Client: European Commission
Report Date: December 2012
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Task 3e - Mining
1. Introduction

This document presents the methodology that has been used to assess the mining pressures and associated measures reported in the River Basin Management Plans (RBMPs) of the European Union (EU) as available at 16th January 2012. This methodology or ‘storyline’ adopts a Driver-Pressure-State-Impact-Response (DPSIR) approach.

Mining has been undertaken in Europe for many hundreds of years and it is not surprising that some sites have made a significant impact on the environment. However, the current legacy can largely be attributed to the extraction of metaliferous ore during the last 500 years and coal mining since the industrial revolution of the 18th century. Europe is still an active producer, and significant stakeholder in the worldwide production of purified metal and aggregates. Rises in the price of these commodities will increase the attractiveness of new developments and reopening of closed sites and this will potentially increase pressures associated with mining. Nevertheless, current mining activities are strongly regulated by Member States under National Laws (Mining Code) and the implementation of European Directives. The Environmental Impact Assessment Directive (85/337/EEC) and the Environment Liability Directive (2004/35/EC) for the prevention and remediation of environmental damage based on the polluter pays principle should ensure that appropriate measures are being taken to minimise the impact of current and future developments on the environment. Regulation 166/2006/EC established a European Pollutant Release and Transfer Register (E-PRTR) (amended by Regulation (EC) No 596/2009) which provides a list of all current mineral industries within Europe which exceed a specified size or where there are emissions to air, water and land. Mining activities are also specifically targeted by the Directive on the Management of Waste from Extractive Industries (2006/21/EC). Taken as a package these legislative instruments regulating the current mining sector should ensure that the objectives of the Water Framework Directive (2000/60/EC) and Groundwater Directive (2006/118/EC) are achieved.

Figure 1.1 provides information on the ‘storyline’ and datasets that have been used to develop the assessment of pressures and measures for Task 3e and the relationships between them.
Figure 1.1  Schematic of the methodology for assessing pressures from mining
2. Assessment of pressures

2.1 Use of RBD geological characteristics to identify areas of potential pressure

To identify those areas within Europe which may be subject to pressures from mining, a simple correlation can be made with local geology. Mineralised areas in Europe are widespread (Figure 2.1) and include deposits of world class significance (Kelly et al., 2004). Examples include:

- the Irish zinc deposits;
- the Polish Kupferschiefer copper-silver deposits;
- the Triassic rock zinc-lead ores of Poland, Austria, Slovenia and Italy;
- the Iberian pyrite belt;
- the Fennoscandian polymetallic deposits;
- the Thetian copper-gold arc;
- the Rhennohercyrian terranes of central Europe;
- the Mediterranean base metal deposits in Sardinia and Greece; and
- the more general copper-gold-lead-zinc-silver metallogeny of the Alpine-Balkan-Carpathian-Dinaride geodynamic province.

Due to its long history and strong regulation the mining sector in Europe is innovative in its approach and provides significant services around the world including best practices for others to follow. European projects such as PIRAMID, PADRE and PECOMINES have been initiated in Europe (and funded by the EC) and generated through international collaboration a community of stakeholders and researchers developing and applying best practice. The challenging economic situation in Europe provides the basis for an efficient (in terms of energy efficiency and resource recovery) and sustainable mining industry.
The presence of metal-bearing geological strata can lead to elevated background levels of specific parameters in surrounding water bodies even where there is an absence of specific mining activity. In these circumstances it is sometimes difficult to distinguish the impact of mining on qualitative status especially where Member States (MS) have set specific quality standards which mean that good status is achieved. A comparison of the Chemical Status: Background Concentrations a) Background to Question 6: Annex I Part B of the Directive 2008/105/EC stipulates that Member States may, when assessing the monitoring results against the EQS, take into account natural background concentrations for metals and their compounds, if they prevent compliance with the EQS value. More information and specific examples can be found in the report of Task 2c for the derivation of EQSs.

2.2 Source of data and information

In order to identify and assess the number and significance of pressures associated with mining in the EU, the main sources of data used were DECHMINUE and EPRT-R. The information reported in these databases is focussed on both historical and current mining sites in MS in both western and Eastern Europe. Their assessment of mining pressures consists of lists of sites which have the potential to release chemical contaminants. Although many will have measures in place to prevent environmental release this provides an initial starting point to identify sites that may have the potential to cause harm. However, whilst comprehensive these datasets do not provide exhaustive lists of mining sites in Europe.
MS are currently producing an inventory of potentially contaminated sites which will include historical mining sites. These datasets are not yet complete and it would be a complex task to try to harmonise the information with that contained in DECHMINUE and EPRT-R due to inherent differences in the adopted definitions of ‘potentially contaminated sites’ and the lack of a single objective behind the data collation. Co-operation between MS is required to harmonise definitions and identify the type and magnitude of impact on the environment that might be expected. Much of this data will need to come from site-specific monitoring.

2.3 **Approach**

The approach taken for the assessment of pressures from mining sites in Task 3e has been to rank specific areas within Europe at the RBD level with respect to the level of mining activity and assess the nature of potential impacts. It has not been assumed that the presence of an individual mine automatically implies impact on the environment.

Mining sites represent locations where a specific substance or a group of substances have been naturally enriched above background levels in the environment and where concentrations are sufficiently high to make extraction economically viable. The specifics of the geology and site control extraction processes contribute to making each mining site unique with a characteristic ‘emission signature’ although there will be similarities depending on the nature of the ore deposits. In reviewing the available data on mining sectors some amalgamation of sites has been undertaken to link potential pressures with potential impacts.

Where more than one pressure is identified for a specific site this would increase the overall pressure score, for example a single metal at a concentration that makes extraction economically feasible would be given a score of ‘1’ and the presence of four metals a score of ‘4’.

2.4 **Location and Nature of Sites**

2.4.1 **Historical mining**

The DECHMINUE project was completed in 2001 and collected data predominately related to historical mining sites across nine MS all located in Western Europe: Bulgaria; Germany; Spain; Finland; France; Greece; Ireland; Portugal; and Sweden. A number of current mining sites were included where closure was planned after completion of the project. The database includes a total of 1379 mining sites as presented in Table 2.1.

The project was undertaken by the Bureau des Recherches Géologiques et Minières (BRGM, France) and the dataset contains a significant proportion of French historical mining sites. The details contained for each site provide background information on the specifics of the material mined linked to the type of pressure.
Multiple pressures have been recorded at some sites where more than one metal could be released to the environment. For example, one mining site could potentially release several metals to the environment (silver, copper, iron or lead).

### 2.4.2 Current mining

Large mining sites currently in operation in Europe and ‘emitting pollutants’ are recorded in the European Pollutant Release and Transfer Register (E-PRTR). For a facility to be included in the register it needs to be assigned to one of the following industrial sectors: energy, production and processing of metals; mineral industry; chemical industry; waste and wastewater management; paper and wood production and processing; and intensive livestock production and aquaculture. In addition, thresholds limits are prescribed in Annex 1 of Regulation No 166/2006 which identify those facilities that need to be registered based on size and emissions. In the case of the mineral industry, all facilities relating to underground mining and related operations (category a) are subject to reporting; and for opencast mining and quarrying (category b) reporting is required where the surface of the area effectively under extractive operation equals 25 hectares.

Of the 104758 records in E-PRTR, category 3a (underground mining and related operations) and category 3b (opencast mining and quarrying) have been selected to represent current mining sites in Europe. Additional categories were used to supplement declared mining sites for less relevant categories which include:

- 1.(e) Coal rolling mills;
- 1.(f) Installations for the manufacture of coal products and solid smokeless fuel;
- 2.(a) Metal ore (including sulphide ore) roasting or sintering installations;

<table>
<thead>
<tr>
<th>Country</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>Bulgaria</td>
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<tr>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1379</strong></td>
</tr>
</tbody>
</table>

Table 2.1 Number of mining sites per country in DECHMINUE database
2.(c) Installations for the processing of ferrous metals;
2.(e) Production and processing of metals;
3.(c) Installations for the production of: ornamental and building stone, limestone, gypsum, chalk and slate;
3.(f) Installations for melting mineral substances, including the production of mineral fibres,
3.(g) Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain;
3.(e) Copper production and Precious metals production; and
4.(b) Chemical installations for the production on an industrial scale of basic inorganic chemicals and other facilities in the database that were wrongly allocated to other industry sectors but which were described as mining sites or complex.

The main justification for including current mining sites from the E-PRTR database rests in the direct geological and geographical relationship between the presence of mining ores and the location of sites. Renewed interest (high prices for metal, need for construction materials and development of new materials) in the last two decades has encouraged the development of ancient reserves that were deemed un-economical or previously abandoned due to technical constraints. A total of 3509 sites were used from E-PRTR to identify pressures scores as presented in Table 2.2.

<table>
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<tr>
<td>Portugal</td>
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</tr>
<tr>
<td>Romania</td>
<td>90</td>
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</table>
2.4.3 Aggregation and compilation of mining “pressures”

A total of 4943 sites have been used in the assessment of mining pressures under Task 3e. These sites serve to show where, in Europe, the most significant potential pressures might be found. The different types of mining activities have been separated into the following categories:

- coal (all types of coal have been included);
- metal mining;
- quarrying of aggregates (e.g. sand, gravels);
- quarrying of industrial materials (e.g. barite, feldspar); and
- quarrying of other materials (e.g. fertiliser, potash, phosphate, peat).

This selection provides estimates of the potential risk (pressures from emissions linked to an impact on the environment) which are different for each category. Where a site has been recorded as potentially releasing several contaminants then the score for the site is given for each potentially released substance. A summary of the scores given for each European country is provided in Note: MS highlighted in grey are selected for the assessment of measures.

Table 2.4.

2.4.4 Description of pressures categories and associated “risks”

“Risk” is generally understood to mean the combination of the probability of an event occurring linked to the consequences of that event. In the context of this study, measures taken by MS should ensure that the risk from mining sites is mitigated. A specific water body not achieving good status according to their River Basin Management Plan (i.e. good status should be achieved by 2015 or at the latest in 2027) could be taken as an adverse consequence. The qualification of the event resulting in the failure of the water body is more complex to define as potentially many pressures which are also not necessarily covered by the different pressures listed in Task 3 (agriculture, hydromorphology, drinking water, water abstraction and use and mining) could influence the status of that water body. A specific study is generally appropriate
to assess the factors resulting in a water body to fail to achieve good status and therefore assessing the probability of the event to be realised. The event should be understood in the case of mining as a release of a specific chemical substance at a certain threshold, for example exceeding the EQS applied in the area thus resulting in the failure to achieve good status.

The mining categories identified all have different potential emission capabilities that could eventually pose a risk to the surrounding environment. Pressures identified after the aggregation of the data as explained in Section 2.4.3 would need the characterisation of the type of pressures that could effectively be tackled by characterised measures. Categories of pressures were developed because of eventual similar types of pressures which would help summarise the measures developed by MS to respond to a type of pressure. The following categories of pressures were developed for this study.

i. **Coal mines** can produce Acid Mine Drainage (AMD). AMD which is a key environmental pressure facing the mining industry. AMD occurs when sulphide-bearing minerals in rock are exposed to air and water forming sulphuric acid. It has the potential to devastate aquatic habitats, is difficult to treat with existing technology, and once the chemical process has started can continue for many centuries (Roman mine sites in Great Britain continue to generate acid drainage 2000 years after mining ceased). Acid mine drainage can develop at several points within the mining process: in underground workings, open pit mine faces, waste rock dumps, tailings deposits, and ore stockpiles.

ii. **Metal mining:** where AMD is produced this can lead to the release of heavy metals through changing pH conditions. The low pH of percolating water increases the solubility of metals which are available for transport and which could affect downstream water bodies and ecosystems.

- Mercury is toxic to the central and peripheral nervous systems. Health problems associated with mercury include personality change, deafness, change in vision, loss of muscle co-ordination or tremors, loss of sensation, and difficulties with memory. Mercury can be passed from pregnant mothers to unborn children and also to babies through breast feeding. Because they are still developing, foetuses and children are especially sensitive to the harmful effects of mercury (ATSDR, 1999).

Bacteria within the environment transform inorganic mercury into methylmercury, a more toxic form of mercury which can accumulate in fish. Indigenous populations that rely on subsistence fishing are especially susceptible to the effects of methylmercury, because they are disproportionately exposed through their traditional diet (Wheatley, 2000). One study found that prenatal methylmercury exposure due to consumption of marine mammals and fish by the mother resulted in attention, language, and memory deficits in children (Granjean, 1997).
Arsenic is known to cause cancer of the skin, liver, bladder and lungs. Mines can release arsenic into the air and breathing of arsenic contaminated air near mines is known to cause lung cancer. Arsenic exposure may cause disorders of the nervous system and of the circulatory system. Arsenic exposure may interfere with foetal development. Arsenic can cross the placenta into foetuses and can be transported from mother to her child in breast milk. Unlike mercury, the naturally occurring forms of arsenic are the most toxic (ASTDR, 2007a). Chronic arsenic exposure has been associated with birth defects and still births (Kwok, 2006).

Lead is neurotoxic, which means it destroys brain and nerve cells. Children exposed to lead can suffer from abnormal and reduced physical and mental growth, and may also have lower intelligence. Lead can be passed from mother to child during pregnancy and breast feeding. Developing children are much more sensitive to lead exposure than adults (ASTDR, 2007b). There is evidence that lead can cause health problems at much lower levels than previously thought, and that no level of exposure to lead is safe for developing foetuses or children (Canfield, 2003). Lead exposure has also been associated with attention deficit, hyperactivity disorder and antisocial behaviour (Bellinger, 2008). Lead has been determined to be a probable human carcinogen by the US EPA (2007a). There is also evidence that lead is an endocrine disrupting chemical, with the potential to alter hormone function (Wide, 1980 and Dearth, 2002).

Antimony has a number of adverse health effects. It is a possible human carcinogen associated with the development of lung cancer. Breathing air contaminated with antimony can cause lung diseases, heart problems, and numerous gastrointestinal disorders (Cooper, 2009). The Occupational Safety and Health administration (OSHA) lists cumulative heart and lung damage as major health effects of antimony (US DLOSH, 2004). According to the EPA, these health effects can include antimony pneumoconiosis (lung damage), alterations in pulmonary function, chronic bronchitis, chronic emphysema, pleural adhesions, increased blood pressure, altered EKG readings and heart muscle damage (US EPA, 2007b). Antimony accumulates in organs, especially in the liver and kidneys and also in the blood (Gebel, 1997).

Cadmium is a known carcinogen; some studies of workers exposed to cadmium found higher levels of lung cancer. Cadmium also causes kidney, lung, and intestinal damage (ATSDR, 2009). Cadmium can pass from mothers to children through breast feeding. In animals, cadmium exposure during pregnancy has caused negative effects on behaviour and learning, as well as abnormal foetal metabolism, low foetal weight and skeletal deformations. There is some evidence that cadmium causes reproductive problems in humans including low birth weight and reduced sperm count (US EPA, 2007c).
• Effects in Fish and Aquatic Organisms: In addition to having harmful effects on people, toxic metals can directly affect aquatic organisms including fish. Fish are known to accumulate toxic metals from the water, and fish living in close proximity to mine sites have been found with higher concentrations of toxic metal (Schmitt, 2007). Salmon exposed to mining effluent (the wastewater released by a mine) had greater mortality rates, and were generally smaller than unexposed salmon (Dube, 2005). Some toxic metals such as cadmium and copper can inhibit the olfactory response, the ability of the fish to smell. This is an important effect because fish rely on olfaction, or smelling, to find mates, locate food, and return to home streams (Tierney, 2009). Additionally, metal contamination may affect the food web causing indirect consequences for fish species (Iles, 2005). Metals are known to accumulate in aquatic organisms used as food sources by fish, such as the caddis fly larvae (Sola, 2004).

iii. **Quarrying of aggregates:** these impacts are mainly quantitative and should remain localised as current quarries abstracting water release this water back within the vicinity of the quarry (sufficiently far away to allow work to continue but close enough to limit the cost associated with pumping). The relative impact of quarries for aggregates is therefore usually limited. However, a special case, where the extraction of aggregates takes place within river beds, may require special attention as this can have a significant impact on the hydromorphology of the river bed. Current Environmental Permitting regulations implemented by MS should address this issue when licensing these types of operations. This is a specific measure that will be reviewed in this report.

iv. **Quarrying of industrial materials** combine both potential quantitative impact and potential release of chemicals depending of the material extracted.

v. **Quarrying (other)** is a category which consists of the quarrying/extraction (or in some cases underground mining) of salt, fertiliser or peat. They would be areas were risk of eutrophication could be higher due to the release of phosphorus into the environment which is a limiting factor in most cases for the development of algae or plants.

Note: MS highlighted in grey are selected for the assessment of measures

**Table 2.4** present the results of the assessment of predefined datasets and show that a major limitation of the approach lies in the lack of data for old mining sites in some parts of Europe, for example in Belgium which has a long history of coal mining from the 18th to the 20th centuries. However, the current assessment provides an initial screening of MS where mining could pose an issue to water bodies and where measures would seem necessary to achieve the objectives of the Water Framework Directive.
Different types of mining pressures have been assigned a weight according to their potential impact. A higher score for coal and metal mining and a lower score for quarrying. The calculation that was used for the final score reflects the increased potential impact on waters from coal and metal mining when compared with quarrying activities.

\[
\text{Pressure} = (\text{Coal} + \text{Metal}) \times 100 + (\text{Quarrying(C)} + \text{Quarrying(I)} + \text{Quarrying(O)}) \times 10
\]

<table>
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<th>Medium</th>
<th>High</th>
<th>Very High</th>
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Table 2.3       Bands associated with types of mining pressures for Figure 2.2 and Figure 2.7

The assessment of pressures for the different types of mining is presented from Figure 2.2 to Figure 2.7. Bands associated with individual type of pressure are specific to each mining pressure type and have been selected to reflect the relative potential impact of this mining pressure across MS. Range used for categories are presented in Table 2.3.

Figure 2.7 presents the total score for each RBD and highlights the widespread pressures of the mining industry in Europe.

In discussion with the European Commission, it was agreed that the focus of the assessment of measures would be limited to the following MS due to their high score: Germany, United Kingdom, Spain, Romania, Sweden, Poland, Czech Republic and France.
<table>
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<th>Quarrying (Industrial)</th>
<th>Quarrying (Other)</th>
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<td><strong>2150</strong></td>
<td><strong>1753</strong></td>
<td><strong>428</strong></td>
<td><strong>204</strong></td>
<td><strong>5781</strong></td>
</tr>
</tbody>
</table>

Note: MS highlighted in grey are selected for the assessment of measures

**Table 2.4** Summary of potential pressure scores by country and by type of pressure
Coal mining pressures

Scores assigned based on number of sites

- low
- medium
- high

Country boundary

Map produced by CENIA, CR on behalf of European Commission ©, DG Environment, September 2012

Data source: Administrative boundaries: © EuroGeographics, © FAO (UN), © TurkStat
Source: European Commission – Eurostat/GISCO
ESRI, 2003, EEA data service based on various data providers

Figure 2.2 Coal mining pressures per RBD
Figure 2.3 Metal mining pressure per RBD

Map produced by CENIA, CR on behalf of European Commission ©, DG Environment, September 2012
Data source: Administrative boundaries: © EuroGeographics, © FAO (UN), © TurkStat
Source: European Commission – Eurostat/GISCO
ESRI, 2003. EEA data service based on various data providers

Metal mining pressures
Data source: DECHMINUE, E-PRTR

Scores assigned based on number of sites

- low
- medium
- high

country boundary
Quarrying of construction materials pressures

Data source: DECHMINUE, E-PRTR

Scores assigned based on number of sites

- low
- medium
- high

country boundary

Map produced by CENIA, CR on behalf of European Commission ©, DG Environment, September 2012
Data source: Administrative boundaries: © EuroGeographics, © FAO (UN), © TurkStat
Source: European Commission – Eurostat/GISCO
ESRI, 2003, EEA data service based on various data providers

Figure 2.4  Quarrying of construction material pressure per RBD
Figure 2.5  Quarrying of Industrial material pressure per RBD
Quarrying of other geological materials

Data source: DECHMINUE, E-PRTR

Scores assigned based on number of sites

- low
- medium
- high

country boundary

Map produced by CENIA, CR on behalf of European Commission ©, DG Environment, September 2012
Data source: Administrative boundaries: © EuroGeographics, © FAO (UN), © TurkStat
Source: European Commission – Eurostat/GISCO
ESRI, 2003, EEA data service based on various data providers

Figure 2.6  Quarrying of other materials pressure per RBD
Figure 2.7 Overall score of mining pressure per RBD
2.4.5 Linking pressure and measures in MS reporting

The formal linking of mining pressures and measures should have been facilitated by MS if the reporting of information in WISE has been performed robustly.

Reporting by MS under the category point sources\(^1\) where ‘1 1 Point Contaminated Sites’ or ‘1 4 Point Mine Waters’ should enable the identification of most sites and related impacted water bodies. Only five MS (BE, CZ, ES, IE and SK) have reported figures and the level of detail is limited to ‘point sources’ only, i.e. no sub-categories on the type of point source is reported.

Reasons for failing are reported by category for groundwater but the WISE aggregation report\(^2\) (password protected) for groundwater does not provide any specific indication about the pressure source with specific reference to mining. We have therefore had to use the generic reasons identified for the water body not meeting good chemical status and identify those that may be a result of mining pressures. The criteria are:

a) Saline or other intrusions;

b) exceedance of one or more quality standard or threshold value;

c) failure to meet environmental objectives in associated surface water bodies or significant diminution of the ecological or chemical status of such bodies;

d) significant damage to terrestrial ecosystems which depend directly on the groundwater body; and

e) deterioration in quality of waters for human consumption; significant impairment of human uses or significant environmental risk from pollutants across the Groundwater Body).

For example, where criteria (b) is identified for failure of good quality status and this information is used alongside identification of a pressure from a point source for groundwater and impact from acidification and contamination for surface waters this could be used to identify potential impacts from mining. The results of this comparison are shown in Note: Number and percentage of water bodies failing status presented by ‘reason’. Contamination of surface water is presented as the aggregation of contaminated sediments and contamination by priority substances or other specific pollutants

---


Finally, the MS network of monitoring sites may not provide an accurate assessment of the water quality in the entire water body depending on the distribution of monitoring points. It is likely that the impacts of a specific mining site may not be sufficient to cause sufficient derogation to cause a water body to fail good status, however, the potential cumulative impact of a number of mining point sources may well be seen. It is considered unlikely that individual mining sites would be seen to cause an impact on the quantitative status of groundwater, as the scale of abstraction and discharge of process water is commonly undertaken in relatively close proximity which would not impact on the overall mass balance at RBD level.

The WISE aggregation report summarising impacts on groundwater and surface waters\(^3\) could be used to assess mining pressure (Anthropogenic Diminution, Chemical Diminution, Anthropogenic damage, Chemical Damage, Altered Habitat, Other Groundwater Impact) but a definitive link between mining and pollution by any of these categories remains weak.

The monitoring of metals by MS to assess the status of water bodies could be used to establish the link between pressure from mining when the reason for not achieving good status is found to be an excess of zinc, nickel, arsenic or cadmium. The release of these metals could also arise from non-mining industrial sites and a direct relationship may be derived with caution. A measure of pH which could be representative of AMD could also be considered but the wide natural variation of this parameter does not establish any robust direct relationship either.

---

### Groundwaters

<table>
<thead>
<tr>
<th>Country</th>
<th>1 Point Sources</th>
<th>14 Point Mine Waters</th>
<th>Failing reason (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE</td>
<td>3</td>
<td>Not reported</td>
<td>31 (73.81%)</td>
</tr>
<tr>
<td>CZ</td>
<td>2097</td>
<td>Not reported</td>
<td>136 (78.61%)</td>
</tr>
<tr>
<td>ES</td>
<td>2850</td>
<td>Not reported</td>
<td>87 (13.9%)</td>
</tr>
<tr>
<td>IE</td>
<td>291</td>
<td>Not reported</td>
<td>112 (16.37%)</td>
</tr>
<tr>
<td>SK</td>
<td>245</td>
<td>Not reported</td>
<td>13 (13.4%)</td>
</tr>
</tbody>
</table>

### Surface waters

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of sources</th>
<th>Source details</th>
<th>Details for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY</td>
<td>6</td>
<td>No details requested</td>
<td>Acidification 0 (0%) Contamination 12 (4.62%)</td>
</tr>
<tr>
<td>ES</td>
<td>7034</td>
<td></td>
<td>Acidification 7 (0.14%) Contamination 142 (2.83%)</td>
</tr>
<tr>
<td>FI</td>
<td>447</td>
<td></td>
<td>Acidification 87 (1.41%) Contamination 37 (0.60%)</td>
</tr>
<tr>
<td>FR</td>
<td>1505</td>
<td></td>
<td>Acidification 0 (0%) Contamination 2922 (25.36%)</td>
</tr>
<tr>
<td>IE</td>
<td>2844</td>
<td></td>
<td>Acidification 386 (6.8%) Contamination 784 (13.82%)</td>
</tr>
<tr>
<td>IT</td>
<td>2379</td>
<td></td>
<td>Acidification (61 (0.71%) Contamination 1642 (19.07%)</td>
</tr>
<tr>
<td>LV</td>
<td>1495</td>
<td></td>
<td>Acidification 0 (0%) Contamination 0 (0%)</td>
</tr>
<tr>
<td>SE</td>
<td>1480</td>
<td></td>
<td>Acidification 3968 (16.94%) Contamination 23417 (100%)</td>
</tr>
<tr>
<td>UK</td>
<td>1554</td>
<td></td>
<td>Acidification 1057 (9.64%) Contamination 6167 (56.26%)</td>
</tr>
</tbody>
</table>

Note: Number and percentage of water bodies failing status presented by ‘reason’. Contamination of surface water is presented as the aggregation of contaminated sediments and contamination by priority substances or other specific pollutants.

Table 2.5 Number of point sources at country level and respective failing reasons (from WISE)
3. Assessment of measures

The measures reported by MS for the implementation of the River Basin Management Plan have been reviewed from the WISE database as of January 2012. MS have reported 4552 measures in total and 193 have been identified that could be related to addressing pressures specific to mining.

3.1.1 Germany

DE report a total of 90 supplementary measures of which nine could be applied to directly address mining pressures either to a specific site, or indirectly as a general framework to establish pollution control.

Six measures were reported in DE2000, two in DE4000 and one in DE5000. The categories reported relate to abstraction (1), rehabilitation (5), construction (1) and other (3). The description of measures are very succinct and do not allow technical assessment.

A summary of the measures is included in Table 3.1.

<table>
<thead>
<tr>
<th>RBD name (code)</th>
<th>Number of measure</th>
<th>Type of measure</th>
<th>Code of measures (as reported in WISE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhine RBD (DE2000)</td>
<td>6</td>
<td>Abstraction (1)</td>
<td>56, 24, 25, 38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rehabilitation (3)</td>
<td>21, 36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (2)</td>
<td></td>
</tr>
<tr>
<td>Weser RBD (DE4000)</td>
<td>2</td>
<td>Rehabilitation (1)</td>
<td>16, 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (1)</td>
<td></td>
</tr>
<tr>
<td>Elbe RBD (DE5000)</td>
<td>1</td>
<td>Construction (1)</td>
<td>37</td>
</tr>
</tbody>
</table>

Table 3.1 DE summary of measure concerning mining

Measures aimed at reducing water abstraction relating to mining (56) which is commonly used to control quantitative impacts from quarrying activities but could also be of use for deep mining (underground mining).

Measures controlling substances are specific to individual substances (21), diffuse pollution (36, 24, 38) or point source pollution (25). Acidification is specifically mentioned in measure 37.

DE2000 (Rhine) and DE5000 (Elbe) have been investigated as significant pressures have been assessed from Section 2 of the RBMP. Mining pressures have been clearly identified.
(historic and new) which are preventing water bodies achieving good status through contamination of heavy metals (priority hazardous substances, non priority hazardous substances) and other specific priority hazardous substances. The detail provided in the RBMPs regarding these measures is sparse and does not provide a clear descriptor of the actual practical measure e.g. measure 36 is described as “measures to reduce significant loads from coal mining are centrally agreed between the operator and the Environment Agency”.

Details of the actual techniques in use are presented in the “Steckbrief” document which presents further information regarding specific actions. For example measure PQ_OW_U37 for a specific site on the DE_NRW_27418_7000 water body, indicates that elimination of heavy metal inputs by a large-scale ion exchange system may be used following a technical feasibility study which would treat 330 l/s of groundwater.

The RBMPs do mention that extensive studies will be carried out in the next few years to clarify the technical and organisational solutions to address mining pressures. The fairly recent closing of mining activities in the RBD (Rhine) prevents the implementation of measures as the areas are still exhibiting unstable behaviours (qualitative and quantitative) and the development of mitigating measures is considered to be premature (or at least not possible) for the objective of 2015. Negotiations with the owner (or successors) of the mines are still on-going.

### 3.1.2 United Kingdom

The UK report 1778 measures in January 2012 of which 54 could be considered to address mining pressures. The measures described are both generic, refer to managing and sharing of projects or are applied to a specific area to directly tackle pollution (Table 3.2).

<table>
<thead>
<tr>
<th>RBD code</th>
<th>Measures associated with mining</th>
<th>Total number of measures reported</th>
<th>Percentage of measures addressing mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK01</td>
<td>-</td>
<td>11</td>
<td>0%</td>
</tr>
<tr>
<td>UK02</td>
<td>4</td>
<td>128</td>
<td>3.1%</td>
</tr>
<tr>
<td>UK03</td>
<td>10</td>
<td>124</td>
<td>8.1%</td>
</tr>
<tr>
<td>UK04</td>
<td>6</td>
<td>141</td>
<td>4.3%</td>
</tr>
<tr>
<td>UK05</td>
<td>2</td>
<td>226</td>
<td>0.9%</td>
</tr>
<tr>
<td>UK06</td>
<td>-</td>
<td>181</td>
<td>0%</td>
</tr>
<tr>
<td>UK07</td>
<td>1</td>
<td>163</td>
<td>0.6%</td>
</tr>
<tr>
<td>UK08</td>
<td>1</td>
<td>208</td>
<td>0.5%</td>
</tr>
<tr>
<td>UK09</td>
<td>7</td>
<td>174</td>
<td>4.0%</td>
</tr>
<tr>
<td>UK10</td>
<td>1</td>
<td>97</td>
<td>1.0%</td>
</tr>
</tbody>
</table>
### Table 3.2  UK summary of measures concerning mining

<table>
<thead>
<tr>
<th>RBD code</th>
<th>Measures associated with mining</th>
<th>Total number of measures reported</th>
<th>Percentage of measures addressing mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK11</td>
<td>5</td>
<td>131</td>
<td>3.8%</td>
</tr>
<tr>
<td>UK12</td>
<td>15</td>
<td>194</td>
<td>7.7%</td>
</tr>
<tr>
<td>GBNIIENB</td>
<td>1</td>
<td>65</td>
<td>1.5%</td>
</tr>
<tr>
<td>GBNIIENW</td>
<td>-</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>UKGBNIIENB</td>
<td>-</td>
<td>43</td>
<td>0%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>54</td>
<td>1887</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

The UK measures to address pressures from mining are aimed at controlling abstraction (control of mine water intrusion by reducing groundwater abstraction) and for coal mining sites are principally managed by the Coal Authority. The administrative measure (EWNO0061 in UK03) establishes a non-coal mine strategy for the RBD to address environmental risk through pilot remediation works (Welsh Metal Mine Strategy), highlights benefits and promotes the development into a national programme over future cycles of the RBMPs. Educational measures (ST0160, HU0206, HU0330) include raising awareness among stakeholders (landowners) about problems associated with disturbance of previously mined areas and how these can be avoided (coal mine and metal mines).

Emission control measures implement restoration programmes for specific mines through the development and maintenance of a prioritised list of mine water pumping schemes to prevent intrusion into groundwater. Additionally, the implementation of best practice controls and remediation at abandoned coal and metal mines are carried out in UK03, UK09 and UK11. These programs are assessed separately by other measures with the specific objective to deliver Water Framework Directive benefits including revenue and funding streams from the Aggregate Levy Sustainability Fund, Landfill Tax and waste levies for restoration research and other possible schemes.

The Environment Agency from England and Wales have indicated in position statement (2012) that “9% of groundwater bodies (20% by area) and 9% of surface water bodies (12% by length) in England and Wales are impacted and at risk of not meeting WFD objectives due to pollution from mine waters and mining waste. Polluted groundwater from abandoned mines discharges as much lead, cadmium and zinc into rivers each year as arises from all permitted industrial discharges.”

### 3.1.3 Spain

ES has not reported any specific measures related to mining and the assessment of measures needs to be undertaken directly from the RBMPs. Catalan RBMP is the only RBMP that has been reviewed as it is the only formally reported RBMP for Spain in October 2012.
The Catalan RBD is not as significantly impacted by mining as other RBDs in Spain although there are pressures from gravel and sand extraction. An evaluation of measures implemented to address mining impacts in Spain could be further refined if RBDs were submitted for the Guadalquivir RBD (ES50), Duero RBD (ES20), Cantabrian RBD (ES16) or Minho RBD (ES10).

The mining pressure in the Catalan RBD is mainly due to the extraction of aggregates, ornamental stones and the extraction of fertiliser (potash). The only mine present in the coal category concerns a historical lignite extraction site that has been remediated (soil cover and remediated green area). The extraction of aggregates is subject to a measure to try and establish unifying the basic criteria against pressures that may impact on the condition of groundwater to facilitate proper management and protection of groundwater according for each different pressure. Measure nº6 aims at controlling sediments and hydro-morphological recovery.

A document on the management of quarries in Aragon (Gestión del agua en explotaciones de áridos) provides an example of Best Management Practice that may be followed in Spain. It is however not specified whether this document is being followed by the industry or how it is enforced.

### 3.1.4 Romania

Only RU1000 RBD has been assessed and of the 111 measures reported for this RBD, four measures are specific to mining. Three measures are implemented at water body level and RO7_S_SW_1.4.6 and RO7_S_SW_1.4.7 address a specific mine impact on water bodies.

Measure RO6_S_SW_8.10.7.1 looks at the input of contaminants at sub-unit level to the Black Sea. The analysis of contaminant flux to the Black Sea looking at the contribution of existing pollution sources and the Danube tries to establish a correlation with the Black Sea status.

### 3.1.5 Sweden

SW has not reported any specific measures to mining and the assessment of measures has been undertaken directly from the RBMPs.

The RBMPs of Sweden (SE1 – Bothnian Bay, SE2 – Bothnian Sea) forecast an increase (up to 70% for the mining and quarrying industry) in industrial output until 2015 and therefore it would follow increasing environmental emissions. However, these emissions are largely reduced at source due to most mining sites being controlled by the IPPC Directive. The long history of mining activities in RBDs (SE2 mentioned a mining legacy of 1000 years) have produced heavily polluted water bodies which have been mitigated by liming efforts to reduce the amount of sulphuric acid entering water bodies. These liming treatments undertaken
during several decades seem to have produced results which are considered sufficient enough as a reduction in the liming programme is identified (SE2).

SE3 – North Baltic Sea, SE4 – South Baltic Sea and SE5 – Skagerrak and Kattegast RBMPs have also been investigated and similar information about the forecast in increase of the mining industry production is mentioned alongside a measure for the control of emissions as a specific category regulating current or future mines is in place (Category A).

It should be noted that the background level concentrations for metals in both surface and groundwater in Sweden and the potential for acidic water are high due to the nature of the rocks and soil covers (coniferous species).

### 3.1.6 Poland

Poland has not reported any specific measures to mining and the assessment of measures has been undertaken directly from the RBMPs. PL6000 (Odra RBMP) has been reviewed as it is subject to the most significant pressure. The measures reported in the plan include remediation action (Action 2.2), waste management options and the development of environmental indicators that will be used to assess the success of actions.

Cost of remediation actions are mentioned as being variable depending on the technology used on each sites.

### 3.1.7 Czech Republic

CZ has reported one measure code which is a combination of 24 measures. These research measures cover the entire RBD and provide a framework to conduct studies which finds the origin of sulphate by sulphur isotopic composition. Where anthropogenic sulphate sources are identified, and which are linked to mining (potentially resulting from acid mine drainage) corrective actions are proposed.

### 3.1.8 France

FR has reported 514 measures of which 28 can be related to address mining pressures. Most of the measure are applied at RBD level and are regulating discharge of pollutants from mining activities, proposing funding structures to remediate sites. Distinctions are made between metal mining, quarrying and other side activities such as drilling or mine waste management.

Most of the measures are directed at trying to control current mining activities by requesting a self-assessment of their impact on water quality and quantity and require production and application of a plan to manage the extraction and enhance technique to limit emission and erosion on these sites. A limited number of measures (measure 5A08 in FRD “Le Rhône et les cours d'eau côtiers méditerranéens” and Ponc_2_02 in FRF “L’Adour, la Garonne, la
Dordogne, la Charente et les cours d'eau côtiers charentais et aquitains*) are trying to limit the impact of ancient quarry or mining sites and are focused on the treatment of emissions at the source where there is a “known” impact on the water. Many measures are determined to assess and quantify this impact but mining sites and quarries are specifically mentioned.
4. Discussion

The value of the EU-wide inventory of contaminated sites, which would include historical mining sites, is reduced as individual Member States have differing views on the definition of what constitutes a “contaminated site”. Time delays in building such datasets inevitably mean that the data is out of date. EU-wide guidelines on how to build up an inventory of potentially contaminated sites as well as proven contaminated sites can be useful to exchange good practice in particular for MS not having such inventories. This approach would significantly help the assessment of pressure from mining sites (actual and historical) and would serve to prioritise the regulation or remediation of such sites through an appropriate programme of measures.

For active sites, a qualitative status assessment will depend on site specific thresholds (e.g. Environmental Quality Standards or specific limits) identified in the Environmental Permit. Alternatively, some infrastructures are now protected by the UNESCO e.g. Wieliczka Salt Mine (Poland), the Cornwall and West Devon Mining Landscape (UK) or the Mining Area of the Great Copper Mountain in Falun (Sweden). Also, Geoparks such as the Cabo de Gata-Nijar (Spain) may also limit MS intervention to attain some water bodies’ objectives.

4.1 MS strategy to tackle mining pressures.

Current active mining sites as well as new sites should be or currently are regulated (Environmental Liability Directive, European Directive 2006/21/EC - Article 20 concerning the management of waste of the extractive industry). Some countries have already responded to a questionnaire on the implementation of 2006/21/EC (BE Flanders, CH, CZ, DK, FI, FR, SE,) and a few other are still pending (as in July 2012 for DE, IR, SP – Basque country, UK).

For example BE - Flanders indicates that there are no longer any mining activities (in the context of the mining waste directive) in the Flanders Region. In the beginning of the '80s (approximately 1982) these mining sites were closed (6 sites). At closure they received a license as 'dumping site for waste coming from mining activities in the context of the Flemish Waste Decree. That means that at that time, measures needed to be made to prevent an impact to human health and the environment. Most of those (dumping) 'sites' were rehabilitated, some even for recreational purpose. If at those sites, there will be a transfer or development activity, the sites will be investigated in the context of the Flemish Soil Decree because dumping sites are regulated as potentially contaminating risk activities. “Therefore, Flanders have concluded that for the moment there is no need to make an inventory following article 20 of the Mining Residue Directive.”

4 http://www.commonforum.eu/Questionnaires/MWEI/MWEI_QUEST.asp
In CH, DK activities are limited to the extraction of construction materials i.e. no metallic deposits. Hence the questionnaire does not apply, as all extracted material is considered inert (salt, sand and gravel, soil or limestone). It would be beneficial for the questionnaire to be completed by all Common Forum members to gather information and opinion on the possible release of contaminant from such sites.

Historical sites should go through the following steps:

- Identification of the sites through various national schemes (contaminated land, environmental burdens, historical industrial sites register)

- Site specific assessment of the impact on the environment (qualitative, quantitative). The assessment should contain an estimate of the period of time when the impact is still expected to be measured.

- A priority list of sites to act. Different strategies here could range from individual measure for each site or more general measures which could be implemented at a regional scale.

The implementation of supplementary measures has been reported and assessed by the technical lead for each member states (Groundwater measures, Chemical status, Heavily Modified WB and Environmental Objectives and Exemptions) and only a limited number of MS have mentioned that mining would be a cause for failure of Chemical status or provided exemptions. This is probably due to the non-direct link between mining sites and status of the water bodies.

Some mining activities in the past have created very specific and complex ecosystems which have seen the development of very rare species. Examples include the Young’s Helleborine (*Epipactis youngiana*), a rare endemic orchid principally found on heap created by the coal-mining industry in the Central Lowlands of Scotland and classified as endangered, *Calaminarian* grasslands or more generally metalophytes.

The deposition of metal-rich wastes in terrestrial environments by the metal mining industry (e.g. tailings dumps and sterile piles) or over natural mineral outcrops (Ginocchio and Baker, 2004), has allowed new habitats for potential micro-evolution and colonization of metal adapted variants of common species and for metalophytes colonization (e.g., Allen & Sheppard 1971, Baker 1984, Bush & Barret 1993, Ginocchio et al. 2002). Abandoned and naturally recolonized old mine sites can therefore be seen not only as a liability but also a resource base of unique genetic materials. The study of these plants and their colonization behaviour and evolution observable on former mine sites has improved closure and rehabilitation strategies in some mined areas for example in Canada (Jun 1995).

Care is therefore needed when trying to address a water body status not to impede the implementation of other Directives such as Habitats (92/43/EEC) or other international commitments (UN).
In all cases, when a direct relationship between a mining sites and environmental impacts has been identified, characterised, the measures implemented by MS are deemed to be efficient measures as they are targeted to achieve a specific reduction in the concentration of substances emitted by this site. In that sense, these measures are efficient in tackling the qualitative or quantitative impact of mines in MS. However, the efficiency of a specific measure compared to another measure applied for the same site could be compared in the medium long term to assess its sustainability through Cost Benefit Analysis.

4.2 Conclusion

The EEA Water 2012 Report (Version: 2 dated 23.02.2012) concluded that mining exerts a localised but significant pressure upon the chemical and ecological quality of water resources in parts of Europe, particularly in respect to the discharge of heavy metals.

Mine discharges threaten the attainment of good water quality in a number of locations across Europe. Heavy metals are the most frequently reported cause of poor status in Spain but are a particular issue in the Tinto-Odiel-Piedras RBD with mining discharges being the primary cause. Mercury is a cause of poor status in Swedish transitional waters, although the problem is not as widespread as in Swedish freshwaters and is limited in transitional waters to the Skagerrak and Kattegat, and North Baltic Sea RBDs. In France, heavy metals cause poor status in transitional waters of the Rhone, Loire and Seine RBDs. Heavy metals are also problematic in the Northern Apennines RBD in Italy and the Romanian Danube. However, it is important to mention that the link with mining activities and waterbodies in poor status has not been clearly established.

If current activities are regulated, data should be made available to establish a source of pollution corresponding to the signature of the polluting site. This link requires extensive monitoring over a long period of time and should provide clear evidences ensuring appropriate application of the polluter pays principle.

For historical sites, monitoring and research (universities have a role to play) have provided good example of assessment and remediation options. Abandoned mines represent a particular threat since, in the absence of continued pumping, groundwater levels rise and, ultimately, discharge contaminants within the mine workings.

The time frame to achieve environmental objectives may not be in line with the objective of achieving good status by 2015 for all MS when data is not available.

Key messages:

Most MS measures consist firstly of pumping water from the mine to limit discharge of AMD and secondly active or passive rehabilitation of historical sites which posed a serious threat to human health in populated areas. The impact of historical mines has been mitigated where they posed an obvious issue to change of use.
Recommendation: MS should develop BAT focussing on passive treatment requiring less energy/operational costs.

The use of very costly measures for what is perceived as a poor ecological reward or the implementation of measures with low effectiveness is further limited by the uncertainty remaining in the characterisation of the pollution mechanisms specific to each site.

Recommendation: MS should continue to investigate historical mining sites to understand their long term impacts and refine mitigation techniques.

Recent increase in the price of commodities has been interpreted by MS in their RBMPs as an increase in the pressure from mining.

Recommendation: Natural resources are in demand but a balance between new and recycled resources needs to be established. Control of emissions from mining sites, enforcement of the polluter pays principle and social responsibilities of mining companies should limit environmental impact in the medium - long term.
5. Definitions – References

5.1 Definitions

The following definitions (EC Working Group on Contamination – Soil Thematic Strategy) are proposed:

a. A "potentially contaminated site" is a “site where an activity is or has been operated that may have caused soil contamination”.

b. “Land” represents a geographical area (could be a single site, or it could be a region such as a municipality or larger area). However, it also includes the physical components of this spatial area, such as soil and groundwater beneath the surface of the land.

c. “Site”: A particular area of land, usually related to a specific area of ownership or activity.

d. “Contaminated land”: a geographical area with confirmed presence of “dangerous substances” caused by man in such a level that they may pose a significant risk to a receptor in such a way that action is needed to manage the risks. The risk is evaluated taking into account current and expected uses of the land.

e. “Contaminated site”: a site with confirmed presence of “dangerous substances” caused by man in such a level that they may pose a significant risk to a receptor in such a way that action is needed to manage the risks. The risk is evaluated on a site-specific base taking into account current and expected uses of the site.

5.2 References


Dube MG, MacLatchy DL, Kieffer JD, Glozier NE, Culp JM, Cash KJ. 2005. Effects of metal mining effluent on Atlantic salmon (Salmo salar) and slimy sculpin (Cottus cognatus): using artificial streams to assess existing effects and predict future consequences. Science of the Total Environment 343:135-154


