
**Mine closure and reclamation
planning —**

**Part 2:
Guidance**

*Planification de la fermeture et de la restauration des mines —
Partie 2: Recommandations*



This document is a preview generated by EUS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	vii
Introduction.....	viii
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Closure and reclamation of a mine site.....	2
4.1 General.....	2
4.2 Tailings storage facilities.....	2
4.2.1 General.....	2
4.2.2 Objectives.....	2
4.2.3 Approach.....	3
4.2.4 Status and condition assessment.....	3
4.2.5 Risk assessment.....	4
4.2.6 Closure and reclamation alternatives analyses.....	4
4.2.7 Closure and reclamation plan.....	5
4.3 Water storage facilities.....	6
4.3.1 General.....	6
4.3.2 Objectives.....	6
4.3.3 Approach.....	7
4.3.4 Status and condition assessment.....	7
4.3.5 Risk assessment.....	7
4.3.6 Closure and reclamation alternatives analyses.....	8
4.3.7 Closure and reclamation plan.....	8
4.4 Waste rock dumps.....	9
4.4.1 General.....	9
4.4.2 Objectives.....	9
4.4.3 Approach.....	9
4.4.4 Status and condition assessment.....	10
4.4.5 Risk assessment.....	11
4.4.6 Closure and reclamation alternatives analyses.....	11
4.4.7 Closure and reclamation plan.....	12
4.5 Heap leach facilities.....	12
4.5.1 General.....	12
4.5.2 Objectives.....	13
4.5.3 Approach.....	13
4.5.4 Status and condition assessment.....	13
4.5.5 Risk assessment.....	14
4.5.6 Closure and reclamation alternatives analyses.....	14
4.5.7 Closure and reclamation plan.....	15
4.6 Open pits.....	16
4.6.1 General.....	16
4.6.2 Objectives.....	16
4.6.3 Approach.....	16
4.6.4 Status and condition assessment.....	16
4.6.5 Risk assessment.....	17
4.6.6 Closure and reclamation alternatives analyses.....	17
4.6.7 Closure and reclamation plan.....	18
4.7 Underground workings.....	20
4.7.1 General.....	20
4.7.2 Objectives.....	20
4.7.3 Approach.....	20
4.7.4 Status and condition assessment.....	20
4.7.5 Risk assessment.....	21

4.7.6	Closure and reclamation alternatives analyses.....	21
4.7.7	Closure and reclamation plan.....	21
4.8	Mine infrastructure.....	24
4.8.1	General.....	24
4.8.2	Objectives.....	24
4.8.3	Approach.....	24
4.8.4	Status and condition assessment.....	24
4.8.5	Risk and opportunity assessment.....	25
4.8.6	Closure and reclamation alternatives analyses.....	25
4.8.7	Closure and reclamation plan.....	26
4.9	Temporary closure.....	27
4.9.1	General.....	27
4.9.2	Objectives.....	27
4.9.3	Status and condition assessment.....	28
4.9.4	Risk and opportunity assessment.....	28
4.9.5	Closure and reclamation alternatives analyses.....	28
4.9.6	Closure and reclamation plan.....	28
5	Land reclamation and water management.....	29
5.1	Landforms.....	29
5.1.1	General.....	29
5.1.2	Objectives.....	29
5.1.3	Approach.....	29
5.1.4	Plan.....	30
5.2	Surface preparation.....	30
5.2.1	General.....	30
5.2.2	Objectives.....	30
5.2.3	Approach.....	31
5.3	Vegetation establishment.....	32
5.3.1	General.....	32
5.3.2	Objectives.....	32
5.3.3	Approach.....	33
5.3.4	Evaluating site conditions for revegetation:.....	33
5.3.5	Selection of revegetation approaches.....	34
5.3.6	Revegetation plan.....	35
5.3.7	Monitoring and adaptive management.....	35
5.4	Water management.....	36
5.4.1	General.....	36
5.4.2	Objectives.....	36
5.4.3	Approach.....	36
5.4.4	Water management plan.....	38
5.5	Water treatment.....	39
5.5.1	General.....	39
5.5.2	Objectives.....	39
5.5.3	Approach.....	39
5.5.4	Design.....	40
5.5.5	Operations and maintenance.....	40
5.6	Covers.....	41
5.6.1	General.....	41
5.6.2	Objectives.....	41
5.6.3	Cover design.....	42
5.6.4	Modelling and field testing.....	43
5.6.5	Monitoring and maintenance aspects specific to covers.....	43
5.6.6	Consideration of climate zones.....	43
5.6.7	Objectives.....	44
5.6.8	Wet and tropical climates.....	44
5.6.9	Arid climates.....	44
5.6.10	Cold climates.....	44
5.6.11	Temperate climates.....	45

5.7	Climate change effects.....	45
5.7.1	General.....	45
6	Stakeholder engagement.....	46
6.1	General.....	46
6.2	Objectives.....	47
6.3	Approach.....	47
6.3.1	General.....	47
6.3.2	Stakeholders identification.....	48
6.3.3	Special rights holders.....	48
6.3.4	Indigenous peoples.....	49
6.3.5	Stakeholder mapping.....	49
6.3.6	Engagement methods.....	49
6.3.7	Response program.....	49
6.3.8	Social transition — Post-closure and reclamation stakeholder agreements.....	49
6.3.9	Engagement plan.....	50
6.3.10	Engagement and reporting frequency.....	50
7	Decision and analysis tools.....	50
7.1	Design levels.....	50
7.1.1	General.....	50
7.1.2	Objectives.....	50
7.1.3	Approach.....	50
7.1.4	Conceptual design level.....	51
7.1.5	Pre-feasibility design level.....	51
7.1.6	Feasibility design level.....	51
7.1.7	Detailed design level.....	52
7.1.8	As-built documentation.....	52
7.1.9	Application of design levels to mine closure and reclamation planning.....	52
7.2	Alternatives identification and analysis.....	53
7.2.1	General.....	53
7.2.2	Objectives.....	53
7.2.3	Approach.....	53
7.2.4	Technology screening.....	54
7.2.5	Options screening.....	54
7.2.6	Options analysis.....	55
7.2.7	Stakeholder engagement.....	56
7.2.8	Documentation.....	56
7.3	Designing and operating for closure and reclamation.....	57
7.3.1	General.....	57
7.3.2	Objectives.....	57
7.3.3	Approach.....	57
7.3.4	Design criteria.....	58
7.3.5	Documentation.....	58
7.4	Risk assessment and management.....	59
7.4.1	General.....	59
7.4.2	Objectives.....	59
7.4.3	Approach.....	59
7.4.4	Corporate role in risk management and resilience engineering.....	60
7.4.5	Management of change.....	60
7.4.6	Assessing the risk of design or operational failure in meeting design objectives.....	60
7.4.7	Resilience requirements.....	60
7.4.8	Plan.....	61
7.5	Cost estimating.....	61
7.5.1	General.....	61
7.5.2	Objectives.....	61
7.5.3	Approach.....	62
7.5.4	Level of cost estimates.....	62

7.5.5	Cost estimating methodology.....	63
7.5.6	Guidance for the purposes of cost analysis	63
7.5.7	Cash flow costs.....	63
7.5.8	Financial plan.....	64
7.6	Performance monitoring and reporting.....	64
7.6.1	General.....	64
7.6.2	Objectives	65
7.6.3	Approach	65
7.6.4	Scope	66
7.6.5	Media.....	66
7.6.6	Parameters	66
7.6.7	Compliance and action trigger levels.....	67
7.6.8	Monitoring plan.....	67
7.6.9	Corrective action plan	68
7.6.10	Peer review.....	68
7.6.11	Revisions	68
7.6.12	Data collection and reporting.....	69
7.7	Adaptive management.....	69
7.7.1	General.....	69
7.7.2	Objectives	69
7.7.3	Approach	69
7.7.4	Adaptive management plan.....	70
7.8	Application to the long-term care phase	70
Bibliography		71

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents shall be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 82, *Mining*, Subcommittee SC 7, *Mine closure and reclamation management*.

A list of all parts in the ISO 21785 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides guidance for mine closure and reclamation planning applicable to both new and operating mines. The overarching objective is to promote consistency and quality in planning for mine closure and reclamation internationally. ISO 21795-1 provides requirements for the same material.

The intended audience are those with responsibility for, or an interest in, planning for mine closure and reclamation. This includes mine planners and designers, mine operators, regulators, environmental assessors, communities, indigenous peoples, and financial stakeholders, amongst others.

Mine planning, design and operations must be fully integrated with the closure and reclamation process. Early, continual and comprehensive mine closure and reclamation planning is essential for all new and operating mines because it:

- leads to the highest degree of environmental and social success, usually at a lower cost than if mine closure and reclamation planning is not done from the beginning of the mining project;
- reduces risks and liabilities throughout the mine's operational life and on closure;
- allows for stakeholder involvement throughout, so that relevant knowledge and understanding are brought into the planning process;
- allows for devoting more attention to sustainable development activities identifying socio-economic opportunities for the various closure phases;
- helps build trust with governments, stakeholders and international communities;
- provides additional planning time to understand the complexity of the biophysical characteristics and socio-economic context of each mine site;
- provides for continual improvement and updating of closure and reclamation plans;
- allows companies to better integrate closure and reclamation activities with operations;
- provides time to identify, research and develop new technologies for mine closure strategies and mine closure treatments that increase robustness and resilience of mine closure and reclamation; and
- allows companies to better provision for and schedule closure and reclamation funding.

There are many leading practices and guidance documents related to mine closure and reclamation planning available in various jurisdictions and used by many mining companies and stakeholders. This document captures the intent of such guidance documents so that it can be applied globally.

Mine closure and reclamation planning —

Part 2: Guidance

1 Scope

This document provides guidance related to the necessary mine closure and reclamation planning activities for new and operating mines. Recommendations are provided on:

- closure and reclamation of a mine site;
- land reclamation and water management;
- stakeholder engagement;
- decision and analysis tools.

The following aspects of closure and reclamation are not addressed in this document:

- infrastructure such as rail lines, ports, off-site ore loaders, power stations, etc. that are associated with the mine operation, but which are not located at the mine site;
- detailed survey, testing or monitoring methods, detailed engineering procedures, detailed product requirements, or detailed construction and operational procedures; occupational health and safety management related to closure and reclamation, construction and exploration activities;
- relinquishment of a closed and reclaimed mine site, or portions thereof, to a party (governmental or private entity) not related to the mine operator;
- specific requirements for dealing with the radiological aspects of mine closure and reclamation, such as those that occur at uranium mining and processing facilities and other mines at which naturally occurring radioactive materials are present; however, the other aspects associated with closure and reclamation of these mines are included in this document; and
- closure and reclamation of abandoned mines.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20305, *Mine closure and reclamation — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20305 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>