PEN-YR-ENGLYN

Geotechnical Desk Study

Project no. 4021526

Prepared for:

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Cyfoeth Naturiol Cymru
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Enhancing lives, communities and the environment

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1. Introduction

1.1 Project background

The Pen-yr-Englyn tip, situated between Treorchy and Treherbert, was part of Forestry Commission Wales' "Tips and Slips" initiative from 1999 to 2009. The financial downturn in 2008 led to the postponement of the stabilisation efforts planned for this site, along with the broader programme. Prior to the cessation of the programme, Halcrow had conducted a thorough ground investigation, interpreted landslide activity, and developed a preliminary scheme for earthworks and drainage stabilisation at the Pen-yr-Englyn tip. The site is currently deemed to be on the verge of stability, as indicated by historic soil movements related to a pre-existing periglacial landslide.

The Coal Authority has assigned the highest concern level, Category D, to the Pen-yr-Englyn tip. The land encompassing the tip spans multiple ownerships, including the NRW Welsh Government Woodland Estate and the Rhondda-Cynon-Taff County Borough Council (RCTCBC). There has been partial remediation in the past, specifically at the lower section of the tip.

1.2 Scope of works

Binnies UK Limited (Binnies) was commissioned by Natural Resources Wales (NRW) to carry out a geotechnical desk study, site visit, geomorphological mapping and high-level stability assessment of the Pen-yr-Englyn colliery spoil to enable the production of detailed designs (construction issue) and construction contract documents.

As part of the further appraisal and Detailed Design, the site's environmental setting, ecology, mining legacy and potential community benefits via the Well-being of Future Generations Act will be considered in order to create the most viable option for public use.

This report is part of the wider scope of works and includes:

- A desk-based review of the available site information, including additional reports obtained from NRW and RCTCBC archives.
- Site visit following review of topographic survey information. The site visit will be conducted during a period of increased rainfall to observe site flows (if any). Detailed Geomorphological mapping will also be carried out to build upon the findings of the previous mapping carried out by Arup in 2020.
- A high-level slope failure impact assessment to aid informal cost-benefit analysis and to aid decision-making for physical interventions at the site.
- Recommendations on the design of a geotechnical investigation which aims to inform the geotechnical and geoenvironmental design aspects of this project.

1.3 Sources of information

The content of the desk study has been developed using publicly available information alongside historical studies and other pertinent information supplied, which have been summarised in Table 1

Table 1: Summary of supplied documents

Document ref	Number of items	Title	Author	Date	Description
Letters to RCT re Tips 2010	1	Letters to RCT re Tips 2010	RCT Forestry Commission	2010	Contains emails relating to RCT's landholding boundary around the plateau area and the responsibility of RCT to maintain the drainage systems in these areas.
Review of Monitoring Programme	1	Review of Monitoring Programme	CH2MHILL	2014	Report reviewing historic bi-annual monitoring regime including the Pen-yr-Englyn site.
CTS Dec 2020 Notes	1	Coal Tip Safety Task Force note	Coal Authority	2020	Brief note outlining CA risk assessment work on cat C & D coal tips. No specific information on Pen-yr-Englyn mentioned
Pen Yr Englyn Tip 100 Inspection Checklist	1	Rhondda Tips Monitoring and Inspections + Pen-yr-Englyn Tip 100 – Slope Failure	Coal Authority	2020	Inspection checklist carried out in Feb 2020 at Pen-yr-Englyn. Accompanied by a document containing mapped features, photos and details of new findings.
Pen Yr Englyn Tip 100	2	Location Map Movement Markers	Coal Authority	2013	Various documents relating the position of movement markers and their condition
Groundsure Insight data	2	Groundsure GIS datasets (various)	Groundsure	2020	GIS datasets including historical mapping, environmental database information and geological features. The dataset does not capture the full coverage of the site. Assumed to be based on the 2020 red line boundary in the desk study report produced by Arup

Document ref	Number of items	Title	Author	Date	Description
Arup PYE Materials Management Technical Note	2	Material Management Technical Note (290018-ARP-XX-XX-RP-CE-0010)	Arup	2020	Technical note outlining potential re-use of excavated material s.
PYE CH2MHILL	4	-Pen yr Englyn Tech Note - Proposed felling at Pen yr Englyn Tip	CH2MHILL	2013	Report summarising site conditions and implications on felling operations across the site.
290018-ARP-XX-XX-RP-CE-0001	1	Geotechnical Desk Study	Arup	2022	Comprehensive desk study of ground conditions and slope stability.
RCT Archive Documents (Supplied by NRW)					
D320	4	Pen yr Englyn Tip Report on an Investigation into Shallow Mine Workings	Douglas Technical Services Limited	1986	Report on findings from boreholes (logs included) to investigate shallow mine workings
D0338	1	Pen yr Englyn Land Reclamation Scheme	The Polytechnic of Wales	1987	Comments on a phased reclamation scheme and review of the impact on the stability of the slope
D0377	2	Ynysfeio Colliery – Pen yr Englyn Tip No. 100 Report on Stability	Halcrow	1996	Report on results of surveys and review of historical information on the stability of the site after the reclamations work of the tip on the downslope/
D0379	3	Report on Site Investigation at Pen yr Englyn Tips – Volume 1		1983	Borehole logs, test results, site plans and geological sections.
D0380	1	Report on Site Investigation at Pen yr			Factual report of the Volume 1 site work, ground conditions,

Document ref	Number of items	Title	Author	Date	Description
		Englyn Tips – Volume II			discussion, and recommendations.
D0501	11	Ground Investigation Pen yr Englyn Tip 100 February 1998	Norwest Holst	1998	Factual report with logs and testing results
D0514	3	Pen yr Englyn Tip 100 Stability Report	Halcrow	1998	A follow-up report from the 1996 (D0377) stability report with the addition of the 1997 ground investigation results

2. Site details

2.1 Site location and description

The Pen-yr-Englyn tip is situated on the eastern flank of the Rhondda Fawr Valley in Pen-yr-Englyn, Treherbert, within the Rhondda region. The site's approximate central point is marked by the National Grid Reference SS948980. The location is positioned on the southwestern inclines of Mynydd Ynysfeio, as depicted in Figure 1, which also presents a detailed site layout, including the demarcated site boundary.

Figure 1 presents Ordnance Survey (OS) mapping with 10-metre contours, revealing the hillside's varied topography, including flat areas and a steeper gradient on the northeast side. The one-meter LiDAR survey in Figure 3 outlines the plateau and identifies a mound along the hillside, correlating with the historic tramway route used for spoil transport(further discussed in section 3.1.1). The LiDAR data, validated by site walkover observations, offers a precise depiction of the site's terrain at a 1m resolution. It shows two steep areas on the upper hillside and a smaller flat 'plateau' region at the base. North of the dismantled tramway and associated spoil deposits, a notable bulge can be seen, possibly related to the 'debris flow' area mapped by Halcrow in 2007.

Ownership of the hillside falls under the Welsh Government Woodland Estate, with Natural Resources Wales (NRW) overseeing its management. The area is predominantly forested and features paths informally used by the public for walking. The plateau area at the foot of the slope is owned by Rhondda-Cynon-Taff County Borough Council (RCTCBC). The plateau informally serves as a space for recreational walking and access to the lower hillside regions.

The designated areas for tree harvesting are located on the southwestern slopes of Mynydd Ynysfeio, spanning elevations from approximately 200 meters to 375 meters above the ordnance datum. A key infrastructure element is the Ynysfeio Forest Road, which branches off from the A4061 at Treherbert, ascending the southwestern side of Mynydd Ynysfeio. This road, which is engineered into the slope and primarily rests on rock foundations with adjacent embankments of loose spoil, facilitates access across the ridge to the upper reaches of the adjacent Nant Ynysfeio valley. Additionally, the slope hosts various other pathways, established either by NRW or from historical mining operations, with the primary track's route detailed in Figure 1 and Figure 2.

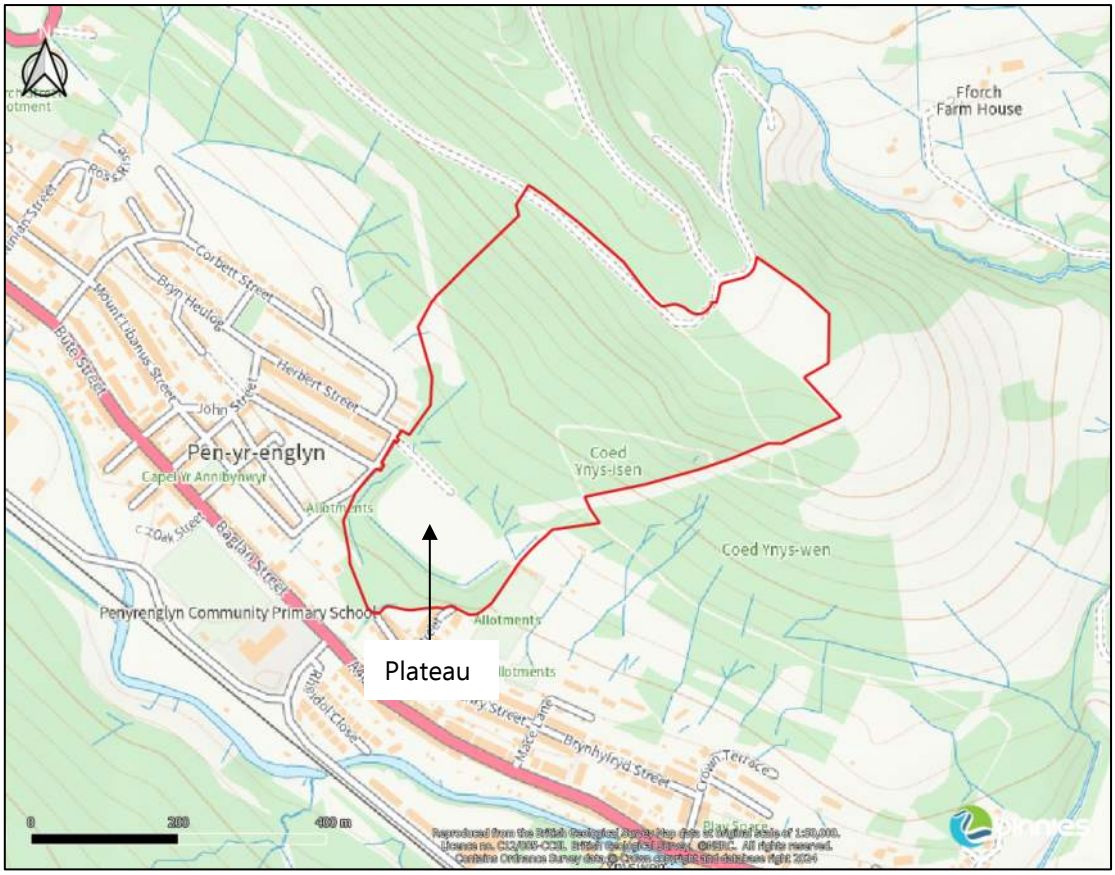

Figure 1: OS site mapping,1:5,000

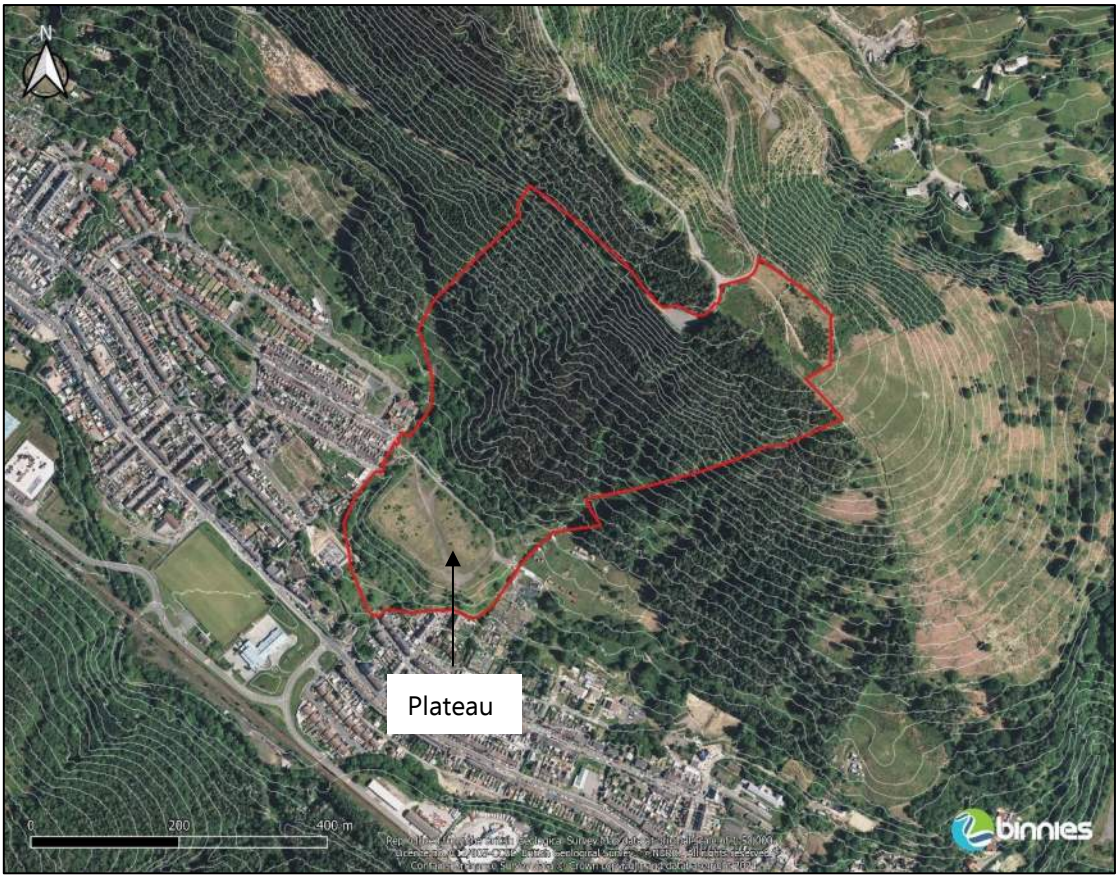

Figure 2: Pre-harvesting (2024) site aerial imagery with 5m contours, 1:5,000

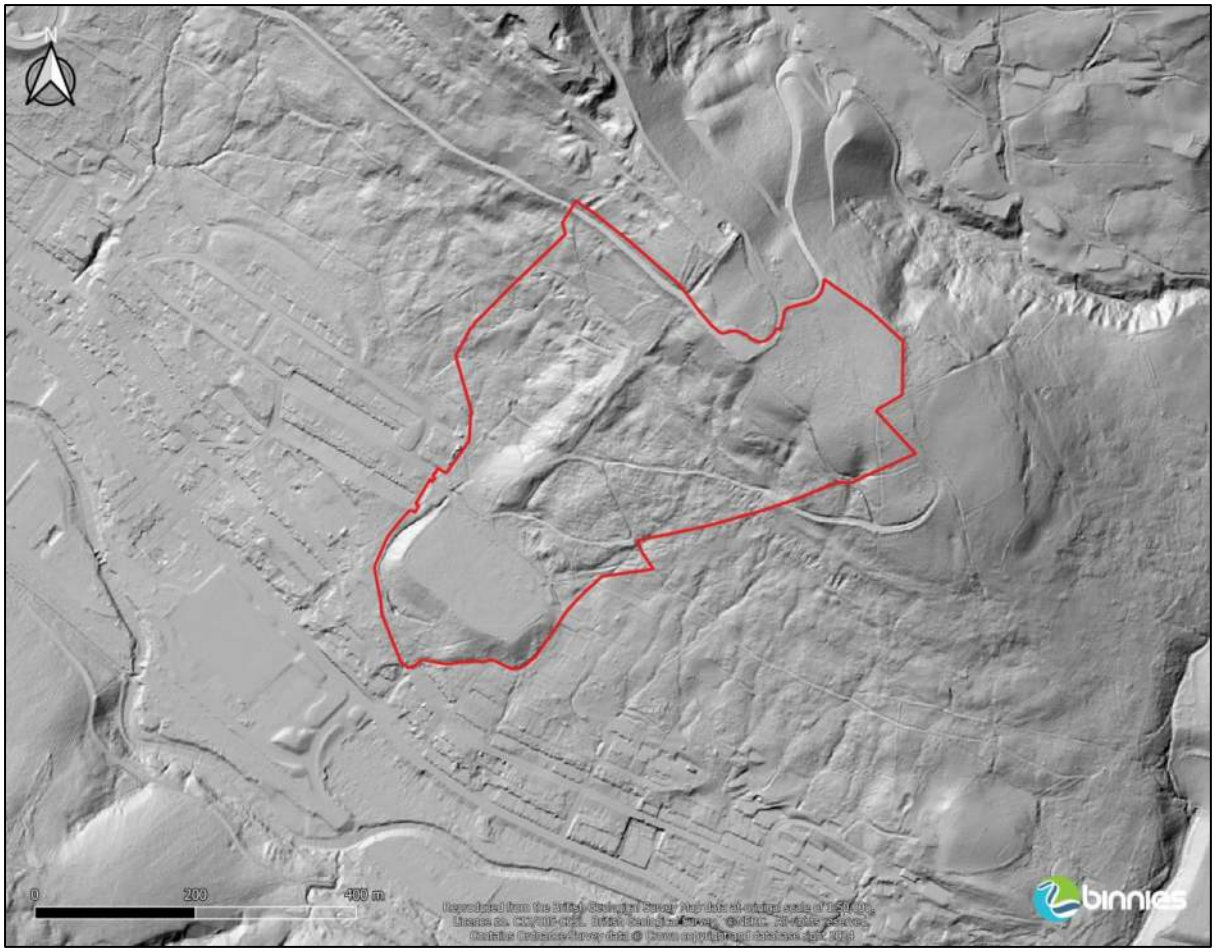

Figure 3: DTM Lidar (1m) 2020 hill shade mapping, 1:5,000

2.2 Proposed works

The proposed works for the site, at the time of preparing this report, are still under development. However, they are likely to comprise:

— Extensive surface drainage scheme including surface ditches to control rain run-off and horizontally bored drains installed into the slope;

— Resurfacing and extensions to the existing forestry tracks;

— Buried attenuation tank, and

— Revegetation of the upper slope.

3. Desk-based assessment

3.1 Historical developments

The historical developments of the site and the surrounding area have been reviewed using historical maps for the site as well as previous studies undertaken and publicly available information for the site area, as described below.

3.1.1 Historical mapping and aerial photography

The development history of the site and surrounding area based upon assessment of historical plans and records is detailed in Table 2. The historical maps reviewed are shown within the supplied Groundsure GIS dataset and range in date from 1875 to 1995.

Table 2: Summary of historical developments

Date	Source and Scale	Historical Land use (on-site)	Historical Land Use (off-site)
1875	Ordnance survey 1:105650	The site is generally undeveloped and comprises mostly open ground with patches of forested areas across the slope. A track runs west to east across the centre of the site and then diverts southwest parallel to the site's western boundary. Various footpaths and boundaries exist. An engine house and adjacent shaft (linked with mine workings of the Abergorki coal seam) are present at the southwestern end of the site at what would be the toe of the present-day plateau. There is also an airshaft marked at the foot of the main slope in the eastern corner of the plateau footprint.	A tramway exists crosscutting the northern edge of the site boundary and linking up with a sandstone quarry 75m north of the site.
1877	Ordnance survey 1:2500	An "Old level (coal)" is marked at the southernmost point of the site which is likely linked to the engine house and air shaft previously mentioned. The remainder of the site remains undeveloped.	No significant changes were noted.
1898	Ordnance survey 1:105650	No significant changes within the site boundary.	No significant changes were noted.
1900	Ordnance survey 1:2500	No significant changes within the site boundary.	No significant changes were noted.
1915	Ordnance survey 1:105650	Significant developments have occurred since 1900's mapping. A tramway now bisects the site up the slope connecting with the Ynys-geio	An additional air shaft is present just offsite directly 100m east of the colliery works. The

Date	Source and Scale	Historical Land use (on-site)	Historical Land Use (off-site)
		Colliery and Engine house. Spoil tips are now present on the upper slopes adjacent to either side of the tramway. laterally extending 130m to the east and 70m to the west. A reservoir exists northeast of the Colliery works and plateau. The colliery works have significantly developed comprising several small buildings across the eastern footprint of the plateau.	northern sandstone tramway is now marked as "old" indicating that it is no longer in use.
1920	Ordnance survey 1:2500	The tipped spoil is mapped at a higher resolution and includes four sloping terraces on the western side of the tramway and three broader sloping terraces on the western side.	No significant changes were noted.
1921 & 1945	Ordnance survey 1:105650	No significant changes within the site boundary.	No significant changes were noted.
1948	Ordnance survey 1:105650	The tramway is no longer mapped along with some of the colliery-related buildings.	No significant changes were noted.
1960	Ordnance survey 1:1250	All colliery spoil buildings are no longer present within the footprint of the plateau. The slope-tipped spoil has been mapped in further detail and comprises several terraces on either side of the dismantled tramway. A footpath is mapped following the tramway and diverting towards the east halfway up the slope.	No significant changes were noted.
1962	Ordnance survey 1:2500	A footpath is noted across east to west on the upper slope of the site below the present-day forestry track.	No significant changes were noted.
1964 & 1965	Ordnance survey 1:105650	No significant changes within the site boundary.	No significant changes were noted.
1965	Ordnance survey 1:2500	No significant changes within the site boundary.	No significant changes were noted.
1968	Ordnance survey 1:1250	No significant changes within the site boundary.	No significant changes were noted.

Date	Source and Scale	Historical Land use (on-site)	Historical Land Use (off-site)
1972	Ordnance survey 1:1250	Some additional buildings (potentially residential) at the toe of the plateau but otherwise no significant changes.	No significant changes were noted.
1982	Ordnance survey 1:105650	Afforestation of the main slope.	The wider area has also been forested on the slope.
1986	Ordnance survey 1:2500	No significant changes within the site boundary.	No significant changes were noted.
1987	Ordnance survey 1:1250	A zig-zag forestry track is now present cutting into the eastern side of the spoil tip.	No significant changes were noted.
1988-1995	Ordnance survey 1:2500	No significant changes within the site boundary.	No significant changes were noted.
Aerial Imagery			
2001 (Dec), 2006 (Dec), 2009 (Dec), 2010 (Dec), 2013 (Jul), 2016 (Aug), 2018 (Jun),2020 (May), 2021 (Jul), 20201 (Sept), 2023 (Jul),	Google Earth Pro	The site is generally shown in its present-day state. The main slope is sporadically forested with trees with various zig, zag, parallel and perpendicular tracks cutting through the forest. Some parts of the forest are distinctly darker indicating potentially wetter regions The plateau shows additional re-profile in the centre of the plateau's toe and eroded footpaths across and around the edge of the plateau. Between 2001 and 2021 the site remains relatively unchanged other than seasonal variations in the vegetation. Evidence of logging operation at the top of the slope is evident in 2023 aerial imagery.	No significant changes were noted.
Note: Reference to published historical maps provides invaluable information regarding the land use history of the site, but historical evidence may be incomplete for the period pre-dating the first edition and between successive maps.			

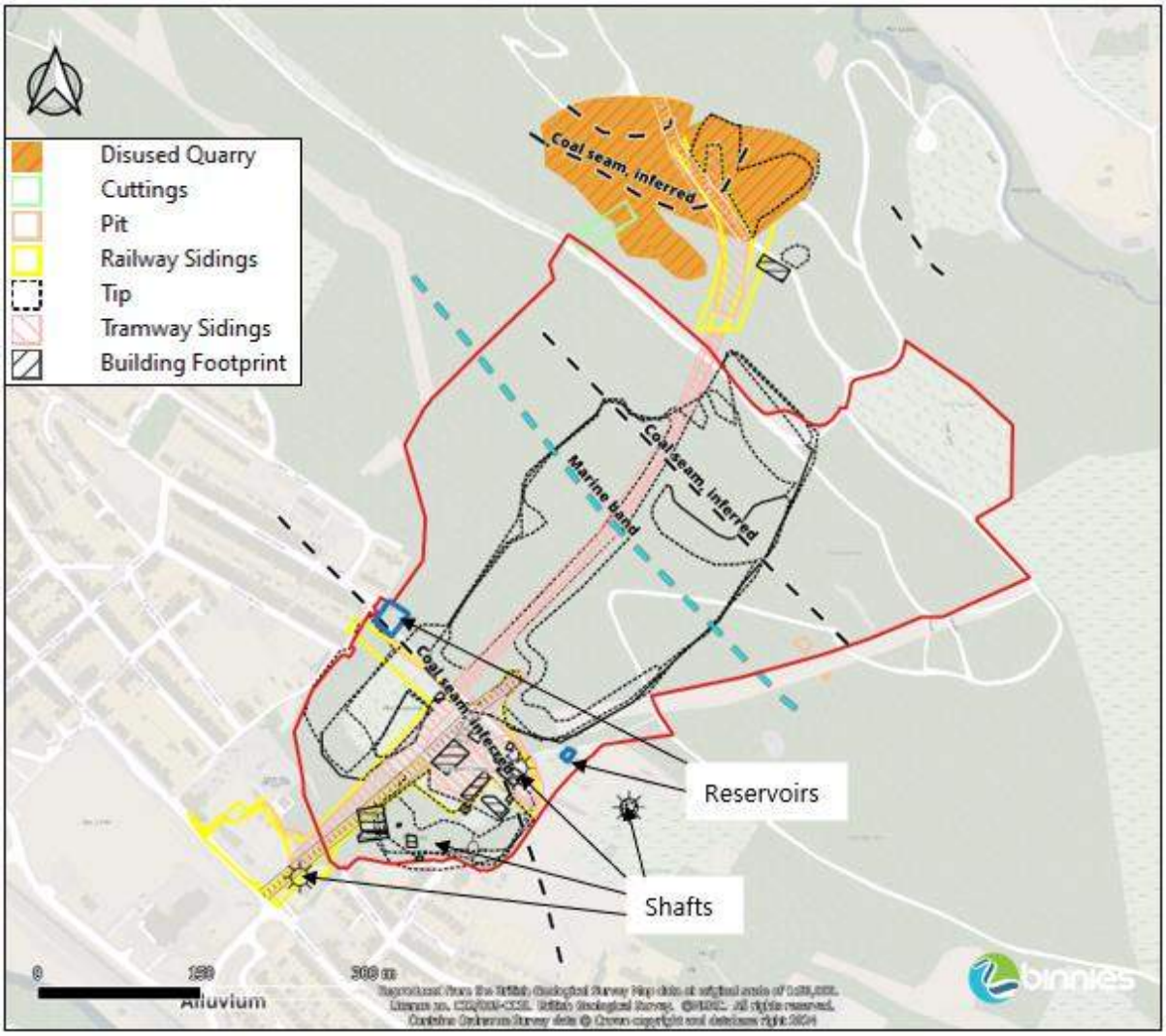

Figure 4: Historical above-ground industrial land use extents including indicative locations of abandoned shafts, adits, reservoirs and historic building footprints.

3.1.2 Unexploded ordnance

As a preliminary risk assessment, publicly available unexploded ordnance (UXO) risk maps were reviewed. These indicate that the site is located in an area with low potential for wartime bombs to be present (Zetica, 2024). Based on the proposed works the risk of encountering a UXO is negligible and will not be considered further.

3.2 Published geology

The geology underlying the site is shown on the British Geological Survey (BGS), England & Wales 1:50,000 series, Pontypridd Solid and Drift Editions (BGS, 1963; BGS, 1975) and on the British Geological Survey interactive map GeoIndex Onshore (BGS, 2024). An extract of the most recent digital geological mapping available is presented in Figure 5.

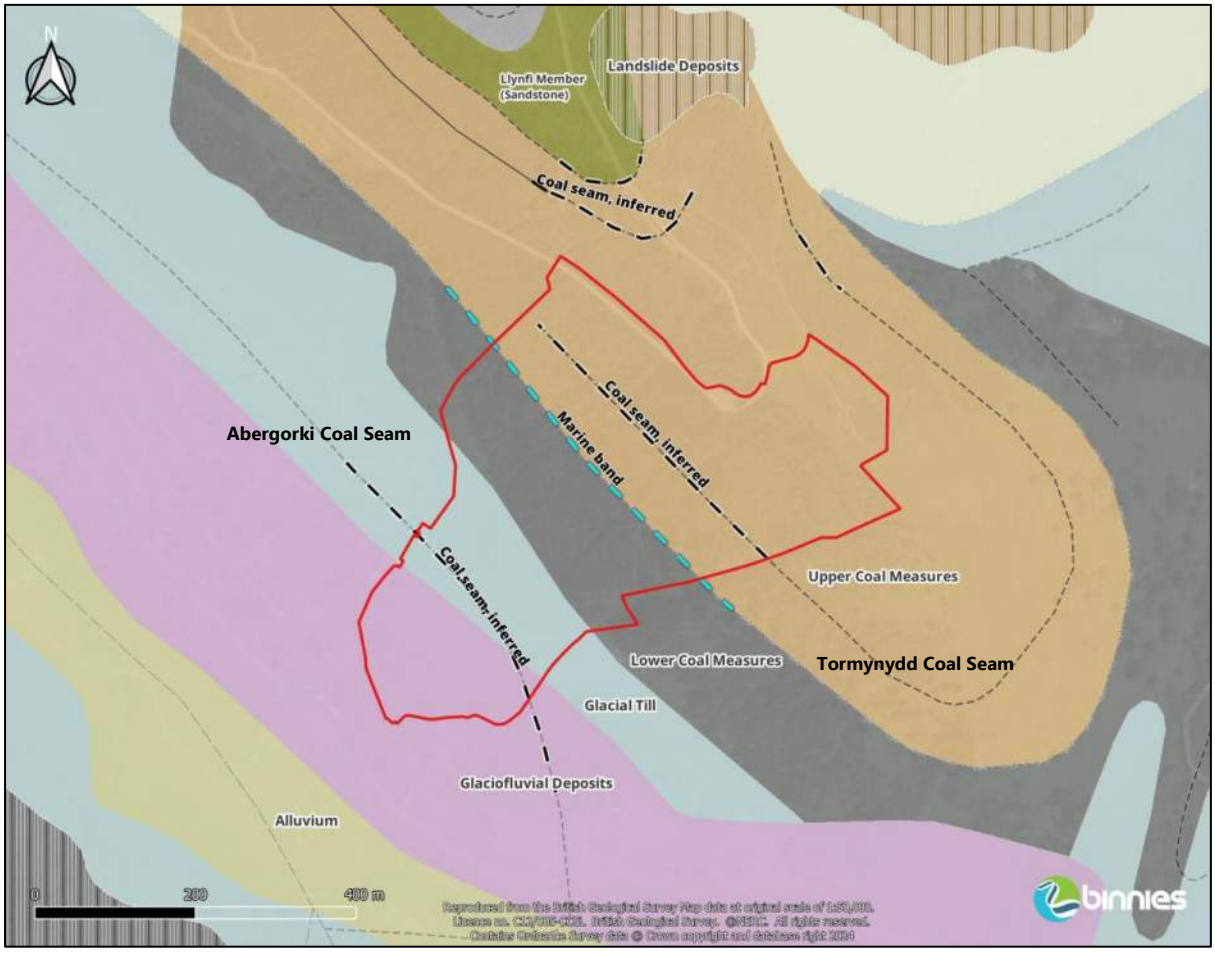

Figure 5: Superficial and Bedrock Geology after (Groundsure, 2023).

3.2.1 Memoir explanation of one-inch geological sheet 248 (Woodland & Evans, 1964)

The accompanying memoir to geological sheet 248 notes that the Tormynydd Coal Seam, often called the No. 3 Rhondda, was also mined as Hafod from Church Level [SS 9735 9562] in Ystrad Rhondda, where it was recorded to be approximately 0.97 meters thick. In other locations, its thickness rarely exceeds 0.61 meters, and at the Ynyswen Level [SS 951 979], it was mined at about 0.56 meters thick. Various exploratory excavations have been made on the east side of the valley, from Treorchy to Pentre, south of Cwm-parc, west of Treherbert, and northeast of Blaen-y-cwm, where the seam's thickness ranged from 0.30 to 0.53 meters.

3.2.2 Artificial Ground

The detailed geological mapping does not show any made ground at the site, though it depicts mounds at the former colliery location extending up the hillside. Similarly, the BGS digital mapping fails to show any made ground at the site. Given the site's history of mining

and tipping, along with observations from site visits, it is known much of the site is covered with colliery spoil. While evidence points to colliery spoil making up the made ground, it is possible that made ground from other activities could also be present. These activities include the plateau's construction, the remediation of old coal workings, the erection, and subsequent removal, of the historical tramway, and construction of the forest track.

3.2.3 Superficial Deposits

Beneath the plateau area, the geological mapping indicates the presence of Glaciofluvial sand and gravel deposits. Deposits of Glacial Till are noted within the northeastern edge of the plateau and extend up the hillside. While alluvial deposits are found along the valley floor and near the river's path, none are mapped within the site's boundaries. However, there may be small, localised deposits of finer-grained material adjacent to present-day watercourses across the site.

3.2.4 South Wales Coal Measures Formation

The South Wales Coal Measures Formation is made up of layers of mudstone, siltstone, and sandstone. This formation is divided into the Upper and Middle Coal Measures, distinguished by a marine band marking their boundary.

The slopes higher up are mainly composed of the Rhondda and Llynfi members within the Upper Coal Measures Pennant Sandstone Formation. These members are separated by the No.2 Rhondda coal seam, with the Rhondda Member positioned above this seam and the Llynfi Member below it. The Rhondda Beds are characterised by mostly medium to thick layers of strong, well-jointed sandstone with minimal mudstone bedding in between. On the other hand, the Llynfi Member consists of a mix of sandstones and mudstones, featuring at least three unnamed thin coal seams, including the Tormynydd Seam towards the base of the member.

The remainder of the site sits on the Middle Coal Measures, which include the Abergorki coal seam. The beds within the Middle Coal Measures are generally sub-horizontal dipping away from the face of the hillside at the site towards the northwest to north-north-west direction, with angles varying from a gentle 1° to a more noticeable 20°. Previous ground investigations have observed that the siltstone layers tend to dip between 5° and 10°.

3.2.5 Coal seams and Marine band

Inferred coal seams are mapped along the northeast edge of the plateau (Abergorki Coal seam) and towards the top of the hillside below the forestry track (Tormynydd Coal seam). As mentioned above there is also a marine band running parallel to the highest inferred coal seam further down the hillside which dictates the boundary between the upper and middle coal measures as shown in Figure 5.

3.3 Previous Studies and Ground Investigations

This section summarises all pertinent findings from a detailed review of the previous studies and ground investigations carried out at the site. A combined exploratory hole plan that includes all ground investigation exploratory holes from the information available is presented in Figure 6 along with Table 3 which gives further details on each location.

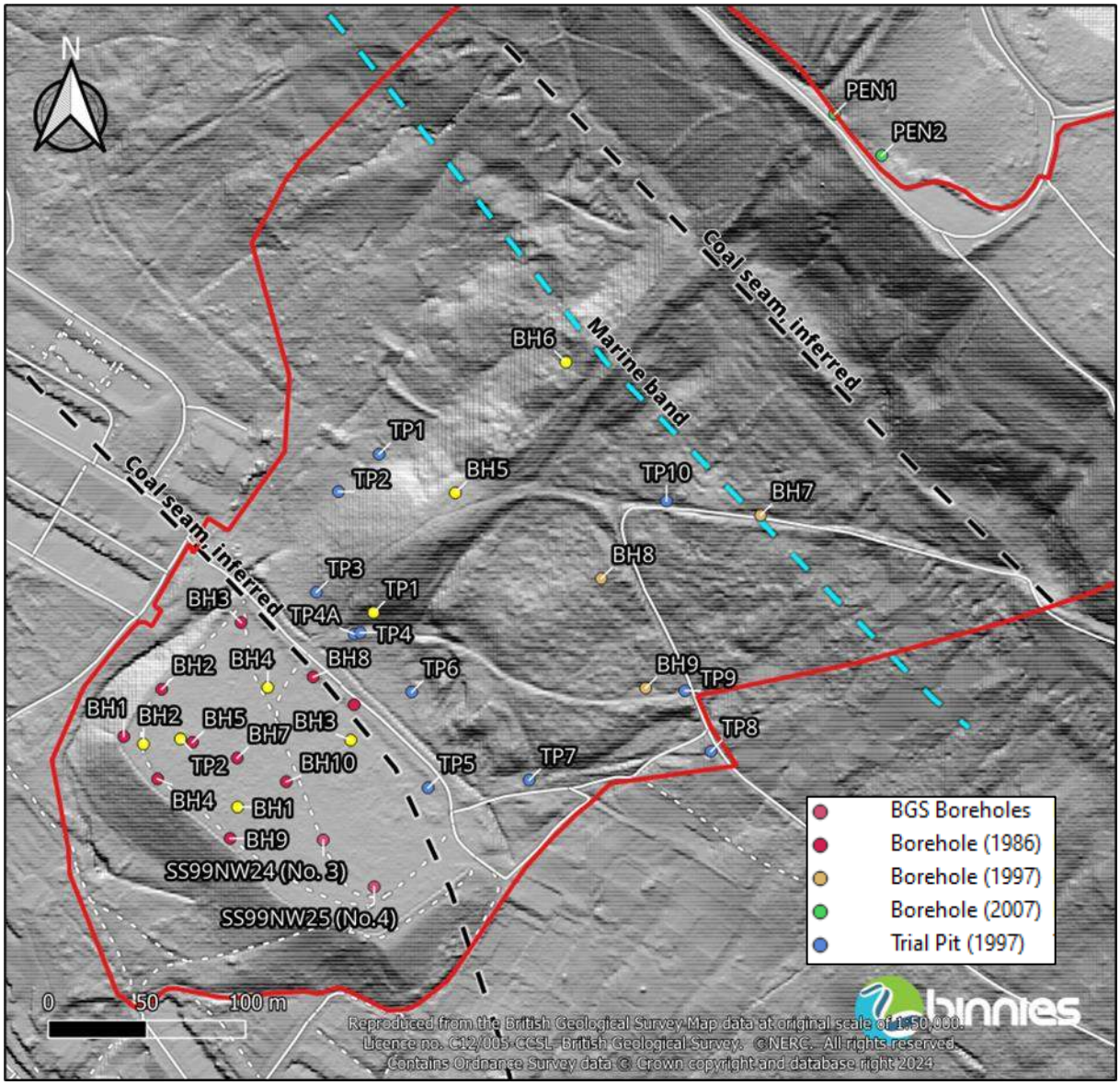

Figure 6: Combined historical exploratory hole plan

Table 3: Summary of historical ground investigation reports

Source	Location ID	Final Depth (m)	Ground Level (mOD)	Northings/Eastings (OSGB)	
(Rowlands, 1983)	BH1 (1982)	14	206.288	197886.538	294696.982
	BH2 (1982)	25	214.116	197918.49	294649.253
	BH3 (1982)	31.5	213.072	197920.475	294754.336
	BH4 (1982)	16.5	213.397	197947.266	294712.263
	BH5 (1982)	23.2	241.995	198045.999	294807.324
	BH6 (1982)	26.8	267.54	198112.383	294863.388
	TP1 (1982)	2.15	220.049	197985.271	294765.846
	TP2 (1982)	3.3	212.795	197921.07	294668.007
	PEN1	69.3	341.8	198235.7	295000.9

Source	Location ID	Final Depth (m)	Ground Level (mOD)	Northings/Eastings (OSGB)	
(Integral Geotechnique, 2007)	PEN2	15	344.6	198214.6	295024
(Halcrow, 1998)	BH7 (1997)	30.05	264.2	198033	294963.3
	BH8 (1997)	25.25	248.6	198000.6	294882.6
	BH9 (1997)	16.25	234.1	197945.4	294905.1
	TP1 (1997)	3.7	229	198064.1	294769.2
	TP10 (1997)	3.5	257.4	198040	294915.5
	TP2 (1997)	3.6	224.7	198045.5	294748.2
	TP3 (1997)	3	217.7	197994.2	294737.3
	TP4 (1997)	4	216.9	197972.8	294759
	TP4A (1997)	4.2	216.9	197972.8	294759
	TP5 (1997)	3.5	212.4	197895	294793.7
	TP6 (1997)	3.5	215.1	197943.1	294785.3
	TP7 (1997)	4.6	216	197899	294845.9
	TP8 (1997)	3.5	231.9	197913.2	294938.5
	TP9 (1997)	3.5	235.6	197944.2	294924.9
(Douglas Technical Services Limited, 1986)	BH1 (1986)	40	214.5	197922.301	294639.249
	BH10 (1986)	38	211.5	197899.345	294721.661
	BH11 (1986)	38	213	197938.505	294756.031
	BH2 (1986)	35	214	197946.288	294658.513
	BH3 (1986)	12	214.2	197980.208	294698.741
	BH4 (1986)	35	214.5	197900.795	294656.39
	BH5 (1986)	35	212.8	197919.367	294735.318
	BH7 (1986)	43	212.2	197911.371	294696.781
	BH8 (1986)	15	214	197952.538	294735.318
	BH8A (1986)	43	214	197952.538	294735.318
	BH9 (1986)	35.5	205.5	197870.562	294693.192
(BGS, 2024)	SS99NW24 (BGS)	302.25	Unknown	197870	294740
	SS99NW25 (BGS)	299	Unknown	197846	294766

3.3.1 BGS boreholes

The BGS GeoIndex Interactive Map shows two records of historical ground investigations that are applicable to the site. Both are located on the plateau towards the southern corner and represent the No. 3 Pit (SS99NW24) and the Ynysfeio Pit (SS99NW25) reaching depths of 302.25m and 299m respectively.

3.3.2 (Rowlands, 1983) Volumes I & II

The 1983 investigation included:

- Six cable percussive boreholes (BH1-6), positioned on the southeastern side of the lower hillside, were then extended by rotary drilling (BH7-9) to depths up to 31m below ground level. Standard Penetration Testing (SPT) was conducted within the borehole.
    - Two piezometers were installed in each of BH2, BH3, BH5 and BH6 representing the superficial and tip material (no longer available).
- A series of geotechnical and geoenvironmental laboratory tests were performed on samples collected from the made ground, superficial deposits, and bedrock. The tests conducted included:
    - Particle size distribution analysis
    - Compaction testing
    - Atterberg limits determination
    - Sulphate and pH testing
    - Loss on ignition
    - Undrained triaxial tests

3.3.3 (Douglas Technical Services Limited, 1986)

This 1986 report on the investigation of shallow mine workings focussed on the identification of shallow mine works of the lower plateau region of the site prior to reclamation works. Ten rotary boreholes (BH1-5, 7-11) were carried out to a depth up to 43m below ground level. Although samples were taken there is no reporting on any geotechnical testing carried out.

3.3.4 (Polytechnic of Wales, 1987)

This is an interpretative report commenting on the stability of the slopes and the verification of remedial works at the time of writing. It concluded that the hillside was stable against any deep-seated failures and recommended that adequate drainage provision where groundwater emerges was installed to avoid erosion and consequent surface instability.

3.3.5 (Halcrow, 1996)

This report focuses on the stability of the main slope and highlights that the tip was built over a spring line associated with the Tormynydd Seam and downslope of it. It also suggests that the central part of the tip was built on pre-existing landslide deposits downslope of the Tormynydd.

This report also included a set of figures showing:

- A general plan of the site and proposed exploratory locations (then carried out by Norwest Holst; 1998).
- Historic developments which upon review do not add any additional value to what has already been stated in the previous sections.

- A geological and geomorphological map identifying historical debris flows, active landslide scarps, mapped glacial till boundary and hydrology based on on-site observations at the time of inspection.
- A conceptual cross-section of the underlying geology.

3.3.6 (Norwest Holst, 1998)

The 1997 investigation included:

- Three cable percussive boreholes, positioned on the southeastern side of the lower hillside were then extended by rotary drilling (BH7-9) to depths of 16.25m, 25.25m, and 30.05m below ground level, respectively. Standard Penetration Tests (SPT) were conducted within the cable percussive borehole sections. Additionally, piezometers were installed in each borehole:
  - BH7 included two piezometers installed, one within the till and another in the mudstone layer, at depths of 8.5m and 29.5m below ground level, respectively.
  - BH8 included two piezometers installed, with their tips situated in the colliery spoil and the till at depths of 10.8m and 13.8m below ground level, respectively.
  - BH9 included two piezometers installed within the colliery spoil and the mudstone, with the upper tip at 3.8m and the lower at 16m below ground level.
- Eleven trial pits (TP1-10 and TP4A) were excavated across the plateau and the lower hillside carried out with a mechanical excavator to a maximum depth of 4.6m below ground level. The trial pits TP1-8 were located around the base of the upper spoil heap, while TP9 and TP10 were located along the old access route.
- A series of geotechnical and geoenvironmental laboratory tests were performed on samples collected from the made ground, superficial deposits, and bedrock. The tests conducted included:
  - Moisture content analysis
  - Atterberg limits determination
  - Density measurement
  - Particle size distribution analysis
  - Organic matter content assessment
  - Sulphate content testing
  - pH value measurement
  - Small shear box testing
  - Consolidated-drained triaxial compression testing with volume change measurement

3.3.7 (Halcrow, 1998)

This report is an interpretation of the 1997/8 investigations carried out by Norwest Holst. It confirmed that the tip was constructed on an old landslip which pre-dates the construction of the present-day tip. The reprofiling that occurred during the 1994 RBC reclamation scheme

was said to reduce the stability of the tip due to the overall net removal of material from the toe of the tip. A stability analysis of the slope was carried out at the time and a factor of safety (FoS) was reported to be between 0.98 and 1.15, with the lowest FoS associated with the front faces of the tip.

3.3.8 (Integral Geotechnique, 2007)

The 2007 ground investigation included:

— Two rotary boreholes (PEN1 and PEN2) at the top of the hillside, above the tip, to depths of 69.3 and 15mbgl. In-situ SPT testing was undertaken, and piezometers were installed in both boreholes.

— No laboratory testing was undertaken as part of the 2007 ground investigation.

3.3.9 Slope monitoring (CH2MHILL, 2014)

Equipment installed on the tip to monitor ground movements has, in part, become untraceable since an inspection in 2017. The Coal Authority's "Rhondda Tips Monitoring and Inspections 2017" report noted a reassessment of movement indicators on February 27, 2017, revealing minimal or negligible displacement, indicative of gradual shifting within pre-existing landslide zones. Nevertheless, recent environmental events, particularly Storm Dennis in February 2020, have reportedly intensified visible signs of ground movement and the tilting of conifer trees in certain sections, as delineated in the referenced figures.

3.3.10 Tylorstown landslip

Although no information has been provided on the 2020 Tylorstown or Wattstown landslips, these are important case studies to review due to their proximity to the site as well as similarity in underlying geology. Binnies recommends that a review of any studies or investigation records that NRW or local council holds be undertaken

3.3.11 Geotechnical Desk study (Arup, 2022).

This is a comprehensive report that summarises the historical information as well as findings from a site walkover (pre-timber harvesting). However, it did not include a review of RCT-supplied reports including the 1983, 1986, 1987, 1996 and 1998 reports mentioned above.

3.4 Hydrology

The surface water from the site flows into the River Rhondda (controlled waterbody) that flows northwest to southeast along the base of the valley 250m south of the plateau.

Based on historical mapping several issues (springs) were present prior to the tipping of any spoil which indicates that there may be a naturally occurring spring line beneath the spoil. The spring line is presumed to be associated with the upper extent of the glacial till which has a low permeability reducing the ability for groundwater to flow vertically into the more permeable middle coal measures.

Figure 7 represents OS watercourse mapping of the site including observed hydrological features identified during the site walkover.

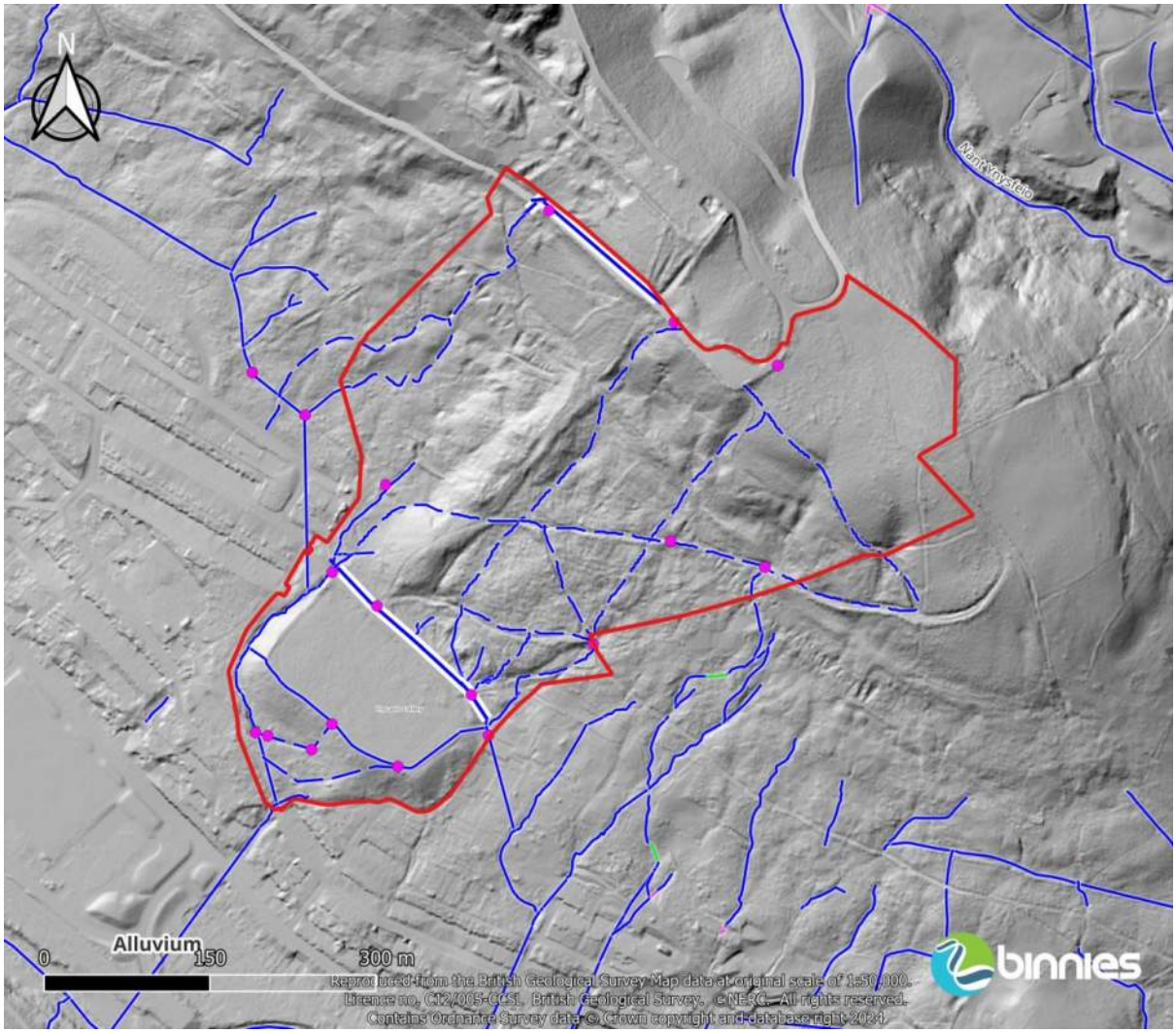

Figure 7: Hydrology mapping including Binnies observed surface water flow pathways (blue-dashed) and culvert locations (pink)

3.5 Hydrogeology

The aquifer classifications and vulnerability information in this section have been taken from the BGS GeoIndex interactive viewer.

3.5.1 Superficial deposits

The superficial deposits (Glacial Till) have been designated as a secondary undifferentiated aquifer. This is due to the variable characteristics these deposits can have. However, given the context of the proposed works it is assumed that the material is potentially a source of base flow to the River Rhondda. This material is also designated as having a medium groundwater vulnerability with a low leaching class.

3.6 Environmental constraints

3.6.1 Sensitive sites

All of the site area is part of a larger area of Registered Landscape of Outstanding Historic Interest in Wales and the most easterly part of the site abuts a Special Landscape Area. The north-eastern site area is designated as a Site of Importance for Nature Conservation.

In addition, there is a Scheduled Ancient Monument around 70m to the north of the site boundary which was designated in 1998 and relates to the remains of a former incline tramway system.

Given the historic mining nature of the site, it has been designated as being at high risk from historic coal mine workings. Once detailed designs have been carried out a Coal Mining Risk Assessment should be undertaken to identify if any present underground workings pose a risk to the developments during and after construction.

3.6.2 Planning

Noise and dust mitigation shall be included in an Environmental Action Plan (EAP) for any works carried out. Consultation with RCT is required to confirm footpath closures or diversions if needed. Permission for Public Rights of Way closure must be obtained prior to works commencing, as required.

A Traffic Management Plan is recommended to control impacts on transport networks and public roads.

Following confirmation of design, the requirement for an Environmental Impact Assessment (EIA) Screening should be reviewed by an EIA Specialist.

4. Site walkover survey and geomorphological mapping

A site walkover was carried out on the 16th of January 2024 by Binnies engineers and accompanied by NRW staff. During the walkover, weather conditions were observed to be dry and overcast with evidence of recent rainfall. The site had also recently been tree harvested and therefore heavy rutting of the round conditions and debris remained across the site making it difficult to identify certain geomorphological features.

A selection of photos was taken on site of notable features which are presented in Appendix A. Photos numbered 95, 112, and 156 show evidence of historic land slips. Springs and marshy areas are evidenced in many of the photos, but it is not known whether this is due to groundwater flow or surface water ponding.

A geomorphological map is presented in Appendix B. The map is a development from the 2023 Arup report and highlights key geomorphological features such as slope gradients, tension cracks, and water features, enabling identification of areas susceptible to erosion, landslides, and other stability concerns. This map provides a basis for evaluating potential failure mechanisms, informing targeted safety and stabilisation measures. Additionally, the map supports the development of drainage control and erosion mitigation strategies to manage the inherent risks of this steep, unconsolidated spoil material.

5. Preliminary ground model

Based on the information obtained a conceptual ground model has been produced representing the transect along the middle tip and is presented in Figure 8. As a limited amount of information exists on the true thickness of the colliery spoil at the site, a comparison of the topography across the wider slope has been carried out in order to estimate its thickness alongside other supporting evidence.

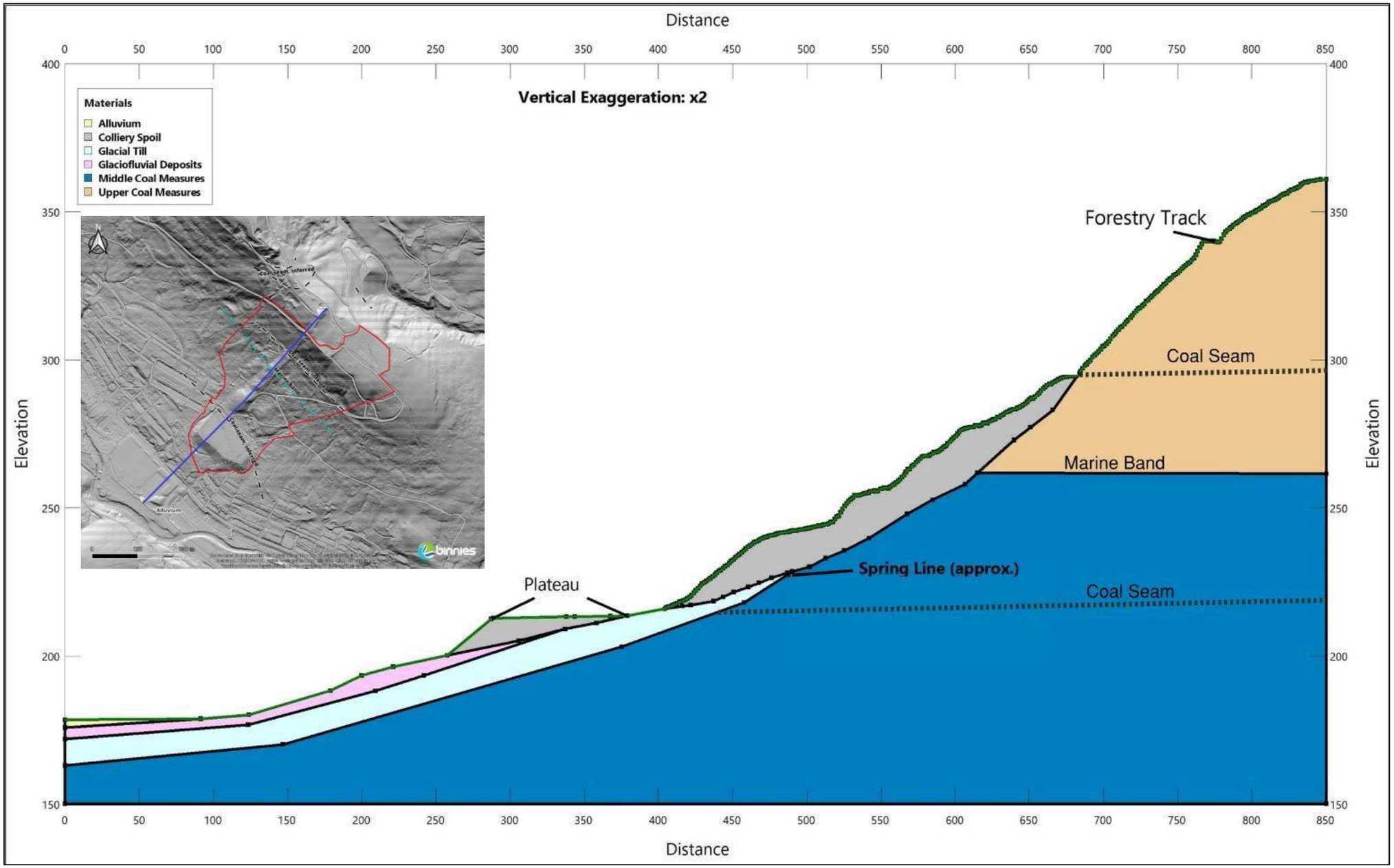

Figure 8: Geological cross-section representing the preliminary ground model where the tip material is assumed to be thickest. Insert map: shows the representative alignment used to develop the cross-section).

5.1 Ground conditions

The ground conditions have been interpreted using information from historic ground investigations and available existing information and are summarised in Table 4.

Table 4 Summary of ground conditions

Stratum	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)	Description
Made Ground – Colliery spoil	0	0-25	Up to ~25	Made ground primarily composed of loose to medium dense, black or dark grey gravelly and sandy material with variable cobble and occasional boulder content. The material mainly consists of angular to subangular fragments of coal, mudstone, and sandstone, often mixed with silt, clay, and occasional rootlets, metal, or glass fragments. The composition includes frequent fine to coarse sand and gravel, with moderate cohesion in some sections due to dampness, but is generally not cohesive. Notable inclusions include black ash, clinker, and coal, with areas of clayey matrix and mottling.
Glacial Till	0-17		0-17m	Consists mostly of firm to stiff, brown sandy clays containing varying quantities of sandstone and mudstone gravel and cobbles. Expected thickness under the toe of the main slope tip is up to 6m.
Glaciofluvial Deposits	2.00-31.95	10.55-35.75	2.0-8.5	Firm to very stiff, light grey, rusty brown, dark brown mottled clays of low to high plasticity containing weathered sandstone gravels. (Only encountered in BH1 (1983), BH2 (1983) and BH3 (1986)).
Bedrock –South Wales Upper Coal Measures	0-16.2*	16.2-32.4*	16.2-32.4*	Encountered at the top half of the slope, the upper coal measures are expected to range up to 30m below the colliery spoil area before encountering eh Middle coal measures.
Bedrock – South Wales Middle Coal Measures	10.7-19.7*	Base not proven		Weathered Mudstone at or close to the rock surface encountered as gravel or gravel with cobbles. The unweathered mudstone generally dips into the slope, towards the northwest through to the north-north-west, with indicated dips ranging from 1° to 20° The Abergorki coal seam is present within this sequence.
*Below the colliery spoil				

6. Preliminary slope stability assessment

Detailed research into the stability of mine waste tips in South Wales is summarised in 'Landslides and Landslide Management in South Wales' (Siddle, Bromhead, & Bassett, Landslides and Landslide Management in South Wales, 2000), the proceedings of a conference that brought together in Cardiff all the active researchers in this field. More detailed analyses, to which reference is made, are included in papers by Siddle et al. (1996) and Jennings and Siddle (1998).

This section examines the conclusions of previous inspections and assessments of Pen Yr Englyn in the context of the findings presented by the publications referenced above.

6.1 Classification of tip failures

Landslides and Landslide Management in South Wales (Siddle, Bromhead, & Bassett, Landslides and Landslide Management in South Wales, 2000) categorises rapid mine waste failures into four types of movement:

— Flow slide: Collapse of a loose, metastable structure leading to rapid pore pressure rise and shear strength loss. The failed material develops a semifluid nature, allowing it to flow.

— Debris slide: Rapid translational movement, usually triggered by heavy rainfall.

— Debris flow: Typically granular material with low clay content, saturated following rainfall or snow-melt. May carry large boulders.

— Outburst failure: Rapid or explosive failures occur when superficial tipped material blocks a natural (or man-made) drainage path, permitting the build-up of water pressure under the waste mass.

6.2 Tip activity

Siddle et al. (1996) examined 23 documented major historic rapid failures dating between 1898 and 1967. All except five of the tips examined were being actively tipped at the times of the failures. There was no information on two of those five and, of the remaining three, the longest period since active tipping ceased was 4 years. It was concluded that the loosely tipped waste materials consolidate with time and become less prone to rapid failure.

It had been found that the average in situ dry density of established, inactive self-compacted tips was 95% to 96% of the BS Standard compaction test (2.5kg rammer) whereas the in situ density measured in the active Number 7 Tip at Aberfan, adjacent to the location of the disastrous flow slide in 1966, was determined at 82%.

The tips at Pen Yr Englyn have been disused for nearly a century and are, therefore unlikely to be loose. This will be confirmed by in situ density measurements and laboratory compaction tests.

The volume of the toe of the main tip was reduced considerably during regrading work in the 1980s. The remaining materials will, therefore, be the more dense, longer-standing wastes. However, the material tipped to the southeast of the main tip is shallower and has not had the same opportunity to self-compact. Although the southeast tips are not very thick, they could be more prone to saturation and mobilisation, which is corroborated by previous reports of tension cracks at the top of this area.

6.3 Morphology of rapid slips

Siddle et al (1996) introduced the following definition of tip failure morphology (Figure 9)

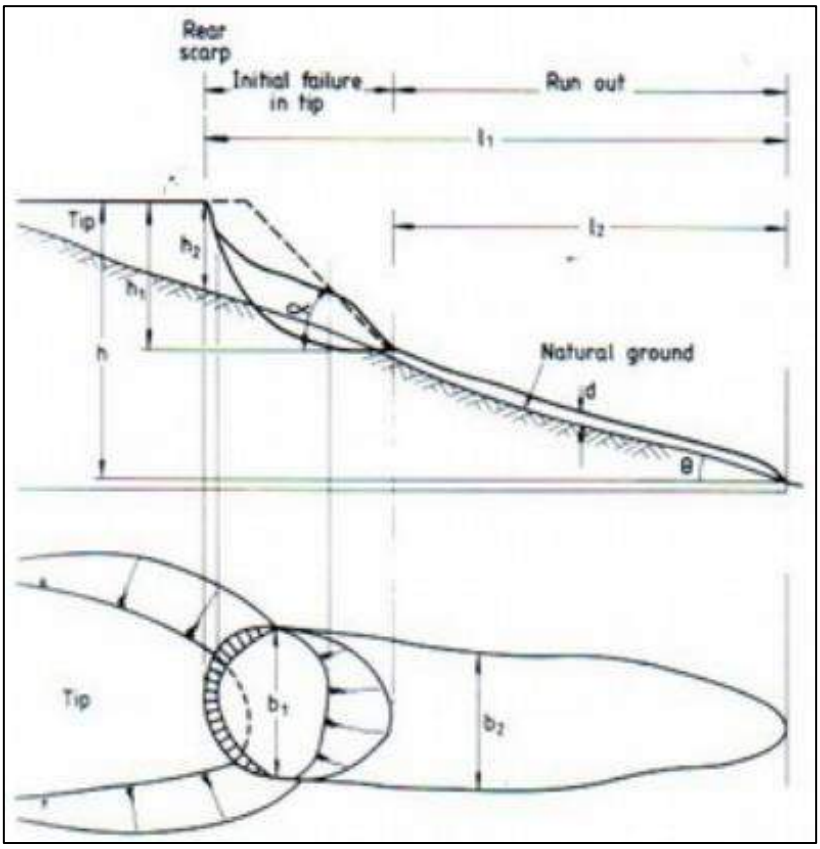

Figure 9: Failure morphology, after Siddle et al. (1996)

Definitions:

h_1 = Vertical interval of initial failure	h_2 = height of tip above natural ground at the scarp
h = vertical interval of entire failure	Θ = gradient of natural ground beneath runout
l_1 = length of failure	l_2 = length of run-out
b_1 = breadth of initial failure in spoil	b_2 = breadth of run-out
α = initial angle of the failed tip	d = average depth of run-out

6.4 Probable length of a failure at Pen Yr Englyn

Data from Siddle et al. (1996) has been plotted in Figure 10 to show the total lengths of the failures (l_1) examined in relation to the height (h_1) of the initial failure.

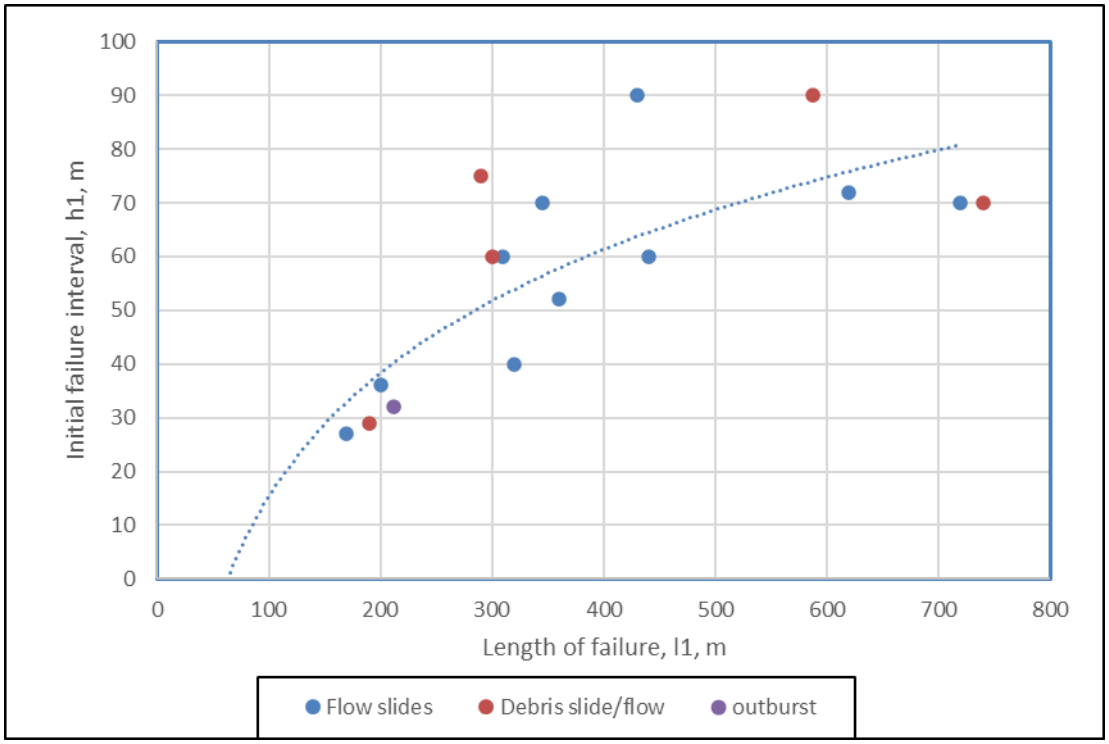

Figure 10: Lengths of failures plotted against initial failure interval, after Siddle et al. (1996)

The ratio of l_1 to h_1 ranges from 3.9 to 10.6 with an average of 6.7. This considerable scatter does not appear to correlate with slope angle but variations are more likely to be influenced by site-specific factors. For example, the 1963 failure of Aberfan Tip 7 was 345m in length while the 1966 disaster originating in the same tip reached some 720m due, according to investigations, to it uncovering a groundwater source that resulted in additional fluidisation of the flowing materials. Other factors that affect the tip mobility include antecedent rainfall, the rate of tipping and the tipping mechanism in use at the time (Siddle, Bromhead, & Bassett, Landslides and Landslide Management in South Wales, 2000). The challenges of determining the morphology of the more historic events might also have given rise to uncertainty and scatter. Nonetheless, the data provide a basis for assessing conditions and options at Pen Yr Englyn.

Most of the failures reviewed were judged to have been flow slides but it can be seen from Figure 10 that the classification of the slide does not have much bearing on the failure length or run-out. On the limited data available, it seems that there is less scatter in the data at relatively low values of h_1.

Jennings & Siddle (1998) reviewed an inventory that had been created including 347 landslides of all types of landslide in South Wales. They noted that the typical downslope length of shallow slides was less than 90m. Although shallow slips could occur on low-angle slopes, most slips affected slopes of 16° or more. Figure 11 shows the results of a slope angle analysis of the hillside at Pen-yr-Englyn to highlight the distribution of slope angles greater than 16° at a 1m resolution using the available 2020 Lidar dataset.

The South East tips on Pen Yr Englyn have historically shown signs of potential instability. The ground model developed from recent topographic measurements and historic ground investigation data shows that the upper part of this area would fail over a depth not exceeding 15m, which would result in a failure length of between 58 and 160m (average 100m, in accordance with the findings of Jennings & Siddle, (1998). The distance from this

failure location to the lower site boundary is around 250m (ie approximately 90m further than the longest potential failure length) so it is most likely that any failure will be contained within the site.

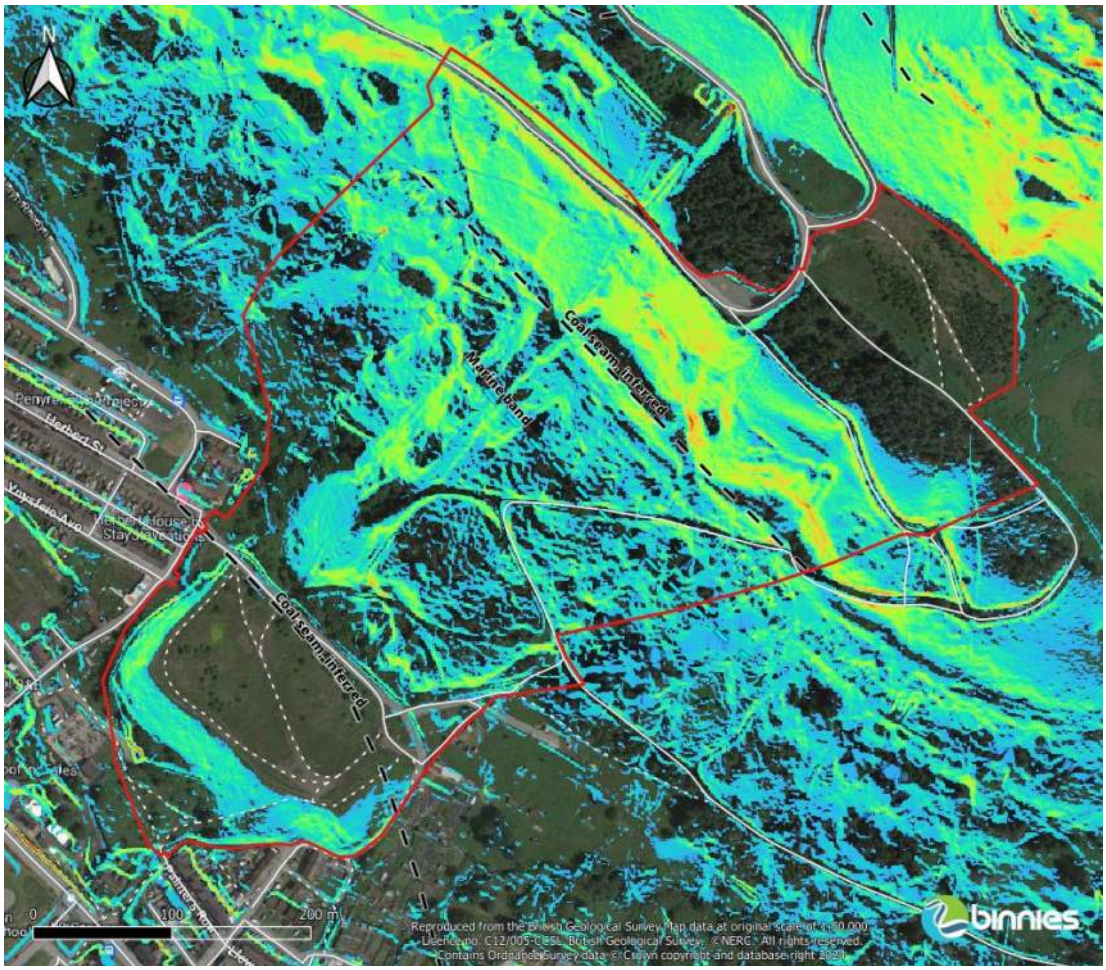

Figure 11: Map of topographic slope angle analysis that highlights slope angles between 16 (blue) to a maximum of 72° (red) at a resolution of 1m.

6.5 Minimising risk at Pen Yr Englyn

In summary, the tips at Pen Yr Englyn are well established and the material will have self-compacted over the years. There have been signs of movement in the past, particularly in the South East area. If such a movement was activated it is likely that any slip would be contained within the site. It would be prudent to create bunds along the lower boundary of the site to protect drains and arrest any shallow local slip that might reach this point from lower on the slope.

Peripheral drains that reduce surface water flows into the tipped material will mitigate the saturation of the waste materials.

It is known that a spring line existed within the higher part of the slope and was covered by the waste tipping. This has increased the risk of an outburst failure. Drainage of the trapped spring line by the proposed subsurface drains will, therefore, form part of the remediation of the site.

7. Preliminary geoenvironmental assessment

The preceding sections identify hazards (sources of contaminants), receptors that may be impacted and plausible linking pathways. Where all three are present this is termed a potentially complete contaminant linkage and a qualitative risk estimation is made.

The colliery spoil is the main source of soil and groundwater contamination identified from the historical review of the site and surrounding area. No chemical testing has been undertaken on samples of this spoil during any of the previous investigations, as such, the contaminative nature of the material is currently unknown. Typical contaminants from colliery spoil/wastes and coal mine workings include heavy metals (iron, zinc, copper, lead, cadmium, manganese, and aluminium), sulphides and chlorides.

7.1 Human health

Sensitive receptors identified at or in the vicinity of the site that could be affected by the potential sources identified above include current and future site where there is a risk of oral, dermal and dust inhalation exposure from potentially impacted soil.

Please note that construction workers and future maintenance workers have not been identified in the conceptual model as receptors because risks are considered to be managed through health and safety procedures according to the CDM Regulations.

7.2 Controlled waters

The controlled water receptors on-site include:

— The Glaciofluvial sand and gravel deposits are classified as a Secondary A aquifer, and the Glacial Tills as Unproductive Strata.

— The bedrock across the site is classified as Secondary A Aquifers of 'medium vulnerability'.

— The River Rhondda runs along the bottom of the valley, circa 300m to the southwest of the plateau. Although there are no rivers running through the site several springs, culverts and associated drainage channels exist across the site which directly feed into the River Rhondda.

Primary sources contributing to the contamination of controlled water bodies include leachate generated within the spoil, originating either from rainwater seeping in or groundwater moving through the spoil from higher ground. This can directly affect adjacent surface water bodies through runoff or cause polluted water to move through the spoil into both the superficial and deeper Secondary Aquifers. While the low permeability of the superficial clay layers present in the Till may somewhat restrict the downward flow of water, groundwater in the spoil is expected to maintain a hydraulic connection with these superficial and deeper aquifer systems.

Run-off from the spoil can also carry contaminated sediments, where spoil heaps or tailings are being eroded by rainfall. This is likely to be exacerbated during and after redevelopment of the site due to colliery spoil disturbance.

7.3 Ground gas

The proposed drainage routes may provide a pathway for ground gas to accumulate or migrate to the surface. No receptors (eg confined spaces large enough for people to enter) are part of the current proposal and as such further investigation into ground gas is not considered necessary at this time.

7.4 Preliminary conceptual site model (pCSM)

A summary of the potentially complete source-pathway-receptor linkages is presented in Table 5 with a risk rating associated with them.

Table 5: Preliminary conceptual site model.

Source	Potential Receptor	Possible Pathway	Probability	Consequence	Risk	Assessment of risk and possible mitigation
Colliery Spoil (heavy metals, sulphides and chlorides).	Construction Workers, Site users, Adjacent residential buildings	Oral Dermal Dust inhalation	1	3	3	Exposed spoil should be revegetated and measures put in place to prevent direct access to the tip.
	Rhondda River Aquifers (superficial and bedrock)	Infiltration of meteoric water through spoil tip and then into drain from springs into the River Rhondda or are in direct hydraulic continuity with aquifers	3	5	15	The proposed works aim to reduce water infiltration within the spoil which should result in an improvement to the draining surface waters on site flowing into the Rhondda River. Baseline testing of surface waters is recommended before works are carried out.

7.5 Materials management

The preferred approach for managing materials is anticipated to involve retaining them on-site, as this represents the most sustainable and cost-effective strategy, eliminating the need for expensive off-site disposal. However, if the geotechnical corrective measures necessitate altering the landscape, particularly where colliery spoil that may be contaminated is involved, such activities must be conducted cautiously to avoid any risk to the designated controlled water bodies.

It is essential to collect and analyse soil samples from the affected areas through chemical testing in a laboratory to assess their suitability for either re-use or the necessity for off-site removal. Should the geo-environmental evaluations reveal substantial contamination within the spoil that poses a risk to human health or the environment, these materials must be treated with extra care. They should be segregated from uncontaminated materials and dealt with according to a pre-established site material management plan.

Unsuitable materials identified during any excavation, stockpiling, or processing works, that cannot be rendered suitable for re-use are likely to require removal from the site to an appropriate waste management facility or transfer station.

8. Recommendations

8.1.1 Lidar Survey

Binnies recommends conducting a high-resolution LiDAR survey to provide a detailed topographic baseline. It will also allow the comparison of recent topographical changes with the 2020 dataset. It would be particularly valuable in areas where vegetation previously interfered with the 2020 survey, potentially unveiling features that could significantly impact detailed design.

8.1.2 Geophysics Survey (Phase 1)

Due to access constraints, tip instability and cost a detailed intrusive investigation may not be feasible. Therefore, a non-intrusive geophysics survey is recommended which will be used to correlate historic findings. Figure 12 shows an example of the outputs of two survey techniques from another site and their interpretation. Table 6 outlines the recommended techniques, their objectives and approximate cost. It is suggested that a combination of techniques be used following best practices to identify any anomalies that each technique may output. The costs included in Table 6 are approximate for budgeting purposes and can be refined if this approach is adopted. A geophysical specialist should be appointed to assess site suitability and feasibility of options as part of a site walkover.

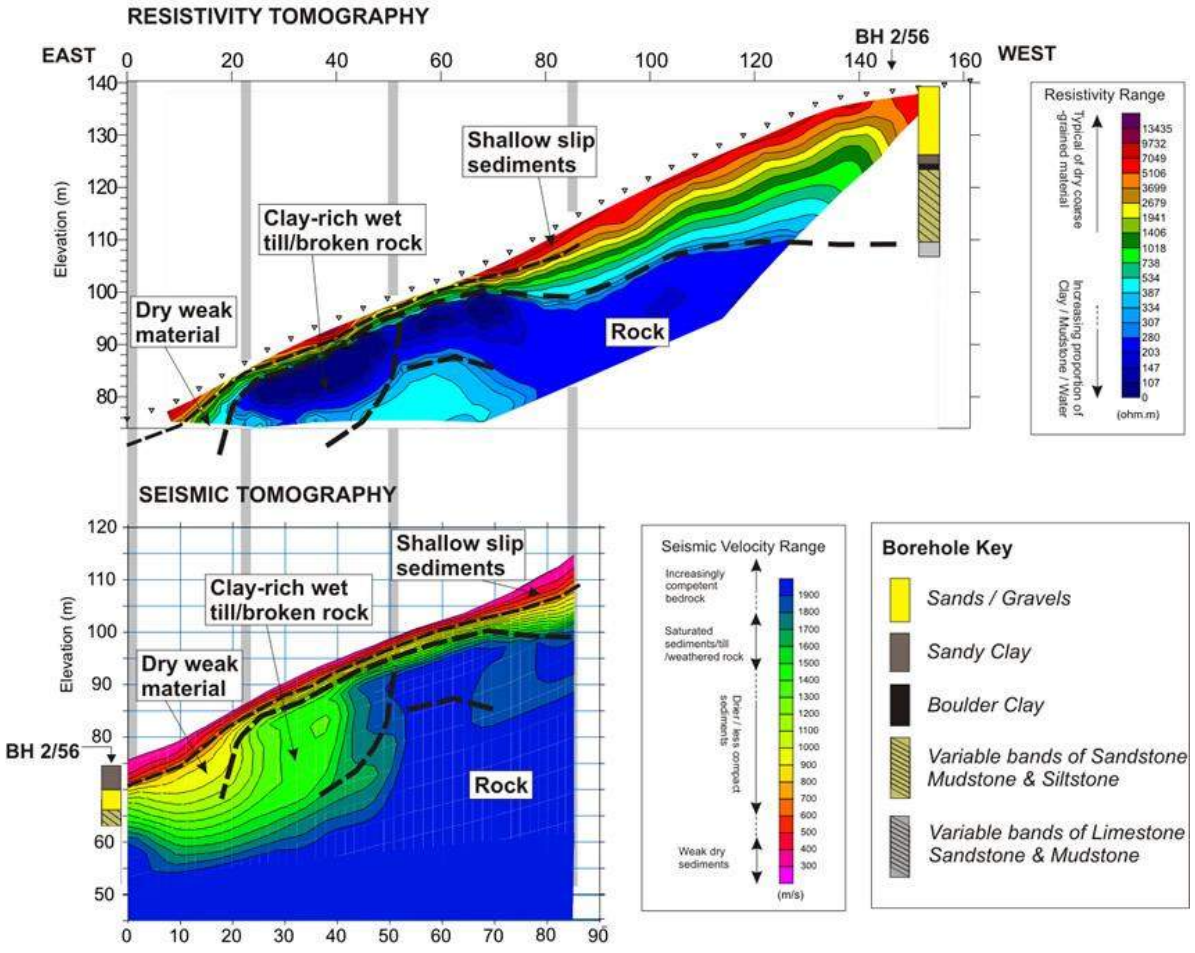

Figure 12: Example resistivity and seismic tomography outputs (Terradat, 2024).

Table 6: Recommended geophysical techniques and objectives.

Technique	Typical Penetration Depth and Spatial Resolution	Objectives	Notes on Deployment and constraints	Approximate Cost
P Wave Seismic Refraction and MASW	Depth: From 2 m – 15 m Resolution: 1.00 at 10 m depth	Depth to bedrock Geological discontinuities such as faulting	Dependent on access conditions Geophone spacing 3 m	£40K
Electrical Resistivity Tomography	Depth: From 0 m at the edges of arrays and up to 20 m (at the centre of the profile) Resolution: 2-3 m as per electrode spacing	Voids Geological strata Moisture Content	Dependent on access conditions Electrode spacing 3 m	£27K
Electrical Conductivity	Up to 7 m depth. 1-2 m horizontal resolution.	Moisture Content and bulk changes in shallow strata. Identify buried features that may impact proposed works.	Carried across the site in localised areas of flat ground without tree stumps and vegetation. Unidirectional grid at 2 m spacing	£4.5K per Ha

8.1.3 Intrusive Investigations (Phase 2)

It is not envisaged that any deep intrusive investigations would be required. However, if deemed necessary, horizontal boreholes into the spoil tips followed by the installation of drainage is recommended.

Hand-dug pits to ~1.5m are recommended in order to carry out in-situ testing and collect samples for geotechnical (density/compaction) and geoenvironmental testing. They will also provide the opportunity to confirm the lateral extent of spoil across the slope.

Surface water sampling is suggested during this phase of work in order to assess the impact of the soil on controlled water and provide a chemical baseline prior to any work.

8.1.4 Additional information and modelling

In light of the 2020 Tylorstown landslip incident, it is recommended that this desk study should be revised to incorporate any pertinent findings from this incident and the subsequent Wattstown slip. A high-level review of the associated reports will provide valuable insights into the geological conditions, failure mechanisms, and the effectiveness of remedial

measures. Such an examination will not only enhance the understanding of potential geotechnical risks at Pen-yr-Englyn but also inform the development of a more robust design and mitigation strategy for this project.

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APPENDICES

Appendix A Site Walkover Photos

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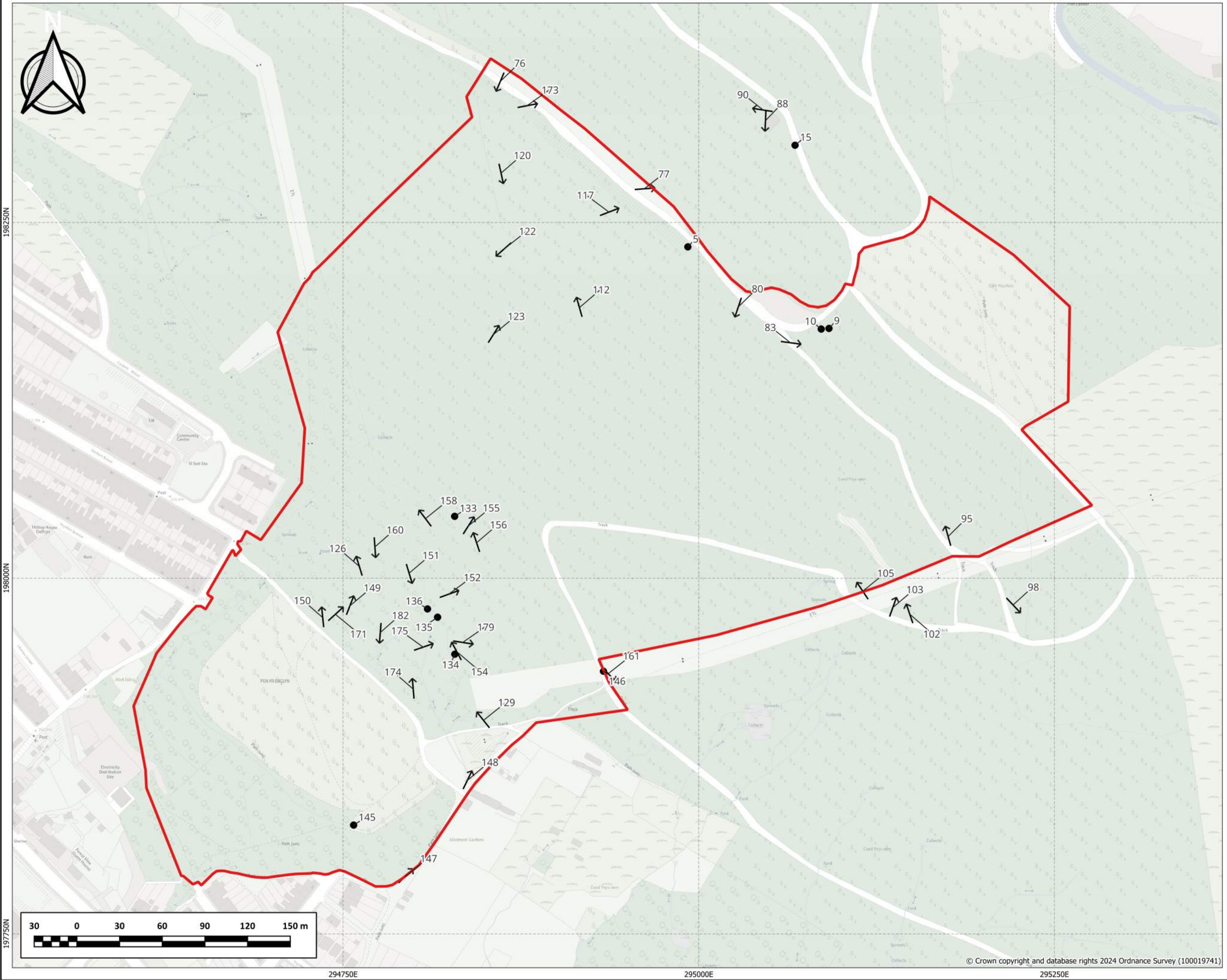
198250N 198000N 197750N



Note: The limits, including the height and depths of the Works, shown in this drawing are not to be taken as limiting the obligations of the contractor under Contract

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Legend:

Site Boundary

SKETCH ONLY
Purpose: This sketch is an informal tool for communicating and collaborating on projects. It shall not be considered as a project output, part of a project output or as satisfying a contractual requirement. All details are indicative and subject to further design and collaboration.

Rev	Drawn	Chkd	Rvwd	Apprvd	Date	Description
P01	JT	RH	AL	AH	10/2024	Suitable for Review and Comment

Designed by: Tasker, James Date: 11/2024

Client

Cyfoeth Naturiol Cymru
Natural Resources Wales

Client drawing no. | Revision

binnies
an RSK Group Company

Project:

Pen-yr-Englyn

Drawing Title:

Pen-yr-Englyn
Site photos

Drawing scale: 1:2500 | Map units: meters
CRS: OSGB36 / British National Grid (EPSG:27700) | Sheet Size: A3

Drawing no. 4021526-BUK-ZZ-00-SK-GE-00003 | Revision P01

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Photo ID	Easting	Northing	Notes	Photo
5	-391840.4888	6741218.42	Logs and brash making up down slope side of forestry track	
9	-391678.9197	6741129.274	Slope covered in brash left behind from deforesting	
10	-391687.6471	6741128.377	Gentle slope dipping east.	
15	-391721.5872	6741336.195	Stoned track	

Photo ID	Easting	Northing	Notes	Photo
76	-392056.5354	6741401.618	Natural drainage channel forming around tree stumps.	
77	-391891.118	6741283.264	Blocked concrete lined channel from brash	
80	-391781.9792	6741151.588	Steep slope below forestry track. Limited tip material identifed.	
83	-391722.1773	6741112.124	Soft, waterlogged forestry track.	

Photo ID	Easting	Northing	Notes	Photo
88	-391761.7391	6741372.979	Listed structure	
90	-391758.4619	6741375.388	Open structure and possible infiltration route into underground coal levels	
95	-391539.217	6740896.17	Minor slip due to road undercutting slope	
98	-391464.181	6740820.069	Stream following loggers track	

Photo ID	Easting	Northing	Notes	Photo
102	-391580.8483	6740807.262	Exposed weathered mudstone	
103	-391598.6839	6740817.707	Exposed weatherd bedrock indicating no tip material.	
105	-391634.4909	6740832.124	Eastern extent of tip material	
112	-391961.6968	6741146.996	Overgrown tip covering evidence of historic failure. No evidence on tension cracks or recent movement observed.	

Photo ID	Easting	Northing	Notes	Photo
117	-391930.5496	6741256.034	Weathered bedrock exposed at the edge of historic tramway	
120	-392053.5164	6741297.631	Small gulley developing along pathway of a small stream flowing through it. Steam not visiblebut audibly flowing under brash. Thought to be linked with culvert on forestry track.	
122	-392048.32	6741211.636	Water present in natural gulley	
123	-392058.4234	6741114.422	Fine clayey material at base of the historic tip. Evident on weathered bedrock rather than tip material.	

Photo ID	Easting	Northing	Notes	Photo
124	-392093.5992	6740946.345		
126	-392204.5825	6740848.316	Spoil visible on track	
129	-392060.4739	6740676.716	Till lining spring	
133	-392097.9124	6740907.399	Minor spring	

Photo ID	Easting	Northing	Notes	Photo
134	-392094.5095	6740751.057	Collection of springs indicating groundwater seeping below forestry track	
135	-392114.8406	6740792.599	Spring with stream tributing to foresty track stream	
136	-392126.4552	6740801.745	Spring	
145	-392204.8799	6740554.888	Drain	

Photo ID	Easting	Northing	Notes	Photo
146	-391926.8061	6740730.207	Blocked culvert	
147	-392145.129	6740498.06	Drainage culvert intersection. Assumed to flow underneath housing	
148	-392077.8531	6740612.7	Culvert silted up	
149	-392214.3108	6740803.408	Stone lined headwall of historic slope drainge	

Photo ID	Easting	Northing	Notes	Photo
150	-392249.8762	6740800.387	Stream flowing westward into culvert which flows southeast underground. Evidence to suggest water flows over and onto plateau during heavy rainfall.	
151	-392148.1068	6740841.838	Steep face at the toe of the slope. Roots are likely improving stability but will decrease over time due to deforestation.	
152	-392102.7597	6740818.976	Exposed tip material typical comprising gravelly/cobbly mudstone	
154	-392092.3647	6740754.05	Multiple water sources along toe of spoil	

Photo ID	Easting	Northing	Notes	Photo
155	-392097.1236	6740868.439	Spoil ridge across the middle area of spoil	
156	-392072.119	6740883.453	Series of small sinkholes. Indicating area of below ground voids.	
158	-392128.8641	6740910.957	First terrace along central tip	
160	-392187.4171	6740870.798	Stream eroding edge of track	

Photo ID	Easting	Northing	Notes	Photo
161	-391920.5119	6740732.581	Exposed Glacial Till	
171	-392227.5466	6740796.315	Seepage from tip flowing after a dry spell of	
173	-392027.1716	6741375.807	Culvert pipe	
174	-392140.7174	6740710.457	Stream at foot of slope in wooded area. Flowing after dry	

Photo ID	Easting	Northing	Notes	Photo
175	-392130.5132	6740758.322	Spring	
179	-392095.0764	6740769.99	Seepage from tip material	
182	-392179.3082	6740773.879	Marshy ground	

Appendix B Geomorphological mapping

294750E 295000E 295250E

198250N 198000N 197750N

Landslide 1984

Binnies mapped underground culvert

OS mapped underground culvert

PEN-YR-ENGLYN

30 0 30 60 90 120 150 m

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Legend:

- Site Boundary

Geomorphological features

*tick marks represent direction of downhill slope

- Culvert
- Spring/collect
- Outlet
- Concave break in slope (sharp)
- Concave break in slope (smooth)
- Convex break in slope (sharp)
- Convex break in slope (smooth)
- Break in slope
- Change in slope
- Gully
- Tension crack (historically mapped)
- Stream (OS mapped)
- Stream (Perennial)
- Stream (Intermittent)
- Stream (Artificial/Modified)
- Landslide
- Collapsed adit
- Marsh

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P01	JT	RH	AL	AH	11/2024	Suitable for Review and Comment

Designed by: Tasker, James Date: 11/2024

Client

Cyfoeth Naturiol Cymru Natural Resources Wales

Client drawing no. | Revision

binnies on RSK Group Company

Project:

Pen-yr-Englyn

Drawing Title:

Geomorphological map

Page 1 of 5

Drawing scale: 1:2500 Map units: meters
CRS: OSGB36 / British National Grid (EPSG:27700) Sheet Size: A3

Drawing no. 4021526-BUK-ZZ-00-SK-GE-00002 | Revision P01

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294625E 294750E 294875E

198375N 198250N 198125N

Natural drainage channel forming around tree stumps.

Culvert pipe

Small gulley developing along pathway of a small stream flowing through it. Stream is not visible but audibly flowing under brash. Assumed to be tributing with culvert on forestry track.

Blocked concrete lined channel from brash.

Weathered bedrock exposed at the edge of historic tramway.

Landslide 1984

Water present in natural gulley.

Overgrown tip covering evidence of historic failure. No evidence on tension cracks or recent movement observed.

Binnies mapped underground culvert

OS mapped underground culvert

16 0 16 32 48 64 80 m

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- Change in slope
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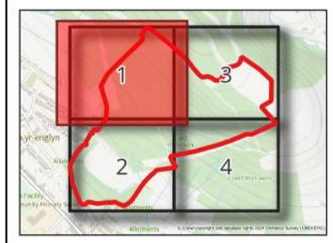
- Stream (OS mapped)
- Stream (Intermittent)
- Stream (Artificial/Modified)
- Landslide
- Collapsed adit



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Drawing Title:

Geomorphological map
Page 2 of 5

Drawing scale: 1:1250 | Map units: meters
CRS: OSGB36 / British National Grid (EPSG:27700) | Sheet Size: A3

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294625E 294750E 294875E

1980000N 1978750N 1977500N

OS mapped underground culvert

Stream eroding edge of track.

Spoil exposed on track.

Seepage from tip flowing after a dry spell.

Stream flowing westward into culvert which flows southeast underground. Evidence to suggest water flows over and onto plateau during heavy rainfall.

Minor spring

Ridge along thickest area of spoil.

Series of small sinkholes. Indicating area of below ground voids.

Spring

Spring tributing to stream along forestry track.

Marshy ground

Spring

Seepage from tip material.

Collection of springs indicating groundwater seeping below forestry track.

Exposed Glacial Till.

Blocked culvert

Stream at foot of slope in wooded area. Flowing after dry spell.

Spring identifying at between Glacial Till and lower extent of spoil.

Culvert silted up.

Water collecting in southeast corner of plateau after light rainfall.

Drain

Drainage culvert intersection. Assumed to flow underneath housing.

16 0 16 32 48 64 80 m

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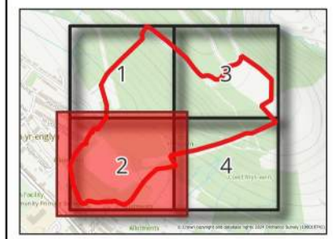

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Project:

Pen-yr-Englyn

Drawing Title:

Geomorphological map
Page 3 of 5

Drawing scale: 1:1250 | Map units: meters
CRS: OSGB36 / British National Grid (EPSG:27700) | Sheet Size: A3

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295000E 295125E 295250E

198375N 198250N 198125N

N

Open structure and possible infiltration route into underground coal levels.

Listed structure

Stoned track.

Blocked concrete lined channel from brash.

Weathered bedrock exposed at the edge of historic tramway.

Logs and brash making up down slope side of forestry track.

Landslide 1984

Overgrown tip covering evidence of historic failure. No evidence on tension cracks or recent movement observed.

Steep slope below forestry track. Limited tip material identifed.

Slope covered in brash left behind from deforesting.

Soft, waterlogged forestry track.

16 0 16 32 48 64 80 m

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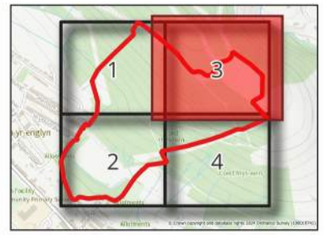

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Geomorphological map

Page 4 of 5

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Drawing no. 4021526-BUK-ZZ-00-SK-GE-00002 | Revision P01

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295000E 295125E 295250E

1980000N 1978750N 1977500N

Minor slip due to road undercutting slope.

Exposed weatherd bedrock indicating no tip material.

Stream following loggers track.

Eastern extent of tip material.

Exposed weathered mudstone.

Exposed Glacial Till.

Blocked culvert

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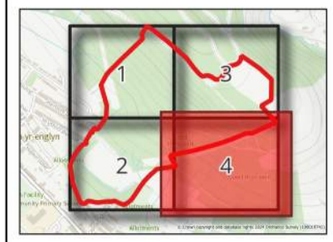

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