State Environmental Conservation Department (ECD),
Sabah, Malaysia

# Environmental Impact Assessment (EIA) Guidelines for River Sand and Stone Mining

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## Preface

The sand and gravel mining industry provides basic raw materials that touch upon many aspects of our daily lives. For many years, sand and gravel have been integral components of the building and road construction industry. Today, demand for sand and gravel continues to increase.

River sand and stone mining, however, may induce channel erosion, reduce recreational and wildlife values, and contribute towards the local extinction of stream fauna. Geomorphic theory as well as published observations on the damaging effects of channel and river reserves mining is enough to stress the need for appropriate planning and implementation of river sand and stone mining activities.

River Sand and Stone Mining is a Prescribed Activity under the Conservation of Environment (Prescribed Activities) Order, effective September 1999. The Environmental Conservation Department is responsible for the implementation of the Order to ensure that the operations are conducted in an environmentally responsible manner.

This guideline is produced to provide guidance on the scope of environmental considerations required during the planning, implementation and abandonment stage of river sand and stone mining activities. It should be regarded as complementary to the *Handbook for Environmental Impact Assessment (EIA) in Sabah*, published by the Environmental Conservation Department.

This Guideline is intended for use by project proponents, environmental consultants and approving authorities when initiating, assessing and approving the EIA for river sand and stone mining activities in the State of Sabah.

Through use of this document it is intended that the key environmental considerations will be identified in the planning of river sand and stone mining activities. Early identification of potential environmental considerations will ensure that subsequent developments will be carried out with minimal adverse environmental impacts.

**Eric Juin**
Director
Environmental Conservation Department

## Introduction

***River sand and stone mining*** is defined as mining, excavating, extracting, quarrying or dredging of sand, gravel, rocks, boulders and other riverbed deposits from the bed, bank, or floodplain of a river, or from a river reserve. Throughout this Guideline, ***sand mining*** is used as an abbreviated form to cover all of the above activities.

The aim of this Environmental Impact Assessment (EIA) Guideline is to provide a framework for the preparation of an EIA for sand mining activities under the requirements specified in the Sabah's *Conservation of Environment Enactment 1996* and *Conservation of Environment (Prescribed Activities) Order 1999*.

The Guideline provides an easy to follow and practical means for assessing environmental impacts, recommending mitigation measures and proposing monitoring programmes for:

- Mining, excavating, extracting, quarrying or dredging of sand, gravel, rocks, boulders, and other riverbed deposits, when the activities takes place from the bed or bank of a river, from a river reserve or within a river-mouth within the State of Sabah.

Specifically excluded from this Guideline is mining, excavating, extracting, quarrying or dredging activities offshore (beyond 1.5 km of the coastline or 10 metres water depth from Lowest Astronomical Tide, whichever is further from the shore).

This Guideline should be used in conjunction with the following documents:

- *Handbook for Environmental Impact Assessment (EIA) in Sabah*, published by the Environmental Conservation Department Sabah (ECD)
- *Environmental Impact Assessment Guidelines for Mines and Quarries* – EG7/95 published by the Department of Environment Malaysia (DOE).

ECD would like to express their appreciation to the Danish Co-operation for Environment and Development (DANCED) for overseeing and assistance in preparation of these Guidelines through ECD's Capacity Building Project. Appreciation is also extended to all government agencies, organisations and individuals for their contribution and support in the formulation of these Guidelines.

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Picture

# 1 Sabah Context

## 1.1 Overview

The total number of land applications approved by Lands and Survey Department for the purpose of river sand and stone mining up to January 2000 is 458. The known number of current sand mining activities in operation is 54, with production capacity ranging from small individual operators of less than 10,000 MT/year to large company operators of more than 50,000 MT/year. The total number of known rivers currently affected is 14 with a high number of operations concentrated along Sg. Tuaran (14 locations), Sg. Papar (11 locations) and Sg. Kadamaian (9 locations).

The total length of rivers affected by the project is estimated at 808 kilometres, covering a total catchment area of 16,800 square kilometres. Based on a conservative estimate, approximately 2.0 million MT of sand, gravel, rocks, boulders and other riverbed deposits are extracted annually from rivers in Sabah. This figure excludes amounts extracted from sand dredging offshore. For comparison, there are approximately 86 known operational land-based quarries in Sabah with a capacity ranging from 50,000 MT/year for small quarry operators, up to 2.0 million MT/year for large company operators.

Sand mining in the State of Sabah is carried out mainly for two purposes, namely:

- Construction requirements – road construction, building materials, etc. Sand from rivers is a important commercially and economically available raw material for building construction in Sabah
- River engineering requirements – flood control, maintaining water supply intake points, etc.

River sand is widely used in the building industry as finishing material. The use of this sand is widespread due to its small/fine size, thus producing smoother texture on the concrete surface. Marine sand is not widely used due to several reasons, namely expensive to extract and clean; quality not meeting JKR requirements where size is normally large/coarse; and problems associated with steel bars corrosion due to the salt contents. In addition, there are also environmental impacts associated with marine sand extraction.

In some areas of Sabah, there is no supply of land-based rock aggregates or if available, the stone quality often does not meet JKR requirements for road or building construction, and river stone is therefore used. These places include Ranau, Telupid and Keningau. The transportation costs to move rocks from other land-based quarries to these areas makes such options less economical attractive.

## 1.2 Typical Project Activities

Typical sand mining operations may involve two main activities, namely; (i) mining from or along the river, and (ii) processing at the project site.

- Mining site –where the actual operation of mining, excavating, quarrying or dredging of sand, gravel, rocks, boulders and other river deposits is taking place. The point of extraction is often mobile, moving upstream and downstream depending upon supply
- Processing site – usually situated on the riverbank where processing of deposits takes place, which may include washing, crushing, screening and stockpiling. The project area is fixed and normally located nearby the mining area.

**Examples of River Sand and Stone Mining in Sabah**

- Rock extraction at Telupid along Sg. Labuk is mainly for road construction
- Sand mining along Sg. Papar is carried out by a private contractor on behalf of Jabatan Air, Sabah to maintain the potable water supply intake point at Kg. Kabang
- Boulders and sand extraction at Tambunan is carried out by a private contractor on behalf of the Drainage and Irrigation Department to minimise the problem of flooding along Sg. Pegalan.

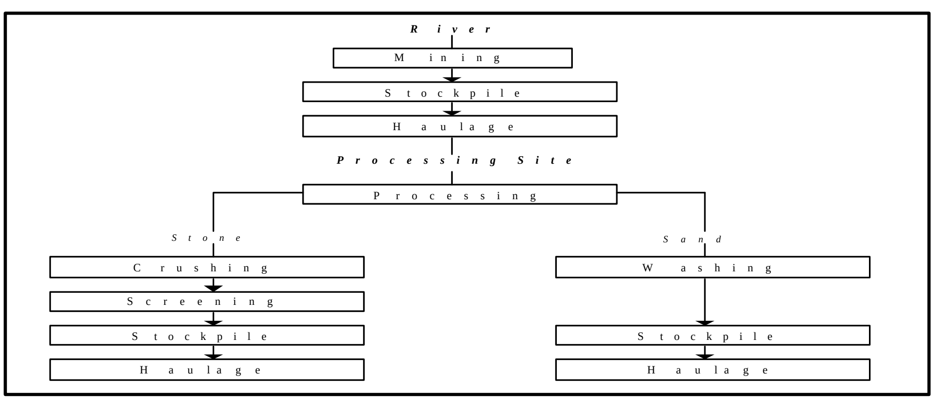



*Figure 1.1: Flow Diagram of Typical Sand Mining Activities*

Current mining methods in Sabah include:

- Mechanical – normally involves the use of construction machinery such as excavator, backhoe, bulldozer, etc. This method is commonly used throughout Sabah in shallow rivers and for larger size deposits

- Hydraulic dredging – specially built equipment to dredge sand, either by excavation, dragging or suction. Normally used for large-scale and complex operations

- Manual – use of manpower with hand shovel, scoop, etc. Normally used for small-scale operations or in conjunction with the mechanical method.

Sand mining by suction method

Sand dredging at river mouth

Stone mining with excavator

*Table 1.1 Known Sand & Gravel Mining Operations in Sabah [as of Jan 2000]*

| District | River |
|---|---|
| Papar | • Sg Papar |
| Beaufort | • Sg Padas, Sg Kimanis |
| Tuaran | • Sg Tuaran, Sg Damit |
| Lahad Datu | • Sg Lamag Kecil |
| Tambunan | • Sg Pegalan |
| Kota Marudu | • Sg Bandau, Sg Talantang |
| Telupid | • Sg Labuk |
| Kota Belud | • Sg Kedamaian |
| Sipitang | • Sg Lakutan |
| Tawau | • Sg Apas, Sg Membalua |

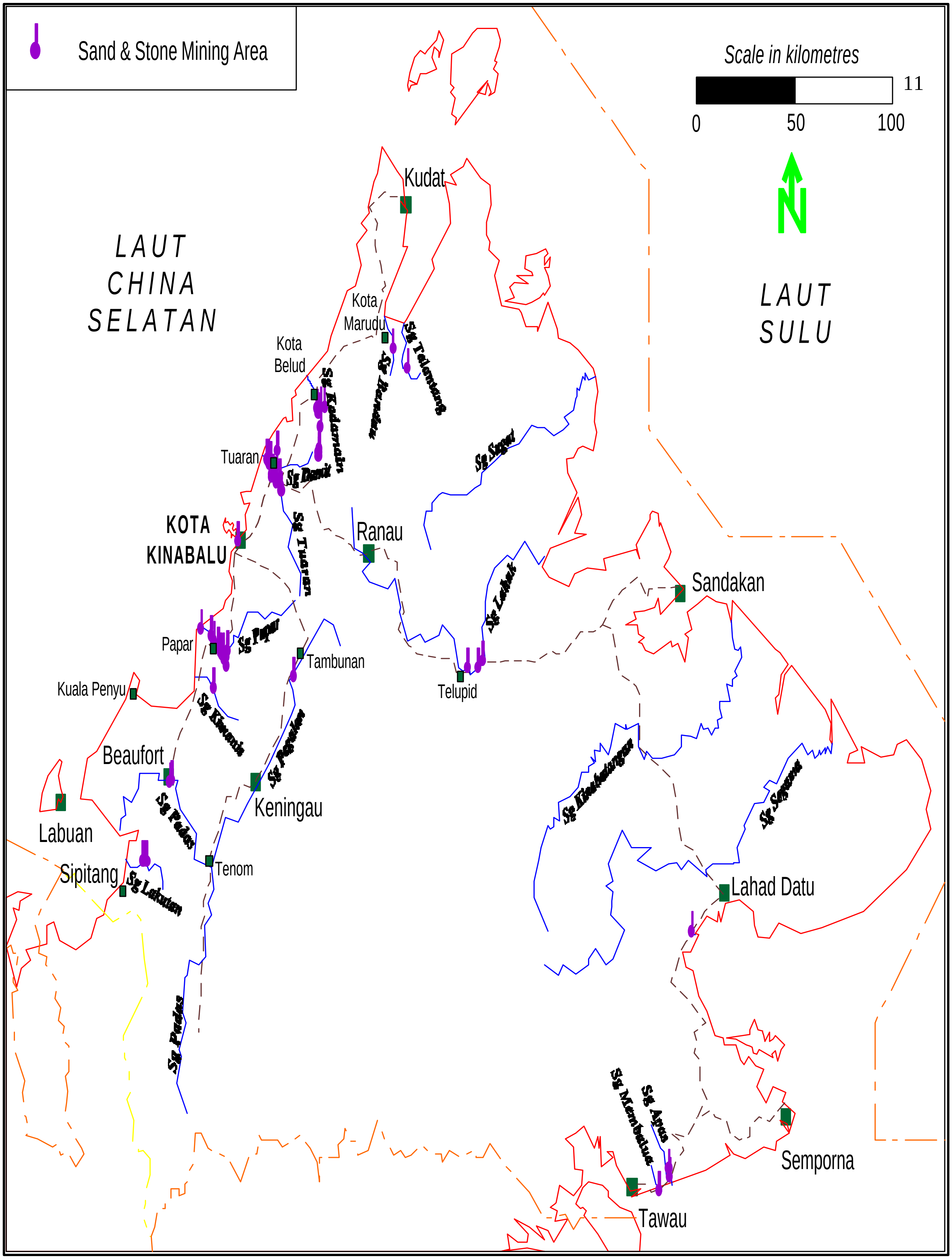



Figure 1.2. Overview of river sand and stone mining in Sabah

## 1.3 Legal Requirements

Effective September 1999, Environmental Impact Assessment (EIA) is a mandatory requirement for sand mining activities in Sabah under the *Conservation of Environment Enactment 1996* and the *Conservation of Environment (Prescribed Activities) Order 1999*. Sand mining is a Prescribed Activity, which requires an EIA approval prior to project commencement. It falls under the following category:

*Section 4: Activities, which may pollute inland water or affect sources of water supply. Paragraph (vi): diversion of watercourses, streams or rivers or the excavation of sand and other rock materials therefrom.*

Failure to observe this directive, the authority, body or person in default shall be guilty of an offence and shall, on conviction, be liable to a term of imprisonment for 5 (five) years and a fine of RM50,000.00 (Malaysian Ringgit fifty thousand only).

## 1.4 Approving Authorities, Administration and Licensing

Any person who intends to undertake sand mining activities in the State of Sabah shall submit to the Director of the Environmental Conservation Department (ECD) an ***EIA Report*** for approval. The Department contact is:

The Director
Environmental Conservation Department
Tingkat 2 & 3, Wisma Budaya
88000 Kota Kinabalu, Sabah

Attention: Environmental Assessment Section
Tel: 088-251290/1
Fax: 088-238120
E-mail: jkas@sabah.gov.my
Homepage: *www. sabah. gov.my/jkas*

Approval is also required from the following authorities:

- Lands and Survey Department (LSD), Sabah - ***Licence*** to remove stone, earth and sand from State land and alienated land from the Assistant Collector of Land Revenue (A.C.L.R.) under Section 23 of Land Ordinance 1930 and Land Rule 3(2)
- Drainage and Irrigation Department (DID), Sabah – ***Written Approval*** for the removal of material from a river or river reserve from the Director of DID under Section 41 of Water Resources Enactment 1998.

Effective September 1999, applications for river sand and stone mining activities in the State of Sabah are subject to the requirements of an EIA. This is in addition to the mining licence issued by the Lands and Survey Department (LSD) and written approval to remove material from a river by the Department of Irrigation and Drainage (DID).

The sand mining licence application procedures are shown in Figure 1.2 and summarised below:

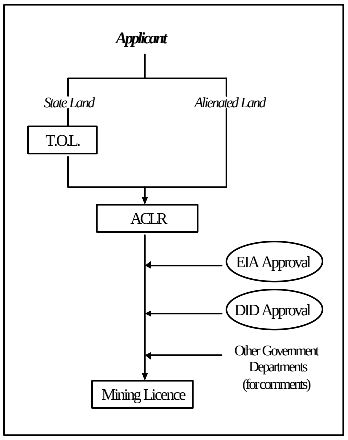



*Figure 1.3: Application Procedures for Sand Mining in Sabah*

- Application shall be made in writing to the LSD for a licence to remove stone, earth and sand from State land or alienated land through the Assistant Collector of Land Revenue (A.C.L.R.) in accordance to Section 23 of Land Ordinance and Land Rule 3(2). For sand mining within State land, a Temporary Occupation Licence (T.O.L.) is required and is to be submitted with the mining application. For sand mining on alienated land, certified copy of land title(s) or letter of consent from land owner is required and to be submitted with the mining application
- The A.C.L.R. shall refer the application to the relevant Departments for technical comments and acceptance, which include EIA Approval for sand mining from ECD (under Section 4 of *Conservation of Environment Enactment*) and Written Approval for removal of material from a river from DID (under Section 41 of *Water Resources Enactment*)
- The A.C.L.R. may issue the mining licence upon acceptance and payment of deposit or enhanced rent.

### 1.5 Key Stakeholders

Key stakeholders in sand mining activities in Sabah include:

- *Department of Irrigation and Drainage (DID)* – to issue written approval to remove deposit from river; and needs sand mining for flood control along rivers and for maintaining irrigation water intake points
- *Engineering contractors* – buying sand and aggregates for road and building construction
- *Environmental Conservation Department (ECD)* – to approve EIA to operate sand mining activity within the State
- *Jabatan Air* (Water Department) – requires sand mining to maintain potable water supply at intake points
- *Land & Surveys Department* (LSD) – to issue a licence to operate sand mining activity on State or alienated land
- *Sabah Quarry Association* – the association for rock quarry operators, with limited membership of sand mining operators
- *River sand and stone mining operators* – to carry out sand mining; and to supply sand and aggregates, either as a company or private individual.

Picture

*Stone Mining: Mining and processing site*

*Sand Mining. Mining and processing site*

Picture

# 2 Environmental Impacts

| Steps | Activities | Issues |
|---|---|---|
| Step 1 | Assessment of impacts | Key environmental impacts include:<br>• Channel erosion<br>• Water quality<br>• Ecological impacts |
| Step 2 | Mitigation measures | |
| Step 3 | Monitoring | |

The purpose of this chapter is to outline procedures that can help identify the environmental impacts associated with river sand and stone mining activities. Methodologies are suggested for evaluating the scale and extent of the impact.

Many of the environmental impacts and criteria associated with river sand and stone mining are not easy to quantify. However, an overall assessment should be based upon whether or not it is thought that the river is able to withstand the activity and still maintain its geomorphic and ecological characteristics. Such a decision must also be based on the assessment of the cumulative impact of the activity, i.e. how many other sand mining activities are already taking place within the drainage system under examination. An integrated consideration of a river's sensitivity to change will help resource management decisions be more compatible with the protection of the environment i.e. that the activity does not jeopardise the sustainability of other appropriate river users and values.

## 2.1 The River System

Moving water and sediment alter the landscape. The actions of streams with alternate periods of erosion and deposition, results in the development of the ever-changing river landscape. From the source of the river to the mouth of the river, the river channel subtly changes form and size. Typically the river channel slope declines and in many cases meanders develop in the lower reaches. Hydraulic factors such as depth, slope and velocity of flow directly produce bank erosion and sediment transport. These factors determine the cross sectional shape, frequency and occurrence of in-channel deposits and meander pattern of river channels.

Flow within a river channel is typically unsteady and turbulent. Under conditions of equilibrium, channels tend to be morphologically stable, transporting the water and sediment load imposed from the catchment upstream without enlarging or aggrading. However, it is important to understand that a channel, which is described as stable, will still naturally erode its bed and banks. If the amount and type of sediment transported is changed, then further alterations will occur as a direct result.

River channels are systems that transport, modify and deposit materials. Water enters the channel by rainfall, by inflow from tributaries and by seepage from the banks. Runoff brings with it dissolved and solid materials. Additional debris is eroded from the stream bank and bed. These sediments are carried down the channel towards the sea and on the way they are occasionally deposited and stored.

The quantity of sediment varies considerably from time to time due to changes in discharge. As velocity increases, the amount of sediments being transported increases correspondingly. Changes in sediment concentration vary from one storm to another. During periods of low flow, relatively little sediment movement takes place, as a consequence river channels tend to be stable in these phases. Conversely, as the flow increases, more and more sediment is entrained from the floor and stream banks. Loose material on the bed is picked up largely because of the fluid drag exerted by the flowing water. Materials from the stream bank are eroded mainly by the action of bank caving as the waters in a channel may undermine the bank and cause collapse.

Much of the material, which is carried during periods of high discharge, is therefore old material reworked from the bed or banks. Most of it moves intermittently often with long periods of storage as channel deposits/bars or on the floodplain, interrupted by short periods of transport.

A river carries a range of material. Pebbles and sand move along the bed as bed load, silts and clays in suspension (suspended load) and material in solution (dissolved load). The absolute quantities and the relative proportions of these components vary from one stream to another and from one time to another. The coarser particles move only when the discharge is very high and many of the larger boulders entering the channel may be too big to be moved by all but the greatest floods and may accumulate to form channel deposits. Finer silts and clays may be in almost perpetual motion while dissolved material, such as fertilisers and other soluble compounds are constantly being carried downstream.

There are two important implications of this selective transport phenomenon. The first is that material is actively sorted by size during transport; the second is that different components of the stream sediment are in equilibrium with different flow conditions.

The intermittent movement and deposition of sediments within the stream channel is associated with the development of a variety of sedimentary structures and bed forms. Many of these are dependent upon the complex interplay between stream velocity and particle size so that as the discharge increases during a storm the character of the bed forms may change. The bed forms like other features of the channel adjust to equilibrium with prevailing flow conditions.

The importance of extreme events in shaping a river channel and providing sediments cannot be underestimated. Extreme events may scour out new channels, infill old ones and cause extensive erosion of the banks.

Increases or decreases in the supply of sediment to channels influence all the characteristics of the stream - its width, depth, velocity, turbulence and profile. Under extreme conditions the input of new sediment may convert a meandering channel to a braided form.

Not all the effects of human interference with stream channels and drainage basins are as dramatic. Often the consequences are subtle. Nevertheless, man's use of the drainage basin almost invariably has impact on the stream system, and frequently the impacts eventually feed back to affect man himself. There is therefore a need to manage them not in a piecemeal fashion but as integrated parts of the whole drainage basin.

Figure 2.1 Channel morphology and typology (as per 9.8)

Figure 2.2 Channel morphology and typology (as per figure 9.10 and 9.11)

## 2.2 Impacts Assessment based on site characteristics

Environmental assessment for sand mining activities depends on several factors, namely the size of the operation, the complexity of mining methods, and locality. Project size, complexity and sensitivity are defined below in Table 2.1:

*Table 2.1. Project size, complexity and sensitivity*

| Size | Capacity |
|---|---|
| Small | 1,000 MT/month or less |
| Medium | 1,000 to 5,000 MT/month |
| Large | More than 5,000 MT/month |
| **Complexity** | **Activity** |
| Simple | Manual method; mechanical method |
| Complex | Use of hydraulic dredger; use of dragline; use of suction equipment |
| **Sensitivity** | **Activity** |
| Normal | Anything not listed as 'sensitive' |
| Sensitive | River mouth; gazetted conservation areas; high risks channel erosion sites; localities within 500 m of water supply intake point |

## 2.3 Major Environmental Impacts

The major adverse environmental impacts of sand mining activity are:

- **Channel erosion** due to the hydrologic changes caused by channel deepening
- **Water quality** contamination from suspended solids and oily discharges
- **Ecological** impacts.

Other adverse environmental impacts of sand mining activity include:

- Loss of river section used for fishing, leisure, eco-tourism or navigation
- Objectionable noise levels from mining and transportation activities
- Dust and atmospheric pollutants from machinery and transport vehicles
- Increase in traffic density from transportation activities.

The three key environmental components that are normally affected are described below along with suggested assessment methodologies. The classification of impacts is based on an integrated environmental assessment of each environmental issue (see Annex C).

### 2.3.1 Channel Erosion

Sand mining within or adjacent to a river channel can initiate channel erosion and degradation. If in-stream mining alters channel geometry enough to create local inflection of stream gradient or if point bar mining increases the river channel gradient enough to increase water velocity above and at the mined sites, then local channel scouring and erosion may result. Although it is recognised that erosion is a natural processes, it is generally accepted that mining and dredging exacerbates the problem. The processes most commonly associated with channel degradation are:

**Large-scale removal of river sediment**

In the case of the large scale removal of river sediment, the river may be left with excess energy and two scenarios, may develop: (i) If the river banks are well protected by vegetation or engineering works, the excess energy may erode and deepen the river bed, and (ii) if the channel sides are not protected by vegetation the banks will erode, leading to bank collapse and the possible loss of valuable land and property. This may also lead to downstream sedimentation problems.

**Digging below existing riverbed**

If river sand and stone mining results in digging below the existing riverbed level or the creation of hollows in the river bed, then local erosion can occur both upstream and downstream of the excavation site. The hollows provide a site for the downstream movement and accumulation of bed load, which leads to the development of a steeper slope at the head of the hole. The steeper slope allows water to flow faster, which causes continued erosion on the upstream side and along the steeper slope.

**Alteration of channel bed form and shape**

Alteration of the channel bed form and shape may also cause the local deflection of the river channel, again increasing the risk of local erosion.

*Table 2.2 Summary of the key physical impacts associated with sand mining activities*

| Possible cause | Impact | Typical effects |
|---|---|---|
| (i) Large-scale extraction of river material, (ii) mining/dredging below the existing river bed, (iii) alteration of channel bed form and shape | Erosion of channel bed and banks, increase in channel slope and change in channel morphology | Undercutting and collapse of riverbanks, and loss of land and/or structures, upstream erosion as a result of increase in channel slope and changes in flow velocity, downstream erosion due to increased carrying capacity of the stream, downstream changes in patterns of deposition and change in channel bed/habitat type |

*Channel erosion along Sg papar*

## Assessment Method for Channel Erosion

### Site Assessment

For all mining activities it is important to assess and identify sites that may be exposed to risk as a result of the intended activity alongside an assessment of the level of risk. The methodology involves the assessment of risk by means of:

- Estimate the maximum annual volumes per section of stream that could be extracted without causing detrimental effects. This is difficult to estimate due to the lack of suitable measuring techniques for measuring replacement rates. However, an estimate of the existing volume of material at the site can be made using area/volume estimates. Due to these measurement constraints, the replacement estimate should be conservative
- Description of deposits to be mined (the larger the deposit size, the slower the replacement rate) and intended locality of mining.

- Plot the longitudinal profile of the river at project site including 500 m upstream and downstream sections. If a topographic map was used then the profile could be derived from the contours. However, if air photos alone were used, then the channel slope should be surveyed (Figure 2.3)
- Describe the steepness of the river banks including 500 m upstream and downstream sections
- On a 1:50,000 scale map, locate other active sand and stone mining activities along the entire river system.

Figure 2.3 Longitudinal profile

- Mapping and classifying (Figure 2.4) the river channel at the project site and minimum 500 m upstream and downstream areas. This river base map will subsequently be used for additional maps/overlays. Given the dynamic nature of river channels, the base map should be produced from the most recent air photographs available. Alternatively the site should be surveyed. However, if a recent topographic map of sufficiently large scale exists (1:12,500 or larger) then this may be used. The base map should furthermore include a habitat classification of the areas surrounding the river system (Figure 2.5)
- Overlay on the base map settlements, houses, bridges, structures, river reserve (20 meter each side of the river), navigation areas, recreation areas, fishing areas, burial reserves and other important land area. The layer must cover all structures within or nearby the river reserve, 20 metres either side of the river bank, minimum from 500 m upstream to 500 m downstream of the borders of the project site (Figure 2.6)
- Overlay on the base map the main geomorphological features of the channel and flood plain minimum form 500 m upstream to 500 m downstream of the borders of the project site. This should include sites of active erosion, sites of active deposition within the channel and on the floodplain. Identify and map the location of channel deposits. The size of channel deposits should be described, i.e. silt, sand, gravel, cobble, boulder (Figure 2.4)
- Overlay finally on the base map the assessed risk areas for channel erosion, specifying low, medium and high-risk areas. As no exact quantifiable erosion criteria exist, the impact expressed must the based on a 'best possible' assessment of the all the above informations gathered (extraction rates, geomorphological condition of the channel and banks, structure locations, etc.).

**Example**

'As the intended location of the project is upstream and nearby an actively eroding bank of a meander, nearby an important feeder channel for a rice irrigation scheme, it is suggested that operations are confined to section x of the intended project site or an alternative site be sort.'

Computer modelling do offer opportunities to examine the effect of sand mining on physical processes, but it should be recognised that, if reliable results are to be obtained, data requirements are high and the possible cost implications of such a modelling exercise should not be overlooked. For the use of computer modelling see Annex D.

Figure 2.4 Base Map

Figure 2.5 Structure overlayer

Figure 2.6 Geomorphological overlayer

### 2.3.2 Water Quality

The ways in which sand mining activities might impact upon the rivers water quality include increased short-term turbidity at the mining site from re-suspension of sediment, sedimentation due to stockpiling and dumping of excess mining materials and organic particulate matter and oil spills or leakage from excavation machinery and transportation vehicles. Table 2.3 summarizes the surface water quality issues that might result from sand mining activities.

Increased suspended sediment as a result of increased riverbed and bank erosion or from the disturbance of fine grained sediments as a direct result of mining and dredging, increases suspended solids in the water at the site and downstream. Suspended solids may adversely affect water users and the aquatic ecosystem. The impact is particularly significant if water users downstream of the site are abstracting water for drinking/domestic use. Suspended solids can also significantly increase water treatment costs.

Chemical contamination can arise from chemicals brought on to the site such as fuel oil. Oil spills and leakage from excavation machinery and transportation vehicles may pollute the environment.

*High turbidity at mining site*

*Wastewater from processing site*

*Table 2.3 Examples of the impact of sand mining activity on water quality*

| Activity | Impact | Typical effects |
|---|---|---|
| Mining/dredging | Re-suspension of sediments and/or release of contaminants into water column | Reduced water quality for downstream users and increased costs for down stream water treatment plants |
| Poorly planned stockpiling and uncontrolled dumping of overburden | Point source sediment pollution and slumping of material into river | Reduced water quality for downstream users, increased costs for down stream water treatment plants, slumping of material into river may deflect flow and initiate local scouring and erosion and loss of land covered by slump |
| Chemical/fuel spills | Contamination of run-off and water supply | Poisoning of aquatic life, reduced water quality for downstream users and increased costs for down stream water treatment plants |

Assessment Method for Water Quality

The assessment methodology should emphasise the assessment of site and catchment characteristics. However, water sampling and analysis may be required for selected projects.

**Site assessment**
For small or medium and simple mining activity in an area of normal sensitivity, it may be sufficient to assess the impact of deteriorated water quality by identifying the number and type of water users downstream of the site. The information presented for the channel erosion site assessment may also be used to provide information as to whether or not water users downstream are at risk. However, the area of assessment should be extended at least 5 kilometres downstream from the project site. The latter information may be presented on a 1:50,000 or 1:25,000 scale topographic map. The maps should show the location of water abstraction points, water catchments, fish breeding areas and other potential users/sites that may be affected by the decreased water quality.

The map should outline the areas that might be impacted during for example low, medium and high velocity, thereby also indicating high-risk periods (heavy rain, breeding periods, low tide, etc.). The assessment shall be weighed against the expected extraction rates.

The amount of runoff and discharge from the processing site should be assessed. The location of the proposed processing site and the waste dump, runoff and discharge site should be clearly identified and mapped.

**Water quality assessment**
Water sampling to assess water quality issues may be taken for two reasons:

- If operations have already started, water samples might be taken at the time of operation. One sample should then be taken 500 m upstream and two downstream of the operation site, 100 m and 500 m respectively, in order to assess the impact of the operation
- Sampling of the existing water quality may be used to assess and characterize the condition of the catchment. If the intended project site is within, or wholly constitutes a pristine catchment, this alone may warrant a reconsideration of the project location. Sampling sites as above.

Water samples are to be collected and analysed as follows:

- Samples to be collected from a representative depth and section of the river i.e. using an integrated depth sampler (USDH 48), or collection of the sample at approximately 0.6 the depth of the river
- Sampling location should be marked on the base map and a photograph provided of sample collection
- Sampling can be limited to daylight hours
- Samples to be analysed for Total Suspended Solids concentrations (mg/l) by an accredited laboratory. If the suspended solids concentration is determined in house, the method and materials should be described.

### 2.3.3 Ecological Impacts

The running water aquatic ecosystem performs a vital ecological role in maintaining aquatic habitats. River sand and stone mining can severely impact the total ecology of a stream from the base of the food chain - aquatic plants - through to the benthic communities and higher order fish and mammals. Mining and dredging of the river channel can directly destroy in-stream and river reserve habitats for a broad range of species as well as indirectly impair the functioning of the aquatic ecosystem in the affected nearby areas.

Aside from the direct loss of habitat, increased stream turbidity as a result of the mining activity may temporarily reduce light penetration within the river. Since most mining activity takes place during the day this will directly impact rates of photosynthesis and therefore primary production rates. Increased sediment loads can also cause problems with fish spawning as deposited silts provide unfavourable conditions for adhesive eggs, causing an out migration of fish, crustaceans and invertebrates from affected areas. Studies of North American fish assemblages show that the impacts are more significant on a shallow river and fast flowing habitats. However, this impact would have to be assessed alongside ambient conditions. If the river system already suffers from high-suspended sediment loads, this should be reported and the potential additional impact from mining assessed accordingly.

In-stream habitats also provide for a diverse set of environments. Pools, riffles (faster flowing stream sections) and bars are composed of different bed materials, which provide different environments for a variety of benthic organisms. In general benthic invertebrates decrease in number as the bottom sediment become smaller, as the larger substrate provides insects with a firm surface to hold on to as well as protection from the force of the current.

However, in general, if the site is mined within acceptable limits, there is evidence that disrupted sites are resilient and maintain a high potential to recover. A case study in Tampa Bay Florida (Conner/Simon, 1979) quantitatively sampled two dredged areas and one control area, before dredging and one year after dredging. The immediate effects of dredging on the soft bottom community were reductions in numbers of species (40 % loss), densities of macroinfauna (65 %) and total biomass of invertebrates (90 %). A re-survey of the site 6-12 months later showed no difference between the dredged and control areas in number of species, densities or biomass (except of one area). Although it may be dangerous to extrapolate these results, it is clear that once the disturbance stops, re-colonisation by benthic organisms does take place.

In terms of ecological importance, the river reserve also supports a wide range of sensitive and threatened habitat types, why impacts caused by developing access routes to the mining sites should also be assessed.

*Table 2.4 Examples of the impact of sand mining activity on natural habitats*

| Possible cause | Impact | Typical effects |
|---|---|---|
| Mining and site preparation | Removal of channel substrate, re-suspension of stream bed sediment and clearance of vegetation for processing, stockpiling and access sites | Direct loss of river reserve habitat, disturbance of species attached to riverbed deposits, reduced light penetration, reduced primary production, smothered aquatic habitats, reduce feeding time for filter-feeding organism and reduced feeding opportunities |

**Inventory - habitat map**

Surveys of the aquatic environment need only be carried out if the site is located upstream or nearby know fish breeding grounds or other ecologically sensitive areas. Specialist advice and assistance may be required to conduct such a survey but the essential elements should be spatially based and include:

- A series of stream bed samples for benthic organisms
- A quantitative measure of fish populations
- A measure of fish diversity at the site
- An assessment of the importance of the site in terms of breeding
- An assessment of the trophic links and structure.

River reserve habitats are often important sites for a broad range of plants and animal species. The site importance is related to the diverse range of habitats, access to water and the rich feeding grounds found alongside the waters edge and flood plain. However, an assessment of the ecological significance of a locality requires a site inventory that will provide answers to two questions: (i) what communities of fauna and flora occur at or nearby the project site, and (ii) where do they occur and in what numbers?

For river reserve and terrestrial sites a useful inventory for management purposes can be as simple as a habitat map. The map can be based on aerial photography interpretation with ground checks, augmented by known or existing information on the distribution of important species. It is almost impossible to measure the populations of many small plants and invertebrates, but if it is known that they are associated with a particular habitat type, then mapping that habitat may prove sufficient (see Figure 2.4 in section 2.3.1).

The habitat map may also be produced by site surveys alone, using the location base map and by sketching in habitat types. If it is know that the locality is either a permanent or temporary home (migratory) for endangered species then data should be collected on these species. The presence of endangered species may be difficult to assess from a limited number of visits, particularly if the species is migratory, therefore discussions with specialist groups i.e. Sabah Parks, Wildlife Department, World Wide Fund for Nature, Malaysia, may provide additional insight.

Ecologically dominant forms, endangered species or species whose numbers reflect important ecological processes should be recorded. Even crude indications of the numbers of these species will add to the value of the inventory. Highly precise numbers are seldom important except when populations are to be managed intensively.

The overall assessment should be based on for example (i) habitat type in accordance to State, national and regional significance, and (ii) socio-economic significance i.e. impact on local fish breeding grounds, access to fishing sites, eco-tourism, (iii) the scale of mining operation and the location and scale of the processing site and the impact of these on the natural habitats, and (iv) legally protected or endemic species.

## 2.4 Additional Impacts

### 2.4.1 Land/Water Use

Most sand mining activities impact upon land and water use, if only in the short term. Impacts will range from a temporary change in land use associated with the project site, actual and potential use for eco-tourism purposes and potential to disrupt access or navigation along the river or river mouth. The assessment can be based on for example opinion surveys, scale of land use changes, socio-economic impacts.

### 2.4.2 Noise

The sources of noise in sand mining are mainly heavy diesel-powered plant, both mobile and semi-mobile. Noise from these sources is inherent in the machine and therefore cannot be subdued. Various items of fixed plant can also produce noise.

- *Semi-mobile plant* includes excavators, loaders, bulldozers working in the mining area
- *Mobile plant* includes dump trucks, lorries and graders
- *Fixed plant* includes rock crushers, washing plant and screening plant.

One of the major difficulties encountered in predicting noise impacts from mining activities is that the activity is often temporary and mobile rather than fixed at a permanent position. The reasons for such difficulties include; (i) mining sites are not fixed and will change according to availability of sand/stone supply along the river, (ii) much of the work is conducted outdoors without the benefits of fixed plant houses, (iii) the use of large numbers of mobile and semi-mobile plant, and (iv) mining works often only operate for a short duration.

The assessment should mainly be based on the project type, scale and timing of activities, and the location in relation to nearby high-risk areas, mainly human settlements. The noise impact can also be assessed through a comparison with the existing noise in the area, and/or a comparison with absolute levels that are judged to be satisfactory, e.g. through opinion surveys.

### 2.4.3 Air Quality

Dust is the principal cause of concern for residents living near the processing site. Operations likely to produce dust are on-site lorry movements and sand/stone handling. Dust can be generated from wind whipping of stockpiles and processing site floors. Overburden removal and the construction, maintenance and extension of bunds around the site can also cause dust. In addition, vehicles and fixed plant will produce some fumes. Processing plant such as crushers, screens, hoppers and associated conveyors can create dust.

The assessment should be based on the project type, activities and scale, and the location in relation to nearby high-risk areas, mainly human settlements. There are no nationally agreed methods of predicting the effects on the surrounding area of dust or gaseous emissions.

### 2.4.4 Traffic & Transportation

Traffic creates noise and dust as well as affecting existing traffic flows. Traffic associated with sand mining tends to be mainly large lorries, which can be very noticeable near the project area. Traffic impacts on the road capacity can be assessed by considering the changes in average traffic density. Air dust and noise impacts from traffic are discussed in sections 2.4.2 and 2.4.3, respectively.

## 2.5 Cumulative Impacts

Significant environmental impacts may not occur for a single mining operation along a particular river. However, the situation may change if several sand mining activities operational at the same time or close to each other. In such a situation, the following guides should be considered:

- Minimum distance between two or more simultaneous sand mining operation should be 1000 m river length
- No multiple operations are allowed if the river flow/velocity is more than 3.0 m/s or river depth less than 1.0 m.

## 2.6 Baseline Data Requirements

Before a potential environmental impact of a sand mining activity can be properly assessed, it is necessary to have a clear picture of the existing environment. This means collecting baseline data for both river and river reserve. As well as collating existing data, field measurements will almost certainly be required. Data to be collected depends on the Terms of Reference for the EIA study and the data requirements specified in the previous sections. Table 2.5 gives an overview of possible baseline data to be collected.

*Table 2.5 Possible baseline data*

| Environmental Characteristics | Examples of appropriate data |
|---|---|
| Hydrology | Channel characteristics (width, river depth, length, speed, water level, flow); hydrological regime (catchment area, tributaries) |
| Geomorphology | Landslips; bank type |
| Sediment | Soil type |
| Land use | Agriculture; settlement; burial ground |
| Water use | Fishing; navigation; recreation; water intake |
| Water quality | Ambient situation (TSS, Oil & Grease)<br>Sources of pollution |
| Flora and fauna | Habitat type; rarity; diversity |

Picture

Picture

# 3 Mitigation Measures

| Steps | Activities | Issues |
|---|---|---|
| Step 1 | Assessment of impacts | |
| Step 2 | Mitigation measures | Key mitigation measures include:<br>• Proper site selection<br>• Zoning of mining area<br>• Modifying operational practices<br>• Controlling runoff and discharges |
| Step 3 | Monitoring | |

The purpose of this chapter is to assist in determining possible preventive, remedial or compensatory measures for each of the adverse impacts evaluated as significant.

Mitigation will consist of a number of related actions, many of which may consist of no more than ensuring effective management and control of site operations. Mitigation measures can take many forms, including the following:

- Preventive - to be addressed during the pre-feasibility study including site selection; orientation of layout; and method of mining
- Control - to be addressed during development and operational phases and related to working practices such as limiting the mining area and landscaping
- Compensatory - whereby it is recognised that there will be an impact and that some compensation for the loss is to be made. This could include a specific contribution towards local conservation.

This chapter covers (i) identification of the major mitigation measures for the key environmental impacts and suggests implementation methodologies to be used to help minimise or eliminate the impacts, and (ii) description of other mitigation measures, including secondary rehabilitation measures.

### 3.1 Key Mitigation Measures

Key mitigation measures for sand mining activity include:

- Proper site selection
- Zoning of mining area
- Modifying sand mining operational practices
- Controlling runoff and discharge from processing site.

Other relevant mitigation measures include:

- Proper selection of access to mining area
- Control of traffic for transportation from mining area to processing site and end-users
- Systematic water spraying during dry periods to minimise air pollution
- Noise control measures.

### 3.2 Proper Site Selection

The selection of a location for sand mining depends primarily on the availability of riverbed materials and secondarily on the physical characteristics of the site. Proper planning during the feasibility study is important to ensure that the proposed site is environmentally acceptable.

Good site locations for sand mining typically satisfy the following criteria: (i) Suitable land area nearby is available for the processing and waste management needs, and (ii) construction, operation and maintenance of the activity so that it does not damage sensitive habitats and threaten protected species. This also includes land and water used by local population.

The specific requirements for proper site selection are:

*(a) Site mining area should be at a distance of more than 500 meters from:*

- High risks channel erosion area
- Sites known to be important fish breeding grounds
- Gazetted environmentally sensitive areas
- Water supply intake point for potable or irrigation water
- Burial reserves.

*(b) Extraction rate should not exceed the assessed replacement rate*

*(c) Shallow and fast flowing river sections with steep channel slopes should be avoided*

*(d) Avoid interference with human activities:*

- River is not used for navigation or recreation or fishing
- Settlement along riverbanks (within 500 m or assessed high risk areas).

*(e) Coastal sand dredging or beach sand mining is not allowed in the following areas:*

- Water depths less than Mean Low Low Water (MLLW) mark
- Within 1.5 km of coral reefs with greater than 20 % of live coral cover
- Within 1.5 km of protected areas
- Within 60 m of the Mean High High Water (MHHW) line.

The proposed sand mining site shall be checked for acceptability by maps produced during the impact assessment, maps produced by Government Departments such as LSD and DID and literature prepared by Government Departments such as ECD, DOE or DID.

## 3.3 Zoning of Mining Area

The impacts of sand mining on the stability of riverbanks and on natural habitats can be minimised by the provision of buffer zones between the mining site and surrounding area.

Based on the mapping of the location of mining operations in relation to impact areas (high risk areas) buffer zones between mining and processing areas and high-risk areas (e.g. channel erosion sites and settlements) should be provided. The following can be used as examples of zoning for sand mining activities:

- Each licensed mining area should not be more than 2.0 ha in area or 250 metres in river-length, whichever is smaller
- Mining is only allowed within designated sections of the river length.

The above example can be implemented as follows:

- Measure the length of the licensed mining area. The section should not extend beyond the maximum 250 metres length
- Use of flag and pole to mark the mining area
- Post proper signs and inform personnel of the allowable mining area.

## 3.4 Modifying Operational Practices

### Working Procedures

Some environmental impacts can be minimised through the application of appropriate work procedures. This is particularly applicable for sand mining activity, where the project siting is constrained by the availability of riverbed materials.

Mining Area

- Mining operations from one side of riverbank only
- A minimum of access points with minimum width
- No dumping or storage of mined materials along river reserve
- Temporary stockpile should be placed outside the riverine reserve (more than 20 meter's from edge of the river) or outside gazetted areas, whichever is greater
- No stockpiling of mined materials in the river
- River reserve vegetation along the river reserve should not be cleared or cut except at the designated temporary access site(s)
- Machinery and transportation vehicles entering the river should always be clean and free from oil leakage's
- Do not construct local driveway or bridge between riverbanks and mining site.

Processing Site

- Oily wastewater should not be discharged directly to the river without treatment using oil trap
- Machinery and transportation vehicles leaving the project site should always be clean and if necessarya wheel washing facility to be provided
- Overburden or excess mining materials should not be dumped within the riverine reserve (more than 20 meter's from edge of the river) or within gazetted areas, whichever is greater.

### Timing of Operations

Some environmental impacts can be minimised through the correct timing of mining operations. The mining activities should be carried out during low flow conditions to minimise impacts on channel erosion and water quality, during non-breeding periods to protect fishes and aquatic life assemblages, and during non-sensitive periods to minimise noise impact.

Avoid mining activities during the following periods:

- During or immediately after heavy rain events
- During known breeding periods (use data from Fisheries Department)
- During low tide (use data from DID)
- Nighttime between 19:00 hrs to 07:00 hrs.

### 3.5 Controlling Runoff and Discharge

The impacts on water quality can be mitigated by means of appropriate working procedures as follows:

- Construction of sedimentation ponds at the processing site to regulate runoff and trap sediments
- Preparation of drainageways (network of perimeter and feeder drains) and outlet to handle concentrated runoff
- Slope protection and turfing on exposed slopes to minimise soil erosion.

A *sedimentation pond* is a basin and barrier made either of earth, rock or concrete designed to trap and store sediment eroded from the processing and stockpiling site. The following criteria are applicable for the construction of sedimentation ponds at the processing site:

- Ponds should be properly designed to sufficiently trap and accommodate sediments transported by surface runoff
- Two ponds should be built in parallel to allow cleaning operations
- Ponds should be regularly maintained by removing the deposited material at appropriate intervals
- Sediments removed from the ponds should not be placed or disposed near waterways
- It is more effective in terms of trapping sediment to construct a series of small sedimentation ponds rather than one large pond e.g. to accommodate 100 $m^3$, 5 ponds of 20 $m^3$ in series are better than 2 ponds of 50 $m^3$
- To facilitate the settling of larger particles, the length of the pond should be eight times the width
- Ponds should not be constructed on natural waterways or streams.

The design of sedimentation pond depends on several factors, including (i) size of the operation particularly amount of water used for sand/stone washing; (ii) project locality which relates to rainfall intensity of the area; and (iii) the operational physical area. Three main important criteria for effective pond design are holding volume (sufficient size to hold wastewater and runoff); retention time (sufficient time to allow for silt deposition within pond prior to discharge); and location (appropriate location to capture all discharges from the processing area). The following guide can be used:

| Category | Production Capacity | Holding Volume | Typical Pond Size | No of Pond |
|---|---|---|---|---|
| Small | < 1,000 MT/month | 40 $m^3$ | 6 m x 2.5 m x 1.5 m | 2 |
| Medium | 1,000 – 5,000 MT/month | 40 – 200 $m^3$ | 6 m x 2.5 m x 1.5 m | 2 |
| | | | 10 m x 3.5 m x 2.0 m | 3 |
| Large | > 5,000 Mt/month | 200 $m^3$ | 10 m x 3.5 m x 2.0 m | 3 |

The best location to place sedimentation pond is on relatively flat area and at the inside boundary of processing area, before entering public river or stream.

The following are applicable for provisions of *drainage* at the processing site:

- Perimeter and feeder drains should be designed to sufficiently accommodate peak surface runoff
- If necessary, enlarge or deepen existing drains or streams to accommodate the additional peak runoff and to avoid stream overflow and flooding
- Select and install lining materials for drainageways that are appropriate to prevent surface drain erosion
- Drainageways should be regularly maintained by removing the deposited silts, at appropriate intervals
- Design drainageways based on local topography of the processing site.

The following are applicable for provisions of *drainage* at the processing site:

*Table 3.1. Indicative rates for selected drainage works in Sabah*

| Control Measures | Unit | Rates (RM) |
|---|---|---|
| Roadside concrete drain | m | 60.00 to 85.00 |
| Unpaved drain | m | 7.50 to 22.50 |
| Culvert | m | 375.00 to 825.00 |
| Sediment trap with gabions | $m^3$ | 600.00 to 800.00 |
| Geotextile layer | $m^2$ | 15.00 to 22.50 |

## 3.6 Additional Mitigation Measures

### 3.6.1 Site Access

To minimise impacts on river reserve, access to the mining site should be limited to one access only. The access should be selected based on minimal environmental impacts, namely areas with minimum vegetation or habitat and gentle slope. Upon completion of mining activity, the access should be rehabilitated before opening a new entry point. The access should be restored to near original conditions and area replanted with vegetation.

### 3.6.2 Traffic & Transportation

Mitigation measures for traffic should include an assurance that heavy traffic takes the most environmentally suitable route to and from the project site. On-site parking can be provided to avoid public parking of vehicles overnight. The hours during which traffic enters and leaves the site can be carefully controlled.

### 3.6.3 Air Quality

Mitigating measures to control air pollution include:

- *Design control*: Dust suppression system to wet crushed stone surface and covered conveyor

- *Dust Control*: Systematic water spraying along haul roads, processing site floors and stockpile area. For normal days, water spraying frequency of 2 to 4 times a day and for windy/dry days, frequency of more than 6 times a day
- *Transportation control*: Haul roads should be kept smooth, well graded and cleaned. Avoid overloading and transported materials to be sheeted. Wheel washing facilities to be provided at the entrance.

#### 3.6.4 Noise

There are several mitigating measures that can be used to reduce noise:

- *Operating hours*: Consideration should be given to controlling the times of mining and processing operations. Activities shall be planned accordingly to take into account noise tolerance (i) at night time (resting and sleeping period), (ii) at day time (schooling period)
- *Notification*: Awareness is an important factor in reducing noise-related annoyance. It leads to preparedness and tolerance. Residents surrounding the mining and processing sites should be notified in advance of the operational activities
- *Design control*: Noisy fixed plant should be located away from noise-sensitive boundaries, as should haul routes. Baffle mounds or fencing can be used to screen noisy operations. Haul roads to be kept as smooth and well graded as possible
- *Transportation control*: Haul roads to be kept as smooth and well graded as possible. Transportation vehicles shall maintain appropriate travelling speeds along the haul roads and should avoid the running of engines for long periods of time when in a stationery position at the project site.

### 3.7 Secondary Rehabilitation Measures

When it is not possible to directly mitigate the environmental impact, secondary rehabilitation measures can be employed. Possible rehabilitation measures for sand mining activities could include, for example, a local road improvement scheme or riverbank improvements.

**Road improvements.** Transportation between the mining area and project site normally make use of local or village roads. Use of heavy vehicles and high frequency might result in structural damage and increased maintenance costs. Rehabilitation measures could include:

- Damage to sealed roads should be immediately repaired. Road resurfacing should be carried out at a frequency of once per year minimum
- Local gravel roads should be graded and re-gravelled (minimum once in three months)
- Local earth roads should be graded and gravelled before use and maintained thereafter as for gravel roads.

Approval is required for the construction and maintenance of public road either from Jabatan Kerja Raya or Municipal Council / District Council.

*Table 3.2. Indicative rates for selected civil works in Sabah*

| Control Measures | Unit | Rates (RM) |
|---|---|---|
| Crushed aggregate roadbase | $m^3$ | 50.-100.00 |
| Supply, lay and compact double bituminous surface dressing | $m^3$ | 15.00 to 30.00 |
| Riverbank walling (0.1 m diameter bakau piles of 6 m depth) | m/run | 350-400.00 |

**Improvement of riverbanks.** Channel erosion often occurs on riverbanks with no or minimum vegetation cover. Secondary rehabilitation measures could include:

- Plant trees along the riverbanks with no or minimal vegetation, irrespective of signs of erosion or not. However, careful selection of species is required to e nsure that trees are suitable for banks improvement as well as not interfering with the existing species. Species of trees include *Nephrolepis sp*. for steep riverbanks and *Centrosema pubescen*, *Veviter hedgegrow*, *Acacia mangium* and *cow grass* for other areas
- Construction of artificial walls such as sheet piling or gabion to protect riverbanks on riverbanks with vegetation and with signs of erosion. Approval from DID is required for the design and construction of this engineering works.

*Table 3.3. Indicative rates for selected revegetation control measures in Sabah.*

| Control Measures | Unit | Rates (RM) |
|---|---|---|
| Planting of vetiver grass | $m^2$ | 22.50 to 27.00 |
| Close turfing (cow grass) | $m^2$ | 2.50 to 4.30 |
| Spot turfing | $m^2$ | 1.20 to 2.00 |
| Planting legumes seeds (manually) | $m^2$ | 4.50 to 6.00 |
| Planting legumes seeds (hydroseeding) | $m^2$ | 3.30 to 3.80 |
| Acacia mangium, 3’ high | No | 100.00 |
| Honolulu creepers | No | 800.00 |

Picture

Picture

# 4 Monitoring

| Steps | Activities | Issues |
|---|---|---|
| Step 1 | Assessment of impacts | |
| Step 2 | Mitigation measures | |
| Step 3 | Monitoring | Environmental monitoring includes:<br>• Compliance monitoring<br>• Impact monitoring. |

This chapter includes the following:

- Monitoring requirements to ensure compliance of the recommended mitigation measures
- Procedures for monitoring residual environmental impacts.

## 4.1 Compliance monitoring

The project proponent should provide the following information. The frequency of monitoring and reporting will be laid down in the Agreement of Environmental Conditions.

### 4.1.1 Proper site selection and zoning of mining area

The project proponent should submit to ECD a site location map showing the areas of the river that has been mining during the previous period. The site map should be accompanied with photographs of the mining site and photographs of the river areas adjacent to the allowable mining area. The allowable mining area should be re-mapped every two years.

The project proponent should furthermore submit photographs of the placement of flagpoles and signs indicating zone of allowable mining area.

### 4.1.2 Modifying operational practices

The project proponent should provide the following for the previous mining period:

- Layout map of the actual processing site
- Actual mining schedule used indicating area, period and timing of operations
- Volume and type of material extracted during the period
- Map identifying actual sites mined.

**Example of mining schedule**

'For April 2000, stone mining was carried out twice - (i) *Period:* between 3 to 5 April; *Locality:* Kampong X, 0.7 km upstream of the processing site; *Quantity:* 550 MT; *Method:* Excavator; (ii) *Period:* 16 April; *Locality:* Kampong Y, 0.3 km downstream of the processing site; *Quantity:* 200 MT; *Method:* Excavator.'

### 4.1.3 Controlling runoff and discharge

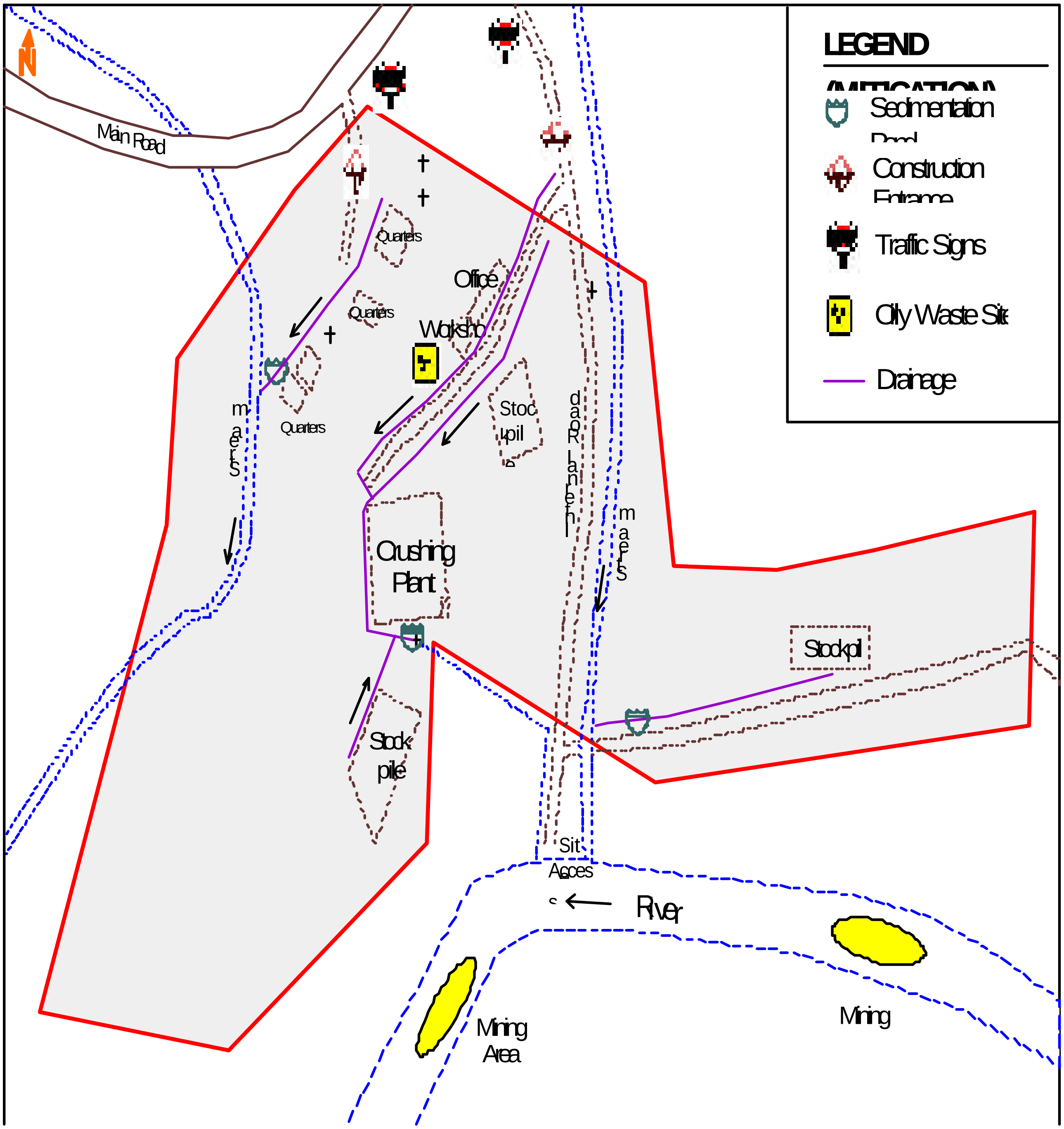
The project proponent should provide the following:

- Locality map, photographs and specifications of sedimentation pond and drainageways (see Figure 4.1)
- Actual maintenance schedule of sedimentation pond and drainageways during the previous period.

**Example of maintenance schedule**

'For April 2000, pond maintenance was carried out once - (i) *Period:* 2 April; *Locality:* Pond A.' 'For April 2000, one new pond was constructed – (i) *Date of construction:* 23 April; *Locality:* Pond X; *Dimensions:* 8m x 2m x 1.5m.' 'For April 2000, no maintenance of drainageways.'

*Figure 4.1 Typical Processing Site Layout Plan*



## 4.2 Impact Monitoring

If environmental assessment shows that the project may impact high-risks areas, the project proponent should provide the following residual environmental impact information. The frequency of monitoring and reporting will be laid down in the Agreement of Environmental Conditions.

### 4.2.1 Channel erosion

If the environmental assessment identified that the mining area is located within a sensitive area or area of high risk, then the following impact monitoring should be carried out:

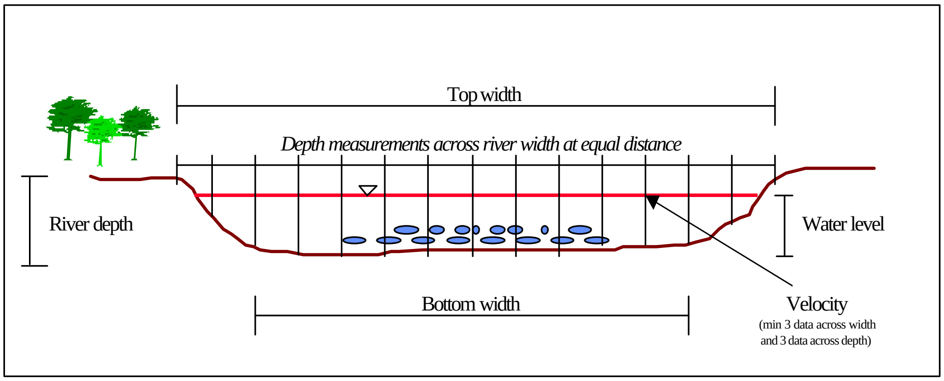
- Mapping of the physical and hydrological characteristics of the river and riverbanks at the risk areas. Physical data include river cross-sectional profile (see Figure 4.1) and river plan view or layout map
- Photographs of physical conditions along both sides of riverbanks.

When making the assessment consideration should be given to natural events and processes.

*Table 4.3. Impact monitoring of channel erosion*

| Stations | Place | Items to be Monitored | Standards |
|---|---|---|---|
| 2 | High risk areas | Channel cross section - width | < 25 % increment |
| | | Channel cross section - depth | < 10 % reduction |
| General survey | High risk areas | Signs of slips | < 10 % failure at site<br>< 10 % upstream |

*Figure 4.1 Typical Cross-sectional of River Profile*



### 4.2.2 Water quality

If environmental assessment indicates that the mining site is located within a sensitive area, ECD or an appointed third party may periodically monitor water quality for signs of water quality deterioration that could be attributed to the project. Monitoring will be undertaken during operation. Three samples will be taken, namely 500 m upstream, and 100 m and 500 m downstream.

### 4.2.3 Ecology

If the environmental assessment indicated that protected or sensitive habitat or species were present or within the immediate vicinity of the project site, further ecological monitoring could be carried out as follows:

- Re-mapping / surveying the habitat surrounding the mining site (see Figure 4.2)
- Repeated surveys of selected indicator species to monitor population trends
- Photographs of vegetation and habitat along both sides of riverbanks
- When possible - photographs of in-channel aquatic habitats e.g. algal growth on sub-strate surface.

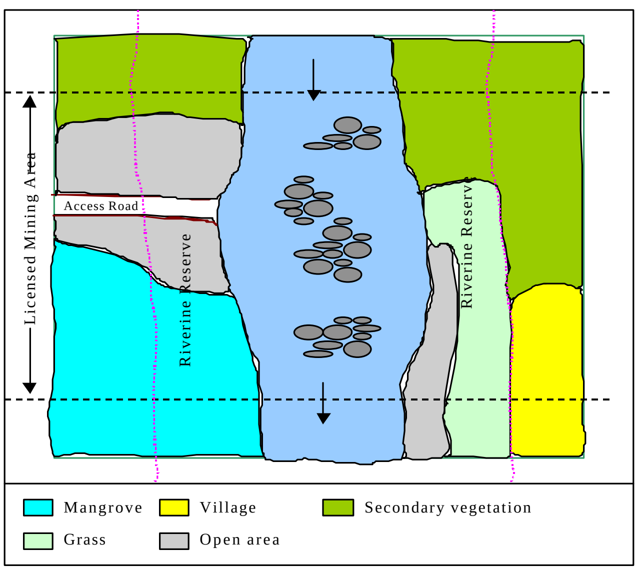



*Figure 4.2 Habitat map*

*Table 4.2 Impact Monitoring of Ecological Impacts*

| Station | Place of Monitoring | Items to be Monitored | Standards |
|---|---|---|---|
| General survey | 500 m upstream, and down-stream of mining area | Extent of habitat | < 50 % reduction |

Picture and text annexes

## Annex A Statutory Controls

*Annex Table 1. Legislation*

| Legislation | Controlling Authority |
|---|---|
| **Conservation** of Environment (Prescribed Activities) Order 1999 | Environmental Conservation Department, Sabah |
| **Environmental** Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 | Department of Environment, Malaysia |
| **Fisheries** Act 1985 | Jabatan Perikanan, Malaysia |
| **Land Ordinance** 1930 | Lands and Survey Department, Sabah |
| **Water Resources** Enactment 1998 | Drainage and Irrigation Department, Sabah |
| **Water Supply** Ordinance 1961 | Jabatan Air, Sabah |

**Conservation of Environment (Prescribed Activities) Order 1999**

Section 3: Any person who intends to undertake any of the prescribed activities shall submit to the Director a report, which is to be prepared by such expert or authority as may be approved by the Director – a) On the impact of such activities on the environment and on the sustainable utilisation, preservation and management of the natural resources of the State; and b) On the measures being preventive, mitigating or abatement to be taken for the protection and enhancement of the environment.

Section 4: Such report shall be submitted to the Director and shall be in the approved Form as specified in the Second Schedule hereto, which may be used with such modifications as may be required, depending upon the circumstances of each particular case. First Schedule – Prescribed Activities, Section 4 (vi): diversion of watercourses, streams or rivers or the excavation of sand and other rock materials therefrom.

**Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987**

Section 2: The activities specified in the Schedule are prescribed activities. Schedule, Section 11 (c): Sand dredging involving an area of 50 hectares or more.

**Fisheries Act 1985**

Section 38(1): The State Authority or, in respect of the Federal Territories of Kuala Lumpur and Labuan, the Minister may make rules specifically or generally for the proper conservation, development, management and regulation of turtles and inland fisheries in any State in Malaysia or in the Federal Territories of Kuala Lumpur and Labuan, as the case may be, and may, in particular, make rules for all or any of the following purposes: (k) for the purpose of the conservation of fish in riverine waters, to regulate and control the construction of any slide, dams or other obstruction, or the removal of sand or gravel or other alteration to the natural environment or habitat of fish.

**Land Ordinance 1930**

Part I, Section 24(1): All coal, minerals, precious stones and mineral oils, and are deemed always to have been, reserved to the Government, together with the right to enter upon any lands and to search for, win, carry away and dispose of such articles in, on or under the same, and to resume such portions of land as may be necessary for examining or working any mines or for the removal of the products thereof, upon payment of compensation to the owner for damages to such lands or building thereon.

**Water Resources Enactment 1998**

Part IV, Section 17(1): No person shall, unless authorised by a licence for a water activity or otherwise authorised in accordance with this Enactment, engage in a water activity, meaning to – a) take or use water from a water body; b) return water to a water body directly or indirectly by artificial means; c) control, divert or mitigate flood waters outside a floodplain management area referred to in Part VI of this Enactment; or d) carry out a water body alteration activity.

Part VII, Section 40(1): From the date of the commencement of this Enactment, river reserves and shore reserves are established on land, which is – a) in the case of river reserves, within twenty metres of the top of the bank of every river, including its estuary, where the river channel is not less than three metres in width; and b) in the case of shore reserves, within twenty metres of the bed of all coastal waters.

Part VII, Section 41(1): Within a river reserve or shore reserve or on, in or above a water body it is an offence to undertake, without the approval in writing of the Director, any activity, which involves – a) the removal of natural vegetation or the removal or deposition of material; b) the erection of a structure or building; or c) the carrying out of a commercial or agricultural activity, unless the activity is of a type, which the Director has declared in writing, does not require approval.

**Water Supply Ordinance 1961**

Part VII, Section 25 (1): Any person who deposits or allows to be deposited any earth, material or liquid in such manner or place that it may be washed, fall or be carried into any waterworks shall be guilty of an offence and shall be liable to a fine of five hundred ringgit.

## Annex B Glossary of Terms

**ambient noise** - means the all-encompassing noise associated with a given environment, being usually a composite of sound levels from many sources near and far

**aquatic environment** - means those physical and biological features, including land, water, the atmosphere, animals and plants, which are within, under, over, in contact with, or sustained by the water in rivers

**consultant** - means the Environmental Consultant conducting the EIA study

dB(A) - means decibel-A-weighted, a unit of measurement of sound level corrected to the A-weighted scale using a reference level of 20 micropascals

**declared channel** - means a channel, canal, drain, or artificial watercourse, which has been declared to be a declared channel in Section 66 of Sabah Water Resources Enactment 1998

**Director** - means the Director of State Environmental Conservation Department, Sabah

**effluent** - means any discharge either sewage or industrial effluent by an operation to the receiving environment

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

**inland waters** - include any reservoir, pond, lake, river, stream, canal, drain, spring or well, any part of the sea abutting on the foreshore, and any other body of natural or artificial surface or subsurface water

**monitoring programme** - means 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

**natural resources** - means air, biological diversity of resources, oil, gas, forest and forest produce, land, rocks, soils, sub-soils, animals, birds, plants, marine or aquatic life, and waters of the State of Sabah

**noise levels** - means sound level

**pollutants** - means any natural or artificial substances, whether in solid, semi-solid or liquid form, or in the form of gas or vapour, or in a mixture of at least two of these substances, or any objectionable odour or noise or heat emitted, discharged or deposited or is likely to be emitted, discharged or deposited from any source which can directly or indirectly cause pollution and includes any environmentally hazardous substances

**pollution** - means any direct or indirect alteration of the physical, thermal, chemical, biological, or radioactive properties of any part of the environment by discharging, emitting, or depositing 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, fish or aquatic life, or to plants

**residual impact -** means the potential environmental impact remaining after mitigating measures have been adopted into a project plan

**river** - means a watercourse of natural origin wherein water flows either continuously or intermittently, whether or not its conformation has been changed by artificial means, and includes swamps or marshes, whether forming the source or found upon the course of or feeding such watercourse

**river mouth -** means area downstream of the river where it meets the sea, up to 12 nautical miles from the low low water mark

**river reserve** - means a reserve within twenty metres of the top of the bank of every river, including its estuary, where the river channel is not less than three metres in width

**sand mining** - means mining, excavating, extracting, quarrying or dredging of sand, gravel, rock, boulder and other riverbed deposits from the bed or bank of a river, or from a river reserve. Material is won by either excavator, face shovel, backhoe, dragline, suction pump, etc.

**species** - means a group of pants or animals, with similar characteristics and common name that reproduce true to type

**vegetation** - means all species of plants and trees, moss, algae and fungi, whether terrestrial or aquatic, and any other vegetable products of the soil or water

**waste** - includes any matter prescribed to be scheduled waste, or any matter whether in a solid, semi-solid or liquid form, or in the form of gas or vapour, or in the form of gas or vapour which is emitted, discharged or deposited in the environment in such volume, composition or manner as to cause pollution

**water** - means 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

## Annex C EIA Matrix

The criteria used for the impact assessment of key environmental impact of sand mining activities are:

- The *magnitude* of change/effect, which is a measure of the importance in relation to the spatial boundaries
- The *permanence* of the impact, which defines whether the condition is temporary or permanent
- The *reversibility* of the condition, which defines whether the condition can be changed and is a measure of the control over the effect of the condition
- To what extent the impact is *cumulative*, which is a measure of whether the effect will have a single direct effect or whether there will be a cumulative effect over time, or a synergistic effect with other conditions.

A summary impact matrix for sand mining activity is shown in the Annex Table 2.

*Annex Table 2: EIA Matrix for Sand Mining Activity*

| Project stage | Major Environmental Impacts | Magni-tude | Perma-nence | Reversi-bility | Cumula-tive |
|---|---|---|---|---|---|
| Develop-ment/ | Channel Erosion | 2 | 3 | 3 | 3 |
| Operation | Water Quality | 2 | 2 | 2 | 3 |
| | Natural Habitats | 2 | 2 | 2 | 3 |
| | Air Quality | 2 | 2 | 2 | 2 |
| | Noise | 2 | 2 | 1 | 1 |
| | Traffic | 2 | 2 | 1 | 1 |
| | Land/Water Use | 2 | 2 | 1 | 1 |
| | Socio-Economic | 2 | 1 | 1 | 1 |

*Magnitude of change/effect: 1:within project site; 2:local conditions; 3: regional/national/international*
*Permanence: 1:no change/not applicable; 2: temporary; 3: permanent*
*Reversibility: 1: no change/not applicable; 2: reversible; 3: irreversible*

*Cumulative: 1: no change/not applicable; 2: non-cumulative/single; 3: cumulative/synergistic*

## Annex D Computer Modelling

Computer or physical modelling does offer opportunities to examine the effect of sand mining on physical processes but it should be recognised that if reliable results are to be obtained, data requirements are high and the possible cost implications of such a modelling exercise should not be overlooked. The reliability of model results depends upon a great many contributing factors. These include: the soundness of the underlying theory; skills of the modeller in translating that theory to a computer program; the quantity and quality of input data and the applicability of the technique to the issue at hand. If models are decision-making tools then the users of the results are, *de facto*, decision makers. Inappropriate use of the results is often caused by poor awareness of the model's limitations and its inherent assumptions and simplifications.

An important principle for users of models is to ask why a particular modelling technique is being used. Computer models, however, may be suitable for larger, more complex projects and for mining in or nearby sensitive areas.

When computer models are used, the model must be well tested and approved for use by the National Hydraulic Institute of Malaysia (NAHRIM). It is advisable that the Consultant has prior consultation with ECD and NAHRIM regarding the acceptability of particular computer software for project-specific application.

Examples of commercially available computer models:

- QUAL-2E: Enhanced Stream Water Quality Model adopted by US Environmental Protection Agency to stimulate water quality constituents in a steady state mode
- BOSS SMS: Surface Water Modelling System which model the water surface elevation, flow velocity, contaminant transport and dispersion, sediment transport and deposition for complex two-dimensional horizontal flow problems
- ISIS: Software system for simulating flow, water quality and sediment transport in rivers.

## Annex E Abbreviations

| | |
|---|---|
| ACLR | Assistant Collector of Land Revenue |
| DID | Department of Irrigation and Drainage |
| DOE | Department of Environment (Malaysia) |
| ECD | Environmental Conservation Department (State of Sabah) |
| EIA | Environmental Impact Assessment |
| ha | hectare |
| km | kilometre |
| LSD | Lands and Survey Department |
| m | metre |
| $m^3$ | cubic metre |
| m/s | metre per second |
| mg/L | milligram per litre |
| MT | metric tonnes |
| NAHRIM | National Hydraulic Research Institute of Malaysia |
| RM | Malaysian Ringgit |
| Sg | Sungai (river) |
| TOL | Temporary Occupation Licence |
| TSS | Total Suspended Solids |
| WHO | World Health Organisation |

## Annex F Information on Experts

*Annex Table 2. List of Relevant Expert Organisations and Useful Contacts*

| Organisation | Address | Contacts |
|---|---|---|
| Environmental Conservation Department, Sabah (ECD) | Tingkat 2 & 3, Wisma Budaya, Jalan Tunku Abdul Rahman, 88000 Kota Kinabalu | 088-251290 (t)<br>088-238210 (f) |
| Jabatan Alam Sekitar, Malaysia (DOE) | Tingkat 7, Blok E, Bangunan KWSP, 88000 Kota Kinabalu. Sabah | 088-250122 (t)<br>088-241170 (f) |
| Drainage and Irrigation Department, Sabah (DID) | Tingkat 5 & 6, Menara Khidmat, Jalan Belia, 88000 Kota Kinabalu | 088-280531 (t)<br>088-242770 (f) |
| Jabatan Perikanan, Sabah | Pusat Penyelidikan Perikanan, Likas, 88940 Kota Kinabalu | 088-428415 (t)<br>088-425890 (f) |
| National Hydraulic Research Institute (NAHRIM) | Blok A, Kompleks JPS, Km 7, Jalan Ampang, 68000 Kuala Lumpur | 03-456 4017 (t)<br>03-456 4028 (f) |

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