Environmental Management Plan
(Appendix B3)

Project Number: 42916-014
March 2019

INO: Sarulla Geothermal Power Generation Project

Prepared by Sarulla Operations Limited

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Final Report

Biodiversity Monitoring: Stage 1

Camera trapping and Wildlife Surveys

A rare picture of a pangolin (*Manis javanica*), listed as Endangered on the IUCN Red List and protected under Indonesian law, together with a Barking deer (*Muntiacus muntjac*) also a protected species, caught together on camera trap at SOL.

7th of July 2014

by

PanEco/YayasanEkosistem Lestari

requested by

Sarulla Operations Ltd.
Appendix III

_Sarulla Operations Ltd._ _Mott MacDonald_

**Report Biodiversity Monitoring Survey**
PanEco/ YayasanEkosistem Lestari/ Sumatran Orangutan Conservation Programme

Stage one: Reconnaissance surveys (16-22 Nov 2013)

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Executive Summary

Reconnaissance biodiversity surveys were carried out as part of the development of the Sarulla Operations Ltd (SOL) Geothermal project, at the request of Mott MacDonald for the 'Stage one NIL1 pre-construction' development of the project location. Due to time and money constraints extensive biodiversity surveys were not possible in the short time available, as only 7 days of field survey time were allocated. Hence limited biodiversity reconnaissance surveys were carried out (16-22 November 2013). Land-clearing operations had already commenced in July 2013. The aim of these surveys were to provide some further baseline data on the pre-determined 'Target Species' and their local habitat, prior to site clearance associated with NIL1.

A PanEco/YayasanEkosistem Lestari (YEL) survey team, working in the Batang Toru forest area since 2006 with a focus on conservation of the genetically unique orangutan population residing in this specific area, conducted 13 reconnaissance transect surveys, over a period of 7 days, amounting to a total survey effort of 36.2 kilometers. Surveys were focused on two IUCN Red List category Critically Endangered species (Sumatran orangutan and tiger) and an additional 4-5 species listed as Endangered. A number of 'secondary' species, either listed as Vulnerable or Sumatran tiger prey species were also focus of the survey. In addition vegetation parameters were surveyed, camera traps were placed, and aerial mapping with UAV planes was carried out.

Primary and secondary forested areas made up the dominant land use categories surrounding the SOL project area, together making up 60.2% of all survey sample locations. A large percentage of the area surrounding the SOL project site is comprised of land units with both medium (i.e., 10-40 cm DBH) to large-sized (i.e., > 40 cm DBH) tree species. and comprised mostly of closed canopy forests, intermixed with forest gardens (benzoin and old rubber).

Agile gibbons *Hylobates agilis*, Pig-tailed macaques *Macaca nemestrina*, mitred leaf monkeys *Presbytis melalophos*, and Siamang *Symphalangus syndactylus* were either directly encountered or heard during the 7-day surveys. No direct sightings of Sumatran orangutan *Pongo abelii*, nor their nests, were encountered during the current recce surveys.

The presence of five ungulate species, including Sumatran serow *Capricornis sumatraensis*, Common barking deer *Muntiacus muntjak*, Sambar deer *Cervus unicolor*, wild boar *Sus scrofa*, and Greater mouse deer *Tragulus napu* was confirmed. The most commonly encountered mammal sign encountered was of Sun bears *Helarctos malayanus*. A tiger scat filled with Pangolin *Manis javanica* remains was encountered, as well as a possible tiger footprint. All of the main tiger prey species were still encountered in the SOL project area (wild pigs, barking deer, sambar deer, serow, pig-tailed macaques).

High levels of human usage, forest gardens, evidence of hunting (wildlife and birds), as well as illegal logging were encountered throughout the SOL area. Limiting access over project roads to reduce extraction of wildlife and timber, maintaining arboreal corridors on locations along newly planned roads, socio-economic programmes focusing on protein alternatives, socialization, and improved garbage management are highly recommended.

Sarulla Operations Ltd is building a relatively environmentally-friendly geothermal energy power plant that will have local impacts on the highly biodiversity and unique Batang Toru forests. To compensate for the impacts, it has the opportunity to play an important role in the long-term conservation of the wider Batang Toru forest complex (both east and west blocks), thus demonstrating a wider commitment to environmental best practices and conservation.
Introduction

Batang Toru Forest: Conservation Importance

The importance of the Batang Toru Forests for conservation came to light following the first orangutan surveys, carried out in 2000 in the West Batang Toru Forest Block (WBTFB). This, and follow-up surveys in the WBTFB resulted in the current population estimate of 400-600 orangutans (Singleton et al. 2004). This area harbors the only viable orangutan population south of Lake Toba, which has now been found to be genetically distinct and unique (Nater et al. 2011, 2012).

The WBTFB consists of hill and lower montane forest primarily covering extremely rugged terrain (400 - 1123 m asl.), and contains orangutans throughout its c. 810 km2 (81.344 ha) of forest. A smaller orangutan population has also been encountered in the East Batang Toru forest block (forest area: 54.940 ha), east of the Tarutung-Sipirok road. The Batang Toru forests are also home to the critically endangered Sumatran tiger. The most recent published Sumatran tiger population estimated at 300 individuals in the wild, scattered throughout the island of Sumatra (Ministry of Forestry, 2007), although this number is considered to be an underestimate (Wibisono et al., 2011).

Since 2006, PanEco/YEL/SOCP has been operating a Flora & Fauna monitoring station in the West Batang Toru Block, located some 20 km from the SOL project area (see Fig. 1). The forest area in between the two locations constitutes of contiguous primary forest, at elevations around 1000 m asl.

Fig. 1: Map of SOL survey area and YEL research station in the WBTFB

PanEco/YEL/SOCP have operated a small number of camera traps (up to 10 operational camera’s) in the study area near the monitoring station since 2009. In combination with
direct observations a total of 50 mammal species (non-Chiropteran) have been documented in the WBTFB so far (Table 1).

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</table>

Table 1: List of mammal species (non-Chiropteran) occurring in the Batang Toru forest.

**Target species and legal status**

Mott MacDonald listed Six Critically Endangered or Endangered species (as determined by the IUCN Red List of Threatened Species) that were identified as occurring or having the potential to occur within the ‘Project Area’. These are as follows, and were considered the ‘Target Species’ for the current biodiversity monitoring survey:

- Sumatran orangutan (*Pongo abelli*);
- Siamang (*Symphalangus syndactylus*);
- Agile gibbon (*Hylobates agilis*);
• Sumatran tiger (Panthera tigris sumatrae);
• Malayan pangolin (Manis javanica); and
• Asian tapir (Tapirus indicus).

Although not listed as one of the main 'Target species', Mitred leaf monkeys (Presbytis melalophos), likewise listed as Endangered on the IUCN Red List, also has the potential to occur in the SOL project area.

In addition, the following species were also considered to have conservation importance and/or are potential prey species for the Sumatran tiger. These species, which are known to occur within the ‘Project Area’, were considered 'secondary' species of conservation importance, and their presence was also focused upon during the biodiversity monitoring survey:

• Marbled cat (Pardofelis marmorata);
• Sumatran serow (Capricornis sumatrensis);
• Sambar deer (Cervus unicolor);
• Malayan sun bear (Helarctos malayanus);
• Binturong (Arctictis binturong);
• Slow loris (Nycticebus coucang); and
• Wild boar (Sus scrofa).

A total of 7 species occurring in the WBTFB are listed as Critically Endangered or Endangered under the IUCN Red List, and another 11 mammal species found in the Batang Toru forest area are listed as Vulnerable (Table 2).

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Table 2: List of mammals species in Batang Toru categorized by the IUCN Red List as CE, EN, VU.

Two (non-Chiropteran) mammal species found in the WBTFB, namely the Sumatran Orangutan and Mitred leaf monkey, are Sumatran endemics.
Legal status of target species
A total of 21 mammal species (see Table 1) recorded in the WBTFB are listed in the appendix of the implementing regulation no 6, 1999 [Peraturan Pemerintah nomor 6, tahun 1999, Pengawetan Tumbuhan dan Satwa, Implementing Regulation on Preservation of Plants and Wildlife]. This regulation implements the Act of the Republic of Indonesia No. 5 Concerning the Conservation of Natural Resources and their Ecosystems [Undang-Undang No 5. Tentang Konservasi Sumber Daya Alam Hayati dan Ekosistemnya, 1990].

This law states that it is illegal to:
- Catch, harm, kill, to keep as a pet, to move or sell a protected species, either alive or dead.
- To move a protected species from one place to another, within, or export from Indonesia.
- To sell or own parts of a protected species or any items made from a protected species.

Violation of the above, are punishable to a maximum of:
- 5 years in jail
- Rp. 100,000,000,- in fine

Aims of the biodiversity monitoring field surveys

• To provide further baseline data on the presence and habitat usage of species of conservation importance (i.e., ‘Target Species’), which are known, or have the potential to occur, in the ‘Project Area’.

This included:

- Creating habitat and species distribution maps.
- Interpreting data collected from the field surveys in the context of ‘the Project’, and the wider conservation objectives of the Batang Toru Forest.

• To monitor the potential effects of ‘the Project’ on ‘Target Species’ and to inform changes to the Environmental Management Plan, as well as requirements within the Biodiversity Action Plan and Biodiversity Off-set Management Plan.

Methodology

Reconnaissance Transect Surveys
Due to time and money constraints an extensive biodiversity survey was not possible at this point, and the three primate ‘Target Species’ were surveyed using reconnaissance transect surveys. These would be carried out on foot through areas of suitable habitat. In particular, four teams of surveyors would walk pre-determined reconnaissance transects throughout the ‘Project Area’, and try to cover as much of the ‘Project Area’ and surrounding habitat as possible. The reconnaissance transects would be walked between 07:00 – 16:00 each day, for a total of 7 days.

Data collected during the reconnaissance transect surveys will include the following:
• Animal contacts: Time, GPS location, species, number of individuals, compass bearing & distance of the group center from the observer, and photographs;
• Orangutan nest contacts: Time, GPS location, nest age / height / position, diameter at breast height of the nesting tree (s), compass bearing & distance of the nest from the observer, and photographs;
• Animal vocalizations: Time, GPS location, species, compass bearing & estimated distance of the vocalization;
• Animal signs: Time, GPS location, species, type of sign, compass bearing & estimated distance of the animal sign from observer, photograph, and a detailed description;

Target species include: agile gibbon, siamang, Mitred leaf monkey, Sumatran orangutan.

**Vegetation mapping**
Vegetation profile obtained along recce surveys (every 100 meters): type of land cover, canopy height, canopy cover, diameter at breast height of trees in the area, and a description of the vegetation.

**Camera Trapping**
The three terrestrial mammal ‘Target Species’ and the terrestrial ‘Secondary Species’ were be surveyed using camera-trap surveys. In particular, six camera traps will be placed within the ‘Project Area’, at least 100 meters from one another. The survey aims to cover a combination of habitat types and locations within the areas of NIL1 and WJP1.

Following placement, the camera-traps will run between 2-3 months at a single location. Each month, the camera-traps should be checked, and the following actions should be taken:

- Check and replace batteries;
- Change SD card;
- Ensure that the camera is still functioning and that there is nothing obstructing the camera’s lens.

After a camera trap session and/or photograph upload, the following data should be recorded for each camera trap night:

- Species recorded;
- The number of events (i.e. independent picture events) per species;
- The number of individuals per event.

Once a camera-trap location has been completely surveyed, the camera-traps should be moved to a new suitable location within the ‘Project Area’, so that they may be used to survey a new location.

Target species include: Sumatran tiger, Asian tapir and Malayan pangolin.
Secondary species include: marbled cat, Sumatran serow, sambar deer, sun bear, binturong and wild boar.

**Remote Aerial Survey Using Unmanned Aerial Vehicle**
The goal of the remote aerial survey is to obtain a high-resolution photo-mosaic to allow for delineation of the habitat types in the project area. The various stages of the survey are as follows:
• Determine viable take-off/landing sites;
• Fly grids taking video and/or still photographs. Video provides an overview of a wide area, photographs can be assembled in a photo-mosaic and geo-referenced so that it can be used in GIS.
• Analysis of the photo-mosaic and videos in collaboration with field team members to delineate broad habitat classes, and thus better determine potential distribution of target species.

The goal is to produce photo-mosaic of the project area, with a maximum total area of 4km².
Results
Survey Results_ Stage 1

Between 16-22 November 2013, the Yayasan Ekosistem Lestari (YEL) survey team conducted 13 reconnaissance transect surveys, amounting to a total survey effort of 36.2 kilometers. Due to the amount of construction already being conducted at the SOL project site, it proved impractical to walk the predetermined transects. This was primarily because part of the forest to be surveyed was already cleared, noise levels could be heard within the surrounding forested areas, and human disturbances are known to impact the presence of animals. Furthermore, with the amount of heavy machinery doing construction in the project area, it was difficult for the YEL survey team to adequately survey along the access road leading to NIL 1. As such, all reconnaissance transects were focused in the forested areas surrounding the aforementioned access road and the planned access road to WJP1(Fig. 2_Map of all surveys walked).

Habitat Structure at the SOL Project Area
From the reconnaissance transects that were walked, the most frequently contacted land unit type was tall primary forest (29.0%), followed by benzoin dominant forest gardens (18.8%), secondary/disturbed forest (16.1%), low primary forest (15.1%), combined benzoin/rubber forest gardens (8.6%), rice fields (3.2%), rubber dominant forest gardens (3.2%), villager cleared lands (1.6%), durian forest gardens (1.6%), open scrub forest (1.6%), and open sulfur rock lands (1.1 %) (Fig. 3). From these figures, it is clear that primary and secondary forested areas are the dominant land use categories surrounding the SOL project area, as they together make up a total of 60.2% of all survey sample locations.

Fig. 3: Forest types/Land use categories encountered in the SOL project area

When each sampled location was categorized by the diameter at breast height (DBH) of the tree species in the area, the most frequently contacted class was the <10 cm and 10-40 cm DBH (48.4%), followed by the <10 cm, 10-40 cm, and >40 cm class (38.7%), the <10 cm DBH
class (8.1%), and areas lacking trees (4.8%) (Fig. 4). These figures indicate that a large percentage of the area surrounding the SOL project site is comprised of land units with both medium (i.e., 10-40 cm DBH) to large-sized (i.e., > 40 cm DBH) tree species.

Furthermore, the majority of areas surveyed had land units with tree canopy heights of either 20-30 m (40.9%) or 10-20 m (40.3%), and land units with trees 0-10 m (18.8%) were encountered infrequently (Fig. 5). Land units with trees >30 m in height were not crossed during the recce surveys and a large percentage of the areas surrounding the SOL project site are comprised of medium-height (i.e., 10-30 m) trees species.
Fig. 5: The presence of various canopy height classifications for all surveyed locations.

Lastly, the majority of land units surveyed had tree canopies that were categorized as between 75-100% closed (56.5%), followed by 50-75% closed (21.0%), 25-50% closed (14.0%), and 0-25% closed (8.6%) (Fig. 6). This is a quite striking result, as this indicates that the land units surrounding the SOL project area are comprised of relatively closed canopy forests.

Fig 6: Canopy closure for all surveyed locations.
Evidence for Fauna at the SOL Project Area
Tables 3-6 list the faunal evidence from the most recent survey effort, in the areas within and surrounding the SOL project site.

Primates
The presence of four primate species was confirmed, including Agile gibbons *Hylobates agilis*, Pig-tailed macaques *Macaca nemestrina*, Mitred leaf monkeys *Presbytis melalophos*, and Siamang *Symphalangus syndactylus* (Table 3). Agile gibbons was detected via both vocalizations and direct contacts, Pig-tailed macaques was detected via direct contact and camera traps, Mitred leaf monkeys were directly contacted, and the presence of Siamang was confirmed via vocalizations.

For the three Endangered primate species that were detected within the SOL project area, it is thought that at least four different groups of *Hylobates agilis* were seen and/or heard, and also that the SOL project area contains at least one group of each *Presbytis melalophos* and *Symphalangus syndactylus*. Figure 7 shows the locations of all primate encounters.

![Map of all primate encounters during the recce surveys](image-url)

Fig. 7 Map of all primate encounters during the recce surveys
The YEL survey team also confirmed the presence of five ungulate species, including Sumatran serow *Capricornis sumatraensis*, Common barking deer *Muntiacus muntjak*, Sambar deer *Cervus unicolor*, Wild boar *Sus scrofa*, and Greater mouse deer *Tragulus napu* (Table 4; Fig. 8). Of the ungulates, *Sus scrofa* was the most frequently detected, and was recognized via footprints, nesting sites, and feeding signs. The next most frequently detected ungulate was the barking deer which was detected via fecal remains, footprints, camera traps, and vocalizations, followed by the Sambar deer which was identified via fecal remains, footprints, and feeding remains. The Sumatran serow was detected via fecal remains and footprints, and finally the Greater mouse deer, which was identified via fecal remains and camera traps.

Fig.8: Map of all ungulate encounters during the recce surveys

Appendix III - 14
Other Faunal evidence

Finally, an additional mix of 10 faunal species were confirmed to be present in the areas within and surrounding the SOL project site (Table 5; Fig. 9). These include Sun bears Helarctos malayanus, Pangolin *Manis javanica*, Yellow-throated marten *Martes flavigula*, Large tree shrew *Tupaia tana*, Black-banded squirrel *Callosciurus nigrovittatus*, Three-striped ground squirrel *Lariscus insignis*, Low’s squirrel *Sundasciurus lowii*, an unidentified rat, *Muridae* (sp.1), an unidentified bat, *Chiroptera* (sp.1), and pheasant/wildfowl scrapings, *Phasanidae* (spp.).

![Fig.9: Map of all other faunal encounters during the recce surveys](image_url)
Tiger evidence
All of the main tiger prey species were still encountered in the SOL project area (wild pigs, barking deer, sambar deer, serow, pig-tailed macaques). During the recce survey, a large carnivore scat filled with pangolin scales/bones was encountered in short-pole primary forest (dominated by 'arang') near one of the active fumeroles, at 0.29km distance from WJP1 [UTM: Y 207082.34; X 502719.09]. Prior evidence of a tiger scat filled with pangolin scales has been found on the old PT Teluk Nauli logging road in the WBTFB.
A potential tiger footprint was encountered [UTM: Y 208226.16; X 503209.01], though exact measurements were difficult to obtain due to the fact that it was encountered in the forest on leaf litter substrate.

Sun bear evidence
The most frequently encountered mammal sign during the recce surveys were of sun bears (n=21 sign). This primarily consisted of fresh to medium aged claw marks (1-12 months old) and broken into stingless bees nests, but termite feeding sign was also encountered. Sun bear sign was encountered throughout the SOL project area.

Encounter rates
For all animal detections (excluding camera trap evidence), the top three species with the highest encounter rates were Helarctos malayanus, Sus scrofa, and Hylobates agilis. These species each had detection rates >0.3 signs/km walked. The next most frequently detected animals were Muntiacus muntjak, Cervus unicolor, Manis javanica, and Capricornis sumatraensis, all of which had a detection rate of <0.3 - >0.1 signs/km walked. All other detected species had encounter rates that were <0.1 signs/km walked (Fig. 10).
Fig. 10: Encounter rate for the faunal species encounter at the SOL project site. The numbers indicate the total number of signs (see tables 3-6 for the signs included in this survey, excluding camera trap photos) per kilometer walked. The total survey effort was 36.2 kilometers walked.

Camera Trapping
Six Bushnell X-8 Trail Cam [model 119327] camera traps were provided by Mott MacDonald and placed in potential locations in the field (Fig. 2) and will be left in the field for 1 month [in picture mode]. Six additional camera traps from YEL were placed for the 1-week survey period [Bushnell Trophy Cam XLT] throughout the project area [5 in video mode, 1 picture mode].

A total of 9 mammal species were recorded in the first week of camera trapping [Table 6].

Table 6: Preliminary camera trapping results

<table>
<thead>
<tr>
<th>English name</th>
<th>Latin name</th>
<th># of independent events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common barking deer</td>
<td>Muntiacus muntjak</td>
<td>1</td>
</tr>
<tr>
<td>Larger mouse deer</td>
<td>Tragulus napu</td>
<td>1</td>
</tr>
<tr>
<td>Pig-tailed macaque</td>
<td>Macaca nemestrina</td>
<td>4</td>
</tr>
<tr>
<td>Three-striped ground squirrel</td>
<td>Lariscus insignis</td>
<td>1</td>
</tr>
<tr>
<td>Low’s squirrel</td>
<td>Sundasciurus lowii</td>
<td>1</td>
</tr>
<tr>
<td>Large Treeshrew</td>
<td>Tupaia tana</td>
<td>1</td>
</tr>
<tr>
<td>Forest Rat</td>
<td>Muridae (sp.1)</td>
<td>2</td>
</tr>
<tr>
<td>Bat (unID)</td>
<td>Chiroptera (sp.1)</td>
<td>1</td>
</tr>
<tr>
<td>Poacher</td>
<td>Homo sapiens</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total events</strong></td>
<td></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>
Aerial Surveys using Unmanned Aerial Vehicles (UAVs)

Aerial surveys using two Skywalker UAV's were conducted over 2 days (21st and 22nd November). Six missions were flown producing 4 sets of photographs (1,286 photographs in total) for stitching into mosaics, and 3 aerial videos (ca. 48 minutes total run time). Four missions were conducted on the first day from the abandoned NIL2 site at approximately 1,071 m asl, but only 2 successful missions were flown from the NIL1 site (874m asl) on the second day due to bad weather conditions throughout much of the day. On the first day, the first video mission was flown at 100m above the launch altitude (ala), but all subsequent missions were flown at 150m afa. On the second day, missions were flown at 250m afa. At the end of the Day 1, strong winds caused one of the 2 UAVs to crash causing damage that could not be immediately repaired, thus leaving only one UAV available for missions on Day 2.

Results

Videos
The 3 videos give a very good overview of the work site and surrounding habitats, and the path of the video can readily be followed on the hi-resolution satellite images available from most of the area from Google Earth. The exact provenance of the Google imagery is not yet known, but is probably within the last 6 years. Because an HD camera was used for video capture, screen grabs can readily be made to produce stills of areas of interest. For example, the first video, several small openings were readily visible, including a probable illegal logging camp to the west of the NIL-1n site (chainsaws were heard regularly from both launching sites; at the NIL-1n site on Day 2, a group of young men on motorbikes passed though towards the forests to the west claiming to be working their benzoin trees, but shortly afterwards a chainsaw started up from the direction in which they had been heading).

Aerial Photo-mosaics

Four preliminary georeferenced and orthorectified aerial photomosaics (geotif format) have been produced using Agisoft. These can be directly imported into a GIS either in 2d or 3d. Three of the photomosaics have more than 85% overlap. The best of these has a small overlap with the 4th mosaic, which shows the area currently being cleared by SOL. Thus aerial mosaics, with resolutions of between 6.0 and 6.6cm pixel size, are available for an area of approximately 330ha of the work site. This is less than the area hoped for (primarily caused by bad weather and a camera failure on Day 2), but demonstrates that with the right conditions, it would be feasible to completely map whole area.

Initial examination of the photo-mosaics show that broad land cover categories such as ricefields, sulphur/rock fields, open scrub forest and closed canopy forest are easily identifiable. Features such as crown size and colour are readily possible, but further investigation and comparison with ground survey data is required to determine to what extent it is possible to differentiate between the taller forest sub-categories such as benzoin-enriched, old rubber, and primary tall canopy forests.

A 3D representation of the project site that clearly shows the terrain and broad land cover categories, the ground tracks surveyed, and the locations of animal sign and sightings has
also been produced. Such a representation of the site greatly facilitates a spatial understanding of the topography and habitats in the area.

NB: The aerial videos, photos, photomosaics and flight paths of the missions will be provided digitally on DVD or memory stick because their large file size (est. total over 10Gb).
Discussion
The current follow-up biodiversity survey (Stage 1: Pre-construction) was commissioned 4 months after land clearing had commenced. Large amount of disturbance and human activities were occurring in the area (construction teams for land clearing, multiple chainsaws operating for project tree felling; multiple chainsaws operating for illegal tree felling; hunters [wildlife and birds]; large number of vehicles, trucks, bulldozers, excavators, motorbikes traveling through the area; survey teams operating throughout the area).

Although no orangutan nests were encountered during this short recce survey [16-22 November 2013], SOL project staff that had worked in the area some years prior to the current construction activities, reported direct observation of an orangutans near the NIL 1 road (A. Samuel pers.comm.).

Socio-economic interview surveys carried out by YEL between 2007-2009 covered some 49 villages/hamlets near the SOL project area (out of a total of 378 villages/hamlets surveyed). A total of 55 out of 235 respondents, from 25 villages/hamlets reported having seen orangutans in the recent past near the SOL project area. Six respondents from 5 different villages/hamlets reported having seen a tiger or tiger sign in the recent past. A total of 14 respondents from 7 separate villages/hamlets reported having seen a tapir (YEL unpublished data).

Hunting levels have been found to be consistently high in the area (Wich et al. 2012). Respondents from nearly all villages/hamlets interviewed near the project area reported to hunt (44 out of 49 villages/hamlets). This included hunting of orangutans, siamang and gibbons (3 out of 49 villages/hamlets), but also tapir, serow, sambar, sun bear and a variety of other species (YEL unpublished data).

The road developed into the forested area for the geothermal project (past and present) will have facilitated access for hunters. This is probably, in part, a contributing factor to the fact that no orangutan nests were found during the current recce survey.

Analyses of time series of satellite images and maps since the 1980s indicate that the natural forest/human impact interface around the Batang Toru forests has been relatively stable for decades if not much longer. The Tarutung and Sarulla valleys have been widely populated and cultivated for more than 200 years (based on reports of explorers who visited the area in the early 1800s), yet the Batang Toru forests and their rare and endangered species have survived to the present, despite being surrounded by a people with no religious taboos against consumption of any species, and despite the rampant deforestation of much of Sumatra since the 1980s. The factors that have preserved it to date are almost certainly difficulty of access due to its rugged topography, and its unsuitability for cultivation. There appears to be a distinct inverse correlation between the presence of established human communities and the land units that comprise the bulk of the remaining forests. The current main threats to the forest complex are immigrants from Nias who have no traditional knowledge of its limitations for cultivation (particularly along the western periphery of the west Block), and improvement of access into the rugged forested areas due to the activities of major developments such as the Sarulla geothermal project would consist of the main driver for future forest encroachment, illegal logging, and facilitation of hunting. For example, without the access granted by the company's road infrastructure that enable logs to be taken out of the forest by road in commercial quantities, the current illegal logging around the project site would not be happening at the current scale.

Appendix III - 20
The west and east Batang Toru forest blocks, between which the company's operations lie, are the last refuge of the most genetically distinct and rare orangutan population in existence. With an estimated remaining population of between 400 and 600 individuals and less than 100,000 hectares of their potential habitat remaining, any disturbance to even small areas of this habitat is of extreme concern, and is likely to become a major conservation issue as the importance of this orangutan population becomes increasingly recognized by the global conservation community.

While the survey team was primarily tasked with faunal surveys, it also became apparent during the surveys that the habitats surrounding this project site, in particular the floral and faunal assemblages around the bare sulphur/rock areas and fumeroles, are likely to be unique. To our knowledge, they have been not been seriously studied to date, possibly because they are not classic "rainforest" assemblages. It is quite possible that they comprise unique assemblages, or even species, that are uniquely adapted to these environments. The presence of these habitats, along with our knowledge of different but also diverse habitats and wildlife surrounding the SOCP field monitoring station about 23km WSW from the project site, further reinforce the fact that the Batang Toru forests are a truly unique remnant of Sumatra's biodiversity heritage. The Sarulla Geothermal development, along with other major developments around the forests, such as the Martabe Goldmine near Batang Toru town and the Sipansihaporas Hydroelectric installation, are very well placed to make a significant contribution to the conservation of these forests. These developments are without a doubt extremely important for the economic development of the Tapanuli districts, and the welfare of its people. But failure to recognize, and mitigate the potentially disastrous impacts of their developments on the surrounding environment and its important biodiversity, will lead to long term irreplaceable losses of environmental services and biodiversity, on which surrounding communities have depended for at last 200 years. The loss of environmental services, especially the hydrological cycle and soil stabilization, that will occur if access to these forests is not controlled, will ultimately cause serious economic losses for local communities, most of whom are very dependent on the hydrological services provided by healthy forests for their domestic and irrigation water supplies.

While the commencement of large scale land clearing and earth moving in the absence of suitable environmental monitoring and mitigation protocols is often the norm in Indonesia (although in contravention of Indonesia's own environmental legislation), it is regrettable that such a high-profile project with significant international investment should follow the "business as usual" model where environmental considerations are reduced to a box-ticking paper exercise with no real implementation in the field.

It would seem a great pity if SOL, and other companies developing large-scale projects around the Batang Toru forests, do not take the opportunity to combine the economic benefits that they will surely bring in the short- and medium-terms, with the long-term benefits for the districts and their people, that would accrue from wise environmental management that could be achieved by the adoption, implementation and dissemination of best environmental practices, and a more 'modern' broader commitment and contribution towards conservation of the dwindling biodiversity in this area.
Recommendations

**Connectivity:**
Any new road construction or re-construction in forested areas [i.e. to NIL 1 and to WJP 1] should maintain several locations along the road where arboreal connectivity [< 3 meter gap] is maintained to provide access for arboreal primates (gibbons, siamang, orangutans, Mitred leaf monkeys) to still use their home ranges that might be dissected by road development. Such connectivity should be maintained every at least at every 250 meters along the road.

**Hunting:**
Hunting of protected wildlife, or any wildlife for that matter as well as poaching for songbirds, is common throughout the SOL project area, and several recommendations are made:

- Limiting/halting free access using project roads;
- Conservation/hunting agreements with main villages/hamlets close to the project area, focusing on hunting bans of protected species, with in return providing protein alternatives (i.e. fish ponds, chicken farming, pig farming);

**Illegal Logging:**
Illegal logging around the SOL project area was encountered in several locations and should be halted. The high occurrence of illegal logging in the areas most likely related to the road access, as cut timber is taken out over the road.

**Garbage Management:**
Large amounts of daily rubbish were being disposed of randomly in the forest by SOL staff (water bottles, cigarette pack/butts, lunch packaging, plastic bags etc). Instructions to staff and control measures should be put in place to stop this littering, and previous litter should be picked up from throughout the SOL project area.

**Company Capacity for Environmental Management and Monitoring:**
It is strongly recommended that the company increase its capacity for monitoring environmental and biodiversity impacts. Although our primary mandate was assessing the absence/presence of key fauna, we were concerned to see not only the illegal activities but local communities that have unwittingly or not been abetted by the company, but also the potential for serious local environmental impacts, such as sedimentation, top soil loss, and river pollution, from the current rapid land clearing activities. It would seem that the company currently has little capacity either for monitoring the biodiversity or environmental impacts of its activities, let alone planning and implementing mitigation measures.

**General Comments:**
Because of its scale and importance to the local economy, SOL is perfectly placed to introduce improved environmental practices by implementing the above recommendations for prevention of hunting of protected wildlife, illegal logging, and garbage management. While the company may feel it maintains the support of local communities by bowing to pressure to allow open access to the forests surrounding its work sites, in the long term this policy can rebound on the company as its practices become more widely known. On the other hand, rigorously imposing best practices on its own workforce and dissemination of these amongst local communities will enhance the company's international reputation, provide a strong case study for other companies operating in Indonesia, and modify
environmentally damaging practices by local communities that appear to currently be accelerating around the work sites.

Furthermore, the company is building a relatively environmentally-friendly energy power plant that will have local impacts on the highly biodiverse and unique Batang Toru forests. But it has the opportunity to play a very important role in the long-term conservation of the wider Batang Toru forest complex (both east and west blocks), thus further demonstrating a wider commitment to environmental best practices and conservation.
References


