



Environmental Management Plan

Development of Sarulla Geothermal Field and Power Plant of 330 MW Capacity

**North Tapanuli Regency,
North Sumatera Province**

August 2009

VALIDATION SHEET

GOVERNOR OF NORTH SUMATERA DECREE

NUMBER: 671.26/3067/K/2009

ON 12 AUGUST 2009

CONCERNING

ENVIRONMENTAL FEASIBILITY OF THE
DEVELOPMENT OF SARULLA GEOTHERMAL FIELD
AND POWER PLANT WITH CAPACITY OF 330 MW IN

NORTH TAPANULI REGENCY

NORTH SUMATERA PROVINCE



Sarulla Operations Ltd (SOL)
2009

STATEMENT

No: SOL-092/DIR/VII/2009

The undersigned,

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As the project proponent for the Development of Sarulla Geothermal Field and Power Plant of 330 MW Capacity in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency, North Sumatera Province, states that:

1. We will implement the commitments on environmental management and monitoring as specified in Environmental Management Plan and Environmental Monitoring Plan for the Development of Sarulla Geothermal Field and Power Plant of 330 MW Capacity in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency, North Sumatera Province.
2. We will undertake environmental management and monitoring as appropriate in accordance with relevant regulations.

This statement is prepared truthfully and to be used appropriately.

Jakarta, June 2009

Sarulla Operations Ltd. (SOL)



A handwritten signature in black ink is written over a blue and white 6000 Indonesian postage stamp. The stamp features a portrait of a man and the text '6000' and 'METERAL TEMPEL'.

Aries Pardjianto

Director

FOREWORD

SARULLA OPERATIONS LTD., (SOL) a consortium between PT MEDCO GEOPOWER SARULLA, ORSARULLA INC., SARULLA POWER ASSET LTD., and KYUDEN SARULLA PTE LTD, plans to develop Sarulla geothermal field and 330 MW power plant in Pahae Jae and Pahae Julu Districts of Tapanuli Utara Regency, Sumatera Utara Province.

The development of this project will bring positive impacts but on the other hand possibilities of negative impacts on physical-chemical components, biological components, and socio-economic, socio-cultural, and public health components.

AMDAL documents of Sarulla geothermal field development were approved in November 2005 by the Governor of Sumatera Utara. Considering (a) additional activities like production well operation and drilling; (b) changes in vapor and brine cooling system from water to air, which is more environmentally friendly; (c) constructions and operations of internal electricity transmission from Silangkitang (SIL) to Namora I Langit NIL; (d) changes of project proponent from PT PLN (Persero) to Sarulla Operations Ltd. (SOL), the 2005 AMDAL documents have been revised in order to continue the development of Sarulla geothermal field and power plant.

Following an approval of Term of Reference Document by the Environmental Impact Control Agency of North Sumatera Province No: 973/BPDL-SU/BTL/2008 on 8 August 2008, the Environmental Impact Statement (ANDAL), Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL) documents have been prepared. These documents have been prepared in accordance to Minister of Environment Decree No. 08 of 2006 regarding Guidance for Preparing Environmental Impact Assessment Documents.

Sarulla Operations Ltd. is committed to environment, health and safety (HSE) in conducting its activities. It is expected that this project will give benefits to the stakeholders, especially to local communities, local government, employees and its shareholders.

To those who have helped in the completions of ANDAL, RKL, and RPL documents, we express our gratitude.

Jakarta, June 2009

Project Proponent,
Sarulla Operations Ltd., (SOL)

Aries Pardjimanto
Director

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CHAPTER I

INTRODUCTION

In compliance with the applicable regulations in Indonesia, this Environmental Management Plan (*Rencana Pengelolaan Lingkungan* = RKL) shall be submitted with Environmental Impact Statement (*Analisis Dampak Lingkungan Hidup* = ANDAL) and Environmental Monitoring Plan (*Rencana Pemantauan Lingkungan Hidup* = RPL). This RKL was prepared in accordance with Minister of Environment Regulation No. 08 of 2006 concerning guidance on the preparation of Environmental Impact Analysis (*Analisis Mengenai Dampak Lingkungan* = AMDAL).

The development of Sarulla geothermal field and power plant Sarulla PLTP is located \pm 40 km south of the city of Tarutung on the Trans-Sumatra highway (Tarutung-Sipirok) with Sarulla Operations Ltd (hereafter referred to as SOL) as the project proponent. Administratively this project is located in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency, North Sumatera Province (see **Map 1-1**).

1.1 AIMS AND OBJECTIVES

1.1.1 Aims

The ANDAL document identified positive and negative significant impacts on the environment due to the activities of developing Sarulla geothermal field and power plant. Aims of the Environmental Management Plan are:

- To comply with all applicable regulations in relation to pollution control, waste management and environmental quality monitoring;
- To ensure that SOL activities are environmentally sound and sustainable i.e. effective management of natural resources to support economic and social developments in Indonesia, in particular to support economic and social developments in North Tapanuli Regency, North Sumatera Province;
- To manage environmental changes resulting from the activities of developing Sarulla geothermal field and power plant hence safeguarding environmental quality;
- To increase the positive impacts (benefits) and to prevent, control and manage the negative impacts (risk).



LEGENDA
Legend

- Ibukota Propinsi
Provincial Capital
- Ibu Kota Kabupaten/Kotamadya
Regency Capital/Municipality
- Ibu Kota Kecamatan dll
District Capital
- ▲ Gunung
Mountain
- Jalan
Road
- +— Rel Kereta Api
Railway
- +—+— Batas administrasi Propinsi
Province Administrative Boundary
- +—+— Batas Administratif Kabupaten
Regency Administrative Boundary
- +—+— Sungai
River

N
0 12.5 25 50 Kilometers

Sumber (Source) :
 Peta Rupa Bumi Indonesia (BAKOSURTANAL)
 The Shuttle Radar Topography Mission (SRTM), Resolusi 90 meter
 Universal Transverse Mercator (UTM), Zona 47 Utara, Datum Reference WGS 84

RENCANA PENGELOLAAN LINGKUNGAN
ENVIRONMENTAL MANAGEMENT PLAN

LOKASI PROYEK PENGEMBANGAN PANAS BUMI DAN PEMBANGUNAN PLTP SARULLA
PROJECT LOCATION OF GEOTHERMAL POWER PLANT

Skala Scale	1:300.000	Digambar Oleh Drawn By	GGG
Peta Map	I - 1	Diperiksa Oleh Proofreader	ABU
Tanggal Revisi Revision Date	25/10/08	Digabung Oleh Compilation	ERM

The Environmental Management Plan was prepared to maintain the equilibrium between environmental components in the vicinity of the project area by:

- Determining preventive, management and control measures on the negative impacts and enhance the positive impacts from the activities of developing Sarulla geothermal field and power plant;
- Involving relevant government agencies and authorities in the environmental management in North Tapanuli Regency, North Sumatera Province;
- Providing sufficient funds to implement the Environmental Management Plan and the Environmental Monitoring Plan to preserve current environmental conditions.

1.1.2 Objectives

Objectives of the Environmental Management Plan are as follow:

- To provide guidelines and directions to implement the environmental management and monitoring of the development of Sarulla geothermal field and power plant;
- To ensure that any environmental changes due to the activities of developing Sarulla geothermal field and power plant in North Tapanuli Regency, North Sumatera Province does not decrease environmental quality;
- To preserve and maintain environmental quality around the development of Sarulla geothermal field and power plant project area in North Tapanuli Regency, North Sumatera Province;
- To enhance and further develop the positive impacts and to control the negative impacts arising from the development of Sarulla geothermal field and power plant;
- To establish mechanisms to coordinate environmental management activities with relevant government agencies.

1.2 ENVIRONMENTAL POLICY

According to SOL's environmental policy, SOL is obliged to adhere to all applicable regulations concerning the environment, and health and safety, as well as to contribute to community development in the vicinity of the development of Sarulla geothermal field and power plant project area. SOL is committed to implement international standard best practice on environmental management, and health and safety (*lingkungan, kesehatan dan keselamatan kerja* = K3L). SOL acknowledges that its environmental management system must be integrated in each stage of the development of Sarulla geothermal field and power station. The success of its management system is measured by the following key points:

- Existence of work environment where employees are able to fulfill their obligations without risks of having accidents or work-related injuries;

- Pollution prevention;
- Compliance with applicable Government regulations and SOL's commitments to the environment, and health and safety;
- Fulfillment of stakeholders' expectations which include employees, local communities, governments, shareholders, and SOL customers;
- Efficient use of natural resources;
- Continuous improvements.

To achieve all of the above points, SOL is committed to implement a management system on the environment, health and safety as follows:

- To identify environmental, health and safety risks in all activities of developing Sarulla geothermal field and power plant;
- To establish objectives and targets for each significant risk;
- To implement plans, standards, and procedures to manage and monitor such risks;
- To carry out audits, evaluate and report the performance on the environment, health and safety on a regular basis;
- To undertake continuous improvements in order to achieve compliance with applicable regulations and SOL's commitments.

SOL organization structure to develop Sarulla geothermal field and power plant is presented in Appendix 2.

1.3 THE PURPOSES OF ENVIRONMENTAL MANAGEMENT PLAN (RKL)

One of the purposes of environmental management is to maintain environmental carrying capacity while achieving the schedule targeted to develop Sarulla geothermal field and power plant.

The Environmental Management Plan serves as directions and guidelines for SOL as the project proponent, and also for government agencies. The purposes of the Environmental Management Plan are:

- To provide directions for the project proponent to managing the environment in the vicinity of the project area;
- To serve as guidelines for the project proponent, government agencies and institutions in the implementation on environmental management in accordance to one's functions and responsibilities;
- To assist the government in environmental decision-making, planning and management;
- To assist regional/local governments in environmental monitoring and development in order to preserve the environment;
- To avoid conflicts between local communities and the project proponent;

- To prevent environmental degradation and to focus on enhancing the positive impacts for local communities and regional/local governments.

CHAPTER II ENVIRONMENTAL MANAGEMENT APPROACH

2.1 TECHNOLOGICAL APPROACH

Process and technical approach, in accordance with currently available technology, is to be used to prevent, control, minimize and manage the negative impacts of the project activities. As much as possible, efforts are directed to preserve the environment and not to exceed environmental carrying capacity. Specific technical program includes:

2.1.1 Power plant technology

The development of Sarulla power plant employs air cooling system from Ormat Energy Converter (OEC). Hence, the development does not require make-up water. Brine and steam are to be re-injected into reinjection wells.

2.1.2 Drilling technology

Drilling includes production wells and reinjection wells. The drilling process will use water base mud (WBM) to prevent the borehole walls from caving during drilling. At certain depths, well casing will be installed to prevent caving of the borehole, and to prevent leakage from or to soil and rock formations. After the drilling is completed, well head will be equipped with tools to control fluid flow rate from the well. It is anticipated that drilling will utilize water from Batang Toru River approximately 400m³ for each well.

Chemicals required for drilling activity consist of WBM and cementing materials. The types and the amounts of the chemical required depend on the depth and the characteristics of the drilled formations. The typical chemicals required are as follow:

- Barite;
- Bentonite;
- Caustic soda;
- Sodium bicarbonate;
- Hightemp defloculent;
- Hightemp fluid (control additive).

Each chemical has its own MSDS and most of the chemicals are categorized as non-hazardous and non-toxic (non-B3) based on a list published by the United States

Environmental Protection Agency (US-EPA). Storage and treatment of these chemicals and their residuals will refer to the associated MSDS.

Directional drilling technology will be employed to ensure an efficient use of drilling well pads during well development.

2.1.3 Air pollution control technology

Non-condensable gases (NCG) in the steam (mostly CO₂ and a small amount of H₂S) will be piped from Bottoming OECs heat exchangers to top of air cooled condenser fan and released to atmosphere.

2.1.4 Waste management technology

- Oil and chemical waste

The oil and chemical waste from the geothermal field and the power plant will be treated according to Government Regulation No. 85 of 1999 concerning changes to Government Regulation No. 18 of 1999 concerning the management of hazardous and toxic wastes. Used lubricant oil will be temporarily stored in a drum before handled by a licensed waste management contractor.

- Liquid waste

Liquid waste from the power plant operation is originated from domestic waste and steam. Domestic waste is transferred to septic tanks whilst steam is re-injected into reinjection wells and if required, H₂SO₄ is to be added to control pH.

- Solid waste

Solid waste in forms of metals and cables are to be collected and transferred to a temporary storage near the project area. The temporary storage area is to be integrated with the temporary storage area for the installation of transmission network.

Domestic solid waste is biodegradable and to be collected in a temporary storage area at the project location. The waste will be handled by a licensed waste management contractor and transferred into the nearest licensed final disposal area.

2.2 SOCIO-ECONOMIC APPROACH

This approach includes steps for the project proponent to manage significant impacts by undertaking activities based on social interactions and collaborations with central/regional/local governments. The approach is specified as follows:

1. To involve local communities in the vicinity of the project area to actively participate in environmental management activities;

2. To prioritize local workforce recruitment according to skills possessed and to pass SOL selection process;
3. To collaborate with third-party in providing goods and services thus improving local economy;
4. To provide public facilities to local communities in the vicinity of the project area according to project proponent's capability;
5. To create and maintain harmonized social interaction with local communities in the vicinity of the project area to avoid social problems.

2.2.1 Anticipative Approach

This approach is identical to preventative efforts to avoid negative impacts (that can be predicted) as early as possible, or if unavoidable, to minimize the impacts as much as possible.

The initial step is to provide transparent information on the project activities. Information shall be presented in a clear and simple format, easily understood by local communities in order to minimize discrepancies between the project proponent and the local communities.

The anticipative approach shall be undertaken periodically in the form of consultation.

2.2.2 Direct and indirect approaches

Direct approach: directly towards local communities interested in the project.

Indirect approach: by approaching informal leaders i.e. community, religious and traditional leaders who lead non governmental institutions and considered as role models in the communities.

2.2.3 Segmentary approach

This is a segmented approach to be undertaken when complicated and interconnected problems occur.

A mediator with the ability to carry out segmentary approach proportionally and not to ignore issues between different stakeholders is necessary to reach a solution.

This approach is effective to manage community unrest in relation to workforce mobilization prior to and following the end of construction stage.

2.2.4 Stimulative approach

This approach focuses on managing socio-economic-cultural impacts as construction stage ends. The process of social adaptation within the local communities with the project existence in their life does not stop as operation stage commences.

The local communities still have to seek their new identity i.e. integration between the traditional and geothermal industry styles.

Stimulus shall be provided to put an end to gaps that exist due to discontinued primary impacts and to create secondary impacts.

2.2.5 Qualitative and quantitative approaches

Qualitative approach: the focus of this approach is to measure the success of the environmental management system related to socio-cultural parameters. Exact science cannot approach parameters such as cultural, custom, community perception, etc. Thus analogical methods and value judgment play an important role as qualitative approach.

Quantitative approach: can be used as guidelines to evaluate the success of the environmental management system related to socio-economic parameters. Quantitative calculations can be implemented to measure increase and decrease of community income before and after the project, business growth and decline, number of assets, turnover, capital, etc.

2.2.6 Community development approach

In order to manage the environmental impacts due to project activities, the project proponent shall undertake community development programs. The programs are expected to accommodate community participation together with the project proponent in environmental management.

2.3 INSTITUTIONAL APPROACH

Environmental management activities are not solely project proponent's responsibilities but require involvement and integration between relevant institutions. It is therefore important to:

- Coordinate with relevant institutions to develop and monitor the environment, and health and safety;
- Coordinate with North Tapanuli Regency and relevant institutions in managing potential social issues;
- Cooperate with various stakeholders including Non Governmental Organizations and local community leaders in undertaking community development programs;
- Inform local communities on the objectives and benefits of the development of Sarulla geothermal field and power plant.

2.4 ENVIRONMENTAL MANAGEMENT APPROACH

As a commitment to the highest environmental management standard, the project proponent plans to implement an environmental management system such as ISO 14001 or similar standard.

CHAPTER III ENVIRONMENTAL MANAGEMENT PLAN

3.1 PRE-CONSTRUCTION STAGE

3.1.1 Socio-economic, socio-cultural, and public health components

3.1.1.1 *Land ownership and occupancy*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Land ownership

b) *Source of significant impact*

Land acquisition

2. *Impact indicator*

- Changes in land ownership that used to be owned by local community in the vicinity of the project areas
- Community unrest due to the land acquisition

3. *Environmental management objective*

To avoid and minimize community unrest due to land acquisition process

4. *Environmental management plan*

- Prepare a project plan and to coordinate with relevant authorities on areas which will be acquired
- Undertake public consultation for each land acquisition activity
- Persuasively approach land owners/users in order to obtain information on land ownership status and size of land
- Investigate, ensure and record the land ownership information
- Coordinate with relevant local authorities (National Land Agency North Tapanuli Regency, Head of District (*camat*) and village heads (*kepala desa*) during the land acquisition process
- Obtain mutual agreements between the project proponent and land owners on the values and forms of compensation towards land and vegetation acquisitions in accordance with applicable laws and regulations

5. *Environmental management location*

The development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the pre-construction stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: National Land Agency (BPN), North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.1.1.2 *Community unrest*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community unrest

b) *Source of significant impact*

Land acquisition

2. *Impact indicator*

- Complaints from the community regarding boundaries and size of land
- Different opinions in land value and compensation types for land and/or vegetation acquisitions

3. *Environmental management objective*

To avoid and minimize community unrest due to land acquisition process

4. *Environmental management plan*

- Prepare a work plan consisting of land acquisition mechanism, land compensation system and monitoring plan
- Consult and disseminate accurate information regarding land acquisition activities
- Carry out land acquisition activities fairly and openly

5. *Environmental management location*

Villages in the vicinity of the development of geothermal fields and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the pre-construction stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.2 CONSTRUCTION STAGE

3.2.1 Geophysical and chemical components

3.2.1.1 *H₂S*

1. *Significant impact and source of significant impact*

a) *Significant impact*

H₂S concentrations in ambient air

b) *Source of significant impact*

Well drilling and production testing

2. *Impact indicator*

Minister of Environment Decree No. Kep-50/MENLH/11/ 1996

3. *Environmental management objective*

To minimize H₂S concentration in ambient air

4. *Environmental management plan*

- Secure well locations and limit access for local communities

- Workers nearby well locations must be equipped with PPE (Personal Protective Equipment)
- Production test locations will be equipped with H₂S monitoring equipment
- Maintenance of construction vehicles
- Reduce vehicles speed to a maximum of 40 km/hour
- Put 'Do Not Enter' signs for unauthorized personnel during the drilling and test production
- Evacuate personnel and residents around well locations if H₂S concentration is exceeded
- If based on monitoring results the H₂S concentration exceeds the threshold, production wells will be reduced to ensure achievement of H₂S concentration standard

5. *Environmental management location*

Around the area of well drilling and production testing

6. *Environmental management period*

During the construction stage

7. *Environmental management institutions*

- Implementer: SOL.
- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.2.1.2 *Noise*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Noise

b) *Source of significant impact*

- Mobilization of equipment and material
- Well drilling and production testing

- Power plant construction
2. *Impact indicator*
Minister of Environment Decree No Kep-48/MENLH/11/1996
 3. *Environmental management objective*
To minimize an increased in noise level
 4. *Environmental management plan*
 - Maintenance of construction vehicles
 - Reduce vehicles speed to a maximum of 40 km/hour
 - Install silencer to reduce noise
 - Workers nearby production test well to use ear muff
 - Put 'Do Not Enter' signs for unauthorized personnel during the drilling
 - Plant trees with wide canopies to reduce noise level
 - Consultation with communities close to the project location
 5. *Environmental management location*
 - Road access within the development of Sarulla geothermal fields and power plant project area
 - Well locations
 - Power plant construction area
 6. *Environmental management period*
During the construction stage
 7. *Environmental management institutions*
 - Implementer: SOL
 - Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
 - Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.2.2 Socio-economic, socio-cultural, and public health components

3.2.2.1 Job opportunities

1. Significant impact and source of significant impact

a) Significant impact

Job opportunities

b) Source of significant impact

Workforce recruitment

2. Impact indicator

Numbers of local and non-local workers recruited by SOL and its contractors

3. Environmental management objective

- To optimize job opportunities for local communities
- To prioritize local communities in workforce recruitment

4. Environmental management plan

- Provide job opportunities for local communities who fulfill company's requirements and qualifications
- Encourage contractors to hire as many local workers as possible

5. Environmental management location

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. Environmental management period

During the construction stage

7. Environmental management Institutions

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.2.2.2 *Business opportunities*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Business opportunities

b) *Source of significant impact*

Construction activities

2. *Impact indicator*

Creation of business opportunities for local communities

3. *Environmental management objective*

To increase local communities' participation in project activities

4. *Environmental management plan*

- Provide job opportunities for local communities who fulfill company's requirements and qualifications
- Encourage contractors to hire as many local workers as possible

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the construction stage

7. *Environmental management Institutions*

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.2.2.3 *Community income*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community income

b) *Source of significant impact*

Construction activities

2. *Impact indicator*

Household income

3. *Environmental management objective*

- To optimize job opportunities for local communities
- To prioritize local communities in workforce recruitment
- To increase the level of participation of local businesses in the project

4. *Environmental management plan*

- Provide job opportunities for local communities who fulfill company's requirements and qualifications
- Provide opportunities for local businesses to participate in the provision of goods and services

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the construction stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.2.2.4 *Community unrest*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community unrest

b) *Source of significant impact*

- Workforce recruitment

- Well drilling and production testing
 - Installation of transmission network
2. *Impact indicator*
- Community complaints regarding workforce recruitment
 - Local concerns toward well drilling and production testing
 - Local concerns toward transmission network
3. *Environmental management objective*
- To avoid and minimize community unrest towards workforce recruitment during the construction stage
 - To avoid community unrest towards well drilling activity
 - To avoid community unrest towards installation of transmission network
4. *Environmental management plan*
- Prepare a work plan on local workforce recruitment during drilling and installation of transmission network
 - Consult and disseminate accurate information on workforce recruitment and its requirements fairly and openly
 - Public consultation on the drilling plan
 - Public consultation on the plan to install transmission network
5. *Environmental management location*
- Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency
 - Villages in the transmission network area
6. *Environmental management period*
- During the construction stage
7. *Environmental management Institutions*
- Implementer: SOL
 - Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
 - Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli

3.2.2.5 Transportation

1. Significant impact and source of significant impact

a) Significant impact

Ground traffic disruption

b) Source of significant impact

Mobilization of equipment and materials

2. Impact indicator

- PHF (Peak Hours Factors)
- Number of traffic accidents

3. Environmental management objective

- To minimize traffic congestion
- To minimize traffic accidents
- To increase traffic safety

4. Environmental management plan

- Installation and maintenance of traffic signals
- Cover trucks properly to avoid spillage of materials onto the road
- Collaborate with professional contractors in the provision of transportation services for equipment and materials
- Routine and scheduled maintenance for heavy duty vehicles
- Routine road inspections with relevant government authorities to ensure safe and good road conditions, and that local communities' activities do not endanger traffic conditions
- Operation of heavy duty vehicles during non-peak hours

5. Environmental management location

Roads accessed by project vehicles in North Tapanuli Regency

6. Environmental management period

During the construction stage

7. Environmental management Institutions

- Implementer: SOL
- Supervisor: Traffic and Road Transportation Agency of North Tapanuli Regency

- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.3 OPERATION STAGE

3.3.1 Geophysical and chemical components

3.3.1.1 H_2S

1. *Significant impact and source of significant impact*

a) *Significant impact*

H_2S concentrations in ambient air

b) *Source of significant impact*

Power plant operation

2. *Impact indicator*

Minister of Environment Decree No. Kep-50/MENLH/ 11/1996

3. *Environmental management objective*

To minimize H_2S concentrations in the ambient air

4. *Environmental management plan*

- If the H_2S concentration at the monitoring locations exceed the odor quality standard of 0.02 ppm, emission of H_2S from power plant will be controlled using technologies such as LO-CAT sulfur recovery unit until the concentration meets the odor quality standard
- Secure power plant location and limit access for local communities
- Workers working in the surrounding power plant area must be equipped with PPE (Personal Protective Equipment)
- Equip power plant with H_2S monitoring equipment

5. *Environmental management location*

Around power plant locations

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL

- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.3.1.2 *Noise*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Noise level

b) *Source of significant impact*

Power plant operation

2. *Impact indicator*

Minister of Environment Decree No. Kep-48/MENLH/ 11/1996

3. *Environmental management objective*

To minimize an increase in noise level

4. *Environmental management plan*

- Workers in and around power plant to use ear muff
- Install silencer to reduce noise
- Plant trees with wide canopies to reduce noise level

5. *Environmental management location*

Around power plant locations

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North

3.3.2 Socio-economic, socio-cultural, and public health components

3.3.2.1 Job opportunities

1. Significant impact and source of significant impact

a) Significant impact

Job opportunities

b) Source of significant impact

Workforce recruitment

2. Impact indicator

Numbers of local and non-local workers recruited by SOL and its contractors

3. Environmental management objective

- To optimize job opportunities for local communities
- To prioritize local communities in workforce recruitment

4. Environmental management plan

- Provide job opportunities for local communities who fulfill company's requirements and qualification
- Encourage contractors to hire as many local workers as possible

5. Environmental management location

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. Environmental management period

During the operation stage

7. Environmental management institutions

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli

3.3.2.2 Business opportunities

1. Significant impact and source of significant impact

a) Significant impact

Business opportunities

b) Source of significant impact

Operation activities

2. Impact indicator

Creation of business opportunities for the local communities

3. Environmental management objective

To increase local communities' participation in the project

4. Environmental management plan

- Provide opportunities for local businesses to participate in the provision of goods and services
- Provide guidance for local businesses in order to fulfill company's standards

5. Environmental management location

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. Environmental management period

During the operation stage

7. Environmental management institutions

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.3.2.3 *Community income*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community income

b) *Source of significant impact*

Operation activities

2. *Impact indicator*

Household income

3. *Environmental management objective*

- To optimize job opportunities for local communities
- To prioritize local communities in workforce recruitment
- To increase the level of participation of local businesses in the project

4. *Environmental management plan*

- Provide job opportunities for local communities who fulfill company's requirements and qualifications
- Provide opportunities for local workers to grow and expand

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.3.2.4 *Community unrest*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community unrest

b) *Source of significant impact*

Workforce recruitment

Operation of transmission network

2. *Impact indicator*

- Community complaints regarding workforce recruitment
- Local concerns toward operation of transmission network

3. *Environmental management objective*

- To avoid and minimize community unrest towards workforce recruitment during the operation stage
- To avoid community unrest towards operation of transmission network

4. *Environmental management plan*

- Prepare a work plan on local workforce recruitment in fair and open ways
- Public consultation on the operation of transmission network

5. *Environmental management location*

- Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency
- Villages in the transmission network area

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North

3.4 OTHER MONITORING

3.4.1 Solid and liquid waste monitoring

3.4.1.1 *Surface water quality*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Heavy metals, hazardous and toxic (B3) wastes

b) *Source of significant impact*

Drilling wells, sump pit, well production (during production test) which potentially produce both B3 and non-B3 wastes

2. *Impact indicator*

- Compliance with waste water quality standards
- Compliance with Minister of Energy and Mineral Resources Decree No. 45 of 2006 regarding the Management of Drilling Reservoir, Slurry Waste and Drill Powder in Oil and Gas Drilling Activities
- Compliance with B3 waste regulations (Government Regulations No. 18 of 1999 and No. 85 of 1999)

3. *Environmental management objective*

- To reduce impacts to surface and ground water qualities
- To ensure proper management of B3 wastes according to the applicable B3 regulations

4. *Environmental management plan*

a) *Domestic solid waste:*

Solid waste disposal to landfills

b) *Liquid waste:*

- Liquid domestic waste water treatment from all project activities in domestic waste water treatment plant
- Condensate and brine generated during the power plant production testing and operational to be injected into reinjection wells
- Construction of sump pit that is coated with waterproof layer. Collected water in the sump pit, used in the drilling process as drilling mud component to be returned into the wells

c) *B3 waste:*

- Fragments in the drilling mud to be stored in the sump pit
- Drilling mud to be stored in the sump pit
- Ensure that equipment and materials purchased by SOL do not contain PCBs, asbestos, ozone depleting substances and other prohibited materials according to relevant regulations
- Neutralize and securely store used lead acid batteries
- Collection of used oil, which then stored into drums and handed over to registered B3 management companies for further process
- Installation of secondary containments around flammable and hazardous materials as required
- Regular training on B3 waste management for employees

5. *Environmental management location*

- Sarulla project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency
- B3 wastes temporary storage
- Domestic waste water treatment plant.
- Non B3 waste landfill
- Well locations

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Mining and Energy Agency of North Sumatera Province
- Mining and Energy Agency of North Tapanuli Regency
- Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2 Community development programs

3.4.2.1 Provision of education services and facilities

1. Significant impact and source of significant impact

a) Significant impact

Provision of education services and facilities for local communities

b) Source of significant impact

Increased demands for education services and facilities

2. Impact indicator

Distribution of education facilities around the project area in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency

3. Environmental management objective

- To assist local governments in the provision of required education services and facilities under Community Development Program
- To ensure responsible and effective use of Community Development Program funds

4. Environmental management plan

Cooperation with relevant stakeholders in formal education and training to improve the qualities of local community resources

5. Environmental management location

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. Environmental management period

During the operation stage

7. Environmental management institutions

- Implementer: SOL
- Supervisor: Education Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2.2 *Provision of public health services*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Provision of public health services and facilities

b) *Source of significant impact*

Increased demands for health services and facilities

2. *Impact indicator*

Distribution of health facilities around the project area in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency

3. *Environmental management objective*

To assist local governments in the provision of required health services and facilities under Community Development Program

4. *Environmental management plan*

Cooperation with relevant stakeholders in health services

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Health Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2.3 *Initiatives for improving farming and agriculture cultivation techniques*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Agriculture productivity in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency

b) *Source of significant impact*

- Limited knowledge on agricultural commodities with high economic values amongst young farmers
- Low level of interest on agricultural activities amongst younger generation
- Shortage of agriculture production
- Limited high quality agricultural production facilities
- Limited skills in using agricultural machineries amongst farmers

2. *Impact indicator*

Production level and types of agricultural commodities around the project area in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency

3. *Environmental management objective*

- To maintain and increase production level and agriculture commodity types
- To increase competitiveness of local agriculture commodities

4. *Environmental management plan*

Cooperation with relevant stakeholders in local agriculture

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Agriculture Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2.4 *Local business opportunities*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Local communities' participation level in various economic activities

b) *Source of significant impact*

- Level of local community participation integrally and equally in local business opportunities
- Level of local community's business skill
- Availability of access to sources of funding and capitals

2. *Impact indicator*

- Number of locally owned and managed businesses
- Types of goods and services provided
- Local economic activities value

3. *Environmental management objective*

To increase participation of local communities in economic activities

4. *Environmental management plan*

- Encourage the use and purchase of local products and services by SOL and its contractors
- Provide assistance in training and opportunities to participate in local business activities
- Increase local communities' involvement in entrepreneurship through local business activities
- Cooperation with local communities to improve the qualities of local goods and services

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Industrial Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2.5 *Provision of public infrastructures*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Local communities' needs and demands for public services

b) *Source of significant impact*

- Rapid growth and development rates
- Local communities' increased demands for public services

2. *Impact indicator*

Local governments' request to provide public infrastructures

3. *Environmental management objective*

To support local governments in its efforts to provide adequate public services to local communities

4. *Environmental management plan*

- Cooperation with local governments to determine public infrastructures to be provided
- Encourage and assist local governments to develop its own social service initiatives

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Public Work Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2.6 *Cultural preservation*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Changes in traditional, cultural values and customs

b) *Source of significant impact*

Increasing presence of modern society and its associated infrastructures and materials

2. *Impact indicator*

Traditional activities, cultural festivals, books and monographs on language, history, sociology and local anthropology

3. *Environmental management objective*

To assist local communities in keeping their traditional cultures intact

4. *Environmental management plan*

Support local ethnics program s and activities, preserve local culture including traditional activities (dances), cultural festivals, seminars and conferences, books and monographs on language, history, sociology and local anthropology

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Education Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.4.2.7 *Awareness of SOL activities*

1. *Significant impact and source of significant impact*

c) *Significant impact*

Accuracy and completeness of information about SOL activities within the local communities

d) *Source of significant impact*

Misinformation circulating in the local communities concerning SOL activities

2. *Impact indicator*

Lack of awareness and understanding of SOL activities (such as employment, training and business opportunities) within the workforce and local communities

3. *Environmental management objective*

To ensure accuracy and completeness of information about SOL activities

4. *Environmental management plan*

Regular information dissemination related to SOL activities to community leaders and local government

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Education Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.5 POST-OPERATION STAGE

3.5.1 Socio-economic, socio-cultural, and public health components

3.5.1.1 *Job opportunities*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community unrest

b) *Source of significant impact*

Employee release

2. *Impact indicator*

Unemployment due to employee release

3. *Environmental management objective*

To prevent high level of unemployment to occur by the end of the project

4. *Environmental management plan*

Consultation with workers on the plan to release employees

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the post-operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Labor Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.5.1.2 *Business opportunities*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Business opportunities

b) *Source of significant impact*

Completion of the operation stage

2. *Impact indicator*

Reduction of business opportunities for local communities

3. *Environmental management objective*

To maintain business opportunities for local communities

4. *Environmental management plan*

Public consultation on the completion of project activities

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the post-operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Labor Agency and Industrial Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.5.1.3 *Community income*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community income

b) *Source of significant impact*

Completion of the operation stage

2. *Impact indicator*

- Reduction of business opportunities for local communities
- Reduction of community income around project location

3. *Environmental management objective*

To avoid a decrease in community income

4. *Environmental management plan*

- Consultation with workers on the plan to release employees
- Provide adequate compensation to workers in accordance with applicable regulations
- Public consultation on the completion of project activities

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

6. *Environmental management period*

During the post-operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Labor Agency and Industrial Agency of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency, Mining and Energy Agency of North Sumatera Province, Mining and Energy Agency of North Tapanuli Regency, Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.5.1.4 *Community unrest*

1. *Significant impact and source of significant impact*

a) *Significant impact*

Community unrest

b) *Source of significant impact*

Workforce release

2. *Impact indicator*

Community unrest due to workforce release

3. *Environmental management objective*

To avoid and minimize community unrest due to workforce release

4. *Environmental management plan*

- Prepare a work plan on workforce release
- Consultation with workers on the plan to release employees

5. *Environmental management location*

Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency

Villages in the transmission network area

6. *Environmental management period*

During the post-operation stage

7. *Environmental management institutions*

- Implementer: SOL
- Supervisor: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province, Environmental Office of North Tapanuli Regency
- Reporting to: Environmental Impact Management Agency (*Bapedalda*) of North Sumatera Province
- Environmental Office of North Tapanuli Regency
- Mining and Energy Agency of North Sumatera Province
- Mining and Energy Agency of North Tapanuli Regency
- Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

3.6 POST-OPERATION ENVIRONMENTAL MANAGEMENT PLANS

The post-operation stage occurs if and when transmission line or power plant equipment cannot serve its economic function, and therefore shall be deactivated. The deactivation process is anticipated to last 6 to 8 months prior to decommissioning. Local industries (especially PT. PLN) will be notified to assess the possibility to utilize the geothermal energy.

3.6.1 Closure of production and reinjection wells

Wells will be deactivated by following well closure procedure and areas around the wells will be rehabilitated. Reclamation of the wells area will be conducted with planting local plants. Well closure procedure is as follows:

- To block the borehole with cement with a minimum of 30 m thickness placed on top of production casing shoe and another layer of cement on top. Mud with similar or greater density than those used as drilling mud will be used as filling between the cement layers;
- Production and reinjection wells closure will follow the procedure for permanent well closure.

3.6.2 Deactivation of pipelines and supporting facilities

All pipelines, pumps and separators will be deactivated in this stage following the procedure specified below:

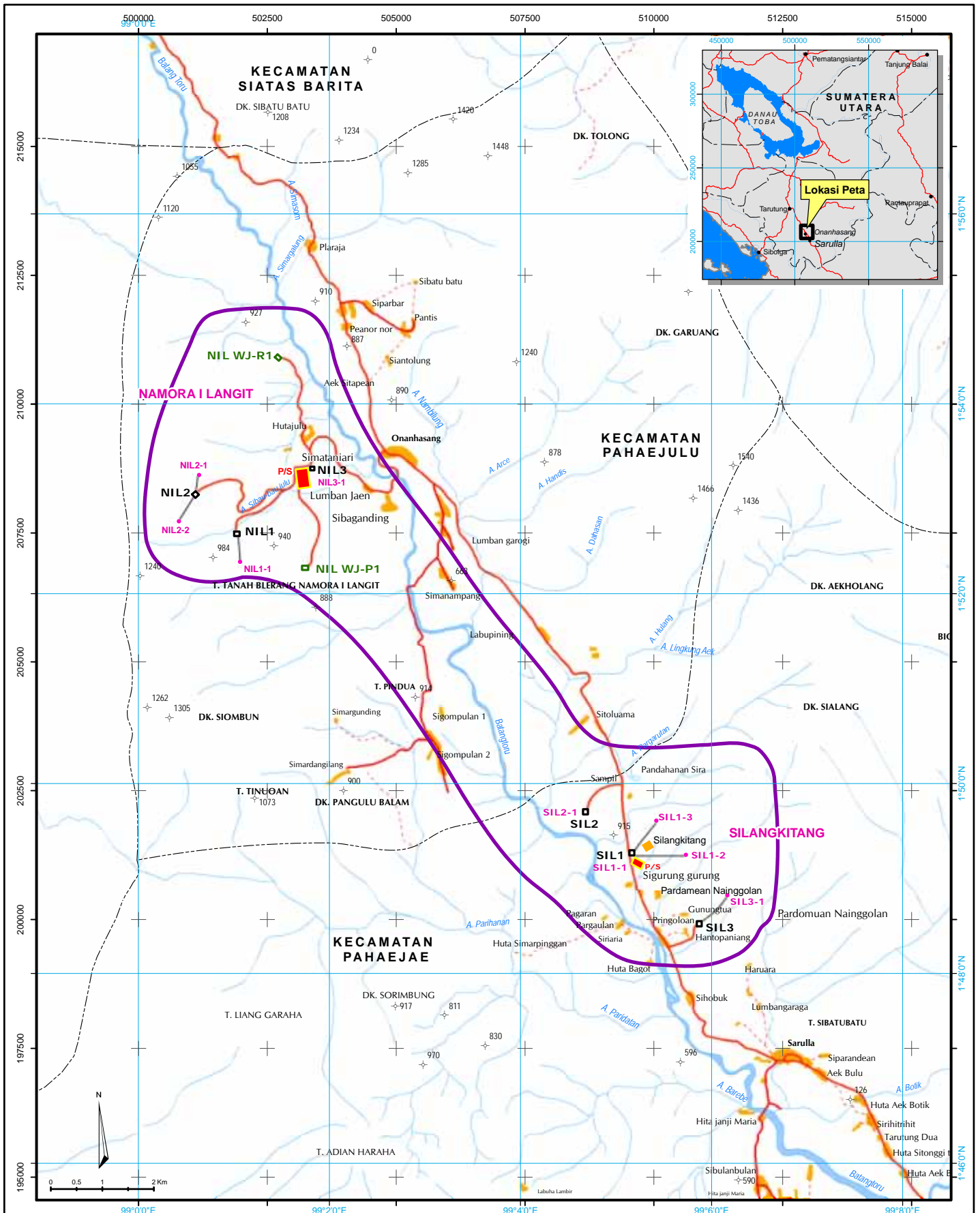
- Pipelines and other supporting facilities will be dismantled, loaded onto trucks then sold to scrap metal buyers, or disposed to a licensed disposal area;
- Well pads will be replanted with grass and local plants.

3.6.3 Deactivation of geothermal power plants

As the operation stage is completed, all power plants will cease to operate and will be demolished.

- All functional equipment will be dismantled to be reused in other projects in Indonesia or abroad, or to be sold;
- The remainder of equipment and buildings will be demolished. The debris will be sold to debris buyer or loaded onto trucks to be disposed to a licensed disposal area;
- Power plant locations will be rehabilitated i.e. replanted with grass and local vegetation;
- Unused land will be sold;
- SOL workforce release will work follow the applicable law and regulations, and will comply with work contracts.

A summary of matrix of project closure is provided in Appendix 1.



Legenda
Legend

- Titik Ketinggian
Elevation Point
- Jalan Arteri
Arteri Road
- Jalan Kolektor
Collector Road
- Jalan Lokal
Local Road
- Batas Kecamatan
Kecamatan Boundary
- Sungai
River
- Permukiman
Village
- Sumur Eksplorasi Namora I Langit dan Silangkitang
Namora I Langit and Silangkitang Exploration Wells
- Lokasi Sumur Baru (West JEC)
New Well Site (West JEC)
- Pembangkit Listrik
Power Station
- Lokasi pengelolaan Lingkungan
Environmental Management Site

Keterangan :
Note :

DK : Bukit
Hill

Aek : Sungai
River

T. :Tinggi
Elevation

Sumber (Source) :
Peta Topografi - BAKOSURTANAL, 1977, Skala 1 : 50.000.
Medco Geothermal Indonesia

RENCANA PENGELOLAAN LINGKUNGAN
ENVIRONMENTAL MANAGEMENT PLAN

LOKASI PENGELOLAAN LINGKUNGAN
ENVIRONMENTAL MANAGEMENT SITE

Skala Scale	1 : 100.000	Digambar Oleh Drafter	GGG
Peta Map	III - 1	Diperiksa Oleh Proofreader	ABU
Tanggal Revisi Date Revision	23/10/08	Digabung Oleh Compilation	ERM

BIBLIOGRAPHY

- APHA, 1992. *Standard Methods*, APHA, AWWA, WPCF, Washington DC.
- Arsyad, S., 1989. *Konservasi Tanah dan Air*, IPB – Press, Bogor
- Cox, G. W., 1975. *Laboratory Manual of General Ecology*. Wm. C. Brown Co. Inc. Dubuque, Iowa.
- Dinas Kesehatan Propinsi Sumatra Utara. 2002. *Profil Kesehatan Propinsi Sumatra Utara 2001*. Medan.
- Hammer, W.I. 1981. *Second Soil Conservation*. Consultant Report. AGOF/INS/78/006. Tech. Note No. 10. Centre for Soil Research, Bogor, Indonesia
- London, J.R. 1984. *Soil Suitability for Crops*. Booker Tropical Soil Manual, Booker Agric, Int'l Ltd., London.
- Neuman, W. L. 2000. *Social Research Method: Qualitative and Quantitative Approaches*. Fourth Edition. Allyn & Bacon. New York.
- Odum, E.P., 1971. *Fundamental of Ecology*., W.B. Saunders and Co. Philadelphia
- Pertamina Unocal North Sumatera Geothermal, Ltd.,1998. Analisis Dampak Lingkungan (ANDAL) Pengembangan Lapangan Panas Bumi Silangkitang dan Pembangunan PLTP Sarulla Unit 1 dengan Kapasitas 110 MW, Kabupaten Tapanuli Utara, Provinsi Sumatera Utara. LP-ITB. Jakarta.
- PT. PLN (Persero), 2005. Analisis Dampak Lingkungan (ANDAL) PLTP Sarulla Tapanuli Utara, Prov. Sumatera Utara. PT. Berlian Jaya Mandiri. Medan
- Rusli, Said. 1996. *Pengantar Ilmu Kependudukan*. Edisi 7 (Revisi). LP3ES. Jakarta.
- Soemarwoto, O. 1991. *Analisis Dampak Lingkungan* (. Gajah Mada University Press, Yogyakarta.
- Suratmo, G., 1988, *Analisis Mengenai Dampak Lingkungan*, Gajah Mada University Press, Yogyakarta.
- West Japan Engineering Consultant, Inc., 2007. Indonesia Sarulla Geothermal Project. West JEC. Japan
- Wishmeyer, W.H., and D.D. Smith., 1978. *Predicting rainfall erosion losses: a guide to conservation planning*. USDA Agr. Handbook.

Appendix 1

**ENVIRONMENTAL MANAGEMENT PLAN
MATRIX SUMMARY**

Environmental Management Plan Summary Matrix

Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
A. Pre-construction stage										
Socio-economic, socio-cultural, and public health components										
Land ownership and occupancy	Land ownership	Land acquisition	<ul style="list-style-type: none"> Changes in land ownership that used to be owned by local community in the vicinity of the project areas Community unrest due to the land acquisition 	To avoid and minimize community unrest due to land acquisition process	<ul style="list-style-type: none"> Prepare a project plan and to coordinate with relevant authorities on areas which will be acquired Undertake public consultation for each land acquisition activity Persuasively approach land owners/users in order to obtain information on land ownership status and size of land Investigate, ensure and record the land ownership information Coordinate with relevant local authorities (National Land Agency North Tapanuli Regency, Head of District (camat) and village heads (kepala desa) during the land acquisition process Obtain mutual agreements between the project proponent and land owners on the values and forms of compensation towards land and vegetation acquisitions in accordance with applicable laws and regulations 	The development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the pre-construction stage	SOL	National Land Agency (BPN), North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Community unrest	Community unrest	Land acquisition	<ul style="list-style-type: none"> Complaints from the community regarding boundaries and size of land Different opinions in land value and compensation types for land and/or vegetation acquisitions 	To avoid and minimize community unrest due to land acquisition process	<ul style="list-style-type: none"> Prepare a work plan consisting of land acquisition mechanism, land compensation system and monitoring plan Consult and disseminate accurate information regarding land acquisition activities Carry out land acquisition activities fairly and openly 	Villages in the vicinity of the development of geothermal fields and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the pre-construction stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

Environmental Management Plan Summary Matrix

Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
B. Construction stage										
Geophysical and chemical components										
H₂S	H ₂ S concentrations in ambient air	Well drilling and production testing	Minister of Environment Decree No. Kep-50/MENLH/11/ 1996	To minimize H ₂ S concentration in ambient air	<ul style="list-style-type: none"> Secure well locations and limit access for local communities Workers nearby well locations must be equipped with PPE (Personal Protective Equipment) Production test locations will be equipped with H₂S monitoring equipment Maintenance of construction vehicles Reduce vehicles speed to a maximum of 40 km/hour Put 'Do Not Enter' signs for unauthorized personnel during the drilling and test production Evacuate personnel and residents around well locations if H₂S concentration is exceeded If based on monitoring results the H₂S concentration exceeds the threshold, production wells will be reduced to ensure achievement of H₂S concentration standard 	Around the area of well drilling and production testing	During the construction stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Noise	Noise	<ul style="list-style-type: none"> Mobilization of equipment and materials Well drilling and production testing Power plant construction 	Minister of Environment Decree No. Kep-48/MENLH/11/1996	To minimize an increased in noise level	<ul style="list-style-type: none"> Maintenance of construction vehicles Reduce vehicles speed to a maximum of 40 km/hour Install silencer to reduce noise Workers nearby production test well to use ear muff Put 'Do Not Enter' signs for unauthorized personnel during the drilling Plant trees with wide canopies to reduce noise level Consultation with communities close to the project location 	<ul style="list-style-type: none"> Road access within the development of Sarulla geothermal fields and power plant project area Well locations Power plant construction area 	During the construction stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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								Implementer	Supervisor	Reporting to
Socio-economic, socio-cultural, and public health components										
Job opportunities	Job opportunities	Workforce recruitment	Numbers of local and non-local workers recruited by SOL and its contractors	<ul style="list-style-type: none"> To optimize job opportunities for local communities To prioritize local communities in workforce recruitment 	<ul style="list-style-type: none"> Provide job opportunities for local communities who fulfill company's requirements and qualifications Encourage contractors to hire as many local workers as possible 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the construction stage	SOL	Labor Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Business opportunities	Business opportunities	Construction activities	Creation of business opportunities for local communities	To increase local communities' participation in project activities	Provide opportunities for local businesses to participate in the provision of goods and services	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the construction stage	SOL	Labor Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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								Implementer	Supervisor	Reporting to
Community income	Community income	Construction activities	Household income	<ul style="list-style-type: none"> To optimize job opportunities for local communities To prioritize local communities in workforce recruitment To increase the level of participation of local businesses in the project 	<ul style="list-style-type: none"> Provide job opportunities for local communities who fulfill company's requirements and qualifications Provide opportunities for local businesses to participate in the provision of goods and services 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the construction stage	SOL	Labor Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Community unrest	Community unrest	<ul style="list-style-type: none"> Workforce recruitment Well drilling and production testing Installation of transmission network 	<ul style="list-style-type: none"> Community complaints regarding workforce recruitment Local concerns toward well drilling and production testing Local concerns toward transmission network 	<ul style="list-style-type: none"> To avoid and minimize community unrest towards workforce recruitment during the construction stage To avoid community unrest towards well drilling activity To avoid community unrest towards installation of transmission network 	<ul style="list-style-type: none"> Prepare a work plan on local workforce recruitment during drilling and installation of transmission network Consult and disseminate accurate information on workforce recruitment and its requirements fairly and openly Public consultation on the drilling plan Public consultation on the plan to install transmission network 	<ul style="list-style-type: none"> Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency Villages in the transmission network area 	During the construction stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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								Implementer	Supervisor	Reporting to
Transportation	Ground traffic disruption	Mobilization of equipment and materials	<ul style="list-style-type: none"> PHF (Peak Hours Factors) Number of traffic accidents 	<ul style="list-style-type: none"> To minimize traffic congestion To minimize traffic accidents To increase traffic safety 	<ul style="list-style-type: none"> Installation and maintenance of traffic signals Cover trucks properly to avoid spillage of materials onto the road Collaborate with professional contractors in the provision of transportation services for equipment and materials Routine and scheduled maintenance for heavy duty vehicles Routine road inspections with relevant government authorities to ensure safe and good road conditions, and that local communities' activities do not endanger traffic conditions Operation of heavy duty vehicles during non-peak hours 	Roads accessed by project vehicles in North Tapanuli Regency	During the construction stage	SOL	Traffic and Road Transportation Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
C. Operation stage										
Geophysical and chemical components										
H₂S	H ₂ S concentrations in ambient air	Power plant operation	Minister of Environment Decree No. Kep-50/MENLH/11/1996	To minimize H ₂ S concentrations in the ambient air	<ul style="list-style-type: none"> If the H₂S concentration at the monitoring locations exceed the odor quality standard of 0.02 ppm, emission of H₂S from power plant will be controlled using technologies such as LO-CAT sulfur recovery unit until the concentration meets the odor quality standard Secure power plant location and limit access for local communities Workers working in the surrounding power plant area must be equipped with PPE (Personal Protective Equipment) Equip power plant with H₂S monitoring equipment 	Around power plant locations	During the operation stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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								Implementer	Supervisor	Reporting to
Noise	Noise level	Power plant operation	Minister of Environment Decree No. Kep-48/MENLH/11/1996	To minimize an increase in noise level	<ul style="list-style-type: none"> Workers in and around power plant to use ear muff Install silencer to reduce noise Plant trees with wide canopies to reduce noise level 	Around power plant locations	During the operation stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Socio-economic, socio-cultural, and public health components										
Job opportunities	Job opportunities	Workforce recruitment	Numbers of local and non-local workers recruited by SOL and its contractors	<ul style="list-style-type: none"> To optimize job opportunities for local communities To prioritize local communities in workforce recruitment 	<ul style="list-style-type: none"> Provide job opportunities for local communities who fulfill company's requirements and qualification Encourage contractors to hire as many local workers as possible 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Labor Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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								Implementer	Supervisor	Reporting to
Business opportunities	Business opportunities	Operation activities	Creation of business opportunities for the local communities	To increase local communities' participation in the project	<ul style="list-style-type: none"> Provide opportunities for local businesses to participate in the provision of goods and services Provide guidance for local businesses in order to fulfill company's standards 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Labor Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Community income	Community income	Operation activities	Household income	<ul style="list-style-type: none"> To optimize job opportunities for local communities To prioritize local communities in workforce recruitment To increase the level of participation of local businesses in the project 	<ul style="list-style-type: none"> Provide job opportunities for local communities who fulfill company's requirements and qualifications Provide opportunities for local workers to grow and expand 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Labor Agency and Industrial Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
Community unrest	Community unrest	<ul style="list-style-type: none"> Workforce recruitment Operation of transmission network 	<ul style="list-style-type: none"> Community complaints regarding workforce recruitment Local concerns toward operation of transmission network 	<ul style="list-style-type: none"> To avoid and minimize community unrest towards workforce recruitment during the operation stage To avoid community unrest towards operation of transmission network 	<ul style="list-style-type: none"> Prepare a work plan on local workforce recruitment in fair and open ways Public consultation on the operation of transmission network 	<ul style="list-style-type: none"> Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency Villages in the transmission network area 	During the operation stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
D. Other monitoring										
<i>Solid and liquid waste monitoring</i>										
Surface water quality	Heavy metals, hazardous and toxic (B3) wastes	Drilling wells, sump pit, well production (during production test) which potentially produce both B3 and non-B3 wastes	<ul style="list-style-type: none"> Compliance with waste water quality standards Compliance with Minister of Energy and Mineral Resources Decree No. 45 of 2006 regarding the Management of Drilling Reservoir, Slurry Waste and Drill Powder in Oil and Gas Drilling Activities Compliance with B3 waste regulations (Government Regulations No. 18 of 1999 and No. 85 of 1999) 	<ul style="list-style-type: none"> To reduce impacts to surface and ground water qualities To ensure proper management of B3 wastes according to the applicable B3 regulations 	<p>Domestic solid waste:</p> <ul style="list-style-type: none"> Solid waste disposal to landfills <p>Liquid waste:</p> <ul style="list-style-type: none"> Liquid domestic waste water treatment from all project activities in domestic waste water treatment plant Condensate and brine generated during the power plant production testing and operational to be injected into reinjection wells Construction of sump pit that is coated with waterproof layer. Collected water in the sump pit, used in the drilling process as drilling mud component to be returned into the wells <p>B3 waste:</p> <ul style="list-style-type: none"> Fragments in the drilling mud to be stored in the sump pit Drilling mud to be stored in the sump pit Ensure that equipment and materials purchased by SOL do not contain PCBs, asbestos, ozone depleting substances and other prohibited materials according to relevant regulations Neutralize and securely store used lead acid batteries Collection of used oil, which then stored into drums and handed over to registered B3 management companies for further process Installation of secondary containments around flammable and hazardous materials as required Regular training on B3 waste management for employees 	<ul style="list-style-type: none"> Sarulla project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency B3 wastes temporary storage Domestic waste water treatment plant. Non B3 waste landfill Well locations 	During the operation stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
<i>Community Development Programs</i>										
Provision of education services and facilities	Provision of education services and facilities for local communities	Increased demands for education services and facilities	Distribution of education facilities around the project area in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency	<ul style="list-style-type: none"> To assist local governments in the provision of required education services and facilities under Community Development Program To ensure responsible and effective use of Community Development Program funds 	Cooperation with relevant stakeholders in formal education and training to improve the qualities of local community resources	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Education Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Provision of public health services	Provision of public health services and facilities	Increased demands for health services and facilities	Distribution of health facilities around the project area in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency	To assist local governments in the provision of required health services and facilities under Community Development Program	Cooperation with relevant stakeholders in health services	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Health Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
Initiatives for improving farming and agriculture cultivation techniques	Agriculture productivity in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency	<ul style="list-style-type: none"> Limited knowledge on agricultural commodities with high economic values amongst young farmers Low level of interest on agricultural activities amongst younger generation Shortage of agriculture production Limited high quality agricultural production facilities Limited skills in using agricultural machineries amongst farmers 	Production level and types of agricultural commodities around the project area in Pahe Jae and Pahe Julu Districts, North Tapanuli Regency	<ul style="list-style-type: none"> To maintain and increase production level and agriculture commodity types To increase competitiveness of local agriculture commodities 	Cooperation with relevant stakeholders in local agriculture	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Agriculture Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Local business opportunities	Local communities' participation level in various economic activities	<ul style="list-style-type: none"> Level of local community participation integrally and equally in local business opportunities Level of local community's business skill Availability of access to sources of funding and capitals 	<ul style="list-style-type: none"> Number of locally owned and managed businesses Types of goods and services provided Local economic activities value 	To increase participation of local communities in economic activities	<ul style="list-style-type: none"> Encourage the use and purchase of local products and services by SOL and its contractors Provide assistance in training and opportunities to participate in local business activities Increase local communities' involvement in entrepreneurship through local business activities Cooperation with local communities to improve the qualities of local goods and services 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Industrial Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

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								Implementer	Supervisor	Reporting to
Provision of public infrastructures	Local communities' needs and demands for public services	<ul style="list-style-type: none"> Rapid growth and development rates Local communities' increased demands for public services 	Local governments' request to provide public infrastructures	To support local governments in its efforts to provide adequate public services to local communities	<ul style="list-style-type: none"> Cooperation with local governments to determine public infrastructures to be provided Encourage and assist local governments to develop its own social service initiatives 	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Public Work Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Cultural preservation	Changes in traditional, cultural values and customs	Increasing presence of modern society and its associated infrastructures and materials	Traditional activities, cultural festivals, books and monographs on language, history, sociology and local anthropology	To assist local communities in keeping their traditional cultures intact	Support local ethnics programs and activities, preserve local culture including traditional activities (dances), cultural festivals, seminars and conferences, books and monographs on language, history, sociology and local anthropology	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	Education Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

Environmental Management Plan Summary Matrix

Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
Awareness of SOL activities	Accuracy and completeness of information about SOL activities within the local communities	Misinformation circulating in the local communities concerning SOL activities	Lack of awareness and understanding of SOL activities (such as employment, training and business opportunities) within the workforce and local communities	To ensure accuracy and completeness of information about SOL activities	Regular information dissemination related to SOL activities to community leaders and local government	Villages in the vicinity of the development of Sarulla geothermal field and power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the operation stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
E. Post-operation stage										
Socio-economic, socio-cultural, and public health components										
Job opportunities	Community unrest	Employee release	Unemployment due to employee release	To prevent high level of unemployment to occur by the end of the project	Consultation with workers on the plan to release employees	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the post-operation stage	SOL	Labor Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

Environmental Management Plan Summary Matrix

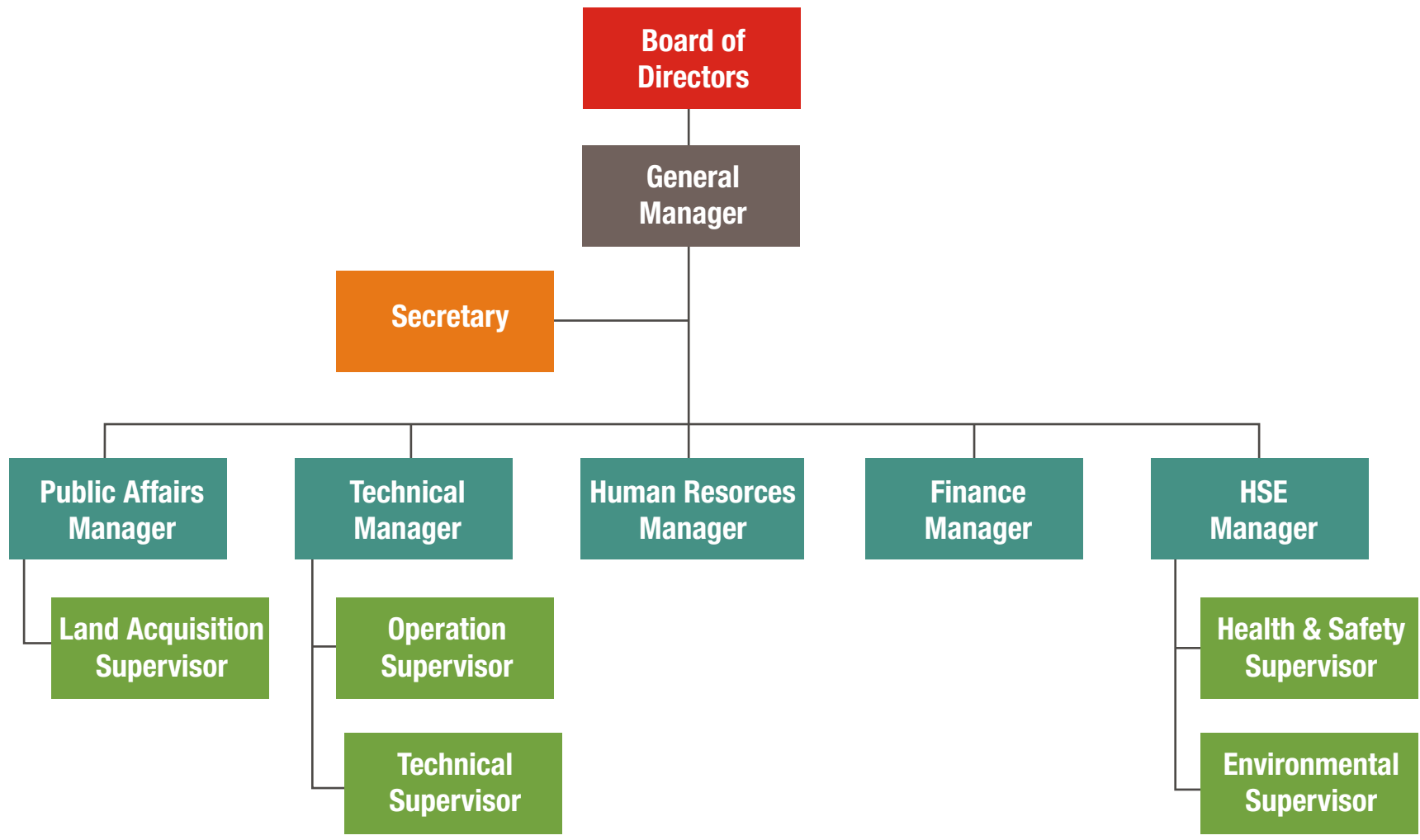
Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
Business opportunities	Business opportunities	Completion of the operation stage	Reduction of business opportunities for local communities	To maintain business opportunities for local communities	Public consultation on the completion of project activities	Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency	During the post-operation stage	SOL	Labor Agency and Industrial Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources
Community income	Community income	Completion of the operation stage	<ul style="list-style-type: none"> Reduction of business opportunities for local communities Reduction of community income around project location 	To avoid a decrease in community income	<ul style="list-style-type: none"> Consultation with workers on the plan to release employees Provide adequate compensation to workers in accordance with applicable regulations Public consultation on the completion of project activities 	<ul style="list-style-type: none"> Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency 	During the post-operation stage	SOL	Labor Agency and Industrial Agency of North Tapanuli Regency	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

Environmental Management Plan Summary Matrix

Environmental Component/ Activity	Significant Impact Parameter	Source of Significant Impact	Impact Indicator	Environmental Management Objective	Environmental Management Plan	Environmental Management Location	Environmental Management Period	Environmental Management Institution		
								Implementer	Supervisor	Reporting to
Community unrest	Community unrest	Workforce release	Community unrest due to workforce release	To avoid and minimize community unrest due to workforce release	<ul style="list-style-type: none"> Prepare a work plan on workforce release Consultation with workers on the plan to release employees 	<ul style="list-style-type: none"> Villages in the vicinity of the development of geothermal field and Sarulla power plant project area in Pahae Jae and Pahae Julu Districts, North Tapanuli Regency Villages in the transmission network area 	During the post-operation stage	SOL	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency 	<ul style="list-style-type: none"> Environmental Impact Management Agency (<i>Bapedalda</i>) of North Sumatera Province Environmental Office of North Tapanuli Regency Mining and Energy Agency of North Sumatera Province Mining and Energy Agency of North Tapanuli Regency Directorate General of Mineral, Coal and Geothermal of Department of Mineral and Energy Resources

Appendix 2

SOL ORGANIZATION CHART



Sarulla Operations Ltd. Organization Structure