CHAPTER 8
MITIGATION MEASURES

CHAPTER 8

8.1 ADHERENCE TO DOE GUIDELINES

In the process of identifying the appropriate pollution prevention and mitigation measures (P2M2s), the technologies and practices which can be described as "the state of the art" or "best available technologies" (BATs), or "industry best practices" shall be evaluated and discussed in this subchapter. This applies to all stages of project implementation including the construction and operation stages.

The requirements and specifications stipulated in the following documents issued by the DOE shall be adhered to:

- Guidance Document for addressing soil erosion and sediment control aspect in EIA Report.
- Guidance Document for the preparation of Land Disturbing Pollution Prevention and Mitigation Measures (LD-P2M2)
- Other relevant guidelines and guidance documents issued by the DOE pertaining to environmental-related system and management.
- Other documents issued by the DOE from time to time related to EIA process which may cover other environmental aspects shall also be adhered to.

8.2 PROPOSED MITIGATION MEASURES

This subchapter contains a discussion of all the mitigation measures which have been adopted and incorporated into the design and implementation of the project to effectively eliminate, prevent and minimize predicted adverse impacts. For each potential adverse impact, at each stage of project implementation, the mitigation measure shall be identified, documented and costed. Mitigation measures include all actions and activities taken, put in place, or executed which could be structural, non-structural, procedural, or administrative in nature, to mitigate the adverse impacts. The Project Proponent shall provide evidence to show his commitment to implement all the proposed pollution prevention and mitigation measures (P2M2s).

From the identification and study of the resultant impacts during various stages of quarrying, the potentially significant environmental issues are found to be related to:

- Soil erosion and loss of topsoil.
- Stripping of overburden and waste generation.
- Water pollution and degradation of water quality.
- Changes to surface and groundwater regime.
- Slope Stability.
- Air pollution due to generation and dispersion of dust.
- Noise pollution.
- Vibration and air-blast from blasting operation.
- Loss of flora, fauna and habitats.
- Generation of employment or business opportunities.
- Socio economic development.
- Aesthetic, rehabilitation and abandonment.

8.2.1 Soil Erosion and Siltation

Mitigation Measures

The estimated soil losses for the worst-case scenario were based on the assumptions that the vegetation was cleared and the soil left exposed for extended period of time. However, it must be recognised that the worst-case scenario is only hypothetical, and the situation is most unlikely to happen.

Firstly, the clearing and earthworks is minimal with the only concern is during the construction of haulage road to the quarry face platform. Then rock extraction works shall be carried out within the face itself. Even if the site were abandoned halfway through the site preparation stage, the cleared area would soon be colonised and covered by the pioneer vegetation. If the Project is progressing as planned, there will be no soil or loose materials to erode along the slope as the area shall be retained as green-belting. The preparation of quarry benches could trap any run-off from the upper riser slope by the next lower bench.

Nevertheless, potential soil erosion is a concern, and can be damaging the environment if it is not handled properly. However, the relatively flat land shall only impose impact of siltation rather than erosion. The following mitigation measures or development concepts should be adopted to minimise the environmental disturbance and hence soil erosion. They include staging of the Project development, particularly for activities such as land clearing and earthworks will preserve the existing vegetation on the areas, which are not immediately affected by land development. This reduces the size of the area:

- Exposed to the elements of water erosion at any one time, and because development of smaller area can be completed more quickly, the actual exposure time of any particular area is also minimised. As compared to a cleared area, keeping the area vegetated would reduce the potential soil loss by as much as 1,000 times.

- Once an area has been cleared of its natural vegetation, every attempt should be made to revegetate the area as soon as possible. The development should establish cover crop as soon as possible at any exposed areas, which need not be further, worked or used for day-to-day operation of the project. Once a cover of leguminous creepers or grasses is well established, for example, the erosion risk is reduced by a factor of 100.
- A combination of cover crop and terracing/plat-forming would reduce the potential erosion hazard even further. Where an exposed slope with soil materials is more than 10 meter long, the development should terrace the slope at 3-5 m interval. In comparison to a bare 40° slope with a length of 50 meter, plat-forming at 9 meter interval and the establishment of cover crop in the Project area, for example, would reduce the estimated soil loss by a factor of approximately 300.
- The benches or platforms should be constructed with a very slight reverse gradient sloping towards the hillside. By doing so, any run-off with or without eroded soil particles from the upper riser slope would be trapped by the next lower bench. This would further reduce the net soil loss from a slope, and hence the actual sediment delivery to the valley floor and/or waterway.
- More erosion-prone development activities like site clearing and removal of overburden should be scheduled for the drier period of the year when the rainfall erosivity would be lower. If these activities could be completed and any exposed sites properly prepared and stabilised before the wetter season returns, the potential soil loss would be substantially reduced.
- All filled areas must be firmly consolidated and compacted to reduce the presence of loose soil materials, which are more erodable.
- Larger and/or steeper cut or fill batters may be terraced and provided with appropriate drainage installation to discharge the runoff.
- The control of surface runoff is an important element in reducing the erosion hazard. Water should be directed down cut barters over solid rock, through U-shaped culvert pipes or over riprap installation.
- Suitable sedimentation ponds are proposed to be provided to filter the runoff before it is discharged into the small stream of the site. The runoff from the Project site, particularly from the quarry face should be directed to this trap/pond before it is discharged into the small stream.

Typical schematic diagram of sediment basin or sedimentation pond, which is commonly used, is as shown in **Figure 8-1**, while location of the proposed sedimentation ponds are shown in **Appendix 5-2** (LD-P2M2).

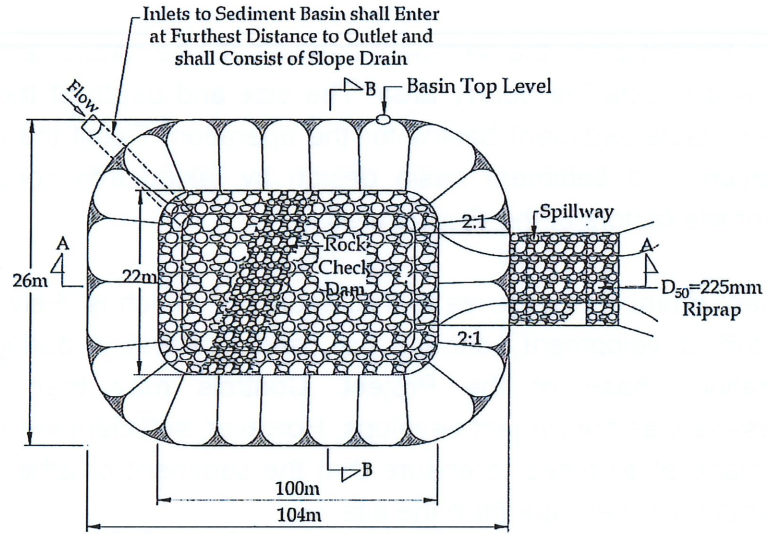
For the Project area, the sediment basin shall use natural enclosed valley within and beside the quarry area. The size and depth of the valley shall create suitable sediment basins for the operation. Detail the principle and calculation of a sediment basin design by taking into consideration all relevant site factors of the Project area.

Sediment retention measures to trap sediment, which is likely to be issued from the development, should be used preferably during the initial preparation phase of the Project. Controls may then be required progressively as the Project develops. However, sufficient measures should be in place at all times to ensure that the sediment or other water-borne pollutants do not escape from the site.

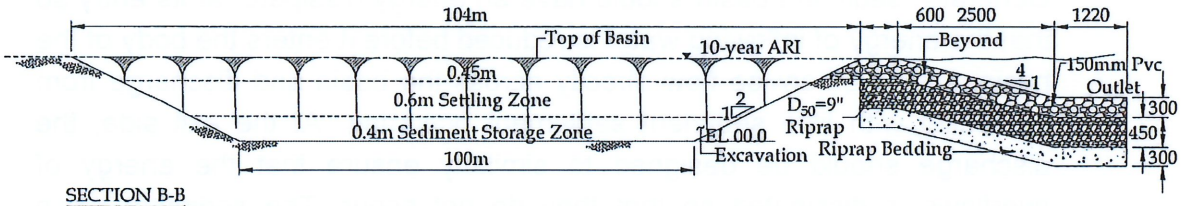
Generally, sediment basin should have an energy dissipater at its entry so that the energy of inflowing water is reduced before it enters the body of the basin. It may otherwise flow directly across the basin and discharge from the outlet with little sediment settlement occurring. At the exit side, the discharge should be designed to similarly ensure that the energy of overflows is dissipated so that they do not scour. The sediment basin should have adequate depth (minimum one metre) to ensure that there is capacity on the floor for sediment to collect without risk of that sediment being remobilised during high flows. It is recommended that the sump volume should be more than the estimated peak discharge from the contributing catchment for the one in 10 years storm.

If a sediment basin is to work effectively, the accumulated sediment shall be removed when it occupies certain percentage of the basin volume. Upon removal, this sediment should be transported to a suitable disposal site where it cannot be remobilised to pollute rivers. The level of soil erosion risk can be further reduced if the following practices are adopted:

PLAN



SECTION A-A



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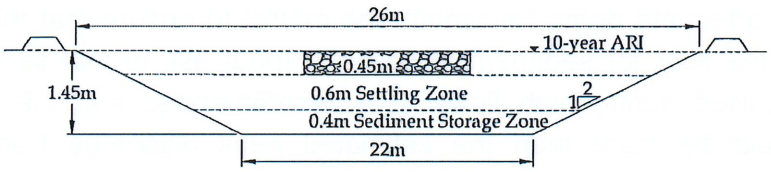

Engineering Drawing for Wet Sediment Basin for Development Site

Source: JPS (2000)

HEXATREND QUARRY SDN. BHD.	KenEp Consultancy & Services
FIGURE 8-1 SCHEMATIC DIAGRAM OF THE TYPICAL SEDIMENT BASIN DESIGN	Report Ref.: KCS/HQ/472-EIA-0119-2505-R1 Not to Scale

Sensible scheduling of activities

More critical development activities such as site clearing and earthworks should be undertaken during a dry spell, or as much as possible, are scheduled for the drier period of the year.

Minimise soil disturbance

Wherever possible, soil disturbance should be minimised. Particularly in the case of haulage road construction, disturbance could be reduced by minimising cut-and-fill operations. Where cut-and-fill operations are unavoidable, the cut slopes should have a safe angle of repose, be appropriately benched if it is a long slope, and be cover cropped immediately after the earthworks. The filled area should be properly compacted and cover cropped as soon as possible.

Control of surface runoff

The control of surface runoff is an important element in reducing the soil erosion hazard. Appropriate drainage system should be installed to lead the runoff from upper slopes without causing too much soil erosion, especially gullying, scouring and mass movement due to slope failure.

Water should be directed down barters over solid rock, through U-shaped culvert pipes or over riprap installation. **Appendix 5-2** illustrates an example of typical outfall drains which is proposed to be constructed along the haulage road of the Project.

Retention of hill vegetation

This does not reduce soil erosion, but the vegetation buffer would act as filter and decrease the net delivery of silt during runoff flow from the upper hill area to the lower areas and finally into the earth drains and sediment basins before being discharged into adjacent waterway.

Conclusion

The present soil erosion modelling has shown that soil losses from bare-hill sides could be high, even on moderately steep slopes. However, by adopting appropriate soil conservation measures, the estimated soil losses could be drastically reduced to acceptable levels.

8.2.2 Sedimentation

The problem to deal with here is the potential sediment pollution. To ensure that the water discharged from the Project area is of an acceptable standard, the following steps should be taken:

- The proposed mitigation measures taken for soil erosion in **Para 8.2.1** shall be implemented to ensure source for the siltation is controlled. Proper implementation of the mitigation will greatly reduce the impact of siltation from the Project area.
- Installation and maintenance of sediment basins - Through proper design of the internal drainage system and the water features, the water from the area can be 'treated' first before it is discharged. The sedimentation ponds shall treat silt and suspended solids by settling and trapping them. The ponds, with their larger surface area, can also help to aerate the water thereby increasing the content of dissolved oxygen to a level that will satisfy the BOD requirement. Vegetation planted in and around the ponds and waterways will also have beneficial effects. Plants around the ponds and on the slopes will act as a buffer and help to trap or filter out some of the suspended sediment load of the runoff.
- Maintenance of drainage system shall be regularly carried out. Re-design or add on number of drainages shall be considered from time to time viewing to the current situation.
- The staging of the Project will help to reduce potential soil erosion and the resultant sediment pollution.
- Monitoring of water quality – The Project Proponent must also monitor the water quality at the point of discharge from the Project site to ensure that the water is of an acceptable quality. This will be further discussed in **Chapter 9**.

8.2.3 Overburden Stripping

Mitigation Measures and Management of Overburden Stockpiles

The progressive overburden removal and staging system of quarrying shall be adopted by the Project means that during development works only affected area shall be touched, while during operational stage the overburden shall only be stripped when the quarry face levelled to be reduced to another lower bench. The other unaffected areas shall be remained as its natural environment. These systems shall minimise the amount of overburden removal activity done at one time, thus problem regarding the stockpile area shall be solved and can be properly managed from affecting the environment.

The storage of the stripped overburden should be consolidated. Though the stockpiled material will be gradually depleted for progressive rehabilitation and road maintenance need, they will most likely remain until the whole reserve is being quarried. It is therefore recommended that the more permanent stockpiles may be seeded with suitable grasses or some leguminous cover crops.

Stockpile should be smoothed to a neat and tidy outline. Precaution should be taken to prevent any loss of the overburden materials from the stockpile through water or wind erosion. The material should also be suitably compacted and graded and maintain a suitable angle of repose for the purpose of slope stability.
It is also necessary to construct permanent drains, sediment basins and other protective works, sufficient to ensure that surface runoff will not erode the surface of the overburden stockpiles placed therein and cause siltation elsewhere within or outside the quarry.

8.2.4 Hydrological Regime and Water Quality

Mitigation Measures

A number of measures have been devised to reduce and to mitigate the impact of quarrying on the quality and quantity of water resources. Some of the measures are as follows:

- Redirect storm water around quarrying operation using drains, collection and diversion ditches. Outfall drains are proposed to be constructed along the internal access road.
- Provide wastewater treatment systems such as sedimentation ponds for the collection and treatment of site runoff, sediment bearing effluents and other aqueous discharges.
- Minimize earthwork operations during periods of high rainfall.
- Reduce site runoff by grassing and sealing soil and overburden mound and by progressive restoration of quarried-out areas.
- Provide grassy filter strips between exposed soil surfaces and receiving waters.
- Riparian buffer zones should be identified at an early stage and appropriately marked in order to ensure that no clearing activity or earthworks will encroach such areas.
- The spent oil and grease should also be collected and disposed off to authorized agent as it is classified as scheduled waste and must be treated in proper manner.
- Appropriate grout curtains, plugs and seals and subsurface drainage systems to minimise the potential for ground water degradation.
- Surface roads with rock, crushed gravel, asphalt or other approved material to reduce run-off and siltation and pollution of water courses. Remove any material spilled on public roads.

Generally, the most effective mitigation measures are those which involve the pre-treatment of quarry waste waters before they are discharged to receiving water bodies so that acidification, siltation and other water pollution problems are avoided.

In addition, measures which prevent both surface and ground water coming into contact with the quarry faces and hence significantly reduce the risk of pollution such as interception devices and drains, etc. may also prove to be effective.

However, even if all available mitigation measures are employed some siltation and/or acidification of watercourses may occur. This issue that concerns potential residual impacts and monitoring requirements is discussed in the **Chapter 9**. The hydrological impact assessment is attached in **Appendix 7-2**.

Runoff Surface Water and Drainage

As discussed earlier, runoff surface water as a result of rain demands much attention when designing quarrying operations. Most potential problems can be dealt with by good design of the water system. This should integrate the various requirements and optimise the cost-effectiveness of the system. Control of erosion and runoff could be achieved by a number of elements and uses a number of tools. These include:

- Vegetating surfaces
- Mulching
- Roughening/ridging of surfaces
- Terracing and low gradient
- Netting

Downward percolation of surface waters and rainfall may cause infiltration into the excavated materials. It may also penetrate the rock through fissures and joints, which may weaken the geological structure of the quarry. The outflow of water that has percolated through contaminated material may be highly polluted. Control of infiltration therefore requires either that the wastes be isolated from the source of water or that their permeability is decreased by appropriate compaction.

Drainage forms an important part of a successful quarrying operation. Too much water will make the haul roads slippery thus making it dangerous for the lorry to pass. All drainage runs must be designed for anticipated flows and be in such a position and depth that they are capable of receiving outfalls from under drainage which may be installed. Drainage measures to protect the excavation or associated disturbed areas and sediment retention measures to trap sediment, which is likely to issue from these areas, should be installed preferably during the development phase, before material extraction commences. Controls may then be required progressively as the excavation develops. However, sufficient measures are in place at all times to ensure sediment or other water-borne pollutants do not escape from the site.

The excavation areas and the haulage road should be adequately drained with intermittent channels, so that operational and storage areas are maintained as dry as practical and more serious erosion which may disrupts access or generate unmanageable quantities of sediment is controlled. The collected run off together with any other excess water from disturbed areas of the site should be directed into a sediment sump or pond prior to discharge away from the site or the pond.

If the discharge of runoff from above sources increases flows in a receiving drainage line down-slope, erosion control may be required within that drainage line to mitigate the damage, which the increased flows can otherwise cause. Generally, however, it will be sufficient to dissipate the energy of flows where they enter the receiving drainage line so they do not cause localised erosion at that point.

Water Quality Standard

The pertinent regulation, which has a direct bearing on discharges from the Project, is the Environmental Quality (Sewage) Regulations 2009. It controls the discharge of industrial and domestic effluents (and sludge) into inland waters and onto land; including those from the Project. This regulation defines parameter limits for two standards controlling discharge of effluents to inland waters; i.e. Standard A for discharge to water supply catchment areas and Standard B for discharge to other inland waters.

Guidelines for acceptable effluent discharges into a municipal sewerage system are included for consideration by Sewage Authorities in regulating wastewater discharges from plant. Pollutant parameters and their respective values included under Standards A and B of the Regulations are presented in **Appendix 8-1.**

8.2.5 Rock Slope Protection

Mitigation Measures

As stabilisation and protection of rock slopes is aspect which need to be taken into consideration. Rock slopes, rock faces or bench walls are needed to be stabilised and protected by incorporating several measures such as rock bolts, dowels, rock anchors, reinforced concrete lining and/or combination of measures. Either one or a combination of methods could achieve slope wall stabilisation and support.

As for the rock slopes and rock walls protection measures, several measures shall be incorporated to stabilize the final bench walls are such as the following:

- Normal bench blast design depending on the rock competency;
- Smooth blasting using pre-splitting or trimming;
- Putting in the jute bag;
- Rock bolting;
- Dowels;
- Anchoring; or
- Combination of above

It is also recommended that monitoring equipment to be instituted to evaluate the effectiveness of the support and stabilisation measures installed.

8.2.6 Blasting Operation

Mitigating Measures

The main nuisances of blasting are vibration, noise and fly-rock. The general mitigation measures for each of the nuisances are summarised in **Table 8-1.** However, specific mitigation measures have been dealt with separately under each heading as shown above.

Also important to be considered in blasting operation are the shot-firer for the operation, the person that supervise the whole blasting operation. This person shall have experienced in blasting operation at sensitive areas and quite well knowledge in using of the latest technology used in blasting. This competent person shall have the qualification in term of certificates from the authorities involve such as the Mineral and Geoscience Department and the Police Department.

Table 8-1: Summary of Mitigation and Safety Measures Relating to Blasting Operation

Particulars	Mitigation And Safety Measures
To incorporate safety margin	❑ Design blast, including the size of maximum instantaneous charges (MICs) and detonating sequence, to minimise environmental effects. ❑ Check the setting out of holes and record any deviations. ❑ Use corrects stemming. ❑ Monitor the blast to provide feedback for future blast designs and also its effects to the environment.
To Limit Over Pressure	❑ Avoid use of surface detonating cord and secondary blasting where possible. If it has to be used, cover it adequately. ❑ Avoid blasting in adverse weather conditions, especially when the wind is from the site towards sensitive premises and when there is low cloud. ❑ Consider an appropriate orientation of the working face in relation to sensitive areas.

Table 8-1: Summary of Mitigation and Safety Measures Relating to Blasting Operation (Cont')

Particulars	Mitigation And Safety Measures
To Limit Flyrock	❑ Inspect the boulder for natural joints, voids and other weaknesses. ❑ Ensure that the design is thorough and follows the Regulations. ❑ Select the orientation of the boulders. ❑ Use screen nets when in any doubt.
Safety in Blasting	❑ Times of shotfiring - The times of shotfiring would be posted where persons who may be affected would be able to see them. As this may include members of the public, it is advisable to place notices at the quarry entrance and other access points, e.g. 'Danger – Shot-firing between the hours of ... and ..., Warning ..., All Clear ...' ❑ Assessment of danger zone - To assess the area that is cleared for shot-firing. ❑ Withdrawal of personnel from the danger zone, taking appropriate shelter. ❑ The 'safe position' where the shot-firer can take shelter after lighting the fuse. ❑ Warning system - The system of audible signals for shot-firing and "all clear" that can be heard clearly throughout any area likely to be affected. ❑ Any flags or portable notices that are used and where they are to be positioned. Sentries - The specific places where they are to stand and their duties. ❑ The names and addresses of any nearby residents that are to be warned beforehand that shot-firing is to take place. ❑ Inspection of the site after the blast - What the shot-firer checks and looks for before allowing the all-clear signal to be given. ❑ Procedure for the shot-firer to follow in the event of a misfire: consulting the manager, posting of notices, erection of barriers, etc. ❑ Arrangements to be made if charged holes have to be kept overnight.

8.2.7 Explosive

Mitigating Measures

Only persons with satisfactory knowledge and training should be qualified to handle explosives and blasting accessories. Detail safety for each types of explosive shall be addressed by the explosive suppliers, while the general safety considerations to be observed are as follows:

- Every effort should be made to avoid exposing explosive materials to shock, heat or friction. Do not smoke or allow any matches or open flame whilst handling explosives and blasting accessories.
- Only recognised non-explosive accessories shall be used in blasting work.
- It is advisable to transport only the required amount of explosives and detonators to the blast area.

Explosives and detonators should be kept apart from each other until the last possible moment.

- The boxes of explosives and detonators should be opened individually well away from the blast area or the vicinity of the stockpiles.

8.2.8 Air Pollution

Mitigation Measures

- Exposed soil areas, excavated materials, stockpiles and haul roads shall be dampened with water during dry ambient conditions. The minimum number of wet suppression units to be provided must be specified in operation contract clauses.
- Before work commences, the contractor will prepare a dust control strategy in agreement with regulatory requirements.
- Vehicle wheel-wash facilities shall be provided at the exits to paved road (exit / entry points); the wheel-wash facilities shall be manned at all times and the tyres of all vehicles exiting the site must be cleaned.
- Vehicle speed restrictions shall be imposed to reduce dust generation and dispersion.
- During the transport of potentially dusty materials to/from the site, lorry load shall be provided with secure load covers; load covers shall extend over the tail and side boards.
- All lorries utilized to transport potentially dusty materials to / from the site shall be of an appropriate design to ensure load containment; transport vehicles shall not be overloaded.

- During material excavation/deposit, the heights from which materials are dropped shall be controlled to a minimum practical height to minimize the dust generation.
- A good standard of housekeeping shall be maintained. If roadways to the site access locations are contaminated with construction materials / soil, clean up must be conducted. Road sweeping and washing will provide an effective means for reducing dust entrainment.
- Visual inspections shall be conducted on a regular basis to identify significant dust entrainment and as a means of assessing the effectiveness / requirement for additional mitigation measures.
- If any complaints are received these shall be investigated promptly with remedial measures implemented as appropriate; complaints investigation and corrective actions shall be documented.
- Vehicle/equipment exhaust discharges shall be visually inspected to ensure no excessive emissions of black smoke; where possible, site equipment exhausts are to be orientated away from the ground; Vehicle/equipment air emissions shall be controlled by simple good practice procedures (such as turning off equipment when not in use).

The following **Table 8-2** summarizes the source and possible control measures that shall be undertaken in order to reduce air pollution particularly dust emission including from the crushing plant operation.

Table 8-2: Sources of Dust Emission and Possible Control Measures

Source	Sphere of influence	Possible Control Measures
Rock drilling	Immediate personnel	Implant wet suppression Dry collection of drilled rocks Respiratory gears is compulsory or PPE
Blasting	Site staff	Prepare proper blast design Use mats when blasting operation Blast during opposite wind direction
Conveying	Site and immediate personnel, possibly public on small site	Implant wet suppression Wet and dry collection Proper enclosure Isolated control cabin Respiratory gears is compulsory or PPE

Source : Kevin, H (1993)

Table 8-2: Sources of Dust Emission and Possible Control Measures (Cont')

Source	Sphere of influence	Possible Control Measures
Raw material transportation	Immediate personnel and site staff	Use water sprinkler
Crushing	Immediate personnel and site staff	Isolated control cabin Partial encapsulation Use water sprinkler Respiratory gears is compulsory or PPE
Screening	Immediate personnel and site staff	Proper enclosure Wet suppression Wet and dry collection Isolated control cabin Respiratory gears is compulsory or PPE
Surge pile	Immediate personnel and site staff	Wet suppression Isolated control cabin Respiratory gears is compulsory
Stock pile	Immediate personnel and site staff, public	Wet suppression Wet and dry collection Use feeder chute
Product transportation	Public and immediate personnel	Covering of rocks
Access road	Site staff and public	Track spraying Dampened and sweeping of road Surfacing in extreme cases
Vehicles	Public and site personnel	Wheel-washing facilities

Source : Kevin, H (1993)

8.2.9 Noise

Mitigation Measures

Selection of 'quiet' plant and working methods shall be the main thrust of the mitigation measures to be implemented to abate the relevant noise issue pertaining to the Project both during the development and operational stages of the Project.

- Plant that is quieter than that on which the preliminary noise predictions have been based should be used, and use of low noise equipment and working methods must be specified in construction contract tender documents. Reductions in source sound power levels of 5 - 10 dB(A) may be achievable in some cases.
- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the operation programme.
- Transportation (such as lorry), machinery and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum.
- Operation activities should not take place at night-time. If this is absolutely unavoidable local residents shall be advised by the contractor following consultation with local community leaders.
- Plant known to emit noise strongly in one direction, should, where possible, be orientated so that the noise is directed away from nearby sensitive receivers.
- Silencers or mufflers on equipment should be utilized and should be properly maintained during the operation program.
- Temporary noise barriers and screens shall be constructed to protect sensitive receivers if necessary.
- Local community leaders should be consulted beforehand and agreement reached over appropriate timing for any particularly noisy activities.
- If any complaints are received these shall be investigated promptly with remedial measures implemented as appropriate. All complaints are to be recorded and details of investigations and corrective actions shall be documented.
- If operation noise does become an issue or if complaints are received, additional measures shall include:
- avoiding simultaneous noisy activities,
- Other measures which may be given consideration during operation stage shall include the followings:

    - Pumps - Pump or gearbox noise levels should be reduced using insulation/cladding or acoustic enclosure.

- Air Compressors - Most compressor manufacturers now provide 'low-noise' compressor packages as standard, and these should be specified for the project. The compressors would be housed within a proprietary acoustic enclosure with appropriate intake/discharge silencing.
- Control Valve/ Piping Noise - The primary means of reducing valve noise is to use low noise valve trims which achieve the reduction in noise level by dropping pressure in stages rather than in a single stage. If low noise trims cannot be used for a given duty, downstream piping may require acoustic insulation (mineral wool insulation with steel cladding).
- Diesel Engines - Noise levels can only be reduced significantly by enclosure of the unit in an acoustic enclosure or by locating the unit in a separate building. Particular attention may be required to the intake and exhaust arrangements for the room/enclosure and an exhaust silencer maybe required to achieve acceptable noise levels for the diesel exhaust.
- Electric motors - a wide range of low noise or silenced designs of motors are available, and these should be specified for use in the project. Noise reduction measures may include use of air intake / discharge silencing, special (unidirectional) fans, use of acoustic fan covers and / or increasing the frame size.

8.2.10 Solid and Hazardous Wastes

Mitigation Measures

Even the Project site shall not have problem in discharging the wastes, as precaution, the following mitigation measure are proposed and shall be implemented wherever practicable.

Cut Vegetation

- Large stumps, small branches and other organic materials shall be disposed of via mulching / composting in a suitable area within the site; and
- Open burning shall be prohibited.

Excavated Materials

- Surplus excavated material and inert wastes (soil, broken rock etc) shall be reused on site as structural fill, landscaping, erosion control and restoration features wherever practicable.

General Refuse

- General refuse generated on-site shall be stored in enclosed bins separate from hazardous wastes.
- Solid wastes generated from the Project site especially from the site office is expected to be minimal. Therefore, it is proposed to be disposed within the Project site. Thus, the disposal of solid waste from the Project is not expected to be problem.

Construction Wastes

- The generation of construction waste shall be minimized through careful control of materials ordering procedures to avoid surplus materials.
- Scrap metals (eg welding rods, end caps, off-cuts etc.) shall be recovered and sent for recycling as scrap.
- Other inert general wastes shall be collected and disposed of via local dumpsites or as infill material if appropriate.

Wastes Management

- A comprehensive waste management plan must be prepared by the contractor before starting work, detailing all waste types and quantities which are expected to be generated, and detailing means of minimizing, storing, transporting, and disposing of wastes. The plan must be approved before work commences.
- Waste is to be stored in appropriate designated and marked areas.

- Reuse of materials shall take place wherever possible (eg drums and containers shall be returned to suppliers for reuse), thus avoiding disposal (generally with only limited reprocessing).
- Recovery and recycling shall take place wherever possible, thus avoiding disposal (reprocessing may be required).
- Scheduled waste must be treated and disposed of according to relevant laws, guidelines, and best practice.
- In the event of inappropriate or inadequate disposal of waste generated as a result of operation activities the contractor shall bear the full liability for any further clean-up costs.

Hazardous Wastes

All hazardous wastes must be managed in accordance with relevant regulations. Wherever possible, these wastes shall be recycled (e.g. lube oils etc). As stipulated under Environmental Quality (Scheduled Wastes) Regulations, 2005, any wastes which fall under First Schedule of the regulations if were generated shall be stored, transported, treated and disposed at prescribed premises by contractor registered under DOE. Some examples of such wastes are spent lubricant oil, waste grease, sludge from oil storage tank and dust from dust emission control system.

Appropriate manner of handling the said wastes would reduce the associated impacts. The potential for environmental damage from improper use of these materials shall be very clearly understood by users and the following guidelines shall be implemented:

- All fuel tanks and storage areas shall be provided with drip collection devices and be sited on sealed areas with a bund enclosure capable of containing 110% of the inventory of the largest tank. Provision of a weather shelter over the storage tank is an appropriate measure to prevent the accumulation of rainwater within the bund.

- Fuel and other hazardous materials (eg. lube oil etc) shall be stored in a secure area (dyke bund enclosure with hard-standing base) located at least 100 m from watercourses and on-site drainage channels. Material Safety Data Sheets (MSDS) shall be maintained for all materials.
- Refueling activities shall not be conducted within 100 m of watercourses or on-site drainage channels.
- Dedicated maintenance and refueling areas shall be identified and provided with bund hard standing with the provision of sediment traps and oil interceptors.
- The change-out of lubrication oils from construction equipment and vehicles on the site shall be controlled. Spent lubrication oil is classified as a hazardous waste and shall be handled and disposed of in accordance with regulatory requirements.
- The relevant government authorities shall be immediately informed of any accidental spills of fuel, oil, or other hazardous materials. Any such spills shall be to the satisfaction of these authorities. The resultant recovered material shall be appropriately disposed of as a hazardous waste.
- In the event of any pollution to watercourses occurring as a result of operation activities, the construction shall bear the full liability for any clean-up and restoration costs.

8.2.11 Fuel Oil Storage

Mitigation Measures

The potential for environmental damage from improper use of these materials should be very clearly understood by users and the following guidelines should be implemented:

- Regardless of their size or contents all fuel containers should be handled carefully.
- All containers, full or empty, should be handled with care, since drums with broken seals often contain some fuel. In addition to the potential for pollution, such drums may, in the case of lighter hydrocarbon products, contain fumes, which may be explosive.

- Transportation and storage of fuel and lubricants should be in properly constructed containers of an approved design before being collected by competent personnel to be treated or disposed at appropriate site according to the regulations mentioned previously.
- Fuel storage in dumps or caches should be set back from any waterbody and located on relatively flat land.
- Large containers should be 30 meters from a waterbody and should be dyke bund to maximise the chances of containing spills.
- These dyke bunds should be built of impermeable material such as concrete, clay, hydrocarbon resistant plastic sheeting or other approved impervious lining.
- The perimeter dyke bund should be able to retain possible spillage amounting to 110 - 125 % of tank capacities.
- Run-offs from the tank area to be routed through oil trap prior to discharge to external drains.

8.2.12 Sewerage Discharge

Mitigation Measures

Although the design of the sanitary wastewater at the operating site is handled by the septic tanks, the system is expected to consist of collection, aeration, clarification, disinfection and sludge thickening/dewatering stages. The system shall ensure the quality of effluent and facilities complies with the limits specified under the Industrial Effluent Standards, if discharge done. Provision of proper managed of available sanitary facilities for the workforce is necessary to ensure that associated impacts are negligible. Some of these are as follows:

- Workers shall be provided with adequate sanitation facilities;
- Toilet facilities shall be provided whereby the cleaner shall be responsible for regular site visits to collect the accumulated waste for off-site disposal;
- At least one toilet shall be provided for every 15 workers;
- The waste shall be properly stored and managed to minimize contaminated run-off to the water bodies.

8.2.13 Traffic and Transportation

Mitigation Measures

Mitigation measures, which may be implemented to deal with impacts generated by traffic, are related to air pollution and noise. These have been elaborated in other sections of this report. However, for easy reference the following basic measures are relevant:

- In order to minimize dust dispersion during transportation, it is suggested that the wetting of dirt roads shall be undertaken regularly during any dry spells.
- Prior to leaving the Project site, tyres of lorry should be hosed down with water to ensure that soils and fugitive dust are not scattered onto the public roads.
- Vehicles conveying product materials should be covered to effectively contain the materials and to avoid spillage along the way that may cause accidents. Any material spilling onto the public or private land shall be cleaned up.
- Vehicles conveying product materials and equipment must not exceed the permissible tonnage to prevent formation of cracks and potholes on the existing roads.
- Proper maintenance of the lorry concerned could reduce vehicular smoke emission. Deployment of poorly maintained old vehicles should be avoided.
- Good planning and co-ordination will reduce the frequency of delivery and therefore the number of trips. Transportation activities should as far as possible to be restricted to day light hours but outside the peak traffic periods.
- The Project Proponent shall install clear speed limit and warning signs beside the road approaching to work-site areas.
- The speed limit of trucks in community areas shall be restricted to 30 km/h.
- To minimize traffic congestion and accidents, material transportation shall be avoided during the peak hours,

- A The Project Proponent shall develop specific transport / traffic safety plans to include vehicle routing, policy, laws and regulations, briefings and training, vehicle maintenance and operational procedures, training and safe driving techniques.
- Any abnormal load movements shall adhere to prescribed routes to the site to be agreed with the authority / police and scheduled to avoid peak hours on local roads.
- The Project Proponent shall keep and maintain records of any transportation accidents with the history and details of causes for further planning of prevention measures.

8.2.14 Flora

Mitigation Measures

In order to inflict minimal damage to the flora environment, the quarrying operation should be carried out with close supervision in an orderly manner as follows:

- Bulldozing of the entire vegetative cover is to be discouraged. Trees can be cut with chainsaws. Branches and unwanted stumps should be disposed properly and waterways must not be blocked.
- Soil and overburden materials should not be piled close to waterways as to prevent or minimise sediment being washed directly into the watercourses. This will also ensure the protection of the riparian flora.
- Implementation of progressive re-vegetation programme on unutilised areas during the quarrying operation and also after the cessation of the quarry.
- The first step in the re-vegetation is to back-fill the excavated area with certain thickness of topsoil. During excavation, the topsoil, subsoil and the rocky overburden materials are to be separately stockpiled.
- Before back-filling is carried out, topsoil which has been stockpiled in deep mounds for a long period of time is needed to be tested for its pH and also microbial activity.
- The topsoil is checked to be free from subsoil, roots, rock over 2.5 cm in diameter, herbicides, contaminants and other extraneous materials.

- During back filling, the rocky materials are first put in to be followed at appropriate depths by subsoil and then the topsoil.
- For re-vegetation success on ground, topsoil is to be spread to a depth of 15 cm over the entire selected areas in order to provide organic matter and important nutrients for the plant material.
- As for re-vegetation on quarry benches, some final specification shall be designated. Slope of final quarry faces to be proposed is 80° with bench height of 8.0 m and bench width of 4.0 m. On each bench, backfilling of topsoil shall be carried out at about 1.0 m depth with some 0.5 m of the bench shall be retained as buffer.
- Planting with *Axonopus sp.* (cowgrass) is probably the quickest way to stabilise the soils in the back-filled areas. If left alone, secondary pioneer species such as *Melastoma, Macaranga, Brookea sp.* And *Dillenia sp.* will also colonise the area very quickly. This process can be hastened by planting *Dilleniasp.* easily grows from cutting while others may be transplanted.

8.2.15 Fauna and Their Habitats

Mitigation Measures

- Erosion controls (see **Section 8.2.1** above) will help to prevent sediment pollution and siltation of watercourse and hence reduce the potential impacts upon the aquatic fauna.
- On the completion of quarrying at certain site, progressive rehabilitation and re-vegetation programme will establish new habitats and canopy bridges as well as prevent soil erosion. Such efforts would help to reduce the negative impacts of the development on the ecology and fauna of the site. The planting of appropriate trees will attract the birds and squirrels back.
- The Proponent should ensure that none of its employees carries fire arms into the adjacent forest at any times, as these are often used to poach animals. In addition, trapping of any animals either as food or for sale should also be discouraged.

Wildlife Management Plan

Project proponent is to be aware of the 'Wildlife Conservation Act 2010 (Act 716)' and understand thereof in the fullest. This will facilitate understanding, appreciation and the implementation of the act in relation to wildlife conservation.

The work force employed in the project will be reminded of the prohibition of capture, encroachment into adjacent forest reserve, disturbing, chasing, killing by any means and black-market sales and trade of any wildlife species. Any individual or groups caught infringing the act shall be prosecuted by law under the Wildlife Conservation Act. Regulations related to wildlife crimes should be signposted at the proposed project site such as shown in **Figure 8-2** below.

Figure 8-2a: A sample signboard content showing the regulations related to wildlife.

- **Development and Site Clearance in Phases**
  The site is undulating where the site clearance and overall quarry exercise will be completed in phases to minimize the impact on wildlife movement and allow slow and steady migration into deeper pockets of adjoining forest yet untouched.

- **Cage Trapping**
  There will be arrangement of Cage Trapping of endangered and vulnerable species. Sufficient monetary budget will be allocated for the Cage Trap, Manpower, transportation to safe shelter, release to sanctuary and all necessary logistics therein. This is in light of the introduction of Wildlife Conservation Act 2010 (Act 716), where the protection, rehabilitation and growth of vulnerable and endangered species are ensured and protected by the act.

- **Human Wildlife Conflict (HWC)**
  Conflict between human being and wildlife may occur due to developmental impacts that cause collateral damage to the unprotected wildlife community. This conflict between 'Human – Tiger and 'Human – Elephant' seems to be rising with passing days as more and more pristine forest watershed being destroyed for unsustainable development. The damage is irreversible not only to wildlife community but other important components of environment vital for climate and ecology.

There are incidents more often than not where the precious and priceless wildlife species are subjected to brutal and barbaric assault leading to death and injury. There are crooked gangs and syndicate who capture and killed wildlife species for illegal trade as there is always demand for medicine, skin, jewellery, ornament and other usages. As recent as 2019 in Melaka, Clouded Leopard (Harimau Dahan) (Neofelis nebulosa), a totally 'Protected Species' under ***Wildlife Conservation Act 2010 (Act 716)*** was brutally killed and put on viral. Similar cases of other species, such as Leoaprd (Harimau Belang) slaying in Pahang, was recorded in 2016 and slaying of Asian Elephant in Pahang as well. It is heartening to note that '***Jabatan Perhilitan Malaysia'*** is taking drastic action to stem it and prosecuting the culprit at the earliest possible time following the empowerment of '***Wildlife Conservation Act 2010 (Act 716)***.

- **Human – Wildlife Conflict (HWC) In the Context of the Proposed Quarry Exercise**

  Human-wildlife conflict is not new anymore as incidences of encroachment into protected areas/reserve by poachers, increase in road kills and illegal trade are often reported in newspaper and other media. Thus, in the wake of proposed quarry operation, there must be extreme caution that such conflict is prevented in every way possible.

  In light of the introduction of ***Wildlife Conservation Act 2010 (Act 716)***, the protection, rehabilitation and growth of vulnerable and endangered species are prioritized now more than before. However, actions should still be taken to prevent/ minimize human wildlife conflict. The mitigation measure is as recommended below:

  i. Reporting to the nearest **Jabatan PERHILITAN** (Department of Wildlife and National Parks [DWNP]) in the event of any '**Human Wildlife Conflict (HWC)**' by the proposed project proponent with **Pejabat Perhilitan Negeri Terengganu** at: 1 – 800 – 88 - 5151. Any complaints can also be electronically filed on the website as follows: (www.wildlife.gov.my).

ii. The project proponent must be aware of the wildlife species under 'Total Protection' of the 'Wildlife Conservation Act 2010 (Act 716)' may encroach into the area for many reasons. Under such circumstances, they must report to the authority for rescue and safety. No bodily harm to precious species unique to our environment will be accepted and laws relating to mandatory prosecution will be immediately applied at full force.

Mitigation Plan

i. During site clearance for quarry operation, the important is to exercise in phases and provide riparian reserves to minimize the impact on wildlife movement and allow slow and steady migration into deeper pockets of adjoining forest yet untouched.

ii. Once they are sighted, Jabatan Perhilitan will be informed immediately so that they can come and chase out to nearby forest. The animal will be scared by firing shot into the sky and herded into the jungle.

iii. Erecting electric wire fence/hoarding and digging deep drain/trench along the border of the proposed project shall prevent the species from encroaching into proposed rubber estate.

iv. Trapped and injured species within the site shall be captured and transferred to safer places by Jabatan Perhilitan.

v. Other than those mentioned, traditional way of chasing wildlife species can be practiced as follows:

- By burning old tyre and shouting to scare the animal so that it can elope into jungle
- Digging deep trench at the border
- Collective effort rather than individual
- Involve Jabatan Perhilitan, various nature conservation groups and NGOs will help immensely in the management of wildlife.

8.2.16 Occupational Safety and Health

Mitigation Measures

The following measures may be considered to enhance their work place safety and industrial hygiene:

- The Project Proponent shall ensure that the health, safety and general welfare of the employees as stipulated under the Occupational Safety and Health Act 1994 (Act 514) are properly taken care of. Emphasis shall be placed on the enforcement of safety rules for workers, road safety regulations, and proper and regular maintenance of machinery and vehicles.
- The employer must provide information, instruction, training and supervision as is necessary to guarantee the safety and health of its employees. First aid equipment must be readily accessible at all work sites, and training shall be provided to designated first aid personnel.
- Safety on all phases of the works must be addressed fully right from the start. A safety committee must be organised together with a Safety Manual to cover all the areas of concern.
- Road design shall incorporate safety measures with respect to road gradient, bend radius, road width, etc. Certain precautions must be exercised while driving the haulage lorry.

To mitigate against the worker-related impacts, the following measures are proposed to be adopted:

- Exposed soil areas, excavated materials, stockpiles and haul roads shall be dampened with water during dry ambient condition to minimize dust dispersion.
- Train workers to operate machinery properly so as to reduce dust generation.
- Only well-maintained equipment shall be operated on-site and equipment should be serviced regularly during the operation.
- Ensure that the site is kept orderly and tidy with good working conditions and first-aid units in working areas.

- Workers shall be provided with adequate sanitation facilities. At least one latrine shall be provided for every 15 workers.
- Rules shall be introduced to prevent disturbance to local communities, with sanctions for those who break rules. Appropriate training must be provided for workers.
- Educate the workers on precautions to prevent the spread of sexually transmitted diseases.
- No use of illegal migrant workers from abroad is to be permitted.
- Establish a health surveillance system and provide health promotion training for selected groups of workers.
- Safety precautions and plans must be rigorously followed at all times.
- Provide sufficient training for pollution control safety measures, first aid, and fire-fighting.
- Establish effective on-site safety procedures and control systems.
- Establish an emergency response plan.
- The Project Proponent is to establish a public liability scheme for people and property in the vicinity of the Project area to cover the costs of compensation after an accident.
- Undertake a health promotion program and support activities which will help prevent illnesses associated with the Project, such as local community capacity building.

8.2.17 Socio-Economics

Mitigation Measures

The local population must be given the first opportunity when suitable employment positions arise. The local communities shall also be encouraged and given the opportunity to acquire the necessary technical know-how through training scheme related to the operation.

In terms of infrastructure, the Project shall utilise the road which is connected to the main road, Jalan Paka. The road access to the project site can be access by using the dirt road. The road will be used to transport workers and material to the Project area. Although no benefits for the local people could be attributed to the provision of amenities, utilities and infrastructure, no adverse impacts could be identified either.

Since nuisance and public safety are unavoidable impacts, its mitigation measures are needed to be of concern. Such measures as listed in previous **Para 8.2.9** shall be carried out to overcome the issues.

8.2.18 Aesthetics and Visual Intrusion

Mitigation Measures

Concealment of Impact

The most commonly adopted approach to mitigation of visual impact is to conceal the offending elements from view. In the case under study, this can be achieved by planning the layout of the quarry faces which shall consist of a belt formation within the multi-benches open-pit design. Other alternative approaches include sitting and operational modifications; arranging belt of trees or grass-covered earth bund such that it obscures the offending view; camouflage; and housekeeping - these are expanded upon in **Table 8-3**.

Table 8-3: Measures for Mitigation of Visual Impact due to Quarrying

1.	Site selection
	❑ Orientate the quarry to limit visibility of working faces
	❑ Stagger the quarry access to prevent direct views into the site
	❑ Ensure sufficient land is available to enable landform modelling, off-site planting and perimeter treatment
	❑ Consider topographic position and the potential for natural screening.
2.	Method of working
	❑ Work in a direction away from major sightlines
	❑ Phase extraction to limit the area of disturbance
	❑ Restore progressively
	❑ Consider alternative extraction methods.
	❑ Design and locate processing plant to reduce visibility, giving attention to colour, cladding, height of structures etc.
3.	Screening
	❑ Construct planted and/or seeded earth mounds giving careful attention to avoidance of sudden changes in gradient and direction, and using shallow gradients wherever possible.
	❑ Undertake advance planting (secondary benefits may arise such as biomass products, commercial timber, and wildlife value)
	❑ Build dry stone walls in appropriate regions
	❑ Retain existing vegetation wherever possible
	❑ Consider temporary planting at long term quarry units
4.	Camouflage
	❑ Consider colour and cladding of buildings and plant, within safety margins
	❑ Utilise local natural stone products for buildings and roofs where possible
	❑ Limit the height of structures, stockpiles and waste dumps as far as possible, and design with shallow gradients
5.	Haulage
	❑ Locate and design haulage facilities so as to minimize visibility at the outset
	❑ Route internal haul roads to avoid punctuating the skyline
	❑ Route external haulage to avoid sensitive properties and landscapes
6.	Housekeeping
	❑ Maintain the internal quarry environment - especially where visible externally (remove scrap, keep stockpile and waste disposal areas tidy)
	❑ Undertake regular weed control in on and off site planting areas
	❑ Keep external roads clean and mud-free, including the quarry access and visitor facilities

Certain elements such as skylined plant cannot easily be screened, and the quarry face itself may be impossible to screen when situated on high ground. The approach here shall be to design the quarry such that the number of viewers is minimized, and the time period of visibility is limited. High structures shall be sited, wherever possible, such that they do not intersect the skyline.

Innovation

It could be argued that in certain situations, quarry landforms introduce an element of drama into the landscape. The very fact that natural cliffs and gorges are regarded as visually acceptable suggests that steep quarry faces, particularly if partially vegetated, will not always be aesthetically objectionable.

However, two difficulties arise when attempting to apply this concept to visual impact mitigation in the quarrying industry:

- It is often not the quarry landform which creates the biggest perceived impact during operation, but ancillary processing areas, busy access roads, and mobile plant. Therefore it is commonly not until after the cessation of operations that the landform can be to be visually acceptable.

- The perceived degree of visual impact may be further fuelled by a lack of familiarity with the industry on the part of the observer. Landforms and structural elements associated with the quarry may be instantly regarded as alien in the surrounding landscape simply because of a lack of comprehension. This situation may be overcome by pro-active development of a climate of mutual understanding and co-operation with the local community. It is notable that operators who have adopted these measures tend to have least difficulties in terms of complaints received, and objections to new planning applications. A further innovative approach is the construction of viewing platforms with interpretation boards - a measure which has achieved considerable success in other countries.

Restoration

Once quarry operation have ceased, the opportunity arises to create positive landscape gain through restoration. However, this opportunity will be considerably enhanced if at least some of the quarry area has already been restored by this time, by progressive and proactive restoration. The disturbed and partially destroyed land can be replaced with a new design which may be of equal value to the original landscape. End use for the quarry includes the following:

- Agriculture and forestry;
- Nature conservation (including geological conservation);

However, the success of such after-uses depends upon early planning, progressive restoration, proper aftercare and long term management (eg Coppin, 1981). Restoration works must incorporate best practice with regard to soil handling, plant establishment and maintenance operations (Coppin and Bradshaw, 1982). It is recommended that wherever possible, restoration trials be undertaken at an early stage to ascertain the most successful techniques for the proposed quarry. This requires that the concept of quarry restoration and afteruse is known at an early stage, but that the approach is allowed to be sufficiently flexible to permit changes in quarry operations, working methods, afteruse demand, and restoration techniques.

Conclusion

Aesthetic or visual impact shall not be an issue of concerned as the quarry shall not be exposed to the full view of the public. It is located in a secluded area and thus not visible from public places or from nearby settlement areas. The extent to which the Project site is visible depends principally upon the size of the operation and the nature of the surrounding topography. At the end of the development, with some mitigation measures to be implemented, the scenery and the general aesthetics of the area will be greatly enhanced. This must be construed as a significant positive impact.

8.2.19 Issues Related to Rehabilitation

The appearance of abandoned quarry has done much harm to the reputation of the extractive industry. Quarries are frequently abandoned complete with untidy stockpile of overburden, rusting plant and machinery, concrete foundation and some partly demolished buildings. These frequently attract the attention of vandals that will usually aggravate the situation. Ways therefore need to be found to arrest to prevent such occurrences from happening at the proposed operations.

Reclamation, restoration and rehabilitation are ways in which the problems of derelict ex-quarry land may be overcome. They are important in quarrying as experience show that the potential for environmental disturbance continues even after a quarry has ceased operation permanently. Its degree of disturbance decrease as the areas concerned is returned to its natural form. Remedial measures in the form of restoration and rehabilitation of the area are indeed necessary to be initiated in order to expedite this process of naturalisation. Incorporation of these measures into the long term planning of a quarrying scheme is a wise step, as it will harmonise between the requirement for raw material and the necessity for the preservation of the environment. However, some quarries have a long anticipated life, which make it difficult to determine the precise after-use of the site, say in some 10 to 20 years' time.

Legal provisions may be used to impose the requirement for restoration, reclamation and rehabilitation programmes in quarries. In Malaysia, however, such requirements are not clearly defined either legally or administratively. Legal requirement pertaining to reclamation and restoration of quarry lands in Malaysia is not clear. There is no specific provision in the National Land Code or national policy that require that land that has been disturbed by quarrying be rehabilitated or restored, even though attempts have been made to impose such conditions through administrative means. It is therefore quite difficult to implement the requirement for reclamation, restoration and rehabilitation of quarry land in Malaysia.

Reclamation includes both restoration and aftercare together with any other operations necessary to return the area to an acceptable environmental condition. This may be for either the resumption of the former land use, generally agriculture, or for a new use. After-use is the succeeding use after quarrying for example, agriculture, amenity, including nature conservation, industrial or other development.

Unlike most other forms of development, quarry sites can commonly be restored to their former use, or to a new acceptable use. As soon as an area has been completely been worked and is ready to be abandoned, the site will have to be rehabilitated. Overburden, which has been previously removed and stored on site, can be used to fill up any quarry faces created during the quarrying operation. Exposed slopes are to be appropriately terraced, topsoiled and returfed with scrubs, grass or leguminous cover crops or planted with fast growing tree species such as *Leucaenaleucocephala*(Petaibelalang), *Acacia auriculaeformis*(Akasia) *and Ficusreligiosa* (Ara).

8.2.20 Issues Related to Abandonment

Mitigation Measures

Careful planning and execution may avoid Project abandonment. Where abandonment could not be avoided before the completion of the Project, retraining and redeployment of the affected workforce may mitigate the adverse social impacts due to retrenchment of employees.

When operations are completed, the area shall be tidied up, all facilities not otherwise required shall be removed. Depending on the end-use and requirements of the landholder, it may be appropriate to retain certain services. Otherwise these shall be removed. Building structures, machinery and wastes shall be removed. The ultimate aim shall be to leave the site under a tidy, stable, free-draining and vegetated condition to blend in with the adjacent landscape and plant communities. It shall also be free of any unexpected hazards to the public.

8.3 SUMMARY

The potential environmental impacts and their corresponding mitigation measures where required are summarised in **Table 8-4**. For the purpose of the assessment and proposed mitigation measures as mentioned above, it is assumed that the Project will be planned in phases which will enable the Project to operate efficiently.

Table 8-4: Summary of Significant Environmental Impacts, Proposed Pollution Prevention and Mitigation Measure (P2M2) and Residual Impact

Potential Impact	Sources of Impact	Proposed Pollution Prevention and Mitigation Measure (P2M2)	Residual Impact	
			Nature of Impact (Adverse, Beneficial or Not Significant)	Significance (Minor, Major, Moderate)
Dust Pollution	**Development/ Operation**	• Frequent spraying of water on the exposed surface especially during dry seasons. • Regular spraying the entrance and exit points of the site. • Implement all construction vehicles to go through the washing bay after tire washing from the quarry site before exiting the site. • Traffic controls such as speed limits and traffic volume restrictions to reduce dust churned up by vehicles. The recommended speed is not exceeding 30 km/h along the haulage road. • Vehicles transporting earth and construction material should be covered properly with tarpaulin to reduce wind-blown dust. • Transport of earth and materials should be confined to non-peak hours, if possible. • The burning of plant debris and other construction wastes is prohibited. A warning sign board must be erected to send the message across at all time. • Proper maintenance and frequent servicing of vehicles to reduce exhaust fume emissions. • Carry out dust monitoring programme. • Workers should be supplied with respiratory masks.	• Not significant	• Minor

Potential Impact	Sources of Impact	Proposed Pollution Prevention and Mitigation Measure (P2M2)	Residual Impact	
			Nature of Impact (Adverse, Beneficial or Not Significant)	Significance (Minor, Major, Moderate)
Noise and Vibration	**Development/ Operation**	• The machinery used should also be properly checked and maintained at optimum operating conditions. All machinery should be shut down when not in use. • Overall noise level emitted from the transportation of the construction equipment and materials to be controlled by routing all construction vehicles to routes that will cause minimum disturbance. • Any complaints from nearby residents should be immediately attended to and actions taken. Impose and enforce a speed limit on all vehicles moving within the project site for example at max of 30 km/h. • Regulate the number of external and internal vehicle trips per day. • Maintain natural buffer zones to attenuate the noise impact. • Carry out noise monitoring programme. • Provide workers with earplugs or earmuffs. • Have work shifts for the workers. • Carry out regular audiometric test on the workers. • Adopt proper and safe blasting technique. • Engage qualified personnel to handle blasting and explosive. • Avoid secondary blasting. • Use delay blasting technique and correct stemming. • Carry out quarry face survey. • Monitor blast as feedback for future blast design. • Install effective noise suppression system.	• Not significant	• Moderate

Potential Impact	Sources of Impact	Proposed Pollution Prevention and Mitigation Measure (P2M2)	Residual Impact	
			Nature of Impact (Adverse, Beneficial or Not Significant)	Significance (Minor, Major, Moderate)
Water Quality	**Development / Operation**	• Ensure minimum or no direct water discharge into any of the nearby natural water courses. • The surface runoff from the project area is being channelled into the temporary drainage system and subsequently to the sedimentation pond built in place, before finally discharge. • Adequate sedimentation pond, siltation pond to contain water. • Oil and grease leakages from servicing the construction equipment, is to be drained into a drum for collection and disposed as 'scheduled waste' at the designated skid areas. • Fuel, grease, engine oil storage must be carefully sited to avoid contamination of the surface waters. • Domestic and solid wastes should be collected in covered bins and finally disposed off into an approved dumpsite.	• Not significant	• Moderate

Potential Impact	Sources of Impact	Proposed Pollution Prevention and Mitigation Measure (P2M2)	Residual Impact	
			Nature of Impact (Adverse, Beneficial or Not Significant)	Significance (Minor, Major, Moderate)
Soil Erosion and sedimentation	**Development/ Operation**	• Limit the work area to the minimum and expedite work during dry season. • Overburden stockpile cleared regularly and be compacted. • Maintain the sediment pond constructed. • To maintain bund and drainage in place within the project site to minimize soil erosion on-site as well as runoff and siltation off-site.	• Not significant	• Moderate
Waste Generation	**Development/ Operation**	• Proper disposal at approved dump site. • Adequate disposal bin prepared on site.	• Not significant	• Minor
Health and Safety (Operation)	**Dust Nuisance**	• Carry out dust monitoring programme. • Workers should be supplied with respiratory masks.	• Beneficial	• Minor
	Noise Nuisance	• Carry out noise monitoring programme. • Provide workers with earplugs or earmuffs. • Have work shifts for the workers. • Cary out regular audiometric test on the workers.	• Not significant	• Minor
	Occupational accidents	• Follow the emergency response plan formulated.	• Not significant	• Minor