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# The Environmental Consequences of Opencast and Deep Mining

Extracting minerals from the surface of the Earth or below the surface requires moving a lot of earth. Although reclamation of land disturbed by mining operations is required by law, some disturbances are permanent. Processing of coal creates waste that must be carefully controlled to avoid leakages into surrounding ecosystems (see case study 2). In some areas, old mines abandoned before the beginning of strict regulation of mining operations pose a problem. In many cases, the companies that operated these mines are no longer in existence so it is difficult to assign liability for the costs of cleaning up the site.

### Opencast Mining

Opencast coal now accounts for over a third of the UK's total coal output (mainly due to the decrease in deep-mining as a result of pit closures in the 1980s). Opencast coal activities currently take up over 12,000 hectares of land, the equivalent of a hole 50 square miles wide and 100 metres deep. Of the 17,300 jobs in the UK coal industry, 3,719 are in opencast mining. Tables 1 and 2 give some idea of the amount of coal produced per year in the UK and how much is remaining, Fig 1 shows how opencast coal production has varied over the last twenty years:

**Fig 1 Opencast Coal Production 1986-2005**

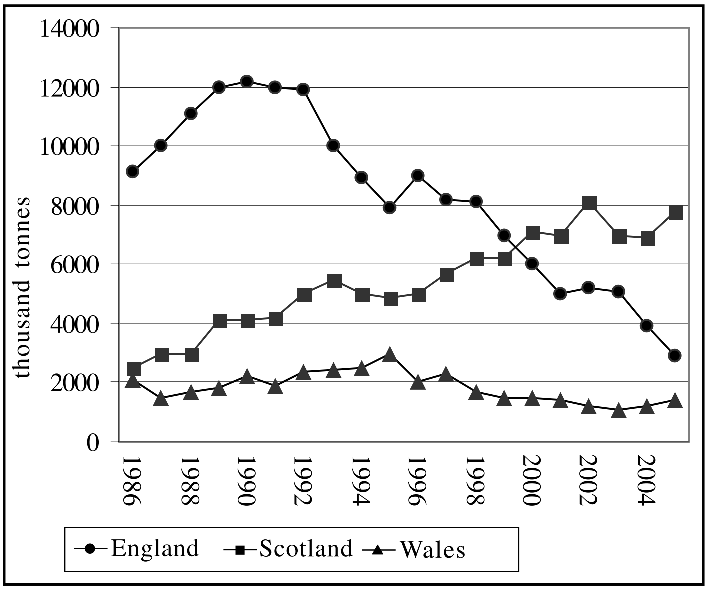



**Table 1: Great Britain: opencast coal production in 2003–2004**

| Mineral Planning Authority | 2003 | | 2004 | |
|---|---|---|---|---|
| | Tonnes | Operational sites | Tonnes | Operational sites |
| England total | 4,068,264 | 20 | 3,040,371 | 20 |
| Wales total | 1,188,915 | 9 | 1,405,493 | 11 |
| Scotland total | 6,868,912 | 22 | 7,546,849 | 24 |
| Great britain total | 12,126,091 | 51 | 11,992,713 | 55 |

**Table 2: Great Britain: reserves of opencast coal remaining in operational sites at 31st December 2003 and 2004**

| Mineral Planning Authority | 2003 | | 2004 | |
|---|---|---|---|---|
| | Tonnage remaining | Number of sites | Tonnage remaining | Number of sites |
| England total | 5,156,393 | 16 | 2,760,142 | 12 |
| Wales total | 5,190,439 | 7 | 4,032,434 | 9 |
| Scotland total | 17,649,058 | 14 | 30,453,490 | 21 |
| Great Britain total | 27,995,890 | 37 | 37,246,066 | 42 |

In order to open a new opencast mine planning permission must be sought. This takes into consideration the impact of the mine on the surroundings via an Environmental Impact Assessment (EIA), see case study 1.

Tables 3 and 4 show the number of planning applications made by extraction authorities for new opencast sites that were approved and refused.

**Table 3: Great Britain: applications for opencast coal which have been granted planning permission during 2004**

| Authority | Applications approved | Total hectares | Total reserves (tonnes) |
|---|---|---|---|
| England total | 5 | 121 | 1,181,000 |
| Scotland total | 3 | 577 | 2,100,000 |
| Wales total | 1 | 400 | 2,100 000 |
| Great Britain total | 9 | 1098 | 5,381,000 |

**Table 4: Great Britain: applications for opencast coal which have been refused planning permission during 2004**

| Authority | Applications declined | Total hectares | Total reserves (tonnes) |
|---|---|---|---|
| England total | 3 | 207 | 2,210,000 |
| Scotland total | 1 | 118 | 900,000 |
| Wales - Nil return | | | |
| Great Britain total | 4 | 325 | 3,110,000 |

Opencast will not be used if extraction costs are too high and profits are too low (i.e. 'reduced viability'). It is relatively simple and cheap, highly mechanised and is safer for the work force compared to deep mining. Opencast coal extraction can be a relatively short-term land use and most of the excavated material can be returned to the ground. Reclamation can bring about improvements to landscapes, particularly where development takes place on previously derelict land. The industry also provides vital employment opportunities, particularly in rural areas.

***Case study 1 Glasgow, Scotland***

*A planning application to extract coal from an 11.8 hectares area of Green Belt land at Lochwood Farm, Glasgow was lodged in 1987. The application was complicated by four specific landscape features:*

- *The existence of Bishop Loch, an S.S.S.I., the presence of the M73 motorway, the existence of Drumpellier Country Park, and the presence of a large urban area dominated by public sector housing.*

*An EIA was prepared in readiness for the inevitable Public Inquiry, it revealed:*

- *Studies of noise generation by heavy machinery showed that noise levels one kilometre from the site were not likely to increase from a background level similar to rush-hour traffic. The depth of the excavation would confine much of the noise.*
- *Dust particle size would result in rapid fallout from the atmosphere. The prevailing wind would blow the dust away from the urban area.*
- *Security fencing would prevent children from gaining access to the site, and the location would present no significantly different safety hazards to that of Bishop Loch.*
- *Strength tests on the motorway embankment foundation suggested that a short-lived excavation would not cause problems and that if correctly infilled, long term stability problems should not occur.*
- *To prevent the accidental drainage of Bishop Loch the developer agreed to remove the north west extraction area from the planning proposal.*
- *Assuming that the ground water table was not altered and that contaminated water was not allowed off site there was little evidence to suggest that the flora of Bishop Loch would be damaged.*
- *Some birds might be disturbed by the noise of machinery but, in general, birds are able to adapt to background noise.*

*The EIA resulted in the following proposals being placed in the application:*

- *The land would be stripped of overburden, the coal extracted, to a maximum depth of 30 metres, and the overburden replaced.*
- *Apart from the removal of coal no other material would be added to or removed from site.*
- *No explosives would be used during the life of the site.*
- *Security fencing would be installed around the perimeter of the site.*
- *Work would be confined to normal working hours, 07.00 and 19.00hrs, Monday to Friday.*
- *No heavy vehicles would travel through the adjacent housing area.*
- *Extraction of coal would be complete in two years with a further one year for rehabilitation.*
- *On completion of the work the contractor would offer the site for a nominal sum of £1 to a local public organisation for subsequent use as an urban farm or conservation area.*
- *The contractor would reseed and undertake tree planting.*

*A public inquiry into the proposed opencast site at Lochwood resulted in the Secretary for State refusing planning permission. The reasons for refusal were:*

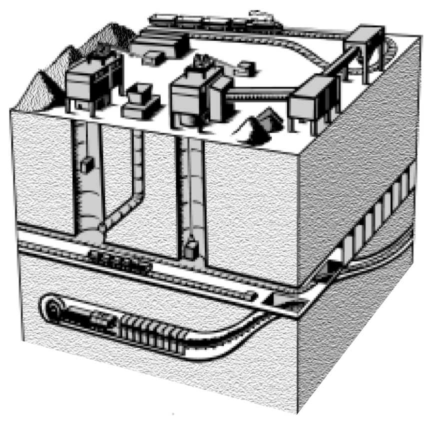
- *Lack of evidence to support a local need for the coal mined at the proposed site.*
- *Lack of clear evidence that the local hydrology would remain undisturbed by the workings.*
- *Lack of clear evidence that local bird life would remain undisturbed by the workings*
- *Concern that planning consent would result in a flood of applications for development in the Green Belt, some of which would not generate environmental gain.*

## Deep mining

Most coal seams are too deep underground for opencast mining. Deep mining is very expensive because it requires a lot of manual labour and machinery; it involves digging lots of horizontal tunnels and vertical shafts.

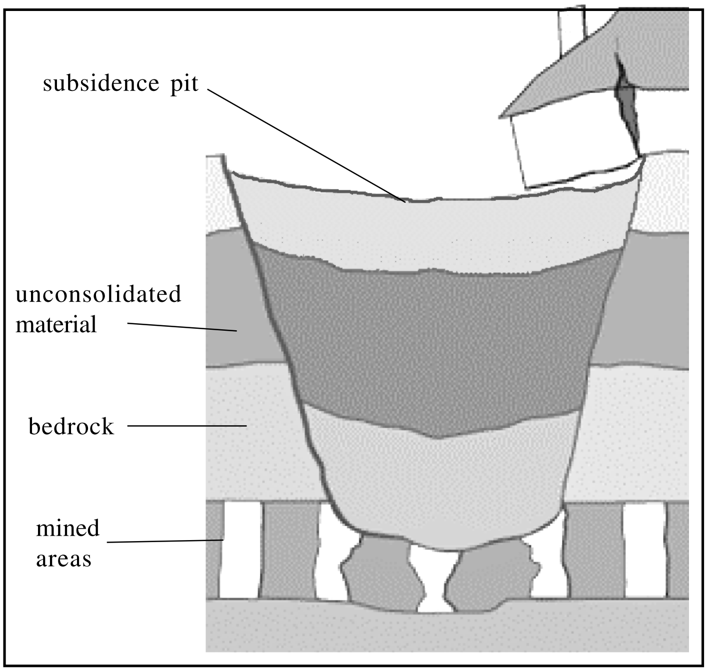
Due to the cost, deep mining is only used if:

1. The coal is mostly high grade (i.e. lots of profit can be made upon sale).
2. The coal seams are thick i.e. there is a lot to mine before you need to dig another shaft or tunnel, which takes both time and money.
3. The coal seams are nearly horizontal, not fractured or faulted, so coal is easy and quick to get at from one tunnel.
4. There are no drainage problems as flooding is always a danger to the workforce.
5. The rock above the seam is safe and stable therefore so it will not cave in above the workers (i.e. 'suitable overburden').



## Subsidence
This can occur as a result of deep mining. Subsidence, in the context of underground mining, is the lowering of the Earth's surface due to collapse of bedrock and unconsolidated materials (sand, gravel, silt, and clay) into underground mined areas (Fig 2).

**Fig 2 Subsidence**




Mine subsidence, like an earthquake, is a geological hazard that can strike with little or no warning and can result in very costly damage. Unlike an earthquake, mine subsidence generally affects very few people. However, if a mine collapses under a motorway, for example, many lives and industries are affected. Mine subsidence in March 1995 caused a portion of an eastbound stretch of motorway in Ohio, USA to collapse. This subsidence event and the following repair work closed the motorway for several months, costing an estimated $3.8 million. Mine subsidence can also cause foundation damage to buildings, disrupt underground utilities, and be a potential risk to human life. In the UK insurance claims for subsidence now total more than £400 million.

## Coal Mine Methane
Methane is a natural product resulting from the decay of organic matter. As coal forms, methane produced is adsorbed by the coal. In a natural gas reservoir, such as sandstone, the gas is held in spaces within the rock, methane in coal it is held under pressure on the surface of the coal. The release of this pressure through fracturing of the coal allows methane to escape. Methane is a greenhouse gas which, according to the Inter-Governmental Panel on Climate Change, has a global warming effect 21 times greater than that of carbon dioxide over a 100 year time horizon.

The methane continues to emit from mines and collect in them after closure. Recently the concept of collecting the gas from abandoned mines to provide an energy source which would otherwise be waste has been developed. This is called Coal Mine Methane (CMM). It can be extracted by using the existing mine shafts where they remain open, or by drilling from the surface into the abandoned workings. The commercial exploitation of this methane will allow it to be safely harnessed, providing energy whilst also reducing ventilation of greenhouse gases into the atmosphere and make a major contribution to meeting Kyoto reduction targets.

To date, six projects have been completed by private sector companies. There are over 900 former deep mines in the UK containing an estimated 32 billion $m^3$ of methane, it is clear to see why many more being planned over the next few years.

### Acid Mine Drainage
All forms of mining are likely to generate areas where coal is stacked and where the coal has significant sulphur content, such coal heaps generate highly acidic metal-rich drainage. This can also arise form abandoned coal mines, stocks, handling facilities and waste tips. Subsurface mining often progresses below the water table, in which case water must be constantly pumped out of the mine in order to prevent flooding. When a mine is abandoned, the pumping will cease and the water table will return to its former position, flooding the mine. Coal mines may generate highly acidic discharges where the ore extracted is iron sulphide. This can be broken down into metal ions and sulphuric acid by colonies of bacteria. These microbes occur naturally in the rock, but limited water and oxygen supplies usually keep their numbers low. Acidophiles (bacteria adapted to acidic conditions) favour the low pH levels of abandoned mines. This acid can then drain into water bodies surrounding the coal mine, lowering the pH, killing aquatic flora and fauna that are unable to tolerate low pH.

Some mines dating from Roman times are still producing acid drainage and here in the United Kingdom, many discharges from abandoned mines are exempt from regulatory control. In such cases the Environment Agency has provided innovative solutions, including constructed wetland solutions (see below) such as on the River Pelena in the valley of the River Afan near Port Talbot.

## Solutions to Acid Mine Drainage

### Carbonate neutralisation
Generally, limestone that could neutralise acid is lacking at sites that produce acidic discharge. Limestone chips may be introduced into sites, neutralising the acid. Where limestone has been used, such as at Cwm Rheidol in mid-Wales, the impact has been much less than anticipated. An insoluble calcium sulphite layer forms on the limestone chips preventing further neutralisation.

### Constructed wetlands
Constructed wetlands systems may be a more cost-effective treatment alternative to artificial treatment plants. A range of bacteria and other microbes along with wetland plants may be used to filter out heavy metals and raise pH. Anaerobic bacteria in particular are known to be capable of reverting sulphate ions into sulphide ions. These sulphide ions can then bind with heavy metal ions, precipitating heavy metals out of solution and reversing the entire process.

***Case Study 2 Kentucky, USA***

- *On 11th October 2000 a Massey Energy coal impoundment (where coal waste is produced and disposed of) sent 306 million gallons of black coal slurry into the Big Sandy River and its tributaries.*
- *To put it in context, this caused more damage than the 1989 Exxon Valdez oil spill off the coast of Alaska.*
- *The spill was a result of a thinner than regulation barrier between the underground mine and the impoundment eroding away.*
- *This barrier was constructed as a result of an earlier leak in 1994.*
- *Slurry from the impoundment broke into an adjacent deep mine, discharged to the surface and impacted over 75 miles of streams in Kentucky and West Virginia.*
- *The spill killed fish, contaminated drinking water and covered gardens in over two metres of thick black coal slurry.*
- *The area has still not recovered from this disaster.*

***Summary of the Arguments For and Against Opencast and Deep Mining***

| ***Arguments for:*** | ***Arguments against:*** |
|---|---|
| • *Existing derelict land could be improved and provide amenity and future development opportunities.* | • *Proximity to communities can have a detrimental effect not only on the environment but also on the quality of life for local people* |
| • *The removal of all coal and related minerals in one go may eliminate uncertainty over future disturbance for local communities.* | • *There is uncertainty regarding the possibility of increased environmental impacts due to site extensions.* |
| • *The distance of the proposal in relation to local communities may not raise significant impacts.* | • *There may be other developments close by that could subject a local community to a cumulative environmental disturbance.* |
| • *Traffic can be re-routed to avoid disturbance to local habitats.* | • *Disruption from noise (including blasting), pollution of land, air and water can be recurring problems.* |
| • *Extraction may reveal or enhance earth science conservation features.* | • *Radical change to the local landscape is an inevitable, if short term, consequence of opencast working. Even after restoration, it can take many years for the landscape to return to its former state.* |
| • *Restoration will provide new landscape benefits in keeping with the landscape character of the area or new habitats could be created.* | • *The impact of extraction can restrict efforts to attract and retain investment in an area.* |
| • *Acid discharge could be controlled.* | • *Local opportunities for recreation and access to the countryside could be lost.* |
| • *Jobs created* | |

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