Yayasan Sabah Danced

Management of Maliau Basin Conservation Area Sabah, Malaysia

TECHNICAL ASSISTANCE REPORT No. 30

Environmental Impact Studies (EIS)
For Maliau Basin Studies Center at
Maliau Basin Conservation Area

January 2002

Author: SEM CONSULTANTS
Block F, Lot 8, 2nd Floor
New Donggongon Township
MY 89500 Penampang, Sabah, Malaysia
Phone: + 60 88 728057 Fax: + 60 88 726057

This Document:

ENVIRONMENTAL IMPACT STUDIES (EIS)
FOR MALIAU BASIN STUDIES CENTER AT
MALIAU BASIN CONSERVATION AREA

Prepared For:

Maliau Basin Management Committee (DANCED-YAYASAN SABAH PROJECT)
Innoprise Corporation Sdn. Bhd
Forestry Division
8th & 9th Floor, Wisma Innoprise,
Teluk Likas, Kota Kinabalu
P.O.Box 11622,
MY 88817 Kota Kinabalu
Sabah, Malaysia

Prepared and Submitted by:

SEM CONSULTANTS
Block F, Lot 8, 2nd Floor,
New Donggongon Township
89500 Penampang, Sabah.
Tel: 088-728057 Fax: 088-726057

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1.0 EXECUTIVE SUMMARY

.1 Description of the Project

The Management of Maliau Basin Conservation Project (DANCED-YAYASAN SABAH) is in the process of establishing a Study Center at the southern border of the Maliau Basin Conservation area in a Class II Forest Reserve. A site of the study center has been proposed to be located on an area covering approximately 70 ha with a built-up area of approximately 18 ha west of the Maliau River. The development of the proposed field center consists of 19 components located at different locations within the planned 18 ha built-up area. (see Site Plan Drawing No: 0068/1/SP/01.

Although EIA report is not legally required for a small area such as the proposed site for the Field Center, in view of Maliau Basin being a gazetted Class I protection area, the Project Management through their own initiative has commissioned the conduction of environmental studies of the proposed development/site specifically to assess the following issues:

- solid waste and waste water
- noise and traffic
- flora and fauna

1.2 Findings

1.2.1 Environmental Impact

Solid and Liquid Wastes

Solid and liquid wastes from the development of the field center will mainly be from domestic i.e. from staff/workers quarters and the wastes from the laboratory/center. It is anticipated however, that there will be a greater amount of solid wastes generated from the construction of the field center and all the buildings that come with the center. These wastes are in the form of construction materials and plant debris resulting from site clearing.

Similarly, liquid wastes from the center will mainly be from domestic wastes i.e. sewage and kitchen wastes water. Sewage wastes and domestic wastewater (kitchen waste water) will need a proper treatment at the center to prevent contamination of waterways.

Other wastes that are of concern are oil and grease from kitchen and from vehicle depot and workshop.

Flora

It is found that there will be more trees that will be sacrificed than the actual reported in the development plan. The trees reported in the development plan to be cut are only trees with dbh above 30 cm. A large number of trees in the site are trees below the 30 cm dbh. Dr. Campbell Webb in his Technical Assistant Report no. 22, indicated that the site for the field center has been heavily logged and out all the trees he identified, only one tree was recommended not to be cut i.e. tree No. 1352. Most of the trees he identified at the site are not in the IUCN red list of endangered species. However, as stated earlier, most of the trees at the site are trees that are below the 30 cm dbh and as such, it is difficult to ascertain the status of these trees without a detailed inventory of the species these trees. A detailed inventory of these trees however, is not part of this EIA study.

For the purposes of sustainability and integrity of the conservation however, replacement planting with local, native species is advisable to be initiated by the Management committee elsewhere of the area in order to replace the trees that are to be cut from the site.

Fauna

Apart from displacement of the 70 hectares, noise from the construction of roads and the facilities, the major impact on the wildlife would be the danger of vehicular movement/transportation especially during construction period. During the initial operational period, impact to the wildlife apart from the displacement would be minimal. However, it is anticipated that as the road network is improved and the Keningau-Tawau road is completed, impact to the wildlife would increase, as the area becomes more accessible to poachers and also the danger of vehicular movement would increase. The potential negative impact to wildlife are:

- Increase access of poachers to the area (hunting threat)
- Danger of wildlife being run over or knocked by vehicular vehicles
- Displacement of wildlife due to land clearing
- As the road are widened and a belt of trees bordering the road are cut to help the drying of the road surface, some species may become ecologically isolated as they avoid crossing the road. This is true for a number of canopy-species and species reluctant to move out in open areas including smaller mammals and certain bird species.
- During operation of the study center, frequent vehicular movement and noise from this vehicular transportation will scare away wildlife from their habitat.

Dr. Carl Traeholt reported in his Technical Assistance Report for Zoological survey the abundance of rodents' population in the area.

Water Source

Since the project has already identified the Maliau River located about 1 kilometer from the MBSC, no assessment of water source was made, in this study. The architect technical consultant reported that water analysis has been taken but no results have been reported.

During our survey, no analysis was conducted to determine the quality of the water was made. It is recommended however, that a complete water quality testing be conducted before the water is to be piped for use in the area.

Traffic Impact

Presently, there is minimum traffic that goes into the area and there is negligible impact of the traffic to the wildlife, although the increased level through 2001 may already have had some negative effects on the population of Tembadaus (Dr. Carl Traeholt). The existing access road to the MBSC are presently frequented by many species of wildlife. Wildlife moves freely along the access road without the danger of being run over or knocked over by vehicular transport.

During the construction period of the center, traffic and vehicular movement will increase many folds to transport equipment and building materials to the area. The increase amount of workers working on the construction requires more transportation thus increasing the traffic in the area. This will have greater negative impact on the wildlife safety and movements. This impact however is anticipated to decrease at the completion of the center and at the initial operation.

The major and more detrimental impact of traffic will likely be felt once the road

network in the area is completed and the road linking Keningau to Tawau is completed particularly the main Keningau-Tawau road as the road being public road may be difficult to mitigate unless the road is constructed with gravel. The access road to Maliau Basin and the study center however, can be regulated to a certain extent by constructing the road with gravel only in areas frequented by wildlife. Tarmac road may be constructed in more exposed areas. More importantly, traffic can be regulated through the following steps:

- Prepare a traffic rules and regulation for the Maliau Conservation Area.
- Vehicular entry to the Maliau Basin area must strictly be regulated by constructing an entry gate where visitors must register and be brief on the 'dos' and 'don'ts' of the in the conservation area including traffic regulation.
- Strict enforcement of traffic regulation at all time by hiring a traffic personnel to monitor traffic movement in the conservation area.
- Construct a speed bumps at appropriate intervals to control vehicular speed.
- Strictly enforce traffic movement regulation. For example no visitors or unauthorized vehicles should be allowed entry after sunset. Vehicles entry should only be limited to those patrolling the area.

Noise Impact

The concern of noise impact is mainly to the wildlife but to a lesser degree to the workers population that will be stationed in the area. Noise impact is expected to be just temporary in nature as long as the building materials used in the construction are carefully selected and the noise coming from the generator set are carefully considered during installation.

Noise impact from the site will mainly come from the construction equipment such as machinery, excavators and vehicular transport.

Other impacts

Energy Source

The Architect Technical Consultant Mr. Paul Bidinger has identified two possible alternative energy supply solutions for MBSC apart from using generator sets:

a. Solar Photo Voltage PV and
b. Micro Hydro Power (HP)

Before any of these can be considered, a feasibility studies must be conducted by expert in the field to determine the best choice.

2.0 GENERAL INFORMATION

Project Title
The title of this project is Environmental Impact Study for Maliau Basin Field Center

2.2 Project Proponent/Management

This project comes under the management of Maliau Basin Management Committee of the DANCED-YAYASAN SABAH project whose address is at:

Innoprise Corporation Sdn. Bhd
Forestry Division
8th & 9th Floor, Wisma Innoprise,
Teluk Likas, Kota Kinabalu
P.O. Box 11622,
MY 88817 Kota Kinabalu
Sabah, Malaysia

Contact Persons: Mr. Hans Moeller
Chief Technical Advisor

Dr. Waidi Sinun
Project Director

Tel: 088 – 326300/326312
Fax: 088 – 243244
E—mail: hsmsabah@icsbrbj.po.my

2.3 EIS Consultant

The consultant appointed to prepare this Environmental Impact Study is Sustainable Environmental Management Consultants (SEM-Consultants), an environmental management consultancy firm based in Kota Kinabalu, Sabah. Its correspondence address is:

SEM – Consultants
Lot 8, Block F, 2nd Floor
Donggongon New Township
89500 Penampang, Sabah.

Contact person: B. Beth Baikan, Ph.D.
Managing Director

Tel: 088-728 057 / 726 034
Fax: 088-726 057/716107
E-mail: sepm1@tm.net.my

3.0 PROJECT DESCRIPTION

3. Statement of Need

Although EIA report is not legally required for a small area such as the proposed site for the Field Center, in view of Maliau Basin Conservation area being a gazetted Class I protection area, there is a need to preserve the environmental integrity of the area. The Project Management being fully aware of the importance of the area as conservation area, therefore, initiated in commissioning this environmental studies in order that all aspect of conservation is protected from degradation resulting from the implementation of the proposed field center.

3.2 Concept and Phases

The development of the field center will be carried out in phases on an area totaling approximately 70 hectares over a period of 3-5 years. The following are the proposed phases of the field center development:

No	Proposed Building/Center	Approximate Gross area (m^2)	Expected Implementation
1.	Office Block	488	Phase 2A
2.	Conference Building	215	Phase 2A
3.	Laboratory	480	Phase 2A
4.	Rest House	465	Phase 2A
5.	A/V Lounge & Toilet Block	80	Phase 2A
6.	Tree Top Lounge	72	Phase 3
7.	Accommodation 'A'	259	Phase 2A
8.	Accommodation 'B'	324	Phase 2A
9.	Surau	130	Phase 3
10.	Bedrooms accommodation	206	Phase 2B
11.	VIP Chalet	87	Phase 3
12.	Hostel	674	Phase 2B
13.	Detached House	87	Phase 2B
14.	Semi-detached house	139	Phase 2B/3
15.	Class Room	155	Phase 2B
16.	Service Building	161	Phase 2B
17.	Field	N/a	Phase 2A
18.	Badminton Court	N/a	Phase 2A
19.	Water Treatment Plant	N/a	Phase 2A
20.	Car Park	N/a	Phase 2A
21.	Information Center	256	Phase 3
22.	Viewing Tower	19	Phase 3
23.	Gen-Set Room	15	Phase 2A

3.2.1 Project Main Activities

The main activities of the project are

- Investigation and Planning Stage
- Construction Stage

- Operational Stage

Investigation stage of the project involve:
- Site Survey and preparation of development plan/drawings
- Commissioning of Environmental Impact Survey and Assessment

All the activities during investigation and planning stage have no significant impact on the environment.

Construction Stage.
The construction stage of the project involves the following activities:
- Construction of roads
- Land clearing and construction of the field center facilities
- Installation of other facilities/amenities (water storage, power supply etc)

The initial construction of roads involves cutting and earth moving, clearing of vegetation and construction of bridges for stream crossings. This stage is considered to have major impact on the environment due to the nature of the activities. Erosion will increase but is anticipated to be more localized.

Operational Stage
The operational stage of the project activities would involve the following:
- Establishment of the study center and staffing.

The initial stage of the operational phase will have minimum impact, as there will be small number of the staff to be stationed at the center. However, the long term cumulative impact of the operation phase will have a major impact on the environment in terms of solid wastes, wastewater, traffic, noise and flora and fauna impact.

3.3 Project Location

The project is located within the administrative District of Tawau. It is accessed through the Tawau-Keningau Road about 220 kilometers from Tawau.

3.4 Site characteristics

Land use
The existing land use of the project site is Class II Forest Reserve, which have been heavily logged. There are no villages or local inhabitants within the area except for those working in the Maliau Basin or the plantation and concession surrounding the area

Water Use
Since there are no inhabitants in the catchment area of Sg. Maliau and the immediate surroundings, the quality of the water at the Maliau River just a kilometer away from the site can be said to be relatively free from anthropogenic effluents, but will from time to time be influenced by silt and debris from natural landslides in the Basin.

Biological Environment
Biological environment in the project site includes terrestrial habitat such as flora and

fauna in secondary forest. (Details of flora and fauna found in the project area are appended in Annex 1)

It is a well-known fact that there is a relatively high diversity of wildlife/fauna in the Maliau Basin Conservation Area. Surveys conducted by several researchers confirm the diversity of fauna in the area and some of these are endangered or threatened species, e.g. 67 of 261 different bird species recorded in the area are included in IUCN and Birdlife International's 'Red Data Book on threatened bird species (2000). (See Zoological Survey report by Carl Traeholt, Interim Wildlife Survey Progress Report, Technical Report Assistance # 7 and reports by Sabah Parks on birds, Technical Report # 25. Lists of wildlife found in Maliau is excerpted from these reports and appended in this report for the purpose of reference only.

4.0 IMPACT PREDICTION AND EVALUATION

4.1 The Environmental Impact Assessment

The scope of the Environmental impact assessment for this report is focused on the following main issues:

- Solid Wastes and Liquid Wastes
- Impact of Traffic on Wildlife
- Impact on Noise on Wildlife and human

4.1.1 Solid Wastes

Assessment

Solid wastes

Since the proposed study center is still in the planning stage, assessment of solid wastes was made through assumption and based on the future estimated population at the center.

Findings

Solid wastes generated from the establishment of the study center are of two types:

a. Solid wastes resulting from land clearing, site preparation, road construction and construction of the study center. These wastes consist of plant debris, earth wastes and construction material wastes such as woodchips, cements, bricks and other construction materials.

b. Solid wastes generated from the operation of the study center, which mainly comes from domestic wastes from staff quarters, offices, restaurants, lodging house and laboratory. These wastes can be classified as recyclable and non-recyclable wastes.

The solid wastes generated from the former can be classified as temporary wastes which if managed properly will have no lasting impact to the environment. These are wastes that can easily be managed by proper removal and cleaning of the site once the construction is completed.

Solid wastes generated from the later (domestic wastes and wastes during operation of the center) will have detrimental impact to the environment and have a larger cumulative impact that if not properly managed at the initial stage will be harder to mitigate. The composition of these types of wastes can further be divided into several types of wastes such as:

PAPERS
MIXED PAPERS such as:
Envelopes, magazines,
catalogs, paperbacks,
writing paper, paper bags, mails

- NEWSPAPERS (All newsprint material)
- CARDBOARD such as:
  Boxes and other corrugated cardboard (e.g. smooth on the outside, wavy in the middle)
- THIN CARDBOARD
  Any thin cardboard such as shoe, cereal & cookie boxes, paper

egg cartons, toilet paper rolls, etc.

METALS, GLASS, PLASTIC & CARTONS

Metal Cans & Scrap Metal

Aluminum & tin cans, foil & pie plates, empty steel aerosol can, empty latex paint cans, scrap metal (any item that's all metal)

GLASS BOTTLES

Glass food & beverage containers

PLASTIC (BOTTLES/JUGS)

All plastic bottles such as milk, detergent, bleach, soda, salad dressing, etc.

MILK & JUICE CARTONS & DRINK BOXES

WET SOLID WASTE such as:

Food scraps or left over foods, vegetables trimmings etc.

Because of the wide variety of solid wastes generated from households, this makes management of the wastes more complex. The classification of the types of wastes above makes it easier to sort the wastes into recyclable, non-recyclable reusable and combustible.

During the initial stage of the operation period, the amount of solid wastes generated will be minimal if the amount of staff and workers are kept to a minimum. As the center established and infrastructures as well as facilities improved however, the amount of people needed at the center will increase and so will the number of visitors. Correspondingly, the amount of wastes generated will increase tremendously.

The Seventh Malaysia Plan reported that the amount of waste generated by urban population in 1993 range from 0.34 –0.85 kg/capita/day. ACE-solid waste guidelines estimated waste volume by the number of household occupants and the types of residence. The table below gives an estimated waste volume per person per month.

Types of Residence	**Waste Volume**
Apartment/Condominium	¾ cubic yard /per person/per month
One Bedroom	1 ¼ cubic yard/ bedroom/ per month
One unit apartment	2 ¼ cubic yard per unit /per month
Department store	1 ½ cubic yard per $1000 sales
Discount store	¼ cubic yard per $1000 sales
Office	¼ cubic yard per 100 sq ft/per month
Restaurant	¾ - 1 cubic yard per 100 meals served
School	½ cubic yard per 100 students/day without cafeteria
School with cafeteria	1 cubic yard per 100 students/day

Based on the table above, the amount of solid wastes that will be generated from the study center at each addition to the number of people can easily be estimated using the guidelines in the table above.

Using the figure in the 7th Malaysia plan, assuming that the number of staff at the initial stage of operation is 40 persons each with spouse without children, the

amount of garbage generated per day would range from 28 Kg to 68 Kg. Therefore, the initial waste production can be said to be minimal. However, wastes from the offices and laboratory must also be taken into consideration in planning for wastes management.

The current practice in Danum Valley whereby the solid wastes are disposed off on hill slope does not protect the environment and should be avoided. Transferring the wastes to other locations is detrimental to the future use of the land where the wastes are currently disposed of on hill slope. Additionally, the practice of dumping the solid wastes on hill slope is potentially detrimental to waterways, as these wastes will eventually be carried out by surface run off into streams and waterways.

Although the land where the wastes are disposed of at present may be empty and no immediate use, future use of the land by future generation must be taken into consideration before it is used for waste dumping.

4.1.2 Liquid wastes

Finding

As with the solid wastes, the source of liquid wastes and wastewater will mainly be from domestic (household wastewater including kitchen, toilet and bathroom wastes water).

The volume of wastes water production is dependent on the number of people in the center and the types of activities to be conducted in the center.
Potential environmental impact of wastes water (kitchen waste water and sewage) can be detrimental if management and disposal is not carefully planned at the initial stage.

Past experience with lack of planning in management and disposal as is currently experienced at the Borneo Rainforest Lodge (Borneo Rainforest Lodge Concepts and Routine Management by Joseph Gasis) shows a negative impact particularly in odor.

At the entrance to the proposed site of the Maliau Basin Study Center, there is a pond that at present pose an eyesore and uninviting to visitors with dead trees and heavily sedimented (See Plate No.13). It was also found that the pond is part of a wetland area that is low lying and always damp or soggy. This can be excavated deeper and turned into a lagoon to serve as an alternative onsite sewage secondary disposal system as well as water quality and storm water management and wildlife and fish habitat.

4.1.3 Oily wastes

Another wastes that could have potential negative environmental impacts are oily wastes. Oily wastes come mainly from vehicle maintenance workshop such as oil change, lubricating oil and household grease.

The major hazard associated with oily wastes is the surface and ground water contamination if they are improperly disposed of on ground surface.
Other hazard include health hazard from inhalation and skin irritation due to contact with these oily wastes.

4.1.4 Ecological Impacts (flora and fauna)

Flora (vegetation)

A site visit was conducted from the September 11th to 14th to survey the area. The site survey was conducted with the assistance of two field technicians from SEM-Consultant, an Architect from the Hussein Architect Sdn. Bhd and several field technicians from the Maliau Management Staff.

Prior to proceeding to the Maliau Basin Conservation Area, a short stop at the Luasong Forestry Center was made to talk to the staff in-charge of the Maliau Basin. Unfortunately, all staff concerned was not available at that time therefore, I was not able to interview the staff in charged of soil research on the Maliau Basin. The types of soil at the site of the center determines how much of the contaminants are bound by the soil particles and how much will leach into the subsoil. The type of soil at the site is an important consideration and must be taken into account when constructing a pit system to prevent leaching of potentially harmful leachates into the subsoil and pollute the water source..

During the site visit, a briefing to all the field technicians was done by the EIA Consultant, Dr. Baikan prior to field survey to explain the methodology of the survey and what to look for at the site.

The site survey was conducted specifically to see the existing environment at the site of the project such the vegetation at the site, soil condition –slope, stream directions, distance to water source, the water quality (by observation only), condition of the access road. A brief survey was conducted for wildlife through night drive and morning and evening for birds' observation. Nine-member team (6 staff of the Maliau Basin Management Group and 3 staff of SEM Consultants) conducted the survey.

Assessment

The team transected the whole future build-up area to get the feel of the area and to examine the existing environment. Trees that were marked to be cut in the development plan were checked against the trees in the field.

It was not possible to make trees count on the site, as there are numerous tree stands that are below 30 cm dbh but nonetheless are healthy trees that are worth preserving. Locations of each of the potential trees to be cut from the area are recorded with GPS reading.

Findings

Flora (Vegetation) Survey

There were several trees that were marked in the plan but could not be located in the field due to the lack of mark in the field. There were also numerous trees that are under 30 cm dbh that will be forfeited (See Plates No 4-6).

Specifically, the clearing of the area in site 1 on the development plan i.e. building for Rest House will results in loss of a dense tree saplings between 10 to 25 cm dbh. These trees although small are healthy trees that have potential for commercial values.

Similarly, the clearing of the area for the laboratory sites will results in loss of a large number of Seraya Punai saplings apart from the identified trees already marked in the development plan.

Dr. Campbell Webb in his Technical Assistant Report no. 22, indicated that the site

for the field center has been heavily logged. As reported in the technical report, out of all the trees identified by Dr. Webb, only one tree was recommended not to be cut i.e. *Koompasia excelsa*, tree No. 1352. As indicated by Dr.Webb, taxa collected from the site was compared to the IUCN red-list of endangered species. Although there was none of the taxa collected appeared in the red-list of endangered species, it does not necessarily mean that there is no endangered species in the area. However, it is difficult to ascertain the status of the trees without detailed inventory of the trees at the site. The list of trees identified to likely be cut during the construction of the Maliau Basin Studies Center are appended in Appendix 1.

Fauna (Wildlife) Survey (Impact of traffic)
Assessment
Assessment of wildlife survey impact was made through evaluation of several existing wildlife survey reports of the Maliau Basin Conservation Area. These reports include:

a. Zoological Survey report submitted by Dr. Carl Traeholt
b. Interim Wildlife Survey Progress Report No. 7 by Titol Peter Malim and Dr. Shigeki Yasuma
c. Technical Assistance Report No 25 by Alim Biun and Maklarin Lakim

The above reports were supplemented by site survey through 'night ride' conducted on the evenings and nights of the September 11th, 12th and 13th 2001.

Findings
From reading the reports and from the night ride along the road in the area, it can be said that it is a well-known fact that there is an abundant diversity of wildlife in the Maliau Basin Conservation area as well as its surrounding area including the MBSC. The species of wildlife found in the area from the various survey conducted for the area is appended in Annex II.
During the night ride, a large number of wildlife ranging from Banting, wildboar, deer, porcupine, sambar deer, snakes, were spotted within the Maliau Basin Conservation area. During the morning drive to the Belian Camp and the evening drive from the Gatehouse to the Agathis camp, several birds were spotted but the species could not be identified (as I am not familiar with bird species.) The Maliau Basin Conservation Area is indeed rich in wildlife diversity.
Dr. Carl Traeholt reported in his Technical Assistance Report for Zoological survey the abundance of rats' population in the area.

From an environmental perspective on the establishment of the study center in the area, apart from displacement of the 18 hectares built up area and the 70 hectares total alienated for the field center and the noise from the construction of roads and the facilities, the major impact on the wildlife would be the danger of vehicular movement/transportation especially during construction period and the disturbance of the wildlife due to the traffic.

Presently, there is minimum traffic that goes into the area and there is negligible impact of the traffic to the wildlife at the moment. The existing access road to the MBSC is presently frequented by many species of wildlife. Wildlife moves freely along the access road without the danger of being run over or knocked over by vehicular transport.

During the construction period of the center however, traffic and vehicular movement

will increase many folds to transport equipment and building materials to the area. The increase amount of workers working on the construction requires more transportation thus increasing the traffic in the area. This will have greater negative impact on the wildlife safety and movements. Vehicular and human induced noise will scare away wildlife from their habitat. This impact however is anticipated to decrease at the completion of the center and at the initial operation.

During the initial operation period, impact to the wildlife apart from the displacement would be minimal as it is minimal clearing of land will be carried out.

The major and more detrimental impact of traffic will likely be felt once the road network in the area is completed and the road linking Keningau to Tawau is completed. The completion of the road linking Keningau to Tawau and the access roads within the Maliau Basin Conservation Area will bring some potential negative impacts to the wildlife. The potential negative impacts to wildlife are:

- Increase access of poachers to the area (hunting threat)
- Danger of wildlife being run over or knocked by vehicular vehicles
- As the roads are widened and a belt of trees bordering the roads are cut to help the drying of the road surface, some species may become ecologically isolated as they avoid crossing the road. This is true for a number of canopy-species and species reluctant to move out in open areas including smaller mammals and certain bird species.

4.1.5 *Water Source*

Since the project has already identified the Maliau River located about 1 kilometer from the MBSC, no assessment of water source was made. The architect technical consultant reported that water analysis has been taken but no results have been reported so far. During our survey therefore, no analysis was conducted to determine the quality of the water was attempted. It is recommended however that a complete water quality testing be conducted before the water is to be piped for use in the area.

4.1.6 Noise Impact

The concern of noise impact is mainly to the wildlife but to a lesser degree to the workers population that will be stationed in the area. Noise impact is expected to be just temporary in nature as long as the building materials used in the construction are carefully selected and treated for acoustic control and the noise coming from the generator set are carefully considered during installation.
Noise impact from the site will mainly come from the construction equipment such as machinery, excavators and vehicular transport.

Once completed, the noise impact during the operation will be negligible and will only be noise from the household (television noise, radio and stereo etc).

4.1.7 Other impacts

Energy Source
The Architect Technical Consultant Mr. Paul Erik Bidinger has identified two possible alternative energy supply solutions for MBSC apart from using generator sets:

c. Solar Photo Voltage PV and
d. Micro Hydro Power (HP)

A rather detailed description of each type and cost-benefit of each has been presented

by the technical advisor. Nevertheless, before any of these can be considered, a feasibility studies must be conducted by expert in the field to determine the best choice.

Light Pollution

Light pollution in the context of MBSC is the "emission of artificial light into areas where it is unneeded or unwanted". In the context of MBSC, light pollution will be negligible as if lighting is confined to the buildings and offices only. Street light is not anticipated to be installed in any of the street in the MBCA therefore, the ecological disruption of light is will be negligible. A small disruption especially in areas surrounding the buildings will be expected. This disruption may be in term of disruption to the nighttime environment of flora and fauna.

5.0 RECOMMENDED MITIGATION MEASURES

5. Recommendation

A range of mitigation measures was explored to identify appropriate and practical mitigation measures of the identified impacts for the establishment of the study center. These recommendations are discussed and presented in this section.

5.1.1 Solid Waste Mitigation Measures

The first thing we must realize in dealing with solid wastes is that we cannot solve the solid waste dilemma just by finding new places to discard the trash. What is currently practiced in Danum Valley must not be repeated in Maliau Basin Conservation area (See Plate No. 1-3). What may be an empty and excess area at present may be a much needed area for the future generation. Therefore, hiding the trash by throwing them in the valley or hill slope must be avoided at all cost.
The mitigation measures that are proposed and recommended here are ways and means to reduce the amount of solid wastes to be discarded into pit/landfill or burn.

a. Source Reduction

Since the source of wastes in the Maliau Basin Studies Center is mainly from the households, source reduction in this context would be the purchase, or use of materials (such as products and packaging) to reduce the amount or toxicity of trash generated from the households.
Source reduction not only help reduce waste disposal and handling costs as it avoids the costs of recycling, composting, landfilling, and combustion, but it also conserves resources and reduces pollution to the environment.

As the saying goes, it is easier said than done, putting source reduction into practice will require some change in our daily routines but this does not mean a return to a more difficult lifestyle. In fact, it may results in positive outcome. If we don't reduce waste, the economic and social costs of waste disposal will continue to increase, and we will face increasingly harder decisions about managing our trash. The following are some means to reduce the wastes at source:

- Reduce the Amount of Unnecessary Packaging
  Packaging serves many purposes. Its primary purpose is to protect and contain a product. It also provide information, and preserve hygienic integrity and freshness. Some packaging, however, is designed largely to enhance a product's attractiveness or prominence on the store shelf. Since packaging materials account for a large volume of the trash we generate, they provide a good opportunity for reducing waste. Therefore, buy products that are economically packaged or better yet, buy products that are loose without fancy packaging.

- Buy in bulk
  Choose large or economy-size items for household products that are used frequently, such as laundry soap, shampoo, baking soda, pet foods. These sizes usually have less packaging per unit of product. For food items, choose the largest size that can be used before spoiling. This is especially important in the context of MBSC as it saves frequent trips to town.

- Buy concentrated products
  They often require less packaging and less energy to transport thus saving money as well as natural resources.

- Practice sharing with neighbor
  Seldom-used items, like certain power tools and party goods, often collect dust, rust, take up valuable storage space, and ultimately end up in the trash. Infrequently used items also might be shared among neighbors, friends, or family. Sharing items saves both money and natural resources. Such items that can be shared or borrowed are:
  - tables, chairs, centerpieces, linens, dishes, and silverware.
    ladders, chain saws, rug cleaners, and garden tillers.

  Share newspapers and magazines with neighbours to reduce the generation of waste paper.

- Sell or donate goods instead of throwing them out.
  Instead of discarding unwanted appliances, tools, or clothes, donate them to neigbhours or the villagers or the needy.

- Maintain and repair durable products.
  Some products if maintained and repaired properly, such as long- wearing clothing, tires, and appliances are less likely to wear out or break and will not have to be thrown out and replaced as frequently. Although durable products sometimes cost more initially, their extended life span may offset the higher cost and even save money over the long term.

- Choose long lasting products
  Choose low-energy fluorescent light bulbs rather than incandescent ones. They'll last longer, which means fewer bulbs are thrown out, and cost less to replace over time.

- Adopt practices that reduce waste toxicity.
  Apart from reducing the amount of materials in the solid waste stream, reducing waste toxicity is another important component of source reduction. Some jobs around the home may require the use of products containing hazardous components. Nevertheless, toxicity reduction can be achieved by learning the alternatives use of product you have around the house. In many cases the amount and toxicity of waste around the house can be done by using alternative methods or products without hazardous constituents to accomplish a certain task. Some of these alternatives are:

  Drain cleaner--Use a plunger or plumber's snake instead of chemical drain cleaner.
  Glass cleaner--Mix 1 tablespoon of vinegar or lemon juice in 1 quart of water. Spray on and use newspaper to wipe dry.

  Toilet bowl cleaner--Use a toilet brush and baking soda or vinegar. (This will clean but not disinfect.)

  - Furniture polish--Mix 1 teaspoon of lemon juice in 1 pint of mineral or vegetable oil, and wipe furniture.

Rug deodorizer--Deodorize dry carpets by sprinkling liberally with baking soda. Wait at least 15 minutes and vacuum. Repeat if necessary.

Silver polish--Boil 2 to 3 inches of water in a shallow pan with 1 teaspoon of salt, 1 teaspoon of baking soda, and a sheet of aluminum foil. Totally submerge silver and boil for 2 to 3 more minutes. Wipe away tarnish. Repeat if necessary. Another alternative is to use nonabrasive toothpaste.

Plant sprays--Wipe leaves with mild soap and water; rinse.
Mothballs--Use cedar chips, lavender flowers, rosemary, mint, or white peppercorns.

Flea and tick products--Put brewer's yeast or garlic in your pet's food; sprinkle fennel, rosemary, or eucalyptus seeds or leaves around animal sleeping areas.

When preparing alternatives, mix only what is needed for the job at hand and mix them in clean, reusable containers. This avoids waste and the need to store any cleaning mixture.

b. Reuse containers and products.

Another way to reduce the amount of wastes generated from the center is by reusing containers and products to extend their life. Many everyday items can have more than one use. Before discarding bags, containers, and other items, consider if it is hygienic and practical to reuse them. Reusing products extends their lives, keeping them out of the solid waste stream longer and help reduce the cost of managing solid waste and often conserves materials and resources.

- A sturdy mug or cup can be washed and used time and again. Bring your own mug to work to avoid buying plastic cups for the office.

- Sturdy and washable aluminum and plastic utensils and tableware can be used over and over again at home and for picnics, outdoor parties, and potlucks.

- Check if 'recharged' cartridges for laser printers, copiers, and fax machines are available for the office and laboratory. They not only reduce waste, but also save money.

- Some bottles and jugs for beverages and detergents are made to be refilled and reused.

- Where possible, use rechargeable batteries to help reduce garbage and to keep toxic metals found in some batteries out of the waste stream.

- Always remember that your goal is to reduce solid waste, so think about reusable when shopping.

    - Reuse paper and plastic bags on the next shopping trip, or take a

string, mesh, or canvas tote bag to the store.

- Reuse scrap paper envelopes and gift boxes, ribbons and other papers.
  - Use both sides of a piece of paper for writing notes before discarding or recycling it.
  - Save and reuse gift boxes, ribbons, and larger pieces of wrapping and tissue paper.
  - Save packaging, colored paper, egg cartons, and other items for reuse
  - Reuse newspaper, boxes, packaging "peanuts," and "bubble wrap" to ship packages. Brown paper bags are excellent for wrapping parcels.

- Wash and reuse empty glass and plastic jars, milk jugs, coffee cans, dairy tubs, and other similar containers that otherwise get thrown out. These containers can be used to store leftovers as well as buttons, nails, and thumbtacks. An empty coffee can makes a fine flower pot.

- Avoid disposable products.
  Much waste can be avoided by switching to cloth napkins, towels and diapers, washable plates and other tableware for picnics, rechargeable batteries, refillable razors, lighters, pens and pencils. Use a reusable coffee filter in coffee maker. These will greatly minimize the use of disposable filters thus reducing the amount of wastes. Use reusable mugs instead of plastic and paper cups for coffee.

CAUTION: Do not reuse containers that originally held products such as motor oil or pesticides. These containers and their potentially harmful residues should be discarded (following manufacturers' instructions on the label) as soon as they are empty. Also, never store anything potentially harmful in containers designed for food or beverages. Always label containers and store them out of reach of children and pets.

c. Recycle and use recycled materials

Recycling is the process by which materials are collected and used as raw materials for new products. There are four steps in recycling: collecting the recyclable components of solid waste, separating materials by type (before or after collection), processing them into reusable forms, and purchasing and using the goods made with reprocessed materials. Recycling prevents potentially useful materials from being landfilled or combusted, thus preserving our capacity for disposal. Recycling often saves energy and natural resources. There are many items in our wastes that are recyclable. Some of these are:

- Paper,
- Mixed Paper such as: Envelopes, magazines,catalogs, paperbacks, writing paper, paper bags, mail, newspapers.
- Aluminum cans (soda cans), foil & pie plates,
- Cardboards such as boxes and other corrugated cardboard (smooth on the outside, wavy in the middle)
- Thin cardboards such as shoe, cereal & cookie boxes, paper egg cartons, toilet paper rolls, etc.
- Glass, Plastic & Cartons

In the context of Maliau Basin Studies Center however, due to the distance

from town like Tawau and Keningau where only a limited recycling center is operating, sending recycle materials to the recycling center in either of these places on a routine basis may not be feasible. Some items such as newspapers and aluminum cans, can be accumulated and send to the recycling center in Tawau as and when a vehicle is going down for other purpose may be feasible but not for all kinds of recyclable on a regular basis. Other alternative is to have a recycling center at the site when funds and expertise permits the Management to do so.

It has to be realized however that while recycling can reduce wastes in the landfill or pit, it is not always a cost efficient way of reducing wastes especially where the volume of recyclable materials is small. Due to the cost involve and the limited recycling facilities in the region, recycling is not a realistic recommendation at this stage.

Nevertheless, reducing wastes in the solid wastes streams can still be done and recommended by choosing products made from recycled materials.

e. **Composting**

Composting is also a form of recycling which can play a key role in diverting organic wastes from disposal facilities.

Backyard composting of certain food scraps and kitchen waste can significantly reduce the amount of waste that needs to be managed or put in into the incinerator or the pit system. When properly composted, these wastes can be turned into natural soil additives for use in gardens, and use as potting soil for houseplants.

Composting is easy and it can take advantage of degradability of natural materials such as some foods. This is one way of returning nutrients to the earth.

Many foods can be composted, including vegetable trimmings, egg shells, coffee grounds with filters, and tea bags. In addition to leaves, grass, and yard clippings, vacuum cleaner lint, wool and cotton rags, sawdust, shredded newspaper, and fireplace ashes can be composted. DO NOT compost meats, dairy foods, or any fats, oil, or grease because they can attract pests

Composting Procedure

A compost pile can be set up in a corner of the yard with few supplies. Choose a level spot about 3- to 5-feet square near a water source and preferably out of direct sunlight. Clear the area of sod and grass. When building a composting bin, such as with chicken wire, scrap wood, or cinder blocks, be sure to leave enough space for air to reach the pile. One removable side makes it easier to tend the pile.

Start the pile with a 4-inch layer of leaves, loose soil, or other coarse yard trimmings or tree leaves. If you are going to compost food scraps (a slightly more involved process), you should mix them with yard trimmings when adding them to the pile. Alfalfa meal or clean cat litter may be added to the pile to absorb odors. In dry weather, sprinkle water on the pile, but don't get it too soggy. Turn the pile every few weeks with a pitchfork to circulate air and distribute moisture evenly. Don't be surprised by the heat of the pile or if you see worms, both of which are part of the decomposition process. Make sure children do not play in the composting pile or bin.

In most climates, the compost is done in 3 to 6 months when it becomes a dark crumbly material that is uniform in texture. Spread it in the garden or yard beds. The compost also can be used as potting soil.

Construction of Composting Bins:

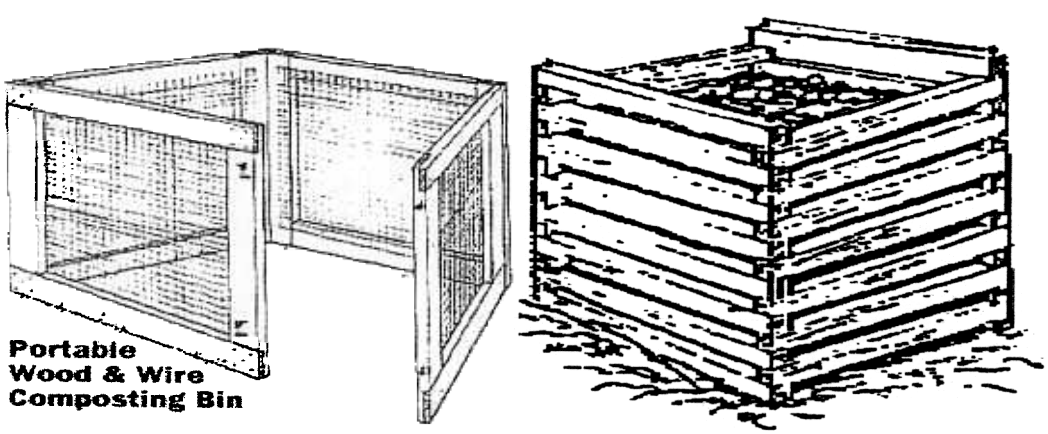
Materials needed:

- Poultry wire, wood or cinder blocks.
- Leaves, loose soil, food scraps

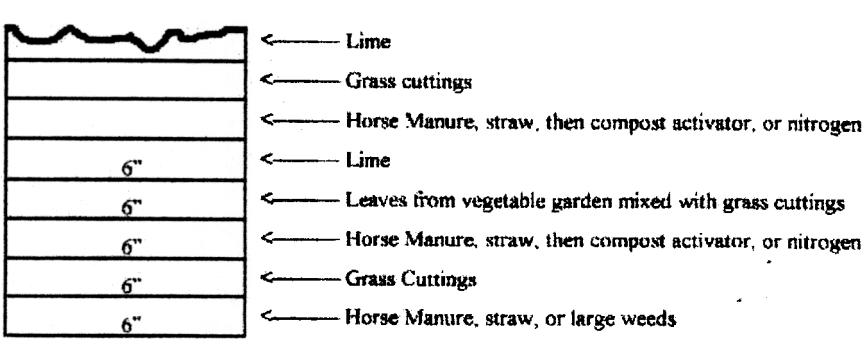
Steps:

- Select an area spot about 3 to 5 feet square near a water source and preferably out of direct sunlight.
- Clear the area of sod and grass.

Construct a composting bin. It is preferable to construct a composting bin with one removable side that makes it easier to tend the composting pile such as shown below.



- Start the pile in the bin with a 4-inch layer of leaves, loose soil or other coarse yard trimmings or tree leaves.
- Put in all biodegradable waste such as left over foodstuff, vegetable peels, paper, dried leaves, etc. Alfafa meal or clean cat litter may be added to the pile to absorb odors. The following shows an example of a layer compost pile.



- Cover with a thin layer of soil
- Water once or twice a week especially during dry weather to keep it moist but do not get it too soggy.
- Every 15 days or so turn the contents of the pit. Add more waste as it is generated.
- After 3 to 6 months the compost manure will be ready for use as shown in the picture below:

See Annex IV for more detail procedures of constructing bins and boxes for composting.

f. **Other alternatives to reducing solid wastes before they end up in the landfill, pit system or incinerator.**

Although the claims that certain products such as some plastic bags, paper products, and other goods are degradable have been hotly debated, this still does not save landfill space. Whether this claim has merits or not, the truth is, degradation occurs very slowly in landfills due to sunlight unable to penetrate the landfill thus photo degradation cannot take place. According to some reports, researchers have unearthed cabbages, carrots, and readable newspapers that have been in landfills for 30 years or more. It is unlikely that products marketed as degradable would achieve better results. Even if biodegradable products do perform exactly as they are supposed to, they still use up resources that could be reclaimed through recycling[1].

Therefore, the recommended alternative way to deal with such products especially at the Maliau Basin Studies Center are:

- Restrict the use of plastic bags into the area by encouraging the use of reusable canvas/cloth grocery bags.
- Strictly regulate the use of plastic bags in all the households at the center by imposing the amount of plastic per household to a minimum.
- Reuse plastic bags for grocery shopping and avoid disposing them either in pit or indiscriminately.

[1]The Consumer's Handbook for Reducing Solid Waste, August 1992[1]
(http:/www.epa.gov/epaoswer/non-hw/reduce/catbook.htm

- Visitors and tourist must be prohibited to bring in plastic bags and all disposable plastic products when entering the area.

When all of the above have been done to reduce the amount of wastes in the MBSC, the following can then be considered to handle wastes that are truly not usable, or not recyclable or those that are more expensive to reduce, reuse or recycle. Some of these items are: Metal Cans & Scrap Metal, empty steel aerosol can, empty latex paint cans, scrap metal or pesticides containers etc. Therefore it may be cheaper and more efficient to dispose them through the following:

g. **Pit System**

Pit system has been successfully used in other areas in disposing solid wastes. This system however, is only suitable in areas where the volume of solid wastes is small and the solid wastes are free of hazardous materials and the area is away from waterways. Many people are often unaware of the negative impacts of hazardous materials disposed off in pit system that eventually seeped into the water system.

Where the soil is porous and permeability is rapid, the pit system is not recommended. Metal cans that are non-hazardous can be discarded through the pit system.

The pit system can either be constructed individually by household or a community waste pit can be dug at suitable location at the site. The pit should be away from water source and preferably away from the quarters or lodging house so as to avoid odor. It should be large and deep enough to cater for the wastes from all the households in the center to avoid frequent digging. The size of the pit has to be carefully considered to cater for the amount of wastes to be discarded in them. In order to reduce the volume of waste that are thrown in the pit, metal cans should be compacted first before throwing them in the pit.

h. **Incinerator**.

As the center becomes more and more populated and as activities and tourist facilities become more and more developed, there will be a need for a proper and efficient facilities to cater for waste disposal. Waste combustion through incinerator plays a key role in managing waste that cannot be reduced or recycled. Combustion in specially designed facilities reduces the bulk of waste and provides the added benefit of energy recovery. Source reduction and recycling can remove items from the waste stream that may be difficult to burn, cause potentially harmful emissions, or make ash management problematic.

It is recommended that incinerator using solar energy (available in the US) be installed at suitable location (the site has been identified by the Architect).

Although incinerator has been successfully used, negative environmental impact has been reported resulting from a high content of heavy metals in the fly ash from the Refuse Derive Fuel. In some places, sorel cement has been used to stabilize fly ash originating from incinerators.

i. **Environmental and hygiene personnel**

All the above recommended mitigation measures to reduce wastes at the center and to properly dispose them will not be achieved without the strict enforcement of the mitigation measures. Therefore, it is highly recommended here that a personnel be hired specifically to strictly enforce the mitigation measures recommended in this report. The following are foreseeable tasks of the environmental and hygiene personnel at the center:

- To enforce the mitigation measures outlined in this report.
- To monitor the staff and household solid wastes disposal habit.
- To ensure that each staff and household comply to requirement of reducing the solid wastes through reduction at source, reusing and limiting the use of plastics in each household.
- To ensure that kitchen solid wastes are composted properly,
- To enforce strictly the plastic use regulation on tourist and visitors to the center.
- To monitor the use of plastic in offices and to ensure that they are not disposed of indiscriminately in any area within the center.

5.1.2 Liquid Waste Mitigation Measures

a. Septic tank

Septic tanks have been proposed by the Project Architect to treat primary sewage from household and the office buildings at the MBSC. These septic tanks will be expected to adequately cater for the Center. A three chambered septic tank with the same capacity with the traditional septic tank is recommended.

b. Lagoon (wetland) system

c. At the entrance to the proposed site of the Maliau Basin Study Center, there is a pond that at present pose an eyesore and uninviting to visitors with dead trees and heavily sedimented. This can be excavated deeper and turned into a lagoon to serve as secondary wastewater treatment before they are release into the waterways.

Apart from serving as secondary wastewater treatment, the lagoon can also function as some wildlife and fish habitat, storage of surface runoff and storm water management, recreation and aesthetic.

- Wildlife and fish habitiat

  Wetlands are one of the most productive ecosystem in the world and are critical for survival of many organism including zooplankton, worms, insects, crustaceans, reptiles, amphibians, fish, birds, mammals and plants[2].

  In the context of the proposed lagoon (wetland) at MBSC, it provides excellent habitat for amphibians, birds, insects, and aquatic plants. It has been estimated that wetlands provide habitats for 190 species of amphibians, 270 species of birds, 11 orders of insects and 5000 species of plants[3]. Amphibians including frogs, toads, and salamanders are abundance in Maliau Basin. These animals and their egg masses and

[2] Mitsch and Gosselink 1986 as reported in Balogh and Walker "Golf Course Management and Construction –Environmental Issues, 1992.

[3] Rucker 1988 as reported in Balogh and Walker "Golf Course Management and Construction – Environmental Issues, 1992.

tadpoles provide a critical food supply for snakes, fishes and other fauna. Therefore, the proposed lagoon system will provide good habitats for these amphibians.

While there was no fish observed at the pond during the survey, fries of some local species (indigenous to the area) can be released in the lagoon once the lagoon is constructed to enable the fish to populate the lagoon. Fishes from the lagoon however, should not be fished for consumption.

- Surface runoff and storm water management
  Surface runoff from the MBSC area can also be directed into the lagoon to prevent flash flooding. This also serves as sedimentation and siltation pond to the runoff pollutants thus preventing them to be release into the waterways that may contaminate the river water. Apart from serving as siltation, it can also store storm water during heavy rain thus slowing the entry of storm water into the rivers and also preventing the sediments loads to get into the river system.
- Recreation and Aesthetic
  Many wetlands in Sabah have recreational and aesthetic value. They provide recreational areas for fishing, canoeing, and bird and wildlife watching. Examples of these are the many lagoons in golf courses around Sabah. In the US, it is estimated that about 50 million people spend nearly $10 billion annually to observe and photograph wetland-dependent birds[4].
  The proposed recommended lagoon for secondary treatment of wastewater at MBSC can be built to have recreational and aesthetic value.
  A 3-5 foot walkway either across the lagoon for bird watchers or at the perimeter of the lagoon can be constructed out of the trees that are cut from the area to make way for the MBSC. This will also help utilize the cut trees and reduce the amount to be thrown out.

The following are important points to take into account when constructing the lagoon.

- The lagoon must be constructed as natural as possible with no concrete lining.
- The soil to be dug can either be used as embankment of the lagoon or spread in the area. Ensure that they will not end up clogging drains or waterways.
- Inventory of plant habitats in the area to be excavated for the lagoon should be carried out. This is to ensure that some of these plants can be replanted back so as not to introduce non-native plants. As much as possible, plants to be planted should be native plants of the area.
- Choose native wetland/lagoonae plants for planting in the lagoon.
- Wildflowers/plant native to the area can be planted at the perimeter of the lagoon not only for aesthetic purposes but also as buffer zone. Wildflowers can also attract butterflies and add to the recreational value of the lagoon.

(Design and depth of the lagoon have been discussed with the project architect)

[4] US. EPA 1988 as reported in Balogh and Walker, 1992

d. Oily waste disposal system.

Another liquid waste that also needs to be mitigated is oily waste that comes from maintenance workshop and kitchen oil and grease

Handling and disposal of oily wastes at the MBSC should strictly follow the Malaysian Department of Environment Guideline on the management and disposal of waste oil, EG9/94[5]

5.1.3 Flora Impact Mitigation Measures

a. Mitigation recommended to minimize the flora impact at the MBSC is through minimizing tree cut as much as possible. Minimizing cut however, does not mean ignoring the risk of branches falling. Every effort must be taken to minimize the risk and hazard not only to staff and personnel at the center but also visitors. As much as possible the experience of Borneo Rainforest of leaving too many trees around building resulting in buildings become moldy due to too much moisture and lack of light penetration, should be avoided at all cost. This is to avoid reapplying for permit to cut trees from the Forestry Department, which could take a long process. Also, cutting trees after the buildings are put in place will be much harder.

b. Replacement planting

As it has been recognized that there will be substantial trees particularly those that are under 30 cm dbh that will be cut to make way for the development of the MBSC. In view of this substantial loss, it is highly recommended that replacement planting with local/native species be carried out elsewhere in the Maliau Basin Conservation area.

By carrying out replacement planting, not only that sustainability of the native species is ensured but also augurs well for the area being a conservation area.

In doing a replacement planting, seedling of the native species can first be either collected from the area or seeds are collected and germinated in nursery.

5.1.4 Mitigation Measures to Traffic impacts on Wildlife/fauna Impact Mitigation

As indicated in the earlier section, the major and more detrimental impact of traffic to wildlife will likely be felt once the road network in the area is completed and the road

linking Keningau to Tawau is completed. The main Keningau-Tawau road once complete may be difficult to mitigate unless the road is constructed with gravel at the stretch adjacent to the MBCA. It is likely that this road will be a tarmac road and it will be difficult to control vehicular speed.

The access road to Maliau Basin and the study center however can be regulated to a certain extent by constructing the road with gravel only in areas frequented by wildlife. Tarmac road may be constructed in more exposed areas. More importantly, traffic can further be regulated through the following steps:

[5] Guidelines on the Management and disposal of wastes in upstream petroleum industries

a. Prepare traffic rules and regulation for the Maliau Conservation Area.
b. Vehicular entry to the Maliau Basin area must strictly be regulated by constructing an entry gate where visitors must register and be briefed on the 'dos' and 'don'ts' of the MBCA including traffic regulation specifically for MBCA. A guard must be posted at the gate to ensure that entry regulations are enforced at the entry point.
c. Strict enforcement of traffic regulation at all times by hiring a traffic personnel to monitor traffic movement in the conservation area.
d. Construct speed bumps at appropriate intervals for example at 20 meter intervals to control vehicular speed. The surface of the road must carefully be constructed where surface of road most frequented by wildlife should be constructed with gravel only.
e. Strictly enforce traffic movement regulation by regulating driving hours in the MBCA. For example no visitors or unauthorized vehicles should be allowed entry after sunset. Vehicles entry past the regulated driving hours should only be limited to those patrolling the area.
f. As there will be increase danger of poachers after the completion of the Keningau-Tawau Road, it is highly recommended that patrolling the border be carried out. This will also mean increasing the number of rangers in the area.
g. Strict registration procedures of visitors should be enforced at the entry point and each visitor should be briefed of the traffic regulation of the MBCA.
h. Where necessary, road toll system may be employed.
i. Limit access road to a one-way road with width not exceeding 4-4.5m.
j. Do not allow visitors to feed animals to avoid animal getting use to coming out to the roadside.

5.1.5 Mitigation Measures to Noise Impact

As indicated in earlier section, the noise impact from the site will mainly come from the construction equipment such as machinery, excavators and vehicular transport. Thus most of these noises are deemed temporary in nature as long as the building materials used in the construction are carefully selected and the noise coming from the generator set are carefully considered during installation. The noise that will have potential impact particularly to wildlife will be the traffic movement noise.

The following are some of the mitigation measures that are recommended to reduce the impact of noise at the site.

a. Using soundproof material where necessary. Soundproof materials are aplenty and available in the market. Therefore, they should be carefully selected to be used in minimizing the noise emitted from the buildings.
b. Noise can also be controlled by spray paint specially designed for noise reduction
c. Noise impact from traffic movement can be minimized by using tire crumbs to spread on roads. This had been successfully used in USA particularly in conservation area and parks.
d. Locating power generator sets in subsoil and away from residential or office site.

5.1.6 Mitigation measures of light impact

As indicated earlier, light pollution is negligible in the MBSC as street lights will not be installed and lights will be limited to buildings and offices. Nevertheless, where light causes glare and energy waste, the following should be practice to reduce them.

a. Use only efficient lighting by avoiding unnecessary lighting.
b. Light only around the areas for which the light is needed. This will avoid light trespass into areas where it is not need.
c. Select only low pressure sodium or high pressure sodium lamps
d. Avoid the use of mercury-vapour lamps as they are high energy consumer.

Photographs:

Plate No 1: Solid Wastes disposal area and practices for Danum Valley Research Center, located about 8 kilometres of Danum

Plate No 2: Solid Waste pushed down the hill slope at Danum Valley

Plate No 3: Garbage accumulated at the bottom of the hill at Danum Valley Wastes disposal area.

Plate No 4.

Plate No 5.

Plate No 6

Plate 4-6: Trees at the site of the MBSC that are under 30 cm dbh that will be forfeited for the construction of the MBSC.

Plate No 7: Some of the trees marked to be cut at the site of the MBSC

Plate No 8

Plate No 9.

Plates Nos 8-9 are existing access road at the MBCA leading to MBSC.

Plate No 10: Existing access road to Belian Camp

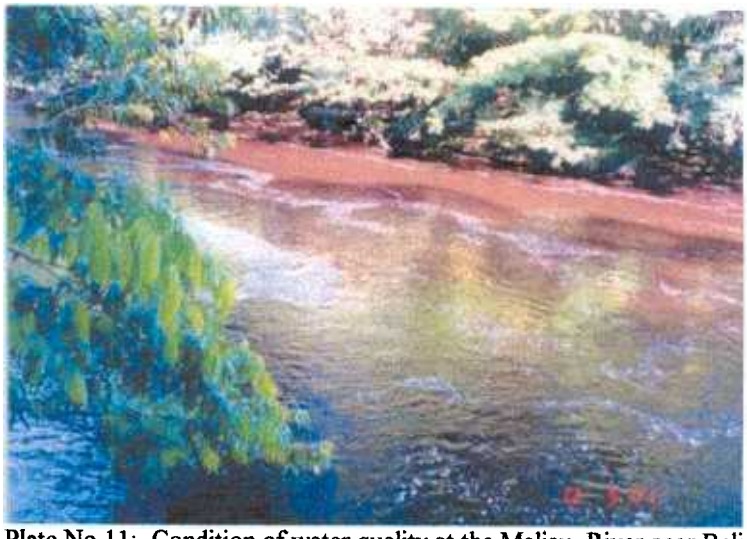


Plate No 11: Condition of water quality at the Maliau River near Belian Camp

Plate No 12: Water tank to store water pumped from Danum River at the Danum Research Center

Plate No 13: Pond at the entrance to the MBSC site that could be excavated to turn into secondary wastewater treatment.

Plate No 14: Tree fell on the road during evening ride to watch wildlife at Kilometer 11 (between Gatehouse and Agathis Camp)

Plate 15: MBCA staff clearing the felled tree from the road at 8 p.m

Plate 16: Part of the survey team posing at the end of survey.

ANNEX I:

TREES THAT WILL PROBABLY NEED TO BE CUT DURING CONSTRUCTION OF THE MB FIELD CENTER

Trees that will probably need to be cut during construction of the MB Field Centre

Building #	Tree #	Taxa	Notes
7&8	1250	*Dialium* sp.	No redlist spp. in genus
"	1222	*Shorea* sp.	"
	1252	*Shorea* sp.	
	1337	*Ixonanthes reticulatum*	Not on redlist
	1332	*Shorea* sp.	No redlist spp. in genus
	1330	*Canarium* sp.	Not matched to redlist spp.
	1326	*Lithocarpus* sp.	"
	1328	*Eusideroxylon zw.*	Not on redlist
4-6	1336	*Drypetes* sp.	Not matched to redlist spp.
"	1341	*Eusideroxylon* zw.	Not on redlist
"	1348	*Eusideroxylon* zw.	Not on redlist
"	1352	*Koompassia excelsa*	DO NOT CUT
"	1345	*Eusideroxylon zw.*	Not on redlist
"	1344	*Shorea* sp.	No redlist spp. in genus
"	1342	*Shorea* sp.	"
"	?	*Aglaia* sp.	No redlist spp. in genus
"	?	*Ficus* sp.	Leave for wildlife value?
2	1047	*Eusideroxylon* zw.	Not on redlist
"	1043	*Eusideroxylon* zw.	Not on redlist
"	?	*Shorea* sp.	No redlist spp. in genus
"	1032	cf. *Cynometra* sp.	"
"	1039	*Ochanostachys am.*	Not on redlist
"	1037	*Ficus* sp.	No redlist spp. in genus
"	?	*Eusideroxylon zw.*	Not on redlist
12	1047	*Shorea* sp.	No redlist spp. in genus
"	1052	*Shorea* sp.	"
"	?	*Parkia* cf. *speciosa*	Not on redlist
10-mid	941	*Quercus* sp.	No redlist spp. in genus
"	?	*Shorea* sp.	"
10-N	?	*Shorea* sp.	
10-S			Could not locate building
14-S		None	
14-N	?	*Shorea* sp.	No redlist spp. in genus
"	?	*Shorea* sp.	"
1	1029	*Artocarpus* sp.	
"	1027	*Eusideroxylon* zw.	Not on redlist
"	1026	*Payena* sp.	No redlist spp. in genus

ANNEX II:

LISTS OF FAUNA FOUND AT THE VICINITY OF THE MALIAU BASIN STUDIES CENTER (BELIAN CAMP)

Bird Research Project (Bird Banding) Mailau Basin (Belian Camp) Conservation Area

Yellow pb.: Yellow plastic band, TL: Total length, W: Wing, Tar: Tarsus, B: Beak

Appendix 2

No.	Ring No.	Common Name	Scientific Name	Sex	Age	TL	W	T	Tar.	B	Wgt	Net	Notes
1	B 00410	Yellow-vented Bulbul	*Pycnonotus goiavier*		A	135	88		20	15x8	28	C	No tail feathers
2	B 00411	Puff-backed Bulbul	*Pycnonotus eutilotus*		A	193	93	82	17	15x8	36	C	
3	A 00463	Hairy-backed Bulbul	*Tricholestes criniger*		A	149	71	69	14	13x5.5	15	C	
4	A 00464	Cream-vented Bulbul	*Pycnonotus simplex*		J	160	70	71	16	11x5	18	C	
5	A 00465	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*		J	78	50	23	13	8x4	7	C	
6	A 00466	Little Spiderhunter	*Arachnothera longirostra*		J	156	63	43	15	40x5	15	C	
7	A 00467	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	F	J	82	50	24	14	8x5	8	B	
8	A 00468	Little Spiderhunter	*Arachnothera longirostra*		A	131	62	42	15	35x5	11	B	
9	A 00469	Hairy-backed Bulbul	*Tricholestes criniger*		A	156	76	70	15	8x4.5	16	B	
10	A 00470	Brown Fulvetta	*Alcippe brunneicauda*		A	136	65	55	19	5x5	15	B	
11	A 00471	Rufous Piculet	*Sasia abnormis*	F	A	85	50	21	12	13x4.5	9	B	
12	A 00472	Brown Fulvetta	*Alcippe brunneicauda*		A	133	65	58	19	11x4.5	15	B	
13	A 00473	Brown Fulvetta	*Alcippe brunneicauda*		A	135	67	58	19	10x4.5	14	C	
14	A 00474	Cream-vented Bulbul	*Pycnonotus simplex*		A	158	72	66	16	12x5	18	C	
15	A 00475	Brown Fulvetta	*Alcippe brunneicauda*		A	129	65	55	18	11x5	17	C	
16	A 00476	Spectacled Bulbul	*Pycnonotus erythrophthalmos*		A	162	76	70	15	12x5	18	C	
17	A 00477	Rufous-tailed Tailorbird	*Orthotomus sericeus*		A	126	50	41	22	16x4.5	13	C	
18	A 00478	Yellow-breasted Flowerpecker	*Prionochilus maculatus*		J	86	51	25	13	9x5	9	C	
19	A 00479	Yellow-rumped Flowerpecker	*Prionochilus xanthopygius*	M	A	88	53	27	12	8x5	8	C	Endemic
20	A 00480	Yellow-rumped Flowerpecker	*Prionochilus xanthopygius*	F	A	81	46	25	12	9x5	8	C	Endemic
21	B 00412	Short-tailed Babbler	*Malacocincla malaccense*		A	134	67	35	30	14x5	27	A	
22	A 00481	Hairy-backed Bulbul	*Tricholestes criniger*		A	155	76	71	13	12x4.5	17	B	
23	A 00482	Purple-naped Sunbird	*Hypogramma hypogrammicum*	M	A	141	64	50	18	19x5	12	A	
24	B 00413	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		A	200	96	84	19	15x7.5	29	B	
25	B 00414	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		A	211	98	87	21	17x7.5	36	B	
26	B 00415	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		J	201	96	87	20	17x7.3	33	B	
27	B 00416	Short-tailed Babbler	*Malacocincla malaccense*		A	140	72	37	59	15x6	24	B	
28	B 00417	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		A	200	96	86	20	16x7	35	A	
29	B 00418	Ferruginous Babbler	*Trichastoma bicolor*		A	179	87	87	30	18x7.5	29	A	
30	A 00483	Little Spiderhunter	*Arachnothera longirostra*		J	168	74	47	17	40x5	15	C	
31	A 00484	Brown Fulvetta	*Alcippe brunneicauda*		A	145	69	62	18	11x5.5	14	C	
32	A 00485	Hairy-backed Bulbul	*Tricholestes criniger*		A	149	71	82	14	11x5	14	C	
33	B 00419	Puff-backed Bulbul	*Pycnonotus eutilotus*		A	196	92	82	17	14x10	40	C	
34	Yellow pb.	Blue-eared Kingfisher	*Alcedo meninting*		A	154	68	27	6	33x10	19	C	
35	A 00486	Brown Fulvetta	*Alcippe brunneicauda*		A	141	68	58	20	10x5.5	15	C	
36	A 00487	Brown Fulvetta	*Alcippe brunneicauda*		J	138	70	60	19	11x7.5	15	C	
37	B 00420	Short-tailed Babbler	*Malacocincla malaccense*		A	125	60	35	22	15x6	23	B	
38	A 00488	Little Spiderhunter	*Arachnothera longirostra*		A	158	68	45	15	42x5	15	B	
39	B 00421	Grey-headed Babbler	*Stachyris poliocephala*		A	135	62	49	22	17x8.5	21	B	
40	B 00422	Yellow-vented Bulbul	*Pycnonotus goiavier*		A	177	81	77	20	16x6	30	C	
41	B 00423	Buff-vented Bulbul	*Iole olivacea*		J	185	78	80	18	17x8.5	22	C	
42	A 00489	Grey-chested Jungle-Flycatcher	*Rhinomyias umbratilis*		A	141	67	63	21	16x6	22	C	
43	A 00490	Sooty-capped Babbler	*Malacopteron affine*		A	155	67	64	18	15x5	22	C	
44	A 00491	Sooty-capped Babbler	*Malacopteron affine*		A	162	77	70	20	16x6	17	C	
45	A 00492	Sooty-capped Babbler	*Malacopteron affine*		A	161	77	70	20	15x5.5	19	C	
46	A 00493	Brown Fulvetta	*Alcippe brunneicauda*		A	137	64	56	20	12x5	14	C	
47	B 00424	Puff-backed Bulbul	*Pycnonotus eutilotus*		A	207	94	88	17	17x7	42	C	
48	A 00494	Brown Fulvetta	*Alcippe brunneicauda*		A	138	65	58	19	11x4.5	13	C	
49	A 00495	Cream-vented Bulbul	*Pycnonotus simplex*		J	158	67	65	15	11.5x5	18	C	
50	C 00054	Rufous-tailed Shama	*Trichixos pyrrhopygus*		J	197	95	85	25	19x8	43	C	
51	B 00425	Sooty-capped Babbler	*Malacopteron affine*		A	160	74	66	20	16x6	21	A	
52	Yellow pb.	Blue-eared Kingfisher	*Alcedo meninting*		A	149	65	26	6	39x6	19	A	
53	B 00426	Scaly-crowned Babbler	*Malacopteron cinereum*		A	162	76	67	21	18x5	16	A	
54	A 00496	Sooty-capped Babbler	*Malacopteron affine*		A	159	75	68	20	15x5	17	A	
55	A 00497	Scaly-crowned Babbler	*Malacopteron cinereum*		A	159	76	68	20	15x4.5	19	A	
56	A 00498	Sooty-capped Babbler	*Malacopteron affine*		A	152	70	64	19	15x5	19	A	
57	B 00427	Rufous-crowned Babbler	*Malacopteron magnum*		A	191	77	22	20	20x8.5	33	A	
58	B 00428	Chestnut-rumped Babbler	*Stachyris maculata*		A	172	87	74	23	19x5.5	30	A	
59	A 00499	Sooty-capped Babbler	*Malacopteron affine*		A	157	77	67	20	17x5.5	19	A	
60	A 00500	Scaly-crowned Babbler	*Malacopteron cinereum*		A	156	75	60	20	12x5	16	A	
61	A 00501	Hairy-backed Bulbul	*Tricholestes criniger*		A	162	75	66	15	13x5.5	15	A	
62	B 00429	Chestnut-rumped Babbler	*Stachyris maculata*		A	171	81	66	20	17x8.5	28	A	
63	B 00430	Rufous-crowned Babbler	*Malacopteron magnum*		A	180	88	70	22	18x7	27	A	
64	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	143	61	21	8	35x8	19	A	
65	A 00502	Scaly-crowned Babbler	*Malacopteron cinereum*		A	153	75	63	17	13x5	16	A	
66	B 00431	Puff-backed Bulbul	*Pycnonotus eutilotus*		J	195	92	84	17	13x8.5	36	C	
67	A 00503	Cream-vented Bulbul	*Pycnonotus simplex*		J	158	72	63	15	11x8.5	19	C	
68	C 00055	Chestnut-backed Scimitar-Babbler	*Pomatorhinus montanus*		A	190	78	79	28	21x8	29	B	
69	A 00504	Spectacled Bulbul	*Pycnonotus erythrophthalmos*	F	A	161	75	62	15	10x5.5	19	B	
70	A 00505	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	F	A	87	51	21	12	9x5.5	8	B	
71		Yellow-breasted Flowerpecker	*Prionochilus maculatus*	F	A	98	59	27	13	9x5.5	9	B	
72	A 00506	Dusky Munia	*Lonchura fuscans*		A	106	49	36	12	8x7	9	B	Endemic
73	A 00507	Cream-vented Bulbul	*Pycnonotus simplex*		J	169	76	70	16	12x5.5	20	B	
74	A 00508	Yellow-rumped Flowerpecker	*Prionochilus xanthopygius*	F	A	91	50	25	12	8x6	8	B	Endemic
75	A 00509	Spectacled Bulbul	*Pycnonotus erythrophthalmos*	F	A	168	76	68	15	12x5.5	20	B	
76	A 00510	Hairy-backed Bulbul	*Tricholestes criniger*		A	147	71	64	13	11x5	14	A	
77	A 00511	Scaly-crowned Babbler	*Malacopteron cinereum*		A	148	74	62	20	12.5x5	27	A	
78	A 00512	Grey-chested Jungle-Flycatcher	*Rhinomyias umbratilis*		A	163	78	65	18	12x7	22	A	
79	A 00513	Scaly-crowned Babbler	*Malacopteron cinereum*		A	146	72	55	19	12x5	14	A	

80	A 00514	Scaly-crowned Babbler	*Malacopteron cinereum*		A	174	63	73	20	15x5	21	A		
81	B 00432	Rufous-crowned Babbler	*Malacopteron magnum*		A	188	91	76	23	17x8	33	A		
82	A 00515	Yellow-rumped Flowerpecker	*Prionochilus xanthopygius*	M	A	93	52	26	12	8x5	8	A		
83	A 00516	Grey-bellied Bulbul	*Pycnonotus cyaniventris*		A	184	78	67	20	10.5x5	22	C		
84	A 00517	Hairy-backed Bulbul	*Tricholestes criniger*		A	170	79	69	13	12x5	18	A		
85	A 00518	Plain Sunbird	*Anthreptes simplex*	F	A	122	59	44	14	15x4.5	10	B		
86	A 00519	Plain Sunbird	*Anthreptes simplex*	M	A	130	59	46	14	15x4.5	8	B		
87	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	142	57	21	6	32x8	27	B		
88	A 00520	Rufous-winged Philentoma	*Philentoma pyrhopterum*	F	A	163	78	68	15	14x7	17	B		
89	A 00521	Yellow-rumped Flowerpecker	*Prionochilus xanthopygius*	F	A	94	55	28	13	8x6.5	8	C		
90	A 00522	Rufous Piculet	*Sasia abnormis*	M	A	83	52	21	10	12x4	7	B		
91	A 00523	Large-billed Blue-Flycatcher	*Cyornis caerulatus*	M	A	145	78	60	17	14x7	19	A		
92	A 00524	Hairy-backed Bulbul	*Tricholestes criniger*		A	147	78	70	14	14x4.5	14	A		
93	B 00433	Yellow-vented Bulbul	*Pycnonotus goiavier*		A	191	87	75	21	14x6	29	C		
94	Yellow pb.	Blue-eared Kingfisher	*Alcedo meninting*		A	151	64	23	7	36x6	17	C		
95	A 00525	Rufous-tailed Tailorbird	*Orthotomus sericeus*		A	134	51	45	23	15x4	11	C		
96	C 00056	Grey-cheeked Bulbul	*Alophoixus bres*		A	212	99	86	19	17x8	38	C		
97	A 00526	Spectacled Bulbul	*Pycnonotus erythrophthalmos*	F	J	166	73	70	15	11x5	18	C		
98	H 00001	Crested Serpent-Eagle	*Spilornis cheela*	F	A	486	352	215	80	35x15	667	A		
99	A 00527	Scaly-crowned Babbler	*Malacopteron cinereum*		A	168	81	68	20	13x5	18	A		
100	A 00528	Large-billed Blue-Flycatcher	*Cyornis caerulatus*	M	A	161	78	60	15	13.5x7.5	20	A		
101	B 00434	Ferruginous Babbler	*Trichastoma bicolor*		A	189	88	71	29	17x8	28	A		
102	C 00057	Rufous-tailed Shama	*Trichixos pyrrhopygus*	M	A	222	101	90	26	17x8.5	47	B		
103	A 00529	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	F	A	95	52	25	10	8x4.5	8	B		
104	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	149	61	24	67	35x9	18	B		
105	A 00530	Yellow-rumped Flowerpecker	*Prionochilus xanthopygius*	M	A	93	54	24	12	9x5	8	C		
106	A 00531	Striped Tit-Babbler	*Macronous gularis*		A	146	60	56	21	11x5	16	C		
107	C 00058	Grey-cheeked Bulbul	*Alophoixus bres*		A	211	100	82	18	18x8.5	38	A		
108	A 00532	Scaly-crowned Babbler	*Malacopteron cinereum*		A	148	71	58	19	11.5x5	16	B		
109	A 00533	Striped Tit-Babbler	*Macronous gularis*		A	138	59	52	19	12x6	16	C		
110	B 00435	Olive-winged Bulbul	*Pycnonotus plumosus*		A	185	82	74	17	15x7.5	30	C		
111	A 00534	Chestnut-winged Babbler	*Stachyris erythroptera*		J	128	55	47	20	11x5	14	A		
112	A 00535	Chestnut-winged Babbler	*Stachyris erythroptera*		J	131	54	47	19	11x5	14	A		
113	B 00436	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		A	212	97	77	20	18x7.5	37	A		
114	A 00536	Purple-naped Sunbird	*Hypogramma hypogrammicum*	F	A	137	63	49	15	17x5.5	10	B		
115	C 00059	Puff-backed Bulbul	*Pycnonotus eutilotus*		J	211	94	88	20	15x6	41	C		
116	C 00060	Puff-backed Bulbul	*Pycnonotus eutilotus*		A	212	94	87	18	18x7	38	C		
117	A 00537	Rufous-winged Philentoma	*Philentoma pyrhopterum*	F	A	172	82	71	19	15x8	16	C		
118	B 00437	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		A	196	90	78	20	15x7.5	32	A		
119	Yellow pb.	Rufous-backed Kingfisher	*Ceyx rufidorsa*		A	145	58	22	7	34x6	19	B		
120	A 00538	Spectacled Bulbul	*Pycnonotus erythrophthalmos*		J	168	74	63	14	11x6	18	C		
121	B 00438	Ferruginous Babbler	*Trichastoma bicolor*		A	187	78	61	29	14x7	26	B		
122	B 00439	Ferruginous Babbler	*Trichastoma bicolor*		A	180	87	65	30	16x7	31	B		
123	B 00440	Buff-vented Bulbul	*Iole olivacea*		J	207	88	82	20	15x6.5	38	C		
124	A 00539	Little Spiderhunter	*Arachnothera longirostra*		A	151	61	40	14	35x4.5	12	C		
125	Yellow pb.	Rufous-backed Kingfisher	*Ceyx rufidorsa*		A	152	61	24	7	35x6	19	B		
126	A 00540	Chestnut-winged Babbler	*Stachyris erythroptera*		J	152	56	41	18	11x5	12	C		
127	A 00541	Scaly-crowned Babbler	*Malacopteron cinereum*		J	140	69	54	18	12x4	14	C		
128	A 00542	Spectacled Bulbul	*Pycnonotus erythrophthalmos*		A	171	78	67	16	11x5	20	A		
129	A 00543	Rufous-tailed Tailorbird	*Orthotomus sericeus*		A	135	50	46	21	16x4	11	B		
130	A 00544	Fluffy-backed Tit-Babbler	*Macronous ptilosus*		A	161	74	63	22	14x6	21	B		
131	A 00545	Scaly-crowned Babbler	*Malacopteron cinereum*		J	153	75	58	19	12x5.5	16	B		
132	A 00546	Scaly-crowned Babbler	*Malacopteron cinereum*		A	168	81	65	18	14x5	18	B		
133	A 00547	Scaly-crowned Babbler	*Malacopteron cinereum*		A	164	77	62	20	13x5	18	B		
134	B 00441	White-chested Babbler	*Trichastoma rostratum*		A	152	76	59	24	16x6	22	B		
135	B 00442	White-crowned Forktail	*Enicurus leschenaulti*		A	180	82	78	27	15x5	26	B		
136	A 00548	Asian Paradise-Flycatcher	*Terpsiphone paradisi*	F	A	208	89	92	17	16x10	21	A		
137	B 00443	Grey-headed Babbler	*Stachyris poliocephala*		A	144	73	50	21	16x5.5	24	B		
138	A 00549	Little Spiderhunter	*Arachnothera longirostra*		J	167	70	44	15	40x5	14	B		
139	B 00444	Scarlet-rumped Trogon	*Harpactes duvaucelii*	F	J	237	105	111	10	13x10	37	C		
140	A 00550	Brown Fulvetta	*Alcippe brunneicauda*		A	142	70	58	20	10x5.5	14	C		
141	A 00551	Brown Fulvetta	*Alcippe brunneicauda*		J	148	70	61	20	10x5.5	14	C		
142	A 00552	Brown Fulvetta	*Alcippe brunneicauda*		J	148	68	57	19	10x5.5	14	C		
143	A 00553	Brown Fulvetta	*Alcippe brunneicauda*		J	148	73	61	20	10.5x4	14	C		
144	A 00554	Fluffy-backed Tit-Babbler	*Macronous ptilosus*		A	160	68	65	20	16x9	21	A		
145	B 00445	Puff-backed Bulbul	*Pycnonotus eutilotus*		A	206	91	83	15	15x8.5	37	C		
146	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	148	59	22	8	34x6	20	B		
147	H 00002	Brown Wood-Owl	*Strix leptogrammica*		A	440	320	195	51.5	41x14.5	555	C		
148	A 00555	Purple-naped Sunbird	*Hypogramma hypogrammicum*	M	A	150	71	51	16.5	20x5	12	C		
149	Black pb.	Blue-eared Kingfisher	*Alcedo meninting*	M	A	190	78	37	7	44x9	37	D(A)		
150	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	137	59	22	7	30.5x6	18	D(A)		
151	A 00556	Spectacled Bulbul	*Pycnonotus erythrophthalmos*		J	166	72	71	16	11x5	18	E(B)		
152	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	142	58	23	7	35x5.5	19	E(B)		
153	A 00557	Siberian Blue Robin	*Erithacus cyane*		J	142	75	49	23	10x4.5	15	D(A)	Migratory	
154	Yellow pb.	Blue-eared Kingfisher	*Alcedo meninting*		A	152	54	28	7	37x8	20	D(A)		
155	D 00042	Maroon Woodpecker	*Blythipicus rubiginosus*		A	218	116	66	18	26.5x9	71	E(B)		
156	A 00558	Purple-naped Sunbird	*Hypogramma hypogrammicum*	M	A	143	66	45	15	18x5	12	C		
157	A 00559	Rufous-winged Philentoma	*Philentoma pyrhopterum*	F	A	173	85	70	15	14x8	28	C		
158	A 00560	Hairy-backed Bulbul	*Tricholestes criniger*		J	167	78	70	19	14x5	18	D(A)		
159	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	148	60	24	7	33x8.5	19	D(A)		
160	A 00561	Purple-naped Sunbird	*Hypogramma hypogrammicum*	F	A	135	60	46	15	17x5.5	11	E(B)		
161	A 00562	Brown Fulvetta	*Alcippe brunneicauda*		J	152	75	65	21	11x4.5	15	E(B)		
162	Yellow pb.	Black-backed Kingfisher	*Ceyx erithacus*		A	140	61	24	6	33x9	18	E(B)		
163	A 00563	Spectacled Bulbul	*Pycnonotus erythrophthalmos*		J	160	70	63	15	12x5.5	17	E(B)		
164	A 00564	Chestnut-winged Babbler	*Stachyris erythroptera*		A	132	61	48	17	14x5.5	12	E(B)		
165	A 00565	Hairy-backed Bulbul	*Tricholestes criniger*		A	154	69	63	17	12x5	14	D(A)		
166	A 00566	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	F	J	93	57	24	12	9x5	9	E(B)		

167	B 00446	Chestnut-rumped Babbler	*Stachyris maculata*		A	171	66	70	25	15x6	27	E(B)	
168	B 00447	Chestnut-rumped Babbler	*Stachyris maculata*		A	186	90	71	22	18x6.5	31	E(B)	
169	B 00448	Ferruginous Babbler	*Trichastoma bicolor*		A	183	91	65	30	18x6.5	31	E(B)	
170	A 00567	Scaly-crowned Babbler	*Malacopteron cinereum*		A	158	76	59	19	14x5	17	E(B)	
171	A 00568	Grey-chested Jungle-Flycatcher	*Rhinomyias umbratilis*		A	159	75	61	15	13.5x6	20	E(B)	
172	A 00569	Chestnut-winged Babbler	*Stachyris erythroptera*		A	132	62	51	20	13x5	13	E(B)	
173	B 00449	Rufous-crowned Babbler	*Malacopteron magnum*		A	179	84	64	21	15.5x6	28	E(B)	
174	H 00003	Oriental Bay Owl	*Phodilus badius*	M	A	255	200	80	40	25x15	214	E(B)	
175	A 00570	Chestnut-winged Babbler	*Stachyris erythroptera*		A	134	63	49	18	12x4.5	12	E(B)	
176	A 00571	Cream-vented Bulbul	*Pycnonotus simplex*		A	174	80	68	17	12x5	21	E(B)	
177	A 00572	Scaly-crowned Babbler	*Malacopteron cinereum*		A	151	73	61	20	11x5	14	E(B)	
178	A 00573	Hairy-backed Bulbul	*Tricholestes criniger*		J	157	71	62	13	11.5x6	13	D(A)	
179	C 00081	White-browed Shama	*Copsychus stricklandi*		A	243	99	123	28	14x8	37	D(A)	
180	A 00574	Fluffy-backed Tit-Babbler	*Macronous ptilosus*		A	167	77	68	23	13x7	21	E(B)	
181	A 00575	Fluffy-backed Tit-Babbler	*Macronous ptilosus*		A	166	69	62	22	14x7	21	E(B)	
182	B 00450	White-crowned Forktail	*Enicurus leschenaulti*		J	130	95		29	17x8	38	C	
183	A 00576	Spotted Fantail	*Rhipidura perlata*		J	178	86	83	15	12x8	15	D(A)	
184	B 00457	White-crowned Forktail	*Enicurus leschenaulti*		A	214	92	99	30	17x8	33	C	
185	B 00458	Cream-vented Bulbul	*Pycnonotus simplex*		J	177	78	61	18	14x8.5	27	C	
186	A 00577	Red-eyed Bulbul	*Pycnonotus brunneus*	F	J	176	72	70	18	11x5.5	20	C	
187	B 00459	Puff-backed Bulbul	*Pycnonotus eutilotus*		A	202	90	78	17	15x8.5	37	C	
188	B 00460	Red-eyed Bulbul	*Pycnonotus brunneus*		A	192	84	69	18	14x8	29	C	
189	A 00578	Cream-vented Bulbul	*Pycnonotus simplex*		A	171	75	65	18	10x5.5	24	C	
190	B 00461	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*		A	180	86	70	17	15x8	29	D(A)	
191	A 00579	Purple-naped Sunbird	*Hypogramma hypogrammicum*	F	A	132	61	40	14	19x5	12	D(A)	
192	A 00580	Hairy-backed Bulbul	*Tricholestes criniger*		A	152	71	61	15	12.5x5	13	E(B)	
193	A 00581	Hairy-backed Bulbul	*Tricholestes criniger*		A	149	70	60	15	13x5	13	E(B)	
194	A 00582	Yellow-breasted Flowerpecker	*Prionochilus maculatus*		A	95	52	25	12	8x5	8	C	
195	A 00583	Rufous Piculet	*Sasia abnormis*	M	A	62	54	18	11	12x5	9	E(B)	
196	A 00584	Chestnut-winged Babbler	*Stachyris erythroptera*		J	118	55	42	18	12x4.5	13	C	
197	B 00462	Ferruginous Babbler	*Trichastoma bicolor*		J	171	84	60	28	19x8.5	30	D(A)	
198	B 00463	Grey-headed Babbler	*Stachyris pallocephala*		A	133	65	49	22	17x5.5	22	C	
199	B 00464	Chestnut-rumped Babbler	*Stachyris maculata*		A	173	80	166	22	17x8	31	C	
200	B 00465	Chestnut-rumped Babbler	*Stachyris maculata*		A	177	84	67	23	22x6.5	30	E(B)	
201	A 00585	Rufous Piculet	*Sasia abnormis*	M	A	83	52	21	12	13x5	19	C	
202	A 00586	Dusky Munia	*Lonchura fuscans*		J	102	45	38	11	10x6.5	19	E(B)	Endemic
203	B 00466	Rufous-crowned Babbler	*Malacopteron magnum*		A	169	85	68	21	15x7.5	27	E(B)	
204	A 00587	Little Spiderhunter	*Arachnothera longirostra*		A	159	69	42	15	42x6	16	D(A)	
205	A 00588	Fluffy-backed Tit-Babbler	*Macronous ptilosus*		A	156	72	62	23	13x6	20	E(B)	
206	A 00589	Fluffy-backed Tit-Babbler	*Macronous ptilosus*		A	155	66	65	20	13x6	19	E(B)	

ANNEX III:

BIRDS OF MALIAU BASIN

BIRDS OF MALIAU BASIN

Mtt: Mist netted, **Mig/Res:** Migratory/Resident
IUCN – categories: VU- Vulnerable; LR- Lower Risk; NT- Near Threatened

Appendix: 1

Family/Species	Agathis Camp	Belian Camp	Notes	IUCN/Others Observed
Accipitridae				
Blyth's Hawk Eagle *Spizaetus alboniger*	+			+
Crested Serpent Eagle *Spilornis cheela*	+	+ 1 mtt	Accidentally mist netted	+
Falconidae				
White-fronted Falconet *Microhierax latifrons*		+	Endemic LR/nt	+
Phasianidae				
Great Argus *Argusianus argus*	+	+	LR/nt	+
Columbidae				
Lagre Green Pigeon *Treron capellei*	+	+	VU/A1 c+2c	+
Green Imperial-Pigeon *Ducula aenea*		+		
Mountain Imperial-Pigeon *Ducula badia*		+		+
Emerald Dove *Chalcophaps indica*	+	+		+
Psittacidae				
Blue-crowned Hanging-Parrot *Loriculus galgulus*	+	+		+
Cuculidae				
Large Hawk-Cuckoo *Cuculus sparverioides*	+	+		
Moustached Hawk-Cuckoo *Cuculus vagans*		+		
Banded Bay Cuckoo *Cacomantis sonneratii*		+		+
Plaintive Cuckoo *Cacomantis merulinus*		+		+
Drongo Cuckoo *Surniculus lugubris*		+		+

Raffle's Malkoha *Phaenicophaeus chlorophaeus*	+	+		+
Red-billed Malkoha *Phaenicophaeus javanicus*	+			+
Chestnut-breasted Malkoha *Phaenicophaeus curvirostris*	+	+		
Greater Coucal *Centropus sinensis*		+		+
Strigidae				
Oriental Bay Owl *Phodilus badius*		+ 1 mtt.		
Brown Wood-Owl *Strix leptogrammica*		+ 1 mtt.		+
Apodidae				
Glossy Swiftlet *Collocalia esculenta*	+	+		+
Silver-rumped Swift *Raphidura leucopygialis*	+	+		+
Little Swift *Apus affinis*	+	+		
Hemiprocnidae				
Grey-rumped Treeswift *Hemiprocne longipennis*	+			+
Whiskered Treeswift *Hemiprocne comata*	+	+		+
Trogonidae				
Red-naped Trogon *Harpactes kasumba*	+	+	(LR/nt)	+
Scarlet-rumped Trogon *Harpactes duvaucelii*	+	+ 1 mtt	(LR/nt)	+
Orange-breasted Trogon *Harpactes oreskios*	+			+
Cinnamon-rumped Trogon *Harpactes orrhophaeus*	+		LR/nt	
Alcedinidae				
Common Kingfisher *Alcedo atthis*	+			
Blue-eared Kingfisher *Alcedo meninting*	+ +	+ 5 mtt.	(VU/A1c+2c)	+ +

Banded Kingfisher *Lacedo pulchella*				
Black-backed Kingfisher *Ceyx erithacus*	+	+ 8 mtt		+
Rufous-collared Kingfisher Actenoides concretus	+			
Rufous-backed Kingfisher *Ceyx rufidorsa*		+ 2 mtt.		+
Meropidae				
Red-bearded Bee-Eater *Nyctyornis amictus*	+	+		+
Bucerotidae				
White-crowned Hornbill *Berenicornis comatus*	+	+	(LR/nt)	+
Bushy-crested Hornbill *Anorrhinus galeritus*	+	+		+
Wreathed Hornbill *Aceros undulatus*	+	+		+
Asian Black Hornbill *Anthracocerus malayanus*	+	+		+
Rhinoceros Hornbill *Buceros rhinoceros*	+	+	LR/nt	+
Helmeted Hornbill *Buceros vigil*	+	+	LR/nt	+
Megalaimidae				
Brown Barbet *Calorhamphus fuliginosus*	+	+		+
Gold-whiskered Barbet *Megalaima chrysopogon*	+	+		+
Red-crowned Barbet *Megalaima rafflesii*	+	+	LR/nt	+
Yellow-crowned Barbet *Megalaima henricii*	+	+	LR/nt	+
Blue-eared Barbet *Megalaima australis*	+	+		+
Indicatoridae				
Malaysian Honeyguide *Indicator archipelagicus*		+	Rare	

Picidae				
Rufous Piculet *Sasia abnormis*	+	+ 4 mtt.		+
Common Goldenback *Dinopium javanense*	+			
Olive-backed Woodpecker *Dinopium rafflesii*	+	+	LR/nt	
Crimson-winged Woodpecker *Picus puniceus*	+			+
Buff-rumped Woodpecker *Meiglyptes tristis*	+			+
White-bellied Woodpecker *Dryocopus javensis*	+	+		+
Great Slaty Woodpecker *Mulleripicus pulverulentus*	+			+
Maroon Woodpecker *Blythipicus rubiginosus*	+	+ 1 mtt.		+
Orange-backed Woodpecker *Reinwardtipicus validus*	+	+		+
Eurylamidae				
Green Broadbill *Calyptomena viridis*	+	+	LR/nt	+
Black-and-yellow Broadbill *Eurylaimus ochromalus*	+	+	LR/nt	+
Banded Braodbill *Eurylaimus javanicus*	+			+
Black-and-red Braodbill *Cymbirhynchus macrorhynchus*	+			
Hirundinidae				
Pasific Swallow *Hirundo tahitica*	+	+		+
Motacillidae				
Grey Wagtail *Motacilla cinerea*	+	+	Migratory	+
Campephagidae				
Bar-winged Flycatcher-Shrike *Hemipus picatus*		+		+
Black-winged Flycatcher-Shrike *Hemipus hirundinaceus*		+		+

Chloropseidae				
Green Iora *Aegithina viridissima*	+		LR/nt	+
Common Iora *Aegithina tiphia*	+			
Lesser Green Leafbird *Chloropsis cyanopogon*	+	+	LR/nt	+
Greater Green Leafbird *Chloropsis sonnerati*		+		+
Asian Fairy Bluebird *Irena puella*	+	+		+
Pycnonotidae				
Black-and-white Bulbul *Pycnonotus melanoleucos*	+		LR/nt	+
Grey-bellied Bulbul *Pycnonotus cyaniventris*	+	+ 1 mtt	LR/nt	+
Puff-backed Bulbul *Pycnonotus eutilotus*	+	+ 8 mtt.		+
Black-headed Bulbul *Pycnonotus atriceps*	+	+		+
Yellow-vented Bulbul *Pycnonotus goiavier*		+ 3 mtt.		+
Cream-vented Bulbul *Pycnonotus simplex*	+	+ 8 mtt.		+
Red-eyed Bulbul *Pycnonotus bruneus*		+ 2 mtt.		+
Spectacled Bulbul *Pycnonotus erytrophthalmos*		+ 8 mtt.		+
Finsch's Bulbul *Criniger finchii*	+		LR/nt	
Ochraceous Bulbul *Alophoixus ochraceus*	+	+		+
Grey-cheeked Bulbul *Alophoixus bres*	+	+ 2 mtt.		+
Yellow-bellied Bulbul *Alophoixus phaeocephalus*	+	+ 7 mtt.		+

Hairy-backed Bulbul *Tricholestes criniger*	+	+ 13 mtt.		+
Buff-vented Bulbul *Iole olivacea*		+ 2 mtt.	LR/nt	+
Streaked Bulbul *Ixos malaccensis*		+		+
Straw-headed Bulbul *Pycnonotus zeylanicus*		+		
Olive-winged Bulbul *Pycnonotus plumosus*		+ 1 mtt.		
Turdidae				
Rufous-tailed Shama *Trichixos pyrropyga*	+	+ 2 mtt.	LR/nt	+
Magpie Robin *Copsychus saularis*	+	+		+
Siberian Blue Robin *Erithacus cyane*		+ 1 mtt.	Migratory	
White-browed Shama *Copsychus stricklandii*	+	+ 1 mtt.		+
White-crowned Foxtail *Enicurus leschenaultii*	+	+ 3 mtt.		+
Timaliidae				
Black-capped Babbler *Pellorneum capistratum*	+	+		+
Temminck's Babbler *Pellorneum pyrrogenys*	+			+
White-chested Babbler *Trichastoma rostratum*	+	+ 1 mtt.	LR/nt	+
Ferruginous Babbler *Trichastoma bicolor*	+	+ 6 mtt.		+
Short-tailed Babbler *Malaccocincla malaccensis*	+	+ 3 mtt	LR/nt	+
Rufous-crowned Babbler *Malacopteron magnum*		+ 5 mtt.	LR/nt	+
Scaly-crowned Babbler *Malacopteron cinereum*	+	+ 15 mtt.		+

Sooty-capped Babbler *Malacopteron affine*		+ 7 mtt.	LR/nt	+
Chestnut-backed Scimitar Babbler *Pomatorhinus montanus*	+	+ 1 mtt.		+
Striped Wren Babbler *Kenopia striata*	+	+	LR/nt	+
Striped Tit-Babbler *Macronous gularis*	+	+ 2 mtt.		+
Fluffy-backed Tit-Babbler *Macronous ptilosus*		+ 6 mtt.	LR/nt	+
Chestnut-rumped Babbler *Stachyris maculata*	+	+ 6 mtt.	LR/nt	+
Rufous-fronted Babbler *Stachyris rufifrons*	+			+
Chestnut-winged Babbler *Stachyris erythroptera*	+	+ 7 mtt.		
Brown Fulvetta *Alcippe brunneicauda*	+	+ 14 mtt.	LR/nt	+
Chestnut-crested Yuhina *Yuhina everetti*	+	+	Endemic	+
Grey-headed Babbler *Stachyris poliocephala*	+	+ 3 mtt.		+
Sylviidae				
Arctic Warbler *Phylloscopus borealis*	+	+	Migratory	
Yellow-bellied Prinia *Prinia flaviventris*	+	+		+
Dark-necked Tailorbird *Orthotomus atrogularis*	+	+		+
Rufous-tailed Tailorbird *Orthotomus sericeus*	+	+ 3 mtt.		+
Muscicapidae				
Spotted Fantail *Rhipidura perlata*	+	+ 1 mtt.		+
Grey-headed Flycatcher *Culicicapa ceylonensis*	+	+		+

Verditer Flycatcher *Eumyias thalassina*	+			+
White-tailed Flycatcher *Cyornis concretus*	+			+
Hill Blue Flycatcher *Cyornis banyumas*	+			
Bornean Blue Flycatcher *Cyornis superbus*	+			+
Large-billed Blue Flycatcher *Cyornis caerulatus*		+ 2 mtt.	Lr/nt	+
Grey-chested Jungle Flycatcher *Rhinomyias umbratilis*	+	+ 3 mtt	LR/nt	+
Rufous-tailed Jungle Flycatcher *Rhinomyias ruficauda*	+	+		+
Asian Brown Flycatcher *Muscicapa daurica*	+	+	Mig/Res	
Rufous-winged Philentoma *Philentoma pyrhopterum*		+ 3 mtt.		+
Maroon-breasted Philentoma *Philentoma velatum*	+	+	LR/nt	+
Black-naped Monarch *Hypothymis azurea*	+	+		+
Asian Paradise Flycatcher *Terpsiphone paradisii*	+	+ 1 mtt.		+
Sittidae				
Velvet-fronted Nuthatch *Sitta frontalis*	+			+
Dicaeidae				
Yellow-rumped Flowerpecker *Prionochilus xanthopygius*	+	+ 6 mtt.	Endemic	+
Crimson-breasted Flowerpecker *Prionochilus percussus*	+			+
Yellow-breasted Flowerpecker *Prionochilus maculatus*	+	+ 7 mtt.		+
Orange-bellied Flowerpecker *Dicaeum trigonostigma*		+ 1 mtt.	Endemic	+
Nectariniidae				
Plain Sunbird *Anthreptes simples*	+	+ 2 mtt.		

Plain-throated Sunbird *Anthreptes malacensis*	+			
Purple-naped Sunbird *Hypogramma hypogrammicum*	+	+ 6 mtt.		+
Crimson Sunbird *Aethopyga siparaja*	+	+		+
Temminck's Sunbird *Aethopyga temminckii*	+	+		+
Little Spiderhunter *Arachnothera longirostra*	+	+ 7 mtt.		+
Spectacled Spiderhunter *Arachnothera flavigaster*		+		+
Sturnidae Hill Myna *Garcula religiosa*	+	+		+
Cracticidae Bornean Bristlehead *Pityriasis gymnocephala*	+	+	Endemic LR/nt	+
Estrildidae Dusky Munia *Lunchura fuscans*	+	+ 2 mtt.	Endemic	+
Dicruridae Greater Racket-tailed Drongo *Dicrurus paradiseus*	+	+		+
Oriolidae Dark-throated Oriole *Oriolus xanthonotus*	+	+	Lr/nt	+
Corvidae Crested Jay *Platylophus galericulatus*	+	+	LR/nt	+
Black Magpie *Platysmurus leucopterus*	+	+	Lr/nt	+
Large-billed Crow *Corvus macrorhynchos*	+	+		

ANNEX IV:

SUMMARY OF MITIGATION MEASURES

1. HOW TO REDUCE SOLID WASTE IN MALIAU BASIN STUDIES CENTER

The mitigation measures that are proposed and recommended here are ways and means to reduce the amount of solid wastes to be discarded into pit/landfill or burn.

a. First of all, avoid throwing trash in valleys, hill slope or in vacant areas anywhere in the area.

b. Source Reduction

- Buy products that are economically packaged or better yet, buy products that are loose without packaging.
- Buy products in bulk
  Choose large or economy-size items for household products that are used frequently, such as laundry soap, shampoo, baking soda, and pet foods.
- Buy concentrated products
- Practice sharing with neighbors
  Share or borrow seldom-used items, like certain power tools, tables, chairs, centerpieces, linens, dishes, and silverware, ladders, chain saws, and garden tillers with neighbors.
- Share newspapers and magazines with neighbors to reduce the generation of waste paper.
- Sell or donate goods such as unwanted appliances, tools, or clothes to neighbors or the villagers instead of throwing them out.
- Maintain and repair durable products.
  Some products if maintained and repaired properly, such as long- wearing clothing, tires, and appliances are less likely to wear out or break and will not have to be thrown out and replaced as frequently. Although durable products sometimes cost more initially, their extended life span may offset the higher cost and even save money over the long term.
- Choose long lasting products
  Choose low-energy fluorescent light bulbs rather than incandescent ones. They'll last longer, which means fewer bulbs are thrown out, and cost less to replace over time.
- Use alternative products to reduce waste toxicity. The following are some alternatives means to reduce toxicity:
  - Drain cleaner--Use a plunger or plumber's snake instead of chemical drain cleaner.
  - Glass cleaner--Mix 1 tablespoon of vinegar or lemon juice in 1 quart of water. Spray on and use newspaper to wipe dry.
  - Toilet bowl cleaner--Use a toilet brush and baking soda or vinegar. (This will clean but not disinfect.)
  - Furniture polish--Mix 1 teaspoon of lemon juice in 1 pint of mineral or vegetable oil, and wipe furniture.
  - Rug deodorizer--Deodorize dry carpets by sprinkling liberally with baking soda. Wait at least 15 minutes and vacuum. Repeat if necessary.
  - Silver polish--Boil 2 to 3 inches of water in a shallow pan with 1 teaspoon of salt, 1 teaspoon of baking soda, and a sheet of aluminum foil. Totally submerge silver and boil for 2 to 3 more minutes. Wipe away tarnish. Repeat if necessary. Another alternative is to use nonabrasive toothpaste.
  - Plant sprays--Wipe leaves with mild soap and water; rinse.
  - Mothballs--Use cedar chips, lavender flowers, rosemary, mint, or white peppercorns.

- Flea and tick products--Put brewer's yeast or garlic in your pet's food; sprinkle fennel, rosemary, or eucalyptus seeds or leaves around animal sleeping areas.

When preparing alternatives, mix only what is needed for the job at hand and mix them in clean, reusable containers. This avoids waste and the need to store any cleaning mixture.

c. Reuse containers and products.

Many everyday items can have more than one use. Reusing products extends their lives, keeping them out of the solid waste stream longer and help reduce the cost of managing solid waste and often conserves materials and resources.

- Bring your own mug to work to avoid buying plastic cups for the office.
- Wash and reuse washable aluminum and plastic utensils and tableware over and over again at home and for picnics, outdoor parties, and potlucks.
- Check if 'recharged' cartridges for laser printers, copiers, and fax machines are available for the office and laboratory. They not only reduce waste, but also save money.
- Some bottles and jugs for beverages and detergents are made to be refilled and reused.
- Where possible, use rechargeable batteries to help reduce garbage and to keep toxic metals found in some batteries out of the waste stream.
- Reuse paper and plastic bags on the next shopping trip, or take a string, mesh, or canvas tote bag to the store.
- Reuse scrap paper envelopes and gift boxes, ribbons and other papers.
  - Use both sides of a piece of paper for writing notes before discarding it.
  - Save and reuse gift boxes, ribbons, and larger pieces of wrapping and tissue paper.
  - Save packaging, colored paper, egg cartons, and other items for reuse
  - Reuse newspaper, boxes, packaging "peanuts," and "bubble wrap" to ship packages.
- Wash and reuse empty glass and plastic jars, milk jugs, coffee cans, dairy tubs, and other similar containers. Use these containers to store leftovers as well as buttons, nails, and thumbtacks or flower pots.
- Avoid disposable products. Switch to cloth napkins, towels and diapers, washable plates and other tableware for picnics, rechargeable batteries, refillable razors, lighters, pens and pencils.
- Use a reusable coffee filter in coffee maker to minimize the use of disposable filters thus reducing the amount of wastes.
- Use reusable mugs instead of plastic and paper cups for coffee.

CAUTION: Do not reuse containers that originally held products such as motor oil or pesticides. These containers and their potentially harmful residues should be discarded (following manufacturers' instructions on the label) as soon as they are empty. Also, never store anything potentially harmful in containers designed for food or beverages. Always label containers and store them out of reach of children and pets.

d. Recycle and use recycled materials

In the context of Maliau Basin Studies Center recycling is not a realistic recommendation at this stage. Nevertheless, reducing wastes in the solid wastes streams can still be done

recommended by choosing products made from recycled materials.

nposting

Backyard composting of certain food scraps and kitchen waste can significantly reduce the amount of waste that needs to be managed or put into the incinerator or the pit system. When properly composted, these wastes can be turned into natural soil additives for use in gardens, and use as potting soil for houseplants.
Many foods can be composted, including vegetable trimmings, egg shells, coffee grounds with filters, and tea bags. In addition to leaves, grass, and yard clippings, vacuum cleaner lint, wool and cotton rags, sawdust, shredded newspaper, and fireplace ashes can be composted. **DO NOT** compost meats, dairy foods, or any fats, oil, or grease because they can attract pests

Composting Procedure

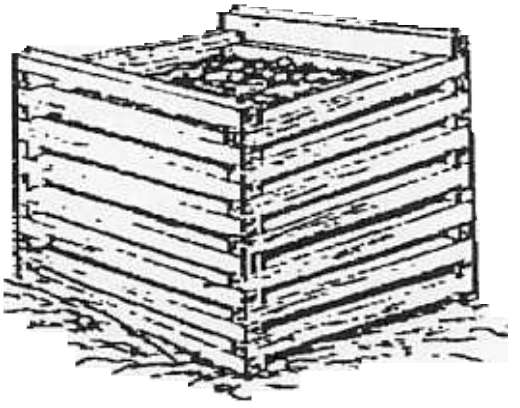
Construction of Composting Bins:

Materials needed:

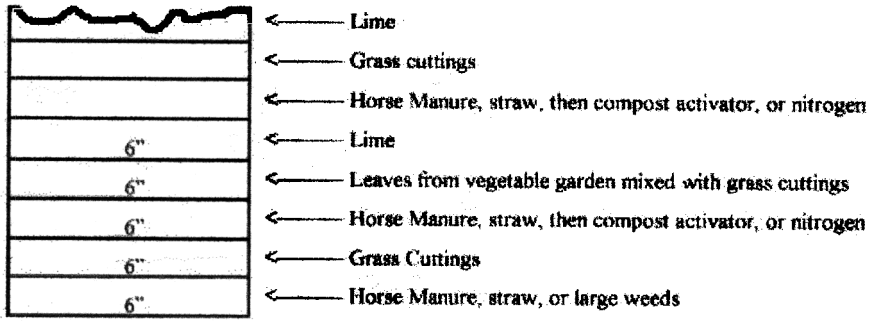
- Poultry wire, wood or cinder blocks.
- Leaves, loose soil, food scraps

Steps:

- Select an area spot about 3 to 5 feet square near a water source and preferably out of direct sunlight.
- Clear the area of sod and grass.
- Construct a composting bin. It is preferable to construct a composting bin with one removable side that makes it easier to tend the composting pile such as shown below.



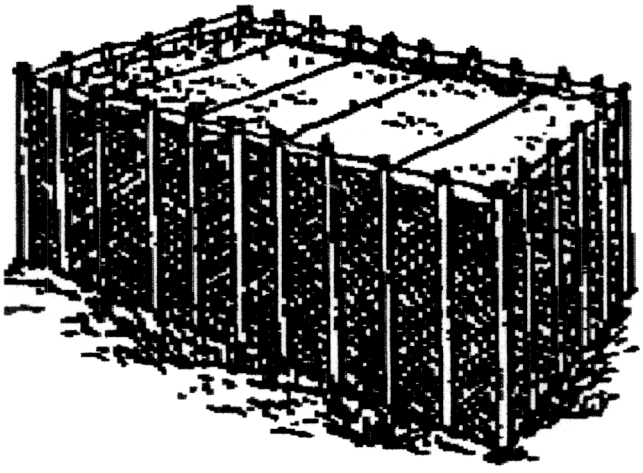
- Start the pile in the bin with a 4-inch layer of leaves, loose soil or other coarse yard trimmings or tree leaves.
- Put in all biodegradable waste such as left over foodstuff, vegetable peels, paper, dried leaves, etc. Alfafa meal or clean cat litter may be added to the pile to absorb odors. The following shows an example of a layer compost pile.



- Cover with a thin layer of soil
- Water once or twice a week especially during dry weather to keep it moist but do not get it too soggy.
- Every 15 days or so turn the contents of the bin. Add more waste as it is generated.
- After 3 to 6 months the compost manure will be ready for use as shown in the picture below:

BUILDING BINS AND BOXES FOR COMPOST

i. Chicken Wire Bin.

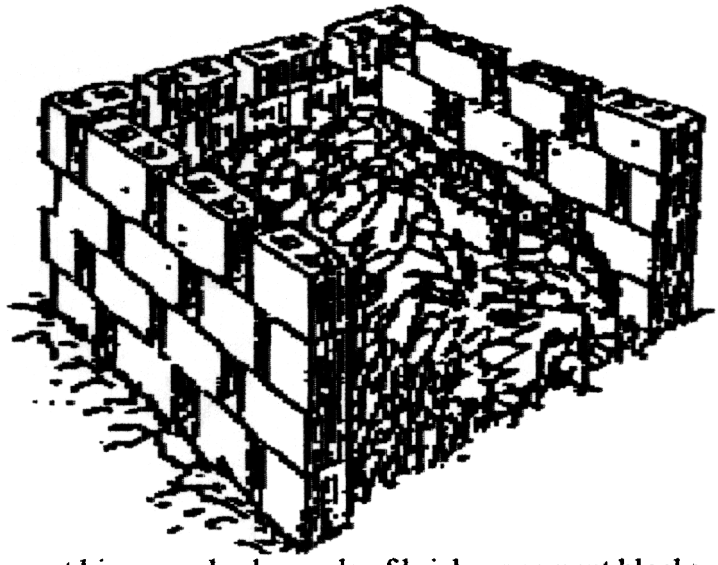


A variation of the wire retainer described above can be made using chicken wire, wood stakes and soft iron baling wire. Thirty feet of ½"-woven chicken wire, 30 four-foot high stakes and about 60 feet of soft iron baling wire will make a container that will hold about 200 cubic feet of compost.

To construct this container:

- First mark off a rectangle about 10'x5'.
- Drive the stakes six inches deep along the edge of this rectangle, placing them about a foot apart.
- Loop the bin with a continuous strip of baling wire.
- Place the chicken wire inside the stakes and fasten it by twisting small pieces of baling wire around the stakes.
- Tie lengths of baling wire across the width of the container to keep the stakes from spreading when the bin is filled with compost. These cross braces looped over alternate pairs of stakes allow ample space for easy loading of your compost. As the compost presses outward against the chicken wire, the stakes will pull the soft baling wire bracings tightly around the container.
- When it's time to turn the compost, remove the small ties holding the chicken wire to the wood stakes.
- Then remove the cross bracing wires.
- After pulling out the wooden stakes, carefully roll away the chicken wire and turn the compost pile.
- Use the same materials to rebuild your container within shoveling distance of the old heap.

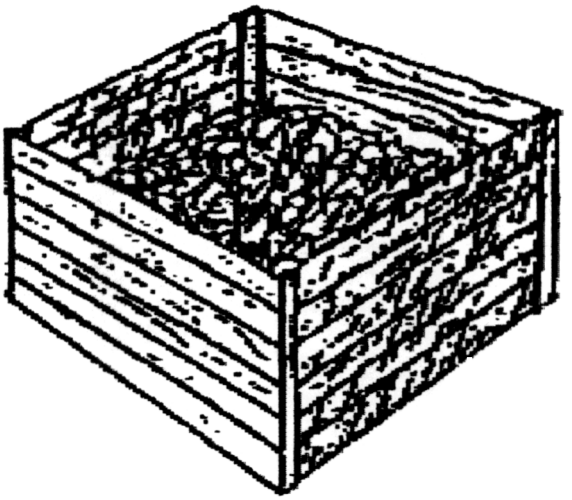
ii. Block or Brick Bins



Compost bins can also be made of brick, or cement blocks, or rocks.

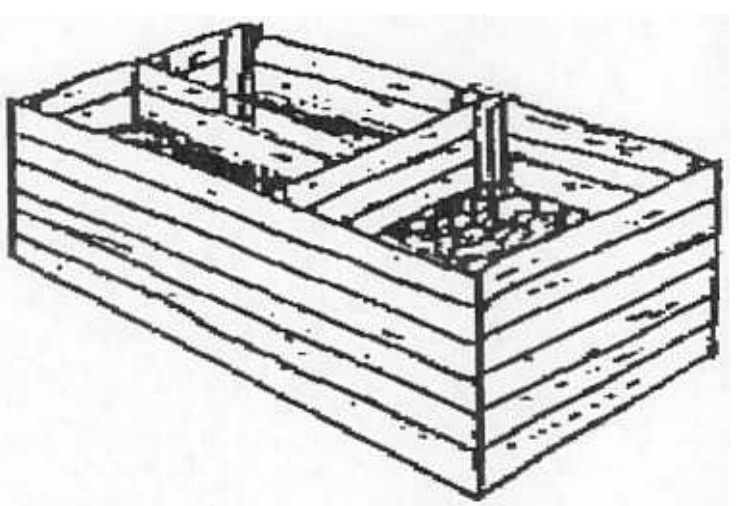
- Lay the blocks without mortar.
- Leave spaces between each block to permit aeration.
- Pile them up to form three sides of a square container.
- This bin is sturdy, durable and easily accessible.

iii. Wooden compost bin



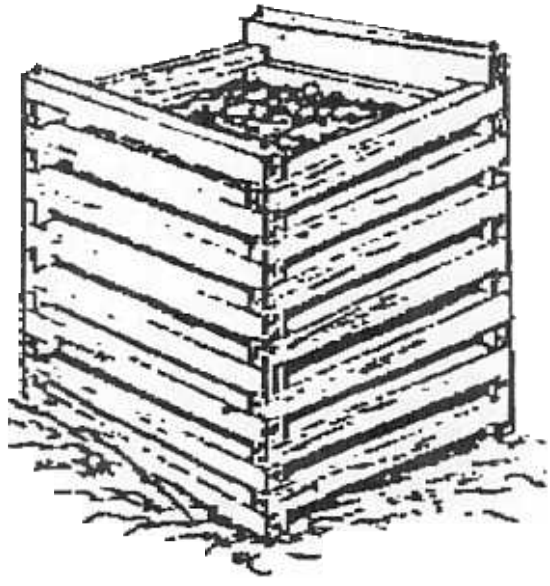
The simplest is a wooden structure 4 feet square by 4-5 feet high without top or bottom as shown in the picture.

- The wooden sides consist of 6-inch wide by ¾-inch thick boards.
- Allow ½-inch of air space between each board so that air may penetrate the heap from all sides.
- The box is movable.
- Place a divider in front that slides down between two posts so that when you **want to** empty the box, you can pull the dividers upward and take them out one by one.
- Two by fours (2x4s) provide the structural framework for this box.
- The preferred method of filling the box is to mix organic materials thoroughly with soil, lime and manure.
- Make one air hole in the center of the box all the way down to the ground using a crowbar.
- If you turn the mixture twice, you don't need to put in an air hole after the second turn.
- When the compost is ready to be turned, it has to be piled outside the box and then put back again.
- You can save yourself some time by doubling the box size (4'x8') with a partition in the center as shown in the diagram below. The material is forked from one section into the other and a new batch is then placed into the first section.



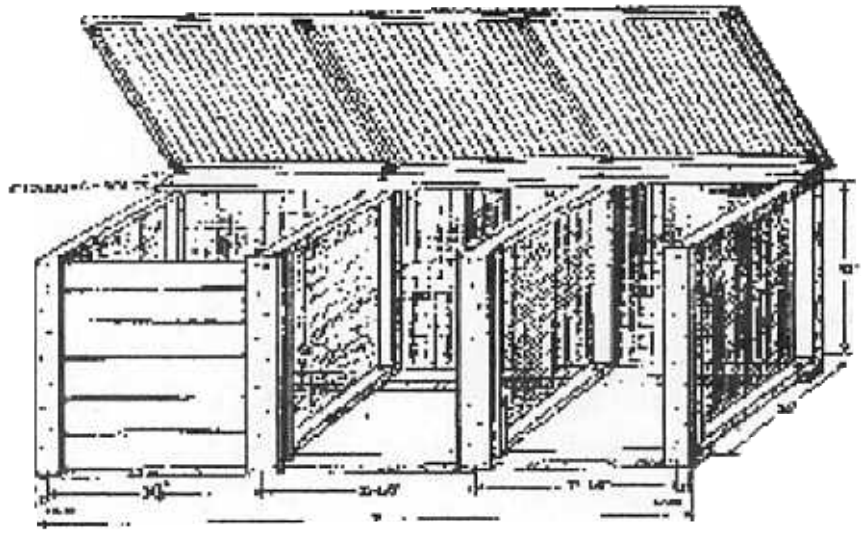
- If you turn your compost heap twice, make a three-section box (12'x4'). The third section/compartment can be used to cure and store the finished compost.

iv. The Lehigh-Keston Bin.



The Lehigh-Keston compost bin is a popular design. The bin is made of wooden slats, is very portable, long lasting, and ideal for proper compost ventilation.
Drill holes at the ends of each slat vertically from top to bottom. Fasten together by inserting metal rods through the holes to form a square.

v. Wood and Wire Stationary Three-Bin System



- This system is used to compost large amounts of yard and kitchen wastes in a brief period of time.
- Wastes are stored until enough are available to fill an entire bin.
- Materials are then chopped, moistened and layered to ensure a hot compost.
- Piles are turned weekly for aeration.

- A pile made with a balance of fresh greens and woody materials and turned weekly can be ready to use in three weeks.
- The texture of the finished compost depends on the materials composted.
- Construction requires basic carpentry skills and tools.

Materials.

2 - 18-foot treated 2x4s
4 - 12-foot, or 8 - 6-foot treated 2x4s
1 - 9-foot, and 2 - 6-foot 2x2s
1- 16-foot cedar 2x6
9 - 6-foot cedar 1x6s
22 feet of 36-inch wide ½-inch hardware cloth
12 - ½-inch carriage bolts, 4-inches long
12 - washers and 12 nuts for bolts
3 - lbs. of 16d galvanized nails
1/2 lb. - 8d galvanized casement nails
250 - poultry wire staples or power stapler w/1" staples
1 - 12-foot, and 1 - 8-foot sheet 4 oz. clear corrugated fiberglass
3 - 8-foot lengths of wiggle molding

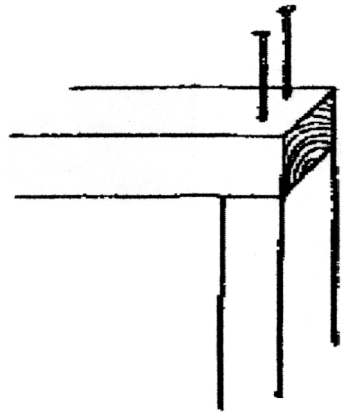
Tools.

Hand saw or circular power saw drill with 1/2" and 1/8" bits; screwdriver, hammer, tin snips, tape measure, and pencil; 3/4" socket or open ended wrench, carpenter's square, (option — power stapler with 1" long galvanized staples), safety glasses and ear protection.
40 - gasketed aluminum nails for corrugated fiberglass roofing
2 - 3" zinc plated hinges for lid
8 - flat 4" corner braces with screwsz
4 - flat 3" T-braces with screws

Construction Details.

Build Dividers.

- Cut two 31½" and two 36" pieces from each 12-foot 2x4.
- Butt end nail the four pieces into a 35"x36" square. Repeat for other three sections.
- Cut four 37" long sections of hardware cloth, and bend back edge 1".
- Stretch hardware cloth across each frame; check for squareness of the frame and staple screen tightly into place every 4" around edge.



Set Up Dividers.

- Set-up dividers parallel to one another 3 feet apart.
- Measure and mark centers for the two inside dividers.
- Cut four 9-foot pieces out of the two 18-foot 2x4 boards.

- Place two 9-foot base boards on top of dividers and measure the positions for the two inside dividers.
- Mark a center line for each divider on the 9-foot 2x4.
- With each divider, line up the center lines and make the base board flush against the outer edge of the divider.
- Drill a 1/2" hole through each junction centered 1" in from the inside edg
- Secure base boards with carriage bolts, but do not tighten yet.
- Turn the unit right side up and repeat the process for the top 9-foot board.
- Using the carpenter's square or measuring between opposing corners, make sure the bin is square, and tighten all bolts securely.
- Fasten a 9-foot long piece of hardware cloth securely to the backside of the bin with staples every 4" around the frame.

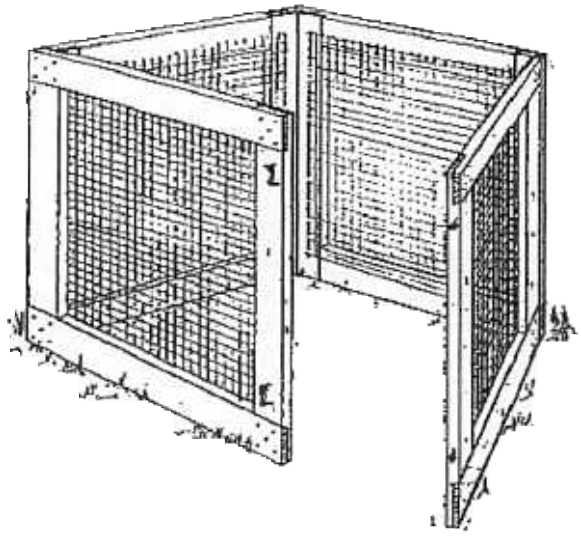
Front Slats and Runners.

- Cut four, 36" long 2x6s for front slat runners.
- Rip-cut two of these boards to 4 3/4" wide and nail them securely to the front of the outside dividers and baseboard, making them flush on top and outside edges.
- Save remainder of rip-cut boards for use as back runners.
- Center the remaining full-width boards on the front of the inside dividers flush with the top edge, and nail securely.
- To create back runners, cut the remaining 2x6 into a 34" long piece and then rip-cut into 4 equal pieces, 1¼"x2".
- Nail back runner parallel to front runners on side of divider leaving a 1-inch gap for slats.
- Cut all the 1x6" cedar boards into slats 31¼" long.

Fiberglass Lid.

- Use the last 9 foot 2x4 for the back of the lid. Cut four 32½" 2x2s and one 9 foot 2x2.
- Lay into position on ground as illustrated on page four and check for squareness.
- Screw in corner braces and T-braces on bottom side of the frame.
- Center lid frame, brace side down on bin structure and attach with hinges.
- Cut wiggle board to fit the front and back 9-foot sections of the lid frame.
- Pre-drill wiggle board with 1/8" drill bit and nail with 8d casement nails.
- Cut fiberglass to fit flush with front and back edges.
- Overlay pieces at least one channel wide.
- Pre-drill fiberglass and wiggle board for each nail hole.
- Nail on top of every third hump with gasketed nails.

vi. Portable Wood & Wire Composting Bin



This portable bin provides a convenient way to compost moderate volumes of yard wastes with minimal labor. Yard wastes are simply added to the bin as they are generated. With no effort besides occasional moistening, compost will be ready in 6 months to 2 years. Chopping or shredding materials, maintaining adequate moisture by watering and covering with plastic or heavy fabric and occasional turning will produce finished compost in a shorter period of time. Texture of the finished compost depends on the materials composted and how long they are left in the bin. Mixing fresh greens with brown yard wastes will produce the best results.

This bin is very flexible. It fits well in small spaces, and may be used either as a yard waste holding bin or as a portable turning unit. The bin can be easily moved to turn piles or to harvest finished compost and build a new pile: Simply undo the latches, pull the sides apart and move it. Compost may then be turned into the bin at its new location, and finished compost can be removed from the bottom.

Construction methods:

Materials.

1- 12-foot pressure treated 2x4
3 - 12-foot fir 2x4
12 feet of 36" wide ½" hardware cloth
100 - 1 ½" galvanized No. 8 wood screws
4 - 3" galvanized butt door hinges
150 - poultry wire staples or power stapler
1 - 10-oz. tube exterior wood adhesive
6 - large hook and eye gate latches

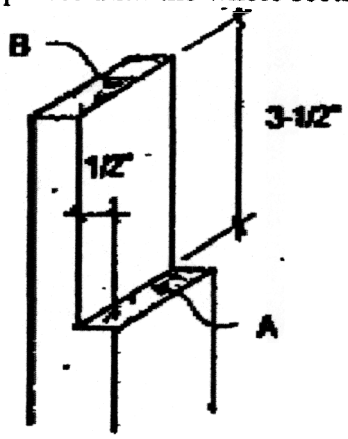
Tools.

Hand saw and chisel, *or* radial arm saw with dado blade, *or* circular saw, *or* table saw. Hammer, screwdriver, tin snips, caulking gun, pencil and small carpenter's square. *Use eye and ear protection.*

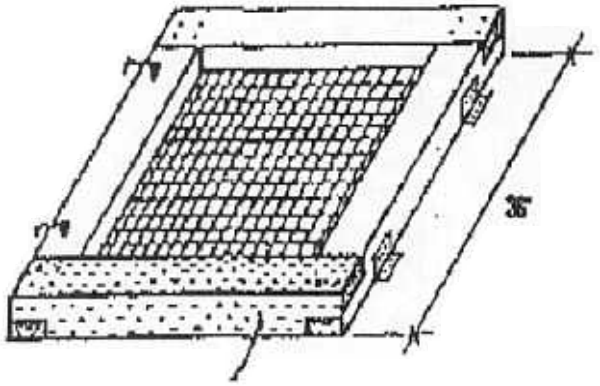
Construction Details.

- Cut each 12-foot 2x4 into four 3-foot long pieces.
- Cut a 3/4" deep and 3-1/2" wide section out of each end, for a total of 32 lap cuts.
- If using handsaw and chisel, cut 3/4" down at the 3½"-line at A in diagram to right.
- Cut a ½"-deep groove into the end of the board at B in the diagram.

- Place a thick wood chisel in the end groove and split the wood with a hammer to **the 3** ½" cut.
- If using a radial arm saw, circular saw or table saw, set blade depth to 1/3" and make multiple passes until the whole section is removed.



- Make four, 3-foot square frames from the lap jointed 2x4s.
- Use one pressure treated 2x4 on each frame.
- Put enough construction adhesive to fill the gaps when the lap joints are screwed together.
- Fasten each joint with four screws.



- Cut the hardware cloth with tin snips into four, 3-foot square sections.
- Bend the edges of the cloth back over 1" for strength.
- Lay one onto each of the four frames.
- Center and tack each corner with a poultry wire staple.
- Hammer place a staple every 4" along all four edges of the hardware cloth.
- Try to tension the cloth so it will not sag when filled with compost.
- Connect each pair of frames together with two hinges.
- Then put the hook and eye gate latches on the other ends so that the sections latch together.

Plans courtesy of: Seattle Tilth Association and Seattle Solid Waste Utility. A resource for other material is from Wisconsin Department of Natural Resources Bureau of Solid Waste Management

f. Other alternatives to reducing solid wastes before they end up in the landfill, pit system or incinerator.

- Encourage the use of reusable canvas/cloth grocery bags.
- Impose the amount of plastic per household to a minimum.
- Reuse plastic bags for grocery shopping and avoid disposing them either in pit or indiscriminately.
- Do no allow visitors and tourist to bring in plastic bags and all disposable plastic products when entering the area.

g. Pit System

- Use the pit system if the volume of solid wastes is small and the solid wastes are free of hazardous materials and the area is away from waterways.
- Do not construct the pit system is porous soil and permeability is rapid, the pit system is not recommended. Metal cans that are non-hazardous can be discarded through the pit system.
- Construct the pit system at suitable location away from water source and preferably away from the quarters or lodging house so as to avoid odor.
- Dig a large and deep enough pit to cater for the wastes from all the households in the center to avoid frequent digging.
- The size of the pit has to be carefully considered to cater for the amount of wastes to be discarded in them.
- Compact metal cans before throwing them in the pit to reduce the volume of wastes that are thrown in them.

h. Incinerator.

- It is recommended that incinerator using solar energy (available in the US) be installed at suitable location (the site has been identified by the Architect).

i. Environmental and hygiene personnel

- It is highly recommended that a personnel be hired specifically to strictly enforce the mitigation measures recommended in the EIA report. The following are foreseeable tasks of the environmental and hygiene personnel at the center:
  - To enforce the mitigation measures outlined in the report.
  - To monitor the staff and household solid wastes disposal habit.
  - To ensure that each staff and household comply to requirement of reducing the solid wastes through reduction at source, reusing and limiting the use of plastics in each household.
  - To ensure that kitchen solid wastes are composted properly,
  - To enforce strictly the plastic use regulation on tourist and visitors to the center.
  - To monitor the use of plastic in offices and to ensure that they are not disposed of indiscriminately in any area within the center.

2. HOW TO MANAGE LIQUID WASTE AT THE MBSC

a. Septic tank

The use of septic tank has been agreed between the management and the architect.

b. Lagoon (wetland) system

- Turn the pond at the entrance to the proposed site of the Maliau Basin Study Center into a lagoon to serve as secondary wastewater treatment before they are release into the waterways.
- Apart from serving as secondary wastewater treatment, the lagoon can also function as some wildlife and fish habitat, storage of surface runoff and storm water management, recreation and aesthetic.
- Construct a 3-5 foot wooden walkway along the perimeter or across the lagoon for recreation purpose or for wildlife watchers. This will enhance the aesthetic value of the lagoon.

The following are important points to take into account when constructing the lagoon.

- The lagoon must be constructed as natural as possible with no concrete lining.
- The soil to be dug can either be used as embankment of the lagoon or spread in the area. Ensure that they will not end up clogging drains or waterways.
- Inventory of plant habitats in the area to be excavated for the lagoon should be carried out. This is to ensure that some of these plants can be replanted back so as not to introduce non-native plants. As much as possible, plants to be planted should be native plants of the area.
- Choose native wetland/lagoonae plants for planting in the lagoon.
- Wildflowers/plant native to the area can be planted at the perimeter of the lagoon not only for aesthetic purposes but also as buffer zone. Wildflowers can also attract butterflies and add to the recreational value of the lagoon.

c. Oily waste disposal system.

- Handling and disposal of oily wastes at the MBSC should strictly follow the Malaysian Department of Environment Guideline on the management and disposal of waste oil, EG9/94[1]

FLORA IMPACT MITIGATION MEASURES

a. Minimize tree cut as much as possible but do not ignore the risk and hazard of falling branches.

b. Every effort must be taken to minimize the risk and hazard not only to staff and personnel at the center but also visitors. As much as possible the experience of Borneo Rainforest of leaving too many trees around building resulting in buildings become moldy due to too much moisture and lack of light penetration, should be avoided at all cost. This is to avoid reapplying for permit to cut trees from the Forestry Department, which could take a long process. Also, cutting trees after the buildings are put in place will be much harder.

c. Carry out replacement planting of local/native species elsewhere in the Maliau Basin Conservation area to ensure sustainability of the native species.

d. In doing a replacement planting, collect seedling of the native species from the area or germinate seeds in nursery.

[1] Guidelines on the Management and disposal of wastes in upstream petroleum industries

HOW TO REDUCE TRAFFIC IMPACTS ON WILDLIFE/FAUNA

- Prepare traffic rules and regulation for the Maliau Conservation Area.
- Regulate vehicular entry to the Maliau Basin area by constructing an entry gate with gate guard posted to ensure entry regulations are enforced at the entry point.
- Visitors must register and be briefed on the 'dos' and 'don'ts' of the MBCA including traffic regulation specifically for MBCA.
- Hire traffic personnel to monitor traffic movement in the conservation area.
- Construct speed bumps at appropriate intervals for example at 20 meter intervals to control vehicular speed. The surface of the road must carefully be constructed where surface of road most frequented by wildlife should be constructed with gravel only.
- Regulate driving hours in the MBCA. Do not allow visitors or unauthorized vehicles to enter the area after sunset. Allow only patrol vehicles to enter the area after the regulated driving hours.
- Carry out frequent border patrolling after the completion of the Keningau-Tawau Road. This will also mean increasing the number of rangers in the area.
- Employ road toll system where necessary.
- Limit access road to one-way road with the width not exceeding 4.5 meters.
- Do not allow visitors to feed animal to avoid animal getting use to road and endanger themselves.

HOW TO MITIGATE NOISE IMPACT AT THE MBSC

- Use soundproof materials where necessary. Soundproof materials are aplenty and available in the market.
- Noise can also be controlled by spray paint specially designed for noise reduction
- Using tire crumbs to spread on roads can minimize noise impact from traffic movement. This has been successfully used in USA particularly in conservation area and parks.
- Locate power generator sets in subsoil and away from residential or office site.

HOW TO MINIMIZE LIGHT POLLUTION AT THE MBSC

Light pollution can easily be reduce with little effort. The following are ways to reduce light pollution in the MBSC

- Change to efficient lighting by limiting the use of light where it is not necessary.
- Design lighting around the purpose which it is to serve only to avoid light 'trespass' into other areas where it is not needed.
- Use only shielded energy efficient fixtures.
- Select low pressure sodium or high pressure sodium lamps which use significantly less electricity.
- Avoid the use of mercury-vapor lamps.

Reference

Cornell Cooperative Extension by Chemung County, *"Building Bins and Boxes for Compost"*,www.cce.cornel.edu/chemung/compost1.htm

Spokane Regional Solid Waste System, *"Composting"*, www.spokanesolidwaste.org/combins.htm

Texas Disposal Systems
www.texasdsposal.com/htmfiles/compostingf/composting.html

Yglecias's Gardening Tips, "Co*mposting"*,
www.geocities.com/Athens/Ithaca/1853/compost.html