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## Article

# Strategic Adoption of Voluntary Sustainability Standards: Business Implications of ANSI/NSI 373 in the Dimension Stone Industry

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## Abstract

Based on semi-structured interviews with individuals with direct involvement in the certification process, this study examines the ANSI/NSI 373: Sustainable Production of Natural Dimension Stone standard from a business perspective, analyzing its adoption within the North American dimension stone industry and comparing it to voluntary sustainability initiatives (VSIs) in the forest sector. Key factors driving adoption include environmental and social responsibility, competitive positioning, and market differentiation. The findings reveal both the opportunities and the barriers that businesses face in integrating sustainability standards, including certification credibility, operational challenges, and varying levels of industry acceptance. While ANSI/NSI 373 offers potential value in branding and environmental responsibility, inconsistent firm responses and rigorous certification demands pose challenges to widespread implementation. This research underscores the need for strategic collaboration among industry stakeholders to enhance adoption, improve market positioning, and leverage sustainability as a business advantage.

**Keywords:** dimension stone; ANSI/NSI 373 standard; voluntary sustainability initiatives; certification compliance; social responsibility; market positioning; competitive advantage



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## 1. Introduction

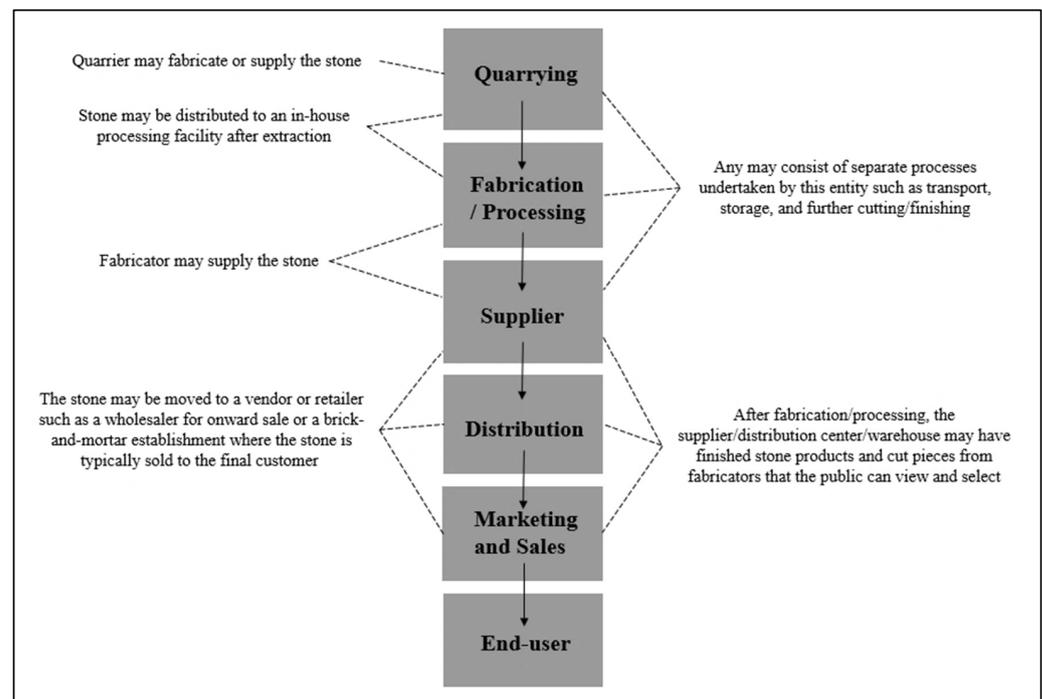
The dimension stone industry—a key supplier for architectural, construction, and design applications—is under increasing pressure from markets and stakeholders to demonstrate environmental and social responsibility. Firms have started to address these expectations. A key response has been the creation and adoption of voluntary sustainability initiatives (VSIs). One such initiative is the ANSI/NSI 373: Sustainable Production of Natural Dimension Stone standard—a certification designed to promote responsible quarrying and processing practices within the North American stone industry (Natural Stone Institute, 2022).

Similar to forest certification programs such as the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI), ANSI/NSI 373 offers a structured framework aimed at improving environmental performance, social governance, and long-term economic viability in the natural stone sector. This standard is particularly relevant as the demand for sustainable building materials grows, fueled by global trends in green con-

struction, corporate environmental, social, and governance (ESG) commitments, and the rising influence of sustainability in procurement decisions.

Dimension stone refers to quarried blocks that are cut and finished for uses from architecture, interior design and construction, to monuments, sculpture, and landscaping (Bianco & Blengini, 2019; Minerals Education Coalition, 2022). Dimension stone, such as marble, granite, limestone, quartzite, slate, and sandstone, has been quarried for millennia and continues to be a traditional product today in applications such as floors, walls, tiling, paving, countertops, furniture, and stairs (Careddu, 2019). There are also engineering applications for dimension stones such as bridges, walls, blocks, beams, and arches. Structural benefits of dimension stone include reliable support systems and durability, while fabrication benefits include manipulation and cutting ability (Boothby, 2015).

The industry is structurally fragmented. Natural stone producers vary widely in size, location, and operational practices. The production system typically involves a multi-step supply chain: quarrying, fabrication/processing, supplier, distribution, marketing and sales, and end user (Figure 1). Low integration can obscure supply-chain visibility and complicates third-party audits and chain-of-custody tracking—essential elements of credible certification (Natural Stone Institute, 2025; The University of Tennessee Center for Clean Products, 2009a; Vanteddu & Nicholls, 2020). In other words, firms are often vertically integrated, controlling multiple stages of production (Guan & Rehme, 2012).



**Figure 1.** The dimension stone supply chain.

The dimension stone supply chain faces growing scrutiny due to the environmental and social impacts of its quarrying, processing, and distribution activities, including effects on ecosystems, resource consumption, air and water quality, and community well-being (Boiral & Heras-Saizarbitoria, 2017; Careddu, 2019; Gazi et al., 2013). These challenges make sustainability a critical business consideration. In response, sustainability certification is increasingly viewed as a strategic tool, helping firms address risks while supporting market differentiation and brand reputation (Potts et al., 2018; Rezaee, 2016; United Nations Conference on Trade and Development, 2023).

It is important to consider how the nature of the dimension stone supply chain, especially as it is often vertically integrated, can impact the implementation and verification of sustainability standards such as ANSI/NSI 373. Integration can both hinder and support certification efforts. Limited integration reduces supply chain visibility and poses challenges for third-party verification and chain-of-custody tracking, both of which are essential to credible sustainability certification (Calkins, 2018; Potts et al., 2018). Vertically integrated firms may streamline certification by improving transparency and consistency in meeting ANSI/NSI 373 criteria (Natural Stone Institute, 2022, 2025). In contrast, traceability may be complicated when materials pass through multiple intermediaries (or cross between legal jurisdictions), making it difficult to verify sustainability claims (Potts et al., 2018).

ANSI/NSI 373 addresses the industry's chronic transparency gaps and unverified sustainability claims. Historically, producers self-reported sustainable practices without third-party verification, making it difficult for stakeholders—especially those in green building markets—to assess the credibility of such claims (Potts et al., 2018; Spanier, 2016). Lack of representation, or misrepresentation of stone origin and fabrication locations—for example, labeling imported stone as domestic—further undermined trust in the supply chain (Calkins, 2018; Reis, 2004). ANSI/NSI 373 addresses these issues through a certification process that integrates comprehensive sustainability criteria and a traceability system to clarify the origin and processing of materials (Calkins, 2018; Natural Stone Institute, 2022).

The standard aims to educate stakeholders, thereby promoting a more transparent supply chain (NSF International, 2019; Natural Stone Institute, 2022, 2025; Vierra, 2023). The ANSI/NSI 373 certification process includes several steps: producers apply for site-specific certification, undergo a conformity assessment to verify eligibility, and proceed with documentation review and on-site audits (Natural Stone Institute, 2022, 2025; Novak, 2021). If the criteria are met, a certificate is issued. The ANSI/NSI 373 certification is valid for three years and includes continuous monitoring through annual documentation reviews in the second and third years, overseen by a third-party certification body. In the fourth year, recertification involves a comprehensive evaluation, including both a documentation review and an on-site audit. The certification evaluates various sustainability categories, including water use, transportation, site management, land reclamation, corporate governance, energy efficiency, waste management, safer chemical use, human health and safety, and innovation. Scoring is based on a points system. Appendix A (Table A1) outlines the criteria assessed and verified in each category—including required and optional categories—with some having multiple requirements, optional sub-criteria, or indicators. Certified facilities must produce a sustainability report detailing their sustainability practices and compliance with environmental and social responsibility standards.

Its point system sets four tiers—Bronze, Silver, Gold, and Platinum. After meeting all prerequisite criteria, facilities earn higher certification levels by fulfilling an increasing number of optional sustainability criteria across categories such as energy, water, site management, land reclamation, waste management, corporate governance, and safer chemical use.

Demand from architects, heightened public awareness, and the green-building boom have underscored the need for credible certification. This exigency is underscored by projections that a quarter of all building materials in use as of 2000 will be replaced by 2030 (The University of Tennessee Center for Clean Products, 2009b). Meanwhile, with the U.S. alone consuming 2.5 million tons of stone valued at USD 520 million in 2022, the global market for dimension stone is expected to reach USD 12.02 billion in 2029 (Business Research Company, 2025; U.S. Geological Survey, 2023).

Despite ANSI/NSI 373 being recognized by programs such as Leadership in Energy and Environmental Design (LEED) and the Living Building Challenge (LBC) since 2016,

the dimension stone industry's limited participation in sustainability dialogues and lack of third-party verified claims have made it difficult for designers to earn certification credits (Calkins, 2018; Natural Stone Council's Sustainability Committee, 2020; Roberts, 2016; Spanier, 2016). However, rising demand for ecolabeling, transparency, and ethical sourcing has driven the adoption of voluntary sustainability initiatives (VSIs), such as ANSI/NSI 373, which offer third-party certification and credible sustainability claims (Bartley, 2003; Potts et al., 2018; United Nations Conference on Trade and Development, 2023). In North America, concerns about environmental degradation, origin mislabeling, and regulatory gaps further motivated industry and stakeholder action, leading to the development of the ANSI/NSI 373 standard (Novak, 2021; Spanier, 2016).

For firms that prioritize environmental and social responsibility, sustainability is now a core strategic concept. It seeks to balance economic growth, social progress, and environmental care to ensure long-term business viability—meeting present needs without compromising the ability of future generations to meet theirs (Brundtland, 1987). Sustainability requires integrating responsible practices across all operations, from supply chain management to product development, and is regulated both internally and externally, often involving measurable goals and long-term planning (Careddu, 2019; Carter et al., 2015; Kibert, 2016).

In the dimension stone industry, corporate responsibility has traditionally centered on economic performance and regulatory compliance. However, the introduction of the ANSI/NSI 373 standard represents a significant shift toward sustainability. This voluntary standard establishes rigorous criteria for responsible quarrying and stone production, addressing environmental management, worker health and safety, fair labor practices, and community engagement. By adopting ANSI/NSI 373, firms move beyond compliance to align with global sustainability expectations. This shift signifies a strategic transformation—one that enhances transparency, builds stakeholder trust, and positions certified firms more competitively in a market increasingly focused on sustainability. In essence, ANSI/NSI 373 illustrates the stone industry's evolving view of corporate social responsibility (CSR): from a narrow focus on profit to an integrated model that balances ethical, social, and environmental priorities within business strategy.

Despite its contested and evolving nature (Carroll, 1999; Moon et al., 2005), CSR is fundamentally a strategy for managing the social, environmental, and ethical impacts of business. Rather than focusing solely on profit, CSR emphasizes the broader role businesses play in contributing to the well-being of society. It plays a crucial role in fostering trust and loyalty among customers and stakeholders, enhancing corporate reputation, and boosting employee morale and engagement. Through initiatives that support communities, promote environmental sustainability, and uphold ethical standards, companies not only make a positive social impact but also reinforce their own competitiveness and long-term resilience in a changing marketplace. On the whole, CSR encompasses a firm's obligations to meet societal expectations across environmental, social, and economic dimensions (Bansal, 2005; Kakabadse et al., 2005; Pan et al., 2021; Rezaee, 2016). This broader commitment is often captured in the concept of the "triple bottom line", people, planet, and profit—the essence of sustainability (Elkington, 1997).

The literature suggests that firms are motivated to undertake VSIs due to their alignment with CSR (Potts et al., 2018; Rezaee, 2016; United Nations Conference on Trade and Development, 2023). Key drivers for adopting VSIs and engaging in CSR include responsible management, ethical conduct, good governance, enhanced reputation, competitive advantage, profit, market access, product differentiation, and alignment with stakeholder and societal interests (Kakabadse et al., 2005; Potts et al., 2018; Rezaee, 2016).

Several theories explain why—and how—firms adopt VSIs and pursue CSR. Stakeholder theory stresses accountability to stakeholders and the need for ethical management to satisfy diverse interests, which is crucial for long-term business success (Clarkson et al., 2011; Fassin, 2012; Fernando & Lawrence, 2014; Freeman et al., 2004; Hult et al., 2011; Rezaee, 2016; Phillips et al., 2003). Legitimacy theory highlights the importance of aligning with societal norms to maintain a firm’s social contract and credibility, with sustainability reporting and disclosure serving to legitimize and protect the firm’s image (Deegan, 2002; Nishitani et al., 2021; Rezaee, 2016; Tilling, 2004). Signaling theory explains that firms use VSIs to communicate their sustainability and financial performance to stakeholders, enhancing their reputation and credibility through “virtue signaling” (Brower et al., 2017; Rezaee, 2016; Westra, 2021). Economic motivations also play a role, as VSIs can lead to cost savings through resource efficiency, meet market demand for certified products, facilitate market entry, and allow firms to charge premium prices, thereby providing both business and financial incentives for adoption (Marx et al., 2022; Potts et al., 2014; Rezaee, 2016; Vierra, 2023).

As businesses worldwide respond to growing environmental and social responsibility concerns, VSIs have become vital tools for promoting environmental stewardship, corporate social responsibility, and economic viability (Potts et al., 2014; United Nations Conference on Trade and Development, 2023). In North America, the dimension stone industry has adopted the ANSI/NSI 373 standard as a framework for sustainable quarrying and processing, offering potential benefits such as improved market positioning and long-term competitiveness (Natural Stone Institute, 2022).

This study explores the role of ANSI/NSI 373 in advancing sustainability within the North American dimension stone industry, exploring how sustainability and certification are being integrated into the supply chain and perceived by stakeholders. It addresses knowledge gaps by assessing the effectiveness of ANSI/NSI 373 in promoting sustainable practices, identifying barriers to broader adoption, and evaluating industry perceptions. Despite increasing interest in VSIs and the rising demand for green building materials, the dimension stone sector has been underrepresented in broader sustainability discussions and infrastructure planning (Calkins, 2018; Novak, 2021; Reis, 2004; United Nations Conference on Trade and Development, 2023).

To enhance understanding and effectiveness of sustainability certifications in this sector, the study draws comparisons to established forest certification models, identifying key challenges, opportunities for improvement, and the drivers influencing ANSI/NSI 373’s advancement. By incorporating insights from industry professionals and lessons from mature certification frameworks, this research provides insight into advancing sustainability efforts in the North American dimension stone industry.

Given the growing emphasis on sustainability in securing the industry’s long-term viability, this study provides timely insights into the drivers, challenges, and impacts of ANSI/NSI 373 adoption. The findings highlight necessary enhancements to maximize its effectiveness and broader adoption. Additionally, the research contributes to discussions on sustainable business practices by identifying barriers such as compliance costs, credibility concerns, and varying industry engagement levels.

Ultimately, this paper seeks to advance the discourse on voluntary sustainability standards as strategic tools for firms in natural resource sectors. It offers recommendations for business leaders and policymakers on integrating sustainability into core business operations and leveraging certification for long-term value creation.

## 2. Materials and Methods

The study uses a qualitative approach to assess the implementation and business implications of the ANSI/NSI 373 sustainability standard within the North American dimension stone industry. It aims to evaluate the effectiveness of the standard, identify barriers to adoption, and explore market-driven solutions for broader implementation. A comparative analysis with established forest certification schemes serves as a benchmark to examine the opportunities and limitations of ANSI/NSI 373 in a business and sustainability context.

The comparison highlights key differences in governance, market recognition, stakeholder influence, and the challenges and benefits of certification. Forest certifications, such as FSC and SFI, are widely recognized, embedded in procurement policies and green building programs, and supported by public awareness and NGO advocacy. In contrast, ANSI/NSI 373 operates under broader mining laws that obscure dimension stone's unique sustainability concerns, limiting its visibility and uptake (Calkins, 2018; Gazi et al., 2013; Novak, 2021; Potts et al., 2018).

Forest certifications also influence behavior through recognizable ecolabels, user-friendly procedural systems, and robust third-party support. ANSI/NSI 373 faces obstacles such as inconsistent terminology, limited incentives, and low consumer awareness (Novak, 2021; Potts et al., 2018). Despite these challenges, ANSI/NSI 373 offers benefits such as credible sustainability claims and market differentiation.

The study identifies opportunities to strengthen ANSI/NSI 373 by improving visibility, affordability, and strategic adoption. Lessons from the forestry sector offer valuable guidance for improving the standard's long-term impact, competitive edge, and economic viability.

### 2.1. Research Methodology and Theoretical Framework

This study uses Grounded Theory Methodology (Birks & Mills, 2015; Strauss & Corbin, 1997), enabling the generation of conceptual categories rooted in stakeholder narratives and industry experiences. Participants were initially selected using purposive strategies to ensure relevant expertise, while grounded theory guided the emergence of analytic categories from industry perspectives (Ahmad & Wilkins, 2024; Suri, 2011; Birks & Mills, 2015).

This study employed two complementary purposive sampling techniques:

1. Maximum variation sampling—ensuring the inclusion of stakeholders with diverse perspectives and roles in the supply chain to capture a broad spectrum of insights.
2. Snowball sampling—leveraging industry networks to identify additional relevant informants with deep knowledge of ANSI/NSI 373 certification and its business implications.

Data collection continued until thematic saturation was reached and no new codes emerged (Glaser & Strauss, 1967; Guest et al., 2020). This iterative process ensured that the emerging themes were both representative and robust.

### 2.2. Data Collection

To gain a comprehensive understanding of the ANSI/NSI 373 standard and its impact, two primary data sources were used:

1. Literature Review: A targeted review of academic articles, industry reports, sustainability certification documents, and trade publications was conducted. Key sources included publications from the Natural Stone Institute, peer-reviewed research on sustainability certifications, and market reports on sustainable building materials. The literature review provided contextual grounding and informed the development of interview questions.
2. Semi-structured Interviews: In-depth interviews were conducted with:

- Quarry operators who have adopted the ANSI/NSI 373 standard;
- Non-certified quarry operators;
- Industry regulators and policymakers;
- Sustainability consultants and non-governmental organizations (NGOs);
- Distributors, importers, and industry associations.

Participants were selected based on their direct involvement with the ANSI/NSI 373 certification process and their role in shaping the market dynamics of certified stone products. The selection process aimed to capture a holistic view of both the challenges and strategic opportunities for certification adoption.

### 2.3. Interview Process and Data Analysis

The interview guide included open-ended questions organized around four key themes, allowing interviewees to expand on issues of personal relevance. Key themes explored included:

- Awareness and market perception of ANSI/NSI 373-certified products;
- Economic considerations, including certification costs and potential business benefits;
- The role of certification in competitive differentiation and supply chain integration;
- Barriers to adoption and strategic solutions for increasing uptake.

Data analysis was conducted through thematic coding, identifying patterns and recurring themes that emerged from stakeholder interviews (Braun & Clarke, 2006). Insights were compared with findings from the forestry certification sector to identify industry-specific challenges and highlight potential cross-sector learnings.

Grounded theory and purposive sampling ensured findings that reflect the business environment in which ANSI/NSI 373 operates. The methodological approach allows for an exploration of sustainability certification as a strategic business tool, rather than merely a compliance framework, reinforcing its potential role in enhancing market competitiveness and corporate sustainability strategies.

### 2.4. Considerations

Both the forest and dimension stone industries have complex, multi-step supply chains and face sustainability challenges that prompted the development of voluntary sustainability initiatives (VSIs), such as FSC and ANSI/NSI 373 (Novak, 2021). However, key differences have affected the adoption of certification.

The comparative analysis with established forest certifications reveals both instructive parallels and important contextual differences. The forestry sector's success with sustainability certification has been underpinned by strong public scrutiny, widespread NGO involvement, and centralized supply chains that facilitate traceability and standardization. These factors created a receptive environment for third-party verification and made certification a credible market signal (Novak, 2021). In contrast, the dimension stone industry is structurally fragmented, and with low consumer visibility and limited civil society pressure—conditions that reduce the perceived necessity and effectiveness of certification (Gazi et al., 2013; Potts et al., 2018). While ANSI/NSI 373 can draw inspiration from the institutional scaffolding that supports forest certifications, its success will depend on adapting these lessons to the distinct economic and political realities of the stone sector. This includes fostering stronger stakeholder coalitions, investing in traceability systems, and aligning certification efforts with public procurement policies to increase legitimacy and demand.

To date, ANSI/NSI 373 remains relatively unknown outside niche markets, partly due to the stone industry's historically low engagement with sustainability marketing (Calkins, 2018; Natural Stone Institute, 2025). Although ANSI/NSI 373 incorporates trace-

ability and third-party verification similar to FSC's chain-of-custody system, it faces challenges in gaining consumer recognition and broad industry adoption.

Despite these hurdles, the forestry sector offers a useful model. Lessons from its certification trajectory may provide direction for the growth in credibility and effectiveness of ANSI/NSI 373 certification over time.

### 3. Results

Stakeholder interviews and a comparison with forest certification reveal key insights into how sustainability initiatives are adopted, implemented, and valued in the stone and forestry sectors. Regulators and NGOs favor stricter compliance, whereas many quarry operators and industry groups call for simpler processes to boost adoption.

The findings show that ANSI/NSI 373 offers opportunities, but its effectiveness and market viability hinge on overcoming several challenges. Broader adoption will require a stronger framework, higher industry awareness, and—above all—market demand plus regulatory incentives. The results are categorized into themes that reflect the key business considerations, challenges, and benefits of the ANSI/NSI 373 standard.

#### 3.1. Adoption and Market Awareness

Although the standard is recognized, adoption among North American stone producers remains low, especially compared with the extent of forest certification. Many stakeholders are unaware of the business advantages of certification—a major barrier to wider uptake (Espinoza et al., 2012; Ozanne & Vlosky, 2003; Teisl et al., 2002; Tikina & Innes, 2008). Builders and architects, who play a crucial role in shaping demand for certified products (Bowers et al., 2014; Vierra, 2023), often do not grasp the value of certified stone (Natural Stone Council's Sustainability Committee, 2020; Natural Stone Institute, 2025; Novak, 2021). This lack of awareness extends to consumers, where recognition of certification benefits is minimal. This contrasts sharply with the well-established consumer demand for certified wood products in the forestry sector.

Market recognition has been a driving force in the success of forestry certifications, where consumer demand for sustainably sourced products has incentivized adoption (Bartley, 2003; Espinoza et al., 2012; Potts et al., 2014; Tikina & Innes, 2008; United Nations Conference on Trade and Development, 2023). The visibility of certification labels on consumer goods has further reinforced this demand, effectively differentiating certified wood in the marketplace, and influencing purchasing decisions (Aguilar & Vlosky, 2007; Anderson & Hansen, 2004; Espinoza et al., 2012; Teisl et al., 2002; Tikina & Innes, 2008). In contrast, the dimension stone industry has yet to achieve similar market differentiation, limiting the incentive for firms to pursue ANSI/NSI 373 certification. Certification has yet to affect stone prices or consumer choices (Natural Stone Institute, 2025), unlike in forestry, where it is a major market differentiator (Aguilar & Vlosky, 2007; Espinoza et al., 2012; Hansmann et al., 2006; Tikina & Innes, 2008). Strengthening consumer awareness and demand could provide a stronger business case for certification within the stone industry.

Regulation also shapes certification uptake. Forestry certifications benefit from national and international regulations that promote or mandate the use of certified wood in public construction projects (Bartley, 2003; Espinoza et al., 2012; Moeltner & Van Kooten, 2003; Tikina & Innes, 2008). This regulatory support has helped establish certification as an industry standard in many regions (Prakash & Potoski, 2012; United Nations Conference on Trade and Development, 2023). ANSI/NSI 373 lacks comparable regulatory backing, limiting its force in the market. Advocacy for integrating ANSI/NSI 373 certification into public procurement policies and environmental regulations could significantly enhance adoption rates.

Where forestry enjoys policy incentives, the stone industry faces a regulatory gap. Environmental NGOs and regulatory representatives suggest that incorporating ANSI/NSI 373 certification into broader legal frameworks could drive adoption and compliance. Incentives such as tax breaks, subsidies, or inclusion in sustainability rating systems could further encourage industry participation. Aligning certification with government policies and market expectations would enhance its business viability and contribute to a more sustainable supply chain for dimension stone products.

### 3.2. Certification Process and Costs

Survey data show that roughly 30% of quarries have adopted, or are in the process of adopting, ANSI/NSI 373. However, adoption rates vary significantly by region, with higher uptake in areas near major urban centers where demand for sustainable building materials is stronger.

While some operators have adopted the standard, the extent of implementation differs across firms. Smaller operations often target only the easiest benchmarks, not full compliance. Commonly implemented sustainability measures include water recycling and dust control, whereas more resource-intensive practices, such as comprehensive land reclamation, are less frequently pursued due to cost constraints.

Economic feasibility is the chief barrier to adoption. Many interviewees cited the high initial and ongoing costs, as well as the complexity of certification, as significant deterrents—particularly for smaller quarries with limited financial resources. The certification process requires extensive documentation, regular audits, and substantial adjustments to operational practices, creating additional financial and administrative burdens. Unlike forestry, certification offers stone producers no premium pricing or obvious market gains (Aguilar & Vlosky, 2007; Ozanne & Vlosky, 2003; Potts et al., 2014; Tikina & Innes, 2008). This lack of market differentiation diminishes the business case for investment in certification.

Tackling these financial and operational barriers is key to broader adoption. Strategies such as financial incentives, streamlined certification pathways, or greater market recognition for certified stone products could enhance participation rates. Additionally, industry-wide efforts to communicate the long-term business value of certification—through regulatory alignment, corporate sustainability commitments, or green building incentives—may help shift the cost–benefit perception among quarry operators.

### 3.3. Environmental and Social Impacts

Despite adoption challenges, firms that have achieved ANSI/NSI 373 certification report significant operational and reputational benefits. Certified operators cite improved waste management practices, leading to reduced material waste, more efficient water use, and enhanced stakeholder relations due to increased transparency and community engagement. These reported benefits align with those observed in the forestry sector, where well-documented environmental and social improvements have contributed to certification's broader acceptance and market value (Marx et al., 2022; United Nations Conference on Trade and Development, 2023).

However, compared to established forestry certifications, the ANSI/NSI 373 standard is perceived as less comprehensive. While the standard includes guidelines for community engagement and biodiversity, its requirements are less stringent than those in forestry certifications. For example, ongoing biodiversity assessments, which are a key component of forestry certifications, are not mandated under ANSI/NSI 373. This disparity may limit the perceived sustainability value of ANSI/NSI 373 certification relative to its forestry counterparts.

Some adopters cite social gains—job creation and community investment—from certification commitments. However, these benefits are not consistently reported across all certified firms, suggesting variability in how firms integrate environmental and social responsibility into their sustainability strategies. Strengthening the social impact framework of the ANSI/NSI 373 standard—potentially through enhanced requirements or business incentives—could further improve adoption rates and increase its value proposition within the market.

### 3.4. Economic Viability

The economic impact of adopting the ANSI/NSI 373 standard varies within the dimension stone industry. While some quarry operators have embraced the certification, citing improved marketability and enhanced environmental credibility as key benefits, others remain hesitant due to the perceived complexity and costs of compliance. These costs include both direct expenses, such as certification fees, and indirect costs related to employee training and operational modifications. Small to medium-sized enterprises, in particular, expressed concerns over the financial and resource requirements necessary to meet certification standards.

Initial savings from reduced waste and water use often vanish under certification and maintenance costs. Moreover, the absence of premium pricing for certified stone products further limits the economic incentives for adoption. In contrast, certified forest products frequently command higher market prices, reinforcing the financial viability of certification in the forestry sector (Espinoza et al., 2012; Irland, 2007; Tikina & Innes, 2008). Without similar market recognition and price differentiation, ANSI/NSI 373 certification struggles to present a strong business case for many firms.

Some stakeholders also see the process as overly bureaucratic and resource-heavy. To enhance adoption, interviewees recommended streamlining certification requirements and increasing government and industry support programs—particularly for small and medium enterprises. Financial incentives, such as tax credits or grants, and greater alignment with green building initiatives could improve the economic feasibility of certification and encourage broader industry participation.

## 4. Discussion

Market positioning plays a critical role in determining a firm's response to ANSI/NSI 373. The results of this study highlight the intricate relationship between economic incentives, regulatory frameworks, and sustainability practices within the dimension stone industry. These findings reinforce the existing literature that underscores the pivotal role of market demand and regulatory support in the successful implementation of certification programs (Marx et al., 2022; Potts et al., 2014; United Nations Conference on Trade and Development, 2023). Unlike mature forestry certification models supported by robust regulatory and market frameworks, ANSI/NSI 373 remains in its early adoption phase, with insufficient demand and regulatory incentives to encourage widespread industry uptake.

This discussion further examines these findings, analyzing their implications for industry stakeholders and exploring strategic opportunities to strengthen the economic viability and market positioning of sustainability certifications in the dimension stone sector. Recommendations include enhancing regulatory integration, increasing consumer awareness, and developing financial incentives to encourage broader adoption of ANSI/NSI 373 certification.

#### 4.1. Barriers to Adoption

Market positioning, in relation to a firm's response to ANSI/NSI 373, refers to how a firm distinguishes itself and communicates its value by achieving and promoting certification to this sustainability standard. By adopting ANSI/NSI 373, a firm signals to customers, architects, builders, regulators, and other stakeholders that its dimension stone products meet rigorous environmental, social, and health criteria, verified through third-party certification.

A key barrier to broader ANSI/NSI 373 adoption is limited awareness among producers and consumers about the tangible benefits of certification. Unlike the forestry sector—where certification is well-established and widely valued by the market (Forest Stewardship Council, 2022; Programme for the Endorsement of Forest Certification, 2024; Sustainable Forestry Initiative, n.d.)—stakeholders in the dimension stone industry have yet to fully recognize the standard's strategic value. This gap underscores the need for focused educational and marketing efforts to demonstrate how certification can support operational efficiency, enhance competitive positioning, and aid in compliance with evolving environmental regulations (Novak, 2021; Potts et al., 2014; Potts et al., 2018; Prakash & Potoski, 2012; Rezaee, 2016; Spanier, 2016).

Economic constraints, particularly for small to medium-sized quarries, present another significant challenge to scalability. Similar financial barriers have been observed in other industries implementing sustainability standards (Marx et al., 2022; Potts et al., 2014). Certification costs, covering documentation, audits, and operational changes, often require offsetting incentives to be economically feasible for smaller firms (Blankenbach, 2020; Carlson & Palmer, 2016; Marx et al., 2020; Marx et al., 2022; Reis, 2004). Without financial subsidies, tax incentives, or premium pricing structures for certified stone, adoption rates are likely to remain stagnant.

Regulatory support is also a crucial factor in driving industry-wide adoption. The findings suggest that government agencies can play a transformative role by integrating sustainability certifications into building codes, procurement policies, and public sector construction projects (Kibert, 2016; Potts et al., 2018). Additionally, increasing consumer awareness and demand for certified sustainable products can create stronger market-driven incentives, encouraging more producers to pursue certification as a competitive advantage (Novak, 2021; Potts et al., 2018; Prakash & Potoski, 2012). Aligning certification with existing green building initiatives and sustainability-driven procurement strategies could further enhance its adoption and long-term viability.

#### 4.2. Certification Costs vs. Benefits

The perceived cost–benefit imbalance remains a significant barrier to the widespread adoption of the ANSI/NSI 373 standard. Many stakeholders view the financial and operational burdens of certification as outweighing the immediate economic benefits. This challenge is particularly evident when compared to the forestry sector, where market demand for certified products justifies the investment. For the dimension stone industry, developing mechanisms that more directly link certification to financial incentives—such as access to new markets, competitive differentiation, or premium pricing—could significantly enhance the attractiveness of the ANSI/NSI 373 standard (Fiore, 2017; Potts et al., 2018; Spanier, 2016).

Similar to the forestry sector's early struggles with certification adoption (Potts et al., 2014; Tikina & Innes, 2008), the dimension stone industry is likely to encounter comparable obstacles. A key challenge is the disproportionate impact on smaller firms, which may lack the financial and operational resources needed for compliance. Without adequate support structures, such as subsidies, tax incentives, or streamlined certification processes, small and

medium-sized enterprises (SMEs) may be reluctant to engage. At the same time, if industry-wide certification becomes the norm, non-certified firms risk competitive disadvantages, potentially limiting their market access and long-term sustainability. Strategic initiatives, including regulatory integration and financial assistance programs, could help mitigate these challenges and create a more balanced cost–benefit structure for stakeholders across the industry.

#### 4.3. Benefits

While cost remains a barrier, some firms report tangible operational benefits. Firms that have implemented the ANSI/NSI 373 standard report notable environmental and social benefits, including improved waste management, reduced resource consumption, and strengthened community relations. Such outcomes demonstrate the potential for VSIs to drive industry-wide improvements, reinforcing the long-term value of certification. Moreover, these benefits provide a compelling business case for broader adoption, suggesting that increased uptake could align with global sustainability goals and enhance the competitive positioning of certified firms (Marx et al., 2022; Potts et al., 2014).

A comparative analysis with forestry certifications highlights key areas for improvement within the ANSI/NSI 373 standard. Forestry certifications have evolved to encompass comprehensive biodiversity conservation and community engagement mandates, which have yielded both ecological and social benefits (Forest History Society, n.d.; Forest Stewardship Council, 2022; Perera & Vlosky, 2006; Programme for the Endorsement of Forest Certification, 2024). By integrating similar provisions, the ANSI/NSI 373 standard could enhance its overall impact and industry acceptance. One of the key strengths of forestry certifications is their emphasis on stakeholder engagement, requiring firms to conduct consultations, implement conflict resolution mechanisms, and support local economic development. These elements have been instrumental in fostering public trust and ensuring the equitable distribution of sustainability benefits (Forest Stewardship Council, 2022; Programme for the Endorsement of Forest Certification, 2024; Perera & Vlosky, 2006).

The ANSI/NSI 373 standard could benefit from incorporating more structured community engagement requirements. While some guidelines for stakeholder interaction exist, they lack the specificity and enforceability seen in forestry certifications. Strengthening this component could not only improve relations with local communities but also enhance regulatory and market support for certified operations.

Additionally, forestry certifications address a broad spectrum of environmental, social, and economic factors, ensuring long-term sustainability through biodiversity conservation and ecosystem protection. Regular assessments of forest health, regeneration, and wildlife corridors are integral to their frameworks (Forest Stewardship Council, 2022; Programme for the Endorsement of Forest Certification, 2024). In contrast, the ANSI/NSI 373 standard primarily focuses on quarrying-related environmental concerns, such as water and air quality, land degradation, and waste management (Natural Stone Institute, 2022). While these are critical, the absence of explicit mandates for biodiversity conservation and social engagement represents a gap that, if addressed, could elevate the standard's overall effectiveness and market value. Expanding ANSI/NSI 373 to include biodiversity preservation strategies—similar to those required in forestry certifications—could enhance its credibility and make it a more attractive investment for businesses seeking to align with sustainability-driven market trends.

#### 4.4. Strategies for Enhanced Adoption

Social responsibility is rarely a focal point in marketing strategies and sales of building materials, including dimension stone, despite growing demand for environmentally respon-

sible products (Reis, 2004). Even within the forestry sector—where certification has been scrutinized for decades—sustainability messaging remains uneven (Espinoza et al., 2012; Perera & Vlosky, 2006). However, increasing environmental concerns and recognition by green building rating systems have significantly contributed to the adoption of VSIs in forestry, leading to a broader range of certified wood products (Espinoza et al., 2012). While dimension stone has not traditionally been as closely linked to environmental concerns as has been the case with wood products, expanding the adoption of sustainability certifications such as ANSI/NSI 373 could establish certified stone as a preferred option in green building projects. As seen in the forestry sector, continued promotion and integration of ANSI/NSI 373 within industry standards and rating systems could drive greater certification rates and elevate the role of sustainability in material selection (Forest Stewardship Council, 2013).

To enhance adoption, strategic efforts should focus on simplifying the certification process, reducing costs, and strengthening the visibility of economic benefits. Industry associations and certification bodies can play a pivotal role in increasing awareness by actively promoting the business advantages of certification, not only to producers but also to architects, developers, and procurement professionals (Richinelli, 2018b). Forming partnerships with environmental advocacy groups and leveraging digital marketing strategies—such as targeted social media campaigns and industry webinars—could further drive consumer awareness and demand for certified products (Karnatz et al., 2021).

Additionally, refining the certification framework to reduce compliance burdens and enhance cost-effectiveness would be essential in encouraging wider participation, particularly among small and medium-sized enterprises (SMEs) (Ireland, 2007; Natural Stone Institute, 2025; United Nations Conference on Trade and Development, 2023). Potential approaches include offering tiered certification levels, financial incentives, or streamlined auditing processes that maintain credibility while making compliance more accessible. By aligning ANSI/NSI 373 with market trends and green building policies, the dimension stone industry could replicate the success of forestry certification programs, ensuring that sustainability becomes a more integral factor in firms' material selection and procurement decisions.

#### 4.5. Competitive Advantage

Achieving ANSI/NSI 373 certification offers firms in the dimension stone industry a significant competitive advantage by positioning them as leaders in sustainability within a marketplace that increasingly prioritizes environmental responsibility. Certification serves as a credible, third-party verification that a firm's products meet rigorous sustainability standards, distinguishing them from competitors and enhancing appeal to environmentally conscious buyers. Certification under ANSI/NSI 373, verified by independent third-party audits, can help firms qualify for green building programs such as LEED, further expanding their market opportunities and demonstrating a commitment to continuous improvement. This is potentially valuable in the green building sector, where architects, developers, and builders frequently seek materials that align with certifications such as LEED. As a result, certified firms are more likely to be selected for these high-profile projects and may even command premium pricing.

Beyond marketing benefits, the certification process itself requires firms to improve operational practices in critical areas such as water recycling, energy efficiency, waste management, and worker safety. These improvements support sustainability goals while also improving efficiency and reducing costs, thereby strengthening the firm's competitive position. Furthermore, third-party verification adds legitimacy to a firm's sustainability

claims, building trust with customers, partners, and other stakeholders, and helping to counteract skepticism around greenwashing.

Importantly, ANSI/NSI 373 is not a one-time achievement. Firms must undergo recertification every three years and have opportunities to reach higher levels—Silver, Gold, or Platinum—based on continued performance improvements. This structure encourages ongoing innovation and embeds a culture of sustainability leadership within the organization, making certification both a mark of distinction and a driver of continuous progress.

Although systematic data is lacking, brief anecdotal notes in the industry trade magazine, *Stone World*, have reported several benefits from ANSI/NSI 373 certification, including enhanced tracking of, and quantification of, environmental data, and more efficient documentation which in turn improved the management and communication of its environmental performance (Fiore, 2017; Kamery, 2019; Richinelli, 2018a, 2018b). Market-related benefits from certification have been reported as increased visibility and credibility in sustainability-conscious markets; this allowed the firm to attract environmentally aware customers and design professionals seeking certified materials for LEED and LBC projects. The reports have indicated that certification has fostered greater internal awareness and commitment to sustainable practices. These illustrate that ANSI/NSI 373 certification has led to both operational improvements and market differentiation, helping firms reduce risk while gaining recognition in green building sectors.

#### 4.6. Strategic Adoption

Adopting the ANSI/NSI 373 standard is a strategic decision for firms since it integrates sustainability directly into core business policies and practices. This alignment enables firms to proactively address evolving market demands, regulatory shifts, and stakeholder expectations. By integrating ANSI/NSI 373 into their strategy, firms can demonstrate leadership in social and environmental responsibility, enhance their brand reputation, build trust with investors and customers, and differentiate their products in a competitive marketplace.

This strategic approach enables businesses to:

- Anticipate and exceed regulatory and market trends, reducing compliance risks and driving operational efficiencies;
- Strengthen competitiveness by meeting or exceeding sustainability benchmarks, unlocking access to new markets and customers that prioritize responsible sourcing;
- Build long-term value by integrating sustainability into risk management and strategic planning, improving business resilience and supporting growth;
- Clearly communicate sustainability efforts to investors, regulators, and the public, fostering transparency and accountability.

Adopting ANSI/NSI 373 as part of business policy is not merely about regulatory compliance; it is a forward-looking, strategic move that positions the firm for long-term success in a marketplace increasingly shaped by sustainability priorities.

#### 4.7. Long-Term Industry Impact

The long-term impact of ANSI/NSI 373 will depend on the industry's ability to clearly and compellingly communicate its value. To secure widespread adoption, it will be critical to strengthen the business case for sustainability by linking certification directly to tangible economic benefits, such as operational cost savings, enhanced regulatory compliance, and market differentiation. With growing demand for sustainable products, positioning sustainability as a competitive advantage will be vital for industry relevance and growth (Martínez-Ferrero & García-Sánchez, 2017; Marx et al., 2022; Potts et al., 2018; Spanier, 2016).

Mirroring the trajectory of forest certification, to meet the standard's objectives, the dimension stone industry must enhance the visibility and credibility of sustainability

certifications. This can be achieved by creating transparent, rigorous certification processes that are easy for both industry professionals and consumers to understand, trust, and value. Increased public awareness campaigns highlighting the benefits of certified sustainable stone products, as well as the importance of certification, will play a pivotal role in fostering broader market acceptance.

Moreover, to align with evolving market trends and sustainability objectives, the industry should collaborate with architects, designers, and other stakeholders to develop and promote standards that genuinely reflect sustainable practices. Such collaboration will align the dimension stone sector with broader environmental goals and strengthen the certification's long-term credibility.

As the demand for sustainable building materials continues to grow, ensuring that certified products are not only accessible but also competitively priced and aesthetically diverse will be essential. The stone industry must address these factors to remain viable in a market where both consumers and professionals are increasingly prioritizing environmentally conscious decisions. Ultimately, expanding the availability and appeal of certified sustainable options—balancing functionality and design—can position the stone industry as a sustainability leader and drive broader product adoption.

## 5. Conclusions

ANSI/NSI 373 certification illustrates the potential and constraints of voluntary sustainability initiatives in structurally fragmented industries. This study highlights the strategic challenges and opportunities of implementing voluntary sustainability initiatives, focusing on the ANSI/NSI 373 certification in the dimension stone industry. Although adoption remains hindered by high certification costs and weak regulatory incentives in a market with scattered demand for sustainability claims, the business value of certification remains significant. ANSI/NSI 373 provides a structured framework for firms to align with sustainability goals, enhance their market positioning, and meet growing stakeholder expectations around environmental and social responsibility.

A comparative analysis with established forest certifications reveals key lessons for improving ANSI/NSI 373's effectiveness. The forestry sector, spurred in part by higher public scrutiny and the presence of influential NGOs, has benefited from strong consumer recognition, established market incentives, and supportive policy environments—factors that have facilitated broader certification adoption. To achieve results comparable to the forestry sector, the dimension stone industry must prioritize market development, stakeholder engagement, and policy advocacy. Wider adoption will depend on expanding ANSI/NSI 373's environmental and social scope, fostering stronger community partnerships, boosting market visibility, and advocating for supportive regulation.

Economic barriers, particularly for small and medium-sized firms, along with a lack of immediate financial returns, remain significant obstacles to adoption (Kamery, 2019; Spanier, 2016). Addressing these challenges requires a multi-faceted approach, including financial incentives, increased market awareness, and stronger regulatory frameworks (Rezaee, 2016). Stakeholders must rethink how sustainability certifications are marketed and implemented, emphasizing both long-term environmental and social benefits and clearer economic incentives.

Targeted workshops, seminars, and marketing campaigns can build awareness among producers and consumers about the practical benefits of certified stone products. Additionally, advocating for regulatory changes—such as requiring sustainability certifications in public procurement—could help drive demand for certified materials (Bartley, 2003; Marx et al., 2022; Potts et al., 2018). Financial mechanisms, including subsidies, tax incentives, or premium pricing models, could further support certification adoption

(Bartley, 2003; Tröster & Hiete, 2018). Simplifying certification requirements and reducing compliance costs would also lower barriers to entry, making ANSI/NSI 373 more accessible for smaller producers (Blankenbach, 2020; Carlson & Palmer, 2016; Marx et al., 2020; Reis, 2004).

ANSI/NSI 373 offers the dimension stone industry a strategic opportunity to distinguish certified products in a marketplace increasingly focused on sustainability. As demand for green building materials and responsible sourcing grows, this standard may serve as a credible tool for marketing, signaling verified environmental and social responsibility to architects, designers, and end-users (Natural Stone Institute, 2022; Novak, 2021). Certification enhances brand reputation, builds trust with the design and construction community, and opens doors to niche markets that prioritize transparency and sustainability (Blankenbach, 2020; Rezaee, 2016). By meeting rigorous third-party standards, firms may access green building programs such as LEED, further expanding their opportunities.

Achieving ANSI/NSI 373 certification not only supports reputation and market expansion but also delivers tangible competitive advantages. Certified firms may position themselves as sustainability leaders, improve operational efficiency through better waste and resource management, and gain preferential access to clients and projects that prioritize responsible sourcing. As the industry adapts to evolving stakeholder expectations, ANSI/NSI 373 certification can become a strategic asset for long-term business growth and differentiation.

By systematically examining ANSI/NSI 373's integration, this study advances understanding of how sustainability standards function in low-visibility supply chains. Alongside evaluating the standard's structure and use, the study compares it with the more established forest certification sector, highlighting transferable lessons and strategies. By leveraging insights from forestry, it explores how third-party certification can drive strategic development, operational efficiency, and competitive advantage in dimension stone, while also assessing broader business benefits such as enhanced stakeholder trust, improved traceability, and access to sustainability-driven markets. These findings have broader implications for sustainability discussions within the industry and across the building and design sectors (Natural Stone Institute, 2022, 2025; Novak, 2021).

In sum, this paper lays essential groundwork for understanding the experiences and evolving practices of early adopters of ANSI/NSI 373. It highlights the promise and complexity of advancing sustainable production in the natural stone sector, while clearly identifying the gaps in formal impact measurement that future studies are poised to address. Future studies can build on these findings as adoption increases, supporting international replication and informing policy development.

This case underscores the difficulty of using voluntary certification to drive sectoral sustainability in contexts with low consumer visibility and limited regulatory backing. It suggests that without cross-sector coordination and strategic policy alignment, certification risks becoming symbolic rather than transformational. By learning from established certification models in the forestry sector and adapting these insights to the dimension stone industry, stakeholders can position ANSI/NSI 373 not merely as a compliance measure but as a strategic tool for long-term competitiveness and sustainable value creation.

This research underscores the value of sustainability certification for improving transparency, reputation, and market access, and calls for more robust data collection and reporting within the industry. ANSI/NSI 373 represents a significant step forward in formalizing environmental and social responsibility within the natural stone industry. Structured, evidence-based before-and-after comparisons of economic, social, and environmental impacts would undoubtedly strengthen policy assessment and adoption incentives globally; however, publicly accessible, standardized data capturing key impact metrics

such as turnover, profit, or environmental performance before and after the standard's introduction remain limited or unpublished at this stage.

The study contributes insights by drawing on qualitative interviews with industry practitioners intimately involved in the standard's implementation. These firsthand accounts shed light on progress made, practical challenges encountered, and perceived benefits achieved to date—offering valuable early evidence from within the field. The research points to the dynamic realities of adoption and continuous improvement embodied in ANSI/NSI 373's tiered certification framework.

There is a need to recognize the value in explicitly expanding this empirically grounded examination of ongoing implementation and recognize the need for future research to leverage more comprehensive, longitudinal datasets as certification matures. This will enable robust quantitative assessments of economic, social, and environmental outcomes attributable to the standard and appraising the business case for sustainability in the dimension stone sector.

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## Appendix A

**Table A1.** ANSI/NSI 373 Categories and Criteria. Required criteria: R; Optional: O; Containing both required and optional elements: R/O; Source: Natural Stone Sustainability Standard ANSI/NSI 373 Sustainable Production of Natural Dimension Stone. Opting for optional credits allows operators to earn additional points, leading to higher levels of certification.

Category	Required and Optional Criteria
Water	<ul style="list-style-type: none"> <li>Water reduction planning (R)</li> <li>Recycled water (R/O)</li> <li>Water use management (non-potable water sourcing/water reuse/sludge management) (R/O)</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>Chain-of-custody documentation (R)</li> <li>Transportation activity tracking &amp; management program (R)</li> </ul>
Site management	<ul style="list-style-type: none"> <li>Site management plan covering maintenance and operations (for quarries or fabrication facilities) (R)</li> <li>Enhanced site management plan (R/O)</li> <li>Third-party verification of site management plan (O)</li> </ul>

Table A1. Cont.

Category	Required and Optional Criteria
Land reclamation and adapted reuse	<ul style="list-style-type: none"> <li>• Post closure reclamation plan (R)</li> <li>• Community involvement with post closure plan (O)</li> <li>• Exemplary site closure reclamation plan with documented involvement of local community (O)</li> </ul>
Corporate governance	<ul style="list-style-type: none"> <li>• Prohibitions on forced labor (R)</li> <li>• Prohibitions on child labor (R)</li> <li>• Prevention of discrimination (R)</li> <li>• Employee participation in community (R)</li> <li>• Social accountability plan (R)</li> </ul>
Energy	<ul style="list-style-type: none"> <li>• Energy inventory (quantity and type consumed) (R)</li> <li>• Energy management and reduction (R/O)</li> <li>• Carbon management (O)</li> <li>• Renewable &amp; alternative energy sourcing (O)</li> </ul>
Management of excess process materials & waste	<ul style="list-style-type: none"> <li>• Inventory of excess process materials &amp; solid waste (R)</li> <li>• Track and manage excess process material &amp; waste program (R)</li> <li>• Demonstrated waste reduction (O)</li> <li>• Demonstrated solid waste reduction (O)</li> </ul>
Safer chemical and materials management	<ul style="list-style-type: none"> <li>• Chemical inventory of all materials and chemicals used in operations (R)</li> <li>• Chemical inventory management and maintenance plan (R)</li> <li>• Develop and implement chemical and materials management program that uses environmentally preferable options (O)</li> <li>• Elimination of chemicals of concern (O)</li> </ul>
Human health and safety	<ul style="list-style-type: none"> <li>• Occupational safety plan (R)</li> <li>• Improved workplace safety (O)</li> <li>• Management of air quality (R)</li> </ul>
Innovation	<ul style="list-style-type: none"> <li>• Innovation—health and safety (O)</li> <li>• Innovation—transportation (O)</li> <li>• Innovation—waste reclamation or reuse (O)</li> <li>• Innovation—energy conservation (O)</li> </ul>

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