HARDROCK PROJECT
CONCEPTUAL NOISE AND VIBRATION MANAGEMENT AND MONITORING PLAN

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1.0 INTRODUCTION AND ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN OVERVIEW

Greenstone Gold Mines (GGM) is committed to minimizing environmental effects through the implementation of mitigation measures, monitoring and adaptive management for the Hardrock Project (the Project) within Environment Management and Monitoring Plans (EMMPs) for construction and operation. Through the EMMPs, the Project's environmental risks and opportunities are addressed in a comprehensive, systematic, planned and documented manner to meet the following objectives:

- The Project is carried out in compliance with existing legislation, consistent with Federal and Provincial guidelines, best practices and GGM corporate policies;
- Measures to mitigate environmental effects are documented;
- Benefits from the Project are enhanced; and
- Reporting is structured to inform adaptive management and continual improvement.

The EMMPs guide environmental management for the Project and are progressively developed as the Project moves through the EIS/EA, permitting, and construction, and updated based on continual improvement during operations through adaptive management.

EMMP development begins during the EIS/EA stage with the preparation of Conceptual Environmental Management Plans. These EMMPs are broad in their level of detail, commitment-based and focused on the construction and operation phases of the Project. They include input received from consultation during the Draft EIS/EA stage. The closure phase is addressed in the Conceptual Closure Plan. The level of detail in the EMMPs advance as the Project moves through more detailed engineering and planning and as permit/regulatory requirements are available.

1.1 Environmental Management and Monitoring Plans

The Project's Environmental Management System, includes a comprehensive set of management and monitoring plans collectively referred to as Environmental Management and Monitoring Plans (EMMPs). The EMMPs outline environmental protection measures to mitigate potential environmental effects.

The EMMPs include:

- Water Management and Monitoring Plan;
- Conceptual Waste Rock Management Plan;
- Conceptual Emergency Response Plan;
- Conceptual Waste Management Plan;
- Conceptual Erosion and Sediment Control Plan;
- Conceptual Greenhouse Gas Management and Monitoring Plan;
- Conceptual Air Quality Management and Monitoring Plan;
- Conceptual Spill Prevention and Response Plan;

- Conceptual Soil Management Plan;
- Conceptual Noise and Vibration Management and Monitoring Plan;
- Conceptual Explosives and Blasting Management Plan;
- Conceptual Aquatic Management and Monitoring Plan;
- Conceptual Biodiversity Management and Monitoring Plan; and
- Conceptual Archaeology and Heritage Resource Management Plan.

These Plans are considered "living" documents and will be updated as needed in support of environmental management activities during future permitting, development and operation phases.

2.0 PROJECT SUMMARY

Mining of the Hardrock deposit has been designed as an open pit. The process plant will operate 365 days per year with a Life of Mine (LOM) of approximately 15 years. The mill throughput ranges from 24,000 tonnes per day (tpd) for approximately the first two years of operation (i.e., Mill Phase 1), increasing to 30,000 tpd for the balance of operation (i.e,. Mill Phase 2). The overall Project development schedule will consist of the following main phases, during which various Project activities will be completed:

- Construction: Years -3 to -1 with early ore stockpiling commencing after the first year of construction.
- Operation: Years 1 to 15, with the first year representing a partial year as the Project transitions from construction to operation.
- Closure:
  - Active Closure: Years 16 to 20, corresponding to the period when primary decommissioning and rehabilitation activities are carried out.
  - Post-Closure: Years 21 to 36, corresponding to a semi-passive period when the Project is monitored and the open pit is allowed to fill with water creating a pit lake.

The key components of the Project are as follows:

- open pit
- waste rock storage areas (WRSAs) (designated as WRSA A, WRSA B, WRSA C and WRSA D)
- topsoil and overburden storage areas
- ore stockpile
- crushing plants and mill feed ore storage area
- process plant
- tailings management facility (TMF)
- water management facilities for contact water including collection ditches and ponds
- power plant and associated infrastructure

- liquefied natural gas plant
- explosives facility
- buildings and supporting infrastructure
- water supply and associated infrastructure
- sewage treatment plant
- effluent treatment plant
- lighting and security
- site roads and parking areas
- watercourse crossings and habitat compensation/offsets
- Goldfield Creek diversion
- onsite pipelines
- fuel and hazardous materials
- aggregate sources
- temporary camp

Project activities include the relocation of existing infrastructure currently located within the PDA, including a portion of Highway 11, a Ministry of Transportation (MTO) Patrol Yard, and Hydro One Networks Inc. (Hydro One) facilities.

3.0 MANAGEMENT AND MONITORING PLAN PURPOSE

3.1 Purpose

The purpose of the GGM Hardrock Project Conceptual Noise and Vibration Management and Monitoring Plan (NVMMP) is to:

- describe requirements for the routine management/maintenance of sources of noise and vibration during construction and operation.
- describe requirements for monitoring noise and vibration during various stages of the project, as the basis of asserting compliance of project construction and operation against the predictions described in the Project EIS/EA.
- describe acoustic assessment and reporting requirements for provincial (and federal) approval/compliance.
- develop a monitoring program to verify the effectiveness of the mitigation measures implemented for the Project and compliance with the requirements and guidance identified in the TDR. These project activities include:
  - Construction
  - Operations
  - Blasting - the blasting activities from construction and operation are a source of impulsive noise and transient (short term) vibration effects. Due to the nature of this source, blasting noise and vibration is measured separately from regular construction and operation

- Identify:
  - minimum equipment performance requirements
  - monitoring locations
  - duration and timing of the monitoring
  - analysis and reporting requirements
  - training of field personnel
- provide guidance for abatement if exceedances are found during compliance verification.

The Conceptual NVMMP described herein applies only to the Hardrock Project activities and addresses only noise and vibration management issues that involve off property areas. Workplace noise and vibration and worker exposure assessments, controls, and mitigation measures will be addressed separately.

3.2 Performance Objectives

Objectives and targets are established to drive continuous improvement in environmental performance and are consistent with the overall strategic goals of the Project. Objectives are measurable (where possible), monitored, communicated, and updated as appropriate.

In support of GGM's overarching environmental objective (to work to prevent or mitigate any environmental impacts, meet or exceed regulatory requirements and strive to continually improve our environmental practices and performance), GGM has established the following performance objectives for the management and vibration emissions that considers key Project interactions and compliance obligations:

- monitor atmospheric noise, air blast overpressure, and ground vibration associated with Project activities;
- maintain compliance with applicable regulatory requirements, conditions and guidelines;
- track noise and vibration effects from the Project and implement action plans as needed; and
- verify the noise and vibration predictions made during the environmental assessment (EA).

4.0 SCOPE

The scope of the Conceptual NVMMP applies to the area of the Project that will undergo changes through construction and/or operation to accommodate the advancement of Project and associated monitoring. The Conceptual NVMMP applies to the construction and operation phases of the Project with closure phase included in the Conceptual Closure Plan.

The Conceptual NVMMP applies to individuals working for or on behalf of GGM, including employees and contractors, which have a role and/or accountability for the development, implementation and maintenance of this EMMP.

GGM will make reasonable efforts that suitably qualified (licenced where applicable) contractors are used for the transport of materials, supplies and waste materials, and that contractors have appropriate controls and management plans in place to reduce the likelihood of incidents during transport. Similarly, Project components under the management and maintenance by third parties are outside the scope of this EMMP. The scope of the Conceptual NVMMP applies to Project infrastructure and management under the care and maintenance of GGM.

5.0 PLANNING

5.1 Organizational Roles and Responsibilities

All persons working for or on behalf of GGM, including employees and contractors, have a role in the successful implementation and maintenance of the Conceptual NVMMP. Table 5-1 outlines roles and responsibilities for noise and vibration management and monitoring activities:

Table 5-1. Conceptual Roles and Responsibilities

Role	Responsibility
Construction Manager (for construction phase) Mine Manager (for operation phase)	Collaborate with the Environment Manager to plan and implement noise and vibration effect management during construction activities. Collaborate with the Environmental Manager to plan and implement noise and vibration effect management during operation phases. Collaborate with the Environmental Manager to provide Noise and Vibration awareness and safety training to Project personnel and contractors.
Environment Manager	Collaborate with the Construction Manager and General Manager, as described above. Collaborate with the Construction Manager and General Manager to communicate compliance obligations and provide training to employees and contractors related to EMMP. Identify, document, track, and maintain up-to-date compliance obligations related to EMMP goals.
Mine Manager	Responsible overall mining activities
Drill and Blast Supervisor	Coordinating with explosives contractor the delivery of explosives to the open pit to meet mine plan and operational requirements Notification procedures for general public prior to blast events, as needed. Implement procedures outlined in Emergency Response Plan. Establishment of notification procedures for GGM staff and contractors prior to blast events and protocol for countdown to event and local notifications at access point(s) to blast zone. Responsible for clearing area if applicable, and cordoning off of blast zone at access points. Responsible for notification of all clear after blast event and removing access barriers.
Technician	Comply with EMMP requirements as directed with Construction, Operation or Environmental Mangers
Equipment Operator	Comply with EMMP requirements as directed with Construction, Operation or Environmental Mangers
Employees / Contractors	Follow outlined compliance obligations related to EMMP, including noise and vibration reporting requirements.

5.2 Compliance Obligations

The Conceptual NVMMP is developed and implemented to comply with applicable legislative, regulatory, permit and other relevant obligations, outlined in the following sections.

5.2.1 Environmental Assessment Process Requirements

5.2.1.1 Provincial Terms of Reference

As described in the Approved Terms of Reference, the EA includes a variety of environmental protection and management measures to guide the planning, design, construction, operation and closure of the Project (section 4.1.4) and identification of a monitoring framework related to compliance and effects monitoring (section 8.2).

5.2.1.2 Federal Environmental Impact Statement Guidelines

The EIS Guidelines for the Hardrock Project include development and implementation of follow-up and monitoring programs (section 8.0). The follow-up program verifies the accuracy of the effects assessment and the effectiveness of the measures implemented to mitigate the adverse effects of the Project. The goal of a monitoring program is to ensure that proper measures and controls are in place in order to decrease the potential for environmental degradation during all phases of the Project and to provide clearly defined action plans and emergency response procedures to account for human and environmental health and safety.

5.2.1.3 Draft EIS/EA Report

Section 24 of the Draft EIS/EA includes a listing of proposed Follow-up Monitoring and Environmental Management Plans, which included a commitment to produce a Conceptual Explosives Management Plant intended to outline control measures to be followed in order to prevent effects to operations and limit vibration beyond the PDA. The Conceptual NVMMP has been developed in conjunction with the Explosives Management Plan.

Subsequent to the draft EIS/EA submission, comments were raised by several parties requesting additional clarification on the how noise will be monitored and at what locations. Available information has been incorporated to develop this Conceptual NVMMP Plan.

5.2.2 Regulatory Requirements

5.2.2.1 Federal Regulatory Requirements

Health Canada provides guidance in the document “Useful Information for Environmental Assessments (Health Canada 2010)”. However Health Canada also endorses provincial limits for noise from a project therefore provincial requirements are used and discussed below.

Only provincial requirements are discussed as there are no federal guidelines or regulations available that provide an assessment approach or quantitative limits for vibration during construction or operation.

5.2.2.2 Provincial Regulatory Requirements

The performance objectives for the project activities are quantitative thresholds or targets provided by regulatory guidelines or other applicable guidance documents and are summarized below:

- For construction and operation noise, in accordance with the NPC-300, sound level limits at points of reception (PoR) are:
  - in a Class 2 acoustic environment is 50 dBA for the daytime and 45 dBA nighttime
  - in a Class 3 acoustic environment is 45 dBA for the daytime and 40 dBA nighttime
- For construction vibration, the following are the best practice limits:

Frequency of Vibration [Hz]	Vibration Peak Particle Velocity [mm/s]
Less than 4	8
4 to 10	15
More than 10	25

- For operation vibration:
  ISO 2631-2 provides guidance pertaining to upset limits of vibration exposure to humans within a dwelling or structure. The quantitative limits provided in ISO 2631-2 relate to a level which causes annoyance based on prolonged or continuous exposure. The standard provides that the acceptable limit for vibration exposure is 0.14 mm/s measured as root square mean (RMS) velocity.
- For blasting noise and vibration:
  NPC-119 provides limits to noise and vibration at receptor locations depending on whether the blasting effects are predicted or monitored. For blasting activities that are monitored, the guideline specifies the following limits:
  - vibration less than12.5 mm/s measured as peak particle velocity (PPV) at each Point of Receptor (PoR)
  - overpressure (sound level) less than 128 dB (peak sound pressure level) at each PoR

5.2.2.3 Municipal Regulatory Requirements

The Municipality of Greenstone has published a noise by-law but does not have bylaws regarding vibration. By-law No. 03-28 (CMG 2003) includes a list of the sounds that are deemed to disturb or likely to disturb an inhabitant of the community. The by-law primarily focuses on residents and their individual noise emissions. For example, the by-law specifies that “No owner shall cause or permit the creation, presence or existence of any noise or unusual sound that disturbs or are likely to disturb any inhabitant of the Municipality of Greenstone”. No specific clauses for industrial facilities are noted in the noise by-law therefore the NVMMP will primarily focus on provincial requirements.

6.0 SUPPORT

6.1 Competence, Training and Awareness

GGM requires that persons working under its management, including employees and contractors, have the knowledge, understanding, skills and abilities to complete work in a manner that protects the environment. The following actions will be established to provide worker competency, training and awareness:

- Personnel assigned to monitoring, compliance testing and mitigation activities are expected to have met the educational and appropriate training commensurate with their duties. Such training may consist of classroom lectures, workshops, teleconferences or on-the-job training.
- An annual review of the NVMMP and appendices will be conducted with the appropriate GGM personnel.

6.2 Communication

6.2.1 Notification of Exceedances

If the applicable criteria are exceeded then the MOECC will be notified and an investigation into the root cause will be undertaken, as there may be several potential explanations for an exceedance other than the Hardrock Project. The notification of exceedances of applicable noise and vibration standards will be reported to the MOECC District Manager within 7 days of the exceedance(s) being identified.

If it is determined that GGM was the likely cause, for example through review of facility operations during that period, then the MOECC will be formally notified.

7.0 IMPLEMENTATION OF MITIGATION MEASURES

7.1 General Approach

To reduce noise from the Project, mitigation measures include:

- Advise nearby residents of major noise generating activities.
- Implement a complaint response procedure to address noise complaints should they arise.
- Where possible, GGM will conduct blasting on weekdays, typically mid-day. GGM will also endeavor to avoid blasting on statutory holidays.
- Where possible, major construction activities will be scheduled to take place during daytime hours (i.e., 07:00 h to 19:00 h) to avoid sensitive night-time periods.
- If the total area of ventilation openings exceeds 4% of the total façade area, an acoustical louver will be provided.
- The development plan for WRSA A will take into account strategies to limit potential noise disturbance on MacLeod Provincial Park and other nearby residents. This may include reducing night-time work during the camping season on the east portion of the WRSA

and/or the establishment of rock berms, and/or specialized back up alarms or box liners on the trucks operating at WRSA A.

7.1.1 Construction Noise

Construction noise is not predicted to be a concern with the implementation of standard measures for mitigating noise emissions. These measures will include:

- Where possible, major construction activities will be scheduled to take place during daytime hours (i.e., 07:00 to 19:00) to avoid sensitive nighttime periods.
- Noise mitigation measures (e.g., muffler systems) will be installed on construction and other mobile equipment and equipment will be properly maintained.
- Construction equipment turned off when not in use (i.e., a no idling policy will be implemented).

7.1.2 Operation Noise

The following mitigation measures are considered for the Project design:

- Noise mitigation measures (e.g., muffler systems) will be installed on construction and other mobile equipment and equipment will be properly maintained.
- Select equipment and/or design acoustical enclosures to limit overall noise emissions.
- Limits on the overall noise emissions transferring through doors for building enclosures.
- Air inlet and discharge silencers for exhaust stacks associated with diesel or natural gas-fueled generators.

7.2 Blasting Noise and Vibration

Mitigation measures to be incorporated into:

- Advise nearby residents of planned blasting activities.
- Implement a complaint response procedure to address vibration complaints should they arise.
- Where possible, GGM will conduct blasting on weekdays, typically mid-day. GGM will also endeavor to avoid blasting on statutory holidays.
- With respect to the Highway traffic, as a precautionary measure GGM will discuss with MTO the possibility of posting warning signs along Highway 11.

7.3 Closure

Mitigation and monitoring activities associated with decommissioning, reclamation and rehabilitation during the closure phase is presented in the Conceptual Closure Plan. However, noise and vibration monitoring is not anticipated at this phase.

8.0 MONITORING, EVALUATION AND REPORTING

8.1 Monitoring, Measurement, Analysis and Evaluation

Noise and vibration monitoring will be conducted to measure sound and vibration at key locations on and adjacent to the Project. Table 8-1 and Table 8-2 summarize the conceptual monitoring program for noise and blasting respectively.

Table 8-1: Summary of Noise Monitoring Program

Parameter	Monitoring Method	Frequency	Location	Responsibility
Sound level Leq [1hour]	Type 1 sound level meter	To be determined	To be determined (6 to 10 within the Project area)	Environment Manager
Meteorology 1. wind speed 2. wind direction 3. temperature 4. relative humidity	meteorological tower	To be determined	To be determined	Environment Manager

Table 8-2: Summary of Monitoring Program for Blasting

Parameter	Monitoring Method	Frequency	Location	Responsibility
Blasting Noise	capable of logging peak sound pressure level	To be determined	To be determined (potentially CHR 1, Rosedale Point, MacLeod Park)	Environment Manager
Blasting Vibration	capable of logging vibration as peak particle velocity	To be determined	To be determined (potentially CHR 1, Rosedale Point)	Environment Manager

8.2 Noise Monitoring (Excluding Blasting)

8.2.1 Equipment Requirements

Noise monitoring equipment used as a part of the surveys conducted for the monitoring program must meet the following performance requirements:

- type 1 integrating sound level meters used
- sound level meters calibrated in the last 3 years by manufacturer or independent accredited laboratory

- calibration verified with a portable field-calibrator before and after the measurement period(s)
- portable field-calibrator calibrated within the last year by manufacturer or independent accredited laboratory

Other requirements (i.e. monitoring, monitoring timing and reporting requirements) are discussed in the following sections.

8.3 Construction

8.3.1 Selection of Monitoring Locations

The locations of noise monitors for construction noise will be dependent on the type, duration and location of the construction activities that will occur. Noise monitors will be deployed for each major construction activity at (or as near as possible) the nearest PoR(s) from the major construction activity. The length of the monitoring period/timing will be selected, considering the construction schedule, during period(s) for which the majority of the equipment will be operational at a given area.

8.4 Operations

8.4.1 Selection of Monitoring Locations

Noise monitors will be deployed at receptor location(s) which are nearest to operation activities as well as at the periphery of major noise contributing areas including:

- process plant area and on-site power generation
- roadways (WRSA and tailings)

Monitoring will be conducted for a minimum of 72 hours at the beginning of each phase of operation and periodically thereafter depending on results. The frequency of monitoring and/or requirements for additional monitoring will be reviewed and may be modified for this component of the Program based on completed monitoring results and operational changes.

8.5 Blasting

The blasting activities from construction and operation are a source of impulsive noise and transient (short term) vibration effects. Due to the nature of this source, blasting noise and vibration is measured separately from regular construction and operation discussed above.

8.5.1 Equipment Requirements

Blast monitoring equipment used as a part of the surveys conducted for the Program meets the performance specifications specified in NPC-119 (MOECC 1978) including:

- capable of logging peak sound pressure level (type 1 level)
- capable of logging vibration as peak particle velocity
- calibrated within the last two years by the manufacturer or an independent, accredited laboratory

Each monitoring equipment unit will be set to log instantaneous air overpressure and vibration velocity.

8.5.2 Selection of Monitoring Location

Vibration and overpressure meters will be deployed for initial blasting events for construction and operation located as close as possible to the receptor anticipated to be the most affected. Meters deployed outdoors within a residence property will be within 7 m of the building as per NPC-119. In addition, a second meter will be located at or near the PDA boundary proximate to the cultural heritage resource (CHR) 1, a residential building owned by GGM and potentially additional meters in the vicinity of inhabited areas (Rosedale Point neighborhood and Macleod Provincial Park).

Blasting activities will be conducted up to several times per week during the daytime period over the construction and operation phase. Monitoring will be conducted during blasting activities until compliance is confirmed at which point monitoring may be reduced or discontinued.

8.6 Reporting

The form and frequency of follow-up reporting will be determined as the Project progresses through EA and permitting, however, it is anticipated that those elements relevant to the Conceptual NVMMP will be assembled into a formal summary report and provided to interested parties on an annual basis during construction and operation and during closure in years when monitoring is carried out. The reporting will be used to inform adaptive management reviews. Receiving, documenting and responding to communication from external interested parties, including complaints, will also form part of reporting under this Plan.

8.1 Continual Improvement

Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning from their outcomes. Adaptive management provides the flexibility to address/accommodate new circumstances, to adjust monitoring, implement new mitigation measures or modify existing measures.

GGM will identify and correct incidents with appropriate and lasting measures aimed to prevent reoccurrence and/or similar occurrences. The Adaptive Management Framework (Figure 8-1), provides a formalized approach to:

- formally track and monitor activities;
- report and as needed investigate incidents, including non-conformance and non-compliance events;
- develop and implement corrective and preventive actions; and
- continue monitoring and update relevant EMMPs.

Corrective actions will be assigned as appropriate, including actions to prevent their reoccurrence. Corrective actions will vary according to the results of incident investigation and in consideration of other incidents related to noise and vibration management.

GGM is committed to the continual improvement of its environmental management and performance. As part of the GGM Adaptive Management Framework, the Conceptual NVMMP

will be assessed annually to verify implementation and the continued suitability, adequacy and effectiveness of the Plan. The review will identify elements of this EMMP in need of revision, and evaluate performance against established performance objectives.

Figure 8-2 presents the overall approach to developing and advancing the EMMPs from the final EIS/EA to the construction Phase of the Project. The first stage of EMMP development begins with preparation of Conceptual Environmental Management Plans as part of the final EA/EIS. These Conceptual EMMPs are commitment-based and broad in their level of detail. The EMMPs guide environmental management for the Project and are progressively developed as the Project moves through the EA/EIS, permitting, and construction, and updated based on continual improvement during operations through adaptive management.

9.0 REFERENCES

Ministry of the Environment and Climate Change, “Environmental Noise Guideline: Stationary and Transportation Sources – Approval and Planning Publication NPC-300”, August 2013 (MOECC, 2013)

Ministry of the Environment and Climate Change, “Publication NPC-102: Instrumentation”, 1978 (MOECC, 1978a)

Ministry of the Environment and Climate Change, “Publication NPC-103: Measurement Procedure”, 1978 (MOECC, 1978b)

Ministry of the Environment and Climate Change, “Publication NPC-119: Noise from Blasting”, 1978 (MOECC, 1978c)

Technical Data Report: Hardrock Project - Noise and Vibration Assessment, March 2017 (Stantec, 2017)

10.0 FIGURES

Figure 8-1: Hardrock Project Adaptive Management Framework

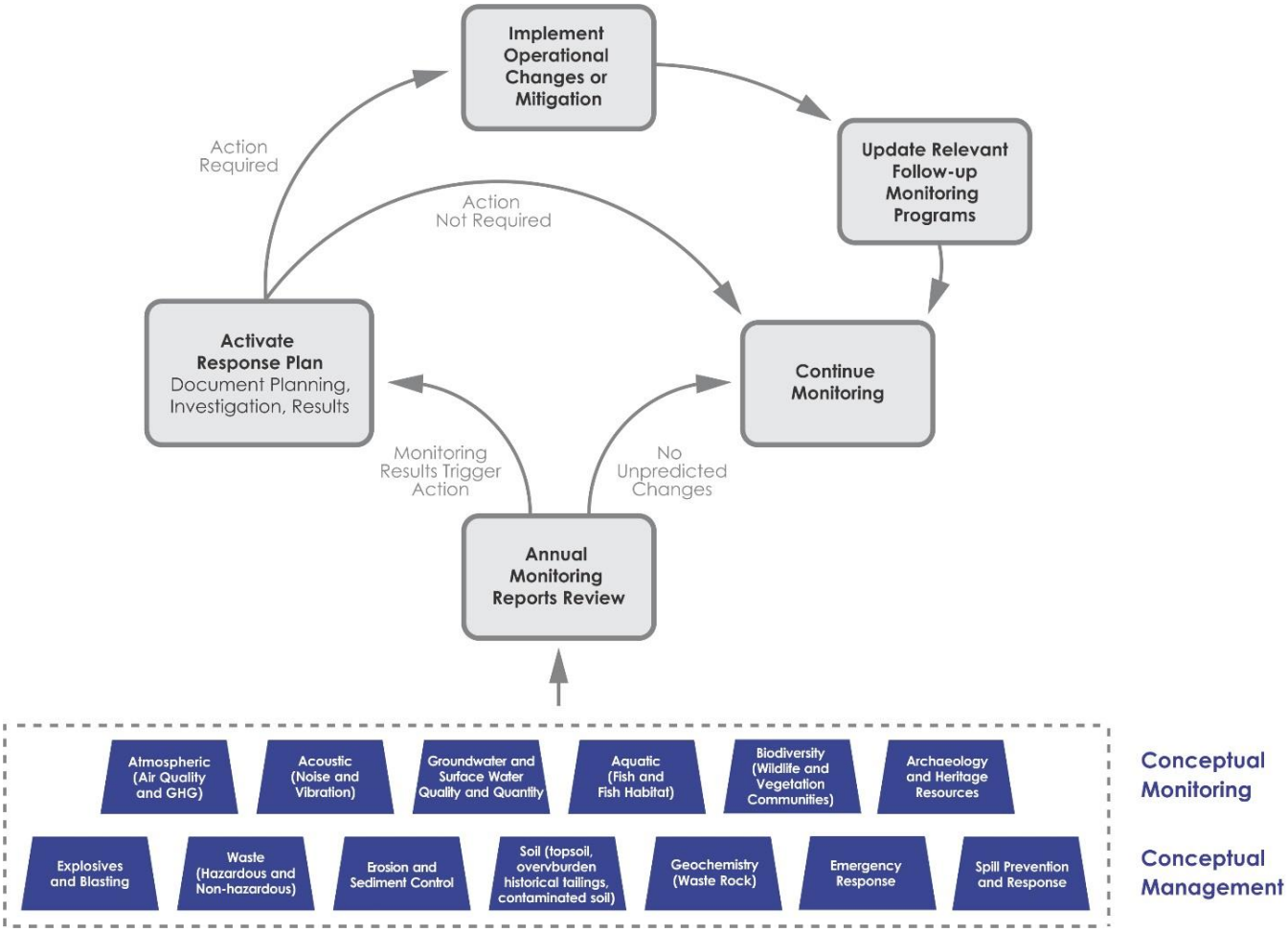

Figure 8-2: Environmental Management and Monitoring Plan Development EA to Construction