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A review of European Union legal provisions on the environmental impact assessment of non-energy minerals extraction projects

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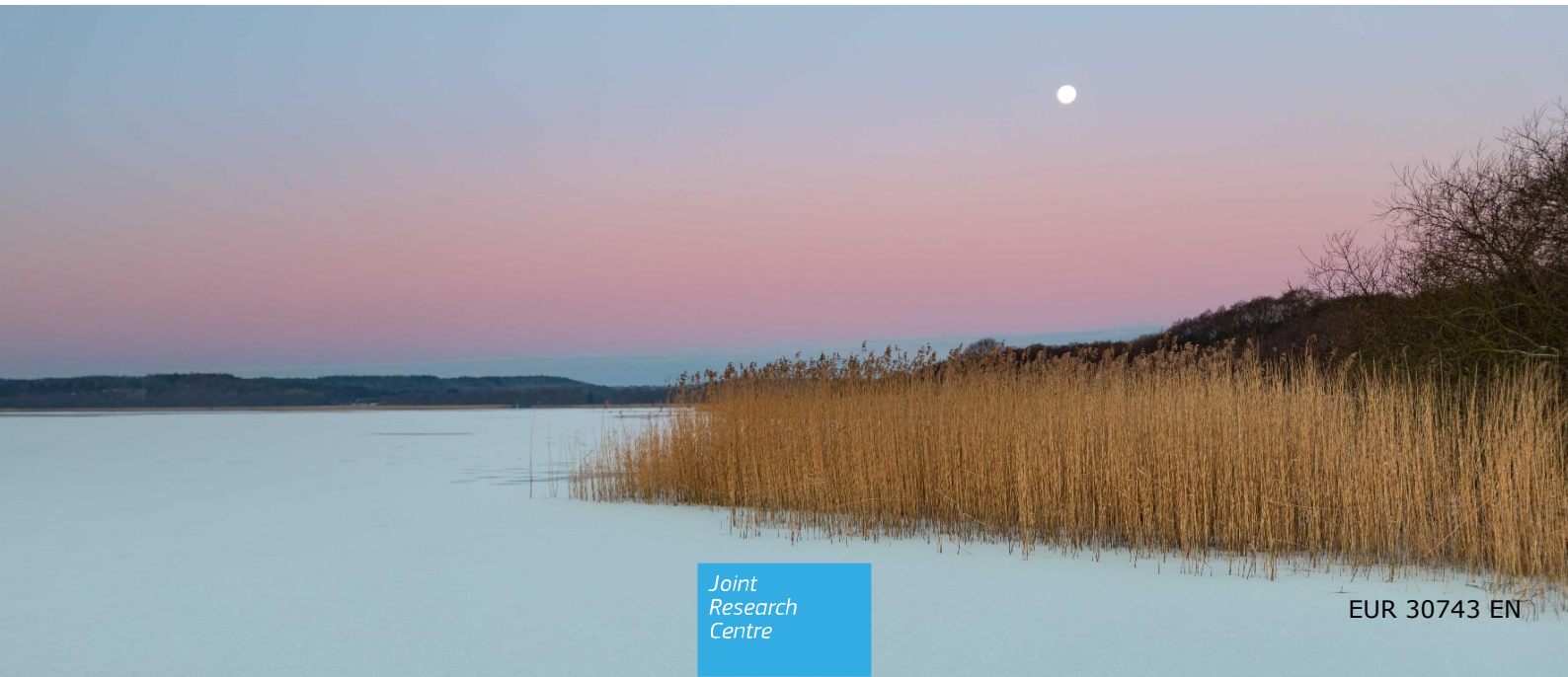

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Contents

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Executive Summary

Raw materials are essential to our modern lifestyle. They are used in a wide range of applications from building materials to food industries, clean energy or electronics. In 2008, the European Commission adopted the Raw Materials Initiative, which is targeted at the secure access to raw materials both within the EU and globally. It identified a range of objectives and actions, inter alia, conducting resource efficient exploration, securing the access to domestic mineral reserves and promoting streamlined permitting.

Non-energy extractive industries (NEEI) sites, if not properly designed and managed, may have significant impacts on the environment. Effects depend, inter alia, on the type of mineral, extraction methodology, substances used in mineral treatment, extractive waste characteristics, site-specific environmental conditions and the way extractive waste is managed.

The Environmental Impact Assessment (EIA) Directive provides a framework to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment at the earliest possible stage in technical planning and decision-making for certain public and private projects.

This study is intended to assist the sector in achieving fluent approval of EIA reports and streamlined environmental permitting. It is a concise document for developers, competent authorities, the public, and the "*public concerned*" encompassing all the relevant Community legislation. It provides a review of the key environmental factors and some impact assessment elements along the mining life cycle phases, in addition to a few good practice cases. It also reviews the risk assessment methodologies, environmental monitoring, mitigation measures and assessment of alternatives, as well as environmental liability and information management issues.

The list of potential key environmental aspects and impacts is not exhaustive. Environmental factors and related risks not mentioned in this document need to be addressed in the EIA of a given project. The document has limited emphasis on permitting procedural issues and it does not provide a review of the state-of-art in Member States.

This document is not binding in any way for developers or competent authorities in their application of the EIA Directive and its transposed national laws. The requirements for an environmental impact assessment are exclusively regulated in the EIA-Directive. Where this document goes beyond the requirements of the EIA or treats topics that are not covered by the EIA, the explanations and statements shall be understood as non binding opinions and recommendations. It is the exclusive mandate of the Court of Justice of the European Union to authoritatively interpret EU Community law. Nevertheless, this study may constitute the basis for a later EU guidance document if all stakeholders support the concept and show interest in its further development.

1 Introduction - Purpose and structure of the document

Background

Raw materials are essential to our modern lifestyle, they are used in a wide range of applications from building materials to food industries, clean energy or electronics.

The European Green Deal and the European Digital Strategy aim at transforming the EU, by 2050, into a resource efficient, climate neutral society that takes advantage of the opportunities of digital transformation. This transition while "*dematerializing our economy*" has, as a consequence, an increased consumption of certain raw materials.

In a global context, with more vulnerable value chains and an increased competition for resources, non-energy extractive industries (NEEI) in Europe are an essential part of the sustainable supply of mineral raw materials to the EU economy.

In November 2008, the European Commission adopted the Raw Materials Initiative, which sets out targeted measures to secure and improve access to raw materials both within the EU and globally. It identified a range of objectives and implementation actions which could potentially influence the competitiveness of the extractive industry in the EU, inter alia, safeguarding the access to domestic mineral reserves and promoting streamlined permitting[1].

Purpose of this document

NEEI extraction sites, if not properly designed and managed, may have significant impacts on the environment. These effects depend on the type of mineral, mining practices, substances used in the processing stage, and the way extractive waste is managed.

The Environmental Impact Assessment (EIA) Directive[2] provides a framework for assessment of the likely significant effects of certain public and private projects before their authorisation. The Directive ensures public participation in decision-making and thereby strengthening the quality of decisions in a way that maximises the benefits to the society and enhances the civil society engagement in approval of projects in the quarrying and mining sector.

The main objective of this document is assisting the sector in achieving a fluent, streamlined environmental permitting. It aims at providing a concise, easy-to-use document for developers of non-energy minerals extraction projects, the competent authorities involved in EIA evaluation and approval process, the public and the "*public concerned*", such as interested NGOs and citizens. The methodological approach is to serve with the relevant Community legislation references, a review of the key environmental aspects along the mining life cycle phases (Chapter 4.3), technical attributes and good practice cases for a more efficient preparation and evaluation of the EIA report, the core of environmental decision-making. In a way, this study is a textbook which may extend beyond the legal requirements of the EIA Directive in a strict sense. Some of the described processes and cited legislation correspond to permitting applications that might be separate to the approval of the EIA report but which are part of the complex mining permitting procedures, which the operator will face anyway, such as soil and landscape management, climate and energy framework targets.

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1 Permitting in the extractive sector was covered thoroughly by the Minlex study; https://op.europa.eu/en/publication-detail/-/publication/18c19395-6dbf-11e7-b2f2-01aa75ed71a1

2 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment; https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1567155919188&uri=CELEX:02011L0092-20140515

In the context of this document, "*streamlining*" means coordinating or joining the environmental assessment procedures applied to a project[3] with a view to reducing unnecessary administrative burdens, creating synergies and hence speeding up the environmental assessment process, whilst at the same time ensuring a maximum level of environmental protection in accordance with the EU environmental acquis. Hence, streamlining does not imply any weakening of environmental protection requirements foreseen under EU legislation. On the contrary, the recommendations set out in this document serve to improve the quality of the permitting process.

Structure of the document

The document has chapters on the risk assessment methodologies, monitoring schemes, assessing alternatives, environmental liability and information management issues. However, the main focus of this document is to provide a framework for the inventory of key environmental aspects of the different life cycle phases of non-energy mineral extractive projects in the context of the major environmental factors of concern (Figure 1). The list of potential key environmental aspects is not exhaustive. Environmental factors and related risks not mentioned in this document may need to be addressed in the EIA of the given project.

This document is a practical guide for all stakeholders, a structured digest of existing knowledge on the field, with concise figures and decision-making flowcharts on the key environmental aspects that are taken into account in course of the EIA, if relevant to the given project.

Limitations of the document

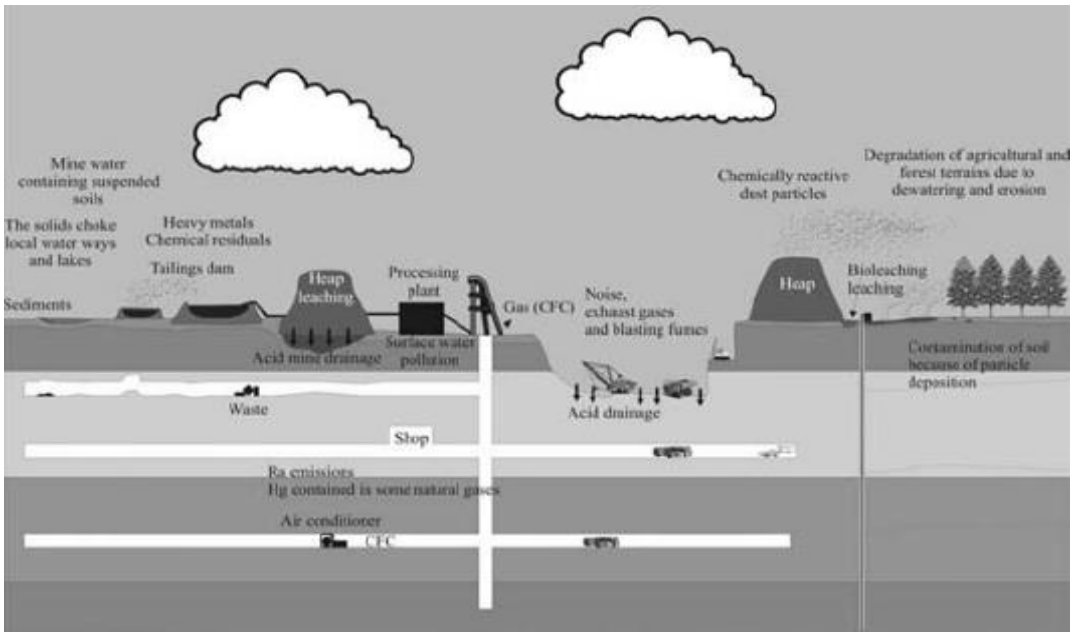
The document has limited emphasis on permitting procedural issues and legal interpretations, and it does not provide a review of the state-of-art practice in Member States (MS). Nevertheless, good practice cases in MS are referred to.

Because of the diverse and voluminous character of the topics it covers, this document does not provide a full list of scientific or technical references. It **focuses on the Community legislation and available guidance documents** and selected literature. It summarizes the aspects of extraction types and mining life cycle phases versus potential key environmental aspects. As well, it shares information on relevant information sources publicly available on a European scale.

This document is not binding in any means for developers or competent authorities in their application of the EIA Directive[4] and national laws transposing it. The Court of Justice of the European Union is the only source of definitive interpretation of EU law.

[3] Commission Notice 2016/C 273/01
[4] Directive 2011/92/EU

Figure 1: Non-energy minerals extraction and potential environmental impacts (Haupt et al. 2001)



2 Scope of this document

2.1 Raw Materials in scope

The document covers extraction projects[5] of non-energy mineral raw materials. The material groups in scope are[6]:

- metallic minerals (ferrous and non-ferrous metals, precious metals);
- industrial minerals (chemical applications (phosphate rock, potash, magnesite, etc.) and physical applications (asbestos, silica sand, diatomite, perlite, zircon, etc.), peat, gemstones, etc.);
- construction minerals (aggregates (gravel, sand, clay, crushed rocks), ornamental (decoration) stones); and
- on-site mineral by-products, extractive waste, other waste, end-of-waste.

The following are excluded from the scope:

- Energy minerals (fossil fuels, such as lignite, coal, anthracite, oil and gas, oil shale; uranium and thorium ores (actinides)).
- Food and non-food biotic raw materials.

2.2 Stages of the mining life cycle in scope

The scope covers the following stages of the mining life cycle:

- mineral exploration;
- planning and design;
- mine construction (incl. external and internal infrastructure, site preparation, etc.);
- operation
    - mineral extraction;
    - minerals treatment (processing);
    - on-site stockpiling, waste and end-of-waste management, by-product generation, re-use, recycling, recovery of waste and residues;
    - transportation and handling (on-site and to the next value chain phase, the latter which is usually in the scope of the EIA of extractive projects);
    - temporary suspension;
- final closure and post-closure of mines (progressive (syn-operational) rehabilitation, rehabilitation and post-closure aftercare (incl. monitoring[7]) and re-development options).

Mineral exploration falls under the scope of the EIA. For such projects, competent national authorities have to determine either through a case-by-case examination or according to threshold or criteria if the project is to be made subject to an assessment because of its likely significant effects on the environment taking into account the relevant screening selection criteria of Annex III of the EIA Directive. Drilling is the only exploration method which is nominated in the Annex II (2d) of the Directive. Exploration is not in the central

[5] In the context of the EIA Directive "*projec*t" means the execution of construction works or of other installations or schemes, and other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources;

[6] More detailed classification and list of minerals is provided by the INSPIRE Directive Technical Guideline No. D2.8.III.21 (https://inspire.ec.europa.eu/id/document/tg/mr)

[7] Environmental monitoring is an overarching activity from the start of a licensed project, in principle, with no negative environmental impact. In some cases it can have significant impacts, e.g. unwanted connection of aquifers by technologically poor groundwater monitoring wells.

focus of this document. Secondary off-site processing (e.g. thermal manufacturing and metallurgical processing) is out of the scope of this document, in line with the Extractive Waste Directive. Environmental permitting (and the undertaking of an EIA) is frequently related to the extension or expansion of existing extractive operations. This document is focusing on new projects.

2.3 Extraction types in scope

The document deals with the following major extraction types:

- Underground (subsurface) extraction.
- Open-cast (surface) extraction (incl. quarries).
- Extraction under water (coastal marine, fluvial and lacustrine dredging, incl. aggregates and placer minerals (metals)), aggregate excavation below the groundwater level. Deep sea metals extraction is not treated in this document.
- Other novel technology such as brines (saline or high concentration geofluids rich in halogens and alkali metals) extraction through deep drillings, in situ leaching of metals.
- Minerals by-production at other works[8] are out of the scope.

2.4 Project types in scope

In the meaning of the EIA Directive, as provided in its Annex I and II, the focus is on non-energy raw materials extraction projects:

- Quarries and open-cast mining where the surface of the site exceeds 25 hectares, or peat extraction, where the surface of the site exceeds 150 hectares (Annex I);
- Quarries, open-cast mining and peat extraction (projects not included in Annex I), (Annex II);
- Underground mining (Annex II);
- Extraction of minerals by marine or fluvial dredging (Annex II);
- Deep drillings[9] (Annex II);
- Surface industrial installations for the extraction of coal, petroleum, natural gas and ores, as well as bituminous shale (Annex II), with regard to coking coal and graphite which are critical materials[10].

Other project types included in Annex I and Annex II can be relevant for non-energy raw materials extraction projects but are not under the scope of this document:

- Groundwater abstraction or artificial groundwater recharge schemes where the annual volume of water abstracted or recharged is equivalent to or exceeds 10 million cubic metres (Annex I);
- Groundwater abstraction and artificial groundwater recharge schemes not included in Annex I[11] (Annex II);

[8] aggregates from landworks, infrastructure works, and artificial lake constructions; sulphur and carbon-dioxide from hydrocarbons extraction; gypsum from coal power plants flue gas; metals from steel plants slags; lithium and halogens from thermal waters etc.

[9] Interpretation of definitions of project categories of Annex I and II of the EIA Directive https://ec.europa.eu/environment/eia/pdf/cover_2015_en.pdf. Annex II (2) (d) to the EIA Directive contains only an indicative list of deep drillings. See ruling about deep drilling definitions in cases C-531/13, C-127/02.

[10] A few minerals of this commodity group are in scope, e.g. graphite and coking coal are critical materials, graphite is classified as an industrial mineral.

[11] In Case C-263/08, the Court considered the above project category.).

- Dams and other installations designed for the holding back or permanent storage of water, where a new or additional amount of water held back or stored exceeds 10 million cubic metres (Annex I);
- Dams and other installations designed to hold water or store it on a long-term basis (projects not included in Annex I), (Annex II);
- Initial afforestation and deforestation for the purposes of conversion to another type of land use[12] (Annex II 1.(d));
- Construction of roads, harbours, and port installations, including fishing harbours (projects not included in Annex I)**[13]** (Annex II);
- Coastal work to combat erosion and maritime works capable of altering the coast through the construction, for example, of dykes, moles, jetties and other sea defence works, excluding the maintenance and reconstruction of such works (Annex II);
- Installations for the disposal of waste (projects not included in Annex I), (Annex II);[14]
- Waste-water treatment plants (projects not included in Annex I), (Annex II).

In general, this document does not focus on associated or ancillary works located outside of the designated mining area perimeter. However, extractive projects usually involve such activities (e.g. external infrastructure developments, water treatment plants, electricity transformator stations, etc.), and permitting practices require the presentation of all of these in the EIA. The interpretative note published by the Commission[15] should be consulted in case of such works are part of the extractive project ("*If it appears that the associated works are inextricably linked to the main works, their approval and initiation should be considered as an initiation of the project.*").

The document does not make further distinctions of the size and volume of the activity, for the reason that MS may have more stringent legal provisions and regulatory practices than the Directive. As reflected in the MS legislation profiles at the EU Raw Materials Information System (RMIS)[16], a few MS choose the option of Article 4(b) of the Directive[17] by applying specific thresholds or criteria sets for the extractive projects (see Annex I).

Voluminous extractive projects may be part of related national, regional or local plans or programmes which can be subject to strategic environmental assessment (SEA)[18], e.g. in some countries as a pre-condition for publishing concession tenders, or as part of national or regional spatial development plans. The obligations stemming from the SEA Directive are out of the scope of this document; however, results of the SEA can be taken into account when a screening or EIA is undertaken for a mining project. If the project is likely to have significant environmental impacts on another country, a transboundary EIA is carried out[19].

This document does not discuss in details the procedural issues of "*screening*", "*scoping*", "*public consultation*", "*joint or coordinated assessment*" and "*development consent*" in the meaning of the Directive and other administrative aspects because these depend very much on the national legislation, the specific case, the regulatory approach of the

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12 http://ec.europa.eu/environment/eia/pdf/cover_2015_en.pdf:„*Conversion*" refers to any conversion of land use.

13 In Case C-142/07 the Court held that an exception for the applicability of the EIA Directive with regard to urban roads 'cannot be accepted'.

14 Landfill sites are included in this project category, as the Court held in its judgment in Case C-121/11..

15 https://ec.europa.eu/environment/eia/pdf/Note%20-%20Interpretation%20of%20Directive%2085-337-EEC.pdf

16 https://rmis.jrc.ec.europa.eu/

17 *„… for projects listed in Annex II, Member States shall determine whether the project shall be made subject to an assessment in accordance with Articles 5 to 10 …. through thresholds or criteria set ..."*

18 Directive 2001/42/EC; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0042&qid=1580379072222&from=EN

19 https://ec.europa.eu/environment/eia/pdf/Transboundry%20EIA%20Guide.pdf

competent authorities, and these are not specific to the extractive sector. The above procedural issues are presented in details in specific EU guidance documents listed in chapter 8.3.

3 PART A – OVERVIEW OF THE LEGISLATIVE REQUIREMENTS FOR THE PREPARATION OF THE EIA REPORT FOR EXTRACTION PROJECTS OF NON-ENERGY RAW MATERIALS

Legal background

The amended EIA Directive provides a clear flow of procedure which the developer and the competent authorities follow (Figure 2)[20]. It also mentions that "*In order to stimulate more efficient decision-making and increase legal certainty, Member States should ensure that the various steps of the environmental impact assessment of projects are carried out within a reasonable period of time, depending on the nature, complexity, location and size of the project. Such time-frames should, under no circumstances, compromise the achievement of high standards for the protection of the environment, particularly those resulting from Union legislation on the environment other than this Directive, and effective public participation and access to justice.*"

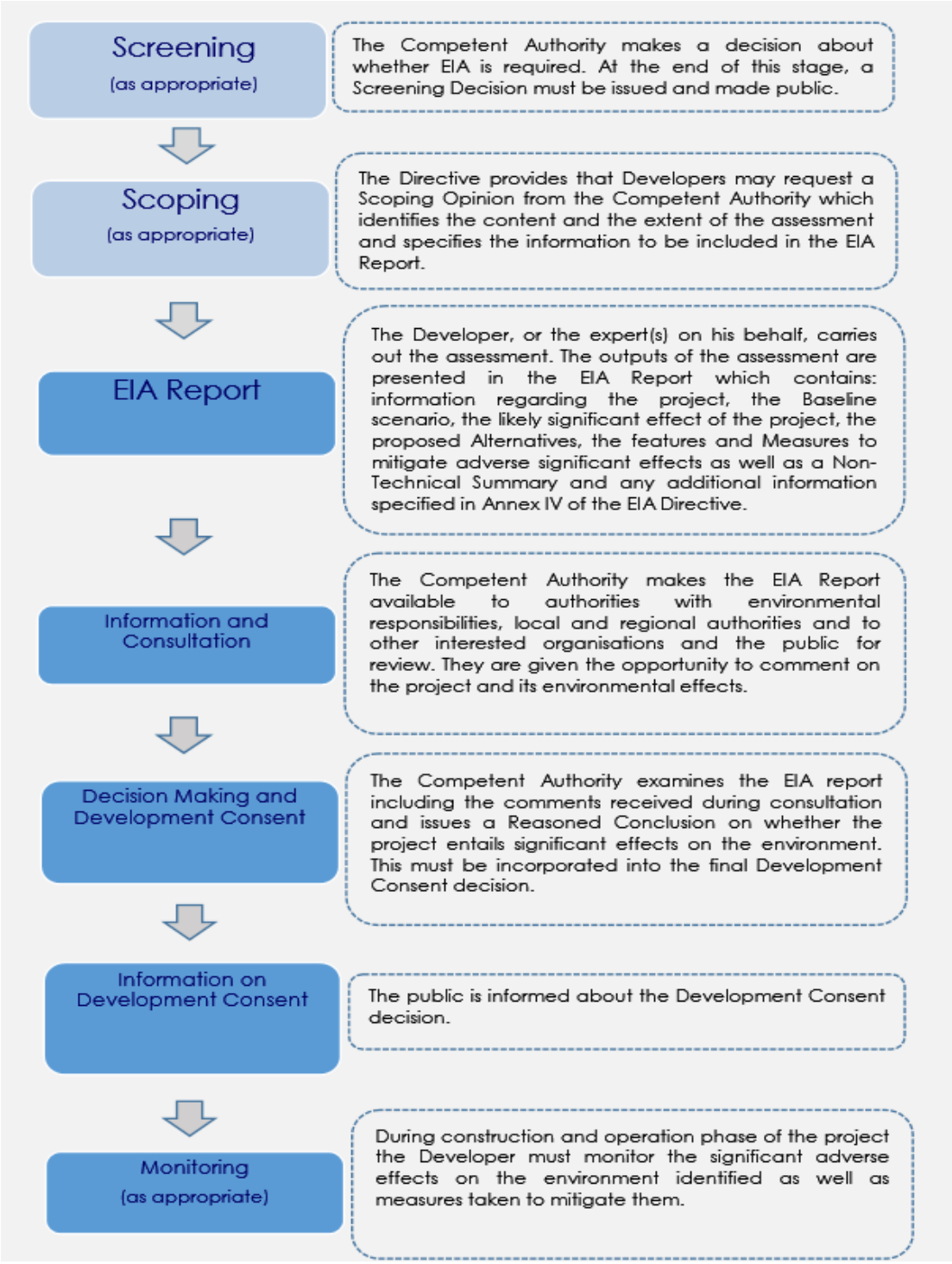
It is important to note that the assessment of the possible transboundary impacts is a core element of the EIA (Article 7 of the Directive) also in case of extractive projects, which makes the procedure on Figure 2 more complex.

There are numerous other pieces of Community legislation that are relevant to mining projects. These are listed in Chapter 8.1. Most of them, with the exception of Regulations (and a part of the Decisions), are Directives and Decisions that are transposed into national legislation of EU countries. The most relevant provisions of this legislation applicable to mining projects are embedded in the different chapters of this document. The summary of the national legislation can be accessed at the Raw Materials Information System (RMIS) based on mainly the results of the MINLEX[21], MIN-GUIDE[22] and MINVENTORY[23] projects.

RMIS also provides detailed information on the national policy context, the permitting procedural characteristics, including related case law examples.

[20] http://ec.europa.eu/environment/eia/pdf/EIA_guidance_EIA_report_final.pdf
[21] http://www.minlex.eu/
[22] https://cordis.europa.eu/project/id/689527
[23] https://ec.europa.eu/jrc/en/scientific-tool/minventory

Figure 2: The schematic EIA approval procedure[24]



[24] EIA guidance - EIA report (2017)

Note: In certain MS jurisdictions, an EIA plan (a preliminary description how the operator plans to assess the impacts) must be submitted and approved first.

3.1 Screening

For projects listed in Annex II of the Directive, the national authorities have to decide whether an EIA is needed (Articles 2(1), 4(2)). This is done through the "*screening procedure*", which determines the effects of projects on the basis of *(a)* thresholds/criteria or *(b)* a case by case examination or a combination of these. The national authorities shall take into account the criteria laid down in Annex III.

Since a detailed EC guidance[25] is published on this topic and many MS require an EIA for almost all extractive projects, and only a few apply specific thresholds for the sector (see Annex I of this report), this document does not cover this aspect. As regards the establishment of thresholds or criteria, it must be borne in mind that Article 4(2)(b) of the EIA Directive confers a measure of discretion on the Member States in that regard. However, that discretion is limited by the obligation set out in Article 2(1) of the Directive to make projects likely, by virtue inter alia of their nature, size or location, to have significant effects on the environment subject to an impact assessment[26].

3.2 Scoping

The scoping procedure is not the subject of this document. Article 5(1-2) provides an option for the developer to request a scoping opinion from the competent authority, and set conditions in the event that this takes place. It is not mandatory but encouraged, as it may bring several benefits as outlined in the relevant EC guidance[27]. However, if the developer requests such an opinion, the competent authority is obliged to issue it.

The procedural details of this stage can be diverse across MS. In some countries there are so-called preliminary EIAs for the clarification of the critical impacts, and the consultation with the authority prior to the preparation of the EIA report is also an option in most MS. For example, in Finland an EIA programme must be prepared and discussed with the authority[28]. Submitting supplementary information during the approval procedure and at the different levels of appeals provided inside the national public administration framework, outside court jurisdiction, may also allow the developer to re-assess the environmental impacts. Moreover, experiences indicate that scoping resolutions do not prevent the authorities and involved clients to raise additional requirements during the approval of the EIA.

For extractive projects it is recommended for the developer to request the scoping option in the way national legislation stipulates and regulatory practice requires.

3.3 Exemptions

Articles 1(3), 2(4) and 2(5) set waivers for MS to exempt specific projects or parts of projects from the provisions of the Directive in case of defence purposes, response to civil emergencies, or other exceptional cases[29]. Temporary aggregates extraction supplying material for interim dams during dramatic flooding can be an example for response to civil emergency exemption. Similar exceptions were accepted in case of, supply of gas, and renewable energy (further details are in Commission Notice 2019/C 386/05[30]).

Article 10 provides for competent authorities to respect the limitations imposed by national legislation and administrative provisions with regard to commercial and industrial

[25] https://ec.europa.eu/environment/eia/pdf/EIA_guidance_Screening_final.pdf
[26] https://ec.europa.eu/environment/eia/pdf/EIA_rulings_web.pdf
[27] https://ec.europa.eu/environment/eia/pdf/EIA_guidance_Scoping_final.pdf
[28] https://tem.fi/documents/1410877/2851374/Environmental+Impact+Assessment+Procedure+for+Mining+Projects+in+Finland
[29] Commission guidance document regarding application of exemptions under the EIA Directive – Articles 1(3), 2(4) and 2(5) (14.11.2019); EIA guidance - EIA report (2017)
[30] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019XC1114(02)&from=EN

confidentiality, including intellectual property, and the safeguarding of the public interest. This provision is set without prejudice of the EU requirement on the open access to environmental information for the public[31] and for clients involved in the EIA approval procedure.

This can be relevant for the extractive sector because in some MS the information on mineral reserves, production or geological data can be of commercial confidentiality ("*business secrecy*"). The Directive 2016/943/EU[32] provides rules on such classified information. There might be circumstances where the disclosure of certain environmental information would not be in the public interest. For example, when the protection of a habitat, a mineral assemblage or a historical relict dictates that their location should be kept secret.

3.4 Joint and coordinated procedures

Article 2(3) calls for streamlining environmental assessment with other, similar requirements of the Habitats, Wild Birds, Water Framework and Industrial Emissions Directives. The Commission Notice (2016/C 273/01)[33] provides some guidance on the coordinated and/or joint procedures which can be relevant for extractive projects in association with the "*appropriate assessment*" under the Habitats and the Birds Directives or from assessments arising from other directives, e.g. the Industrial Emissions Directive.

3.5 Consultation, decision making, development consent

The preparation of the EIA report is the major focus of this document, as well as the monitoring which is an essential part of the project approval. The authority decision making and the development consent are not specific to the sector, and the EC Guidance on the preparation of the EIA report discusses these in details[34]. Therefore these latter aspects are not presented herein.

However, when taking into account that extractive projects

(a) may have a negative perception amongst the public, and

(b) may require a significant change in land use for a long period of time,

the consultation with authorities likely to be concerned by the project and the public concerned[35] is of outstanding importance during the whole procedure for the overall feasibility of such projects. Consultation may be extended to national scale due to their political importance, or to international scale if the likely impacts are transboundary in dimension. The EIA report is typically the document to which the public has open access and from which they can obtain most of the necessary environmental information. Therefore, it is of paramount importance that the EIA report, and especially the non-technical summary is written in a language style that is understandable for both the authorities and the public.

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31 Directive 2003/4/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0004&qid=1580398969893&from=EN

32 Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L0943&qid=1580401977092&from=EN)

33 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016XC0727(01)&from=EN

34 EIA guidance - EIA report (2017); https://ec.europa.eu/environment/eia/pdf/EIA_guidance_EIA_report_final.pdf

35 *„the public affected or likely to be affected by, or having an interest in, the environmental decision-making procedures referred to in Article 2(2). For the purposes of this definition, non-governmental organisations promoting environmental protection and meeting any requirements under national law shall be deemed to have an interest"* (Art.1(2)e of the Directive)

Public acceptance is usually a prerequisite for the development of any new economic projects which involve environmental permitting. The analysis on "*Public acceptance*" of the 2018 Raw Materials Scoreboard[36] showed that the development of public awareness is rather slow but can also turn extremely fast, especially from positive to negative perception due to major accidents, such as tailings dam failures[37].

In this context, there are a number of EU MS and international good practice cases published on the consultation, in a broad sense, with the public concerned (EU Raw Materials Scoreboard; EC, 2018). The most common elements of these approaches that may assist in obtaining the public acceptance are:

- ✓ start consultation at the earliest possible and reasonable permitting stage;
- ✓ setting up of representative local groups which the company can liaise with;
- ✓ employ professional PR expert or company;
- ✓ transparency is key in confidence building;
- ✓ make relevant information accessible on-line and real-time (e.g. monitoring data), and in analogue format too (e.g. local library);
- ✓ involve locals in environmental monitoring;
- ✓ invest into local infrastructure and business, explain and widely promote contributions to sustainability of local economy and social development, and to the improvement of environmental conditions (especially in case of brownfields);
- ✓ place an emphasis on potential positive impacts, the monitoring, mitigation, and compensation measures in the EIA report;
- ✓ highlight on voluntary environmental management schemes, and ecolabel of products, even if downstream, if any, in the EIA report;
- ✓ present in-depth the efforts on de-carbonization, resource efficiency and circular economy measures;
- ✓ show analogue best practice facilities for local opinion leaders and decision makers, organize facility visits;
- ✓ continue these efforts throughout the life cycle of the mine.

Public opposition may happen when the extractive projects restrict the open access to information referring to business confidentiality, and the above principles don't rule the general attitude of companies.

In recent years many EU H2020 projects dealt with the social dimension and public acceptance of extractive activities. Their list is published by EASME[38]. Most of them worked on methodological developments (MINGUIDE, ORAMA, MINLAND, SLIM) or carried out expert surveys (MINLAND), and/or focusing on certain materials (SECREETS, SLIM), value chain stage (INFACT) or different public acceptance scales (STRADE, INTRAW, REMIX, MIREU).

When preparing for obtaining the social acceptance, mine developers should be aware of the basic typology of environmental compliance of persons and the corresponding potential management response tools (Figure 3).

[36] https://rmis.jrc.ec.europa.eu/?page=scoreboard2018#/
[37] https://ejatlas.org/about
[38] Kotkina et al. (2019)

Figure 3: Types of conduct in the context of environmental compliance and potential responses (source: EC SWD(2018)10 final)

More guidance on consultation and public participation is provided by Commission Notice (2016/c 273/01)[39].

3.6 Mineral exploration and the EIA procedure

The mineral raw material life cycle has several sub-stages at the front end, such as fundamental research, geological, geophysical and geochemical field surveys (reconnaissance), prospecting, and exploration, including exploration during the on-going extraction, which have limited environmental relevance as compared to the later life cycle phases. Among the surface geophysical methods, the seismic survey usually requires consultation with the environmental inspectorate in order to avoid the disturbance of habitats during certain periods of the year.

Deep drilling is the only exploration method which is explicitly indicated in the EIA Directive, however, other exploration methods may also fall under the scope of the Directive. Exploration drilling is widely used in the non-energy mineral sector, and in case of deep-seated ore deposits drillholes may intersect several groundwater aquifers. Technically well designed and managed drillholes usually don't pose any threat on the environment beyond the temporary surface damage. However, accidents may happen, poor design and imperfect technical safety can lead for example to emissions to groundwaters.

Drilling is nominated in the Annex II (2d) of the Directive. The screening procedure should clarify in each case whether exploration projects with drilling should be submitted to an EIA procedure. With regard to introducing national thresholds for hydrocarbons drilling in Poland, the Court of Justice of the European Union (CJEU) found the country in breach with Directive's requirements (Case C-526/16)[40].

[39] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016XC0727(01)&from=EN
[40] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A62016CN0526&qid=1611563739146

4 PART B - THE PREPARATION OF THE EIA REPORT FOR EXTRACTION PROJECTS OF NON-ENERGY MINERAL RAW MATERIALS

Art. 5(1) of the Directive sets out what developers must include as a minimum in the EIA report. Annex IV, referenced in Art. 5(1)(f), expands on these requirements, it includes the following:

Description of the project: an introduction to the project, and includes a description of the location, the characteristics of the construction, and the operational phases, as well as estimates of the expected residues, emissions, and waste produced during the construction and operation phases (Art. 5(1)(a), Annex IV.1).

Baseline scenario: a description of the current state of the environment, and the likely evolution thereof without the implementation of the project. This sets the stage for the subsequent EIA, and MS should ensure information for the baseline scenario held by any authorities is available to the developer (Annex IV.3).

Environmental factors (compartments, media) affected: a description of the environmental factors likely to be significantly affected by the project, with specific emphasis being placed on climate change, biodiversity, natural resources, and accidents and disasters (Art. 3, Annex IV.4,8).

Effects on the environment: this section addresses the concept of 'significant effects' and the importance of cumulative effects with other existing and/or approved projects (Art. 5(1)(b), Annex IV.5).

Assessment of alternatives: alternatives to the project must be described and compared, with an indication of the main reasons for the selection of the option chosen (Art. 5(1)(d), Annex IV.2).

Mitigation or compensation measures: features and/or measures to avoid, prevent or reduce, and offset adverse effects are also considered (Art. 5(1)(c), Annex IV.7).

Monitoring: monitoring measures proposed should be included in the EIA report, where significant adverse effects have been identified. This monitoring shall be carried out during the construction and operation of a project, as well as post-closure (Annex IV.7).

Non-technical summary: an easily accessible summary of the content of the EIA report presented without technical jargon, hence understandable to anybody without a background in the environmental aspects (Art. 5(1)(e), Annex IV.9).

In case the project may have transboundary impacts, it is recommended to designate in the EIA report a **separate chapter dedicated to the transboundary impacts** where all relevant information is presented in a comprehensive way. It may speed up the procedures required by Article 7 in the affected Member State.

In accordance with Art. 5(3), experts preparing the EIA report should be competent, and the competent authority reviewing the EIA report should have or have access to sufficient expertise to examine it. Where necessary, the competent authority seeks from the developer supplementary information.

4.1 Description of the mineral extraction project

This chapter of the EIA report is an introduction to the project, and includes a description of the location, the characteristics of the construction and operational phases, as well as estimates of the expected residues, emissions, and waste generated, as well as closure and rehabilitation management plans (Art. 5(1)(a), Annex IV.1). The description comprises information on the site, design, size and other relevant features of the project.

4.1.1 Description of the location of the project (Annex IV.1.a)

- Identifiers, as required by the relevant national law, such as name of the extraction site and the company, administrative data (company and tax register, number and access of available authority permits), name, licence No. and access of involved competent expert(s),
- Financial viability of the company, if required by the relevant national law, proof of ability to meet bonding requirements sufficient to cover the anticipated costs of environmental management during extraction, as well as the costs, by a third party, of closure and long-term post-closure liabilities associated with extraction.
- Postal address, land register number(s), co-ordinates of the site polygon (geographical, GPS, and INSPIRE conform co-ordinates (e.g. Lambert Azimuthal Equal Area (ETRS89-LAEA)[41] in case of risk of transboundary impacts) with a map of the site location.
- Size of the facility (surface and underground area and depth), detailed figures on areas covered by buildings, processing plants, shafts, linear infrastructure, tailings, waste heaps (also volumes for the two latter), and on lateral coverage of underground facilities and their volumes.
- Description of the existing infrastructure (energy grid, water supply, sewage system, roads, railways, waterways, other means of transportation, telecommunication, local food supply, settlements, etc.).
- Short introduction to geographic setting and local environmental conditions (landscape, geomorphology, hydrogeochemistry, hydrogeology, hydrology[42], vegetation, etc.), current land use classification, soil quality categories on the site (EC JRC classification[43], or national classification), description of previous activities in case of brownfield development[44]. Maritime spatial planning categories where relevant.
- Brief presentation on the local and regional economy (composition, performance, prospects) and the social patterns (employment, cultural and historical heritage, indigenous population).
- Assessment of the alternative location of the individual mine installations, short reasoning of the chosen location.

[41] https://inspire.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_RS_v3.2.pdf
[42] based on available data in accordance with Annex II of Directive 2000/60/EC
[43] https://esdac.jrc.ec.europa.eu/Awareness/SoilTypes.html
[44] https://ec.europa.eu/environment/integration/research/newsalert/pdf/39si_en.pdf

4.1.2 Description of the characteristics of the project (Annex IV.1.b,c,d)

The clear and concise description of the physical characteristics of the whole extractive project defines the project and its various elements, covering its whole life cycle. It is important to highlight that the below list of characteristics is not exhaustive.

- Objectives and main characteristics of the extractive project:

  - minerals to be extracted, estimated quantities[45], planned operations and annual production volume, planned on-site processing, storage and transport of the products and wastes;

  - new project, expansion of an existing project (e.g., increase in mine land area or increase in annual production)

  - major construction, extraction, treatment (processing) and closure technologies and technical solutions;

  - utilization of the product(s), brief market review, planned collateral local economic activity (by-products and reused/recycled/recovered waste, shared/cascade use of resources, innovation hub, downstream value chain options, infrastructure development, industry park, etc.);

  - expected start and duration of the whole project and its major stages (construction, operation, closure and post-closure (de-commissioning, rehabilitation);

  - importance of the extraction on local/regional/country/global scale.

- Construction phase characterization (Note: construction works can be contemporaneous to extractions):

  - legal and physical measures in changing the land use categories (requisite demolition works, clearing off and depositing topsoil);

  - elements of the local fauna and flora, habitat and ecosystems, biodiversity and natural resource management plan;

  - measures for conserving or translocating vegetation, and protected species;

  - description of the planned surface and subsurface construction installations and activities (e.g. buildings, infrastructure, extraction facilities and workings mineral processing and waste management facilities) demonstrated on good resolution maps (typical scales 1:1000 – 1:10000) and their timing; a visualization made available on-line is recommended;

  - raw materials and construction products to be used, including estimate of volumes, quality, source, transportation means, residues generated, supported preferably by a simplified material flows diagram;

  - quantities and types of waste generated (e.g. volume, tonnage, characteristics and behavior of the extractive waste generated);

  - volume, quality, source, transportation means of incoming raw materials (construction materials, treatment chemicals, etc.) used for extraction (incl. progressing constructions and progressive rehabilitation);

  - volume, quality (incl. EWC[46] code), source, transportation means and disposal management of wastes and by-products generated;

[45] UNFC 2020. Estimates associated with Viable Projects are defined in many classification systems as Reserves

[46] European Waste Catalogue (or "EU List of Waste"), Comm. Dec. 2000/532/EC

- volume, characteristics, management and treatment of water influenced by extractive activities (e.g. drainage from the site, dewatering from open pit and underground mine);

- plan for securing water availability, maximizing water recycling and minimizing fresh water intake, eliminating uncontrolled water discharge;

- established physical protection (fence, dam, land barrier) and safeguarding of the site, additional buffer zones if any (restrictions in nearby land use due to quarrying explosives, landslides of heaps, risk of tailings dam failure, underground extraction);

- new infrastructure development and new services which the local population can benefit from (roads, water and energy supply, sewage plant, communication network, fire station, medical service, public transport, visitor center, observation tower, etc.)[47];

- an estimate, by type, quantity, source and timing (daily, periodical, seasonal) of expected emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation) during the construction phase.

- Operation phase characterization concentrates on systematically describing the unit processes used in the mining project and the emissions arising from each of these and the mitigation methods applied. These emissions and estimates of their spreading in the surroundings are the basis for the subsequent assessment of both ecological and health effects:

  - quantitative data of changing the land use (km^2);

  - removed or disturbed fauna and flora species, habitat, and ecosystem, logged or translocated vegetation;

  - description of the planned surface and subsurface extractive and other installations and activities (buildings, infrastructure, extraction facilities and workings mineral processing and waste management facilities) demonstrated on good resolution maps (typical scales 1:1000 – 1:10000) and their timing; a visualization made available on-line is recommended;

  - volumes, characteristics and spatial distribution of minerals to be extracted, treated, temporarily stored and sold annually and during the life cycle of the mine;

  - volume, quality, source, transportation means of incoming raw materials (construction materials, treatment chemicals, etc.) used for extraction (and progressing constructions and progressive rehabilitation);

  - quantities and types (e.g. volume, tonnage, source, characteristics and behavior (incl. EWC[48] code), management, handling and transport, treatment and disposal, storage and deposition of different residues (e.g. extractive wastes, other wastes, by-products) generated, the design of extractive waste management facilities and plan for their progressive rehabilitation and final closure;

  - volume, characteristics, management and treatment of extractive activities influenced water (e.g. extractive waste influenced water (e.g. seepage), adic mine drainage/acid rock drainage, dewatering from open pit and underground mine, drainage, drainage from the extractive site);

[47] The use of infrastructure by third parties should be well defined in a legal frame (e.g. contract) by setting clear responsibilities and waivers. Any mine post-closure uses of the infrastructure by third parties according to public requirements and national building regulations cannot be imposed on the company.

[48] European Waste Catalogue (or "*EU List of Waste*"), Comm. Dec. 2000/532/EC

- progressive rehabilitation works (e.g. covering) of the extractive waste facilities;

- data on the annual and life cycle scale use of other resources (energy, water, human resources, financial resources (optional));

- preferably, the presentation of all material and product flows is supported by material flow diagram(s);

- an estimate, by type, quantity, source and timing (daily, periodical, seasonal) of expected emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation) during the operation phase;

- minimize noise and dust emissions, and prevent land use conflicts, taking into account the growing competition between land use, biodiversity and water resources;

- promote energy savings and increase the use of renewable energy sources such as solar panels and wind to reduce carbon dioxide emissions. As mining is a major energy user, it needs to develop new technologies to improve its energy efficiency;

- minimize or mitigate any environmental impacts on people and communities, including on the use of resources such as energy, water, and productive soils.

- Final closure and post-closure phase characterization:

  - planned surface and subsurface decommissioning and demolition activities, decontamination works if needed, potential site re-use;

  - management of residues and wastes remaining on site, volume and tonnage of the extractive wastes and other wastes generated, review and verification of the characteristics and behavior of the wastes;

  - physical and chemical stabilization of extractive waste facilities such as waste rock heaps and tailings ponds, backfilled mine voids; other workings;

  - flooding of the open pit and underground mine and management and treatment of the overflow;

  - measures and technologies, such passive or active engineered barriers or passive treatment wetlands or active water treatment plants to avoid, prevent and reduce the potential impacts to soil, groundwater and surface water due to seepage and migration of pollutants from extractive waste influenced waters and other extractive activities influenced waters (e.g. overflow from open pits);

  - rehabilitation plans (landscaping, reshaping the slopes, re-location of topsoil, revegetation (re-cultivation), surface hydrology works) demonstrated on good resolution maps (typical scales 1:500 – 1:10000), a visualization made available on-line is highly recommended;

  - changing the land use categories in accordance with site re-use;

  - safety works related to active or passive protection of remaining facilities against intruders and natural impacts (e.g. warning signs, fencing, closing of the roads and road connections and entrance to the mine);

  - re-use and new facilities (renewable energy production (solar, geothermal, wind, water reservoir), sport and tourism facilities (golf course, race tracks, observation tower, mining museum etc.), other industry, agriculture, forestry, housing, etc.)[49];

[49] See footnote 44.

- estimate, by type, quantity, source and timing (daily, periodical, seasonal) of expected emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation) major emissions during closure and post-closure.

The closure of a mine requires functional and tested technical and scientific methods, so that the restoration of quarries, tailings, waste areas and infrastructure allow further sustainable use of the area according to plans. Mine closure has a major impact on surrounding communities and planning for the social and economic aspects of the transition should start well in advance. Possible approaches include support of economic diversification and creation of alternative livelihoods, capacity building, professional training, and others. Part of the wealth generated by mining should serve as a catalyst for sustainable development of the communities.

- A description of the details of reasonable project alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics (e.g. local environmental conditions), and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects. Alternatives may include alternative locations of extractive waste facilities, water storage ponds, production plants and discharge pipelines in the recipient waterbody, annual production volume of the ore or extractive wastes, amount or quality of waste water discharged, amount of water intake, characteristics of the extractive waste as well as size of the extractive waste facilities.

4.2 Baseline scenario (Annex IV.3)

Legal background

According to Art. 5(1) "*The information to be provided by the developer shall include at least...any additional information specified in Annex IV relevant to the specific characteristics of a particular project or type of project and to the environmental features likely to be affected*." Annex IV(3): "*A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*."

Baseline conditions are the conditions and state of the environment and the other elements (socio-economic, cultural, infrastructure)[50] at the time of starting the extractive project in a broad sense, i.e. before launching any preparatory actions at the site, including intrusive, penetrative exploration. *Baseline scenario*, the description of baseline conditions and their likely natural evolution trends, has outstanding importance because

- it provides information on the status and trends of environmental factors against which significant effects and cumulative effects can be compared and evaluated;
- it is the foundation against which the whole project and its technology solution alternatives are assessed;
- it forms the basis for designing monitoring measures;
- it supplies the front-end input parameters for the database to be established by the extractive project.

[50] EIA guidance - EIA report (2017)

In addition, with regard to the specific attributes of the sector,

- extractive projects' several decades lifetime implies that the project needs to be also assessed against an **evolving environmental baseline**;
- in a worst case scenario, extractive projects may induce accidents ("*design basis accident*"). The installation must be designed according to established criteria against accidents so the environmental damage, where applicable, and the emission release are kept within authorized limits.

Geology defines the occurrence of mineral deposits so mining is geographically constrained and related extractive activities are placed where the mineral resources exist, with no or very limited possibilities to be relocated. In some cases, they involve high concentrations of certain elements due to natural background levels and historical or diffuse pollution.

In spite of the dispositive character of the cited provisions, it is in the interest of the developer to prepare a sufficiently detailed and accurate baseline scenario which provides evidence on existing natural anomalies or historical pollutions. In Europe, pristine natural settings are rare, and the distinction between "*greenfield*" and "*brownfield*"[51] is not always easy. In this regard, it is recommended that extractive projects start collecting environmental data (e.g. hydrological and hydrogeological, hydrogeochemical characteristics and site-specific conditions) already at the prospecting and exploration stage such as during field observations, and geological mapping, geochemical and geophysical surveys, and drilling campaigns depending on the maturity of the project. The collection of data related to soil, subsoil, bedrock and water usually acquired during geological mapping and mineral exploration.

In "*bona fide*", the burden of preparing the baseline scenario could be significantly decreased by applying the above legal waivers and the scoping option with the competent authority. However, related experiences at the extractive sector do not confirm this, therefore a holistic approach can be the secure and economic solution.

4.2.1 Spatial dimension

The Directive does not provide further details on the lateral dimensions that the baseline scenario covers. Mineral extraction might mean diffuse source emission but also point source emssions, e.g. "*end-of-pipe*" emission to water bodies in case of ore mines with pump station outlets, or treatment plant cleaned waste water discharge through ditches or pipelines. Modern extraction technologies and prevention measures allow for a minimum emission. Nevertheless, as a practical rule of thumb, the "*near-field*" can be interpreted laterally as extending from the mining area (or plot) perimeter to the nearest settlements (or protected species and habitats, water catchment, food crops) as potential closest receptors. The "*near field*" is examined in principle, for all environmental factors and substances that can be identical to or have cumulative effects with any potential future emissions, typically a few to dozens of km in distance. However, the "*near-field*" is case dependent. Waste water discharge pipelines may be few to tens of km long and the emissions may have an impact on water quality another tens of kilometers downstream the discharge point.

The "*far-field*" scale is usually limited to two contexts/scenarios:

- the accidental release[52] of concentrated pollutants to surface waters capable of travelling immediately and long distances (few tens to hundreds of km) along a pollution pathway which can be confined in an ideal case;

[51] https://ec.europa.eu/environment/integration/research/newsalert/pdf/39si_en.pdf

[52] EIA includes the expected effects deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned (Art. 3(2), Annex III 1(f) of the EIA Directive.

- the highly dispersed air emissions with similarly long distances and potential impacts.

Since local and regional social and economic impacts are considered in the EIA, the spatial limit can be also set along the area from which the mine recruits its workforce. It also facilitates a safe and healthy work environment for employees, and contribute to the health and safety of surrounding communities.

4.2.2 Temporal dimension

The Directive requires an outline of what is likely to happen to the environment should the project not be implemented – the so-called "*do-nothing*" scenario. This gives the baseline scenario a dynamic dimension going beyond the static presentation of the "*moment zero*" situation[53]. This is especially important for issues where there is considerable uncertainty, such as climate change, or for long-term developments, such as extractive projects. Predicting uncertain elements can be challenging, particularly concerning the availability of information, when carrying out the scenario assessment with reasonable effort. This uncertainty can be managed if the EIA transparently explains the methods and assumptions used so that the reader can evaluate the result. It is also an important element when conducting an open, inclusive and continuing dialogue with local communities throughout the mining cycle.

The timeline of the future assessment of baseline conditions is not set in the legislation. Extractive projects generally last for decades and the risk of environmental impacts may last similarly long or even several hundred years. Therefore, the projection period is carefully established as a function of the given project characteristics (see MWEI BREF[54]). Natural attenuation processes, spontaneous biodiversity remediation can efficiently function at such a time scale, along with other evolving environmental baseline constituents. In addition to the physical and chemical stability of the extractive waste facilities and other remaining structures, maybe the mobilization and migration of potentially toxic leachates to surface or groundwaters are one of the most important factors to be considered in the long-term behaviour of a mining site.

4.2.3 The baseline assessment

The description of the current state of the environment must be sufficiently detailed and accurate to ensure that the effects arising during the project can be adequately assessed[55]. At the same time, the collection of data and the assessment of the baseline need to be completed with reasonable effort. Developers need to determine what aspects are important and can be readily understood and where qualified assumptions or estimates can be made to ensure the timely completion of the EIA report. Essentially, it involves proactively determining what is relevant and finding the data and information necessary to set the framework against which to assess impacts on the environment[56].

Baseline conditions and their likely future natural changes are the basis of comparison for environmental parameters to be used during the environmental impact assessment. In this regard, the most complete list of the parameters to be studied is a reflection of those used in the impact assessment of the project. Hereby, a comprehensive set of all theoretically possible aspects are listed. A proportionate selection is made depending on the needs of each individual project:

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53 EIA guidance - EIA report (2017)

54 Best Available Techniques Reference Document for the Management of Waste from Extractive Industries (MWEI BREF)

55 https://ec.europa.eu/environment/eia/pdf/EIA_guidance_EIA_report_final.pdf

56 EIA guidance - EIA report (2017)

Landscape, soil, subsoil:

- high resolution topography map of the site (typical scales 1:500 – 1:10000) with existing infrastructure, land use patterns, soil classes, detected landslides, land subsidence, soil erosion, waste dumps;
- soil quality: classification; pH; electrical conductivity; organic carbon content; salt content; major chemical elemental composition, including potential future pollutants (toxic elements and ions[57], processing chemicals and dangerous chemical substances[58]; and soil capacity for natural attenuation processes (biological activity, alkalinity for neutralization, etc.); the required list of these parameters depend on the geology and the land use history of the site;
- geological conditions (geological map, rock composition and bedding style, tectonic and seismic features, hydrogeological conditions, mineral and chemical characteristics), mineral deposits;
- natural geochemical background levels, including inorganic elemental composition, organic carbon content, carbon dioxide and hydrocarbons seepages, natural radioactivity, and any mineral, petrological or geochemical alterations which may indicate natural processes identical or similar to the effects of the project;
- anthropogenic contaminants in sub-soil in case soil chemistry had indicated pollution;
- absorption capacity of any wetlands, riparian areas, river mouth, coastal zones and marine environment;
- landscape and sites of historical, cultural, archaeological and industrial heritage significance.

Biodiversity:

- occurrence, type, status of vegetation also in context of land use (forests, croplands, pristine settings) and ecosystems both terrestrial, freshwater and marine;
- nature reserves and parks;
- areas classified or protected under national legislation, Natura 2000 areas designated pursuant to Directive 92/43/EEC and Directive 2009/147/EC[59];
- inventory of native, migratory and invasive species and their habitats;
- prevailing farming practices in local agriculture.

Water:

- high resolution hydrology and hydrogeology map of the site and the near-field with surface waters, groundwater, and marine water quality status (biological and chemical) and physical characteristics (water level, piezo-metric (hydraulic)head, flow patterns (seasonal changes, sediment flux, travel times from surface and to surface), and a far-field outlook;
- natural floods and flood risks, including extreme tide in coastal marine setting;
- bottom sediments, chemical and biological (ecological) characterization, a reasoned selection of quantitative indicators from the lists provided by Directives 2000/60/EC, 98/83/EC, 2006/118/EC, 2008/56/EC, 2010/75/EU, 2012/18/EU, and Decision 2455/2001/EC;
- water balance, current water discharge, also in context of local climate change.

[57] e.g. As, Cd, Pb, Hg, ammonium, chloride, nitrate, sulphate
[58] e.g. cyanide, xanthate, acids, PAH, BTEX, pesticides
[59] There can be sites classified under international conventions (e.g. Ramsar Convention) but these are usually protected by the EU Community and national legislation.

Air:

- local and near-field meteorological and climate conditions (daily and seasonal temperature changes, wind and precipitation pattern, humidity, insolation hours and angles);
- current vibration, noise, heat, ionizing and electromagnetic radiation, and light emission levels measured in line with Directives 2000/14/EC, 2002/49/EC and 2015/996/EU;
- a reasonable selection of indicators on air quality from the lists provided by Directive 2010/75/EU and Regulation 525/2013/EU (greenhouse gases), Directive 2004/107/EC (As, Cd, Ni, Hg, B(a)P, PAH), Directives 2008/50/EC and 2284/2016/EU (NOx, SOx, PM, NMVOC, CO, heavy metals), Regulation 2019/1021/EU (POPs), Regulation 1005/2009/EU (ozone depleting substances).

Socio-economics:

- population density and settlements, minorities, education, employment and mobility figures;
- general health status of the local population, statistics and known local anomalies;
- occupational health and safety;
- local economies, infrastructure patterns, current sources and use of energy and raw materials;
- cultural traditions, societal cohesion and interconnectivity, NGO activity, local attitude towards new industry projects;

and their likely future evolution without the accomplishment of the planned project for a projection period identical to or longer than[60] the duration of the extractive project.

[60] It is recommended to prolong it until the end of the active monitoring.

4.3 Environmental factors and impact assessment elements (Annex IV.5)

Legal background

According to Article 3 of the Directive, "*the environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors:*

(a) population and human health;

(b) biodiversity, with particular attention to species and habitats protected;

(c) land, soil, water, air and climate;

(d) material assets, cultural heritage and the landscape;

(e) the interaction between the factors ….

The effects on the factors … shall include the expected effects deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned."

Annex IV points 4-5. repeat the above list with examples, also highlighting on some likely significant effects.

It is important to note that the "*description of the likely significant effects on the factors … should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the project*" (Annex IV(5.)).

The above provisions stipulate a step-by-step methodological approach where the complete inventory - a systematic identification, list and review - of project-specific potential key environmental aspects is of paramount importance for the later impact assessment. In this regard, this document provides a series of checklist tables with the major environmental aspects clustered into six major environmental compartments, and their extraction life cycle (value chain) stages and sub-stages. Such a matrix system allows to accommodate:

- a preliminary, proxy assessment of the potential impacts to be further studied and assessed;
- the indication of the relevant EU law governing the given aspect, or in lack, the relevant national thresholds;
- references on the EU and national BATs and BREFs, which help the review and replacement by alternative techniques.

The thematic of the six clusters of environmental factors are:

Air and climate, Land, Water, Resource Use, Biodiversity, and Social & Economics.

In addition, a separate chapter deals with overarching aspects related to circular economy.

The type of emissions of extractive projects depend a lot on the type of mineral extracted, extraction and mineral treatment practices, substances used at mineral processing, characteristics of the extractive waste and the way it is managed. If not properly addressed, these impacts can occur during the exploitation of the mine, but also long after the cessation of activity. The summary tables are prepared for metalliferous ore mining; the key environmental aspects may differ significantly at industrial minerals and aggregates extraction projects.

It is important to note that **the list of potential key environmental aspects might not always have to be applied as a whole. The list is not exhaustive, environmental factors and related risks not mentioned in the document also need to be addressed and assessed in the EIA of a given project**.

The presentation of all environmental factors and all possible emission sources and potential impacts is beyond the scope and volume limits of this report.

The major mining life cycle stages presented are[61]:

a) Construction
    a. Surface
    b. Underground
b) Extraction
    a. Surface
    b. Underground
    c. On (under) water
    d. Other novel technology
c) Mineral treatment (processing, beneficiation)
    a. Comminution, screening
    b. Physical and chemical separation
    c. Other (e.g. microbiological separation)
d) Material storage and waste management
    a. Gangue and waste rock heaps
    b. Tailings ponds
    c. Operational waste
    d. Material storage (incl. extracted minerals, chemicals, explosives, fuels)
    e. Recycling, recovery, by-products
e) Transportation (incl. near-field settlements)
    a. Truck, haulage
    b. Conveyors (belts, elevators, buckets)
    c. Pipelines (waste water, product, energy, etc.)
    d. Railways
    e. Water-born
f) Closure
    a. Temporary suspension
    b. Decommissioning
    c. Rehabilitation (including syn-operational progressive rehabilitation)
    d. Aftercare

The Tables 1-6 use symbol codes, the legend of which is:

√: in general, there is low potential for the environmental factor to be impacted, the impact assessment is not necessarily quantitative, being limited to available data or analogue cases;

√√: in general, there is a potential for the environmental factor to be impacted, the environmental impact assessment is based on the analysis of data measured for the project

[61] As noted in chapter 3.6, exploration has limited environmental risks, therefore not presented hereafter.

and compared with the environmental baseline, also including risk calculations of the potential impacts.

It is important to note that the above legend does not predict that an extractive project has positive or negative impacts, it reflects the potential for the magnitude and likelihood of any effect in general in an absolute sense which is worth studying and assessing in more detail. The potential interactions between the above factors are highlighted in the text at each chapter and at the impact assessment methodology sections (e.g. at cumulative effects).

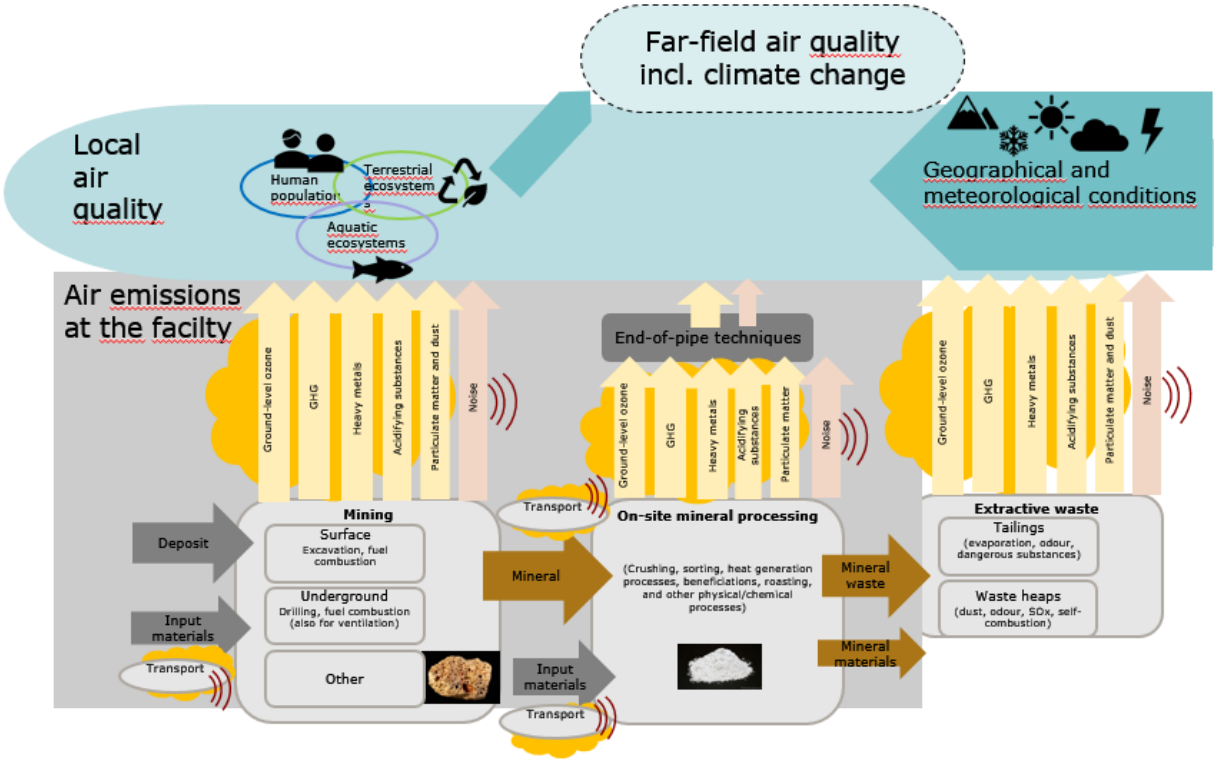
4.3.1 Air and climate (Annex IV.4.,5.)

Emissions to air from extractive projects occur during all stages of the mining life cycle (Figure 4, Table 1). Some extractive projects may have a diffuse source, fugitive air emission, therefore its monitoring, confinement and control can be challenging.

In general, the non-energy minerals extractive sector in a strict sense (limited to upstream activities such as extraction and primary processing) generates greenhouse gases in low quantitites, which contribute insignificantly to climate warming, mostly related to energy use. Nevertheless, downstream the value chain of some minerals, for example, bauxite to alumina production, there are energy intensive technologies, such as the secondary mineral processing taking place usually off the mining site.

The extractive sector can also generate noise, odour and dust, depending on the mining practices in place. Emissions to air are mainly diffuse emissions from the extractive waste management area, i.e. dusting or particle emissions. At most sites, particles are emitted from both the activities related to the extractive process, including mineral processing, and from the management of extractive waste. The impacts of extractive projects and project alternatives may be assessed by using different predictive modelling tools (e.g. modelling of diffuse emissions, modelling of dust particles spreading, modelling of mining noise, odour dispersion modelling).

Figure 4: Interactions of air, climate and minerals extraction



Air quality

Air quality levels result from complex processes. Once pollutants enter the atmosphere, they may undergo physical and chemical changes before reaching a receptor. Primary pollutants are first emitted and then, depending on weather and topographic conditions etc., these can form secondary pollutants and be transported over long distances. These pollutants can cause serious effects to people's health and to the environment.

Depending on the mineral deposit and the type of extraction, the sector contributes to the emission of main[62] air pollutants with implications for the health of humans and ecosystems, including particulate matter[63], non-methane volatile organic compounds (NMVOCs)[64], and substances that can contribute to acidification[65]. Particulate matter is a complex mixture of microscopic solid or liquid matter in the air, and a key pollutant affecting human health. $PM_{2.5}$ and PM_{10} refer to, respectively, a particle size up to 2.5 and 10 µm. While PM_{10} can, for example, enter the lungs and reduce visibility, $PM_{2.5}$ can be responsible for the most severe damage to human health given their greater risk to pass much deeper into the respiratory system. NMVOCs are a mixture of organic compounds with various chemical compositions that behave similarly in the atmosphere; exposed to sunlight, they react with ultraviolet (UV) rays to ground-level ozone, which can have severe negative impacts on human health. Acidifying substances include e.g. SO_2, primarily coming from the burning of fuels that contain sulphur, or NO_x, coming mostly from road transport. Metalliferous ore extraction may generate toxic heavy metals air emission[66].

Legal background

The Article 3(1(c)) of the EIA Directive requires to "*identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on … air*". Annex III(1.(f)) identifies air pollution as a potential risk to human health. Annex IV(1.(d)) defines *„an estimate, by type and quantity, of expected … emissions (such as ... air …)"* as a mandatory element of the description of the project, as well, among the factors likely to be significantly affected by the project (4.).

Further legal pieces in the context of air quality are considered in the EIA, such as vibration, noise, heat, ionizing and electromagnetic radiation, and light emission levels in accordance with Directives 2000/14/EC, 2002/49/EC and 2015/996/EU; and indicators on air quality from the lists provided by Directive 2010/75/EU and Regulation 525/2013/EU (greenhouse gases), Directive 2004/107/EC (As, Cd, Ni, Hg, B(a)P, PAH), Directives 2008/50/EC and 2284/2016/EU (NOx, SOx, PM, NMVOC, CO, heavy metals), Regulation 2019/1021/EU (POPs), Regulation 1005/2009/EU (ozone depleting substances). All the relevant pieces are listed in Chapter 8.1.

The two Ambient Air Quality Directives[67] set air quality standards for some pollutants. To achieve these standards, the National Emission Ceilings Directive[68] sets commitments[69] for the five main air pollutants, and establishes reporting on PM_{10}, heavy metals and other pollutants. The Industrial Emissions Directive (IED)[70] requires large industrial facilities the

[62] Main air pollutants according to the Directive (2016/2284/EU) on National Emission Ceilings include nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO2), ammonia (NH3) and fine particulate matter (PM2.5).

[63] See methodological notes for a description.

[64] Ibid

[65] Such as SO_2, primarily from the burning of fuels that contain sulphur, or NO_x, coming mostly from road transport.

[66] EEA (2019b). Pollution of heavy metals is addressed by the EU air quality policy, the Convention on Long-Range Transboundary Air Pollution (CLRTAP) on heavy metals and the mercury regulation (2017/852/EU, developed as a response to the Minamata Convention on Mercury).

[67] Directive 2008/50/EC and Directive 2004/107/EC

[68] Directive (2016/2284/EU). See data at https://www.eea.europa.eu/themes/air/national-emission-ceilings.

[69] MS should undertake assessments of air pollution and air quality, and develop programmes to reduce national emissions. See DG ENVIRONMENT, Reduction of National Emissions - National Air Pollution Control Programmes, https://ec.europa.eu/environment/air/reduction/NAPCP.htm.

[70] Directive 2010/75/EU.

application of 'best available techniques' (BATs). BATs specified in reference documents (BREFs) establish emissions limits for industrial processes. There are also other source-specific standards on air pollutants coming from the regulation on eco-design, energy efficiency, and combustion plants.

Air pollutant sources

Airborne emissions occur during each stage of the mine cycle, but especially during construction, and extraction. Activities of extraction, processing, handling, and transport depend on equipment, processes, and materials that may generate hazardous air pollutants. Mining operations also mobilize large amounts of material, and dust particles are easily dispersed by the wind from exposed surfaces of extractive waste unless the dust emissions are effectively prevented and minimised. The largest sources of air pollution in extractive operations are:

- Particulate matter (PM) originated from excavations, blasting, transportation, wind erosion, fugitive dust from tailings, stockpiles, waste dumps, and haul roads. Exhaust emissions from mobile sources (cars, trucks, heavy equipment) raise PM levels.
- Gas and other substances resulting from the combustion of fuels in stationary and mobile sources, explosions, and mineral processing.

Once pollutants enter the atmosphere, they may undergo physical and chemical changes before reaching a receptor. These pollutants can cause serious effects to people's health and to the environment.

Mobile sources of air pollutants include heavy vehicles used in excavation, cars that transport personnel at the mining site, and trucks that transport extracted materials. The level of polluting emissions from these sources depends on the fuel and conditions of the equipment.

Stationary sources represent the main gaseous emissions from combustion of fuels in power generation installations, and drying, roasting, operations. Many producers of precious metals smelt metal on-site, prior to shipping to off-site refineries. Typically, gold and silver is produced in melting/fluxing furnaces that may produce elevated levels of airborne mercury, arsenic, sulfur dioxide, and other metals.

Fugitive emissions are those emissions which do not pass through a stack, chimney, vent or other functionally-equivalent confined outlet. They include: storage and handling of materials, mineral processing, fugitive dust, blasting, construction activities, roadways, leach pads, tailing ponds, and waste rock heaps.

Good practice case

The Management of Waste for the Extractive Industries Best Available Technique Reference Document (MWEI BREF) concludes on BAT NOs 49-54 related to prevention and minimisation of air pollution, noise and odour. For example, BAT 49 is on dust management which includes techniques such as water or water-based solutions spraying, wind protection systems, progressive landscaping and geomorphic reclamation, temporary vegetative, wet or dry covers.

At different potash mines in Germany, different approaches for the covering of large potash heaps are being tested, using vegetative and non-vegetative covers. If not enough space around the tailings heap is available, which is often the case for large potash heaps, the materials need to be stable even if applied almost parallel to high-gradient slopes (35-38°), otherwise the land use would be too great for large heaps. A mixture of different components as covering material is necessary to maintain structural stability under these conditions as natural soils do not meet these requirements.

Noise pollution may include noise from vehicle engines, loading and unloading of rock into steel dumpers, chutes, power generation, and other sources. Cumulative impacts of shoveling, ripping, drilling, blasting, transport, crushing, grinding, and stock-piling can affect wildlife and nearby residents.

Vibrations are associated with many types of equipment used in mining, mineral processing operations, and blasting. Vibration may affect the stability of infrastructures, buildings, and homes of people living near large-scale open-pit mining operations. At large scale and long lasting projects the settling of a micro-seismic monitoring network can be a reasonable solution to prevent court cases on liability for damages on built assets.

Odours can be collateral to exhausts of fuel engines, evaporation of treatment chemicals, atmospheric exposure (oxidation) of sulphidic rocks and some industrial minerals (e.g. peat), as well, very rarely, natural H_2S may be released during the extraction of some deposits.

Light pollution can be present at large scale projects both at surface and underground mines**. Heat anomalies** at large quarries with black or dark coloured light-adsorbing rocks (magmatic and volcanic rocks) may change local climate to an insignificant degree. As well, ventilation shaft outlets are point sources of heat at deep mines with high geothermal gradient. Heat anomalies together with significantly changed evaportranspiration patterns due to soil and vegetation removal, and modified wind flows due to altered geomorphology, or increased humidity by extensive tailings ponds, may have a significant impact on **local climate** at large scale mines.

Ionizing radiation can be a significant environmental issue at different deposit types and at all extraction methodologies because naturally occurring radioactive materials (NORM) can be common at some deposits. Its pollution pathways are not limited to air particles but can be direct on workers (radon inhalation or contact with activated metal tools), and indirectly on other receptors in the food chain through air and water-borne pollution pathways. **Electromagnetic noise** means hardly any risk, and seldom has any effect on the local population or workers.

Toxic **heavy metals**, persistent organic pollutants (**POP**), non-methane organic volatile compounds (**NMVOC**), polycyclic aromatic hydrocarbons (**PAH**), benzene, toluene, ethyl benzene and xylene (**BTEX**) may be present also in air but more common as soil contaminants. These emissions are usually insignificant at modern extractive projects.

Climate neutrality

Legal background

The Article 3(1(c)) of the EIA Directive explicitly requires to "*identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the … climate*".

Annex III(1.(f)) considers it as one of the particular characteristics of a project to be considered: "*the risk of major accidents and/or disasters which are relevant to the project concerned, including those caused by climate change, in accordance with scientific knowledge*".

Annex IV(4.) regulates it as a mandatory element of the EIA report: "*description of the factors specified in Article 3(1) likely to be significantly affected by the project: … climate (for example greenhouse gas emissions, impacts relevant to adaptation)*"; and among the likely significant effects (5.(f)): "*the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change*".

In the meaning of the international conventions and EU legislation[71], **greenhouse gases (*"GHGs"*)** are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). The **ozone depleting substances**[72] are chlorofluorocarbons, halons, hydrochlorofluorocarbons (HFCs), carbon tetrachloride, methyl bromide, etc.

Climate action is at the core of the European Green Deal. The 2030 climate and energy framework includes targets[73]:

- 40% cuts in greenhouse gas emissions (from 1990 levels),
- 32% share for renewable energy,
- 32.5% improvement in energy efficiency (compared to 2007),

all of which are relevant to extractive projects.

The EU emissions trading system (EU ETS)[74] is a key tool for reducing greenhouse gas emissions cost-effectively, however, non-fossil fuel extractive installations are excluded from this system.

The emissions reductions of the sectors not covered by the EU ETS are regulated by the 2009 Effort Sharing Decision[75]. MS are responsible for national policies and measures to limit emissions from these sectors. Potential measures that can be relevant for the non-fuel minerals sector include, for example:

- reducing transport needs,
- a shift away from transport based on fossil fuels,
- support schemes for retrofitting buildings,
- more efficient heating and cooling systems,
- renewable energy for heating and cooling.

Transport represents a quarter of Europe's GHG emissions, road transport is the biggest emitter (70% in 2014). There are three priority areas for action:

- Increasing efficiency by digital technologies, smart pricing and encouraging the shift to lower emission transport modes.
- Speeding up deployment of low-emission alternative energy, e.g. advanced biofuels, electricity, hydrogen, renewable synthetic fuels and electrification.
- Zero-emission vehicles, improvements of internal combustion engines.

The Ecodesign legislation also sets energy efficiency and environmental requirements for industrial products. Energy labels provide information to consumers on products' energy consumption and environmental performance.

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71 Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community
Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases

72 Fluorinated gases ("*F-gases*") are often used as substitutes for ozone-depleting substances. These are aggressive GHGs, with a global warming effect 23 000 times greater than carbon dioxide, and their emission is rising, by 60% since 1990, in contrast to all other GHGs, which have been reduced. Hydrofluorocarbons (HFCs) are the most aggressive F-gas group, although relatively short-lived. The other groups, perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) remain in the atmosphere for thousands of years. The F-gas emissions will be cut by two-thirds by 2030 compared with 2014 levels. F-gases can present at the extractive sector, e.g. heat pumps and some machinery.

73 https://ec.europa.eu/clima/policies/strategies/2030_en

74 https://ec.europa.eu/clima/policies/ets

75 Decision No 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

When preparing the climate chapter of the EIA report, the developers of extractive projects are advised to familiarize with their national energy and climate plans (NECPs)[76] which were introduced by the Regulation on the governance of the energy union and climate action (2018/1999/EU[77]), agreed as part of the Clean energy for all Europeans package[78] (2019).

Non-fuel minerals extractive projects are not considered as being liable for global climate change[79], nevertheless,

- extractive activities account for a minor percentage of all GHG emissions in the EU[80] with a decreasing trend (grinding is responsible for approx. 40% of the energy consumption and consumes up to 4% electrical energy globally[81]);
- large scale mining sites might have an unfavourable impact on local climate conditions;
- *vice versa*, weather extremes of the changing climate, not included in the design base, may induce catastrophic failures of mining installations as a stand-alone or as one of the cumulative causes. Also concerns are rising about water availability under climate changes scenarios, and the related risk of production disruptions;
- the due presentation of climate aspects may improve the project reputation among the public.

Minerals extractive projects can contribute to climate change through:

- emission of GHGs, some of them also being relevant to ozone depletion;
- increasing solar radiation absorbed by the Earth due to change in land cover, emission of dust, vapor, etc.;
- lost CO_2 uptake by forests and vegetation that is cleared off;
- emission of waste heat to the air;
- effects on local climate by changed morphology, vegetation, wind channels, etc..

Extractive projects need to be adapted to better cope with natural phenomena caused by climate change. This implies the consideration that the design parameters identified at a project's inception may no longer be valid at the end of its potentially long lifespan. It represents a shift in conceptual approach, from the traditional assessment of environmental impact to taking possible long-term risks into account. Natural hazards are included in the risk assessments with a higher weight.

A potential concept to manage climate change issues is **resilience** of a system. It is coping with, and reacting to, shocks or persistent structural changes by either resisting them (*absorptive capacity*) or by adopting a degree of flexibility and making changes to the system (*adaptive capacity*)[82]. When disturbances are not manageable, the system needs to engineer bigger changes (*transformative capacity*).

Long-term (30-50 years) extractive projects need to be assessed against an **evolving environmental baseline**. EIA reports show how the changing baseline can affect the project and how the project may respond over time. The EIA helps setting the context for

[76] https://ec.europa.eu/info/energy-climate-change-environment/overall-targets/national-energy-and-climate-plans-necps_en

[77] https://ec.europa.eu/energy/topics/energy-strategy/energy-union_en#regulation-on-the-governance-of-the-energy-union-and-climate-action

[78] https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en

[79] However, Annex I of the Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading lists downstream activities such as metal ore (including sulphide ore) roasting or sintering installations, production of cement clinker in rotary kilns, manufacture of glass and ceramic products by firing, aluminium production (i.e. perfluorocarbons).

[80] EU Raw Materials Scoreboard

[81] Energy Consumption in Mining Comminution Jack Jeswiet*, Alex Szekeres, Procedia CIRP 48 (2016) 140 – 145

[82] https://ec.europa.eu/jrc/en/publication/challenge-resilience-globalised-world

the project by taking potential climate change impact (including disaster risks) into consideration which makes the project more resilient.

The main characteristics that are most likely to pose significant challenges to addressing climate change in the EIA are[83]:

- the long-term and cumulative nature of effects;
- complexity of the issues and cause-effect relationships;
- uncertainty, acknowledging assumptions and limitations.

Some recommendations for meeting the above challenges are shown in Figure 5.

Figure 5: How to approach climate challenges (source: EC, 2013)[84]

Key challenges	Tips on how to approach them
Long-term and cumulative nature of effects	• Avoid 'snapshot' analyses (i.e. at a single point in time) and consider trends, *with* and *without* the proposed project; • Work with the notion of absorption capacity/environmental limits.
Complexity of the issues and cause-effect relationships	• Analyse the impact of proposed projects on key climate change and biodiversity trends and their drivers; • Work with worst-case and best-case scenarios.
Uncertainty	• Acknowledge assumptions and the limitations of current knowledge; • Base recommendations on the precautionary principle; • Prepare for adaptive management.

Responses to climate change can be divided into two aspects which are closely interrelated[85]:

- **Mitigation** is used to describe the strategies and process of reducing GHG emissions and enhance GHG sinks[86].
- **Adaptation** (or adaptive resilience) is a process, or set of initiatives and measures, to prevent or minimize the potential damage, to reduce the vulnerability of natural and human systems against actual or expected climate change effects[87]. Adaptation can also be learning how to function with the consequences of climate change, such as temperature rise, rainfall patterns shifting, glaciers melting, sea level rise, and extreme weather resulting in floods and droughts, and the secondary risks triggered by the above phenomena, such as landslides, tailings dam failures, forest fires, dust storms, etc..

More examples on climate change mitigation and adaptation are available in Chapter 4.5.

[83] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (pdf) (2013)
[84] https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf
[85] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (pdf) (2013)
[86] https://www.energy.gov.au/business/large-businesses/industries/mining/mining-opportunities-save https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-energy-management-in-mining-handbook english.pdf
[87] https://climate.copernicus.eu/ http://ecem.wemcouncil.org/#layer,Countries&timeperiod,historical&vartype,climate&variables,GHI&temporal_resolution,01m&statistics,org

For climate change modelling, several tools are available, for example, the Copernicus climate change services[88], and the C3S European Climatic Energy Mixes Demonstrator[89] which combines projections from different climate change models. Commercial data providers using Copernicus open data are downscaling to 3 km[90].

Climate neutrality is very much interlinked with the requirements of circular economy (see Chapter 4.3.7).

88 https://climate.copernicus.eu/

89 http://ecem.wemcouncil.org/#layer,Countries&timeperiod,historical&vartype,climate&variables,GHI&temporal_resolution,01m&statistics,org

90 http://ecem.wemcouncil.org/#layer,Clusters&timeperiod,projection&vartype,climate&variables,TA&temporal_resolution,12m&statistics,org&climate_model,ENSM&emission_scenario,R45

Table 1: Key environmental aspects of air and climate related to mining activities

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS											
		AIR & CLIMATE											
		local climate	GHG	ozone depletion	PM	heavy metals	acidifying substances	POP, NMVOC, PAH, BTEX[91]	odour	noise	vibration	light & heat	ionizing or electromagnetic radiation
CONSTRUCTION	surface	√	√√	√	√√	√	√	√	√√	√√	√√	√	√
	underground	√	√	√	√	√	√	√	√	√√	√	√	√
EXTRACTION	surface	√√	√√	√	√√	√√	√√	√√	√√	√√	√√	√	√
	underground	√	√√	√	√√	√	√	√√	√	√	√	√	√
	on water	√	√	√	√	√	√	√	√	√	√	√	√
	other novel technology	√	√	√	√	√	√	√	√	√	√	√	√
MINERAL TREATMENT	comminution, screening	√	√	√	√√	√	√√	√	√	√√	√√	√	√
	physical, chemical separation	√	√√	√	√	√	√	√	√√	√	√	√	√
	other	√	√	√	√	√	√	√	√	√	√	√	√
STORAGE & WASTE MANAGEMENT	gangue and waste rock heaps	√	√	√	√√	√√	√√	√	√	√	√	√	√
	tailings pond	√	√	√	√	√	√	√	√√	√	√	√	√
	operational waste	√	√	√	√	√	√	√	√	√	√	√	√
	material storage	√	√	√	√	√	√	√	√	√	√	√	√
	extractive waste recycling	√	√	√	√√	√	√	√	√	√	√	√	√
TRANSPORTATION	truck,haulage	√	√√	√	√√	√	√	√	√√	√√	√√	√	√

[91] POP= persistent organic pollutants; NMVOC= non-methane organic volatile compounds, PAH= Polycyclic aromatic hydrocarbons, BTEX= benzene, toluene, ethyl benzene and xylene

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS											
		AIR & CLIMATE											
		local climate	GHG	ozone depletion	PM	heavy metals	acidifying substances	POP, NMVOC, PAH, BTEX[91]	odour	noise	vibration	light & heat	ionizing or electromagnetic radiation
	conveyors (belt, elevator, bucket)	√	√	√	√	√	√	√	√	√√	√	√	√
	pipeline	√	√	√	√	√	√	√	√	√√	√	√	√
	railways	√	√	√	√	√	√	√	√	√√	√	√	√
	water-born	√	√	√	√	√	√	√	√	√	√	√	√
CLOSURE	temporarysuspension	√	√	√√	√	√	√√	√	√	√	√	√	√
	decommissioning	√	√	√	√√	√	√√	√	√	√	√	√	√
	rehabilitation	√	√	√	√	√	√	√	√	√	√	√	√
	aftercare	√	√	√	√	√	√	√	√	√	√	√	√

Conclusive remarks

Non-energy minerals extractive projects, depending on the particular conditions at the extraction site and the nature of the mineral deposit, may have significant impacts on air quality locally, especially through dust, other particulate matter, noise and machinery exhaust gases emissions. Other types of air emissions are usually insignificant. In general, non-energy minerals extraction projects in a strict sense don't have significant impacts on global climate change, as indicated in the relevant legislation.

4.3.2 Land and soil (Annex IV.5b)

Landscape, visual impacts

The visual impact is not a subjective aesthetic category, it is an environmental impact which can be quantified. It is one of the most decisive factors in public views on extractive projects, therefore its importance in the EIA can't be underestimated. In a broader context, visual impact is part of landscape management which does not have any further legal piece or guidance document on EU scale.

Legal analogue and background

Although not binding for the EU as such, the European Landscape Convention[92] of the Council of Europe[93] and its Guide is a good example of how to assess the landscape related aspects. Accordingly, "*landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors".* The Convention represents a progressive new approach to observing and interpreting landscape, which:

- view the territory as a whole, and no longer just identify places to be protected;

- include and combine several approaches simultaneously, linking ecological, archaeological,

- historical, cultural, perceptive and economic approaches;

- incorporate social and economic aspects.

This concept includes that landscape is subject to changes which, within certain limits, have to be accepted. Protective measures are not designed to stop time or to restore natural or human-influenced characteristics that no longer exist; however, they may guide changes in sites in order to pass on their specific, material and immaterial features to future generations. A landscape's characteristics depend on economic, social, ecological, cultural and historical factors, the origin of which often lies outside the sites concerned. In accordance, *"landscape management" means action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes".*

Management of landscape is a continuing action aimed at influencing activities liable to modify landscape. It can be seen as a form of adaptive planning, usually integrated into land use planning, which itself evolves as societies transform their way of life, development and surroundings. It takes account of new social aspirations, anticipated changes in biophysical and cultural characteristics and access to natural resources. Planning also covers the rehabilitation of degraded lands (mines, quarries, landfills, etc.) so that they meet the stipulated landscape quality objectives.

The EIA Directive also recognises the importance of considering visual impacts – as highlighted in recital 16 of Directive 2014/52/EU "*in order to better preserve historical and cultural heritage and the landscape, it is important to address the visual impact of projects, namely the change in the appearance or view of the built or natural landscape and urban areas, in environmental impact assessments*".

The visual impact assessment is relevant for both surface and underground mineral extraction projects. Reducing the visual impact is yet not a fully exploited option by the

[92] http://conventions.coe.int/Treaty/EN/Treaties/Html/176.htm

[93] https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=09000016802f80c9

sector. For both types of extraction, "*invisible mining*"[94] is an emerging initiative that involves

- the location of as many service facilities, processing plants, and even waste facilities into the subsurface as possible, and
- positioning and designing the surface installations into landscape "*camouflage*".

This approach may have also the potential to reduce the costs of conventional mining by avoiding the need to bring rocks to the surface for processing. In addition, it can save the significant cost of rehabilitation works. This approach is also applicable for surface pits, quarries, and strip mines.

The assessment methodology of visual impacts implies an inventory and mapping of potential receptors along settlements and major roads, and the calculation of visual absorption capacity and visual receptor sensitivity. In the context of managing visual impacts, and in the broad context, there is increased room for mitigation measures during the design phase in order to minimize environmental risks at any given time of extraction.

Good practice case

The repealed Commision Decision 2002/272 establishing the ecological criteria for the award of the Community eco-label to hard floor-coverings provided a quantitative scheme on the acceptable visual impact for quarries. The calculation lies in tracing cross sections passing through the quarry front and other external important "*visual points*" (e.g. nearby towns, frequented places, major roads). The calculation of the final score in %, is taken from the highest value of originally calculated values (worst case situation). From each visual point (P), the "*bottom radius*" is traced, tangent to the topographic surface and intercepting the lowest point of the "*visible quarry area*" (the area where the excavation is carried out or there is an active dump). Already rehabilitated areas need not be considered. From the same visual point a second radius (called "*top radius*") is traced, intercepting the highest point of the quarry front. The top radius and bottom radius allow the identification on the section of the quarry of the limits of the height of the visible front (the vertical distance from top to bottom radius matching the front). These geometric data are put into the following formula and the result is the quotient of visual impact of the quarry affecting a specific visual point. <30% is considered as a good score for visual impact[95].

$$x\,\% = \frac{h^2}{(L tan\ 30°)^2} \cdot 100$$

where:

h= vertical height of front visible from P visual point (m);

L= horizontal distance between the worst P and the front (m);

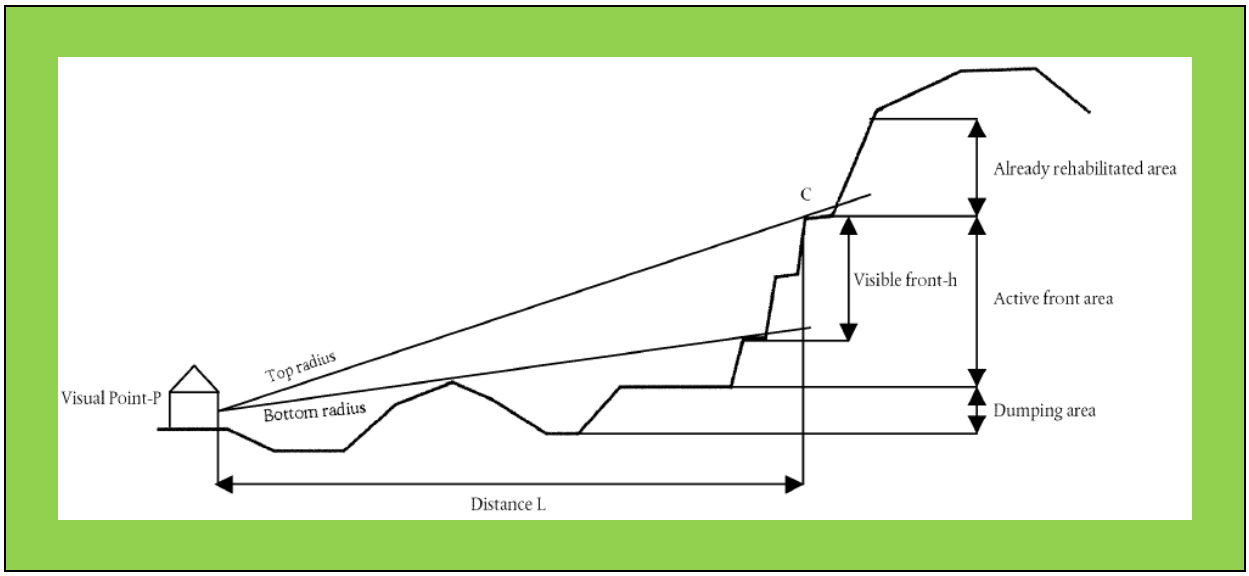
tan 30°= tangent of the average angle of the human eye vision cone;

x %= percent of visual impact.

The term h^2 represents the base surface of the quarry visibility cone, while the term $(L \tan 30°)^2$ represents the base surface of the average visual cone of human eye.

[94] https://www.csiro.au/en/Research/MRF/Areas/Resourceful-magazine/Issue-07/Invisible-mining

[95] According to Dentoni and Massacci (2012) the method by the EC decision leads to the underestimation of the visual impact for alterations which are significantly wider than their height.



Land use

Legal analogue

Land-use planning (and/or spatial development) is under the subsidiarity of the MS and is managed by the public authorities at different levels. There is no EU legislation on the common principles of land-use planning. The European Spatial Development Perspective (ESDP) intended to promote co-operation between MS in pursuit of sustainable development through a more balanced use of land. However, the guiding principles of CEMAT (Council of Europe[96] Conference of Ministers Responsible for Spatial/Regional Planning) do not cover mineral raw materials among the natural resources.

Land use change aspects are one of the major concerns at extractive projects. Land access is an essential pre-requisite for their development. Local, regional and country scale legislation and spatial development and land use plans govern this field. These may have absolute ban or conditional dispositive clauses on extractive projects. Less frequently these may have protective provisions on the safeguard of mineral deposits[97]. In a few EU countries, 3D spatial planning is in place both in legislation and in practice. In such cases, the land use impacts assessment are extended to other uses and utilizations of the underground, for example, other mineral commodities, groundwater, subsurface infrastructures and installations, etc. The Strategic Implementation Plan of the European Raw Materials Innovation Platform (EIP SIP) also supports the transition of 2D land use planning into 3D spatial planning. A sustainable and integrated view on minerals value chains requires the consideration of the pre-exploration phase. Mechanisms for transparent and balanced assessment of minerals resource development and other land use options need to be addressed. In this respect, it is necessary to implement mineral and land use planning which takes into consideration the safeguarding of mineral resource deposits.

Built environment includes all surface and subsurface buildings and built objects, linear infrastructure elements, and their remains.

Cultural heritage may overlap with built environment and local cultural habits. It includes historical, architectural, folkloristic and archaeological aspects. It may overlap with impact assessment on the social aspects, e.g. local culture and traditions not manifested in

[96] Should not be mixed with the EU Council!

[97] Good practice cases are reviewed by the EU MINLAND project. The potential impacts are assessed with regard to the baseline, proposed and future land use categories with the applicable restrictions.

physical, built environmental objects. According to recent Council conclusions[98], "*cultural heritage in all its diversity (whether tangible - including sites and landscapes, artefacts and monuments - or intangible, encompassing knowledge, skills and practices, oral traditions and performing arts) represents an important source of identity, innovation and creativity for individuals and society and, apart from its inestimable intrinsic value for the development and well-being of European society, it also makes an important contribution to economic growth, social inclusion and sustainable development*."

Good practice case

The Austrian national minerals policy is based on three pillars. The Mineral Resources Plan published in 2012 has two phases. *Phase 1* was to draw up a baseline survey by working groups focusing on geology and resources, mineral economics, GIS, security of supply. *Phase 2* identified areas for minerals extraction by adopting a mechanism of conflict management. A new evaluation assessment was carried out taking into account the number and operating status of sand and gravel quarries in a region, information on the use of the material, and the importance of the sites for regional and local raw materials supply. The data are accessible at the Interactive Raw Material Information System (IRIS).

The next stage was to compare the geological potential with the economic significance of the minerals at regional level taking into account transport distances, population density and others. The deposit maps were cross-checked by the prohibited zones classified by federal or State law. In the conflict zones a systematic consultation process with the officials of the federal states was carried out if the conflicts are manageable. The Mineral Resources Plan has been used for the regional development programme in Salzburg, Carinthia, Upper Austria.

An early precursor of the EU raw materials policy in 2000 (COM 2000 (265) final) stressed that "*conditions for land access for the industry have been increasingly influenced by other competing land uses*". The 2010 report by the relevant thematic Ad Hoc Working Group[99] called "*to develop a greater compatibility of national minerals policies and land-use planning"* in MS*.* This also implies a change of the 2D land-use planning legislation and practices into 3D spatial planning, as it was also highlighted in the EIP SIP non-technology pillar[100]. Unlike other forms of land-use, minerals can only be extracted where they are located. Furthermore, minerals extraction is a temporary use of the land. In many instances*,* the development of minerals enables beneficial after-uses for the land including significant opportunities for enhancing biodiversity. The promotion of the emerging concept of "*mineral deposits of public importance*" yet awaits for the EU-wide adaptation, although analogues within the biodiversity, energy and infrastructure policy fields function successfully in the land use planning context.

[98] Council conclusions on risk management in the area of cultural heritage 2020/C 186/01https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2020.186.01.0001.01.ENG&toc=OJ:C:2020:186:TOC

[99] Ad Hoc Working Group on Exchange of best practices on minerals policy and legal framework, information framework, land-use planning and permitting

[100] https://ec.europa.eu/growth/sectors/raw-materials/eip/strategic-implementation-plan_en

Good practice case

Serra d'Aires e Candeeiros in Portugal was used for limestone extraction since the 14th century and includes many small quarries. It is a karstic complex which has been designated as a Natural Park and Natura 2000 site, important at national level for bats. It is also notable for several endemic flora species (*Arabis sadina*), as well as priority habitats, such as *Mediterranean temporary ponds*, *Pseudo-steppe* with grasses and annuals of the *Thero-Brachypodietea,* and *Limestone pavements*. Part of the site is seasonally flooded and classified as RAMSAR site[101]. A spatial plan was elaborated to regulate the extractive activity in the protected area and ensure the preservation of its natural values. This involved five new permitted areas and new rules for quarrying, which required a master plan for each areas, also subject to a Strategic Environment Assessment, including an Appropriate Assessment. The SEA properly defined the areas for limestone quarrying. In this case, the SEA was considered an effective spatial planning tool for the extractive activities at the Natura 2000 site. Quarries are also subjected to EIA and Appropriate Assessment[102].

Concluding remarks

Developers consult the local and regional decision makers of land use planning at the earliest possible stage of planning. In this respect, a national or regional SEA (strategic environmental assessment) undertaken for land use plans or programmes which considers and safeguards the known occurrences of potential mineral deposits may also have a favourable impact on land use decisions and the later EIA permitting. A detailed presentation of the land use aspects before, during and after the project, supported by up-to-date modelling and dynamic visualization tools may help. Further recommendations and good practice cases are provided by the deliverables of the MINLAND project[103].

Surface and subsurface stability

The physical stability of the surface and subsurface is of paramount importance at mining projects, both at the design scenario (vibration by transport or blasting, man-induced earthquakes, minor land subsidence due to undermining) and in case of accidents (sinkholes above underground mines, tailing dams, waste heaps and quarry slope failures). The quantitative probabilistic assessment covering the whole impact area is recommended for most extractive projects.

Legal analogue

The EU legislation is rather detailed on this issue. It covers the general liability aspects, the stability of installations related to extractive waste management, the industry accidents (Seveso Directive 2012/18/EU). In this context, the most explicit piece is the Regulation 305/2011/EU laying down harmonised conditions for the marketing of construction products[104]. According to its Annex I (*Basic requirements for construction works*):

"*Construction works as a whole and in their separate parts must be fit for their intended use, taking into account in particular the health and safety of persons involved throughout the life cycle of the works. Subject to normal maintenance, construction works must satisfy these basic requirements for construction works for an economically reasonable working life.*

[101] https://www.ramsar.org/
[102] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p. http://www.assimagra.pt/project/sustentabilidade-da-industria-extrativa/
[103] https://minland.eu/project/
[104] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1587629611507&uri=CELEX:02011R0305-20140616

1. Mechanical resistance and stability

The construction works must be designed and built in such a way that the loadings that are liable to act on them during their constructions and use will not lead to any of the following:

(a) collapse of the whole or part of the work;

(b) major deformations to an inadmissible degree;

(c) damage to other parts of the construction works or to fittings or installed equipment as a result of major deformation of the load-bearing construction;

(d) damage by an event to an extent disproportionate to the original cause.

2. *Safety in case of fire* ...;

4. *Safety and accessibility in use*

The construction works must be designed and built in such a way that they do not present unacceptable risks of accidents or damage in service or in operation such as slipping, falling, collision, burns, electrocution, injury from explosion and burglaries…".

Eurocodes 7 (EN 1997) and 8 (EN 1998), on Geotechnics, and Seismic Design, respectively, are relevant EU standards in this field.

Extractive projects may cause incidents and accidents with severe consequences on different environmental factors such as long range pollution of aquatic ecosystems, acute effects and fatalities in workers and nearby population, damage in built environment and other assets. Minor incidents can be assessed as increased emissions. In such cases, the emission (source) changes but the "pathway-receptor-effect" assessment methods remain the same. The potential impacts and damages on the surface are presented with a due weight in the EIA report because

- it is the most visible and often long-term impact;
- it may endanger private properties and local population; and therefore
- it has one of the most destructive impacts on public acceptance.

The physical stability and integrity of the land surface may be threatened by the extractive project throughout its life cycle from the construction until the rehabilitation and beyond. It has the following major types:

1. Slope failures (erosion, landslide, collapse, mass movement, liquid flows, etc.) of quarries, waste rock heaps, other material dumps, rehabilitated slopes, tailings dams, and other dams, such as mining site barrier dams.
2. Land subsidence and sinkholes over undermined areas, especially at shallow underground mines with porous sedimentary rock overburden or in a karstic setting.

In case of inadequate design or poor technological implementation both types of phenomenon usually start with a relatively slow process which can be managed if identified on-time during periodic inspections by the operator. In the absence of this, and in case of multiple low-probability but high-risk factors such as extreme precipitation, strong wind, medium and big earthquakes, and human intrusions these slow processes may end up in catastrophic events such as the well-known tailings dam failures[105].

Land subsidence less frequently results in catastrophic events than slope failures. Nevertheless, land subsidence can have a significant negative impact on buildings and private lands resulting in an overall higher loss of assets than the slope failures. In addition, there are few cases where sinkhole formation took place at a dramatic speed. For example, thirty thousand m^3 of lake water and a fisherman disappeared in a couple of minutes in

[105] https://www.icold-cigb.org/GB/icold/icold.asp; https://www.wise-uranium.org/mdaf.html

collapsing karstic overburden of shallow galleries of an abandoned bauxite mine in Hungary in 2007[106].

Concluding remarks

The long term assessment of the physical stability of the land surface and subsurface is an essential part of the EIA report for many extractive projects. It is often an environmental factor for which cumulative effects are studied and presented, as well as a stochastic analysis of design-base and accidental events is carried out.

Soil

Legal analogue

The continued unsustainable use of soils is compromising the Union's biodiversity and climate change objectives. The Commission adopted a Soil Thematic Strategy (COM(2006) 231) with the objective to protect soils across the EU[107]. The Commission in 2014 decided to withdraw the proposal for a Soil Framework Directive but the Seventh Environment Action Programme recognises that soil degradation is a serious challenge. It provides that land is managed sustainably, soil is adequately protected and the remediation of contaminated sites is well underway, and commits the EU to increasing efforts to reduce soil erosion and increase soil organic matter.-

Soil is a complex, variable and living medium. Soil formation is an extremely slow process, soil can be considered as a conditionally and slowly renewable resource (beyond human lifespan). It is the interface between the earth, air and water, therefore it performs many vital functions: food and biomass production, storage, filtration and transformation of water, nutrients and many other substances. Soil is a habitat, serves ecosystems, human activities, landscape, and heritage.

Soil is increasingly degrading. Erosion, loss of organic matter, compaction, salinisation, landslides, contamination, sealing[108] have negative impacts on soil condition, human health, natural ecosystems and climate, as well as on food security and economy. The EC Communications on soil degradation ranked urbanization and infrastructure developments as the major drivers for negative impacts. The extractive sector is not considered as a major threat. However, the operations of extractive industries may be significant at a local level, through the loss of soil through removal and sealing, leading to a loss of functions and biodiversity. Extractive industries also increase the risk of soil pollution.

The uppermost biologically active layer of land, the **topsoil** is the first environmental compartment that is impacted by any extractive project already from construction. Even if disposed of at the site, its functions, organic carbon content, biological activity, and other bio-essential elements (P, N, S, Fe, Se, etc.) are lost rapidly, in a matter of months or a few years, due to oxidation (or the opposite, aerobic bacteria die under anaerobic conditions), and dilution. **Sealing and salinity changes** may also occur. Soil **erosion** may occur either because of unsustainable soil management practices (e.g. leaving bare soil in slopes), changed wind channels, altered hydrographic patterns of the site, vegetation loss due to removal of topsoil, groundwater level drop, as well as in association with accidental events (extreme rain and floods, slope failures, landslides, etc.).

[106] https://infostart.hu/belfold/2007/04/24/eltunt-egy-horgasz-mikor-beszakadt-a-banyato-117880; https://www.origo.hu/itthon/20070424banyatoban.html /in Hungarian/

[107] The EU Biodiversity Strategy for 2030 calls for an update of this Strategy in 2021

[108] https://ec.europa.eu/environment/soil/pdf/guidelines/EN%20-%20Sealing%20Guidelines.pdf https://ec.europa.eu/environment/archives/soil/pdf/sealing/Soil%20sealing%20-%20Final%20Report.pdf

The **subsoil** extends from the topsoil to the soil parent material (geological medium): its quality aspects are similar to the topsoil issues but generally exhibit low levels of biological activity, organic carbon content but higher bulk density. Pollutants deposited on the soil surface can migrate with precipitation to the subsoil unless impermeable layers resist this migration, where contamination could also be transferred to groundwater. Most rocks and constituting minerals are in reducing geochemical conditions in their natural state which can be oxidized. In presence of sulfidic rocks it can generate acid solutes when exposed to atmospheric conditions during mineral extraction and mining waste deposition.

Both at topsoil and subsoil, natural and man-made toxic heavy metals, arsenic, high mineral content and organic pollutants (POP, NMVOC, PAH, BTEX) may present as contaminants. In an ideal case, at modern mines, these emissions are usually confined and controlled.

Mine closure and rehabilitation

This document presents the different stages of closure in a broad sense in the following order, which is not necessarily a time-wise sequence, depending on the national legislation and the individual permit:

Rehabilitation during operation → decommissioning → closure → rehabilitation → monitoring and aftercare → re-use of the site.

In reality, some of these activities are not so distinct phases; they may overlap in time, and even in space, although the latter should be avoided. The closure plan - in a broad sense, covering all the above activities - is an important element of the EIA showing the potential positive impacts of the project, especially the details on how the local society and economy can benefit from the re-instated land use capacities and ecosystem functions of the site. The closure plan increases the understanding of the long-term impacts and describes the measures to prevent and minimise these impacts. In addition, it facilitates the discussion on the objectives for the decommissioning process and how the area will be used after the mine is closed. This relates to a holistic and integrated sustainable approach addressing the whole mining value chain until the end of the mining life cycle including rehabilitation efforts and land reuse planning.

Rehabilitation during operation (Progressive rehabilitation)

The closure of an extraction site starts in parallel to the launch of the minerals extraction activities, which is known as progressive rehabilitation. Syn-operational rehabilitation is driven not only by environmental requirements but business interest and obtaining public acceptance too. Maintaining extractive waste management facilities and mining voids, both on surface and underground, is costly, due to

- the in-built voluminous material assets (machinery, steel or wood support, cables, rails, pipelines, conveyors, lifts, etc.), and
- the need for slopes, underground works, roads maintenance (ventilation, dewatering, monitoring, incl. stability inspections and interventions),

as already referred in the EIA report at the "*Description of the main characteristics of the operational phase of the project"* (Chapter 4.1.2 of this document).

Rehabilitation during operation involves almost all elements of the above activity sequence. Its due presentation in the EIA report is of paramount importance because it is the essential part of environmental performance, technical and business planning.

Progressive rehabilitation of the site is important to minimize both the visual and environmental impacts of extractive activities, especially the impacts posed by extractive waste facilities (e.g. progressive closure of the facilities by covering). Progressive rehabilitation of extractive waste facilities helps to prevent dusting and oxidation of the

extractive waste; therefore, the prevention and minimization of generation of acid mine drainage (AMD/ARD) as well. More information is available in MWEI BREF BAT 38.

The extracted parts of the mineral reserve and the access spaces to it can be backfilled during or soon after the extractive operations in many cases, as a function of

- depth and geometry of the reserve,
- composition and stability of the mineral deposit, its host rocks and overburden,
- technology of excavation and extraction,
- groundwater hydrogeological conditions,
- availability and physical-chemical characteristics of the backfill material,
- future use of this part of the mine for transportation, ventilation, escape route, etc., and
- economic feasibility,

to mention a few. Backfilling may allow a more complete mining of the deposit. If paste backfilling is used, some of the tailings come to beneficial use.

The de-commissioning at this stage may have limitations if, for example, the underground workings need long-term mechanical support, and the in-built infrastructure is needed for the overall functioning of the mine.

The major concern at this stage, as well, is to show

- how progressively the project is rehabilitating the land preparing it for re-use, and
- how efficiently it helps the re-generation of ecosystems and habitats or the re-settling of individual species whether protected or not.

Good practice case

The marl and limestone extraction in the Arrabida Natural Park in Portugal (Setúbal), which is a Natura 2000 site (arborescent matorral with *Juniperus* spp. and *Laurus nobilis* and evergreen forests with *Quercus suber and Q. faginea*) successfully integrates quarrying and habitat restoration with the implementation of a Landscape Rehabilitation & Extraction Plan. This plan aims to minimise impacts on natural habitats and species and maintain the integrity of the Natura 2000 site. A Biodiversity Action Plan also promotes the restoration of the original ecosystems. It includes a monitoring programme to evaluate the effectiveness of actions by assessing the vegetation and fauna populations' status. The restoration techniques were adapted and the restoration process is integrated in the quarry operation. The plan thus ensures the adaptation and improvement of the quarrying activities based on monitoring of the success of restoration actions in terms of fauna and flora communities and ecosystem functioning.[109]

De-commissioning

The de-commissioning of a mine site covers, inter alia:

- the dis-assembly and removal of
  - all machinery (extraction, in-situ processing, transportation, etc.),
  - in-built infrastructure (void support, rails, conveyors, roads, hoists, electricity cables and lights, water, sludge and air pipelines, doors, etc.);

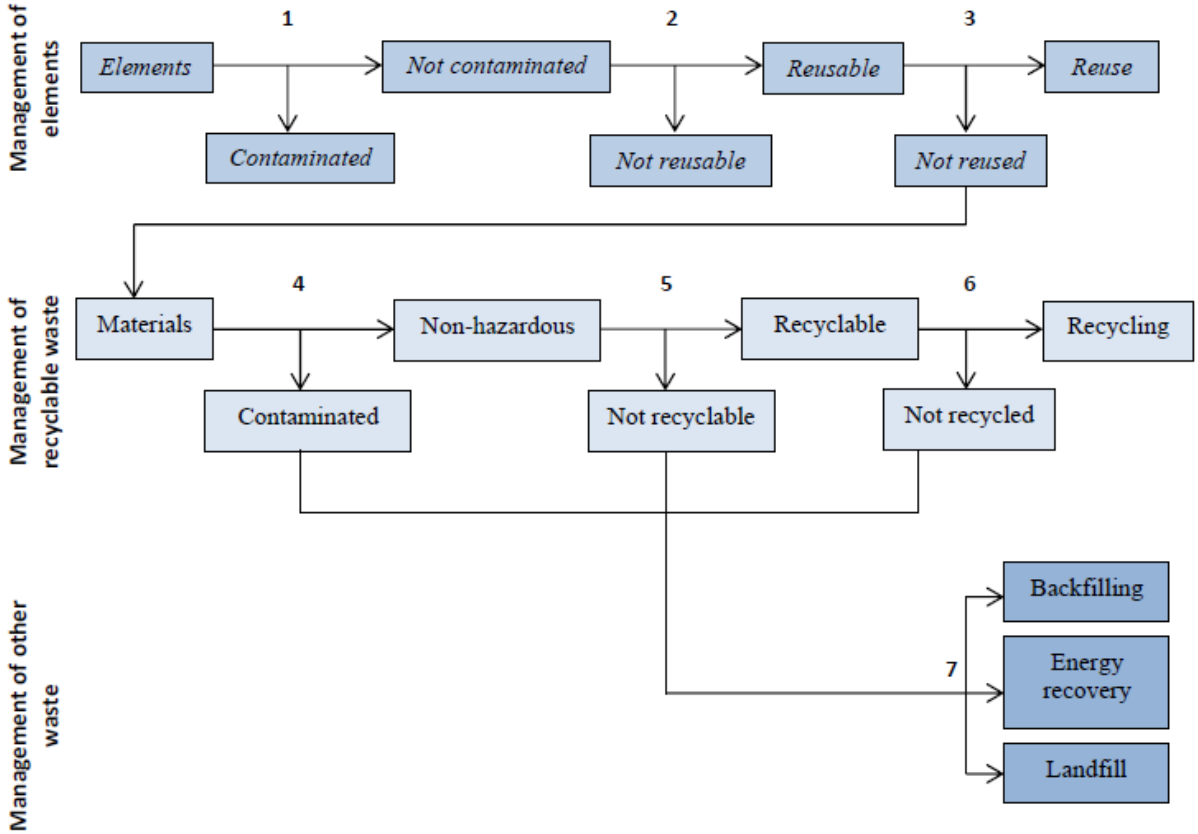
[109] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p. http://quarriesalive2018.uevora.pt/co.html

- demolition or preparation to re-use plants (mineral processing, water and waste treatment) and buildings (shaft towers, offices, stations) both surface and underground;
- decontamination of all contaminated, polluted underground and surface areas, if any;

as technically and economically feasible, and taking into account the potential future re-use of these assets. The aim is to decommission only structures that are not converted to a post mining use.

During decommissioning of extraction sites, the decision making scheme developed for construction and demolition waste can be also applied (Figure 6)[110]. According to this scheme, the information about constructive and non-constructive elements (such as pillars, beams, walls, slabs, etc., also furniture, lightning, electronics, paper, etc.), and corresponding materials should be collected, classified and organized to provide not only the total amount of waste, but also the total amount of the different types of materials.

Figure 6: Decision-making process for construction and demolition waste



[110] http://ec.europa.eu/DocsRoom/documents/31521/attachments/1/translations/

Closure

Legal analogue and background

There are two pieces of EU legislation which have specific provisions relevant to mine closure. According to Council Decision 2010/787/EU on State aid to facilitate the closure of uncompetitive coal mines[111], "*closure*" means "*the permanent cessation of production and sale of the mineral"*, which is a rather restrictive approach for the definition.

The other piece is the Extractive Waste Directive (EWD) which has a separate Article (12) on closure and post-closure procedures for extractive waste management facilities. The developer (operator) only starts the closure procedure if one of the following conditions is satisfied:

(a) the relevant conditions stated in the permit are met;

(b) authorisation is granted by the competent authority, at the request of the operator;

(c) the competent authority issues a reasoned decision to that effect.

A facility may be considered as finally closed only after the competent authority carried out a final on-site inspection, assessed all the reports submitted by the operator, certified that the land affected by a waste facility has been rehabilitated and communicated to the operator its approval of the closure. That approval does not reduce the operator's obligations under the conditions of the permit or the relevant legislation.

The EC Guidance on the EWD prepared by MONTEC (2008)[112] summarizes the objectives of the closure of a waste facility on Figure 7 below.

[111] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1586161230865&uri=CELEX:32010D0787
[112] https://ec.europa.eu/environment/waste/mining/pdf/EU_Final_Report_30.04.08.pdf

Figure 7: (MONTEC, 2008)[113]

Issue	Closure Objectives
Physical Stability	All remaining anthropogenic structures are physically stable
Chemical Stability	Physical structures remaining after closure are chemically stable
Biological Stability	The biological environment is restored to a natural, balanced ecosystem typical of the area, or is left in such a state so as to encourage and enable the natural rehabilitation and/or reintroduction of a biologically diverse, stable environment
Hydrological and hydrogeological environment	Closure aims at preventing physical and chemical pollutants from entering and subsequently degrading the downstream environment - including surface and ground waters
Geographical and climatic influences	Closure is appropriate to the demands and specifications of the location, of the site in terms of climatic (e.g., rainfall, storm events, seasonal extremes) and geographic factors (e.g., proximity to human habitations, topography, accessibility of the mine)
Local sensitivities and opportunities	Closure optimizes the opportunities for restoring the land and the upgrade of land use is considered whenever appropriate and/or economically feasible
Land use	Rehabilitation is such that the ultimate land-use is optimized and is compatible with the surrounding area and the requirements of the local community
Socio-economic considerations	Consideration must be taken of opportunities for local communities whose livelihoods may depend on the employment and economic fallout of the mining activities. Adequate measures are made to ensure that potential socio-economic advantages associated with closure are maximized.

MWEI BREF BAT 11 provides principles on design for closure and also the approach of integrated design which is key to design an extractive waste facility taking into account all relevant parameters in order to optimise the overall environmental, human health and safety aspects in the short and long term (e.g. base structure, dam structure, cover structure, water management and treatment).

One of the primary concerns of closure and after-care is the physical (geotechnical) stability of slopes of quarries and open casts and entries of underground works, waste rock heaps, and dam slopes for sludges and tailings. A detailed description of the technologies used for rock stabilization is beyond the scope of this document. There are different technical standards and requirements concerning the stability, depending on the type of material composition, their potential impact on the environment, and external factors such as seismicity. Whatever the details of a given situation, stability can be achieved by a combination of the following measures:

- reshaping (flattening) a dam or slope,
- erosion prevention measures such as water management, slope stability,
- diversion of undisturbed rainwater runoff from the flanks of a waste facility,
- removing decant water on a tailings surface,

[113] https://ec.europa.eu/environment/waste/mining/pdf/EU_Final_Report_30.04.08.pdf

— dewatering of tailings behind a dam,

— regeneration of disturbed soils,

— seeding, planting vegetation.

Cover systems on extractive waste facilities fulfil one or more of the following purposes:

— control (most often minimization) of the infiltration of precipitation into the wastes, which may lead to the occurrence of contaminated seepage at the toe of the facility and/or infiltration of contaminated water into the groundwater,

— control of gas diffusion into the wastes which may lead to acidification of the wastes and occurrence of acid rock drainage, often carrying heavy metals,

— protection of the waste surface from erosion (e.g., wind erosion, water erosion, etc.),

— isolation of hazardous wastes from public access,

— minimization of the airborne release of contaminants (e.g., radon or gaseous cyanide compounds, etc.),

— support a vegetation cover which corresponds to the intended after-use and restore soil functions,

— prevent air pollution due to wind dust removal.

In the case of tailings which must be dewatered at closure, the cover system may also play a crucial role in draining the pore water which is pressed upwards, and lead it to a collection point from where it is then discharged into the environment or, if need be, pumped to a treatment station. In order to achieve these purposes, the cover will often consist of numerous layers whose functions closely interact with each other. Consequently, the cover system is designed by the following parameters:

- reshaping works of the wastes before a cover is placed,
- thickness of the components (layers) of the cover system,
- material cost (e.g., per m^3 of soil or per m^2 of a synthetic plastic liner),
- special requirements such as compaction,
- surface dewatering measures (e.g., canals, ditches, drains, etc.),
- quality assurance, particularly if strict quality requirements must be fulfilled (e.g., welding plastic liners, etc.),
- future re-development and potential uses of the restored land.

The closure is not only a technical act but where the social and economic aspects are taken care of. Mine closure has a major impact on surrounding communities and planning for the social and economic aspects of the transition should start well in advance. In this regard, the Council Decision 2010/787/EU on State aid to facilitate the closure of uncompetitive coal mines provides a potential analogue:

(a) the cost of paying social welfare benefits resulting from the pensioning-off of workers before they reach statutory retirement age;

(b) other exceptional expenditure on workers who have lost or who lose their jobs;

(c) the payment of pensions and allowances outside the statutory system to workers who have lost or who lose their jobs and to workers entitled to such payments before the closure;

(d) the cost covered by the undertakings for the re-adaptation of workers in order to help them find new jobs outside the extractive industry, especially training costs;…

(g) additional underground safety work resulting from the closure of production units;

(h) mining damage, provided that it has been caused by the production units which have been closed or which are being closed;

(i) all duly justified costs related to the rehabilitation of former mining sites, including:— residual costs resulting from contributions to bodies responsible for water supplies and for the removal of waste water,— other residual costs resulting from water supplies and the removal of waste water;

(j) residual costs to cover former miners' health insurance;

(k) costs related to the cancelling or modification of ongoing contracts (for a maximum value of 6 months of production);

(l) exceptional intrinsic depreciation provided that it results from the closure of production units;

(m) costs of surface recultivation.

The above list is on the cost types eligible for state aid, therefore it does not cover the socio-economic aspects of the near-by population.

It is noted that mine closure might be preceeded by the temporary suspension of operation in some countries, both this and the final closure is usually described in a technical operation plan (TOP).

The mine closure plan is continuously updated during the life cycle of the extractive project taking into consideration the environmental monitoring findings and objectives of the closure. Action and measures to be taken to achieve the closure objectives are described in the closure plan as well as setting out success criteria for demonstration to the competent authorities of the achievement of those objectives.

Rehabilitation

A terminology review

There are a number of terminologies in use at the EU legislation and in practice in connection with the rehabilitation of an industrial site, as summarized below.

Backfilling is placing materials back into the excavation voids for rehabilitation and construction purposes, in order to secure the stability and prevent waste generation and pollution. In an ideal case, it is an integral part of the extraction phase, so-called progressive rehabilitation, but can be also part of the closure phase.

De-commissioning (disassembly, removal, demolition of the core parts, infrastructure, and installations of the site) and de-contamination (clean up of polluted areas) are activities typical at the beginning of the closure procedure.

Restoration is usually used in the context of derelict sites. The Habitats Directive uses the term restoration, but in ways fundamentally different to the way it is used in the extractive industry (to *restore the natural habitats and the populations of species of wild fauna and flora at a favourable conservation status*). This is, therefore, somewhat confusing.

Terms such as reclamation or remediation (*mostly refer to prepare derelict, unusable, contaminated or abandoned lands for use*), and re-cultivation and revegetation (*re-settle soil cover and flora*) should be also avoided when describing the entirety of integrated mine closure and rehabilitation planning.

The EWD provides a broad definition for "*rehabilitation*" which means "*the treatment of the land affected by a waste facility (or an extractive site) in such a way as to restore the land to a satisfactory state, with particular regard to soil quality, wild life, natural habitats, freshwater systems, landscape and appropriate beneficial uses*". The attributes "*satisfactory state*" and "*appropriate beneficial uses*" reflect the universal concept of "*fit-for-use*" and provide the link to the after-care and re-use final stages of an extractive site life cycle.

The most appropriate rehabilitation plans generally require a risk assessment and a cost-benefit analysis in order to optimize the applied solutions and alternatives[114].

According to MWEI BREF, a design for closure and post-closure approach (see BAT 11) helps to ensure the short-term and long-term structural stability of the extractive waste deposition area. The closure design and applicability of closure measures and technologies (e.g. BAT 3, BAT 21, BAT 22, BAT 38, BAT 40, BAT 48, BAT 49, BAT 50, BAT 52) is assessed based on the results of a proper Environmental Risk and Impact Evaluation (see BAT 5).

[114] https://ec.europa.eu/jrc/en/publication/reference-reports/progress-management-contaminated-sites-europe

Good practice case

Gravel extraction along the 45 km section of the Meuse river in Belgium and Netherlands is a traditional cross-border economic activity. In the 1980's social dissatisfaction with gravel extraction and agriculture in floodplains grew, and new visions on river restoration were explored, leading to more integrated approaches to nature conservation, flood risk management, farming, recreation, navigation and mineral extraction. The three overarching goals of the integrated Grensmaas project were to achieve a reduction of flood risk in line with national agreements; to restore at least 1,000 ha of nature and hand it over to managing authorities; and to extract at least 35 million tonnes of gravel. Gravel extraction will continue up to 2024 with an expected gravel output of 52 million tonnes. At the core of the success was the vision of a triple win for flood risk reduction, nature restoration and jobs and growth creation. It ensured an early and broad consensus between key stakeholders which made it possible to integrate this vision into long-term regional planning processes.[115]

Monitoring and aftercare

The developer is responsible for the maintenance, monitoring, control and corrective measures in the post-closure phase for as long as may be required by the competent authority, taking into account the nature and duration of the hazard, save where the competent authority decides to take over such tasks from the developer, after a facility has been finally closed and without prejudice to any national or EU legislation governing the liability of the developer.

The developer, *inter alia,* controls the physical and chemical stability of the facility and can minimise any negative environmental effect, in particular with respect to surface and groundwater, by ensuring that:

(a) all the structures pertaining to the facility are monitored and conserved, with control and measuring apparatus always ready for use;

(b) where applicable, overflow channels and spillways are kept clean and free.

Following the closure of an extractive facility, the developer notifies the competent authority of any events or developments likely to affect the stability of the waste facility, and any significant adverse environmental effects revealed by the relevant control and monitoring procedures. The developer implements the internal emergency plan, where applicable, and follows any other instruction from the competent authority as to the corrective measures to be taken.

In cases and at a frequency to be determined by the competent authority, the developer reports, on the basis of aggregated data, all monitoring results to the competent authorities for the purposes of demonstrating compliance with permit conditions and increasing knowledge of the facility behaviour.

The post-closure monitoring programme can be based on the results of the overall monitoring of the operation phase (see Chapter 4.6), by selecting those indicators which showed adverse deviations from the design base, and extending the scope with those monitoring parameters which are specific to the post-closure, such as surface movements (erosion, subsidence), gas seepage and drainage monitoring of the closed heaps, tailings, backfilled voids, as well as the physical monitoring and protection against trespassing intruders.

In certain cases, the active or passive aftercare by the developer is required by the competent authority in line with EU legislation, or the results of the EIA predict such needs. The aftercare may involve the long-term inspections of high-risk facilities (e.g. category A waste facilities), passive or active treatment of acid mine drainage or other leachates, corrections of malfunctioning sealing covers of heaps, etc..

[115] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p. http://www.restore-quarries.eu/

The supervision and monitoring can extend over several decades or even longer. In this context, it must be considered that monitoring e.g. the functionality of a cover system alone is useless unless corrective measures are taken into account, too. These may include, but are not limited to,

- repair of damaged covers (e.g., erosion gullies, etc.),
- eradication of unwanted species (e.g., deep-rooted plants, etc.),
- re-seeding/re-planting vegetation if previous efforts have not yielded the required results.

Legal background

The EWD (Article 12 (4)) requires under certain circumstances long-term measures and the related costs for rehabilitation of mine waste facilities. Care and maintenance measures ensure that the environmental objectives are safely achieved over the long-term, i.e., over a time period exceeding the immediate closure activities. Such measures may include, but are not limited to:

- long-term geotechnical monitoring of dam and slope stability and tailings consolidation,

- regular checks of erosion control measures and the function of drains, ditches, and water diversion canals,

- inspection of vegetation status on covers, repair/replanting of vegetation if required.

Water treatment is an important aspect during mine closure and in the after-care phase (MWEI BREF BAT 43-47). Treatment of liquid effluents (seepage water, contaminated runoff) may become one of the main cost factors of environmental mitigation of a waste facility particularly in the closure phase of a mine waste facility.

Tailings and waste rock heaps often generate contaminated seepage, which must be treated before it can be discharged into the environment. Tailings ponds often have a decant pond which must be removed before a cover can be placed if "*dry cover*" closure is chosen. The decant pond water may need treatment, too, before it can be discharged into the environment. Typical contamination patterns are metal mining wastes with acid leachates rich in toxic heavy metals, sometimes with arsenic, cyanide, nitrogen compounds, sulphate, salt.

Although, over the long run, the contaminant load from a waste facility may significantly decrease, but may still require treatment. In such cases, conventional active water treatment systems may be replaced by passive or semi-passive water treatment systems (e.g. wetlands, bioreactors). They are often based on biological processes such as microbial sulphate reduction or hyperaccumulation of metals by special plants and algae.

More information on monitoring is available in MWEI BREF BAT 23, 24, 40, 41, 48, 52, 57, and in chapter 4.6 of this report.

Legal background

Commission Implementing Decision[116] 2020/248/EU laying down technical guidelines for inspections of extractive waste management facilities is another legislation source for the topic. Its Annex, 4. Inspections of waste facilities after the closure, PART E Additional elements for inspections of Category A waste facilities provides a useful list that should be taken into account when planning the closure chapter of the EIA:

"*Inspection of dams of Category A waste facilities containing tailings*

[116] https://eur-lex.europa.eu/eli/dec_impl/2020/248/oj

The following shall be taken into consideration where the inspection concerns dams of Category A waste facilities containing tailings:

(a) type and condition of erosion protection;

(b) adequacy of the hydrological design, such as water balance, available free-board (vertical distance (height) between the normal maximum operating level of a pond and the crest of the dam);

(c) composition, status and structural integrity of the beach, such as presence of depressions, tailings density, dust control;

(d) changes of the dam's crest and slope comparing the current state versus the design state;

(e) functioning and condition of the drainage system and its state and geotechnical structures (such as geomembranes, dams) and equipment (such as dam structure monitoring);

(f) leakage and seepage areas, and amount of material leaked;

(g) any detected damages;

(h) trees and vegetation on the dam.

2. Inspection of discharge arrangements of Category A waste facilities containing tailings

(a) adequacy of access to discharge lines and discharge points;

(b) damages of construction and control equipment;

(c) leakage through and around the discharge arrangements;

(d) erosion of downstream outlet;

(e) vegetation in or close to the discharge arrangements;

(f) discharge regulation equipment;

(g) emergency discharge arrangements;

(h) back-up power supply;

(i) rate of increase of discharges to the tailings pond and related rate of increase of the pond level (measured in meters/year);

(j) tailings placement system;

(k) water management system.

Inspections of Category A waste facilities containing waste rocks

(a) weathering of the rocks;

(b) seepage water quality and quantity;

(c) whether the measures taken to minimise the environmental impacts of waste rock facilities are adequate;

(d) correctness and effectiveness of recultivation activities based on relevant legal obligations."

Re-use of the site

The preparation for the re-use and the actual re-use of the mining site is not the responsibility of the developer but the closure objectives are already set to allow and support the planned post mining land uses. Nevertheless, the vision and the presentation of the re-use options and alternatives in the EIA report can be beneficial for the developer and for the approval of the whole project in the community. Numerous innovative good

practice cases are known inside Europe on how to utilize rehabilitated extraction sites for a colorful set of economic and cultural purposes. Reasonable and rational creativity in this regard may generate a positive attitude in stakeholders.

The key environmental aspects are summarized in Table 2.

Good practice case

The building of the Polish National Radio Symphony Orchestra (NOSR), is the result of an urban development strategy in Katowice, Poland. Until 2006, in the heart of the city, the area was a coal mine[117]. In ten years, besides NOSPR, the city also built an International Congress Centre and a Museum. The three big investments totalled €231 million and received support from the ERDF (€123 million). For those investments, Katowice obtained the UNESCO label of "*Creative City of Music*" in 2015 and, in 2018 it accommodated the UN climate summit.

Numerous other well documented success stories are known from all over Europe[118].

Former coal mine, at the centre of Katowice, Poland

Area after urban rehabilitation, Katowice, Poland

[117] https://www.eca.europa.eu/lists/ecadocuments/sr20_08/sr_cultural_investments_en.pdf

[118] http://www.madrid.org/bvirtual/BVCM015009.pdf
http://www.restore-quarries.eu/

Table 2: Key environmental aspects of land and soil related to mining activities

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS										
		LAND AND SOIL										
								soil functions				
		Landscape, visual impacts	land use change	built environment, material asstets	cultural heritage	surface & subsurface stability	subsoil quality	organic carbon & biological capacity	inorganic composition, pollution	Sealing, compaction, Salinity	erosion	soil volume
CONSTRUCTION	surface	√√	√√	√	√	√	√	√√	√	√	√	√√
	underground	√√	√√	√	√	√√	√	√	√	√	√	√
EXTRACTION	surface	√√	√√	√	√	√√	√	√√	√√	√	√√	√√
	underground	√	√	√	√	√√	√√	√	√	√	√	√
	on water	√√	√√	√	√	√	√	√	√	√	√	√
	other novel technology	√√	√	√	√	√	√	√	√	√	√	√
MINERAL TREATMENT	comminution, screening	√	√	√	√	√	√	√	√	√	√	√
	physical, chemical separation	√	√	√	√	√	√	√	√	√	√	√
	other	√	√	√	√	√	√	√	√	√	√	√
STORAGE & WASTE MANAGEMENT	gangue and waste rock heaps	√√	√	√	√	√√	√√	√	√√	√√	√	√
	tailings pond	√√	√	√	√	√√	√√	√	√√	√√	√	√
	operational waste	√	√	√	√	√	√	√	√	√	√	√
	material storage	√	√	√	√	√	√√	√	√	√	√	√
	extractive waste recycling	√	√	√	√	√√	√√	√	√	√	√	√

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS										
		LAND AND SOIL										
								soil functions				
		Landscape, visual impacts	land use change	built environment, material asstets	cultural heritage	surface & subsurface stability	subsoil quality	organic carbon & biological capacity	inorganic composition, pollution	Sealing, compaction, Salinity	erosion	soil volume
TRANSPORTATION	truck, haulage	√	√	√	√	√	√	√	√	√	√	√
	conveyors (belt, elevator, bucket)	√	√	√	√	√	√	√	√	√	√	√
	pipeline	√	√	√	√	√	√	√	√	√	√	√
	railways	√	√	√	√	√	√	√	√	√	√	√
	water-born	√	√	√	√	√	√	√	√	√	√	√
CLOSURE	temporary suspension	√	√	√	√	√	√	√	√	√	√	√
	decommissioning	√	√	√√	√	√√	√	√	√	√	√	√
	rehabilitation	√√	√√	√√	√	√√	√	√√	√√	√√	√√	√√
	aftercare	√	√	√	√	√√	√	√√	√	√	√	√

Concluding remarks

Land management plans integrating the optimization of land and soil use during operation, progressive rehabilitation, biodiversity and ecosystem restoration, water courses management, closure and aftercare, are often central to an EIA report of extractive projects both in case the of surface or underground mining.

4.3.3 Water (Annex IV.5b)

Legal background

The Article 3(1(c)) of the EIA Directive requires to "*identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on … water*". Annex III 1.(c) and Annex IV 1.(c) identify water as a natural resource. Annex III 1(g) considers water contamination as a potential risk to human health.

When describing the location of projects (Annex III 2.), "*the environmental sensitivity of geographical areas likely to be affected by projects must be considered, with particular regard to:*

(b) the relative abundance, availability, quality and regenerative capacity of natural resources (including ... water ...) in the area and its underground;

(c) the absorption capacity of the natural environment, paying particular attention to the following areas:

(i) wetlands, riparian areas, river mouths;

(ii) coastal zones and the marine environment".

Annex IV(1.(d)) requires „*an estimate, by type and quantity, of expected … emissions (such as ... water …)*" as a mandatory element of the description of the project, as well, among the factors likely to be significantly affected by the project (4.): "*water (for example hydromorphological changes, quantity and quality)*".

Further legal pieces in the context of water should be considered, such as:

- Good ecological and chemical status, quantitative water management, re-injection of pumped groundwater, monitoring, main pollutants, emission limits (Directive 2000/60/EC[119] and Directive 2008/105/EC as amended by Directive 2013/39/EC[120]););

- Drinking water thresholds (Directive 98/83/EC);

- Groundwater chemical status and thresholds (Directive 2006/118/EC);

- Qualifying quantities of dangerous substances of Seveso facilities (Directive 2012/18/EU);

- Environmental status of marine waters, monitoring (Directive 2008/56/EC);

- Industrial emissions (Directive 2010/75/EU and Regulation (EC) No 166/2006);

- EWD with threshold values for cyanide in tailings.

The Water Framework Directive (WFD) and its relevant requirements in respect of new projects are more complex than shown above. With regard to projects possibly affecting water status, deterioration is only allowed if justified by overriding public interest or benefits for human health, or positive impacts for sustainable development outweigh disadvantages for water environment, no better environmental alternatives exist which are not disproportionately costly or technically unfeasible, and all mitigation measures are taken to avoid and mitigate negative impacts (Art 4(7) WFD). For existing activities, permits should be in line with the WFD requirements and take into account the status of potentially affected water bodies (Art 10 WFD).

[119] The Water Framework Directive sets tasks on Member States mainly, however, it implies that permits can only be granted subject to compliance with strict criteria to preserve good water quality and quantity and therefore will result in obligations for developers and operators however

[120] Environmental quality standards directive which sets Environmental Quality Standards (concentration limits for emissions in surface water) for a series of priority and priority hazardous substances listed in Annex X of the Water Framework Directive

An integrated approach for streamlined assessment under the EIA Directive and the WFD is provided by the Guidance Document No. 36 "*Exemptions to the Environmental Objectives according to Article 4(7)*[121]". While a streamlining is mandatory – where appropriate – as regards the EIA and the "*appropriate assessment*" under the Habitats Directive, it is up to the MS to decide whether to apply it to the EIA Directive and the WFD[122]. Referring to the approach and different steps for an "*applicability assessment*" in relation to WFD Article 4(7), equivalent steps are required under the EIA and the Habitats Directives (where they apply) that could be taken alongside with the steps under the WFD. This refers particularly to "*screening*", "*scoping*" and the necessary data collection. Such a streamlined approach can lead to significant cost and time savings.

Extractive projects use large portions of land surface and penetrate into the geological domain ("*subsoil*", "*Earth crust*"), therefore they have the potential to impact surface and groundwaters all along the project life cycle. The intrusion into the surface land, the unsaturated (vadose, three-phase) and saturated groundwater zones itself changes the baseline conditions of waters but the emissions, especially when chemicals are included, can be of further concern.

The major focus areas of assessing potential impacts on water are:

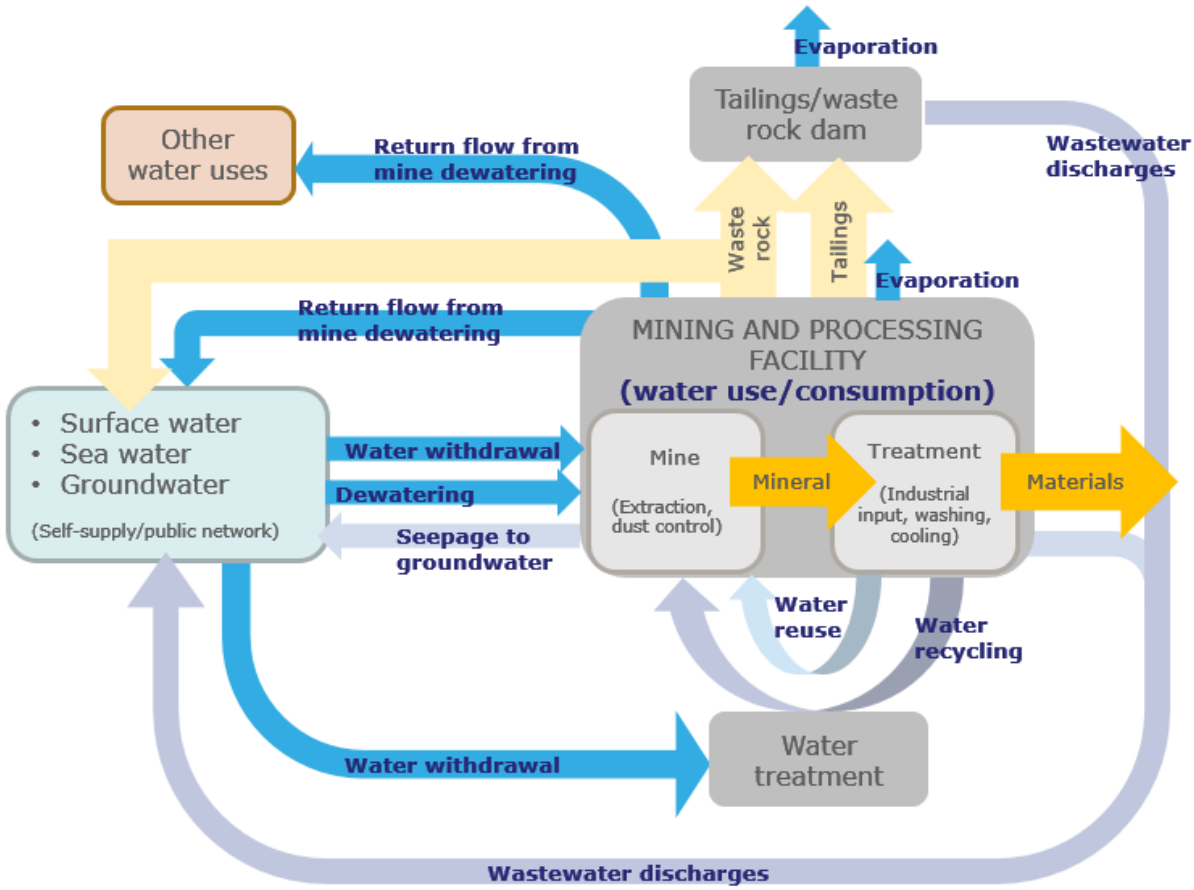
- Change of **physical status of waters** by the installed project facilities and mine voids on surface hydrography, geohydrology, groundwater hydrodynamics, and flow patterns.
- Change of available **water volume and water balance** by the active or passive use of waters -such as recharge rates of surface and groundwater, groundwater bodies' reserve, piezzometric (hydraulic pressure) levels in the river basin or sub-basin, etc.- due to the water use by the extractive project either by drawdown of water levels to make extraction feasible, or by extraction and treatment technologies that require water.
- Change in **water quality** status (chemical, biological, physical) by the emissions of extraction and treatment techniques.
- Change in **water ecosystems**/aquatic environment (status –structure and functioning-, vulnerability, equilibrium, recovery rate etc., either on a short term or a long term basis) by the the installed project mine works/facilities.

The non-energy mineral extractive sector uses water in different ways depending on the material extracted in many of its segments and having a variety of potential minor and significant impacts on both water quality and quantity, and therefore on aquatic ecosystems (Figure 8, Table 3). The interaction starts already from the construction phase, especially at open cast mines, indirectly interfering with the surface waters and shallow groundwater hydrography by the altered evapotranspiration rates, due to clearing off vegetation and topsoil.

[121] https://circabc.europa.eu/sd/a/e0352ec3-9f3b-4d91-bdbb-939185be3e89/CIS_Guidance_Article_4_7_FINAL.PDF

[122] See Commission guidance document on streamlining environmental assessments conducted under Article 2(3) of the EIA Directive http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2016:273:FULL&from=DE

Figure 8: Use of water in non-energy extractive industries (source: Vidal Legaz et al. (2018))



It is important to define the water balance of the waste facilities and the overall water balance for the whole extractive project. Information on the water balance and the quality of different water streams are needed for assessing the impacts on surface and groundwater. The MWEI BREF has further recommendations on it (e.g. BAT 18). The EIA report may include the Water management plan as an attachment.

There are numerous water-related activities and installations in association with construction, extraction, treatment, waste management, closure and rehabilitation, such as:

- dewatering pumping systems;
- diversion of water run-off structures;
- technology water supply (shotcrete support, drilling fluids, cooling, etc.)
- settling ponds/dams;
- reservoirs, sumps;
- system for removing the free water, such as decant towers or decant chute;
- spillways;
- intake structures;
- drains and drainage layers (including seepage control);
- pipelines;
- culverts;

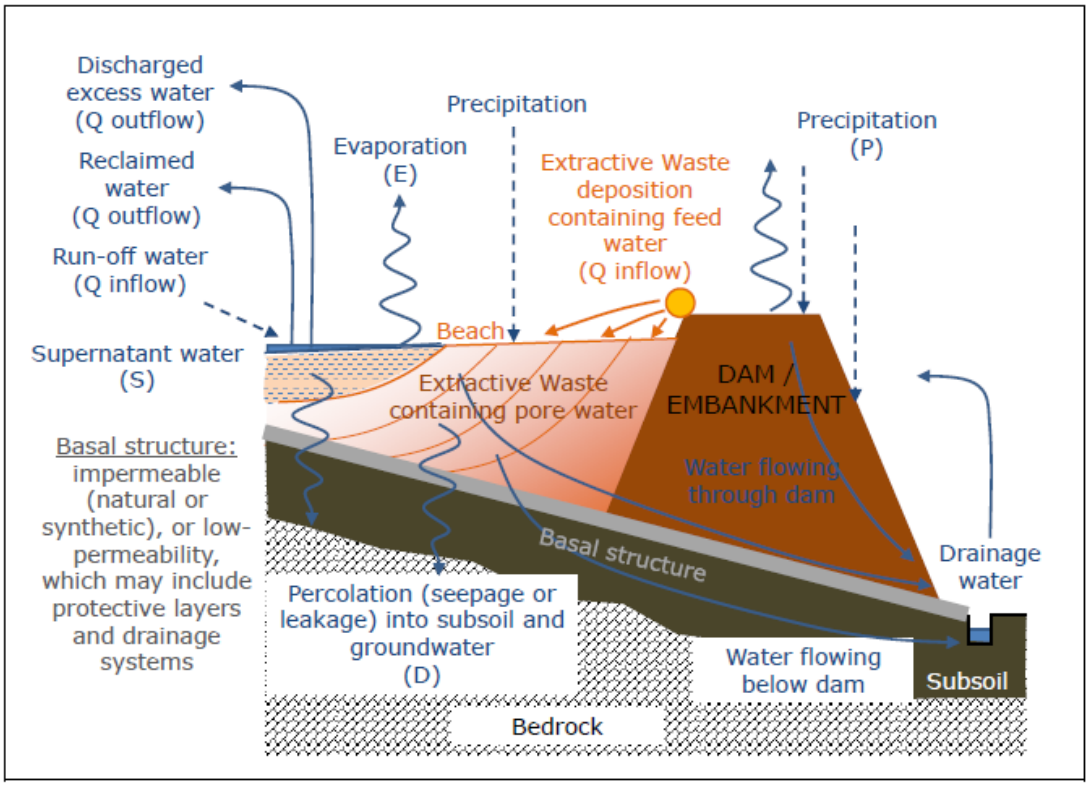
- water supply for drinking, cleaning, washing;
- treatment plants incl. wet mineral processing techniques;
- waste recovery and recycling technologies using water;
- water supply for workers;
- water spraying against dust, irrigation for re-vegetation.

The emissions to surface waters may include:

- acidity or extreme alkalinity (pH) from sulphidic rocks and treatment chemicals;
- suspended particles (solids) and coarser grained sedimentary flux;
- sulphur-bearing compounds (sulphides, sulphates, sulphites, thiosulphates, sulphur) originating mainly from sulphidic rocks and their weathering products as well as from flotation reagents (xanthates, thiophosphates, thioourea, thiocarbamates, alkyl sulfates, sulfonates, etc.);
- nitrites, nitrates and ammonium or ammonia from explosives, amine collectors from flotation;
- inorganic and organic phosphate species (from rocks, local fertilizers and flotation reagents);
- chloride from potash extraction;
- organic contaminants from the host rocks or from local spills;
- fatty acid collectors used in flotation;
- metals and metalloids from the host rocks or treatment reagents (As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Zn, Sb, Ba, Mo, Se, V, NORMs (U, Th);
- cyanides, acids, bases as minerals treatment solvents;
- other substances as defined in the relevant legislation.

Figure 9 illustrates typical water flow patterns across a tailings dam.

Figure 9: Water balance, flow patterns at a tailings dam (source: Extractive waste BREF)



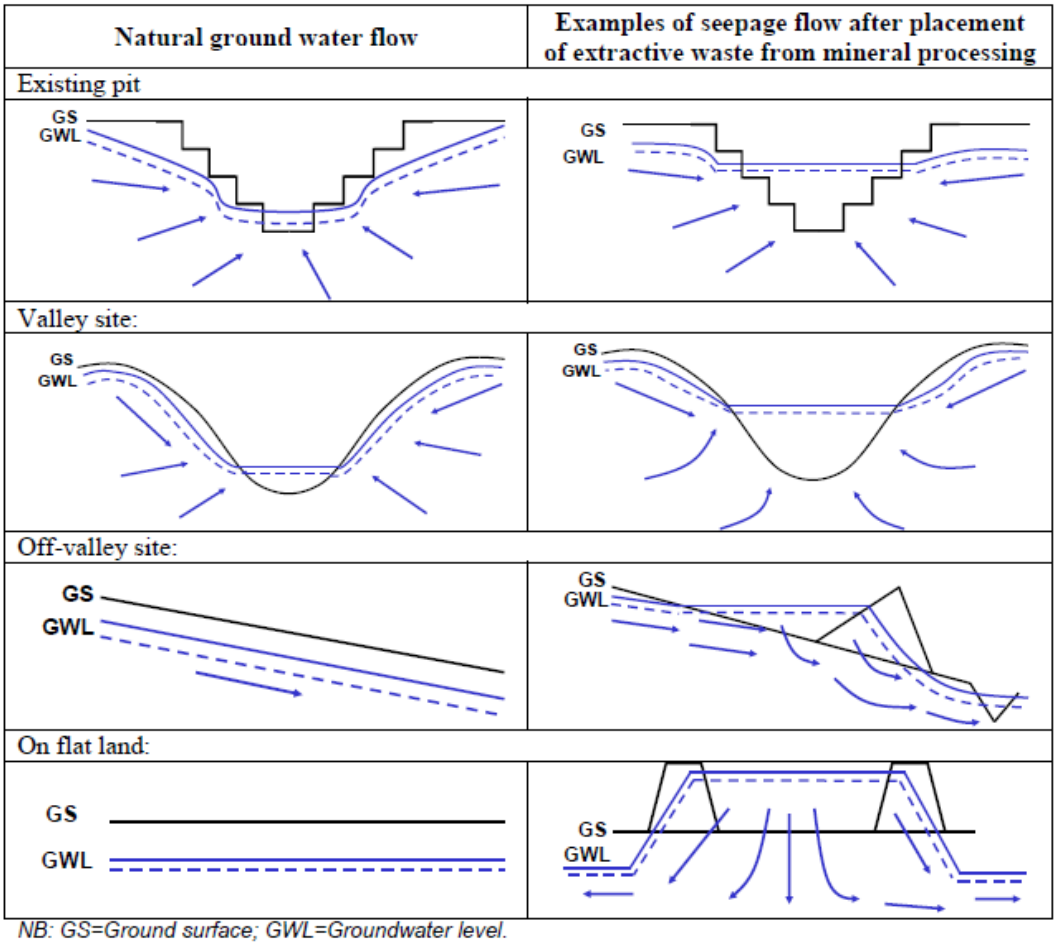
Quality, quantity, surface hydrography, hydraulic pressure and resulting flow pattern of groundwater can be affected. The overall water balance of the area, including minor cumulative effects due to change of local climate can occur on large scale projects.

If proper measures (e.g. perimetric channels, decantation ponds) are not taken, additional sediment flux in surface streams and lakes can affect water quality in the construction and operation phase. Vulnerable, relatively open groundwater systems, such as karstic reservoirs may also be impacted. Extraction site design considers the potential risk of local floods and for potable water reserves in adverse case scenarios. Heaps must be properly designed and constructed to avoid mobilization of inert waste rock masses during high precipitation period. Sediment flux issues may occur at all mineral commodities' extraction.

Extractive waste management facilities influence the original groundwater flow pattern by introducing a hydraulic gradient (difference in hydraulic head between two points divided by the travel distance between the points) (Figure 10). The following figures show schematic examples of seepage flow patterns for original groundwater flow conditions and for the following basic dam types:

- existing pit;
- valley site;
- off-valley site;
- on flat land.

Figure 10: Examples of simplified seepage flow scenarios for different types of extractive waste facilities (EW BREF)



NB: GS=Ground surface; GWL=Groundwater level.

When taking into account water quality factors, in particular for metal sulfide ores mining, the potential toxic metals emission (Pb, Hg, Cd, Cr, Ni etc.), the generation and uncontrolled discharge of acid mine drainage (AMD), and the unintended accidental release of dangerous chemical substances (cyanide, xanthate, etc.) resulting usually from the mineral processing, are the major issues for concern.

Acid mine drainage (AMD) is a potential environmental risk at sulphidic metalliferous ore extraction, at coal mines (out of scope), and at some industrial minerals mines such as native sulphur, gypsum and anhydrite. Sulphidic minerals, when exposed to oxygen and water are readily oxidized and form sulphate solutes in situ in the fractured and loosen rocks and mining voids, or on the surface in extractive waste heaps. These low pH acidic leachates with high concentration of toxic metals can enter pristine groundwater bodies or surface waters.

The change of the hydrography of surface waters is unavoidable in certain cases either because the project uses local surface waters, or because the positioning of certain installations (e.g. tailings ponds) have no alternative and it has an impact on local streams or lakes. The dewatering of the extraction voids itself changes water levels and recharge rates significantly, although, piezometric depressions usually recover within a few years after the closure of such mines. Changing surface hydrography also has a cumulative adverse impact on biodiversity.

Both surface and underground construction and extraction activities have effects on groundwater hydrodynamics (falling hydraulic heads, disturbed flow patterns), and indirectly on surface waters (see previous factor) at temperate climate settings where the

mean groundwater saturation and levels are within the depth range of mining. For this reason, hydrogeological modelling and simulation of impacts is usually a core element of the EIA report, indicating not only the volumetric spatial changes but the travel times, migration paths and discharge surface outlets of the potential pollutants and contaminants, such as AMD.

Hydrogeological, hydrochemical and hydrological modelling in combination with climate change outlook predicts the overall impacts on the water balance and quality locally and also on regional scale, indicating far-field (river basin or sub-basin, and groundwater body and reserve scales) consequences of the project.

The distinct assessment of the risk of natural floods and accidental flood-like events generated by the project is a mandatory element of the EIA report. More frequent extreme weather conditions due to climate change should be taken into account, as well as the cumulative domino effect on how such natural phenomenon may induce or add upon man induced catastrophic events such as tailings dam or waste heap slope failures. In this context, the international standards of ICOLD[123] are recommended to apply.

The assessment of the cumulative, collateral impacts on downstream waters (as pathways to receptors) is relevant mainly in the case of metalliferous ore minerals extraction, in particular, at accidental events such as flooding. The evaluation extends to the biological status of waters, the direct and indirect toxicology effect of the transferred pollutants on the food chain, on biodiversity and on humans.

Good practice case

The extension of the Skövde limestone quarry in Sweden required avoidance of any possible negative effects on a Natura 2000 site which hosts grasslands and a priority habitat type alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*, located downstream of the quarry. In particular the alluvial forests are dependent on a small stream crossing the quarry site. This was ensured through a 1.5 km deviation of the stream away from the planned extraction area, ensuring the continuous flow of water and sediment to the alluvial forest. The due handling of surface waters fulfilled not only the extraction technology but the water management and biodiversity requirements too. The project involved precise planning on the optimal sediment flux and water flow regime to ensure the preservation of the alluvial forests. Three new ponds were also established[124].

[123] https://www.icold-cigb.org/

[124] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p. https://www.cementa.se/sites/default/files/assets/document/bilaga_4-biologiskt_uppfoljningsprogram.pdf

The discharge of untreated wastewater must be avoided. Its characterization, the assessment of alternative treatment solutions and potential re-use, and the related impacts are core elements of water management at the project. Water balance analysis including assessment of quality and quantity of different waste waters as well as understanding the water chemistry is crucial for the assessment of alternative water treatment solutions, the potential re-use and recycling of water, and the related impacts of the project on surface and groundwater.

Addressing the water needs of the extractive sectors must not have an unduly negative effect on natural ecosystems that provide essential services, such as fish provisioning, flood protection, erosion prevention, pollination, and water to users.

Solutions for efficient and equitable allocation of water across all sectors is needed, also tailored to the socio-economic and ecological specificities of a region. Integrated approaches are needed to take into account the interactions between water, natural environment, energy, agriculture, household demand and the extractive sector. This includes exploiting innovative and circular forms of sector integration (e.g. wastewater for energy).

Reducing water use and using water more efficiently does not only generate resource savings but also important energy savings, given the large amounts of energy that are needed for water treatment, water infrastructure (pumping it to end-users and back to waste water treatment facilities), as well as water heating. Applying the circular economy's main principles in the water sector is an important way of addressing the problems outlined above, see Chapters 4.3.4 and 4.3.7.

Concluding remarks

The detailed impact assessment of surface and groundwater both for quality and quantity, and as the potential transfer medium of pollution and potential aquatic ecosystem degradation are often core elements of the EIA report for extractive projects. Water is likely the most vulnerable environmental factor with regard to extractive projects. In situ acquisition of new data on local water characteristics before, during and after the project is often necessary.

Table 3: Key environmental aspects of water-related to mining activities

LIFECYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS									
		WATER (SURFACE & GROUNDWATER)									
		Sediment flux	Toxic heavy metals	acidifying substances (AMD)	other dangerous chemical substances	hydrogarphy of surface waters	groundwater hydrodynamics (hydraulic heads, flow patterns)	overall local & regional water balance	vulnerability of natural or man-made flooding	cumulative, collateral impacts on downstream waters (as pathways to receptors)	waste water generation and treatment
CONSTRUCTION	Surface	√√	√	√	√	√√	√	√	√	√	√
	underground	√√	√	√	√	√√	√√	√	√	√	√
EXTRACTION	surface	√√	√√	√√	√	√√	√√	√	√	√√	√√
	underground	√√	√√	√√	√	√√	√√	√	√	√√	√√
	on water	√√	√	√	√	√	√	√	√	√	√
	other novel technology	√	√	√	√√	√	√	√	√	√√	√
MINERAL TREATMENT	comminution, screening	√	√	√	√	√	√	√	√	√	√√
	physical, chemical separation	√	√	√	√	√	√	√	√	√	√√
	other	√	√	√	√	√	√	√	√	√	√√
STORAGE & WASTE MANAGEMENT	gangue and waste rock heaps	√	√√	√√	√	√	√√	√	√√	√√	√√
	tailings pond	√	√√	√√	√√	√	√√	√	√√	√√	√√
	operational waste	√	√	√	√√	√	√	√	√	√	√√
	material storage	√	√	√	√	√	√	√	√	√	√√
	extractive waste recycling	√	√	√√	√√	√	√	√	√	√	√√

LIFECYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS									
		WATER (SURFACE & GROUNDWATER)									
		Sediment flux	Toxic heavy metals	acidifying substances (AMD)	other dangerous chemical substances	hydrogarphy of surface waters	groundwater hydrodynamics (hydraulic heads, flow patterns)	overall local & regional water balance	vulnerability of natural or man-made flooding	cumulative, collateral impacts on downstream waters (as pathways to receptors)	waste water generation and treatment
TRANSPORTATION	truck,haulage	√	√	√	√	√	√	√	√	√	√
	Conveyors (belt, elevator, bucket)	√	√	√	√	√	√	√	√	√	√
	Pipeline	√	√	√	√	√	√	√	√	√	√
	Railways	√	√	√	√	√	√	√	√	√	√
	water-born	√	√	√	√	√	√	√	√	√	√
CLOSURE	temporarysuspension	√	√	√	√	√	√	√	√	√	√
	decommissioning	√	√√	√√	√√	√	√	√	√	√	√√
	rehabilitation	√	√	√√	√	√	√√	√√	√	√√	√
	aftercare	√	√	√	√	√	√	√	√	√	√

Concluding remarks

Extractive projects can use large quantities of water, and penetrate into the geological domain, therefore there is often a potential to impact surface and groundwaters all along the project lifecycle. Both water quantity and quality can be impacted. Water is also an efficient pollution pathway. In conclusion, water-related issues require detailed presentation in the EIA report which frequently implies the use of dynamic modelling tools.

4.3.4 Resource use

Legal background

According to Annex IV 5., the EIA provides the "*description of the likely significant effects of the project on the environment resulting from, inter alia:*

…(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;

(e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;".

Resource use is the context where the circular economy solutions for the project can be highlighted (see Chapter 4.3.7 for details). In this respect, it is an opportunity to show those attributes of the project where mitigation and compensation measures can significantly contribute to the elimination and counterbalance of environmental impacts (Table 5).

The **energy use**, volume and energy type (electricity, heat, fosil fuels, steam) is assessed along the stages the project, together with the energy efficiency measures to be implemented. Special attention is paid to renewable energy applications during construction and extraction, as well as the potential utilization of the site after closure and remediation, e.g. geothermal power plants, solar energy plants, windfarms, etc. Reference inclusion on energy infrastructure investments or local energy production local public and economy benefit from.

Quantitative water stress can be a major issue for the sector, especially in reference to metallic minerals mining. It covers the consumed volumes from both local and regional water supplies and source composition (surface waters, riverbanks, groundwater from porous and fractured reservoirs, carstic groundwater, seawater, etc.). Water recycling and re-use also provides an added value in the circular economy context, for example pumped out operational groundwater for potable water supply or thermal spa; re-injection into groundwater body/reservoir instead of discharging to surface streams; cascade use of water during the different value chain stages and techniques, etc. Emphasis is put on the rebuilding of surface water and groundwater conditions after closure, if realistic, and support with dynamic modelling results time-wise.

Minerals are natural resources, obviously. TFEU calls for "*prudent and rational utilisation of natural resources*" (Art 191.1). Most minerals are state-owned national assets, their management and exploitation is governed by national legislation and minerals policy, in most EU countries. Mining is targeting at their extraction, the assessment of this aspect is to provide a best estimate on annual volumes and raw material composition, and to indicate how the project complies with legislative and political requirements. An example is the law may promote the developer for the extraction of the whole deposit, and also those parts which are on the edge of profitability and those minerals and elements which were originally not targeted at. The legal provisions on by-products are taken into account at the EIA.

In this respect, material efficiency is presented, preferably on simplified material flow diagrams, as compared to volumes of removed soil, overburden, immediate host rock, backfilled volumes, mineral processing tailings, extractive waste in the strict legal sense of Directive 2006/21/EU. It contributes to the realization of the circular economy strategy.

Water use is presented in details in Chapter 4.3.3.

The **land and soil** use aspects also appear at Chapter 4.3.2. Whilst there the focus is on land use category change, hereby the potential impacts are assessed with regard to the

overall temporary lateral size (land occupation) of the project, together with the volume of removed fertile soil and its destination, i.e. disposed on site for continuous or post-closure remediation or transported elsewhere for other use. The temporary character of the land use is emphasized.

The impact assessment with regard to **infrastructure** use reviews all such current and planned services and their installations also with an emphasis on their capacity to cope with the increased needs, and on their post-closure utilization. Highly transparent and reliable vision is needed to show what solutions will be in place to maintain the new infrastructure after closure. Infrastructure (energy grid, water supply, sewage system, roads, railways, waterways, other means of transportation, telecommunication, local food supply, settlements, etc.) is a typical element on which extractive projects have positive impacts because they usually involve the development of new infrastructure.

Bioresources include the non-fuel, non-food biomaterials (e.g. wood support in underground mines and as construction materials), and ecosystems services (biodiversity). The latter is presented in details in Chapter 4.3.5.

The presentation of the impacts on human resources covers the number and qualification distributions of workers employed both at the site (including outsourcing) and downstream but limited to the near-field settlements. The positive impacts on the labour market and employment should be emphasized in details.

Extractive waste

The extractive industry generates the second largest waste stream in the EU (25-30%)[125]. Absolute and relative (waste/rock) volumes and characteristics of extractive wastes vary significantly across commodity groups. Extractive waste management is regulated on EU scale in detail by Directive 2006/21/EU and its daughter Commission Decisions, and the relevant BREF (MWEI BREF)[120]. It requires a detailed presentation of its potential impacts, see also Chapter 4.3.5. Other operational waste streams are also covered by a set of EU legislation with limited deviations in national laws.

Legal background

As a follow-up of tailings accidents, the Extractive Waste Directive (EWD), its "*daughter*" decisions[126], the amended Environmental Liability Directive, and a specific BREF[127] aim at improving the environmental performance of this sub-sector (Best Available Technique (BAT) Reference Document for the management of wastes from the extractive industries (MWEI BREF))[128]. The amended Seveso Directive[129] focuses on the prevention and management of the related accident risks.

The major regulatory instruments of the EWD are:

- waste categorization, waste management facility classification,
- waste management plan,
- major-accident prevention (internal and external emergency plans),
- permitting issues,

125 https://ec.europa.eu/eurostat/data/database.; https://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=ten00106&language=en

126 EC Raw Materials Information System > Policy & Legislation > EU legislation > EU Community Secondary Law > Extractive waste, https://rmis.jrc.ec.europa.eu/uploads/ExtractiveWaste.pdf.

127 http://eippcb.jrc.ec.europa.eu/reference/mmr.html.

128 http://eippcb.jrc.ec.europa.eu/reference/BREF/jrc109657_mwei_bref_-_for_pubsy_online.pdf

129 Directive 2012/18/EU

- construction and management of the facility (incl. environmental liability),

- closure and post-closure procedures.

The elements of this list correspond well to the different chapters of the EIA report.

The only quantitative regulatory limit values are in Art. 13 of EWD on cyanide concentration in tailings ponds. Qualifying quantities and thresholds for the waste characterization and facility classification are left to daughter Commission decisions (see Chapter 8.1). There are numerous inter-linkages and cross-references to other secondary legislation, such as the Water Framework Directive, Environmental Liability Directive, Landfill Directive, Seveso II Directive, EIA Directive, Dangerous Substances Directive.

Extractive waste has no explicit legal definition, and the Directive adopts the general waste classification terminology of being hazardous, non-hazardous, and inert as in the Waste Framework Directive and in the European Waste Catalogue[130].

During the last 20 years, besides the above set of EU legislation, a number of EC documents, FP7 and H2020 projects' reports, and scientific literature dealt with this topic. As a result, extractive waste management is regulated and interpreted in depth at both EU and national level. For this reason, this chapter of the document is rather condensed, and developers are recommended to study the above documents for further details.

Managing extractive waste related environmental risks is an overarching issue along the EIA report chapters because

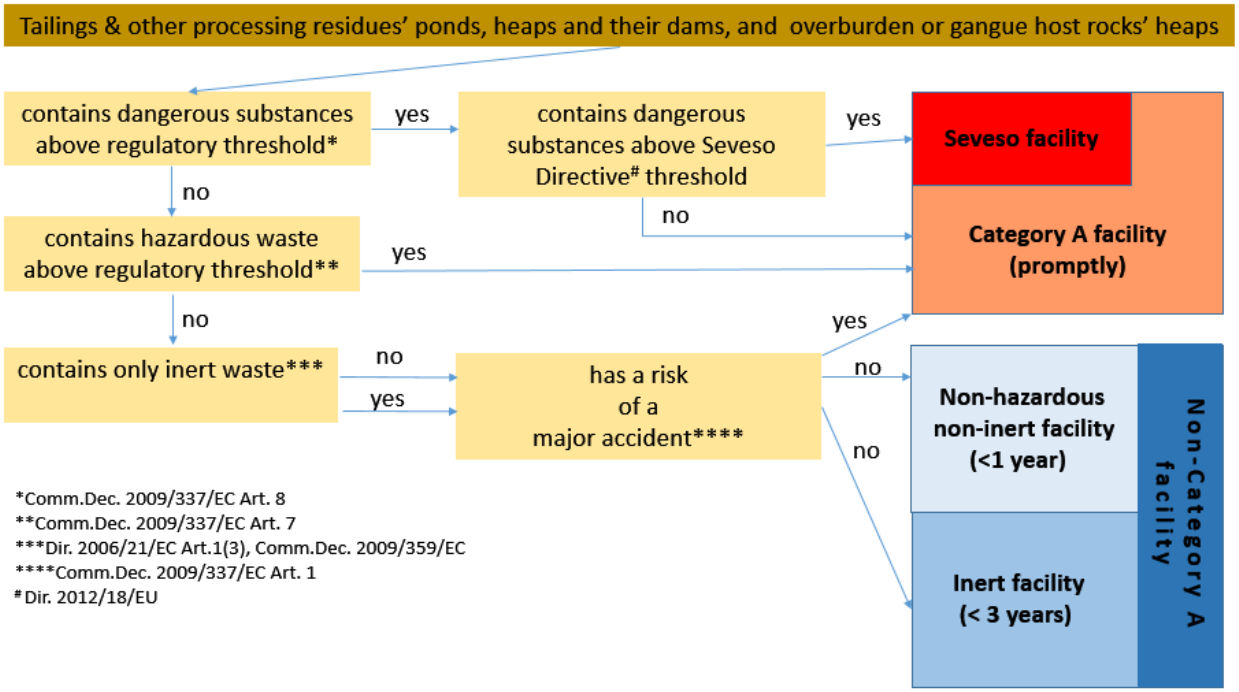
- it is present already from the construction phase;
- most material mass flows and their potential impacts are linked to it;
- the majority of accidents and catastrophic events are related to it;
- it is usually the source of a significant part of the overall project emissions.

On the other hand, from the procedural point of view, there is a potential synergy by integrating the extractive waste management plan into the EIA. The core elements of the major-accident prevention policy, the safety management system and the internal emergency plan in case of a Category A facility could be also annexed to the EIA.

Extractive waste is generated by the extraction, treatment and storage of mineral resources. EWD excludes, inter alia, operational waste, waste from offshore activities, injected water and re-injected groundwater. A potential decision-support scheme for the classification of extractive waste management facilities is presented on Figure 11.

[130] Directive 2008/98/EC on waste and repealing certain Directives;
2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste

Figure 11: A potential decision-support scheme for the classification of an extractive waste management facility



In most EU countries, risk-based inventories of closed or abandoned extractive waste management facilities were established[131].

Good practice case

Registering annual minerals production and extractive waste generation are managed by different authorities in many EU countries[132]. This often makes the monitoring of the overall material flow of a mine difficult, which is an obstacle in observing the progress towards circularity. In Hungary, both flows were supervised by the mining and geological authority which later merged into county government offices, the regulatory one-stop-shops. Since 2009, the annual production, placing back and waste generation volumes are reported on a few paged standard electronic template which feeds in the national inventory on minerals and extractive waste.

Metalliferous sulphidic ores extraction poses a potential environmental risk through surface disposal of sulfidic waste rocks, which can generate acidic leachates when exposed to surface waters. However, it depends on the mineralogical context, including the buffering capacity of the bulk material. Most metallic mineral ores are processed using chemicals into enriched concentrates, which usually results in large volumes of non-inert tailings. Tailings seepage (Talvivaara, 2013) and accidental dam failures (Baia Mare, 2000; Kolontár, 2010) have happened in the recent past in Europe.

The EU's waste management hierarchy[133] applies also for extractive waste. For instance, the back-filling of excavation voids with mining tailings, on surface or underground mines, is preferred. The reprocessing of historical waste heaps and tailings, and the recovery of

131 https://ec.europa.eu/environment/waste/mining/implementation.htm.
132 MINLEX report
133 http://ec.europa.eu/environment/waste/framework/.

minerals from them are also encouraged. Resources recovered from extractive waste can contribute to a sustainable and secure supply of raw materials.

Limited available data on the recovery of raw materials from extractive waste suggest that the recovery rate is rather low, for reasons of economic and technological feasibility[134]. A significant amount of critical raw materials is rejected in tailings ponds and stockpiled as waste rock heaps[127]. Data on extractive waste volumes that are economically, technically and environmentally recoverable (secondary resources) are not available.

Blengini et al. (2016)[135] presents cases on good practices in reference to recovery. The report demonstrates for the EU the potential and the availability of innovative extraction technologies, for example the Penouta mine case. Other examples are the Coto Wagner project, iron ore (INTAUXMA, prefeasibility stage; Molinaseca, Spain) and La Parrilla tungsten mine (Almoharín, Spain). An additional new project is the ReeMAP[136], which intends to extract rare earth metals and phosphorus products from iron ore production residues with an already patented process. Two pilot plants are to be set up in Sweden.

Recovery should ideally not regard one targeted material alone, especially if present in low concentration, but all available minerals must often be valorized in order to make the process economically viable and resource-efficient. Energy demand required for material separation is a major challenge. In addition to the economic value of recovered materials, environmental and social aspects emerged as relevant drivers, for example, reworking of extractive waste can assist with the environmental restoration of abandoned mines. Community engagement is also important for the successful deployment of any recovery project.

For a holistic and detailed guidance on the key environmental aspects related to extractive waste management the MWEI BREF identifies the necessary BAT structured as below:

Safety and stability

- Short-term and long-term structural stability of the extractive waste deposition area
- Physical and chemical stability of extractive waste

Emissions to water, soil and air

- Particles
- Dissolved substances
- Dangerous substances and chemical residues
- Gas and volatile compounds

Other environmental aspects

- Odour and noise
- Visual impact and land use
- Usage of water and consumption of reagents, auxiliary materials, feedstock and energy
- Naturally Occurring Radioactive Materials (NORMs)
- Vibrations and induced seismicity
- Biodiversity.

It is important to note that the other ordinary **non-extractive waste**s' management is also an integral part of the EIA report, for example:

- construction, demolition, decommissioning, decontamination waste;

[134] Mathieux et al. (2017), Gislev et al. (2018).
[135] Blengini et al. (2019)
[136] https://www.lkabminerals.com/en/video/ulrika-hakansson-reemap-introduction/

- end of life vehicles, batteries;
- used mineral processing chemical substances (if not mixed with extractive waste);
- packaging, including plastic, waste;
- other operation and maintenance waste (used lubricants, workers cloths, tools, office waste, etc.)
- water treatment sludge.

For statistical clarity, it is recommended to present their management and potential impacts in a chapter, separately from the extractive waste in the EIA report. For historical reasons – the Waste Framework Directive preceeded the EWD with decades –, these two major streams were presented in one integrated chapter in the EIA report and in the annual waste data reporting by companies for a long time which made it rather difficult to obtain undistorted figures from the EUROSTAST statistics on "*extractive waste*", in the meaning of the EWD.

More information is available at:
http://ec.europa.eu/environment/waste/mining/index.htm

More guidance on the circularity aspects at extractive waste management are provided in Chapter 4.3.7.

Concluding remarks

Extractive projects exploit finite natural resources, ie. minerals, but can also use considerable amounts of energy, and water. Neverthless, the sustainability of such projects on resources can be interpreted and assessed in a broader context through the balanced comparison of positive and negative impacts which might involve the quantitative valuation and presentation of involved resources.

Table 4: Key environmental aspects of resources use related to mining activities

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS								
		RESOURCES USE								
		energy use	water use	minerals extracted	land use	bioresources use	human resources use	Iinfrastructu use	extractive waste	otherwaste
CONSTRUCTION	surface	√	√	√	√√	√√	√	√√	√	√
	underground	√√	√√	√	√√	√√	√	√√	√	√
EXTRACTION	surface	√√	√√	√√	√√	√√	√	√	√	√
	underground	√√	√√	√√	√√	√	√	√	√	√
	on water	√	√	√√	√	√√	√	√	√	√
	other novel technology	√	√	√√	√	√	√	√	√	√
MINERAL TREATMENT	comminution,screening	√√	√√	√	√	√	√	√	√	√
	physical, chemical separation	√√	√√	√	√	√	√	√	√	√
	other	√	√	√	√	√	√	√	√	√
STORAGE & WASTE MANAGEMENT	gangue and waste rock heaps	√	√	√	√√	√√	√	√	√√	√
	tailings pond	√	√√	√	√√	√√	√	√	√√	√
	operational waste	√	√	√	√	√	√	√	√	√
	material storage	√	√	√	√√	√	√	√	√	√
	extractive waste recycling	√	√√	√	√√	√	√	√	√	√
TRANSPORTATION	truck,haulage	√	√	√	√	√	√	√√	√	√
	conveyors (belt, elevator, bucket)	√	√	√	√√	√	√	√√	√	√
	pipeline	√	√√	√	√√	√	√	√√	√	√
	railways	√	√	√	√√	√	√	√√	√	√
	water-born	√	√	√	√	√	√	√	√	√

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS								
		RESOURCES USE								
		energy use	water use	minerals extracted	land use	bioresources use	human resources use	Iinfrastructu use	extractive waste	otherwaste
CLOSURE	temporary suspension	√	√	√	√	√	√	√	√	√
	decommissioning	√	√√	√	√	√	√	√√	√√	√
	rehabilitation	√√	√√	√	√√	√√	√	√√	√√	√
	aftercare	√	√	√	√	√	√	√	√	√

Concluding remarks

Minerals extractive projects are to produce primary raw materials but may also use significant volumes of other resources. This impact can be assessed in an absolute sense, and as compared to the added value it generates, or to the other good performing projects with a similar setting, and also in the context of circularity (see Chapter 4.3.7 indicators) and resource efficiency. Waste rock, tailings and by-product generation can be siginificant but there is usually some future potential resource for re-cycling and recovery.

4.3.5 Biodiversity and ecosystems (Annex IV.5)

Legal background

The Birds[137] and the Habitats[138] Directives are the cornerstones of the EU biodiversity policy. The Directives have two main objectives:

• protect rare and endangered habitat types and habitats of the species of European interest, including wild birds, in order to ensure their survival and restoration through designation of the Natura 2000 sites and appropriate management of the sites;

• protect species across the EU, both within and outside Natura 2000 network, through species protection provisions.

According to Article 1 and 2 of the Birds Directive, MS take the requisite measures to maintain the population of the species, the conservation of species of naturally occurring birds in the wild state, including their eggs, nests and habitats, at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level.

The Habitats Directive has a broader scope, measures are designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest, taking account of economic, social and cultural requirements and regional and local characteristics.

The prohibitions by the Directives include the deliberate destruction of, damage to, having a significant negative effect on these species and their habitats[139]. These cases classify as "*significant adverse effects*" in the meaning of the EIA Directive. Article 16(1) provides derogation clauses, which can be relevant for extractive projects:

"(b) to prevent serious damage, in particular to …. and water and other types of property;

(c) in the interests of …. public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment".

The application of the "*imperative reasons of overriding public interest"* for extractive projects is treated in Commission vs. Spain Case-404/09[140].

The Natura 2000 network

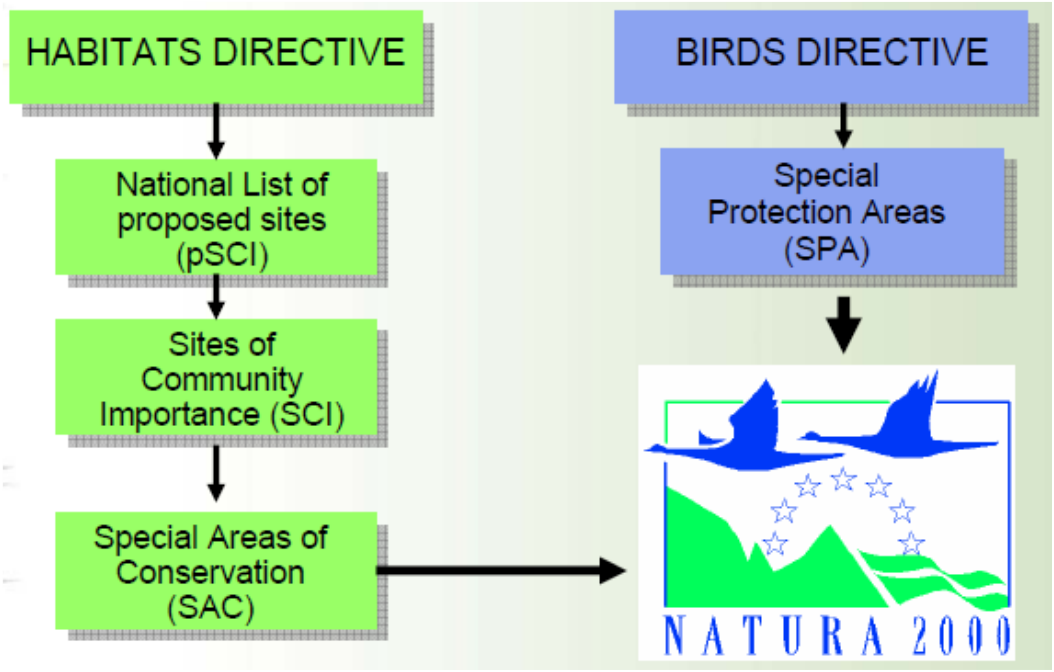
Natura 2000 is a coherent European ecological network of protected areas, which is composed of sites hosting the natural habitats and the habitats of the species of European interest, including wild birds. The purpose of the network is to maintain or, where appropriate, restore these habitats and species at a favourable conservation status in their natural range. This network is not a system of strict nature reserves where human activities are excluded; instead, the two Directives provide a common legislative framework that ensures that human activities are undertaken in a way that does not adversely affect the integrity of Natura 2000 sites. Even though a definition of "*site integrity*" is not provided by the Directives, it is clear from the overall purpose of the legislation that it is understood as ecological integrity related to the environmental characteristics of the site.

[137] Directive 2009/147/EC on the conservation of wild birds
[138] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora
[139] Guidance document on the strict protection of animal species of Community interest under Directive 92/43/EEC; http://ec.europa.eu/environment/nature/conservation/species/guidance/index_en.htm
[140] http://curia.europa.eu/juris/document/document.jsf?text=&docid=115208&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=877687

The presence, at significant level, of habitat types and species of EU interest, which are listed in Annex I and II to the Habitats Directive, is a factor which decides about designation of sites as Natura 2000 (Figure 12). Sites of Community importance (SCIs) are proposed by MS and once approved, are protected by Article 6(2)-(4). It is important to note that MS may not take economic aspects into account at the designation stage. Subsequently, MS have six years to establish site-specific conservation objectives and designate SCIs as special areas of conservation (SACs). At this stage practical management solutions that help integrate the conservation needs into other land use activities may be explored, taking socio-economic aspects into account.

Under the Birds Directive, special protection areas (SPAs) need to be designated for ca. 190 species of birds listed in Annex I of the Directive. MS must also designate sites for other regularly occurring migratory bird species, bearing in mind their breeding, moulting and wintering areas and staging posts along their migration routes, eg. wetlands of international importance (Ramsar Convention sites). SACs and SPAs together cover around 18% of the land area of the EU. The marine component of the network amounts to more than 440 000 km^2.

Figure 12: The EU Natura 2000 Network



In the case of habitats and species not covered by EU law, MS may designate additional habitat sites and species for protection in accordance with equivalent provisions of their national law on nature conservation. One of the main problems during the environmental permitting of extractive projects is their impact on Natura 2000 sites and nationally protected sites. Nevertheless, other, non-protected ecosystems with important services, are also assessed as environmental factors, inter alia, as natural resources.

The main concepts related to site protection and impact assessment are explained in Article 6 Guide[141]. The assessment procedure is further explained in "Methodological guidance on the provisions of Article 6 (3) and (4) of the Habitats Directive 92/43/EEC"[142]. Guidance on

[141] https://ec.europa.eu/environment/nature/natura2000/management/docs/art6/EN_art_6_guide_jun_2019.pdf

[142] https://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

"Non-energy mineral extraction and Natura 2000"[143] aims at informing the stakeholders how best to ensure that NEEI developments are compatible with the provisions of the two EU Directives. It focuses in particular on the procedures to follow under Article 6 of the Habitats Directive and provides clarifications on certain key aspects of this approval process in the context of NEEI developments in particular.

Managing Natura 2000 sites and permitting extractive projects

Legal background

Within Natura 2000 sites, MS:

- take appropriate conservation measures to maintain and restore the habitats and species *for* which the site has been designated to a favourable conservation status (Art. 6(1));

- avoid damaging activities that could significantly disturb these species or deteriorate the natural habitat types or habitats of the protected species (Art. 6(2)).

The **conservation status** ("the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations") of the species is "**favourable**" when (Art. 1(i)):

"— population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and

— the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and

— there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

In case of habitat type (Art 1(e)):

"— its natural range and areas it covers within that range are stable or increasing, and

— the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and

— the conservation status of its typical species is favourable."

The Directive does not provide further clarification on the meaning of disturbance and deterioration but the relevant EC Notice[144] does. **Deterioration** is any form of degradation affecting a habitat, including all the influences on the environment hosting the habitats. Habitat deterioration occurs, when the area is reduced, or the specific structure and functions necessary for the long-term maintenance are reduced in comparison to their initial or restored condition. Contrary to deterioration, **disturbance** does not directly affect the physical conditions of a site; it concerns the species and it may be limited in time (noise, source of light etc.). The intensity, duration and frequency of repetition of disturbance are therefore important parameters.

The general objective of achieving favourable conservations status (FCS) for all habitat types and species listed in Annexes I and II to the Habitats Directive needs to be translated into site-level **conservation objectives**. It is important to distinguish between conservation objectives of individual sites and the overall EU scale objective of achieving FCS. Site-specific conservation objectives are established not only for SACs but also for SPAs. However, it is not necessary to establish specific conservation objectives or conservation measures for species or habitat types whose presence on the site is non-

[143] https://ec.europa.eu/environment/nature/natura2000/management/docs/neei_n2000_guidance.pdf

[144] EC Notice, Managing Natura 2000 sites (2019/C 33/01)

significant according to the Natura 2000 Standard Data Form (i.e. habitats and species with A, B or C, but not D, site assessment in the Standard Data Form for the site)[145].

FCS does not necessarily always apply to the status of species and habitats in the individual site but to their status in the natural range (species) or distribution area (habitats) in the entire national part of a bio-geographical region. This means that a FCS can be achieved for particular species or habitat types of Community interest at the national bio-geographical level. Yet, for the individual Natura 2000 sites conservation objectives have to specify how these sites contribute to achieving this overall goal. This means that specific conservation objectives to be established by the national competent authorities may vary from site to site according to their characteristics and importance for the Natura 2000 network.

Good practice case

Following the cessation of quarrying activity in Mašovice (Czechia), a restoration plan was developed in 2001 aiming at preserving valuable habitats for an endangered amphibian species in the site, the Italian crested newt (*Triturus carnifex*). The plan was discussed with nature conservation authorities and the local municipality. The restoration was successful, ensuring the preservation of aquatic habitats and promoting natural succession of vegetation.

The area was proposed as a site of Community importance for the Natura 2000 network in 2005 and it was designated as a special area of conservation and a Nature Monument in 2013. The management of the site is currently carried out by the Regional Authority of the South Moravian Region in accordance with a management plan approved for the years 2013-2022.[146]

Once the conservation objectives have been defined for a Natura 2000 site, **conservation measures** need to be put in place to achieve these objectives. Several options for establishment of the measures can be considered, see below, which take into account different socioeconomic activities in the sites.

These measures can be established in **management plans** or integrated into other development plans, and can take form of

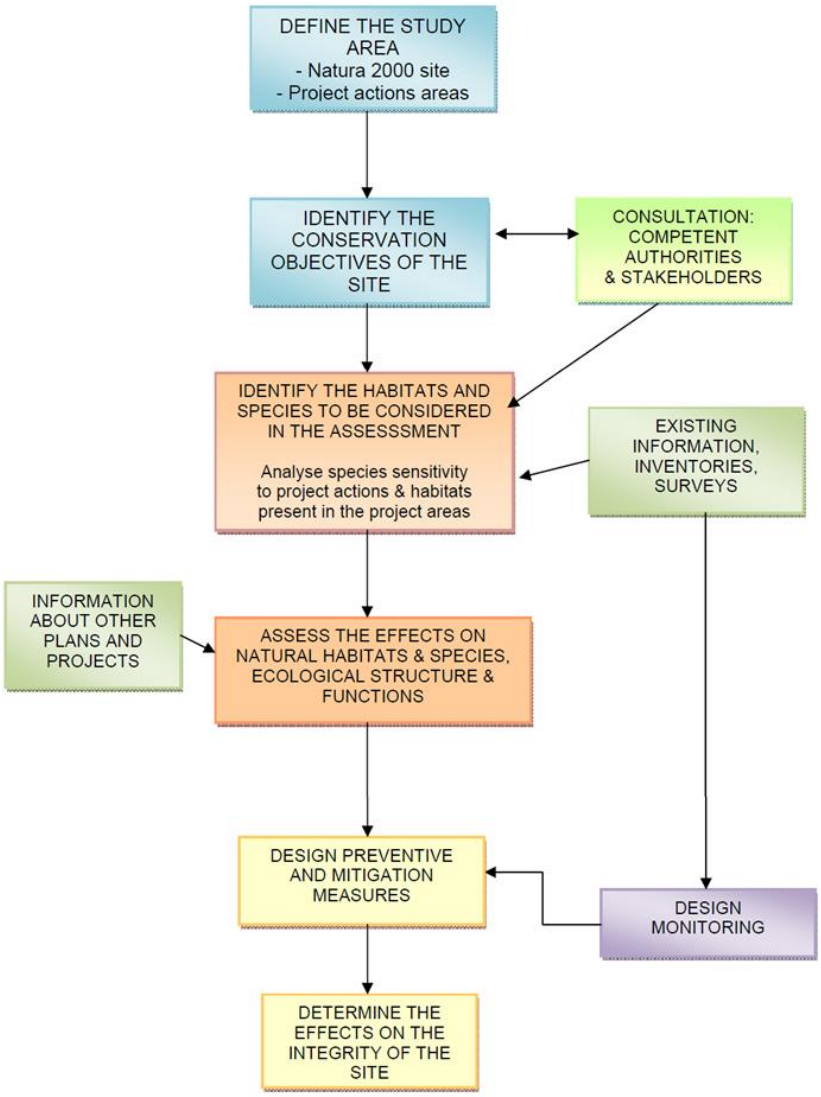
- statutory,
- administrative (incl. authorization of other activities) or
- contractual measures (e.g. agri-environmental agreements with farmers) (Art. 6(1)).

The choice between three types of measures is left to the MS in line with the principle of subsidiarity. There is no hierarchy between these three categories.

According to Article 6(3) of the Habitats Directive, any project likely to have a significant effect on the site should be subject to **appropriate assessment** of its implications for the site in view of the site's conservation objectives. Article 6(4) stipulates that "*if, in spite of a negative assessment of the implications and in the absence of alternative solutions, the project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the MS should take compensatory measures and should inform the Commission. Where the site hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest*." Steps to be undertaken in view of granting a permit are shown below on Figure 13.

[145] Commission Decision 2011/484/EU concerning a site information format for Natura 2000 sites
[146] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p.

Figure 13: Steps to be undertaken at the appropriate assessment (EC, 2010)[147]



The safeguards set out in Article 6(3) are triggered not by a **certainty** but by a **likelihood** of significant effects. Thus, in line with the precautionary principle, assessment has to be carried out even if significant effects are not certain[148]. In determining the likelihood of significant impacts at the screening stage, that is when deciding on the need for an appropriate assessment, mitigation measures (i.e. measures to avoid or reduce negative effects) cannot be taken into account. A likelihood of significant effects may arise not only from projects located within a protected site but also from projects located outside a protected site (C-142/16, paragraph 29), for example, a wetland may be damaged by a toxic spill sourced kilometers away.

If the the screening concludes that significant effects are likely or cannot be excluded, a full appropriate assessment has to be carried out. The appropriate assessment can be a stand-alone document or the integral part of the EIA report, in case the national legislation allows. In the latter case, it should be clearly distinguishable and identifiable in the EIA report.

147 https://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm
https://ec.europa.eu/environment/nature/natura2000/management/docs/neei_n2000_guidance.pdf

148 This was confirmed by the Court's *Waddenzee* ruling (C-127/02 paragraphs 39 — 44)

The information required in the appropriate assessment must be up-to-date and include, as a minimum, the following information:

- area of the habitat or habitat of the species permanently lost (e.g. by clearing of vegetation or removal of suitable breeding/nesting sites);
- area of the habitat or habitat of the species affected (e.g. by pollution, noise, deterioration of other ecological conditions);
- size of resident and migratory species populations affected;
- scale of impact (e.g. by pollution, noise, deterioration of other ecological conditions) on the quality of the habitat or habitat of the species or the survival of species affected.

The appropriate assessment is to analyse the objective impacts (area of habitat lost or damaged, individuls of protected species affected etc.) as well as relative ones (percentage of habitat area lost, percentage of species population affected). It should be done against the targets set in the site-specific conservation objectives which may include targets for restoration.

The appropriate assessment also includes a comprehensive identification of all the potential effects of the project likely to be significant, taking into account cumulative and other effects likely to arise as a result of the combined action with other plans or projects.

It applies the best available techniques and methods to assess the extent of the effects of the project on the integrity of the site. The description of the site's integrity and the impact assessment are based on the best possible indicators specific to the Natura 2000 features, which can also be useful in monitoring the impact of the project implementation.

The competent authority (see their lists at the MINLEX study, RMIS) either agrees to the project as it stands, or it may require:

- certain measures and conditions during construction, operational or closure phases of the project, to remove the negative effects or to reduce them to a level where they no longer affect the integrity of the site;
- alternative options to be explored instead.

Good practice case

The Soto Pajares sand and gravel quarry is located SE of Madrid, Spain in a Natura 2000 site (36 ha), which includes river plains, cliffs, wetlands and moorlands along the Jarama and Manzanares rivers. The site is important for waterfowl, steppe birds and raptors, and as stepping stone for migratory birds. The Biodiversity Action Plan allowed for the proper design and implementation of mitigation and restoration measures that take account of the particular needs of the different species and habitats. The Plan, supported by baseline surveys, is carried out in cooperation with nature conservation experts. The restoration model aims at creating a mosaic of habitats to increase the ecosystem's diversity, such as the creation of shallow water habitats, riparian forests, management of landscape elements in agricultural habitats, etc. Environmental awareness and education activities aim to share experiences with the civil society. A discussion forum is also established to increase communication and cooperation among stakeholders[149].

Through the project construction, and associated infrastructures such as access roads, dumping sites and tailings ponds **habitats may be disturbed, altered, damaged, fragmented or locally removed** (Table 5). The scale of **habitat degradation** depends

[149] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p. https://www.cemex.es/-/empleados-cemex-plantan-650-arboles-para-restaurar-la-gravera-de-soto-pajares

on the size, location and design of the extraction site and its associated infrastructures and the type of natural environment. This may not only result in direct **habitat loss** (i.e. partial or total removal of a habitat locally) at the site but could result in damage to surrounding habitats. The indirect effects may be caused by the alteration of existing hydrological or hydrogeological regimes (for instance through abstraction of groundwater, the diversion of surface waters, water abstraction) or a change in water quality (effluent discharges, soil contamination).

Such indirect effects can cause habitat **deterioration** and loss, not just at the site itself but also further afield, and reduce the ecosystem's resilience.

In the case of extraction projects in and around Natura 2000 sites, the damage to, habitats can result in one or more of the following[150]:

- the loss, degradation or fragmentation of protected habitat types,
- the decline or displacement of local populations of protected species which depend upon these habitats for their survival.

The significance of the damage depends on the rarity and vulnerability of the habitats affected (e.g. even a small area can have major consequences for a habitat type that has a very restricted range) and/or their importance as a feeding, breeding or resting sites for the species affected.

The extraction project may also cause significant disturbance to certain species. The impact may be temporary or permanent, direct or indirect, on-site or off-site and may come into play at different times during the project cycle. Animals can be disturbed by a range of factors such as noise, dust, pollution, human presence, regular movements (e.g. transport). This may affect the species ability to breed, feed, rest or disperse and migrate. According to Euromines (2011) evidence is emerging that the movement of equipment and vehicles and the presence of people, especially if the mine/quarry does not operate continuously, may cause only limited disturbance to fauna.

If the disturbance reaches significant levels it can lead to the exclusion (withdrawal) of the species from that area and hence the loss of, abandoning the habitat use or it can result in poorer survival and/or breeding success. In the case of rare and endangered species even small or temporary disturbances can have serious repercussions for their long-term survival in the region. It may also result in significant **change of species composition**, and can promote **colonization of alien and invasive species**.

The level of disturbance depends on many factors which are assessed both in function of the type of disturbance caused as well as the species likely to be affected (some species are more sensitive to certain disturbance factors than others). The scale and degree of disturbance determines the significance of the impact, as does the availability and quality of other suitable habitats nearby that can accommodate the displaced animals.

Ecological changes caused by mines may favour colonisation by pioneer species, some of which can become invasive. **Colonisation by invasive species** have three origins:

— Natural colonisation from areas where the species is present, by different dispersal means (animals, wind and water). In a largely undisturbed environment, invasive species rarely express their invasive potential due to competition with local species. On the other hand, a new environment may enable invasive species to grow rapidly and establish themselves, thereby increasing the risk of subsequent invasions into other surrounding areas.

— Species introduction due to site rehabilitation. This can be an introduction, for instance, when fish are introduced into ponds, or unintentional, in the case of exotic

[150] Guidance document on non-energy mineral extraction and Natura 2000; https://op.europa.eu/en/publication-detail/-/publication/1ad3394e-de79-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-118558968

seedlings contained in imported soils used for top-filling. The latter is usually prevented through the preservation and re-use of the original soil from the site.

— Uncontrolled introduction by third parties (residents, fishermen). Once operations have ceased, and depending on the rehabilitation of the site, species may be introduced by others having access to the site.

Changes and degradation of aquatic ecosystems in continental freshwater settings may occur in relation to changing hydrography due to re-location of minor streams or as a consequence of very rare but major accidents, such as tailings ponds spills. The marine environment represents a special case in biodiversity vs. extraction, the most potentially impacted elements are the benthic fauna effected by the coastal marine aggregates dredging. Aggregates dredging in rivers may also affect freshwater benthic ecosystems.

Good practice case

The Monte Tondo Gypsum quarry is a historical mining area with a permitted appropriate assessment (AA) in the Emilia-Romagna Region (Italy). Every five years the Region renews the extraction permit on the basis of an extractive plan, subject to EIA and AA of the effects of the extraction activity in a Natura 2000 site.

According to the last AA, the impacts on biodiversity are not significant. The conservation measures adopted for the Natura 2000 site include implementation and monitoring measures specifically aimed to protect the bats' habitat and avoid disturbance to the bat species present. As a result, important bat populations continue to live in the caves and have now additional roosting sites in the artificial tunnels. What is more, the restoration plan for the quarry aims to further enhance the caves for the bats[151].

As compared to the EIA, mitigation and compensation measures have a somewhat different meaning here. **Mitigation measures** in the broader sense, are those measures that aim to minimise, or even eliminate the negative impacts likely to arise from the project so that the site's integrity is not adversely affected. These measures are considered in the context of Article 6(3) and are an integral part of the specifications of the project or conditional to its authorization.

Compensatory measures are independent of the project (including any associated mitigation measures). They are intended to offset the residual negative effects of the project so that the overall ecological coherence of the Natura 2000 network is maintained. They can only be considered in the context of Article 6(4). Well-designed and implemented mitigation measures may limit the extent of the necessary compensatory measures by reducing the residual negative impacts that require compensation. Compensatory measures are only used, in exceptional circumstances, by the derogation procedure of Article 6(4), i.e. only if there are no alternatives and if a plan or project is justified by imperative overriding public interest (Figure 14).

In case the conditions of Article 6(4) of the Habitats Directive are met, compensation measures have to be used to address the impacts caused by extractive projects. For this reason, the management practices of the extractive sector with regard to Natura 2000 sites have a special attention on compensation measures.

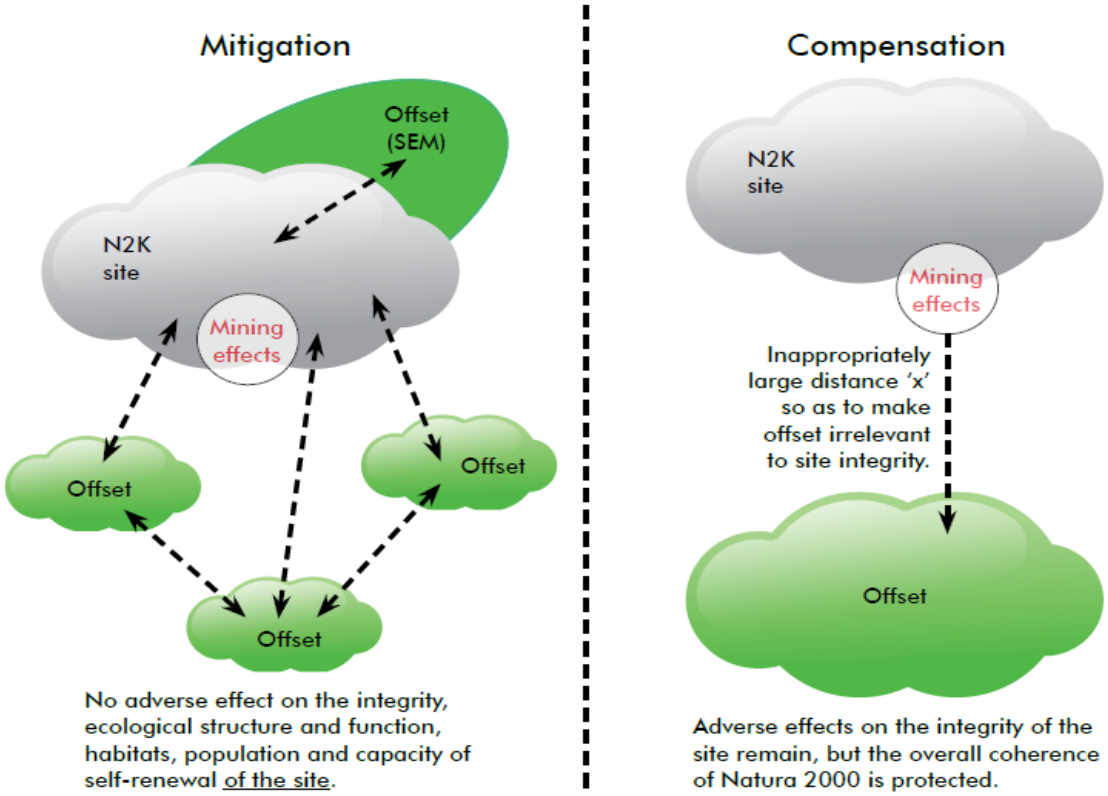
As a general principle, a site should not be irreversibly affected by a project before the compensation is in place. However, there may be situations where it is not possible to meet this condition. For example, the recreation of a forest habitat would take many years to ensure the same functions as the original habitat negatively affected by a project. Therefore, best efforts are made to ensure that compensation is in place beforehand and,

[151] European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p.

in the case this is not fully achievable, extra compensation is needed for the interim losses that would occur in the meantime[152].

Biodiversity offsets are conservation actions intended to compensate for the residual, unavoidable harm to biodiversity caused by development projects, so as to aspire to no net loss of biodiversity. However, this concept is out of the scope of the Birds and Habitats Directives, it can be used, though, in relation to areas or specific ecosystem types protected at national/regional level.

Figure 14: Mitigation and compensation measures by extractive projects at Natura 2000 sites (EUROMINES, 2011)



EUROMINES (2011) proposed the introduction of the **site enhancement measures,** which is defined as conservation actions intended to offset the residual, unavoidable harm caused by projects, so as to maintain the integrity of the Natura 2000 site concerned in view of its conservation objectives. The goal is no net loss and preferably a net gain of biodiversity on the ground with respect to area, composition, structure, function and people's use and cultural values associated with the site's habitats and species of Community interest within the (expanded) Natura 2000 site.

With regard to the above context, it is important to note that the ruling C-521/12 of the CJEU provided clarification on the difference between mitigation and compensation measures[153]: *"Article 6(3) of the Habitats Directive must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site of Community importance, which has negative implications for a type of natural habitat*

[152] Guidance document on non-energy mineral extraction and Natura 2000; https://op.europa.eu/en/publication-detail/-/publication/1ad3394e-de79-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-118558968

[153] https://ec.europa.eu/environment/nature/natura2000/management/docs/art6/EN_art_6_guide_jun_2019.pdf p. 49

present thereon and which provides for the ***creation of an area of equal or greater size of the same natural habitat type within the same site, has an effect on the integrity of that site. Such measures can be categorised as 'compensatory measures'*** *within the meaning of Article 6(4) only if the conditions laid down therein are satisfied. ... It is clear that these measures are not aimed either at avoiding or reducing the significant adverse effects for that habitat type caused by the project; rather, they tend to compensate after the fact for those effects. They do not guarantee that the project will not adversely affect the integrity of the site within the meaning of Article 6(3) of the Habitats Directive.*" It means that if the developer "enhances" biodiversity somewhere in the site by creating an extra stock of a habitat type/habitat of the species it does not necessarily eliminate significant impacts if this habitat damaged elsewhere in the site.

As explained above, in exceptional circumstances, the project may still be allowed to go ahead under certain conditions, despite having been assessed as having negative effects on the site, provided the procedural safeguards of the Habitats Directive are followed[154]. This may be possible if there are no alternatives available and the project is considered to be of overriding public interest. In such cases, compensation measures are introduced.

In the context of the above derogation options, as well as taking SCIs and SACs as analogue examples, the European Innovation Partnership on Raw Materials Strategic Implementation Plan (RM EIP SIP) proposed to further develop the concept of mineral deposits of public importance. The MINATURA 2000 H2020 project developed a definition and framework on it, and the MINLAND project further studied it in light of MS land use planning legislation and approval practices. In spite of the fact that these initiatives have not been further manifested in a political document, the reports of these projects may generate innovative solutions on project scale.

Article 10 of the Habitats Directive also requires MS to endeavour, through land-use planning or development policies, to improve the ecological coherence of the network by maintaining and, where appropriate, developing features of the landscape which are of major importance for wild fauna and flora, such as wildlife corridors or stepping stones (e.g. ponds, woods) which can be used during migration and dispersal. This aspect is considered for the planning of the mine remediation and post-closure activities and solutions.

In addition to site protection, the Birds and Habitats Directives also establish a system of strict protection of certain species across their entire natural range within the EU, i.e. both within and outside Natura 2000 sites. These protection measures apply to species listed in Annex IV to the Habitats Directive and to all wild bird species in the EU. The exact terms are laid down in Article 5 of the Birds Directive and Articles 12 (for animals) and 13 (for plants) of the Habitats Directive.

In essence they require MS to prohibit:

- The deliberate capture or killing of species.
- Their deliberate disturbance, in particular during breeding, rearing, hibernation and migration.
- The deterioration or destruction of breeding sites or resting places.
- The deliberate destruction of nests or eggs, or the uprooting or destruction of protected plants.

The implementation of a plan or development/operation of a project can lead to conflicts with these prohibitions. During the appropriate assessment and EIA the developer together with the competent authority should therefore check if the plan or project is compatible with these species protection provisions. Such a check would require identification of species and their habitats, which could be potentially affected, verification of their presence

[154] https://op.europa.eu/en/publication-detail/-/publication/1ad3394e-de79-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-11855896

on the area affected by a plan or project as well as of their breeding sites or resting places, analysis of possible impacts on the species and of suitable mitigation measures. If impacts on the individuals of the species or on their breeding sites and resting places are confirmed, or if it cannot be excluded, the derogations from strict species protection may be required.

However, it has to be noted that derogations are only allowed in limited cases, e.g. in the interest of public health and safety, provided that there is no other satisfactory alternative and provided that the consequences of these derogations are not incompatible with the overall aims of the Directives. The conditions for applying derogations are set out in Article 9 of the Birds Directive and Article 16 of the Habitats Directive. It is important to note as well that these provisions may also apply to plans and projects which are screened out from appropriate assessment and/or from EIA. In such cases the analysis of whether derogations under Article 9 of the Birds Directive and 16 of the Habitats Directive are applicable will have to be performed in a separate procedure.

A permit to derogate from strict species protection can be granted as a separate decision or within a single permit resulting from different assessments and authorisation procedures. Either way it needs to clearly specify the reasons for and conditions of such derogation. Further information on the strict species protection requirements, including latest guidelines, are available on the European Commission website.[155]

Legal analogue

The Environmental Liability Directive also provides provisions on the damage to biodiversity which complements the necessary understanding of distinctions between adverse environmental effects and environmental damage. Accordingly, damage to protected species and natural habitats does not include previously identified adverse effects which result from an act by the developer which was expressly authorised by the competent authorities.

The significance of any damage that has adverse effects on reaching or maintaining the favourable conservation status of habitats or species has to be assessed by reference to the conservation status at the time of the damage, the services provided by the amenities they produce and their capacity for natural regeneration. Significant adverse changes to the baseline condition are determined by means of measurable data such as:

- "*the number of individuals, their density or the area covered;*

- the role of the particular individuals or of the damaged area in relation to the species or to the habitat conservation, the rarity of the species or habitat (assessed at local, regional and higher level including at Community level);

- the species' capacity for propagation (according to the dynamics specific to that species or to that population), its viability or the habitat's capacity for natural regeneration (according to the dynamics specific to its characteristic species or to their populations);

- the species' or habitat's capacity, after damage has occurred, to recover within a short time, without any intervention other than increased protection measures, to a condition which leads, solely by virtue of the dynamics of the species or habitat, to a condition deemed equivalent or superior to the baseline condition."

The followings do not have to be classified as significant damage:

"*- negative variations that are smaller than natural fluctuations regarded as normal for the species or habitat in question;*

- negative variations due to natural causes or resulting from intervention relating to the normal management of sites, as defined in habitat records or target documents or as carried on previously by owners or operators;

[155] https://ec.europa.eu/environment/nature/conservation/index_en.htm

- damage to species or habitats for which it is established that they will recover, within a short time and without intervention, either to the baseline condition or to a condition which leads, solely by virtue of the dynamics of the species or habitat, to a condition deemed equivalent or superior to the baseline condition."

The mapping and assessment of ecosystems and their services

The elaboration of indicators for the ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020 was published by the EC in 2014. It identifies four major ecosystems:

forest, agro-ecosystems, freshwater ecosystems, and marine ecosystems,

and provides 327 indicators in three clusters:

- provisioning services (nutrition, materials, energy),
- regulation and maintenance services (mediation of pollutants, flows, physical, chemical and biological conditions),
- cultural services (physical, intellectual human interactions).

Beyond mapping these services, the Strategy also calls for the assessment of the economic values of the ecosystem services and for the integration these into the national and EU Community level accounting and reporting systems by 2020 ("*natural capital accounting*"). In case of debates over the assessed environmental impacts on ecosystems by the project, such quantitative valuation may help the development of mutual consensus with the competent authority, as it is becoming a more frequently used justification methodology especially in the course of the compensation and offset issues.

Assessment of potential positive and negative impacts

The ecosystems not protected by Natura 2000 but also with also important services, are taken into account in-depth as environmental factors when assessing the projects in view of their impacts.

The extraction of minerals inevitably has an impact on the land on which it operates. This can also cause negative impacts, significant adverse effects, or damage to natural habitats, wildlife, species and individual elements of flora and fauna, including Natura 2000 sites, the European ecological network of special areas of conservation. The type and degree of impact depends on a range of factors and must therefore be determined on a case by case basis.

However, not all effects are negative. Extractive projects also make an important positive contribution to biodiversity conservation, for instance through the rehabilitation of mining sites after closure or parallel to extraction ("*progressive rehabilitation*"), e.g. at open cast strip mines with rapidly moving excavation fronts. Most companies are adopting and implementing biodiversity policy statements as part of their corporate social responsibility strategy and are actively restoring used quarries and mines for the benefit of wildlife. This has a special added value in territories that had lost much of their nature.

Good practice case

Gravel and sand extraction has been carried out in Miriribel-Jonage Park (Rhone alluvial plain, France) since the 1950s. In 1968, 17 local authorities created an organization, SYMALIM, to manage the area. The excavation of aggregates was at the heart of this project by creating large water bodies. SYMALIM purchased the land and managed the concessions that were granted to private mining companies, in line with a strategy that integrates biodiversity conservation and drinking water provisions. 350 hectares of water bodies were created and, areas for leisure activities have also been developed.

The site is part of the Natura 2000 network and a management plan was adopted in 2009. It contains rare habitats as remnants of what was the natural river before the civil engineering works. It includes riverbank forests and wetlands associated with the river Rhône as well as dry orchid meadows, also of Community interest, and is home to many protected species. Gravel extraction is on-going and contributes to the implementation of the site management plan.[156]

With regard to the Natura 2000 network it is important to highlight two further aspects:

- the EIA report also considers the sites of local protection which are often designated by local municipal decrees or similar; and
- the EIA also takes into account the functioning of the near-field (and far-field when reasoned) ecosystems without any protection.

The EC Guidance document on the non-energy mineral extraction and Natura 2000 (2010)[157] presents a number of case studies on the possible co-functioning of the two Community policies. More recent good practices are reviewed in N2K Group report (2019)[158] on the EU scale. A specific EC Guidance elaborated on integrating climate change and biodiversity requirements into the EIA (2013).

Further information on the topic is provided by the specific EC guidances[159] the European Environment Agency — European Topic Centre on Biological Diversity, the Joint Research Centre.

Concluding remarks

Extractive projects in and around Natura 2000 sites that are likely to have a significant effect on the site in question, must be subject to an appropriate assessment. Depending on the outcome, a decision will be taken whether or not to approve the project and if so under what conditions. In exceptional cases, developments that could have an adverse effect on a Natura 2000 site can still go ahead under certain conditions where the procedural safeguards foreseen by the two Directives are respected, but examples of this have been extremely rare.

156 European Commission, 2019: Non-energy mineral extraction in relation to Natura 2000: Case studies, 97 p.

157 Guidance document on non-energy mineral extraction and Natura 2000; https://op.europa.eu/en/publication-detail/-/publication/1ad3394e-de79-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-118558968

158 https://ec.europa.eu/environment/nature/natura2000/management/pdf/Scoping_Tourism_Natura2000_final.pdf

159 EC Notice, Managing Natura 2000 sites (2019/C 33/01)

Table 5: Biodiversity and ecosystem aspect related to mining activities

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS						
		BIODIVERSITY & ECOSYSTEMS						
		habitat loss, deterioration, fragmentation	disturbance and/or displacement of sensitive species	loss of rare or endangered species, individuals, populations, species and genetic diversity	changes in species composition (local flora & fauna)	site colonisation by alien and invasive pioneer species	changes and degradation of aquatic ecosystems	degradation of non-Natura 2000 ecosystems services (forests, agri, freshwater & marine)
CONSTRUCTION	surface	√√	√√	√	√	√	√√	√√
	underground	√√	√√	√	√	√	√	√√
EXTRACTION	surface	√√	√√	√	√	√√	√	√√
	underground	√√	√√	√	√	√	√	√√
	on water	√	√	√	√	√	√	√
	other novel technology	√	√	√	√	√	√	√√
MINERAL TREATMENT	comminution, screening	√	√	√	√	√	√	√
	physical, chemical separation	√	√	√	√	√	√	√
	other	√	√	√	√	√	√	√
STORAGE & WASTE MANAGEMENT	gangue and waste rock heaps	√√	√√	√	√	√	√	√√
	tailings pond	√√	√√	√	√	√	√√	√√
	operational waste	√	√	√	√	√	√	√
	material storage	√	√	√	√	√	√	√
	extractive waste recycling	√	√	√	√	√	√	√

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS						
		BIODIVERSITY & ECOSYSTEMS						
		habitat loss, deterioration, fragmentation	disturbance and/or displacement of sensitive species	loss of rare or endangered species, individuals, populations, species and genetic diversity	changes in species composition (local flora & fauna)	site colonisation by alien and invasive pioneer species	changes and degradation of aquatic ecosystems	degradation of non-Natura 2000 ecosystems services (forests, agri, freshwater & marine)
TRANSPORTATION	truck,haulage	√√	√√	√	√	√	√	√
	conveyors (belt, elevator, bucket)	√√	√√	√	√	√	√	√
	pipeline	√√	√√	√	√	√	√	√
	railways	√√	√√	√	√	√	√	√√
	water-born	√	√	√	√	√	√	√
CLOSURE	temporary suspension	√	√	√	√	√	√	√
	decommissioning	√	√	√	√	√	√	√
	rehabilitation	√	√	√	√	√	√√	√
	aftercare	√	√	√	√√	√√	√	√

4.3.6 Social and economic factors (Annex IV.5.d)

Local (*„near-field"*) **settlements** can be exposed to the impacts of mining activities, both their environment, their assets, as well as citizens' health and safety directly (see Table 6). Local citizens are the most important receptor groups for which the potentially significant adverse impacts are thoroughly assessed. In addition, local stakeholders are the only "elements" of the environment who can actively support or block a project initiative (see Chapter 3.5 for details).

The impacts on **local infrastructure** can be damaging (e.g. on roads) but also positive, ie. in most cases the developer invests into it in the interest of the technical feasibility of the project. It involves upgrading the existing infrastructure (enlarge sewage system, electricity or gas supply grid) or new investments (road network, water supply), even if not being essential for the extractive project (full wifi coverage, mobile network, etc.). These measures may promote public acceptance especially at remote locations.

Indigenous people have special rights for intervention in the EIA process in some EU countries, e.g. for the Sami people in Finland either because of land ownership issues or protected lifestyle. The rights of minorities are also taken into account because of their partial autonomy and shared governance over minerals or other reasons. Both groups may have absolute veto rights in the EIA approval procedure. National legislation on EIA provides specific provisions on the context of how related impacts are assessed.

Occupational health and safety is an important factor since the extractive industry is the third most risky sector together with logging and fishing in relation to fatalities and accidents, on a global scale (EU Raw Materials Scoreboard, 2018; EC RMIS), although there are differences between surface and underground safety. It is regulated on Community level in details (see Chapter 8.1), the impact assessment is made along these provisions.

Local and regional **employment** generated by a project (job multiplying factor) can be favourably impacted by extraction projects, as well as figures on the overall **economic performance** on a local and regional scale. The cascade effect on the supporting downstream industries and business services areassessed, however, there is no universal methodology for defining system boundaries. Extractive projects contribute to the sustainability of the local economy, also after its cessation, by investing into sustainable business activities during its productive life cycle stages, as stressed in the UN CSD document on the sector[160]: *"There is a need to create linkages between mining and other economic, social and environmental sectors, while promoting the contribution of benefits from mining activities to communities and pursuing sound economic diversification strategies ...".*
In some cases an economic valuation of the project and its specific elements, such as ecosystem restoration, is an integral part of the EIA.[161]

Good practice case

The Tokaj region in Hungary has centuries-long wine producing and mining traditions. The volcanic rocks host significant deposits of industrial minerals such as perlite, kaolinite, zeolite. Since it has been declared a Word Heritage Site in 2002 as *„Tokaj Wine Region Historic Cultural Landscape*", the mining activity has faced serious restrictions in the region. The mining companies try to counterbalance restrictions with active participation at all levels of spatial planning, modernization of extraction technology and transportation, transparency and enhanced public involvement[162].

[160] https://sustainabledevelopment.un.org/intergovernmental/csd19; https://www.un.org/ga/search/view_doc.asp?symbol=E/CN.17/2011/20&Lang=E
[161] http://restore-quarries.eu/documents/4587873817
[162] https://minland.eu/project/

Table 6: Social and economic factors of mining activities

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS						
		SOCIAL & ECONOMIC ASPECTS						
		Vulnerable groups, minorities, indigenous people	Local settlements	Local infrastructure services	Local health & safety	Occupational health & safety	Local & regional employment	Overall local & regional economy
CONSTRUCTION	surface	√√	√√	√√	√√	√√	√√	√√
	underground	√√	√√	√√	√√	√√	√√	√√
EXTRACTION	surface	√√	√√	√√	√√	√√	√√	√√
	underground	√√	√√	√√	√√	√√	√√	√√
	on water	√	√	√	√	√√	√	√√
	other novel technology	√	√	√	√	√√	√	√
MINERAL TREATMENT	comminution,screening	√	√	√	√√	√√	√	√
	physical, chemical separation	√	√	√	√√	√√	√	√
	other	√	√	√	√√	√√	√	√
STORAGE & WASTE MANAGEMENT	gangue and waste rock heaps	√	√√	√	√√	√√	√	√
	tailings pond	√	√√	√	√√	√√	√	√
	operational waste	√	√	√	√	√√	√	√
	material storage	√	√	√	√	√√	√	√
	extractive waste recycling	√	√	√	√	√√	√	√
TRANSPORTATION	truck, haulage	√	√	√√	√√	√√	√√	√√

LIFE CYCLE STAGE	SUBSTAGE, ACTIVITY	KEY ENVIRONMENTAL ASPECTS SOCIAL & ECONOMIC ASPECTS						
		Vulnerable groups, minorities, indigenous people	Local settlements	Local infrastructure services	Local health & safety	Occupational health & safety	Local & regional employment	Overall local & regional economy
	conveyors (belt, elevator, bucket)	√	√	√	√√	√√	√√	√
	pipeline	√	√	√	√	√√	√√	√
	railways	√	√	√√	√√	√√	√√	√
	water-born	√	√	√	√	√√	√	√
CLOSURE	temporary suspension	√	√	√√	√	√√	√	√
	decommissioning	√	√	√√	√	√√	√√	√√
	rehabilitation	√√	√√	√√	√√	√√	√√	√√
	aftercare	√√	√	√	√	√	√	√

Concluding remarks

The importance of social and economic aspects can be underestimated in the EIAs in spite of their growing role and their potential positive impacts. The balanced treatment of social and economic aspects in the impact assessment may have a decisive role in obtaining the support of the interested public for a successful permitting.

4.3.7 Circular economy

Policy and legislation background

Circular economy does not appear in the EIA Directive. The first relevant EC document was published in 2014 (see Chapter 8.2). Among natural resources, the Directive's focus is on soil, land, water and biodiversity (Annex II.A 3.(b), Annex III 1.(c),2.(b), Annex IV 1.(c), 5.(b),(e)).

Legal analogues

The most relevant provisions to circularity are in Annex IV 5. of the EIA Directive:

"*A description of the likely significant effects of the project on the environment resulting from, inter alia:*

(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;

(c) the emission of pollutants, … and recovery of waste".

The Ecolabel Regulation adopted the life cycle approach and elements of the circular economy by stipulating that ecolabel criteria are determined on a scientific basis considering the whole life cycle of products. In determining such criteria, the following are considered:

… (b) substitution of hazardous substances by safer substances, as such or via use of alternative materials or designs, wherever it is technically feasible;

(c) durability and reusability of products;

(d) net environmental balance between the environmental benefits and burdens, including health and safety aspects, at the various life stages of the products … .

Similarly, the Ecodesign Directive on energy products requirements involve a number of parameters which consider circularity aspects (Annex I, Part I), a few of which can be interpreted for an extractive project too:

- possibilities for reuse, recycling and recovery of materials and/or of energy;

- use of materials issued from recycling activities;

- ease for reuse and recycling through:

- number of materials and components used,

- use of standard components, time necessary for disassembly, complexity of tools necessary for disassembly,

- use of component and material coding standards for the identification of components and materials suitable for reuse and recycling,

- use of easily recyclable materials, easy access to valuable and other recyclable components and materials;

- easy access to components and materials containing hazardous substances;

- incorporation of used components;

- avoidance of technical solutions detrimental to reuse and recycling of components and whole appliances;

- extension of lifetime as expressed through: minimum guaranteed lifetime, minimum time for availability of spare parts, modularity, upgradeability, reparability.

The concept of circularity evolved gradually during the last 15 years from different EU policy fields, such as

- the amended **waste** acquis,
- the **raw materials** policy (originating from the natural resources strategy) and
- the **resource efficiency** (later circular economy) field, both in association with industry policy,
- in close relationship with the **decarbonization** roadmap driven by the climate and energy policies, all of which are

eventually integrated into the 2020 Circular Economy Action Plan for a Cleaner and More Competitive Europe, one of the main blocks of the European **Green Deal**.

In spite of the lack of an explicit legal mandate, taking into account the above political drivers and their relevance in obtaining public acceptance, this chapter provides **guidance on how to present the aspects of circularity in the EIA report of an extractive project.** Neverthless, this section does not provide instructions specific to the different raw materials extraction.

In a nutshell, circular economy is about

- reducing the primary natural resource demand and use by the economy in absolute sense, and
- decoupling it from the economic growth and its environmental impacts in a relative sense by improving resource efficiency, resource productivity, re-use and recycling, and the environmental performance,

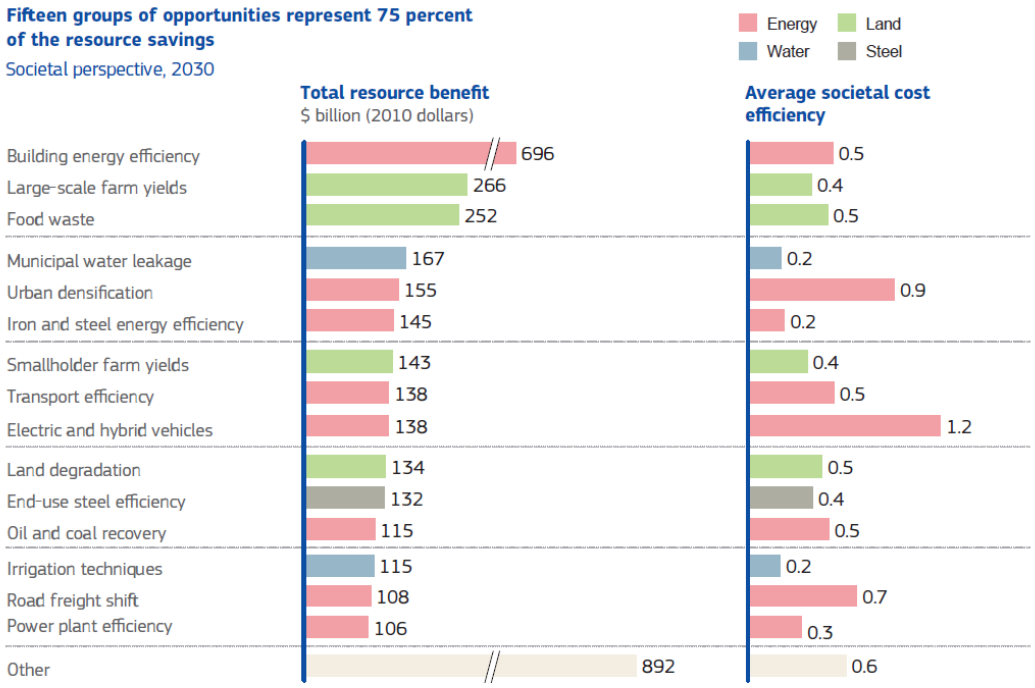
all along the different value chains of economy.

The Green Deal has more holistic and complex objectives on the EU strategic scale. On a global scale a number of the targets and activity areas of the Sustainable Development Goals correspond to circularity. Figure 15 shows those activities where resource efficiency and other circularity measures can save significant cost on global scale. A number of these – energy, transport, land degradation, irrigation, water leakage -, would relate to extractive projects[163].

The application of circular economy practices, as far as the mineral raw materials value chain concerns, is more about being resource efficient across it, and been applied in any production stage. Having the primary mineral resources' main commodities and by-products recovered, recycled and/or reused when they're still in the loop and before ending up as wastes.

[163] SWD (2020) 100 final

Figure 15: The top 15 categories of resource efficiency potential at global scale in 2011[164]



This is not a policy document to review all the EU legislation and EC documents, and their indicators and indicative target values. The list of these sources is in Chapter 8 and in footnotes. However, the quantitative targets are highlighted where relevant at the potentially impacted activity below.

In general, the EU economy improved its circularity performance during the last ten years but yet only ca. 12 % of its material use is from secondary sources, and ca. 19 % of its energy use from renewables.

Legal analogue

What concerns the circularity related legal requirements on the downstream of the value chain, e.g. on products, a good example is the Regulation 305/2011/EU laying down harmonised conditions for the marketing of construction products[165], which is relevant to construction minerals. According to its Annex I (*Basic requirements for construction works*):

"7. *Sustainable use of natural resources*

The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and in particular ensure the following:

(a) reuse or recyclability of the construction works, their materials and parts after demolition;

(b) durability of the construction works;

(c) use of environmentally compatible raw and secondary materials in the construction works."

The legislation[166] on products and especially on products' ecodesign[167] also have elements of circularity.

[164] https://ec.europa.eu/environment/circular-economy/pdf/leading_way_global_circular_economy.pdf
[165] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1587629611507&uri=CELEX:02011R0305-20140616
[166] https://ec.europa.eu/growth/single-market/goods/new-legislative-framework_en
[167] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0125&from=EN

Material flow analysis

The best available tool to understand circularity is the material (including energy and water) flow analysis (MFA), and the so-called Sankey diagrams for its visualization. MFA is used for all flow-type resource change in space and time. It is a common practice to do MFA for

- resources, i.e. materials (fuel, non-fuel, bio, waste), energy, water;
- traded goods (product flows);
- human resources (incl. migration), biodiversity migration, epidemics, etc.,
- at different scales (global, global regions, national economies), and
- in a variety of time windows (quarterly, annually, mid-term, life-long).

However, yet there is limited number of applications for singular mining projects, the ones available were published in the context of life cycle assessments (LCAs). Since both the EIA and the LCA cover the whole project period, the MFA of an extractive project is also made for the whole duration of the project, as a first instance. For some indicators this is the only option, for example construction materials are de-commissioned 30-40 years later, during the de-commissioning phase of the closure; therefore, the recycling rate of construction and demolition waste can only be a rough estimate in the EIA.

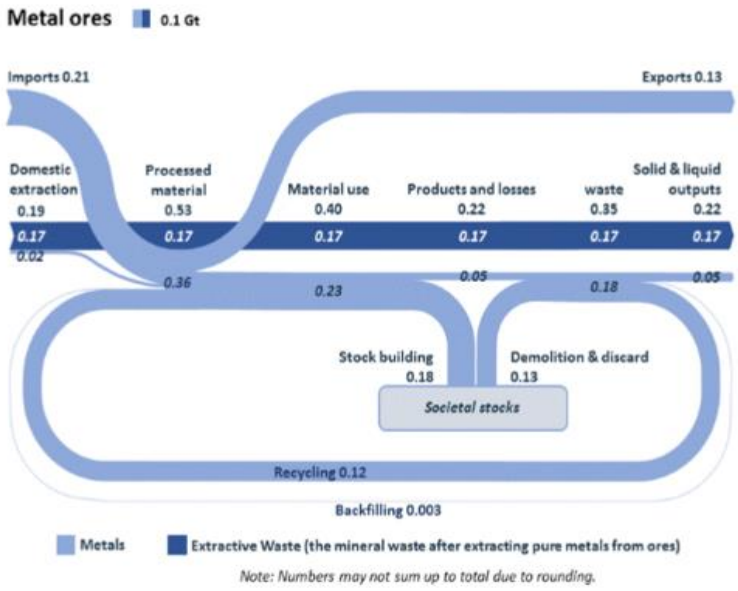
Nevertheless, for many potential indicators, MFAs can be used on annual scale in extractive projects, as shown in the next chapter.

The system boundaries of the MFA model do not necessarily coincide with the permitted mining area. For example, local energy stations and water plants owned and operated by the developer in the interest of the project, even if located out of the mining area perimeter in the near-field, are considered in the analysis.

Another dilemma at e.g. national MFAs, whether to involve water flows. In case of extractive projects, it is a major constituent of material flows (dewatering, tailings, etc.), therefore its inclusion is recommended.

Hereby below, Figure 16 shows a simplified example of the EU MFA for metalliferous ores, metals and their intermediaries in 2014.

Figure 16: Material flows of metals in the EU in 2014[168]



[168] Raw Materials Scoreboard 2016

Potential indicators and measures of circularity

It might seem contradictory how an extractive project - the prime objective of which is the supply of mineral commodities, a finite natural asset, for the economy -, can contribute to circular economy. In fact, this sector is one of the potential candidates to better perform in this regard because it operates with voluminous resources (minerals, rocks, soil, waste, external material input, energy, water, etc.) where even a few percentages of improved efficiency would result in millions and billions of m^3, tonnes, kW, €, etc. of resource saving on the EU scale.

Circularity requirements should not mean additional burden on extractive projects, in fact the opposite, as these requirements are to the core of conscious behaviour of the developer and an integral part of the good business performance for the better efficiency and profitability. Moreover, there are legal evidences at the Community ecolabelling regulatory field on mineral soil improvers and hard floor coverings that the interpretation and use of certain recycling and environmental performance indicators for this sector is feasible.

In this regard, the below list of potential indicators – the measure of relatively or absolutely positive environmental impacts -, is a selection from the conventional chapters of the EIA reports clustered into major resource types, also adopting a number of indicators from the Raw Materials, Resource Efficiency and Circular Economy Scoreboards and ecolabel legislation, and adapting them to the project-scale conditions.

General

Net environmental balance between the environmental benefits and burdens.

Biodiversity

Biodiversity is of prime concern. The number of re-located protected species and habitats indicates the commitment of the developer. A quantitative target value indicating the ratio of pristine and after closure numbers of species and habitats may be also relevant.

Topsoil

Topsoil is a precious natural resource and its major functions are rapidly lost, within a year. Its long-term deposition, or the mixing with subsoil and removed overburden rock should be avoided. Figures on the prompt nearby re-use in its original function, or the annual use in continuous rehabilitation at the site may indicate a sustainable approach. Reduce soil sealing in the remaining part of the mining area.

Land

Annual rehabilitation figures as compared to newly exposed lands are characteristic for „*land recycling*", especially in the case of open cast mining (*rehabilitation simultaneity degree*). Post-mining landscape and the acceptable visual impact[169] during mining can be also considered.

[169] Decision 2015/2099 establishing ecological criteria for the award of ecolabel for growing media, soil improvers and mulch
Decision 2002/272 establishing the ecological criteria for the award of the Community eco-label to hard floor-coverings
Decision 2009/607 establishing the ecological criteria for the award of the Community eco-label to hard coverings
Decision 2021/476 establishing the EU Ecolabel criteria for hard covering products
Decision 2017/1217 establishing the EU Ecolabel criteria for hard surface cleaning products

Air, climate neutrality

Efforts in replacing GHG emitting vehicles fleet, other transportation means, machinery, heating, local power generation by climate neutral solutions. Introducing climate neutrality indicator, e.g. annual mineral production / GHG volume.

Predicting PM and NMVOC emissions at all stages, improving annual trends, if any.

Analysis how circularity measures effect on climate change mitigation and adaptation.

Efforts, if any, on carbon removal from the atmosphere, either without being released or stored for longer periods of time. Carbon removals can be nature based, including through restoration of ecosystems, forest protection, afforestation, sustainable forest management and carbon farming sequestration, or based on increased circularity, for instance through long term storage in wood construction, re-use and storage of carbon in products such as mineralisation in building material.

Minerals, extraction

Efforts on how minerals are extracted in their entirity even if on the edge of being economic, indicating measures to sell, utilize by-product rocks.

3D modelling of the mineral deposit, groundwater patterns, land morphology, etc., that led to the best location of the extraction workings, shafts, and other isntallations with the view on minimizing the environmental impacts.

A holistic material flow model (incl. water) of the extractive project for the whole life cycle, the major value chain stages (construction/extraction/closure), and a posteriori annually as part of monitoring and periodical EIAs.

In spite of the fact that the level of re-working of minerals usually does not reach the level of intermediates, developers take into account and present the following aspects in the EIA.

Estimation of mineral product downstream circularity rate. Pan-EU or national product-specific mean values, if available, e.g. end-of-life recycling input rate (EOL-RIR), and as a complementary, the end-of-life recycling rate (EOL-RR). EOL-RIR looks at recycled material inputs to the EU economy as a fraction of total inputs, the EOL-RR captures the amount of secondary materials recovered at end-of-life compared to the overall waste quantities generated, (i.e. it is an output-related indicator). EOL-RR provides information on the collection and recycling sectors' performance in recovering materials at end-of-life.

The linear pattern of "*take-make-use-dispose*" does not provide producers with incentives to make their products more circular. Ecodesign framework, EU Ecolabel Regulation, the Product Environmental Footprint approach and the EU GPP criteria can help to deliver on circularity. Apply the EU requirements of the extended producer responsibility scheme, present links to the intermediate products at least or even further to downstream users.

If relevant at all, increase recycled content in the products.

Mobilizing the potential of digitalization of product information, including solutions such as digital passports, tagging, especially if the mineral products are packaged. Promoting the use of digital technologies for tracking, tracing and mapping of resources and product flows.

Promoting the uptake of green technologies through verification by the EU Environmental Technology Verification scheme as an EU certification mark.

Facilitating industrial symbiosis and integrated value chains, being part of industry-led reporting and certification systems. Opportunities and challenges establishing or joining industrial ecosystems of the value chain, such as low-carbon industries or raw materials alliance.

Establishing the operator's own sustainability principles, and quantitative targets for reducing carbon and environmental footprints.

Extractive waste (on annual and life cycle scale)[170]

- Waste to Mineral ratio:

extractive waste volume*[171] (disposed of at an extractive waste management facility) / extracted mineral volume (t/t or m^3/m^3)

- Backfill to Waste ratio:

Backfilled material volume / extractive waste volume* (m^3/m^3)

- Total material use ratio:

Total removed material (topsoil+backfill+waste) / extracted mineral volume (t/t or m^3/m^3)

- Extractive waste circularity indicator:

extractive waste volume* / backfilled+temporarily deposited+re-used, recyled, recovered material volumes (m^3/m^3)

- Potential circularity measures of extractive waste management was covered by a number of recent reports[172].

Good practice case

At the old Penouta mine in Spain[173] tailings deposited in dumps and ponds are re-processed by gravimetric separation in combination with electrostatic and magnetic separation, pyro and hydrometallurgical techniques and the following materials are recovered:

- tantalum and niobium (an Sn-Ta-Nb concentrate), which are critical materials;

- quartz, mica, feldspar and kaolin, which are valuable industrial minerals; and

- residual extractive waste, which is used for the final rehabilitation of the site.

The technology does not involve dangerous chemicals or hazardous waste. The efficiency of energy and water use was improved: the water supply for the exploitation plant is by capturing surface water in old water ponds and at the old pit face, which is currently flooded. The processing plant has a closed circuit water system so that water recovery reaches 70%.

[170] https://ec.europa.eu/growth/content/report-recovery-critical-and-other-raw-materials-mining-waste-and-landfills_en
https://op.europa.eu/en/publication-detail/-/publication/f18472f8-36aa-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-87989698

[171] *in case of tailings deduct the water content

[172] https://ec.europa.eu/growth/content/report-recovery-critical-and-other-raw-materials-mining-waste-and-landfills_en
https://op.europa.eu/en/publication-detail/-/publication/f18472f8-36aa-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-87989698

[173] Blengini, G.A., Mathieux, F., Mancini, L., Nyberg, M., Viegas, H.M. (Editors); Salminen, J.; Garbarino, E., Orveillon, G., Saveyn, H., Mateos Aquilino, V., Llorens González, T., García Polonio, F., Horckmans, L., D'Hugues, P., Balomenos, E., Dino, G., de la Feld, M., Mádai, F., Földessy, J., Mucsi, G., Gombkötő, I., Calleja, I. (2019), 'Recovery of critical and other raw materials from mining waste and landfills: State of play on existing practices', Publications Office of the European Union, Luxembourg, ISBN 978-92-76-03391-2, doi:10.2760/494020

Other waste

Reducing (over)packaging and packaging waste, including by setting targets and other waste prevention measures. Present measures for re-use and recycling of packaging waste, consider restrictions on the use of some packaging materials, in particular where mineral products can be handled safely without packaging.

Reducing the complexity of packaging materials, including the number of materials and polymers used. Developing measures on unintentional release of microplastics.

Use of biodegradable or compostable plastics, based on an assessment of the applications, where such use can be beneficial to the environment, and of the criteria for such applications.

Addressing the sustainability performance of construction materials, including the possible introduction of recycled content requirements, taking into account their safety and functionality. Promoting measures to improve the design, durability and adaptability of built assets, and apply digital logbooks for constructions to document these aspects on the long-term.

Considering voluntary over-performance of material recovery targets set in EU legislation for construction and demolition waste and its material-specific fractions.

Presenting indicative targets and corresponding measures of WEEE (waste electrical and electronic equipment), batteries, end-of-life vehicle used in extractive activities, and other sector-specific waste streams re-use and recycling (machinery, rails, conveyors, gallery steel or wood support structures, etc.).

Introducing indicative targets for recycled material content in product, and access the EU market observatory for key secondary materials.

Water

Presenting waste water "*resource recovery*" type treatments such as

- energy generation,
- capture nutrients (N, P, K), consider natural means of nutrient removal such as algae,
- recycle irrigation (e.g. against dust) grade water (alleviating water scarcity),
- improve fresh water quality and aquatic habitats (biodiversity) via reduced eutrophication-oxygen depletion.

Industrial water pretreatment, a standard component to protect traditional wastewater collection and treatment infrastructure, must be optimised for greater gains in efficiency and water reuse.

Producing more mineral "*tons per drop*" of water.

An essential precondition to reducing the use of water is that the resource is properly priced. Watershed conservation and sustainable water management can also contribute to increasing water availability while reducing water use.

A waste water recovery closed system helps avoiding sawing waste dispersion to the environment and feeds the recycling loop. Water contained in close proximity to the place where it is used and it is conveyed by closed pipes to the treatment/processing plant. After clearing, water should be recycled.

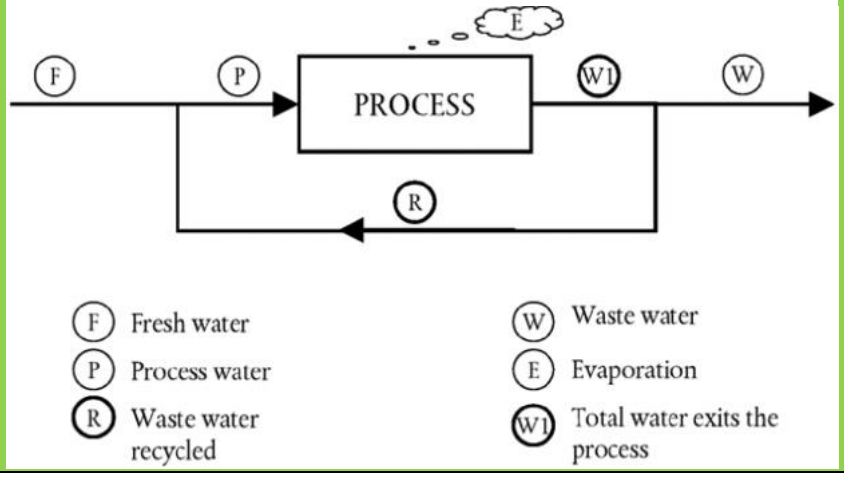
Major water savings can be realized through improving water use efficiency (in particular through more efficient irrigation systems of roads and heaps, enhanced efficiency in mineral processing based on local water availability/scarcity levels).

Rivers flow across, groundwater bodies extend over to country boundaries – in case of relevant setting, take part in joint-entities to affect equitable, effective and inclusive water use (with parallel pollution reduction), according to the approaches set forth in integrated water resource management by the Water Framework Directive, can be a progressive tool for better water management.

Good practice case

Commision Decision 2009/607 establishing the ecological criteria for the award of the Community eco-label to hard coverings set an indicator for waste water recycling. Waste water produced by the processes included in the production chain should reach a recycling ratio of at least 90 %. It is calculated as the ratio between the waste water recycled or recovered by applying a combination of process optimisation measures and process waste water treatment systems, internally or externally at the plant, and the total water that leaves the process.

$$\text{Recycling ratio} = \frac{\text{Waste water recycled}}{\text{Total water exists the process}} \cdot 100 = \frac{R}{W1} \cdot 100$$



The first piece in the acquis specific to water circularity is the Regulation (EU) 2020/741 on minimum requirements for water reuse. It mainly regulates urban waste water reuse by agriculture irrigation, however, Member States may use reclaimed water for further uses such as industrial water reuse (Annex I, Section 1).

Chemicals

Coping with the presence of dangerous chemicals in tailings, ore concentrate, and downstream products, developing methodologies to minimise the concentration of these substances that pose problems to health or the environment, in synergy with measures under the sustainable products policy framework and with the ECHA Database on substances of very high concern.

Listing priority risk phrases which present in the mineral product.

Substitution/replacing of hazardous substances by safer substances.

Energy

A potential energy efficiency indicator:

Mineral volume (or value) / total energy consumed at site annually (t, m^3, € / kwh, €)

A potential renewable energy indicator:

Renewables consumed (and generated) / fossil energy* consumed (and generated) annually (kWh/kWh)

**can be reduced with the renewable part of the incoming national/regional(?) energy mix if known*

With an ambition of developing a complex scoring system (a composite indicator) on circularity the matrix introduced by Comm. Dec. 2009/607/EU could be used as an analogue (Figure 17). Such a system would make it possible to compare circularity performances of projects producing the same minerals under similar conditions.

Figure 17: Matrix for scoring raw material extraction management for natural stones

Indicator	Notes	Score				
		5 (excellent)	3 (good)	1 (sufficient)	Threshold	Relative weights
I.1. Water recycling ratio	$\frac{\text{Waste Water Recycled}}{\text{Total Water Leaving the Process}} \cdot 100$ See Technical appendix — A3	> 80	80 — 70	69 — 65	< 65	W3
I.2. Quarry impact ratio	m^2 affected area (quarry front + active dump) / m^2 authorised area [%]	< 15	15 — 30	31 — 50	> 50	W1, W2
I.3. Natural resource waste	m^3 usable material / m^3 extracted material [%]	> 50	50 — 35	34 — 25	< 25	—
I.4. Air quality	Yearly limit value measured along the border of quarry area. PM 10 suspended particles [$\mu g/Nm^3$] Testing method EN 12341	< 20	20 — 100	101 — 150	> 150	W2
I.5. Water quality	Suspended solids [mg/l] Testing method ISO 5667-17	< 15	15 — 30	31 — 40	> 40	W1, W2, W3
I.6. Noise	Measured along the border of quarry area (dB(A)) Testing method ISO 1996-1	< 30	30 — 55	56 — 60	> 60	W2

4.4 A methodological review of environmental impact assessment

4.4.1 What are the "*significant effects*"?

Legal background and analogues

The assessment of significant effects (or impacts) is an essential concept of the Directive. It is referred to several times in the Directive (Art. 2(1), Art. 3(1), Art. 5(1), Annex IV(5)), but **no clear definition is provided and significance has to be assessed in light of the project's specific circumstances**.

Based on the EMAS Regulation definitions *environmental impact* means any change to the environment, whether adverse or beneficial, wholly or partially resulting from the developer's activities, products or services. According to its Annex I (5), when establishing the criteria for significant impact the developer considers the following elements:

(1) potential harm or benefit to the environment including biodiversity;

(2) the condition of the environment (such as the fragility of the local, regional or global environment);

(3) size, number, frequency and reversibility of the impact;

(4) existence and requirements of relevant environmental legislation;

(5) views of the interested parties, including employees.

Additional elements may be considered depending on the type of activities and products of the developer.

The Ecolabel Regulation considers the followings as the most significant environmental impacts:

- the impact on climate change,

- the impact on nature and biodiversity,

- energy and resource consumption,

- generation of waste,

- emissions to all environmental media, pollution through physical effects and use,

- release of hazardous substances.

The assessment of significance relies on informed experts' judgments about what is important, desirable or acceptable with regards to changes triggered by the project. These judgments are relative and must always be understood in their context. There is no international consensus among practitioners on a single or common approach for assessing the significance of impacts. As a good practice, assessment methods define clear thresholds or criteria, based on the characteristics of an impact, in a clear and unambiguous manner that can be understood by anyone reading the EIA Report.

A threshold can be defined as a quantitative or qualitative standard and generally derived from scientific knowledge and it is frequently included in regulatory standards. If no legislation or scientific standards are available, practitioners evaluate impact significance in a more subjective way by using the multi-criteria analysis method, for example combining the magnitude of the predicted effect (timing, scale, size, and duration of the impact) and the sensitivity of the receiving environment to change, including its capacity to accommodate the changes the projects may bring about (e.g. natural attenuation capacity of the soil against pollution).

Once the environmental sensitivity and impact magnitude have been described, the next is to scale and weight the two criteria by means of a matrix, in order to determine how significant the predicted impacts will be (Figure 18).

Figure 18: A potential matrix of environmental sensitivity versus the magnitude of environmental impact

Impact magnitude	Environmental sensitivity		
	High	*Medium*	*Low*
Major	High	High	Moderate
Moderate	High	Moderate	Minor
Minor	Moderate	Minor	Negligible

While the magnitude is determined by empirical prediction, sensitivity involves more subjective judgments in terms of how a certain environmental receptor is valued. Discretion from the expert is required in assigning different weight to the criteria. The assessment of the project's future impacts might involve various uncertainties. A more risk-based approach is used when there is uncertainty about the receiving environment, which approach takes the likelihood that the impact will occur in the future into account.

Most of the above steps are widely accepted and used in practice however, its core parts, and the assessment of the "*significant effects*" on the environment is described broadly and in a static way by the Directive and its Guidance.

Other recent pieces of Community legislation (e.g. REACH (Regulation 1907/2006/EC), extractive waste management facility classification) address more explicitly the traditional pollution source – pollution pathway – potential receptors assessment methodology.

4.4.2 Environmental risk and impact assessment

Legal background

Although Annex III of the Directive is to set criteria whether a project is subject to an EIA, it provides hints on the impact assessment methodology:

"*Type and characteristics of the potential impact*

The likely significant effects of projects on the environment must be considered … with regard to the impact of the project on the factors …, taking into account:

(a) the magnitude and spatial extent of the impact (for example geographical area and size of the population likely to be affected);

(b) the nature of the impact;

(c) the transboundary nature of the impact;

(d) the intensity and complexity of the impact;

(e) the probability of the impact;

(f) the expected onset, duration, frequency and reversibility of the impact;

(g) the cumulation of the impact with the impact of other existing and/or approved projects;

(h) the possibility of effectively reducing the impact."

In the context of accidents, Annex IV (8.) refers to the risk assessment methodologies applied by the Seveso Directive and the Nuclear Safety Directive: "*description of the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to Union legislation such as …"*. Most of the accidents and environmental catastrophes at the extractive sector are related to the extractive waste management.

Hazard is the intrinsic property of a substance, a character of an activity, or a situation with a potential for creating adverse effects, damage or major accident to human health and environment. In this regard, Chapter 4.3 provides a proxy guide on the identification and inventory of the specific hazards related to the extractive sector whilst Chapter 4.4 is a methodological review how environmental risks and impacts can be assessed and evaluated.

Risk is the likelihood of a specific effect occurring within a specified period or in specified circumstances[174], or in another approach, the combination of the probability of an event and the consequences of that event[175]. The definition of **significant risk** can be, for example, a combination of a probability of occurrence of damage (effect, event) and its magnitude that cannot be disregarded without calling into question the project itself[176]. The **acceptable risk** is a level of risk for which the time, cost or effort of further reducing it would be grossly disproportionate to the benefits of such reduction[177].

Environmental risk and impact assessment is any method used to measure, calculate, predict or estimate the environmental risks and impacts, therefore, by definition, it can be either quantitative or qualitative, or their combination.

An example for a qualitative risk assessment matrix is in use in Australia for the extractive sector (Figure 19). However, developers should aim at quantitative assessments with ranges of variation and uncertainty, whenever possible. When the methods and assumptions are described transparently, the readers can assess the results themselves.

A similar approach is further developed in Finland by GTK (Geological Survey of Finland) (Kauppila, 2015), also including the sensitivity (vulnerability) of the impacted environmental compartment (receptor) and the uncertainties in the environmental impact assessment. This methodology is integrated into an on-line toolkit, the the ARVI-tool[178]. The resulting impact matrix can handle technology alternatives too.

[174] Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances
[175] Directive 2013/30/EU on safety of offshore oil and gas operations
[176] Directive 2009/31/EC on the geological storage of carbon dioxide
[177] Directive 2013/30/EU on safety of offshore oil and gas operations
[178] https://tupa.gtk.fi/posteri/tp_0393.pdf

Figure 19: An indicative risk assessment matrix for extractive projects[179]

Likelihood	CONSEQUENCE				
	Minor impact	Moderate impact	Serious impact	Extreme impact	Catastrophic impact
Almost certain: expected to occur in project plan	M	H	C	C	C
Likely: probably will occur in project plan	M	H	H	C	C
Possible: might occur in some circumstances	L	M	H	C	C
Unlikely: may occur at some time	L	L	M	H	C
Rare: will occur only in exceptional circumstances	L	L	M	H	H

Risk levels: L = low, M = moderate, H = high, C = critical.

International and national sources do use different scales for both likelihood and consequences, usually between 3-7 classes. For example, the IPCC (Intergovernmental Panel on Climate Change) applies seven classes for likelihood (Figure 20)[180].

Figure 20: The IPCC likelihood scale

Likelihood scale	Likelihood of the outcome
Term	
Virtually certain	99 – 100% probability
Very likely	90 – 100% probability
Likely	66 – 100% probability
About as likely as not	33 – 66% probability
Unlikely	0 – 33% probability
Very unlikely	0 – 10% probability
Exceptionally unlikely	0 – 1% probability

Probabilistic (or stochastic) risk assessment (PRA) is a systematic and comprehensive methodology to evaluate risks associated with a project and the effects of its stressors on the environment. Risk in a PRA is defined as a feasible detrimental outcome of an activity, and characterized by two quantities:

1. the magnitude (severity) of the possible adverse consequence(s), and

[179] https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-biodiversity-management-handbook-english.pdf

[180] EC, 2013: Guidance on integrating climate change and biodiversity into EIA https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

2. the likelihood (probability) of occurrence of each consequence.

Consequences are expressed numerically (e.g., the number of people potentially impacted) and the likelihoods of occurrence expressed as probabilities or frequencies (i.e., the number of occurrences or the probability of occurrence per time). PRA usually answers three basic questions:

1. What can go wrong that lead to adverse consequence(s)?
2. What and how severe are the potential detriments, or the adverse consequences?
3. How likely to occur are these consequences, or what are their probabilities or frequencies?

PRA is therefore used in the foresight prediction of the so-called "*tail-risk*" (or "*key risk*") events, the right wing extremes (low probability high impact) of the Gaussian normal distribution of environmental impacts, to characterize incidents and accidents which are not part of the business-as-usual design of the project. For highly extreme situations, which are out of the scope of this document, at a very high level of uncertainty, PRA involves modelling with random number variables (e.g. Monte Carlo simulation) or with fuzzy algorithms.

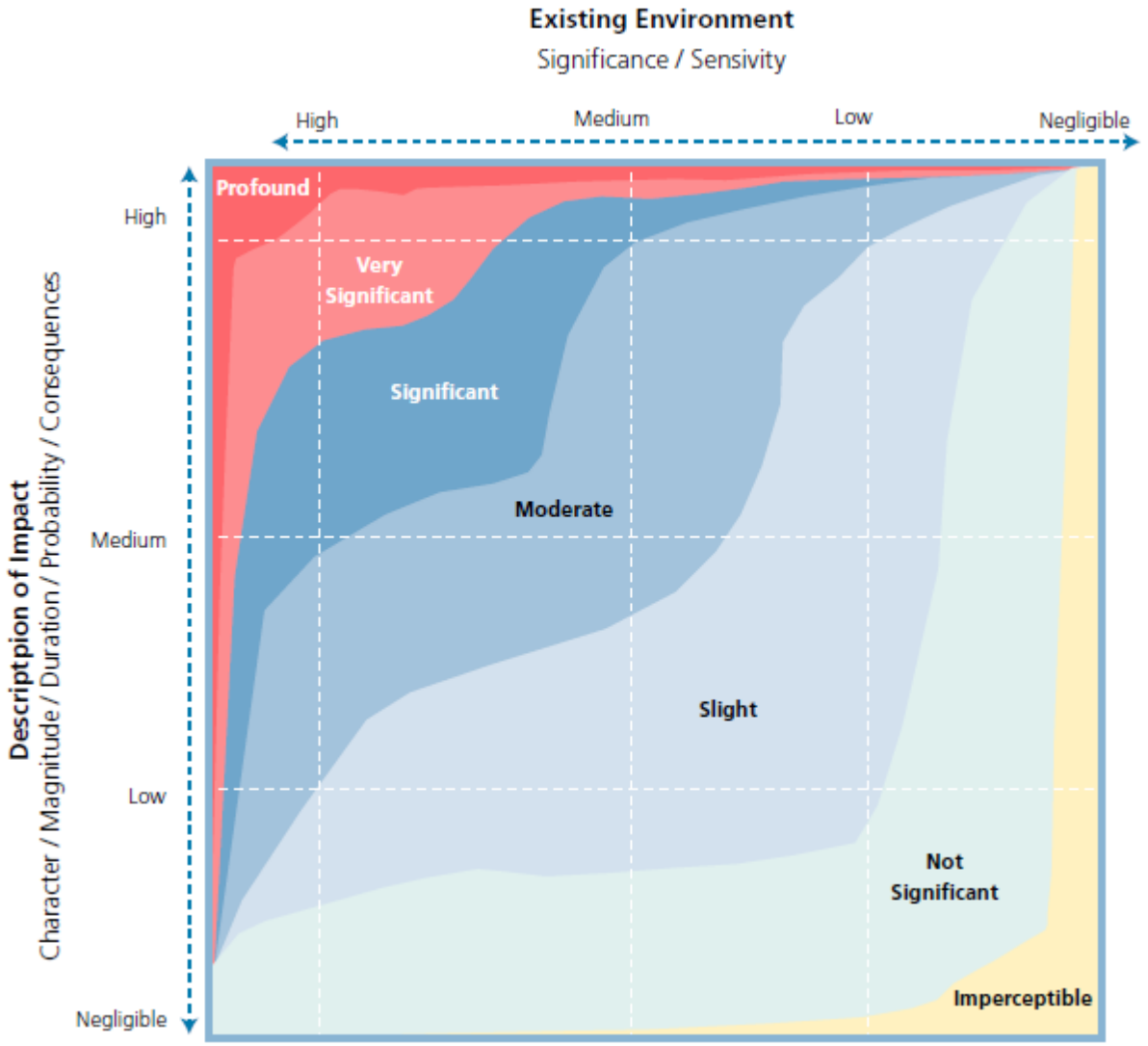
The deterministic risk assessment is used for the evaluation of the "*design basis*" normal operational environmental impacts and minor incidents. It uses conservative rules and standards, and business-as-usual scenarios because it is to characterize a well-known and predictable extractive project and its planned performance with acceptable and contained environmental impacts.

Figure 21: Definitions of significant effects (EPA, 2017)[180]

Describing the Significance of Effects ''Significance' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful (also see *Determining Significance* below.).	**Imperceptible** An effect capable of measurement but without significant consequences.
	Not significant An effect which causes noticeable[2] changes in the character of the environment but without significant consequences.
	Slight Effects An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
	Moderate Effects An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
	Significant Effects An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
	Very Significant An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
	Profound Effects An effect which obliterates sensitive characteristics

Figure 22 shows how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact. There are seven generalised degrees of impact significance that are commonly used in EIAs in Ireland: Imperceptible, Not Significant, Slight, Moderate, Significant, Very Significant and Profound. Generalised definitions of each of these are provided in Figure 21 above. Where more specific definitions exist within a specialised factor or topic e.g. biodiversity, these should be used in preference to these generalised definitions.

Figure 22: The EPA (Ireland) approach for determining significance



A possible checklist of the information to consider for describing the environmental effects is provided by EPA, 2017[181] (Figure 23)

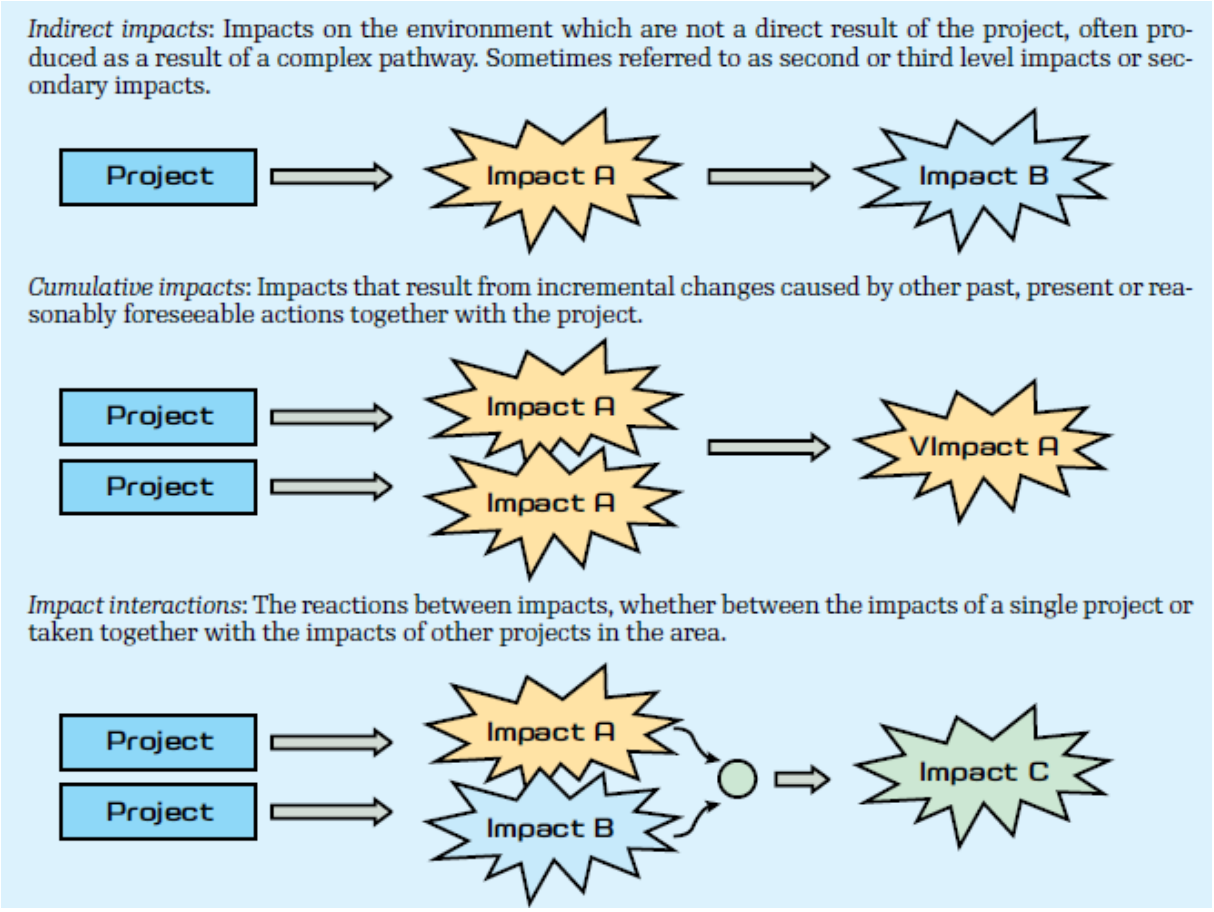
[181] https://www.epa.ie/publications/monitoring--assessment/assessment/EPA_EIAR_Guidelines.pdf

Figure 23: A checklist of the information to consider for describing effects

CRITERIA	DETAILED QUESTIONS - TO DETERMINE WHETHER THE EIAR HAS:
a. **Magnitude and spatial extent of the effects**	◢ clarified the size and scale of the effects? ◢ indicated the spatial extent of the effects (will some, much or all the areas be affected)? ◢ identified the receptors which will be affected, indicating their sensitivity and significance?
b. **Nature of the Effects**	◢ clarified which part of the environment will be affected and how significantly? ◢ identified the aspect of the environment affected? ◢ described whether the effects is positive, neutral or negative?
c. **Transboundary nature of the effects**	◢ indicated the spatial extent of the transboundary effects (will some, much or all of the jurisdiction be affected)?
d. **Intensity and complexity of the effects**	◢ quantified the amount or intensity by which the character/quality of any environmental factor will change? ◢ described the degree of change; (i.e. imperceptible, slight or significant)? ◢ Identified the significance of the effect [Profound or insignificant]
e. **Probability of the effects**	◢ established the level of certainty of the assessment's findings? ◢ highlighted consequence that cannot be determined?
f. **Expected onset, duration, frequency and reversibility of the effects**	◢ stated whether the effects will be continuous, intermittent or occasional? ◢ indicated whether the effects will be temporary, short, medium or long-term? ◢ highlighted irreversible effects?
g. **Cumulation of the effects with the effects of other existing and/ or approved projects**	◢ described cumulative effects? ◢ considered cumulative effects due to cumulation of effects with those of other projects that are existing or are approved but not yet built or operational?
h. **Possibility of effectively reducing the effects**	◢ indicated whether the effects can be mitigated? ◢ stated whether compensation is available, possible or acceptable?

Assessing cumulative impacts is an explicit requirement by the Directive. The relevant EC EIA guideline describes cumulative impacts as impacts that arise when the planned project and other past, present or reasonably foreseeable projects together result in incremental changes that combine to generate various kinds of cumulative impacts, including indirect impacts. These cumulative impacts may relate to such factors as traffic flows, water quality in rivers and lakes, demographic structures and the fragmentation of habitats (Figure 24)

Figure 24: Typology of indirect and cumulative impacts, and impact interactions (EC, 1999)[182]



A focal element of the environmental impact assessment is the presentation of the effects on human health which can be impacted either through direct intake (inhalation, noise damage, accidental injuries) or through the food chain. It implies a detailed pollution source – pathway – receptor approach extended by, if needed, a toxicology study. The evaluation of effects is carried out by reference to accepted standards (usually EU or international) of safety in dose, exposure or risk. These standards are in turn based upon medical and scientific investigation of the direct effects on health of the individual substance, effect or risk. This practice of reliance upon doses and thresholds for environmental pathways provides robust health protection criteria for analysis relating to the environment. The assessment of impacts on population & human health should refer to the assessments of those factors under which human health effects might occur, as addressed elsewhere in the EIA report e.g. under the environmental factors. There must be a clear distinction among the different population groups such as workers, population of near-by settlements, far-field consumers, accidentally exposed tourists, intruders, etc.

Risks posed by accidental contamination emissions to humans (human health risk assessment) or to ecosystems (ecological risk assessment) are part of the EIA. While human risk assessment studies the probability of impact on a single organism (US EPA 1989), ecological risk assessment studies the impact on multiple organisms. A difficulty in the latter is the choice of receptors such as for example fish species in stream water that are indicators of total risk to the ecosystem. Contamination risk is the combined effect of the probability of contamination and the significance of toxic impacts. This is studied through the pathway from (1) hazard description, through (2) dose/response (toxicity)

[182] https://ec.europa.eu/environment/archives/eia/eia-studies-and-reports/pdf/guidel.pdf

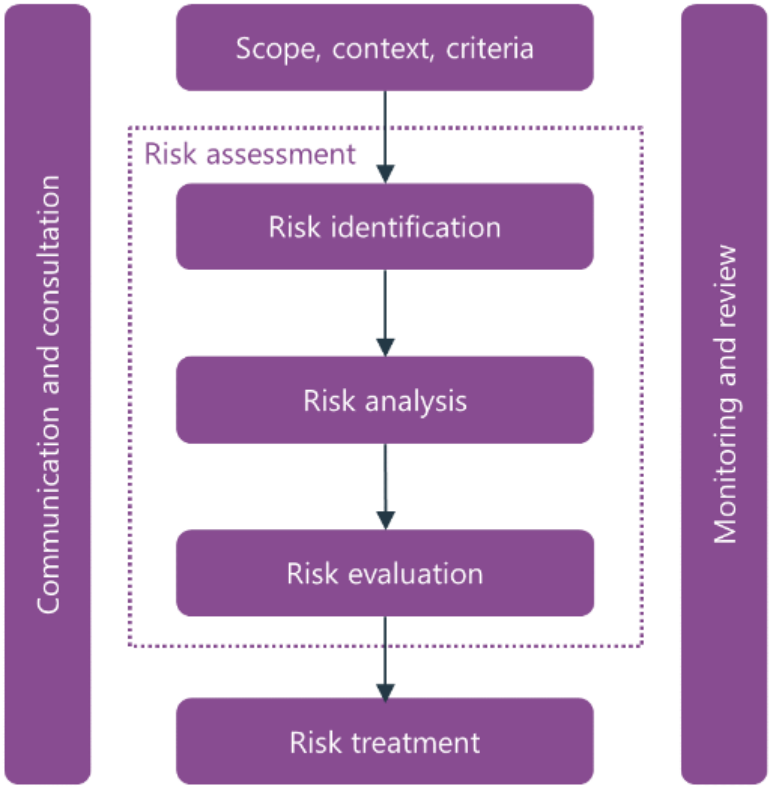
analysis, (3) contaminant transport, (4) exposure assessment, to (5) risk characterisation and (6) risk management (van Leuwen and Hermens 1996; US EPA 2007).

US EPA (2001) gives description of risk-based assessment of mine sites. Risk scoring systems developed for mine sites and contaminated lands are available (e.g. Quercia et al. (2004) on the PRAMS method (Preliminary Risk Assessment Model)). For example, acidification of waters can have direct toxic effect on aquatic biota. Acidification can lead to the secondary release of heavy metals from sediments, thus becoming available for human metal toxicity. Heavy metals in AMD can be efficiently retained in nearby organic-rich wetland sediments, for example, climatic change or anthropogenic activity can lead to a drop in groundwater levels that in turn leads to erosion and oxidation of reduced sediments, thus exposing metals to human intake (Jordan and Abdaal, 2013). Human and ecological risk assessments are complementary to each other.

The Hazard Ranking System (HRS) is a simple scoring system US EPA uses to evaluate relative threats to public health and the environment posed by threatened releases of hazardous substances (US EPA 1992). A relative risk-based methodology called PRAMS was developed for the assessment of problem areas for soil contamination in Europe (EEA 2005). The model consists of two tiers, Tiers 1 and 2 that can be applied subsequently or independently. Both tiers lead to an assessment and ranking of sites by Human health and Ecological risk scores. Based on the Irish Historic Mine Sites Inventory and Risk Classification Scoring System the EC developed a similar risk ranking guide for the inventory of closed extractive waste management facilities in Europe (Stanley et al., 2011). This method includes (1) preliminary screening and site selection, (2) source–pathway–receptor model and (3) risk ranking system.

In overall, risk management is guided by the international standard *ISO31000: 2018 Risk Management* (Figure 25) for describing what are universally applicable risk management principles and processes.

Figure 25: The risk management process (ISO 31000:2018)



The Risk Assessment component of risk management is concerned with identifying, analysing and evaluating risk within the project context. Risk assessment is expected to cover all types of risks in a systematic and holistic way. It consists of the following steps:

1) Risk Identification uses a structured approach to account for and describe all potential hazards, regardless of magnitude or likelihood of occurrence. The result is a comprehensive list of potential hazards (see Chapter 4.3 of this document). Note that the terms 'hazard' and 'risk' are often (incorrectly) used interchangeably in everyday parlance, whereas this document understands risk as the measure of significance (likelihood X magnitude) of a hazard. This step is often hence referred to by the industry as "*hazard identification*".

2) Risk Analysis involves a qualitative and/or quantitative review of hazards to clarify their root causes, likelihood, consequences, and existing barriers in place to avoid them entirely or to minimise potential impacts. Risk arising from a hazard is calculated using the simple relation:

$$Risk = Likelihood\ \textit{(probability)}\ of\ occurrence \times (s)\ \textit{(magnitude)}\ of\ occurrence$$

3) The Risk Analysis accurately accounts for any assumptions, limitations and sensitivities, which are carefully considered and clearly communicated along with its overall findings. Ranking of risks may also be performed to identify those of highest priority.

4) Risk Evaluation is used to compare the level of risk found by Risk Analysis with criteria that were set at the start of the process. The outcome of this evaluation may be to consider additional measures or barriers to further reduce risk. Evaluation decisions are generally taken in accordance with the developer's objectives and regulatory goals and norms. In the meaning of the EIA Directive this stage also corresponds to the "*Assessment of alternatives*" phase.

Risk Treatment involves taking additional steps to manage risk. Risk treatment may include a cost-benefit analysis to determine whether further risk reduction measures should be implemented. In the meaning of the EIA Directive it partly overlaps with "*mitigation or compensation measures*".

4.4.3 Life cycle analysis

In a broader context, there are various methods for quantification of environmental impacts, such as carbon footprint, substance flow analysis, environmental impact assessment, eco-labelling and life cycle assessment (LCA) (Jolliet et al., 2015).

LCA methodology in accordance with ISO 14040, 2006a and ISO 14044, 2006b is adopted for evaluating the environmental impacts and benefits, and it involves four phases:

(1) goal and scope definition,

(2) life cycle inventory,

(3) life cycle impact assessment,

(4) interpretation and results.

Environmental LCA is a pivotal guide to identifying environmental problems and reducing related impacts for companies and organizations in need of LCA. It is a unique sustainability tool, provides a framework that addresses a growing demand for practical technological solutions[183].

[183] O. Jolliet, M. Saade-Sbeih, S. Shaked, A. Jolliet, P. Crettaz: Environmental Life Cycle Assessment (first ed.), CRC Press (2015), pp. 10-14, 10.1201/b19138
ISO 14040 Environmental Management - Life Cycle Assessment - Principles and Framework (2006)
ISO 14044 Environmental Management - Life Cycle Assessment - Requirements and Guidelines (2006)

After gathering data on the raw material extractions and substance emissions associated with a product's life cycle, the third phase of an LCA is the life cycle impact assessment (LCIA). The inventory determines the quantities of materials and energy extracted, as well as the emissions to water, air, and soil. The different steps of the impact assessment are the classification of emissions into different impact categories, characterization of midpoint impacts, and damage (end point) characterization. The impact assessment methods are simple to apply, though their development can be relatively complex.

Legal analogue

The EU legislation has adopted the LCA concept, inter alia, Annex I of the Ecodesign Directive have relevant provisions:

"*In so far as they relate to product design, significant environmental aspects must be identified with reference to the following phases of the life cycle of the product…:*

(a) raw material selection and use;

(b) manufacturing;

(c) packaging, transport, and distribution;

(d) installation and maintenance;

(e) use; and

(f) end-of-life, meaning the state of a product having reached the end of its first use until its final disposal.

In particular, the following parameters must be used, as appropriate, and supplemented by others, where necessary, for evaluating the potential for improving the environmental aspects:

(a) weight and volume of the product;

(b) use of materials issued from recycling activities;

(c) consumption of energy, water and other resources throughout the life cycle;

(d) use of substances classified as hazardous …;

(e) quantity and nature of consumables needed for proper use and maintenance;

(f) ease for reuse and recycling as expressed through: number of materials and components used, use of standard components, time necessary for disassembly, complexity of tools necessary for disassembly, use of component and material coding standards for the identification of components and materials suitable for reuse and recycling…, use of easily recyclable materials, easy access to valuable and other recyclable components and materials; easy access to components and materials containing hazardous substances;

(g) incorporation of used components;

(h) avoidance of technical solutions detrimental to reuse and recycling of components and whole appliances;

(i) extension of lifetime as expressed through: minimum guaranteed lifetime, minimum time for availability of spare parts, modularity, upgradeability, reparability;

(j) amounts of waste generated and amounts of hazardous waste generated;

(k) emissions to air (greenhouse gases, acidifying agents, volatile organic compounds, ozone depleting substances, persistent organic pollutants, heavy metals, fine particulate and suspended particulate matter)…;

(l) emissions to water (heavy metals, substances with an adverse effect on the oxygen balance, persistent organic pollutants); and

(m) emissions to soil (especially leakage and spills of dangerous substances during the use phase of the product, and the potential for leaching upon its disposal as waste).”

4.4.4 Carbon footprint assessment

The non-energy minerals extractive sector is a relatively low risk industry with regard to GHG emissions. Diesel fuelled extraction technologies, transportation of overburden and extracted rock and processing of materials are the activities for concern. At certain underground mines the diffuse release of natural CO_2 and CH_4 can be an issue. For the above reasons, the EU legislation does not consider this sector among the ones in focus in the context of climate change (see Chapter 4.3.1)

Nevertheless, carbon footprint calculations might be required by the competent authorities or the interested public. Such a methodological guide is provided by the European Investment Bank[184]. Projects emit GHGs into the atmosphere, either directly (e.g. fuel combustion or production-process emissions) or indirectly through purchased electricity and/or heat. In addition, many projects result in emission reductions or increases when compared to what would have happened if the project didn’t exist, referred to as the baseline. The objective of the methodology is twofold:

- to assess the absolute GHG emissions of the projects; and
- to assess any emission variations compared to a baseline, referred to as the relative emission.

4.4.5 Product environmental footprint (PEF) and Organisation environmental footprint (OEF)

The Product Environmental Footprint (PEF)[185] is an LCA-based method to quantify the environmental impacts of products (goods or services). The overarching purpose of PEF is to enable to reduce the environmental impacts of goods taking into account supply chain activities (from extraction of raw materials, through production and use and to final waste management and/or recycling). This purpose is achieved through the provision of detailed requirements for modelling the environmental impacts of the flows of material/energy and the emissions and waste streams associated with a product throughout its life cycle.

The Organisation Environmental Footprint (OEF) is also an LCA based method to quantify the environmental impacts of organisations, such as companies, public administrative entities and other bodies.

Legal analogues

Both methods harmonize requirements provided in international standards and guidelines:

ISO 14040:2006 Environmental management — Life cycle assessment — Principles and framework;

ISO 14044:2006 Environmental management — Life cycle assessment — Requirements and guidelines;

ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification;

ISO 14046:2014 Environmental management — Water footprint — Principles, requirements and guidelines;

ISO 14020:2000 Environmental labels and declarations — General principles;

[184] https://www.eib.org/en/about/documents/footprint-methodologies.htm#
[185] https://eplca.jrc.ec.europa.eu/EnviromentalFootprint.html

ISO 14021:2016 Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling)

ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and procedures;

ISO 14050:2009 Environmental management — vocabulary

ISO/TS 14071:2014 Environmental management — Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006

ISO 17024:2012 Conformity assessment – General requirements for bodies operating certification of persons.

PEF Guide, Annex to Commission Recommendation 2013/179/EU on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (April 2013);

ILCD (International Reference Life Cycle Data System) Handbook[186];

Ecological Footprint Standards[187];

Greenhouse Gas Protocol - Product Life Cycle Accounting and Reporting Standard [188] (WRI/ WBCSD);

BP X30-323-0:2015 General principles for an environmental communication on mass market products (ADEME)[189];

PAS 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services (BSI)[190];

ENVIFOOD Protocol[191].

FAO:2016. Environmental performance of animal feeds supply chains: Guidelines for assessment. LEAP Partnership.

To produce reliable, reproducible, and verifiable PEF/OEF studies, a core suite of analytical principles are adhered to: *i)* relevance, *ii)* completeness, *iii)* consistency, *iv)*accuracy, and *v)* transparency.

The PEF/OEF methods quantify the potential impacts through the quantification of 16 impact categories. The selection of the EF impact categories is comprehensive in the sense that they cover a broad range of relevant environmental issues related to the product supply chain of interest, following the general requirements of completeness of PEF studies. EF impact categories also include methods to quantify impacts related to GHG emissions (i.e. carbon footprint) and water use (i.e. water footprint). It is worth mentioning that not all EF impact categories have the same level of robustness[192]: this aspect is factored in the mandatory weighting factors to be used to perform a PEF/OEF study. During the EF pilot phase the need to further advance on some impact categories was identified: for example, regarding resource use, a shift towards the implementation of resource dissipation was

[186] Available online at http://eplca.jrc.ec.europa.eu/?page_id=86
[187] Global Footprint Network Standards Committee (2009) Ecological Footprint Standards 2009.
[188] WRI/WBCSD 2011, Greenhouse Gas Protocol – Product Life Cycle Accounting and Reporting Standard.
[189] Withdrawn on May 2016.
[190] Available online at http://www.bsigroup.com/en/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050/
[191] ENVIFOOD Protocol, Environmental Assessment of Food and Drink Protocol, European Food Sustainable Consumption and Production Round Table (SCP RT), Working Group 1, Brussels, Belgium
[192] This is transparently reported in the JRC Technical Report "Suggestions for updating the PEF method" (Zampori, Pant 2019). Table 2 provides details on the robustness of each impact category.

found promising. No methods were available at the time of the EF pilot phase[193], therefore the impact category "resource use, minerals and metals" is assessed through a depletion-based approach.

To perform PEF and OEF studies the use of high-quality data is necessary. For this purpose, the EC has developed requirements to develop EF-compliant datasets: i) to be consistent with EF requirements and ii) to ensure the highest quality level today achievable in LCA (while improvements are still possible and the EC is already working on it through the Data Working Group of the EF transition phase[194]). This is achieved through the fulfilment of specific requirements related to: IT-specific format, meta-data, modelling requirements, data quality requirements and assessment, review. Thousands of EF-compliant datasets, covering a wide range of products and services, have already been developed and they are available through the Life Cycle Data Network.

Potential applications of PEF studies without an existing PEFCR (Product Environmental Footprint Category Rules) for the product(s) in scope are:

- In-house applications
    - optimisation of processes along the life cycle of a product,
    - support to environmental management,
    - identification of environmental hotspots,
    - support for product design minimising environmental impacts along the life cycle,
    - environmental performance improvement and tracking,
- External applications: (e.g. business to business (B2B), business to consumer (B2C)):
    - responding to customers and consumers demands,
    - marketing,
    - co-operation along supply chains to optimise the product along the life cycle,
    - participation in 3rd party schemes related to environmental claims or giving visibility to products that calculate and communicate their life cycle environmental performance.

Potential applications of PEF studies performed in compliance with an existing PEFCR for the product in scope, in addition to the ones listed above, are:

- Comparisons and comparative assertions (i.e. claims of overall superiority or equivalence of the environmental performance of one product compared to another (based on ISO 14040:2006)) based on PEF studies.
- Comparison and comparative assertions against the benchmark of the product category followed by a grading of other products according to their performance versus the benchmark.
- Identification of significant environmental impacts common to a product group.
- Reputational schemes giving visibility to products that calculate their life cycle environmental performance.
- Green procurement (public and corporate).

[193] Following the discussions at the Technical Advisory Board (TAB) of the EF pilot phase, several projects have been undertaken to develop methods based on the concept of dissipation (e.g. projects within JRC, the EIT Raw Materials funded the SUPRIM project and many others The metals and mining industry has called for the results of SUPRIM to be incorporated into an update of the PEF method.

[194] The Data Working Group is composed by the major LCA software vendors, database developer and experts. It is mandated by the Technical Advisory Board of the EF transition phase, to further improve technical aspects and other requirements of EF-compliant data sets.

4.5 Assessment of alternatives and mitigation measures

The assessment of alternatives and mitigation measures are carried out in combination, especially in complex systems such as minerals extractive projects, and more specifically, metalliferous ores extraction. Both aspects are studied along all life cycle sub-stages of an extractive project. The Directive is not fully consistent in this respect; Article 5(1) lists mitigation first and alternatives' assessment as the next step, while Annex IV is in the opposite order. This document follows the latter logic.

4.5.1 Assessment of alternatives (Annex IV.2.)

Legal background

According to Article 5(1(d)) of the Directive the information to be provided in the EIA report by the developer includes at least, among others: "*a description of the reasonable alternatives studied by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment*".

In addition, Annex IV (2) provides further details: "*a description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.*"

Although mineral extractive activities are limited to the occurrences of mineral reserves, the assessment of alternatives is becoming relevant for this sector too, for example what concerns the actual positioning and visual design of the different facilities, the precise modelling of output volumes and their logistics options and timing, also in harmony with habitats' seasonality, the tailor-made choice of alternative technologies, and mitigation measures to mention a few. The "do-nothing" can be an alternative too. The do-nothing alternative is a general description of the evolution of the key environmental factors of the site and environs if the proposed project did not proceed. It is similar to but typically less detailed than the 'likely future receiving environment' description at the baseline assessment.

The assessment of alternatives is not much more in practice than a transparent insight into the planning and decision making procedure of the developer, driven by economic and technical feasibilities, and extended to and combined by sound environmental considerations as an integral part of multi-parameter complex decision making.

In an ideal case the assessment of alternatives is contemporaneous with advanced stage planning. As the analysis of the MINLEX country profiles show, the EIA is required typically at the stage of extraction permitting, before submitting the technical operation plan for extraction (see Annex I of this report) but it can be required already at the exploration permitting or when establishing the mining area and changing land use status. In these latter cases, the framework parameters and the project details are not available for the developer which makes the assessment of alternatives difficult.

As noted in Chapter 3.5, the protection of commercially sensitive data can also be an obstacle against the full scale insight for the engaged public to understand and accept why more favourable environmental solutions were dismissed by the developer e.g. for economic reasons. Nevertheless, it is the interest of the developer to provide an access to this part of its decision making.

In practice, the developer needs to provide in the EIA report[195]:

[195] EIA guidance - EIA report (2017)

- the screening methodology and resulting short list of unreasonable alternatives;
- the description of the reasonable alternatives studied, and
- the reasons, decision making criteria for selecting the chosen options.

"*Reasonable alternatives*" must be relevant to the project's specific characteristics. The selection of alternatives is limited in terms of feasibility. On the one hand, an alternative should not be ruled out simply because it would cause inconvenience or cost to the developer. At the same time, if an alternative is very expensive or technically or legally difficult, it would be unreasonable to consider it to be a feasible alternative. In addition, the cost of necessary additional monitoring efforts or mitigation and compensation measures of alternatives is also taken into account.

Screening out alternatives which might not be considered reasonable can be done by using filters such as:

- the alternative (technology) is not yet proven, not licensed, no related standard available;
- the alternative (technology) is extremely costly which puts the whole project's feasibility in question;
- the emission of the technology is unacceptable in absolute terms;
- the alternative is explicitly against a regulation;
- the alternative will obviously lack the involved stakeholders' consent.

The next step is to shortlist and describing the reasonable alternatives, and then assessing and comparing them. It is recommended to structure the presentation of the reasonable alternatives' assessment into the following major topics:

- Location of the project (regional, national, international alternatives of the targeted commodities).
- Annual production volume (ore, extractive wastes).
- Location, positioning (orientation, size, layout, visual design and appearance of the mining area and its built installations (shafts, galleries, buildings, production plants, waste facilities, water storage ponds, etc.).
- Supply grid, infrastructure solutions inside and outside the mining area.
- Timeframe of construction and expected lifespan of the mine (incl. annual production volumes), temporal changes (daily, seasonal or market driven periodicity).
- Construction technologies (incl. during mining), material use and transportation means.
- Extraction method.
- Mineral processing technique.
- Location and volume of raw water pumping.
- Water management methods.
- Water treatment techniques.
- Location of discharge point of purified waste water in the recipient water body (e.g. pumping stations, discharge ditches and pipelines).
- Volume and quality of waste water discharged to recipient water body.
- Extraction and mineral processing working schedule and related timing/programming of these activities.

- Management of operational and extractive waste.
- Ways of internal and external transportation (materials and workers), and their schedule.
- Mine closure and remediation alternatives.

The method for assessing the reasonable alternatives depends a lot on the type of the alternatives; the only requirement in the Directive is the comparison of the environmental effects (not risks or impacts!)[196]. The level of details concerning the description of the environmental effects of the reasonable alternatives can't be less than for the eventually chosen option.

Nevertheless, the aim of the exercise is to provide a transparent and well justified comparison. A modified SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis in structured table format may fit the purpose and can be convincing for all stakeholders involved in the EIA decision-making, especially if installed with a robust quantitative scoring system for the assessment parameters of the alternatives, and possibly giving different weight to certain priority criteria, including the different emission typed to the various environmental compartments (and avoid shifting emissions from one compartment to another).

In this exercise, what concerns the technology and technique alternatives, the use of the national and EU level BATs and BREFs is highly useful even if not mandatory in the given Member State. Similarly, international standards, and lists of best practice solutions by sub-sectoral industry associations are accessible and recommended to cite when assessing the reasonable alternatives.

The "*do-nothing*" scenario or "*no project*" alternative describes what would happen should the project not be implemented at all[197]. In some Member States, national legislation requires the "*do-nothing*" scenario to be considered and included in the EIA Report. In some cases, however, the "*do-nothing*" scenario cannot be considered a feasible policy option, as the project is clearly needed: for example, if the minerals policy or the waste management policy dictates the action, then the adequate facility must be built. It is noted that the "*do-nothing*" scenario is heavily based on and interconnected to the baseline assessment.

When considering alternatives, mitigation measures are also taken into account (see next chapter). More guidance on the assessment of alternatives is provided by the EIA Guidance on the EIA report[198].

Concluding remarks

The assessment of alternatives is of particular importance in case of extractive projects by referring to the given geology of mineral deposits. The evaluation of alternative settings of the facilities and the choice of extraction, treatment and transportation solutions does matter in reducing the potential environmental impacts and optimizing the project performance.

[196] EIA guidance - EIA report (2017)
[197] EIA guidance - EIA report (2017)
[198] https://ec.europa.eu/environment/eia/pdf/EIA_guidance_EIA_report_final.pdf

4.5.2 Mitigation and compensation measures (Art. 5(1), 8a, Annex IV.7)

Legal background

According to Article 5(1(c)) in the EIA report the information to be provided by the developer includes at least, among others, *"a description of the features of the project and/or measures envisaged in order to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment".* Annex IV (7) states that a "*description of the measures envisaged to avoid, prevent, reduce, or if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparing of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover by the construction and operational phases.*"

Mitigation measures might influence how alternatives are assessed (Table 7). For example, an alternative might be considered unfeasible until considering a mitigation or compensation measure that reduces the impact of the alternative. In addition, by considering mitigation measures when assessing all alternatives, even feasible alternatives may be benefited from an environmentally sounder project design.

Table 7: Examples for mitigation and compensation measures at extractive projects

TYPE OF MEASURE	DETAILS, EXAMPLES
MEASURES TO AVOID AND PREVENT IMPACT	▪ Changing methods (e.g. transportation, extraction) or techniques (e.g., mineral processing, waste management, water treatment). ▪ Not undertaking certain project components (e.g., backfilling instead of surface heaps, dispose hazardous waste at a commercial site externally) ▪ Avoiding areas that are environmentally sensitive. ▪ Avoid seasons when biodiversity is vulnerable (e.g., no blasting). ▪ Putting in place preventative measures to stop adverse effects from occurring (e.g., further advancing the technology with specific filters or unti treatments).
MEASURES TO REDUCE AND MINIMIZE IMPACT	▪ Scaling down the project (e.g., decrease extraction output volume; reduce surface extension of the mining area). ▪ Relocating certain installations of the project (conveyor belts, dumps, service buildings, etc.). ▪ Redesign elements of the project to the extent it is still in line with economic and technical feasibility (access to deposit, processing and waste management complex, etc.). ▪ Using alternative technology and methodology (see above). ▪ Efficient environmental monitoring. ▪ Improving the recycling and re-use of process water, improving the water treatment. ▪ Taking supplementary proactive measures to reduce the impacts either at the source, at the pathway, if confined, or at the receptor (e.g. build noise barriers, use end-of-pipe filters, change type of road surface, water dusty roads and waste heaps in dry season, isolate leachates' drainage system

TYPE OF MEASURE	DETAILS, EXAMPLES
	with engineered barriers, use filters at shaft ventilation outlet, use closed mineral processing technology as much as possible, safeguard human intrusion to site, control near-field crops cultivation, etc.). ▪ Progressive closure and temporary covers of extractive waste facilities.
MEASURES TO OFFSET AND COMPENSATE IMPACT	▪ Offset or compensate for residual adverse impacts that cannot be avoided or further reduced in one area with improvements elsewhere. ▪ Site decontamination, remediation, rehabilitation, restoration to create new capacities for the land site. ▪ In-kind compensation (re-use mining voids (e.g. geothermal energy plant, biosphere reserve, museum, new industry application, recreation and health resort, etc.) and involve locals in the venture. ▪ Monetary compensation (support noise isolation of nearby houses, finance road maintenance, develop new infrastructure).

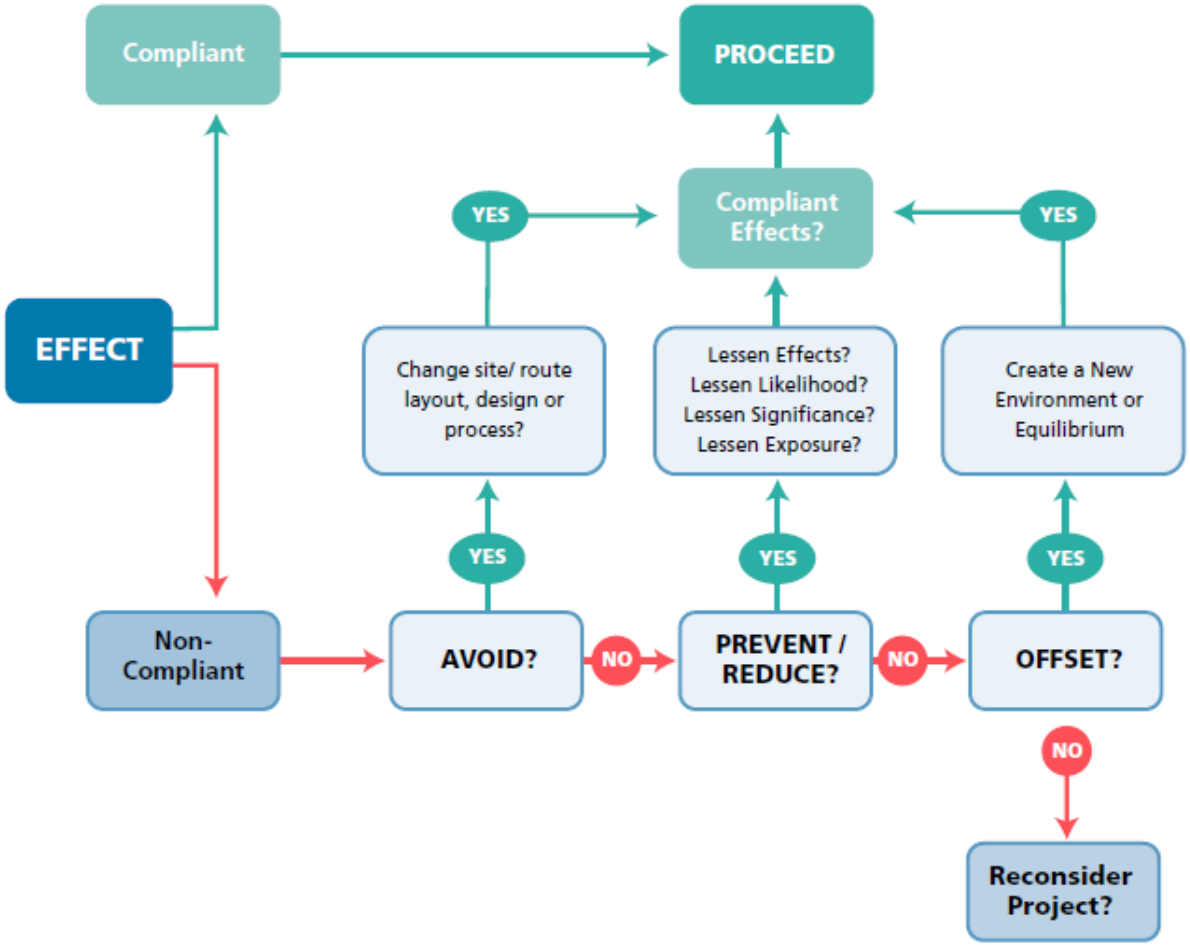
In accordance with the precautionary and preventive action principle, a long-term approach should be promoted, and priority is given to avoiding impacts (prevention measures), while remediation and compensatory measures should only be considered as a last resort, assessed on the basis of how effective they are in reducing potentially significant adverse environmental impacts.

In some cases, existing legislation (e.g. the IED), refers to the use of best available techniques, as set out in reference documents, in order to ensure that project developers and operators use the latest, most effective and economically justified technology. From this perspective, best available techniques (BATs) can provide a reliable benchmark to identify risk management approaches and technologies that may be in turn be considered as mitigation measures in the EIA report. The EIA report clearly describes the adverse impact each measure is intended to avoid, mitigate or compensate when implemented. It also describes the effectiveness of such measures, their reliability and certainty, as well as the commitment to ensuring their practical implementation and monitoring of the results.

The best mitigation measures are incorporated into the permitted design and operation of the project (EPA, 2017). Other mitigation measures may respond to exceedances detected by monitoring and are expressed as 'if'/'then' measures setting out a sequence of actions and responsibilities, e.g '*if the BOD levels in the holding pond exceed the stated parameter then the discharge valve shall be closed until the levels return to permitted levels'.*

There are four strategies for the mitigation of effects - avoidance, prevention, reduction of effect or exposure, and offsetting. The efficacy of each is related to the stage in the design process at which environmental considerations are taken into account. Effects avoidance is most applicable at the earliest stages, while prevention may be provided up to a much later stage. Mitigation of last resort, such as remedy or offsetting, may be the only option available for largely designed projects or for projects that cannot avoid significant effects due to their need to locate on a particular site. A possible decision making chart on mitigation measures is shown on Figure 26.

Figure 26: Mitigation measures flowchart (EPA, 2017)



Climate neutrality

For climate change **mitigation,** it is important to investigate options to eliminate GHG emissions, rather than dealing with mitigating their effects[199]. Mitigation measures can be introduced in e.g. mine construction and operation activities that use energy and resources more efficiently. Impact may be less negative in terms of quantity of emissions, but still have overall negative impact, unless the carbon used in development and transport is unequivocally equal to zero. Some mitigation measures that address climate change can themselves have significant environmental impact (e.g. renewable energy generation or tree planting may have adverse impacts on biodiversity). Carbon footprint calculations and Life Cycle Assessment (LCA) are useful quantitative decision support tools in finding the most efficient solutions. Such models may take into account externalities, such as e.g. in a country where 40% of the electricity is originated from fossil fuel plants, the overall net carbon balance may not change significantly when replacing diesel engines to e-vehicles. Figure 27 shows some examples on the mitigation aspect.

[199] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (pdf) (2013)

Figure 27: Examples of alternatives and mitigation measures in relation to climate change[200]

Main concerns related to:	Examples of alternatives and mitigation measures
Direct GHG emissions	• Consider different technologies, materials, supply modes, etc. to avoid or reduce emissions; • Protect natural carbon sinks that could be endangered by the project, such as peat soils, woodlands, wetland areas, forests; • Plan possible carbon off-set measures, available through existing off-set schemes or incorporated into the project (e.g. planting trees).
GHG emissions related to energy	• Use recycled/reclaimed and low-carbon construction materials; • Build energy efficiency into the design of a project (e.g. include warmcel insulation, south facing windows for solar energy, passive ventilation and low-energy light bulbs); • Use energy-efficient machinery; • Make use of renewable energy sources.
GHG emissions related to transport	• Choose a site that is linked to a public transport system or put in place transport arrangements; • Provide low-emission infrastructure for transport (e.g. electric charging bays, cycling facilities).

When addressing **climate change adaptation** concerns the EIA report, developers not only consider historical data on climate, but also identify and present the climate change scenario in the assessment process. This facilitates discussion on whether the expected climatic factors should be considered in the project design and how they may affect the project's environmental context. In particular, developers outline extreme climate situations to be considered as part of the environmental baseline analysis. Figure 28 provides examples of basic questions when identifying major climate change adaptations.

[200] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (pdf) (2013)

Figure 28: Examples for key questions on climate change adaptation[201]

Main concerns related to:	Key questions that could be asked at the screening and/or scoping stage of the EIA
Heat waves (take into account that heat waves are usually associated with water scarcity — see also the suggestions for droughts)	• Will the proposed project restrain air circulation or reduce open spaces? • Will it absorb or generate heat? • Will it emit volatile organic compounds (VOCs) and nitrogen oxides (NO_x) and contribute to tropospheric ozone formation during sunny and warm days? • Can it be affected by heat waves? • Will it increase energy and water demand for cooling? • Can the materials used during construction withstand higher temperatures (or will they experience, for example, material fatigue or surface degradation)?
Droughts due to long-term changes in precipitation patterns (also consider possible synergistic effects with flood management actions that enhance water retention capacity in the watershed)	• Will the proposed project increase water demand? • Will it adversely affect the aquifers? • Is the proposed project vulnerable to low river flows or higher water temperatures? • Will it worsen water pollution — especially during periods of drought with reduced dilution rates, increased temperatures and turbidity? • Will it change the vulnerability of landscapes or woodlands to wild fires? Is the proposed project located in an area vulnerable to wildfires? • Can the materials used during construction withstand higher temperatures?
Extreme rainfall, riverine flooding and flash floods	• Will the proposed project be at risk because it is located in a riverine flooding zone? • Will it change the capacity of existing flood plains for natural flood management? • Will it alter the water retention capacity in the watershed? • Are embankments stable enough to withstand flooding?
Storms and winds	• Will the proposed project be at risk because of storms and strong winds? • Can the project and its operation be affected by falling objects (e.g. trees) close to its location? • Is the project's connectivity to energy, water, transport and ICT networks ensured during high storms?
Landslides	• Is the project located in an area that could be affected by extreme precipitation or landslides?
Rising sea levels	• Is the proposed project located in areas that may be affected by rising sea levels? • Can seawater surges caused by storms affect the project? • Is the proposed project located in an area at risk of coastal erosion? Will it reduce or enhance the risk of coastal erosion? • Is it located in areas that may be affected by saline intrusion? • Can seawater intrusion lead to leakage of polluting substances (e.g. waste)?
Cold spells and snow	• Can the proposed project be affected by short periods of unusually cold weather, blizzards or frost? • Can the materials used during construction withstand lower temperatures? • Can ice affect the functioning/operation of the project? Is the project's connectivity to energy, water, transport and ICT networks ensured during cold spells? • Can high snow loads have an impact on the construction's stability?
Freeze-thaw damage	• Is the proposed project at risk of freeze-thaw damage (e.g. key infrastructure projects)? • Can the project be affected by thawing permafrost?

As mentioned above, the presentation of preparedness and response to climate change challenges is an important element of the EIA report. A set of such challenges and measures are listed in Figure 29.

[201] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (pdf) (2013)

Figure 29: Examples of alternatives and mitigation measures related to climate change adaptation concerns[202]

Main concerns related to:	Examples of alternatives and mitigation measures
Heat waves	• Ensure that the proposed project is protected from heat exhaustion; • Encourage design optimal for environmental performance and reduce the need for cooling; • Reduce thermal storage in a proposed project (e.g. by using different materials and colouring).
Droughts	• Ensure that the proposed project is protected from the effects of droughts (e.g. use water-efficient processes and materials that can withstand high temperatures); • Install livestock watering ponds within animal-rearing systems; • Introduce technologies and methods for capturing storm water; • Put in place state-of-the-art wastewater treatment systems that make reusing water possible.
Wildlife fires	• Use fire-resistant construction materials; • Create a fire-adapted space around the project (e.g. use fire-resistant plants).
Extreme rainfall, riverine flooding and flash floods	• Consider changes in construction design that allow for rising water levels and ground water levels (e.g. build on pillars, surround any flood-vulnerable or flood-critical infrastructure with flood barriers that use the lifting power of approaching floodwater to automatically rise, set up backwater valves in drainage-related systems to protect interiors from flooding caused by backflow of wastewater, etc.); • Improve the project's drainage.
Storms and winds	• Ensure a design that can withstand increased high winds and storms.
Landslides	• Protect surfaces and control surface erosion (e.g. by quickly establishing vegetation — hydroseeding, turfing, trees); • Put in place designs that control erosion (e.g. appropriate drainage channels and culverts).
Rising sea levels	• Consider changes in construction design to allow for rising sea levels (e.g. building on pillars, etc.).
Cold spells and snow	• Ensure that the project is protected from cold spells and snow (e.g. use construction materials that can withstand low temperatures and make sure the design can resist

Surface stability

One of the primary concerns in extractive waste management (and subsequent closure and after-care) is the physical (geotechnical) stability of slopes and dams and terrain. A detailed description of the technologies used for tailings and waste rock stabilization is found in the MWEI BREF on extractive waste. There are different technical standards and requirements concerning the stability, depending on the type of the wastes, their potential impact on the environment, and external factors such as seismicity. Whatever the details of a given situation, stability can be achieved by a combination of the following measures (not necessarily all being applicable to the same waste facility):

- reshaping (flattening) a dam or slope,
- erosion prevention measures such as water management,
- diversion of undisturbed rainwater runoff from the flanks of a waste facility,
- removing decant water on a tailings surface,
- dewatering of tailings behind a dam,
- seeding, planting vegetation.

[202] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (pdf) (2013)

Nevertheless, there are numerous other surface stability mitigation measures are needed during the construction, operation, closure phases at all extractive projects (see also Chapter 4.3.2). Maybe the most efficient modern tool for monitoring unstable slopes and subsidence is based on the satellite-based InSAR (Interferometric Synthetic Aperture Radar) technique using satellite radar imaginery, such as that publicly provided by Sentinel-1 satellite mission. It provides mm-precise measurements over large areas on a weekly-monthly basis and can serve as scanning tool for the complete area above the mine and the direct environment. Depending on the satellite, up to 100,000 measurements per km^2 can be obtained[203]. For specific unstable slopes early warning systems can be implemented using ground based radar interferometry, which provides a near real time measurement of ground surface displacements, automatically delivering alert warnings. Non-satellite monitoring methods, such as conventional geodesy or LIDAR surveys are also widely used.

Soil

There are different ways to compensate for the loss of soil and its functions[204]:

1. Re-using the topsoil excavated when carrying out soil sealing in a certain area so that it can be employed elsewhere. Topsoil can be re-used to improve soil of poor quality. Careful handling of soil during its removal from the host site, including soil stripping, storage and transport, is necessary to limit its degradation and allow a certain degree of recovery of its function when at its new location, and a key factor for successful re-use. However, there are often practical difficulties in re-using topsoil, for example because of the environmental impact of transporting such a bulky material by numerous heavy lorries or because the conditions at the receiving site are not conducive to re-use of locally available excavated soils.
2. De-sealing of a certain area (soil recovery) in compensation for sealing elsewhere. It means restoring part of the former soil profile by removing sealing layers such as asphalt, loosening the underlying soil, removing foreign materials and restructuring the profile. The objective is to restore an effective connection with the natural subsoil. De-sealing as a compensation measure is sometimes linked to a wider approach aiming at mine rehabilitation, for example by removing derelict buildings and providing for suitable areas of green space. As the full restoration of soil functions at a previously sealed site may be technically difficult or too costly, the re-use of such a site is carefully assessed. It helps to avoid land take (and fragmentation) somewhere else and is of overall benefit from the viewpoint of sustainability.

Good practice case

The Green Infrastructure concept[205] developed in the urban design context can be implemented to reduce the heat-island effect, thus adapting to climate change and lowering energy demand for heating and cooling, maintain or increase the infiltration potential of land, while also avoiding high surface water runoff and relieving drainage systems, reduce storm water runoff that pollutes local waterways by treating rain where it falls. Dense shrub and tree plantings in and around the mining site can absorb large amounts of dust and air pollutants while also acting, to a certain extent, as a filter for noise and reduction of pests (e.g. insects). Furthermore, green infrastructure may provide other social community benefits, e.g. ecosystem and habitat revitalisation.

[203] https://earsc-portal.eu/display/EO4RawMaterials/Product+Sheet%3A+Surface+Subsidence
[204] https://ec.europa.eu/environment/soil/pdf/guidelines/EN%20-%20Sealing%20Guidelines.pdf
[205] https://ec.europa.eu/environment/soil/pdf/guidelines/EN%20-%20Sealing%20Guidelines.pdf
https://ec.europa.eu/environment/archives/soil/pdf/sealing/Soil%20sealing%20-%20Final%20Report.pdf

One of the most effective ways of establishing green infrastructure is to adopt a more integrated approach to land use management. This is usually best achieved through strategic spatial and land use planning enabling more interactions between neighbouring land uses (biodiversity/ecosystem corridors) and sectoral planning (e.g. with local agriculture or industry). This is especially the case for heavy and long-lasting infrastructures needed for the mine site such as roads, railway lines, business parks or waste water treatment plants.

Green roofs on mine installations reduce the negative effects of soil sealing and can help in preventing surface runoff, though do not compensate for the loss of many soil functions. They also have a value as habitats for certain plants and some wildlife, exert a positive effect on the microclimate through water transpiration (cooling effect), and contribute to air quality by filtrating airborne particulate (Siebielec et al., 2010). Their cost is comparable to that of conventional roofs, especially in combination with solar modules.

More good practice cases in EU countries are provided in an EC report (2011)[206].

Water

Table 8 below presents some water treatment issues and techniques related to extractive waste management.

Table 8: Extractive waste influenced water treatment techniques overview (source: MWEI BREF)

Contaminants category	**Examples of targeted contaminants / parameters**	**Examples of Passive treatment**	**Examples of Active treatment**
Suspended particles	TSS, TSP, turbidity	Settling ponds (including ponds containing extractive waste from mineral processing) Wetlands	Clarification in tanks Coagulation and flocculation Air flotation Media filtration Membrane filtration
Dissolved substances	TDS, phosphates, nitrates, nitrites, ammonia, sulphates, chlorides, fluorides, metals, BOD, COD, dissolved hydrocarbons	Settling ponds (including ponds containing extractive waste from mineral processing) Aerobic and anaerobic wetlands	Aeration and active chemical oxidation Active aerobic biological oxidation Anoxic BCRs Co-precipitation Adsorption Ion exchange Nanofiltration Reverse osmosis
Alkalinity or acidity	Basic or acid load, acidity or alkalinity, pH	OLDs/OLCs SAPS Anaerobic wetlands	Active neutralisation
Process contaminants	Flocculants, cyanides	Aerobic wetland ponds	Aeration and active chemical oxidation, Cyanide destruction using SO2/air or hydrogen peroxide

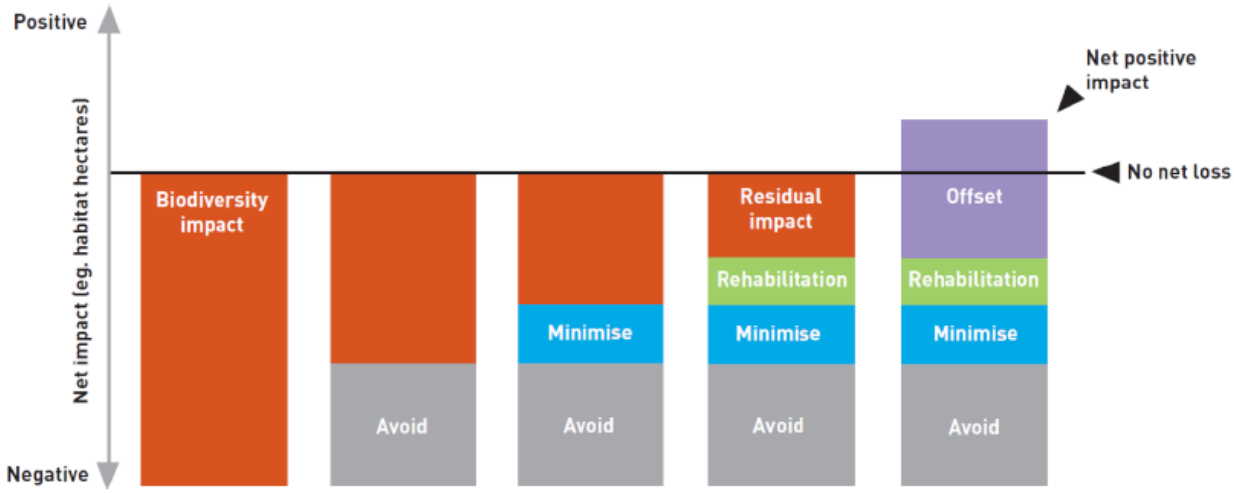
[206] https://ec.europa.eu/environment/archives/soil/pdf/sealing/Soil%20sealing%20-%20Final%20Report.pdf

Biodiversity

In Australia the mitigation hierarchy is widely used as a practical framework for managing risks and impacts to biodiversity (Figure 30). The mitigation hierarchy is a sequence of actions:

1. to anticipate and avoid project impacts on biodiversity where feasible;
2. to minimise impacts where complete avoidance is not feasible;
3. to rehabilitate when impacts occur;
4. where significant residual impacts remain, to offset for them.

Figure 30: Mitigation hierarchy of impacts on biodiversity in Australia[207]



In Australia the conventional qualitative risk assessment methodology is also in use when assessing biodiversity impacts. Figure 31 provides an example on the classification of biodiversity-specific consequences.

Figure 31: Example definitions of intrinsic risk impact consequences

CONSEQUENCE	DESCRIPTION
Minor	Incidental and localised impacts to natural habitat
Moderate	Small-scale conversion of natural habitat
Serious	Large-scale conversion of natural habitat or small-scale conversion of 'critical' habitat (e.g. known to be occupied by species with 'EN' conservation status)
Extreme	Large-scale loss of 'critical' habitat (e.g. known to be occupied by species with 'EN' conservation status)
Catastrophic	Large-scale loss of 'critical' habitat (e.g. known to be occupied by species with 'CR' conservation status)

[207] https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-biodiversity-management-handbook-english.pdf

Compensatory measures appropriate or necessary to offset the adverse effects may consist of[208]:

- habitat improvement in existing sites: improving the remaining habitat on the site or restoring the habitat on another Natura 2000 site, in proportion to the loss due to the project;
- habitat re-creation: creating a habitat on a new or enlarged site, to be incorporated into Natura 2000; or
- in association with other works, proposing a new site of sufficient quality and establishing/implementing conservation measures for this new site.

The range of compensatory and accompanying measures found in current practice in the EU also includes:

- species reintroduction;
- species recovery and reinforcement, including reinforcement of prey species;
- land purchase;
- rights acquisition;
- reserve creation (including strong restrictions in land use);
- incentives for certain economic activities that sustain key ecological functions;

reduction in (other) threats, usually to species, either through action on a single source or through coordinated action on all threat factors (e.g. factors stemming from space-crowded effects).

[208] https://ec.europa.eu/environment/nature/natura2000/management/docs/art6/new_guidance_art6_4_en.pdf

4.6 Monitoring (Art. 8a, Annex IV.7)

Monitoring typically serves at least three purposes at mining projects:

1) checking if the EIA predictions were correct;

2) regular environmental monitoring to detect pollution, check compliance, get early warnings, see trends; and

3) reduction of unknowns for mine closure (learn about the site and wastes).

Legal background

Annex IV(7) of the Directive sets out the information for the EIA Report:

"*A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases*."

The proposed monitoring measures are incorporated in the development consent, as Article 8a states:

"(1) The decision to grant development consent shall incorporate at least the following information:
(b) any environmental conditions attached to the decision, a description of any features of the project and/or measures envisaged to avoid, prevent or reduce and, if possible, offset significant adverse effects on the environment as well as, where appropriate, monitoring measures.

(4) In accordance with the requirements referred to in paragraph 1(b), Member States shall ensure that the features of the project and/or measures envisaged to avoid, prevent or reduce and, if possible, offset significant adverse effects on the environment are implemented by the developer, and shall determine the procedures regarding the monitoring of significant adverse effects on the environment.

The type of parameters to be monitored and the duration of the monitoring shall be proportionate to the nature, location and size of the project and the significance of its effects on the environment.

Existing monitoring arrangements resulting from Union legislation other than this Directive and from national legislation may be used if appropriate, with a view to avoiding duplication of monitoring."

Recital 35 of the 2014 amendment of the Directive provides further clarification:

"*Member States should ensure that mitigation and compensation measures are implemented, and that appropriate procedures are determined regarding the monitoring of significant adverse effects on the environment resulting from the construction and operation of a project, inter alia, to identify unforeseen significant adverse effects, in order to be able to undertake appropriate remedial action. Such monitoring should not duplicate or add to monitoring required pursuant to Union legislation other than this Directive and to national legislation*."

At the extractive industry, environmental monitoring is of paramount importance and great challenge because

- a wide variety of environmental factors are for concern;
- most of the potential emission types are diffuse, dispersed in character, monitoring can be difficult;
- the activity may occupy territories of land, monitoring can be voluminous and costly;
- the impacts, especially physical stability of land and groundwater issues (e.g. AMD), may be prolonged after the termination of the extractive activity, therefore "*a posteriori*" monitoring is usually required which can be specified in the closure and aftercare plan.

For the above reasons, a holistic monitoring plan in the EIA report and its due implementation is the prime interest of the developer itself, and in this regard, the best practice is to introduce a robust monitoring network voluntarily, as much as reasonably possible, with the involvement of independent actors such as certified environmental expert, the representatives of the local public (NGOs, schools, municipal officers) etc.. In a broader context, an efficient monitoring programme is important in

- successful environmental permitting and performance,
- mitigating and compensating significant adverse effects,
- remedial actions,
- the context of environmental liability (see next chapter), and
- the general liability for damage on assets under the realm of the national Civil Codes and Building Acts (e.g. damage of buildings due to vibration or land subsidence).

The objectives of monitoring, inter alia, are[209]:

- To ensure that significant adverse impacts of the project do not exceed impacts projected in the EIA and that measures taken to offset such impacts are carried out as planned. The systematic ex-post impact monitoring of adverse significant effects offers an opportunity to identify if forecasted impacts are not developing as predicted, so that steps may be taken for rectification. Monitoring also tracks the effectiveness of measures set in place to mitigate or to compensate for significant effects. Monitoring also allows for additional or unforeseen relevant information to be taken into account, cumulative impacts for example, allowing for remedial action.
- The planned methods with which significant adverse effects can be assessed for robustness can help to improve the identification of impacts in future periodical EIAs and audits which is a requirement in most MS. Monitoring can shed light on the effectiveness of the EIA report, with regards to the quality of the data used and the accuracy of methods. This can improve transparency, legitimacy, and effectiveness, especially if documented evidences are publicly available.
- The proposed monitoring scheme in the EIA is in line with monitoring requirements of other specific EU legislation (and of national legislation). This last element of monitoring is treated in details in this document under each environmental factor (Chapter 4.3).
- The monitoring of extractive waste facilities and related emissions and impacts are described in the BAT conclusions of MWEI BREF (e.g., BAT 23, 24, 40, 41, 48, 52, 57).

[209] EIA guidance - EIA report (2017)

Legal background and analogues

The only sector-specific piece of EU legislation is the Commission Implementing Decision[210] 2020/248/EU laying down technical guidelines for inspections of extractive waste management facilities. Its Annex, PART D "*Focus of inspections over the different life-phases of waste facilities*", Chapters 2. "*Inspections of waste facilities in operation*", 3. "*Final on-site inspection of waste facilities …*", 4. "*Inspections of waste facilities after the closure …*", and PART E "*Additional elements for inspections of Category A waste facilities*" provide useful details on the competent authority's inspections. These aspects are highly relevant for designing the appropriate monitoring programme for extractive waste management facilities.

There are other analogues for sectoral indicators under the EU ecolabel legislation, for example on hard floor covers, soil improvers, dolomite for milk. As well, monitoring guidelines exist specific to environmental compartments, e.g. on soil[211].

Developing monitoring indicators is essential, though not mandatory, in a monitoring programme. Indicators are highly dependent on the details of a mining project. Taking into account of

- the baseline conditions, including the vulnerability of the environment,
- the environmental factors at higher risk and their level of uncertainty,
- environmental quality standards (which are based on annual average measurements or otherwise),
- the complexity of mitigation and compensation measures, and
- the associated costs

may guide developers in identifying the appropriate indicators.

Universal guidance, beyond the ones set in EU or national legislation, on selecting the indicators and the frequency of their measurements, does not exist. A series of indicators are set in the EU Raw Materials Scoreboard using the universal RACER criteria (Relevance, Acceptability, Credibility, Easiness, Robustness), although these are not limited to the non-energy minerals sector, and environmental performance, and also cover global scale.

One potential regulatory example for the selection of monitoring indicators is the EMAS Regulation (Annex IV chapter C), the environmental performance indicators:

- give an accurate appraisal of the developer's environmental performance;
- be readily understood and unambiguous;
- allow for a year on year comparison in order to assess whether the performance has improved;
- allow for comparison with sector, national or regional benchmarks, and regulatory requirements.

[210] https://eur-lex.europa.eu/eli/dec_impl/2020/248/oj
[211] https://ec.europa.eu/environment/archives/soil/pdf/vol5.pdf

Good practice case

The EMAS Regulation proposes indicators some of which can be relevant to extractive projects:

— total direct energy consumption, corresponding to the total annual amount of energy consumed by the developer;

— total renewable energy consumption, corresponding to the total annual amount of energy consumed by the developer that was generated from renewable energy sources;

— total renewable energy generation, corresponding to the total annual amount of energy generated by the developer from renewable energy sources;

— annual mass-flow of key materials used (excluding energy carriers and water), expressed in units of weight (kg or tonnes) or volume (m^3) or other metrics commonly used;

— total annual water use (litres or m^3);

— total annual generation of waste, broken down by type (kg or tonnes) or volume (m^3), or in other metrics commonly used;

— the 'total annual generation of hazardous waste' (kg, tonnes, or m^3);

— the forms of land use with regard to biodiversity expressed in units of area (m^2 or ha):

total use of land,

total sealed area,

total nature-oriented area on site,

total nature-oriented area off site;

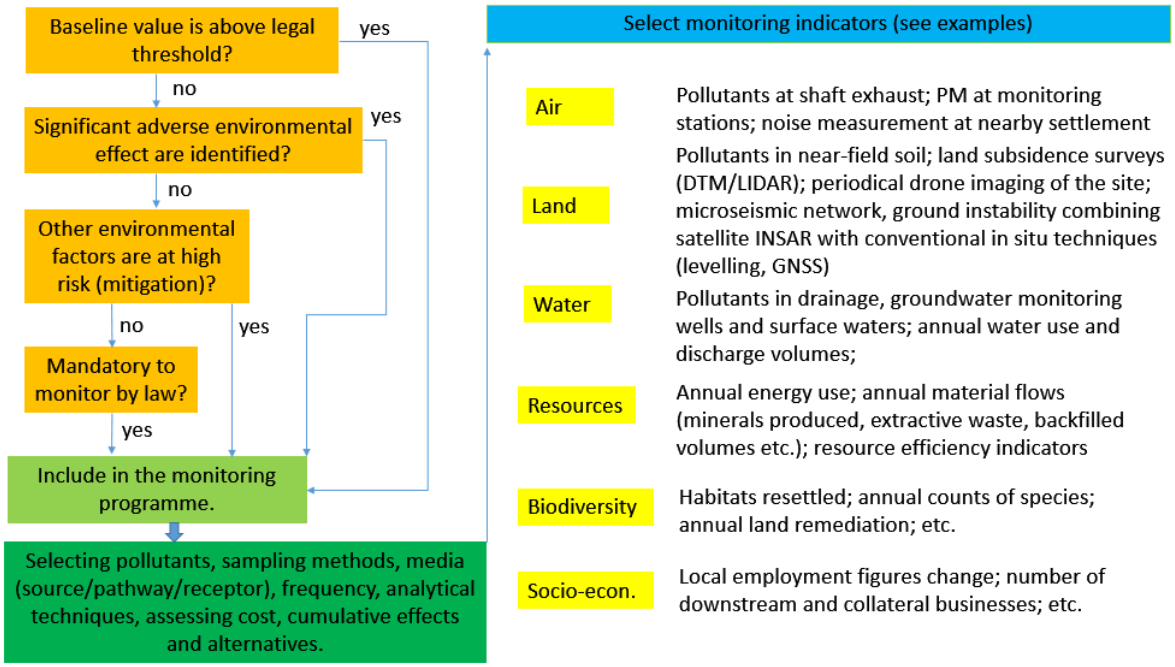
— the 'total annual emission of greenhouse gases', including at least emissions of CO_2, CH_4, N_2O, HFCs, PFCs, NF_3 and SF_6, expressed in tonnes of CO_2 equivalent,

— the 'total annual air emission', including at least emissions of SO_2, NOx and PM, expressed in kilograms or tonnes.

Baseline conditions and the identified and assessed environmental factors and potential impacts during operation (incl cumulative effects) are obvious aspects to take into account when designing the monitoring programme. Another important decision making is on whether to monitor the emissions at the source and/or the potential pathway(s) and/or the environmental receptor(s) at risk. The monitoring programme is usually that part of the EIA report which is consulted by the competent authorities and the involved public, therefore its final version is generally a result of joint compromise.

A potential decision-making flow of designing a monitoring programme for extractive projects is shown below on Figure 32.

Figure 32: Designing the monitoring programme, a potential flowchart and examples



For example, the extractive waste BREF provides a summary of good practices on air monitoring indicators and measurement frequencies (Table 9). The monitored parameters and the frequency depend a lot on their relevance for the given extractive waste management facility.

Table 9: Reported monitoring parameters and frequencies for ambient air quality and dust deposition from diffuse emissions to air (source: Extractive Waste BREF)

Reported parameter*	**Reported unit***	**Number of sites***	**Reported annual monitoring frequency range (min.-max., unless only one value reported)***	**Reported EN/ISO standard***
Diffuse dust emissions:				
TSP	µg/m^3	5	1-84-	NS***
PM_{10}	µg/m^3	8	365-Continuous****	EN 12341
$PM_{2.5}$	µg/m^3	1	Continuous****	NI**
Dust deposition:				
Deposition rate	Mg/m^2/day	8	1-56	NS***
Dust characteristics:				NI**
Metals and metalloids content (e.g. As, Cd, Zn, Ni, Cu, Fe, Cr, Hg, Ti, Co)	µg/m^3 µg/m^2/day	8	1-679	NS***
Dust conductivity	mS/m	1	56	NI**
Total sulphur content	µg/m^3	1	12	NI**
Diffuse gas emissions:				
VOCs	NI**	0	NI**	NI**
Other air pollutants	NI**	0	NI**	NI**

**Parameters, information and data reported by operators via the questionnaire (in total 87 questionnaires).*

***NI stands for No Information, meaning that operators did not provide information.*

Reported parameter*	Reported unit*	Number of sites*	Reported annual monitoring frequency range (min.-max., unless only one value reported)*	Reported EN/ISO standard*

****NS only stands for National Standard provided only.*

*****Includes long-term compaign (several months) of continuous (automated) monitoring of particles..*

The MWEI BREF also provides a similar inventory of the commonly used surface water monitoring parameters and sampling frequency, as well as the applied international standards (Table 10).

There are a number of EC guidance documents available for the different environmental factors, for example on groundwater[212], surface water[213] and others[214], however, there exists no specific guide on the non-fuel minerals extractive sector monitoring, except the MWEI BREF. Although directly not applicable for the sector, the principles of the Industry Emissions Directive on monitoring (Art. 16) is recommended to consult.

Concluding remarks

A carefully designed monitoring plan is of paramount importance in the EIA report of an extractive project. Monitoring indicators are selected among the emissions and environmental factors which are significantly adversely impacted. The chosen methodologies support the sustainable data acquisition on the long term and consider online public access to these data, or to their periodical digests.

Table 10: Reported monitoring parameters and frequencies for surface water (source: MWEI BREF). Please note that the monitored parameters and the frequency depend a lot on their relevance for the given extractive waste management facility.

Reported parameter*	Reported unit*	Number of sites*	Reported annual frequency range (min.-max., unless only one value reported)*	Reported EN/ISO standard*
pH	-	37	1-365	EN ISO 10523
Electrical conductivity	S/cm	24	1-365	EN27888
Hardness	°dH $CaCO_3$-mg/l	4	10	Ni**

212 https://circabc.europa.eu/sd/a/729b38fe-4141-48e8-b808-04c3ecc91975/Groundwater%20monitoring%20Report.pdf; https://circabc.europa.eu/sd/a/e409710d-f1c1-4672-9480-e2b9e93f30ad/Groundwater%20Monitoring%20Guidance%20Nov-2006_FINAL-2.pdf

213 https://circabc.europa.eu/sd/a/e54e8583-faf5-478f-9b11-41fda9e9c564/Guidance%20No%2019%20-%20Surface%20water%20chemical%20monitoring.pdf

214 https://ec.europa.eu/environment/air/reduction/ecosysmonitoring.htm; https://ec.europa.eu/environment/soil/publications_en.htm; https://ec.europa.eu/environment/air/quality/data_reporting.htm

Reported parameter*	Reported unit*	Number of sites*	Reported annual frequency range (min.-max., unless only one value reported)*	Reported EN/ISO standard*
TDS	mg/l	7	9-365	EN 15216
Colour	Pt/Co Pt-mg/l	5	4-11	EN ISO 7887-6
Temperature	°C	15	4-365	Ni**
Density	mg/l	1	10	Ni**
TSS	mg/l	32	1-365	EN 872
Turbidity	FTU	2	NI*	Ni**
Settleable Solids	ml/l	1	36-36	Ni**
COD****	mg/l	26	4-365	EN 1484 EN ISO 6060 ISO 15705
BOD_5	mg/l	7	4-52	EN ISO 1899-1
BOD_7	mg/l	7	25-50	Ni**
PAHs	mg/l	1	1	Ni**
Phenols	mg/l	3	1-36	ISO 6439
C_{30}-C_{40}	mg/l	1	52	EN ISO 9377-2
THC	mg/l	3	1	Ni**
TOC	mg/l	5	1-52	EN 1484
VOC_S	mg/l	1	2	Ni**
Alkalinity	mmol/l	10	52	EN ISO 9963-1
S^{2-}	mg/l	1	1	Ni**
$S_2O_3^{2-}$	mg/l	1	25-52	EN ISO 10304-3
SO_3^{2-}	mg/l	1	1-1	Ni**
SO_4^{2-}	mg/l	27	1-365	EN ISO 10304-1 ISO 9280
Total S	mg/l	2	10-11	EN ISO 17294-2
Ag	mg/l	1	36	EN ISO 11885
Al	mg/l	12	1-54	EN ISO 11885
As total	mg/l	21	1-52	EN ISO 17294-1 EN ISO 17294-2
Ba	mg/l	7	11-52	EN ISO 11885 EN ISO 7294-2
Be	mg/l	1	11	EN ISO 7294-2
Ca	mg/l	10	4-52	EN ISO 17294-1 EN ISO 17294-2
Cd	mg/l	21	1-327	EN ISO 11885 EN ISO 17294-1 EN ISO 17294-2
Co	mg/l	9	10-52	EN ISO 11885 EN ISO 17294-2

Reported parameter*	Reported unit*	Number of sites*	Reported annual frequency range (min.-max., unless only one value reported)*	Reported EN/ISO standard*
Cr (VI)	mg/l	1	1	NI**
Cr total	mg/l	19	1-52	EN ISO 11885 EN ISO 172494-1 EN ISO 17294-2
Cu	mg/l	24	1-52	
Fe total	mg/l	22	1-54	
Hg	mg/l	19	1-327	EN 1483 EN ISO 11885 EN ISO 17852
K	mg/l	8	4-52	EN ISO 11885 EN ISO 17294-1 EN ISO 17294-2
Mg	mg/l	15	2-52	
Mn	mg/l	13	1-52	EN ISO 11885
Mo	mg/l	4	9-12	EN ISO 17294-2
Na	mg/l	9	4-52	EN ISO 11885
Ni	mg/l	21	1-52	EN ISO 17294-1
Pb	mg/l	20	1-138	EN ISO 17294-2
Sb	mg/l	5	50-52	EN ISO 17294-2
Se	mg/l	3	1-32	
Sn	mg/l	2	1-11	
Sr	mg/l	1	NI*	NI**
Ti	mg/l	3	2-11	EN ISO 11885 EN ISO 17294-2
U	mg/l	2	36	NI**
V	mg/l	3	11-36	EN ISO 11885 EN ISO 17294-2
W	mg/l	1	4	EN ISO 11885
Zn	mg/l	24	1-138	EN ISO 11885 EN ISO 17294-1 EN ISO 17294-2
NH_4^+	mg/l	16	12-365	ISO 5664
NO_2^-	mg/l	5	36-136	EN 2677 EN ISO 13395
NO_3^-	mg/l	12	25-365	EN ISO 13395
NO_2^-+ NO_3^-	mg/l	2	4-11	
Total Kjeldahl N	mg/l	15	4-50	EN 25663
Total N	mg/l	8	8-29	EN 12260 EN ISO 11905 EN ISO 13395

Reported parameter*	Reported unit*	Number of sites*	Reported annual frequency range (min.-max., unless only one value reported)*	Reported EN/ISO standard*
PO_4^{3-}	mg/l	7	12-136	NS only***
Total P	mg/l	22	3-54	EN 1189 EN ISO 11885 EN ISO 6878
WAD CN^-	mg/l	1	NI*	NI**
Total CN^-	mg/l	3	1-10	NI**
Br^-	mg/l	2	10-12	NI**
Cl^-	mg/l	20	10-327	EN ISO 10304-1 ISO 9297
F^-	mg/l	2	12-32	NI**
AOX	mg/l	3	12	NS only***
^{226}Ra	Bq/l	2	36	NS only***
Coliform bacteria	CFU/100ml	2	12	NS only***
Fish egg	NI	1	12	NI**
Toxicity	TU	1	2	NI**
	Diluition factor	1	10	NS only***

NB: Sampling programme and techniques are described in EN ISO 5667 on water quality-sampling. The sampling point is located where the emission leaves the extractive waste management installation.

**Parameters, information and data reported by operators via the questionnaire (in total 87 questionnaires).*

***NI stands for No Information, meaning that operators did not provide information.*

****NS only stands for National Standard provided only.*

*****EN ISO 6060 is not applicable for samples with a chloride content higher than 1 g/l.*

5 Environmental liability

5.1 Environmental liability and environmental criminal liability

Environmental liability, the practical implementation of the "*polluter-pays*" principle, is not an element of the EIA but competent authorities take it into account, when defining the financial security to be provided by the developer. The financial security is usually a legal obligation collateral to environmental or operation permit.

Legal analogue

Directive 2004/35/CE on environmental liability with regard to the prevention and remedying of environmental damage (ELD) is a recommended reading for developers.

"*Damage*" is a measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly. "*Environmental damage*" means

(a) damage to protected species and natural habitats that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species. The significance of such effects is to be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I of this Directive. Damage to protected species and natural habitats does not include previously identified adverse effects which result from an act by an operator which was expressly authorized.

(b) water damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential of the waters concerned, with the exception of adverse effects where Article 4(7) of Directive 2000/60/EC applies;

(c) land damage is any land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms.

The Directive provides further hints on preventive and remedial actions, bearing the related costs. A Commission Guidance is published on the interpretation of environmental damage[215].

The ELD is the EU legislation establishing a framework for environmental liability of operators, including in the mining sector, for the damage the caused to natural resources (protected species and natural habitats, water, land). If a causal link between their activity and the damage can be established (covering sudden and accidental damage as well as gradual pollution), the liable operator is strictly liable (without proof of negligence or intent) if the operator falls into one of the categories of Annex III ELD (e.g. IED, waste management activities (WFD, Landfill Directive), mining waste activities (EWD), etc). If liable of causing an imminent threat of damage or an actual damage, the operator has to prevent the damage or to remedy the already occurred damage (i.e. to restore the damaged natural resources to their baseline condition) and to bear all costs involved and following from preventive or remedial action (implementing the polluter pays principle)[216].

Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law defines that the following

[215] Commission Notice Guidelines providing a common understanding of the term 'environmental damage' as defined in Article 2 of Directive 2004/35/EC of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage 2021/C 118/01 (C/2021/1860)

[216] More information about the Directive can be found on the Europa server under: https://ec.europa.eu/environment/legal/liability/index.htm

conduct constitutes a criminal offence, when unlawful and committed intentionally or with at least serious negligence:

(a) the discharge, emission or introduction of a quantity of materials or ionising radiation into air, soil or water, which causes or is likely to cause death or serious injury to any person or substantial damage to the quality of air, the quality of soil or the quality of water, or to animals or plants;

(b) the collection, transport, recovery or disposal of waste,including the supervision of such operations and the aftercare of disposal sites, and including action taken as a dealer or a broker (waste management), which causes or is likely to cause …;

(c) the shipment of waste …;

(d) the operation of a plant in which a dangerous activity is carried out or in which dangerous substances or preparations are stored or used and which, outside the plant, causes or is likely to cause …;

(e) production, processing, handling, use, holding, storage, transport, import, export or disposal of nuclear materials or other hazardous radioactive substances which causes …;

(f) the killing, destruction, possession or taking of specimens of protected wild fauna or flora species, except for cases where the conduct concerns a negligible quantity of such specimens and has a negligible impact on the conservationstatus of the species;

(g) trading in specimens of protected wild fauna or flora species …;

(h) any conduct that causes the significant deterioration of a habitat within a protected site;

(i) the production, importation, exportation, placing on the market or use of ozone-depleting substances.

It is understood that these comprise the worst-case scenario, and usually have nothing in common with a standard EIA report of an extractive project but it is the piece of former EU legislation which provides hints on environmental liability in the criminal context.

5.2 Financial security

A commitment on the volume and format of financial security is not an explicit component of an EIA report. Its main role is to provide a financial security/warranty for any environmental damages or environment related design base activities in case of major events (e.g. mine closure and rehabilitation after the bankruptcy of the developer) for the competent authorities. In some countries, this instrument is applied not only for environmental liability but for compensating the losses of the state, such as suspended/abandoned investment into the development of a mine, failed payment of dues (e.g. royalty after production, land occupation fees, permitting fees, fines, etc.).

While "*environmental liability*" concerns "*unknown damage*" or "*fortuities*" (sudden and accidental damage etc.), "*environmental responsibility*" concerns "*known damage*" or "*certainties*". Another interpretation is where liability is legal responsibility, and responsibility is what one should do (accountable for). Extractive operations may trigger both, but the applicable financial security instruments are different. For environmental liabilities mainly insurance works, in particular in the case it is involuntary. For mandatory financial security it is the most common instrument, followed by bank guarantees and reserves. Insurance cannot cover environmental responsibilities (such as for closure or post-closure of a mining site – so-called "*after-care measures*") because insurance applies only to fortuities, never to certainties. Financial security instruments and mechanisms for environmental responsibilities, which again are not obtained unless financial security is mandatory, include bank guarantees, reserves, and bonds.

According to the MINLEX study, the national legislation may require it as a requisite at the permitting stages such as establishing a mining area, approving the EIA, licensing the technical operation plan, etc. As well, the liquidity formats of the financial guarantee cover a wide range.

Legal analogue and background

Article 8 of the Environmental Liability Directive, where extractive waste management is in scope, concerns the financial guarantees for the competent authority. The competent authority recovers, inter alia, via security over property or other appropriate guarantees from the operator who has caused the damage or the imminent threat of damage, the costs it has incurred in relation to the preventive or remedial actions. However, there is a five years limitation period for the recovery of the costs (Art. 10).

Article 14 calls for national measures to encourage the development of financial security instruments and markets by the appropriate economic and financial operators, including financial mechanisms in case of insolvency, with the aim of enabling developers (operators) to use financial guarantees to cover their environmental responsibilities.

According to Article 14 of the Extractive Waste Directive the competent authority, prior to the commencement of any relevant operations, requires a financial guarantee (e.g. in the form of a financial deposit, including industry-sponsored mutual guarantee funds) or equivalent, so that all obligations under the permits issued, including post-closure provisions, are discharged, and there are funds readily available at any given time for the rehabilitation of the land affected by the waste facility. MS have the possibility to waive these requirements in case of non-category A waste facilities, according to Article 2.

The calculation and periodical adjustment of the guarantee is made on the basis of:

- the likely environmental impact of the waste facility, taking into account in particular the category of the waste facility, the characteristics of the waste and the future use of the rehabilitated land,

- the assumption that independent and suitably qualified third parties will assess and perform any rehabilitation work needed.

The daughter piece of legislation to EWD is Commission Decision 2009/335/EC on technical guidelines for the establishment of the financial guarantee[217] based on an earlier Guidance[218] on financial guarantee and inspections. The Commission Implementing Decision[219] 2020/248/EU laying down technical guidelines for inspections of extractive waste management facilities also has a reference on financial guarantees.

According to Article 1 of Comm. Dec. 2009/335/EC the calculation of the financial guarantee, in context of extractive waste management, is based on:

"(a) the likely impacts on the environment and on human health;

(b) the rehabilitation, including after use;

(c) applicable environmental standards and objectives, including physical stability of the facility, minimum quality standards for the soil and water resources and maximum release rates of contaminants;

(d) technical measures to achieve environmental objectives, in particular measures ensuring the stability of the facility and limit environmental damages;

(e) measures required during and after closure, including land rehabilitation, after closure treatment and monitoring, and reinstate biodiversity;

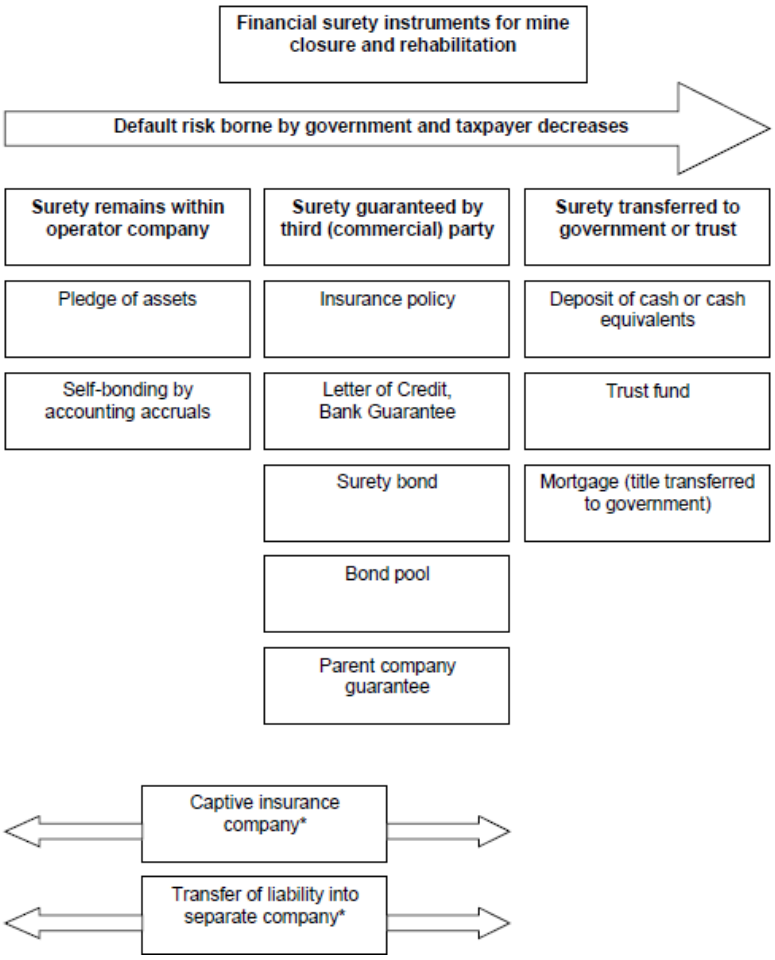
(f) estimated time scale of impacts and mitigation measures;

[217] https://eur-lex.europa.eu/eli/dec_impl/2020/248/oj
[218] https://ec.europa.eu/environment/waste/mining/pdf/EU_Final_Report_30.04.08.pdf
[219] https://eur-lex.europa.eu/eli/dec_impl/2020/248/oj

(g) assessment of the costs necessary for land rehabilitation, closure and after closure, monitoring or treatment of contaminants. The assessment shall be performed by independent and suitably qualified third parties and shall take into account the possibility of unplanned or premature closure."

With certain limitations or extensions, the above approach can be applied for the whole extractive project. The Decision does not provide further hints on the liquidity format of the guarantees but the Guidance does (Figure 33)

Figure 33: Financial guarantee instruments (MONTEC, 2008)[220]



Because of the significant deviations in scales of mining companies at the different minerals extractive subsectors, efforts for establishing mutual liability funds and risk pools across the different subsectors at national or international level usually fail. Major companies can afford entering commercial risk management policies available on the market that SMEs (small and medium size enterprise) may not be able to afford. Small and medium size enterprises, comprising most of the construction minerals extraction sector, and also some of the industrial minerals, are less capable to join such a financial scheme, mainly due to lack of resources.

The MORA model in Spain provides a toolkit for quantifying financial guarantees, including an on-line tool[221].

[220] https://ec.europa.eu/environment/waste/mining/pdf/EU_Final_Report_30.04.08.pdf

[221] https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/responsabilidad-mediambiental/modelo-de-oferta-de-responsabilidad-ambiental/#:~:text=MORA%2C%20es%20una%20herramienta%20voluntaria,prestan%20a%20su%20estado%20original

5.3 Environmental management schemes

Voluntary environmental management schemes are not required by the EIA Directive. These are additional optional proofs of the environmental commitment of the developer. It helps building the credibility of the mining company in the public and the competent authority, and it improves the environmental performance in general. There is a wide selection of voluntary auditing schemes on international level (e.g. ISO 14000), and on EU level (EMAS, based on but going beyond the ISO 14001), and also specific schemes for the minerals sector at international level. In Spain there is a specific scheme for the minerals extractive sector but in the broader, sustainability context.

The participation in one or more of the above schemes is rather common by major mining companies. Small and medium size enterprises, comprising most of the construction minerals extraction sector, and also some of the industrial minerals, might be less active in adopting such schemes, mainly due to lack of resources.

Legal analogue

The major EU piece of legislation governing this field is the Regulation 1221/2009/EC on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS). EMAS is an important instrument of the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan. It is to promote continuous improvements in the environmental performance of developers, the systematic, objective and periodic evaluation of their performance, the provision of information on environmental performance, an open dialogue with the public and interested parties, and the active involvement and appropriate training of employees.

The EMAS components are very much identical to other quality assurance systems by having the elements of:

environmental review → environmental management system → internal audit → environmental statement → independent audit → registration.

It is noted that EMAS is for the developers (ie. mining companies), therefore, they are liable also for the indirect environmental aspects resulting from the interaction with third parties (business partners, sub-contractors) which can to a reasonable degree be influenced by the developer.

What concerns the involvement of the developers in voluntary international schemes, the RMIS sustainability chapter provides an exhaustive list of these[222]. However, most of these initiatives are not limited to the environmental performance but address other social and economic aspects to, which are not typical issues for the EU extractive sector. Nevertheless, a number of them, such as the Extractive Industry Transparency Initiative (EITI), the Kimberley Process Certification Scheme (KPCS), OECD Due Diligence Guidance, Conflict Minerals (Regulation 2017/821/EU) have the official EU acknowledgment.

The developer may want to further extend the enhanced environmental liability to its products. In this case the EU ecolabel and eco-design policies come into consideration. In contrast to EMAS, the Ecolabel Regulation[223] applies for goods and services. EU Ecolabel criteria are determined on a scientific basis considering the whole life cycle of products[224].

[222] https://rmis.jrc.ec.europa.eu/?page=international-initiatives-392e53
[223] Regulation (EC) No 66/2010 on the EU Ecolabel
[224] also consult EN ISO 14024

There are a few implementing pieces of the ecolabel legislation which are relevant to the extractive sector[225].

Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products defines ecodesign as the integration of environmental aspects into product design with the aim of improving the environmental performance of the product throughout its whole life cycle[226]. It has limited application to the topic.

The European Commission is promoting and has defined Corporate Social Responsibility (CSR)[227] as the responsibility of enterprises for their impact on society and, therefore, it is company led. Companies can become socially responsible by

- integrating social, environmental, ethical, consumer, and human rights concerns into their business strategy and operations; and
- following the law.

CSR has a direct link to the minerals sector through due diligence[228].

[225] Decision 2015/2099 establishing ecological criteria for the award of ecolabel for growing media, soil improvers and mulch
Decision 2009/607 establishing the ecological criteria for the award of the Community eco-label to hard coverings
Decision 2017/1217 establishing the EU Ecolabel criteria for hard surface cleaning products

[226] https://ec.europa.eu/growth/industry/sustainability/ecodesign_en

[227] https://ec.europa.eu/growth/industry/sustainability/corporate-social-responsibility_en

[228] https://ec.europa.eu/docsroom/documents/34482

6 Information sources (Arts. 2(4),5(4), Annex IV.3.,10)

This chapter aims to provide an overview on publicly available data and information sources which are relevant for the EIA in the context of extraction projects of non-energy primary mineral raw materials and their on-site material streams. The list of datasets information sources covers environmental factors, information about mineral reserves, resource and production and social information relevant to carry out an EIA. Within the research of H2020 project "*Optimizing quality of information in RAw MAterial data collection across Europe*" (ORAMA)[229], several dataset relating to social and environmental dimensions of extraction were selected and reported. In addition, Raw Materials Information System (RMIS) and Raw Materials Scoreboard developed by the European Commission are important sources of environmental and social data and information in the field of raw materials to use as a source relevant for EIA.

For the appropriate management and service of environmental data, either collected from external sources or generated by the developer during planning and operation, i.e. monitoring data, there is a number of pieces of Community legislation, which are recommended readings[230].

A review of the most relevant database and sources are shown per EIA topic in Table 11.

[229] https://orama-h2020.eu/

[230] Directive 2003/4/EC on public access to environmental information
Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)
Directive 2016/943/EU on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure
Commission Regulation 1205/2008/EC implementing Directive 2007/2/EC as regards metadata
Directive 2003/98/EC on the re-use of public sector information

Table 11: EU community data and information sources

EIA topic	Provider and Title of dataset	Access (URL)	Description
General dataset	EC – Eurostat database	https://ec.europa.eu/eurostat/data/database	datasets for different topics
	European Environment Agency	https://www.eea.europa.eu/data-and-maps	national emissions, water, land cover, etc.
	European Environment Information and Observation Network (EIONET)	https://www.eionet.europa.eu/	environmental data and information
	Copernicus (previously Global Monitoring for Environment and Security)	https://www.copernicus.eu/en	relevant services in the context of biodiversity: land monitoring, climate change, marine environmental monitoring
	ESA Geohazards Exploitation Platform	https://geohazards-tep.eu/#!	This ESA platform provides access to INSAR processing tools and results available at ESA cloud computing platform.
	Infrastructure for Spatial Information in the European Community (INSPIRE)	https://inspire-geoportal.ec.europa.eu/envDomain_selection.html?view=qsEnvDomain	datasets for air, nature, water, noise, waste, industrial emissions, industrial accidents
	United Nations Environmental Data Explorer	https://geodata.grid.unep.ch/	national, subregional, regional and global statistics and maps covering themes like freshwater, population, forests, emissions, climate, disasters, health, GDP
	EC Raw Materials Information System	https://rmis.jrc.ec.europa.eu/	overarching information on raw materials on global, EU and EU countries scale, especially detailed information on legislation based on MINLEX, MINGUIDE and MINVENTORY projects
	European IPPC Bureau – Best Available Techniques Reference documents BREF	https://eippcb.jrc.ec.europa.eu/reference/	information on specific IED sectors in the EU on the best techniques and processes used with emission and consumption data
	European Reference Life Cycle Data Systems (ELCD)	https://eplca.jrc.ec.europa.eu/ELCD3/	the EU's knowledge base that responds to business and policy needs for social and environmental assessments of supply

EIA topic	Provider and Title of dataset	Access (URL)	Description
		https://eplca.jrc.ec.europa.eu/LCDN/ https://eplca.jrc.ec.europa.eu/EUFRP/ https://eplca.jrc.ec.europa.eu/SDPDB/	chains and end-of-life waste management, otherwise known as life cycle assessments
	Earth Observation for Raw Material Mining	https://earsc-portal.eu/pages/viewpage.action?pageId=69894197	a compilation of environmental information sources by ESA and partners, mainly in context of remote sensing
Biodiversity and Climate change	EEA - Biodiversity Information System for Europe (BISE)	https://www.eea.europa.eu/themes/biodiversity/bise-2013-the-biodiversity-information	data and information on species, habitat types and sites of interest in Europe and to related products for biodiversity indicators and assessments
	Global Biodiversity Information Facility (GBIF)	https://www.gbif.org/	free and open access to biodiversity data on a global scale
	Natura 2000 Network Viewer	http://natura2000.eea.europa.eu/#	dataset shows the location of protected areas across Europe
	European Environment Agency Ecosystem assessments (MAES) - National designations	https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-13	reporting under Habitats Directive, and Birds Directive, Common Database on Nationally Designated Areas (CDDA) managed
	Global Earth Observation System of Systems (GEOSS) - Group on Earth Observations Biodiversity Observation Network (GEO BON)	https://geobon.org/	it makes biodiversity data more accessible to decision makers and the scientific community
	EuMon (species and habitats of Community interest) EU BON (European Biodiversity Observation Network)	http://eumon.ckff.si/index1.php http://www.eubon.eu/	a portal for biodiversity monitoring in Europe, national responsibilities, and biodiversity coverage of the Natura 2000 network
	Copernicus	https://www.copernicus.eu/en https://climate.copernicus.eu/	relevant services in the context of biodiversity are: land monitoring, climate change and marine environmental monitoring

EIA topic	Provider and Title of dataset	Access (URL)	Description
	CORINE land cover	https://land.copernicus.eu/pan-european/corine-land-cover	the spatial extent of mineral extraction, measured over 4 periods between 1990 and 2012
	IPCC Data Distribution Centre	https://www.ipcc-data.org/	climate, socio-economic and environmental data, both from the past and future scenarios
Air	Emissions Database for Global Atmospheric Research (EDGAR) - Global Greenhouse Gases Emissions v4.3.2	http://edgar.jrc.ec.europa.eu/overview.php?v=432_GHG	GHG emissions by economic sector and by country, covering also the mineral mining sector. Emissions of single GHGs and GHGs sums reported in CO_2 equivalents. Possible also to estimate GHG implied emission factors (emissions intensity).
Natural radiation	JRC Digital Atlas of Natural Radiation	https://remon.jrc.ec.europa.eu/About/Atlas-of-Natural-Radiation/Digital-Atlas	a collection of maps displaying the levels of radioactivity caused by different natural sources in Europe (cosmic ray, U, Th, K in soil, indoor radon)
Water & Marine datasets	Eurostat - datasets: env_wat_abs; env_wat_cat; env_wat_cat	http://appsso.eurostat.ec.europa.eu	water abstraction for mining and quarrying; water use for mining and quarrying, waste water discharge volume for mining and quarrying
	Water Information System for Europe (WISE)	https://water.europa.eu/	WISE illustrates a wide span of water related information by visualisations on interactive maps, graphs and indicators
	European Marine Observation and Data Network (EMODNET)	https://www.emodnet.eu/	physical and biological marine data and information
	Environmental Marine Information System (EMIS)	https://ec.europa.eu/jrc/en/scientific-tool/environmental-marine-information-system	spatial, temporal, physical and biological marine variables, and related environmental information, derived from satellite remote sensing and/or numerical modelling
	European Atlas of the Seas	https://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/	natural and socio-economic aspects and features in the marine and coastal regions of Europe

EIA topic	Provider and Title of dataset	Access (URL)	Description
	European Pollutant Release and Transfer Register (E-PRTR)	https://ec.europa.eu/environment/industry/stationary/e-prtr/legislation.htm	data on pollutant emissions to water from major EU industrial facilities, which also include the raw materials industry
	International Mine Water Association (IMWA)	https://www.imwa.info/	in case of mining, IMWA gathers research from worldwide experts in the field
	Member States national offices	-	water withdrawal/use for mining and quarrying and in some cases for specific mining sectors (by water source for some countries)
Chemicals and industrial datasets	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)	https://echa.europa.eu/	source of information on the chemicals manufactured and imported in Europe; it covers their hazardous properties, classification and labelling
	Major Accident Reporting System (MARS)	https://emars.jrc.ec.europa.eu/en/emars/content	chemical accidents and near misses
	European Pollutant Release and Transfer Register (ePRTR)	https://prtr.eea.europa.eu/#/home	amounts of pollutant releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water
Mineral reserves and resources	GeoERA - Mineral Intelligence for Europe (Mintell4EU)	https://geoera.eu/projects/mintell4eu7/	data related to mineral resources
	European Minerals Knowledge Data Platform (EU-MDKDP), Minerals4EU	http://minerals4eu.brgm-rec.fr/	data related to mineral resources
	PERC Reporting Standard 2017	http://www.vmine.net/perc/documents/PERC%20REPORTING%20STANDARD%202017.pdf	PERC reporting standard including definitions of mineral resources and mineral reserves in accordance with CRIRSCO
Mineral production	Austrian Federal Ministry - World Mining Data	https://www.world-mining-data.info/	production figures of 65 mineral commodities from 168 countries summarized and statistically evaluated
	British Geological Survey - World Mineral Production	https://www.bgs.ac.uk/mineralsUK/statistics/worldStatistics.html	mineral production statistics for the five year period from 2014 to 2018, for more than 70 mineral commodities, by country worldwide

EIA topic	Provider and Title of dataset	Access (URL)	Description
Waste	National Data sources		published data similar to the Eurostat data using the EWC-Stat codes
	Smart Ground platform	http://smart-ground.eu/	waste facilities site locations, waste type, composition etc.
	Minerals4EU data platform	http://minerals4eu.brgm-rec.fr/	mine sites, waste facilities locations, waste type; data from Promine and ProSum projects are incorporated
	Minventory	https://ec.europa.eu/jrc/en/scientific-tool/minventory	information on competent authorities reporting data on mine waste
	Company reports	http://database.globalreporting.org/	company or site-specific waste facilities locations, volumes, composition etc.
Noise	EEA. The NOISE Observation & Information Service for Europe	http://noise.eea.europa.eu/	presents the environmental noise levels across Europe for roads, railways, airports, industry and specific cities; maps are updated every five years
Traffic	Eurostat	https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Freight_transport_statistics https://ec.europa.eu/eurostat/statistics-explained/index.php/Road_freight_transport_statistics https://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics#Modal_split	annual road freight transport road freight transport statistics freight transport statistics
	Department for Transport: - Road traffic website (Beta) - National Trip End Model (NTEM)	https://www.dft.gov.uk/traffic-counts/download.php https://data.gov.uk/dataset/11bc7aaf-ddf6-4133-a91d-	Trip origin-destinations for use in transport modelling. The forecasts take into account national projections of population, employment, housing and car ownership, and the information is shown by regions across the United Kingdom.

EIA topic	Provider and Title of dataset	Access (URL)	Description
		84e6f20a663e/national-trip-end-model-ntem	
Human health	EEA - Emissions factors for the minerals industry	https://www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/2-industrial-processes/2-a-mineral-products/2-a-5-a-quarrying/view	PM_{10} PM_{25} Total Suspended Solids (TSP)
	European Health Information Gateway	https://gateway.euro.who.int/en/	indicators of health impacts, but not specific to the minerals industry
	Eurostat - Good health and well-being	https://ec.europa.eu/eurostat/web/sdi/good-health-and-well-being	good health and well-being statistics
	World Health Organization - The European health statistics app	http://www.euro.who.int/en/data-and-evidence/the-european-health-statistics-app	general health
Soil and Land use	European Commission - European Soil Database (ESDB)	https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties	soil parameters
	MINLAND	https://minland.eu/project/	policy summaries and good case studies in context of land use and minerals management
	European Commission - Soil Threats Data	https://esdac.jrc.ec.europa.eu/content/esdac-themes	soil erosion, organic carbon decline, compaction, salinization, soil biodiversity decline, land take, food security, landslides, heavy metals
	European Commission - Soil Point Data (LUCAS and SPADE 2, SPADE M)	https://esdac.jrc.ec.europa.eu/resource-type/spade-2; https://esdac.jrc.ec.europa.eu/resource-type/spadem	particle size distribution, pH, organic carbon, carbonate and phosphorus content etc.
	European Commission - Soil Projects Data	https://esdac.jrc.ec.europa.eu/resource-type/soil-projects-data	various soil properties

EIA topic	Provider and Title of dataset	Access (URL)	Description
	EIONET-CSI	https://www.eea.europa.eu/data-and-maps/indicators/ape_f02-emissions-of-acidifying-substances/eea-core-set-of-indicators-csi	soil data especially of contaminated sites due to mineral/oil extraction and production
	EEA - GIS map application for European Protected sites	http://www.eea.europa.eu/data-and-maps/explore-interactive-maps/european-protected-areas-1	protected sites including national designations and EU designations
Extractive Waste	ProSUM project, EU Urban Mine Knowledge Data Platform	http://www.urbanmineplatform.eu/homepage	information on arising, stocks, flows and treatment of waste electrical and electronic equipment, end-of-life vehicles, batteries and mining wastes
	European Commission - Generation of waste by the Mining and quarrying sector	http://ec.europa.eu/eurostat/web/waste/waste-generation-and-management/generation/mining-quarrying	waste amount in kg per inhabitant and tonnes
	GTK - ProMine Anthropogenic Concentrations (AC) database	http://ptrarc.gtk.fi/ProMine/default.aspx	tonnage and metal content (i.e. possible presence of strategic metals) for France
	BDSTM database (French Database of Sites and Mining Titles)	-	environmental data, also mineral deposit data (location of tailings tonnage and grade) for France
	Dechminue database	-	based on a European project and pinpoints many mining waste sites over 9 European countries (Bulgaria, Finland, France, Germany, Greece, Ireland, Spain, Portugal, Sweden)
Employment	Eurostat – datasets: lfsa_egana; lfsa_egan22d; lfsa_eisn2; sbs_sc_ind_r2	http://ec.europa.eu/eurostat/data/database	employment by sex, age, economic activity; with detailed breakdown of mining types; industry by employment
Health and Safety	Eurostat - Accidents at work	http://ec.europa.eu/eurostat/data/database	number of accidents; incidence rates of accidents (number of accidents per 100,000 workers);

EIA topic	Provider and Title of dataset	Access (URL)	Description
			days lost due to accidents
	ILOSTAT - Safety and health at work	https://ilostat.ilo.org/	national, for a number of countries, incl. data for the mining and quarrying sector

7 Glossary and abbreviations

abnormal operations	an operational process deviating from normal operation which is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions
accident	any unintended event, the consequences or potential consequences of which are significant from the point of view of environmental protection or technical safety
alternatives	different ways of carrying out the project in order to meet the agreed objective; alternatives can take diverse forms and may range from minor adjustments to the project, to a complete re-design
aquifer	a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater
backfilling	any recovery operation of non-extractive waste where suitable non-hazardous waste is used for purposes of reclamation in excavated areas or for engineering purposes in landscaping; waste used for backfilling must substitute non-waste materials, be suitable for the aforementioned purposes, and be limited to the amount strictly necessary to achieve those purposes
	placing extractive waste (ore residue, ore treatment residue, host rock, overburden) back into the excavation voids for rehabilitation and construction purposes, whether created through surface or underground extraction
baseline scenario	description of the current status of the environment in and around the area in which the project will be located; it forms the foundation upon which the assessment will rest
BAT best available techniques	the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole
body of groundwater	a distinct volume of groundwater within an aquifer or aquifers
brownfields	derelict and underused, or even abandoned former industrial or commercial sites, which may have real or perceived contamination problems. They are mainly found in urban areas of those regions where once flourishing heavy industries have now closed down. Bringing them to beneficial use, thus saving precious greenfield sites, normally requires coordinated

	intervention on the part of owners, local authorities and citizens living in the neighbourhood.
BTEX	benzene, toluene, ethylbenzene and xylene
by-product	a substance or object resulting from a production process the primary aim of which is not the production of that substance or object if the following conditions are met: further use of the substance or object is certain; the substance or object can be used directly without any further processing other than normal industrial practice; the substance or object is produced as an integral part of a production process; further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.
CJEU	Court of Justice of the European Union
coastal water	surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters
compensation measures	measures envisaged to offset any identified significant adverse effects on the environment
cumulative effects	changes to the environment that are caused by activities/projects in combination with other activities/projects
dam	an engineered structure designed to retain or confine water and/or waste within a pond
damage	measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly
design basis	the range of conditions and events taken explicitly into account in the design, including upgrades, of a mineral extraction installation, according to established criteria, so that the installation can withstand them without exceeding authorised limits by the planned operation of safety systems
developer	the applicant for authorisation for a private project or the public authority which initiates a project
EC	European Commission
EEZ	Exclusive Economic Zone
EIA	environmental impact assessment
EITI	Extractive Industry Transparency Initiative

emission	direct or indirect release of substances, vibrations, heat or noise from individual or diffuse sources in the installation into air, water or land
end-of-waste	waste which has undergone a recycling or other recovery operation is considered to have ceased to be waste if the substance or object is to be used for specific purposes; a market or demand exists for such a substance or object; the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and the use of the substance or object will not lead to overall adverse environmental or human health impacts
EPRTR	European Pollutant Release and Transfer Register
extractive industries	all establishments and undertakings engaged in surface or underground extraction of mineral resources for commercial purposes, including extraction by drilling boreholes, or treatment of the extracted material
extractive waste facility	any area designated for the accumulation or deposit of extractive waste, whether in a solid or liquid state or in solution or suspension, for the defined time-periods; such facilities are deemed to include any dam or other structure serving to contain, retain, confine or otherwise support such a facility, and also to include, but not be limited to, heaps and ponds, but excluding excavation voids into which waste is replaced, after extraction of the mineral, for rehabilitation and construction purposes
fossil fuel	non-renewable carbon-based energy sources such as solid fuels, natural gas and oil
greenhouse gases (GHG)	carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3)
groundwater	all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil
hazard	the intrinsic property of a substance, a character of an activity, or a situation with a potential for creating adverse effects, damage or major accident to human health and environment
heap	an engineered facility for the deposit of solid waste on the surface
IED	Industrial Emissions Directive (the former IPPC Directive)
incident	any unintended event, the consequences or potential consequences of which are not negligible from the point of view of environmental protection or technical safety
inert waste	waste that does not undergo any significant physical, chemical or biological transformations; it will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way

	likely to give rise to environmental pollution or harm human health; the total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater
inspection	all actions, including site visits, checks of internal measures, systems and reports and follow-up documents, and any necessary follow-up, undertaken by or on behalf of the competent authority to check and promote compliance of establishments with the requirements of a legislation or a permit
INSPIRE	Infrastructure for Spatial Information in the European Community
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standard Organization
JRC	Joint Research Centre of the European Commission
landscape	an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors
landscape management	action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes
LCA	life cycle assessment
leachate	any liquid percolating through the deposited waste and emitted from or contained within a waste facility, including polluted drainage, which may adversely affect the environment if not appropriately treated
major accident	an occurrence of a major failure, such as a major emission, collapse of installation, fire, explosion resulting from uncontrolled developments in the course of the operation of any establishment, and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment
marine waters	the seabed and subsoil on the seaward side of the baseline from which the extent of territorial waters is measured extending to the outmost reach of the area where a MS has and/or exercises jurisdictional rights, and coastal waters, their seabed and their subsoil
microenterprises	an enterprise which employs fewer than 10 persons and which has an annual turnover not exceeding EUR 2 million or an annual balance sheet total not exceeding EUR 2 million
minerals	a naturally occurring deposit in the earth's crust of an organic or inorganic substance, such as energy fuels, metal ores, industrial minerals and construction minerals, but excluding water

mineral supply chains	the system of activities, organisations, actors, technology, information, resources and services involved in moving and processing the minerals from the extraction site to their incorporation in the final product
minerals treatment (beneficiation, processing)	mechanical, physical, biological, thermal or chemical process or combination of processes carried out on mineral resources, including from the working of quarries, with a view to extracting the mineral, including size change, classification, separation and leaching, and the re-processing of previously discarded waste, but excluding smelting, thermal manufacturing processes (other than the burning of limestone) and metallurgical processes
mitigation measures	measures envisaged to avoid, prevent or reduce any identified significant adverse effects on the environment
monitoring measures	procedures to keep under systematic review the significant adverse effects on the environment resulting from the construction and operation of a project, and to identify unforeseen significant adverse effects, in order to be able to undertake appropriate remedial action
MS	member states (countries) of the European Union
NMVOC	non-methane volatile organic compound
off-shore	area of the sea and seabed extending from the low water mark of ordinary or medium tides outwards
operator	any natural or legal person who operates or controls an establishment or installation or, where provided for by national legislation, to whom the decisive economic or decision-making power over the technical functioning of the establishment or installation has been delegated
ozone depleting substances	chlorofluorocarbons, halons, hydrochlorofluorocarbons, carbon tetrachloride, methyl bromide, etc.
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PM	particulate matter emission to the air
pollution	direct or indirect introduction, as a result of human activity, of substances, vibrations, heat or noise into air, water or land which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment
pond	a natural or engineered facility for disposing of fine-grained waste, normally tailings, along with varying amounts of free water, resulting from the treatment of mineral resources and from the clearing and recycling of process water

POPs	persistent organic pollutants
product	substance, preparation, or good produced through a manufacturing process, other than food, feed, living plants and animals, products of human origin and products of plants and animals relating directly to their future reproduction
production cost	total costs related to current production, including mining operations, operations for the treatment (processing, beneficiation) of extracted minerals, and transport to the utilization point, normal depreciation and market-based interest charges on borrowed capital
project	the execution of construction works or of other installations or schemes, and other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources
public concerned	one or more natural or legal persons and, in accordance with national legislation or practice, their associations, organisations or groups affected or likely to be affected by, or having an interest in, the environmental decision- making procedures; non-governmental organisations promoting environmental protection and meeting any requirements under national law should be deemed to have an interest
REACH	Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals
recovery	any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy
recovery, natural recovery	in the case of water, protected species and natural habitats the return of damaged natural resources and/or impaired services to baseline condition and in the case of land damage, the elimination of any significant risk of adversely affecting human health
recycling	any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes; it includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations
rehabilitation	the treatment of the land affected in such a way as to restore the land to a satisfactory state, with particular regard to soil quality, wild life, natural habitats, freshwater systems, landscape and appropriate beneficial uses
remedial measures	any action, or combination of actions, including mitigating or interim measures to restore, rehabilitate or replace damaged

	natural resources and/or impaired services, or to provide an equivalent alternative to those resources or services
re-use	any operation by which products or components that are not waste are used again for the same purpose for which they were conceived
risk	the likelihood of a specific effect occurring within a specified period or in specified circumstances; or in another approach, the combination of the probability of an event and the consequences of that event
river basin	the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta
RMIS	European Commission Raw Materials Information System
SEA	strategic environmental assessment
severe conditions	conditions that are more severe than conditions related to design basis accidents; such conditions may be caused by multiple failures, such as the complete loss of all elements of a safety system, or by an extremely unlikely natural event
significant environmental risk	a high environmental risk (the combination of a probability of occurrence of damage (event with negative effect) and its magnitude) that cannot be disregarded without calling into question the project itself
SME	small and medium-sized enterprises, which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, or an annual balance sheet total not exceeding EUR 43 million, but excludes microenterprises
soil	the top layer of the Earth's crust situated between the bedrock and the surface, composed of mineral particles, organic matter, water, air and living organisms
soil sealing	permanent covering of an area of land and its soil by impermeable artificial material (e.g. asphalt and concrete), for example through buildings and roads.
surface water	inland waters, except groundwater; transitional waters and coastal waters, except in respect of chemical status for which it also includes territorial waters
treatment	the mechanical, physical, biological, thermal or chemical process or combination of processes carried out on mineral resources, including from the working of quarries, with a view to extracting the mineral, including size change, classification, separation and leaching, and the re-processing of previously discarded waste, but excluding smelting, thermal manufacturing processes (other than the burning of limestone) and metallurgical processes
TFEU	Treaty on the Functioning European Union

unpolluted soil	is the upper fertile layer of the ground that is not deemed to be polluted under the national law of the Member State where the site is located or under Community law
volatile organic compound (VOC)	any organic compound (containing at least the element C and one or more of H, halogens, O, S, P, silicon or N, with the exception of CO_x, inorganic carbonates and bicarbonates) as well as the fraction of creosote, having at 293,15 K a vapour pressure of 0,01 kPa or more, or having a corresponding volatility under the particular conditions of use, capable of producing photochemical oxidants by reactions with nitrogen oxides in the presence of sunlight
waste	any substance or object which the holder discards or intends or is required to discard
waste prevention	measures taken before a substance, material or product has become waste, that reduce the quantity of waste, including through the re-use of products or the extension of the life span of products, the adverse impacts of the generated waste on the environment and human health, the content of hazardous substances in materials and products
WEEE	waste electrical and electronic equipment
WFD	Water Framework Directive

8 References

8.1 EU Community legislation

The below pieces of Community environmental legislation are considered as the legal basis for extractive projects' EIA, listed in thematic clusters, and in historical order inside the cluster.

Environment in general

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC

Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC

Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage

2006/61/EC: Council Decision of 2 December 2005 on the conclusion, on behalf of the European Community, of the UN-ECE Protocol on Pollutant Release and Transfer Registers

Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC

Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law

Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products

2009/607/EC: Commission Decision of 9 July 2009 establishing the ecological criteria for the award of the Community eco-label to hard coverings

Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel

Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment

Commission Decision (EU) 2015/2099 of 18 November 2015 establishing the ecological criteria for the award of the EU Ecolabel for growing media, soil improvers and mulch

Commission Decision (EU) 2017/1217 of 23 June 2017 establishing the EU Ecolabel criteria for hard surface cleaning products (notified under document C(2017) 4241)

Commission Decision (EU) 2021/476 of 16 March 2021 establishing the EU Ecolabel criteria for hard covering products

Selected BREFs related to the scope

Industrial risk

Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC

2014/895/EU: Commission Implementing Decision of 10 December 2014 establishing the format for communicating the information referred to in Article 21(3) of Directive 2012/18/EU of the European Parliament and of the Council on the control of major-accident hazards involving dangerous substances (notified under document C(2014) 9334)

Air and climate

Council Directive 87/217/EEC of 19 March 1987 on the prevention and reduction of environmental pollution by asbestos

Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air

Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe

Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer

Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities

Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006

Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81

Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council

Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants

Nature conservation (biodiversity)

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

Council Resolution of 15 December 1998 on a forestry strategy for the European Union

Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds

Chemicals

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods

Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals

Regulation (EU) 2017/852 of the European Parliament and of the Council of 17 May 2017 on mercury, and repealing Regulation (EC) No 1102/2008

Council Decision (EU) 2017/939 of 11 May 2017 on the conclusion on behalf of the European Union of the Minamata Convention on Mercury

Council Regulation (EU) 2017/997 of 8 June 2017 amending Annex III to Directive 2008/98/EC of the European Parliament and of the Council as regards the hazardous property HP 14 'Ecotoxic'

Waste

Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture

European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste

Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles

2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147)

Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics

2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II to Directive 1999/31/EC

2005/369/EC: Commission Decision of 3 May 2005 laying down rules for monitoring compliance of Member States and establishing data formats for the purposes of Directive 2002/96/EC of the European Parliament and of the Council on waste electrical and electronic equipment

Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC

Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives

Commission Regulation (EU) No 849/2010 of 27 September 2010 amending Regulation (EC) No 2150/2002 of the European Parliament and of the Council on waste statistics

Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste

Council Regulation (EU) No 333/2011 of 31 March 2011 establishing criteria determining when certain types of scrap metal cease to be waste under Directive 2008/98/EC of the European Parliament and of the Council

2011/753/EU: Commission Decision of 18 November 2011 establishing rules and calculation methods for verifying compliance with the targets set in Article 11(2) of Directive 2008/98/EC of the European Parliament and of the Council

Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)

Commission Regulation (EU) No 493/2012 of 11 June 2012 laying down, pursuant to Directive 2006/66/EC of the European Parliament and of the Council, detailed rules regarding the calculation of recycling efficiencies of the recycling processes of waste batteries and accumulators

Commission Regulation (EU) No 1179/2012 of 10 December 2012 establishing criteria determining when glass cullet ceases to be waste under Directive 2008/98/EC of the European Parliament and of the Council

Commission Regulation (EU) No 715/2013 of 25 July 2013 establishing criteria determining when copper scrap ceases to be waste under Directive 2008/98/EC of the European Parliament and of the Council

Regulation (EU) No 1257/2013 of the European Parliament and of the Council of 20 November 2013 on ship recycling and amending Regulation (EC) No 1013/2006 and Directive 2009/16/EC

Commission Directive (EU) 2016/774 of 18 May 2016 amending Annex II to Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles

Commission Implementing Regulation (EU) 2017/699 of 18 April 2017 establishing a common methodology for the calculation of the weight of electrical and electronic equipment (EEE) placed on the market of each Member State and a common methodology for the calculation of the quantity of waste electrical and electronic equipment (WEEE) generated by weight in each Member State

Commission Implementing Decision (EU) 2018/1147 of 10 August 2018 establishing best available techniques (BAT) conclusions for waste treatment, under Directive 2010/75/EU of the European Parliament and of the Council (notified under document C(2018) 5070)

Extractive Waste

Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC

2009/335/EC: Commission Decision of 20 April 2009 on technical guidelines for the establishment of the financial guarantee in accordance with Directive 2006/21/EC of the European Parliament and of the Council concerning the management of waste from extractive industries

2009/337/EC: Commission Decision of 20 April 2009 on the definition of the criteria for the classification of waste facilities in accordance with Annex III of Directive 2006/21/EC of the European Parliament and of the Council concerning the management of waste from extractive industries

2009/358/EC: Commission Decision of 29 April 2009 on the harmonisation, the regular transmission of the information and the questionnaire referred to in Articles 22(1)(a) and 18 of Directive 2006/21/EC of the European Parliament and of the Council on the management of waste from extractive industries

2009/359/EC: Commission Decision of 30 April 2009 completing the definition of inert waste in implementation of Article 22(1)(f) of Directive 2006/21/EC of the European Parliament and the Council concerning the management of waste from extractive industries

2009/360/EC: Commission Decision of 30 April 2009 completing the technical requirements for waste characterisation laid down by Directive 2006/21/EC of the European Parliament and of the Council on the management of waste from extractive industries

Commission Implementing Decision (EU) 2020/248 of 21 February 2020 laying down technical guidelines for inspections in accordance with Article 17 of Directive 2006/21/EC of the European Parliament and of the Council

Water

Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

Decision No 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC

Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

Protocol for the Protection of the Mediterranean Sea against pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil

2013/5/EU: Council Decision of 17 December 2012 on the accession of the European Union to the Protocol for the Protection of the Mediterranean Sea against pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil

Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning

Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse

Noise

Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors

Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise

Regulation (EU) No 540/2014 of the European Parliament and of the Council of 16 April 2014 on the sound level of motor vehicles and of replacement silencing systems, and amending Directive 2007/46/EC and repealing Directive 70/157/EEC

Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council

Technical safety, occupational health

Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work

Council Directive 89/654/EEC of 30 November 1989 concerning the minimum safety and health requirements for the workplace (first individual directive within the meaning of Article 16 (1) of Directive 89/391/EEC)

Commission Directive 91/322/EEC of 29 May 1991 on establishing indicative limit values by implementing Council Directive 80/1107/EEC on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work

Council Directive 92/91/EEC of 3 November 1992 concerning the minimum requirements for improving the safety and health protection of workers in the mineral- extracting industries through drilling (eleventh individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC)

Council Directive 92/104/EEC of 3 December 1992 on the minimum requirements for improving the safety and health protection of workers in surface and underground mineral-extracting industries (twelfth individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC)

Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety

Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (Seventeenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (Sixth individual Directive within the meaning of Article 16(1) of Council Directive 89/391/EEC)

Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC

Directive 2009/104/EC of the European Parliament and of the Council of 16 September 2009 concerning the minimum safety and health requirements for the use of work equipment by workers at work (second individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC

Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC

Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom

Directive 2014/33/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to lifts and safety components for lifts

Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres

Directive 2014/28/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market and supervision of explosives for civil uses

Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment

Miscellaneous

Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the re-use of public sector information

Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications

Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection

Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93

Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

2010/787/EU: Council Decision of 10 December 2010 on State aid to facilitate the closure of uncompetitive coal mines

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC

Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC

Directive 2014/23/EU of the European Parliament and of the Council of 26 February 2014 on the award of concession contracts

Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC

Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC

Commission Regulation (EU) 2016/1005 of 22 June 2016 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards asbestos fibres (chrysotile)

Commission Implementing Decision (EU) 2016/1804 of 10 October 2016 on the detailed rules for the application of Articles 34 and 35 of Directive 2014/25/EU of the European Parliament and of the Council on procurement by entities operating in the water, energy, transport and postal services sectors (notified under document C(2016) 6351)

Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure

Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017 laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas

8.2 Communications on circular economy and raw materials

Communication from the Commission - Promoting sustainable development in the EU non-energy extractive industry /COM/2000/0265 final/

Communication from the Commission - Safe operation of mining activities: a follow-up to recent mining accidents /COM/2000/0664 final/

Communication from the Commission - Towards a Thematic Strategy on the Sustainable Use of Natural Resources /COM/2003/0572 final/

Communication from the Commission - Thematic Strategy on the sustainable use of natural resources /COM/2005/0670 final/

Communication from the Commission - The raw materials initiative: meeting our critical needs for growth and jobs in Europe /COM/2008/0699 final/

COMMUNICATION FROM THE COMMISSION - A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy /COM/2011/0021 final/

COMMUNICATION FROM THE COMMISSION - TACKLING THE CHALLENGES IN COMMODITY MARKETS AND ON RAW MATERIALS /COM/2011/0025 final/

COMMUNICATION FROM THE COMMISSION - Roadmap to a Resource Efficient Europe /COM/2011/0571 final/

COMMUNICATION FROM THE COMMISSION - MAKING RAW MATERIALS AVAILABLE FOR EUROPE'S FUTURE WELL-BEINGPROPOSAL FOR A EUROPEAN INNOVATION PARTNERSHIP ON RAW MATERIALS /COM/2012/082 final/

REPORT FROM THE COMMISSION On the implementation of the Raw Materials Initiative /COM/2013/0442 final/

COMMUNICATION FROM THE COMMISSION - On the review of the list of critical raw materials for the EU and the implementation of the Raw Materials Initiative /COM/2014/0297 final/

COMMUNICATION FROM THE COMMISSION - Towards a circular economy: A zero waste programme for Europe /COM/2014/0398 final/

COMMUNICATION FROM THE COMMISSION ON RESOURCE EFFICIENCY OPPORTUNITIES IN THE BUILDING SECTOR /COM/2014/0445 final/

COMMUNICATION FROM THE COMMISSION Closing the loop - An EU action plan for the Circular Economy /COM/2015/0614 final

REPORT FROM THE COMMISSION on the implementation of the Circular Economy Action Plan COM/2017/033 final

COMMUNICATION FROM THE COMMISSION The role of waste-to-energy in the circular economy COM/2017/034 final

COMMUNICATION FROM THE COMMISSION - A European Strategy for Plastics in a Circular Economy COM/2018/028 final

Commission notice on technical guidance on the classification of waste, C/2018/1447

COMMUNICATION FROM THE COMMISSION on a monitoring framework for the circular economy (COM/2018/029 final)

COMMISSION STAFF WORKING DOCUMENT Measuring progress towards circular economy in the European Union – Key indicators for a monitoring framework (SWD/2018/017 final)

COMMISSION STAFF WORKING DOCUMENT Report on Raw Materials for Battery Applications (SWD(2018) 245 final)

COMMISSION STAFF WORKING DOCUMENT Sustainable Products in a Circular Economy - Towards an EU Product Policy Framework contributing to the Circular Economy (SWD(2019)92final)

REPORT FROM THE COMMISSION on the Implementation of the Strategic Action Plan on Batteries: Building a Strategic Battery Value Chain in Europe (COM/2019/176 final)

REPORT FROM THE COMMISSION on the implementation of the Circular Economy Action Plan (COM/2019/190 final)

COMMUNICATION FROM THE COMMISSION The European Green Deal (COM(2019) 640)

COMMUNICATION FROM THE COMMISSION A new Circular Economy Action Plan For a cleaner and more competitive Europe (COM(2020) 98 final)

COMMISSION STAFF WORKING DOCUMENT Leading the way to a global circular economy: state of play and outlook (SWD(2020) 100 final)

COMMUNICATION FROM THE COMMISSION Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil' COM/2021/400 final

8.3 EU Community guidance documents

General methodological guides[231]

Commission guidance document on streamlining environmental assessments conducted under Article 2(3) of the EIA Directive (2016)

ENVIRONMENTAL ASSESSMENTS OF PLANS, PROGRAMMES AND PROJECTS - RULINGS OF THE COURT OF JUSTICE OF THE EUROPEAN UNION

EIA guidance - Screening (2017)

EIA guidance - Scoping (2017)

COMMISSION NOTICE Guidance document regarding application of exemptions under the Environmental Impact Assessment Directive (Directive 2011/92/EU of the European Parliament and of the Council, as amended by Directive 2014/52/EU) – Articles 1(3), 2(4) and 2(5) (2019/C 386/05)

EIA guidance - EIA report (2017)

Interpretation of definitions of project categories of annex I and II of the EIA Directive (2015)

Interpretation suggested by the Commission as regards the application of the EIA Directive to ancillary/associated works (2012)

Interpretation of definitions of certain project categories of annex I and II of the EIA Directive (pdf) (2008)

Clarification of the application of Article 2(3) of the EIA Directive

EIA - Guidance on Screening - 2001

Screening checklist: PDF, Word

EIA - Guidance on Scoping - 2001

Scoping checklist: PDF, Word

EIA Review Check List - 2001

Collection of information and data to support the Impact Assessment study of the review of the EIA Directive

Study Improving the Impact of Environmental Impact Assessment

Final report on "*The Relationship between the EIA and SEA Directives project*"

Training Package on EU Law on Environmental Impact Assessment (EIA)

Guidelines on the Assessment of Indirect and Cumulative Impacts as well as Impact interactions
(introduction, full text of the guidelines)

Guidance on the implementation of Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment

Study concerning the preparation of the report on the application and effectiveness of the SEA Directive (Directive 2001/42/EC) (Milieu Ltd., 2016)

Links between the Water Framework Directive and Nature Directives

Links between the Marine Strategy Framework Directive (MSFD 2008/56/EC) and the Nature Directives

Links between Natural and Cultural heritage

[231] https://ec.europa.eu/environment/eia/eia-support.htm

A Starter's Guide Overview on the main provisions of the Water Framework Directive, the Marine Strategy Framework Directive, the Birds and Habitats Directives, and the Floods Directive: similarities and differences

Study on the Assessment of Indirect and Cumulative Impacts as well as Impact interactions Introduction of volume 1 and volume 2, full text of volume 1 and volume 2

Commission Notice on technical guidance on the classification of waste (2018/C 124/01)

Commission Notice Guidelines providing a common understanding of the term 'environmental damage' as defined in Article 2 of Directive 2004/35/EC of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage 2021/C 118/01 (C/2021/1860)

Guides for different sectors

Streamlining environmental assessment procedures for energy infrastructure Projects of Common Interest (PCIs) (2013)

Guidance on the Application of the Environmental Impact Assessment Procedure for Large-scale Transboundary Projects (2013)

Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (2013)

Application of EIA Directive to the rehabilitation of landfills (2010)

Implementation of the Environmental Impact Assessment on the basis of precise examples – IMPEL report, 2012

Streamlining environmental assessment procedures for energy infrastructure 'Projects of Common Interest (PCIs)' - 24 July, Brussels (presentations)

The Use of Spatial Data for the Preparation of Environmental Reports in Europe (JRC technical support, 2010)

Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment (2013)

Guidance on the management of Natura 2000 sites

Best practices for the management of Natura 2000 sites

Guidance on financing natura 2000 Sites

Natura 2000 in the Marine Environment

Guidelines for the management of wilderness and wild areas in Natura 2000

Restoration and Natura 2000

Natura 2000 and spatial planning

Guidelines on non-financial reporting – Supplement on reporting climate-related information

COMMISSION NOTICE Reporting Guidelines on Disaster Risk Management, Art. 6(1)d of Decision No 1313/2013/EU (2019/C 428/07)

COMMISSION STAFF WORKING DOCUMENT Corporate Social Responsibility, Responsible Business Conduct, and Business & Human Rights: Overview of Progress Brussels, 20.3.2019 SWD(2019) 143 final

Guides for the Water Framework Directive[232]

N° 1 - Economics and the Environment - The Implementation Challenge of the Water Framework Directive

N° 2 – Identification of Water Bodies

N° 3 - Analysis of Pressures and Impacts

N° 4 – Identification and Designation of Heavily Modified and Artificial Water Bodies

N° 5 - Transitional and Coastal Waters - Typology, Reference Conditions and Classification Systems

N° 6 - Towards a Guidance on Establishment of the Intercalibration Network and the Process on the Intercalibration Exercise

N° 7 - Monitoring under the Water Framework Directive

N° 8 - Public Participation in Relation to the Water Framework Directive

N° 9 - Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive

N° 10 - Rivers and Lakes - Typology, Reference Conditions and Classification Systems

N° 11 - Planning Processes

N° 12 - The Role of Wetlands in the Water Framework Directive

N° 13 - Overall Approach to the Classification of Ecological Status and Ecological Potential

N° 14 - Guidance on the Intercalibration Process (2008-2011)

N° 15 - Groundwater Monitoring (WG C)

N° 16 - Groundwater in Drinking Water Protected Areas

N° 17 - Direct and indirect inputs in the light of the 2006/118/EC Directive

N° 18 - Groundwater Status and Trend Assessment

N° 19 - Surface water chemical monitoring

N° 20 - Exemptions to the environmental objectives

N° 21 - Guidance for reporting under the WFD

N° 22 - Updated WISE GIS guidance (Nov 2008)

N° 23 - Eutrophication Assessment in the Context of European Water Policies

N° 24 - River Basin Management in a changing climate

N° 25 - Chemical Monitoring of Sediment and Biota

N° 26 - Risk Assessment and the Use of Conceptual Models for Groundwater

N° 27 – Deriving Environmental Quality Standards – version 2018

N° 28 - Preparation of Priority Substances Emissions Inventory

N° 29 - Reporting under the Floods Directive

N° 30 - Procedure to fit new or updated classification methods to the results of a completed intercalibration exercise

N° 31 – Ecological Flows (final version)

N° 31 – Ecological Flows_Policy summary

[232] https://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

N° 32 - Biota Monitoring

N° 33 - Analytical Methods for Biota Monitoring

N° 34 - Water Balances Guidance (final version)

N° 35 - WFD Reporting Guidance

N° 35 - WFD Reporting Guidance_Annex 5

N° 35 - WFD Reporting Guidance_Annex 6

N° 36 - Article 4(7) Exemptions to the Environmental Objectives

N° 37 - Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies

N° 37 - Mitigation Measures Library

N° 1 - The EU Water Framework Directive: Statistical aspects of the identification of groundwater pollution trends and aggregation of monitoring results

N° 2 - Groundwater Body Characterisation

N° 3 - Groundwater Monitoring

N° 4 - Groundwater Risk Assessment

N° 5 - Groundwater Management in the Mediterranean

N° 6 - Groundwater Dependent Terrestrial Ecosystems

N° 7 - Recommendations for the review of Annex I and II of the Groundwater Directive 2006/118/EC

N° 8 - Methodologies used for assessing Groundwater Dependent Terrestrial Ecosystems

N° 9 – Groundwater Associated Aquatic Ecosystems (Original English version)

N° 9 – Groundwater Associated Aquatic Ecosystems (German translation)

Technical Report on Aquatic Effect-Based Monitoring Tools

Technical Background Document on Identification of Mixing Zones

Policy Document on Natural Water Retention Measures

Good Practices on Leakage Management - Main Report

Good Practices on Leakage Management - Dissemination plan

Good Practices on Leakage Management - Case Study document

CIS Guidelines on Water Reuse

Technical Report on Voluntary Groundwater Watch List Concept & Methodology

Technical Report on Threshold Value Variability Analysis

Report summarising the results of the questionnaire on better consideration of drinking water resource protection in river basin management planning

Best practice for establishing nutrient concentrations to support good ecological status

Voluntary Groundwater Watch List (Endorsed V.3.1 – June 2019)

First List facilitating Annex I and II review process of the Groundwater Directive (endorsed V.2.1 – June 2019)

Guides for the energy and non-energy extractive sector

Guidance on Non-energy mineral extraction and Natura 2000

Application of the EIA Directive to projects related to the exploration and exploitation of unconventional hydrocarbon (2012)

Guidance document on best practices in the Extractive Waste Management Plans

GUIDANCE DOCUMENT FOR ARISK-BASED PRE-SELECTION PROTOCOL FOR THE INVENTORY OF CLOSED WASTE FACILITIES AS REQUIRED BY ARTICLE 20 OF DIRECTIVE 2006/21/EC

Study on the impact of gold extraction in the EU

Establishment of guidelines for the inspection of mining waste facilities, inventory and rehabilitation of abandoned facilities and review of the BREF document

Guidelines for the inspection of mining waste facilities

Guidlines on financial guarantees and inspections for mining waste facilities

Hydrocarbons Guidance Document

Best Available Techniques Guidance Document on upstream hydrocarbon exploration and production

Communication from the Commission Safe operation of mining activities: a follow-up to recent mining accidents /COM/2000/0664 final/; https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1565015811906&uri=CELEX:52000DC0664

European Commission, 2001: Management of mining, quarrying and ore-processing waste in the European Union, 88 p.; https://ec.europa.eu/environment/waste/studies/mining/0204finalreportbrgm.pdf

European Commission, 2010: Study on the impact of gold extraction in the EU, 44 p.; https://ec.europa.eu/environment/waste/mining/pdf/IH_2010-001.pdf

European Commission, 2011: GUIDANCE DOCUMENT FOR A RISK-BASED PRE-SELECTION PROTOCOL FOR THE INVENTORY OF CLOSED WASTE FACILITIES AS REQUIRED BY ARTICLE 20 OF DIRECTIVE 2006/21/EC, https://ec.europa.eu/environment/waste/mining/pdf/Pre_selection_GUIDANCE_FINAL.pdf

European Commission, 2012: Implementation Report of Directive 2006/21/EC on the Management of waste from Extractive Industries, 147 p.; https://ec.europa.eu/environment/waste/studies/mining/Study%20Implementation%20report%20Extractive%20Waste%20Directive.pdf

European Commission, 2012 Establishment of guidelines for the inspection of mining waste facilities, inventory and rehabilitation of abandoned facilities and review of the BREF document, 19 p.; https://ec.europa.eu/environment/waste/mining/pdf/Inspection-Rehabilitation_BREF_report.pdf

European Commission, 2016: Implementation Report of Directive 2006/21/EC on the Management of waste from Extractive Industries, 131 p.; https://ec.europa.eu/environment/waste/studies/mining/waste_extractive_industries.pdf

European Commission, 2017: Assessment of Member States' performance regarding the implementation of the Extractive Waste Directive; appraisal of implementation gaps and their root causes; identification of proposals to improve the implementation of the Directive, 201 p., https://ec.europa.eu/environment/waste/studies/pdf/KH-01-17-904-EN-N.pdf

European Commission, 2019: Development of a guidance document on best practices in the Extractive Waste Management Plans, ISBN 978-92-76-00037-2 doi: 10.2779/061825, 46 p.; https://publications.europa.eu/en/publication-detail/-/publication/f18472f8-36aa-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-87989698

8.4 EU and non-EU countries' selected guidance documents

EU countries

Belgium, Flanders

DEPARTEMENT LNE AFDELING MILIEU-, NATUUR- EN ENERGIEBELEID DIENST MILIEUEFFECTRAPPORTAGEBEHEER, 2013: Richtlijnenboek milieueffectrapportage Basisrichtlijnen per activiteitengroep: ontginningen – 199 p. https://omgeving.vlaanderen.be/sites/default/files/atoms/files/ontginningen.pdf

Denmark

Miljøministeriet By- og Landskabsstyrelsen 2009: Vejledning om VVM i planloven, ISBN 978-87-7091-030-9, 129 p. https://naturstyrelsen.dk/media/nst/9948968/vvm_vejledning2.pdf

Finland

Ministry of Employment and the Economy, 2015: Guide: Environmental Impact Assessment Procedure for mining projects in Finland – Helsinki, ISSN 2342-7922, ISBN 978-952-227-964-4, 102 p., https://julkaisut.valtioneuvosto.fi/handle/10024/75001

Kauppila, T., 2015. Summary: Good Practices in Assessment of the EnvironmentalImpacts of Mining Projects. GEOLOGIAN TUTKIMUSKESKUS (GTK),Tutkimusraportti 222, 144 p., http://tupa.gtk.fi/julkaisu/tutkimusraportti/tr_222.pdf

Good Practices for Environmental Impact Assessment and Meaningful Engagement in the Arctic – Including Good Practice Recommendations 2019 – Arctic Council, 37 p., SBN: 978-952-361-005-7; https://www.sdwg.org/wp-content/uploads/2019/05/EIA_Report_Screen_Lores_Spreads.pdf

Ireland

Environmental Protection Agency, Ireland, 2017: Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR). https://www.epa.ie/pubs/advice/ea/drafteiarguidelines.html

Department of Housing, Planning and Local Government, Ireland, 2018: Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment. https://www.housing.gov.ie/sites/default/files/publications/files/guidelines_for_planning_authorities_and_an_bord_pleanala_on_carrying_out_eia_-_august_2018.pdf

Department of the Environment, Climate and Communications, 2019: Guidance for Mineral Exploration; https://www.gov.ie/en/publication/d16da-guidelines-for-mineral-exploration/

Department of the Environment, Climate and Communications, 2019: Exploration Drilling - Guidance on Discharge to Surface and Groundwater, 38 p.; https://www.gov.ie/en/publication/d16da-guidelines-for-mineral-exploration/

Department of the Environment, Climate and Communications, 2019: Guidance for Good Environmental Practice in Mineral Exploration, 11 p.; https://www.gov.ie/en/publication/d16da-guidelines-for-mineral-exploration/

Sweden

Roadmap for a competitive fossil-free mining and minerals industry in Sweden 2019 – SveMin, (in Sweedish with English abstract)

https://www.svemin.se/fardplan-for-en-konkurrenskraftig-och-fossilfri-gruv-och-mineralnaring/

Spain

Guía de buenas prácticas en la ejecución y diseño de voladuras en banco; https://energia.gob.es/mineria/Explosivos/Guias/Guia-buenas-practicas-voladuras-banco.pdf

GUÍA SOBRE CONTROL GEOTÉCNICO EN MINERÍA SUBTERRÁNEA; https://energia.gob.es/mineria/Seguridad/Guias/Gu%C3%ADas/Guia-control-geotecnico-mineria-subterranea.pdf

GUÍA SOBRE CONTROL GEOTÉCNICO EN MINERÍA A CIELO ABIERTO

GUÍA ESTABLECIMIENTOS DE BENEFICIO; https://energia.gob.es/mineria/Seguridad/Guias/Guías/2016_Guia_Establecimientos_de_Beneficio.pdf

Modelo de Oferta de Responsabilidad Ambiental; https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/responsabilidad-mediambiental/analisis-de-riesgos-sectoriales/herramientas.aspx

Proyecto de guía metodológica. Sectores: Minería de sulfuros polimetálicos y minería de sales potásicas; https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/responsabilidad-mediambiental/Guia%20Metodologica_tcm30-194065.pdf

US EPA, US AID, CCAD, 2011: EIA Technical Review Guidelines: Non-Metal and Metal Mining – https://www.epa.gov/sites/production/files/2014-04/documents/miningvol1part2.pdf

Other countries

Norway

Roadmap for decarbonized metal production in 2050; https://www.norskindustri.no/siteassets/dokumenter/rapporter-og-brosjyrer/veikart-for-prosessindustrien_web.pdf

Canada, British Columbia

Conceptual Site Model (CSM) Guidance (PDF, 1.2 MB)

Joint Act Permit Application Information Requirements (PDF)

Metal Leaching and Acid Rock Drainage (ML/ARD) Guidance and Policy (PDF)

Dust Management Plan Guidance (PDF)

Technical Guidance 1: Environmental Impact Assessment and Technical Assessment Terms of Reference (PDF)

Technical Guidance 2: Information Requirements Table (PDF)

Technical Guidance 3: Develop a Mining Erosion and Sediment Control Plan (PDF)

User Guide for Developing a Mining Erosion and Sediment Control Plans (PDF)

Technical Guidance 4: Annual Reporting Under the Environmental Management Act (PDF)

User Guide to Annual Reporting Requirements for Mining Under the Environmental Management Act (PDF)

Technical Guidance 6: Water and Air Baseline Monitoring Guidance For Mine Proponents and Operators (PDF)

User Guide to Water and Air Baseline Monitoring Requirements for Mining PDF)

Technical Guidance 7: Assessing Design Size and Operation of Sediment Ponds (PDF)

User Guide for Designing Sediment Ponds Used in Mining PDF)

Technical Guidance 8: Framework for Development and Use of Freshwater Science-Based Environmental Benchmarks for Mines (PDF)

Technical Guidance 9: Preparing Nitrogen Management Plans for Mines using Ammonium Nitrate Fuel Oil Products for Blasting (PDF)

Technical Guidance 10: Bioremediation and Discharge of Hydrocarbon Impacted Soils at Producing Mine Sites (PDF)

Technical Guidance 11: Development and Use of Initial Dilution Zones for Effluent Discharges (PDF, 1 MB)

Parameters of Concern Fact Sheet (PDF)

Mining Operations Fact Sheet (PDF)

Industrial Camps Fact Sheet (PDF)

Best Achievable Technology Fact Sheet (PDF).

Long-Term Average vs. Short-Term Maximum Water Quality Guidelines Fact Sheet (PDF)

Water Quality Management Fact Sheet (PDF)

China

Guidance document on Green Mines; https://www.stradeproject.eu/index.php?id=7

Australia

Biodiversity Management - Leading Practice Sustainable Development Program for the Mining Industry; https://industry.gov.au/resource/Documents/LPSDP/LPSDP-BiodiversityHandbook.pdf

Community Engagement and Development - Leading Practice Sustainable Development Program for the Mining Industry; https://industry.gov.au/resource/Documents/LPSDP/LPSDP-CommunityEngagement.pdf

Community Health and Safety Handbook - Leading Practice Sustainable Development Program for the Mining Industry; https://industry.gov.au/resource/Documents/LPSDP/LPSDP-Community-Health-and-Safety-Handbook.pdf

Energy Management in Mining - Leading Practice Sustainable Development Program for the Mining Industry; https://industry.gov.au/resource/Documents/LPSDP/LPSDP-Energy-Management-in-Mining-Handbook.pdf

https://industry.gov.au/resource/Documents/LPSDP/HazardousMaterialsManagmentHandbook_web.pdf

https://industry.gov.au/resource/Documents/LPSDP/LPSDP-CyanideHandbook.pdf

https://industry.gov.au/resource/Documents/LPSDP/LPSDP-MineClosureCompletionHandbook.pdf

https://industry.gov.au/resource/Documents/LPSDP/LPSDP-MineRehabilitationHandbook.pdf

https://industry.gov.au/resource/Documents/LPSDP/LPSDP-RiskHandbook.pdf

https://industry.gov.au/resource/Documents/LPSDP/LPSDP-TailingsHandbook.pdf

https://industry.gov.au/resource/Documents/LPSDP/LPSDP-WaterHandbook.pdf

Industry associations

World Aluminium, 2018: Sustainable Bauxite Mining – 116 p.; http://www.world-aluminium.org/media/filer_public/2018/05/18/170518_sbmg_final.pdf

IUCN, 2014: Biodiversity management in the cement and aggregates sector – Gland, Switzerland, 84 p.; http://www.uepg.eu/uploads/Modules/MediaRoom/2014-008.pdf

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8.5 Selected scientific literature

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Annex I: EIA and IED aspects in EU countries' legislation, an extract from the MINLEX report

	EIA guidance	EIA in permitting	thresholds applied	confidentiality applied	IED/BREF applied	National BREF
Austria	---	----	----	----	-----	-----
Flanders	yes	extraction	yes	yes	------	----
Wallonia	yes, for quarries	exploration or extraction permit	yes	no	yes, for quarries	no
Belgian North Sea	yes	exploration or extraction permit	no	no	yes	no
Bulgaria	----	Reserve certificate, Exploration	----	----	----	---
Croatia	---	location (land use) permit	---	---	---	---
Cyprus	---	land use planning	---	---	---	---
Czechia	---	extraction	---	----	----	----
Denmark	yes	extraction	no	no	no	no
Estonia	no	exploration, extraction	yes	no	no	no
Finland	yes	extraction	----	----	----	----
France	no	extraction	yes	no	yes	no
Germany	---	Extraction technical operation plan	---	---	---	----
Greece	----	extraction	----	----	----	----
Hungary	National legislation, EC Natura Guide	extraction TOP	yes	yes	yes	no
Ireland	yes	exploration drilling, extraction	----	----	yes	----
Italy	----	extraction	----	----	----	----
Latvia	no	exploration	yes	no	no	no
Lithuania	----	land use extraction	---	---	---	---
Luxembourg	---	extraction	---	----	----	---
Malta	----	extraction	----	----	----	----

The Netherlands	----	extraction	----	----	----	----
Poland	----	exploration	---	---	----	-----
Portugal	no	extraction	yes	no	yes	in prep.
Romania	---	exploration	---	---	yes	----
Slovakia	----	exploration	---	----	yes	---
Slovenia	---	land use	---	----	----	----
Spain	yes	extraction TOP	---	no	yes	no
Sweden	yes	exploration	no	no	no	no

Note: It is strongly recommended to consult the RMIS Member States Legislation country profiles for further details. The above extracts may reflect the interpretation of the authors.

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