



Diagnosing Critical Raw Materials Sector Readiness in Candidate Countries: A PESTLE-Based Assessment of North Macedonia

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Abstract

The Critical Raw Materials Act (CRMA), adopted by the European Union in 2024, has reorganised the regulatory horizon facing third-country and candidate-country suppliers of raw materials destined for European industrial value chains. Mineral-rich states located along the EU's enlargement frontier — including those of the Western Balkans — are now confronted with a dual obligation: aligning their domestic regulatory frameworks with the EU *acquis* as a precondition of accession, and demonstrating sufficient governance, environmental, and traceability performance to qualify as compliant upstream partners under the CRMA's strategic-supplier expectations. This paper offers a structured macro-environmental diagnostic of one such jurisdiction — North Macedonia — using the PESTLE (Political, Economic, Social, Technological, Legal, Environmental) framework as the analytical instrument. The diagnostic synthesises evidence drawn from peer-reviewed geochemical and policy literature, official accession monitoring, authoritative trade and production statistics, and primary national legal sources. Results indicate that North Macedonia's mineral endowment and existing concentrate-export profile already articulate the country into European supply chains for lead, zinc, and copper, while ferro-nickel exports have undergone a pronounced contraction in recent reporting periods. However, sectoral readiness for deeper integration is constrained by deficits in environmental enforcement capacity, by the absence of domestic intermediate processing capability, and by an extractive-waste inventory whose remediation needs remain only partially addressed despite documented concentrations of antimony, arsenic, and several companion metals at characterised facilities. The analysis identifies a feasible near-term development trajectory built on two reinforcing pillars — environmental and ESG upgrading of operating concentrate streams, and pilot-scale secondary recovery integrated with mandated remediation at priority sites — while underlining that institutional credibility, rather than mineral prospectivity, is the rate-limiting determinant of progress.

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Introduction

Three policy currents converge on the question of how candidate countries integrate into the European raw-materials economy. The first is the shift in industrial strategy that has accompanied the European Green Deal and the digital transition: meeting decarbonisation targets in transport, electricity generation, and energy storage requires materials whose supply is geographically concentrated and economically volatile [1]. The second is the consolidation of this strategic concern into binding regulation through the Critical Raw Materials Act, Regulation (EU) 2024/1252, which lists thirty-four critical and seventeen strategic raw materials and assigns 2030 benchmarks to the share of European demand to be satisfied by domestic extraction, processing, and recycling, while simultaneously capping single-source third-country dependency [1]. The third is the reactivation of EU enlargement in the Western Balkans, where the acquis-alignment process now intersects with the same raw-materials agenda through a layered set of strategic partnerships, accession-conditioned reform, and access to financing instruments oriented towards green and circular industries.

For North Macedonia, these currents arrive at a sector whose trajectory has been shaped by the long arc of Balkan mineral exploitation. Polymetallic veins at Sasa, Toranica, and Zletovo, porphyry copper-gold systems at Bučim and Borov Dol, the legacy ferro-nickel platform at Kavadarci, and a constellation of feasibility-stage projects — Ilovica–Štuka, Plavica, Crn Vrv, Kazan Dol, Kadiica — together constitute a base from which European-facing supply commitments could in principle be expanded [2-4]. Yet the same heritage has bequeathed an extensive footprint of unremediated tailings, slag heaps, and contaminated dumps, several of which have been the subject of recent geochemical re-examination as potential secondary sources of EU-listed materials [5-8]. These two faces of the country's mineral profile — prospectivity and liability — occupy the same physical and institutional space, and any credible CRM development trajectory must address them in parallel.

The literature on Western Balkans mining has matured considerably over the last decade. Region-wide assessments compiled under the RESEERVE project produced a West Balkan Mineral Register documenting both primary and secondary deposits in compliance with INSPIRE specifications [3,9]. Geochemical and mineralogical studies have characterised tailings in Serbia and North Macedonia in support of European secondary-supply strategies [7,8]. Strategic policy commentary from the Adria region has analysed CRMA implications for candidate jurisdictions [2,10]. Resource-efficiency assessments across Eastern and South-Eastern Europe have benchmarked North Macedonia against comparator economies [11]. What remains thinner in the literature is a country-level synthesis that combines this scientific evidence with the institutional and regulatory dimensions captured in EU accession monitoring, and that assesses readiness against the specific CRMA performance benchmarks now in force.

This paper aims to contribute that country-level synthesis. The contribution is threefold. First, it operationalises the PESTLE framework as a structured diagnostic for sectoral readiness, rather than as a generic environmental-scanning device. Second, it organises the available evidence on North Macedonia along six analytical dimensions, each evaluated against an explicit EU-anchored benchmark. Third, it derives a parsimonious set of evidence-grounded policy levers calibrated to the CRMA's strategic-supplier expectations and to the country's accession trajectory.

The remainder of the paper is organised as follows. Section 2 sets the conceptual anchor, summarising the CRMA architecture and the established use of PESTLE in resource-sector diagnostics. Section 3 documents the methodology and source base. Section 4 presents the PESTLE diagnostic, dimension by dimension. Section 5 synthesises cross-dimensional findings, and Section 6 concludes with policy implications.

Conceptual Background

The CRMA Supply Architecture

The CRMA codifies an interventionist response to documented vulnerabilities in European raw-materials

supply. Its substantive innovations include the formal designation of strategic and critical materials lists, the establishment of share-of-demand benchmarks for domestic capacity by 2030, the introduction of fast-tracked permitting for projects designated as strategic, the creation of due-diligence obligations along industrial value chains, and explicit provisions for the recovery of critical materials from extractive waste [1,12]. The Act simultaneously frames the role of trusted third-country suppliers, with diversification and traceability serving as twin pillars. For an EU candidate, this architecture creates incentives that operate across the political, regulatory, and commercial registers concurrently — a feature that is well captured by a multi-dimensional analytical framework.

The relationship between extractive-waste valorisation and CRMA compliance deserves particular emphasis. Recent reviews of recovery from mine and mineral-processing tailings document significant advances in selective leaching, biohydrometallurgical methods, and integrated remediation–recovery workflows that lower the energy and water footprint of secondary-source utilisation relative to primary extraction [5]. These methodological advances align directly with the CRMA's recycling and circularity ambitions and create technical grounds on which a country with a substantial extractive-waste legacy can pursue compliance pathways without first expanding primary mining capacity.

PESTLE as a Resource-Sector Diagnostic

The PESTLE technique was developed in the strategic-management literature as a tool for cataloguing macro-environmental influences on the success or failure of an organisation, an industry, or a market, by sorting those influences into political, economic, social, technological, legal, and environmental categories [13]. The framework's adaptability to sector-level analysis has been demonstrated across diverse contexts, including the construction industry, distributed energy infrastructure in Mozambique, and low-grade copper-mining viability in Zambia [13–15]. In resource-sector applications, the framework's strength lies in surfacing the institutional and environmental conditions that frequently dominate project economics in transition jurisdictions — conditions that purely techno-economic studies tend to underweight. Soares and colleagues report that political and economic factors

collectively account for nearly half of the weight assigned by experts in developing-country PESTLE applications, a finding consistent with the prominence of governance and macroeconomic conditions in mining-investment decisions in the Western Balkans [14].

PESTLE is used here in its diagnostic rather than its descriptive mode. Each dimension is assessed against an explicit EU-derived benchmark, evidence is extracted from traceable peer-reviewed or institutional sources, and findings are aggregated into a cross-dimensional synthesis intended to support policy formulation rather than scenario forecasting.

The Western Balkans Research Base

Three lines of inquiry are relevant. The first comprises geological and metallogenic studies of the region's mineral systems, situating the principal deposits within the Tethyan Eurasian metallogenic belt and characterising their host-mineralogical and ore-genetic features [2–4]. The second focuses on extractive-waste inventories: Šajn and colleagues estimate that approximately 2.6 gigatonnes of mining and metallurgical waste are deposited at 1,650 sites across the West Balkan region, with around 270 million tonnes at 42 sites considered prospective for valorisation [6]. Site-specific geochemical work documents commodity-grade and trace-element signatures at active and abandoned tailings facilities in North Macedonia [7,8]. The third concerns regulatory and policy framing, including the implications of the CRMA for the Adria region and an emerging body of analytical work on EU–Western Balkans secondary-raw-materials cooperation [10,12]. None of these literatures has yet been integrated into a country-level diagnostic for North Macedonia organised explicitly around CRMA performance categories.

Methods

Analytical Approach

The diagnostic follows a four-step procedure. First, evidence is extracted from a curated source base (Section 3.2) and assigned to one of the six PESTLE dimensions. Second, each dimension is summarised against an EU-derived benchmark drawn from CRMA articles, accession monitoring criteria, or relevant directives (Water Framework, Mining Waste, Environmental Liability, Habitats). Third, dimension-level findings are aggregated into a cross-cutting analytical narrative that traces compounding interactions between dimensions

— conditions in which a deficiency in one register amplifies constraints in another. Fourth, the findings are translated into an evidence-anchored set of policy levers, each tied to an institutional actor and a measurable indicator.

Source Base and Verification

To ensure that the diagnostic rests on traceable evidence, only four categories of sources are admitted: (i) peer-reviewed journal articles and conference papers; (ii) official EU regulatory and monitoring documents; (iii) intergovernmental statistics from established providers; and (iv) sectoral analyses produced by recognised research institutions. Press materials and unverified secondary aggregations are excluded. Within these categories, recency was prioritised wherever the underlying conditions are subject to rapid change — particularly in the political, economic, and legal dimensions.

The geochemical evidence base draws on Steiner et al.'s tailings characterisations, the regional secondary-raw-materials assessment of Šajn et al., the Veles slag-deposit study, the long-standing Lojane investigation by Alderton and co-authors, and the Jugohrom hexavalent-chromium contamination study by Mihailovski et al. [6-8,16,17]. The legal-regulatory evidence is anchored in Regulation (EU) 2024/1252 and the European Commission's 2025 enlargement monitoring report on North Macedonia [1,18]. Production and trade statistics are taken from the Reichl and Schatz World Mining Data compilation, the European Training Foundation review on critical-raw-materials skills, and the West Balkan Mineral Register [9,19,20]. Western Balkans context and policy framing rely on Borojević Šošтариć, Giannakopoulou et al, Pličanič et al., Kursunoglu, and Righetti et al. [2,5,10,11,21,12].

Limitations

Three limitations should be noted at the outset. The diagnostic is qualitative, drawing on quantitative data where they exist, but does not weight PESTLE dimensions through stakeholder-survey methods of the type applied in some prior applications [14,15]. Some indicators — particularly those concerning beneficial ownership and concession-level revenue flows — are imperfectly disclosed in publicly accessible records. Finally, the trade-flow series for ferro-nickel exhibits a pronounced break in the most recent reporting period that warrants independent corroboration before policy conclusions are drawn from it.

PESTLE Diagnostic: Findings

The diagnostic findings are summarised in Table 1, which juxtaposes the principal evidence available for North Macedonia in each PESTLE dimension against the corresponding EU benchmark. The narrative below elaborates the entries and links each to the underlying source.

Table 1: Macro-Environmental Diagnostic of the North Macedonian Critical Raw Materials Sector Against EU Benchmarks.

Dimension	Evidence (North Macedonia)	EU benchmark	Diagnostic verdict
Political	Closer alignment with EU accession trajectory; persistent rule-of-law and anti-corruption concerns flagged in 2025 monitoring [18]; institutional reorganisation through a dedicated Ministry of Energy, Mining and Mineral Resources	Trusted-supplier governance under CRMA Article 8; rule-of-law conditionality under enlargement	Material gap in enforcement credibility

Economic	Lead, zinc, and copper concentrates exported at scale; mining and quarrying contributes a modest share of GDP; ferro-nickel exports show a sharp contraction in 2024 reporting [22]	CRMA 2030 benchmarks for extraction, processing, recycling; single-source cap [1]	Upstream participation present; Upstream participation present; intermediate processing absent
Social	Documented community opposition and concession termination at Kazandol (2018); pollution incident at Toranica (2025) with parliamentary scrutiny [18]; weak public participation in environmental decision-making	Acquis on public participation in EIA/SEA; CRMA ESG and community-consent expectations	Elevated social-licence risk
Technological	Active flotation and SX/EW capacity at Bučim; underground operations at Sasa with paste-backfill modernisation; characterised tailings inventory of approximately 177 megatonnes [7]; no domestic intermediate refining	CRMA recycling benchmark; BAT compliance for extractive industries	Secondary-resource potential not yet operationalised
Legal	2025 Mineral Resources Act introducing strategic-project designation and concession-fee revisions; EIA and SEA frameworks not fully aligned with the EU acquis [18]	EIA and SEA Directives; Environmental Liability Directive; CRMA due-diligence obligations	Partial alignment; environmental-law gaps require closure
Environmental	Hexavalent chromium concentrations at Jugohrom reported at 132.98 mg/L against a 0.01 mg/L maximum allowable level [17]; arsenic and antimony concentrations exceeding 10,000 ppm at Lojane [7,16]; structural shortfalls in inspection capacity [18]	Water Framework Directive; Mining Waste Directive; Habitats Directive; NATURA 2000	Documented non-compliance at legacy sites

Political Dimension

The political dimension is dominated by the country's EU accession trajectory and by the institutional configurations through which mining is governed. The European Commission's 2025 monitoring report confirms that North Macedonia has progressed through screening across all six negotiating clusters and has adopted a Reform Agenda within the EU Growth Plan's Reform and Growth Facility framework [18]. This represents the principal enabling political condition, since accession conditionality creates institutional incentives for the kind of regulatory convergence that the CRMA also rewards.

Against this enabling background, the same monitoring report records that no progress was made in the prevention of corruption during the reporting period, that corruption is described as both prevalent and a serious concern, and that specific credibility problems were documented at the State Commission for Prevention of Corruption [18]. In sectors where licence allocation, environmental permitting, and inspection regimes shape access to deposits and operating conditions, governance deficits of this character translate directly into sovereign and project risk.

The institutional architecture of mining governance has been the subject of recent reform. The establishment of a Ministry of Energy, Mining and Mineral Resources, separate from the broader economic portfolio, has the potential to enable more focused regulatory development for the extractive sector, particularly in coordination with energy-transition and decarbonisation portfolios. The same period has seen the introduction of a revised Mineral Resources Act, including a strategic-project designation that enables accelerated environmental permitting for deposits meeting EU criticality criteria, and an upward revision of concession fees in early 2025. Whether these provisions translate into compliance-grade outcomes will depend on enforcement capacity rather than on legislative text alone — a point underlined by the parliamentary scrutiny that followed the 2025 Toranica incident discussed below.

Economic Dimension

The economic dimension presents a profile of upstream concentrate participation in European value chains, accompanied by a structural absence of intermediate processing capacity. North Macedonia's principal mineral exports are lead, zinc, and copper concentrates produced at Sasa and Bučim respectively, alongside a smaller flow from Borov Dol and feasibility-stage projects with unrealised commercial output [3,19]. Reichl and Schatz report annual lead production of approximately 43,490 tonnes and zinc production of approximately 31,040 tonnes in the most recent fully reported period, with associated silver output from the polymetallic deposits at Toranica, Sasa, and Zletovo and gold output from the porphyry systems [19]. Mining and quarrying contribute a modest but stable share of national gross domestic product, in the low single-digit range typical of small upstream economies in the region. The export-led character of the sector means that price formation, marginal-cost competitiveness, and CRMA compatibility are the salient economic determinants. None of these are domestically controlled. The ferro-nickel platform at Kavadarci illustrates the sensitivity to international conditions: a sector that historically generated export receipts of comparable order to combined lead-zinc-copper exports is reported in national trade statistics to have undergone a near-complete contraction in 2024 [22]. Whether this represents structural, ownership-driven, or transient causes warrants validation against

firm-level reporting before being incorporated into national supply-chain strategy. A second economic feature is the deferred liability embedded in legacy tailings: at characterised sites including Bučim, Sasa, Probištip, and Lojane, geochemical investigations document material concentrations of by-product elements with current or prospective EU criticality status [7]. The opportunity cost of leaving these resources unrecovered is therefore a direct economic counterpart to the environmental liability discussed below.

Social Dimension

The social dimension of CRM development in North Macedonia is conditioned by two recent episodes that illustrate the fragility of social licence. The first is the termination of the Kazandol copper concession in 2018, in response to organised community opposition centred on water and agricultural impacts. The second is the Toranica tailings incident of March 2025, which prompted parliamentary hearings and intensified public scrutiny of dam-safety regimes. The European Commission's 2025 report explicitly identifies the latter as having revealed serious enforcement gaps and a lack of emergency-preparedness protocols [18]. Both episodes are consistent with the broader institutional finding that public-participation mechanisms in environmental impact assessment remain weak and that access-to-justice for environmental matters is limited in practice. These episodes have a cumulative effect on the political feasibility of new project approvals. Where mining is perceived to advance against, rather than with, local communities, opposition becomes self-reinforcing, particularly when channelled through court proceedings or international arbitration. From an investor perspective, this kind of risk is poorly diversifiable and is therefore priced into capital-cost expectations or expressed through outright avoidance. The technical workforce dimension is a subordinate but consequential constraint. Skills in geometallurgy, hydrometallurgy, and environmental monitoring — precisely the competencies required for an integrated remediation–recovery programme on legacy waste — are scarce in the domestic labour market, and emigration pressure on technically qualified personnel further depletes the available base. The European Training Foundation has documented the broader skills gap relevant to CRM-sector development across the European context [20].

Technological Dimension

Technological capability splits into two streams with differing maturity profiles. The primary-extraction stream is operational. The Sasa mine sustains a substantial flotation circuit with reported processing of plant feed in the order of three-quarters of a million tonnes annually and outputs of lead and zinc concentrates aligned with European processor specifications. The Bučim copper operation combines a flotation circuit with solvent-extraction–electrowinning capacity. The Kavadarci ferro-nickel platform, when operating, has constituted the only metallurgical integration in the country, producing low-carbon ferronickel granules for stainless-steel applications. Beyond these operating assets, no domestic capacity exists for the intermediate refining or downstream metallurgical conversion that would qualify under the CRMA's processing benchmark.

The secondary-resource stream is at present scientifically characterised but commercially untested. Steiner and colleagues report aggregate volumes of approximately 177 megatonnes at characterised facilities in North Macedonia, with copper-related mineralogy at Bučim, lead-zinc tailings at Sasa with measurable gallium and germanium signatures, and lead-zinc tailings at Probištip with documented indium concentrations of approximately 9 ppm in addition to commodity-grade lead and zinc [7]. The Lojane tailings, much smaller in mass at over one million tonnes, present the most extreme geochemical signature, with arsenic and antimony each exceeding 10,000 ppm, alongside elevated leachability under wet conditions [7,16]. Šajn and colleagues situate these site-level findings within a regional inventory that estimates 1,650 deposit sites across the Western Balkans hosting approximately 2.6 gigatonnes of mining and metallurgical waste, of which approximately 270 megatonnes at 42 sites are considered prospective for valorisation under contemporary metal prices [6]. Their 2022 estimate of recoverable value, at approximately USD 18.1 billion across the region, places the West Balkans in a materially different position from incidental brownfield reprocessing prospects elsewhere in Europe [6].

The Veles slag deposit warrants individual mention. Its geochemical re-examination identifies an average zinc content of approximately 9.6 percent, an estimated 120,000 tonnes of recoverable zinc, and the additional presence of cadmium, silver, gold, indium, and trace concentrations of selected rare earth elements in a single, spatially-bounded, urban-proximal landfill [8]. The site combines a remediation imperative with a metallurgical-recovery prospect that few legacy waste deposits in Europe can match. International recovery technologies have advanced sufficiently to make such resources accessible: hydrometallurgical and biohydrometallurgical methods, ambient-temperature bioleaching with appropriate microbial consortia, and integrated remediation–recovery workflows compatible with Best Available Techniques are documented in the contemporary review literature [5,21].

Table 2: Geochemical and Volumetric Profile of Characterised Tailings Facilities in North Macedonia. Compiled from [7,8,16].

Facility	Area (ha)	Volume (Mt, approx.)	Notable geochemical signatures	Relevance to CRM recovery
Bučim	~250	~125	Cu-related mineralogy; elevated Cu, Mo, Re reported	Secondary Cu recovery; potential by-product co-extraction
Sasa (I–III)	~47 (combined)	~20	Pb–Zn tailings; measurable Ga, Ge, In	By-product recovery (Ga, Ge, In) requires concentrate metallurgy
Probištip (I–III)	~97 (combined)	~30	Pb ~4,640 ppm; Zn ~4,020 ppm; In ~9.1 ppm	Re-processing of Pb–Zn with In by-product after remediation

Lojane	~3	~1	As >10,000 ppm; Sb >10,000 ppm; high leachability	High Sb potential; remediation is the priority constraint
Veles slag (MHK Zleto-vo)	~3.3 (33,000 m ²)	~1.2	Zn ~9.6%; Pb ~1%; Cd, Ag, Au, In, selected REE	Coupled urban remediation and metallurgical recovery
Total (characterised)	—	~177.2	Heterogeneous; site-specific assessments required	Aggregate secondary base; no operational recovery to date

Legal Dimension

The legal-regulatory dimension presents partial acquis alignment with sectorally relevant gaps. The Mineral Resources Act adopted in 2025 introduces a number of features that move the regime closer to CRMA expectations: a strategic-project designation that allows accelerated environmental permitting for deposits meeting CRM criteria; a clearer concession-term and royalty structure; and quarterly fee-payment mechanisms intended to support municipal-level fiscal flows. These provisions provide the formal legislative basis for CRMA-aligned project pipelines.

The European Commission's 2025 report nonetheless identifies persistent gaps that condition the practical effect of these reforms [18]. The Environmental Impact Assessment and Strategic Environmental Assessment frameworks are not yet fully aligned with the corresponding EU directives, which has direct implications for both accession progress and CRMA strategic-project eligibility, since fast-tracked permitting under the Act presupposes a baseline of EU-equivalent environmental review. Alignment with the Environmental Liability Directive is incomplete. A law on industrial emissions was adopted in mid-2025, but implementing guidance and inspection capacity remain to be established. Beneficial-ownership transparency for concession-holding entities is not systematically published, a gap relative to CRMA due-diligence expectations and to anti-corruption commitments under enlargement conditionality. Pličanič and colleagues identify additional legal questions specific to circular-economy approaches in the country, including end-of-waste status determination, construction-sector legislation governing the use of recycled aggregates, and the interaction between national circular-economy roadmaps and EU directives [21].

Environmental Dimension

The environmental dimension presents the most acute documented gap between national conditions and EU benchmarks. Three quantified pollution cases provide the principal evidence. At the Jugohrom dump in the Polog valley, Mihailovski and colleagues report hexavalent-chromium concentrations in shallow groundwater reaching 132.98 mg/L, exceeding the documented maximum allowable concentration of 0.01 mg/L by more than four orders of magnitude, with downstream river effects [17]. At Lojane, the long-standing study by Alderton and colleagues documents the mobility of arsenic and antimony in tailings holding over one million tonnes of material with localised arsenic-concentrate pockets [16], findings reinforced by the more recent geochemical work of Steiner and colleagues showing arsenic and antimony signatures each above 10,000 ppm [7]. At Toranica, the Commission's 2025 report describes the March 2025 incident as having revealed serious enforcement gaps and a lack of preparedness protocols [18]. At the Veles slag landfill, Šajn and colleagues document widespread soil and air contamination with cadmium, lead, and zinc that historically generated elevated lead concentrations in the blood of local schoolchildren [8]. At system level, the Commission identifies insufficient environmental-administration staffing, weak transparency in permitting procedures, limited progress on circular-economy and waste-management implementation, incomplete alignment with the Environmental Liability Directive, stalled progress on the Habitats and Birds Directives, and inadequate NATURA 2000 preparation [18]. Each of these is consequential for CRM-sector development, since EU-aligned mining and processing operations depend on baseline environmental-governance performance that current arrangements do not yet provide.

The environmental dimension also contains the principal opportunity. The same legacy contamination that constitutes liability is, in several documented cases, geochemically co-located with concentrations of CRM-relevant elements that are technologically accessible under contemporary recovery methods [5,7,8]. Environmental remediation and secondary-resource recovery can, in principle, be configured as complementary rather than competing programmes, but only if executed under independent environmental monitoring and with strict water and emissions controls.

Discussion

Three patterns emerge from the dimension-level findings.

The first concerns the relationship between political and legal conditions on the one hand and economic outcomes on the other. The country's existing concentrate exports demonstrate that European supply chains can absorb upstream output produced under current conditions: the buyer side has accommodated, through pricing and contracting, the risks attaching to the Western Balkans as a sourcing region. What it has not absorbed — and is unlikely to absorb in the CRMA era — is investment exposure to the regulatory, environmental, and litigation risks that accompany upstream expansion or processing investment. The Kazandol arbitration and the Ilovica–Štuka procedural history both illustrate the cost of misaligned environmental and concession governance for project economics. CRMA due-diligence expectations will sharpen this distinction further. The credibility deficit identified in the political dimension therefore translates not into a failure of current trade flows but into a constraint on the deepening of those flows toward higher-value processing stages. The second pattern concerns the joint geochemical and environmental signature of the legacy tailings inventory. Sites characterised in the published literature as environmental hotspots — Lojane, Veles, Probištip, the broader Sasa complex — are the same sites characterised as containing materially relevant concentrations of CRM-listed or prospectively listed elements [6,7,8,16]. This co-location offers an opportunity to design integrated remediation–recovery interventions whose financial logic differs from greenfield primary mining. The capital intensity of secondary-resource recovery is in general lower than that of new mine development; the social-licence risk profile is different (the underlying

sites are not pristine and remediation has independent public-interest justification); and the alignment with CRMA recycling and circularity provisions is direct. Whether this opportunity becomes operational depends on the establishment of three preconditions: a national inventory of secondary resources with risk-ranked prioritisation; environmental-monitoring capacity sufficient to ensure that recovery activities do not exacerbate existing contamination; and contracting structures — with downstream EU processors — through which the recovered material can be priced and traded under CRMA-compatible due-diligence regimes.

The third pattern concerns the function of EU accession as a meta-driver. Accession conditionality, the CRMA, the Reform and Growth Facility, the Western Balkans CRM cooperation track, the European Training Foundation's CRM-skills agenda, and the broader strategic-autonomy literature all push in the same direction with respect to the institutional reforms that the diagnostic identifies as constraining [18,20]. The historically novel feature of the present moment is the alignment of these external drivers with the commercial incentives of EU-side processors and battery-supply-chain participants seeking near-shore, traceable raw-materials inputs. This alignment is unlikely to persist indefinitely. The CRMA's 2030 benchmarks will catalyse capacity investment elsewhere — in Serbia, in the Iberian peninsula, in Scandinavia, and outside Europe under strategic-partnership agreements — and the windows of opportunity for any specific candidate jurisdiction to be designated as a priority partner are correspondingly time-bound.

Two further observations should be recorded. First, the analysis here is conducted at a level of aggregation that may obscure differences across deposits and operators. Site-level techno-economic studies remain necessary for the design of any specific intervention, particularly at Lojane, where geochemical hazards constrain the operational envelope, and at Veles, where urban proximity raises additional planning and consent considerations. Second, the diagnostic does not address the wider regional political economy in which competition among Western Balkans jurisdictions for European preference operates: a comparative assessment across Serbia, Bosnia and Herzegovina, Albania, Montenegro, and Kosovo would supplement the country-level findings reported here.

Conclusions and Policy Implications

This paper has presented a structured PESTLE diagnostic of the readiness of North Macedonia's critical raw materials sector for deeper integration into European supply architectures shaped by the Critical Raw Materials Act. The diagnostic indicates that geological prospectivity and existing concentrate-export flows are not the rate-limiting determinants. The decisive factors are the credibility of environmental enforcement, the alignment of EIA and SEA frameworks with the EU acquis, the transparency of concession governance, and the operational integrity of tailings-safety regimes — conditions whose present performance falls materially short of CRMA strategic-supplier expectations.

Six policy levers follow from the analysis, presented here without ranking and with explicit linkages to the diagnostic evidence.

First, a national strategy on critical and secondary raw materials, mapped explicitly to the CRMA's strategic and critical materials lists and to the 2030 benchmarks. Such a strategy should incorporate a standardised inventory and risk-ranking of tailings and extractive waste, building on the geochemical work of Steiner and colleagues and Šajn and colleagues and prioritising sites where commodity recovery is co-located with documented environmental hazard [6-8].

Second, comprehensive EIA and SEA acquis alignment, in line with the European Commission's 2025 recommendations [18]. This is the legal reform with the largest single effect on investment risk reduction and on the eligibility of any subsequent strategic-project designations under the Mineral Resources Act.

Third, an extractives-transparency standard covering concession agreements, beneficial ownership, environmental permits, inspection outcomes, and revenue flows, published as open and machine-readable datasets. Such transparency is a precondition both for CRMA due-diligence compliance and for the credibility of the anti-corruption agenda that EU monitoring identifies as unresolved [18].

Fourth, mandatory tailings-safety audits and emergency-response protocols across operating and inactive facilities, with independent monitoring and

public reporting. The Toranica incident demonstrates that present arrangements are inadequate even at active mines, while the geochemical signatures at Lojane document the urgency of pre-emptive action at legacy sites [7,16,18].

Fifth, pilot-scale secondary-recovery initiatives at high-priority sites — Lojane, Probištip, Sasa, and the Veles slag landfill — designed in tandem with mandated remediation, governed by strict water and emissions controls, and conditional on community consent. Pilot results should be reported against CRMA recycling-benchmark progress and feed the national strategy referenced above.

Sixth, sustained investment in human capital and applied-research infrastructure, with priority on hydrometallurgy, geometallurgy, and environmental monitoring. Coordinated programming with the European Training Foundation's CRM skills agenda and with regional research groups conducting Western Balkans tailings-geochemistry work would shorten the lead time required to operationalise the recommendations above [6,7,20].

The shared feature of these levers is that they precede, rather than accompany, large-scale primary-mining expansion. The position taken here is that an upstream investment-led trajectory in advance of governance reform would compound rather than resolve the dimensions of risk identified by the diagnostic. The sequence matters: institutional credibility is the threshold condition under which both the CRMA's strategic-supplier expectations and the broader objectives of the EU accession process can be jointly met.

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