Environmental Impact Assessment (EIA)

Guidelines for Stone Quarry Activities

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Foreword

The Environmental Impact Assessment (EIA) has been widely used as a critical tool in managing and clarifying the complex interrelationships between development and the environment. It provides assessment of the environmental consequences of development actions in a systematic, holistic and multidisciplinary way.

In Sabah, the Environment Protection Department is imposing two environmental impact assessment categories namely the EIA or the Proposal for Mitigation Measures (PMM) in managing any development listed as prescribed activities under the Environment Protection (Prescribed Activities) (Amendment) Order 2013.

The purpose of these Guidelines is to provide practical guidance to environmental consultants, developers, planning authorities and any other stakeholders on procedural aspects as well as the processes involved in the preparation of the EIA/PMM report. It intents to provide a structured framework for the scope of environmental considerations required during the planning, implementation and maintenance stages of any prescribed development activity. Identification of potential environmental issues at the initial stage of development is essential for the selection of realistic mitigation measures. Significance of this approach will ensure that any development activity will be carried out with minimal adverse residual environmental impacts.

It is the Department’s hopes that these Guidelines will result in greater consistency and understanding on the basic of environmental requirements, selection of alternatives, identification of environmental issues, preparation of mitigating measures as well as environmental compliance and monitoring to ensure sustainable and profitable activities are achieved.

The Department gratefully appreciate the valuable assistance from government agencies, organizations and individuals in their comments, feedback and inputs on these Guidelines. We welcome comments and suggestions for the continuous improvement of these Guidelines in future.

Yabi Yangkat
Director
Environment Protection Department
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1 Introduction

1.1 Definitions

The aim of this EIA guideline is to provide a framework for the preparation of an Environmental Impact Assessment (EIA) and Proposal for Mitigation Measures (PMM) report for stone quarry activities in the State of Sabah, Malaysia. This EIA guideline should serve as an operating manual for the Project Proponents as well as a guide for environmental consultants.

The expression “Environmental Assessment” will in this document refer to either EIA or PMM as appropriate. The term “TOR” is likewise used generically to refer to either Terms of Reference (TOR) for EIA and Scoping Note for PMM as appropriate.

Within Sabah, stone quarry activities are categorised as a “prescribed activity” under the Second Schedule of the Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005. This requirement therefore subjects the Project Proponent to appoint an environmental consultant registered with the Environment Protection Department (EPD), to conduct an Environmental Assessment report for submission to, and approval by EPD Sabah prior to project commencement.

This EIA guideline focuses on the planning and control of stone quarry developments and management of impacts on adjacent areas. The main objective of this guideline is to provide environmental consultants, developers, contractors and government agencies involved with stone quarry activities with:

Information on how to avoid and minimise environmental impact, which is preferable to the more costly option of undertaking remedial action;

Information on the likely impact of stone quarry activities on the environment and how this is to be assessed; and

Suggested best practice environmental measures to meet the performance objectives.

This EIA guideline is not prescriptive or detailed. Each Environmental Assessment will require the environmental consultants to tailor their assessment to particular site conditions and make their own assessment of measures appropriate to the site.
The content of this EIA guideline may be amended from time to time in order to keep abreast with the latest developments and improvements in techniques and new understanding of the environmental impacts and risk. Such changes may be issued by EPD in a complete revision of this document, or in separate additional guidance notes which address specific issues.

This EIA guideline has been produced in consultation with relevant technical departments, stakeholder representatives, and other interested organisations. Printed copies of this and other EIA guidelines are available from EPD.
1.2 Assessment Procedure – A Quick Reference

The environmental assessment procedure may be divided into seven steps as described in Table 1-1. Of these steps, only steps 3 and 4 are dealt with in this guideline as these include issues particular to stone quarry activities. The remaining steps are standard procedures, common to all Environmental Assessment reports. These steps are described in detail in the Handbook on Environmental Impact Assessment in Sabah (November 2005) issued by EPD.

Table 1-1: Assessment Procedures

<table>
<thead>
<tr>
<th>The Seven Steps</th>
<th>Summary of Main Required Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1: Project Screening</td>
<td><strong>Project Proponent:</strong></td>
</tr>
<tr>
<td></td>
<td>• Check Section 2.3 to see if the project is required to undertake an EIA or PMM</td>
</tr>
<tr>
<td></td>
<td>• Consult with EPD as to whether the project should undertake an EIA or PMM</td>
</tr>
<tr>
<td></td>
<td>• Consult with EPD whether planning documents are sufficient</td>
</tr>
<tr>
<td>Step 2: Selection of Environmental Consultants</td>
<td><strong>Project Proponent:</strong></td>
</tr>
<tr>
<td></td>
<td>• Select EPD registered consultants to undertake preparation of TOR and the EIA; or Scoping Note and the PMM</td>
</tr>
<tr>
<td>Step 3: Project Scoping and Preparation of Terms of Reference/ Scoping Note</td>
<td><strong>Environmental Consultant:</strong></td>
</tr>
<tr>
<td></td>
<td>• Undertake scoping activities</td>
</tr>
<tr>
<td></td>
<td>• Assess initial project description and assist the Project Proponent to make amendments</td>
</tr>
<tr>
<td></td>
<td>• Perform initial site visit</td>
</tr>
<tr>
<td></td>
<td>• Prepare a draft TOR or Scoping Note</td>
</tr>
<tr>
<td></td>
<td>• Undertake the public hearing activities required for Special EIA</td>
</tr>
<tr>
<td></td>
<td>• Participate in review meetings</td>
</tr>
<tr>
<td></td>
<td>• Finalise the TOR for EIA or Scoping Note for PMM and obtain final approval from EPD</td>
</tr>
<tr>
<td>The Seven Steps</td>
<td>Summary of Main Required Activities</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------------</td>
</tr>
</tbody>
</table>
| **Step 4:** Undertaking the EIA/ PMM Study | **Environmental Consultant:**  
  • Assess the project details  
  • Assess the existing environments  
  • Assess the environmental impacts  
  • Devise and propose mitigation measures  
  • Devise and propose monitoring programmes |
| **Step 5:** Preparation of the EIA/ PMM Report | **Environmental Consultant:**  
  • Adhere to the EPD requirements based on the approved TOR/ Scoping Note in the preparation of the EIA/ PMM report  
  • Prepare the EIA/ PMM report in line with the EPD chapter by chapter recommendations  
  • Discuss with the Project Proponent on the findings and content of the EIA/ PMM report |
| **Step 6:** Submission of the EIA/ PMM Report | **Environmental Consultant:**  
  • Submit the EIA/ PMM report to EPD  
  • Undertake the public hearing activities required for Special EIA  
  • Participate in review meetings  
  • Submit additional information if required and finalise the EIA/ PMM report |
| **Step 7:** Preparation of the Agreement of Environmental Conditions/ Mitigation Declaration | **Project Proponent:**  
  • Review the draft Agreement of Environmental Conditions (AEC)/ Mitigation Declaration (MD) prepared by EPD  
  • Signing of Letter of Undertaking on AEC/ MD  
  • Implement mitigation measures and monitoring programmes  
  • Submission of periodic environmental compliance report as required in the AEC/ MD |
2 Sabah Context

2.1 Geographical Overview

Today, the quarry industry remains a key component of continued economic growth, providing raw materials for construction, manufacturing and transportation. In Sabah, there are two main sources of aggregates: land based aggregates and river extracted gravel. There are more than 40 active quarry sites within Sabah; these consist of major operating quarries and smaller sites which operate on low-output basis. Refer to Figure 2-1 for quarry locations in Sabah.
Figure 2-1: Quarry Location in Sabah

Geology
- Alluvium, peat, coral, sand, silt, mud, clay and gravel
- Adamellite, granodiorite, tonalite, tonalite porphyry and other hypabyssal rocks
- Gabbro, dolerite
- Gneiss, schist, amphibolite and associated granite, granodiorite and tonalite
- Olivine, basalt and dacite lava, pyroclastic rocks, andesite, tuff and silicified volcanic rocks
- Sandstone, limestone, shale, marl, mudstone, conglomerate, coal beds
- Sandstone, shale, limestone, chert, tuff, spilite, basalt, volcanic breccia, agglomerate
- Sandstone, shale, mudstone, slump breccia, chert, tuff, some limestone and coal beds
- Sandstone, shale, phyllite, argilitic, some limestone and volcanic rocks
- Serpentine, peridotite, dunite, pyroxenite
- Tuffaceous sandstone and mudstone, conglomerate, volcanic breccia, agglomerate, tuff

Legend
- Quarry
- Hill

Source:
Minerals and Geoscience Department Malaysia
2.2 Current Trends

The rapid development of public infrastructure and the construction industry in Sabah in recent years necessarily involves the extensive use of construction materials, especially stone/aggregates.

A common definition of stone/aggregate is ‘any rock, which has been broken up by explosive and/or mechanical means’. Rock aggregate (also known as crushed rock) is produced by crushing rock material and sieving it into various size categories. Larger rock, sometimes greater than 1 meter across (e.g. used for embankment protection, sea walls, and others) also falls into this category. Rock aggregate is a common material in civil construction, being used for concrete aggregate, bituminous aggregate, dense graded road base, railroad ballast, filter stone, manufactured fine aggregate and backfill/breakwater blocks.

The stone quarry industry is an important industry to the state and national economy due to its role in supplying essential raw materials for the construction and manufacturing industries. However, it is recognised that stone quarry activities can have a significant impact on the environment. This document provides guidelines for avoiding, or minimising those impacts.

An environmentally sustainable stone quarry industry is vital to the development of the State. Critical to this will be having all stakeholders, the government authorities and the industry working together to foster a culture of best practice in all aspects of quarrying activities.

2.3 Legal Requirements

Under the Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005, the submission of PMM and EIA are mandatory requirements for stone quarry activities in Sabah under the Second Schedule of the Order. Specifically, the prescribed activities are:

First Schedule: List of Prescribed Activities Requiring Proposal for Mitigation Measures (PMM) Report

Item 5: Quarries

Quarrying of aggregates, limestone, silica, quartzite, sandstone, sand, marble or stones within 200 metres from any streams or rivers

Second Schedule: List of Prescribed Activities Requiring Environmental Impact Assessment (EIA) Report
Item 9: Quarries

Para (i) Quarrying of aggregates, limestone, silica, quartzite, sandstone, sand, marble or stones for commercial or construction purposes within 3 kilometres of:

(a) Any existing settlement, residential, commercial or industrial area, major roads, or any buildings for public purposes; or

(b) Any area for which a license, permit or approval has been granted for development of settlement, residential, commercial or industrial area, major roads, or any buildings for public purposes.

There are also other prescribed activities that have an indirect connection to stone quarry activities. These include (but are not limited to):

Second Schedule: List of Prescribed Activities Requiring Environmental Impact Assessment (EIA) Report

Item 9: Quarries

Para (ii): Earthwork involving extraction, removal, filling or dumping of earth with a volume of 40,000 cubic metres or more

Under Section 12A of the Environment Protection Enactment 2002, amended in 2012, failure to comply to the requirement for an Environmental Assessment may result in a fine not exceeding fifty thousand ringgit (RM50,000) or imprisonment for a term not exceeding two years, or both a fine and imprisonment, under the First Schedule. Under the Second Schedule, failure to comply may result in a fine not exceeding one hundred thousand ringgit (RM100,000) or imprisonment for a term not exceeding five years, or both a fine and imprisonment.

An Environmental Assessment is an important technique for ensuring that the likely impacts of stone quarry activities on the environment are fully understood and taken into account, before such development is allowed to commence. The main objectives of an Environmental Assessment for stone quarry activities are:

- To assess and recommend the most appropriate stone quarry development options based on existing site conditions, so as to minimise impacts on the environment;
• To identify, predict and wherever possible quantify the significance of any adverse impacts on the environments and communities that are likely to be affected by the stone quarry activity;

• To formulate and incorporate appropriate and cost effective mitigation and abatement measures into overall planning for stone quarry activities; and

• To determine a suitable and effective programme for ensuring environmental compliance and monitoring of residual impacts.

Other legal requirements applicable to stone quarry activities, which should be referred to by the environmental consultant during preparation of the Environmental Assessment report are:

<table>
<thead>
<tr>
<th>Legal Requirements</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Quality Act, 1974</td>
<td>− Restriction and prohibition of pollution (air emissions, noise pollution, inland waters, soil, waste, hazardous and scheduled substances)</td>
</tr>
<tr>
<td></td>
<td>− Prohibition of open burning</td>
</tr>
<tr>
<td></td>
<td>− Management of scheduled waste</td>
</tr>
<tr>
<td>Environmental Quality (Sewage) Regulations 2009</td>
<td>− Provision and proper operation of sewage treatment system</td>
</tr>
<tr>
<td></td>
<td>− Sewage discharge quality</td>
</tr>
<tr>
<td>Environmental Quality (Scheduled Wastes) Regulations 2005</td>
<td>− Management and disposal of scheduled waste including storage and labelling</td>
</tr>
<tr>
<td>Wildlife Conservation Enactment 1987</td>
<td>− Protection and management of plants and animals</td>
</tr>
<tr>
<td>Town and Country Planning Ordinance (Sabah Cap. 141)</td>
<td>− Preparation and approval of schemes for designated landuse of an area (zoning)</td>
</tr>
<tr>
<td>Land (Quarry) Rules 1997</td>
<td>− License for aggregate extraction</td>
</tr>
<tr>
<td>Water Resource Enactment, 1998</td>
<td>− Water conservation areas</td>
</tr>
<tr>
<td></td>
<td>− Flood plain management areas</td>
</tr>
<tr>
<td></td>
<td>− River reserves</td>
</tr>
</tbody>
</table>
### Legal Requirements

<table>
<thead>
<tr>
<th>Legal Requirements</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural Heritage (Conservation) Enactment 1997</td>
<td>Preservation and conservation of cultural heritage sites</td>
</tr>
<tr>
<td>Explosives Act 1957 (revised 1978)</td>
<td>Use, storage and transport of explosives</td>
</tr>
<tr>
<td>Local Municipal Rules including Earthwork By-Laws</td>
<td>Requirements for planning submission including site layout, drainage and others</td>
</tr>
<tr>
<td>Sabah Biodiversity Enactment, 2000</td>
<td>License to access biological resources</td>
</tr>
</tbody>
</table>

In addition to the legal requirements, there are several guidelines related to the environment which should be considered by all stone quarry activities applicants. These include (but are not limited to):

- Guidelines on the Prevention and Control of Soil Erosion and Siltation in Malaysia (Department of Environment, 1996);
- Guidelines on Occupational Vibration (Department of Occupational Safety and Health, 2003)
- Environmental Impact Assessment Guidelines for Mines and Quarry (Department of Environment, 1995); and
- Guidelines for Erosion and Sediment Control in Malaysia (Department of Irrigation and Drainage, 2nd Edition 2011).

These guidelines should be followed as appropriate (depending on the project concept and site specific issues) by the environmental consultant during preparation of the Environmental Assessment report for submission to EPD.

The guidelines and legislation above are correct as of November 2012. It is the duty of the environmental consultant at all times to update the list and to apply the latest regulations as issued by relevant government agencies.

### 2.4 Application and Approving Procedures

Any person who intends to undertake stone quarry activities in the State of Sabah is required to submit an Environmental Assessment report to the Director of EPD, Sabah for approval. The contact details for EPD are:
In addition, written approval is also required from the following local authorities prior to commencement of stone quarry activities (but not limited to):

- **Lands and Surveys Department**
  
  A license to remove stone, earth and sand from state and alienated land is required from the Assistant Collector of Land Revenue, as required under Section 23 of the Land Ordinance 1968 and Land Rule 3(2).

- **Minerals and Geoscience Department Malaysia, Sabah**
  
  Approval of the Geological Report and blasting design.

- **Royal Malaysian Police**
  
  In order to obtain the explosive material for blasting purposes, an explosive permit needs to be obtained from the Royal Malaysian Police. Approval of the Environmental Assessment report (from EPD) and blasting design (from Minerals and Geoscience Department) is required in order to apply for an explosive permit.

### 2.5 Key Stakeholders

As part of the environmental assessment procedure, EPD will seek technical comments from relevant departments with responsibilities for specific aspects relating to stone quarry activities. The main responsibilities of these departments in relation to the environmental assessment are listed below. However, the departments may also comment on any other aspect of the assessment, if deemed relevant.
<table>
<thead>
<tr>
<th>Department</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lands and Surveys Department</td>
<td>Land titles/ ownership</td>
</tr>
<tr>
<td>District Office</td>
<td>Local settlement issues, i.e. flooding, public complaints and others</td>
</tr>
<tr>
<td>Department of Irrigation and Drainage</td>
<td>Drainage system, water catchment areas, water supply, riparian reserves</td>
</tr>
<tr>
<td>Public Works Department</td>
<td>Slope concerns, road network</td>
</tr>
<tr>
<td>Water Department</td>
<td>Water intake points</td>
</tr>
<tr>
<td>Town and Regional Planning Department</td>
<td>Zoning</td>
</tr>
<tr>
<td>Municipal Council</td>
<td>Municipality issues, i.e. waste management</td>
</tr>
<tr>
<td>Minerals and Geoscience Department Malaysia, Sabah</td>
<td>Slope stability, geological and soil features, stone reserve estimation</td>
</tr>
<tr>
<td>Department of Environment</td>
<td>General environmental concerns (air, effluent, water, scheduled waste and other)</td>
</tr>
</tbody>
</table>

The list of departments is not exhaustive and may vary depending on the development concept and sensitivity of the location.

EPD is responsible for overseeing the environmental assessment procedure in relation to the prescribed activities and at the same time, requires comments/ concerns/ advice from the key stakeholders for decision making.
3 Typical Project Activities

3.1 Project Plan

An environmental impact assessment is an assessment of an intent, i.e. the assessment of the potential impacts occurring from well described planned activities.

It is therefore important that all activities, which have potential environmental impacts, are planned and described in sufficient detail prior to the environmental assessment. After the initial project information, the Environmental Assessment report therefore concerns the project description or plan.

The Project Proponent must provide the environmental consultant with a detailed description of all stone quarry activities, including supporting activities.

3.2 Project Stages

Generally, stone quarry activities will involve four (4) main stages, i.e. pre-development; site preparation, operation stage and quarry closure or abandonment.

The activities involved during each stage are listed below in Table 3-1:

Table 3-1: Typical Activities for Stone Quarry Activities

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Development</td>
<td>• Land acquisition and access</td>
</tr>
<tr>
<td></td>
<td>- Acquire land</td>
</tr>
<tr>
<td></td>
<td>- Relocation of existing occupants (if any)</td>
</tr>
<tr>
<td></td>
<td>• Investigation</td>
</tr>
<tr>
<td></td>
<td>- Detailed site surveying</td>
</tr>
<tr>
<td></td>
<td>- Preparation of geological report</td>
</tr>
<tr>
<td></td>
<td>- Detailed design for quarry layout and phasing plan, Erosion and Sediment Control Plan (ESCP)</td>
</tr>
<tr>
<td></td>
<td>- Collection of baseline environmental data</td>
</tr>
<tr>
<td></td>
<td>for use in preparation of Environmental Assessment report</td>
</tr>
<tr>
<td>Stage</td>
<td>Activities</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Site Preparation</td>
<td>• Construction of an access road to the quarry site</td>
</tr>
<tr>
<td></td>
<td>• Clearing of vegetation</td>
</tr>
<tr>
<td></td>
<td>• Drainage management and controls</td>
</tr>
<tr>
<td></td>
<td>• Site containment controls (sedimentation ponds, noise and dust barriers)</td>
</tr>
<tr>
<td></td>
<td>• Mobilization of machinery and equipment</td>
</tr>
<tr>
<td></td>
<td>• Provision of site facilities (site office, amenities, power, water, and others)</td>
</tr>
<tr>
<td>Operation</td>
<td>• Drilling and blasting</td>
</tr>
<tr>
<td></td>
<td>• Excavation</td>
</tr>
<tr>
<td></td>
<td>• Crushing</td>
</tr>
<tr>
<td></td>
<td>• Sorting and stockpiling</td>
</tr>
<tr>
<td></td>
<td>• Overburden management</td>
</tr>
<tr>
<td></td>
<td>• Water infiltration management, treatment and disposal</td>
</tr>
<tr>
<td></td>
<td>• Risk management</td>
</tr>
<tr>
<td></td>
<td>• Transporting materials</td>
</tr>
<tr>
<td></td>
<td>• Environmental monitoring</td>
</tr>
<tr>
<td>Quarry Closure or</td>
<td>This stage involves rehabilitation of the site so that it is left in an</td>
</tr>
<tr>
<td>Abandonment</td>
<td>acceptable state both functionally and aesthetically. Re-vegetation is an</td>
</tr>
<tr>
<td></td>
<td>essential component of site rehabilitation.</td>
</tr>
<tr>
<td></td>
<td>A plan for site rehabilitation should be prepared. The order in which the</td>
</tr>
<tr>
<td></td>
<td>resource is extracted and the management of residual materials is frequently</td>
</tr>
<tr>
<td></td>
<td>dictated by the project closure plan for the site.</td>
</tr>
</tbody>
</table>
4 Scoping

This chapter deals with the scoping stage which defines the work scope for preparation of the Environmental Assessment report (refer to Table 4-1).

Table 4-1: Assessment Procedures - Scoping

<table>
<thead>
<tr>
<th>The Seven Steps</th>
<th>Summary of Main Required Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 3: Project Scoping and Preparation of Terms of</td>
<td>Environmental Consultant:</td>
</tr>
<tr>
<td>Reference/ Scoping Note</td>
<td>• Undertake scoping activities</td>
</tr>
<tr>
<td></td>
<td>• Assess initial project description and assist the Project Proponent to</td>
</tr>
<tr>
<td></td>
<td>make amendments</td>
</tr>
<tr>
<td></td>
<td>• Perform initial site visit</td>
</tr>
<tr>
<td></td>
<td>• Prepare a draft TOR or Scoping Note</td>
</tr>
<tr>
<td></td>
<td>• Undertake the public hearing activities required for Special EIA</td>
</tr>
<tr>
<td></td>
<td>• Participate in review meetings</td>
</tr>
<tr>
<td></td>
<td>• Finalise the TOR for EIA or Scoping Note for PMM and obtain final approval</td>
</tr>
<tr>
<td></td>
<td>from EPD</td>
</tr>
</tbody>
</table>

Scoping is the identification of potential environmental impacts and the predicted extent of the impacts. This exercise is an important early stage of the environmental assessment process to ensure that the assessment is carried out properly and appropriately, i.e. that the report is sufficiently comprehensive, while at the same time preventing the assessment from becoming unnecessarily protracted or expensive due to inappropriate focus on issues of only minor concern.

In general, the scoping process is outlined in the EPD’s Handbook on Environmental Impact Assessment in Sabah. This section briefly outlines the main steps in scoping, but primarily focuses on providing specific guidance on:

Identification and preliminary assessment of potential impacts with respect to certain approaches to stone quarry activities and with respect to specific project locations; and

Selection of appropriate assessment methodologies, based on project sensitivities.
In order to carry out the above, a comprehensive description of the project in terms of location, activities and processes needs to be developed. This is described in the following section.

4.1 Project Information

The first step in scoping is to obtain as much relevant information about the project as possible, to ascertain the scale of the project and its component activities which may result in impacts to the environment.

4.1.1 Description

A description of the project location, activities and potential qualitative and quantitative impacts should be developed at this stage, in order to identify the stages, activities or characteristics of the proposed project that are likely to give rise to environmental impacts.

4.1.2 Project Location

A preliminary assessment of the baseline conditions shall be made to identify key sensitive receptors. Consideration should be given to the existing topography and drainage features, soil and vegetation conditions, wildlife, traffic conditions, water, air and noise quality as well as sensitive habitats and land uses.

A site visit and preliminary consultations with relevant regulatory authorities must be undertaken during the scoping exercise.

4.1.3 Identification and Prioritisation of Impacts

Based on the previous steps, a list of all potential environmental impacts should be made with a preliminary estimate of their relative significance. The key impacts are those with the highest potential significance, considering both spatial scale, significance to stakeholders, potential impact severity and mitigation potential. EPD’s Handbook on Environmental Impact Assessment in Sabah is a useful resource for this assessment. A prioritised list of impacts shall thereby be established and clearly described.

For each key impact identified, the anticipated zone of impact should be estimated by the expert judgement of the relevant specialists, based on conditions at the site. The zone of impacts may differ depending on the environmental component; the zone of impact for noise pollution for example may be much smaller than the potential river water quality zone of impact,
owing to properties of both the polluting and the dispersing agent and the conditions at the site.

Some potential impacts and their zone of impact for stone quarry projects are shown in Figure 4-1.
Source: Adapted from DOE Malaysia EIA Guidelines for Land Reclamation Projects, 2008

Figure 4-1: Main issues and extent of impacts for stone quarry activities
4.2 Types of Impacts

Whereas stone quarry activities can provide significant planning and development opportunities as well as benefits to the public if properly planned and executed, there are also numerous potential adverse impacts that have to be taken into account. The potential impacts are site and project specific, depending, among other factors, on topography and drainage patterns, nearby environmental receptors, size and layout.

Whilst the environmental assessment evaluates both positive and negative impacts, the positive impacts are generally site specific, related to the project objectives, whilst the negative impacts can be considered as generic impacts on the physical, ecological, or socio-economic environments. A non-exhaustive list of main potential impacts related to stone quarry activities are provided in Section 5.3; these are also listed in Figure 4-1.

4.3 Terms of Reference

The TOR for the Environmental Assessment shall directly reflect the scoping exercise whereby the environmental consultant should address the identified impacts as fully as practicable. The level of analysis from baseline studies and the sophistication of prediction and evaluation methodologies, shall be tailored to the level of significance of the impacts and hence level of precision required for the evaluation, as illustrated in Figure 4-2. Less attention should be given to those issues which have lesser significance. In practical terms, this means that the level of uncertainty may be higher for these issues.
4.3.1 Data Collection Requirements

Collecting existing data is always the first step in the collection of baseline information. It must however be reviewed for its relevance to the proposed site, its accuracy, and used as a basis for determining what primary field investigations may be required to ‘fill the gaps’.

Primary field surveys are almost always required for most aspects of the environment, such as: existing vegetation and habitats, wildlife, water quality, topography, socio-economic and other factors. Field surveys are needed either because published information in Sabah often does not exist at a suitable scale, or is not generally applicable to the project being assessed.

Where primary field surveys are required, careful consideration must be given to the design of the field survey and sampling programme (refer to Figure 4-3). The data collection must focus on the key issues needed to be examined for the Environmental Assessment (identified during the scoping process), and should be collected at the appropriate time(s) of the year. In Sabah, this may include consideration of rainy and dry seasons, and on the coast, the monsoon and inter-monsoon periods.
It is important to address the temporal scale of the project when designing the baseline survey programme. A long-term stone quarry operation programme (e.g. more than ten years) would require a baseline survey that captures natural seasonal variations within that period; while for a short project (e.g. one to five years operation), capturing a snapshot of the existing conditions can be sufficient.

In addition, the survey programme shall take into account the anticipated zone of impact for the issue in question to ensure that all potential sensitive receptors are included.

It should also be highlighted that a more detailed baseline, capturing seasonal variations, provides more security for the Project Proponent, in the event that natural variations are incorrectly perceived by stakeholders or regulators as project-derived impacts.
Selection of Survey Stations & Methodologies

**Inputs**
- **Secondary Data:**
  - Historical Baseline
  - Identify key receptors & seasonal variability

**Requirements**
- **Project Details & Expected Implementation Methodology**
  - Location and layout
  - Project schedule
  - Technology & methodology
  - Production rate

- **EPD/ Stakeholder Consultation:**
  - Identify concerns
  - Identify requirements
  - Additional secondary data & local experience

- **Representative of the Impact Area:**
  - Impact stations
  - Reference stations

- **Representative Impacts Affecting the Habitat:**
  - Loss of habitat
  - Soil erosion
  - Water quality
  - Air and noise quality
  - Increase in traffic
  - Airblast, flyrocks and ground vibration

- **Representative of the Scale of the Project:**
  - Spatial extent
  - Duration

- **Representative of the Environment:**
  - Key communities and structure
  - Seasonal variability

Source: Adapted from PIANC, 2010

Figure 4-3: Examples of criteria for selection of baseline survey stations and methodologies
5 Impact Prediction and Evaluation

This chapter deals with the assessment of the impacts that are likely to occur in the existing environment when the project activities are implemented (refer to Table 5-1).

Table 5-1: Assessment Procedures - Description of Impact Assessment

<table>
<thead>
<tr>
<th>The Seven Steps</th>
<th>Summary of Main Required Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 4: Undertaking the EIA/</td>
<td>Environmental Consultant:</td>
</tr>
<tr>
<td>PMM study</td>
<td>• Assess the project details</td>
</tr>
<tr>
<td></td>
<td>- Plan assessment</td>
</tr>
<tr>
<td></td>
<td>• Assess the existing environments</td>
</tr>
<tr>
<td></td>
<td>- Physical environment</td>
</tr>
<tr>
<td></td>
<td>- Biological environment</td>
</tr>
<tr>
<td></td>
<td>- Human environment</td>
</tr>
<tr>
<td></td>
<td>• Assess the environmental impacts</td>
</tr>
<tr>
<td></td>
<td>- Air pollution due to land clearing and general quarrying operations</td>
</tr>
<tr>
<td></td>
<td>- Noise pollution from utilisation of heavy machineries/ equipment and quarrying operations</td>
</tr>
<tr>
<td></td>
<td>- Airblast, flyrocks and ground vibration from rock blasting works</td>
</tr>
<tr>
<td></td>
<td>- Deterioration of water quality</td>
</tr>
<tr>
<td></td>
<td>- Soil erosion and sedimentation from land clearing works</td>
</tr>
<tr>
<td></td>
<td>- Slope stability</td>
</tr>
<tr>
<td></td>
<td>- Generation of overburden materials</td>
</tr>
<tr>
<td></td>
<td>- Waste management</td>
</tr>
<tr>
<td></td>
<td>- Loss of terrestrial/ riverine ecology due to vegetation removal</td>
</tr>
<tr>
<td></td>
<td>- Impacts on existing traffic and transportation pattern</td>
</tr>
<tr>
<td></td>
<td>- Social economic concern/ benefits</td>
</tr>
<tr>
<td></td>
<td>- Visual impact</td>
</tr>
<tr>
<td></td>
<td>- Cultural heritage concern</td>
</tr>
<tr>
<td></td>
<td>- Project closure or abandonment</td>
</tr>
</tbody>
</table>
This section outlines procedures for identifying the environmental impacts associated with stone quarry activities as well as proposed methodologies for assessing the scale and extent of the environmental impact. The magnitude of the impacts depends on the combination of existing conditions and the selected technologies and methodologies, while the zone of impact depends on existing environmental conditions such as topography, vegetation, land use and traffic. Adverse environmental impacts affect habitats and livelihoods outside the project area, and hence the Project Proponent is responsible to minimise such impacts by adopting mitigation measures. As a general principle, mitigation measures should preferentially focus on addressing the impacts in order to eliminate/minimise the residual impacts.

The assessment must consider site characteristics, the proposed quarry development concept and the cumulative impact with other existing or proposed development within close proximity to the site. The environmental consultant’s approach to assessing these interrelated factors should be clearly described based on the TOR as approved by EPD.

5.1 Description of Plans and Site

Step 4 of the overall environmental assessment process may be divided into four (4) main parts:

i. Description of planned activities and existing environment conditions;

ii. Assessment of environmental impacts;

iii. Devising mitigation measures; and

iv. Formulation of monitoring programme.

This chapter deals with the description of plans and the existing conditions within the site and the zone of impact (refer to Table 5-2).

The assessment of the existing environment and thus also the activities and associated mitigation will, to a large extent, be based on an analysis of topographic maps combined with knowledge of the field conditions. These maps are based on aerial photo interpretation of dense canopy cover and can only be indicative of terrain contours and smaller features such as creeks and
streams. The actual delineation of areas and mitigation measures must be based on the verifiable conditions in the field i.e. be based on field surveys.

Table 5-2: Assessment Procedures - Description of Plans and Existing Environments

<table>
<thead>
<tr>
<th>The Seven Steps</th>
<th>Summary of Main Required Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 4:</td>
<td>Environmental Consultant:</td>
</tr>
<tr>
<td>Undertaking the EIA/PMM study</td>
<td>• Assess the project details</td>
</tr>
<tr>
<td></td>
<td>• Plan assessment</td>
</tr>
<tr>
<td></td>
<td>• Assess the existing environments</td>
</tr>
<tr>
<td></td>
<td>• Physical environment</td>
</tr>
<tr>
<td></td>
<td>- Water</td>
</tr>
<tr>
<td></td>
<td>- Air and noise</td>
</tr>
<tr>
<td></td>
<td>- Soils and geology</td>
</tr>
<tr>
<td></td>
<td>- Meteorology</td>
</tr>
<tr>
<td></td>
<td>• Biological environment</td>
</tr>
<tr>
<td></td>
<td>- Flora and fauna</td>
</tr>
<tr>
<td></td>
<td>• Human environment</td>
</tr>
<tr>
<td></td>
<td>- Public administration</td>
</tr>
<tr>
<td></td>
<td>- Demography</td>
</tr>
<tr>
<td></td>
<td>- Livelihoods and economic activities</td>
</tr>
<tr>
<td></td>
<td>• Assess the environmental impacts</td>
</tr>
<tr>
<td></td>
<td>• Devise and propose mitigation measures</td>
</tr>
<tr>
<td></td>
<td>• Devise and propose monitoring programmes</td>
</tr>
</tbody>
</table>

The impact assessment is, as mentioned, based on a combined knowledge of the intent and the existing environment.

An assessment must therefore be made of the existing environment, its components and its sensitivity to impacts from the stone quarry activities. In order to provide a basis for comparison during later monitoring, it is important to have a set of baseline data, describing clearly the pre-project conditions. The description provided must be clear and direct to the point being discussed.

5.1.1 Site Consideration

Consideration on the selection of a location for a stone quarry site depends primarily on the availability of suitable rock and suitable access at a particular
site. However, the following conservation value areas should be avoided, where possible:

- Areas of geological value such as fossils or geological structures which have been identified by the Minerals and Geoscience Department or higher education institute as a site suitable for gazettlement as a study area;
- Areas of protected plant or animal species; and
- Forested ridge areas which have inherent aesthetic visual qualities.

### 5.1.2 Project Screening

Screening is recommended to be applied by environmental consultants to determine the aspects that should be covered in an Environmental Assessment report. The process of screening should be simple and rapid, but effective enough to eliminate major potential environmental impacts that have residual significance, such as destruction of environmentally sensitive areas or priority habitat.

Screening allows for focus on real environmental issues at an early stage of the assessment process and allows for environmentally sensitive planning and the early resolution of some issues. This will minimise the possibility of residual impacts. Project screening is conducted by assessing the project details in relation to the existing environment as described in Section 5.1.3 and Section 5.1.4.

### 5.1.3 Assess the Project Details

In order to be able to propose realistic mitigation measures, the following initial information should be obtained prior to embarking on any field surveys or assessments. This information will provide the scope of work for the assessments to be included in the Environmental Assessment report.

A more detailed description of the project concept, with all available technical data should be given in the Environmental Assessment report, in terms of:

i. **Project Location and Concept**

   - Exact location of proposed quarry site and all receptors within zone of impact. These should be shown on a map with an appropriate scale and coordinate system;
- Layout plan and description of the proposed project components (site office, workers’ quarters, workshop, quarry face, stockpile area, overburden stockpile, crusher plant and others);

- Size of proposed quarry operation areas;

- Estimated amount of aggregates to be extracted per month/year;

- List of equipment and machineries to be used including for transportation of finished products;

- Details on crusher plant to be utilised including air and noise pollution control measures;

- Statement of need for the proposed project;

- Work implementation schedule;

- Local structure plan for the area and its nearby surroundings; and

- Mapping of existing land use and sensitive areas (including residential area, forest reserves areas, river/streams, water intake points, historical or archaeological sites and others) within the zone of impact from the site.

ii. Site Clearing

- Detailed site survey plan showing ground levels, rivers, existing structures and others within the site; and

- Description of site clearing method and area involved.

iii. Rock Extraction Methodology

- Blasting design details; and

- Quarry phasing plan including rock face direction.

5.1.3.1 List of Supporting Documents Required

The following reports/ details (plus other appropriate reference sources) should be made available and incorporated in the Environmental Assessment report where relevant:
<table>
<thead>
<tr>
<th>Report/ Study</th>
<th>Details Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geological Report prepared by a registered geologist</td>
<td>Geological reconnaissance, petrographic analysis, residual soil and depth of</td>
</tr>
<tr>
<td></td>
<td>weathering, physical properties of aggregates, potential geological hazards</td>
</tr>
<tr>
<td></td>
<td>and stability issues (slope failures, ground settlement, sinkholes), estimated</td>
</tr>
<tr>
<td></td>
<td>amount of rock reserves and overburden materials,</td>
</tr>
<tr>
<td>Erosion and Sediment Control Plan (ESCP) as prepared by a competent party</td>
<td>Layout and design details for erosion control facilities such as sediment basin,</td>
</tr>
<tr>
<td>(latest as per submitted to the local authority)</td>
<td>silt traps and temporary drainage network</td>
</tr>
<tr>
<td>Blasting Design(^1) prepared by a licensed shotfirer/mining engineer</td>
<td>Blasting frequency, initiation system,</td>
</tr>
<tr>
<td></td>
<td>number of blast holes, number of rows, spacing, stemming, type of explosives,</td>
</tr>
<tr>
<td></td>
<td>maximum number of holes per delay</td>
</tr>
</tbody>
</table>

5.1.4 Assess the Existing Environment

It is necessary to provide sufficient information to give a brief but clear illustration of the existing environmental components. These components include, to the extent applicable (but are not necessarily limited to) the following:

- **Physical Environment**: topography, slope features, soil, geology, seismology, hydrology, climate, surface water, ground water, air quality and noise level.

- **Biological Environment**: wildlife, forest, rare, protected or endangered species (flora and fauna), fisheries, aquatic biology, wilderness or protected areas, key conservation value habitats or species.

- **Human Environment**: population and communities (including numbers, locations, compositions, employment and others), land use, location of important economic resources (including plantations), infrastructural

\(^1\) The blasting design is required for the environmental consultant to estimate the minimum safe distance. However, as the blasting design is dynamic in nature depending on the quarry development progress, the final blasting design which is approved by the Minerals and Geoscience Department should be made available prior to commencement of the quarry operation.
facilities (including water supply, electricity, sewerage, flood control/damage and others), institutions (such as schools, hospitals and places of worship), transportation (roads, navigation and others), archaeological, historical and cultural values and aesthetic values.

The baseline study for the Environmental Assessment should concentrate on identifying those environmental components that may be significantly impacted by the proposed project. These may be identified through ground observation, literature review and stakeholder consultation. The description can be presented in the form of mapping, listing or reports in the Environmental Assessment report.

5.1.5 Study Area and Zone of Impact

Generally, a study area for the preparation of an Environmental Assessment report covers 3 km radius from the project site boundaries. However, the study area should focus on what the environmental consultant deems to be the zone of impact. A clear delineation of the study area based on actual ground survey conducted is important to define the area within which impacts should be considered.

There may be different zones of impact for physical (such as water quality, vibration, flyrocks, traffic and air emission/noise nuisance), biological (such as wildlife species, habitat and diversity) and human (such as social issues affecting communities, cultural and aesthetic aspect and land use) environment. The environmental consultant should overlap these impact zones and decide which zone is particularly sensitive and where impacts are likely to be of some significance. Such zones may reach far downstream from the sites, particularly if there are sensitive areas downstream or locality concerns. The zone of impact can be determined after understanding the concept of the proposed development and conducting ground observations to identify these sensitive areas.

The extent of the study area/zone of impact must be mapped out, clearly defined and justified in the TOR document and agreed upon with EPD. This will particularly include human settlements that are to be included in the assessment surveys for the preparation of the Environmental Assessment report.

5.2 Impact Assessment

The Environmental Assessment for stone quarry activities will assist in the following:
• Planning of site preparation works;

• Identification of environmental impacts and the risk of negative impacts;

• Exclusion or protection of sensitive or vulnerable areas; and

• Protecting environmental components in the immediate site area, in adjacent areas and in the broader environment.

Integrating environment protection at the project planning stage will ensure that measures to avoid and minimise pollution can be built into the project design and work schedule. The Environmental Assessment should not only consider the environmental impact on a site, but whether or not significant off-site effects are likely. An initial assessment of the site should be conducted to identify sensitive environmental areas or land-uses that require protection. These may include:

• Sensitive or endangered flora and fauna;

• Aquatic plants and animals, if a natural waterway is affected; and

• Historical buildings/ cultural areas that are considered as sensitive.

The first activity to be performed as part of the Environmental Assessment process is to identify environmental issues which are important and which will need to be studied in detail, and to identify and eliminate issues which are of little or no importance and therefore can be excluded from the Environmental Assessment study.

5.2.1 EIA Matrix

Impact assessment is not an exact science. The assessment of impacts therefore requires a deep knowledge and understanding of the local environment and the development concept. Therefore, different assessments are likely to come to similar but still somewhat different conclusions.

The environmental consultant should combine their personal experience with recent international and local research results, monitoring reports from neighbouring areas of active stone quarry activities, new survey data and in some cases from the results of modelling.

Literature on the impacts of stone quarry activities already exists and in the first instance this should be consulted. A review of known impacts documented for similar environments is likely to provide a good foundation for the basis of the impact assessment.
Results obtained from computerised mathematical models need to be verified against field data. It should be recognised that for the results to be representative, the data requirements are high and limited by the quality of the input data. To enable verification by EPD, actual procedures must be made available. Before using computer models, prior consultation and approval with EPD is advisable.

It cannot be stressed enough that the environmental consultant should take a realistic and site specific view of the project. They shall neither promote nor counter the proposed activities but realistically present, what in their professional opinion is realistic to expect as a result of the plans. In order to have an impact on the planning, the environmental consultant should focus on a limited number of significant key issues supported by literature review and project specific information. In addition to an assessment of the probability (risk) of the impact to occur, each issue shall be described with a view of:

- The magnitude of the projected impact.
- The permanence of the projected impact.
- The reversibility of the projected impact.
- Cumulative impacts over time of the projected impact.

This means that these four points must be represented as sub-headings for each description of an impact.

The summary of results shall be presented in an EIA Matrix, an example of which is shown in Table 5-3. To guide the reader of the Environmental Assessment report, this summary table is best placed before the descriptions of each environmental impact.

**Table 5-3: EIA Matrix (Example)**

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Magnitude</th>
<th>Permanence</th>
<th>Reversibility</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Environmental Impacts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Pollution</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Noise Pollution</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Airblast, Flyrocks and Ground Vibration</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Water Quality Deterioration</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Slope Stability</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Impacts</td>
<td>Magnitude</td>
<td>Permanence</td>
<td>Reversibility</td>
<td>Cumulative</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------</td>
<td>------------</td>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>Overburden Management</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Other Environmental Impacts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Generation</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Traffic and Transportation</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Social Economic</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Visual Impact</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Abandonment</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Legend**  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude</td>
<td>1</td>
</tr>
<tr>
<td>Permanence</td>
<td>No change/ not applicable</td>
</tr>
<tr>
<td>Reversibility</td>
<td>No change/ not applicable</td>
</tr>
<tr>
<td>Cumulative</td>
<td>No change/ not applicable</td>
</tr>
</tbody>
</table>

When scoring the level of impact, the environmental consultant should give justification on how the scoring has been done and what has caused very high or very low assessment scores. This can be done by repeating the table row at the end of each impact description. An example is given in Table 5-4.
Table 5-4: Activity Level EIA Matrix (Example for Air Pollution)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude of Change/</td>
<td>2</td>
<td>Dust dispersion extent approximately 500 m from project site.</td>
</tr>
<tr>
<td>Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanence of Impact</td>
<td>2</td>
<td>Temporary – only during stone quarry operation (crushing, transportation,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>stockpiling).</td>
</tr>
<tr>
<td>Reversibility of Condition</td>
<td>2</td>
<td>Reversible upon cessation of quarry activities or with air pollution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>control measures in place.</td>
</tr>
<tr>
<td>Cumulative Impact</td>
<td>3</td>
<td>Cumulative impact with other conditions such as surrounding traffic.</td>
</tr>
</tbody>
</table>

5.2.2 Use of Geographical Information System (GIS)

The representation of spatial data by means of a GIS provides an appropriate tool for representing and analysing spatial data sets, particularly for larger, more complex and sensitive projects. GIS therefore offer good opportunities to examine the environmental sensitivity of different environments.

It is a requirement to submit datasets directly to EPD. The GIS used by the environmental consultant should be able to export datasets in a format readable by the EPD’s system. The environmental consultant should therefore consult the EPD before the analytic work begins in order to ensure such compatibility.

EPD may from time to time issue a list of map formats including standardised map symbols or spatial data requirement, which must be used in maps submitted as part of an Environmental Assessment.

5.2.3 Optimisation of Project Plan

The environmental consultant will at several points during the assessment, find that the plan description provided by the Project Proponent is suboptimal seen from an environmental point of view. There may be environmental management issues, which are not included in the plan description, there may be certain parts of the project scope, timing or lay-out, which are not seen as acceptable, or there may be suboptimal choices of technologies or methodologies. The environmental consultant will, when such flaws in the plan description become obvious, advise the Project Proponent on recommendable plan changes so the final plan, which is being assessed by
the environmental consultant, is optimised for environmental management, i.e. negative environmental impacts are being minimised through proper choice of scope, technologies and methodologies.

It is unavoidable that the project activities will cause some residual impacts even when all activities are carried out in the best possible manner. The assessment by the environmental consultant will then concentrate on assessing the magnitude and effect of these residual impacts. There will be no more that the Project Proponent can do to minimise them. There will, however, be some mitigation in the form of compensation that can be implemented. Off-set planting or replacement of habitat conservation, cash compensation or substitutes for lost livelihoods or environmental services are among the options for mitigating unavoidable and thus residual, impacts.

Project optimisation options must be thoughtfully considered and reported in the Environmental Assessment report so that the maximum benefits of the project are clearly understood. These benefits should be considered against any residual impacts that may be identified in the Environmental Assessment.

5.3 Environmental Impacts

The environmental impacts associated with stone quarry activities concern:

- Air pollution
- Noise pollution
- Airblast, flyrocks and ground vibration
- Water quality
- Erosion and sedimentation
- Slope stability
- Overburden material management
- Waste disposal
- Ecology
- Traffic and transportation
- Social-economic
• Visual impact
• Cultural heritage
• Closure or potential abandonment

Documented advice should be provided to Project Proponents at an early planning stage on best ways to improve the environmental sustainability of the project. For example, provide site location or blasting design alternatives that reduce the risk of environmental impacts and improve the environmental performance and aesthetics of the project. This may require the environmental consultant to obtain specialist advice from technical specialists (i.e. geologist or mining engineer) on such matters.

Different activities related to stone quarry activities cause different impacts, while technologies, methodologies and local, site specific conditions determine the extent of the impacts, i.e. the zone of impact and the severity. As a planning tool, it is important that the Environmental Assessment gives very clear recommendations to the Project Proponent on how activities should be implemented. The surrounding community, however, is more concerned on where, when and how, impacts will affect their livelihoods; less on why. The definition of impact, particularly residual impact, should therefore be clear and define impacts in terms of time, quantity and quality.

5.3.1 Air Pollution

Air pollution during stone quarry activities is caused by dust nuisance. Dust can be defined as finely divided solid matter and is a concern due to its harmful physiological effects. Dust becomes a nuisance when it is in the form of clouds, reducing visibility, creating an uncomfortable environment (irritation of eyes, ears, nose, throat and skin). In addition, dust nuisance may also increase equipment maintenance cost due to excessive wear and premature failure of components.

A wide variety of stone quarry activities produce dust. These include:

• Site clearing;
• Drilling;
• Blasting;
• Crushing;
• Excavating;
• Filling;
• Dust from overburden disposal area;
• Transportation of materials; and
• Vehicle movements on unsealed surfaces.

Dust particles are transported by wind. Wind borne dust can settle on neighbouring, or distant, properties, resulting in particle deposition on surfaces, which may affect operations or simply represent a nuisance for others. Dust deposition on vegetation can affect photosynthesis process, thus impacting growth of vegetation. In addition, excessive dust emissions may cause site health and safety concerns due to the higher risk of accidents and down time. High levels of dust concentration in the environment may represent a health hazard to local residents.

**Assessment Methodology:**

*Air Quality Assessment:* Conducting baseline air quality sampling at the boundary of project site or nearby sensitive receptors, especially any residential areas within 500 m of the project site boundary. Results obtained from the baseline sampling shall be compared with Recommended Malaysian Ambient Air Quality Guidelines published by the Department of Environment (DOE).

Air sampling should be conducted as follows:

• Samples are to be collected at the site boundary or nearest receptors. The sampling location should be clearly indicated on a map together with GPS coordinates and photographs of the sampling site.
• Samples are to be collected for duration of 24-hours to establish baseline data.

*Site Assessment:* Identification and mapping of the proposed quarry face and zone of impact features in the vicinity of the quarry site. The map should be presented on a topographical map at a scale of 1:50,000 or 1:25,000. The map should also show the location of the nearest receptors that may be affected by the air pollution.

*Meteorological Data:* It is important to obtain the meteorology data at the project area from the Malaysian Meteorological Services Department, particularly wind rose data, which is essential in predicting the possible areas that will be affected by dust dispersion.
5.3.2 Noise Pollution

Noise can cause annoyance; nuisance; sleep disturbance and can affect wildlife and domesticated animals.

Stone quarries can have many activities that generate noise:

- Earthworks;
- Excavation;
- Drilling and blasting;
- Crushing and screening; and
- Transport of materials.

Noise can affect humans psychologically as well as physically. It can potentially lead to hearing damage and affect the quality and precision of work. Table 5-5 gives the critical sound intensity levels and their effect on humans.

Table 5-5: Critical sound pressure levels and their effects on humans

<table>
<thead>
<tr>
<th>$L_{eq}/\text{dB(A)}$</th>
<th>Type of work</th>
<th>Human Reaction</th>
<th>Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Working more than 5 hours per day without protection</td>
<td>Hearing damage</td>
<td>Difficult</td>
</tr>
<tr>
<td>90</td>
<td>General mechanical equipment, workshops, and others</td>
<td>Affects nervous system</td>
<td>-</td>
</tr>
<tr>
<td>80</td>
<td>General erection sites</td>
<td>-</td>
<td>Need raise voice</td>
</tr>
<tr>
<td>70</td>
<td>Equipment assembly requiring precision</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>60</td>
<td>Laboratory work, offices and others</td>
<td>Affects mental state</td>
<td>Normal voice</td>
</tr>
<tr>
<td>50</td>
<td>Work requiring special attention</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>Work requiring extreme attention</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Vutukuri and Lama, 1986
**Assessment Methodology:**

**Noise Level Assessment:** As the operation of the stone quarry, machinery and equipment will result in elevated noise levels, a risk assessment of noise pollution in relation to the surrounding communities should be conducted. This can include (among others) a comparison of the noise level from different equipment in relation to the distances from the site obtained from published literature, example as shown in Table 5-6.

**Table 5-6: Typical noise levels from various quarry operations**

<table>
<thead>
<tr>
<th>Type of Equipment/Process</th>
<th>Distance</th>
<th>Noise (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening</td>
<td>1 m</td>
<td>105</td>
</tr>
<tr>
<td>Crushing</td>
<td>1 m</td>
<td>100</td>
</tr>
<tr>
<td>Compressor</td>
<td>1 m</td>
<td>100</td>
</tr>
<tr>
<td>Drilling Machine</td>
<td>1 m</td>
<td>110</td>
</tr>
<tr>
<td>Truck Movement</td>
<td>15 m</td>
<td>80</td>
</tr>
</tbody>
</table>

*Source: QPA, 2000*

Reference should also be made to noise conditions at the project site in relation to the allowable noise limits stipulated by the Department of Environment in the Planning Guidelines for Environmental Noise Limits and Control in the Environment, 2007. In addition, the period of the stone quarry activities and implementation stages should also be taken into consideration in the assessment. Baseline noise level monitoring should be conducted at the nearest receptors or site boundary to determine the present level for comparison during the implementation stage of the proposed project. The sampling locations should be clearly indicated on a map together with the GPS coordinates and photographs of the sampling activity. Existing sources of noise nuisance should also be properly documented.

**Site Assessment:** Identification and mapping of the proposed quarry face and existing land use including settlement areas within the zone of impact. The scale of the map should be presented on scale of 1:50,000 or 1:25,000 topographical map.

**5.3.3 Air-blast, Fly-rocks and Ground Vibration**

**Blasting:** Quarry blasting involves drilling of blast holes in the rock, either vertical or inclined or sometimes horizontal, at an appropriate distance between one another. Each hole is then filled with explosive material, primed and detonated. Figure 5-1 illustrates the process. The timing of the detonation of each hole is in a delayed fashion in an effort to utilise the maximum energy.
for breakage and at the same time lessen air-blast, fly-rocks and ground vibrations.

**ROCK BLASTING**

1 face survey
2 drilling the shot holes
3 checking the holes
4 charging with explosives & stemming top
5 detonating the explosives
6 shotpile ready for loading

Source: www.northstonematerials.com

**Figure 5-1: Stages of blasting**

**Air-blast:** Air-blast is the air waves generated by blasting. Air-blast creates over-pressure which means simply that the pressure is over and above the atmospheric pressure. It is unusual for air waves from blasting operations to reach potentially damaging levels for residences. If they do, damage is usually in the form of broken windows. Even in operations where there is no damage potential, air waves are still a matter of considerable concern when they generate sounds which are heard by residents of an area. These waves can generate audible sounds which can be heard if they fall within the frequency range of the listener (about 20 – 20,000 Hertz).

Not all blasts are directly audible. If the distance is great, or charges are deeply buried, or the frequencies are too low, the blast may not be heard by persons outside the quarry site. However, small pulses of air-blast may
generate audible secondary sounds in houses in the vicinity; i.e. rattling of loose windows and doors or sound like an impact against the walls. Such effects may lead some building occupants to have concerns that strong shaking has taken place and that damage may have occurred. When people are outdoors, they may not hear those sounds and usually pay little attention to the same air waves.

The sources of air-blast or objectionable blast noise are:

- The use of lay-on or plaster charges often used in secondary blasting;
- Poorly stemmed holes; and
- Blown-out shots resulting from poor design patterns.

**Fly-rocks**: Fly-rock is the term for undesirable projectiles of blasted material. In particular types of rock there is a compatible relationship between the height of the explosive column in the holes, drilling pattern and charge ratio. When this is compromised, the explosive’s gas energy is vented violently into the atmosphere and propels rocks in front of it. Probable reasons for fly-rock could be:

- Insufficient overburden;
- Inadequate stemming;
- Incorrect spacing;
- Overcharging with explosives;
- Secondary blasting; and
- Out of sequence initiation.

Damage to life, equipment and buildings can be severe if fly-rock occurs. However with good supervision and blasting design techniques the chances of fly-rock can be minimised.

**Ground Vibration**: Upon explosive detonation in rocks, the charge is converted instantly to hot gases at intense pressure, which causes rock to fracture or break. This action will produce air-blast into the surrounding air and induce vibration in the ground. The ground vibration caused from blasting is similar to the motion of a floating object placed in water near an energy source. The distance between the wave crests that move the object is the
wavelength. The speed at which the waves travel outward from the energy source and move past the object is the propagation velocity.

**Figure 5-2: Vibration effect is dependent on the distance of sensitive area and rock characteristic**

In blasting, ground particles oscillate in response to a vibration wave. This oscillation is measured in particle velocity. The maximum rate is the Peak Particle Velocity (PPV). In blasting, this is measured in millimetres per second (mm/s). Peak particle velocity is the maximum rate of particle movement. Displacement is the distance the particle moves back and forth, or the distance a particle or object moves from its position of rest. The change in displacement over a unit of distance is called strain.

Ground vibration is similar to a seismic event, in that it causes the ground to shake. It does have the capacity to cause damage to structures at very high readings. Concern is commonly raised about the vibration level of single events and cumulative effects of low-level vibration from multiple events. A person can normally feel vibration levels in excess of 1 mm/sec. Vibrations in quarries can result from:

- Blasting;
- Machinery (rock breakers, and others); and
- Truck traffic.

**Vibration Caused by Blasting**
Ground vibration is transmitted from the site of a blast through the ground. Its transmission is affected by the geology of the terrain and the distance to the receptor source (refer to Figure 5-2). Ground vibration will typically move faster and at a higher frequency in rock than in soil. Ground vibration is measured in peak particle velocity (PPV) in mm/s.

Blast design can be modified to ensure vibration and air over-pressure levels are within acceptable limits. The principal design criteria that can be employed for this are:

- Number of blast holes;
- Weight of explosive;
- Amount of stemming; and
- Delay timing.

**Vibration Caused by Machinery**

Typically, stone quarry activities involved the use of hydraulic rock breakers which generally has ground vibration levels of 4.5 mm/s at 5 metre distance and 0.1 mm/s at 50 metre distance (Northern Express Environmental Report, 2007). There are a number of strategies for reducing the effect of vibration from machinery:

i. **Distance.** The vibration value decreases rapidly with distance from the source. The actual rate of reduction is dependent on the geology of the site and on the surrounding terrain.

ii. **Machinery supports.** Machines can be mounted on footings that use rubber bearing pads or springs to isolate the vibrations from the ground.

iii. **Machinery enhancement.** Inertia blocks can be used to add system mass and therefore reduces vibration.

**Vibration Caused by Road Traffic**

Typical vibration levels measured for truck traffic are shown in Table 5-7 below:

**Table 5-7: Typical vibration level from truck movement**

<table>
<thead>
<tr>
<th>Quarry Vehicle</th>
<th>Typical Ground Vibration Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck traffic (smooth surface)</td>
<td>&lt;0.2 mm/s @ 20m</td>
</tr>
<tr>
<td>Truck traffic (rough surface)</td>
<td>&lt;2 mm/s @ 20m</td>
</tr>
</tbody>
</table>

Source: Northern Express Environmental Report
The most severe vibrations associated with road traffic result from heavy vehicles with stiff suspension moving rapidly along roads with irregular surfaces.

In Malaysia, regulation for explosive usage is under the purview of the Explosives Act 1957 (revised 1978). The Act does not mention any limit for vibration and air-blast effect. However, the safety of explosive usage is still the responsibility of the explosive user as stipulated generally in the Explosive Act and Occupational Safety and Health Act. Presently, the Minerals and Geoscience Department recommend a limit of 5 mm/s for housing areas. In addition, as for sensitive projects, for example sites located in urban areas, the vibration limit can also be referred to the Planning Guidelines for Vibration Limits and Control in the Environment published by the Department of Environment, Malaysia. Any proposal for blasting activities requires prior approval from the Minerals and Geoscience Department. Assessment on the proposed blasting design will give an indication on the level of vibration.

**Assessment Methodology:**

**Blasting Design:** Air-blast, fly-rocks and ground vibrations are all managed by careful blast design. Blasting designs are to be undertaken by a licensed shotfirer, and should be made available to the environmental consultants. Predicted air-blast and ground vibration should be incorporated in the Environmental Assessment report to ensure that they comply with stipulated guidelines by Minerals and Geoscience Department Malaysia. The environmental consultant is only responsible for checking that these outcomes comply with the appropriate standards and limitations for the site, and is not required to check the details of the blast design for correctness. As the blasting design is dynamic and may change from time to time, the final blasting design to be adopted for implementation should be approved by the Minerals and Geoscience Department.

**Air-blast:** Air-blast level can be estimated using the following United States Bureau of Mines (USBM) equation. This equation however does not provide an indication of the degree of scatter in the data collected, nor of the degree of confidence in the prediction of levels, using the equation. This is probably due to the variability of the basic mechanisms producing the over-pressure which include cases of stemming ejection, face blow-out, exposed initiation system, unconfined blasting and normal well controlled blasting.
\[ A = 165 – 24 \log_{10} \left( \frac{R}{Q^{1/3}} \right) \text{ dBL} \]

Whereby:
- \( A \) = Over-pressure for confined charges (dBL)
- \( R \) = Distance from charge point to structure (m)
- \( Q \) = Maximum explosive charge per delay (kg)

The calculated air-blast overpressure should be compared with the stipulated limit of 120 dBL by the Minerals and Geoscience Department.

**Ground Vibration:** The following United States Bureau of Mines (USBM) equation is normally used to predict vibration generated by blasting activities.

\[ V = 1143 \left( \frac{R}{Q^{0.5}} \right)^{-1.6} \]

Whereby:
- \( V \) = the peak particle velocity (mm/s)
- \( Q \) = charge mass per delay in kg of explosives
- \( R \) = distance between the charge point and the monitoring point

The predicted ground vibration results should also be compared with the Department of Environment’s Planning Guidelines for Vibration Limits and Control in the Environment.

### 5.3.4 Deterioration of Water Quality

Stone quarry activities will change the topography of the site, with consequent changes in drainage pattern. Vegetation removal also increases the rate of rainfall runoff.

It is often necessary to manage surface drainage with the provision of drainage interception bunds (e.g. at the top of the excavation) to redirect flows, and with the installation of drainage channels to cater for concentration of flow.

Where the stone quarry excavation intercepts the groundwater table, it may necessitate separate measures to drain the quarry pit, often involving pumping. The interception of groundwater and its diversion to surface drainage may also result in an interruption of groundwater flows, a lowering of the water table in the local area, and potentially dewatering of adjacent watercourses.
Any runoff from cleared surfaces, or discharges from the quarry pit or floor, is likely to have elevated levels of sediment (both suspended and dissolved). In addition there may be other contaminants depending on the nature of the soils and/or rocks that are exposed in the quarrying process, and any leakages from machinery at the stone quarry.

The quality of the water discharged from the site can have impacts on downstream ecological communities and water users.

**Assessment Methodology:**

The water quality deterioration impact should be assessed through baseline water sampling at nearby watercourses or discharge points with analysis undertaken by accredited laboratories under Skim Akreditasi Makmal Malaysia (SAMM) by the Department of Standards, Malaysia to ascertain baseline water quality. Water quality parameters to be monitored should include (but are not limited to): temperature, pH, turbidity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Ammoniacal-Nitrogen, Oil & Grease, Total Coliform Count and Faecal Coliform Count.

Depending on the geology and nature of the soils and rock at the site, it may be appropriate to also test for certain metals (iron, lead and others), where deemed required based on site characteristics. This is especially true when the project involves a limestone quarry, due to its permeable characteristics. Results should be compared to the National Water Quality Standards for Malaysia (NWQSM) based on the river water usage and the Water Quality Index (WQI) classification by the Department of Environment (DOE).

**5.3.5 Soil Erosion and Sedimentation**

Soil erosion and excessive sedimentation problems arising out of stone quarry development activities can pose a threat to the environment if not systematically controlled. Soil erosion can also lead to the cumulative effects of siltation and sedimentation in streams and rivers downstream as well as reduced depth of riverbeds and watercourses, which inhibits navigation and leads to flash floods in low-lying areas.

Any disturbance of the in-situ soil will elevate the potential for increased soil erosion and run-off - in particular steep rock faces that are typical of quarry operations and are very prone to erosion. Eroded material is carried downstream to areas of flatter terrain where it is deposited as sediment.
Stone quarry activities at a site will result in some, or all, of the following occurring:

- Removal of protective vegetation cover;
- Exposure of underlying soil horizons that may be less pervious, or more erodible than the surface layers;
- Reduced capacity of soils to absorb rainfall;
- Shortened time of concentration of surface runoff due to altered steepness, distance and/or surface roughness characteristics (including removing vegetation and top-soil);
- Increased energy in storm-water runoff due to concentration and velocity;
- Alteration of ground-water regime, with potential impacts on drainage and slope stability; and
- Exposure of subsurface materials which are unsuitable for vegetation establishment.

The potential for erosion relates to the characteristics of the soil, the vegetative cover, exposure of the site to storm-water runoff, steepness of the site, slope length, and concentration of storm-water flows.

**Assessment Methodology:**

Site assessment can be conducted to identify the existing areas which are prone to erosion; areas likely to collect sediment; type of vegetation cover; and other erosion sources from outside the site. A possible approach in assessing soil erosion is to conduct a conceptual Erosion and Sediment Control Plan (ESCP).

*Preparation and Assessment of Conceptual Erosion and Sediment Control Drawings:* These scaled drawings must be superimposed onto the topographic map indicating the mitigating measures to be implemented onsite. The drawings must contain the following information for each stage of the stone quarry development:

a) List of all Best Management Practices (BMPs) indicating their number and location;

b) Stockpile, overburden and disposal management areas; and
c) Areas to be preserved, critical buffer areas and river reserves.

5.3.6 Slope Stability

Landforms are the products of the local balance between weathering, erosion and deposition, and are continuously evolving. Slopes that are too steep for weathered material to remain stable are subject to periodic failure. Instability may be associated with moderate to steeply sloping terrain or with land which has been disturbed by man. Natural slopes that have been stable for years may fail during the quarry activities, which may bring about (a) changes in the slope topography; (b) changes in groundwater conditions; (c) stress changes in the soil underlying the slope and (d); acceleration of the rate of weathering of rock.

Blasting activities during quarry operation change the slope topography and release residual horizontal stresses allowing expansion of the slope. Joints or weak zones may be exposed along which sliding may occur. Over steepening of the slope gradient to create a platform can also induce instability.

The change in groundwater flow patterns may cause detrimental changes to the stability of the newly constructed slope or the existing in-situ slopes that were stable prior to quarry operation.

**Assessment Methodology:**

A summary of the impact assessment of slope stability is outlined below:

- Review of quarry development progress plan;
- Slope map produced by computer software from topography map; and
- Review of geological report for the proposed quarry.

The information shall be assessed and potential slope instability areas identified and transferred to a topographical map of appropriate scale. These should include key findings from these assessments, as well as recommendations by the environmental consultant to ensure these are considered during the preparation of the Environmental Assessment report.

5.3.7 Overburden Management

Overburden or top soil is removed prior to rock extraction. Methods of overburden disposal vary for each quarry operation. Overburden removal from the rock face and disposal within or outside the quarry area can be a major
source of erosion and sediment discharges, particularly if the disposal site is not properly located and managed.

**Assessment Methodology:**

The ability of overburden disposal area(s) whether temporary or permanent, both onsite and offsite, to accommodate overburden should be assessed by taking into consideration estimated overburden volume and the size and location of the proposed disposal area. This includes aspects such as topography (existing and proposed ground level, including exclusion of steep areas); distance to nearby receptors; hydrology (distance to nearest natural river/stream) and transportation impacts.

### 5.3.8 Waste Management

Wastes generated by stone quarry activities include:

- Sludge (usually clay/silt) materials collected in sedimentation ponds;
- Waste oils or chemicals from vehicle, machinery, or other uses;
- Domestic wastes (sewage, drainage) from on-site sanitary or kitchen facilities;
- Vegetative waste from site clearing activities; and
- General waste.

If these wastes are not properly managed they can result in pollution of surface or groundwater, soil contamination, health impacts, and visual unsightliness.

**Assessment Methodology:**

The impact of sewage should be assessed based on the quality of the sewage effluent and its compliance to the Environmental Quality (Sewage) Regulations 2009. As for solid waste, the impact should be assessed based on the predicted amount of garbage produced daily and measures adopted for proper management onsite.

### 5.3.9 Ecology

Stone quarry establishment will necessitate the removal of vegetation. Depending on the area affected, this may represent impacts on native flora species, or removal of important habitat for native fauna. Particular focus
should be placed on the assessment of potential impacts on unique or rare plants, or species of major conservation or scientific interest.

**Assessment Methodology:**

An assessment survey will need to be undertaken to identify the range of species and the nature of habitat at the proposed site. This survey needs to be extended beyond the site boundary to include areas within the zone of impact, as native fauna beyond the site boundary, in particular, can be affected by the quarry activities (particularly from noise, dust, vibration and air blast).

5.3.10 Traffic and Transportation

Transportation of finished products - i.e. aggregates to potential buyers - can cause dust and noise nuisance as well as affecting the traffic volume, flow and density in the surrounding area. In some circumstances, this increased traffic volume may impact other road users, as well as the public amenities associated with residential users and nearby sensitive areas (schools, hospitals, wildlife sanctuary and others). Increased truck traffic may exceed road design limits, leading to increased maintenance costs.

**Assessment Methodology:**

Traffic and transportation impacts from stone quarry operations on the current road capacity, can be assessed by considering the changes to the existing average traffic density. Calculations of additional traffic volume generated on main and feeder roads, as well as a description of the existing road infrastructure, together with illustrations, should be provided in the Environmental Assessment report.

5.3.11 Socio- Economic

Stone quarry activities generally provide significant economic and social benefits such as: long term economic and employment benefits; enhancement of surrounding infrastructure; stimulation of secondary industry and services, as well as enhancement of technical skills and educational levels. However, if they are conducted without proper planning and operation, stone quarry activities also have the potential for significant impact on the environment, including disruption to the ground surface and ecosystem and changes to the existing social patterns/ community livelihood.
Assessment Methodology:

Description of Existing Socio-Economic Conditions: This includes a description of the following from field studies, ground surveys and published reports:

- Existing and Proposed Land-Use
  
  This includes zoning for the area within and surrounding the proposed quarry site and any designated receptors that are found during field visits.

- Land Status/ Tenure
  
  Land issues/ claims should be highlighted, if any.

- Key Demographic and Economic Characteristics
  
  This applies to the surrounding community within the zone of impact and includes:
  - Location of populations within and surrounding the project site (clearly illustrated on a map)
  - Population
  - Gender and age groups
  - Ethnic group and religion
  - Education background
  - Socio-economic status (i.e. economic activities, income, occupation)
  - Agriculture communities surrounding project area (livestock farming and others)
  - Sensitive areas (i.e. burial grounds, historical buildings/ artefacts, cultural sites, water catchments, archaeological sites, tourist attractions, and others) (clearly illustrated in a map)

- Infrastructure/ Service/ Facilities
  
  Urban Area – within 500 metres radius or 5 – 10 minutes walking distance (i.e. child care centre, kindergartens, schools, clinic or hospital, shops, public transport, recreation centres, places of worship and others (clearly illustrated on a map).
Rural Area – within 3 km radius from the site.

- **Perception and Awareness/ Community Engagement**

  Consultation should, at the very early planning stage, provide the community with an opportunity to be informed and to influence decisions which may affect them. The Project Proponent must commit to this consultation by giving opportunity for community to participate in the decision making process as the project may affect the way their local area is developed.

  A consultation plan document including the following should be prepared:

  - *Objective of the consultation process;*
  - *Identification of zone of impact (receptors that will be impacted by the project);*
  - *Level of communication, i.e. door to door interview, questionnaire distribution, community dialogue, and others.*
  - *Relevant questions that should be posed to the community can include (but are not limited to):*
    - Have you heard about the new upcoming project?
    - What are your concerns related to the project?
    - What benefits do you perceive from this project?
    - What is your recommendation for improvement of the project?
    - What is your level of acceptance of the upcoming project?

  The number of respondents to be consulted within the zone of impact must be determined and justified by the environmental consultant with **locations of those interviewed marked in a map.** Emphasis should be given on consultation with the village head/ local representative.

  - *How issues raised in the public consultation are to be handled in the EIA report*

  Brief social survey notes describing the project concept and outlining the social consultation method including list of questionnaire must be prepared and documented in the Environmental Assessment report.
In general, many predicted economic impacts are beneficial and encouraged by the local decision makers. However, there are likely to also be negative impacts, particularly for those residing near to the proposed project. The potential local employment benefits of a proposed project can be encouraged through appropriate skills training programmes for local people. In addition, the project may provide business spin-offs and contract opportunities to the local service providers and industries.

5.3.12 Visual Impact

Stone quarries can cause visual impact through:

- Removal of existing landscape features such as hills; and
- Introduction of intrusive features such as quarry faces or overburden mounds.

The features of a quarry that can visually affect the landscape depend very much on the specific location and surrounding environment of the quarry. These include:

- Size, form and colour of plant and machinery;
- Exposure of the ground surface or quarry face;
- Location, size, and shape of bund walls, stockpiles, waste disposal areas, fences; and
- Location of access roads.

Assessment Methodology:

Assessment of visual impact is often difficult to predict and quantify as it is largely subjective. Therefore, it is necessary to assess this component in a consultative manner, involving as wide a sample of potentially affected persons as possible. The perception and aspiration of the community on particular landscape features must be taken into account. The assessment should also take priority on compatibility of the proposed quarry development with existing local plans and regional planning.

5.3.13 Cultural Heritage

The establishment of a quarry may impinge on existing archaeological assets, whether known prior, or discovered during the course of the project. The environmental consultant needs to check on ground and consult with the
relevant government agencies including Museum Department to verify whether there is any known cultural significance at the proposed project area.

5.3.14 Site Closure/ Abandonment

When the rock source within the site boundary has been exhausted, the project site will be closed down. The closure will be in accordance with a conceptual project closure plan that has been established prior to the commencement of work at the site. The manner in which the quarry is managed for the post-operation phase will define its long-term environmental implications. In Malaysia, there are examples of quarry areas being re-established for productive use including housing and commercial development and recreational facilities.

Assessment Methodology:

The environmental consultant must review this closure plan and identify residual impacts that may be associated with it. Recommendations for improving the plan should also be included in the environmental assessment report including obtaining feedback from the surrounding population.

The closure plan should incorporate a program of progressive rehabilitation; i.e. as each area is worked over, rehabilitation activities for the area should follow shortly after. In this way, the required activities at the time of project closure are minimised, and the rehabilitation outcome enhanced, as earlier re-vegetation will be well established. Rehabilitation works should take consideration on area stabilisation, re-vegetation works as well as dismantling/ removal of existing structures.

Abandonment refers to an event whereby the stone quarry activities have to be halted either temporarily or permanently before the resource has been completely extracted. This may be due to circumstances such as: economic down-turn; declining market demand for the material produced by the quarry; management issues and/ or technical problems arising during the implementation of the project.

Abandonment involves the withdrawal of onsite workers and removal of machinery and equipment used for the stone quarry activities. Improper abandonment can cause soil erosion from exposed working areas, aesthetically unpleasant and unhealthy environments that provide breeding sites for disease vectors and pest species.

The environmental assessment report should specify site rehabilitation works aimed at reducing, or eliminating negative impacts related to project
abandonment. If the project closure plan incorporates progressive rehabilitation (see above) the activities required at project abandonment may be minimal.

5.4 Additional Impacts

The list of potential impacts above is non-exhaustive as the environmental consultant should extend or shorten the list of issues depending on local conditions. The discovery of particular key conservation value areas or particular sensitive habitats will require the inclusion of new issues while other issues may not be applicable for that particular project.
6 Mitigation Measures

This chapter covers identification of the major mitigation measures for the environmental impacts identified (refer to Table 6-1).

Table 6-1: Assessment Procedures – Description of Mitigation Measures

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<td>• Control of noise nuisance</td>
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<td>• Control of airblast, flyrocks and ground vibration levels</td>
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<td></td>
<td>• Minimising water quality deterioration</td>
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<td></td>
<td>• Provision for erosion and sediment control measures</td>
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<td></td>
<td>• Management of overburden materials</td>
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<td></td>
<td>• Management of waste generated</td>
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<td>• Provision for habitat and wildlife protection/conservation</td>
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The previous section included a description of methods for assessing planned activities and their impact on the environment. It also points out that there may be impacts from necessary and unavoidable activities, which were not included in the project plan and description. Mitigation measures therefore address three different scenarios:
• Proposals for improved technologies or methodologies for planned activities in order to minimise their negative environmental impact, e.g. site selection, site layout orientation, quarry implementation method or exclusion of high risk areas.

• Proposals for management activities, which are not included in the Project Proponent’s original plan of activities but which are necessary in order to control environmental degradation, e.g. waste management, drainage, soil erosion control practices, and others. This is mainly related to working practices such as limited works hours.

• Proposals to compensate for unavoidable, residual impacts, e.g. community development programmes or a specific contribution towards local conservations or offsets.

The environmental consultant should assess the adequacy of the measures to alleviate or mitigate negative environmental impacts planned by the Project Proponent. Where the Project Proponent’s measures can be strengthened or where they are seen as insufficient, the environmental consultant should propose mitigation in the form of proposals for alternative technologies, methodologies or scope of work. Addressing the key physical impacts prior to design finalisation is essential to the sustainability of the overall design concept. For residual impacts, the environmental consultant should, where appropriate, propose mitigation measures to compensate for the effects of the impacts. It is important to note that the recommended mitigation measures for a project in the Environmental Assessment report must be based on the different stages of project implementation such as site preparation, quarry operation as well as closure or abandonment.

The environmental consultant should for each foreseen impact and for each proposal for changes to scope, technology or methodology assess the risk level and magnitude of all expected residual impacts and state these clearly in the Environmental Assessment report.

In addition, there are requirements, which are imposed for administrative reasons. These include employment of an environmental officer, provision of maps and other information, which may be necessary for environmental monitoring.

It is, however, important that the Project Proponent and the environmental consultant together use the latest knowledge and development in the respective fields, in order to devise a project and site specific plan for environmentally sound management and associated mitigation. The pointers
included in this guideline should not be seen as a complete, ready-made
direct solutions, but rather as principles of mitigation.

At the same time, it must be stressed that any combination of site, technology
and methodology will warrant a unique set of mitigation measures.

6.1 Key Mitigation Measures

6.1.1 Air Pollution

The mitigation measures that can be considered for air pollution control
include (but are not limited to):

- **Air quality compliance** - Air pollution and dust needs to be managed in
  compliance with the recommended limits for air quality.

- **Location of stockpiles** - At the planning stage, there should be an
  assessment of prevailing winds, and this should guide the location of
  stockpiles, spoil mounds, conveyors, and others to minimise dust being
  blown outside the site boundary.

- **Vegetation barriers** - These consist of dense stands of mature trees, can
  act as windbreaks to help alleviate dust generation.

- **Dust control for crusher plant** - Conveyors and transfer points can be
  major sources of dust generation. Acceptable mitigation measures for
  these can be any or all the following:

  - Enclosures (refer to Plate 6-1)
  - Mist sprays (refer to Plate 6-2)
  - Dust extraction equipment
Plate 6-1: Enclosed conveyor belts installed at crusher plant for dust minimisation

Plate 6-2: Example of mist sprays at crusher plant to reduce dust dispersion
• **Minimising distance** - Minimising the distance between the discharge point and the top of the stockpile can reduce dust generation.

• **Cease operations** - During periods of high wind speeds operations may be ceased or curtailed to prevent excessive dust leaving the site.

• **Water spraying** – Grounds of the quarry site and stockpiles including overburden areas and access roads may be regularly sprayed with water to reduce dust generation (refer to Plate 6-3). The frequency should be determined based on site conditions.

![Plate 6-3: Dust suppression on grounds of quarry area via water tanker trucks](image)

• **Wheel washing facility** - Provide a wheel washing facility at site exit points to avoid dirt being carried out of the project area. Water from the washing facility should be changed regularly to ensure clean water (without silt) at all times. The facilities should be connected to the sedimentation basin to treat dirty water, prior to final discharge.

• **Speed limit** - Speed limits should be applied to unsealed roads to limit dust generation (as well as noise, and maintenance requirements).
• **Material cover** - Dust can also be reduced during the transportation of materials by covering loads on trucks. Less effective, but still useful is to limit the fill height of material in the tray to the level of the top of the tray.

• **Site Entrance** - Quarry entrance can be sealed/layered with aggregates to minimise dirt carried offsite on vehicle tyres.

### 6.1.2 Noise Pollution

The mitigation measures that can be considered for noise pollution control include (but are not limited to):

• **Noise quality compliance** - Noise generated from the site needs to be kept within the national standards. This may require restrictions to operating hours.

• **Vehicle** - Avoid deployment of poorly maintained old transport vehicles and equipment.

• **Physical Barriers** - Noise attenuation may be achieved to some degree by barriers. These may be bund walls installed at the site, zinc hoardings, vegetation barriers, or natural topographic features (refer to Plate 6-4).

• **Vegetation barriers** - If trees are being considered as effective noise attenuation means, the trees need to be mature, the plantings relatively dense, and the width of barrier greater than 20 metres. The stand of trees also needs to extend to well above the point source of the noise.
Plate 6-4: Provision for zinc hoarding and planting of trees along quarry boundary as air and noise barrier

- **Silencers** - Machinery such as compressors, engines, generators, and exhausts may be fitted with silencers to reduce their impact, if necessary.

- **Speed limit** - Truck noise on access roads and haulage roads can be reduced by maintaining low speeds and through regular vehicle maintenance. Proper selection of access roads can also reduce noise impacts.

### 6.1.3 Air-blast, Fly-rocks and Ground Vibration

The mitigation measures that can be considered for air-blast, fly-rocks and ground vibration include (but are not limited to):

- **Blasting design** - Drilling and blasting are common activities at stone quarry operations. Drilling depths, spacing, and blast patterns are subject to specialist design and need to be closely managed by the quarry operator. If these are not adequately managed it can result in uncontrolled fly-rock, high levels of ground vibration, and air-blast noise, and unsafe bench faces or quarry floors. Drilling and blasting designs vary with a number of factors - type and hardness of the rock, moisture content,
degree of existing fracture, size of material that is sought, type of explosive used, and others.

These specialist designs do not come under the purview of the environmental consultant in preparing the EIA. It is the responsibility of the quarry operator to ensure that the operational impacts described above, as well as the safety issues, are managed through appropriate drilling and blasting design and operational procedures. The preliminary blasting design by a licensed shot firer should be made available during the preparation of Environmental Assessment report for the consultant to include the predicted air-blast, fly-rocks and ground vibration impacts towards the nearest receptor.

- **Sensitive areas** - For any blasting within 500 m of sensitive structures, special precautions must be taken: e.g. placing thick rubber mat (such as heavy conveyor belting), or heavy wood beams (such as old railway sleepers) over the blast area and/ or using a cable blasting net over the shot to contain broken debris within the blast area (see Plate 6-5). This is normally only feasible on small blasting areas.

Plate 6-5: Usage of blasting mat to prevent fly-rock

- **Permit requirements** - It is likely that permits will be required for any blasting activities. Noise and vibrations associated with blasting activities
must fall within standards specified in the permit. Higher noise levels may be allowed for blasting, given the very short period of the noise event.

6.1.4 Deterioration of Water Quality

The key objective of the mitigation measures is to protect existing waterways and groundwater resources from impacts from the stone quarry activities. The mitigation measures that can be considered for water quality deterioration include (but are not limited to):

- **Drainage flow** - As far as possible, drainage should follow existing drainage lines with vegetation along the drainage lines retained.

- **Cut-off drainage** - Cut-off drains or diversion banks can prevent surface flows from entering the quarry works areas. These should discharge into vegetated natural drainage lines, or as distributed flow across an area stabilised against erosion.

- **Sedimentation ponds** - Run-off from works areas should be routed towards sedimentation ponds. These trap sediment and reduce suspended sediment loads before runoff is discharged from the stone quarry site. Sedimentation ponds should be designed based on runoff, retention times, and soil characteristics. There may be a need to provide a series of sedimentation ponds to achieve the desired outcome.

- **Flow barriers** - Additional methods for trapping sediments include using barriers to flow such as silt fences, crushed rock filters, hay bales, logs, or sandbags.

- **Vegetation buffer** - A vegetated buffer strip around the perimeter of the site where surface water flow passes through can be effective, and should be provided along any significant waterways passing through the site.

- **Groundwater** - Where groundwater may be impacted (i.e. excavations below the water table) a detailed study may be required to determine potential impacts and appropriate mitigation.

6.1.5 Soil Erosion and Sedimentation

The mitigation measures that can be considered for soil erosion and sedimentation include (but are not limited to):

- **Sedimentation ponds** - Provision of sedimentation ponds based on the ESCP drawings to capture material eroded at the site.
• **Ground cover** - Design of surface ground cover to minimise soil exposure to intense rainstorm. Adequate soil compaction works should be conducted at the end of each working day to reduce soil erosion.

• **Retain vegetation** - Retain existing or re-plant the vegetation at the site wherever possible.

• **Run-off diversion** - Minimise or divert high velocity runoff away from sensitive/easily prone to erosion areas through provision of proper drainage systems.

• **Drainage** - Construction of high volume drainage systems conforming to site conditions to handle concentrated or increased runoff from intense rainstorms.

• **Monitoring and maintenance** - Regular monitoring and maintenance of erosion control systems so that they perform as specified.

### 6.1.6 Slope Stability

Applying appropriate slope design and protection can prevent slope failure, thus minimize soil erosion as well as improving safety. The mitigation measures that can be considered for slope stability include (but are not limited to):

• **Benching** - Provision for slope benching system at the quarry face (refer to Plate 6-6).
Plate 6-6: Benching system implemented at quarry face area

- **Turfing** - Turfing should be carried out to establish vegetation on the slope making it more stable.

- **Weather condition** - Blasting activities and related earthworks should not be carried out during wet and rainy weather conditions.

- **Retain vegetation** - Existing vegetation on hill slopes especially on undeveloped areas are to be retained as much as possible to act as natural buffers.

- **Checking slope areas** - Regular checking of the slope surface and surrounding areas for signs of possible slope failure and soil erosion should be carried out.

### 6.1.7 Overburden Management

The mitigation measures that can be considered for overburden management include (but are not limited to):

- **Sediment barriers** - Overburden which mainly consists of topsoil should be protected from stormwater runoff using temporary perimeter sediment barriers such as gravel bag berm, silt fence, sandbay, sedimentation pond
or rock filter. Suitable slope gradient should be provided together with proper perimeter drainage system to ensure proper runoff flow. Refer to Figure 6-1.

![Diagram of typical ground finished for overburden disposal site]

**Figure 6-1: Typical ground finished for overburden disposal site**

- **Compaction** - Proper earth compaction to an appropriate density should be conducted immediately to stabilize the soil materials, thus reducing the amount of surface runoff.

- **Turfing** - Close turfing should be conducted on the ground of the overburden disposal site if it is not immediately used for other uses.

- **Drainage maintenance** - Regular maintenance on the drainage system around the overburden disposal sites.

- **Overburden management** - Overburden materials can also be sold to sites nearby and the environmental consultants need to take consideration the environment impacts caused during the transportation from the overburden disposal site to the destination site as well as its suitability for disposal. Else, the overburden materials can also be utilised to construct earth bunds for internal roads. Refer to Plate 6-7.
6.1.8 Waste Management

The mitigation measures that can be considered for waste management include (but are not limited to).

- **Minimise waste** - All efforts must be made to minimise the amount of waste generated through recycling and prudent procurement and operation. Where feasible, waste should be removed to public waste disposal sites. Where this is not feasible, pits may be dug at safe distances from water bodies and to a depth that does not pose any instability to slopes or offer opportunities to wildlife or pests to dig it up. Burning of waste is not permitted in Sabah. It is imperative that groundwater is not impacted by the disposal of wastes in these pits.

- **Zero burning** - Biomass waste from site clearing may not be burned but can be left for natural decomposition. The environmental consultant should emphasise options for better utilisation of smaller dimensions of woody biomass (such as small trees and branches) from site clearing.

- **Provision of waste bins** - Provision for sufficient waste bins for collection of solid waste generated onsite. These bins should be emptied on a
regular basis and the waste collected should be disposed off at the local authority’s approved disposal sites.

- **Housekeeping** - Good housekeeping practice onsite (wastes should be properly disposed off at designated containers/areas).

- **Location of facilities** – The location of workshops and fuel/lubricant storage facilities (if any) should be at least 50 metre distance from the nearest natural waterway and installed with proper oil traps (refer to Plate 6-8).

Plate 6-8: Oil skid tank with proper bunding facilities and sheltered

- **Oily/scheduled waste** - Collect used oil and oily wastes from machinery and transportation vehicles and store and label in proper containers for disposal. A temporary storage facility should be constructed within the project site, and should be fenced, covered, bunded, sign posted, have impervious flooring, and be provided with proper drainage and oil trap. The facility should be sited more than 50 m away from any river, stream or sensitive area. Refer to Plate 6-9.
6.1.9 Ecology

The mitigation measures that can be considered for ecological impacts include (but are not limited to):

- **Protection** - Identify and protect sites deemed as valuable habitats or containing threatened species.

- **Relocation** - Where important habitats or species cannot be protected at the site the following should be considered:
  - Relocation of fauna species, nesting sites and others to a suitable nearby location.
  - Multiple replanting, or conservation activities at an alternative site, as an offset strategy for mature vegetation that has to be removed.

- **Buffers** - Provide vegetative buffers to protected areas.

- **Vegetation linkages** - Retain vegetation linkages to intact ecological communities on the boundary of the site as far as possible.
• **Wetlands** - Incorporate wetlands into sedimentation pond designs to provide additional or alternative habitat for wetland flora and fauna species.

### 6.1.10 Traffic and Transportation

The mitigation measures that can be considered for traffic and transportation impacts include (but are not limited to):

- **Road upgrading** - Upgrading and/or widening of local roads used to access the site.

- **Planned routes** - Using specified routes to and from the site that avoid sensitive areas such as schools and others.

### 6.1.11 Socio-Economic

Consideration should be given to the affected local population by protecting sources of local water supply, fishing and recreation areas. In addition, effective public relations exercise is important in ensuring social acceptability of the project. The mitigation measures that can be considered for socio-economic impacts include (but are not limited to):

#### a) Employment

- **Employment and Business Opportunities** - Preference for employment and business should be given to local population. This will provide some opportunities to the local people to participate in the operation of the project, as well as providing them with an opportunity to earn extra income. In addition, their employment and business participation will prevent social resentment and conflicts, increase their positive feelings towards the project, and create a sense of pride towards the development of their area.

#### b) Consultation

- **Public Relations** - Conduct a proper public relations exercise involving the local authorities. Two-way communications through dialogue helps both parties to understand each other, sets a forum for understanding, and establishes rapport. Information about the numerous benefits of the project and environmental impacts should be made readily available to the public.

- **Dialogue** - Hold regular meetings/dialogues with the surrounding population and their community leaders, both prior to, and during the operation of the project. The Project Proponent should explain to the
villagers the nature of the project, the extent to which it will affect their villages, and the mitigation measures undertaken to eliminate or minimize environmental, social and economic problems.

6.1.12 Visual Impact

The visual impact of the quarry needs to be considered at the planning stage. Careful location decisions regarding angle of approach to the quarry face, location of access roads, plant, machinery and stockpiles, retention of vegetation and others can make a big difference to the visual impact.

The mitigation measures that can be considered for visual impacts include (but are not limited to):

- **Retain vegetation** - Retain existing vegetation where effective for screening of the site.

- **Vegetation screens** - Provide screens in the form of grass, bushes, vegetated or earthen bunds.

- **Plant vegetation** - Plant additional vegetation in areas facing the surrounding settlements to minimise visual intrusion.

- **Site layout** - Where practical, working faces and plant locations should be oriented away from vantage points.

- **Rehabilitation** - Where feasible, uppermost benches should be worked out and rehabilitated as soon as possible.

- **Painting** - Machinery, plant, fences, and exterior faces of buildings can be painted to blend in with, rather than contrast with, the surrounding environment.

The target for the rehabilitation program is to reinstate the landscape at the site to its original condition or better.

6.1.13 Abandonment/ Closure

In the event that the stone quarry operations are abandoned, every attempt should be made to reinstate the condition of the site to that which existed prior to commencing quarry activities. Whilst this will not be feasible where large scale excavation works have taken place, as a minimum, the cleared area should be re-vegetated. This will involve breaking up compacted ground, covering with topsoil, and planting/ seeding with selected local tree species and/ or cover crops.
Where a structure is partly erected, this should be demolished and removed from the site.

All drainage provisions, including sedimentation ponds should be retained.

All equipment, machinery and waste materials should be removed from the site.

6.2 Residual Impacts

It is unavoidable that there will be some adverse impacts from the earthwork activities even if these are carried out with every intention of avoiding or minimising such impacts.

There will be a loss of ecological features, in terms of natural wildlife habitat together with surface runoff which pollutes the waterway as a result of land clearing. For such impacts, the risk and the magnitude should be assessed as part of the assessment procedure.

6.2.1 Off-set of Residual Impacts

Residual impacts relating to the loss of biodiversity/habitat may be countered by off-set activities elsewhere. Particular key conservation value habitats may be protected elsewhere. Such off-set activities may balance the impact in full or partially, but should in all cases be considered.

6.2.2 Mitigation of Residual Impacts

Residual impacts are already minimised through the choice of technologies or methodologies. Mitigation is therefore only possible through compensation or substitution. Compensatory measures in terms of replacement of habitat loss, re-vegetation, alternative access to livelihoods and others are among the available options for mitigation of residual impacts.
7 Monitoring Programmes

This chapter covers the recommended monitoring programmes based on the mitigation measures highlighted for the identified environmental impacts (refer to Table 7-1).

Table 7-1: Assessment Procedures – Description of Monitoring Programme

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Environmental monitoring provides feedback on the actual environmental impacts of a project. Monitoring results will assist in the judgement of whether the environmental mitigation measures proposed are successful in reducing or eliminating negative environmental impacts. An environmental monitoring programme is also used to ensure compliance to the recommended mitigation measures and environmental standards stipulated by EPD, Sabah and other relevant agencies.

Generally, an environmental monitoring programme will involve collecting data for one or more of the following purposes (Everitt, 1992):

i. To establish a baseline, that is, gathering information on the basic site characteristics prior to development or to establish current conditions;

ii. To establish long term trends in natural undisturbed systems to establish natural baselines;

iii. To estimate inherent variation within the environment, which can be compared with the variation observed in another specific area;

iv. To make comparison between different situations (for example, pre-development and post development; upstream and downstream) to detect changes; and
v. To make comparisons against a standard or target level.

Without a monitoring system, there is no mechanism for ensuring that the specified mitigation measures are being implemented and for evaluating the success of the mitigation measures undertaken.

The environmental monitoring programme will generally comprise compliance and impacts monitoring. Compliance monitoring aims to ensure compliance to the recommended mitigation measures and environmental standards stipulated by EPD, Sabah and other relevant agencies whereas impacts monitoring provides feedback on the actual environmental impacts of a project in order to confirm that a project is meeting the agreed level of impact and that the predictions of impacts made during the environmental assessment have been accurate.

7.1 Compliance Monitoring

The environmental consultant should, in the Environmental Assessment report, propose means and schedules for monitoring whether the technologies and methodologies applied in the project comply with the recommended measures and methods. This compliance monitoring plan will then, by the EPD, be used as a basis for an Agreement of Environmental Conditions (AEC) or Mitigation Declaration (MD), which is an agreement between the EPD and the Project Proponent on how environmental management of the project should be optimised.

The environmental consultant must, for each of the mitigation measures proposed in relation to the environmental issues that have been identified, recommend how, when and where a monitoring can be implemented to verify that the recommendations have been followed.

EPD has also established a standardised monitoring system. The system is linked to a database within EPD. This database will store all future monitoring data from all monitoring of stone quarry activities.

The frequency of environmental monitoring and reporting is dependent on the stages of the project and sensitivity of the area, i.e. erosion prone area, social concerns and will be specified by EPD through the AEC/ MD issued with the Environmental Assessment approval.

There are requirements for submission of maps and photos to support compliance monitoring. Maps must follow standard cartographic requirements of showing geo-references, scale and north arrow, while photos must have dates and geo-reference.
7.1.1 Monitoring Techniques

Compliance monitoring will be undertaken primarily by means of the techniques listed below. This information should be submitted to EPD based on the agreed frequency of monitoring until the project is completed.

**Photographs.** Photographs to provide evidence of the implementation of the recommended mitigation measures. Photographs should, for example, be used to verify compliance with the following mitigation measures:

- Provision for slope strengthening methods, i.e. benching and close turfing.
- Provision for erosion control facilities onsite, i.e. sedimentation pond, silt trap and drainage network, re-vegetation works on exposed areas.
- Provision for dust and noise suppression facilities, i.e. wheel washing facilities, planting of trees, installation of zinc hoarding, condition of access roads.
- Stockpile areas for overburden and topsoil, highlighting measures for protection from erosion.
- Provision of wet suppression system provided at the crusher plant or other dust encapsulation system.
- Provision of signboards are erected to indicate date and time of blasting operations. Refer to Plate 7-1.
Plate 7-1: Example of signboard indicating blasting operation period

- Changes to the landscape of the area.
- Proper waste management practice onsite, i.e. provision for collection bins, general site conditions at the workers quarters, site office, storage area, workshop, sewage facilities, and others.
- Proper transportation management including utilisation of approved routes, allowable vehicles load and others.
- Provision of buffer zones or protected area management.

When photographs are submitted for compliance monitoring, the exact location should be clearly marked on a map together with a GPS reading and a direction bearing. The date and time should be noted.

Field checks. Periodic field checks during site preparation and operation stage of the stone quarry activities should be undertaken in order to ensure compliance with the following mitigation measures:

- Erosion and sediment control features including locations and effectiveness of the structures in place.
- Improved working practices/ management procedures.
- Phased quarrying progress.
• Man-made items such as slope protection and drainage system (cracks or spalled concrete surface and support; debris, undesirable vegetation growth and other obstruction to water flow; erosion; unstable trees and others).

• Landscaping works.

• Reducing dust and noise problems.

• Provision of buffer zones or protected area management.

• Proper waste handling.

• Proper transportation management.

**Records.** Records of stone quarry activities to ensure compliance with the following mitigation measures:

• Blasting operation details to ensure that the blasting design is strictly followed.

• Maintenance of erosion control facilities, i.e. sedimentation pond, silt trap and drainage network.

• Daily working hours.

• Adequate personal protective equipment to workers working in high noise level and/or dusty areas.

**Maps/ layout plans.** Maps/ layout plans to indicate locations of key mitigation measures during implementation. These should, for example, be used to verify compliance with the following mitigation measures:

• Provision for slope strengthening measures, i.e. benching and close turfing.

• Provision for erosion control facilities onsite, i.e. sedimentation pond, silt trap and drainage network, re-vegetation works on exposed areas.

• Provision for dust and noise suppression facilities, i.e. wheel washing facilities, planting of trees, installation of zinc hoarding.

• Proper waste management practice onsite, i.e. provision for waste bins, general site conditions at the workers quarters, site office, storage area, workshop, sewage facilities, and others.
A sample of the overall recommended mitigation measures and monitoring points can be referred in Figure 7-1.

Figure 7-1: Example of overall mitigation measures and monitoring location map

**Scheduling and responsibilities.** As the Environmental Assessment report covers the stone quarry activities, therefore the need for images and other monitoring requirements should be planned accordingly. The monitoring
programme should be formulated in advance by the environmental consultant in collaboration with the Project Proponent in accordance with the schedule of implementation, and be approved by the EPD through the AEC/MD.

The Environmental Assessment report should clearly state the responsibilities and actions to be taken in relation to compliance monitoring, as follows:

- Allocate institutional and administrative responsibilities for planning, management implementation and monitoring of the environmental requirements; and

- Allocate responsibilities to execute mitigation measures, including the detailed design of the mitigation measures.

Non-compliance will normally be followed by the issuance of an order to comply and a simultaneously and immediate compounding of the non-compliance offence according to the Environment Protection Enactment 2002.

The Project Proponent and/or environmental consultant should consult the EPD for advice if there are difficulties in implementing the approved mitigation measures and monitoring programmes.

In some cases EPD may request a “re-assessment” of specific aspects of the operation related to the mitigation measures found to be in “non-compliance”.

### 7.2 Impacts Monitoring

Impacts monitoring is concerned with the monitoring of the residual impacts or the effectiveness of the mitigation measures. The Environmental Assessment report will have provided baseline data showing the situation as it was before the site preparation and quarrying activities took place. All subsequent impact monitoring will relate to this baseline data. It is therefore important that the environmental consultant plans sampling points and parameters for baseline sampling to coincide with points and parameters for impact monitoring.

#### 7.2.1 Air Pollution

Impacts monitoring for air pollution control should include (but is not limited to) the following:

- Visual inspection for excessive dust level generated from the site.

- Visual inspection of the effectiveness of water sprinkling system.
• Air quality monitoring for total suspended particulates at suitable locations to determine the level of dust generated from the site.

• Visual inspection of the condition of public access road utilised for the project’s transportation activities.

7.2.2 Noise Pollution

Impacts monitoring for noise pollution control should include (but is not limited to) the following:

• Audio inspection of noise levels generated from the site.

• Records of noise level monitoring at suitable locations to determine the level of noise nuisance generated from the site.

7.2.3 Air-blast, Fly-rocks and Ground Vibration

Impacts monitoring for air-blast, fly-rocks and ground vibration control should include (but is not limited to) the following:

• Visual inspection at the blasting area/quarry face.

• Vibration level monitoring at suitable locations to determine the vibration generated during blasting operations.

• Records of any relevant complaints from local businesses or residents, and how these have been addressed.

7.2.4 Water Quality Deterioration and Soil Erosion

Impacts monitoring for water quality deterioration and soil erosion should include (but is not limited to) the following:

• Visual inspection for signs of erosion within the site.

• Water quality analysis particularly for turbidity and total suspended solids at suitable locations, to determine changes in the water quality in local waterways attributable to project activities. Additional parameters may be recommended depending on site characteristics.

• Visual inspection on the functionality of the erosion control measures onsite, i.e. sedimentation pond, silt traps and others.
7.2.5 Others

Impacts monitoring for other environmental issues identified could include (but is not limited to) the following:

- Visual inspection for general cleanliness and good management practices within the site.
- Any incidents or complaints related to quarry and transportation activity.
- Discovery of protected or unique floral, faunal or aquatic species within the project site.
- Discovery of historical sites/ artefacts/ burial grounds within the project site.

7.2.6 Monitoring Frequencies

Frequencies of monitoring depend upon the timing and schedule of project activities. The monitoring frequency can be varied. If the environmental consultant finds there is a particular parameter, which should be monitored more frequently due to increased activity levels, an increased monitoring frequency should be proposed in the Environmental Assessment report. On the other hand, if little activity is on-going, and the operation is in compliance over an extended period, the Project Proponent may request a less intensive monitoring schedule. Changes in the monitoring frequency will be decided on a case-by-case basis by EPD.
References

In addition to the relevant laws, regulations and guidelines, the following list includes general and specific literature, which may be useful for the reader.


Centre for Environmental Management and Planning, Aberdeen University, Aberdeen, Scotland, pp. 3-6 and 11-14.


27. Websites


www.northstonematerials.com
Appendix 1: Glossary of Terms

Activity – basic element of a project or plan that has the potential to affect any aspect of the environment. Projects are composed of activities. Activities are often called actions.

Conservation – process of looking after a conservation area so as to retain its significance, and includes maintenance, preservation, restoration, reconstruction, adaptation or a combination of two or more of these.

Cultural Heritage – any antiquity, historical object, historical site, site, area (whether on land or in the sea), fabric, building, structure, ethnographic matter, work of art, manuscript, coin, currency note, medal, badge, insignia, crest, flag, armour, vehicle, ship and tree, which has a significant and special architectural, aesthetic, historical, cultural, scientific, economic, environmental or any other interest or value and has been declared to be subject to preservation or conservation under Section 4(1) of the Cultural Heritage (Conservation) Enactment, 1997.

Environment – means the physical factors of the surroundings of human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants and the social factor of aesthetics.

Environmental Impact – an estimate or judgement of the significance and value of environmental effects on physical, biological, social or economic environment.

Factor – basic element of analysis used in any method. In most methods, factors relate to some form of environmental impact.

Groundwater – water occurring under the surface of the ground in any geological formation including alluvial layers, or in land which has been reclaimed or artificially filled.

Local Authority – any person or body of persons appointed under any written law to exercise and perform the powers and duties which are conferred or imposed on a local authority under any written law.

Matrix Method – identifies interaction between various project actions and environmental parameters and components.

Monitoring Programme – all actions taken and equipment used for the purpose of detecting or measuring quantitatively or qualitatively the presence, amount or level of any substance, characteristic or effect.
Pollution – any direct or indirect alteration of the physical, thermal, chemical or biological properties of any part of the environment by discharging, emitting, or depositing environmentally hazardous substances, pollutants or wastes so as to affect any beneficial use adversely, to cause a condition which is hazardous or potentially hazardous to public health, safety, or welfare, or to animals, birds, wildlife, fish or aquatic life, or to plants or to cause a contravention of any condition, limitation or restriction to which a license under the Environmental Quality Act, 1974 is subject.

Quarry – a place, typically large, deep pits from which stone or other materials are or have been extracted.

River – a continually or intermittently flowing body of water, and includes a stream or modified watercourse by does not include any artificial watercourse unless it is a declared channel.

Shot firer – person appointed must have such knowledge, training and experience as are appropriate to ensure that he is competent to fire shot safely.

Vegetation – all species of plants and trees, whether terrestrial or aquatic, and any other vegetable product of the soil or water.

Water – water flowing over the ground in significant quantities, water in a water body and water returned by artificial means to a water body, including drainage water, stormwater, wastewater, effluent and sewage generated by urban, industrial and agricultural activities.

Water body – a river, estuary, lake, lagoon, swamp, marsh or other wetland; an aquifer; coastal water and a declared channel.

Zone of Impact – an extent of area which will receive the greatest effect from an activity.
## Appendix 2: List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ACLR</td>
<td>Assistant Collector of Land Revenue</td>
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<tr>
<td>AEC</td>
<td>Agreement of Environmental Conditions</td>
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<tr>
<td>DID</td>
<td>Department of Irrigation and Drainage</td>
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<tr>
<td>DOE</td>
<td>Department of Environment</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>EPD</td>
<td>Environment Protection Department</td>
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<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
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<tr>
<td>JMG</td>
<td>Mineral and Geoscience Department Malaysia, Sabah</td>
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<tr>
<td>LSD</td>
<td>Lands and Surveys Department</td>
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<tr>
<td>MD</td>
<td>Mitigation Declaration</td>
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<td>NWQSM</td>
<td>National Water Quality Standards for Malaysia</td>
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<tr>
<td>PMM</td>
<td>Proposal for Mitigation Measures</td>
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<tr>
<td>RM</td>
<td>Ringgit Malaysia</td>
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<tr>
<td>ROI</td>
<td>Region of Influence</td>
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<tr>
<td>Sg.</td>
<td>Sungai (River)</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>USBM</td>
<td>United States Bureau of Mines</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>ZOI</td>
<td>Zone of Impact</td>
</tr>
</tbody>
</table>
## Appendix 3: Contact Details

Contact details for other key government agencies related to stone quarry activities are as following:

<table>
<thead>
<tr>
<th>Department</th>
<th>Address</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lands and Surveys Department</strong></td>
<td>Wisma Tanah dan Ukur, Jalan Perwira, Beg Berkunci No. 2044, 88576 KOTA KINABALU</td>
<td>Tel No.: 088 - 527600/527601</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax No.: 088 - 413626</td>
</tr>
<tr>
<td><strong>Sabah Wildlife Department</strong></td>
<td>Tingkat 5, Blok B, Wisma MUIS, 88100 KOTA KINABALU</td>
<td>Email:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel No.: 088 - 215167/214515</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax No.: 088 - 222476/254767</td>
</tr>
<tr>
<td><strong>Department of Irrigation and Drainage</strong></td>
<td>Aras 5, Wisma Pertanian, Jalan Tasik, Luyang, Off Jalan Maktab Gaya, Beg Berkunci 2052, 88767 KOTA KINABALU</td>
<td>Email: <a href="mailto:jhl@sabah.gov.my">jhl@sabah.gov.my</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel No.: 088 - 280500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax No.: 088 - 242770</td>
</tr>
<tr>
<td><strong>Water Department</strong></td>
<td>Tingkat 6, Blok A, Wisma MUIS, Beg Berkunci No. 210, 88825 KOTA KINABALU</td>
<td>Tel No.: 088 - 232364</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax No.: 088 - 232396</td>
</tr>
<tr>
<td><strong>Town and Regional Planning Department</strong></td>
<td>Tingkat 3, 4 dan 5, Blok B, Wisma Tun Fuad Stephens, KM 2.4, Jalan Tuaran 88646 KOTA KINABALU</td>
<td>Email: <a href="mailto:muis.air@sabah.gov.my">muis.air@sabah.gov.my</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel No.: 088 - 222336/222337/222031</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax No.: 088 - 222557</td>
</tr>
<tr>
<td><strong>Minerals and Geoscience Department Malaysia, Sabah</strong></td>
<td>Jalan Penampang, Beg Berkunci 2042, 88999 KOTA KINABALU</td>
<td>Email: <a href="mailto:jmgsbh@jmg.gov.my">jmgsbh@jmg.gov.my</a></td>
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<td>Tel No.: 088 - 260311/252494/252496</td>
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<tr>
<td></td>
<td></td>
<td>Fax No.: 088 - 240150</td>
</tr>
<tr>
<td><strong>Department of Environment, Sabah</strong></td>
<td>Aras 4, Blok A, Kompleks Pentadbiran Kerajaan Persekutuan Sabah, Jalan UMS-Sulaman, 88450 KOTA KINABALU</td>
<td>Email: <a href="mailto:sabah@doe.gov.my">sabah@doe.gov.my</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel No.: 088 - 488166</td>
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<tr>
<td></td>
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<td>Fax No.: 088 - 488177/488178</td>
</tr>
<tr>
<td><strong>Royal Malaysian Police</strong></td>
<td>Ibu Pejabat Polis Diraja Malaysia Kontinjen Sabah, Beg Berkunci No. 2062,88560 KOTA KINABALU</td>
<td>Tel No.: 088 - 450200/212222</td>
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<td>Fax No.: 088 - 240475</td>
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<td>Email: <a href="mailto:cccsbh@rmp.gov.my">cccsbh@rmp.gov.my</a></td>
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</table>
Appendix 4: List of Environmental Consultants/ Study Team

The following list includes the expertise, which in most cases should form part of the assessment team for stone quarry activities EIAs depending on site characteristics and environmental issues identified. Some team members may cover two or more of these fields of expertise:

- Soil Erosion
- Hydrology
- Geology
- Air Quality and Noise
- Socio-Economic
- Mining

Each member of the team, involved for their specialist subject(s), should be involved in the entire environmental assessment cycle from scoping, baseline data collection, impact prediction and evaluation, and identification of mitigation measures.

The list of registered environmental companies related to environmental report preparation can be referred to on the website of EPD: http://www.sabah.gov.my/jpas/
Appendix 5: Standard List of Content

The content of the Environmental Assessment report shall consist of the following:

CHAPTER 1: EXECUTIVE SUMMARY

Project Description

Findings

CHAPTER 2: GENERAL INFORMATION

Project Title and Project Proponent

Environmental Consultant

Public Hearing (for Special EIAs)

CHAPTER 3: PROJECT DESCRIPTION

Statement of Need

Concept and Phases

Description of Location

Project Status

CHAPTER 4: IMPACT PREDICTION AND EVALUATION

Significant Environmental Impacts

EIA Matrix

Impact Assessment

CHAPTER 5: RECOMMENDED MITIGATION MEASURES

Recommendations

Additional Mitigation Measures

CHAPTER 6: RECOMMENDED MONITORING PROGRAMME

Compliance of Mitigation Measures

Residual Impacts

ANNEXES

Annex 1: Baseline Environmental Data and Information

Annex 2: Methodologies and Analysis of Data

Annex 3: List of References

Annex 4: Terms of Reference