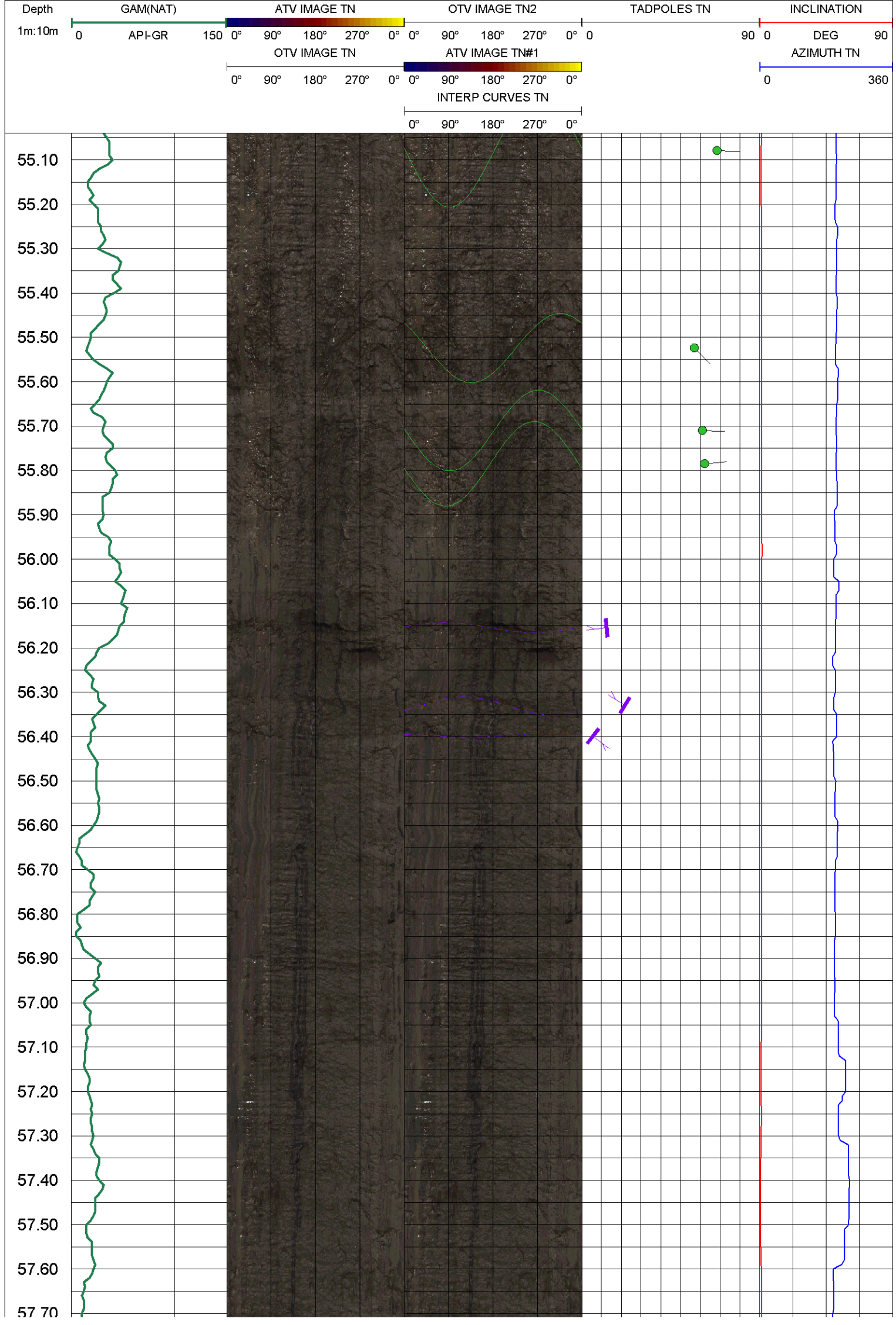
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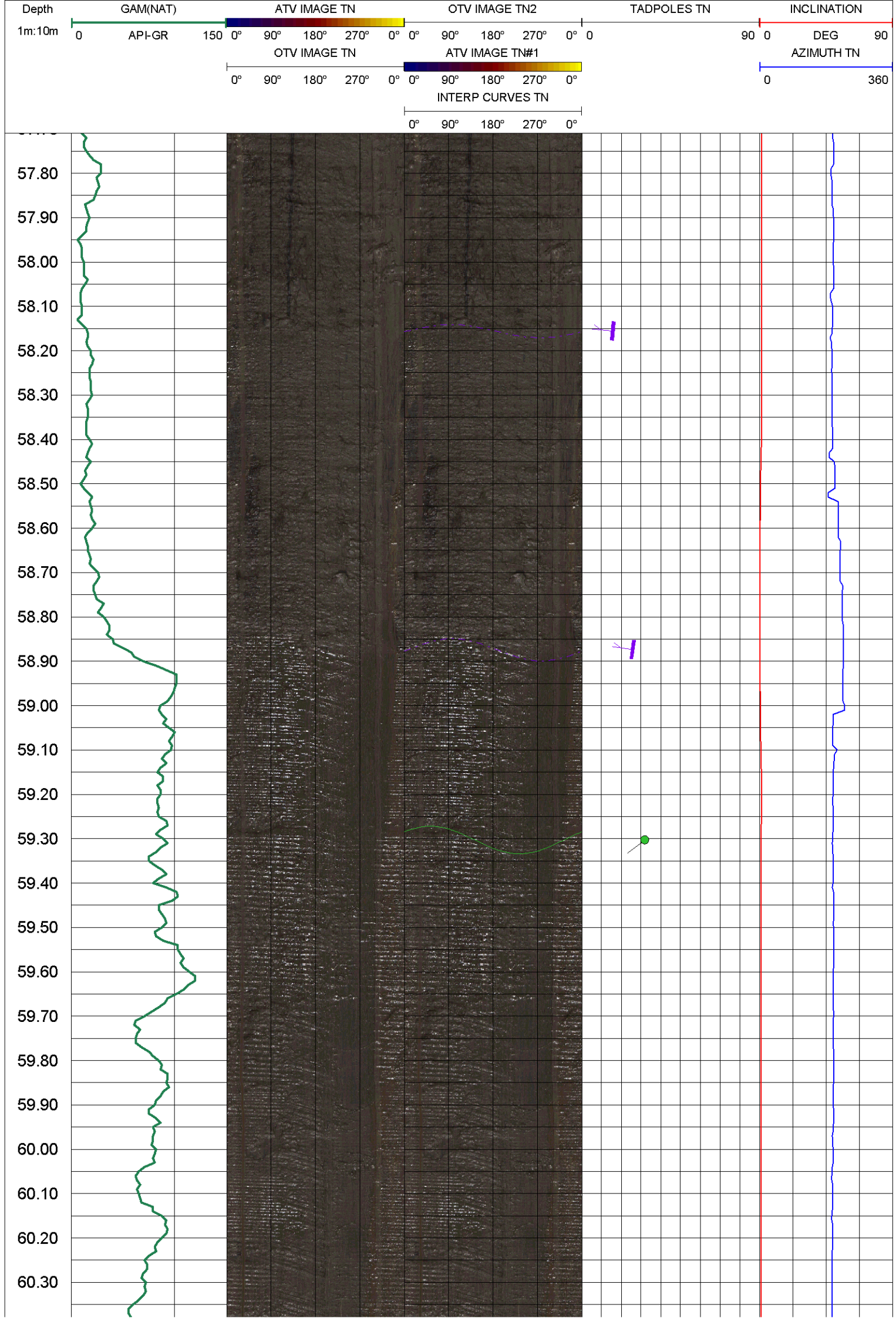
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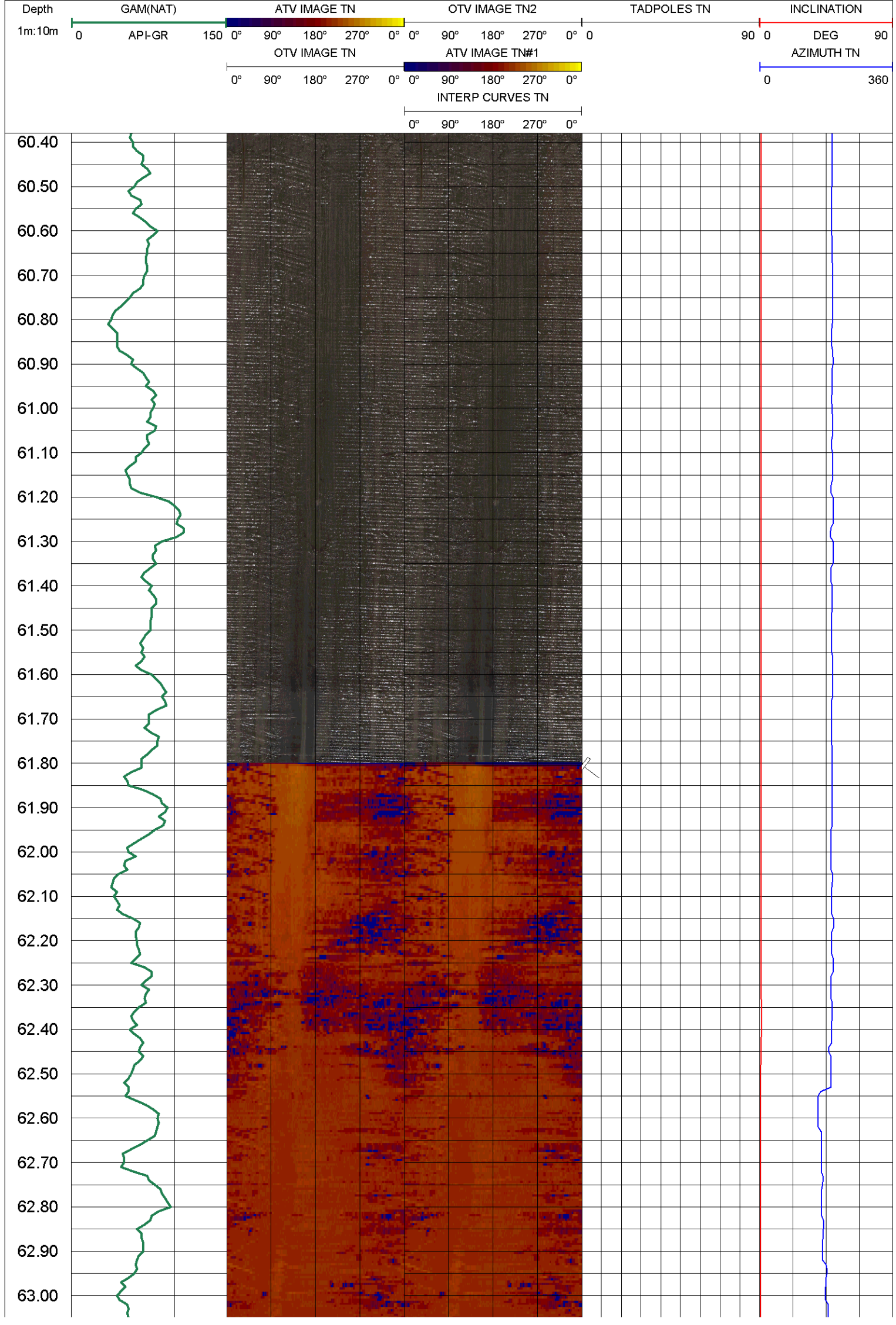
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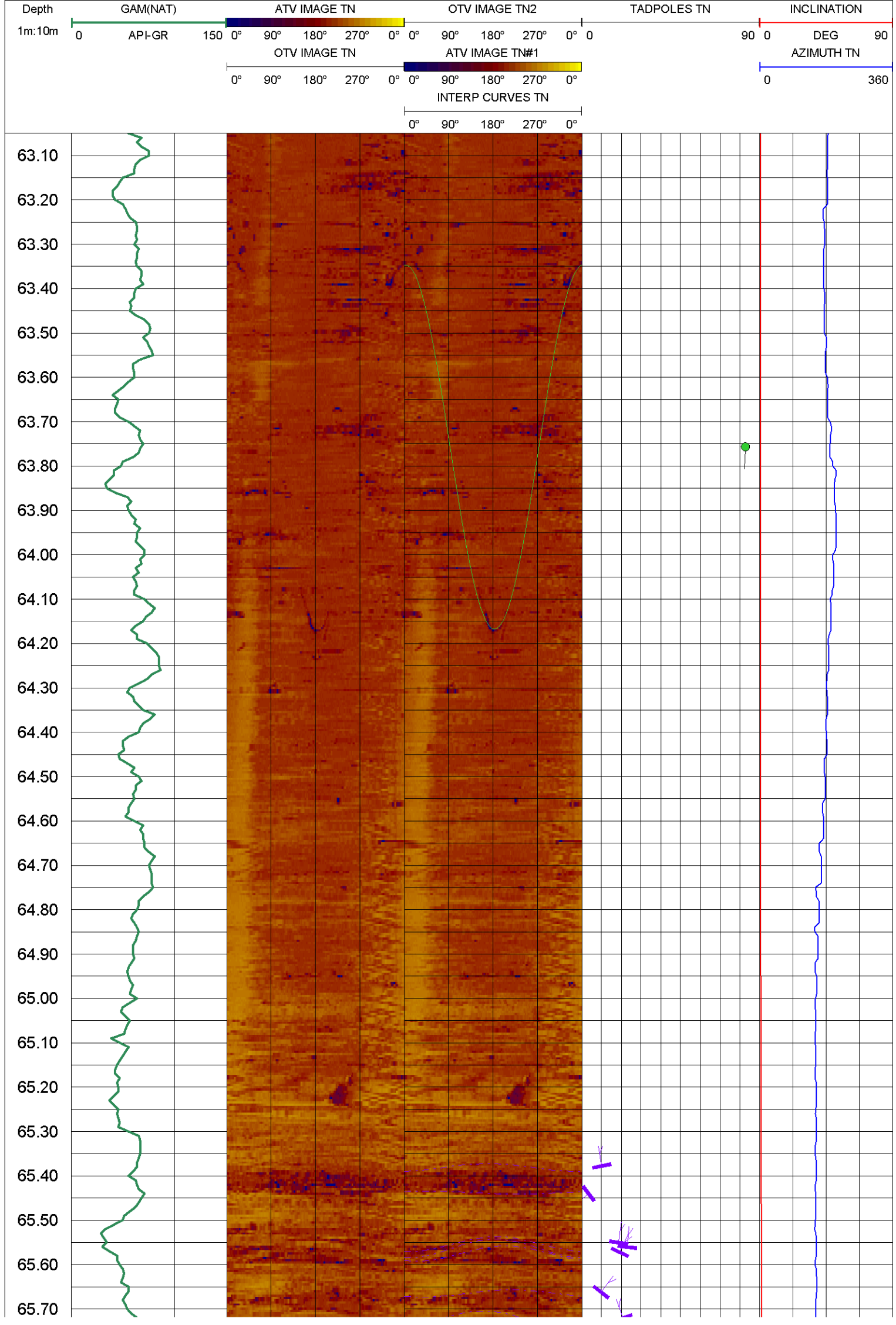
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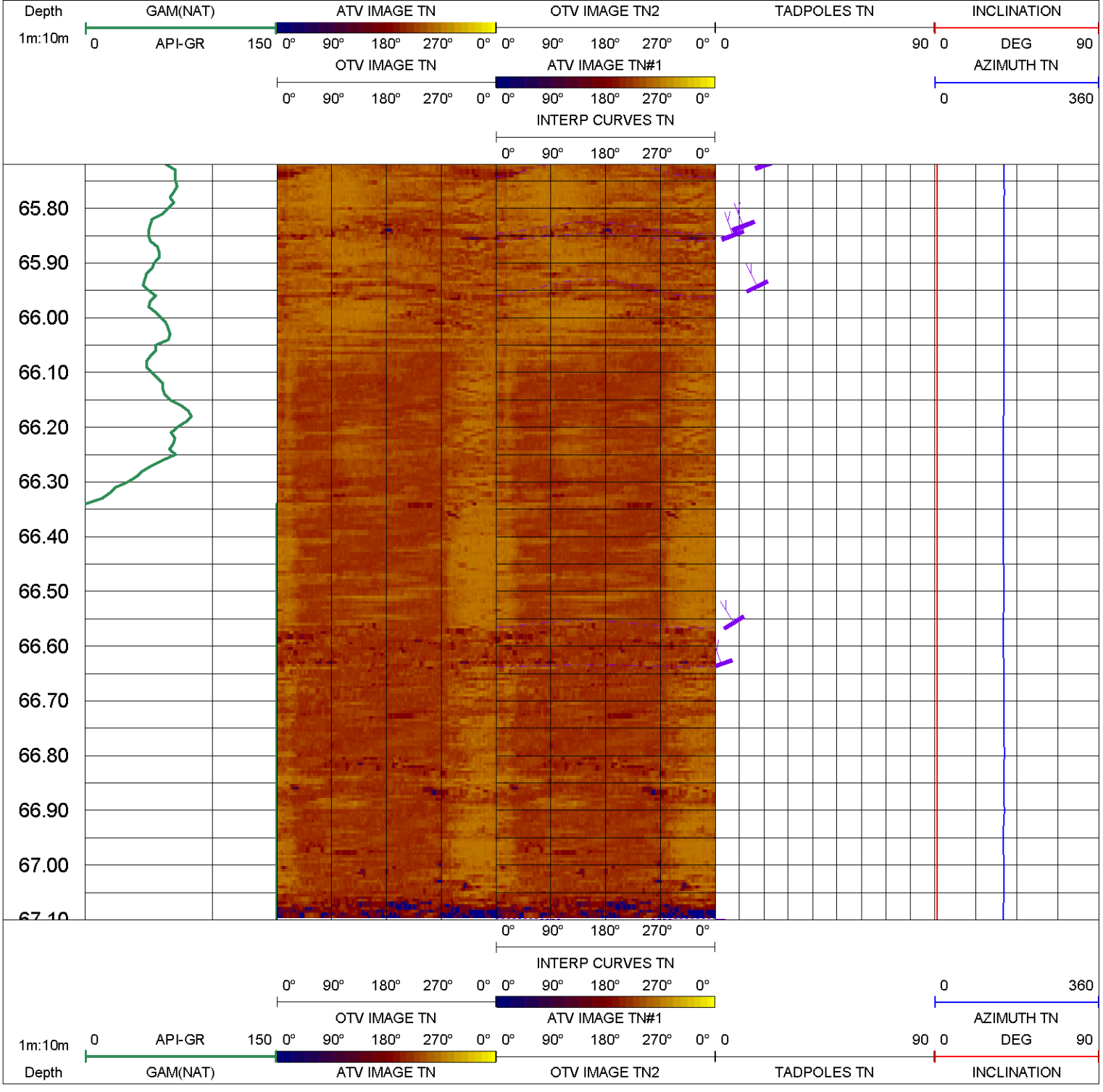
AZIMUTH TN
0
360
INTERP CURVES TN
0° 90° 180° 270° 0°
63.10
63.20
63.30
63.40
63.50
63.60
63.70
63.80
63.90
64.00
64.10
64.20
64.30
64.40
64.50
64.60
64.70
64.80
64.90
65.00
65.10
65.20
65.30
65.40
65.50
65.60
65.70


Depth
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GAM(NAT)
0
API-GR
150
ATV IMAGE TN
0° 90° 180° 270° 0°
OTV IMAGE TN2
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TADPOLES TN
0
90
INCLINATION
0
DEG
90
OTV IMAGE TN
0° 90° 180° 270° 0°
ATV IMAGE TN#1
0° 90° 180° 270° 0°
AZIMUTH TN
0
360
INTERP CURVES TN
0° 90° 180° 270° 0°
65.80
65.90
66.00
66.10
66.20
66.30
66.40
66.50
66.60
66.70
66.80
66.90
67.00
67.10
INTERP CURVES TN
0° 90° 180° 270° 0°
OTV IMAGE TN
0° 90° 180° 270° 0°
ATV IMAGE TN#1
0° 90° 180° 270° 0°
AZIMUTH TN
0
360
1m:10m
0
API-GR
150
ATV IMAGE TN
0° 90° 180° 270° 0°
OTV IMAGE TN2
0° 90° 180° 270° 0°
TADPOLES TN
0
90
INCLINATION
0
DEG
90
Depth
GAM(NAT)