The Past We Inherit the Future We Build: Abandoned Mines and Minewater Pollution

By James M. Ellison

Centre for Environmental Strategy, University of Surrey

Introduction

For many of us in the North East of England the 110th Durham Miners Gala on 9th July 1994, still being the largest annual political gathering in Britain, is major event our calender. It is a place where people take stock, reflect on the past and through cultural and historical bond optomistically build a context to the future. Many were trying to make sense of the closure of the Durham coalfield and the term `stopping the pumps' had taken on a very different dimension; this time it seemed "they were stopping the lot". Abandoned, with an inherited legacy of potential minewater pollution ,but paradoxically not forgotten as it turned out to be the biggest attended Gala for almost twenty years. And the emotion of recent events was portrayed in a poignant reminder by the Area President when he remarked in his message to the Gala that:

The villains of the piece, British Coal, have uprooted and absconded from the region like thieves in the night, leaving behind the unemployment and the social and environmental decay in their wake. (1)

If groundwater rebound after the closure of the coalfield becomes a problem here then equally it is a global problem related to economic and social change. However, if anyone thought the era of coalmining was over then that is ignoring its historical antecedents. Any future policy and strategy depends as much on the constitution of democratic regulatory frameworks and institutions as on the political will to manage minewater as an integral part of the socio-economic/environmental life-cycle of coal as a fuel. New Life Cycle Analysis (LCA) methodologies for this are now being developed, based upon the PEMS database, at the Centre for Environmental Strategy at Surrey University. LCA is a method for determining the environmental performance of a process or activity providing quantification of impacts say to water and generation of wastes and evaluates opportunities to effect environmental improvements. This paper looks to the future while building on past experiences in the North East of England, Russia\Ukraine, and in the United States, arguing for an `environmental mining contract' of a Cradle to Grave Programme in Britain for new mines and re-opened mines within a transparent planning and regulatory framework.

Ellison - The Past We Inherit the Future We Build: Abandoned Mines and Minewater Pollution

North East England

British Coal is currently proceeding with its colliery closure and privatisation programme. Twenty eight mines were up for lease, advertised to the private sector, but only nine have been taken. With 19 mines apparently unsaleable according to British Coal they may eventually close each operation down. The political crisis over this issue could have been diffused yet the decision to proceed with the closure programme has certainly raised the conciousness of the public over minewater pollution (Table 1.). The prospect of mine abandonment poses serious problems for the environment and public health from the cessation of pumping minewater. For it is not just Acid Mine Drainage (AMD) that poses the problem but the possiblity of that in rising groundwater intersecting some landfill sites, mobilising hazardous materials.

Table 1

Discharges from Coal Mines which Cause Significant Pollution Problems

(By Original National Rivers Authority Region)

Region	Discharges by No.	km Affected	BC	Other Coal	Working	Abandoned
Northumbria	15 (all)	18 (12)	11	4	4	11
North West	24 (14)	57 (25)	19	5	Nil	24
Severn Trent	4 (all)	19 (4)	Nil	4	Nil	4
Welsh	21 (all)	54 (22)	6	15	Nil	21
Yorkshire	36 (most)	50 (11)	Most	Few	Nil	36
Total	100	198				

Source: NRA March 1994

The Wheal Jane experience in Cornwall graphically illustrated the government's approach until recently to potentially identical problems in the North East.

The British Government took no action and pollution reached the groundwater in November 1991. In January 1992, the pollution reached the river Carnon. On January 26th 1992 it was calculated that 9 million litres of polluted water were pouring out of the mine daily...(2)

Until the 'Memorandum of Understanding' between British Coal and the NRA (18/11/93), British Coal had stated that pumping will cease at the stations and maintain they have no legal responsibility under the Water Resources Act 1991, (s.88/89). However, the NRA were adamant that they would use their powers under Water Resources Act 1991,(s.161) to ensure preventitive or remedial action was taken as a consequence of minewater rebound to prevent pollution and or the polluter will pay irrespective of qualifications. Clearly, they believed they had a case to answer if deliberate cessation of pumping operations causes pollution of the groundwater and compromises the integrity of landfill sites. Now its a question of 'watch this space for the future' as one senior NRA person put it.

However, British Coal minewater team expect the new Coal Authority to pick up the tab for the maintenance of the pumping operations and cover any litigation. The government in turn are keen to see that liabilities from cessation of mining operations are `capped' to realise the maximum value of the mines by minimising the inherent future costs for the prospective buyers. But as there are no takers for 19 remaining pits. it is understandable that the NRA have advised British Coal that they now must give them 3 months notice of their intension to close a mine.

Policy and Strategy

Progression from the present impasse is important for managing future minewater during coal production and after closure of collieries. Environmental responsibility should be such that the abandonment of the mine should be managed in a controlled way as part of the `Life Cycle of Production'within a Cradle to Grave Programme with government even taking into account the social-economic and environmental cost to the PSBR and the local community. Operators of mines should be mindful of their responsibility to maintain the quality and condition of the mine, its waters and the associated chemical constituents as part of a sustainable activity in the production of coal so that it forms a a preventative measure for the future of the area. As this is in the national interest, supportable grants should be available provided the mine owner maintains some form of `environmental mining contract' as part of the Cradle to Grave life of the working and abandoned mine.

Two essential elements within this should be similar to that for opencast mining operations. Firstly, appropriate financial bonds following LCA and contained in a Cradle to Grave Programme of the proposed mining operation, one for the impacts of the production cycle upon inland and coastal environments and communities (pace the Durham Coastal Spoil) and one specific to minewater and water quality. This would take into account such measures as socio-economic and environmental impacts, the markets for the coal, the proper and full utilization of the coals to the appropriate markets, the predictive analysis of flow distribution showing the `transmissivity' of the hydraulic system, the predicted discharge locations and rates and aftercare arrangements such as pumping and treatment plants. Secondly, appropriate technological support to process the water during and after production to appropriate quality standards. From my own experience the NRA have confirmed:

> **Certain materials or chemicals which could have been removed may have been left in the mine and then shown to be the origin of the subsequent cause of pollution. Certain deliberate steps may or may not have been taken below ground, which adversely affected the condition and location of the emerging water.(3)**

The main attention of legislation with regard to minewater should be to focus upon `the intended or consequential action of mining operations to change the hydraulogical and water quality conditions in a given area by virtue of those mining operations'. Provision for amelioration or rehabilitation of a mining area when mines are abandoned would best be regulated through the planning system by a local authority, having specific knowledge of an area,. Already opencast operators have to enter legally binding agreements for aftercare conditions under Section 106 of the Town and Country Planning Act 1990. These conditions run with the land whoever owns that land and carry a financial bond. To convert this process to cover minewater discharge would require the agreements to be specific to aftercare conditions

pertaining to discharges and similar to those financial guarantees on water pumping in DoE Circular 25/85 on sand and gravel workings. A Mineral Planning Guidance Note on the construction of a Cradle to Grave Programme would be give some framework to the mining operator and the planners alike. However, in the case of deep mines some technical back-up guarantees would be required to periodically monitor and maintain the quality of the discharges.

With the advent of an £8 billion new market in clean coal technology within the next few years (4) the possibility of new mines opening under a Labour Government is very real. This presents an extremely good opportunity to provide a LCA of a coal-mine to account and develop provision for socio-economic, technical, legal, financial and continual environmental aftercare agreements especially for groundwater rebound. The historical legacy of previous operations (pre-1947) should be accounted for by the previous operators of re-opened mines sharing the burden with the State (1947-1994). After all, it is only recently that annuities paid to previous coal owners totalling at least £388 million over 50 years have ceased(5). Those new sections of mines that are to be re-opened should come under a similar contract agreement as for new mines to restore and guarantee pumping for amelioration of minewater discharges. resultant from their operations. It is worth noting that a year ago a background report from E.C.(6) proposed to assess the "usefulness of civil liability as a means of allocating responsibility for the costs of remedying environmental damage and of preventing future damage".

Where NRA Catchment Management Plans (CMP) allied to statutory Water Qualities Objectives for long abandoned mines compliments the policy and strategy approaches outlined here. For if a long abandoned mine is to be re-opened then the LCA and the cradle to grave programme would be actioned in tandom with the CMP and within a regulated framework.

We are not forgetting the varying degrees of integrity of some landfills sites, former and current in the coalfield which could compromise mine water discharges or be compromised by groundwater rebound. Furthermore, it is conceivable that rising groundwater interacting with residual subsidence movements in bord and pillar and even longwall workings of the coalfield (7,8) could combine to mobilize heavy metals, disturb pockets of methane and force them to the surface. Additionally, the hazard posed by dissolved methane has been consistenly underestimated due to the inadequacies of the available groundwater sampling methods (9), Certainly, in one sense the NRA(3) by suggesting a co-ordinated approach to the combined problem of water quality from abandoned mines (Table 2) and contaminated land sites readily accepts the possible relationship between the integrity of landfill sites being compromised by and interacting with minewater discharge and polluting the groundwater. The fear of course is not so much of the individual impact of chemicals, biological constituents or heavy metals but their combined `cocktail effect' with AMD on the water quality.

Not having British data to hand Table 3 represents the best available information of Municipal Solid Waste (MSW). Keele Valley landfill currently produces leachate at a rate of 1.5 litres per second (L/s) and contains 16 million tonnes of waste(10). However, the problem in the coalfields is that many of landfill sites lack integrity, are contaminated with industrial waste which is often of unknown quantity even though the type of waste is known and are politically sensitive (11).

Table 2 - Water Quality of Current Pumped Discharges

Site Name	pH	TDS (mg/l)	Cond (µS/cm)	Fe total (mg/l)	Zn total (mg/l)	SO_4^{2-} (mg/l)
Kibblesworth	7.1	3185	4900	0.630	0.056	690
Lumley 6th	7.1	2700	3400	1.110	0.003	500
Chester Moor	7.2	3140	3410	0.800	0.024	820
Nicholsons	7.1	3100	3620	5.800	0.034	1170
Kimblesworth	7.3	1800	1960	5.000	0.030	380
Ushaw Moor	6.9	1000	1366	0.865	0.060	580
Sherburn Hill	7.3	2090	2380	8.600	0.035	840
Page Bank	6.8	1930	2300	0.745	0.019	775
Vinovium	6.9	1560	1847	1.250	0.049	600

Information collated from entries on the public register of the National Rivers Authority. TDS = Total Dissolved Solids; Cond = Conductivity at 20°C. Wherever possible, all results are from the same sample; however, some data are from different sample entries, screened for their consistency with the time series as a whole.

Table 3

Selected Chemicals Released from Landfill Leachate per 1Kg of MSW

Nitrogen	40.441 mg/kg waste
Phosphorous	0.025 mg/kg waste
Arsenic	0.002 mg/kg waste
Cadmium	0.001 mg/kg waste
Chromuim	0.009 mg/kg waste
Fluoride	0.012 mg/kg waste
Lead	0.148 mg/kg waste
Manganese	0.428 mg/kg waste
Zinc	0.038 mg/kg waste
Mercury	*0.009 mg/tonne waste*

Source: Keele Valley Landfill, Ontario Ministry of Environment, 1993.

It is well to remind ourselves of the basic problem with cessation of minewater pumping:

Ellison - The Past We Inherit the Future We Build: Abandoned Mines and Minewater Pollution

The oxidisation occurs as air moves through de-watered workings. After cessation of working, rising water encounters the oxidisation residues and flushes them into solution, causing a sudden and drastic deterioration in water quality. Thus the quality of the water currently pumped in the coalfiled is of little use as a guide to the quality of water which will eventually emerge at the surface. ..... there is little hope that future uncontrolled discharges in the coalfield will be innocuous. (12)

While most of the attention in the North East of England has focussed upon the Wear Valley (12) there are historical and economic reasons for paying just as much attention to the Team Valley:

- The integrity of critical landfill sites in the Gateshead to Chester le -Street corridor being compromised.
- The degree of quality and control in the level of the River Team which has been known to flood Tyneside's largest industrial estate at Team Valley.
- The integrity of the main east coast railway line between Newcastle and Durham.
- Sewarage treatment works near Lamesley
- Methane Gas emissions from old mine workings which already persist along the 5 miles of the valley from Birtley to the river Tyne and are prominent in the Bensham area of Gateshead.

Given the problems of uncontrolled discharges, the idea of a reduction in controlled discharges, especially from the big Kibblesworth pumping operation must take cognisance of several factors:. The station has a unique geographic location and cessation of pumping would raise serious questions. Engineers could take a leaf out of the methods of social scientist in collating anecdotal evidence with historical documentation. In the case of the Team Valley and its associated mining we know from personal experince and anecdotal evidence handed down through generations, together with historical documentation (14) that substantial and continuous bord and pillar working, breaking into bell pits, old workings like huge grottos, discovering chinamens hats and official and unofficial interconnections to change the flow of underground water, across and up and down the valley and `robbing of pillars' was the norm rather than the exception, even at Ravensworth Park Drift in 1964.

NRA argue that the continual flooding in the Team Valley was due to rain water draining off the land and that the groundwater level is 50 metres below ground. However continuing modelling by Wardell and Armstrong still indicates that despite easing the pressure by designing more free flowing discharges at strategic locations below 10metres AOD " groundwater levels may build up in the southern part of the Team Valley (Lamesley?) as they have in the past to more than 30AOD metres" (15) and then again flow paths are complicated by the Team Valley Wash. The result of that is that seepages could develop from shafts and adits below the 30 metre level.

For the record the former pits in that southern valley floor area were: Ravensworth Shop Pit, Allerdene, Lamesley, Lady Park Drift, Bewick Main, Chowdene Pit, A full audit of the valley and its associated mines over the years is required as almost every one without exception is interconnected. Connections which existed between those and the Betty Pit on the A1 and `holed into' old workings of the mines on Gateshead Fell, Sprinwell and the Annabella,

Portobello and Harraton (Cotia) Collieries brings into question the integrity of the idealised concept of partially interconnected 'PONDS' adapted from British Coal's model. Arguably, these are more interconnected than the model claims and they give the impression that the system is constant and consistent but from the evidence and like human life that is hardly true.

Wardell and Armstrong, in addition admit that they are also " confronted with limited data on pyrite for this area which makes the water quality most uncertain" (15). The one thing that consistently comes across in this business is the difficulty of modelling abandoned mines, associated minewater and groundwater rebound and the uncertainty of of real outcomes. Sherwood and Younger (12) have drawn attention to the inadequacies of off-the shelf groundwater models having imitations and built-in assumptions and with the problems of modelling groundwater rebound as collating data and information of abandoned mines. It is understood, Wardell and Armstrong as consultants to the NRA are in the process of revising their approach to modelling groundwater rebound in the coalfield. As any miner will tell you the pit has a life of its own even when its abandoned, and there lies the rub and the cavil!.

The long term aim must be to:

develop better indicator and natural resource accounting which will over time give some better measure of the benefits and the damage to the environment associated with economic change. (16)

because it was those who pulled the economic change levers that left us with this unecessary minewater legacy. It then becomes apparent that although we inherited the past misdeameanours of others that is no excuse for not building a positive framework for the future for control of minewater and the coal industry in particular using the cradle to grave LCA approach in tandem with CMP's and using refined modelling and simulation techniques.

Donbass/Kuzbass and United States Experience

The institution of economic reform in the Former Soviet Union (FSU) designed by the International Monetary Fund (IMF) to release large reserves of fuel and energy has been of doubtful benefit to the Russian people both economically and environmentally. The reform of fuel and energy have been characterized by the transfer of ownership and decision-making from the central state to private ownership. Ironically, the mining industry and associated reserves have taken on the form of joint stock companies (with limited liability) to be downloaded into the private sector. This process will be familiar to those with an interest in economic history of Britain and privatisation of British industry where the failure of these institutions before the 2nd World War led the State to put the coal industry in the 'intensive care unit' for a few decades. It is the legacy of this approach to mining that we in Britain are only coming to terms with now, so what chance Russia? There private sector/ joint stock companies are being constituted as a solution to economic ills and even environmental degradation by the 'correction of market distortions'. This ignores the historical record of western countries in minewater pollution where the environmental performance of private mining firms have been no better than State owned mining operations.

The problem in the Kuzbass coal mining area is that , as in Britain will, close many of the pits deemed uneconomic with the responsibility of rehabilitation and liabilities resulting from

AMD lost in the vacuum of litigation between mineowner, the local state and central government. The fact that neither the local or central state is in an economic position to cope with problem has overlooked a major point. A stark reminder that regulatory processes and structures were lacking in coping with water discharges from abandoned mines came from the recently formed environmental protection agency:

We are entering the market without possessing in fact any systems at all (either economic or legal) for environmental regulation.(17)

Environmental problems resulting from mineral extracting are not the sole domain of any political ideology or country, but are the result of the manner in which the country has exploited those reserves within a framewoork of institutional regulatory structures and processes. Currently, there are parallels between Russia and the position of mining and AMD in Britain prior to and after the 2nd World War which are set to be exacerbated and as such constitute a cause for serious concern. Clearly, the prevelance of such a deliterious situation may deter foreign/Russian private investment to develop coal production as a sustainable activity to include the management of minewater and the rehabilitation of the environment from AMD (18).

In 1992 the Russion Parliament passed a new Mineral Resources Law (19) which would allow any business from any country to extract minerals from the ground. The new law contains provision for licences to terminate with the lapse of time and for the early termination of the licence on the occurrence of ceratin events including, a threat to the life and health of the population and restoration of the site. However, there is little mention about any preventive responsibilities and of who will fund the clean up of any AMD that should that occur. Existing environmental degradation legal responsibilities are conspicuous by their absence. Importantly for the longer term, the legislation does contain a provision to the effect that if an international treaty is enacted the international treaty will take precedence over the Russion one, recognising Russia as a signatory to the European Energy Charter.

The vast experience of the mining industry in the United States shows how the private sector has not always been able to self regulate on minewater discharge and the country has needed a compilation of regulatory institutions. Overiding concern with minewater has been at opencast sites with leaching of sulphides from overburden and waste rock at mine sites on exposure to oxygen as well as the mobilisation of metals into ground water and streams causing degradation of aquatic ecosystems (20)OTA 1992:34). Approximately, fifty of the 1,190 'Superfund' hazardous waste sites in the United States are former mineral operations. Discharges from the former Berkeley copper mine in Montana have contaminated the Clark Fork River and nearby aquifers with heavy concentrations of lead, zinc, and cadmium. In fact:

The pit and a network of underground mine workings contain more than 40 billion litres of acid mine water.(21)

However, on smaller scales strategies have been developed by mine operators which are an example to their British and Russian counterparts in reducing the cost of minewater treatment. Artificial bogs and swamps at coal mines have reduced acidic discharges Public conciousness of minewater discharges and potential pollution is now a global issue. Raised in the U.K by deep mine closure, in Russia and Ukraine by privatisation it is once more at the leading edge in the United States review of regulation and legislation which will set the global agenda for two main reasons:

- Under review on Capitol Hill is the General Mining Law of 1872 governing mining on federal land. This has prompted public demand for the creation of a clean-up fund of around $50 billion, creating a new industry in environmental rehabilitation.
- The relative success and possible updating of the Surface Mining Control and Reclamation Act (SMCRA) by the Department of Interior which sets:
  - performance standards for mining operations
  - permits blocking for failure to meet water quality standards and reclamation plans
  - bonds related to performance to cover costs of reclamation
  - high degree of inspection and enforcement
  - abandoned mine reclamation program.

One of the most important points from SMCRA is the abandoned mine reclamation Fund where coal production is taxed at the rate of $0.35 per tonne for surface coal and $0.15 per tonne for deep mined to provide for the rehabilitation of land abandoned prior to the passsageof the Act in 1977. Ten thousand mining sites are on the Abandoned Mines Inventory, 1,500 are proved to have AMD or Alkali drainge problems (OSM 42). Rehabilitation work has been undertaken, or is under way on on 500 sites.

Conclusion

The political and environmental conciousness of the people is as much important in regulation and legislation as the health of the environment and it is quite clear that this has changed over the last fifty years. It is of little wonder the Ukraine Mineworkers delegation at the 110th Durham Miners Gala had almost as much concern over minewater pollution on their minds as maintaining some control over coal production back home. There again, groundwater pollution from was one issue the miners in the Donbass and Kuzbass organised around from 1985. With further pressure in the United States and the NRA and the DTI in Britain adopting a position after justified reasoning from the academic world (12, 13) it is now time to `reason together' on a national and a global scale and to manage minewater as a Cradle to Grave activity in a mining industry with the appropriate institutions and regulation that buys time for complete sustainability. In that way we really are inheriting the past and building the future!.

REFERENCES

1. David Guy, Durham Area NUM President's Address to the 110th Durham Miners Gala, 9/7/1994
2. Europe Report 453 (AVG), 30/4/92
3. NRA, 1994, Abandoned Mines and the Water Environment. Report of the National Rivers Authority, Water Quality Series No.14. London HMSO 46pp.
4. P.Eveurts, ETSU Coal Research Officer, 20/6/1994
5. Ellison J.M. The Political Economy of Opencast Mining in Scotland and North East England. Unpublished Ph.D. Thesis, Department of Sociology and Social Policy, University of Durham, 550pp. (1994)
6. European .Commission 1993, Remedying Environmental Damage (ISEC/B13/93, 7 May 1993)
7. Yao X.L. and Reddish D.J. Analysis of residual subsidence movements in the UK coalfields, Quarterly Journal of Engineering Geology, 27, 15-23 (1994)

8. Whittaker, B. N. and Reddish, D. J. 1989, Subsidence, Occurrence, Prediction and Control, Elsevoir, Amsterdam.
9. Lewin K. and Bradshaw K. Continuous Monitoring of Methane in Groundwater, Report to the Health and Safety Executive (No. 49/1993)
10. Keele Valley Landfill, 1993, Leachate effluent chemical analysis summary form, Keele Valley Landfill, Maple, for Ontario Ministry of Environment
11. Durham County Council, Environment Department, Record of Waste Disposal Sites, Private and County Council licensed since 1976, (1993)
12. Younger O.L. and Sherwood J.M. The Cost of Decommisioning a Coalfield: Potential Environmental Problems in County Durham. Mineral Planning Vol. 57, pp.26-29 (1993)
13. Younger P.L. Possible Environmental Impact of the Closure of Two Collieries in County Durham. Journal of the Institution of Water and Environmental Management. Vol. 7, pp.521-531 (1993).
14. Ellison Papers, Church Commission Boxes 165-168, Paeleography Department, University of Durham.
15. Wardell Armstrong A study of the Regional Hydrogeology of the Durham Coalfield and the Potential Impact of Ceasing Mine Dewatering (5 Volumes). Report to the National Rivers Authority, Northumbria Region. Newcastle (1993).
16. Slater D.(HMIP Director) The Effect of Environmental Laws, Regulations and International Trends on Environmental Innovation and Practice: Paper given to The Royal Academy of Engineering, 28 March 1994.
17. Feshbach, M and Friendly, A. 1992. Ecocide in the USSR. New York, Basic Books pp. 109-110
18. Boyd , J. 1993. Allocation of Environmental Liabilities in Central and Eastern Europe. Resources, Summer 1993
19. Financial Times 21/2/1992
20. Office of Technology Assessment, 1992, Managing Industrial Solid Wastes from Manufacturing, Mining, Oil and Gas Production and Utility Coal Combustion. Washington, D.C. U.S Government Print Office.
21. Young, J. 1992. Mining the Earth. World Watch Paper 109, Washington D.C., World Watch Institute.