GUIDELINE FOR THE USE OF GEOTECHNICAL REVIEW BOARDS

Prepared for
The Large Open Pit III Project
University of Queensland
St. Lucia, QLD 4072
Australia

Prepared by
Robotham Consulting Services Pty Ltd
41 Ellerslie Crescent
Taringa, QLD 4068
Australia

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1 Introduction

The use of a Geotechnical Review Board (GRB) has become common in major mining operations and projects as part of operational and/or technical assurance. However, the application and scope of a GRB varies widely, often taking the form of an audit or a design/operational review, rather than a focus on critical technical and operational assessment of high-risk challenges and identification of gaps in site geotechnical processes. This guideline seeks to clarify and simplify how a GRB could be used and managed to best deliver effective technical assurance at any site [1].

2 What is a GRB?

The Cambridge English dictionary defines a review board as "*a group of people who are chosen to examine an activity or process to find if changes or improvements need to be made*" (Cambridge, 2024). Similarly, the Collins English dictionary describes "*a group of people in authority who examine a situation or system to see if it should be improved, corrected, or changed*" (Collins, 2024).

Hoek and Imre, 1995 states that "*A Consulting Board should be composed of a small number of internationally recognised authorities in a number of disciplines. The purpose of the Board should be to provide an objective, balanced and impartial view of the overall design and construction progress on a project. The Board should not be used as a substitute for normal consulting services since members do not have the time to acquire all the detailed knowledge necessary to provide direct consulting opinions*."

In the case of tailings storage facility management, the Global Industry Standard for Tailings Management (GISTM) describes an Independent Tailings Review Board (ITRB) *as "a board that provides independent technical review of the design, construction, operation, closure, and management of tailings facilities. The independent reviewers are third parties who are not and have not been directly involved with the design or operation of the particular tailings facility. The expertise of the ITRB members shall reflect the range of issues relevant to the facility and its context and the complexity of these issues."*

Robotham, 2024, simply describes a GRB as "*a group of selected experts who provide a balanced and impartial view of an activity or situation to see if and how it can be improved*" and goes on to state that it "*should report to senior leaders, who have authority to consider feedback and to enact change where necessary*".

As stated by Hoek and Imre (1985), the GRB should not be used for "normal consulting services" and should focus on the quality of the geotechnical[2] works being undertaken with consideration to alternative solutions based on cumulative GRB knowledge and experience.

Application of a GRB is different to undertaking an audit. Read & Stacey (2009) defines the difference between a review and an audit as follows: "*A review addresses the ability of the management practices to address the hazards in the mine. An audit addresses whether or not the asset/project is following the procedures to reduce the risk of the identified hazard*". In addition, a review should also assess the capability of the site team to deliver on necessary hazard management practices. From the above, it would be wasteful, and costly, to use GRB expert members to simply identify whether technical and operation geotechnical work is being completed in line with internal, or external, guidance/standards. Instead, the GRB members should be engaged to access and employ their broad and varied technical skills, knowledge, and experience to improve site geotechnical hazard management processes and risk-based decision making at a site.

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[1] The term site in this document includes any asset, business facility or project.

[2] In this context the term geotechnical also includes geology, structural geology, hydrogeology, mine planning and implementation, and other specific technical areas that are pertinent to the challenges being faced at a given site.

A GRB should not be asked to make decisions or "approve designs" for a site. Technical, operational, and business risk and its management resides with the site owner. GRB members should, however, be accountable for the opinions that they present based on the information provided by the site and the field observations made.

2.1 Composition of a GRB

A GRB should comprise expert individuals whose skills are matched to the technical and operational challenges faced at a site, whether these be related to a mine slope, underground excavation, major construction, tailings storage facility, etc. Typically, a GRB might include specialists in rock and/or soil mechanics, mining hydrogeology/hydrology, structural geology, excavation monitoring, tailings facility design and construction, and mining engineering with strong familiarity with the mining environment. Other disciplines such as site investigation, materials characterisation, geochemistry, or risk management could also be considered, dependent upon the risks and challenges faced by the site. Much as individual GRB members might be experts in their specific fields, it is also very useful if they have broad and overlapping technical knowledge so that they can challenge and comment on each others' opinions so that GRB feedback does not represent the thoughts of one individual only.

A key element in selection of GRB members is diversity, with consideration to different operational and technical backgrounds as well as experience in operations, design, consulting, academia, etc. Members with a combination of these experiential elements will add most value to the GRB process and outcomes. Another important issue is the personality of GRB members and their ability to work together, and state their opinions whilst listening to, and acknowledging the opinions of others.

The independence of GRB members from the subject site must also be considered. Individuals who have previously been involved with, or have been accountable for, geotechnical design or implementation at a site may have valuable prior historical knowledge of a site but could also be conflicted in that they may be commenting of work with which they, or their companies, were previously involved. GRB members should be able to view geotechnical activities at a site with fresh eyes and be able to bring new ideas and experiences from the many other sites with which they have been involved. For this same reason GRB membership should be reviewed and periodically refreshed over time. This is discussed further in Section 6.

Hoek & Imrie (1995) suggests that "*an ideal board does not require a [chairperson] since it acts as a self-regulating unit*". Robotham, 2024, "*found this to not be the case, with the chairperson being critical to the mechanics of the GRB process, for managing reporting deliverables and as the primary contact between the GRB and senior mine leadership*". Dependent upon the site-defined scope of work and feedback requirements, a site/GRB may choose whether to identify a chairperson or not. Where succinct and brief feedback is required at the end of an engagement, a GRB might stay at site and prepare and issue its commentary before departure. This would not require identification of a chairperson. For more broad engagements, where reports are prepared after GRB members have left site, a chairperson should be identified to support delivery of feedback and assist with engagements. This individual could be identified by the site, or otherwise selected by the GRB members and rotated as necessary to ensure timely delivery of feedback. If a chairperson is identified, it is essential that this individual does not dominate the GRB process and its deliverables, while retaining a role of facilitator and in leading provision of critical feedback to the site. The role of a chairperson, if identified as necessary, is discussed in further detail in Section 0.

By accessing the knowledge and experience of a well selected GRB, site leaders can better appreciate the broad range of technical and operational aspects and challenges of their operations. This can assist in both risk identification and assessment at the site but also in determination of practical solutions to technical and operational challenges, many of which may have been experienced by GRB members at other sites with which they have been involved.

A site may need to periodically refresh GRB membership to match the site's changing technical or operational priorities and to bring in fresh ideas and thinking. This can be a sensitive process as many technical specialists enjoy GRB activities and might not want to step-down. A GRB Charter/ToR should specify a defined time period over which a member should serve before consideration is given to change (See example in Appendix 1). Any

change would need to be determined by the site and should include prior, open conversations with all GRB members on what the changes might be, when they should occur as well as which prospective new members might be considered. The onboarding of new GRB members is also a challenge given the likely steep learning curve necessary to get up to speed with the remaining members. A membership overlap period of at least 6 months is suggested to allow smooth departure and onboarding of new GRB members.

2.2 Application of a GRB

GRBs should be reserved for engagement on management of geotechnical hazards that have the potential to become critical to a site. Either different types of review, or reduced frequency of review(s), should be considered for lower potential hazard challenges. An example of review type relative to criticality of geotechnical hazards is shown in Table 1.

Increasing Hazard impact ↑	Hazard Level	Type of Review	Purpose	Use	Composition
	Critical	Geotechnical Review Board (Independent)	Detailed independent review of technical and/or operational processes for geotechnical risk management with communication of identified issues to business senior leadership	Complex technical or operational challenges or studies which represent critical geotechnical risk to the business	Typically three to four recognised, multidisciplinary technical specialists with specific expertise matched to asset requirements
	High	Independent Geotechnical Reviewer	Detailed independent review of technical and/or operational processes for geotechnical risk management and communication of identified issues to asset senior leadership	Routine review of design changes, risk management approaches which represent high geotechnical risk to the business	A specialist with geotechnical experience beyond that of the asset team which is matched to site requirements
	Medium	Internal Geotechnical Reviewer	To assess and provide feedback to the asset on geotechnical aspects of changes to planning, design and implementation at an asset.	Ongoing planning and operational geotechnical issues	In-house (where available) or external specialist with experience at least equivalent to the asset geotechnical design/operations function
↓	Low				

Table 1 Example of technical review level matched to identified geotechnical hazard impact.

In terms of site review frequency, the following is suggested:

- Critical - GRB (independent) every 6 months to one year;
- High - Independent Geotechnical Reviewer (or a GRB at a reduced frequency of every one to two years); and
- Medium to Low - Internal Geotechnical Reviewer as needed.

2.3 Benefits of using a GRB

In addition to technical review and challenge, when used properly, the following benefits may also be gained from using of a GRB:

- **Enhanced critical thinking and improved presentation skills**. Following continued challenge by, and feedback from, a GRB, site teams can learn to better undertake and present their technical information in a clear, simple and logical fashion. Over time they can also learn to better identify critical factors by self-review and pre-empting comments that may be made by GRB members;
- **Sites taking ownership of technical functions from external consultants**. Many sites use external consultants to present technical data, analysis and outcomes. Following GRB challenge, site teams can often improve their partnering with their consultants and take over presentation duties, ultimately taking increased ownership of the work being completed and presented for their site;

- **Increased site team confidence and capability development**. By close interaction and engagement with GRB members during on-site meetings, site team members have the opportunity to discuss a range of technical issues and opportunities with highly experienced practitioners. Mentoring gained during these encounters can be highly beneficial to individual career development; and
- **Improved communication of critical issues to senior leaders.** Feedback and concerns from site practitioners with the responsibility of managing site geotechnical risks will be more readily acknowledged and acted upon, if supported and/or communicated by the GRB.

3 GRBs and the Three Lines of Assurance model

Most major mining companies use a Three Lines of Assurance or Three Lines of Defense (3LoD) model to provide strong governance and assurance of technical risk management processes. The Institute of Internal Auditors (IIA, 2020) model is shown in Figure 1, with definitions and comments on each of the three lines shown in Table 2.

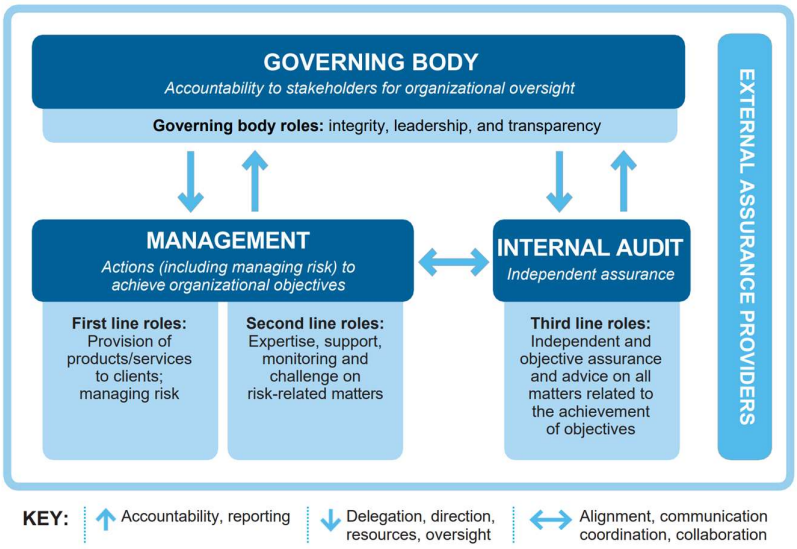

Figure 1 The Institute of Internal Auditors Three Lines of Assurance model.

When considering the IIA model, a GRB could be considered as support to either, or both, of the First or Second line functions.

As a First line function, the GRB would visit a site, review data gathered, and analysis undertaken by a site team (and its consultants) and provide direct feedback, challenge, and recommendation to the site (at the First line) to support risk management based on its observations and findings. The authority for any necessary change to observed processes and practices would not come from the GRB itself, but from those in authority to whom the GRB provides its feedback.

As a Second line function, the GRB might be engaged by a central corporate group, external to the site, to review and challenge the work undertaken by the site (in this case, the First line).

In simple terms, a GRB at the First line can be considered as a review and challenge initiated by a site to better manage its own risk. At the Second line the application of a GRB is triggered by persons or processes outside of a site and is “imposed” upon it, in line with corporate technical assurance requirements.

The Third line might engage independent technical specialists to support internal audit and to determine whether assurance processes are functioning well. It would not directly engage its own GRB, although it might interview GRB members as part of site technical assurance.

Line of Defense	IIA definition	Additional comments
First	This function is most directly aligned with the delivery of products and/or services to clients of the organisation. It is directly accountable for managing risk at an asset;	As part of this function, specific geotechnical risks are identified, assessed and monitored and critical controls implemented
Second	This function aids risk management by engaging with internal and external specialists to provide complementary expertise, support, monitoring, and challenge to the first line. However, responsibility for managing risk remains a part of first line assurance	Company standards are typically defined and communicated for implementation as part of this function
Third	This is an internal audit function which provides independent and objective assurance and advice on the adequacy and effectiveness of governance and risk management processes. Findings are reported to management/senior leadership to promote and facilitate continuous improvement	

Table 2 Definition of IIA Three Lines of Defense with comments

Given the need for a GRB which is independent, the role of "the client" needs to be considered as well as the organisational structure of the site in question. If the client works at a site and is also accountable for remuneration of the GRB members, the review should be considered a First Line function. Similarly, if the client sits within a central technical function (outside of the site itself) and funds the GRB, it should be considered a Second line function. Confusion can arise where remuneration is made from a site while the client sits within a central function area, or vice versa.

Notwithstanding the above potential confusions, the GRB function can sit well within the 3LoD model with successful engagement depending on clear and effective communication around the GRB function and site reporting lines.

4 Managing a GRB

Key to management of a GRB is a clear understanding of why a site needs a GRB and what would be the scope of its review. Before selecting GRB Members, a site needs to understand the specific technical elements of the risks which its business and operations are facing. This is critical in determining the specific skill areas of the GRB members to be identified and appointed. The suggested next key steps are:

- Identification and appointment of a site representative/corporate technical lead to set the agenda and coordinate GRB activities;
- Development of a clear Charter/Terms of Reference (ToR) for a GRB - This should set out the GRB's purpose, how it will function, frequency of engagements and the expectations of the GRB and site team members in order for the process to be effective. An example of a simple and generic GRB ToR is presented as Appendix 1;
- Selection of GRB members to match the identified risks. When inviting individuals to join a GRB, an appreciation of their personalities is important given that all members need to be able to effectively and respectfully work together (Hoek & Imrie, 1995);

- Identification of a chairperson for a GRB, if needed (refer Section 2.1). This individual can play a role in supporting GRB activities including:
  - Building consensus within the GRB on key feedback, and mediation on issues and areas of GRB disagreement/misalignment; and
  - Leading the completion and delivery of formal end of review feedback as well as the written GRB report. This is a challenging issue given that once GRB members leave site they are often involved in other projects and may not have allocated sufficient time to complete their report. The chairperson may need to facilitate caucus sessions with all members to gain consensus on site feedback whilst also avoiding deep-dives into every aspect of discussion, especially when information presented has been limited; and
- Development of meeting agendas and framing of key technical topics.

4.1 Planning a GRB engagement

GRB members are typically in high-demand and plan work out for many months. Similarly, site teams have very full work calendars, often linked to Life of Mine (LoM) planning processes and operational and capital cost approval time horizons. For these reasons forward-planning is essential to identify specific weeks for on-site GRB visits to ensure both member availability and a time which suits the site. If a site is seeking approval for a major project, presentation to, and endorsement by, a GRB prior to initiation of capital approval processes can significantly smooth the path forward. Lack of support from a GRB could also lead to a need for delaying capital approval requests if it is identified that there are risks to a project which have not yet been fully evaluated.

A site should not underestimate the time that it takes to prepare for a GRB engagement. Once an agenda has been identified, which would include all topics for which the site would like GRB feedback, presentations for each topic need to be developed. These should, where possible be issued as pre-read to the GRB members, accompanied by any additional supporting documentation[3]. Each presentation should be sufficient to explain the identified issue(s) to the GRB, as well as providing supporting data and analytical/operational outcomes to support any proposed action. If sufficient data is not presented, the GRB cannot be expected to provide clear support or challenge to the work undertaken. Another critical agenda item is “time in the field”. GRB field visits and observations are essential for it to gain a good understanding of site, its condition and how it operates. The GRB might also observe issues, or identify risks, which are not yet known to a site. This remains an essential risk management element of application of a GRB.

5 GRB deliverables

On completion of an engagement, and before departure from site, the GRB should provide brief, provisional verbal feedback (typically accompanied by a presentation/slide pack) to the site team to share its views and also to ensure that a clear understanding of site data, analytical outcomes and geotechnical challenges have been gained. This should be followed by a higher level (less technical) feedback presentation to the site president/managing director/accountable executive to provide confidence, at that level, of what risks have been identified and how they are being managed. GRB engagement with site senior leadership and attendance of senior leaders at opening and closing meetings is a good way to ensure that findings are communicated and understood, as well as to demonstrate the importance of this assurance function to the site and GRB team members.

[3] The GRB should only be provided with the data that it needs, to respond to the issues identified by the site. Sites should avoid provision of large volumes of information that takes up GRB member review time, whilst not directly contributing to increasing their knowledge of the site or the technical and operational challenges that it faces.

The key deliverable from any GRB is written feedback. This needs to concisely and clearly present any identified risks and associated recommendations based on site observations and presentations made.

GRB reports can range in size from a short and sharp 2-pager to more broad discussions over 20 to 30 pages. Some clients are comfortable with a PowerPoint presentation of key observations and recommendations, supported by supplemental notes. With others a more formal written report is required. The client should discuss expectations and requirements with the GRB to ensure that it receives the right level of timely reporting needed to support project risk management efforts.

Some clients may request a draft report for their review and commentary, before a final document is issued. This matter should be discussed and agreed between the client and the GRB, as reports are meant to represent an independent review of the presented materials and site observations. Typically, modification to a report would only be made if the GRB misunderstood the materials presented or was not made aware of a key issue which would have an impact upon their commentary. Even in these cases it is more appropriate for the GRB to issue an additional report detailing the changes since that previous, rather than replace an earlier version at the client's request.

Timeliness of GRB report delivery is important with the value of feedback diminishing as time passes since completion of the site or on-line engagement. GRB responses should be requested within a 2-4 week period following engagement completion, and where possible should exclude:

- Broad repetition of data presented by the site during presentations, unless inclusion is key to explaining a specific finding or recommendation;
- Large numbers of images/photographs of the site, unless these are essential to demonstrating an important identified risk or area for improvement; and
- Large numbers of minor recommendations – the GRB should be focussed on the critical and high risks and not day-to-day low and moderate risk issues (see Table 1). It is however noted that if large numbers of moderate and low level risks are "flying under the radar", a GRB may need to raise this as a broader, systemic issue.

Inclusion of an appendix at the end of the report setting out the meeting agenda (setting out key discussion topics and main locations for site visits undertaken) should be considered to set-out the broad purpose and context of meetings to avoid unnecessary repetition of presentation/meeting detail in the GRB report.

A key tool to assist a site in receiving the feedback that it needs, is the use of focussing questions. These are typically used when a site needs support on a specific technical operational challenge and would like the GRB to provide their comment to add weight to site requests to management. For instance, a site could propose a modified slope design and ask, "Does the GRB endorse the new design approach, as presented?". This question requires a "Yes" or "No" response and allows the GRB to provide qualification to support its response. It should be noted that focussing questions, whilst a useful tool, should not preclude the GRB from making comment or providing feedback on any other issue that it becomes aware of during site engagements or other meetings.

On rare occasions, a GRB might not be able to come to consensus. In this case the GRB would indicate to site that it has not come to an agreed outcome, and would then propose additional data collection/analysis, or present a choice of recommendations based on member knowledge and experience.

6 Getting the best from a GRB

A GRB is formed to review and challenge a site with a view to seeing if and how it can improve. If the GRB is not supporting a site as needed, then the process might need to be modified. Regular check-ins with a GRB should assist in delivering this important risk management process. It is good practice for a GRB and site president/managing director to meet on an annual basis to discuss engagements and deliverables to ensure that valuable feedback and guidance is being provided.

A useful tool in managing site progress against issues identified by a GRB and their recommendations, is an action register. This table or spreadsheet demonstrates if, and how, GRB identified issues have been addressed, or not, as well as site accountabilities for action. It should be noted that GRB recommendations are non-binding and as the risk-owner, the site can choose to decline to implement a GRB recommendation. This is not common, although if it occurs, a strong appreciation of "*why the guidance has not been implemented"* should be made clear by the site, with an acceptance of any associated risk. In these circumstances the GRB should respect the site's decision and avoid repetitious and repeat recommendations unless it identifies that the issue could escalate.

A GRB should be treated as a valued member of a team and a sounding board for technical and operational geotechnical challenges that may be encountered. At every engagement, the GRB should be apprised of the latest site issues and the site team should learn from the knowledge and experience of the GRB members. Surprising a GRB with an issue that has existed for some time but has only recently become a significant business risk does not build a collaborative and trusting relationship. It is better to provide timely updates of key issues as they arise and to use the GRB to provide guidance which will ultimately assist in risk management and operational continuity.

Much as each GRB member may have specific skills relevant to a business, posing questions to a single member in isolation should be avoided. Questions raised should be asked of the whole GRB, which might then rely on the feedback of an individual member, whilst internally challenging this feedback, to ensure that the whole GRB is aligned on the response. The broad experience of the whole GRB membership will typically strengthen or support the recommendations of a single GRB member to provide a better outcome for the site.

Over time, a GRB will become more familiar with a site and team members. This is an obvious benefit, allowing the GRB to more quickly get up to speed with the issues being faced without the need for a re-introduction of site geology, failure mechanisms, historic slope performances, development plans, etc. The converse can also be true, with the GRB becoming overly familiar and feeling that it needs to continually support the site in terms of delivery against production targets. There is a clear difference between a GRB stating that:

- *"The project is supported based on an understanding that the proposed outstanding work will be completed"* vs.
- *"The project cannot be supported until the proposed outstanding work is completed"*

All responses from a GRB need to be supported by the data and analyses presented and based on the knowledge and experience of the GRB members. If that data has not yet been collected or the necessary work completed, the GRB should not support a given action. In this way, the site is then required to make a risk-based decisions on what is known, or undertake further work, to its own satisfaction, and that of the GRB.

7 Conclusion

When managed effectively, a GRB can provide essential technical and operational assurance and risk management support for any site. It provides an opportunity for a site to gain independent, impartial feedback from an external set of highly experienced eyes with the ability to stand-back and view a project, relative to those who might be too close to see any major issues. The GRB can also provide confidence to senior leaders that site technical work is being completed at appropriate levels, relative to internal standards as well as those used in the broader industry, as experienced by GRB members.

A strong and successful GRB process does not happen by accident. It takes significant effort by the site team leads in setting up the GRB, developing meeting agendas and presentation materials, coordinating field visits, gaining support and engagement with site senior leaders, etc. The effectiveness of a GRB is also very much dependent upon the clear communication of the GRB's purpose and an ongoing, open, and honest relationship between the GRB and the site leadership team.

A GRB process is not static and will change over time based on new project priorities and changing risk profiles, potentially leading to modified work scopes and even membership of a GRB. Each site needs to carefully consider how best it can set up and use a GRB to support its requirements.

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Appendix 1

Example of a typical Site GRB Charter/Terms of Reference (ToR)

Highlighted sections below should be replaced with specific information for each site in line with the proposed focus of the selected GRB.

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SITE Geotechnical Review Board Charter

Given the critical importance of actions by SITE to manage potential impacts to mining and related activities, independent technical and operational review by a Geotechnical Review Board (GRB) is required.

Purpose

The purpose of the GRB is to review, and provide comment and guidance on the technical data, analytical methods and results, and mining developments proposed and implemented by SITE and its consultants in relation to:

- Design and development of mine excavations, waste rock dumps, tailings storage facilities, and OTHER and associated geotechnical/hydrogeological risks; and
- Other areas of mining activity, dewatering performance, and geotechnical concern, as identified by SITE and/or the GRB.

It is not the intent of the GRB to replace the responsibilities vested in the Engineer of Record/Design Engineer for each aspect of the site.

SITE will provide focussing questions for GRB response where comment and guidance on specific technical issues is required. These questions should not, however, restrict the GRB from comment on any other areas of specific technical concern identified or discussed.

Membership

The GRB will be selected by SITE and will comprise:

- REVIEW BOARD MEMBERS AS NECESSARY

For meetings, a quorum of the GRB shall be a minimum of two members.

Members of the GRB will serve for a minimum period of three years. After three years, and in order to refresh the GRB and encourage new thinking the SITE may recommend periodic modification to board membership.

Expectations

- Technical data, analytical results and site development plans will be presented to the GRB by SITE, or its consultants, as necessary, and at least two weeks prior to each identified engagement. The intent is for open and timely communication of all mining, geotechnical and hydrogeological issues associated with continued mine, dump slope, and tailings development, such that the GRB can provide guidance on technical and production decisions that need to be considered by SITE.
- Meetings of the GRB will be convened by SITE's MTS Manager. The GRB will meet approximately semi-annually in person at the site, according to a schedule which will be drawn up, and the start of each year, to best fit team member availability and SITE technical review/assurance requirements.
- Additional teleconferences/Webex meetings will be arranged as needed, such that critical site technical issues can be communicated, and guidance provided by the GRB on proposed actions. These meetings will occur at least on a quarterly basis in between site based meetings.

- The GRB will provide comment/guidance to SITE's President (or delegate) on its observations and on issues raised by SITE during a close-out presentation at the end of each visit.
- Written feedback from the GRB shall be provided following each site meeting or Webex/teleconference and should reflect a consensus view of all members. Reports should be issued within three weeks of any meetings/discussions.
- Issues raised by the GRB will be addressed by SITE MTS and communicated to SITE's Senior Leadership Team. However, consistent with industry best practices, the GRB recommendations should be considered non-binding advice and guidance only.
- GRB members should not be directly involved with the design or operations of the facility under review.
- The GRB will provide comment to SITE's President on the effectiveness of the GRB process once per year and at significant milestones.