Prioritisation of abandoned non-coal mine impacts on the environment

SC030136/R8 The North West River Basin District

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This report is the result of research commissioned and funded by the Department for Environment, Food and Rural Affairs (Defra) and the Welsh Government in collaboration with the Environment Agency.

Published by:
Environment Agency, Horizon House, Deanery Road, Bristol, BS1 5AH
www.environment-agency.gov.uk

ISBN: 978-1-84911-257-4

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Dissemination Status:
Publicly available

Keywords:
Abandoned metal mines, mine water, pollution, river catchments, impact assessment, remediation, Water Framework Directive

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Project Number:
SC030136/14

Product Code:
SCHO1111BUVD-E-E

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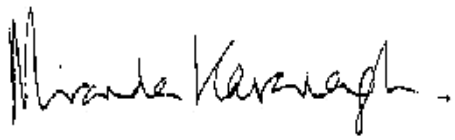

Miranda Kavanagh

Director of Evidence

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1. Introduction

The *Prioritisation of abandoned non-coal mine impacts on the environment* project has generated the most definitive evaluation to date of the impacts on the water environment from abandoned non-coal mines across England and Wales. For the first time, an objective assessment has been carried out to prioritise the rivers in England and Wales where pollution from these mines has the highest impact, and where there is the greatest risk that water bodies (river stretches) will fail to meet the objectives of the Water Framework Directive (European Community, 2000) due to abandoned non-coal mines. The specific water bodies which should be the focus of immediate attention in River Basin Management Plans (RBMPs) have been identified, and the work needed to address mining pollution through both research into passive treatment technologies and catchment monitoring investigations is outlined.

This is one of 13 reports that detail the final results of the implementation of the methodology across England and Wales. This particular report presents the finalisation of the categorisation of surface water bodies for the North West River Basin District, and also details of mine sites and mine waters, to be used as a basis for directing future remediation planning and / or further data collection.

In every report the 13 reports that comprise the outputs of the project are listed, so that the reader may cross-reference between them at need. They are:

I. *A methodology for identification and prioritisation of abandoned non-coal mines in England and Wales*
II. *Prioritisation of abandoned non-coal mine impacts on the environment: The national picture*
III. *Prioritisation of abandoned non-coal mine impacts on the environment in the Dee River Basin District*
IV. *Prioritisation of abandoned non-coal mine impacts on the environment in the Northumbria River Basin District*
V. *Prioritisation of abandoned non-coal mine impacts on the environment in the South West River Basin District*
VI. *Prioritisation of abandoned non-coal mine impacts on the environment in the Western Wales River Basin District*
VII. *Prioritisation of abandoned non-coal mine impacts on the environment in the Humber River Basin District*
VIII. *Prioritisation of abandoned non-coal mine impacts on the environment in the North West River Basin District*
IX. *Prioritisation of abandoned non-coal mine impacts on the environment in the Severn River Basin District*
X. *Prioritisation of abandoned non-coal mine impacts on the environment in the Anglian, Thames and South East River Basin Districts*
XI. *Prioritisation of abandoned non-coal mine impacts on the environment in the Solway-Tweed River Basin District*
XII. *Future management of abandoned non-coal mine water discharges*
XIII. *Hazards and risk management at abandoned non-coal mine sites*

Much of the text in the individual River Basin District (RBD) reports (reports III-XI) are common to all 9 reports, though the information in the tables is different. A detailed description of the methodology used to produce these results is provided in Report I, while Report II provides a national overview of the findings. Implications of the results for future management of abandoned non-coal mine sites is dealt with at length in Report XII, while specific detail of the outputs of the data collated on mine hazards and risk management is provided in Report XIII. It is recommended that the individual RBD reports are read in conjunction with these other national-level reports.

2. Water body impact categories

The initial stage of the prioritisation exercise comprised use of existing data, from various sources, to categorise surface water bodies as *Impacted*, *Probably Impacted*, *Probably Not Impacted* and *Not Impacted*. This exercise was based on the spatial relationship between Environmental Quality Standard (EQS[1]) failures in mining areas, or EQS failures immediately downstream of a mining area as described in detail in the Methodology report. The impact categories grade from *Impacted* where water quality failures are coincident in a water body with former mine sites, to catchments where the quality failures are either not associated with any former mining areas, or there are no reported water quality issues (*Not Impacted* water bodies). The risk categories prefixed "probably" are there to indicate uncertainty in the nature and extent of the link between mining and pollution. *Probably Impacted* describes a water body where there is a pollution problem but uncertainty persists as to whether the mining activity and downstream pollution issue are explicitly connected, either due to distance between source and receptor, or where there are no recorded mine sites in a polluted former mining area. *Probably Not Impacted* water bodies are those in mining areas where there is no water quality concern either in the host or downstream water body. The final numbers of water bodies in each of the impact categories are detailed by RBD in Table 1.

Table 1. Summary statistics showing final categorisation of water bodies across England and Wales (Stage 4, March 2009)

River Basin District (RBD)	Impacted	Probably Impacted	Probably Not Impacted	Not Impacted	Total
Anglian	0	1	181	831	**1013**
Dee	9	10	10	71	**100**
Humber	13	18	151	734	**916**
North West	15	27	63	427	**532**
Northumbria	28	39	38	262	**367**
Severn	31	32	89	599	**751**
Solway-Tweed	3	6	29	149	**187**
South East	0	0	88	308	**396**
South West	57	73	325	680	**1135**
Thames	0	0	154	490	**644**
Western Wales	70	37	143	619	**869**
Grand Total	***226***	***243***	***1271***	***5170***	***6910***

[1] The EQS values used for this project are detailed in the methodology report – see reference list. The metals / metalloids assessed were cadmium, lead, nickel, zinc, copper, iron, manganese, and arsenic.

3. Water body validation and prioritisation

After the initial categorisation of water bodies an online questionnaire was used to collate data from local experts at the Environment Agency. This process served to clarify whether the categorisations were valid (e.g. were area staff aware that the pollution in the mining area was due to something other than abandoned non-coal mines?) and to gather information on the extent of impact of non-coal mine pollution on other receptors (ecology, groundwater and water resources). Figure 1 shows the categorisation of water bodies in the North West RBD. This information was used to allocate an individual score to each of the *Impacted* and *Probably Impacted* water bodies to describe the extent of the impacts of abandoned non-coal mine drainage, shown in Figure 2 (for details of the scoring system refer to the Methodology report).

Tables 4 and 5 (located at the end of the report) show the respective impact scores for the *Impacted* and *Probably Impacted* water bodies in the North West RBD. By reading this report in conjunction with Report II (*The National Picture*), it is possible to see how the results fit into the national prioritisation. These tables contain only a selection of the results with the full details available as a database or a series of GIS (Geographical Information System) layers.

4. Mine site and discharge identification

The online questionnaire also collated data specific to mine sites themselves within the priority water bodies. A range of information was collected (Table 2) covering known polluting sites, the presence of point and diffuse pollution, water quality, flow rates, stakeholder concerns and risks and hazards at abandoned sites. This stage provides the crucial link between prioritising impacted water bodies (Tables 4 and 5) and identifying the polluting mine sites within them that could be the focus for future catchment scoping studies (see Section 5).

Summary details of all mining discharges identified in the North West RBD are presented in Table 6 while Table 7 shows all sites identified where outbreak risk received either a ‘Suspected’ or ‘Yes’ response. It is important to note that not all of the data gathered during the project is shown in the tables. This is simply because it is not possible to present all of this information in a written report such as this. The main items that have been omitted are:

- Water quality and flow-rate data for discharges where it is available
- Text comments relating to evidence of impacts and risks, and whether stakeholder issues are converging or diverging
- Detailed geographical references, such as grid references and water body identifier codes.
- Stability, airborne pollution, safety issues, public / animal health concern information which is summarised nationally in the *Hazards and Risk Management* report and presented in their entirety in the database.

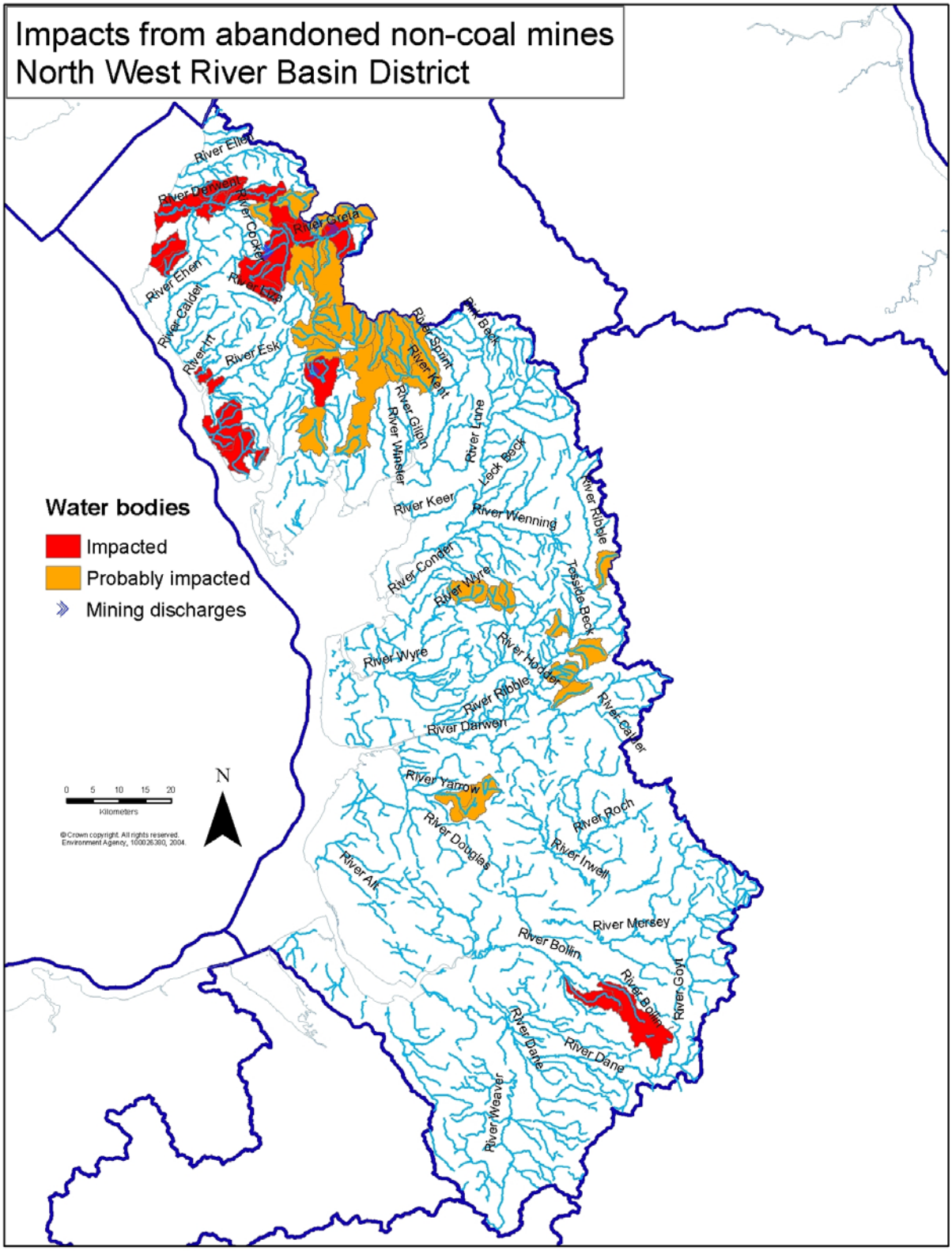

Figure 1. Water bodies *Impacted* or *Probably Impacted* by abandoned non-coal mines in the North West RBD

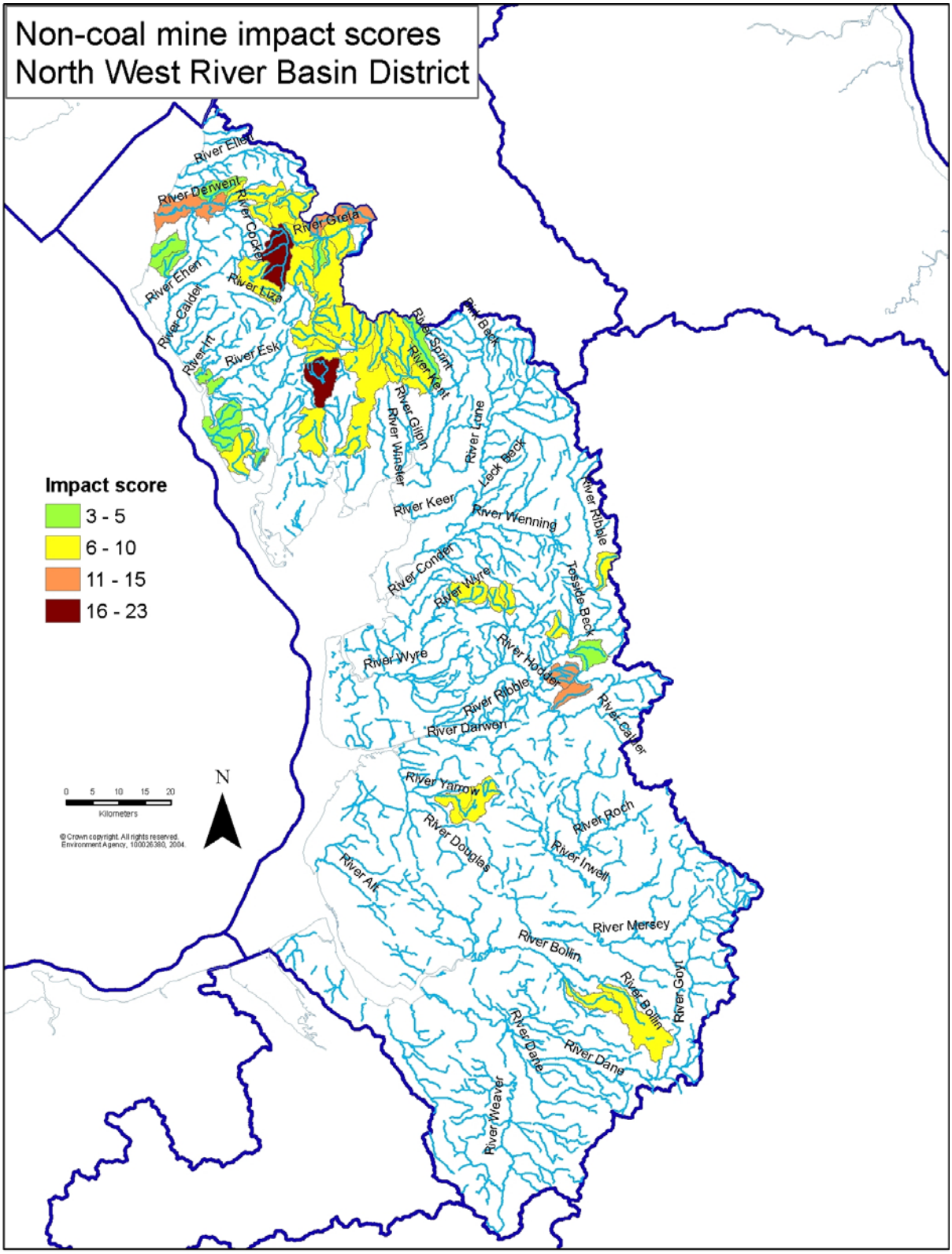

Figure 2. Non-coal mine impact scores for *Impacted* and *Probably Impacted* water bodies in the North West RBD

Table 2. Key information requested in Environment Agency questionnaire

Question / information requested	Comment
Water Body ID and Name	Information provided by Consortium
EQS failure co-ordinates and score	Information provided by Consortium
Categorisation (e.g. *Impacted* etc.)	Information provided by Consortium
Locations of point mine water discharges within water bodies with EQS failures, or in water bodies immediately upstream of water body with EQS failure	Required to characterise *Impacted* and *Probably Impacted* water bodies
If there is a mine water discharge (either point or diffuse) known or suspected then further information on the discharge is required	Including receiving watercourse name, groundwater, ecological and higher impacts, stakeholder information, and water quality
Knowledge of historical mines, irrespective of water pollution issues	Including mine location and name (if known), airborne pollution risk, safety concerns, stability concerns and outbreak risk

5. Preparing for remediation: further investigations and monitoring (Programmes of Measures)

This project has identified the surface water bodies which show the greatest impacts from abandoned non-coal mines, and so should be prioritised for action in the first cycle of River Basin Planning (RBP).

5.1 *Probably Impacted* water bodies

Many water bodies in mining areas are in the *Probably Impacted* category since we do not have water quality data from within the water body itself. We know that abandoned non-coal mines are present but not if they are the specific cause of the downstream pollution. Collecting new data on metal concentrations in these rivers would allow these water bodies to be moved either to *Probably Not Impacted* (if no EQS failures are identified) or to *Impacted* (if EQS are exceeded). All the data tables within the database are editable beyond the timescale of the project to allow such re-categorisation as new information comes to light.

Monitoring would need to be carried out over a 12 month period (ideally at monthly frequency) to ensure variation due to seasonal and flow effects is evaluated. It is recommended that collection of these data is prioritised in the first RBP cycle for the *Probably Impacted* water bodies with the highest impact scores (see Table 5).

5.2 Catchment investigations – *Impacted* and *Probably Impacted* water bodies

Unfortunately, with very few exceptions, we do not have sufficient monitoring data in any water bodies to allow remediation measures to be designed and implemented. This is the case even in the *Impacted* water bodies where we are confident that the pollution is due to abandoned mines, and have been able to identify significant point sources. This is a function of the type of monitoring data that need to be collected to characterise mine water pollution for remediation. Concentrations of metals in rivers or mine water discharges alone are not adequate, the flow must also be measured so that the loading (flux) can be calculated. Such data are rarely available from the Environment Agency's routine monitoring.

As a result, the first stage of implementing Programmes of Measures (POMs) for abandoned non-coal mine pollution is to carry out detailed synchronous monitoring of water quality and flow over at least a 12 month period in affected catchments. These further investigations will allow management and remediation schemes to be implemented in the second and third RBP cycle. If these data are not collected during the first RBP cycle, then it will not be possible to address the threat that pollution from abandoned mines poses to good ecological and chemical status.

The design and execution of such catchment monitoring programmes is described in the accompanying *Future Management of Abandoned Non-Coal Mine Discharges* report, and a comprehensive example of such a study is provided by Mayes *et al.* (2008). In general terms a phased approach is recommended:

1. Scoping study of the catchment (water body scale) to identify main sources of pollution using existing water quality data and other information sources. The data reported in Tables 4, 5 and 6 will inform these studies.
2. Design and implementation of detailed monitoring programmes to collect synchronous measurements of water quality and flow, as well as investigation of the river ecology over a period of at least 12 months.
3. Subject to the results of the monitoring programme, carry out feasibility study for the design and implementation of appropriate management and remediation measures, including pilot-scale treatment trials where appropriate. The suitability of various passive approaches to treatment is provided in the *Future Management of Abandoned Non-Coal Mine Discharges* report, and also by PIRAMID Consortium (2003).
4. Construct and operate management and remediation measures.

Examples of sites at which this phased approach is being implemented by the Environment Agency are shown in Table 3.

Table 3. Example sites at which a phased approach to catchment monitoring is being undertaken by the Environment Agency

RBD	Mine site / catchment
Western Wales	Parys Mountain, Cwm Rheidol, Dylife, Frongoch, Cwmystwyth, Conwy (Nant Gwydyr/Afon Crafnant)
Dee	Clywedog
Northumbria	Saltburn Gill, Rookhope Burn
North West	Coledale Beck

6. Conclusions

By assessing mine waters using water quality, ecological, groundwater and higher impact metrics it has proved possible to objectively prioritise *Impacted* and *Probably Impacted* water bodies into ranked lists. Furthermore, additional data stored in the database enables environmental managers to assess what the other issues are at these sites, such as safety issues, outbreak risk and stakeholder concerns. This information can be used to inform future management of pollution from abandoned non-coal mine sites.

References

European Community (2000). Council Directive 2000/60/EC establishing a framework for Community action in the field of water policy. The Official Journal of the European Communities.

Mayes, W.M., Gozzard, E., Potter, H.A.B. and Jarvis, A.P. (2008) Quantifying the importance of diffuse minewater pollution in a historically heavily coal mined catchment, *Environmental Pollution*, **151**, 165-175.

PIRAMID Consortium (2003) *Engineering guidelines for the passive remediation of acidic and/or metalliferous mine drainage and similar wastewaters*. Passive In-situ Remediation of Acidic Mine / Industrial Drainage (PIRAMID) report, European Commission Fifth Framework Programme. Newcastle University.

Table 4. Prioritisation of *Impacted* water bodies in the North West RBD (all water bodies shown)

RBD priority rank[2]	Water body name	Water Body ID	EQS Score	Ranked EQS Score	Ecological Impact score	Higher Impact score	Groundwater Impact score	Overall Impact score[1]
1	Newlands Beck	GB112075070440	5	4	5	5	3	**17**
2	Yewdale/Church Beck	GB112073071210	4	4	5	5	3	**17**
3	River Derwent	GB112075070520	10	6	0	5	0	**11**
4	Mobberley Brook	GB112069061330	3	3	2	5	0	**10**
5	River Bollin (Source to Dean)	GB112069061320	6	4	0	5	0	**9**
6	Haverigg Pool	GB112074069830	4	4	0	5	0	**9**
=	River Derwent US Bassenthwaite Lake	GB112075073561	4	4	0	5	0	**9**
=	River Derwent DS Bassenthwaite Lake	GB112075073562	4	4	0	5	0	**9**
9	Glenderamackin (Greta)	GB112075070460	2	3	1	5	0	**9**
10	River Cocker	GB112075070350	3	3	0	5	0	**8**
11	River Keekle (upper)	GB112074070030	9	5	0	0	0	**5**
12	Lowca Beck	GB112074070040	2	3	2	0	0	**5**
13		GB212074070210	1	3	1	0	0	**4**
14	Broughton Beck	GB112075073570	3	3	0	0	0	**3**
15	River Annas	GB112074069720	2	3	0	0	0	**3**

Note: 1. Overall impact score = Ranked EQS + Ecological Impact + Higher Impact + Groundwater Impact. 2. EQS Score used to determine Overall priority rank where Overall impact scores are equal

Table 5. Prioritisation of *Probably Impacted* water bodies in the North West RBD (all water bodies shown)

RBD priority rank[2]	Water body name	Water Body ID	EQS Score	Ranked EQS Score	Ecological Impact score	Higher Impact score	Groundwater Impact score	Overall Impact score[1]
1	Glenderamackin d/s Trout Beck	GB112075070470	4	4	2	5	2	**13**
2	Glenderamackin u/s Troutbeck	GB112075070490	2	3	2	5	3	**13**
3	Sabden Brook	GB112071065140	8	5	1	5	0	**11**
4	Mearley Brook	GB112071065510	4	4	2	5	0	**11**
5	Long Preston Beck	GB112071065600	4	4	1	5	0	**10**
=	St John's Beck	GB112075070430	4	4	1	5	0	**10**
7	Holden Beck	GB112071065550	4	4	0	5	0	**9**
=	River Derwent	GB112075070410	4	4	0	5	0	**9**
=	Dash Beck	GB112075070530	4	4	0	5	0	**9**
10	Whitendale river	GB112071065420	2	3	1	5	0	**9**
=	River Brennand	GB112071065400	2	3	1	5	0	**9**
12	River Kent	GB112073071380	1	3	1	5	0	**9**
=	River Gowan	GB112073071410	1	3	1	5	0	**9**
=	River Brathay	GB112073071450	1	3	1	5	0	**9**
15	River Crake	GB112073071190	2	3	0	5	0	**8**
16	River Yarrow DS Big Lodge Water	GB112070064952	1	3	0	5	0	**8**
=	River Yarrow US Big Lodge Water	GB112070064951	1	3	0	5	0	**8**
=	River Kent	GB112073071390	1	3	0	5	0	**8**
=	Trout Beck	GB112073071130	1	3	0	5	0	**8**
=	River Rothay	GB112073071140	1	3	0	5	0	**8**
=	Great Langdale Beck	GB112073071120	1	3	0	5	0	**8**
=	River Leven	GB112073071420	1	3	0	5	0	**8**
=	Tarnbrook Wyre	GB112072066240	1	3	0	5	0	**8**
24	Wythop Beck	GB112075070500	4	4	2	0	0	**6**
25	Swanside Beck	GB112071065530	4	4	0	0	0	**4**
=	Naddle Beck	GB112075070420	4	4	0	0	0	**4**
27	River Sprint	GB112073071430	1	3	0	0	0	**3**

Note: 1. Overall impact score = Ranked EQS + Ecological Impact + Higher Impact + Groundwater Impact. 2. EQS Score used to determine Overall priority rank where Overall impact scores are equal

Table 6. Mining discharge responses for the North West RBD (all sites for which data provided by Environment Agency)[2]

Water Body	Discharge name	Associated mine(s)	Receiving watercourse	Diffuse Pollution	Eco. Impact	G/W Impact	Higher Impact	Visual Impact	Stake-holder Issues	Complaints
GB112075070440	Force Crag Mine Adit 0	Force Crag Mine	Coledale Beck	Yes	Yes	Yes	Yes	No	Yes	No
GB112075070440	Force Crag Mine Adit 1	Force Crag Mine	Coledale Beck	Yes	Yes	Yes	No	Yes	No	No
GB112075070460	Woodend Horse Level	Gategill	Gategill Beck	Suspected	Suspected	Yes	Suspected	Yes	Yes	No
GB112075070470	Brundholme	Brundolme mine, Blencathra mine	Glenderaterra Beck	Suspected	Suspected	Suspected	No	No	No	No
GB112073071210	Bonsor Deep Level	Coniston Copper Mine	Church Beck	Yes	Yes	Yes	No	No	Yes	No

Table 7. Mine sites in the North West RBD where risk of sudden outbreak is confirmed or suspected to exist

Water Body	Mine	Outbreak Risk	Receiving watercourse	Details
GB112075070440	Force Crag Adit 0	Yes	Coledale Beck (Newlands Beck)	Adit blockage (Adit 0), & overflowing crownhole on steep ground, minewater outbreak risk
GB112075070460	Woodend Horse Level, Threlkeld/Gategill Mine	Yes	Gategill Beck	Partial adit blockage due to ochre/debris/vegetation build up.

[2] Note that not all information gathered is included in this table; limited data included only due to difficulties of presentation of all data in printed format. The complete dataset is available with the GIS files associated with these reports.

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