COALBED METHANE EXPLORATION IN SOMERSET. THE CHEW VALLEY, KEYNSHAM & THE MENDIP HILLS

ABSTRACT

This report draws on public information on **coalbed methane** (CBM) exploration in Somerset to highlight the extensive nature of the resource and identify which communities might be impacted by its development. Ninety percent of the current Petroleum Exploration and Development License area was evaluated and reported on by a previous licence holder in 2000. The content of that evaluation is not widely known but is still valid and may have been a motivating factor in the current holder procuring the licences. GeoMet UK's licence relinquishment report is available as a PDF file from the UK Onshore Geophysical Library but without its maps and overlays. This report reproduces those maps from GeoMet's original data and compares them with local administrative units and designations.

Frack Free Chew Valley

16 June 2014

The intention of this report is to draw attention to the possibility of exploration and development of coalbed methane in Somerset using publically available information. The work has been undertaken by Frack Free Chew Valley and is unfunded. Frack Free Chew Valley is a local community group which aims to raise awareness about unconventional gas exploration and development in the Chew Valley area and is a member of the Frack Free Somerset coalition but is not aligned with any political party or environmental group.

Data presented in this report has come from the following sources:

Goodwin, D., 2000, PEDL074 Somerset, Relinquishment report for GeoMet Operating Inc for GeoMet UK Ltd.

Goodwin's report, referred to here as "the GeoMet report", can be downloaded from the UK Onshore Geophysical Library http://maps.lynxinfo.co.uk/docs/Reports/PEDL074.pdf. The report refers to various map overlays which are missing from the electronic document. However both the report and the spatial information on which the overlays are based are available from the National Archives and are copyright the Department of Trade and Industry 2002[1].

http://webarchive.nationalarchives.gov.uk/20121217150421/og.decc.gov.uk/en/olgs/cms/explorationpro/onshore/lic_and_reg/lic_and_reg.aspx

Frack Free Chew Valley has produced an annotated version of GeoMet's report which contains corrections to typographic errors together with reconstructed overlays created from GeoMet's original spatial information. This is included in this document as Annex II.

The use of the GeoMet report and overlays in this report is for information purposes only.

The maps and data are covered by the following copyrights but can be used and distributed for non-commercial information purposes.

DECC says: "This information does not constitute legal, technical or professional advice. Neither the Department nor the licence operator accept any liability for any direct, indirect or consequential loss or damage of any nature, however caused, which may be sustained as a result of reliance upon the information contained in this report." The same goes for Frack Free Chew Valley.

Frack Free Chew Valley, www.frackfreecv.wordpress.com, frackfreechewvalley@gmal.com
Gas Field Free Mendip, www.gasfieldfreemendip.org
Frack Free Somerset, www.frackfreesomerset.org

[1] Thanks to the UK Onshore Geophysical Library for help in locating this information.

Summary and Introduction

The coalition government is keen to promote an American style shale gas revolution in Britain and parts of Somerset have been licensed for exploration and development. Industry interest has focused primarily on coalbed methane (CBM) with shale gas as a secondary possibility. The "great fracking debate" has raged over the past 18 months across Somerset in village halls and in the local and national press. To date no exploratory drilling has taken place despite interest being expressed by the current licence holder, UK Methane, in drilling at Hicks Gate near Keynsham, Compton Martin and Ston Easton. It is also known that a previous licence holder, GeoMet UK, suggested exploration sites near Chew Magna and Hinton Blewett.

This report summaries and makes available the relinquishment report of the previous licence holder GeoMet UK Ltd (PEDL074) with a view to informing local residents of the scale and extent of potential coalbed methane exploration and production in the region. In 2012 Bath and North East Somerset Council (BANES) commissioned the British Geological Survey (BGS) to report on potential problems within BANES regarding hydrocarbon exploration and production but surprisingly BGS did not refer to the GeoMet report or its analysis. This is even more surprising considering that BGS did make reference to the report in its national assessment of CBM potential to the Department of Energy and Climate Change (DECC) in 2010.

GeoMet use a set of spatial criteria to identify the location of suitable coal bearing strata which are at suitable depths, which do not underlie areas that have previously been mined and which do not coincide with urban areas. GeoMet conclude that the prospective and developable area is 108 km^2 which could "accommodate" about 300 gas wells. GeoMet make an estimate of the total gas content but emphasise the high degree of uncertainty.

Of concern to people living in the area will be:

- The spatial extent of the prospective area which impinges on 40 parishes
- The inconsistent use by GeoMet of the urban criteria, which excludes a small number of villages from the prospective area whilst ignoring others. Further the GeoMet map of urban areas is incomplete with many villages missing.
- The shallow depth of the prospective area which includes areas with depths to the base of the coal measures of 500 feet (152m) to 5,000 feet (1,524m).
- The very high number of potential gas wells (300) on a 566m (32 ha) grid.

The government's current proposal to change the law of trespass does not relate to CBM which is covered by the Coal Industy Act 1994. Under this Act CBM operators can already gain subsurface access to the coal measures.

On 9/6/2014 the Prime Minister said in the Western Daily Press that the West Country won't be left behind in economic recovery because among other things:

"We are legislating so that Britain can get the roads and the energy supplies it needs – unlocking our North Sea resources and developing shale gas, so that Britain is less dependent on foreign countries for its resources."

Such an "American style" gas revolution necessitates transformation of entire landscapes into gas fields which in the Somerset case could mean about 300 wells for CMB alone (excluding shale gas) according to CBM specialists GeoMet UK. This would herald whole-scale industrialization of parts of Somerset.

Local residents can only come to an informed opinion about unconventional gas exploration and production within their communities by being properly informed. A knowledge of the extent and density of potential gas wells is fundamental to any discussion on CBM in Somerset but this information has been sadly lacking in an accessible form despite being available in the public domain.

The current licence holder UK Methane will be familiar with the GeoMet report and their stated plans to date have fitted the GeoMet pattern of exploration. Onshore gas development is not included in the Growth and Infrastructures Bill as Nationally Significant Infrastructure (NSI) and planning decisions remain with the local minerals authority. However this status is being kept "under review". Were the government to include unconventional gas as NSI this type of American style development could take place.

Sir Paul Nurse, the President of the Royal Society, has said "Those living in shale gas areas where there might be fracking have a major stake in the decision. They are the ones who will have a big industry moving into their neighbourhoods, and they need to weigh up the disruption and potential risks against the potential economic benefits for themselves locally and for the UK as a whole."

Unconventional Gas Exploration in Somerset and the Chew Valley

The Chew Valley and other areas in the Bristol-Somerset coal fields are covered by petroleum exploration and development licenses (PEDL) which give the license holder the right to explore for and to 'get' petroleum minerals on behalf of the Crown, including shale gas and coalbed methane (CBM).

The current licence holder is UK Methane which holds a 50% share of the licence with Shale Energy plc[2], although it is understood that full ownership may soon pass to UK Onshore Gas Ltd which intends to list on the London Stock Exchange in the near future[3]. The current licence holders also hold the licenses for the northern portion of block ST64 to the south of Midsomer Norton and other areas in Kent and South Wales. Previously the Somerset license was held by GeoMet UK[4] which undertook a desk evaluation of the CBM resource and suggesting locations for prospective test drilling, although it is understood that none took place. Presumably GeoMet did not consider the economics of CBM to be viable in Somerset at the turn of the millennium.

GeoMet UK is a subsiary of GeoMet Inc an American specialists in CBM exploration and development and their license covered Ordnance Survey blocks ST55, ST56, ST65 and ST66 until 1999. GeoMet submitted a licence relinquishment report to the Department of Trade and Industry in 2000.

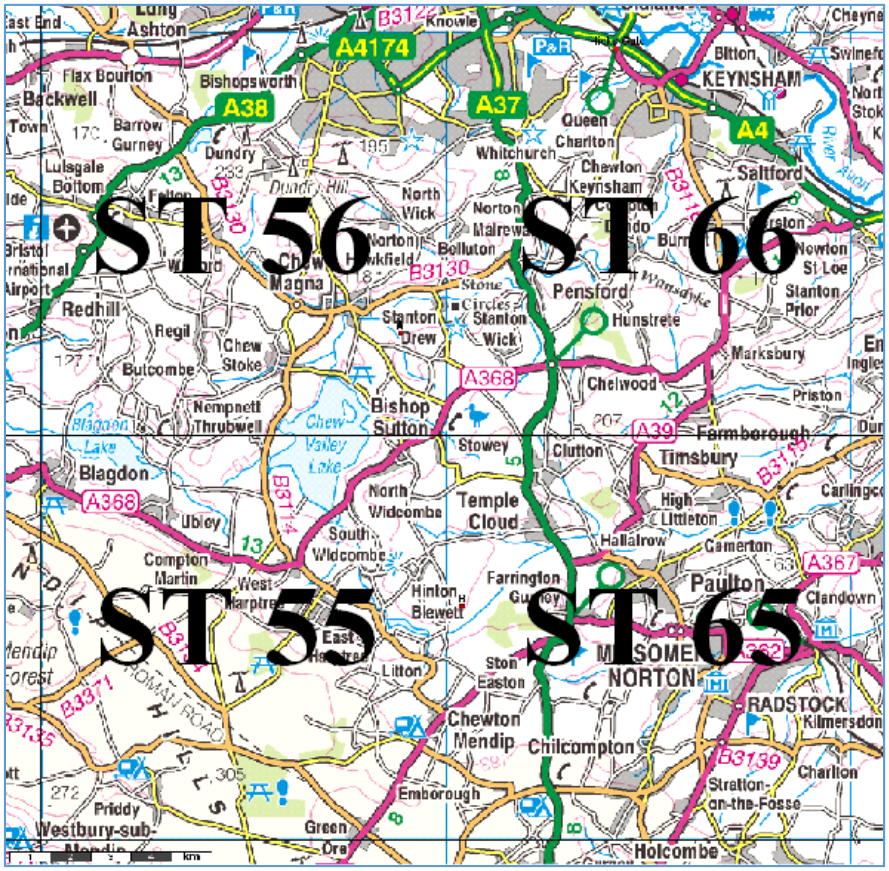


Figure 1 Ordnance Survey blocks that define the GeoMet PEDL area which covers 90% of the UK Methane licenses in Somerset. UK Methane also holds have of block ST 64

[2] The current licenses are numbered PEDL 226, 277, 278.

[3] http://www.thetimes.co.uk/tto/business/industries/naturalresources/article4039802.ece

[4] This licence was known as PEDL 074.

Unconventional gas companies are interested in CBM in Somerset because of the Westphalian Coal Measures associated with the Bristol-Somerset Coalfield, Figure 2.

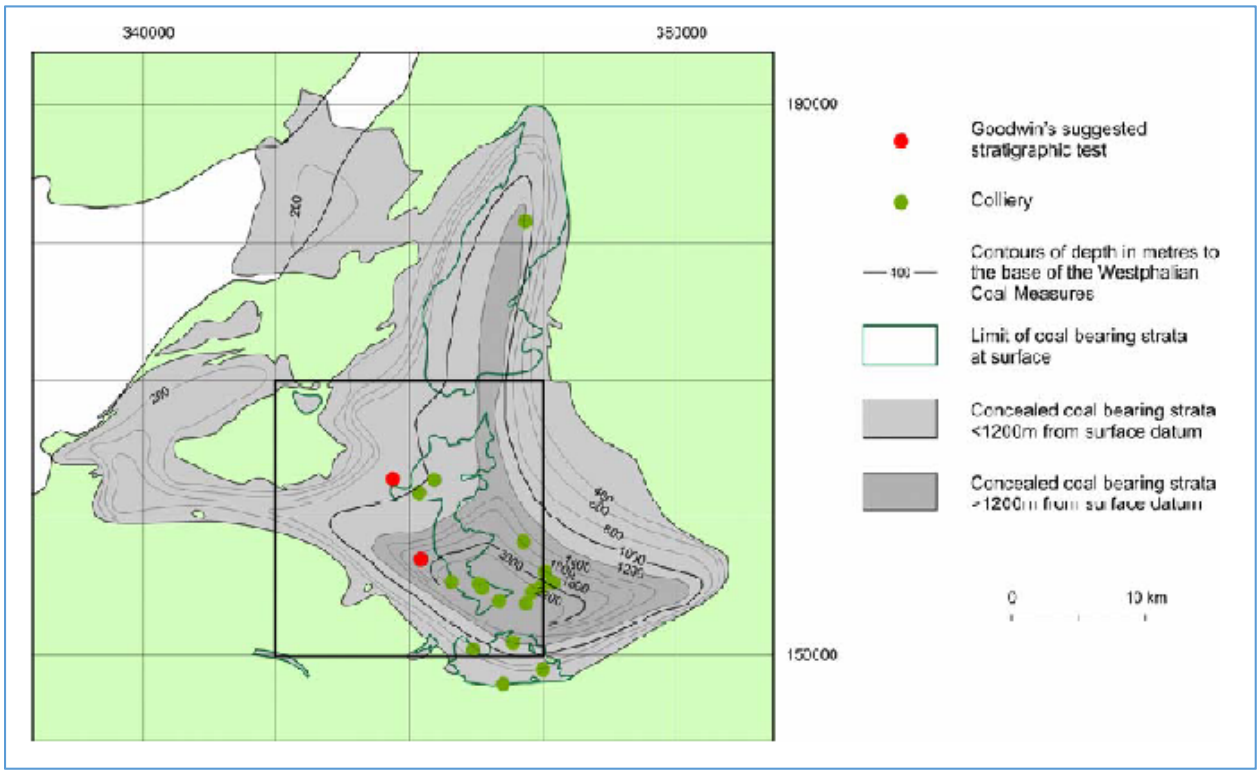
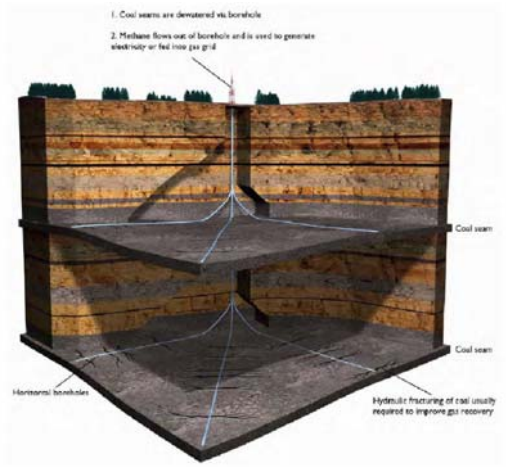
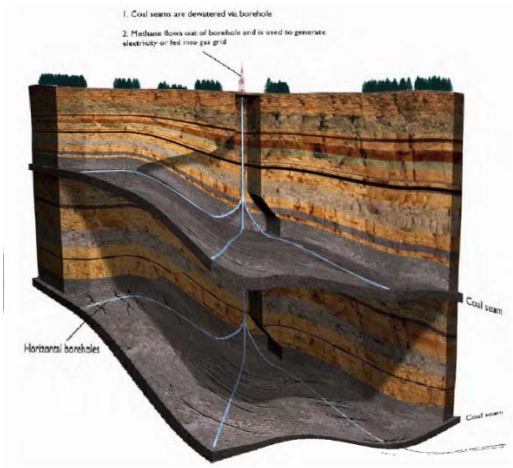


Figure 2 Contours of depth to the base of the Westphalian Coal Measures in the Bristol-Somerset Coalfield, including GeoMet's suggested test sites, DECC 2010.

The local geology, coalbed methane extraction methods and potential environmental impacts are described by Integrale Ltd (2013). In this area the coal bearing strata, or coal measures, form a basin with coal outcropping at the surface at the edge and descending to more than 2,700 m in the centre of the basin. The classic view of horizontal geological strata doesn't apply in this area where the contorted strata and coal seams may be ascending or descending at different rates in every direction.

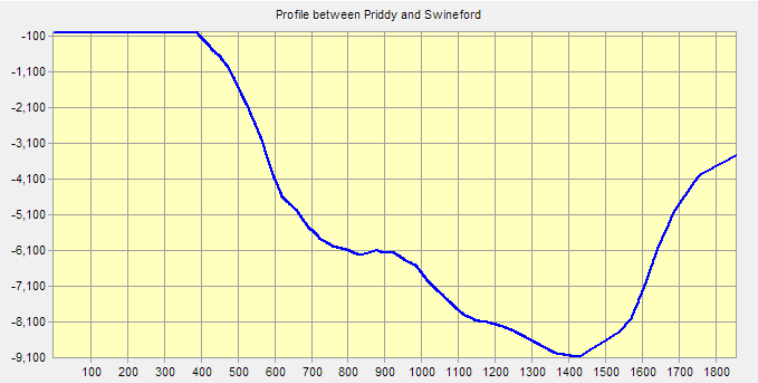


Classic Coalbeds
[Source BGS]



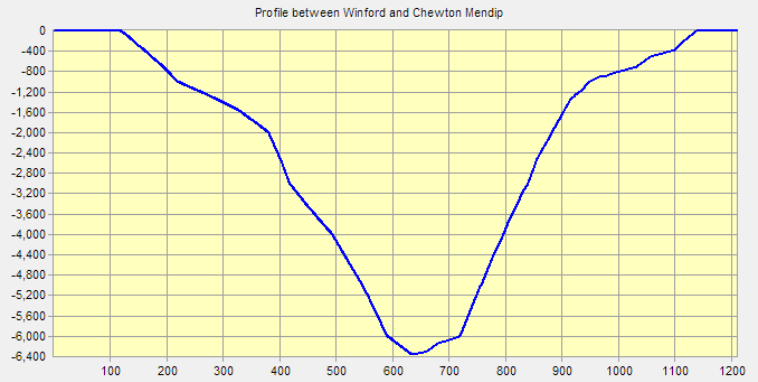
Somerset Coalbeds

Vertical profiles of the depth to the base of the coal measures from Priddy to Swineford and from Winford to Chewton Mendip are illustrated below showing how contorted the coalbeds are.



Profile of the depth of the base of the coal measures between Priddy (on the left) and Swineford (on the right).

Horizontal axis in pixel units = 24 km, vertical axis in feet.



Profile of the depth of the base of the coal measures between Winford (on the left) and Chewton Mendip (on the right).

Horizontal axis in pixel units = 13.5 km, vertical axis in feet.

In late 2012 UK Methane made a planning application to Bath and North East Somerset council to drill a prospective borehole at Hicks Gate near Keynsham but withdrew it saying that it would apply for permission for exploration and production in 2013, although this did not happen and the site is now understood to have been sold and may be developed for another purpose. UK Methane also expressed interest in test drilling at Ston Easton and at Compton Martin but cancelled a meeting with Ston Easton parish council citing corporate reorganisation reasons. To date (June 2014) no further planning applications have been made.

The interest expressed in Hicks Gate, Ston Easton and Compton Martin have been the only public indications by the licence holder of where drilling might take place within the PEDL. However it is known from a DECC (2010) that GeoMet had suggested that two favorable places for test boreholes would be “1.5 km northeast of Chew Valley Lake and 1 km east of Chew Magna” and “about 1.5 km east of Hinton Blewitt”, see Figure 2.

It has been difficult to locate the GeoMet relinquishment report because of the DECC website being reorganized. The report together with its related maps and data have now been obtained from the National Archive. Since 2000 neither the geology nor the state of knowledge on the area has changed so it may be reasonably presumed that the GeoMet report remains valid and should exploration and production proceed that it might do so based on a similar evaluation. Indeed UK Methane’s interest in procuring the licence is probably in part based on the GeoMet report.

The relinquishment report contains a number of typographical errors and is missing its graphical overlays. Frack Free Chew Valley has annotated the report to correct known mistakes and recreated the graphical overlays from the original GeoMet data files. The annotated original report can be found in Annex II.

CBM Resource Evaluation

To identify the prospective area which might be developed GeoMet used the following set of criteria.

The prospective area **excludes**:

- Areas with no coal measures
- Areas with coal measures below 5,000 ft (1,524 m)
- Areas with coal measures above 500 ft (152 m)
- Urban areas
- Mined areas

After applying these criteria GeoMet considers the remaining area the prospective area which might be developed. These prospective criteria have been applied to the GeoMet data obtained from the National Archive and are shown in Figure 3. Areas with no coal measures are shown with green hatching, urban areas are shown as grey, mined out areas as cyan, the depth to the base of the coal measures as black contours and the prospective area in pink. The points A and B are the location of the sites near Chew Magna and Hinton Blewett where GeoMet suggested test boreholes. Note that both of these sites lie directly on the 4,000 foot contour.

GeoMet have used the urban overlay inconsistently by excluding some urban areas but not others.

The conurbation of Bristol, Keynsham, Saltford, Corston and Chilcompton are excluded and the prospective area skirts around Blagdon and Bishop Sutton but all other urban areas in villages are ignored. Whilst Chew Magna, Chew Stoke and part of East Harptree are shown on Figure 3 they are not excluded from the prospective area. Further, many villages are entirely missing from the map as are individual residences and farms. GeoMet state that urban areas occupy 20 km^2 or 5% of the total area whereas their own data indicates it is actually 50.5 $km^{2,}$ or more than 12% of the total - which itself is an underestimate.

Gas content is estimated by GeoMet using available literature and coal rank analysis. Gas content is not considered here.

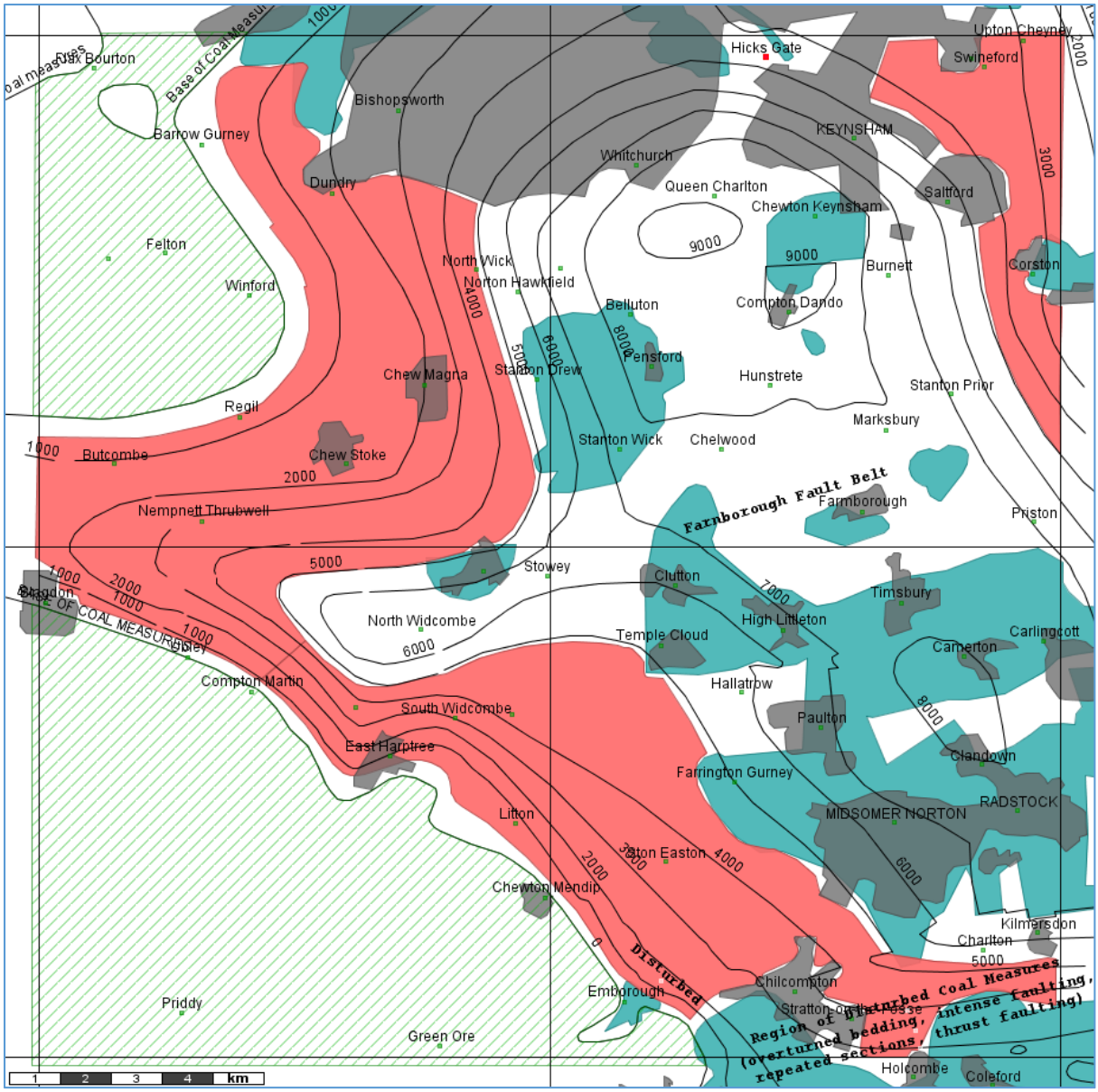


Figure 3 GeoMet prospective area criteria: i) including the base of coal measures between 500' to 5,000' (pink), ii) excluding worked out coal (cyan), iii) excluding (some) urban areas (grey), excluding areas with no coal measures (green hatching), contours of the base of the coal measures are shown as black lines.

GeoMet seriously underestimates the area of urban land associated with villages. Figure 4 shows a more realistic representation of urban areas and isolated buildings using Ordnance Survey data. This illustrates that rather than just two or three villages being located in the prospective are there are actually eighteen with more in close proximity.

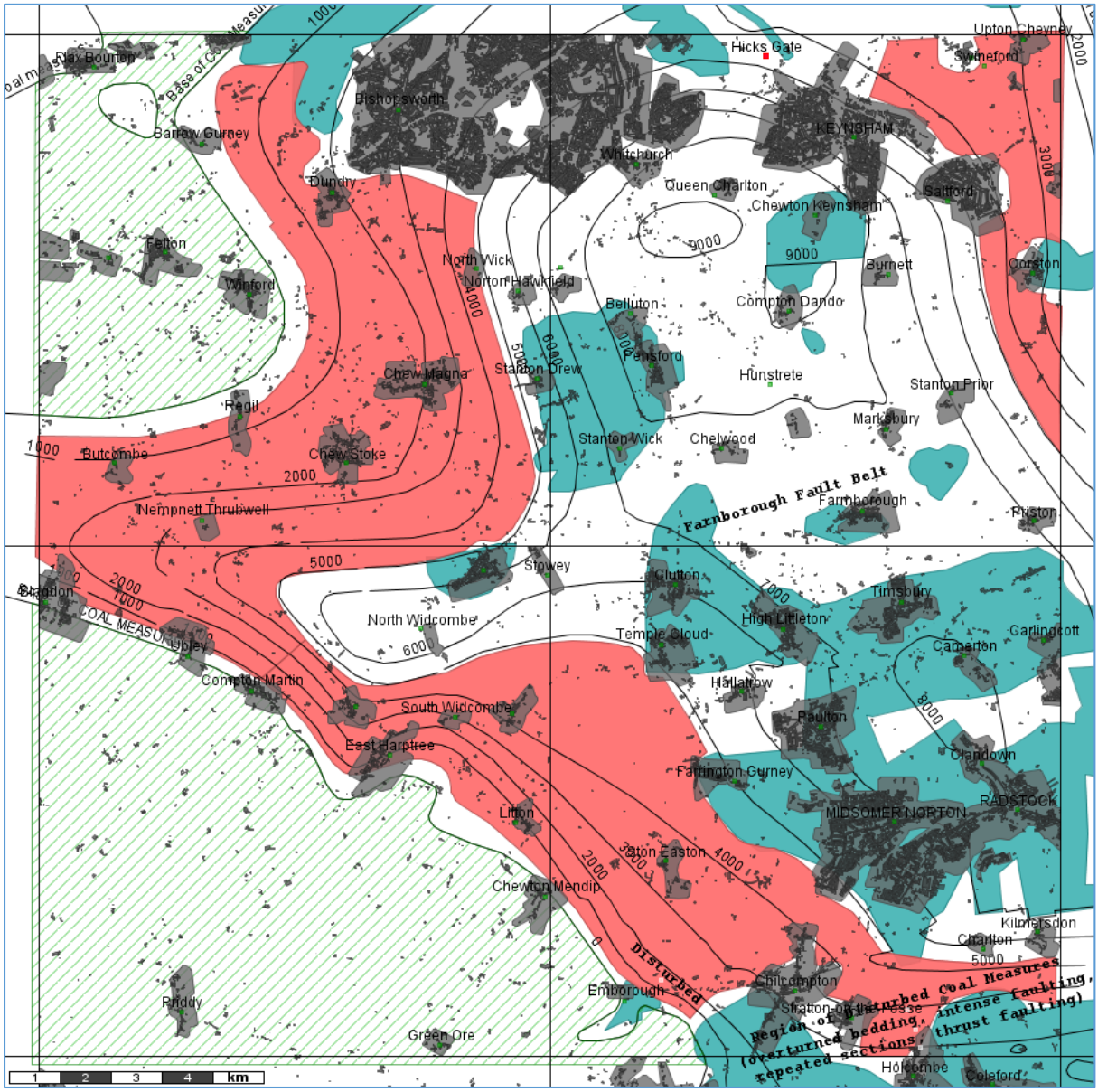


Figure 4 GeoMet prospective area but with a more realistic urban area layer in grey (Ordnance Survey)

GeoMet divides the prospective zone into three sub-areas, shown in Figure 5 and the table below:

Name	Location	Area km^2
Area 1	Keynsham	14
Area 2	Chew Magna	54
Area 3	Hinton Blewett	40

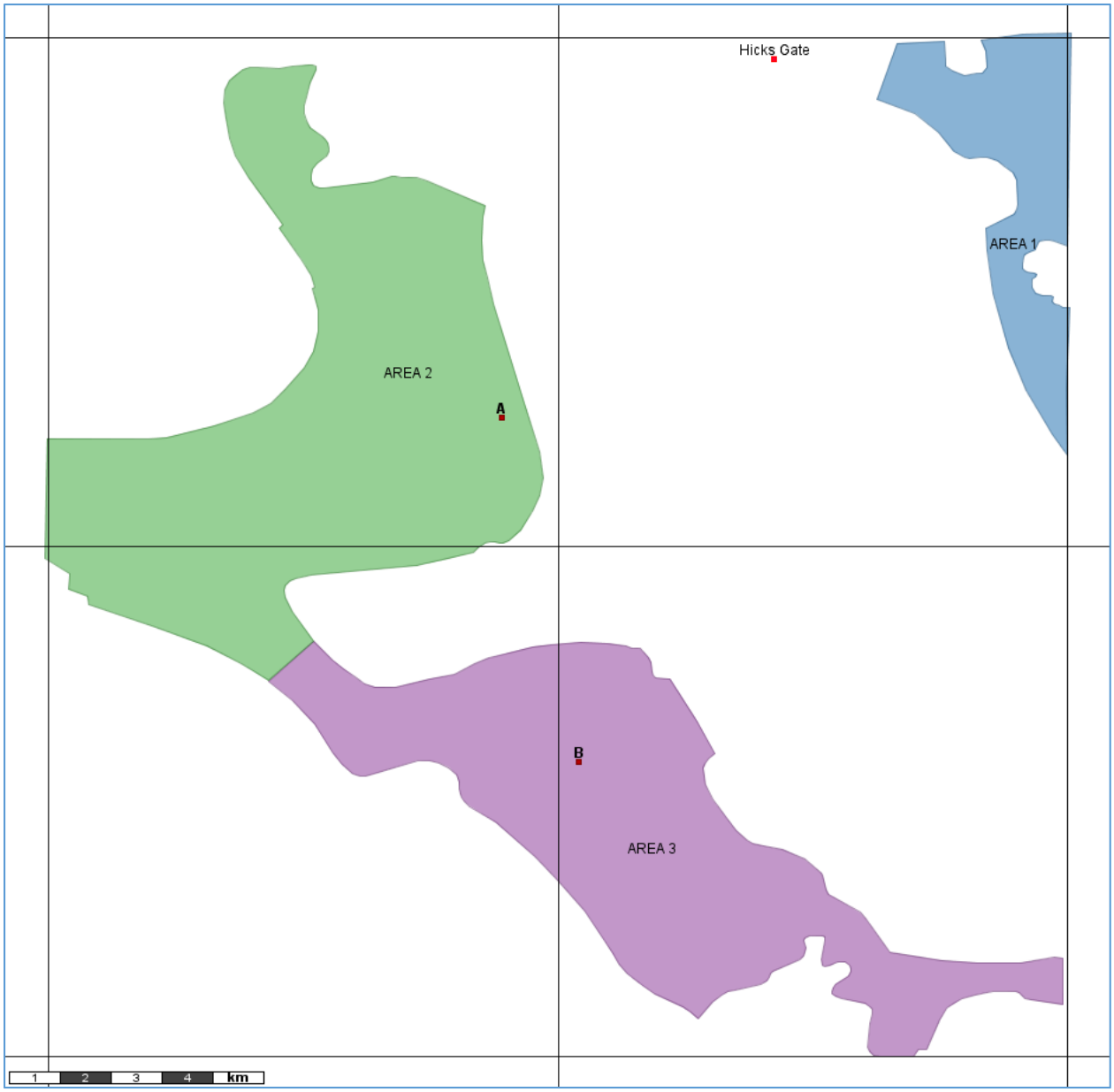


Figure 5 GeoMet prospective sub-areas

Based on a well spacing of one well per 32 hectares[5] GeoMet calculated the maximum number of wells in each of the three sub-areas and estimates that they can "accommodate" 40, 168 and 125 wells in Areas 1, 2 & 3 respectively (sub-area size in km^2 x 100 / 32). One well per 32 hectares is equivalent to a horizontal well spacing of 566m. GeoMet summarises by saying that the "*Maximum number of 700-5,000 ft wells at full development of prospective acreage is about 300*." [6]

Taking this at face value it is possible to lay a grid of points with a 566m spacing over the prospective area to represent a hypothetical but indicative distribution and location of wells at the "full development of prospective acreage". Removing locations that are within the village boundaries and in the lakes indeed results in a distribution of 297 potential well locations, Figure 6.

[5] Halliburton (2009) confirms that CBM wells are normally configured on a grid layout with typically spacing of 40-80 acre, or 16-32 hectares. √32 = 5.66. 5.66 x 100 = 566m.

[6] Note that Geomet clearly state elsewhere that the minimum depth of the prospective area is 500 feet not 700 feet.

Halliburton (2009) noted that industry trials had successfully used horizontal multilateral drilling to reduce the number of wells by a factor of about four (to approximately a 100 ha spacing). However this does not take into account the complex, faulted and contorted geology of Somerset as highlighted by Integrale (2013). Further, the Australian example given in the Annex shows that production CBM gas fields continue to use a dense network of wells, in that case a 56 ha spacing (750m).

The GeoMet data layers have a number of spatial inconsistencies and some layers that should match together do not, for example the boundary of the prospective area should be coincident with the 5,000 foot contour. To make a more consistent dataset FFCV have taken the GeoMet contours of the base of the coal measures and re-interpolated the data to create a set of consistent data for analysis. The contour data were used to create a triangulated irregular network (TIN) from which a regular grid of values were interpolated. This was then used to generate a more consistent prospective area map based on GeoMet's criteria.

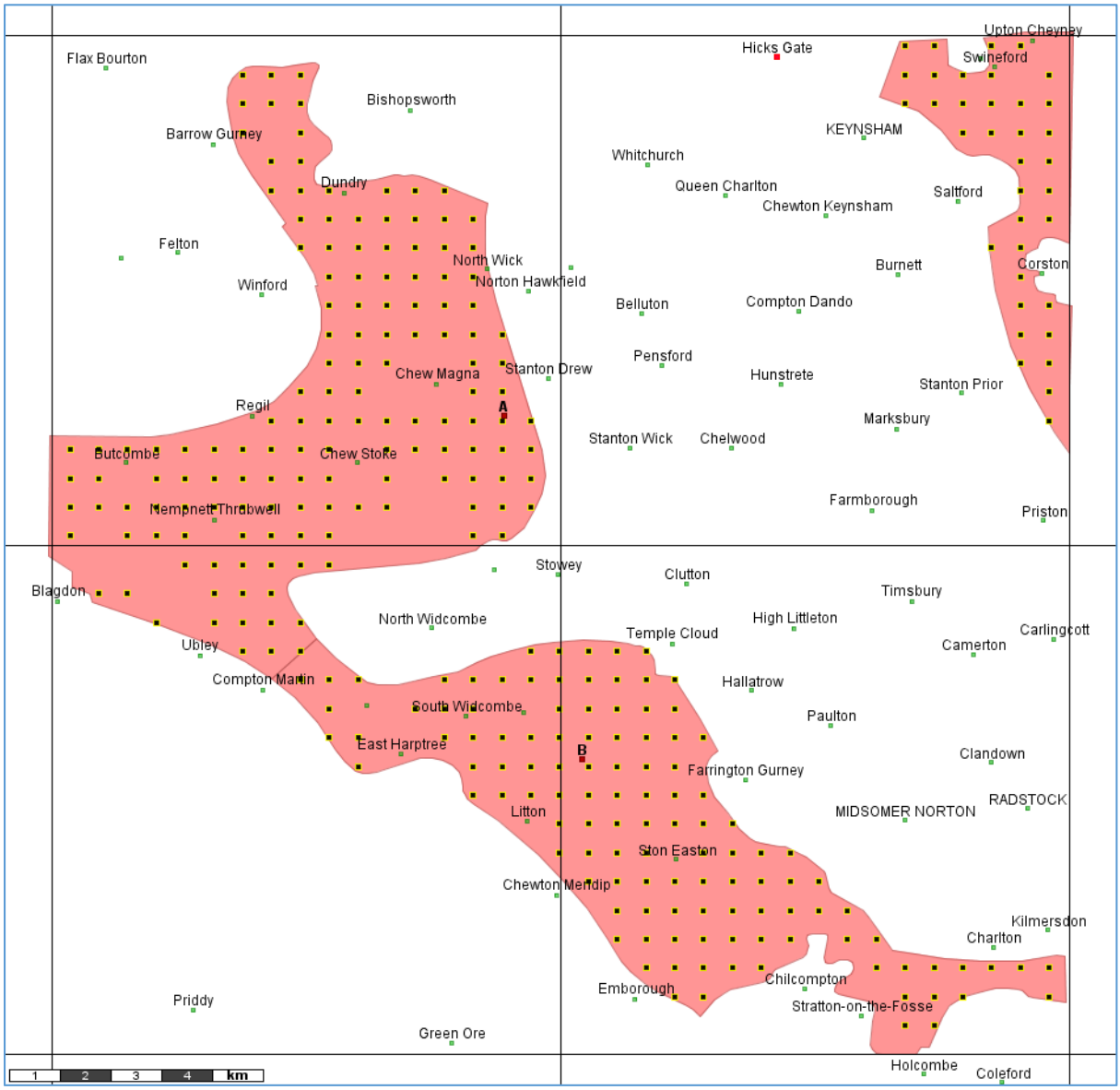


Figure 6 An arbitrarily located 566m grid overlaid onto the GeoMet prospective area showing a hypothetical "full development of the prospective acreage"

Which Parishes and Constituencies would be affected by full development of the prospective acreage?

The parishes and constituencies which would be affected by such a development are illustrated below in Figure 7.

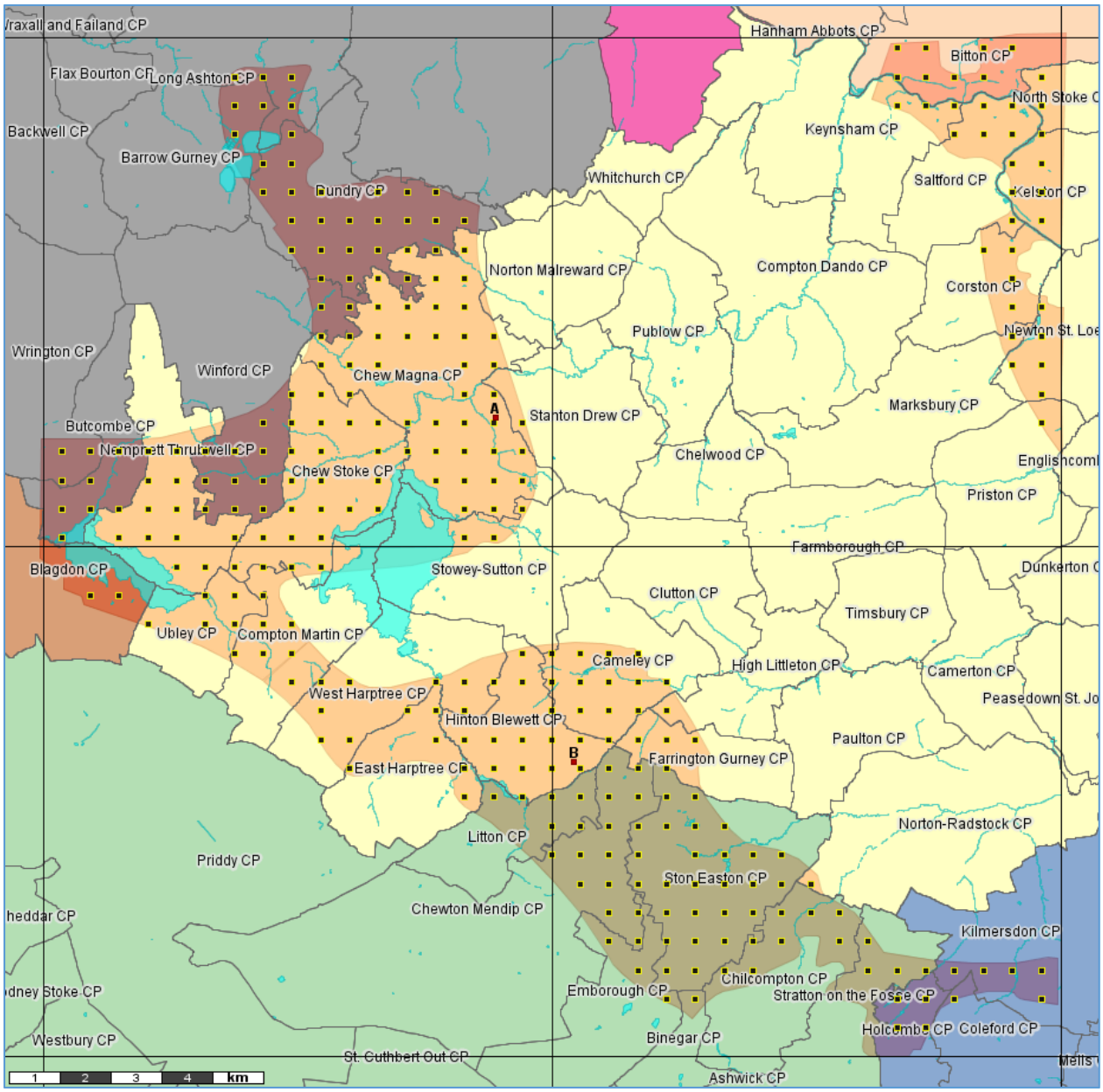


Figure 7 Constituencies and Parishes in relation to the grid of hypothetical wells at the density specified by GeoMet

The forty parishes this may impact and the worst case number of potential wells in each is given below in Table 1 in descending order.

Table 1 Parishes effected by a "full development of prospective acreage"

Parish Name	Potential Number of Wells
Chew Magna CP	38
Ston Easton CP	26
Dundry CP	24
Chew Stoke CP	23
Hinton Blewett CP	14
Cameley CP	13
Chewton Mendip CP	13
Nempnett Thrubwell CP	13
Winford CP	11
Chilcompton CP	8
Bitton CP	8
Compton Martin CP	7
West Harptree CP	7
East Harptree CP	7
Ubley CP	6
Saltford CP	6
Kelston CP	6
Butcombe CP	6
Kilmersdon CP	5
Litton CP	5
Newton St. Loe CP	5
Long Ashton CP	4
Corston CP	4
Emborough CP	4
Holcombe CP	4
Stratton on the Fosse CP	4
Wrington CP	3
Keynsham CP	3
Stowey-Sutton CP	3
Barrow Gurney CP	3
Farrington Gurney CP	3
North Stoke CP	2
Blagdon CP	2
Norton-Radstock CP	1
Binegar CP	1
Marksbury CP	1
Coleford CP	1
High Littleton CP	1
Priston CP	1
Stanton Drew CP	1

The potential well count by constituency is given in Table 2.

Table 2 Constituencies effected by a "full development of prospective acreage"

Constituency	Potential Well Count
North East Somerset	165
Wells	61
North Somerset	51
Somerton and Frome	10
Kingswood Borough	8
Weston-Super-Mare	2

Impact on Designated and Agricultural Areas

If such a "full development of prospective acreage" were to take place on this well spacing then:

- Potentially 174 wells would be located within the Greenbelt, occupying about 1.74 square km
- Potentially 62 wells would be located within the Mendips Area of Outstanding Natural Beauty, occupying 0.62 square km
- On the basis of 1 hectare of land lost per well this would represent a loss of approximately three square kilometres, most of which is currently productive agricultural land. This would be augmented by an intensive network of gas pipelines and other infrastructure.

Surface Hydrology and Water Resources

The study area covers nine main hydrological catchments with the rivers Chew, Wellow, Cam, Conygre and Mells draining into the Avon; the Yeo and Land Yeo draining to the Severn and the area marked Nine Barrows draining into the river Axe and swallow holes, Figure 8. This figure also shows the distribution of hypothetical CBM wells specified by GeoMet.

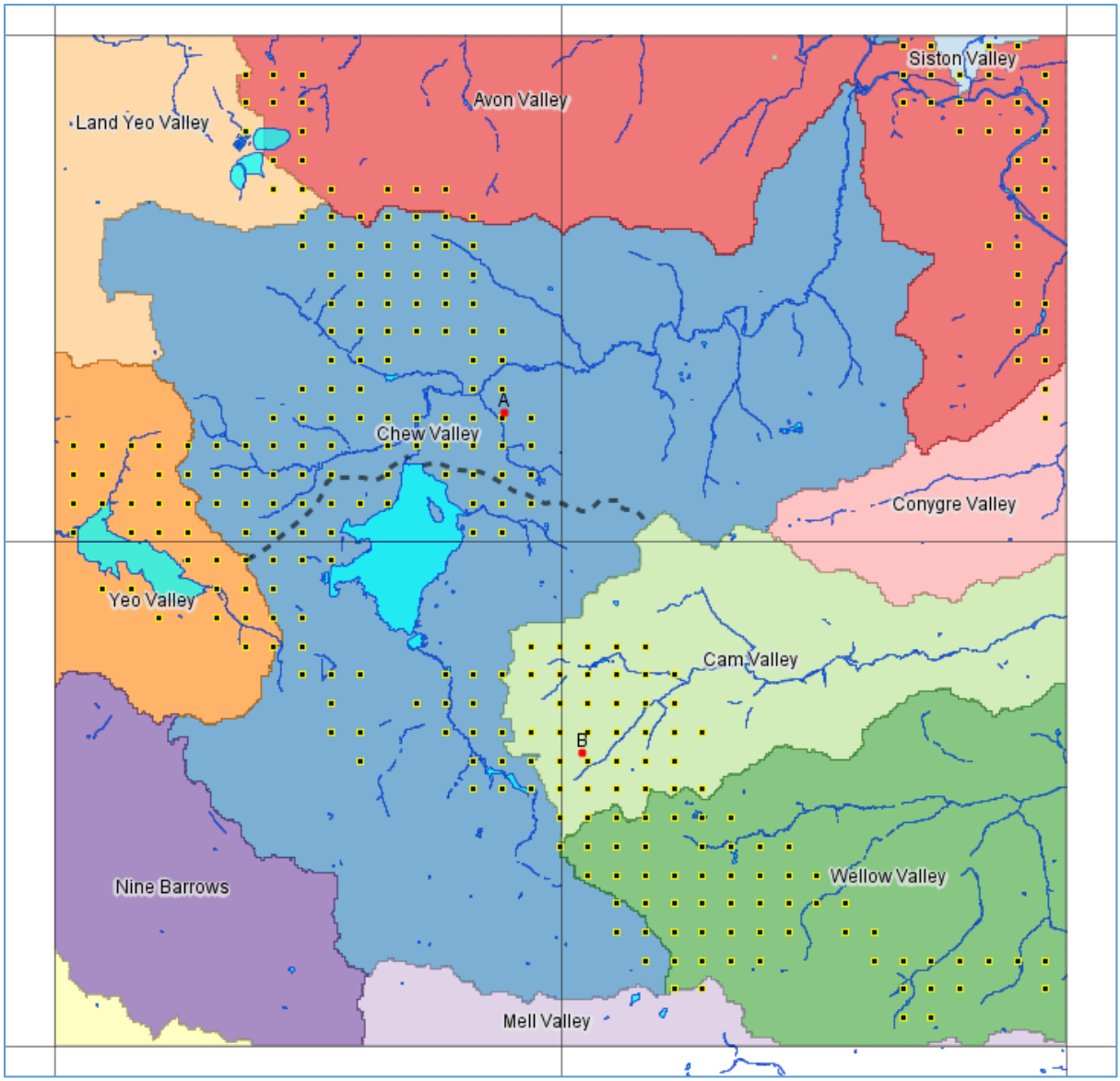


Figure 8 Major drainage catchments of the licence area. Suggested GeoMet test wells marked as A and B.

The dotted line above the Chew Valley Lake is the division between those areas that drain into the lake to the south and those which drain into the Chew River below the dam to the north. The majority (about 73) of potential wells in Chew Magna parish drain into the river below the dam.

The potential number of gas wells per catchment area is given below in Table 3.

Table 3 Potential number of gas wells per catchment area.

Name	Potential No Wells
Chew Valley	121
Wellow Valley	56
Avon Valley	46
Cam Valley	35
Yeo Valley	30
Land Yeo Valley	4
Conygre Valley	2
Siston Valley	2
Mell Valley	1

The surface drainage of the areas occupied by the location of approximately 70 of these hypothetical wells drain into either the Chew Valley, Litton or the Blagdon reservoirs.

Of the locations where test drilling has been proposed:

- Ston Easton drains into the Wellow Valley to the Avon
- Part of Hinton Blewett drains into the Chew Valley above and to the lake, the other part drains into the Cam Valley
- Compton Martin drains into either the Chew Valley or the Blagdon reservoirs
- The site suggested in Chew Magna parish drains into the Chew below the reservoir dam
- Hicks Gate drains into the Avon

Subsurface Drilling

Access to surface drilling sites, whether for exploration or production, requires permission of the land owner although the operator can apply through the Secretary of State to the courts to attempt to gain access. DECC (2014) says that *"In practice, we expect a court is always likely to grant access because granting access to enable these projects to take place would be expedient in the national interest"*. Currently permission to drill across a sub-surface boundary also requires the permission of the land owner whose boundary is being crossed, although the government is undertaking a consultation with a view to change the law of trespass to allow drilling across boundaries below 300m depth. However, for coalbed methane the Coal Industry Act 1994 already enables operators to drill within coal fields without the land owner's permission.

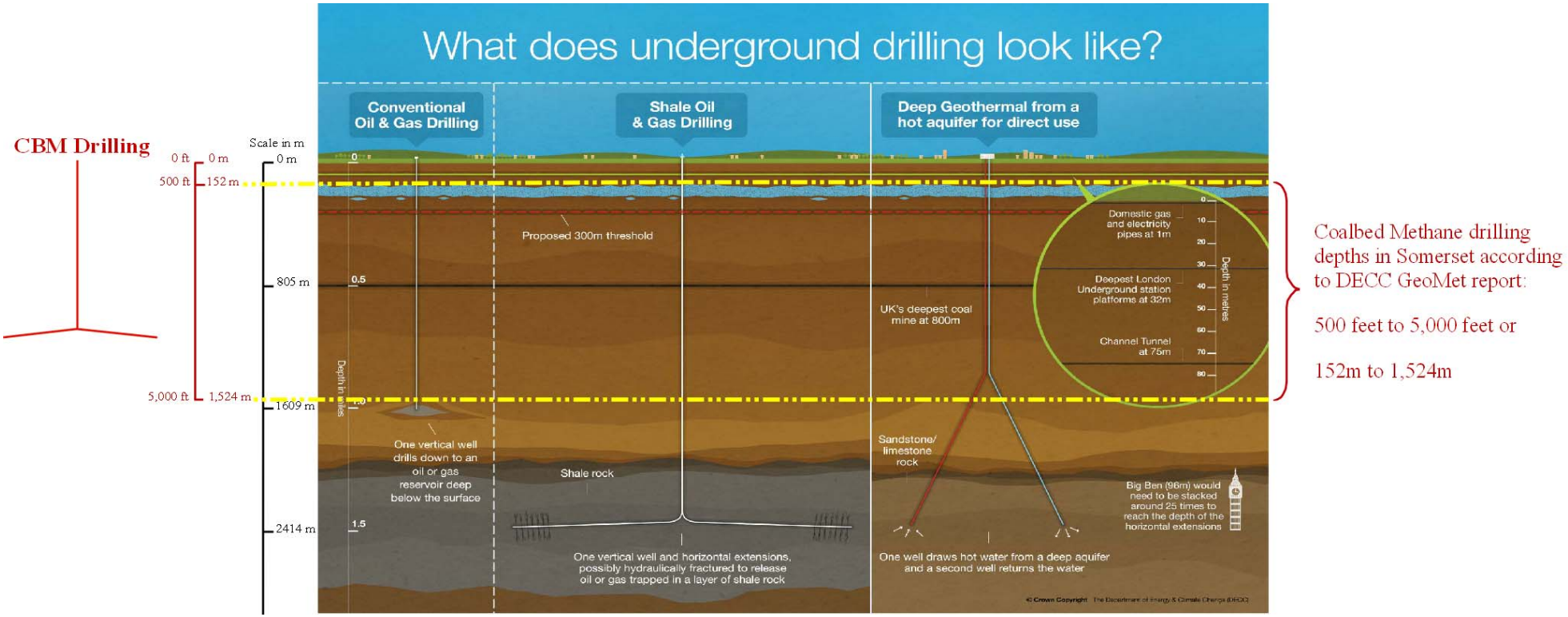


Figure 9. DECC published the above graphic in their consultation document on changing the law of trespass to allow subsurface drilling without the owner's permission below 300m, arguing that the owner has little use for the land at that depth and will not notice activities beyond 300m. They further argue that "these proposals would only apply from 300 metres down. Any hydraulic fracturing would only occur at far greater depths of 1.5 kilometre (around 5000ft) or more". The graphic uses inconsistent units with metres to describe the depth of infrastructure such as the Channel Tunnel and Big Ben but miles to show the full range of depth to shale formations. Coalbed Methane is not covered by these proposals because the operator would already have the right to drill under property through the Coal Industry Act 1994. However, according to the GeoMet report the CBM prospective area would cover coal measures from 152m to 1,524m depth (between the yellow lines in the annotated graphic above), or from half the depth of the trespass threshold up to the minimum quoted by DECC for fracking to occur, 1.5km or "around 5,000 feet".

Conclusions

- The GeoMet report lifts the lid on the scale, extent and location of potential CBM development in Somerset and helps to identify and rank those communities that are at risk of industrialisation.
- Most residents are unaware of the relationship between their communities and the CBM resource. Without knowing the complex spatial nature of the prospective area it is impossible for local communities to make any kind of informed assessment of unconventional gas development in the region.
- Despite all of this information being in the public domain it has not been readily accessible by the public.
- This pattern of development may not happen in practice but the government is in the process of creating an enabling environment for gas companies to explore for and extract the gas resource, build connective infrastructure, keeping under review the option to include unconventional gas as a Nationally Significant Infrastructure which could override local planning decisions, favouring unconventional gas over other energy sources and changing the law of trespass. Unless the Government specifically rules out gas exploration and development in sensitive areas, such industrialization cannot be ruled out.
- UK Methane are likely to have valued the resource in a similar fashion to GeoMet and will try to attract investment on that basis.
- GeoMet seriously underestimates the urban area despite it being one of the main criteria to define the prospective area The prospective area is therefore overestimated and the resource is likely to have been overvalued. However the proposed change in trespass law may simply circumvent this criteria.
- GeoMet's prospective and "developable" area is based on a minimum depth of the base of the coal measures of 500 feet (152 m) and a maximum depth of 5,000 feet (1,524 m). This is a very shallow minimum depth and ten times less than that quoted by government ministers when talking about shale gas fracking. It is about half the depth the government is considering setting as the trespass threshold.
- GeoMet's two proposed drilling sites are directly on the 4,000 ft base of coal measures contour. This same contour passes near UK Methane's proposed sites at Hicks Gate and through the parishes of Compton Martin and Ston Easton where UK Methane expressed interest in drilling. If this is an exploration criteria then applications for exploration drilling might be expected to occur in one or more of the following parishes along that contour (expression of interest has already occurred in those highlighted):

    - Holcombe
    - Stratton on the Fosse (unlikely)
    - Chilcompton (unlikely)
    - Ston Easton
    - Chewton Mendip
    - Hinton Blewett
    - West Harptree
    - Compton Martin
    - Ubley
    - Chew Stoke
    - Chew Magna
    - Dundry
    - Keynsham

    - Corston
    - Newton St Loe
- The proximity of such a large concentration of gas wells to major potable water sources on which hundreds of thousands of people rely may be unwise.
- The impact on local communities of traffic, noise, light and air pollution would be substantial.
- Increased gas prices since 2000 may make exploration of CBM in Somerset more likely because of changed economic circumstances. Conversely in the USA the Environmental Protection Agency (EPA) concluded in 2013 that low gas prices in the USA: "*For new projects, EPA reached the following findings: (1) CBM projects do not generally appear economically viable at present, and for many development opportunities, for substantial periods into the future, and (2) discharge requirements would further delay these projects*‟ *economic viability".* The UK may therefore represent a more favourable investment opportunity for gas companies than the USA.
- Knowledge of the possible spatial distribution of the CBM resource in relation to the landscape, the road network, surface water features, urban areas and population distribution offers the opportunity to model the likely impacts of noise, air, light and atmospheric pollution on the environment and residents, including the negative social return on investment.

References

DECC, 2010, The unconventional hydrocarbon resources of Britain's onshore basins – coalbed methane (CBM), Department of Energy & Climate Change

DECC, 2014, Underground drilling access, Consultation on proposal for underground access for the extraction of gas, oil or geothermal energy.

EPA, 2013, Economic analysis for existing and new projects in the coalbed methane industry, United States Environmental Protection Agency report 820-R-13-006

Goodwin, D., 2000, PEDL074 Somerset, Relinquishment report for GeoMet Operating Inc for GeoMet UK Ltd. Published by DECC.

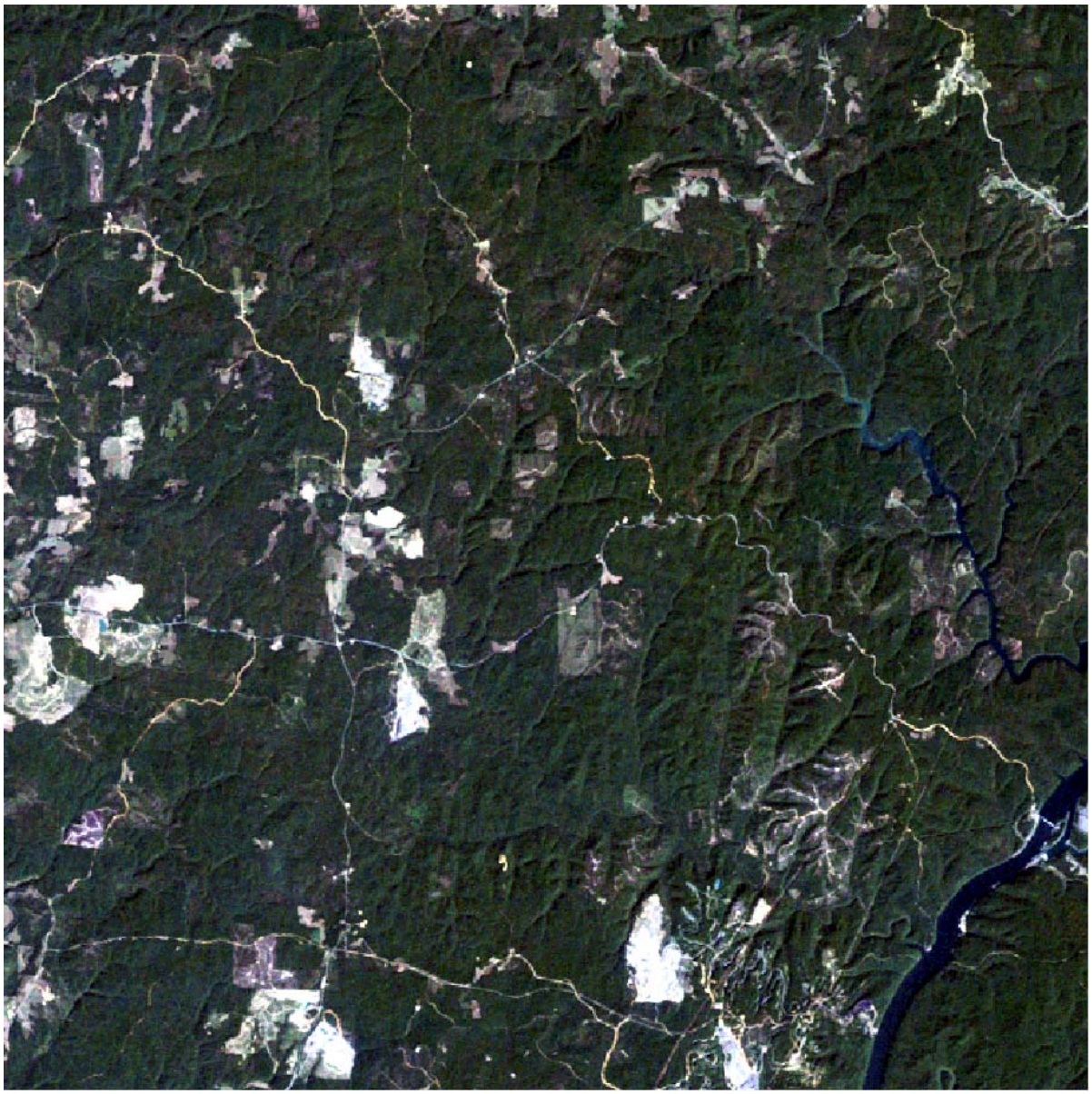
Halliburton, 2009, Production Enhancement, Coalbed Methane Development, http://www.halliburton.com/public/pe/contents/Papers_and_Articles/web/A_through_P/h03493.pdf

Integrale, 2013, Unconventional Gas Exploration & Exploitation in Somerset & Mendip

Annex I

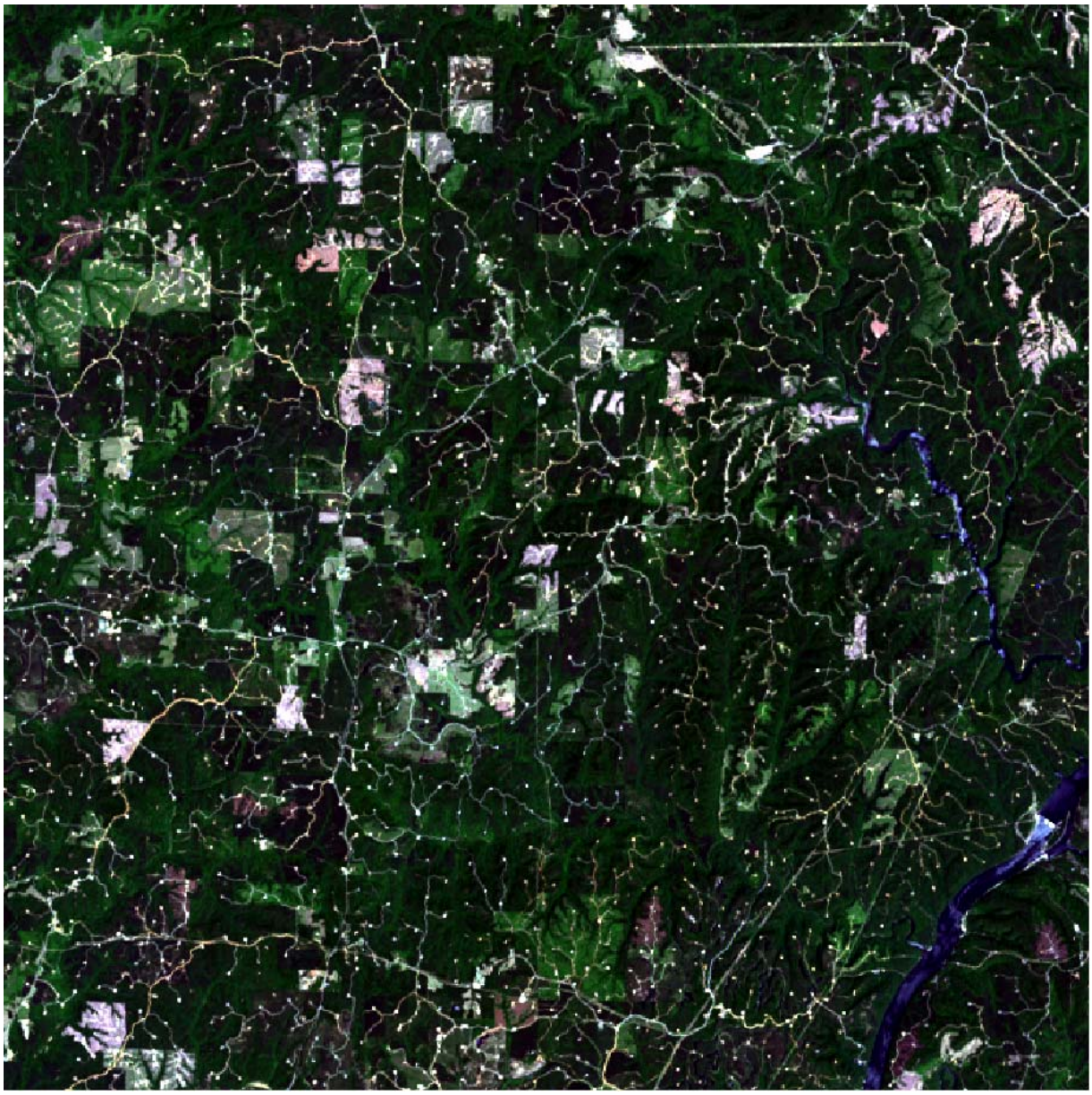
For comparison the satellite images below are of the development of a coalbed methane gas fields in the USA and Australia.

GeoMet Inc has been one of the main developers of coalbed methane in the National Forest of Black Warrior Basin, Tuscaloosa County in Alabama, USA. The 20 km by 20 km block in the satellite image below shows the distribution of coalbed methane gas wells and connecting roads.



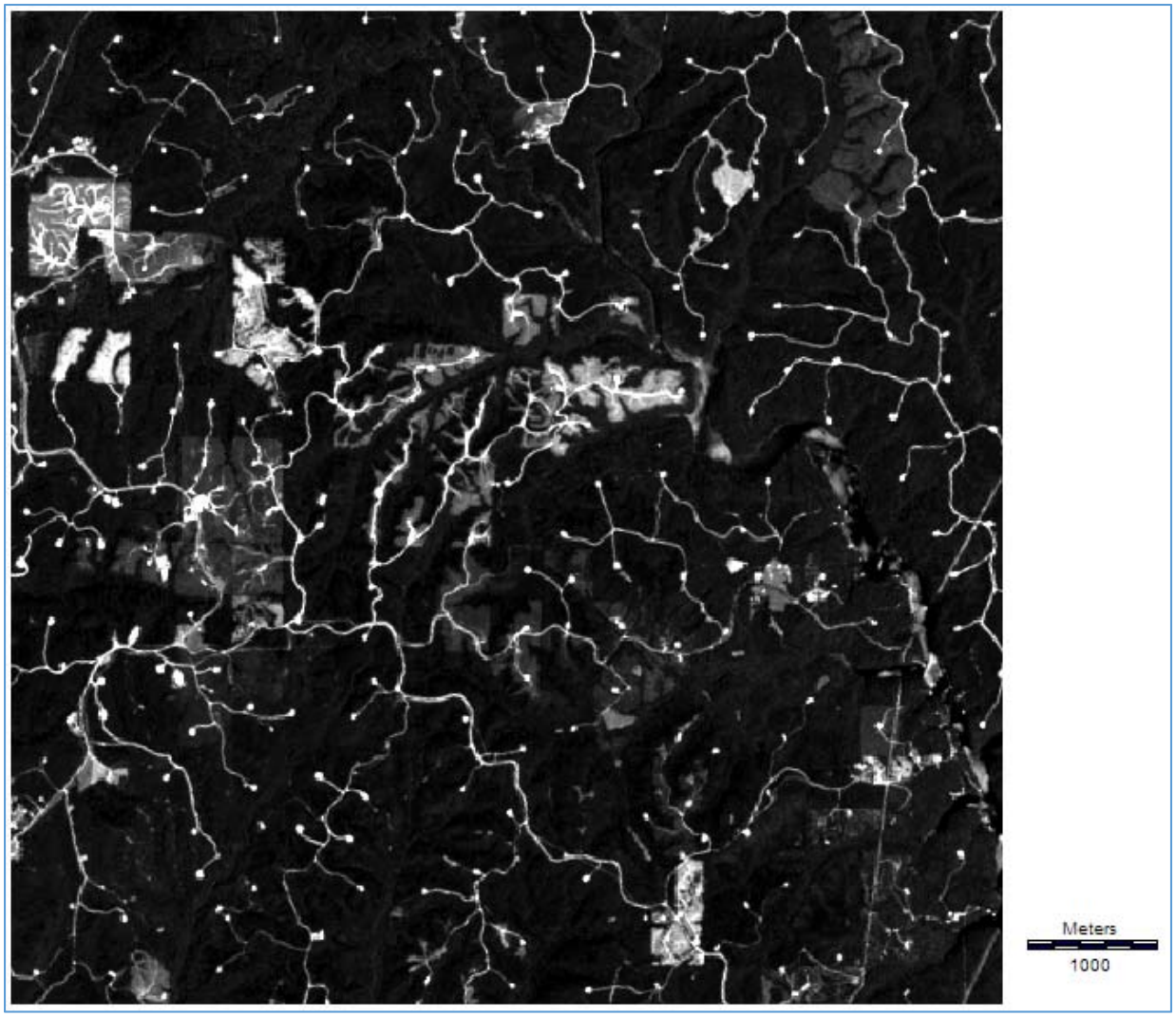
This true colour Landsat 5 image was taken on 11th October 1984 of the National Forest in the Blue Creek and White Oak Creek catchments in the Black Warrior River basin in Alabama at the start of development of coalbed methane development in the area. There are just one or two wells in the south of the image. White areas in the image are where the forest has recently been logged and the bare soil is visible.

Almost exactly 30 years later the entire landscape has been transformed by coalbed methane developers GeoMet Inc and is covered with hundreds of gas wells, connecting roads, pipelines and infrastructure. The well spacing is irregular because of the undulating terrain and varies between approximately 400 m and 500m.



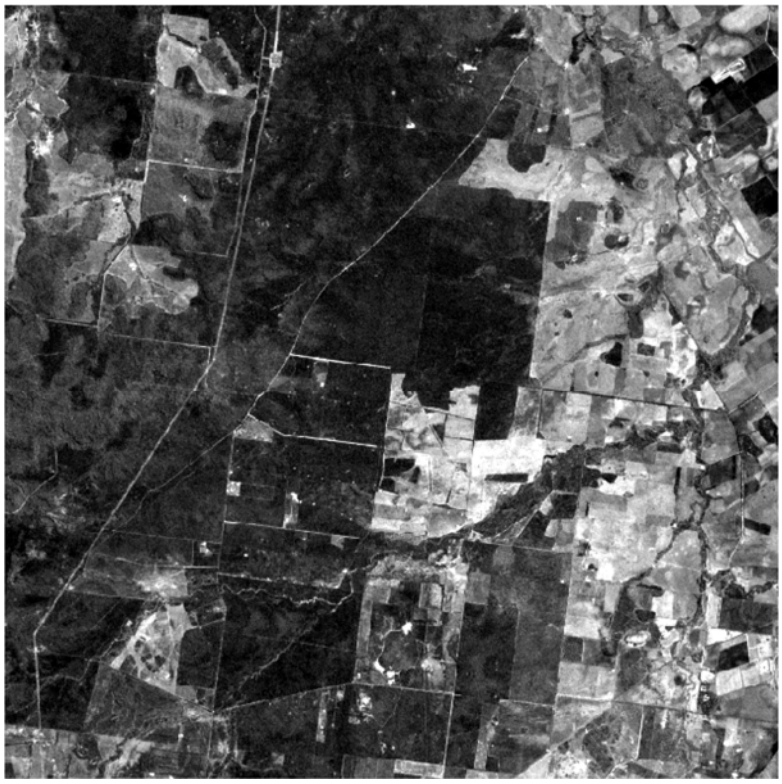
True colour Landsat 8 image (scene 021-037) of White Oak Creek, Tuscaloosa County, Alabama, USA, May 20th 2014.

The US Environmental Protection Agency estimates that coalbed methane is now uneconomic in America and may remain so for the next 30 years until gas prices rise. However it may remain economic in Europe where gas prices are higher than the USA.



Pan-chromatic detail from the same 2014 image.

The Figures below show the development of a coalbed methane gas field in the Kumbarilla State Forest in Queensland, Australia. The first image is of September 2002 when there were no gas wells, the second image is of December 2013 when gas wells cover the landscape on a 750m well spacing (56 ha). Again the images represent a 20 km by 20 km block.



September 9, 2002

Figure 10. 20 x 20 km block, Landsat 7 & 8 091-079, Queensland Australia, September 2002 above, December 2013 below.

Annex II - The Somerset Prospect

PEDL074 Somerset

Report by Douglas RP Goodwin for GeoMet Operating Inc for GeoMet UK Ltd

This is an annotated version of GeoMet UK's report to the Department of Trade and Industry on relinquishment of PEDL 074. The report was submitted to DTI in 1999 but not formatted by DTI until 2003. The copy of the report which is available from the Department of Energy and Climate Change contains a number of typographical errors and is missing all of its figures or "overlays". The report has been annotated to correct known errors and to recreate the missing overlays. It has been possible to recreate the overlays from GeoMet's own geographic information system files. The text of the report has not been edited and all annotations are in bold red courier font. GeoMet's data layers contain some inconsistencies which are highlighted and corrected where possible.

Frack Free Chew Valley, June 2014.

http:/frackfreecv.wordpress.com

PEDL074 Somerset

Report by Douglas RP Goodwin for GeoMet Operating Inc for GeoMet UK Ltd

Licence Area

PEDL074: 400 km^2 - blocks ST55, ST56, ST65 and ST66

Target

Lower and Middle Coal Measures at depths between 500 and 5,000 ft (152-1,525 m) (see Overlay 1 for 1"=1 mile geologic map). Together the Lower and Middle Coal Measures are 2,000 to 2,500 ft (610-762 m) thick with the Middle Coal Measures averaging about 1,600 ft (488 m) and the Lower Coal Measures about 600 ft (183 m).

The Somerset coalfield consists of the northern Pensford and the southern Radstock synclines separated by the east-west trending Farmborough Fault Belt. Only in the southern part of the Radstock Syncline have coals of the Lower and Middle Coal Measures been worked, mainly at the Newbury and Vobster collieries in the southeast and in the New Rock and Moorewood pits to the southwest. Only in the eastern part of Pensford Syncline have coals of the Lower and Middle Coal Measures been worked, at the Globe Pit in the Newton St Loe area in the 19th century.

North of and continguous with the Somerset Coalfield is the southern portion of the Bristol Coalfield, an area known as the Kingswood Anticline. Middle and Lower Coal Measures crop out here and have been extensively mined, both at the surface and underground. Despite complex folding and major faulting some 20 seams, ranging from 0.3 to 2 m thick, have been extensively worked. Some of these workings continue for a short distance onto PEDL074.

One kilometer west of the northwest corner of PEDL074 is the eastern edge of the Nailsea Syncline. Coal workings here were abandoned between 1880 and 1890 because of heavily watered measures and the *inferior quality* of the 12 recorded coals seams of the Lower and Middle Coal Measures. Only two seams, each about 1 m thick, were mined to any extent. A veneer of Lower or Middle Coal Measures may be present beneath Triassic sediments and connect the Nailsea and Somerset coalfields at the northwest corner of the licence.

Lower and Middle Coal Measures Age: Westphalian A-C/Middle Carboniferous/about 320-335 m.y.

Lower and Middle Coal Measures Depths: 0-2,800+m/0-9,000+ft

(Dr. D. P. Creedy of Wardell Armstrong in his 1999 report titled "Coalbed Methane - R & D Needs of the UK" estimates coal depths in Bristol/Somerset at 0-2,200 m. The maximum basin depth/thickness figure quoted above agrees with the British Geological Survey's estimate in the 1993 report titled "An Evaluation of CBM Potential in Great Britain.")

The following section seems to be a description of the graphical overlays but has no heading and is rather confusing.

Prospective Part of Licence
The 'Prospective Part of the Licence' is the area with a depth to the base of the coal measures between -500 and -5,000 which is not in an urban area and not mined out.

Area with no Coal Measures: 95 km^2/23.75 % (Overlay 1)
This is the part of the Non-Prospective part of the licence, the actual area is 93 km^2.

Area with target Coal Measures below 5,000 feet: 136 km^2/34 % (Overlay 1)
This doesn't make sense because the target coal measures are between 500 and 5,000 feet depth, so below 5,000 feet is not part of the target defined above. However the area of the coal measures below 5,000 feet depth in the licence area is 150 km^2.

Area with target Coal Measures above 500 feet: 14 km^2/3.5 % (Overlays 1 and 4)
This is the part of the Non-Prospective part of the licence. 12.5 km^2.

Urban areas: 20 km^2/5 % (Overlay 3)
This is not correct, the GeoMet Urban Area for the whole area of interest is 50.5 km^2. GeoMet appear to have only taken into account the urban areas of Bristol, Keynsham, Saltford, Corston and Chilcompton. Blagdon is skirted around but all other villages are ignored. Further the GeoMet urban area map seriously underestimates the urban area as many villages are entirely missing from the map.

Mined areas not already excluded by urbanization and coal depths: 10 km^2/2.5 % (Overlay 2).

Net prospective and developable area with target coals between 500 and 5,000 feet: 125 km^2/12,500 hectares/31.25 % (Overlay 4).
The GeoMet prospective area GIS file has an area of 108 km^2, this matches the figure given below in the Potential Gas Reserves section and seems to exclude the area near Hicks Gate where UK Methane proposed a test site. The Hicks Gate site is bounded on two sides by previously mined areas out areas.

(The preliminary estimate from Appendix B of the licence application for PEDL074 was 25,000 hectares of probable and possible productive area. This more detailed screening for CBM prospectivity yields one half the original estimate.)

Gas Content

No gas content data are available for Somerset. Creedy in his 1999 report titled "Coalbed Methane - The R & D Needs of the UK" estimates an average gas content of 0.1 m^3/ton for Bristol/Somerset coals. This figure is not based on any measurements. If this estimate is accurate, then this licence is not prospective for CBM development.

Methane is recorded from the Lower and Middle Coal Measures in the Nettlebridge Valley area (southeasternmost PEDL074) and at Kingswood and Easton (just north of PEDL074)

(Preston,1871). Collieries with firedamp (methane) explosions resulting in death include the following mines working the target coals in the vicinity of the southeast corner of PEDL074: Stratton, Newbury, Vobster, Old Vobster and Edford. The sole mention of firedamp ignition in Somerset mines working the Upper Coal Measures was in Kilmersdon in 1759. Kilmersdon is situated 3+ km north of the southeast corner of PEDL074, not far from the Nettlebridge Valley and at the northern edge of a major structure that continues at a low angle to the south, the Southern Overthrust. Historically naked light working (using open flames for illumination) was almost universal in Somerset mines targetting Upper Coal Measures due to the lack of firedamp.

In the absence of gas content data, coal rank analyses will substitute to define CBM prospectivity in PEDL074.

Lower and Middle Coal Measures Rank

Medium volatile bituminous (mvb) to low volatile bituminous (lvb) within PEDL074 (See graphs on following page.)
In general, volatile content of the dry, ash-free bituminous coal is higher, ranging from 31 to 34 % (hvAb), north of the Kingswood anticline. Volatile content decreases to 25-28 % in the Kingswood anticline and continues to decrease southward toward the deepest portion of the Somerset coalfield near Pensford. Overall data are sparse and no Middle and Lower Coal Measures rank data are available for the basin center. However, Upper Coal Measures coals from Pensford Colliery show the highest rank in Bristol/Somerset, with volatiles ranging from 22 to 30 %; borderline lvb to mvb coals are evident 4,000-6,000 feet (1,220-1,820 m) above the target seams in the Pensford-Bromley area. Lower and Middle Coal Measures seams nearest the basin center in the Winford boreholes 4-5 km west of Pensford-Bromley have daf volatile contents ranging from 16 to 20 % - the lowest reported in Bristol/Somerset coalfield. Finally, at the south edge of Somerset basin, volatiles range from 24 to 28 % in seams from Ston Easton No. 1 and 2 boreholes. As expected, coal maturation on the perimeter of Somerset coalfield is less than for coals nearer the depositional center. (Overlay 4)

In British coal basins one of the most important factors controlling the amount of preserved adsorbed methane in coals appears to be the degree of syn- and post-depositional basin uplift and erosion. While enough methane to saturate the coals was probably generated during infilling of Upper Carboniferous coal basins, extensive degasification appears to have taken place during the end-Carboniferous Variscan orogeny. Subsequent Permo-Triassic reburial of coal sequences appears to have been insufficient to significantly replenish adsorbed methane over much of Great Britain. For this reason and due to significant mining of the Upper Coal Measures in the center of Somerset basin, the Upper Carboniferous coals are not considered a primary CBM target in PEDL074. At this stage of exploration, the most prospective area for siting coreholes targets Middle and Lower Coal Measures seams that might still retain their original adsorbed methane.

D.P. Creedy in a 1988 paper titled "Geological Controls on the Formation and Distribution of Gas in British Coal Measure Strata" plots the relationship between methane content and volatile matter content for a range of British coals. His dataset suggests that coals with volatile contents of 30 % would be expected to range from 7-15 m^3/t methane and those with 20% volatiles might range from 12-18 m^3/t methane. In addition Creedy reports that inseam methane content gradients typically range from 0.1 to 0.01 m^3/t per 100 m depth in British coalfields. Raw data for this paper were drawn from a seam gas content database containing some 4000 results of gas content measurement on samples of coal core from surface exploration boreholes. Therefore, these figures may provide general guidance for gas contents of target Somerset coals near their methane sorption capacity.

Somerset volatile content data are presented in Appendix 1 as these are not collated elsewhere in published reports.

Target Coal Thickness

Coal thickness data have been tabulated for PEDL074 in a spreadsheet file titled "Somerset coals" and a paper copy is attached here as Appendix 2. Data for Lower and Middle Coal Measures are sparse and have been plotted with select Upper Coal Measures mining data on Overlay 4.

Because of structural problems and variations in borehole depths, coal data have been plotted as a percent of section rather than as a numeral thickness for each data point. This allows easier calculation of gas reserves.

Potential Gas Reserves

First order gas reserves estimates have been calculated using coal thickness and average gas contents data for methane-saturated coal based on Creedy's plotted relationship of methane content vs volatile content for British coals. (It should be noted that these numbers are *highly* optimistic.) Volatile content data are plotted on Overlay 4 to suggest field-scale trends in coal rank. Prospective developable areas were also outlined and three areas were identified (see overlay). The areal extent of these three regions is 108 km^2, less than the 125 km^2 previously estimated, because an additional 17 km^2 was deemed undevelopable for practical purposes during final review of data for reserve calculations.

Area 1

Area 1 is situated in the northeast corner of the licence. It is isolated from the remaining prospective region by Bristol urbanization and the central Somerset coalfield where, to the southwest, the base of the target coals ranges from 5,000 feet to 9,000 feet in depth.

The Area below contains a typographical error and is missing a leading "1".

Area: **1**4 km^2
Depths: 0-5,000 ft (0-1,524 m)
Thickness of Upper Coal Measures (UCM) % coal: 2.0%
Thickness Lower and Middle Coal Measures (L+MCM) % coal: 1.8%
Average thickness of Area 1 Coal Measures: 3,500 ft/1,067m
UCM estimated gas contents: "8 m^3/t"
L+MCM estimated gas contents: "13 m^3/t"
Coal density: 1.35 tons/m^3 (for all areas)
Assume 100% methane as gas composition for all areas.
Assume the surface 500 feet (152 m) of Coal Measures are not prospective for all areas.

Area 1 calculated methane reserves:

3,000,000 m^2 X 610 m X 0.018 L+MCM coal X 1.35 t coal/m^3 X 13 m^3 CH4/m^3 =0.58 X 109
11,000,000 m^2 X 762 m X 0.018 L+MCM coal X 1.35 t coal/m^3 X 13 m^3 CH4/m^3=2.64 X 109
11,000,000 m^2 X 228 m X 0.02 UCM coal X 1.35 t coal/m^3 X 8 m^3 CH4/m^3=0.54 X 109

Area 1 total reserves: 3.8 X 109 CH4 m^3/0.27 X 109 CH4 m^3/sq km

The maximum number of wells at 32 hectares/wells is 44. This area is too small and isolated and does not merit drilling a corehole.

Area 2

Note that urban areas other than Bristol and Chilcompton are not excluded in Area 2.

Area 2 is situated in the western half of the licence, north of the western extension of the Farmborough Fault Belt that separates this area from Area 3. It is the largest of the three prospective regions. Negatives include the results of the Dundry borehole (v. little coal) that are *assumed to be unrepresentative* of the region and proximity to villages of the best site for a corehole. One positive: the highest coal rank reported in Somerset occurs in the Winford wells.

Area: 54 km^2
Depths: 0- 5,000 ft (0-1,524 m)
UCM % coal: 2.2% L+MCM % coal: 1.3%
Average thickness: 1,500 ft (457 m) above 2,500 ft (762 m) 3,750 ft (1,143 m) between 2,500 and 5,000 ft (762 and 1,524 m)
Area ranging in depth from 500 to 2,500 ft (M+LCM only): 35 km^2
Area ranging in depth from 2,500 to 5,000 ft (All CMs): 19 km^2
UCM estimated gas content: "8 m3/t"
L+MCM estimated gas content: "16 m3/t"

Area 2 calculated methane reserves:

35,000,000 m^2 X 328 m X 0.013 L+MCM coal X 1.35 t coal/m^3 X 16 m^3 CH_4/m^3 =3.2 X 109
19,000,000 m^2 X 762 m X 0.013 L+MCM coal X 1.35 t coal/m^3 X 16 m^3 CH4/m3=4.1 X 109
19,000,000 m^2 X 328 m X 0.022 UCM coal X 1.35 t coal/m^3 X 8 m^3 CH_4/m^3 coal=1.5 X 109

Area 2 total reserves: 8.8 X 109 CH4 m^3 /0.16 X 109 CH4 m^3 / km^2

Both areas 2 and 3 are transected by east-west thrust faults and north-south normal faults and continuity of coals in the subsurface is a major concern. The less competent L+MCM mudstone-dominant strata have generally been squeezed and contorted between more competent rocks, sequences dominated by sandstone and/or limestone, that have also been folded and faulted but to a lesser degree. The Triassic apron along the northern edge of the Mendip Hills probably covers a thrust fault of early Carboniferous rocks overriding less competent Coal Measures for the width of PEDL074. The throw on such thrust faults generally diminishes westward from the Radstock area where offset can exceed 1,000 feet. Hole siting in Somerset must avoid known faults and target larger fault blocks.

This area can accommodate drilling 168 wells on a 32 hectare well spacing. A prospective location to drill a 5,000 ft corehole, designated "A" on Overlay 4, is 1.5 km northeast of Chew Valley Lake and 1 km east of Chew Magna.

Area 3

Note that urban areas other than Chilcompton are not excluded in Area 3.

Area 3 is situated south and southwest of the central part of Radstock basin and north-northeast of the Mendip Hills. Mines working the southeasternmost portion of this area produced gassy coal over many centuries of operations. Siting a corehole in Area 3 involves less geologic risk regarding the presence of methane. Thus, this area is considered more prospective than Area 2.

Area: 40 km^2
Depths: 0-5,000 ft (0-1,524 m)

UCM % coal: 2.5% L+MCM % coal: 2.5%
Average thickness: 1,500 ft (457 m) above 2,500 ft (762 m) 4,000 ft (1,220 m) between 2,500 and 5,000 ft (762 and 1,524 m)
Area ranging in depth from 500 to 2,500 ft (152-762 m) (M+LCM only): 9 km^2
Area ranging in depth from 2,500 to 5,000 ft (762 to 1,524 m) (All CMs): 31 km^2
UCM estimated gas content: "8 m^3/t"
L+MCM estimated gas content: "13 m^3/t"

Area 3 calculated methane reserves:

9,000,000 m^2 X 328 m X 0.025 L+MCM coal X 1.35 t coal/m3 X 13 m^3 $CH4/m^3$ =1.3 X 109
31,000,000 m^2 X 762 m X 0.025 L+MCM coal X 1.35 t coal/m^3 X 13 m^3 $CH4/m^3$=10.4 X 109
31,000,000 m^2 X 328 m X 0.025 UCM coal X 1.35 t coal/m^3 X 8 m3 $CH4/m^3$ coal=2.7 X 109

Area 3 Total: 14.4 X 109 CH4 m^3/0.36 X 109 CH4 m^3/ km^2

In addition to being less risky for siting a corehole, the Area 3 estimated resource density is more than twice that in Area 2. Area 3 can accommodate about 125 wells. A central and prospective site for an Area 3 corehole is about 1.5 km east of Hinton Blewitt (Location "B" on Overlay 4).

<u>Methane resource for PEDL074</u>

1) Best Case Maximum estimated at 2.7 X 1010 CH4 m^3
as calculated above over a 108 km^2area (27% of licence)

2) If the sandstone-dominant shallow UCMs have 0 m3 CH4/t above 5,000 ft:
Estimated at 2.2 X 1010 CH4 m^3

3) Worst case If UCMs have no gas and L+MCMS have 50% of estimated gas content:
Estimated at 1.1 X 1010 CH4 m^3

An assumed recovery factor of 50% would cut the resource estimate by one half to yield an estimate of producible gas.

<u>Average resource density</u>

Best Case: 0.25 X 109 CH4 m^3/ km^2
Worst Case: 0.10 X 109 CH4 m^3/ km^2

Maximum number of 700-5,000 ft wells at full development of prospective acreage is about 300.

Confidence in the gas content figures in making this estimate are not high as no gas content data are available for Somerset coalfield. This is a major reason to core and further assess the CBM potential of PEDL074.

Appendix 1. Bristol-Somerset Coal Seam Volatile Contents

Data for Lower and Middle Coal Measure seams (from north to south) in the Harry Stoke (6-9 km north of PEDL074) and Kingswood (4 km north of PEDL074) areas:

Five Coals, Great Vein and Gillers Inn seams from about 1200 feet in Harry Stoke B borehole [6321 7816] UK coordinates: 31-34 % volatiles, 4-10 % ash and 1-1.5 % sulfur
"Clean" seams between 1,400 and 2,100 feet in Harry Stoke B borehole:
33 % volatiles, 6.8-9.4 % ash and ?sulfur
Gillers Inn Seam from about 2500 feet in Harry Stoke C borehole [6504 7677]:
25 % volatiles, "low ash and sulfur"
Two Feet Seam at Speedwell Colliery [6323 7442] from about 1,100 feet:
28 % volatiles, 7-9 % ash and 1-1.2 % sulfur
Ashton Great Vein of Ashton Park Borehole [5633 7146] from about 500 feet?:
25 % volatiles, 6 % ash, <1 % sulfur

Data for Upper Coal Measures within PEDL074:

7.5" seam at 467 feet in Hursley Hill No. 1 Borehole [6180 6565]:
30.3 % volatiles, 11.5 % ash, 3.6 % sulfur
16" seam at 1146 feet in Hursley Hill No. 1 Borehole:
26% volatiles, 8.1 % ash, 3 % sulfur
9.5" seam at 1593 feet in Hursley Hill No. 1 Borehole:
26 % volatiles, `14 % ash, 6.3 % sulfur
2" seam at 1725 feet in Hursley Hill No. 1 Borehole:
26 % volatiles, 13.6 % ash, 2.0 % sulfur
7" seam at 1791 feet in Hursley Hill No. 1 Borehole:
24 % volatiles, 5.7 % ash, 1.3 % sulfur
27" seam (Pensford 2?) at 1883 feet in Hursley Hill No. 1 Borehole:
25 % volatiles, 15.9 % ash, 5 % sulfur
8" seam at 1886 feet in Hursley Hill No. 1 Borehole:
22 % volatiles, 12.5 % ash, ? sulfur
28" seam (Pensford 3?) at 1889 feet in Hursley Hill No. 1 Borehole:
23 % volatiles, 7.2 % ash, 1.5 % sulfur, 15,660 Btu/lb
9" seam at 1897 feet in Hursley Hill No. 1 Borehole:
24.6 % volatiles, 4.9 % ash, 1.3 % sulfur
7.5" seam at 1920 feet in Hursley Hill No. 1 Borehole:
23.6 % volatiles, 14 % ash, 2.2 % sulfur

Data for Lower and Middle Coal Measures (from north to south) within PEDL074:

66" seam from Ashton Group of coals at 259 feet in Winford No. 1 [5573 6375] and 261 feet in Winford 1a (drilled a few feet away to resample this coal):
17.2-19.5 % volatiles (15.9 % dafcc), 5.7-8.2 % ash, 0.8-0.9 % sulfur (poor sample recovery - recored in 1a borehole)
24" seam from 736 feet in Winford No. 2 [5636 6343]:
15.2 % volatiles dafcc, 4.1 % ash, 0.78 % sulfur (poor sample recovery)
9" seam from 811 feet in Winford No. 2:
18.l % volatiles dafcc, 5.2 % ash, 0.94 % sulfur (poor sample recovery)
100" ? seam at 871 feet in Winford No. 2:
15.0 % volatiles dafcc, 9.1 % ash, 0.88 % sulfur (poor sample recovery)
18-24" seam at 928 feet in Winford No. 2:
16.8 % volatiles daf, 6.8 % ash, 0.95 % sulfur (poor sample recovery)
24 " seam at 950 feet in Winford No. 2:

16.7 % volatiles daf, 8.8 % ash, 1.0 % sulfur (poor sample recovery)
42" seam in Kingswood Group from 1023 feet in Winford No. 2:
17.2-19.5 % volatiles (17.1 % dafcc), 9.5-9.9 % ash, 1.3-1.8 % sulfur; 15,410 Btu/lb (good rec.)
39" seam from 1394 feet in Winford No. 2:
19.1 % volatiles daf, 16.1 % ash, 1.2 % sulfur

(N.B. In the following two holes strata were commonly contorted and steeply dipping.)

21 ft 3 in seam at 904 feet (Main or Callows ?) in Ston Easton No. 1 Borehole [6225 5174]:
"medium volatile", 6.6-20.1 % ash, 0.8-2.8% sulfur
29 ft 3 in seam at 937 feet (Main or Callows ?) in Ston Easton No. 1 Borehole:
23.9 % volatiles dafcc, 10.7 % ash, 1.0 % sulfur
29" seam at 1065 feet (Perrink ?) in Ston Easton No. 1 Borehole:
25 % volatiles, 6.9-7.4 % ash, 1.4-2.3 % sulfur, high carbonates, 15,200 Btu/lb
21" seam at 256 feet in Ston Easton No. 2 Borehole [6211 5158]:
24.5 % volatiles dafcc, 13.5 % ash, 0.9 % sulfur (weathered)
6" seam at 287 feet in Ston Easton No. 2 Borehole:
27.5 % volatiles dafcc,11.6 % ash, 2.6 % sulfur
"3"" seam at 417 feet in Ston Easton No. 2 Borehole:
26.5 % volatiles dafcc, 7.7-18.1 % ash, 1.35 % sulfur
23" seam at 499 feet in Ston Easton No. 2 Borehole:
25.4 % volatiles dafcc, 4.6 % ash, 1.2 % sulfur
10" seam at 503 feet in Ston Easton No. 2 Borehole:
25.2 % volatiles dafcc, 6.5 % ash, 1.9 % sulfur
7 ft 5 in seam at 558 feet in Ston Easton No. 2 Borehole (50 % coal):
24.7 % volatiles dafcc, 7.6-18 % ash, 1 % sulfur

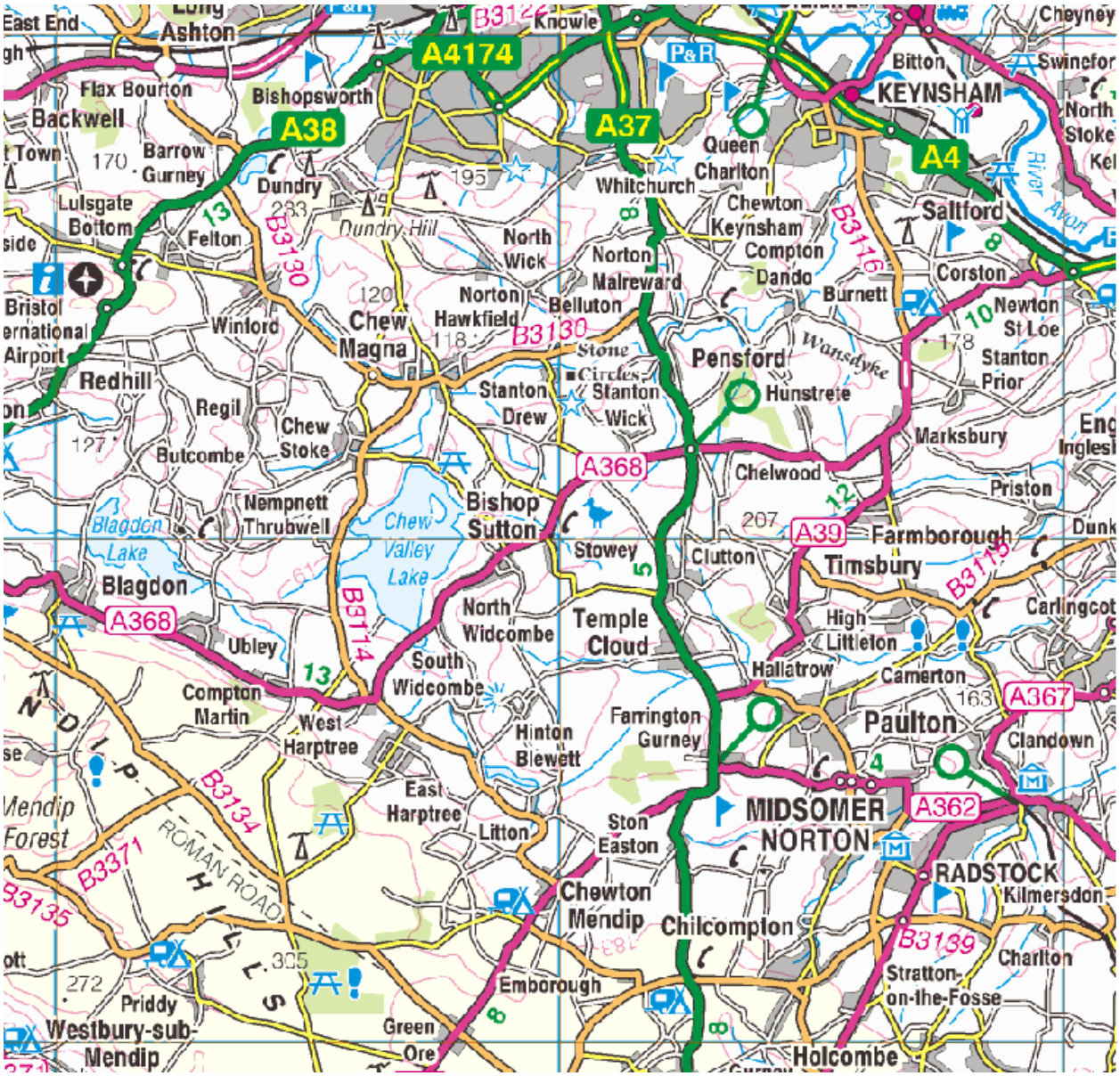


Figure 11. For orientation - area covered by PEDL 074.

Overlay 1, Contours of Depth to Base of Coal Measures, No Coal Measures (green hatch)

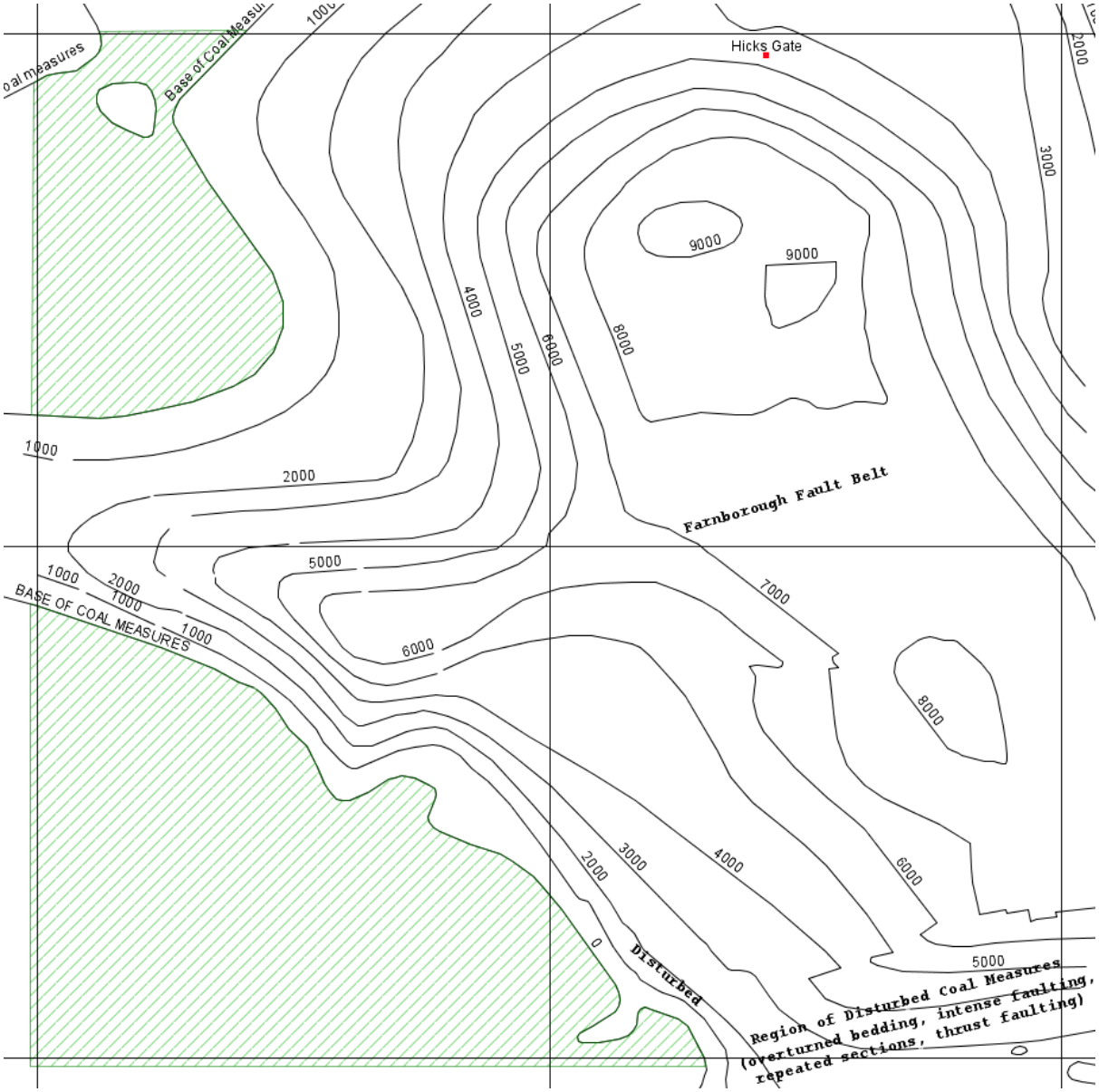


Figure 12. GeoMet's Overlay 1, Area with no coal measures (green) and contours to the base of the coal measures.

Overlay 2, Mined Out Areas

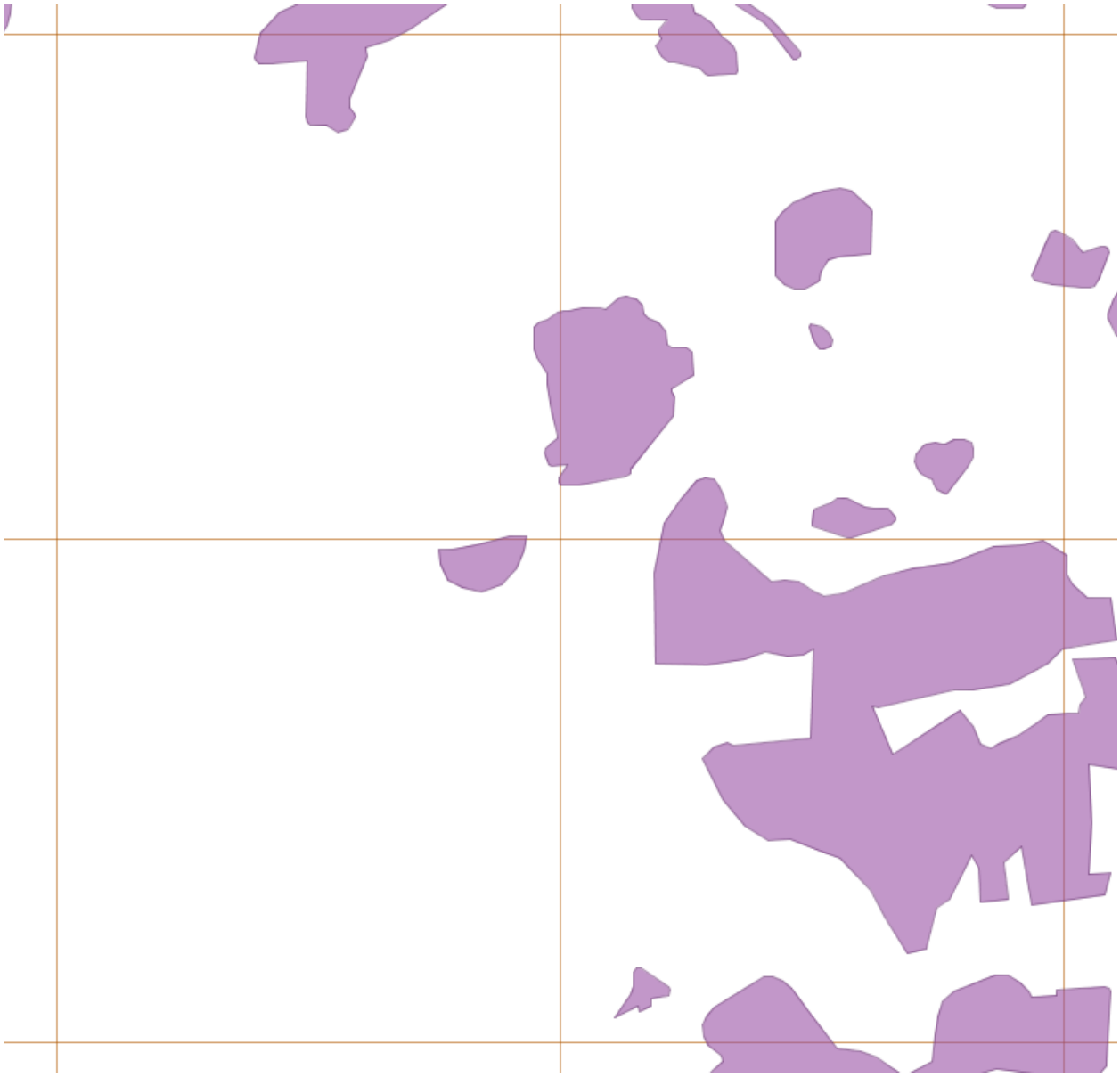


Figure 13, GeoMet's Overlay 2, Mined out areas.

Overlay 3, Urban Areas

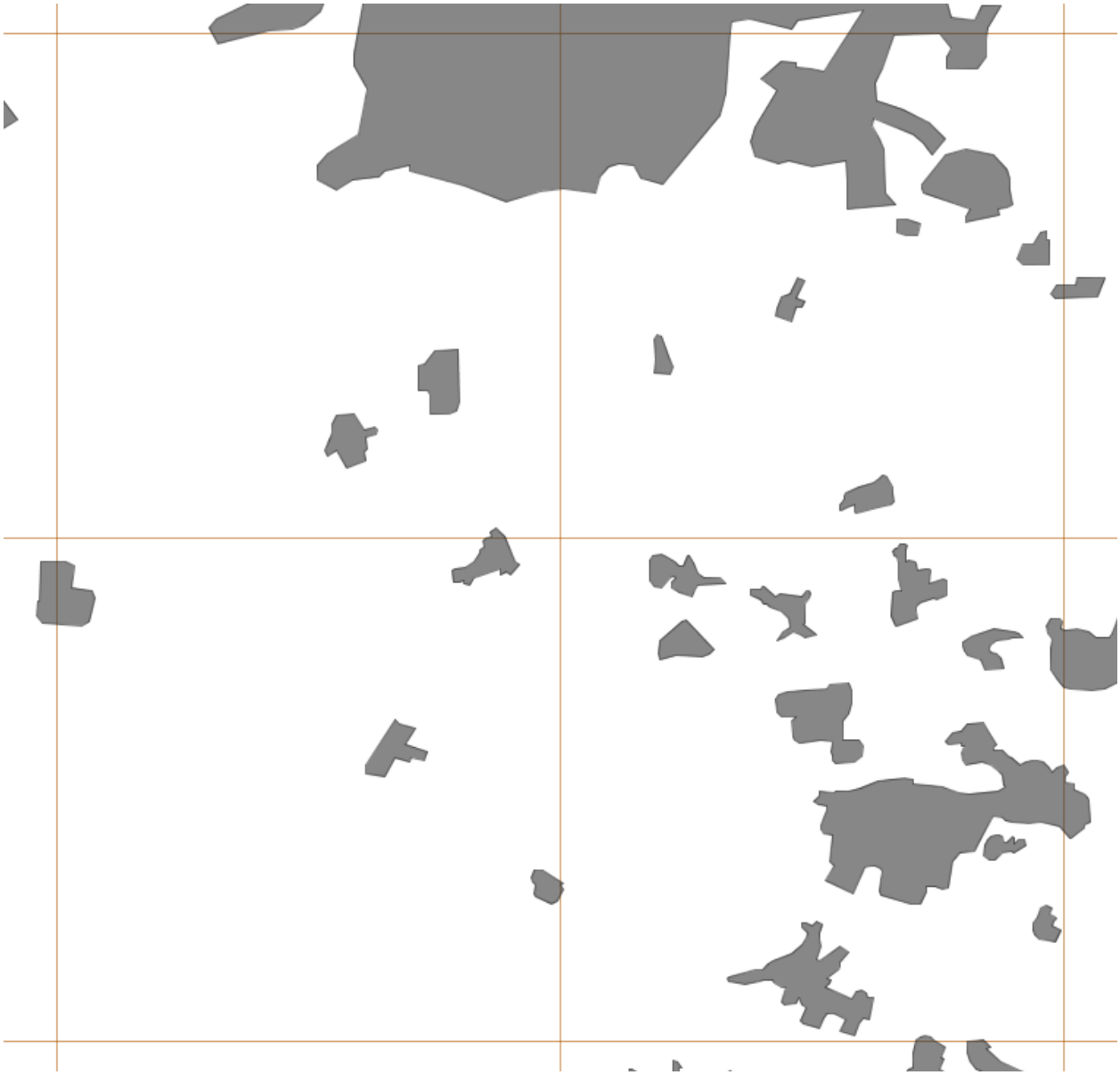


Figure 14, GeoMet's Overlay 3, Urban areas. Note that these urban areas are incomplete and do not contain many villages. Most of the villages on the map are not used by GeoMet.

Overlay 4, Prospective Areas

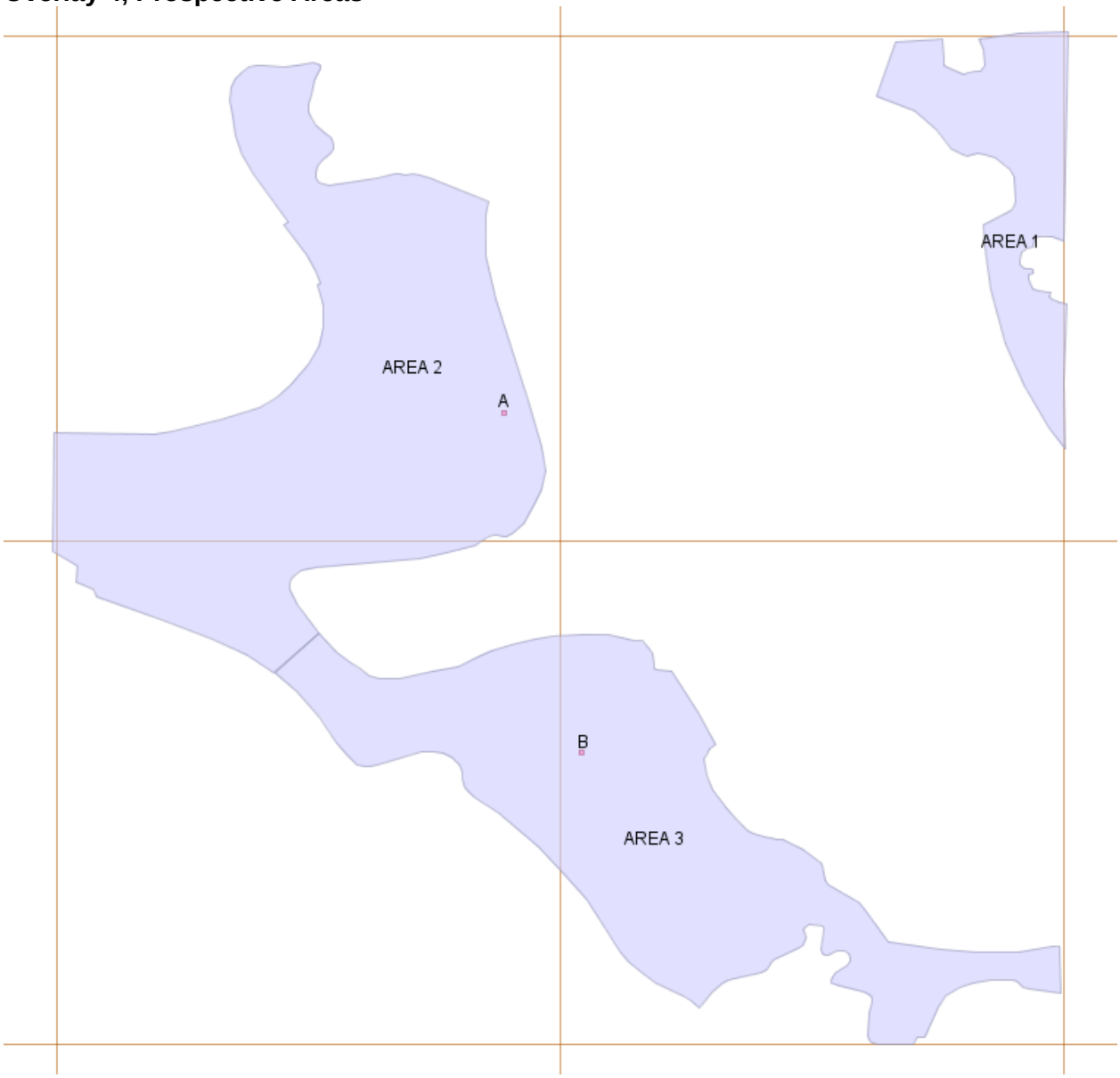


Figure 15, GeoMet's Overlay 4, Net prospective and developable area. This is the area where the coal measures are at depths 500' to 5,000', outside urban areas and in areas not previously mined. Note that this excludes some urban areas but ignores most villages. A and B indicate the location of proposed test sites.

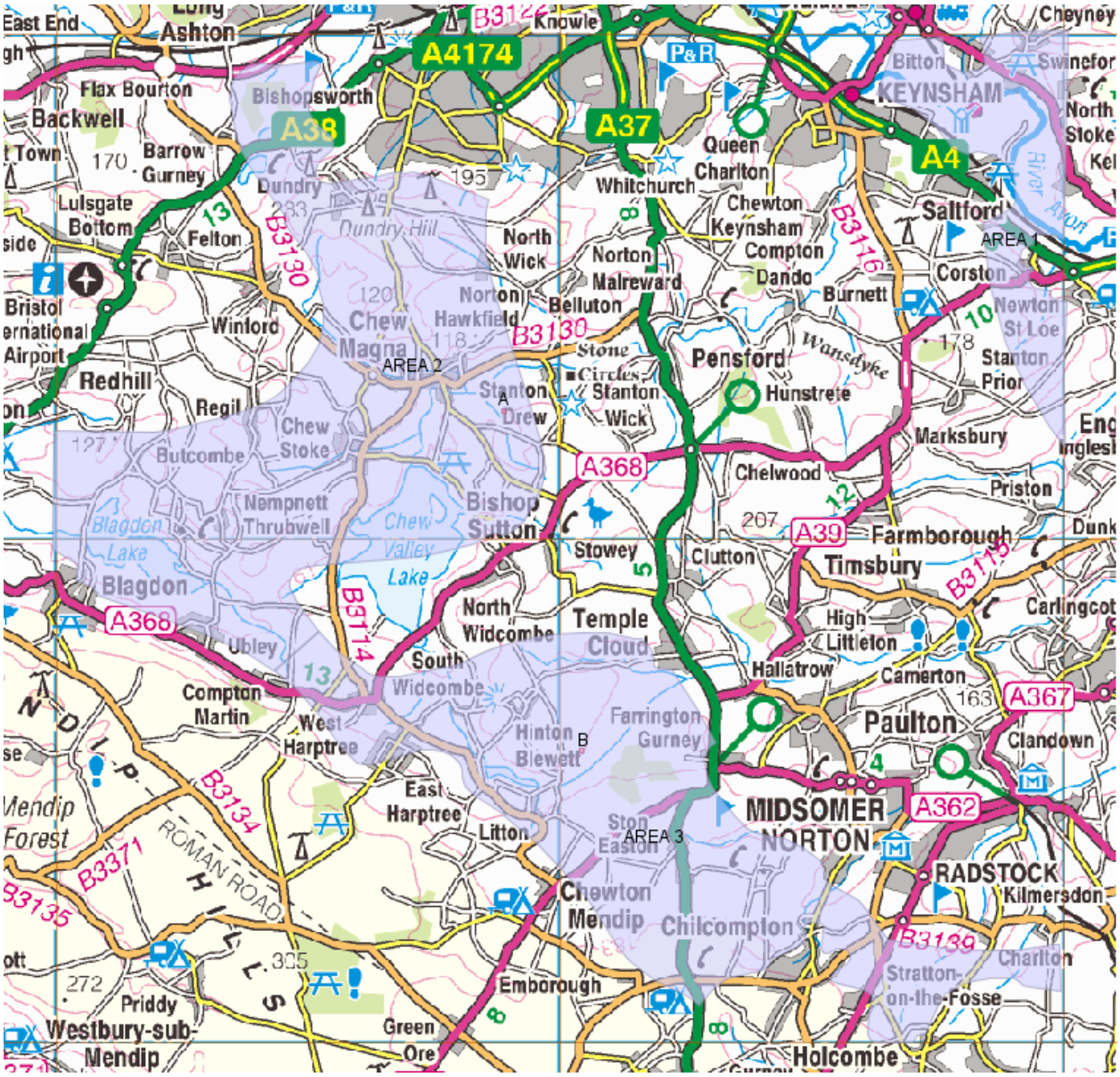


Figure 16. For orientation - GeoMet prospective and developable area on general Ordnance Survey map.