



The Coal
Authority

Swansea Council: Mine Water Heat Opportunities

July 2024



Making a **better future** for people
and the environment **in mining areas**

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Executive summary

Coal mining has taken place in the Swansea Council area since the 17th century with the last mining being associated with Brynlliw/Morlais Colliery on the western boundary of the borough in 1983. Considerable areas of the borough are underlain by coal mine workings, with multiple seams being worked in many localities. The presence of mine workings combined with knowledge (where available) of recovered mine water levels are used to provide a very high level assessment of the potential for exploring the development of open loop mine water heat projects (utilising boreholes) in the borough. In addition to borehole opportunities, gravity-fed discharges (including mine water treatment schemes) have also been assessed for heat potential. Some discharges do not have sufficient data for assessment, hence not included in this report.

The presence of some 'gravity discharges' in the Swansea Council administrative area together with the long period since the mines closed suggests that mine water has largely recovered.

The methodology for heat potential assessments is set out in the overarching report with the assessments for Swansea set out in Section 5.

Good potential exists in a number of heavily populated areas as listed as **1 to 8** in below where a combination of viable drilling depths and mine water recovery suggest that further detailed assessment would be beneficial.

There are a number of 'gravity discharges' where mine water is emitting at surface. This mine water may offer potential for mine water heat without the cost and risk of drilling and pumping. Only two discharges at present have data available to evaluate their heat potential. These are relatively close to potential heat loads and are listed at **9** and **10**.

It is recommended that the opportunities listed above are considered against surface heat demands to highlight those which may be served by mine water heat technologies. A subsequent, more detailed study of the mining and hydrogeology would add further information to firm up the case to take a number of mine water heat projects forward.

Mine water heat opportunities within the Swansea Council area

No./ Area	Opportunity name	Opportunity type	Category	Potential MW _{th}
1	SW Morryston to E Port Mead /Rhydding/Bryncoch	Borehole scheme	Good	Subject to further testing
2	Fforestfach Industrial Estate	Borehole scheme	Good	Subject to further testing
3	Garnoch Industrial estate	Borehole scheme	Good	Subject to further testing
4	West Gorseinon	Borehole scheme	Good	Subject to further testing
5	Llansalmet east	Borehole scheme	Good	Subject to further testing
6	Plasmarl Industrial Estate	Borehole scheme	Possible	Subject to further testing
7	Llansalmet Enterprise Park	Borehole scheme	Possible	Subject to further testing
8	N Fforestfach Retail Park	Borehole scheme	Possible	Subject to further testing
9	Dunvant No.1 discharge	Discharge scheme	Possible	<0.5
10	Craig Cefn Parc discharge	Discharge scheme	Possible	0.9-1.2

1 Introduction

The area covered in this section is the whole of the Swansea Council administrative boundary within which the presence of mine workings combined with knowledge (where available) of recovered mine water levels are used to provide a very high level assessment of the potential for exploring the development of open loop mine water heat projects in the borough.

1.1 Geographic area

Swansea Council covers an area of approximately 429 km², and runs roughly west-east, and includes the Gower Peninsula in the west portion. Urban areas in Swansea Council area include: Swansea City; Gorseinon; and Pontardulais. Urban areas are also along parts of the Gower and long the Tawe Valley. Elevation ranges from sea level to over 370 mAOD in the north part of Swansea.

2 Geological summary

The solid and superficial geology, along with seam information has been ascertained by consultation of the available British Geological Survey records including:

- Online GeoIndex viewer;
- Online geological memoirs;
- Online geology maps (Sheet 230, Sheet 246, and Sheet 247 for Swansea area); and
- Borehole and mine shaft scans across the area of interest.

2.1 Solid geology

A large proportion of the Swansea Council administrative area is on the exposed coalfield, the northern half of the area being the South Wales Upper Coal Measures, which consists of interbedded mudstones, siltstones, sandstones and coal with some ironstone beds. The general structure of the geology is in the form of a large synclinal basin (**Figure 2.1**). The outcrop of the South Wales Middle and Lower Coal Measures outcrop in a fringe approximately 3 km wide to the south of a line between south Swansea city and Llanmorlais.

The south and southeast part of the Gower have Dinantian (Carboniferous limestone) and Lower Devonian (mudstone and sandstone) strata outcropping at surface

2.2 Structural geology

A major geological disturbance is present in the area which influences the mining and mine water hydrogeological regimes. The “Swansea Valley Disturbance” runs from central Swansea city in a north-north easterly direction passing through Pontardawe. While largely outside of Swansea, a further major disturbance exists which influences the mining and hydrogeology relevant to this study, namely the Neath Disturbance trends in a north-easterly direction through Neath town. The disturbances have resulted in zones of heavily fractured ground and large displacements, which form a clear delineation between mined areas.

A number of smaller faults are present which largely trend in a north-south direction and in many cases represent a delineation between mined areas.

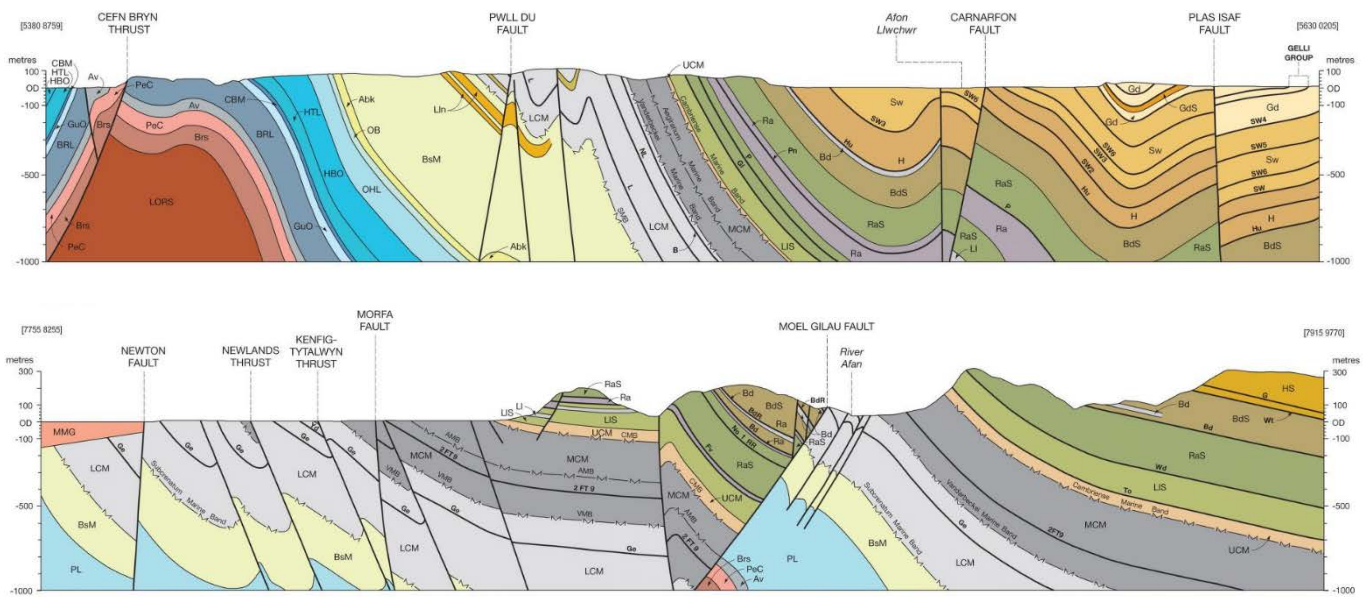


Figure 2.1. Regional geological cross sections for Swansea area.. [Source Geological Sheet 247 Swansea](#)

Top is south to north for west of Swansea. Bottom is south to north for east of Swansea

Contains British Geological Survey materials © UKRI 2024

Regional solid geology and selected structural geology is shown in **Figure 2.2**. The stratigraphic sequence, approximate depths and noted shaft sections are shown in **Figure 2.3**.

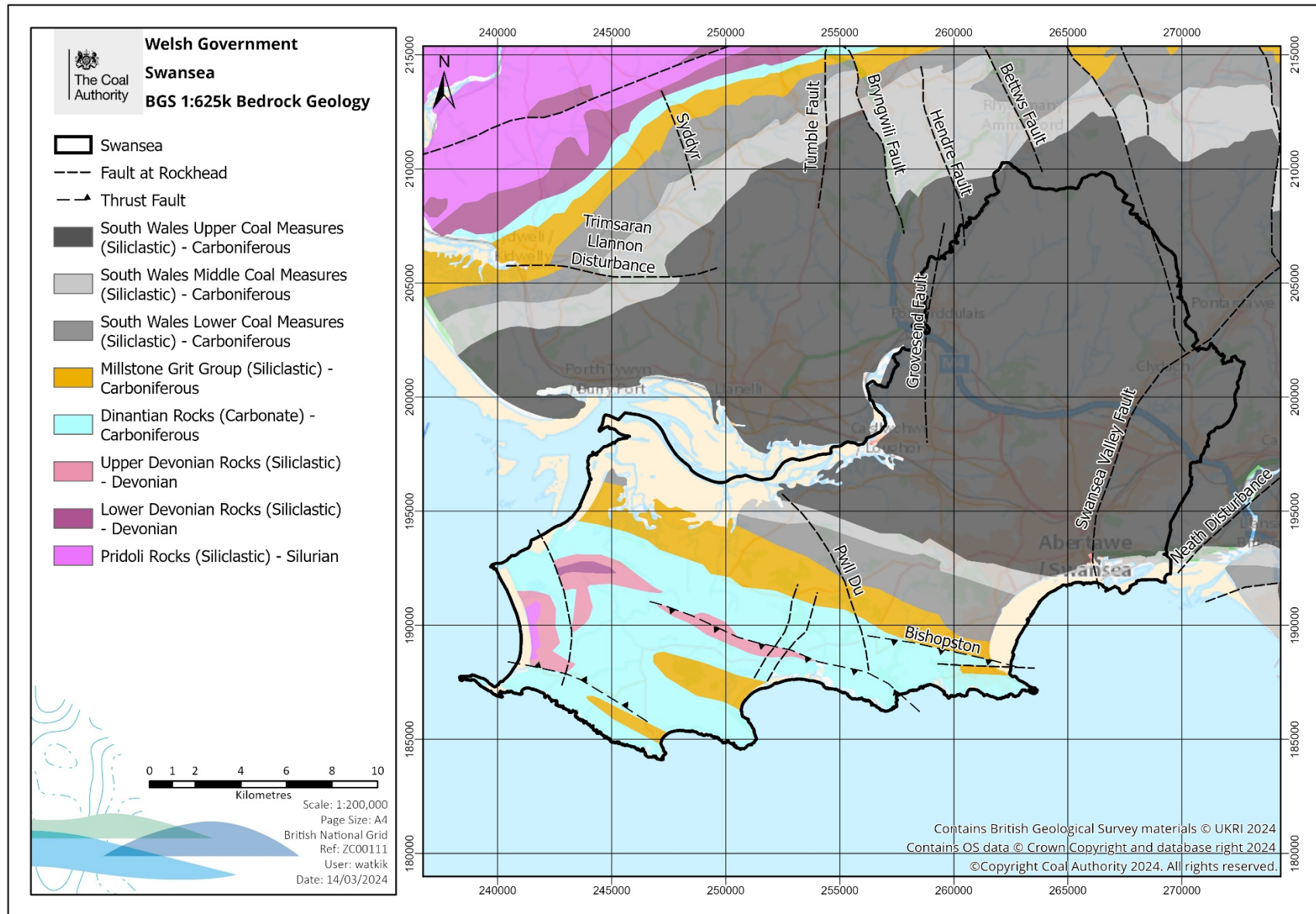


Figure 2.2. Bedrock geology in the Swansea Council area (Contains British Geological Survey materials © UKRI 2024)

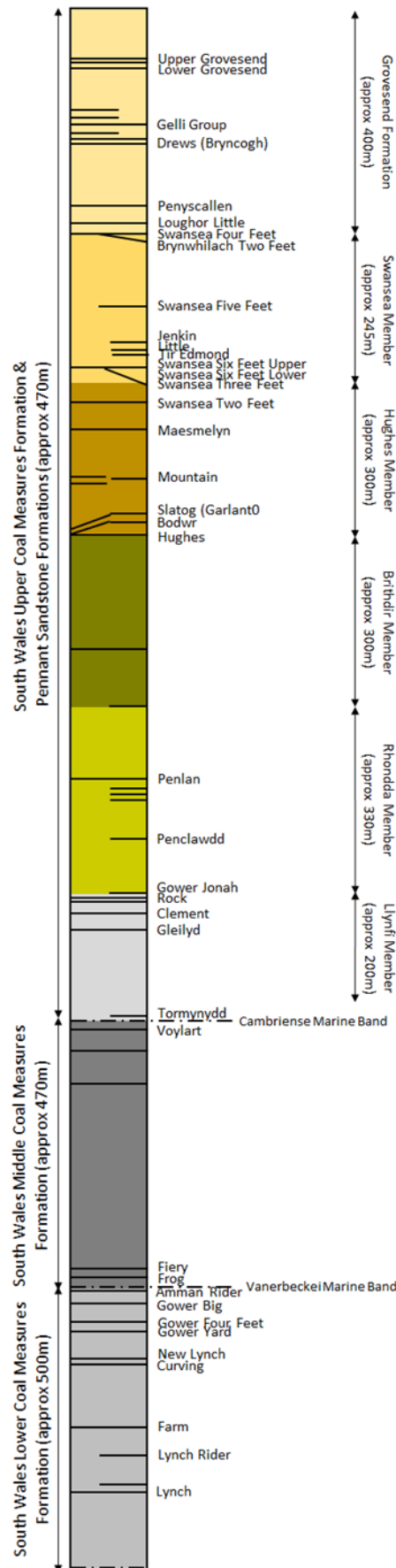


Figure 2.3. Summary stratigraphy and geological sequence for the study area. [Source Geological Sheet 247 Swansea](#)

Contains British Geological Survey materials © UKRI 2024.

3 Mining situation

The coal mining geometry in Swansea splits into two large areas, coincidentally divided roughly along the line of the M4 motorway.

- The area to the north of the M4 is largely single seam working over an area of approximately 70 km². There are numerous north-south trending breaks in the recorded workings due to the presence of faulting.
- The area to the south of the M4 is also extensively worked, but features workings in multiple seams. The area is essentially divided into two bands :-
 - The first band covers an area of approximately 50 km² and extends south of the M4 to the line of the B4295.
 - The second band is one of more limited working at the southern fringe of the Coal Measures to the south of the B4295.

Following colliery closures and end of mines in the 1980/90s, several mines were lost due to flooding. The most recent colliery closures pertinent to this study are set out in **Table 3.1** below. While these are largely outside the Swansea boundary, they are connected to past mining within Swansea and so influence the hydrogeological setting.

Following these closures all mine water pumping ceased and the mines started to refill.

Table 3.1. List of most recent colliery closures

Colliery	Closure date	Mine water block	Comments
Brynlliw/Morlais	1983	3	Collieries outside Swansea to west. Brynlliw and Morlais merged in 1977
Abernant	1988	4	Colliery outside Swansea to north east.
Treforgan	1985	6	Colliery outside Swansea to east
Blaenant	1990	6	Colliery outside Swansea to east
Blaengwrach	1983	6	Colliery outside Swansea to east

Note: a detailed assessment of underground mining connections is required to confirm the mining hydrogeological conceptual model(s)

4 Mine water regime

4.1 Description of mine water blocks

Workings in the South Wales Coalfield are divided into a number of blocks where workings, due to the presence of significant geological disturbances, tend to be in discrete or quasi discrete areas which act independently from a hydrogeological perspective.

Five blocks are relevant to Swansea are blocks 3, 3b, 3c, 4, 4a and 5. The major parts of blocks 3, 3b, 3c and 5 are within Swansea, and the blocks extending into adjacent boroughs to the west and east. Only small areas of blocks 4 and 4a extend into Swansea.

The blocks are shown in **Figure 4.1**. Further detailed studies are required to confirm the boundaries of the mine water blocks, and hydraulic connections internally within the blocks and externally between blocks.

Mine water recovery status for these mine water blocks is considered to be recovered. This is based on the gravity-fed discharges in the areas along with time since colliery closures.

4.2 Monitoring data

4.2.1 Mine water levels

There are no mine water level monitoring points within the Swansea Council boundary. There are several surface discharges of mine water in the area, which may infer that mine water has recovered in much of the borough. A more detailed assessment, which may include exploratory drilling, should be carried out should mine heat be targeted as a solution in a particular locality.

4.2.2 Mine water temperature

A study into mine water temperatures at various depths around the UK coalfields was published in 2020 ([Farr et al, 2020](#)). This study used historic underground water and strata temperatures along with data from mine water pumping where available.

Temperature typically increases with depth but there are localised variations between mine water blocks. **Table 4.1** summarises the collated data from the Farr et al. (2020) study for the Swansea region.

Table 4.1. Anticipated mine water temperature at various depths

Depth (m BGL)	Mean average (°C)	Maximum (°C)	Minimum (°C)
100	11.5	12.1	10.8
200	13.4	14.1	12.7
300	15.1	15.7	14.6
400	17.4	18.4	16.4
500	19.6	21.0	18.3

4.2.3 Mine water chemistry

Mine water chemistry can be highly variable depending on specific location and would not normally form part of any initial high level opportunity scoping considerations guided by this study. The matter would be included in any more detailed, site specific, studies which may be commissioned in future.

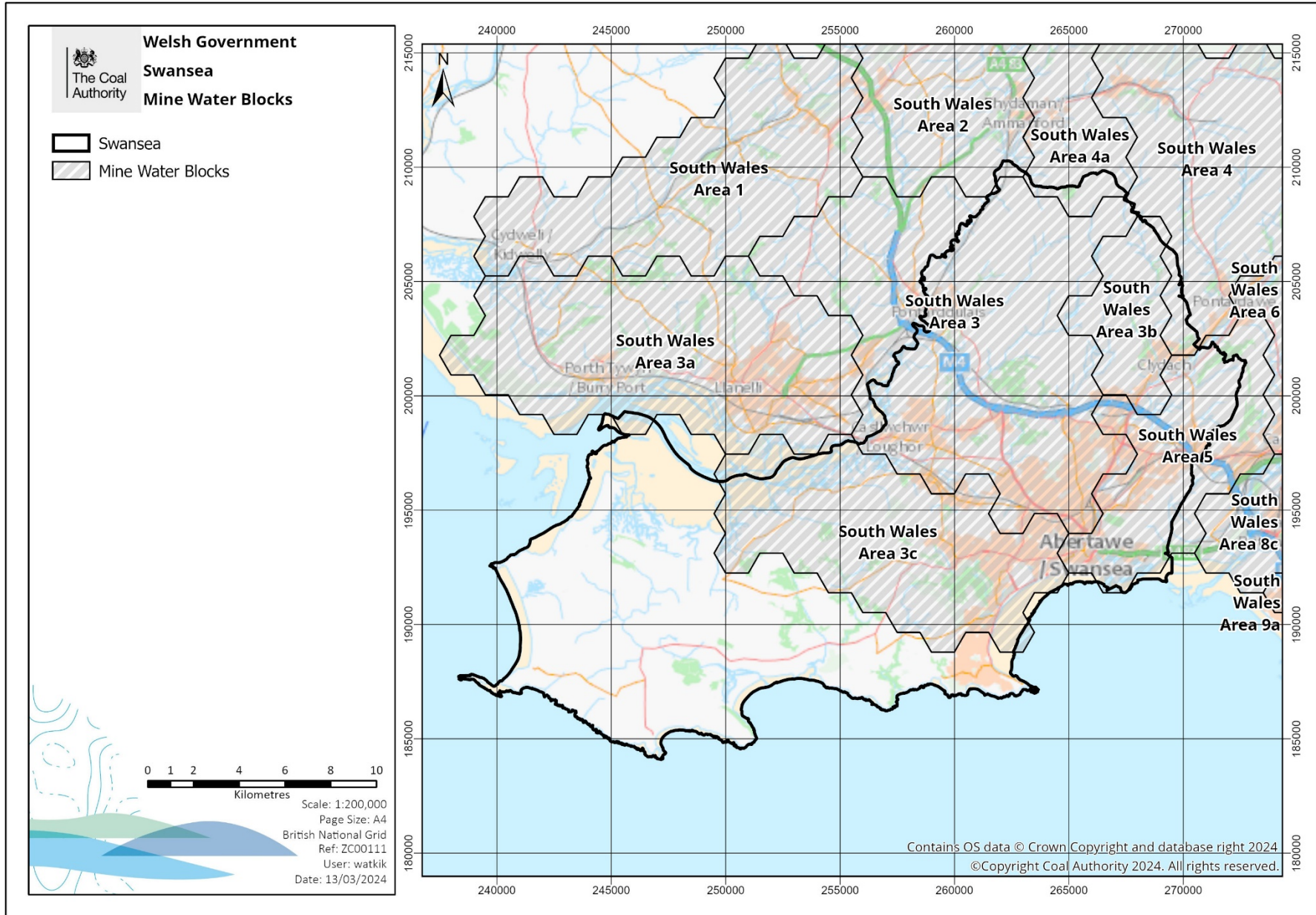


Figure 4.1. Mine water blocks in Swansea

5 Mine water heat opportunities

5.1 Borehole schemes

The prospects for progressing a mine water heat scheme based on drilling boreholes to access and return the mine water are assessed on a 'tier' basis.

Three tiers have been adopted for the purposes of this study, the methodology and assessment criteria being set out in the over-arching report for Welsh Government.

The tiers are:

Good opportunities – shown coloured dark orange

Possible opportunities – shown coloured mid orange

Challenging opportunities – shown coloured light orange

Any areas where no opportunity exists, mainly due to absence of mine workings are shown uncoloured.

The broad opportunity areas within the Swansea Council boundary are outlined below and are illustrated on **Fig 5.1**.

5.1.1 Good borehole opportunities

The 'Good' opportunity areas exist largely in a belt approximately 5 km wide to the south of the M4 motorway. While some of these areas are under undeveloped land, there are significant areas where surface development is present and may present significant heat demand:

- A considerable area stretching from south west of **Morrleston** in the east as far as **Port Mead** in the west may offer good opportunities. Adjacent to this area to the south **Fforestfach** is also considered a good opportunity area.
- Further west a large area stretching from **Penllergaer** through to the eastern side of **Gorseinon** also offers good opportunity from a mining perspective.
- A smaller area exists to the west of **Loughor** but includes significant areas of residential development.
- A further good opportunity area exists to the south of J44 of the M4 which also includes significant residential development.

5.1.2 Possible borehole opportunities

Significant areas ranked as possible opportunities are present in the Swansea area. The principal areas are to the immediate south of the M4 motorway between junctions 44 and 45 taking in much of **Llansalmet**. A fringe on the south eastern part of **Llansalmet Enterprise Park** also offers possible opportunities.

5.1.3 Challenging borehole opportunities

Opportunities are normally classified as challenging if the workings are very deep (with associated high drilling costs) or other complications are present which may lead to higher cost and risk. In some circumstances the presence of very high head loads may make such opportunities worth pursuing as the techno-economic position may still be viable. However in the Swansea Council area the small number of challenging opportunity areas are largely in unpopulated areas with little heat demand so are unlikely to be worth any further investigation.

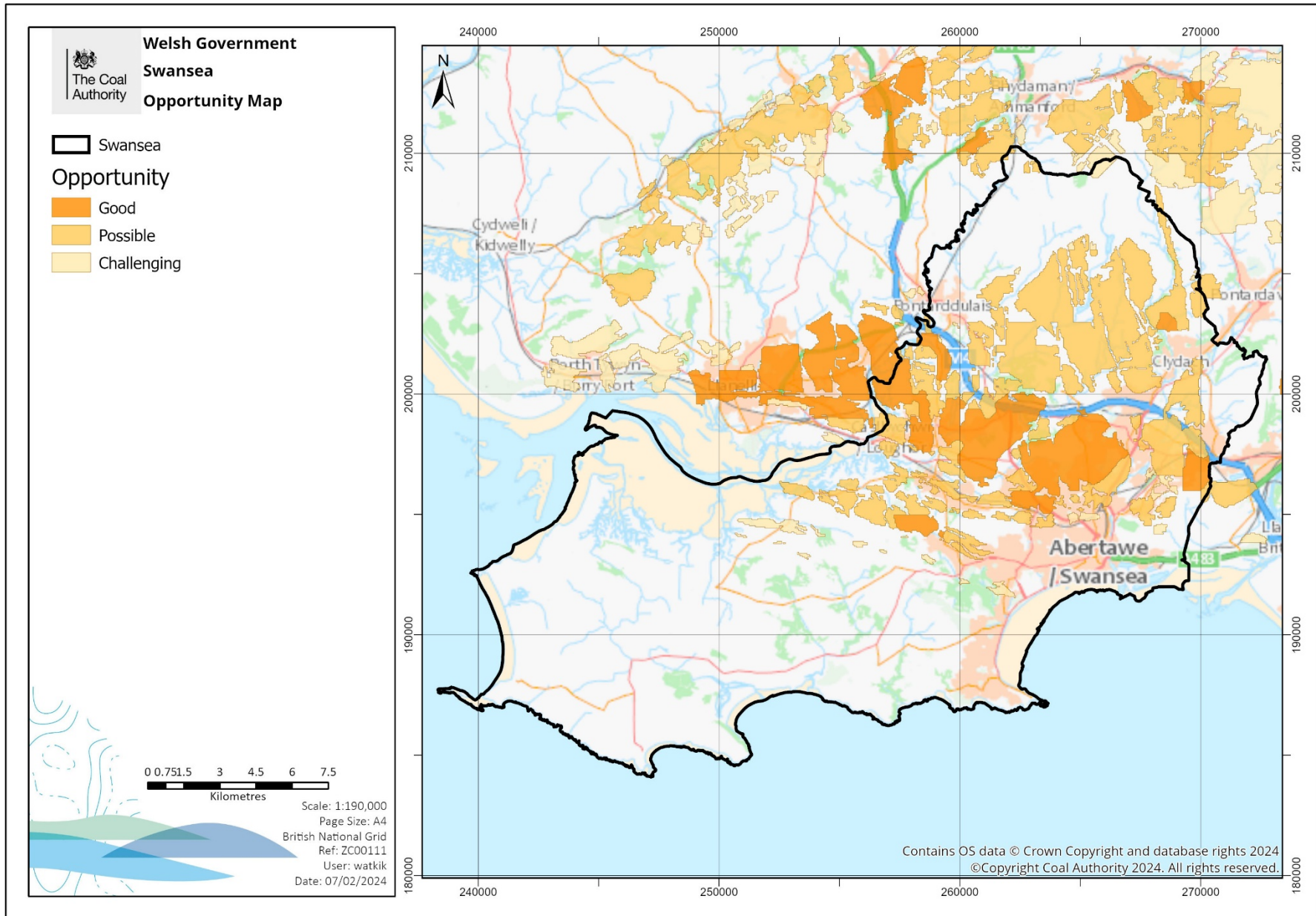


Figure 5.1. Mine water heat opportunities - borehole schemes

5.2 Mine water treatment schemes

Existing Coal Authority mine water treatment schemes where mine water is already either pumped or flowing may in some circumstances potentially offer a lower risk approach to developing mine water heat projects as new drilling and testing of boreholes would not be required.

Proximity to surface development/heat loads will be a dictating factor as to whether the concept is technically and commercially viable for any particular scheme.

This section is only to record that the treatment schemes are there and provide information on the potential and does not imply any guarantee that a heat scheme may be connected to the mine water treatment scheme. Should there be a desire to investigate the potential it is recommended that an early dialogue is opened with the Coal Authority as owners and operators of the mine water treatment schemes.

The only mine water treatment scheme in the Swansea Council is at the extreme northern boundary of the borough. Its details are described below and its location in **Figure 5.4**.

5.2.1 Tan y Garn Treatment Scheme

The Tan y Garn treatment scheme is a gravity fed passive treatment scheme situated alongside the River Cathan upstream of Lon y Felin, and it is situated on the border with Carmarthenshire. The average flow is commensurate with a heat capacity of $<0.1\text{MW}_{\text{th}}$ but as the discharge is over 200 m from the nearest potential heat load. It is considered unlikely to be suitable for playing a part in a mine water heat scheme other than a small-scale scheme.



Figure 5.2. Tan y Garn discharge manhole chamber

5.3 Mine water discharge opportunities

A number of gravity mine water discharges exist in the Swansea area. Many are not monitored for flow rate, water quality, or temperature, some of these may offer heat potential not presented in this report. Gravity-fed discharges generally occur when mine workings connect with the surface, typically via mine entries and boreholes.

The nature of gravity-fed discharges (flow, temperature and quality) will be dependent upon a number of factors including mining type and geometry, the hydrogeological system of the mine workings and rainfall.

Some discharges are likely to be more variable in flow rate and temperature than others but as many of the discharges are not currently monitored for flow rate, water quality or temperature and it is difficult to evaluate with any degree of confidence.

Only two discharges in the Swansea area have some monitoring data (albeit in some cases relatively limited) and are likely to have a heat potential of $>0.5\text{MW}_{\text{th}}$. These are described in the sections below and illustrated on the plan in **Figure 5.4**.

Should a potential heat demand be identified close to one of these discharges or any other discharge in the area, then a more detailed study would be required. Additional investigation and data gathering will likely be required to establish its potential.

5.3.1 Craig-cefn-parc (Cwm Clydach)

The discharge is in to the River Clydach between Clydach and Craig-cefn-parc (**Figure 5.3**). There may be potential small-scale heat users nearby, larger potential heat users may be present in Craig-cefn-parc or Clydach. Further investigations would need to be undertaken to confirm flow rate, temperature, chemistry. Potential heat users and feasibility of transferring the water will also need to be confirmed by a future study.



Figure 5.3. Craig Cefn Parc larger flow rate discharge to Clydach

5.3.2 Dunvant discharges

There are several likely discharges at Dunvant, which discharge into a receiving watercourse(s). Part of the receiving watercourse is culverted, and the exact location(s) of discharge(s) needs to be confirmed. There may be potential heat users within Dunvant. The discharges are on the priority list for coal mine water remediation, although it is uncertain if this will progress and how it could influence heat use at Dunvant. Further investigations would need to be undertaken to confirm flow rate, temperature, chemistry. Potential heat users and feasibility of transferring the water will also need to be confirmed by a future study.

Table 5.1: Mine water treatment schemes and gravity-fed discharges

Name	Flow average L/s	Flow range L/s	Typical temperature °C	Estimated potential heat MW _{th}
Tan y Garn Treatment Scheme	2	<1 to 8	11.1	<0.1
Craig Cefn Parc (Cwm Clydach) Discharge	42 (est)	2 spot readings of 4 and 80	10.6	0.9 to 1.2
Dunvant Discharges	>25 (est)	1 spot reading	11 (est)	>0.5

Note: Potential heat is based on spot readings and / or average flow rate. Potential heat will vary with flow rate, which varies with rainfall. Potential heat at a site may be above or below the estimated value at different stages of the year

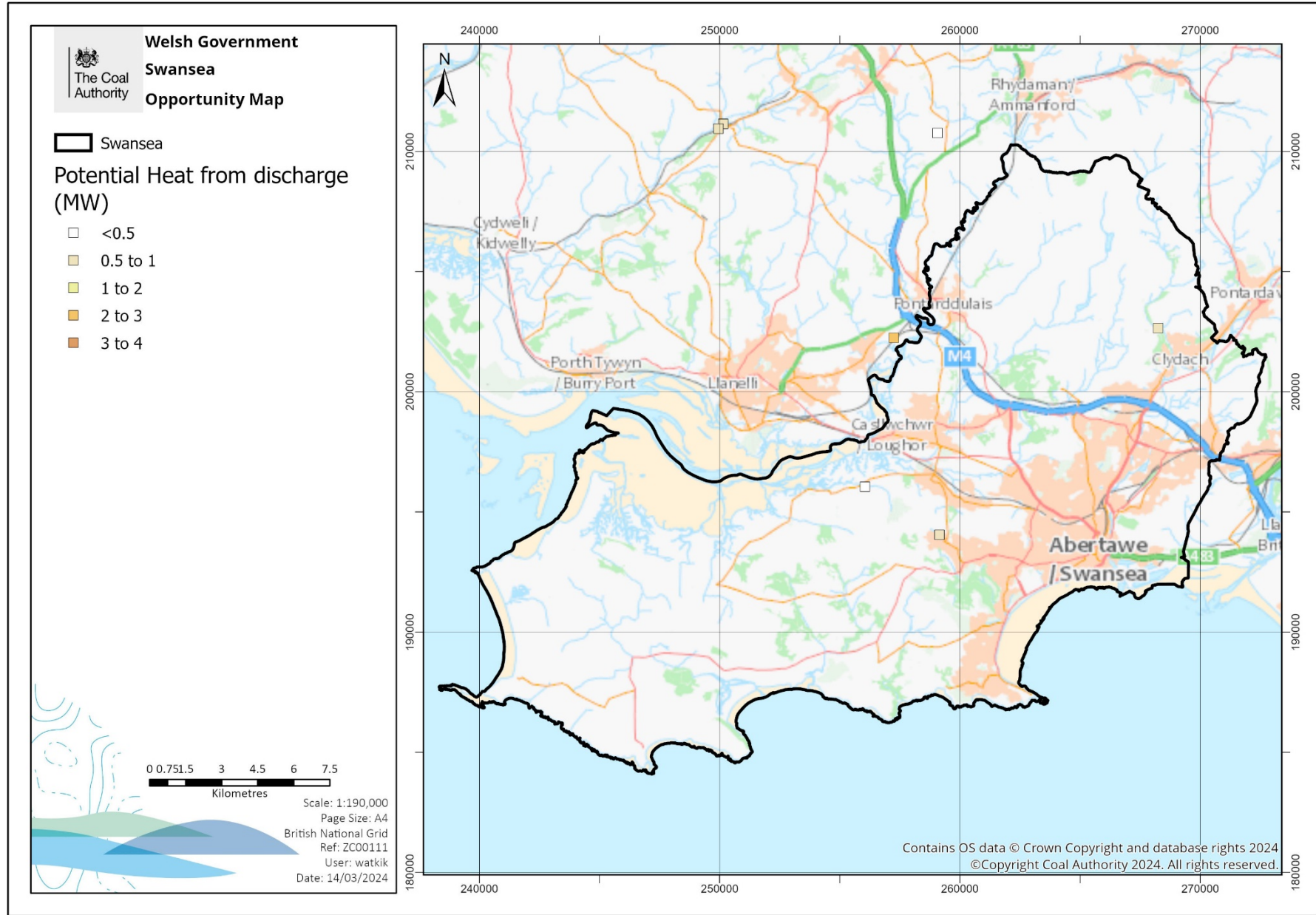


Figure 5.4. Mine water treatment schemes and gravity discharges in Swansea

6 Summary – Swansea Council area

Considerable areas of the northern half of the Swansea Council administrative area are underlain by abandoned coal mine workings. The earlier sections of this report consider the mining and mine water parameters across the whole borough to rank areas by reference to an opportunity classification system (**Figure 6.1**). This summary section overlays the opportunities on populated settlement areas to provide a steer on localities where mining aspects and surface development may present the most likely places to further investigate and potentially deploy mine water heat.

The opportunity areas are set out in **Table 6.1** and their locations in **Figure 6.2**.

Table 6.1. Mine water heat opportunities within the Swansea Council area

No./ Area	Opportunity name	Opportunity type	Category	Potential MW _{th}
1	SW Morriston to E Port Mead /Rhydding/Bryncoch	Borehole scheme	Good	Subject to further testing
2	Fforestfach Industrial Estate	Borehole scheme	Good	Subject to further testing
3	Garnoch Industrial estate	Borehole scheme	Good	Subject to further testing
4	West Gorseinon	Borehole scheme	Good	Subject to further testing
5	Llansalmet east	Borehole scheme	Good	Subject to further testing
6	Plasmarl Industrial Estate	Borehole scheme	Possible	Subject to further testing
7	Llansalmet Enterprise Park	Borehole scheme	Possible	Subject to further testing
8	N Fforestfach Retail Park	Borehole scheme	Possible	Subject to further testing
9	Dunvant No.1 discharge	Discharge scheme	Possible	<0.5
10	Craig Cefn Parc discharge	Discharge scheme	Possible	0.9-1.2

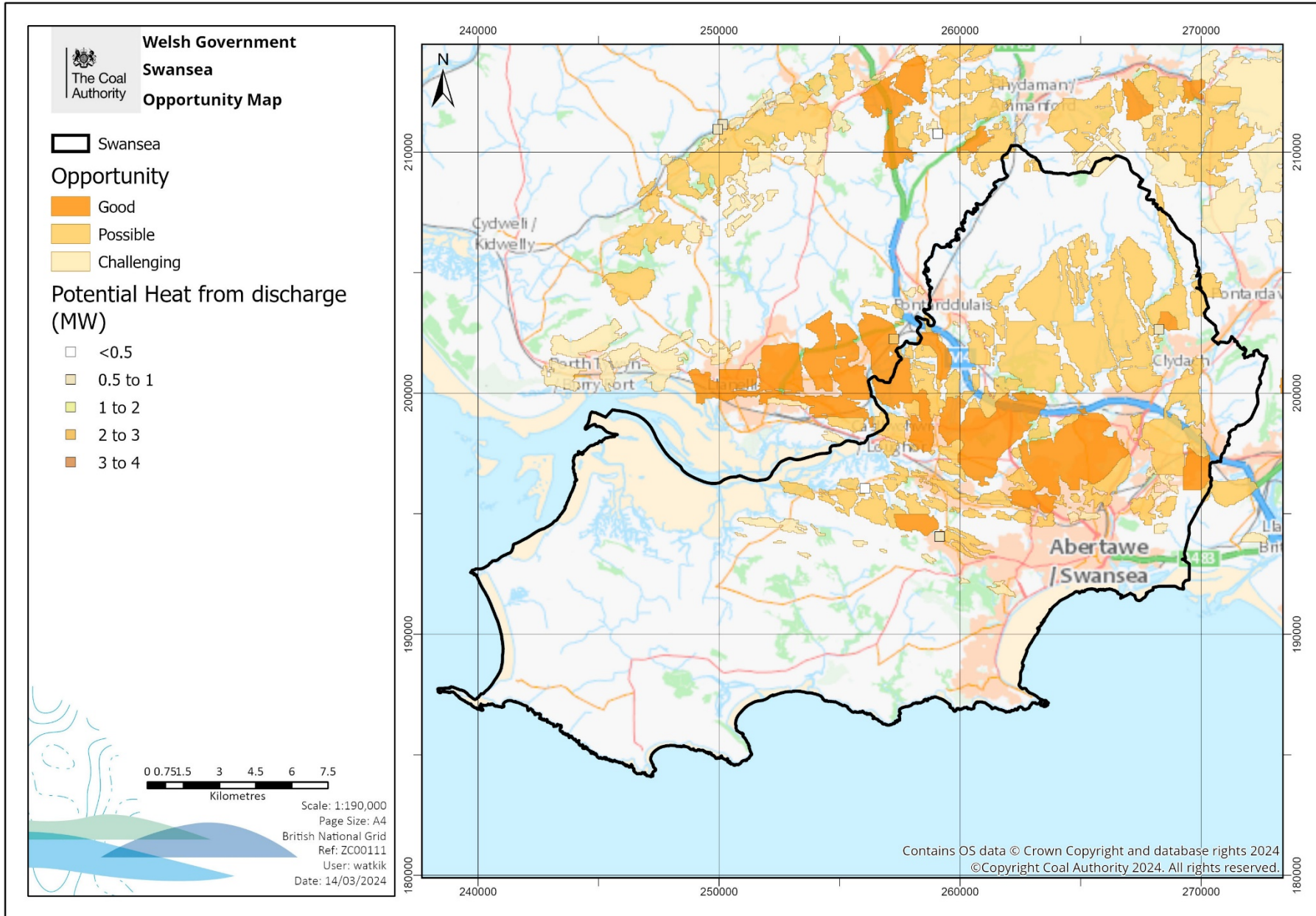


Figure 6.1. Combined mine water heat opportunities map

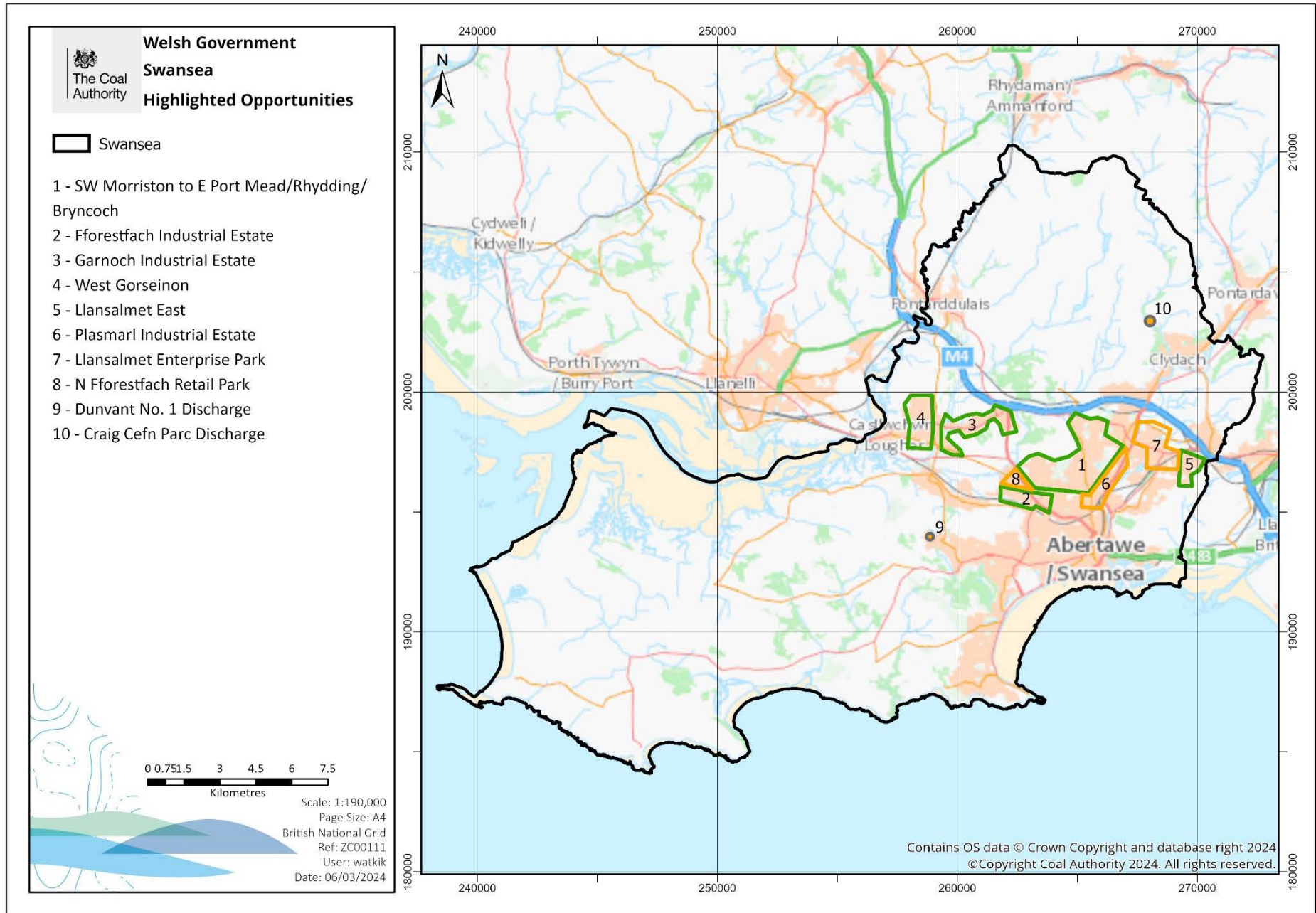


Figure 6.2. Highlighted good opportunities

6.1 Borehole schemes

6.1.1 Good opportunities

In broad terms the main opportunity areas are expected to exist in a 5km wide band to the immediate south of the M4 motorway. The places which may offer the best prospects for development of mine water heat due to the presence of surface development coincident with the opportunity areas are described below and illustrated as **Area 1** to **Area 8** on **Figure 6.2**.

- **Area 1** is a large area to the south west of **Morrison** takes in many developed localities in northeast Swansea city including **Lanngyfelach**, **Mynnydd-bach**, **Tre-boeth** and the eastern fringes of **Port Mead**.
- **Area 2** is an area of multi seam working at depths from shallow (<30 mBGL) to 200 mBGL beneath the **Fforestfach Industrial Estate** which contains many commercial buildings. There may be connections from this area to **area 8** (see possible opportunities below) to the immediate north where the **Fforestfach Retail Park** is situated including Tesco and Next stores.
- **Area 3** is an area of multi seam working stretching from **Penllergaer** to the eastern part of **Gorsienon**. In the centre of this area is the **Garngoch Industrial Estate** which is likely to have significant heat demand. Other major heat loads in this area may be present on eastern fringes of **Gorseinon** including the **Gorseinon Asda Superstore** and other nearby retail outlets.
- **Area 4** is to the west of **Gorseinon** (west of the B4296) where multi seam workings are present. The **Gower College Gorseinon Campus** is situated in this area.
- **Area 5** is situated at the eastern extremity of the borough at **Llansamlet** to the south west of J44 of the M4. With the exception of Talycopa Primary School the potential heat loads are largely residential properties.

6.1.2 Possible opportunities

- **Area 6** contains several commercial properties between the A4067 and the River Tawe and includes the **Plasmarl Industrial Estate**. It is situated adjacent to the immediate south east of Area 1 with workings likely to be connected to area 1 but with only one seam extensively worked hence being ranked possible rather than good. However a scheme could be developed combining areas 1 and 6.
- **Area 7** is situated at the **Llansamlet Enterprise Park** which contains many commercial undertakings and potentially large heat loads. Workings in the northern part of the park are single seam and in the south eastern part two seam hence the opportunity is ranked as possible.
- **Area 8** sits between areas 1 and 2 at the north western part of **Fforestfach Retail Park**. The area is ranked 'possible' due to the less abundant workings than areas 1

and 2. The presence of major retailers such as Tesco, M&S and Dunelm and associated significant heating (and possibly cooling) demand suggests this area may be worthy of more detailed investigation.

6.2 Mine water treatment schemes

While the Tan y Garn treatment system sits just within the borough, its very small size and distance from potential heat loads suggest it is unlikely to have significant potential.

6.3 Mine water discharges

A number of gravity mine water discharges are known to exist in the Swansea area but only two have any monitoring data to enable any assessment of their heat potential.

Ratings have been applied to discharges according to the following criteria:

- Good means heat potential over 0.5MW uncomplicated capture and uncomplicated heat transfer.
- Possible means heat potential over 0.5MW complicated capture or complicated heat transfer.
- Challenging heat potential over 0.5MW complicated capture and complicated heat transfer

The two discharges may be considered as possible opportunities (rather than good opportunities) as the collection of the mine water may present some challenges due to location and topography and the distance to the nearest potential heat loads.

The discharges are:

- Duvant which is located to the north west of Duvant village and is shown as **9** in **Figure 6.2**. Based on the (limited) data available this discharge may have a heat capacity of c. 0.5MW_{th}
- Craig Cefn Parc to the south east of the village of Craig-cefn-Parc and is shown as **10** in **Figure 6.2**. Based on the (limited) data available this discharge is likely to have a heat capacity of c. 0.9 to 1.2MW_{th} .

6.4 Summary and next steps

A number of good, possible and challenging mine water heat opportunity areas have been identified across the Swansea Council region as illustrated in **Figure 5.1**.

While some of the areas are relatively undeveloped, the opportunity areas have been considered against the major developed areas in the borough to seek to identify places where good or possible heat supply opportunities may coincide with significant heat demand. It is suggested that the opportunities covered in this section and listed in **Table 6.1** and shown in **Figure 6.2** are further considered for more detailed study.

The heat potential of the borehole schemes cannot be estimated to any degree of certainty until more detailed and localised study is undertaken. However the fact that those which are classified as good opportunities feature considerable areas of workings which infers a substantial heat potential (>3 MWth).

It is suggested that a survey of the main heat loads, particularly potential large 'anchor' loads such as hospitals or larger public buildings is undertaken in the opportunity areas in **Table 6.1** to establish synergies between potential heat supply and heat demand. This may identify good opportunities to further investigate pilot mine water heat projects through more detailed feasibility work, initially involving desktop studies and subsequent investigative drilling should the potential be attractive.

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