

ggs



Experts in Continuous Monitoring



26th July 2018

Mines Gas – Hazards & Opportunities

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Presentation Content

1. Introduction and the mines gas hazard

2. UK coal mining legacy & the South Lancs Coalfield

3. The Gorebridge incident

4. Mines gas resource opportunities

Sept 2013 - Gorebridge

Council tenants overcome by mines gas and taken to hospital



By Sept 2014 - Gorebridge

22 people had attended A&E or sought medical help – estate evacuated

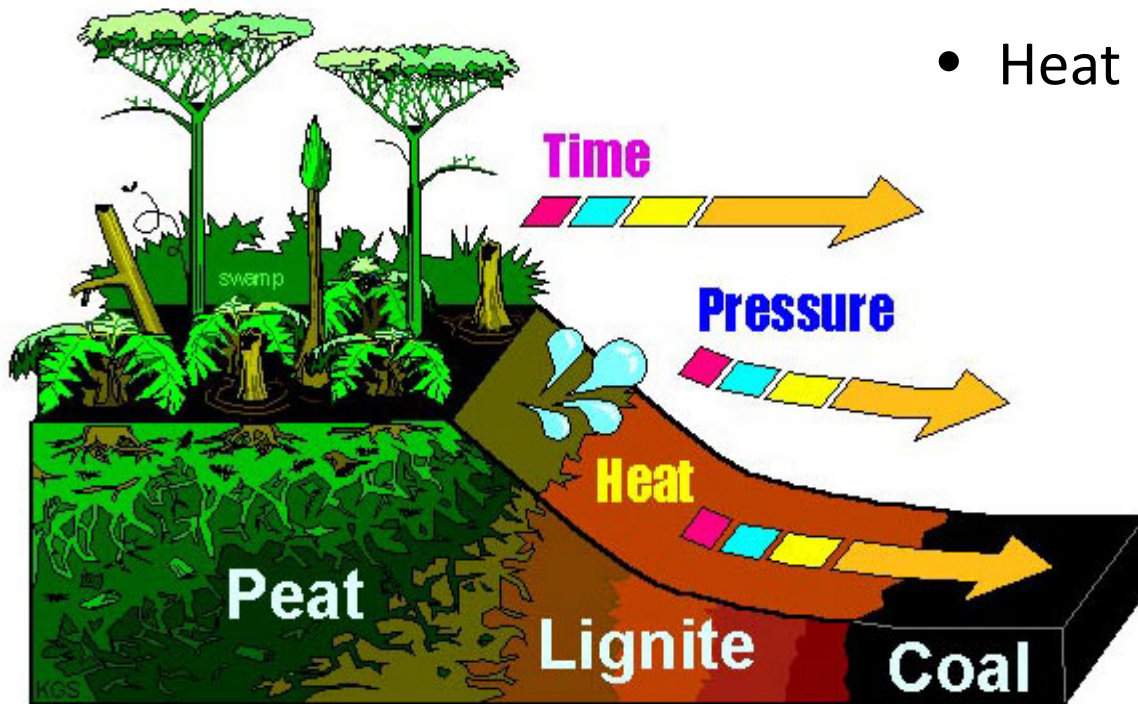


In March 2017, whole estate (64 homes) was demolished

Coal and Gas Formation

Plant material buried and subjected to:

- Time,
- Pressure
- Heat



Coal formed with natural gas:

- 80-95% methane
- some higher chain alkanes
- Some nitrogen
- Some carbon dioxide

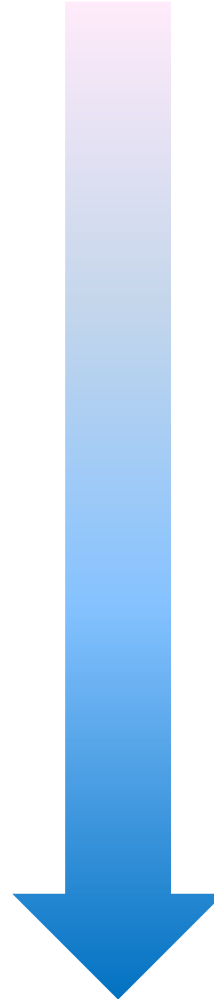
© Steve Greb, Kentucky Geological Survey

**Increasing Depth,
Pressure and
Temperature**

**Methane Content
(per tonne of coal
worked)**



Peat
Lignite
Sub-bituminous
Bituminous
Semi-Anthracite
Anthracite
Meta-Anthracite



50 to 100 m³/tonne

Hazardous Mine Gases

Both Chronic & Acute Risks

Firedamp

Blackdamp or Stythe gas

Afterdamp

Methane

Carbon Dioxide & Nitrogen

Carbon Monoxide



UK Mines Gas Incidents

- Between **1851 and 1980** - 186 coal mine explosions causing 10,000 fatalities (CIRIA 152)
- **1980** – Evacuation of homes in Rotherham (Guardian, 31.1.2001)
- **1987** – Explosion destroyed home in Sutton Scarsfield (Guardian, 31.1.2001)
- **1988** – Demolition and relocation of entire village of Arkwright (DoE 1996)
- **1995** – Fatal asphyxiation in stable in Widdrington (DoE 1996)
- **1998** – Fatal asphyxiation in service trench in Barnsley (NCE, 1999)
- **2000's** – Explosion in home in Workington (Allerdale BC, 2006)
- **2000's** – Demolition and rebuild of school in Workington (Allerdale BC, 2006)
- **2013** – Hospitalisation of council tenants in Gorebridge (IMT, 2017)

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Coal Mining Legacy



11%

of the UK is occupied by the UK coalfield

172,000

recorded mine entries

7 million

properties lie within Britain's coalfield

130,000

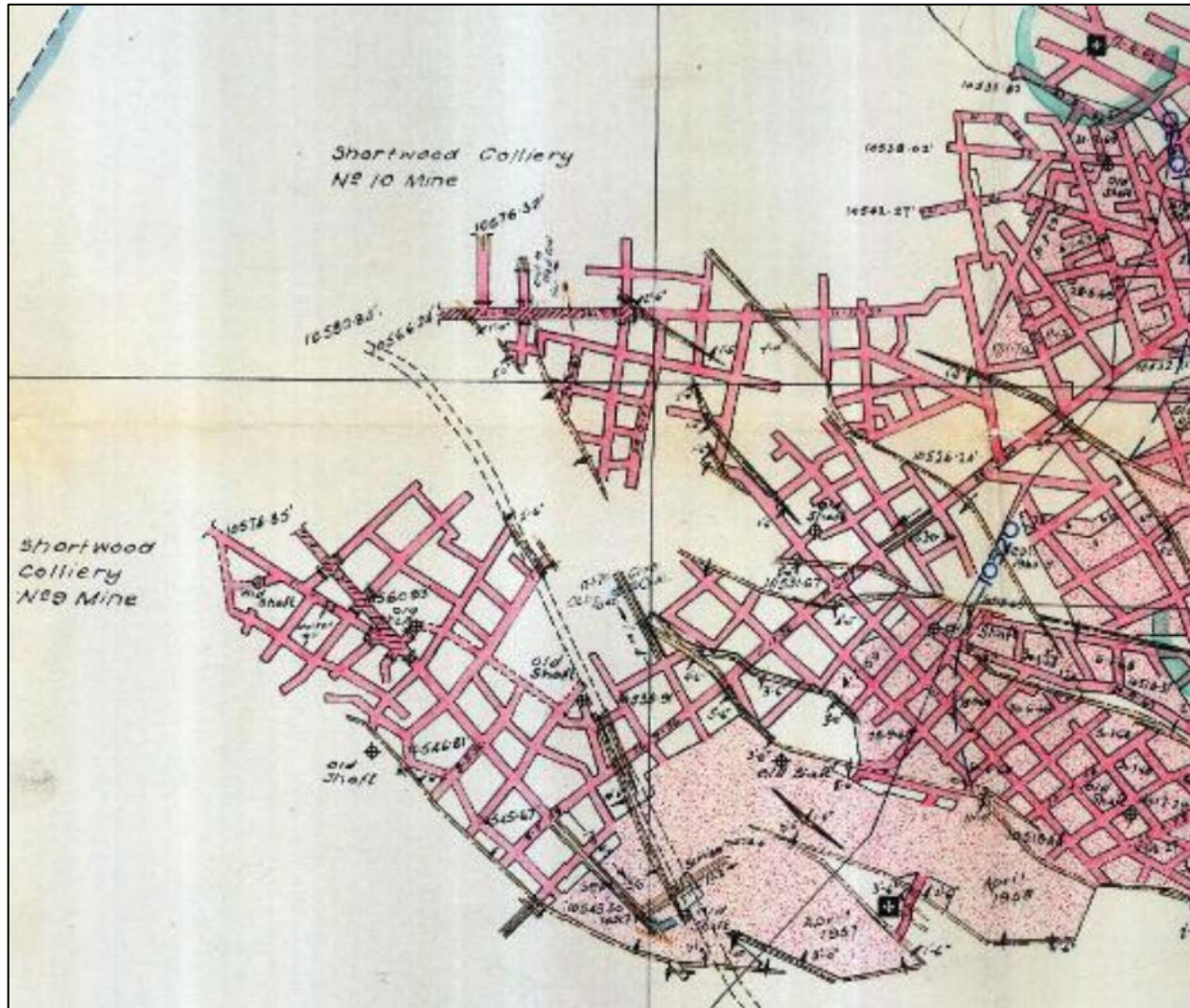
properties lie within 20 metres of at least one mine entry

360,000

abandoned mine plan

Coal Authority Data

Coal Mines Regulation Act, 1887



Progression from:

- workings at coal outcrop
- single shaft 'bell pits'

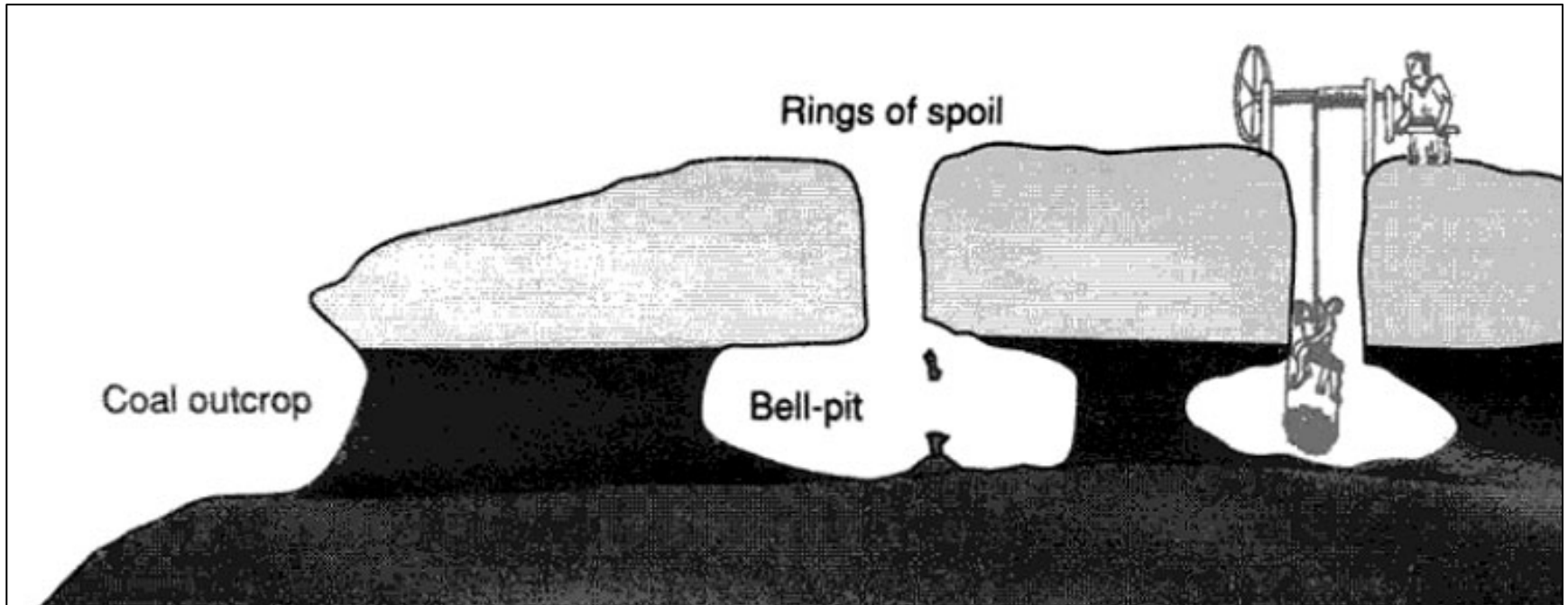
to:

- 'pillar and stall' workings

and finally

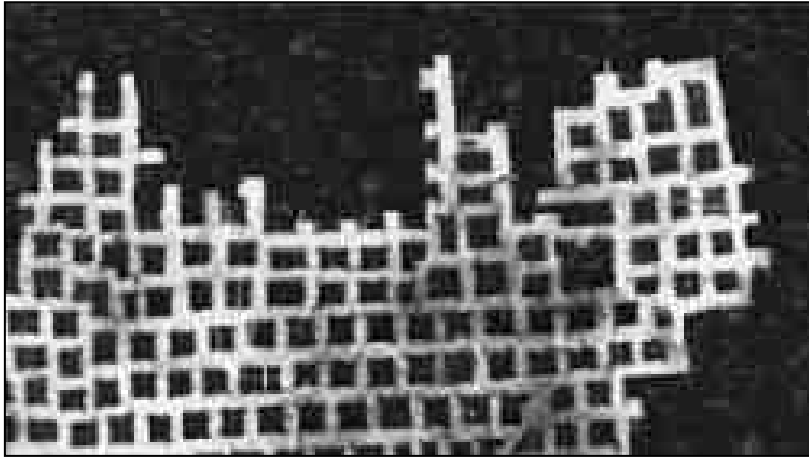
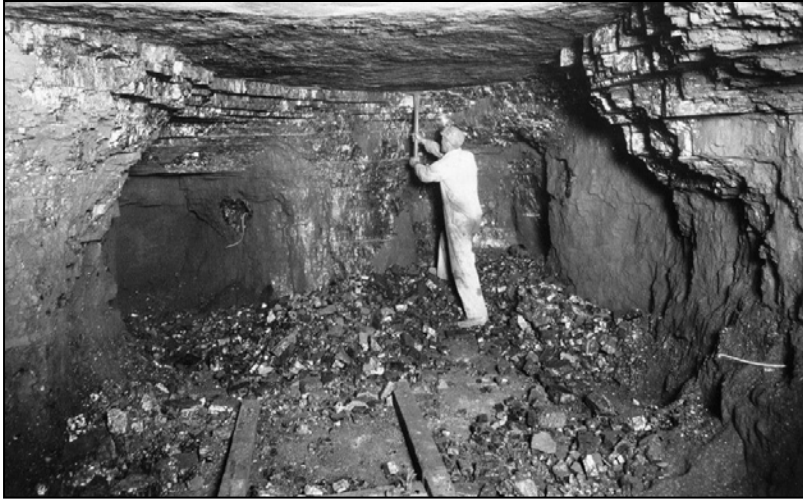
- 'long wall' mining

Early Coal Mining



- Initially worked from outcrop
- Then via 'Bell Pits'
- No records

Pillar and Stall Workings



- Typically 30% coal extraction
- If shallow can lead to crown-hole surface collapse
- If pillars 'robbed' through retreat mining surface subsidence occurred

Photos © British Geological Survey

GeoScience Ref P001520 - Blindwells Opencast Site, Tranent, East Lothian

Long wall mining



Total extraction with progressive subsidence at the surface

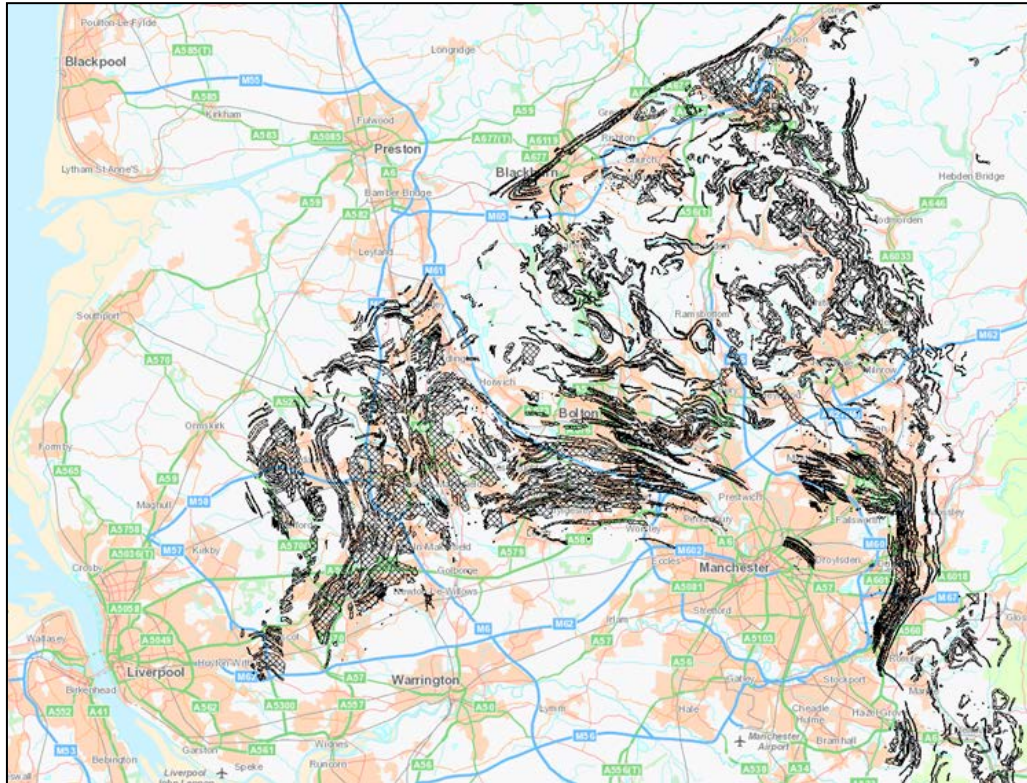
Mines Gas Issues

- **Open voids in abandoned mine workings**
- **Mines gas accumulating in voids**
- **Gas migration pathways to the surface**
- **Pressure driven migration along pathway**

Additional factors:

- **Mines drainage failing**
- **Mine pumps turned off**
- **Rising ground-water in mine workings**

South Lancashire Coal field



Production peaked in 1907 when more than 26 million tons of coal were produced from 358 collieries.

Parkside Colliery was the last deep mine to close in 1993.

©Coal Authority

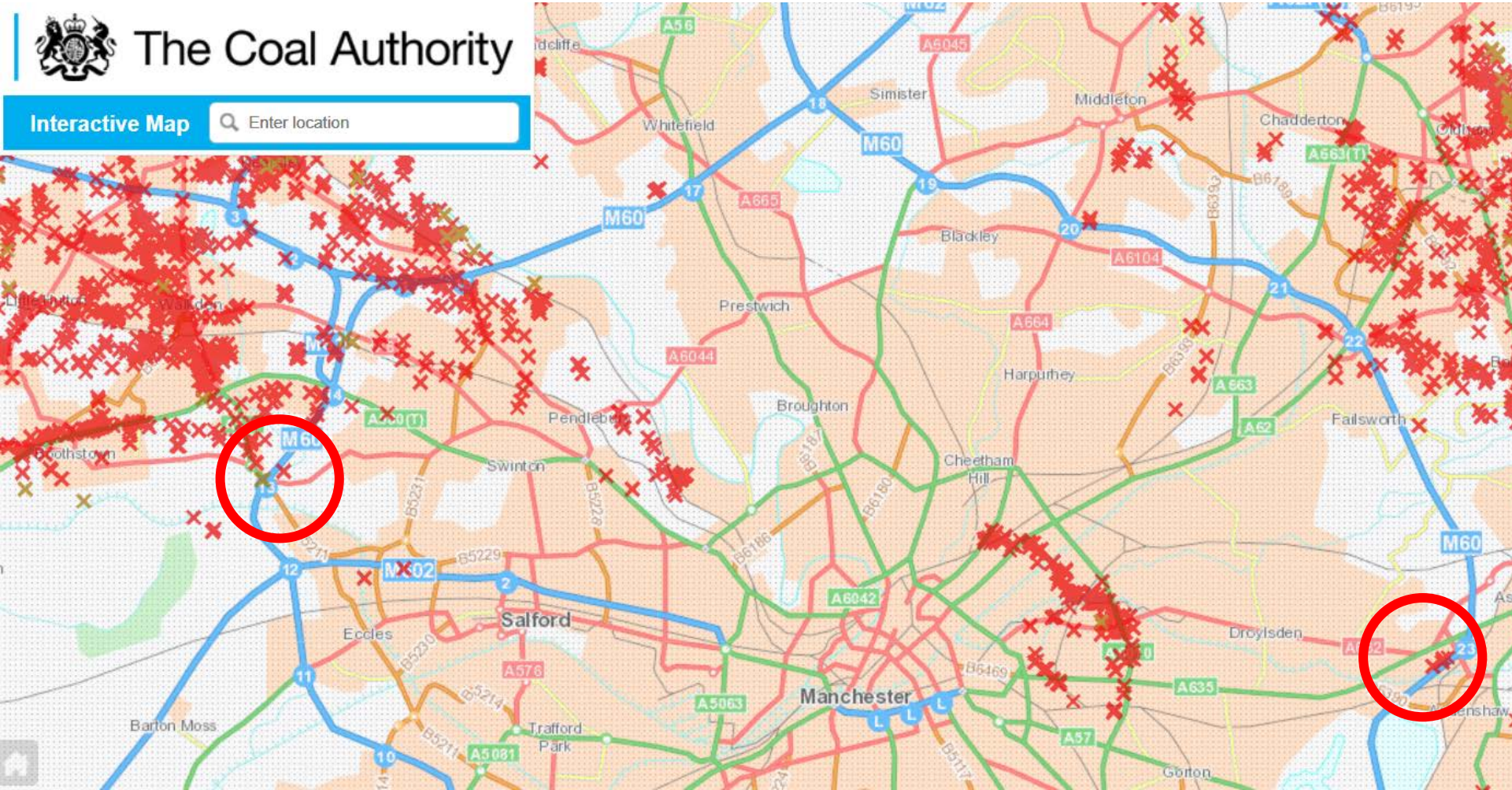
Coal Mine Entries



The Coal Authority

Interactive Map

Enter location



<http://mapapps2.bgs.ac.uk/coalauthority/home.html>

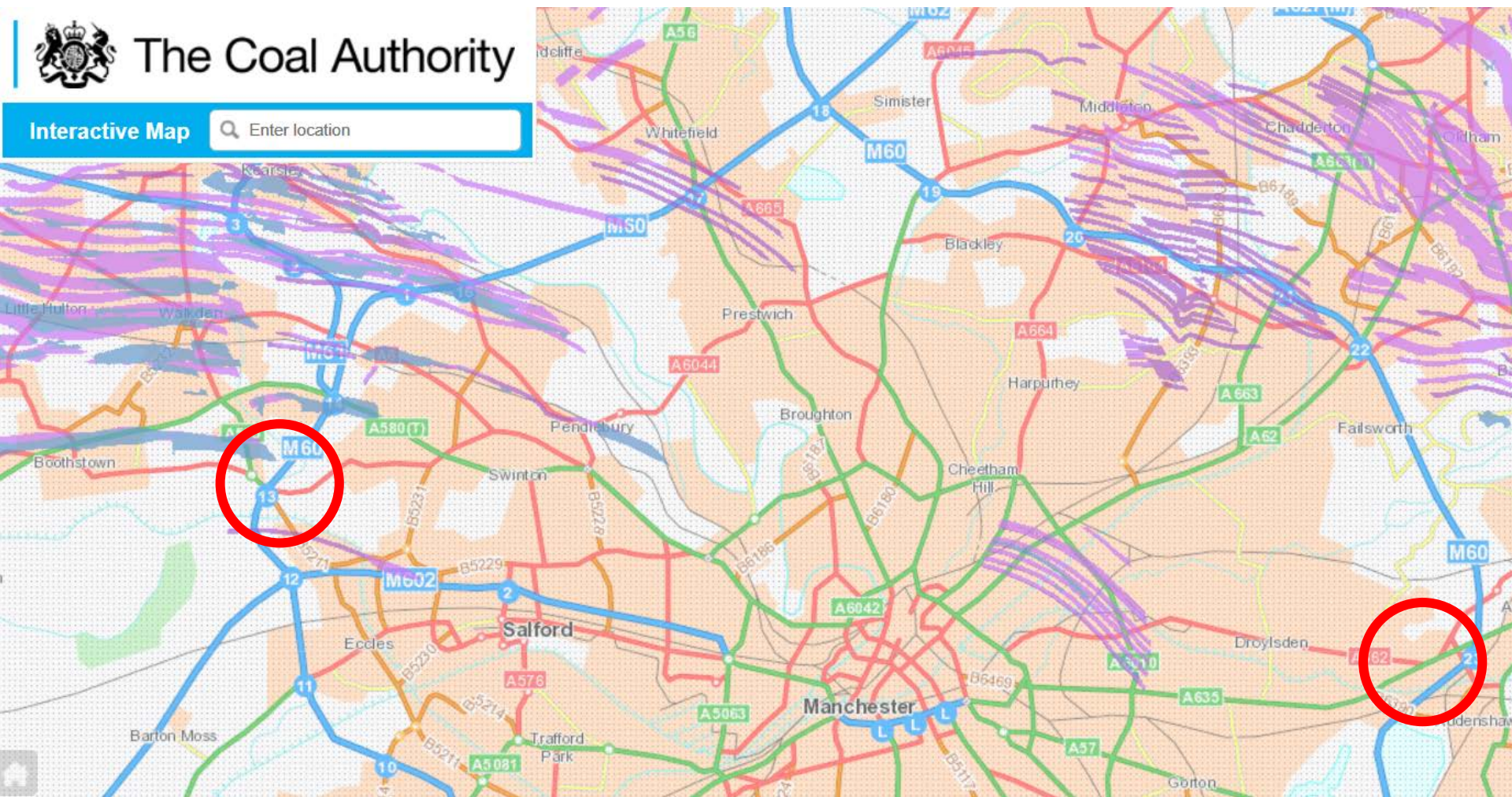
Past Shallow Coal Workings



The Coal Authority

Interactive Map

Enter location



<http://mapapps2.bgs.ac.uk/coalauthority/home.html>

South Lancashire Coal field



Worsley Depth, Salford

Innovations included the development of the canal network .

At Worsley the Bridgewater canal was extended into the Walkden mining district as an underground drainage system draining approximately 25 sq miles of coal mines

Parsonage Colliery Main Shaft Gas Vent 2013



- Large areas of former workings open and interconnected
- Main shaft was used to vent mines gas safely to atmosphere
- Other areas where drainage turned off there has been rising groundwater and workings have been flooded

Ashton Moss Colliery



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**Carbon Dioxide Incident in Gorebridge,
Midlothian, April 2014**

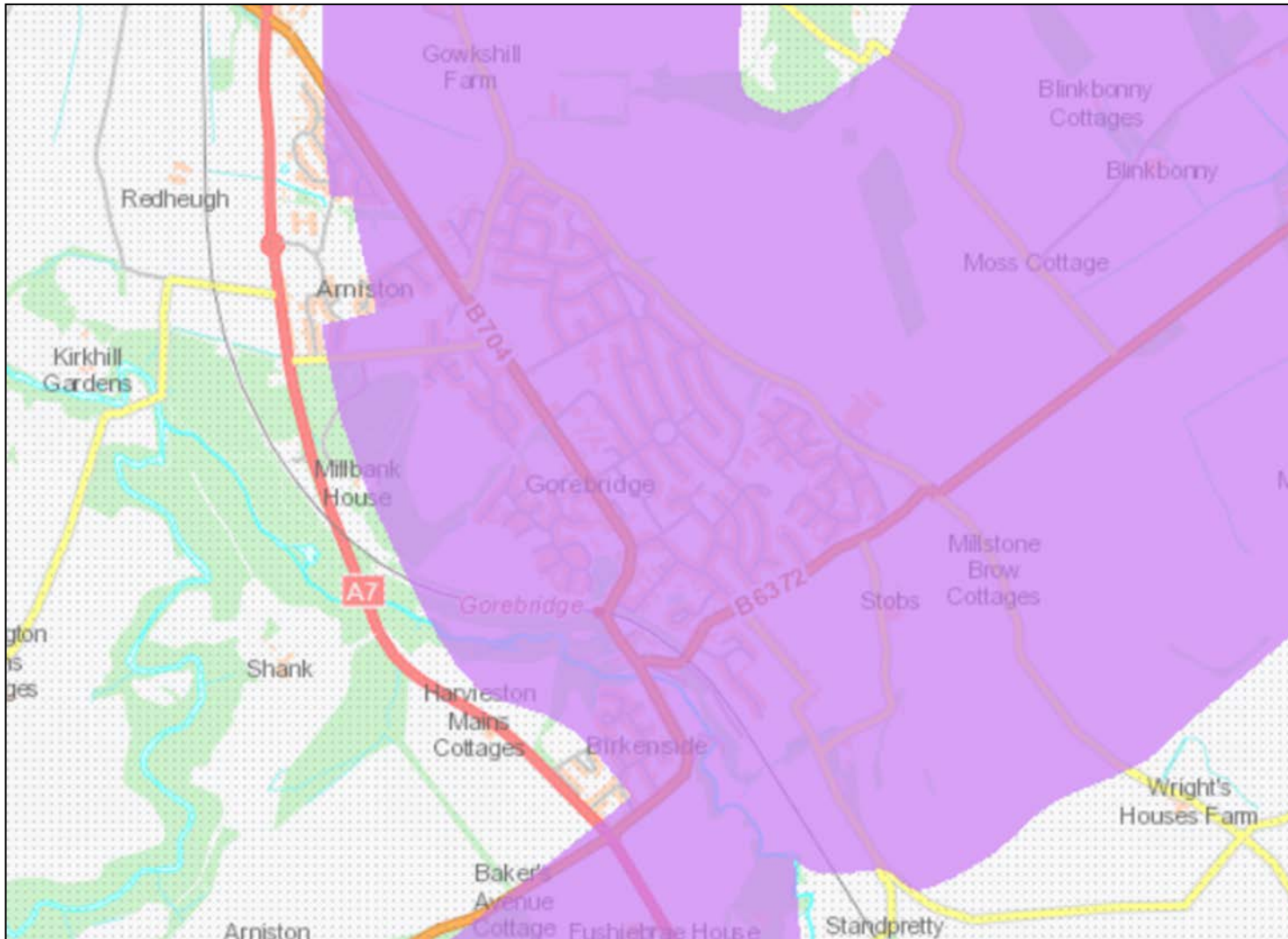
**Final Report of the
Incident Management Team**

November 2017

Chronology

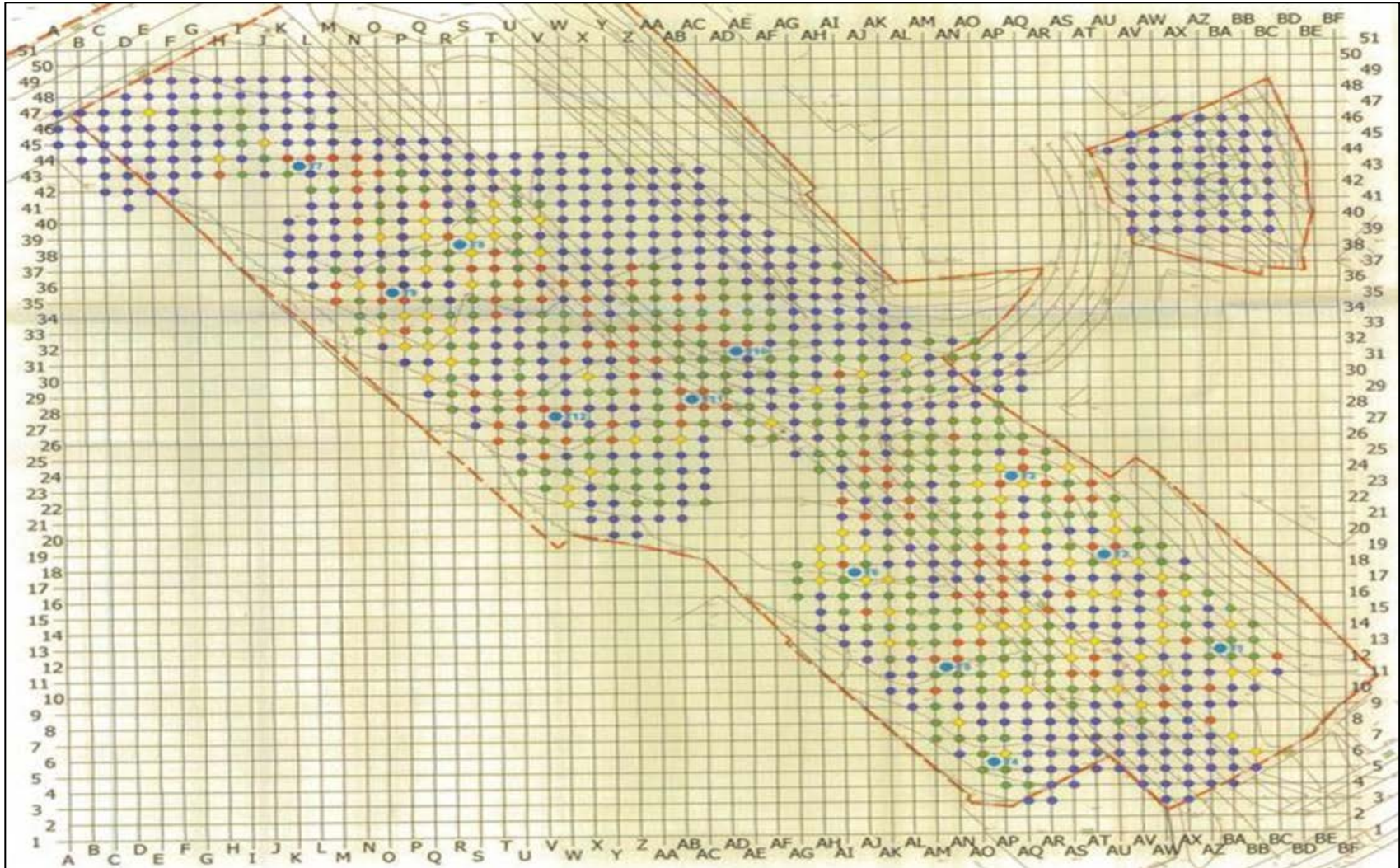
- 2006 Desk Study identifies possible mines gas
- 2006 SI & Risk Assessment doesn't find ground-gas
- Consultants conclude 'low ground-gas risk' – no gas protection measures required
- 2009 sixty four homes built
- Sept 2013 first residents taken to A&E
- April 2014 IMT set up
- by Sept 2014, 22 people had attended A&E or local GP

Gorebridge - Area of Probable Shallow Mine-workings



The Coal Authority

Coal Working Drilling & Grouting Stabilisation



- <1 Tonne
- 5-10 Tonnes
- Pressure Test Borehole
- 1-5 Tonnes
- >10 Tonnes

2013/14 Coal Authority Investigations

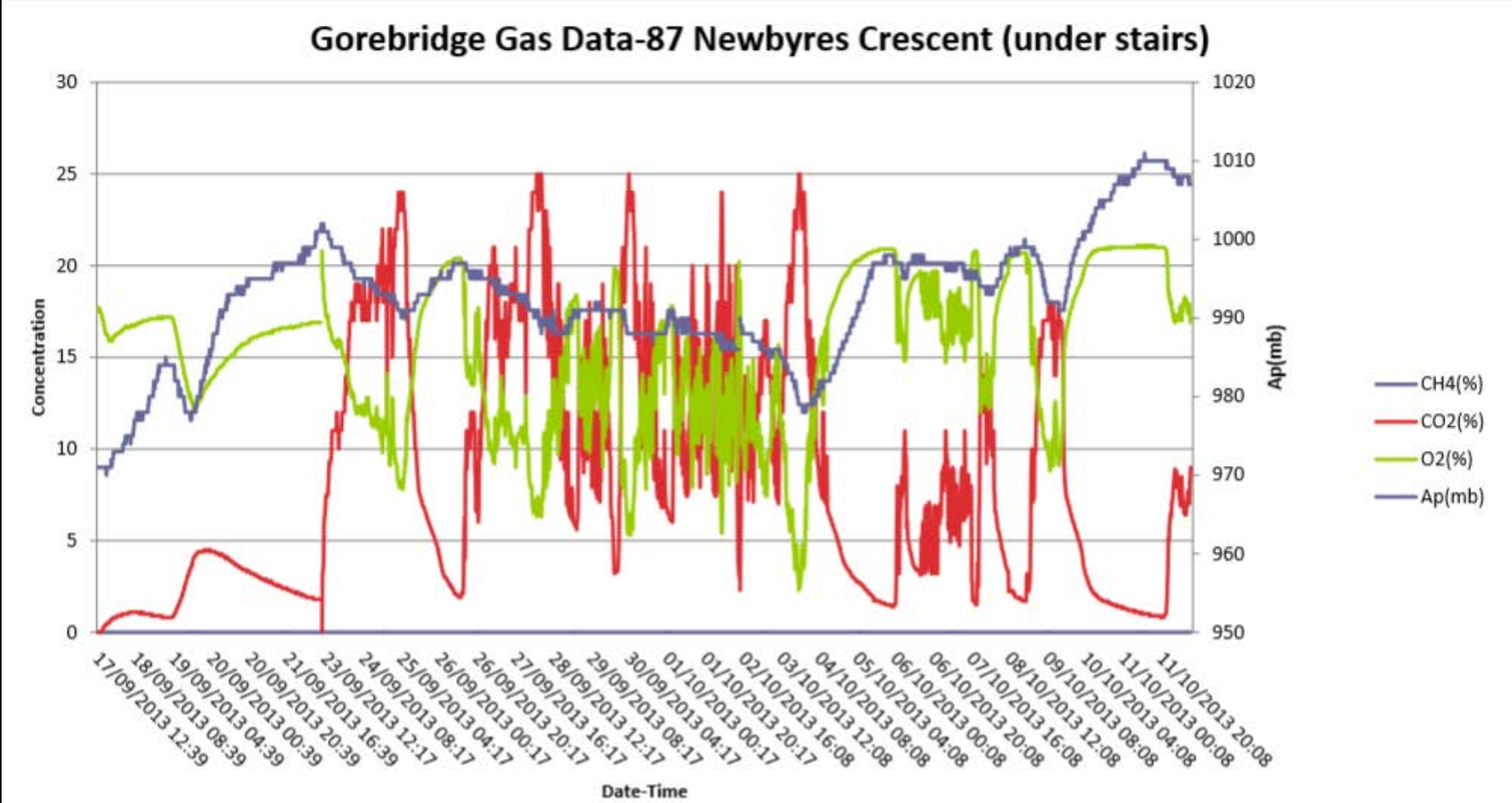
87 Newbyres Crescent found to have:

- **8%** CO₂ in downstairs toilet
- **12%** CO₂ in Lounge (where son had been sleeping)
- **19%** CO₂ beneath kitchen flooring
- **21%** CO₂ measured in hole drilled through raft
- **23%** CO₂ in wall cavity

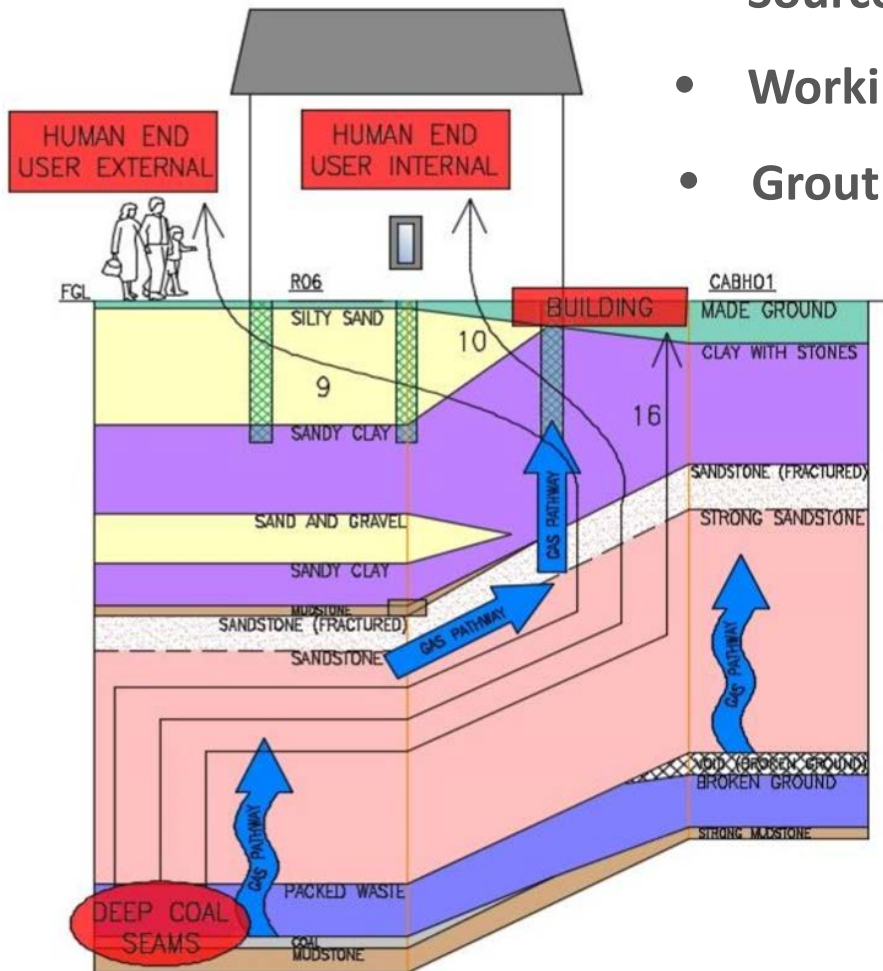
Borehole drilled to the shallowest coal seam at 13m bgl:

- **25.1 %** CO₂ & **4.6%** O₂
- **No grout was found in the coal seam**

Continuous gas monitoring



2017 IMT Report Conclusions



(IMT Report – from Fairhurst)

- Source confirmed as worked coal seam
- Workings not fully grouted
- Grout holes beneath houses possibly not sealed
- SI boreholes beneath houses possible not sealed
- Vibro stone column foundations
- Service entries through raft not sealed
- No gas protection measures installed
- Highest CO₂ associated with falling atmospheric pressure

“Was this was an entirely preventable incident?”

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Mines Gas as a Resource

Former mine workings which:

- are actively degassing,
- have open voids, and
- have surface space for a production pad.

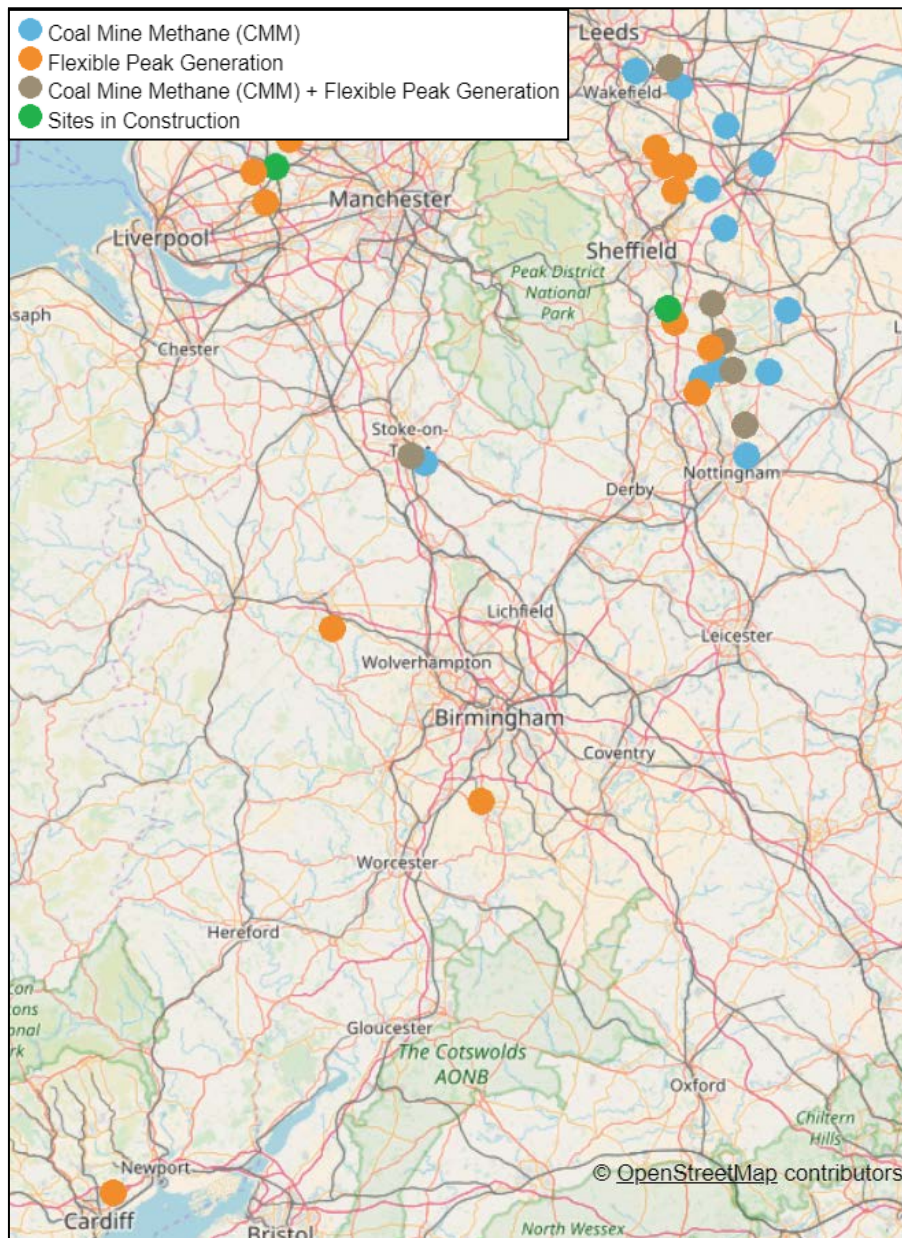
Can be potential commercial sources of methane.

Alkane Energy

Is a UK onshore petroleum operator that utilises methane from abandoned mine workings for power generation for more than 20 years - **Gas to Power.**

- 30 sites across the UK.
- Total installed generating capacity - 160MW.

Alkane Generating Sites in the UK:



Coal Mine Methane (CMM):

Askern, Bevercotes, Bilsthorpe, Cadeby, Florence, Gedling, Kings Mill Hospital, Maltby, Newmarket, Sherwood, Prince of Wales, Edenthorp

Flexible Peak Generation:

Grimethorpe, Houghton Main, Hickleton, Manvers, Markham, Cardiff, Redditch, Shirebrook, Haydock, Telford, Kirkby, Leopold, Star Lane

CMM and Flexible Peak Generation:

Hem Heath, Mansfield (Toray), Wheldale, Warsop, Whitwell, Calverton

Sites Under Construction

Ince, Staveley

Prince of Wales, Yorkshire

Coal Mine Methane Site



©Alkane Energy

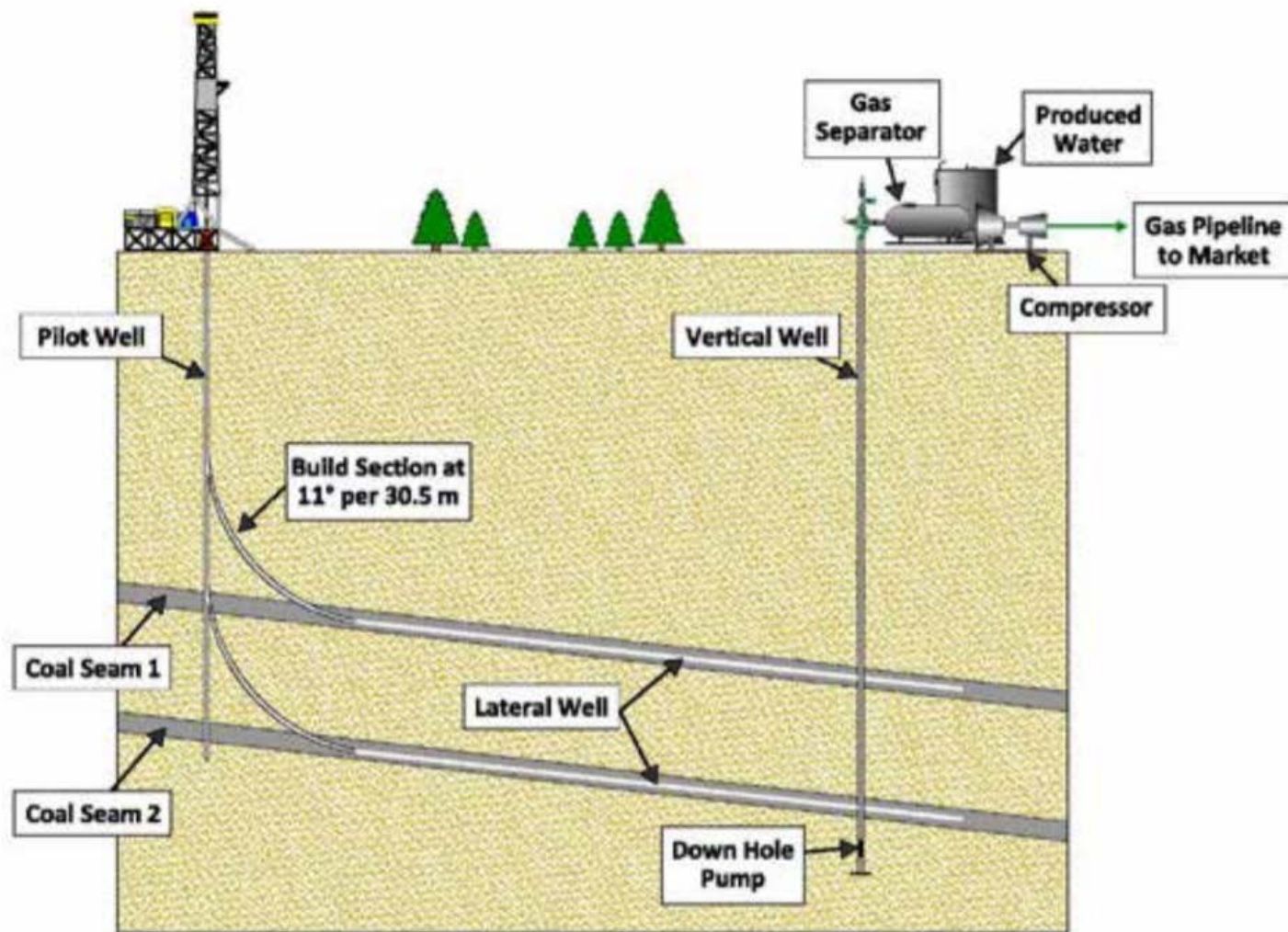
Bevercotes Site, Nottinghamshire

Coal Mine Methane Site



©Alkane Energy

Future Opportunities - Unworked Coal Coal Bed Methane



UNECE, Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines, 2nd Ed., Dec. 2016:

References:

NHS Lothian, Carbon Dioxide Incident in Gorebridge, Midlothian, April 2014. Final Report of the Incident Management Team, Nov, 2017:

<https://www.nhslothian.scot.nhs.uk/MediaCentre/PressReleases/2017/Pages/Report-published-into-CO2-incident-in-Midlothian.aspx>

The Coal Authority – Online Maps:

<http://mapapps2.bgs.ac.uk/coalauthority/home.html>

UNECE, Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines, 2nd Ed., Dec. 2016:

https://www.un-ilibrary.org/environment-and-climate-change/best-practice-guidance-for-effective-methane-drainage-and-use-in-coal-mines-second-edition_19eb00aa-en

Alkane Energy Website:

<https://www.alkane.co.uk/>



Thank you

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