

APPENDIX TWO
MAINSTREAMING OF BIODIVERSITY CONSERVATION INTO RIVER MANAGEMENT:
Sand Mining in Sungai Segama, Sabah
26 October 2021

This report is made for the purpose of compiling our action based on the site visit made on 1 August 2021. Part A indicates our recommendation and next steps that can be taken together with the relevant government agencies while Part B is the site visit report.

PART A

Background

Forever Sabah has been contracted under this DID/UNDP project on riparian conservation to review sand mining activities along the Upper Mid-Segama River. Our field observations on this issue are detailed in **Part B**.

The Sand Mining Issue

The following are issues emerge from our field work: -

1. Sand mining is an important economic activity on the Mid-Segama River;
2. Unfortunately, poor management practices by sand mining operators often lead to high sediment load in non-flooding periods (impacting public and private water supplies from the river as well as fisheries and biodiversity), and contribute (alongside oil palm planting and other human activities) to lateral erosion (river widening) that includes loss of valuable riparian forest and infilling of deeper river pools. These problems are well-known and are not currently being solved when reported.
3. Many sand miners operating along the Segama River appear to be unlicensed, and few are in compliance with the Environment Protection Department's ("EPD") 'Guidelines for Minimising Impacts of Sand Mining on Quality of Specific Rivers in Sabah' ("the Guidelines") (see **Part B**).

Recommendations

1. We believe that implementation of the EPD Guidelines would be the most feasible and effective way to address the sand mining issues along the Segama River, by encouraging Best Management Practices while controlling activities with negative consequences for the river, biodiversity and other water users. The challenge is that the sand miners and other stakeholders are not yet aware of these Guidelines.
2. We recommend socialisation (and awareness building) for the Guidelines among the operators, relevant government agencies and communities through the following: -
 - i. Translation of the Guidelines into Malay (in layman terms) and their dissemination through diverse networks, both government and social;

- ii. Compulsory attendance of a Guidelines refresher course for landowners and operators as a part of compliance criteria for permit approval or renewal; and
 - iii. Annual self-reporting by the operators on compliance with the Guidelines, providing reasons for any non-compliance, as part of compliance criteria for permit approval or renewal.
3. We request that Department of Irrigation and Drainage organize and lead a discussion with Environment Protection Department and Lands and Surveys Department to better understand the practical issues and institutional needs in Lahad Datu/Mid-Segama, with the goal of discussing the above recommendations and establishing in Lahad Datu relevant enforcement agency capacities so that reports on infringements can be easily submitted and operators readily alerted to take action.

PART B

MAINSTREAMING OF BIODIVERSITY CONSERVATION INTO RIVER MANAGEMENT: Site Visit Report in Sungai Segama, Sabah

Component: 3(vii) of the Forever Segama Action Plan 2021

Date: 1 August 2021

Participants: Febe Soliun, Troy Hessler Paul and Chen Kok On

Background

1. Under Component 3(vii) of the Department of Irrigation & Drainage ***Mainstreaming of Biodiversity Conservation into River Management in Malaysia*** project, Forever Sabah aims to work with government agencies and sand & marble mining operators to ensure compliance with Better Management Practices (BMPs), EIAs and relevant legislation.
2. In this report, we evaluate observations of the sand mining operations based on criteria laid down in the ***Guidelines for Minimising Impacts of Sand Mining on Quality of Specific Rivers in Sabah***, August 2011, published by the Sabah Environment Protection Department (“Guidelines”). For ease of reference, the pertinent parts of the Guidelines are summarized in the Appendix.
3. The importance of minimizing the impact of sand mining on the environment has been summarized in Section 1.2 of the Guidelines. The various Sabah legislation which are relevant to sand mining has been summarized in Chapter 2 of the Guidelines.
4. We were unable to visit the sand mining operators in the earlier stages of the project mainly due to the following circumstances:
 - a) The outbreak of the COVID-19 pandemic and various Movement Control Orders imposed by the government; and

- b) The inability to contact any sand mining operator in the area who was willing to speak to us about their operations.
- 5. Finally, we decided to go ahead with the site visit on 1 August 2021 after a landowner, who rented out his land to a sand mining operator, was willing to speak to us off the record.
- 6. During the visit, we managed to:
 - a) speak to that particular landowner;
 - b) speak to one sand mining operator on the phone and his supervisor at the site; and
 - c) visited 2 more sites without being able to speak to their operators.
- 7. Unfortunately, due to the Movement Control Order, none of the operators of the above sites was working at the time of our visit. Therefore, we were unable to witness the actual manner of the sand mining operation.

1) Landowner: Kampung Tawaiyari

- 8. A resident of Kampung Tawaiyari claims to own a piece of land by the riverbank of Sungai Segama, and has rented out his land to a sand mining operator. We visited him at his house.
- 9. The landowner said that his tenant had been renting his land to carry on sand mining operation for over a decade. According to him, the operator had the relevant licenses from the various authorities to do so. However, we were unable to speak to his tenant, the actual operator, because the mining was not currently in operation.
- 10. According to him, the application for the license had been costly at approximately RM40,000, because various documents needed to be prepared. He was unable to specify these documents because it was his tenant who had made the application.

11. When asked whether he thought that the sand mining operation had created any environmental problem, he said no. He said that the sand which has been mined would be replenished by the sand brought by the river flow from upstream. Therefore, the riverbed would not be damaged in the long run.
12. He said that the only person who had complained about his tenant's operation was a lady who allegedly tried (but failed) to extract some payment from his tenant, suggesting that it was an attempt to blackmail.
13. Other than that, the only environmental problem was the noise created by the operation, which could be heard by some of the residents of the village.

2) Site 1: Kampung Kidan-Kidan

14. The operator was not on site, but a few employees were present at their quarters on site. We spoke to a female supervisor, who freely answered our questions and allowed us to enter the site for observation.
15. A suction dredger of this operator appeared to be located in the middle of the river. We were unable to measure whether the sand mining was carried out only on 1/3 of the river as required (Guidelines, Section 3.4). Furthermore, it is unclear whether the location of the dredger would interfere with navigation, which depends on the width of the river channel as well as the depth of the riverbed at the obstructed part of the river (Guidelines, Section 3.1 and 3.2).



16. The processing areas were quite far away from the river reserve (approximately 50 meters), (Guidelines, Section 3.1) However, we were unable to measure the exact distance.



17. De-silted materials were placed away from the riverbank. What appeared to be the dumping area was far away (beyond 50 meters) from the river reserve (Guidelines, Section 4.2).



18. What appeared to be a sedimentation pond was far away from the riverbank, but it was unclear whether it had adequate peak run off control (Guidelines, Section 4.2). No pond was seen to be constructed on top of natural waterways or streams as per Guidelines, (Section 4.5.1) Due to non-operation, we did not see whether the washing water was stored in a pond prior to discharge into the river (Guidelines, Section 4.3).



19. As seen from the above photograph, dry stockpiles were not covered as required (Guidelines, Section 4.2), but the stockpiles were located far away from the river bank (at least 30 meters). We were unsure whether the stockpiles were located more than 30m away from the river bank to prevent the sand stockpile from being washed away if the river water level rises or during heavy rain, (Guidelines, Section 4.3).
20. The stockpile area was not screened with zinc hoarding or any other materials with an approximate height of 2-2.5 m (Guidelines, Section 4.3). However, again, the area was quite far away from the riverbank.
21. As this site was not in operation during our visit, we were unable to confirm whether the other requirements of the Guidelines had been complied with, including the manner of discharge of oily wastewater, dumping of overburden (whether more than 30m from the bank of the river) (Guidelines, Section 4.4), whether silted run-off were controlled prior to discharge straight into the river (Guidelines, Section 4.5.2), and so on.

The washing area:



22. According to the supervisor, the transportation of the sand away from the site were done by the buyers. Due to non-operation at that time, we were unable to observe whether the vehicles leaving the site were clean and prior to entering public roads (Guidelines, Section 4.4)

23. When asked whether the suction dredger would damage the riverbed by over-mining, the supervisor said that it would be unlikely, because the suction would automatically stop once the sand had been finished and when mud entered into the suction. We did not witness the operation so we had no way of confirming whether this is true in practice.
24. Further, there is also no way of knowing whether and to what extent the use of suction dredger would damage the aquatic habitat, although logically it would seem likely.
25. We also managed to speak to the operator's manager on the phone. He explained that their operation had obtained all licenses and complied with all the regulations imposed by the relevant authorities. He insisted that it would not be easy to flout such regulations because the authorities often send personnel to the site to observe and monitor the operation. According to the supervisor, the relevant officers visited their site on a regular basis, approximately once every month, and sometimes up to three times a month.

3) Site 2: Kampung Taliwas

26. No one was present at this site during our visit.
27. A suction dredger of this operator appeared to be located on the edge of the river close to the riverbank. However, we are unable to confirm whether the dredger would be located at the same position during the actual operation or in the middle 1/3 of the river (Guidelines, Section 3.4)



28. Soil erosion at the riverbank was quite apparent.





29. The processing areas were quite far away from the river reserve. (Guidelines, Section 3.1) However, we were unable to measure the exact distance.



30. De-silted materials were placed away from the riverbank. The dumping area also appeared to be far away from the river reserve (Guidelines, Section 4.2)



31. What appeared to be a sedimentation pond was far away from the riverbank, but it was unclear whether it had adequate peak run off control (Guidelines, Section 4.2). No pond was seen to be constructed on top of natural waterways or streams (Guidelines, Section 4.5.1). Due to non-operation, we did not see whether the washing water was stored in a pond prior to discharge into the river (Guidelines, Section 4.3).



The washing area:



32. As seen from the photograph below, dry stockpiles were not covered, but were located far away from the river bank (Guidelines, Section 4.2). We were unsure whether the stockpiles were located more than 30m away from the river bank to prevent the sand stockpile from being washed away if the river water level rises or during heavy rain (Guidelines, Section 4.3). The stockpile area was not screened with zinc hoarding or any other materials with an approximate height of 2-2.5 m (Guidelines, Section 4.3). However, again, the area was quite far away from the riverbank.



33. Again, as this site was not in operation during our visit, we were unable to confirm whether the other requirements of the Guidelines had been complied with, including the manner of discharge of oily wastewater, dumping of overburden (whether more than 30m from the bank of the river) (Guidelines, Section 4.4), whether silted run-off were controlled prior to discharge straight into the river (Guidelines, Section 4.5.2), and so on.

4) Site 3: Kampung Batu 8

34. No one was present at this site during our visit.
35. No suction dredger was seen on site. We are unable to confirm the means used by this operator for sand mining.

What appeared to be the site office / workers' quarter:



36. There was very serious soil erosion and total collapse of the riverbank. Indeed, part of a concrete structure and a huge metal container had even fallen into the river. Assuming (we have no confirmation) that the structure had collapsed after the beginning of the sand mining operation here, this would have failed the criteria of Section 3.2 of the Guidelines, i.e. avoid inducing erosion at the downstream reaches especially in areas with hydraulic structures such as jetties, water intakes etc., and to ensure the rivers are protected from bank and bed erosion beyond its stable profile.





37. It appeared that soil erosion had occurred on both sides of the riverbank.





38. The processing areas were right at the (dangerously close to collapsing) riverbank, which is against the requirement for it to be far away from the river reserve (Guidelines, Section 3.1).





39. What appeared to be a small sedimentation pond was very near to the riverbank, and it was unclear whether it had adequate peak run off control (Guidelines, Section 4.2). Due to non-operation, we did not see whether the washing water was stored in a pond prior to discharge into the river (Guidelines, Section 4.3).



What appeared to be the washing area, which was right at the edge of the riverbank.





40. No area for placing de-silted materials or dumping area was seen (Guidelines, Section 4.2).



41. As seen from the photographs above, dry stockpiles were not covered, and were located very near to the river bank. (Guidelines, Section 4.2) It was doubtful whether the distance was sufficient to prevent the sand stockpile from being washed away during

heavy rain (Guidelines, Section 4.3). The stockpile area was not screened with zinc hoarding or any other materials with an approximate height of 2-2.5 m (Guidelines, Section 4.3).

42. Again, as this site was not in operation during our visit, we were unable to confirm whether the other requirements of the Guidelines had been complied with, including the manner of discharge of oily wastewater, dumping of overburden (whether more than 30m from the bank of the river) (Guidelines, Section 4.4), whether silted run-off were controlled prior to discharge straight into the river (Guidelines, Section 4.5.2), and so on.
43. As of today, our field coordinator was also informed that currently 7 out of the 11 operators in the area have ceased their operations as the cost for land rental had been increased.

Further Questions

44. There were also many other technical criteria in the Guidelines, some of which require technical calculations, which appear not straightforward for lay people to determine or to comply, such as:
 - a) The extraction rate of the sand must not exceed the replacement rate of the accreting channel and may not be more than the determined maximum extractable depth (Section 3.1);

- b) Parts of the river reaches that experience deposition or aggradation shall be identified first. Operators may be allowed to extract the sand deposits in these locations to lessen siltation or aggradation problems (Section 3.2);
 - c) The distance between sites for sand mining shall depend on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand replenishment rate (Section 3.2);
 - d) Layers of sand which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river (Section 3.2, refer Figure 3.1);
 - e) The requirements of Figure 3.1: Volume Extraction Determination Using Sediment Rating Curve;
 - f) Flood discharge capacity of the river could be maintained in areas where there are significant flood hazards to existing structures or infrastructure. Sand mining may be allowed to maintain the natural flow capacity based on surveyed cross-section history (Section 3.2);
45. Therefore, we wonder how such technical requirements are being implemented in practice by the relevant authorities, whether at the headquarters or at the relevant district levels. If at the district levels, whether there are sufficient technical expertise and personnel to monitor compliance adequately.
46. Further, the Guidelines also laid down certain general, macro monitoring requirements, such as:
- a) Sand may be extracted across the entire active channel during the dry season (June to November) (Section 3.2), but on the other hand no mining is allowed during low water level due to dry season or low tide (Section 4.7).

(Due to the effect of climate change, the question is whether it is still relevant to designate when is or is not “dry season” and if not, whether alternative requirements need to be developed);

- b) Annual summary of the physical and biological monitoring to document the evolution of the sites over time, and the cumulative effects of sand and gravel extraction (Section 5.2);
 - c) Physical monitoring and data gathering of Cross-sections, Reach Scale Cross-sections, Mining Site Cross-sections, Longitudinal Profile, Geomorphic Maps, Photo-documentation, Hydrology and Sediment Transport and Groundwater Level (Section 5.2.1);
 - d) Gathering of physical data of bar replenishment and any changes in channel morphology, bank erosion, or particle size (Section 5.2.1);
 - e) Both local monitoring for replenishment at specific mining sites and monitoring of the entire reach to the estuary, to show the cumulative response of the system to sand extraction (Section 5.2.1).
47. The above monitoring and data collection requirements would appear to be highly technical and manpower-intensive. The question is whether there are adequate resources available to implement them.
48. Section 5.2.2 of the Guidelines also required monitoring and data collection about the conditions of the Riparian Habitat, including documenting the Extent and Quality of Riparian Vegetation and the Riparian Vegetation Maps. Again, the question is whether they have been adequately implemented.
49. The monitoring and data collection costs to implement the guidelines are probably much higher than the revenue (if any) generated by the government from the various

fees or levies collected from licenses and other statutory procedures. If so, perhaps the government should consider:

- a) abolish all monitoring of the environmental impact of sand mining, which would be unthinkable;
- b) raising the fees and levies, or imposing sales tax, on the various stages of the sand mining industry, in order to ensure that the sand mining industry “internalizes” / pays for such costs, which are imperative for the protection of the natural environment. Otherwise, the high costs of environmental monitoring or the negative impact of sand mining would remain an “externality” of the industry, which is not adequately reflected in (and therefore distorts) the true economic pricing the river sand. In other words, this would tantamount to making the natural environment “subsidize” the price of river sand, with serious implication for the sustainability of the environment, including for sand mining companies; or
- c) prohibit all sand mining, especially in environmentally sensitive rivers such as the Segama.

Report prepared by:

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Appendix

Summary of the ***Guidelines for Minimising Impacts of Sand Mining on Quality of Specific Rivers in Sabah***, August 2011, published by the Sabah Environment Protection Department.

50. Section 3.1 said:

In determining suitable sites for sand mining extraction the following factors should be considered:

- a) The site must be at least 500 m away from the nearest sensitive receptor such as water intake points, fish breeding areas, irrigation areas and river sections used for navigation, recreational areas or riverine settlement including the following:
 - i. High risk channel erosion area;
 - ii. Sites known to be important fish breeding grounds;
 - iii. Gazetted environmentally-sensitive areas;
 - iv. Water supply intake-points for potable or irrigation water; and
 - v. Proximity to burial reserves.
- b) The extraction rate of the sand must not exceed the replacement rate of the accreting channel and may not be more than the determined maximum extractable depth.
- c) Shallow and fast flowing river sections with steep channel slopes should be avoided.
- d) Avoid interference with human activities.
- e) Avoid sections of the river used for navigation, recreation or fishing.

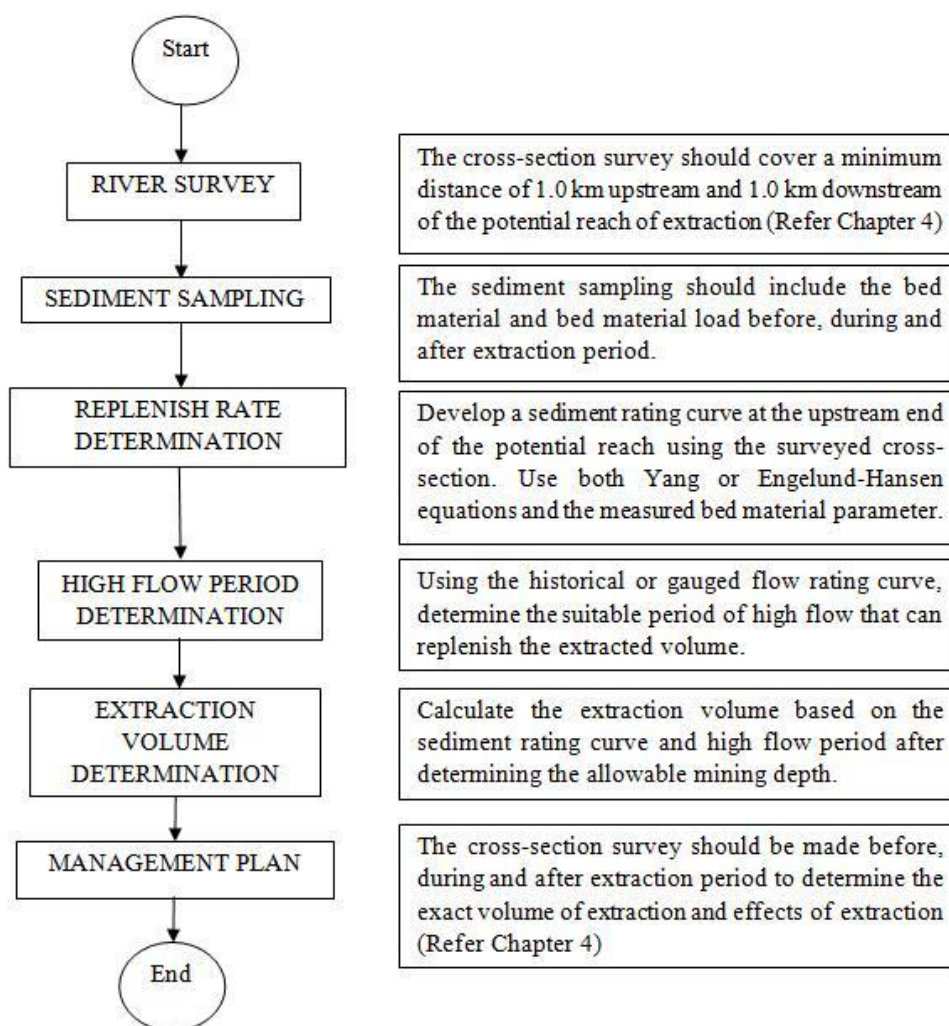
- f) Avoid any areas with settlements along riverbanks (within 500 m of the bank or assessed as high erosion risk areas).
- g) Extraction should not be carried out in fast flowing river sections and must be confined to the designated and demarcated areas.
- h) The Processing areas must be away from the river reserve.

51. Section 3.2, “Sand Mining Policy and Guideline”, said:

- a) The following policies should be taken into consideration before approving sand mining permits:
 - i. Ensure conservation of the river equilibrium and its natural environment.
 - ii. Avoid inducing erosion at the downstream reaches especially in areas with hydraulic structures such as jetties, water intakes etc.
 - iii. Ensure the rivers are protected from bank and bed erosion beyond its stable profile.
 - iv. Avoid interference with the river maintenance work by Department of Irrigation and Drainage (DID) or other agencies.
 - v. No obstruction to the river flow and water transport.
 - vi. Avoid pollution of river water leading to water quality deterioration.
- b) The general guidelines for sand and gravel mining are as follows:
 - i. Parts of the river reaches that experience deposition or aggradation shall be identified first. Operators may be allowed to extract the sand deposits in these locations to lessen siltation or aggradation problems.
 - ii. The distance between sites for sand mining shall depend on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand.

- iii. Sand may be extracted across the entire active channel during the dry season (June to November).
- iv. Layers of sand which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river (refer Figure 3.1).
- v. Sand shall not be allowed to be extracted where erosion may occur, such as at the concave bank.
- vi. Sand and gravel shall not be extracted within 1,000 meter from any crucial hydraulic structure such as pumping station, water intakes, bridges, buildings and such structures.
- vii. Sand mining could be extracted from the downstream of the sand bar at river bends. Retaining the upstream one to two thirds of the bar and riparian vegetation is accepted as a method to promote channel stability.
- viii. Flood discharge capacity of the river could be maintained in areas where there are significant flood hazards to existing structures or infrastructure. Sand mining may be allowed to maintain the natural flow capacity based on surveyed cross-section history.

52. Figure 3.1: Volume Extraction Determination Using Sediment Rating Curve, outlines the process required in determining the locations, periods and quantity for sand and gravel mining. (Source: River Sand Mining Guidelines, DID)



53. Section 3.4 said:

Sabah State DID in its guidelines for river sand mining has mentioned that extraction of sand can only be carried out on 1/3 of the river and the allowable portion of extraction is the middle third of the river

Table 3.1: Allowable Depth of Sand Extraction

Width of River	Allowable Depth of Sand Extraction
Less than 10 metres	Not Allowed
Between 10 and 20 metres	0.5 metres
Between 20 and 50 metres	1.0 metres

More than 50 metres	1.5 metres
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(Source: Sabah State DID, Guidelines for River Sand Mining)

54. Section 4.2, “Operational Practices”, said:

- a) Mining must be confined to one side of the river and should avoid the concave (i.e. erosion prone) side of the river;
- b) The use of river reserve as dumping area must be prohibited; the river itself should not be used as dumping area;
- c) Machinery and transportation vehicles used in the operations must be maintained well and be free of any leakages;
- d) Mining activities should be avoided after heavy rain events and at night times;
- e) Impacts on river water quality must be minimised by construction of sedimentation ponds with adequate peak run off control;
- f) De-silted materials must be placed away from the riverbank;
- g) Dry stockpiles must be covered;
- h) Vehicles transporting washed sand must maintain speed to not more than 30km/hr, be covered to avoid spilling on public roads and should travel on non-peak hours;
- i) Site office and workers quarters must be equipped with proper sanitation facilities. No direct discharge of sewage or sullage must be allowed into the river course;
- j) Proper waste collection bins must be provided; and
- k) Working areas must be made good after operations.

55. Section 4.3, “Stockpiling Management”, said:

- a) Sand stockpiles must be located more than 30m away from the river bank to prevent the sand stockpile from being washed away if the river water level rises or during heavy rain;

- b) Organic matter, debris, pebbles stockpile must be located more than 30m away from the river bank, to prevent it from being washed away when the river rises;
- c) The Stockpile area should be screened with zinc hoarding or any other appropriate materials, with an approximate height of 2-2.5 m; and
- d) Sand should be washed using water from river, segregating sand from pebbles, organic matter, and debris. The washing water should be stored in a pond prior to discharge into the river.

56. Section 4.4, "Processing Site and Maintenance Yard", said:

- a) No discharge of oily wastewater directly into the river;
- b) Wherever skid tank is used for fuel storage, it should be surrounded by a bund and underlain with concrete flooring to prevent any spillages reaching the river;
- c) Equipment, machinery and transportation leaving the site should always be clean and if applicable, provision made for a wheel washing facility to clean tyres prior to entering public roads;
- d) A maintenance yard should be concreted with perimeter drainage to collect oily waste; and
- e) Overburden from mining activities is not allowed to be dumped on the riverbank or riverine reserve (not less than 30m from the bank of the river).

57. Section 4.5.1, "Construction of Sediment Pond", said:

It is recommended the ponds be located outside of natural drainages but if the site is located in a drainage area, the water-produced up-gradient from the site should be routed through an adequately sized culvert under the disturbed area and sedimentation pond or around the disturbed area. One of the primary concerns in developing a sediment pond is to create it so that required future maintenance can be done effectively and economically.

For effective sediment ponds, the following criteria are applicable:-

- a) Ponds should be maintained by removing sludge at the bottom of the pond at regular interval;
- b) Sludge removed from the ponds should not be disposed near the ponds or any waterways;
- c) Two ponds should be built in parallel to allow cleaning operations;
- d) Ponds should not be constructed on top of natural waterways or streams.

Effective sediment ponds to control silted run-off depend largely on the size of the operation and the amount of water used for sand washing. The ponds should be able to hold sufficient amount of wastewater and run-off, with appropriate retention time prior to final discharge point.

58. Section 4.5.2, “Construction of Drainage Ways”, said:

Provision for good drainage systems as part of the mining operation ensures that silted run-off will be controlled prior to discharge into river. In the east coast of Sabah, most of the operations discharge their sand washout water straight into the river, contributing to increased level of turbidity.

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

- a) Outfall of the drainage should be placed with riprap to prevent scouring of river bank;
- b) Perimeter drainage should be lined with geotextile and sand bag, and with check dam to slow the sediment transport;
- c) Periodic maintenance of the drainage ways is needed to remove deposited silt therefore deepening and widening the channel; and
- d) Design of drainage has to take into account the topography of the processing site and the drainage ability to accommodate peak surface run-off.

59. Section 4.6, "Appropriate Transportation Methods", said:

Sand from the project site will be transported mainly via land and possibly by river transportation. Land transportation involves lorries of various sizes. Impact of this type of transportation will be fugitive dust from the sand itself and the gravel road on which the lorries travel. Appropriate measures such as covering the lorries with canvas or plastic sheets can prevent dust nuisance to road users and local residents. Provision for wheel washing facilities can reduce earth from soiling public roads.

Transportation of sand via river may be by barges. This method of transportation is normally utilized for projects which have no road access or only accessible via river. Impact from this method of transportation will be oily wastes due to leakages, boat traffic hazards and disturbance to the riverbed. Regular maintenance on barges is recommended to prevent oil leakages, which may contaminate the river. Safety of other river users should also be a priority to sand mining operators, therefore employment of personnel to regulate traffic flow is recommended. Disturbance on the riverbed on the other hand can be minimised by only allowing barge movement during periods of high water levels.

60. Section 4.7, "Modifying Operational Practices Working Time", said:

There should not be any mining activities on the following periods:

- a) Where there is a water intake point is downstream of the mining site, no operations should be carried out when the plant is taking in water.
- b) During breeding periods of fish and other aquatic inhabitants (the operator should verify with the Fisheries Department).
- c) During low water level due to dry season or low tide (data from DID).

61. Section 5.2, "Monitoring Plan", said:

A brief report summarizing the annual results of the physical and biological monitoring should document the evolution of the sites over time, and the cumulative effects of sand and gravel extraction.

62. Section 5.2.1 Sand Replenishment, Geomorphology and Hydrology said:

Physical monitoring requirements of sand extraction activities should include surveyed channel cross-sections, longitudinal profiles, bed material measurements, geomorphic maps, and discharge and sediment transport measurements. The physical data will illustrate bar replenishment and any changes in channel morphology, bank erosion, or particle size. In addition to local monitoring for replenishment at specific mining sites, monitoring of the entire reach to the estuary will provide information on the cumulative response of the system to sand extraction.

63. The specific focuses of the physical monitoring include the following:

- a) Cross-sections
- b) Reach Scale Cross-sections
- c) Mining Site Cross-sections
- d) Longitudinal Profile
- e) Geomorphic Maps
- f) Photo-documentation
- g) Hydrology and Sediment Transport
- h) Groundwater Level

64. Section 5.2.2 Riparian Habitat said:

a) Extent and Quality of Riparian Vegetation

Document the extent and quality of riparian vegetation, including successional status, and any increase in disturbance indicators (non-native plants). The extent of riparian

habitat can be determined utilizing aerial photos or satellite images. Habitat quality data, i.e., successional status and species composition, must be determined through field reconnaissance.

b) Riparian Vegetation Maps

Develop yearly maps of the sensitive habitat areas and document their aerial extent over time. These maps may be combined with the geomorphic maps. Monitor sites identified as sensitive for disturbance in excess of expected geomorphic trends - i.e., massive bank wasting up or downstream from an active mine site. Monitor sand mining impacts which may translate up and downstream, causing accelerated erosion of sensitive zones and impacting the ability of new habitat to form due to excessive scour or sedimentation.