

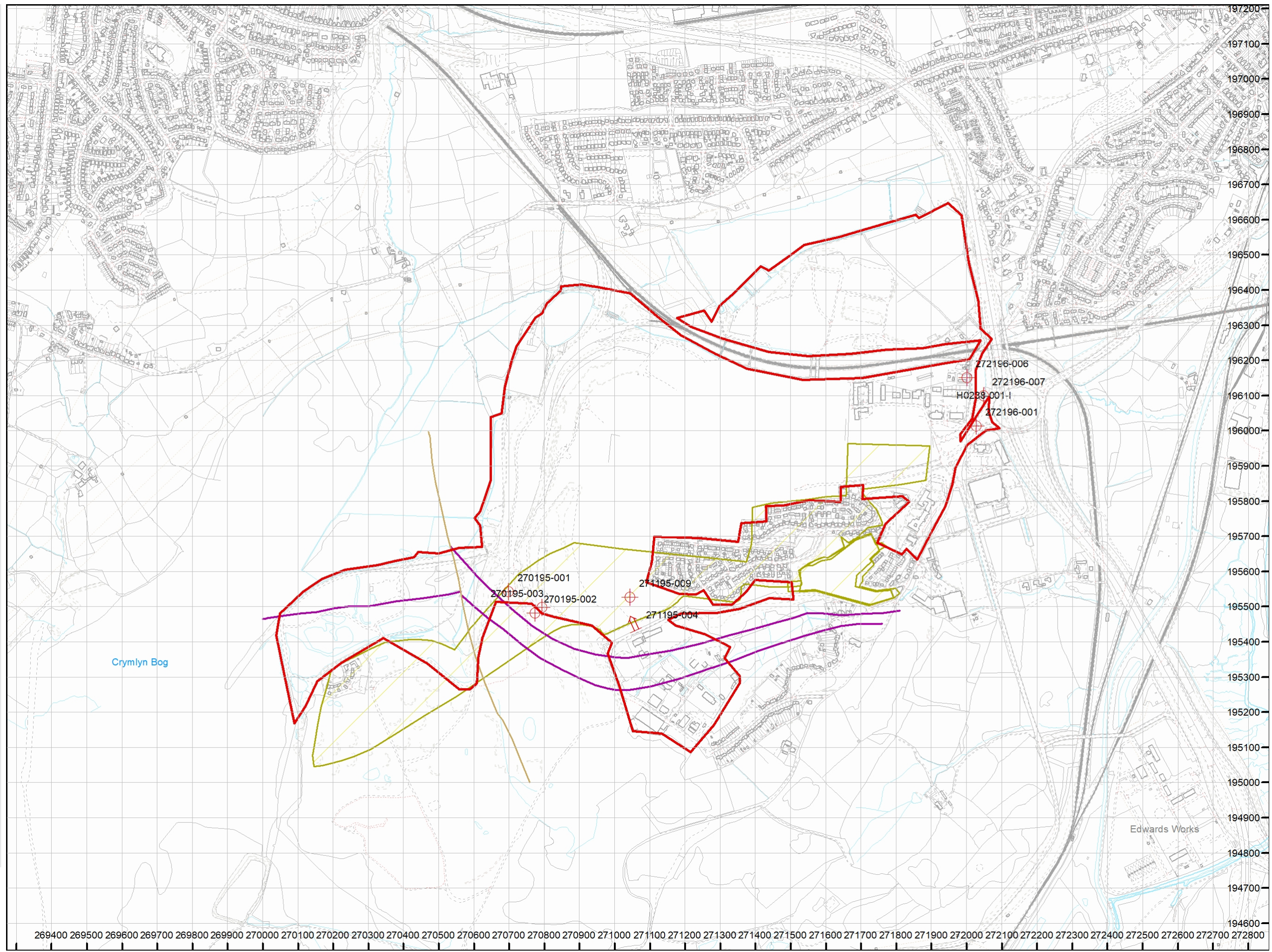
The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

- Approximate position of the enquiry boundary shown 
- Disused mine shaft 
- Disused adit 
- Outcrop (Proven) 
- Geological faults 
- Site investigations 
- Remediated sites 

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St. Modwen Developments Ltd

Coed Darcy

Coal Mining Risk Assessment

November 2021

Project Code: 05474

Document Reference: 05474-OUT-006

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Appendices

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I Introduction

I.1 General

PJA Engineering has been instructed by St. Modwen Developments Limited (St. Modwen) to prepare a Coal Mining Risk Assessment to support a proposed outline planning application for part of the Coed Darcy development site. The Site is outlined in red on Drawing 05474-SK-0401 in Appendix A.

I.2 Report Objectives

The Site falls (partly) within the defined Development High Risk Area, defined by The Coal Authority as where *'recorded coal mining risks are present at the surface or shallow depth and are likely to affect the new development'*.

This Coal Mining Risk Assessment has been produced to identify any coal mining legacy risks at the site and assess which of those risks, if any, may pose a risk to the Proposed Development.

I.3 Development Proposals

The Site is proposed for a mixed end use, comprising residential, commercial, educational and public open space land uses (herein referred to as 'the Proposed Development'). The illustrative masterplan is shown on Powell Dobson Drawing 21009(05) 104 B in Appendix A.

I.4 Limitations

Where information and data has been used in preparation of this report and has been either provided to PJA or prepared by third parties, PJA accepts no responsibility for the accuracy or completeness of that information.

Further details of the report limitations are presented in Appendix E.



2 Sources of Information

The sources of information used in preparing this desk study are listed in [Table 2-1](#).

Table 2-1: Sources of Information

Description	Author	Date	Reference
Coed Darcy: Phase 1 Geo-environmental Desk Study	PJA	October 2021	05474-OUT-005
Bedrock Geology Map for Swansea Sheet 247	BGS	2011	BGS Sheet 247, 1:50,000
Bedrock Geology Map for Swansea Sheet SS79 SW	BGS	1952	Sheet SS 79 SW, 1:10.560
Consultants Coal Mining Report. 29 September 2021	Coal Authority	September 2021	51002684979001
Ground Stability Report	Coal Authority & BGS	August 2008	007.00023581370001
Phase 2 Site Assessment BP Llandarcy Refinery Ltd	Dames & Moore	August 1999	39991-005/DR786R
Mine Workings Investigation. Technical Note: TN336	Atkins	June 2010	5041216-REM-TN-000336
Investigation of Recorded Coal Mining Entries. Technical Note: TN445	Atkins	November 2010	5041216-OSW-TN-000445
Investigation of recorded mine entries on upper terrace. Technical Note: TN494	Atkins	January 2011	5041216-REM-TN-000494
Geo Environmental Assessment & Outline Remediation Strategy: Phase 3 Residential Area	Atkins	May 2011	5041216-REM-RPT-000576
Geo Environmental Assessment & Outline Remediation Strategy: Proposed Persimmon Plot & Upper and Middle Terraces	Atkins	August 2011	5041216-REM-RPT-000645
Coed Darcy Upper Terrace (Monitor Phase 30) Validation Report.	Atkins	October 2014	5041216-PLOTS-RPT-1017
Coed Darcy Monitor Phase 31 Coal Mining Technical Note: TN 1317	Atkins	January 2015	5041216-PLOTS-TN-1317
Coed Darcy Ground Investigation Factual Report	Geotechnics	December 2017	PC176880



3 Site Location & Description

This section presents a summary of the available information on the Site. More details can be found in the PJA Phase 1 Geo-environmental Desk Study (Report Reference: 05474-OUT-005).

3.1 Site Location

The Site addresses approximately 126 hectares of land located off Junction 43 of the M4, approximately 3 miles to the north east of Swansea city centre. Access to the Site is gained via Darcy Business Park off Ffordd Coed Darcy.

The Ordnance Survey grid reference for the approximate centre of the Site is 271190, 195929. The Site boundary is shown on Drawing 05474-SK-0401 presented in Appendix A.

3.2 Site Description

3.2.1 Current Site Use

The Site primarily comprises areas of vacant land associated with the former Llandarcy Oil Refinery and the area of Proposed Development can be divided into two main areas: North Site and Central Site. North Site is separated from Central Site by a railway cutting which is approximately 13m deep and is spanned by a road bridge and various pipe tracks.

The majority of North Site is now mostly vacant, with a cover of scrub vegetation and local stockpiles of material. Operational oil-water separators and a pump house located in a fenced compound are present in the north west of North Site. Overhead powerlines pass through the far west of North Site. The eastern part of North Site is understood to have never been developed historically and currently comprises fields used for grazing by horses. A bowling green is located directly to the south of the fields. Areas of dense vegetation and woodland are present in the north, south east and west of North Site.

To the south of the railway cutting is Central Site, in the east of Central Site is a series of office buildings. The remainder of Central Site is mostly vacant, except for material stockpiles which are present locally, a contractor works compound which is located in the north, and a Reservoir which is located in the north west. The western and south western margins of Central Site are densely wooded.

To the south west of the Central Site is the now closed, Crymlyn Tip. To the south east of Central Site is the Contractors Yard which is accessed via Tank Farm Road and comprises several operational commercial and light industrial units and areas of open storage. Whilst they are located within the red line Site boundary, it is understood that the Tip and Contractors Yard are not proposed for residential development.



3.2.2 Site Boundaries

The northern boundary of North Site is defined by the southern bank of North Site Reservoir, previously used to supply water for firefighting on the refinery, and undeveloped land and woodland in western areas. The southern and western boundaries of North Site are formed by the heavily vegetated railway cutting. Located to the east of North Site is an access track and a vegetated bank, the other side of which is the M4 motorway.

Central Site is generally bound to the north by the railway cutting and to the east by the B4290 Penny-Heol and Llandarcy road. Llandarcy Bog and vacant land of the former oil refinery are located to the south, and Central Site wraps around the recently completed first phase of residential development. The western boundary of Central Site is formed by Crymlyn Bog, which is designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation and RAMSAR site.

3.2.3 Topography

The topography of the Site is highly variable. North Site is domed with the central area at an elevation of approximately 54 metres above Ordnance Datum (maOD), falling away in all directions. The lowest area of North Site is in the south western corner, at an elevation of approximately 29maOD.

Levels across Central Site reflect both the natural topography and earthworks that were carried out to facilitate construction of the former oil refinery. A sandstone ridge is present towards the south of Central Site and a series of terraces were cut into rock to form development plateaus for the refinery. The 'upper terrace' forms the highest point of Central Site, at an elevation of approximately 80maOD, and the ground falls in all directions from this area. The northern, central and eastern parts of Central Site are characterised by gently sloping topography, whilst ground to the west falls sharply to approximately 20maOD at the western Site boundary.



4 Coal Mining Information Review

4.1 Published Geology

4.1.1 Landscaped Ground

Landscaped ground, defined as *'mainly redeveloped areas and others where extensive earth moving has occurred'*, is shown on published British Geological Survey (BGS) Geoindex mapping to be present across all of the Site, with the exception of the fields in the eastern area of North Site.

4.1.2 Made Ground

Made Ground is not shown on published BGS mapping, however based on the historical use of the Site, Made Ground is anticipated to be present across the majority of the Site associated with previous cycles of development, demolition and earthworks, except for where bedrock is exposed at current ground level and in the fields in the eastern area of North Site.

4.1.3 Superficial Deposits

Published geological mapping indicates that the Site is largely underlain by Till, described by the BGS as *'sandy clay with pebble to boulder-size clasts (diamicton)'*. Peat may encroach on the south western part of the Site. Superficial Deposits are shown to be absent from the *'upper terrace'* in the southern part of Central Site, where bedrock is exposed at current ground level.

4.1.4 Bedrock

Bedrock is recorded on published British Geological Survey (BGS) Geoindex mapping as the Brithdir Member, Hughes Member, and Swansea Member of the Pennant Sandstone Formation, described by the BGS as *'green-grey and blue-grey, feldspathic, micaceous, lithic arenites of southerly provenance, with thin mudstone/siltstone and seatearth interbeds and mainly thin coals; the lithologies are commonly arranged in fining-upwards channel-fill sequences.'*

Geological maps (BGS Sheet 247, 1:50,000 and Sheet 79 NW, 1:10,560) indicate the Hughes and Bodwr seam to subcrop along part of the southern boundary of the former refinery and dipping towards the north. The recorded angle of dip, shown on geological maps, varies between 30° to 35°. The Hughes Seam is indicated as being an average thickness of 3ft (approximately 1m) and the overlying Bodwr seam is recorded as being an average of between 3ft and 6ft (approximately 1-2m).

4.1.5 Geological Faults

Published BGS mapping indicates that two faults are recorded on Site. A fault is present trending north - south through the south west of the Site at the eastern end of the Tip, and a second fault is



recorded trending north east – south west, to the south of the Site.

Coal Seams and faults are shown on PJA Drawing: Previous Investigation Locations (Ref: 05474-SK-0405-P0).

4.1.6 Historical Mapping

Historical maps from 1878-1881 record a coal pit and coal level located between 100m and 500m to the east of the Site. By 1899 the coal pit previously recorded 100m to the east is no longer shown, however, an old coal pit is located 325m to the east of the Site. The site of the former coal level approximately 175m to the east of the Site is now labelled as Cwrt y Bettws colliery. By 1938 this is no longer shown on historical maps.

In the south of the Site, historical maps from 1879 show that old coal pits and old quarries are marked near the sub crops of the Hughes and Bodwr seams. On the historical map from 1918 an old coal shaft is also marked near the previously marked coal pit, and the 'old quarry' has been re-labelled as an 'old coal pit'. By the late 1960s, these features are no longer marked, having been previously redeveloped as part of the refinery.

Copies of the historical maps and a full description of the Site history is detailed in the PJA Phase 1 Geo-environmental Desk Study. Oct 2021 (ref: 05474-OUT-005)

4.2 Coal Mining Report

A coal mining report was obtained for the Site from the Coal Authority in 2021 and is presented in Appendix B. A summary of the report is provided below:

- The Hughes and Swansea No. 3 seams, and an unnamed coal seam are all recorded within the enquiry boundary and have been subject to past underground mining at depths ranging from 5m to 131m. The last recorded mining dates range from 1900 to 1914.
- There are no probable unrecorded shallow mine workings.
- Five shafts and an adit are recorded within the enquiry boundary and two further shafts are located directly adjacent to the enquiry boundary.
- Two shafts located in the north east of Central Site and a shaft located directly adjacent to this area of the Site have undergone treatment involving filling, plugging and capping.
- There are no records of treatment of mine shafts or the adit in the south of the Site.
- The Coal Authority report records a 'remediated site' located 11.6m to the north west of the enquiry boundary. This 'remediated site' referenced in the Coal Authority report may refer to treatment of shafts associated with Cwrt-y-Bettws colliery which was historically located to the east of Central Site.



- There are no opencast mines recorded within 500m of the enquiry boundary.
- There are no Coal Authority managed tips recorded within 500m of the enquiry boundary.
- The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50m of the enquiry boundary, since 31 October 1994.
- There is no current Stop Notice delaying the start of remedial works or repairs to the property.
- The Coal Authority is not aware of any request having been made to carry out preventative works before coal is worked under Section 33 of the Coal Mining Subsidence Act 1991.
- There is no recorded mine gas within 500m of the enquiry boundary.
- There are no mine water treatment schemes recorded with 500m of the enquiry boundary.
- There are no records of future underground mining licensing.
- There are no coal mining licenses recorded within 200m of the enquiry boundary.
- No notices have been given, under Section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.
- The property does not lie within the geographical area where a notice to withdraw support has been given.
- The property is not in an area where a notice has been given under Section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.
- The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

4.3 Ground Stability Report

A Ground Stability Report was obtained for the Site by Atkins in August 2008. This report compiles information from the Coal Authority and the British Geological Survey and is provided in Appendix C. The report includes details held by the Coal Authority on the Mine Entries on the Site, and states which entries have been historically treated. Three shafts in the east of Central Site have been historically treated, and details on the recorded remedial works on the shafts are provided in the next section in [Table 5-1](#).

4.4 Dames & Moore Phase 2 Site Assessment BP Llandarcy Refinery Ltd, August 1999

A Phase 2 assessment produced in 1999 by Dames and Moore for BP Landarcy Refinery Ltd (BPLR) has been reviewed and the following information has been taken from a coal mining section of the report. Unfortunately the accompanying appendices to the report which may have included mine abandonment plans were not available to PJA at the time of writing.



Dames & Moore report that extensive mining of the Hughes and Bodwr seams is believed to have occurred beneath North Site and Central Site. It is reported that plans of the workings show the commencement of the worked seam was directly to the south east of Central Site at approximately 45m below ground level (at that point).

It was presumed by Dames & Moore that the workings occupy a similar elevation along the approximate east-west strike of the formations following the dip of the seam to the north-northeast. They reported that the plans suggested that the seam was worked from central north-south galleries with numerous east-west cuts into the seam. Based on the colliery plans, Dames & Moore suggested that the maximum depth of the workings is approximately 115mbgl on North Site and between 75 and 120mbgl on Central Site.

Dames & Moore go on to explain that the plans indicate the Hughes and Bodwr seams were worked from adits along south west and west faces of the main refinery hill where coal seams would have been observed as surface outcrops. This was likely prior to the placement of fill and landform modification during refinery construction.

It was reported by Dames and Moore that workings of the Hughes seam were penetrated by boreholes MSMW171d and MSMW114 and Bodwr workings were intercepted by boreholes MSMW115 and MSMW036. These locations are shown on PJA Drawing 05474-SK-0405-P0 and the Borehole logs are provided in Appendix D.

A summary of Coal Measures strata and mine working features identified in the boreholes is provided in [Table 4-1](#).

Table 4-1: Summary of Dames & Moore Borehole Logs 1999

Borehole	Approximate Grid Ref	Total Depth (mbgl)	Identified Coal (mbgl)
MSMW036	270687.381, 195621.707	25.0	Coal 18 -19.1mbgl
MSMW114	270629.559, 195733.811	20.0	Coal Measures 18.8 - 19.5 mbgl and 19.9 - 20.0 mbgl
MSMW115	270671.385, 195722.922	13.5	Void/easy drilling 5.8-8.5 mbgl (mine workings). Coal shale 10.5 -11 mbgl
MSMW171	270650.011, 195654.777	18.7	Angular locks of sandstone and siltstone from 13.7-18.7 mbgl suspected colliery working or fill therefrom

4.5 Atkins Technical Notes

This section summarises the findings of a series of technical notes produced by Atkins Investigating the recorded mine entries on the site. Copies of these technical notes are included in Appendix D.

4.5.1 Atkins Technical Note 336, June 2010

In July 2009 Atkins carried out a preliminary investigation to investigate the potential for shallow coal/mine workings beneath the initial phases of redevelopment at the wider Coed Darcy site.



Eleven rotary boreholes were drilled to depths of between 24m and 50mbgl, the locations of which are shown on Atkins Drawing 5041216/REM/DWG/000494 provided in Appendix D and on PJA Drawing: Previous Investigation Locations (Ref: 05474-SK-0405-P0).

Three of the 11 boreholes encountered coal, at depths ranging from 12.8m to 26.5mbgl. These locations were RO6, RO7 and RO8 located to the south east of Central site, beyond the boundary of the Proposed Development. Details on the coal encountered are provided in [Table 4-1](#). Coal was not encountered at any other location within the boundary of the development.

Table 4-1: Summary of Encountered coal during 2009 investigations

Borehole	Approximate Grid Reference	Total Depth (mbgl)	Identified Coal (mbgl)
RO6	271450 195592	24	21.60 – 22.00 (Bodwr seam)
RO7	271477 195769	30	26.20 – 26.50 (Bodwr seam)
RO8	271705 195771	25	12.80 – 13.10 (Bodwr seam) 13.70 – 13.90 (Bodwr seam) 14.50 – 14.70 (Bodwr seam/Hughes seam?)

4.5.2 Atkins Technical Note: TN 445, November 2010

To investigate two of the mine entries shown on Coal Authority Records in the southern part of the site, Atkins carried out ground investigation in 2010. Details of these investigations are reported in Atkins Technical Note 455 provided in Appendix D.

A preliminary trenching exercise was carried out at the recorded location of the shaft (taken from Coal Authority records). The trenching confirmed the ground conditions as loose brown silty and clayey sand containing gravel cobbles and boulders. This was underlain by sandstone bedrock at a maximum depth of 3.1mbgl. No evidence of the shaft was encountered, although the investigations were restricted by the presence of steep slopes and a haul road. It was recommended to carry out a geophysical investigation to identify the recorded mine entries.

4.5.3 Atkins Technical Note: TN494, January 2011

Based on Atkins' recommendations, a geophysical investigation was carried out in December 2010 and five anomalies were detected in the vicinity of the recorded shaft and adit at (GR) 271045, 195524 and 271046, 195528 respectively.

It was recommended that the identified anomalies were targeted in future investigations.

4.6 Atkins Geo Environmental Assessment Middle & Upper Terraces

4.6.1 Atkins Geo-environmental Assessment and Outline Remediation Strategy, August 2011

This remediation strategy was produced for the 'Upper and Middle Terraces' for a housing



development outside the boundary of the Proposed Development, as shown on PJA Drawing 05474-SK-0406-P0 included in Appendix A.

As part of this assessment Atkins reviewed the data from the 2009 boreholes. Information from boreholes RO4, RO5 and RO6, located closest to the proposed housing development, was used in this assessment. Coal was only identified in borehole RO6 at a depth of 21.6 to 22.0mbgl.

Based on the overlying sandstone recorded, Atkins concluded there was sufficient solid strata overlying the coal seam to provide six times the seam thickness of cover required to prevent the migration of voids to the surface.

4.6.2 Reprofilng Earthworks – Atkins Upper Terrace Validation Report, October 2014

As part of plot preparatory works for a previous planning submission, the western end of the upper terrace was reprofiled during remedial works carried out between 2012 and 2013. This part of the site was previously referred to as Monitor Phase 30 and is shown on PJA Drawing 05474-SK-0406-P0, included in Appendix A. The remedial and earthworks carried out on this plot are detailed in the Atkins Monitor Phase 30 Verification report.

Reprofilng works were carried out predominantly between December 2012 and April 2013. Across this area there was a general reduction of ground levels which included the associated removal of approximately 45,259m³ of residual soils (Made Ground and natural soils); and approximately 96,364m³ of bedrock.

Ground levels in this area circa 1998 prior to the earthworks were approximately 81-82mAOD as shown on the URS drawing SG/GIS/APR04/1. Ground levels following this reprofilng were between 76-77mAOD; a reduction of between 3m and 5m.

4.6.3 Atkins Technical Note 1317, January 2015

This Technical Note was prepared by Atkins to summarise available information relating to the potential for shallow mineworking and mine entries beneath an area within the site referred to as 'Monitor Phase 31' as shown on PJA Drawing 05474-SK-0406-P0.

The information from the 2009 boreholes was used to assess the depth of anticipated competent strata beneath the area. Boreholes R04, R05, R06, R07 and R08 were used in their assessment, as shown in [Table 4-1](#).

Based on the relatively thin seam thickness recorded, together with the absence of coal in two of the five boreholes, Atkins concluded that it was unlikely that the seams would have been economically viable. Furthermore, using the recorded seam thickness on geological maps and anticipating a depth to the coal seams, Atkins suggested that the depth of competent strata overlying any workings would be >30m.



4.7 Geotechnics Ground Investigation 2017

In December 2017 Geotechnics Ltd carried out a ground investigation under the instruction of Atkins on behalf of St. Modwen. The investigation was carried out to characterise the ground conditions beneath a proposed residential development plot, approximately 1.2km² in size, situated in the centre of the Site. Borehole locations from this investigation are shown on PJA Drawing 05474-SK-0405-P0.

The investigation comprised rotary boreholes, dynamic sample boreholes and trial pits. The factual report on this investigation produced by Geotechnics is included in Appendix D.

Twenty two boreholes were sunk to depths ranging between 4.3m and 25.2mbgl using dynamic sampling and rotary drilling techniques. A summary of the Coal features encountered is presented in [Table 4-2](#). Full borehole logs are included in the Geotechnics Report included in Appendix D.

Table 4-2: Summary of Coal Measures Encountered in 2017 Geotechnics Investigation

Borehole ID	Location	Max Depth	Evidence of Coal Measures
BH01	271058.011 E, 195788.992 N	19.5mbgl	Between 8.5m and 8.6m, extremely closely to very closely spaced coal partings. Between 14.8m and 16.30m extremely closely to very close partings of coal dust. Between 18m and 19m occasional very closely spaced partings of coal dust.
BH02	271129.11 E, 195779.243 N	7.5mbgl	None encountered.
BH03	271405.008 E, 195846.99 N	10mbgl	Between 6.2m and 6.54m very closely spaced coal partings. At 6.54m 3mm coal infill.
BH04	271337.001 E, 195863.984 N	6.5mbgl	None encountered.
BH05	271221.003 E, 195989.031 N	5.0mbgl	None encountered.
BH06	271286.024 E, 195937.019 N	12.0mbgl	None encountered.
BH07	271234.357 E, 196013.702 N	4.5mbgl	None encountered.
BH08	270915.24 E, 195808.334 N	25.2mbgl	Between 15.2m and 15.4m very closely spaced coal partings. Between 17.82m and 17.84m extremely closely spaced coal partings. Between 18.5m and 19.2m extremely closely spaced and very closely spaced coal partings. Between 21.55m and 22.50m very closely spaced and closely spaced coal partings.
BH09	271567.025 E, 195826.991 N	9.5mbgl	None encountered.
BH10	271162.535 E, 195927.529 N	14mbgl	None encountered.
BH11	271129.189 E, 196042.647 N	6.7mbgl	Between 5.8m and 6.7m extremely closely spaced and very closely spaced coal partings.
BH12	271387.997 E, 195882.998 N	9.45mbgl	Between 9.38m and 9.46m very closely spaced coal partings.
BH13	271321.019 E, 195812.013 N	8.0mbgl	Between 7.4m and 7.45m extremely closely to very closely spaced partings of coal.
BH14	271208.120 E, 195833.802 N	10.0mbgl	None encountered.
BH15	270926.469 E, 195738.94 N	11.3mbgl	None encountered.



Borehole ID	Location	Max Depth	Evidence of Coal Measures
BH18	271384.032 E, 195798.483 N	10.mbgf	Between 7.7m and 8.5mbgf closely spaced coal partings.
BH19	271199.007 E, 195804.248 N	7.5mbgf	None encountered.
BH20	270365.24 E, 194749.216 N	5.3mbgf	None encountered.
BH21	270478.038 E, 194796.375 N	8.3mbgf	None encountered.
BH23	270551.341 E, 194770.444 N	8.2mbgf	Between 4.3m and 5.4m sandstone, non intact, recovered as angular to subangular fine to coarse gravel with frequent coal fragments up to 4mm. Between 6.0m and 6.7m sandstone with frequent coal fragments up to 3mm. Between 7.3m and 8.2m sandstone with frequent carbonised plant fossils and coal inclusions.
BH24	270536.489 E, 194885.313 N	6.0mbgf	Between 5.5m and 6.0m extremely closely spaced coal partings.



5 Site Specific Coal Mining Risk Assessment

5.1 Recorded Mine Entries

Information gathered on the recorded mine entries is summarised in [Table 5-1](#).

Table 5-1: Summary of Mine Entries

Coal Authority Reference	Location	Details from Ground Stability Report	Comments	Remaining Risk
270195-001 (shaft)	In the south west of Central Site (on-site)	No treatment details	The position of these shafts is unconfirmed, although they are believed to be located in vegetated areas outside areas of proposed building development.	Low/moderate
270195-002 (shaft)	In the south west of Central Site (on-site)	No treatment details		Low/moderate
270195-003 (shaft)	South west (on-site)	No treatment details		Low/moderate
271195-009 (shaft)	In the south of Central Site (on-site)	No treatment details	These mine entries have been subjected to investigation by Atkins, as covered in technical notes 445 and 494, presented in Appendix D. Investigations did not find any mine entrances. Earthworks documented by Atkins in the vicinity of the shaft comprised a reduction in levels of between 3m and 5m. No evidence of a shaft was apparent during these works.	Low – no evidence of the shaft has been recorded.
271195-004 (adit)	In the south of Central Site (on-site)	No treatment details		Low – the adit has not been located, although this is believed to be located outside any building development.
272196-001 (shaft)	In the north east of Central Site (on-site)	Filled to an unknown specification in June 1972	These shafts are located close to Junction 43 of the M4 where commercial units are present and where highway reprofiling works have been carried out. They are outside areas of proposed development.	Low/moderate
272196-006 (shaft)	In the north east of Central Site (on-site)	Plugged and capped in May/June 1995		Low
272196-007 (shaft)	To the north east of Central Site (off-site)	Plugged and capped in May 1995		Low

5.2 Recorded Coal Workings

Dames & Moore suggested that the recorded mine workings ranged from approximately 45mbgl in the south of Central Site, to approximately 115mbgl on North Site. In the centre of Central Site, the workings are estimated by Dames and Moore to be between 75 and 120mbgl.

There was little evidence of coal in the boreholes drilled in the centre of Central Site during the 2017 ground investigation, and nothing to suggest the presence of seams of sufficient thickness that would be economically viable for mining. It is noted that the majority of these boreholes may



have not extended deep enough to encounter mine workings, however even the deepest borehole, BH08 (approx. 25m) failed to find any evidence of mine workings or seams considered workable.

Furthermore, large parts of the Site have undergone assessment using the data gathered in the 2009 investigation. These assessments were carried out by Atkins for previous phases of intended development. The assessments were undertaken in accordance with CIRIA Special Publication 32 "Construction Over Abandoned Mineworkings" which states a depth of ten times the seam thickness of overlying rock should be sufficient to prevent the migration of voids to the surface. Where sandstone strata is recorded, it is suggested that this can be reduced to a depth of six times seam thickness due to the increased strength of the overlying rock.

Given the Proposed Development lies to the north of the seam outcrops and the seams dip to the north, the previously assessed areas represent the 'worst case' and competent cover will increase towards the north of the site.

With reference to Ciria Guidance C758D: Abandoned Mine workings, the previous assessments have been revisited to take into account 'circumstances when alternative ratios greater than or less than 10 times the seam thickness should be considered'

The highest risk area has been identified as the western end of the upper terrace towards the south west of Central Site, formerly referred to as Monitor Phase 30. This area is the southernmost part of the proposed development, closest to the outcrop of the Bodwr seam (115m to the south) and Hughes seam (170m to the south).

The nearest boreholes to this area are RO4 and RO5 drilled in 2009 to 30mbgl, and neither recorded evidence of coal. Taking into account the lowering of levels in this area in 2012 and 2013 by up to 5m, it can be expressed that these borehole records represent 25m below current ground levels. This would provide 10 times of competent cover assuming (conservatively) the Bodwr seam is 2.5m thick. However C758D explains this 10 times may not be sufficient where the seam is dipping >20 degrees or where there is the potential for multiple seam working to have occurred. In this instance these seams are recorded on geological maps as dipping between 30° to 35°. The Hughes seam is indicated as being an average thickness of 3ft (approximately 1m) and the overlying Bodwr seam is recorded as being an average of between 3ft and 6ft (approximately 1-2m).

Nevertheless, the level of the worked Bodwr seam is reportedly at Ordnance datum (taken from the Dames & Moore 1999 report), and that the ground level at the western end of the upper terrace is approximately 80mAOD. This fact, together with the outcrop position and the dip of the seams would result in a significant thickness of competent cover, in excess of 10 times.

This is broadly in line with the Dames & Moore report that suggests the workings under Central Site are between 75m and 120m below ground level.



Based on this the risk to the Proposed Development from recorded workings is considered to be low.

5.3 Probable Unrecorded Workings and Workable Coal Seam Outcrops

It is likely that the Bodwr and Hughes seams were mined along the outcrop which would have been on the hillside to the south of Central Site. Any such workings are likely to have been buried by earthworks associated with the development of the refinery.

Boreholes drilled by Dames and Moore in 1999 in the south west of Central Site recorded workings believed to be in these coal seams. The location of three shafts recorded by the Coal Authority in this part of the Site are also likely to be associated with workings in these seams. The adit reported by the Coal Authority in the south of the site may also be associated with these seams although its location and elevation to these seams has not been confirmed.

Historical maps up to 1918 also show coal pits in the area of the mine shafts. The workings in the south west part of Central Site are currently overlain by significant thicknesses of Made Ground used to create the railway sidings that occupied this area during refinery operations. The current proposals show no building development near the coal seam outcrops, the areas are shown on the masterplan as areas of landscaping and public open space and the risk to the Proposed Development is considered to be low. Depending on detailed designs and the final intended use of these areas, additional work may be required to identify the mine shafts and design foot paths and cycleways to discourage people from using this area.

5.4 Mine Gas

The Coal Authority Coal Mining Report (presented in Appendix B) reports no recorded instances of mine gas within 500 meters of the enquiry boundary. The preliminary conceptual site model presented by PJA in the Phase 1 Geo-environmental Desk Study, October 2021 (reference: 05474-OUT-005) identifies mine gas as a potential contamination source posing a low to moderate risk to receptors. As such, it is recommended by PJA that a gas risk assessment is conducted using monitoring data to identify the Characteristic Situation and to determine the potential requirement for gas protection measures within properties.

5.5 Recorded Coal Mining Related Hazards

The Coal Mining Report identifies the site as being close to where the Coal Authority has investigated and where necessary remediated mine entries and/or shallow coal mine workings following specific reported hazards.

Based on the data reviewed as part of this risk assessment this is believed to reference the three shafts remediated by the Coal Authority in the eastern part of the site. These shafts, although within



the planning boundary are within areas that have already been developed, and there are no proposed changes in this area that will be affected by the shafts.

The Coal Mining Report states that there have been no claims made against the Coal Authority for mining subsidence since 31 October 1994 and there have been no notices given under Section 46 of the Coal Mining Subsidence Act 1991 stating the Site is at risk of subsidence.

5.6 Geological Features Including Fissures and Break Lines

A major north-south trending fault is shown cutting across the south west of Central Site (as shown on PJA drawing 05474-SK-0405-P0. Although within the boundary of the Site, this geological feature is outside the built development areas in a green corridor with an active foot/cycle path. The risk the fault may pose to this proposed land use is considered to be very low.

5.7 Former Surface Mining Sites

There are no former surface mining sites within the Site boundary. Based on the review of the historical maps, it is possible there were small surface mining activities of the Hughes and Bodwr seams where they sub crop to the south and south west of Central Site. These workings have long since been covered by the development of the refinery. The low risk posed by these now buried features is discussed in Section 5.3.

6 Mitigation Strategy

The following points identify how the risks posed by the historic coal mining of the site have been mitigated. Further mitigation measures considered to be required are also presented here.

6.1 Design Mitigation

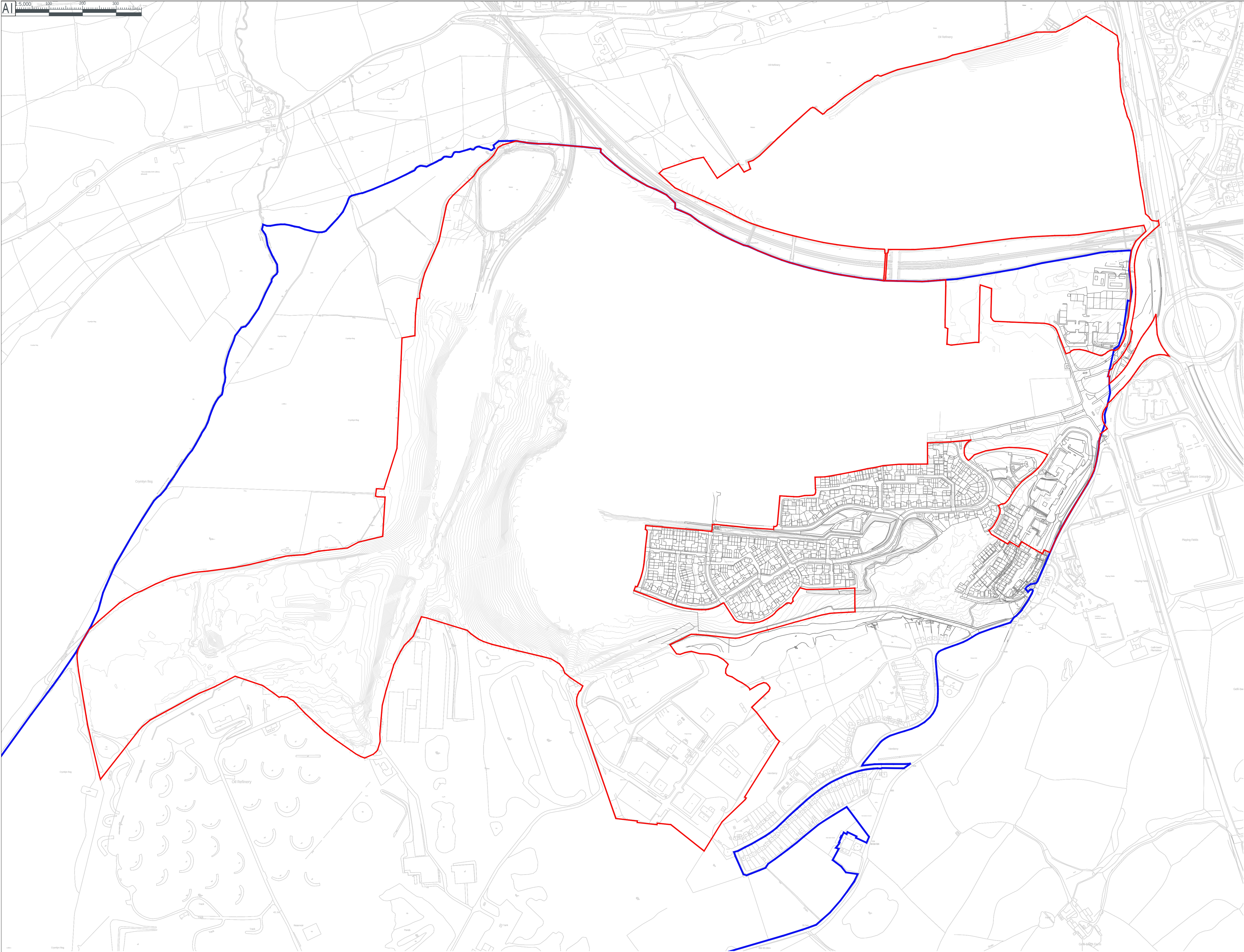
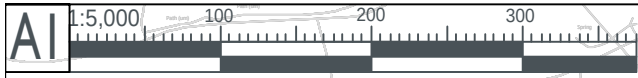
- The illustrative masterplan presented in Appendix A shows the Proposed Development to be generally away from historical coal mining activities. Based on the information reviewed as part of this Coal Mining Risk Assessment, the seams predominantly worked are the Hughes and Bodwr seams which sub crop on the southern and south western side of the hill located beyond the southern boundary of the Proposed Development.
- Areas of the site that may be influenced by shallow workings in these seams have been designated as public open space (footpaths and cycleways) to which the former mine workings pose little risk.

6.2 Future Mitigation

- The documented workings of the Hughes and Bodwr seams are described in the 1999 Dames and Moore report. Mine plans were not available at the time of writing. To confirm the initial risk assessment presented in this report, and to reduce the reliance on the third party report, it is strongly recommended that the abandonment plans for the workings underlying the Site are obtained.
- As recommended in by the Coal Authority in the coal mining report, a Surface Hazard Incident report should be obtained to confirm whether or not the Surface Hazards remediated by the Coal Authority refer to the mine shaft remediation carried out in the east of Central Site, and that no other remedial works have been required elsewhere on the Site.
- Depending on the information detailed in the mine abandonment plans or surface hazard incident report, additional investigation may be required to close out any issues identified with this additional information. Similarly, any reprofiling works substantially changing levels may require additional ground investigation to confirm sufficient rock cover remains over any abandoned mine workings.
- Gas monitoring should be carried out on the finished development profile to enable a gas risk assessment to be carried out and identify the Characteristic Situation of the Site to inform any protective measures required in the Proposed Development.



Appendix A Drawings



NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

1. These drawings should be read in conjunction with all relevant documentation, drawings and standard details.
2. PJA accept no liability for the accuracy of third party data.
3. All dimensions in meters unless otherwise stated. Do not scale from this drawing.

KEY

— Planning Boundary

— St. Modwen Developments Ownership Boundary

REV	DATE	REVISION NOTE	BY

PJA

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CLIENT

St. Modwen Developments Ltd

PROJECT

Coed Darcy

DRAWING TITLE

Red Line Planning Boundary

DRAWING ISSUE STATUS

PJA JOB No.	SUB-CODE	DRAWING NO.	REVISION
05474	-	0401	- P0

Revision Letter: P - Prelim / A - Approval / T - Tender / C - Construction

BIM DRAWING REFERENCE

SCALE	DRAWN	REVIEWED	DATE
AI @ 1:5000	OB	LC	05.10.21