Co-Disposal Is Not a Technology Choice: Early-Stage Strategic Planning for Integrated Mine Waste, Tailings and Backfill Systems

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Abstract

Mine waste planning is still commonly separated into tailings, waste rock, water, closure and underground backfill workstreams. This separation is practical, but it can also lock projects into sub-optimal layouts before the most material whole-of-life decisions have been tested. By the time co-disposal is considered in detail, the mine plan, process flowsheet, tailings technology, haulage routes, waste rock dump locations and closure assumptions may already be fixed.

This paper argues that co-disposal should not be treated as a late-stage technology option, value-engineering opportunity or closure improvement. It should be treated at scoping and prefeasibility level as a strategic material management question: what streams will be generated, in what form, at what rate, with what geotechnical and geochemical behaviour, and with what long-term liability? The objective is not to promote co-disposal as universally preferable, but to force the right questions early enough for the answers to influence the project.

Keywords: co-disposal; tailings; waste rock; backfill; filtered tailings; closure; risk-based planning; integrated mine waste management.

1.0 Introduction

Co-disposal is often presented as a technology. It is not. It is a strategic planning decision about how a mine chooses to manage mass, water, risk, operating complexity and long-term liability. Most projects still progress through early studies by separating mine waste into familiar components: a tailings storage facility, waste rock dumps, a water management system, a closure concept and, where underground mining is involved, a backfill system. Each component may be technically competent, but the combined system may still be poorly optimised because the highest-value decisions sit between the boundaries.

Recent tailings governance frameworks have strengthened expectations for lifecycle management, accountability, independent review and disclosure (Global Tailings Review, 2020; ICMM, 2021). Closure guidance also emphasises that closure should be planned early and iteratively, rather than treated as an end-of-life activity (ICMM, 2019). However, these governance expectations do not always translate into early integrated planning of tailings, waste rock, water, closure and backfill. The result is that conventional slurry deposition, thickened tailings, filtered tailings, waste rock placement and backfill may be compared in separate decision trees rather than as one mine waste system.

The issue is not that separate facilities are always wrong. In many settings they remain the safest and most defensible solution. The issue is that the decision is often made by default. This paper proposes a compact framework for forcing integrated options to be tested while project flexibility still exists.

2.0 Co-disposal as a strategic planning spectrum

For this paper, co-disposal means the planned management of tailings and mine waste rock within an integrated storage, placement or landform system, where the behaviour of one stream is intentionally used to influence the performance, risk or closure outcome of the other. This definition is broader than physical mixing. A project may integrate materials through sequencing, drainage design, encapsulation, trafficable construction platforms, in-pit placement, backfill allocation or closure landform development. Conversely, simply placing materials near each other does not constitute a designed co-disposal system.

The relevant design space is broad. Waste rock may be run-of-mine, selectively placed, crushed, screened, conditioned, trucked or conveyed. Tailings may be discharged as conventional slurry, thickened slurry, paste, filtered cake or a residual stream after underground backfill allocation. Interaction may occur through active pre-mixing, in-facility mechanical mixing, tailings infill of waste rock voids, alternating lifts, rock-buttressed cells, segregated encapsulation or in-pit deposition. Each mechanism has different implications for strength, permeability, saturation, seepage quality, settlement, constructability and closure.

This is why early-stage planning cannot wait for full certainty. Early in the project, co-disposal is often rejected because there is insufficient information; later, it is rejected because the design is too advanced. A structured early-stage framework should therefore define material envelopes, decision gates, pilot or laboratory test requirements, operating assumptions and closure-driven performance criteria. This aligns with broader guidance that tailings management alternatives should consider site conditions, production schedules, material properties, geochemistry, closure and socio-environmental context (Klohn Crippen Berger, 2017).

3.0 Integrated mine waste planning framework

An integrated framework should bring tailings, waste rock, water, backfill and closure into a single decision process. It is not a substitute for design; it is a minimum strategic test before the project becomes committed to separate infrastructure packages.

Table 1. Integrated mine waste planning framework

Planning dimension	Why it matters	Critical early-stage question	Minimum evidence
Material inventory and mass balance	Co-disposal depends on timing, quantity and form of all streams.	Is the project planning separate facilities, or a mine waste system?	Tailings and waste rock schedule; lithology split; water content; backfill demand; closure material demand.
Material compatibility	Combined materials may not behave like either stream in isolation.	Which materials should be mixed, segregated or allowed to interact only under controls?	PSD, strength, permeability, geochemistry, ARD/ML potential, trafficability and combined material testing.
Transport and handling	Most concepts fail at the operating interface, not in the concept drawing.	Can the system be operated every day, at scale, during wet weather and upset conditions?	Haulage, conveyor or pipeline concept; operating narrative; contingency storage; equipment availability.

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Deposition mechanics	The final landform depends on how it is built.	Is the deposition concept a design, or only a drawing?	Lift thickness, placement sequence, compaction, pore pressure, drainage, settlement and monitoring criteria.
Water and geochemistry	Co-disposal may reduce or relocate long-term water-quality risk.	Does the concept reduce liability, or move the problem into a less visible form?	Water balance, seepage, contact water quality, ARD/ML model and closure drainage concept.
Backfill interaction	Backfill reduces surface demand only if it consumes the planned material at the planned rate.	What happens if backfill consumes less tailings, later than planned, or a different fraction?	Backfill demand scenarios, binder constraints, residual tailings characterisation and surface contingency storage.
Governance and risk ownership	Integrated physical systems require integrated management systems.	Who owns the combined risk and who can stop or change deposition?	Accountabilities, integrated risk register, change management, TARP/OMS linkage and independent review.

Source: Author, adapted from early-stage mine waste planning considerations and tailings governance guidance.

4.0 Strategic option and failure-mode screening

Early-stage assessments should compare credible integrated options against conventional alternatives without reducing the decision to a false numerical score. The key output is the uncertainty-reduction plan required to advance, modify or reject each option. Co-disposal performance depends on integrated geotechnical, geochemical and hydrological behaviour rather than on each stream considered separately (MEND, 2000; Pearce et al., 2025).

Table 2. Option screening, critical uncertainties and selection/discard criteria

Option family	Strategic value	Critical uncertainty / common failure mode	Selection or discard criterion
Conventional TSF + separate waste rock dump	Familiar design, clear separation and established permitting pathway.	Default option may advance before integrated alternatives are tested.	Retain if whole-of-life risk, water and closure liability are demonstrably lower or more controllable than integrated options.
Thickened or filtered tailings with separate rock dump	Higher water recovery, smaller pond, potential progressive closure.	Filtered tailings may be treated as “dry”; rheology, trafficability and filtration reliability may be underestimated.	Select only with evidence of moisture range, handling, compaction, wet-weather operation and contingency storage.
Waste rock facility with tailings infill	Potential footprint reduction, saturation control and integrated landform.	Tailings may not fill voids uniformly; perched water, preferential flow, pore pressure or geochemical pathways may develop.	Advance only after representative tailings-rock interaction testing, seepage assessment and geochemical compatibility review.

Option family	Strategic value	Critical uncertainty / common failure mode	Selection or discard criterion
Alternating tailings and waste rock lifts	Sequencing control, encapsulation potential and stronger link to closure landform.	Concept may work on life-of-mine totals but fail monthly or seasonally.	Retain only if the mine schedule provides suitable rock and tailings at the same time, rate and location.
Active mixing of tailings and crushed or conditioned rock	Potential improvement in gradation, void filling, trafficability and closure performance.	Mixing may be assumed but not designed.	Select only if equipment, moisture control, QA/QC, placement method and performance criteria are defined and tested.
In-pit co-disposal	Reduced surface footprint and use of mined-out voids.	Groundwater rebound, pit-wall stability, access and long-term water quality may dominate risk.	Advance only with hydrogeological, pit stability, water-quality and closure spill-point assessment.
Backfill-prioritised system with residual surface co-disposal	Reduced surface demand and improved underground support where backfill is reliable.	Backfill may be treated as guaranteed tailings consumption.	Retain only with under-consumption scenarios, binder and reticulation constraints, and residual surface storage capacity.
Hybrid staged solution	Flexibility to match changing mine phases and material availability.	Transitions may be poorly defined and governance may remain fragmented.	Select only with clear transition triggers, accountable ownership, change management and operational readiness criteria.

Source: Author, based on strategic screening failure modes for integrated mine waste systems.

5.0 Early-stage risk-taking framework

The phrase risk-taking can be uncomfortable in tailings and mine waste management. However, all early-stage planning involves risk-taking. Avoiding an integrated option because it is uncertain does not eliminate risk; it may transfer risk to a familiar conventional option with larger footprint, greater water storage, higher closure liability or lower adaptability. Recent work on co-disposal programme development also supports structured methods and stage gates for testing site-specific uncertainties (Rizzuto et al., 2025).

Table 3. Stage-gate framework for early co-disposal decisions

Study stage	Purpose	Minimum evidence	Decision standard
Scoping	Keep credible integrated options alive.	Preliminary material inventory, geochemical classification, water balance, conceptual layout, backfill demand and fatal-flaw screening.	Do not eliminate co-disposal because of uncertainty unless the conventional alternative is tested against the same uncertainty.
Prefeasibility	Test whether options are technically and operationally credible.	Material characterisation, compatibility testing, deposition concept, transport and handling, backfill interaction, water/geochemistry review, pilot trial plan	Select the option with the best whole-of-life risk-value balance, not the option that creates the least early design discomfort.

Study stage	Purpose	Minimum evidence	Decision standard
		and preliminary governance model.	
Feasibility	Prove operability before execution.	Defined deposition sequence, equipment selection, operating criteria, QA/QC and CQA, monitoring, contingency plan, closure criteria and accountable governance.	No concept should advance unless the project can explain how it will be built, operated, monitored and corrected when performance deviates from plan.

Source: Author.

6.0 Conclusions

Co-disposal should not be treated as a late-stage innovation or technology add-on. It should be treated as an early-stage planning test for the whole mine waste system. The main conclusion is not that co-disposal is always preferable. It is that a project which never tests integrated options cannot demonstrate that it has optimised tailings, waste rock, water, backfill and closure as a system.

The practical conclusions are direct: frame the decision before layouts and closure assumptions are fixed; treat co-disposal as a spectrum rather than a single technology; test material compatibility, deposition mechanics, water and geochemistry, schedule alignment, backfill reliability and governance; require an operating model; and assign clear ownership for the combined risk.

The deliberately direct message is that the industry should stop asking whether co-disposal is a promising technology and start asking why it is not a mandatory early-stage planning question.

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