An Overview of Mine Water Rebound in the South Yorkshire Coalfield

Sean Burke and John Barber

Environment Agency, Phoenix House, Global Avenue, Leeds, LS11 8PG

Abstract In the last two decades there has been a significant decline in coal mining in Europe (Adams and Younger 2001). The cessation of dewatering to permit safe mining has led to significant mine water rebound in the UK (Burke and Younger 2001). However, where mine water rebound is still taking place then a clear understanding of the previous mining operations, historic pumping arrangements and subsequent monitoring are critical in predicting likely mine water recharge rates and discharge points.

In the South Yorkshire Coalfield mine water levels were originally controlled by shallow operational mines. With the closure of these mines, then strategic pumping stations were set up to control mine water levels and therefore protect down-dip coal workings. The closure of many deep operational mines in the early 1990s required an even greater understanding of the mined system and the pumping arrangements at the abandoned/operational collieries and was a key factor in understanding mine water rebound in the South Yorkshire Coalfield.

Mine water levels have now recovered significantly and therefore with the eventual closure of Maltby and Rossington Collieries there is a need for greater understanding of mine systems and mine water level monitoring. This is crucial in assessing future mine water recovery rates, identifying potential discharge points and successfully implementing remediation strategies. This will lead to greater confidence within the Environment Agency when assessing the likely environmental impacts of mine water rebound on controlled waters. Controlled waters include the region's rivers and the Permian and Triassic aquifers that overly the concealed coalfield and are used for public water supply. Recent improvements in river water quality due to better environmental regulation and the decline of inputs from heavy industry could be severely set-back by potential mine water discharges.

1.0 Introduction

The dewatering of deep coal mines is essential to allow safe extraction of coal. With the decline of the UK coal mining industry and subsequent cessation of dewatering of the deep mines, mine water levels have started to recover across the UK coalfields (Cairney and Frost 1975, Younger 1995, Burke and Younger 2000). This recovery has resulted in significant polluting mine water discharges into receiving watercourses (Younger 1997). However, the UK is not alone in experiencing mine water pollution and mine water discharges have occurred for centuries on a global scale. Present examples of such discharges are seen in Spain, Germany, France (Sadler 1998) South Africa (Clarke 1997), South Korea (Cheong et al 1998), China (Feng et al 2000) and the United States (Hedin et al 1994).
Mine water discharges can occur from deep or shallow mine workings, where dewatering is taking place or from abandoned mine workings where ground water rebound is allowed to occur. Where extensive dewatering is taking place to limit the severity and numbers of discharges, then large amounts of water are pumped from the workings from a single or number of individual dewatering shafts. Such water is often of generally good quality therefore does not present significant pollution problems.

This paper intends to show the history of mine water rebound in South Yorkshire and its position today. An attempt to identify potential receptors that may be degraded by mine water pollution is also sought. Areas where uncertainty is apparent are identified and further monitoring is suggested where necessary.

2.0 The South Yorkshire Coalfield

The South Yorkshire Coalfield is a large area of eastward dipping Coal Measures from Sheffield in the south to Barnsley in the north and Doncaster in the east (Figure 1). Early coal mining was carried out with the use of bell pits and drifts into the seam outcrop. Here access was gained via a shallow shaft or drift and coal was extracted from the base of the shaft or drift. As expected, these forms of access to the coal were located to the west near the outcrop of coal seams and therefore exploited reserves at outcrop. When the distance from the base of the shaft or drift to the working area became impracticable then the workings were abandoned and new ones constructed. Though there is little evidence remaining this is expected to have occurred in the west where the seams outcrop near Sheffield and to the west of Barnsley.

When the vertical distance from the surface to the seam became too great then an adit was constructed to gain access to deeper coal reserves. When these were constructed often a drainage adit or sough would be driven below the workings where water was allowed to drain from the workings by gravity into a local river. The location of soughs and adits are critical in assessing mine water rebound as they can often be pathways for mine water recharge or discharge points if mine waters have recovered.

With the advent of the industrial revolution mining was to take place with the use of deep shafts to more profitable reserves as mines were sunk to the east. This led to the closure of many shallow mines with limited resources. Therefore, as mine water levels started to recover in the closed mines serious consideration was necessary to protect the mines working down-dip. Where the distance from the outcrop to the operational mines was short, large feeders of water were allowed to enter the mines. This led to the formation of the South Yorkshire Mines Drainage Committee, which was charge by Act of Government to resolve these problems.

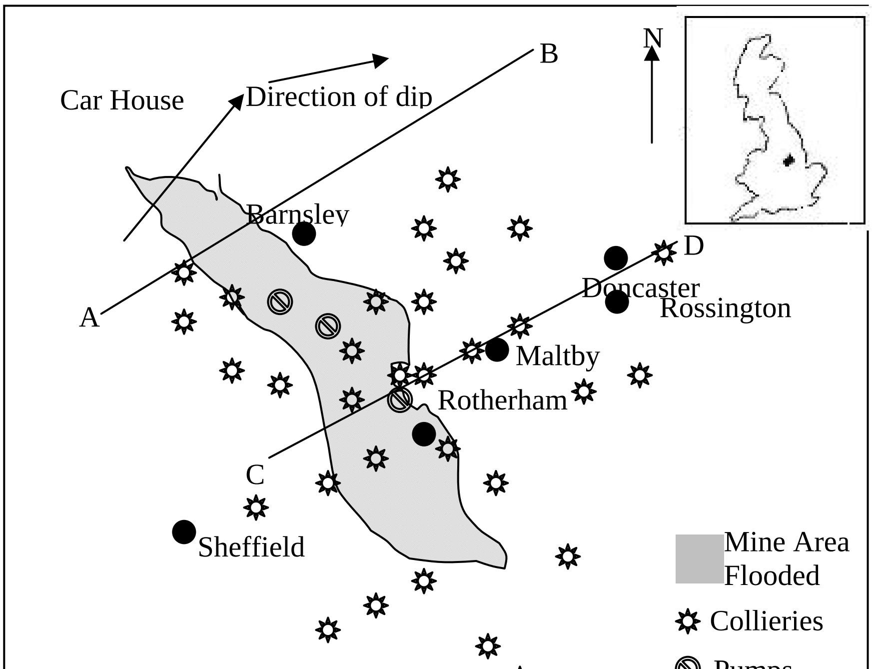

Figure 1. The South Yorkshire Coalfield with areas flooded in 1936. Cross section lines marked AB to CD are for Figures 2 and 3 (Saul 1936).

The South Yorkshire Mines Drainage Committee resolved many arguments between the different private mining companies and one outcome was the formulation of a mines drainage scheme for South Yorkshire.

Figure 1 shows the South Yorkshire Coalfield with the South Yorkshire Mines Drainage Scheme in 1936 with parts of the Barnsley Seam flooded. After the introduction of this scheme mechanised longwall mining was introduced and many of the shallow mines in Figure 1 were closed and dewatering of the area was carried out at many closed colliery shafts and localised within the deeper operational mines. The main coal seam worked was the Barnsley seam which has an average thickness of around 1.7m.

As reserves were exhausted in the shallow mines then new deeper colliery shafts were sunk to many hundreds of meters to exploit deeper and greater reserves. Although wide barriers of unworked coal and/or barren zones associated with major faults effectively isolate the collieries from each other at all worked horizons there are discrete connections between many of the collieries in the Barnsley Seam (Burke and Younger 2000). These connections effectively create large areas undergoing generally simultaneous rebound often called ‘ponds’ (Younger *et al*, 1995). These ponds are often fed by discreet feeders from shallow abandoned mines

The UK experienced a determined mine closure program in the 1980s and 1990s. In the Yorkshire Coalfield 73 collieries were closed or are in the process of closing resulting in extensive cessation of dewatering. British Coal were still operating 19 perimeter pumping stations in 1985, but currently only Maltby Colliery, Rossington Colliery and Car House pumping station control mine water levels in the South Yorkshire Coalfield.

The South Yorkshire Coalfield exhibits large areas of connected underground workings with many sensitive surface water features including the main rivers Don, Dearne and Rother susceptible to potential pollution. To the east lies the concealed coalfield that is overlain by major aquifers comprising the Permian Limestones and the Triassic Sandstone, exhibiting source protection zones protecting large public water supply abstraction wells.

3.0 Mine Water Recovery in the South Yorkshire Coalfield

Figure 2 and Figure 3 show present mine water levels across the coalfield. Mine water levels have now recovered significantly and many up-dip workings are flooded with a gradual migration of water down-dip to the east where mine water levels are controlled by pumping at Maltby and Rossington Collieries.

Figure 2 shows mine water levels from Tankersley near Sheffield in the west to Askern Colliery in the Doncaster area. Mine water in the shallow collieries to the west has almost fully recovered with recent increased discharges in the Worsbrough area currently impacting on river quality and some further recovery still expected near Barnsley Main and Lundwood.

Figure 3 shows mine water levels from Thorpe Hesley in the west to Hatfield in the east. Again substantial recovery has occurred in the shallow collieries of Thorpe Hesley, Warren House and Car House, where water levels are stabilised which may be due to continuous pumping. At Car House. However, there has been substantial recovery at Kilnhurst and Thurcroft with a significant head of water between Thurcroft and Maltby. Mine water may be passing Maltby shaft via old workings in the Barnsley or Swallow Wood seams towards Yorkshire Main workings and ponding adjacent to Rossington Colliery workings.

Figure 2 and Figure 3 show mine water recovery across the coalfield. However, the rate of recovery is dependent on the connectivity between individual areas. This includes roadway connections which exhibit high connectivity and goaf connections (collapsed void) with low to medium connectivity and conductivity.

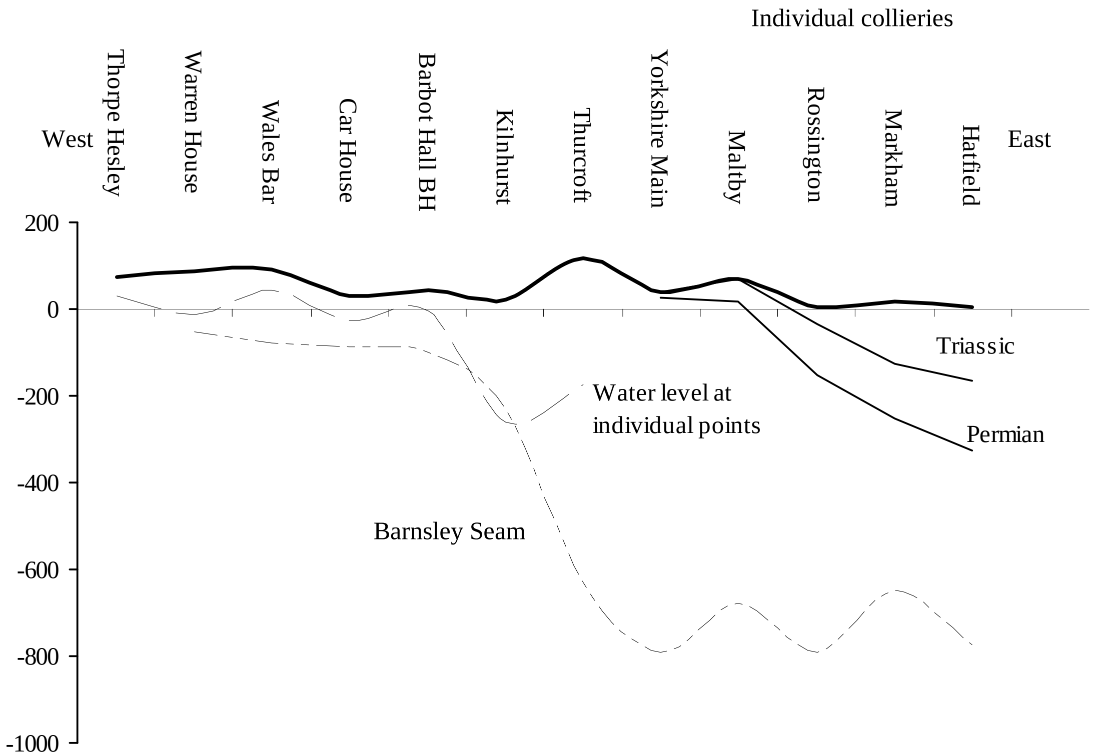

Figure 2. Present mine water levels (or last readings) at individual collieries across the coalfield from the south west to the north east. Figure 1 shows the line of cross section A to B

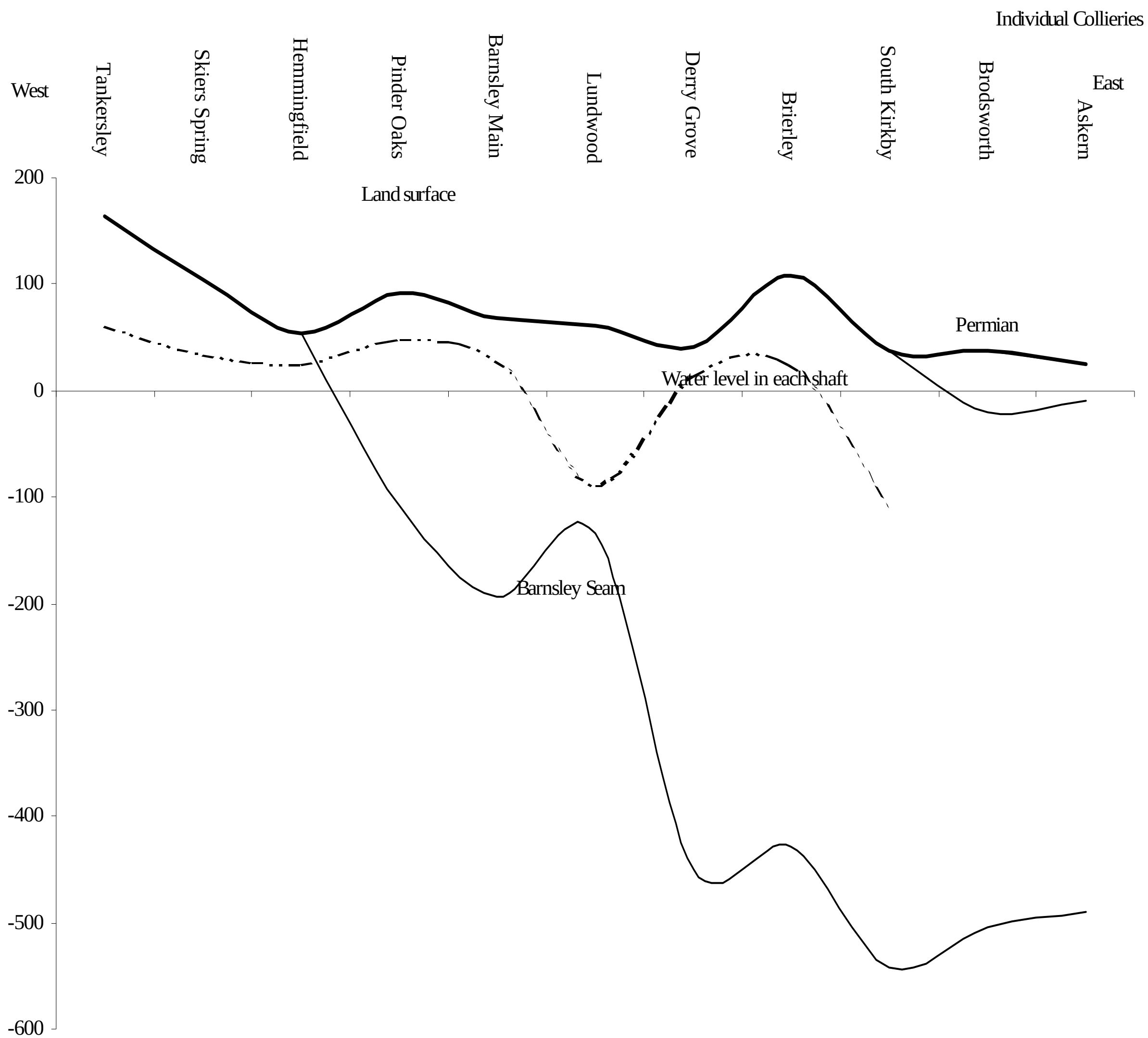

Figure 3. Present mine water levels (or last readings) at individual collieries across the coalfield from the south west to the north east. Figure 1 shows the line of cross section C to D

Figure 4 shows mine water recovery rates at individual mines shown on Figure 2 and highlights the varied rate of recovery. Barnsley Main shows steep mine water recovery while Tankersley is now relatively stable after initial rapid recovery.

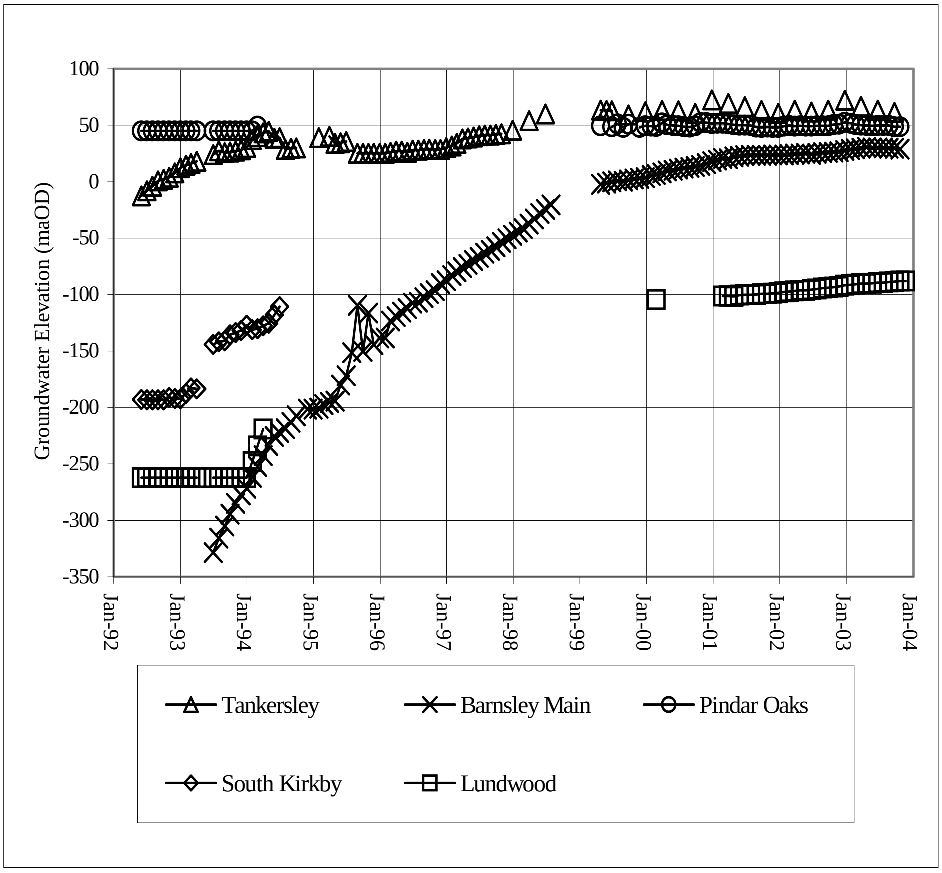

Figure 4. Mine water recovery at selected collieries over time shown in Figure 2

Figure 5 highlights the rate of rebound at selected collieries shown on Figure 3. The relative rates of recovery are highlighted for the deep mines of Thurcroft and Kilnhurst which have a similar recovery rate with surface discharges not expected in the near future unless down-dip workings are already flooded. Warren House and Barbot Hall have both recently demonstrated falling water levels that may be due to either reduced feeders or an increase in connectivity to down-dip workings.

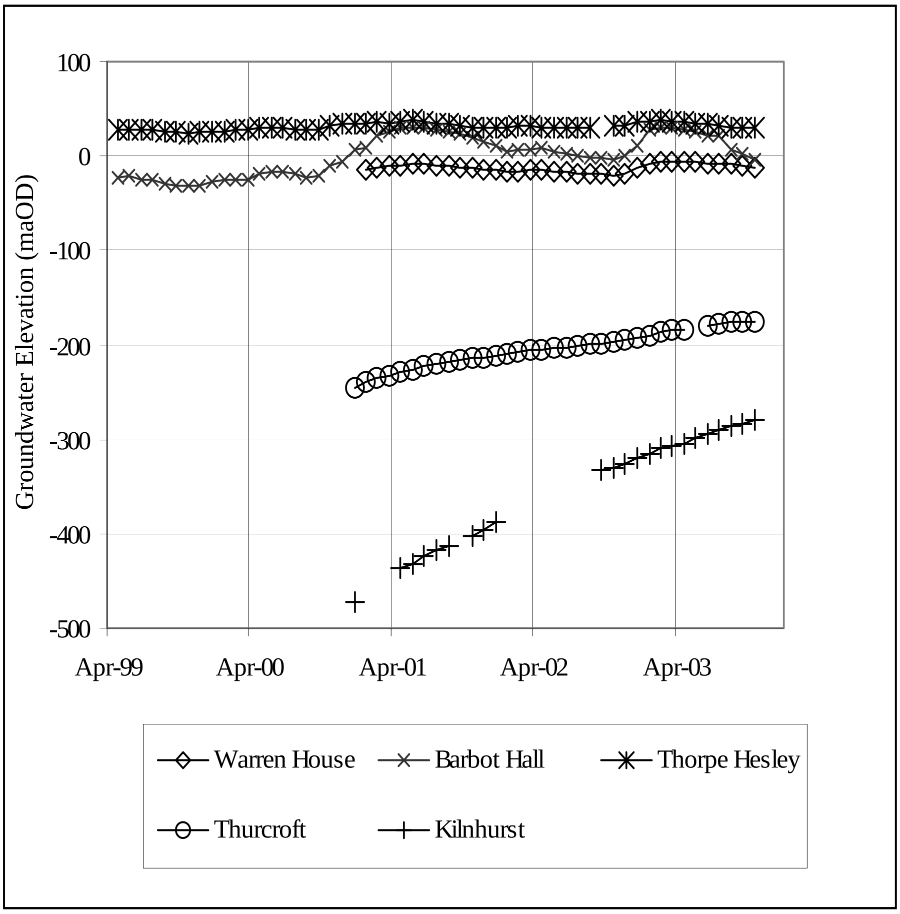

Figure 5. Mine water recovery at selected collieries over time shown in Figure 3

4.0 Conclusions

Mine water is recovering over large parts of the South Yorkshire Coalfield with many receptors potentially at risk from significant mine water pollution. While much work has so far concentrated on preventing and treating mine water discharges to surface water receptors, the risk to major aquifers has not been fully assessed.

The overlying Permian Magnesian Limestone to the east of the coalfield is not extensively used for public supply but has some significant abstraction such as at Ferrybridge Power Station, where groundwater is used for cooling. The large public water supply well-fields situated in the Selby and Doncaster areas abstract water from the Triassic Sherwood Sandstone and have large source protection zones, which extend over the concealed coalfield.

The source protection zones were designed to protect groundwater resources and prevent pollution at the ground surface from infiltrating into the aquifers from above. Mine water recovery could potentially threaten the aquifers from below and would impact upon the Permian Limestone before the Triassic Sandstone. However, it is unclear whether groundwater levels in the Coal Measures will eventually recover to elevations above the current pumped groundwater elevations within the Permian Limestone and Triassic Sandstone.

Currently, groundwater in the eastern part of the exposed coalfield is maintained at significant depth by pumping at the operational collieries located beneath the aquifers. Further monitoring in this area will be required in the coming years in order to predict the timing of mine water recovery to the base of the Permian and the eventual groundwater elevation when recovery is complete. Further work will also be required to understand how mine waters could potentially impact on groundwater quality within the Permian Limestones and the overlying Triassic Sandstones. This will apply to the portion of the aquifers actively used for public water supply as well as the deeper parts of the aquifers where water quality is naturally unsuitable for abstraction.

Acknowledgements

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