Environmental, Social and Health Impact Assessment (ESHIA) for Seismic Acquisition & Exploration Drilling in Block IOR-5, PETRONAS Carigali Myanmar Inc.

Prepared by:

International Environmental Management Co., Ltd

in association with

Environmental Quality Management Co. Ltd.

PETRONAS

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PETRONAS CARIGALI MYANMAR INC.

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT (ESHIA) REVIEW & ENDORSEMENT

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Location : Onshore Block IOR 5, Republic of The Union of Myanmar

Action	Name & Designation	Signature
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Approved By:	Pui Thai Chong Country Chairman PETRONAS Carigali Myanmar Ltd.	2/2/2015

EXECUTIVE SUMMARY

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E1 EXECUTIVE SUMMARY

E1.1 Background

PETRONAS Carigali Myanmar Inc. (hereafter called “PCMI”) is an Operator of Production Sharing Contract (PSC) of Block IOR-5, which is located in the Central Myanmar, shown in **Figure E-1**.

The IOR 5 Production Sharing Contracts (PSCs) has PSC commitments of a total of 217 sq km FF of new 3D Land seismic data acquisition and drilling of 2 exploration wells within the stipulated 3 years exploration period.

IOR 5 lies within Htantabin Area of the Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km.

International Environmental Management Co. Ltd. (IEM) has been contracted by PCMI to prepare an environmental, social, and health impact assessment report (ESHIA) for the proposed Block IOR-5 Project (“the Project”).

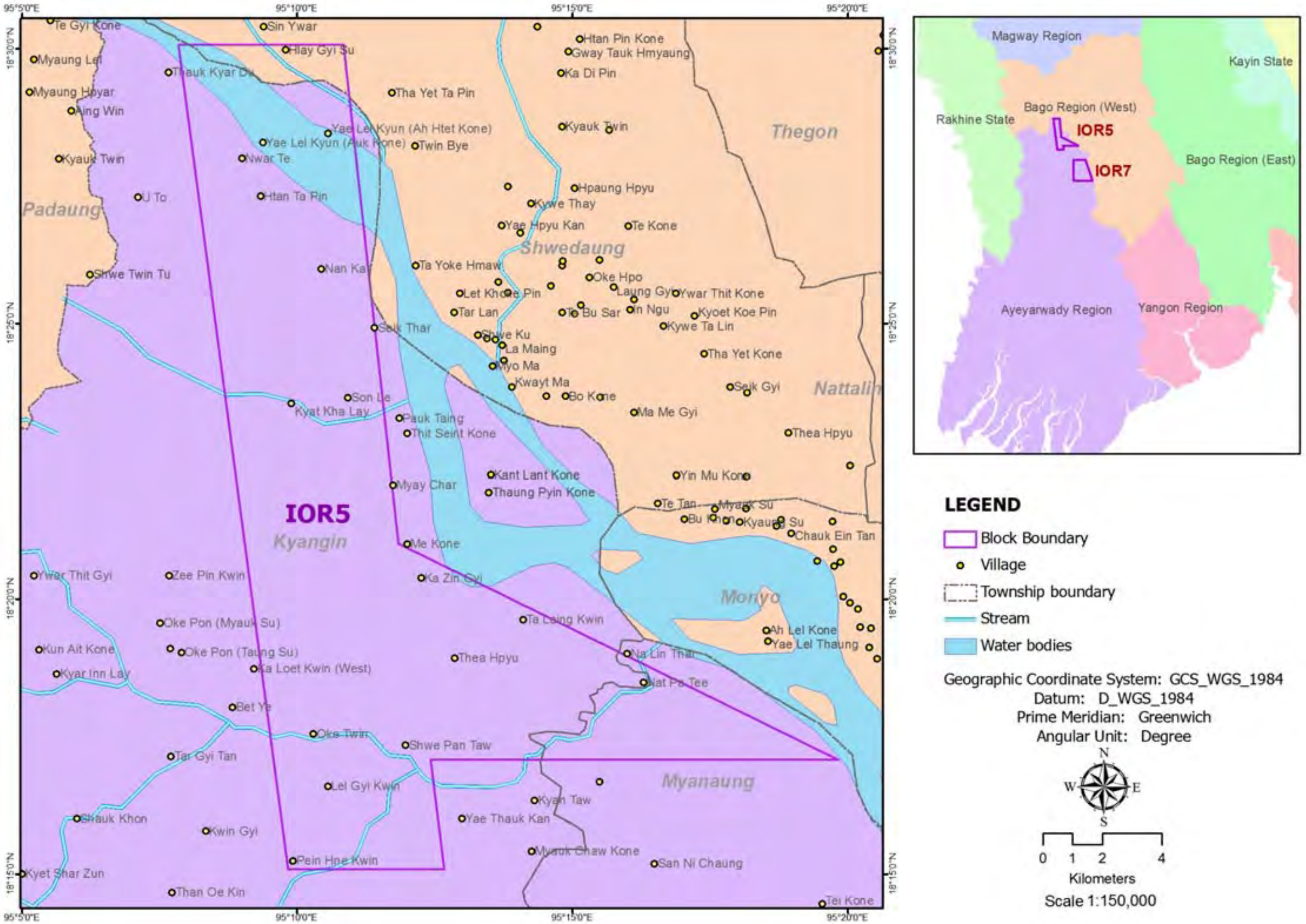


Figure E-1: Blocks IOR-5 Location

E1.2 Myanmar Legislation

E1.2.1 National Legislation

The national legislation applicable to the Project comprises the following sources of law, listed hierarchically in accordance with the Constitution and other laws of Myanmar:

- The Environmental Conservation Law (2012)
- The Foreign Investment Law (2012)
- The Constitution (2008)
- Laws issued by the State Peace and Development Council (SPDC), Myanmar governing body (exercising legislative functions)
- Decrees or subsidiary legislation issued by Ministers

E1.2.2 EIA Requirement

The Myanmar Oil and Gas Enterprise (MOGE) has formally required that all oil and gas companies prepare ESHIAs for new developments.

The Myanmar Government has plans for new laws on ESHIA requirements as indicated by their recently approved 2009 National Sustainable Development Strategy (see below for more details).

EIA Rules, which define EIA requirements, are to be approved soon. Presently the EIA procedures require:

- The projects are required to conduct EIA
- Develop Environmental Management & Monitoring Plan
- EIA has to be conducted by independent Party who is registered Ministry of Environmental Conservation and Forestry (MOECAF)
- EIA Committee shall: approve project or subject to conditions (EIA) or (EMP)
- EIA Committee: (i) grant environmental approval for implementation (ii) refuse to issue environmental approval
- EIA shall be approved by Ministry with the guidance of EIA Report Review Body
- If the project has received approval, the Ministry shall issue an Environmental Compliance Certificate (ECC).

E1.3 ESHIA Objectives & Scope

The purpose of this ESHIA Report is to identify and, to the extent possible, quantify the potential negative impacts and positive benefits of the proposed two well exploration drilling project with respect to the environment, human use values, quality of life and health. Once these impacts have been identified, prevention, mitigation, and monitoring measures will be proposed to minimize impacts.

The specific objectives of this ESHIA are to:

- Identify all planned activities and potential unplanned events;
- Establish an environmental, social and health baseline of the project area;
- Identify and assess potentially significant impacts based on existing conditions to:
    - Physical Resources;

  - Ecological Resources;
  - Human-Use Values;
  - Quality-of-Life Values;
  - Health
- Identify and recommend mitigation measures to minimise potential impacts;
- Recommend a monitoring plan that can track changes in the environment, social issues and health over time and to ensure compliance with Myanmar legislation.

E1.4 Study Area

The study area of the project will cover the entire exploration seismic survey area and proposed well sites for Block IOR-5. The outline of the study area is shown in **Figure E-2**. The block wide study area will be used to identify sensitive receptors in the assessment of impacts on physical resources, biological resources, human use values, and quality of life values. Examples of sensitive receptors are schools, temples, water resources, residential areas, etc.

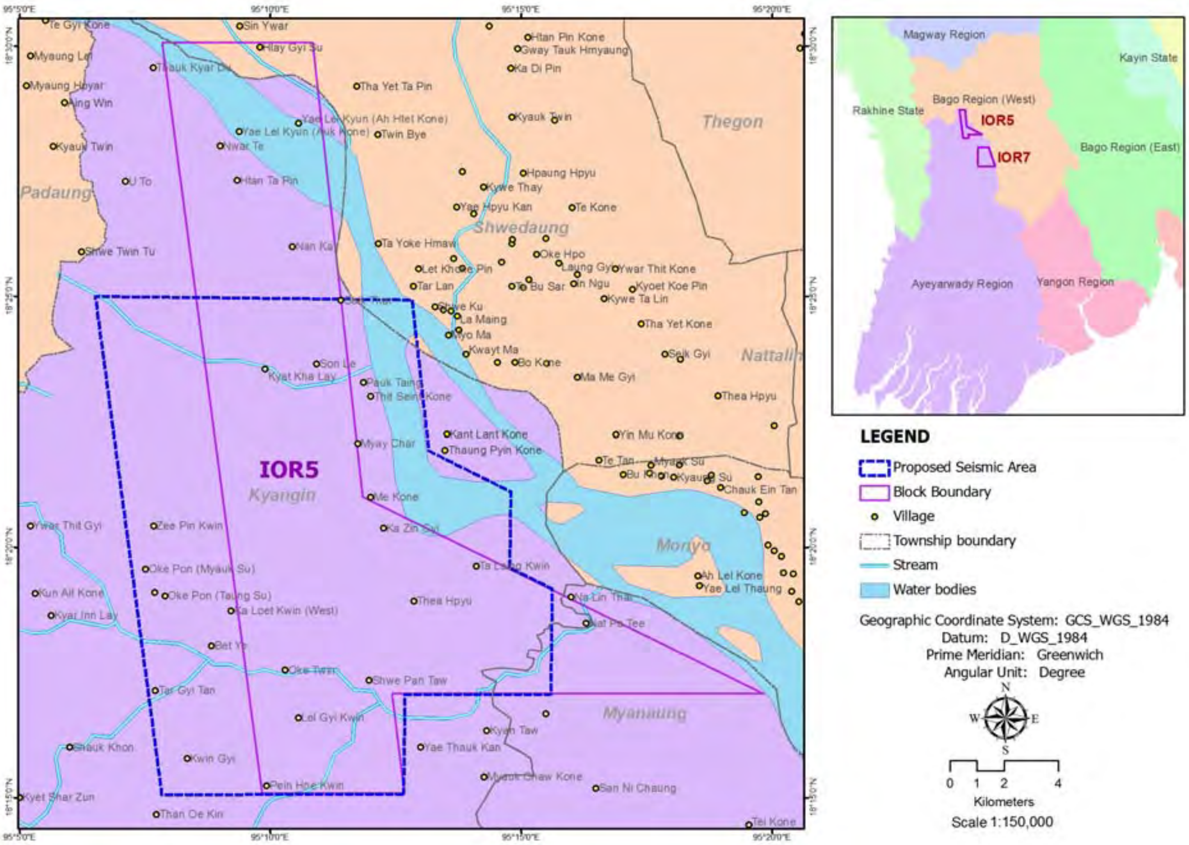


Figure E-2: IOR-5 Study Area

E1.4.1 Data Collection

E1.4.1.1 Primary Data Sources

Data collected for this EIA include details of the proposed project, environmental baseline, socio-economic setting and health conditions of the potentially affected areas. Data were obtained from primary and secondary sources.

Primary data sources include:

- Environmental quality baseline survey for surface water, groundwater quality, and soil survey conducted on 7 - 13 November 2014;
- Environmental quality baseline survey for noise and air quality survey conducted on 7 - 13 November 2014;
- A historical, archaeological and cultural resources meeting with Archaeological Department conducted on 7 - 13 November 2014;
- Traditional Ecological Knowledge (TEK) surveys with local farmers which focused on a number of ecological indicators regarding biodiversity and ecological status was conducted on 7 - 13 November 2014;
- Socio-economic surveys conducted on 7 - 13 November 2014; and
- Focus Group meetings with villagers on 7 - 13 November 2014.

E1.4.1.2 Secondary Data Sources

Secondary data sources came from literature, relevant authorities in the project area. The secondary data sources are cited throughout this report, and listed in the references section.

E1.5 Project Description

The Project was reviewed in order to gain a full understanding of the project and to compile information on project activities. The Project is described in Chapter 2.

PCMI plans to carry out an onshore seismic survey in Block IOR, which lies within Htantabin Area of Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km. The proposed seismic grid will be designed based on available geological information; additional lines will also adjusted according to the terrain and geography conditions, based on topography maps and information obtained from pre-survey scouting trips.

PCMI is in the process of selecting the SEISMIC CONTRACTOR for the seismic survey.

PCMI's exploration drilling program in Block IOR-5 includes drilling 2 exploration wells. The expected spud date in July 2017. The exploration well will be drilled as a vertical well with conventional hole technique. The exploration drilling will be conducted with a typical land drilling rig.

E1.5.1 Project Schedule

The operational aspect (field recording) of the seismic survey programme is scheduled to commence in March 2015. Seismic acquisition in IOR-5 is expected to take 8 months, completing in Jan 2016, and consisting of 160 working days.

Preparation project milestones for the seismic survey can be summarized as follows:

• Kick-off meeting with Contractor for preparation & mobilization plan	March 1, 2015

- Commencement date (first recording shot) June 1, 2015

PCMI anticipates starting this drilling campaign on January 2017, beginning with the civil works and the drilling itself will tentatively commence in July 2017. Well site construction and the drilling of wells will be carried out in succession.

Results from the 3-Dimensional Seismic Surveys over areas may also influence whether all or only some of these wells will be drilled and the order in which they will be drilled.

Project timing ultimately also depends on the following operational constraints:

a) Rig availability, the rig will start to mobilize to well location 2 months before spud date;

b) Construction deadlines: need 2.5 months minimum after well location nominated by Geological and Geophysical;

c) Civil work construction machineries and workers.

Each well will have similar drilling schedules which can be divided into 3 phases. The provisional spud date is 1st of July 2017:

- Construction Phase: ± 75 days (2.5 months)
- Drilling Operations Phase: ± 88 days
- Optional testing up to 22 days;
- Well Suspension/Abandonment Phase and site restoration: ± 30 days

E1.5.2 Seismic Survey

A total of 217 sq km FF of 3D seismic are will be acquired in this campaign. Further adjustment may occur depending on results from field operation.

E1.5.2.1 Vibration Sources

Land seismic data acquisition will use explosives due to the on geophysical objectives, cost, and environmental constraints (terrain) in the project area.

The 3D-seismic survey for this Project will be done using a 2-4 kg/shot point explosives which acts as an acoustic wave source.

E1.5.2.2 Field Office

There will be one or two field offices/base camps for the project. The field office is going to be located tentatively at Myanaung Township, Hinthada District, Ayeyarwady Region and will be finalized only after discussing with the successful contractor. There will be approximately 60 office staff, including geophysicists, party chiefs, permitting crew, QC and supervisory staff, camp boss and client representatives, etc. All personnel will stay and work in the field offices.

Hotels may be rented for base camps and temporary accommodation camps can be built near to the working area. Facilities includes lavatory and shower blocks, kitchen, storeroom, technical workshop, mechanical workshop, fuel facilities, offices and tented accommodation for both senior and junior staff. They will be complemented by a fleet of vehicles with associated safety features. Water supply requirements for field offices are estimated to be approximately 6 m^3/day for 60 workers (100 L/person/day).

Guidelines for office camp, base and secondary camps will be drafted and posted in front of each applicable area to ensure that all personnel are aware of these guidelines. There will be frequently check to ensure that standards are maintained. These guidelines will cover hygiene, sanitation, rubbish disposal, accommodation and food preparation by case of base and secondary camps. Also, the guidelines will be expanded to include electrical and mechanical safety, etc.

E1.5.2.3 Storage of Explosives

Temporary storage of explosives will be located in Ayeyarwady Region, at a safe location determined by the Ministry of Defence. Storage site of the project may differ from these figures. The storage will be within 10 km of the field office. There will be no abode within the 1-km radius of the storage location.

E1.5.2.4 Work Force

Seismic operations will be conducted by SEISMIC CONTRACTOR, based upon the 3D seismic contract executed between PCMI and SEISMIC CONTRACTOR. SEISMIC CONTRACTOR has extensive experience conducting 3D-seismic surveys internationally.

During seismic operations, up to 800 field staff shall be required. Local staff will be preferentially hired for non-skilled jobs. Seismic survey staff from outside the local area will be accommodated at local hotels near the area of the survey. Approximately 100 vehicles in total shall be required for this project, which include pick-up trucks, four-wheel-drive vehicles, water trucks, fuel trucks, fuel storage trucks, ambulances, and explosives trucks.

E1.5.2.5 Transportation Plan

The contractor shall provide at least one basic ambulance and/or emergency services on standby 24 hours/day in the base camp. There will be a speed limit of 80 km/hour (unless otherwise posted) on highways, 60 km/hour on lateritic roads, 20 km/hour in villages or communities, and 80 km/hour on paved roads outside Yangon within the project site and on main roads.

E1.5.3 Exploration Drilling

E1.5.3.1 Type of Drilling Method

The wells will be drilled with a conventional hole size. Slim hole drilling is not an alternative or possible for the PCMI wells. A conventional hole size hole is required because of the depths being drilled, the type of formations being drilled, the kinds of pressures expected, and for hole stability. The final section of the well will be drilled using an 8-1/2-inch drill bit in the reservoir section.

The PCMI drilling program will only use Water Based Mud (WBM) for the drilling campaign.

E1.5.3.2 Accommodation Work Camp Layout

There is no suitable existing accommodation, such as hotels or guest houses, within a reasonable distance of the proposed well sites, so a temporary camp site will be established adjacent to the well sites.

The camp site will be industry-standard, consisting of container-based sleeping and living quarters, messing and recreation facilities, with a capacity to accommodate up to 130 personnel. It will have its own cooking, freezer food storage, laundry and sanitation facilities as well as its own power generation by diesel powered generators.

E1.5.3.3 Access Roads

PCMI will use existing local roads for transportation as much as possible to each well site. However, due to the well sites being located in an agricultural area, PCMI will need to construct new access roads to connect the well sites to the existing main roads for transportation of drilling rig and drilling equipment. The access roads will be designed as dual lane, un-surfaced roads, constructed of compacted granular material. The roads will be 6 m with side slopes of 1.5 m for total width of 9 m, constructed with 200 mm of compacted granular material. It is estimated that a maximum of 10 km of road will be required for each well location.

PCMI will obtain permission from the relevant local authorities and purchase the land from land owners prior to construction of the access roads.

E1.6 Description of the Environment

The project Study Area is centred on IOR-5 for the purpose of describing baseline environmental, socio-economic and health conditions potentially affected by the project and affecting the project. Where appropriate for the purpose of establishing context, data and observations from the region are also referenced.

Block IOR-5 is situated in primarily within Htantabin Area of the Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km. The block area includes land within Bago and Ayeyarwaddy regions. The surrounding area is predominantly agricultural with reserve-forested area and numerous small to medium sized communities. The Ayerwaddy River is flowing at the eastern boundary of the block. The nearest major town is situated towards the east of the block name Kyangin. While a smaller town name Bat Ye is situated towards the west of IOR-5.

Land use in IOR-5 study area is dominated by agricultural activities particularly dry land cultivation along with some irrigated cropland. During the projects socio economic, health and opinion surveys of 400 villagers in 8 communities spread across IOR-5, respondents identified the main agricultural crops as rice, with beans and pulses being the next most common crop. Most households (76%) had livestock, of which over 53% have cows and 16.9% have oxen.

IOR-5 lies in Lower Ayeyarwady watersheds. The dominant hydrological feature in IOR-5 is the Ayeyarwady River which lies on the top northeast of the block. The other surface water features include the Pa Shing Chaung and Pa Daw Chaung streams in the south.

Environmental, social and health information was collected and evaluated in the following areas:

- **Physical Environment**: geography, climate, air quality, noise, geology, soil, surface water hydrology, surface water quality, groundwater;
- **Biological Environment**: flora, fauna, aquatic biota, threatened/endangered species, protected areas;
- **Human Use Values:** land use, agriculture and industry, fishery and aquaculture, irrigation and agricultural water sources, water supply, wastewater management, solid waste management, transportation, power supply, electricity and communications;
- **Quality-of-Life Values**: local administration, demographics, socio-economy, archaeological resources, tourism;
- **Health**: health services and public health statistics.

E1.7 Impact Assessment

An initial screening assessment of project activities consisted of developing a summary matrix of project activities against environmental, social and health parameters to determine if potential impacts were considered significant or not. If any issues were considered significant, then these were assessed in more detail. Qualitative and quantitative analyses were conducted to assess potential impacts on environmental, social or health receptors that may be caused by the proposed project activities. The impact analysis criteria are summarized in *Chapter 5*.

The impact assessment also included an assessment of unplanned events. The assessment examines the potential of the project to result in major hazardous events (such as a fire or oil spill from a blow-out) or environmental hazards to impact the project and the environment (such as earthquakes). The risk assessment includes a qualitative and a quantitative evaluation of risks to help further define the probability and potential consequences of these major hazardous events, and to evaluate the significance and the areas that might be impacted by these events. Specific systems for the further management of the significant risks are then proposed. Residual risk was determined after management measures were defined.

E1.8 ESH Management Plan

In the impact assessment, a number of potentially significant impacts were identified. For each of these project activities, management measures were defined to prevent and/or reduce the likelihood or magnitude of impacts and/or to limit the extent of an impact if one does occur. The proposed management measures take into account applicable guidelines, industry practices, expert judgement, design techniques, and operational control.

In addition, environmental monitoring measures were designed to monitor the environment and project activities. The purpose of these monitoring measures is: to evaluate the effectiveness of the management measures that will be put in place; to assess compliance with Myanmar legislation, guidelines and standards; and to compare environmental conditions after implementation of the project to environmental baseline conditions to document possible change and/or impact.

Once potential well locations are identified site selection criteria have been provided to assist in identifying the most suitable drilling site. A recommended environmental and socio economic baseline sampling program has been provided. Stakeholder engagement suggestions too have been defined.

E1.9 Stakeholder Involvement

Based on stakeholder mapping and information collected during EHS baseline surveys, this ESHIA has engaged the following stakeholder groups:

1. MOGE & MOCAF
2. Directly affected Stakeholders including Village heads and villagers
3. Civil Society, and
4. Authorities at the Township Level.

Stakeholder involvement allows for scoping of issues that are of significance to the communities. Their concerns can assist in identification of potential project impacts that are unique and specific to the communities where the project is situated. Similarly, recommendations from the affected communities on how to manage the potential impacts are essential in developing mitigation measures and management practices for eliminating/reducing negative impacts and enhancing positive impacts.

Consultations also maximize stakeholder understanding of the proposed project through information exchange between the project proponent and the communities that might be affected directly or indirectly by the proposed project activities.

In November 2014, IEM conducted focus group meetings with over 400 villagers in 8 villages in the Htantabin Area of the Ayeyarwady Region of Myanmar within Block IOR5 (total area of 202 sq. km).

Villages Consulted
Shin Su
Kone Myint
Pan Pin Kone
Lel Gyi Kwin
San Kone
Lein Khon
Kyat Kha lay
Chaung Hpyar

Detailed socio-economic surveys were also completed for approximately 400 villagers, or approximately 40 interviews in each of the 8 villages within the Kyangin and Myanaung townships, Hinthada district. As part of the public involvement process, Key Informant Interviews were also conducted with village leaders and health providers. Further, 15 Traditional Ecological interviews and surveys were also conducted in each village to determine the importance of the local biodiversity.

E1.9.1 Focus Groups

At the focus group meetings prior to conducting the socio economic, health and opinion questionnaires, the villagers were informed that PCMI was planning to conduct a seismic program and drill two exploration wells in the IOR-5 block. The project schedule will last up to 6 months for the seismic program and 10 months for each exploration well. The purpose of the seismic and exploration drilling program is to determine if any oil or gas is present. If no oil or gas is found the wells will be abandoned and the area returned to its original state. If oil and gas is found, then the oil and gas will be produced for sale.

The villagers were informed that the focus group meetings and socio economic, health and opinion interviews were being conducted as part of an environmental, social and health impact assessment that is required to obtain approval for the project to proceed and to help guide PCMI to reduce any potential impacts.

E1.9.2 Key Informant Interviews

Key informant interviews were conducted with Village Leaders; Village Medical Officer and Village Education Officer in 8 villages within IOR5.

To ensure the ability to correlate data, a targeted subset of the socio economic and attitude survey was used as a basis for Key Informant Interviews.

E1.9.3 Socio Economic, Health and Opinion Surveys

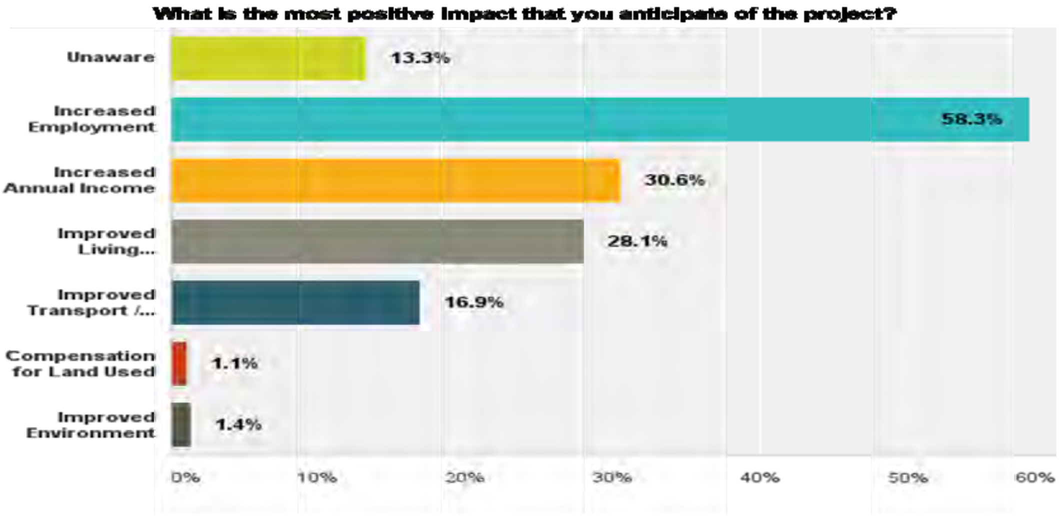
The socio economic, health and opinion questionnaires collected socio economic, health and opinion information in this area and the opinions and understanding of PCMI's planned seismic and drilling program.

The Socio economic, health and opinion Survey are designed to focus on gaining household member information and opinions on:

- The structure and demographics of the household
- Household living standard, employment, income and social and economic condition
- Household and individual health
- Information on the natural environment and human use of the environment; and
- Opinions on the prospective impacts of project during and after construction

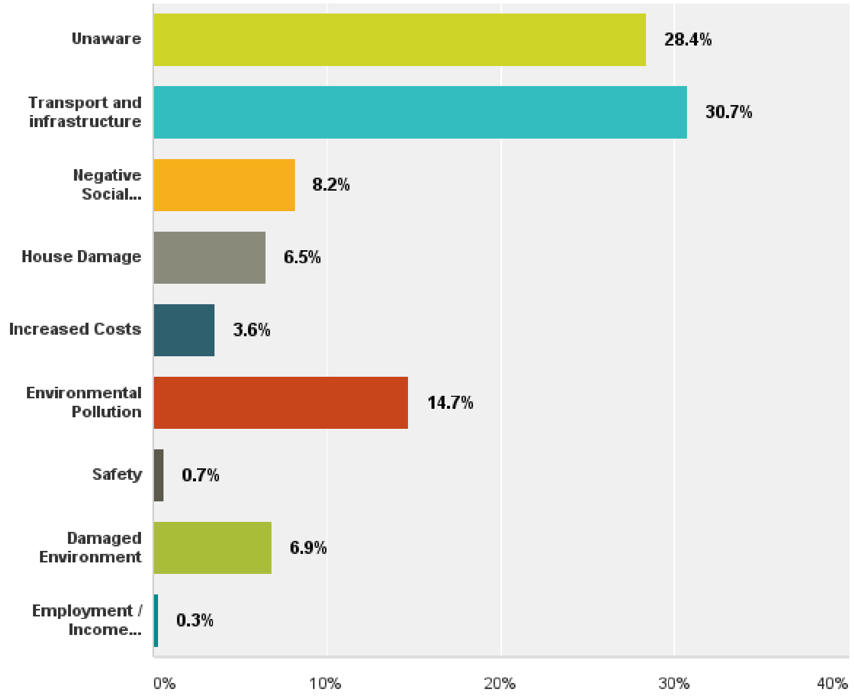
E1.9.3.1 Opinions of Possible Project Benefits

Villagers anticipated increased employment (58%), annual income (31%) and improved transport and infrastructure (17%).



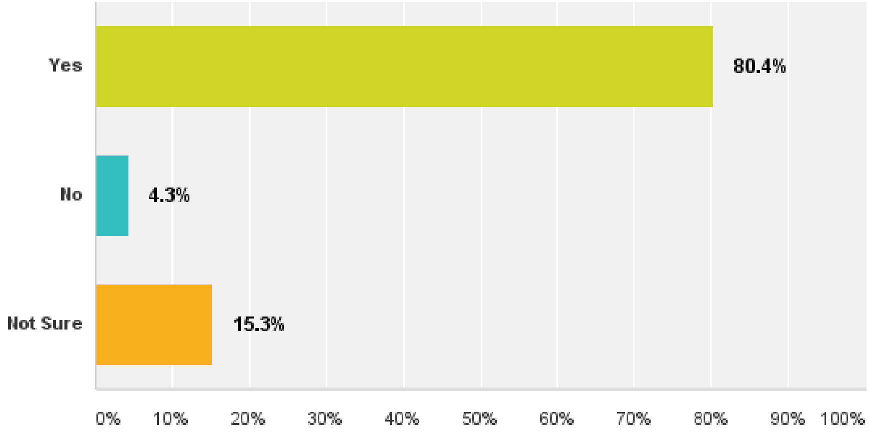
E1.9.3.2 Opinions of Possible Project Impacts

One-third of villagers (31%) claimed they were concerned of transport and infrastructure, while 28% was unaware, 15% were concerned about environmental pollution.



E1.9.3.3 Household Support for Project

Of those interviewed, 80% agree with the planned seismic and exploration drilling program.



E1.10 Impact Summary

E1.10.1 Seismic Survey

The potential impacts identified during the assessment of the 3D-seismic survey activities are summarised in **Table E-1** to **Table E-4**. All impacts are addressed through standard operating procedures and/or through identified contingency plans.

Table E-1: Summary of Seismic Survey Environmental Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Land & Habitat Disturbance	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to local topography	2	E	Med.
		Soil Disturbance and Erosion	1	C	Low
		Disturbance to local Terrestrial Flora	1	C	Low
		Disturbance to local terrestrial fauna	1	C	Low
		Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration	3	C	Med.
		Localized change in water quality	3	C	Med.
		Localized sediment deposition and disturbance to benthic habitats and associated biota.			
Vehicle Movements	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to Fauna	1	C	Low
		Disturbance to traffic	1	D	Low
Air Emissions	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Deterioration of Air Quality due to dust	2	C	Low
		Minor deterioration of local air quality due to emission of pollutants such as NOx and SOx and CO.	1	D	Low
		GHG Release contributing to climate change	1	D	Low
Noise& Vibration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data AcquisitionClean up and Site Restoration	Behavioral disturbance to fauna	2	E	Med.
Light	• Functional lighting on vehicles and camp site	Potential impact on terrestrial fauna	1	D	Low
Liquid Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Localized change in water quality or contaminated soils from oil and grease	2	B	Low
		Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water	2	D	Low
		Contamination of water and soils and injury to fauna	2	D	Med.

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Solid Waste & Hazardous Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Attraction of fauna such as rats and birds. Nutrient enrichment of surrounding water and soils	1	D	Low
		Contamination of water and soils and injury to fauna	3	C	Med.
		Temporary localized decline in water quality. Temporary localized decline in soil quality. Temporary minor toxicity to flora and fauna.	2	B	Low

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table E-2: Summary of Seismic Survey Social Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Change in Land Use	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss of agriculture potential Project operation effects on nearby land productivity Loss of employment for displaced workers that do not own land	0	D	Positive
Transportation	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Increase in and disruption of local traffic	1	C	Low
Water Supply	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Reduction of local community water supply	3	D	Medium
Power Use	• Power for campsite	Increase or decrease of available power for local community			None
Water Drainage	• Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure	1	C	Low
Wastewater	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Potential impact to agriculture, aquaculture and fisheries	1	D	Low
		Potential impact to agriculture, aquaculture and fisheries (Cont.)	1	D	Low
Waste Disposal	• Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Increased waste disposal overloading local infrastructure	1	D	Low
Tourism and Recreational experience	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance and reduction of tourism and recreational experience	1	C	Low
Employment & Income	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential increase in jobs and related income for local communities	0	E	Positive

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Labour In-migration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential conflict between workers from other regions and local communities	1	C	Low
Historical, Archaeological & Cultural Resources	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss or damage to historical and archaeological sites	2	C	Low

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table E-3: Summary of Seismic Occupational Health/Public Health Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Dust	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Respiratory irritation Exacerbation of asthma	2	D	Med.
Noise& Vibration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Hearing impairment for workers and Annoyance for public	1	E	Low
Non-hazardous waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Clean up and Site Restoration	Food safety, gastroenteritis Increase in vector-borne diseases: malaria, typhus and dengue and others.	5	C	High
Hazardous waste	• Material contaminated with oil or chemicals, • Lubricating and hydraulic oil, • Drum and containers used for chemical transportation and storage	Acute exposure such as skin and eye irritation, inhalation exposure etc.	3	C	Med.
Communicable diseases	• Base camp/ Fly camp Construction • Seismic Team Mobilization	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.	3	C	Med.

Note: C - Consequence: 0 – No Injury, 1 - Slight Injury, 2 – Minor Injury, 3 – Major Injury, 4 – Single Fatality, 5 – Multiple Fatalities

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table E-4: Summary of Seismic Survey Unplanned Events

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Fire or Explosion	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible explosion of dynamite or fire at campsite, or fuel storage area	5	B	Medium
Chemical or Hazardous Waste/Materials Spill	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people	3	C	Medium
Transportation Accidents	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible injury or death to personnel; and localized contamination of environment	5	C	High
Earthquakes	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential physical disruption cause building collapse, fires or spills	5	B	Medium

Note:	C -	Consequence:	3-Localized Impact, Major Injury, Localized Damage and Considerable Impact, 5 - Massive Impact, Multiple Fatalities, Extensive Damage, International Impact
	P -	Probability:	A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

E1.11 Exploration Drilling

The residual risk rankings of the impact assessment of the project operations and unplanned events environmental, social, health and unplanned aspects are summarized below in **Table E-5** to **Table E-8**.

Table E-5: Summary of Exploration Drilling Environmental Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Land & Habitat Disturbance	Installation of Infrastructure Road construction Camp site construction Well site construction Well abandonment and site restoration	Disturbance to local topography	2	E	Medium
		Soil Disturbance and Erosion	1	C	Low
		Disturbance to local Terrestrial Flora	1	C	Low
		Disturbance to local terrestrial fauna	1	C	Low
		Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration	3	C	Medium
		Localized change in water quality	3	C	Medium
		Localized sediment deposition and disturbance to benthic habitats and associated biota.			
Vehicle and Rig Movements	Vehicle Movements Rig Movement	Disturbance to traffic	1	D	Low
Air Emissions	Installation of infrastructure	Deterioration of Air Quality due to dust	3	D	Medium
	Drilling Well Testing Flaring	Hydrogen sulphide released	2	B	Low
	Power Generation for Drilling and Flaring Well Testing and Flaring	Minor deterioration of local and regional air quality due to emission of pollutants such as NOx and SOx and CO.	2	D	Medium
	Transportation Road Construction and rehabilitation of Drill Site and Camp Site Construction Power Generation for Drilling Flaring Fugitive emissions	GHG Release contributing to climate change	1	D	Low

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Noise	Installation of infrastructure Drilling and infield operations Well Testing and Flaring	Behavioral disturbance to fauna	2	E	Medium
Artificial Light	Functional lighting on vehicles and drill rig, camp site and well site Flaring	Potential impact on terrestrial fauna	1	D	Low
		Potential impact on terrestrial flora	1	C	Low
Heat	Flaring	Potential impact on local fauna	1	D	Low
Liquid Waste	Drill site drainage	Localized change in water quality or contaminated soils from oil and grease	2	B	Low
	Sewage and sulllage	Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water	2	D	Low
	Infiltration	Infiltration from the cuttings and dirty water waste pit may deteriorate groundwater quality	3	B	Low
Solid Waste	Disposal of non-hazardous wastes from drilling activities	Contamination of water and soils and injury to fauna	2	D	Medium
	Disposal of food and other kitchen wastes from camp site	Attraction of fauna such as rats and birds. Nutrient enrichment of surrounding water and soils	1	D	Low
	Disposal of Hazardous Solid Wastes	Contamination of water and soils and injury to fauna	3	C	Medium
Drill Cuttings and Fluids	Disposal of drill cuttings and sludge	Localized change in water quality and soil quality from chemical composition of drill fluids	2	D	Medium
	Loss of circulation	Deterioration of shallow and deep groundwater	3	B	Medium

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table E-6: Summary of Exploration Drilling Social Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Change in Land Use	Purchase of land for access roads, drill and camp site	Loss of agriculture potential Project operation effects on nearby land productivity Loss of employment for displaced workers that do not own land	0	D	Positive
Traffic	Transportation of equipment, people and services	Increase in and disruption of local traffic	1	C	Low
Water Use	Water for construction exploration drilling and domestic use	Reduction of local community water supply	3	D	Medium
Power Use	Power for drilling operations and work camp	Increase or decrease of available power for local community			None
Water Drainage	Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure	1	C	Low
Wastewater	Project operation effects on water quality	Potential impact to agriculture, aquaculture and fisheries	1	C	Low
Waste Disposal	Disposal of waste in project area	Increased waste disposal overloading local infrastructure	1	D	Low
Tourism and Recreational experience	Project construction and operation effects on tourism and recreation	Disturbance and reduction of tourism and recreational experience	1	C	Low
Employment & Income	Employment & income for nearby communities	Potential increase in jobs and related income for local communities	0	E	Positive
Labour In-migration	In-migration of labour and social interaction	Potential conflict between workers from other regions and local communities	1	C	Low
Historical, Archeological & Cultural Resources	Project construction potentially destroying historical and archaeological sites	Loss or damage to historical and archeological sites	2	C	Low

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table E-7: Summary of Exploration Drilling Health Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Dust	Access/upgrade roads, Site construction, Transportation of granular fill, workers, equipment	Respiratory irritation Exacerbation of asthma	2	D	Medium
Noise	Generator, Transportation, Construction Drilling	Hearing impairment for workers and Annoyance for public	1	E	Low
Non-hazardous waste	Waste disposal, Leaks/spills, Standing water	Food safety, gastroenteritis Increase in vector-borne diseases: malaria, typhus and dengue and others.	5	C	High
Mud Chemicals and drilling waste	Mixing of drilling chemicals, Leak/spill of mud chemicals	Acute exposure such as skin irritation, inhalation exposure etc.	3	B	Low
Hazardous waste	Material contaminated with oil or chemicals, Lubricating and hydraulic oil, Drum and containers used for chemical transportation and storage	Acute exposure such as skin and eye irritation, inhalation exposure etc.	3	C	Medium
Communicable diseases	Migration/influx of outside workers	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.	3	C	Medium
Light and heat	Flaring	Heat exposure Nuisance light	2	B	Low
Flare emissions	Flaring	Increase in respiratory illnesses/diseases Exacerbation of asthma Disturbance psychological wellbeing H2S Fatalities	5	A	Medium

Note: C - Consequence: 0 – No Injury, 1 - Slight Injury, 2 – Minor Injury, 3 – Major Injury, 4 – Single Fatality, 5 – Multiple Fatalities

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table E-8: Summary of Exploration Drilling Unplanned Events

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Blowout	Drilling	Release of uncontrolled volumes of hydrocarbons Fire Explosion	5	B	Medium
Fire or Explosion (not associated with Blowout)	Fuel Storage Flare Testing	Possible explosion or fire of drilling rig or at campsite, or fuel storage area	5	B	Medium
Hydrocarbon Chemical or Hazardous Waste/Materials Spill	Storage of chemicals, hazardous materials or waste	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people	3	C	Medium
Transportation Accidents	Transportation of equipment, personnel, granular fill, mud and cuttings, and waste	Possible injury or death to personnel; and localized contamination of environment	5	C	High
Earthquakes	Physical shifting of earths surface	Potential physical disruption cause building collapse, blowouts, fires or spills	5	B	Medium

Note: C - Consequence: 3-Localized Impact, Major Injury, Localized Damage and Considerable Impact,
5 - Massive Impact, Multiple Fatalities, Extensive Damage, International Impact
P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

E1.12 Conclusion

All environmental issues are ranked as low and can be managed to minimize potential impacts. There is one social issue that is considered to have a medium residual risk. Water use needs for the drilling program could potentially impact community water resource supplies. While PCMI plans to drill separate water wells for its needs, this could impact nearby community water supplies, if it is from the same source. This potential issue needs to be carefully planned to ensure adequate water resources are available for the project that does not impact the local community.

One health aspect has a medium residual risk. Non-hazardous wastes and in particular liquid wastes have the potential to enhance vector borne diseases, which are already an issue in this region. A specific waste management plan needs to be prepared to ensure that all wastes are managed to international standards. Hydrogen Sulphide too, while unlikely is a potentially serious issue that requires monitoring equipment to be installed and tested, as well as having personnel trained on use of emergency response equipment.

Unplanned Events classified as having a medium residual risk include blowouts, fire or explosions, transportation accidents and earthquakes. With respect to transportation accidents, the potential for accident related fatalities exists and specific management procedures and training need to be implemented. Drug testing too is recommended, as this is a known issue in the region.

To mitigate the potential for a blowout, a BOP needs to be installed and tested. Drilling procedures need to be carefully implemented. The risk of fire and related explosions requires that regular monitoring and inspection measures are in place, as well as fire extinguishers strategically placed to minimize any damage should a fire occur.

This region has had earthquakes in the past and design considerations need to be taken to minimize the impact of an earthquake should it occur. Site specific emergency response procedures for all unplanned events need to be in place and training conducted for all staff as appropriate prior to the start of the exploration drilling program.

Recommendations:

The following recommendations are provided:

- Conduct proposed site assessment following proposed site evaluation guidelines once specific drilling targets are identified.
- Conduct recommended environmental and socio economic baseline program for site specific location, as appropriate.
- Implement recommended stakeholder engagement program at least one month before site construction.
- Prepare a site specific waste management plan.
- Prepare a site specific emergency response plan.
- Conduct recommended training program prior to project initiation.
- Evaluate water resource potential to ensure it does not impact local community.
- Identify, clean-up and restore any legacy well sites located within the block.
- Adopt and implement the EMP provided in Chapter 6.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 Background

PETRONAS Carigali Myanmar Inc. (hereafter called “PCMI”) is an Operator of Production Sharing Contract (PSC) of Block IOR-5, which is located in the Central Myanmar, shown in **Figure 1-1**.

The IOR-5 Production Sharing Contracts (PSCs) has PSC commitments of a total of 217 sq km FF of new 3D Land seismic data acquisition and drilling of 2 exploration wells within the stipulated 3 years exploration period.

IOR-5 lies within Htantabin Area of the Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km.

International Environmental Management Co. Ltd. (IEM) has been contracted by PCMI to prepare an environmental, social, and health impact assessment report (ESHIA) for the proposed Block IOR-5 Project (“the Project”).

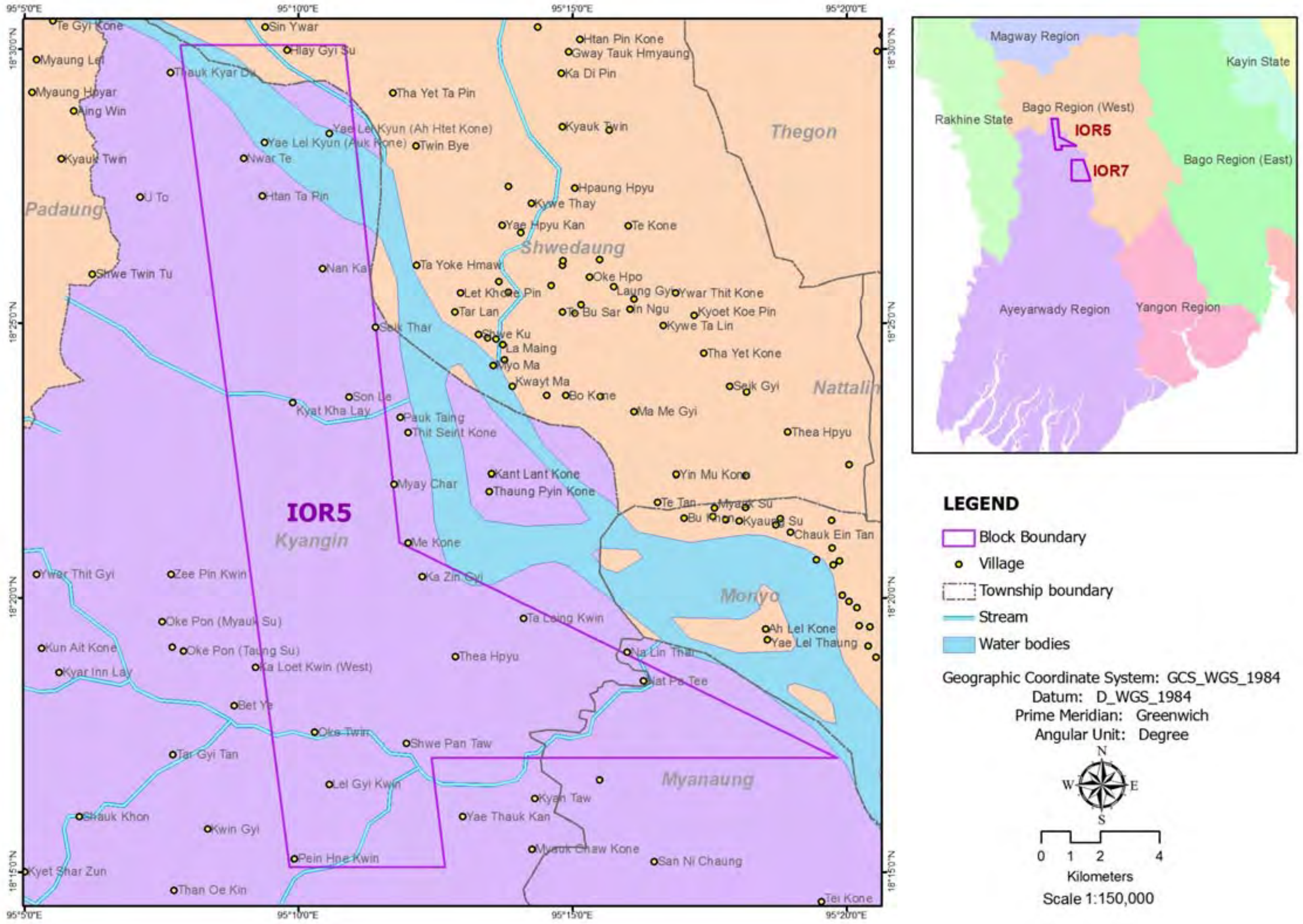


Figure 1-1: Block IOR-5 Location

1.2 ESHIA Objectives

The purpose of this ESHIA Report is to identify and, to the extent possible, quantify the potential negative impacts and positive benefits of the project with respect to the environment, human use values, quality of life and health. Once these impacts have been identified, prevention, mitigation, and monitoring measures will be proposed to minimize impacts.

The specific objectives of this report are to:

- Identify all planned activities and potential unplanned events;
- Establish an environmental, social and health baseline of the project area;
- Identify and assess potentially significant impacts based on existing conditions to:
    - Physical Resources;
    - Ecological Resources;
    - Human-Use Values;
    - Quality-of-Life Values;
    - Health
- Identify and recommend mitigation measures to minimise potential impacts;
- Recommend a monitoring plan that can track changes in the environment, social issues and health over time and to ensure compliance with Myanmar legislation.

1.3 ESHIA Scope

The environmental, social and health impact assessment report for the Project includes:

- a review of applicable legislation;
- a detailed project description of the proposed seismic survey and two exploration well drilling program;
- an evaluation of the existing environmental, social and health conditions;
- an environmental, social and health impact assessment, including both the positive and negative impacts during the construction, the operation and the abandonment period;
- proposed mitigation measures to reduce the potential harmful impacts to the nearby environment, social issues, and health; and
- proposed monitoring program to monitor the environmental, social and health quality that may be affected by the Project.

1.4 Study Area

The study area of the project will cover the entire exploration seismic survey area and proposed well sites for Block IOR-5. The outline of the study area is shown in **Figure 1-2**. The block wide study area will be used to identify sensitive receptors in the assessment of impacts on physical resources, biological resources, human use values, and quality of life values. Examples of sensitive receptors are schools, temples, water resources, residential areas, etc.

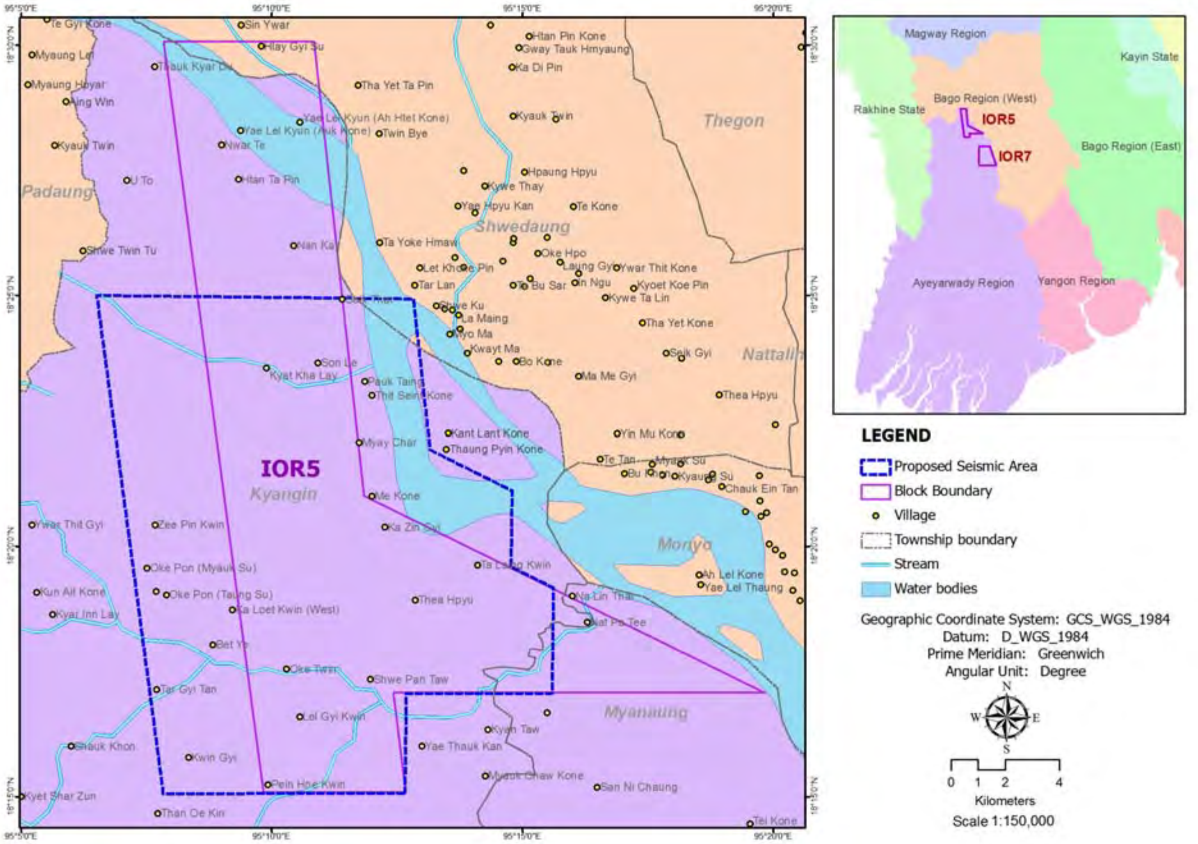


Figure 1-2: IOR-5 Study Area

1.5 ESHIA Methodology

The ESHIA was prepared following the scope outlined in **Section 1.3** and the methodology provided in **Chapter 5: Impact Assessment**.

1.5.1 Data Collection

1.5.1.1 Primary Data Sources

Data collected for this EIA include details of the proposed project, environmental baseline, socio-economic setting and health conditions of the potentially affected areas. Data were obtained from primary and secondary sources.

Primary data sources include:

- Environmental quality baseline survey for surface water, groundwater quality, and soil survey conducted on 7 - 13 November 2014;
- Environmental quality baseline survey for noise and air quality survey conducted on 7 - 13 November 2014;
- A historical, archaeological and cultural resources meeting with Archaeological Department conducted on 7 - 13 November 2014;

- Traditional Ecological Knowledge (TEK) surveys with local farmers which focused on a number of ecological indicators regarding biodiversity and ecological status was conducted on 7 - 13 November 2014;
- Socio-economic surveys conducted on 7 - 13 November 2014; and
- Focus Group meetings with villagers on 7 - 13 November 2014.

1.5.1.2 Secondary Data Sources

Secondary data sources came from literature, relevant authorities in the project area. The secondary data sources are cited throughout this report, and listed in the references section.

1.5.1.3 Public Involvement

The proposed project includes obtaining a total of 217 sq km FF of 3D Land seismic data acquisition and drilling and testing petroleum hydrocarbons from 2 well sites. The public involvement for this EIA consisted of four parts: focus groups, key informant interviews, household leader attitude survey and key ecological knowledge survey.

A socio-economic survey was conducted during 7 - 13 November 2014, covering 8 villages in Block IOR-5.

MOGE assisted IEM/PCMI by contacting local officials in each village and making arrangements for our team to meet with them. MOGE too, participated in each focus group meeting and addressed those questions appropriate for the government to answer.

1.5.2 Project Description

The Project was reviewed in order to gain a full understanding of the project and to compile information on project activities. The Project is described in **Chapter 2**.

1.5.3 Description of the Environment

Environmental, social and health information was collected and evaluated in the following areas:

- **Physical Environment**: geography, climate, air quality, noise, geology, soil, surface water hydrology, surface water quality, groundwater;
- **Biological Environment**: flora, fauna, aquatic biota, threatened/endangered species, protected areas;
- **Human Use Values:** land use, agriculture and industry, fishery and aquaculture, irrigation and agricultural water sources, water supply, wastewater management, solid waste management, transportation, power supply, electricity and communications;
- **Quality-of-Life Values**: local administration, demographics, socio-economy, archaeological resources, tourism;
- **Health**: health services and public health statistics.

1.5.4 Impact Assessment

An initial screening assessment of project activities consisted of developing a summary matrix of project activities against environmental, social and health parameters to determine if potential impacts were considered significant or not. If any issues were considered significant, then these were assessed in more detail. Qualitative and quantitative analyses were conducted to assess potential impacts on environmental, social or health receptors that may be caused by the proposed project activities. The impact analysis criteria are summarized in **Chapter 5**.

The impact assessment also included an assessment of unplanned events. The assessment examines the potential of the project to result in major hazardous events (such as a fire or oil spill from a blow-out) or environmental hazards to impact the project and the environment (such as earthquakes). The risk assessment includes a qualitative and a quantitative evaluation of risks to help further define the probability and potential consequences of these major hazardous events, and to evaluate the significance and the areas that might be impacted by these events. Specific systems for the further management of the significant risks are then proposed. Residual risk was determined after management measures were defined.

1.5.5 Mitigation and Monitoring

In the impact assessment, a number of potentially significant impacts were identified. For each of these project activities, mitigation measures were defined to prevent and/or reduce the likelihood or magnitude of impacts and/or to limit the extent of an impact if one does occur. The proposed mitigation measures take into account applicable guidelines, industry practices, expert judgement, design techniques, and operational control.

In addition, environmental monitoring measures were designed to monitor the environment and project activities. The purpose of these monitoring measures is: to evaluate the effectiveness of the mitigation measures that will be put in place; to assess compliance with Myanmar legislation, guidelines and standards; and to compare environmental conditions after implementation of the project to environmental baseline conditions to document possible change and/or impact.

1.6 Overview of Myanmar Legislation and International Conventions Applicable to this Project

This section lists all legislation relevant to the undertaking of industrial projects in Myanmar. The legislation can be divided into two categories as follows:

- Myanmar Legislation (summarized in **Section 1.7**)
- International Agreements and Conventions (**Section 1.8**)

1.7 Myanmar Legislation

1.7.1 National Legislation

The national legislation applicable to the Project comprises the following sources of law, listed hierarchically in accordance with the Constitution and other laws of Myanmar:

- The Environmental Conservation Law (2012)
- The Foreign Investment Law (2012)
- The Constitution (2008)
- Laws issued by the State Peace and Development Council (SPDC), Myanmar governing body (exercising legislative functions)
- Decrees or subsidiary legislation issued by Ministers
- Any other regulatory requirements

1.7.1.1 The Environment Conservation Law

The Environmental Conservation Law (Pyidaungsu Hluttaw Law No. 9 / 2012) has the following objectives:

a) to implement the Myanmar National Environment Policy;
b) to provide basic principles and give guidance for systematic integration of environmental conservation matters in the sustainable development process;
c) to promote a good and clean environment and to conserve natural and cultural heritage for the benefit of both present and future generations;
d) to reclaim ecosystems that are in the early stages of degradation;
e) to manage prevention of degradation of natural resources and to enable the sustainable use;
f) to implement for the promotion of public understanding and to provide educational programmes for dissemination of environmental awareness;
g) to promote international, regional and bilateral cooperation in environmental affairs;
h) to enable cooperation among government departments, government organizations, international organizations, non-governmental organizations and individuals in matters of environmental conservation.

The Government shall form the Environmental Conservation Committee with the designated Minister as Chairman and with suitable members to conserve, protect and safeguard the environment of the Republic of the Union of Myanmar. The rights of the Committee are as follows:

a) carrying out awareness and activities relating to environmental conservation;
b) suggesting amendments and inclusions, as may be necessary, in the lessons on environmental conservation contained in school lessons in coordination;
c) accepting donations, grants, materials and aids in technology from local and foreign sources and managing and using such money, materials and technologies in environmental conservation activities;
d) forwarding suitable suggestions relating to environmental conservation to the relevant Government departments and organizations;
e) soliciting necessary proposals and suggestions for the conservation and enhancing of environment from the relevant government departments and organizations;
f) prohibiting respective government departments and organizations in the event of the occurrence of environmental damage or situations in which damage may occur and, if necessary, seeking policy from the Union Government;
g) formulating and implementing Myanmar National policies for conservation and enhancement of the environment and other environmental policies.

1.7.1.2 Foreign Investment Law

Foreign Investment Rules:

- If the project will need to conduct Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) in accord with existing relevant laws, the necessary plans has to be included with the project proposal and be submitted to the Myanmar Investment Commission (MIC);
- For the project which is notified as a large scale investment by MIC the projects will need to conduct EIA/SIA notified by the Ministry of Environmental Conservation and Forestry (MOECAF), EIA/SIA report has to be enclosed when the project proposal is submitted to the MIC;
- The MIC shall ask the comments from the Ministry of Environmental Conservation and Forestry on the plans or activities to be included in the Initial Environmental Examination (IEE) or EIA.

1.7.1.3 The Constitution

The latest enacted Constitution (May 2008) provides the most up to date information on governing laws and regulations in Myanmar. The Constitution prevails over any other national legislation or international agreements.

It guarantees every citizen equal rights before the law, and requires enactment of necessary laws that recognize citizens' freedom, equality, rights to liberty and justice, benefits, responsibilities, and restrictions (Article 347, and 21 (a) and (d)).

Article (45) states that The Union shall protect and conserve natural environment. Article 390, calls on the duty of its citizens to assist the Union on the following issues:

- preservation and safeguarding of cultural heritage
- environmental conservation
- striving for development of human resources
- protection and preservation of public property.

1.7.1.4 National Legal and Administrative Framework

Myanmar is divided into twenty-one administrative subdivisions, which include:

- Seven states
- Seven regions
- Five self-administered zones
- One self-administered division
- One union territory

The administrative subdivisions are detailed in **Table 1-1** and **Figure 1-3**.

.

Table 1-1: Administrative Regions of Myanmar

Name	Capital	Population	Area
Ayeyarwady Region	Pathein	6,663,000	35,138
Bago Region	Bago	5,099,000	39,404
Chin State	Hakha	480,000	36,019
Kachin State	Myitkyina	1,270,000	89,041
Kayah State	Loikaw	259,000	11,670
Kayin State	Pa-an	1,431,377	30,383
Magway Region	Magway	4,464,000	44,819
Mandalay Region	Mandalay	7,627,000	37,021
Mon State	Mawlamyaing	2,466,000	12,155
Rakhine State	Sittwe	2,744,000	36,780
Sagaing Region	Sagaing	5,300,000	93,527
Shan State	Taunggyi	4,851,000	155,801
Tanintharyi Region	Dawei	1,356,000	43,328
Yangon Region	Yangon	5,560,000	10,170
Naypyidaw Union Territory	Naypyidaw	925,000	N/A
Danu Self-Administered Zone	Pindaya	N/A	N/A
Kokang Self-Administered Zone	Laukkai	N/A	N/A
Naga Self-Administered Zone	Lahe	N/A	N/A
O Self-Administered Zone	Hopong	N/A	N/A
Pa Laung Self-Administered Zone	Namhsan	N/A	N/A
Wa Self-Administered Division	Hopang	N/A	N/A

Source: MIMU, 2012

The regions were called divisions prior to August 2010. States and regions are divided into districts. These districts consist of townships that include towns, wards and village-tracts. Village-tracts are groups of adjacent villages. The administrative structure of the states, regions and self administering bodies is outlined in the new constitution adopted in 2008.

Each state or region has a Regional Government or a State Government consisting of a Chief Minister, other Ministers and an Advocate General. Legislative authority resides with the State Hluttaw or Regional Hluttaw made up of elected civilian members and representatives of the Armed Forces.

The constitution states that Naypyidaw shall be a Union Territory under the direct administration of the President. Day-to-day functions would be carried out on the President's behalf by the Naypyidaw Council led by a Chairperson. The Chairperson and members of the Naypyidaw Council are appointed by the President and shall include civilians and representatives of the Armed Forces.

Self-Administered Zones and Self-Administered Divisions are administered by a Leading Body. The Leading Body consists of at least ten members and includes State or Regional Hlutttaw members elected from the Zones or Divisions and other members nominated by the Armed Forces. The Leading Body has both executive and legislative powers. A Chairperson is head of each Leading Body.

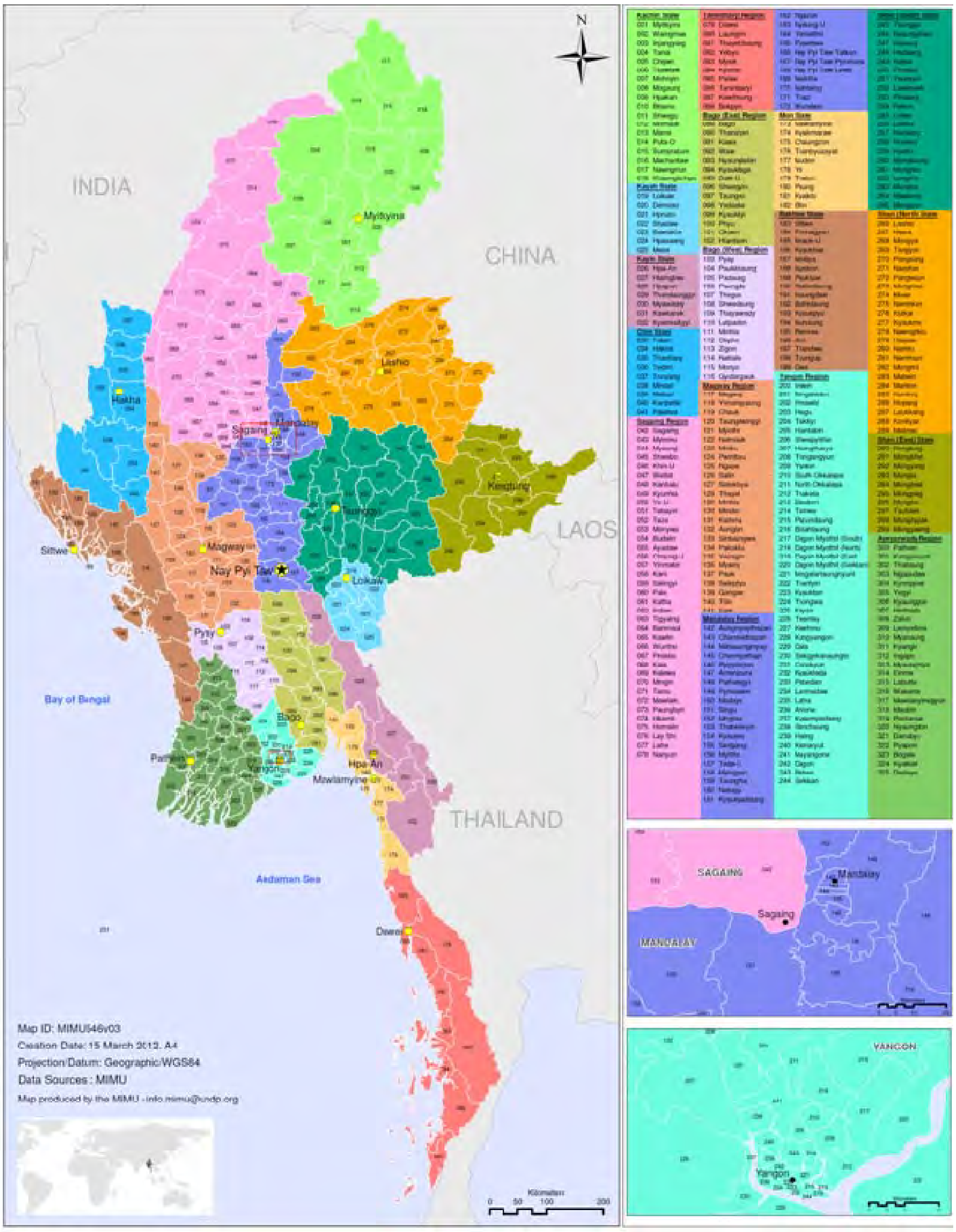


Figure 1-3: Myanmar States/Regions and Townships

EIA Requirement

The Myanmar Oil and gas Enterprise (MOGE) has formally required that all oil and gas companies prepare ESHIAs for new developments.

The Myanmar Government has plans for new laws on ESHIA requirements as indicated by their recently approved 2009 National Sustainable Development Strategy (see below for more details).

EIA Rules, which define EIA requirements, are to be approved soon. Presently the EIA procedures require:

- The projects are required to conduct EIA
- Develop Environmental Management & Monitoring Plan
- EIA has to be conducted by independent Party who is registered Ministry of Environmental Conservation and Forestry (MOECAF)
- EIA Committee shall: approve project or subject to conditions (EIA) or (EMP)
- EIA Committee: (i) grant environmental approval for implementation (ii) refuse to issue environmental approval
- EIA shall be approved by Ministry with the guidance of EIA Report Review Body
- If the project has received approval, the Ministry shall issue an Environmental Compliance Certificate (ECC)

1.7.1.5 Environmental Legislation and Policy Framework

Environmental legislation and protection in Myanmar is a recent development, as can be expected in other parts of the developing world. The first environmental body in the country was created in 1990, called the National Commission on Environmental Affairs (NCEA). The NCEA originated out of the need to provide a national focal point on cooperation with international and regional agencies on global environmental issues. Due to the international nature of this cooperation, the NCEA was initially housed under the Ministry of Foreign Affairs (MOFA) until 2004, when it was transferred to the Ministry of Forestry (MOF).

In April 2011, National Environmental Conservation Committee (NECC) has been reformed as a central organization.

In September 2011, Ministry of Forestry has been changed to Ministry of Environmental Conservation and Forestry (MOECAF) as focal point and coordinating agency.

In February 2012, the Environmental Conservation Department (ECD) was newly set up under the MOECAF to effective implementation of environmental conservation and management.

After 22 years environmental experiences, NCEA has been terminated by emerging of ECD on 31st May 2012.

All laws relating to environment that exist in Myanmar today are being formulated and administered by sectoral ministries and departments concerned.

National Environment Policy (NEP)

The National Environment Policy (NEP) is the first principal policy on environmental protection developed by the NCEA and adopted by the Myanmar Government in 1994. The objective of the NEP is stated as:

"… the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. ...It is the responsibility of the State and every citizen to preserve its natural resources in the interests of present and future generations. Environmental protection should always be the primary objective in seeking development."

With a view to implement the NEP, the NCEA formulated Myanmar Agenda 21 in 1997, under the guiding principles established at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992. Agenda 21 provided the first framework for integrating environmental considerations into national development plans in Myanmar.

Agenda 21 is essentially an environmental action plan for Myanmar and was approved in February 1997. It was written with the assistance of the Asia-Pacific Centre for Environmental Law and the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The document was presented at the June 1997 United Nations General Assembly Session on Agenda 21. It is divided into 4 Parts and 19 Chapters, and reviews the current state of Myanmar development and environment. It suggests policies to be undertaken for improving environmental protection in Myanmar. Some of the major proposals of the Agenda are strengthening the NCEA, possibly turning it into a Ministry; creating a national framework legislation on the environment to improve coordination and cooperation between ministries on issues related to the environment; and creating legislation that requires that environmental impact assessments are done before any development project is undertaken.

Subsequently in 2007, the NCEA developed the National Sustainable Development Strategy (NSDS) for Myanmar. It incorporated the aspirations of Agenda 21 as well as Myanmar's Millennium Development Goals. The NSDS was approved in 2009 and serves as the main guiding principal on environmental protection in the country.

Myanmar National Sustainable Development Strategy (NSDS)

The aim of NSDS is to achieve sustainable development through three sectors focused on natural resource management, economic development, and social development. Relevant government ministries are expected to institutionalize NSDS principles into their sectoral development through short-term, medium-term and long-term actions.

Although much of the NSDS guidelines are for adoption and integration into the government legislation and regulation body, some are targeted at the private sector, such as the polluter pay principle, and reduction of energy consumption and greenhouse gas emission from industries. As NSDS begins to take hold in the country's legislative development, it provides opportunities for the private sector to assist the host country by bringing its operations in line with the goals and activities of the NSDS.

Forest Law, 1992

The Forest Law, 1992 is one of the environmental related laws in the forestry sector. The offences for extracting, moving, keeping in possession unlawfully any forest produce, including fauna and flora are liable to be punished with fine or imprisonment, or for both. For offences relating to teak trees the punishment is heavier. The Courts are empowered to confiscate all forest produce, vehicles, vessels, animals, machinery, tool and equipment in addition to the punishment for the related offence. Forest Officers are also empowered to take administrative actions in respect of forest produce seized.

Protected Areas

Conservation and protection of natural environment is stipulated under Article 45 of the Constitution (2008):

> *"The Union shall protect and conserve natural environment."*

The Ministry of Forestry is the main government body responsible for issuance of laws relating to forest resource management. The two major laws concerning protected areas are:

1. Forest Law 1992
2. Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law 1994

The Forest Law of 1992 replaces the Forest Act of 1902. The new law has a stronger emphasis on environmental protection and biodiversity conservation, including creation of protected areas. It decentralizes forest management through increasing the role of private sector in reforestation and timber trade. The law also incorporates public participatory approaches to forest management with a goal of meeting the basic needs of the rural people dependent on these resources. In general, the law reflects a departure from viewing natural resources purely for its economic value to acknowledging its ecological and social values, therefore, prioritizing the need for conservation, as well as introduction of a decentralized management system involving the public and private sector.

The 1994 Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law replaces the Burma Wildlife Protection Act of 1936. This new law highlights habitat maintenance and restoration; protection of endangered and rare species of fauna and flora; establishment of new parks and naturally protected areas; and buffer zone management.

A total of 45 protected areas have been established in Myanmar. The natural areas for protection are categorized as follows:

- Scientific Nature Reserve;
- National Park;
- Marine National Park;
- Nature Reserve;
- Wildlife Sanctuary;
- Geo-physically Significant Reserve; and
- Other Nature Reserve as determined by the Minister.

1.7.2 Project-Relevant Laws

The laws which currently exist in Myanmar are generally too broad and inadequate to deal with complex environmental and social management issues. For example, detailed legislation does not exist to deal with specific issues, such as waste management and land use. In relation to pollution, Myanmar has no specific laws to govern air and water pollution. A number of discrete laws exist which, either directly or indirectly, relate to environmental and social management in the Union of Myanmar. It is noted that these laws are general in nature and refer primarily to good practice recommendations. Limited, if any, specific criteria are presented.

Items relevant to onshore exploration are discussed below, and a complete list of national environmental legislation is presented in **Table 1-2.**

1.7.2.1 Public Health Law, Section 3

Section 3 of the Public Health Law empowers the Government of the Union of Myanmar to carry out measures relating to environmental health, such as garbage disposal, use of water for drinking and other purposes, radioactivity, protection of air from pollution, sanitation works and food and drug safety.

1.7.2.2 The Oilfield Act, 1918

The Oilfields Act, 1918, provides clarification on activities within the oil and gas industry, and provides the Government with the power to define and alter limits of any notified oilfield. In addition, the Government may make rules for regulating all matters connected with many operations related to the extraction of oil and/or gas. The Act also provides guidance and issues such as preventing oil and gas wastes, reporting of fires, accidents and other occurrences and regulating the collection and disposal of both oil and gas.

1.7.2.3 The Oilfield (Workers and Welfare) Act, 1951

The Oilfields Act, 1951, dictates that the warden of the oilfield is responsible for supervising the waste output of oil or natural gas exploration etc.

1.7.2.4 The Petroleum Act, 1934

The Petroleum Act, 1934 is concerned with regulation of the production, storage and transport of oil so as not to cause pollution and fire.

1.7.2.5 The Underground Water Act, 1930

The Underground Water Act, 1930 provides measures for systematic and sustainable use of underground water.

1.7.2.6 Penal Code, 1961 (and extended in Public Health Law, 1972)

The Penal Code is mainly concerned with public health. The Penal code guidelines considered an offence to “voluntarily corrupt or foul the water of any public spring or reservoir so as to render it less fit for the purpose for which it is ordinarily used”, or to pollute the atmosphere arising from smoke, fumes, noxious odours, dust particles, noise and radioactive substances.

1.7.2.7 Forest Law, 1992

The Forest Law, 1992 is one of the environmental related laws in the forestry sector. The offences for extracting, moving, keeping in possession unlawfully any forest produce, including fauna and flora are liable to be punished with fine or imprisonment, or for both. For offences relating to teak trees the punishment is heavier. The Courts are empowered to confiscate all forest produce, vehicles, vessels, animals, machinery, tool and equipment in addition to the punishment for the related offence. Forest Officers are also empowered to take administrative actions in respect of forest produce seized.

1.7.2.8 Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994

Under the Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994, hunting without licence, breeding protected animals without permission, causing water and air pollution, poisoning water, possessing, selling, transporting or transferring wildlife or any part thereof without permission are treated as actionable crimes. The punishments are more severe for those offences committed against protected wildlife. The Law exempts the possessing of any part of a normally protected or seasonally protected wildlife as a souvenir or wearing as a traditional custom, the possessing or wearing of any part of a completely protected animal with a certificate or registration, possessing, use, sale, transport or transfer of a drug prepared from a part of a protected wildlife species.

1.7.2.9 Pollution Control in Myanmar

The only control of water pollution in the country is through guidelines issued on June 17th, 1994 by the Myanmar Investment Commission. These guidelines notified that all projects already permitted by the Commission under the Union of Myanmar Foreign Investment Law 1988, shall compulsorily install sewage treatment plant, industrial wastewater treatment plant and other pollution control procedures as soon as possible and abide with the sanitary and hygienic rules and regulations set by the authorities concerned. In the future, proposals that are to be submitted to the Commission, either under the Union of Myanmar Foreign Investment Law or the Myanmar Citizens Investment Law, shall also abide by these requirements.

Table 1-2: Environmental Laws in Myanmar

Sector	Relevant Laws in Myanmar
Administrative	The Territorial Sea and Maritime Zones Law, 1977
	The Emergency Provisions Act, 1950
	The Essential Supplies and Services Act, 1947
	The Police Act, 1945
	The Poisons Act, 1919
	The Explosive Substances Act, 1908
	The Towns Act, 1907
	The Village Act, 1907
	The Yangon Police Act, 1899
	The Explosives Act, 1887
	The Penal Code, 1861 of Offences Affecting the Public Health, Safety, Convenience, Decency and Morals
Agriculture and Irrigation	The Fertilizer Law, 2002
	The Plant Pest Quarantine Law, 1993
	The Pesticide Law, 1990
	The Embankment Act, 1909
	Underground Water Act, 1930
Culture	The Protection and Preservation of Cultural Heritage Region law, 1998
Forestry and Natural Resources	The Protection of Wild Life, Wild Plants and Conservation of Natural Areas Law, 1994
	The Forest Law, 1992
Public Health	The National Food Law, 1997
	The Traditional Drug Law, 1996
	The Prevention and Control of Communicable Disease Law, 1995
	The Narcotics Law, 1993
	The National Drug Law, 1992
	The Union of Myanmar Public Health Law, 1972
	Private Health Act, 2007
	The Penal Code of Offences Affecting the Public Health, Safety, Convenience, Decency and Morals (1861)

Sector	Relevant Laws in Myanmar
Occupational Health and Safety	Factory Act, 1951 (safe and healthy workplaces)
	Employment and Training Act 1950
	Workmen's Compensation Act
	Shops and Establishment Act, 1951
	Leave and Holidays Act, 1951
	Minimum Wage Act 1949
	Payment of Wages Act 1936
	Social Security Act 1954
	Trade Dispute Act 1929
Tourism	The Myanmar Hotel and Tourism Law, 1993
Industrial	Myanmar Special Economic Zone Law, 2011
	Dawei Special Economic Zone Law, 2011
	The Private Industrial Enterprise Law, 1990
	The Factories Act, 1951
	The Oilfield (Workers and Welfare) Act, 1951
	The Petroleum Act, 1934
	The Oilfield Act, 1918
Fisheries and Aquaculture	The Freshwater Fisheries Law, 1991
	The Myanmar Marine Fisheries Law, 1990
	The Law Relating to Aquaculture, 1989
	The Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1989
	The Law Amending the Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1993
	The Law Amending the Myanmar Marine Fisheries Law, 1993
Science and Technology	The Atomic Energy Law, 1998
	Science and Technology Development Law (Law No. 5/94, 1994)
Transportation	The Highways Law, 2000
	The Motor Vehicles Law, 1964
	(The Law Amending the Motor Vehicles Law of 1964 enacted in 1989)
	The Myanmar Aircraft Act, 1934
	The Inland Steam Vessels Act, 1917
	The Ports Act, 1907
	The Defile Traffic Act, 1908
	The Yangon Port Act, 1905
	The Canal Act, 1905
	The Obstruction in Fairways Act, 1881
Land Use	Land Acquisition Act, 1894

1.8 International Environmental Conventions, Protocols and Agreements

Myanmar has ratified several international and regional conventions. Those relevant to the project are provided in **Table 1-3**.

Table 1-3: International and Regional Agreements and Conventions

No.	Conventions	Year (Ratified/ Acceded/Accepted)
Environment		
1	Plant Protection Agreement for the Southeast Asia and Pacific Region, Rome 1956	1959 (Ratified)
2	MARPOL: International Convention for the Prevention of Pollution from Ships 1973 and MARPOL Protocol of 1978	1988 (Accession)
3	ICAO: ANNEX 16 to the Convention on International Civil Aviation Environmental Protection Vol. I and II, Aircraft Noise and Aircraft Engine Emission	Accession
4	Agreement on the Networks of Aquaculture Centres in Asia and the Pacific, Bangkok 1988	1990 (Accession)
5	Vienna Convention for the Protection of the Ozone Layer, Vienna 1985	1993 (Ratification)
6	Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal 1987	1993 (Ratification)
7	London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London 1990	1993 (Ratification)
8	United Nations Framework Convention on Climate Change (UNFCCC), New York 1992	1994 (Ratification)
9	Convention on Biological Diversity, Rio de Janeiro 1992	1994 (Ratification)
10	The Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris 1972	1994 (Acceptance)
11	International Tropical Timber Agreement (ITTA), Geneva 1994	1996 (Ratification)
12	United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought, Paris 1994	1997 (Accession)
13	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington DC 1973; and as amended in Bonn, Germany 1979	1997 (Accession)
14	ASEAN Agreement on Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	1997 (Signatory)
15	Kyoto Protocol to the Convention on Climate Change, Kyoto 1997	2003 (Accession)
16	ASEAN Agreement on Trans-boundary Haze Pollution	2003 (Ratification)
17	Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	2004 (Accession)
18	Ramsar Convention on Wetlands of International Importance	2005 (Accession)
19	Establishment of ASEAN Regional Centre for Biodiversity	2005 (Signatory)
20	Declaration on ASEAN Heritage Parks	2003 (Signatory)
21	International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	2004 (Ratification)
22	Catagena Protocol on Biosafety, Cartagena, 2000	2001 (Signatory)
23	Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, Rome, 1973	1994 (Acceptance)
24	United Nations Convention on the Law of the Sea, Montego Bay, 1982	1996 (Ratified)
25	Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, New York, 1994	1996 (Accession)
26	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and their Destruction, Paris, 1993	1993 (Signatory)
27	Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea Bed and Ocean Floor and in the Subsoil there of, London, Moscow, Washington, 1971	1971 (Signatory)

No.	Conventions	Year (Ratified/ Acceded/Accepted)
Social, Labour and Health		
28	Universal Declaration of Human Rights (UNDHR)	signed
29	Convention on the Rights of the Child	1991 (acceded)
30	Convention on Elimination of All Forms of Discrimination against Women (CEDAW)	1997 (acceded)
31	Relevant ILO Conventions in force in Myanmar • C1 Hours of Work (Industry) • C14 Weekly Rest (Industry) • C17 Workmen’s Compensation (Accidents) • C19 Equality of Treatment (Accident Compensation) • C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen’s Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay • C87 Freedom of Association and Protection of the Right to Organize	

CHAPTER 2

PROJECT DESCRIPTION

2. PROJECT DESCRIPTION

2.1 Introduction

PETRONAS Carigali Myanmar Inc. (hereafter called “PCMI”), MOGE and UNOG have jointly invested in on-shore Block IOR-5.

The Petroleum Sharing Contract (PSC), between PCMI and MOGE was signed and effective on 16th Sept 2014 in Naypyidaw, in the Republic of the Union of Myanmar. This chapter discusses the proposed seismic line layout and acquisition parameters of the seismic program to be acquired in March 2014 to satisfy this obligation.

PCMI plans to carry out an onshore seismic survey in Block IOR, which lies within Htantabin Area of Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km. The proposed seismic grid will be designed based on available geological information; additional lines will also adjusted according to the terrain and geography conditions, based on topography maps and information obtained from pre-survey scouting trips.

PCMI is in the process of selecting the SEISMIC CONTRACTOR for the seismic survey.

PCMI’s exploration drilling program in Block IOR-5 includes drilling 2 exploration wells. The expected spud date in July 2017. The exploration well will be drilled as a vertical well with conventional hole technique. The exploration drilling will be conducted with a typical land drilling rig.

The location of Block IOR-5 is shown in **Figure 2-1**.

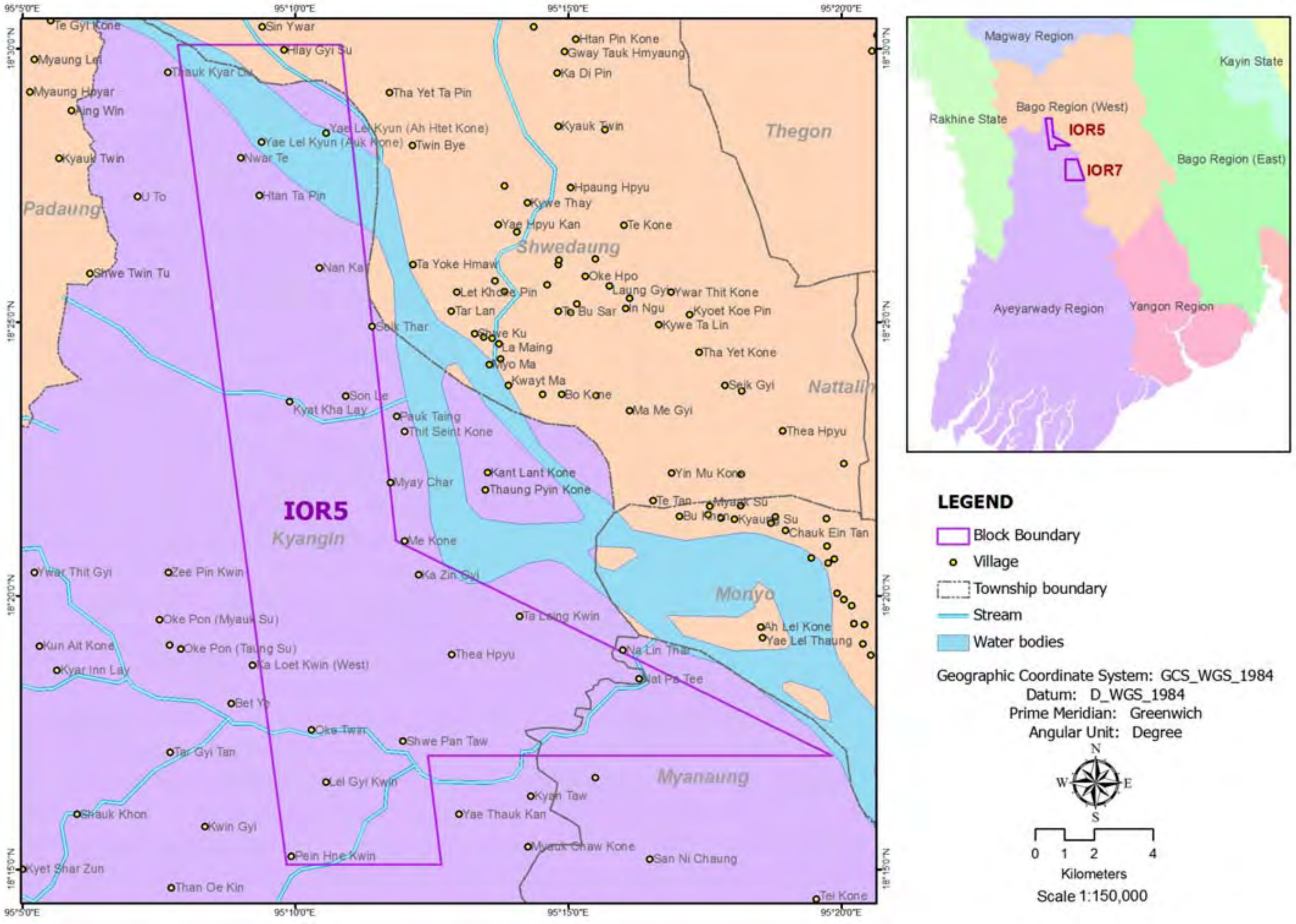


Figure 2-1: Block IOR-5 Location

2.2 Purpose and Objectives of Project

PETRONAS Carigali Myanmar Inc. (PCMI) plans to conduct a 3D seismic survey and drill up to two exploration wells in Block IOR-5. The primary objectives of the onshore seismic survey and the onshore exploration drilling project in Block IOR-5 are to acquire information on stratification and to explore potential reserves under the block. If reservoirs are discovered, further studies on chemical and physical properties of petroleum, age of reservoirs, rock characteristics, porosity, permeability in the formation and others will be conducted. Oil/Gas are the types of petroleum product anticipated from this exploration drilling. If a sustained commercial flow rate of the potential reservoirs is established, PCMI will prepare and submit a separate ESHIA report for production drilling to MOGE for their consensus.

2.3 History and Petroleum Activity within Block IOR-5

2.3.1 Seismic Acquisition History

The existing historic data seismic data consists of 57 km of Gravity data (1976-76) and 250 km of 2D seismic data (1976-84) acquired between by MOGE in the block.

2.3.2 Exploration Drilling History

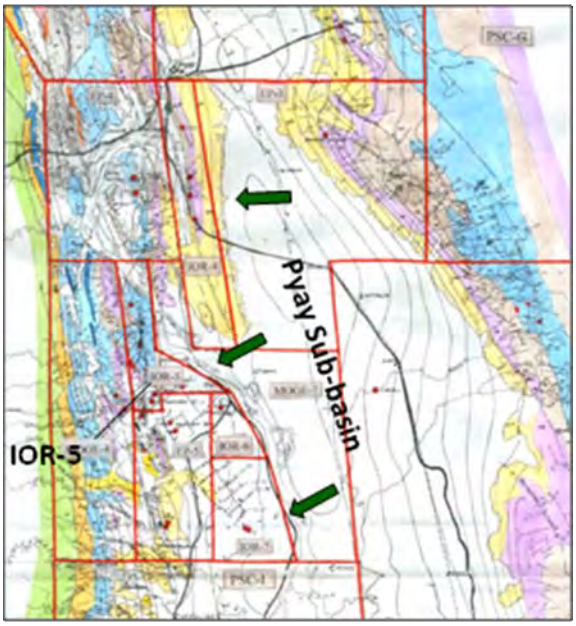
The Htantabin Gas and Condensate field was discovered in 1980. It is known to be a Lower Miocene Gas-Condensate Shoal Limestone play. There are some 39 wells drilled, the deepest well drilled is HDT#1B which was TD at 10740 ft.

The details of the historic drilling are shown in **Table 2-1** and **Figure 2-2**.

Table 2-1: Drilling History in Block IOR-5

Operator	MOGE
HC Discovery, Drilled wells	1980 (well No.3) 39 (Deepest-3273 m) 47-61 deg. API (Condensate) GOR: 5,700 – 52,000 SCF/STB
Drilling Problem	Lower Miocene Pyawbwe Shale
Structure	Thrusted anticline (Kyangin), with x-faults, 6 faulted blocks

Source: PCMI, 2014



Source: PCMI, 2014

Figure 2-2: Historic Exploration Areas in IOR-5

2.3.3 Production History

Oil and gas has been historical produced in Block IOR-5 from a stratigraphic pinch-out of the Pyawbe Limestone (Lower Miocene). The Peak production was 577 BOPD and 10 MMSCFD in December 1982. Currently the production is suspended.

The nearest production facilities are in Htantabin and Myanaung while the nearest refinery is in Seik Tha.

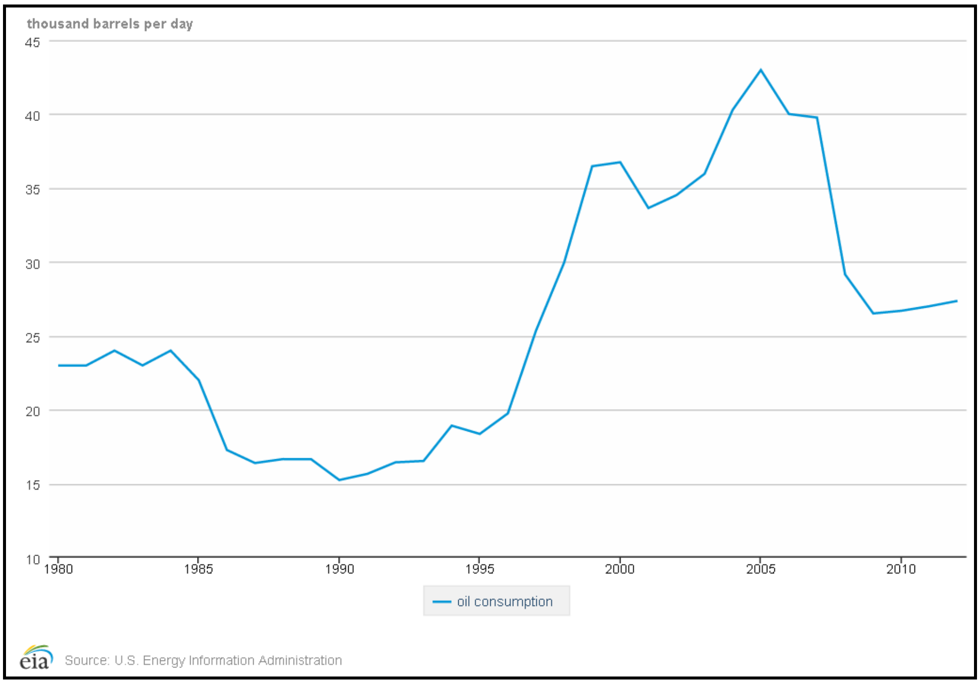
2.3.3.1 Previous Environmental Impact Assessments in Block IOR-5

There has been no previous EIA/SIA conducted in Block IOR-5.

2.4 Project Need and Justification

Burma produces a minimal amount of crude oil and condensates from the onshore Salin basin and offshore Yetagun field. Total liquids production has gradually increased over the past decade from 13,000 barrels per day (bbl/d) in 2000 to 21,000 bbl/d in 2011. However, Burma's limited production and refining capacity are insufficient to meet domestic demand for crude oil and products, making the country a net oil importer. **Figure 2-3** and **Table 2-2** show Myanmar’s crude oil consumption.

PCMI, as the operator of the Myanmar onshore petroleum PSC, is striving to develop and produce oil from its potential reservoirs located within Block IOR-5.



Source: U.S. Energy Information Administration, 2013

Figure 2-3: Myanmar's Oil Consumption 1980 to 2012

Table 2-2: Crude Oil Consumption in Myanmar for last 20 Years

Year	Consumption	Change
1993	16.53	0.56 %
1994	18.92	14.46 %
1995	18.36	-2.97 %
1996	19.75	7.55 %
1997	25.35	28.37 %
1998	29.95	18.15 %
1999	36.48	21.77 %
2000	36.75	0.75 %
2001	33.65	-8.43 %
2002	34.52	2.59 %
2003	35.97	4.19 %
2004	40.29	12.02 %
2005	42.99	6.71 %
2006	40.01	-6.94 %
2007	39.77	-0.59 %
2008	29.16	-26.69 %
2009	26.51	-9.07 %
2010	26.69	0.69 %
2011	27.00	1.16 %
2012	27.36	1.33 %

Source: United States Energy Information, 2013

2.5 Project Alternatives

2.5.1 No Project

If the proposed exploration project is not implemented, economic benefits generated by the project would not occur (**Section 2.4**). Benefits lost would include the following:

- Employment generation and project expenditures during exploration drilling;
- Potential loss/delay of petroleum production from the site;
- Loss of revenue for the Myanmar and local governments through Production Sharing Contracts (PSC);
- The future contribution of crude oil from this area would need to be replaced with an equivalent amount sourced from overseas. Importing crude oil from outside Myanmar has associated impacts from transportation (emissions, potentials for spills) as well as cost implications;
- Employment generation and project expenditures during production.

2.5.2 Project

2.5.2.1 Site Selection Process

The location of well sites in Block IOR-5 will be selected based on the data from 3D seismic acquisition, general site criteria, engineering criteria, economic criteria, and environmental, social and health criteria as summarized in **Table 2-3**.

2.5.2.1.1 General Criteria

The general criteria include an evaluation of Geology, Location, Topography, Land Use and Significant sensitive areas and Infrastructure for the project. The exploration drilling project will explore the location, extent and characteristics of petroleum reservoirs. This project will select the location to drill exploration wells based on geological data and seismic interpretation data in the area (see details in **Section 2.5.2.3**). The most promising location to find petroleum reservoirs based on geological and seismic information will be defined as the ideal location, most suitable for understanding the target petroleum reservoir and most likely to find promising petroleum reservoirs. The ideal location is then evaluated for other constraints, such as steep terrain, land use, sensitive areas and distance from roads.

2.5.2.1.2 Engineering Criteria

Engineering criteria for well site selection regard the following factors: Minimize difficult terrain (such as drilling in steep topography, rocky areas, etc.), Minimize waterway crossings, Maximize use of existing ROW access, Minimize logistical issues (including engineering safety concerns), Minimize drilling distance to reservoir (preferably conventional straight hole) and Minimize overall length of access road construction..

2.5.2.1.3 Economic Criteria

The site selection process incorporates the assessment of the economic value of a potential petroleum hydrocarbon reservoir and its commercial worth against the cost of the investment (including Land Cost Compensation for land, Renting Rig, Construction, Operation and Maintenance costs) for alternate well locations.

2.5.2.1.4 Environment, Social and Health Criteria

Environmental, social and health criteria evaluated to select well site locations are: location as far away as possible from environmental and social sensitive areas. An “ideal” well site location should be located at least 1 km from any large village and near a transportation network or access route that can accommodate transport of the drilling rig. The shortest distance for access road construction must be considered and well site must not be located within reserved area such as national park, wildlife sanctuary, watershed area, reserved forest, historical park and etc. In case it is necessary to use such an area, the project proponent must operate strictly in accordance with applicable laws and regulations of the relevant government agencies.

Table 2-3: Well Site Selection Criteria

Environmental, Social and Health Considerations	**Physical Resources**
	Minimize use of sensitive terrain/soil (e.g. wetland/erosive soil)
	Maximize use of existing highways and access roads
	Minimize number of river, waterway, and canal crossings
	Minimize use of existing river, waterway and canal crossings
	Ecological Resources
	Minimize impact on natural sensitive terrestrial environment
	Minimize impact on natural sensitive aquatic environment
	Minimize impact on national parks, forest reserves, wildlife sanctuaries
	Human Use Values
	Minimize impact on transportation
	Minimize impact on water resources structure (river, waterway and canal crossing)
	Minimize impact on water resources structure
	Minimize impact on low level row crops (e.g., vegetable, sesame, beans and pulses)
	Minimize impact on paddy fields
	Minimize impact on orchards and forest plantations (e.g., mango, coconut, mixed orchard)
	Minimize impact on aquaculture
	Minimize impact on livestock operations (e.g., swine)
	Quality-of-Life Values
	Minimize impact on population centres, settlements
	Minimize impact on individual buildings and residences in ROW
	Minimize visual impacts
	Minimize impact on cultural/religious resources
	Health
	Minimize potential for construction accidents
	Minimize potential for operation accidents (settlements)
	Minimize anxiety of local people
	Minimize impact on water resources structure (river, waterway and canal crossing)
Engineering Design Considerations	Minimize waterway crossings
	Minimize difficult terrain (steep, rocky, etc.)
	Maximize use of existing ROW access
	Minimize logistical issues
	Engineering design (minimize drilling distance to reservoir)
	Minimize overall length of access road construction
Economic Factors	Land compensation cost
	Construction cost
	Operation and Maintenance cost

2.5.2.2 Drilling Phase Alternatives

2.5.2.2.1 Type of Rig

Rig types are still under evaluation. PCMI intends to use a land drilling rig for this drilling campaign. The rig's Drawworks will have a power rating of 1,800 – 2000 HP and a mast height ~43-1/2m. The rig will be powered by four diesel driven generator sets and each rated 600 KVA to supply the rig site with power.

The selection criteria for drilling rigs are:

- Availability
- Cost
- Rig Capability
    - Rig criteria are mostly related to the well depth requirements which consider:
        - Derrick
        - Drawworks
        - Mud Pumps
        - Drillstring
        - Mud System
        - Surface Equipment Limitation (BOP, Wellhead etc)
        - HSEMS
        - Track records
        - Experience

2.5.2.2.2 Type of Drilling Method

The wells will be drilled with a conventional hole size. Slim hole drilling is not an alternative or possible for the PCMI wells. A conventional hole size hole is required because of the depths being drilled, the type of formations being drilled, the kinds of pressures expected, and for hole stability. The final section of the well will be drilled using an 8-1/2-inch drill bit in the reservoir section.

2.5.2.2.3 Type of Mud

Many types of drilling fluids are used on a day-to-day basis world wide. Some wells require that different types be used at different parts in the hole, or that some types be used in combination with others. The various types of fluid generally fall into a few broad categories:

- Air: Compressed air is pumped either down the bore hole's annular space or down the drill string itself. Drilling depth with this fluid is limited.

- Air/water: The same as above, with water added to increase viscosity, flush the hole, provide more cooling, and/or to control dust. Drilling depth with this fluid is limited.

- Air/polymer: A specially formulated chemical, most often referred to as a type of polymer, is added to the water & air mixture to create specific conditions. A foaming agent is a good example of a polymer. Drilling depth with this fluid is limited.

- Water: Water by itself is sometimes used.

- Water-based mud (WBM): A most basic water-based mud system begins with water, and then clays and other chemicals are incorporated into the water to create a homogenous blend resembling something between chocolate milk and a malt (depending on viscosity). The clay (called "shale" in its rock form) is usually a combination of native clays that are suspended in the fluid while drilling, or specific types of clay that are processed and sold as additives for the WBM system. The most common of these is bentonite, frequently referred to in the oilfield as "gel". Gel likely makes reference to the fact that while the fluid is being pumped, it can be very thin and free-flowing (like chocolate milk), though when pumping is stopped, the static fluid builds a "gel" structure that resists flow. When an adequate pumping force is applied to "break the gel", flow resumes and the fluid returns to its previously free-flowing state. Many other chemicals (e.g. potassium formate) are added to a WBM system to achieve various effects, including: viscosity control, shale stability, enhance drilling rate of penetration, cooling and lubricating of equipment.

- Oil-based mud (OBM): Oil-based mud can be a mud where the base fluid is a petroleum product such as diesel fuel. Oil-based muds are used for many reasons, some being increased lubricity, enhanced shale inhibition, and greater cleaning abilities with less viscosity. Oil-based muds also withstand greater heat without breaking down. The use of oil-based muds has special considerations. These include cost and environmental considerations.

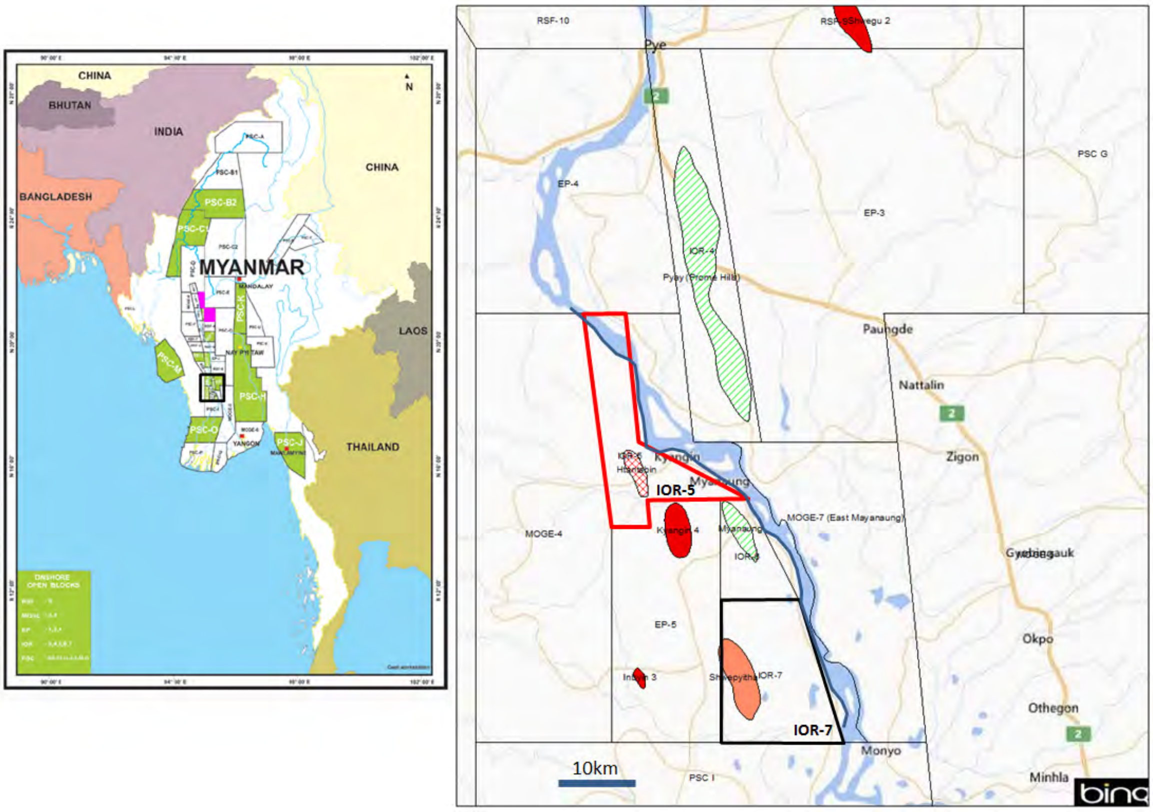
- Synthetic-based fluid (SBM): Synthetic-based fluid is a mud where the base fluid is synthetic oil. This is most often used on offshore rigs because it has the properties of an oil-based mud, but the toxicity of the SBM fluid is much less than an oil-based fluid. This is important when men work with the fluid in an enclosed.

- Non Aqueous Fluid System (NAF): The NAF system was developed to provide: maximum shale inhibition, lubrication, and wellbore stability. Use of an NAF system in the mid sections (vs. a WBM system) will significantly reduce the risk of mechanical failure of the open hole, which could result in the drill pipe getting stuck requiring a back-off and side track. It will also increase the penetration ratio, thus reducing cost and time the rig will be on-site and minimum environmental impact.

The PCMI drilling program will only use Water Based Mud (WBM) for the drilling campaign.

2.5.2.3 Geological Prognosis

Block IOR-5 in Htantabin field is located in the NW edge of the Pyay Sub-Basin in Ayeyarwady Region (**Figure 2-4**). It is the first oil and gas field discovered in 1980 from a limestone reservoir in Myanmar. Stratigraphic rock units of the block are shown in the **Table 2-4**. The regional stratigraphic framework of the Central Myanmar Basin and possible petroleum stystem of the Block IOR-5 and IOR-7 are shown in **Figure 2-6**. In the Block IOR-5, the producing reservoir is the Lower Miocene shoal limestones of Pyawbwe Formation, which contains 5 pay zones with the net pay thickness of 150 ft. The hydrocarbon bearing limestone is developed as a wedge-shaped build up on the west flank. The maximum development of limestone formation attained 1,257 ft in well 2. The fracture porosity is about 10 – 22% with 30-40% of Sw. The peak production of the field is 530 BOPD and 10.056 MMSCFD in December, 1982. The total volume of oil in place is 2.508 MMSTB (P1) and 3.094 MMSTB (P2). Following the first oil and gas production in well 3, a total of 13 wells come in to produce from the limestone reservoir. In most of the wells initial production rates are good enough, however these are followed by rapid decline and even ceased-flowing after water incursion.



Source: PCMI, 2014

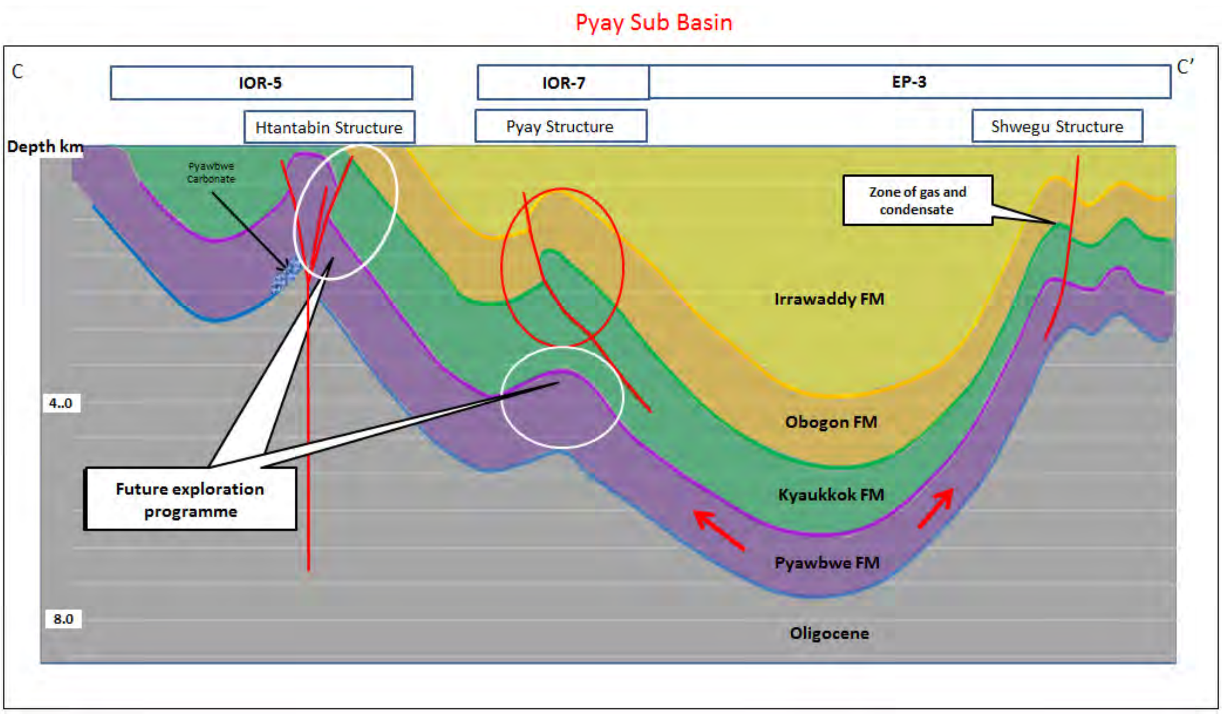
Figure 2-4 Location map of Block IOR-5 in the Pyay Sub-Basin

Table 2-4: Generalized stratigraphy of Block IOR-5 (Modified after MOGE, 2013)

Stratigraphic Units	Stratigraphic Age	Dominant Lithology	Thickness (ft)
Irrawaddy Fm.	U. Miocene - Pliocene	Yellowish brown medium grained sandstones	1000+
Obogon Fm.	Middle to Upper Miocene	Fine sandstones, siltstones, clay-shales (Sandy alternations)	1280
Kyaukkok Fm.	M. Miocene	Yellowish brown, very fine, siltstone-sandstones, shales	1480+
Pyawbwe Fm.	L. Miocene	Grey – dark grey, bluish shale-clay, massive Foraminiferal limestones (grainstone – packstone – wackestone)	5080+

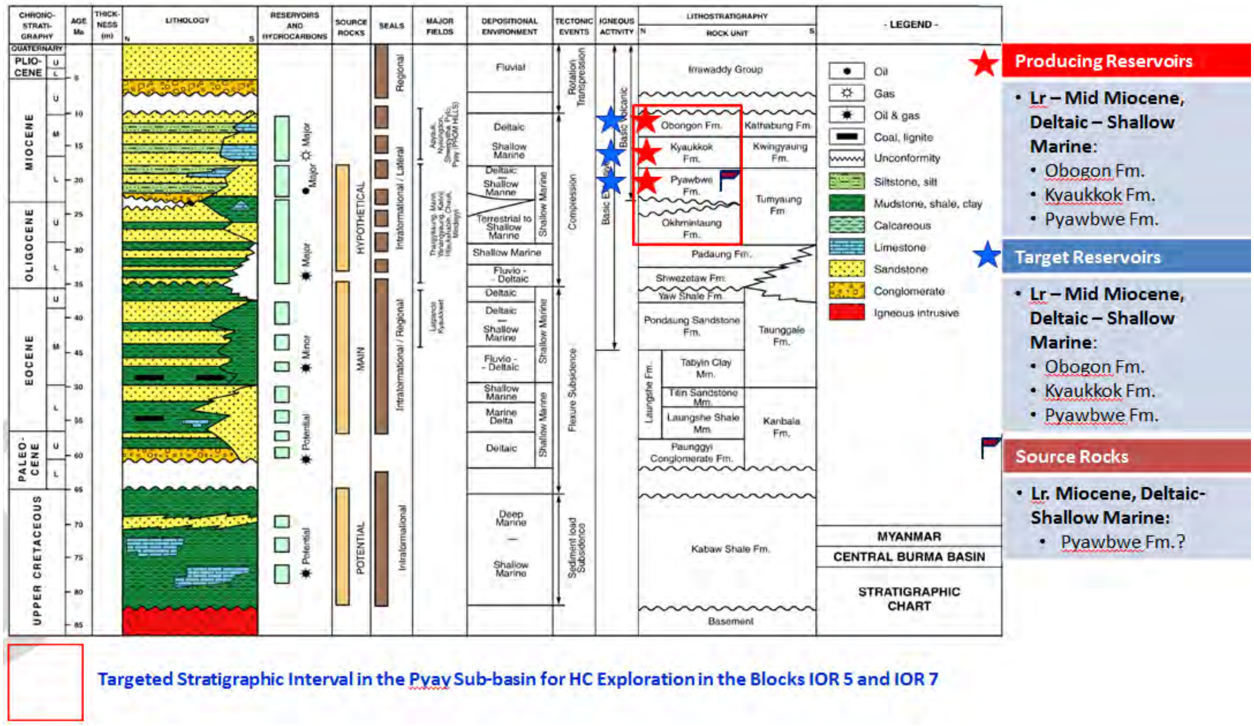
2.5.2.3.1 Geological Structure of the Block IOR-5

Block IOR-5 is situated on the west flank of the NNW-SSE trending Htantabin-Kyangin anticlines, a compressive thrust-related structure of the southern part of Pyay Sub-basin (**Figure 2-5**). To the north, the structure transforms into a crestally faulted anticline. It is broader in the north and narrow down gradually to the south. The very steep crestal belt is bordered to the east and shallower flanks to the west. Mud volcanoes are associated with the steep crestal belt in the northern part of the structure.



Source: PCMI, 2014

Figure 2-5: Schematic structural cross section of Block IOR-5 in the Pyay Sub-Basin showing the subsurface stratigraphic units and the structural styles.



Source: PCMI, 2014

Figure 2-6: Regional stratigraphic framework of the Central Myanmar Basin and possible Petroleum System of the Block IOR-5, showing the producing reservoirs, target reservoirs and possible source rocks.

2.5.2.3.2 Hydrogen Sulphide Potential

The exploration wells are not expected to encounter hazardous levels of H_2S. Regardless, any gas produced from the wells will be constantly analysed for its composition and for the presence of H_2S.

H_2S detection and safety equipment is standard issue (**see Section 2.9**). PCMI's emergency response plan (ERP) includes an H_2S Contingency Plan. Furthermore, the drilling contractor will have their own H_2S Contingency Plan.

2.6 Project Schedule

The operational aspect (field recording) of the seismic survey programme is scheduled to commence in March 2015. Seismic acquisition in IOR-5 is expected to take 8 months, completing in Jan 2016, and consisting of 160 working days.

Preparation project milestones for the seismic survey can be summarized as follows:

• Kick-off meeting with Contractor for preparation & mobilization plan	March 1, 2015
• Commencement date (first recording shot)	June 1, 2015

PCMI anticipates starting this drilling campaign on January 2017, beginning with the civil works and the drilling itself will tentatively commence in July 2017. Well site construction and the drilling of wells will be carried out in succession.

Results from the 3-Dimensional Seismic Surveys over areas may also influence whether all or only some of these wells will be drilled and the order in which they will be drilled.

Project timing ultimately also depends on the following operational constraints:

a) Rig availability, the rig will start to mobilize to well location 2 months before spud date;

b) Construction deadlines: need 2.5 months minimum after well location nominated by Geological and Geophysical;

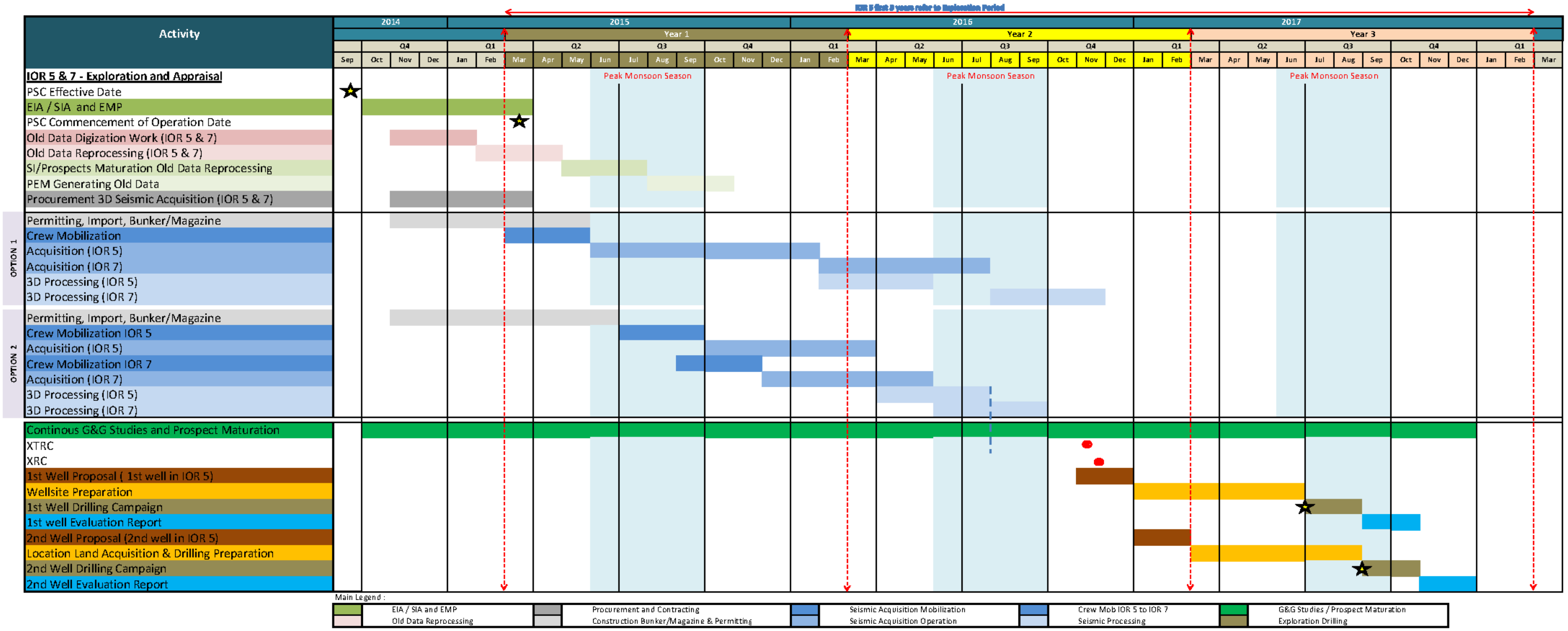
c) Civil work construction machineries and workers.

Each well will have similar drilling schedules which can be divided into 3 phases. The provisional spud date is 1st of July 2017:

- Construction Phase: ± 75 days (2.5 months)
- Drilling Operations Phase: ± 88 days
- Optional testing up to 22 days;
- Well Suspension/Abandonment Phase and site restoration: ± 30 days

A detailed breakdown of project schedule for each well is provided in **Table 2-5**.

Table 2-5: Summary of Project Schedule



Source: PCMI, 2014

2.7 Seismic Survey

2.7.1 Seismic Locations

Block IOR-5 lies primarily within Htantabin Area of Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km. The Ayeyarwady River is flowing at the eastern boundary of the block. The nearest major town is situated towards the east of the block name Kyangin. While a smaller town name Bat Ye is situated towards the west of IOR-5.

Topographically the block is generally flat in the eastern part towards the Ayeyarwady River. The eastern flat land is mostly cultivated with paddy plant and it’s the main source of income for the people in this area. Towards the North Western part of the block the topography is elevated and hilly (Htantabin anticline area).

Table 2-6: Boundary Coordinates of Block IOR-5

Point	Latitude	Longitude
1	18°30’ 00’ ’	95°03’ 00’ ’
2	18°30’ 00’ ’	95°11’ 00’ ’
3	18°21’ 00’ ’	95°12’ 00’ ’
4	18°17’ 00’ ’	95°20’ 00’ ’
5	18°17’ 00’ ’	95°12’ 35’ ’
6	18°15’ 00’ ’	95°12’ 50’ ’
7	18°15’ 00’ ’	95°10’ 00’ ’

Source: PCMI, 2014

Datum: WGS-84, Spheroid: Central Meridian TM96

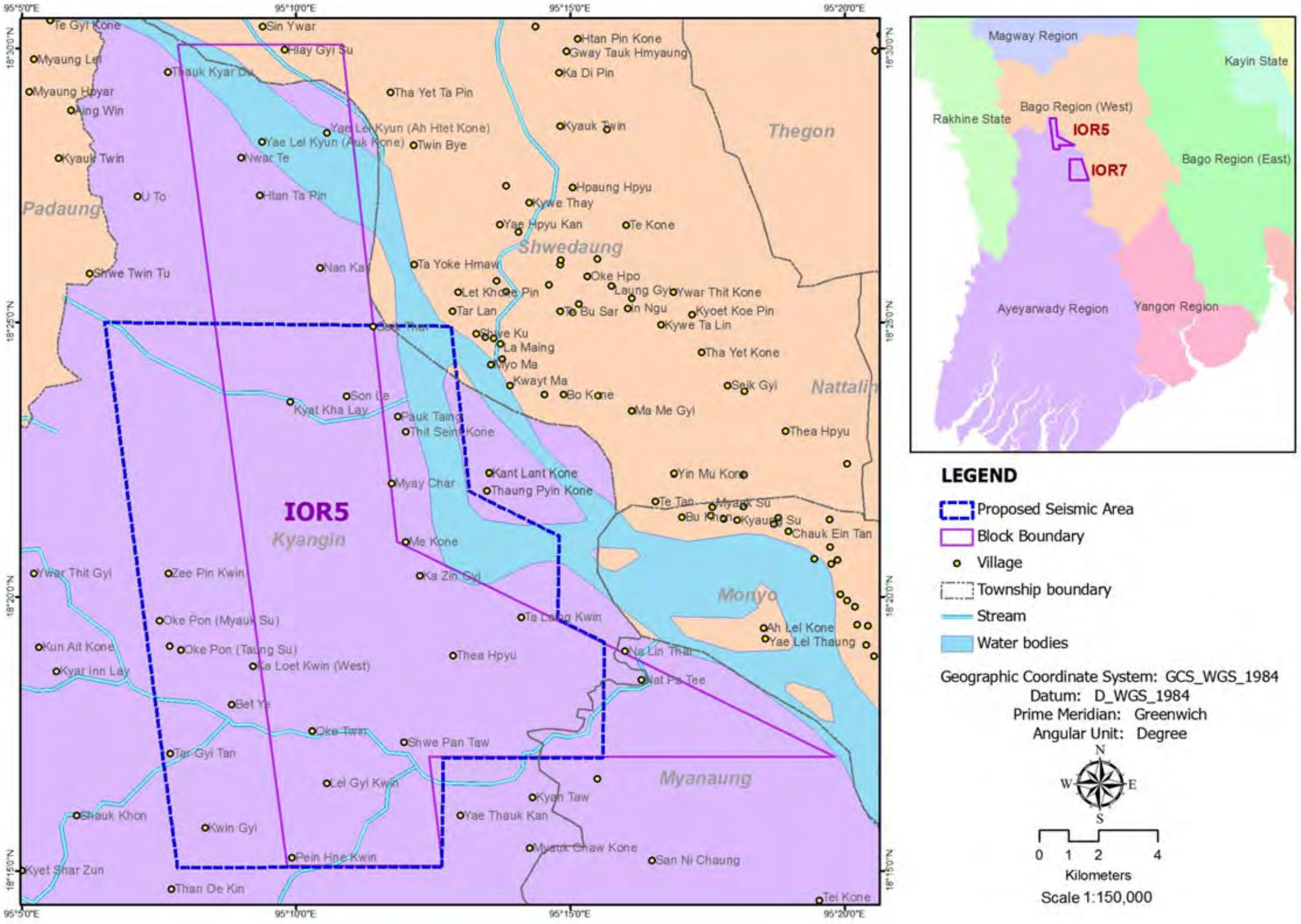
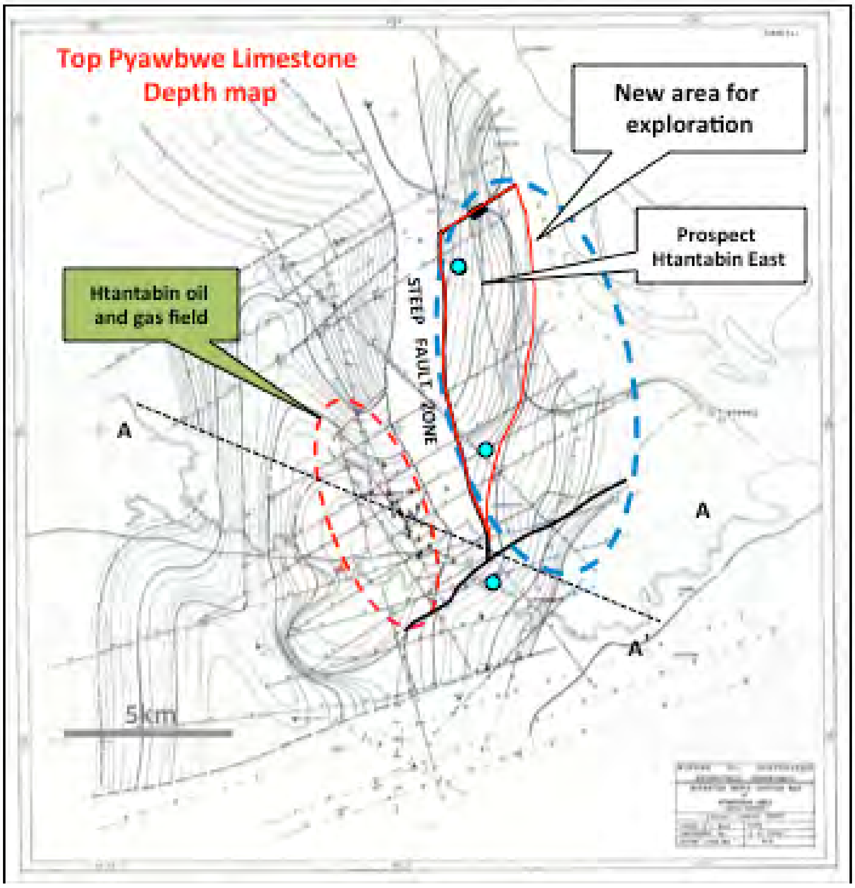


Figure 2-7: Seismic Survey Area for Block IOR-5

2.7.2 Hydrocarbon Leads, Block IOR-5

Geologically IOR-5 block is situated near the north-western edge of Pyay Embayment. In the MOGE geological map it is named as Htantabin area situated west of Kyangin anticline. The remaining potential are Plays of intra Mid Miocene Kyaukkok sandstones on the eastern flank of the anticline and Reef facies yet to be found on the western flank of the anticline.

A map showing the hydrocarbon leads for which this project is based is shown in **Figure 2-8**.

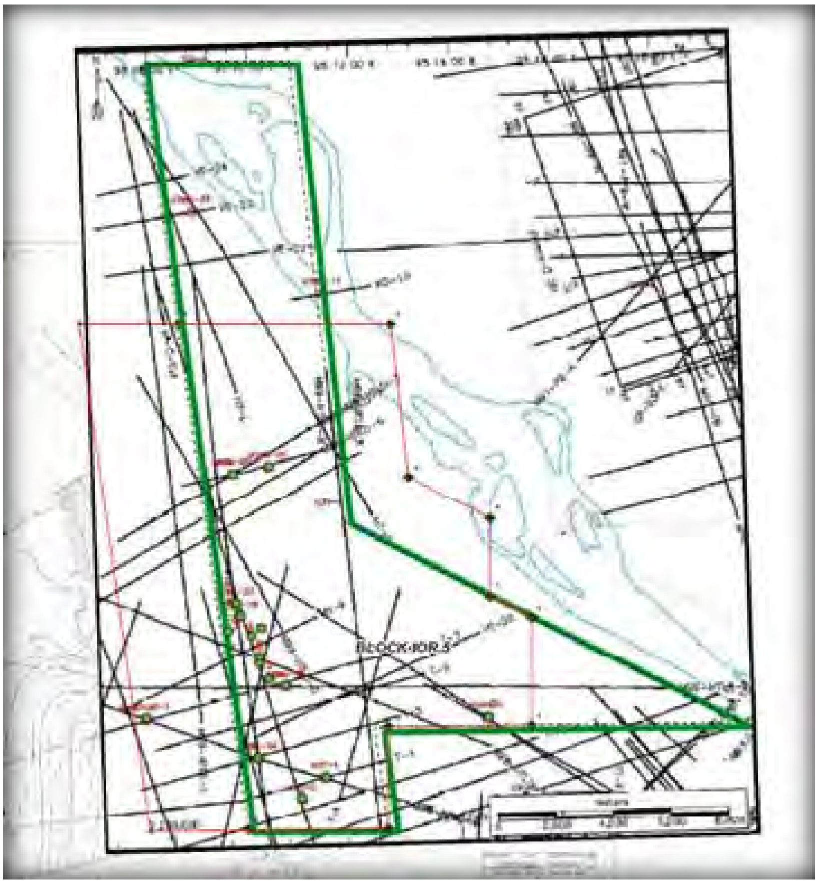


Source: PCMI, 2014

Figure 2-8: Hydrocarbon Leads in Block IOR-5

2.7.3 Proposed Survey Layout

A total of 217 sq km FF of 3D seismic are will be acquired in this campaign. Further adjustment may occur depending on results from field operation. The line layouts are shown in **Figure 2-9**.



Source: PCMI, 2014

Figure 2-9: Survey Area (Block IOR-5)

2.7.4 The Project Office

2.7.4.1 Field Office

There will be one or two field offices/base camps for the project. The field office is going to be located tentatively at Myanaung Township, Hinthada District, Ayeyarwady Region and will be finalized only after discussing with the successful contractor. There will be approximately 60 office staff, including geophysicists, party chiefs, permitting crew, QC and supervisory staff, camp boss and client representatives, etc. All personnel will stay and work in the field offices.

Hotels may be rented for base camps and temporary accommodation camps can be built near to the working area. Facilities includes lavatory and shower blocks, kitchen, storeroom, technical workshop, mechanical workshop, fuel facilities, offices and tented accommodation for both senior and junior staff. They will be complemented by a fleet of vehicles with associated safety features. Water supply requirements for field offices are estimated to be approximately 6 m^3/day for 60 workers (100 L/person/day).

Approximately 100 vehicles will need to be rented for the duration of the contract, and the services of a logistic and labour contractor will be hired to provide fuel supply, catering and transportation services, and all aspects of HSE Management will be observed by their personnel.

PCMI will implement a security policy designed to minimize loss of life and property. The accommodating camp will be illuminated with security lights. A fence will be also installed to prevent intrusions and ensure that all visitors will be screened. Security guards will be scheduled to guard the field office for 24 hours a day and the field working area from 06:00-18:00 hrs. The security plan will be developed prior to the field operation.

PCMI will establish cordial relationship with local security officials and military security as an integrated part of the preparation of any seismic activity.

Analysis and quality control work of the field data will be done in the base camp to obtain the most complete and precise data.

Guidelines for office camp, base and secondary camps will be drafted and posted in front of each applicable area to ensure that all personnel are aware of these guidelines. There will be frequently check to ensure that standards are maintained. These guidelines will cover hygiene, sanitation, rubbish disposal, accommodation and food preparation by case of base and secondary camps. Also, the guidelines will be expanded to include electrical and mechanical safety, etc.

A summary of the guidelines is as follows:

- **Base Camps:** SEISMIC CONTRACTOR (the Seismic Contractor selected by PCMI) will provide, maintain and operate the Base Camps. The Base Camps shall include accommodation and messing, a medical centre, offices, warehouse space, and all other fittings and fixtures required to support the seismic Project. The Base Camps shall include accommodation and office facilities for PCMI Field Representatives and other Contractors assigned to the Project. On completion of the seismic Project, SEISMIC CONTRACTOR shall be responsible for closing the Base Camp facilities and restoring the location as near as possible to its condition prior to the seismic Project.

- **Staging Camps/Labour Camps:** SEISMIC CONTRACTOR will provide, maintain and operate at its sole cost any Staging or Field Camps established to minimize travel time of field personnel to the site of the Project. When required these Staging and Field Camps shall include facilities for PCMI personnel and other PCMI Contractors. On completion of the Project, SEISMIC CONTRACTOR shall be responsible for closing the Staging and Field

Camp facilities and restoring the locations as near as possible to their condition prior to the Project.

- **Regional Support:** MOGE is supporting PCMI to communicate with various other Governmental organizations. The Ayeyarwady Region Governments will support PCMI for the compensation work.

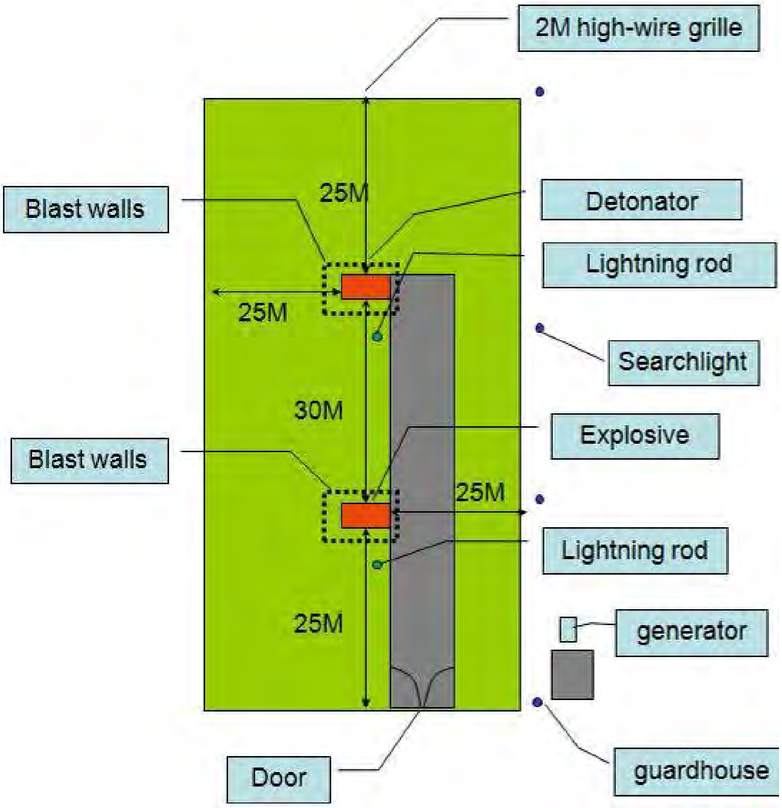
2.7.4.2 Storage of Explosives

Temporary storage of explosives will be located in Ayeyarwady Region, at a safe location determined by the Ministry of Defence. An example of storage site is shown in **Figure 2-10**, and an example layout of temporary explosive storage is shown in **Figure 2-11**. Storage site of the project may differ from these figures. The storage will be within 10 km of the field office. There will be no abode within the 1-km radius of the storage location. Site location criteria and other safety features include:

- No visual obstruction present.
- Permission from local police and has 24-hour security guard for three shifts, eight hours per shift.
- The storage site shall have a lightning rod, spot lights, electrical generator, fire extinguisher, mobile telephone, and security booth outside the fence.
- Wooden containers with ground wires and air flow system.
- Record of visitors who must exchange ID card or other governmental card at security guard point prior to entering the storage facility.

Source: IEM, 2014

Figure 2-10: Explosives Storage Example



Source: PCMI, 2014

Figure 2-11: Example Layout of Temporary Explosive Storage

2.7.5 Work Force

2.7.5.1 *Personnel Plan*

Seismic operations will be conducted by SEISMIC CONTRACTOR, based upon the 3D seismic contract executed between PCMI and SEISMIC CONTRACTOR. SEISMIC CONTRACTOR has extensive experience conducting 3D-seismic surveys internationally.

During seismic operations, up to 800 field staff shall be required, as shown in **Table 2-7**. Local staff will be preferentially hired for non-skilled jobs. Seismic survey staff from outside the local area will be accommodated at local hotels near the area of the survey. Approximately 100 vehicles in total shall be required for this project, which include pick-up trucks, four-wheel-drive vehicles, water trucks, fuel trucks, fuel storage trucks, ambulances, and explosives trucks.

Table 2-7: Estimated Work Force

Position	No. Positions	No. Weeks
Special Services	48-68	24
Topographic Surveying	100-120	16
Line Clearing	10-20	18
Drilling	150-250	15
Recording	200-300	22
Security and Police	30-40	
Other	2	
Total	**540-800**	

Source: PCMI, 2014

2.7.5.2 Transportation Plan

The contractor shall provide at least one basic ambulance and/or emergency services on standby 24 hours/day in the base camp. There will be a speed limit, as shown in **Table 2-9**, on all vehicles for transportation of employees and company representatives, and transportation of field equipment and machines in community areas. There will be a speed limit of 80 km/hour (unless otherwise posted) on highways, 60 km/hour on lateritic roads, 20 km/hour in villages or communities, and 80 km/hour on paved roads outside Yangon within the project site and on main roads. Details of the vehicles required are presented in **Table 2-8**.

Table 2-8: Vehicle Plan

Type of Vehicle	Purpose	Number of Units
4 WD pick up cars	Client/Key personal transportation	20
4WD station wagon	Senior/Key personal transportation	16
Trucks	Worker transportation support	38
Water truck	Logistics support	8
Fuel truck	Logistics support	4
Fuel storage facility	Logistics support	4
Ambulance *(at least one 4WD capable)*	SSHE support	2
Explosive truck	Explosive transportation	8
Total		**100**

Source: PCMI, 2014

Table 2-9: Speed Limits for PCMI Motor Vehicles

Vehicle Type	Highway (unless otherwise posted)	Normal Public Roads (Outside Yangon City)	Service Track, Laterite & Asphalt Roads	Villages & Community
Light Duty Vehicles	80 km/h	80 km/h	60 km/h	20 km/h
Heavy Duty Vehicles	80 km/h	80 km/h	60 km/h	20 km/h

Source: PCMI, 2014

2.7.6 Seismic Survey – Stages of Operation

2.7.6.1 Site Preparation

2.7.6.1.1 Access

Major roads as well as some unpaved access roads are shown in **Figure 2-12**. Most roads within the survey areas are raised laterite. If access through private land is required, the contractor will seek permission from land owners prior to proceeding in writing. Access for vehicles will be restricted to the shot lines to minimize impact on surrounding land.

2.7.6.1.2 Topographic Survey

The essential responsibility of the survey team is to ensure that the survey lines are levelled according to a topographic standard stated in the 3D seismic contract. The topographic surveying activity needs cooperation with the Permitting Team.

The size and scales of produced topographical line sketches (traces) will be such that all crew members can read and fully understand them. Information must include all hazards and omissions, access, offsets, compensate area, no-vehicles area, no-drilling area, etc. In terms of hazards, overhead or underground power lines and cables, rivers, streams, culverts, ditches, house, bridge, steep gradients, holes, fences, animals, half-fallen trees, insect nests, etc are to be considered.

In case of obstacles or sensitive areas within the safety distance, such as houses, buildings, electrical cables, canals, and archaeological areas, the survey team will deviate holes from their planned locations or reduce the amount of explosives according to safety distance standards of SEISMIC CONTRACTOR. These will be verified and approved by PCMI so that the vibration generated from the shots does not impact any obstacles or sensitive areas. The safety distances that will be used for this project are shown in **Table 2-10**. The safety distance may be further confirmed in the field with Peak Particle Velocity (PPV) tests (see **Chapter 6: Environmental Management Plan).**

Table 2-10: Required Setback Distances for Seismic Operations

Obstruction	**Required Safety Distance** **Explosive Sources** **Charge Size Per 20m Hole Depth** **Minimum Horizontal Distance (meter)**	
Charge Size per Shot Hole	**< = 2.0 kg**	**> 2.0 & = < 5.0kg**
Oil or Gas well	50	100
Metal and PVC piped water well	20	50
Concrete ring water well	100	100
Pipeline	60	100
Wooden House	50	100
Brick Cement or Concrete House	50	100
Monastery / School / Medical nursing place / Government offices	100	200
Cemetery	50	100
Concrete Bridge	50	100
Canals (Concrete)	50	100
Dams (Earth or Concrete)	100	150
Power Lines	50	50
High Voltage Power Lines (Large towers)	100	100
Telephone Lines	20	20
Main Roads/ High Ways	20	50
Railway Tracks	50	100
Dirt Roads/ Tracks	10	20
Water Resources	50	50
Ancient monuments / Archaeological site	500	1000
Any Other Obstruction (Including radio transmitters), notify Company representative	Do Not Place	Do Not Place

Remark: These safety distances are modified from 1) an international standard of the United States Bureau of Mines: USBM, 1971; 2) ESHIA Report for 3D onshore seismic acquisition of Block S1 in Phitsanulok, Thailand, March 2012, approved by Department of Mineral Fuels, Ministry of Energy Thailand; 3) Lands Division, Land Management Branch, Petroleum Land Use & Reclamation Section, Government of Alberta, Canada.

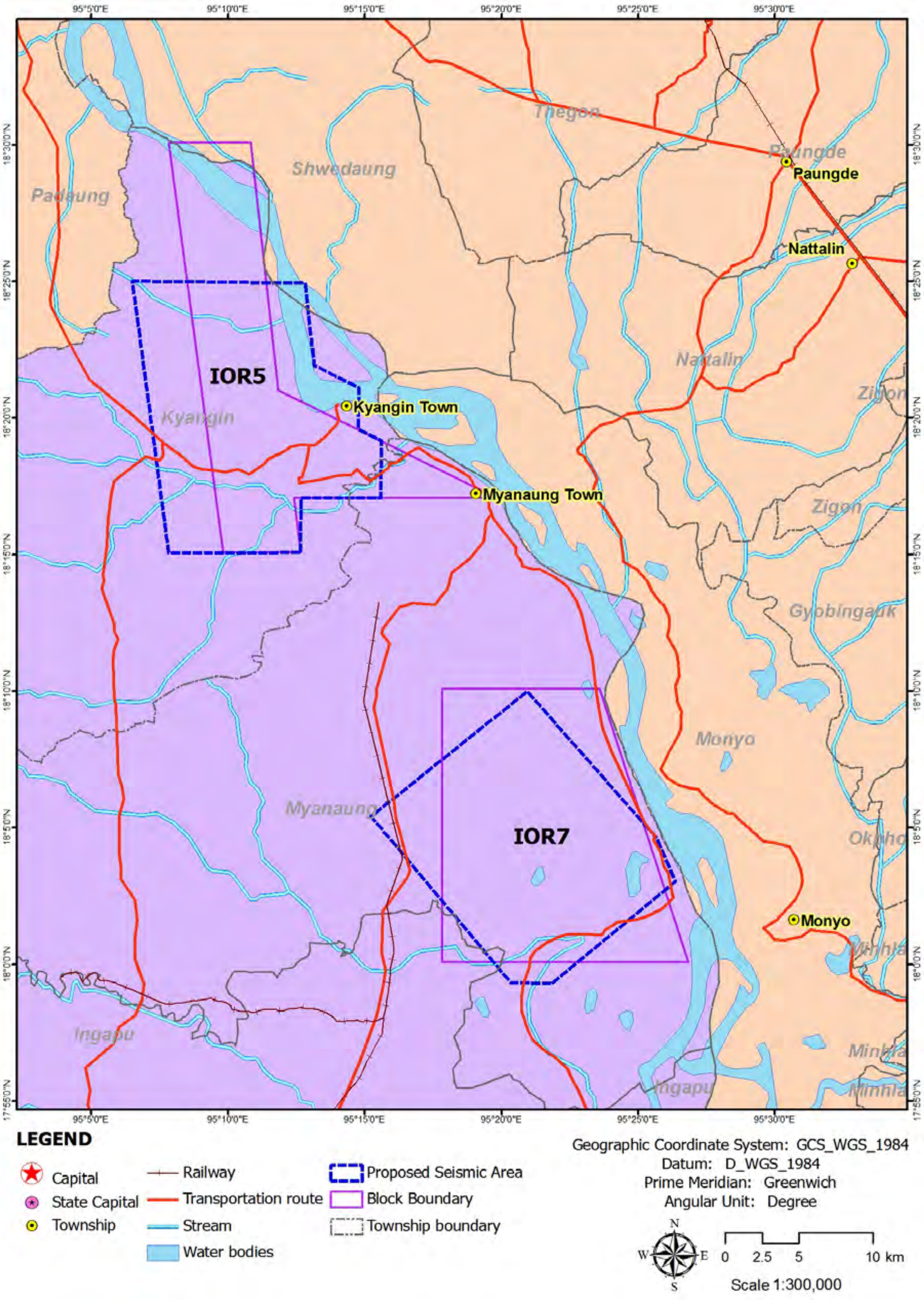


Figure 2-12: Transportation Routes within the Project Area

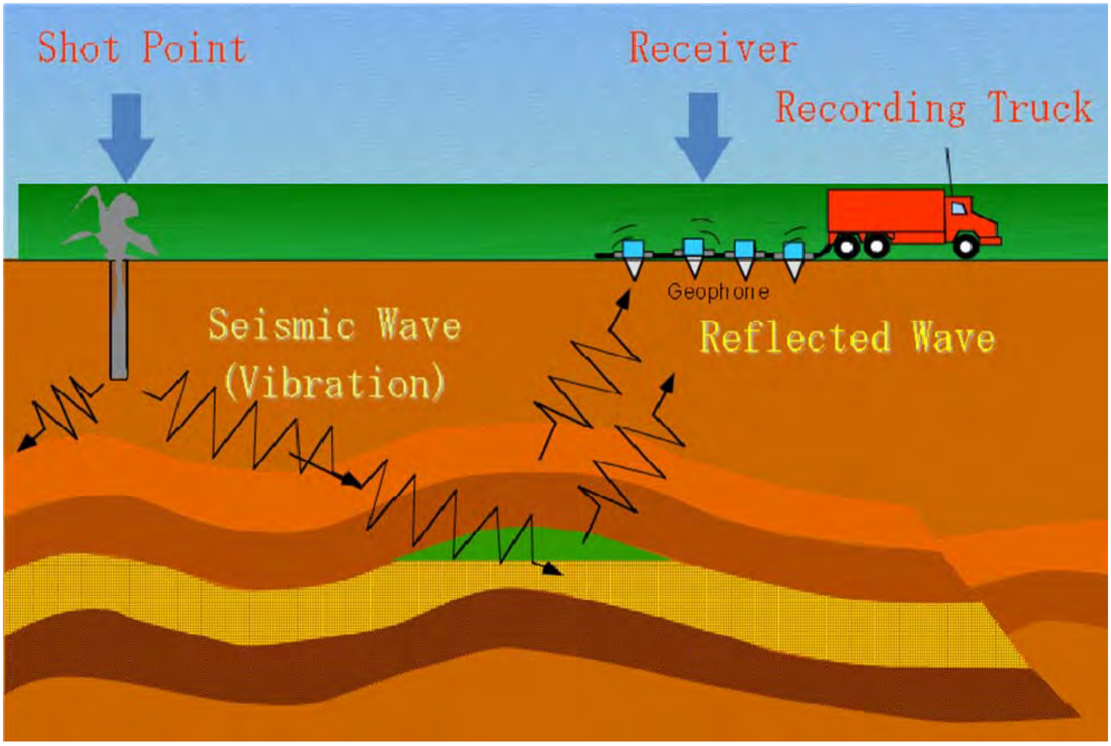
2.7.6.2 *Seismic Survey Procedures*

2.7.6.2.1 Seismic Survey Principles

The 3D-seismic survey will be done using a 2-4 kg/shot point explosives as an acoustic wave source. The principle of seismic survey is based on the different acoustic properties of rock profiles in absorbing and reflecting acoustic waves. The acoustic energy from an explosion will penetrate rock profiles. Part of this energy will be passed into the deeper layers of the profiles, while the remaining energy will be reflected back to sensors (geophone/hydrophone etc). The reflection time from different layers of the profiles, and amplitude of waves, will be recorded. The time taken for acoustic waves to reach rock profiles and reflect back implies the depth of the profiles. The speed of acoustic waves is proportional to the depth of rock profiles.

Information obtained by sensors will be recorded and interpreted using a computer. It provides underground profiles, which will imply types and characteristics of geological structures, as well as potential petroleum reservoirs. An overview of the seismic survey principles can be seen in **Figure 2-13**. Specifications for the seismic survey are shown in **Table 2-11**.

The working unit for this 3D-seismic survey will be divided into five units according to duties; Permitting Team, Survey Team, Drilling Team, Recording Team, and Site Restoration Team.



Source: PCMI, 2014

Figure 2-13: Survey Method using Explosives as a Wave Source

Table 2-11: Seismic Survey Specifications

Survey Name	PCMI Block IOR5
Line Name Convention	LINE XX
Layout Design Type	Split Spread
Receiver Type	8 km marsh geophone rammed or flushed below the surface where possible or solidly coupled to terrain.
Number Of Channel/Group	640 (320 each side for split spread)
Receiver Station Interval	25 m
Number Of Active Trace Per Cable	640
Minimum Offset	12.5 m
Maximum Offset	8000 m
Record Length	6 - 8 Sec @ 2 ms Sample rate.
Uphole Survey	30-40 Uphole
Source Interval	50 m
Source Types	Explosive
Explosives - Shooting Method	Single source centred between receivers
Explosives - Charge And Depth	2-4Kg @ 10 m-30 m (subject to the field test)

Source: PCMI, 2014

2.7.6.2.2 Vibration Sources

Land seismic data acquisition will use explosives due to the on geophysical objectives, cost, and environmental constraints (terrain) in the project area.

The 3D-seismic survey for this Project will be done using a 2-4 kg/shot point explosives which acts as an acoustic wave source.

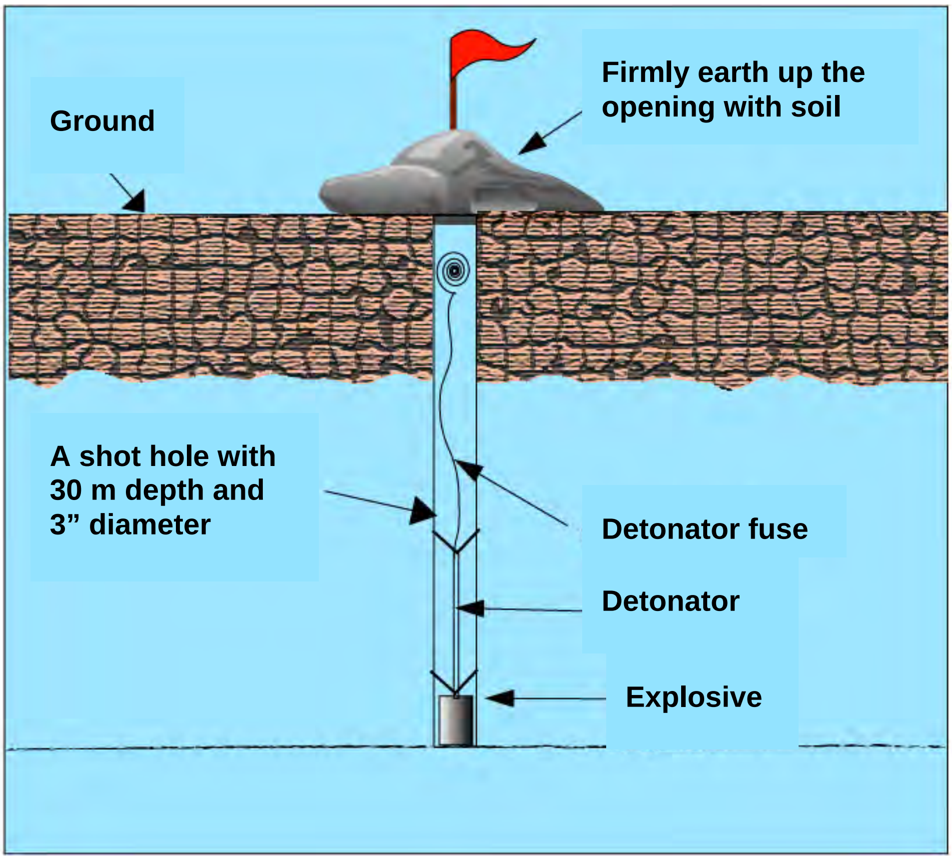
2.7.6.2.3 Explosive Shots

Explosive sources, usually dynamite, are placed in shot holes drilled to below the zone of near-surface weathering or unconsolidated sediments – usually from one meter to thirty meters thick. Burying the source beneath this low-velocity layer increases the energy transmitted deeper into the ground and reduces the amount of energy that goes into creating undesirable by-products. Advantages include its light weight, low cost, lack of required maintenance and capacity for deployment in rugged terrain unreachable by vehicles. However, the process of drilling shot holes, burying the dynamite and cleaning up after the operation is labour intensive, and with this option the survey geometry cannot be changed without drilling new shot holes. Additionally, explosive sources are subject to strict security regulations, and permission for use and transportation may be difficult to obtain in some places (Bagaini et al, 2010).

2.7.6.2.4 Drilling of Shot Holes

Once the Survey Team has finished surveying and coordinating, the Drilling Team will proceed to drill according to the chosen positions and magnitude. Shot points will be 50 m apart and will be drilled to a 10-30 m depth. The physical characters of plotted holes are marked by coloured flags.

The hole dimension is to be a maximum of 30 m deep with a diameter of 3 inches or 7.62 cm. Explosives used will be up to 2-4 kg for each shot point, and will be buried**.** Shot points are offset to simulate a 12x480 channel live shot record. **Figure 2-15** illustrates shot hole drilling.



Source: PCMI, 2014

Figure 2-14: One Hole/Single Hole Pattern

Source: IEM, 2014

Figure 2-15: Examples of Shot Hole Drilling

2.7.6.2.5 Receiver/Geophone Line

The receiver/geophone line will be perpendicular with shot holes lines. Receiving points for each receiver/geophone line will be located at about 25 m apart. A geophone group consists of one/two strings of cable with six/twelve geophones each. The cable acts as a receiver of signals to be relayed to the receiving point. PCMI will ensure that, to the extent possible, trees will not be cut down during the survey. In the case where cutting trees cannot be avoided, permission and approval of such actions will be obtained from relevant authorities and stakeholders. Receiver deployment is shown in **Figure 2-16**.

Source: IEM, 2014

Figure 2-16: Examples of Receiver Deployment

2.7.6.2.6 Explosives, Detonators

The explosives and detonators used in the survey are expected to be ZY60-1-GI explosives and K8TO-2 No.8.0 detonators. Details of the explosives and detonators are presented below.

Explosives: ZY60-1-GI

ZY60-1-GI is an ammonium nitrate emulsion-type explosive (Class 1.1D, UN0081). It consists mainly of ammonium nitrate, which is the same substance used for fertilizer. Explosive powder is grey, odourless, and not a self-ignited substance. Explosives will be packed in a form of Water-in-Oil Emulsion Explosive, wrapped by plastic sheet and contained in a shockproof paper box. There will be approximately 25,000 shot holes in total for this survey. The explosives sub-contractor, responsible for importing and handling the explosives, detonators and ancillary equipments related with the 3D-seismic survey, shall obtain permission from the Ministry of Interior to import explosives weighing 55,000 kg (27,500 pieces). Extra explosives are required in the case of miss-shots, so an additional 10% are imported.

Detonator: K8TO-2 No. 8.0

The total detonator weight to be loaded will be about 260 kg. Electrical wire of 30 m long will be connected to the detonator. The amount of detonators is equal to the seismic source sets. There will also be spare detonators in case of miss-shot, which will total about 26 kg (or 10% of total shots).

2.7.6.2.7 Loading of Shot Holes

The explosives, which are up to 2-4 kg /unit, are packed in a plastic shell with detonator and anchor. Shot holes will be prepared by a pre-loading method, where explosives will be placed at the time of drilling. After each shot hole is loaded, it will be buried by dug-up soil and marked by a flag. Shooting for recording information will occur at a later stage. This method will be used with a single hole with a maximum depth of 30 m.

In loading the shot holes, staff must strictly follow safety regulations as follows:

- Explosives and detonators must be at least 50-m apart and will be combined when the operation loading takes place at the shot holes only.
- Once explosives, detonators, and anchors are loaded, the hole must be filled and compressed with soil or sand. Detonator wire must be connected in a short circuit and hidden in the hole at the depth of at least one foot to prevent stealing or pulling out by people.
- Once loading is completed, the hole must be buried with dug-up soil and marked by a red flag.
- At this stage, the Permitting Team will check the prepared documents. If documents are missing, additional documents will be drafted. All documents will be sent to the office to record cost of value as well as name and address of people that will be awarded compensation.

2.7.6.2.8 Source Generation and Recording

Recording of seismic vibrations from the explosive source will be done approximately 1 week after shot-hole drilling. Once the cables and geophones have been laid out along the lines, the explosives will be used to send vibrations as waves into the ground which are reflected off the different layers and recorded by geophones and transmitted to the data recording truck.

For explosives, if recording fails, e.g., in the case where dust disperses up to the hole surface, a new recording must be done. In the case of a miss-shot explosive, which normally occurs at less than 1% of the total sites, explosives will not be retrieved but the detonator will be cut off to deactivate the miss-shot explosive. Monitoring procedure of explosives and detonators are shown in **Figure 2-17** for pattern holes.

On-field equipment includes cables and geophones, which are connected to a field recorder. An example of a recorder truck is shown in **Figure 2-18**, and examples of field equipment are shown in **Figure 2-19**.

Recording equipment will be placed according to the plotted spots along the seismic lines. Shooting impulses will be done once per spot along the seismic line, then, packing up the equipment and recording will be undertaken. Recording parameters for this survey are shown in **Table 2-12**.

According to SEISMIC CONTRACTOR safety regulations, shooting will be operated by a Shooting Team of five staff; one shooting controller and four signal senders using flags on four directions. On shooting, the shooting controller will blow a whistle to warn other staff to stay in the safety zone. The controller will blow a whistle again on finishing shooting. Shooting will be activated by radio wave from field recorder; no staff will be present in the area.

The reflected wave from shooting will be detected by a receiver, which will relay the wave through repeater circuit and land cable before entering a recording. The obtained information will be interpreted using a computer by a geophysicist. An example of interpreted data is shown in **Figure 2-20**.

At this stage, the line recovery crew and Permitting Team will join in to:

- Fill the shooting hole and/or reclaim the line site
- Announce the date, time, and location of survey, together with information on compensation, to community headman and landowner according to compensation agreement.

Table 2-12: Recording Parameters

Sample Interval	2 ms
Low Cut Filter	Out
High Cut Filer	Fnyquist (FIR)
Record Length	6-8 sec
Tape Format **DVD**	Origigal 3590 Two (2) copies
Data Format	SEG-D

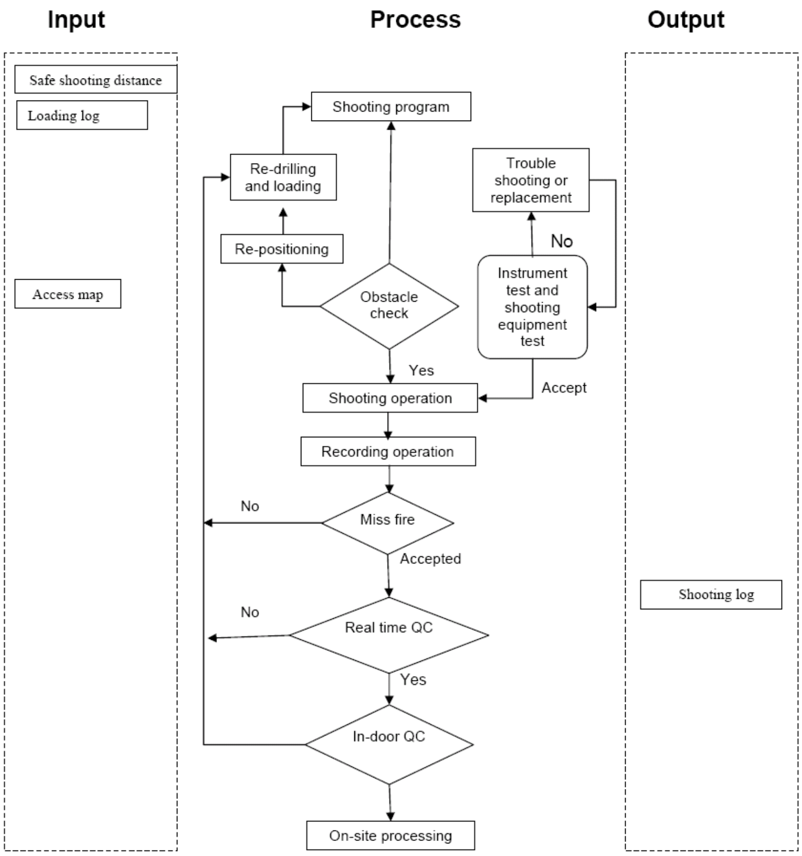


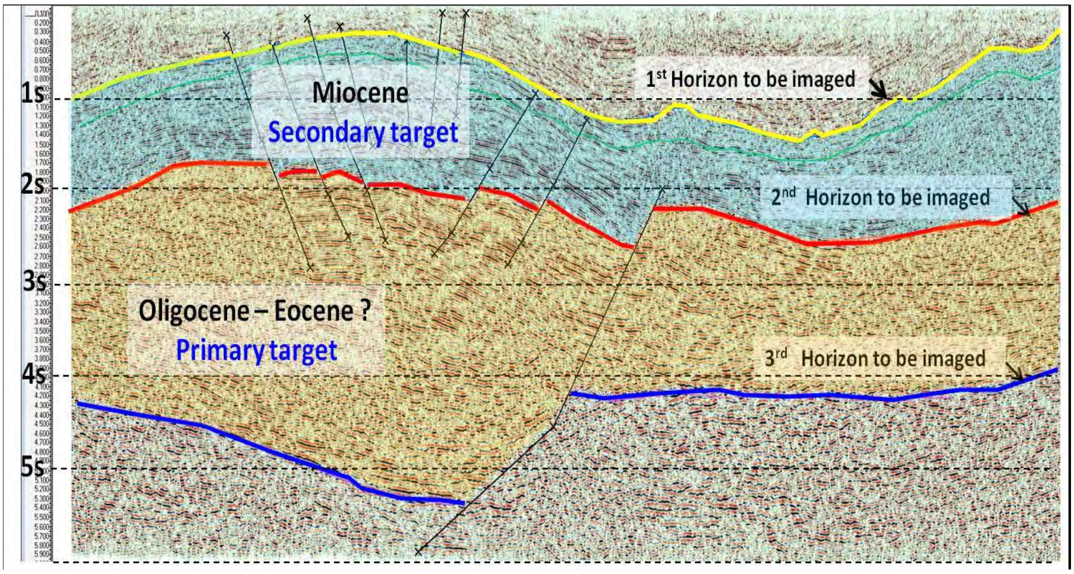
Figure 2-17: Monitoring of Explosives and Detonators for Pattern Holes

Source: http://www.Vibroseismic.com/images/images%20GT/5.seismic%20surveys/grande/SN388_RECORDER_Truck_01.jpg

Figure 2-18: Example of a Recorder Truck

Source: http://www.Vibroseismic.com/page4_GT.html

Figure 2-19: Examples of Field Equipment and Cable Wires



Source: PCMI, 2014

Figure 2-20: Example of Interpreted Information of Petroleum Reservoir Structure

2.7.6.2.9 Transportation of Equipment, Materials, and Personnel

Equipment, materials and personnel will be transported in light four-wheel drive and pick-up trucks. If vehicular access is not possible, equipment and materials will be transported by foot. Approximately 100 vehicles will be used for the seismic program.

Transportation for each working team will be as follow:

- Line Survey Team: personnel transportation will be equipped with safety equipment such as safety belt for every seat.
- Drilling Team: personnel transportation will be equipped with safety equipment such as safety belt for every seat.
- Shooting/Recording Team: personnel transportation will be equipped with safety equipment such as safety belt for every seat.
- Other Team: personnel transportation will be equipped with safety equipment such as safety belt for every seat.

2.7.6.2.10 Demobilization and Site Restoration

Once the survey and recording are finished, equipment will be removed and personnel will leave the site. The site will also be restored into its original state by burying all holes as well as collecting all wastes and materials out of the site. It is expected to take approximately one month to complete the site restoration including recording public complaints, if any.

The 3D-seismic survey activities and the management will be controlled by the project quality plan (land acquisition) and project SSHE plan. All staff must follow such standards in carrying out all activities throughout the project period. This is to ensure that the survey meets its objectives and the survey quality meets the project owner’s demand, which also take into consideration issues of health, safety, and environment of staff and community.

2.7.6.2.11 Summary of Coordination Procedures

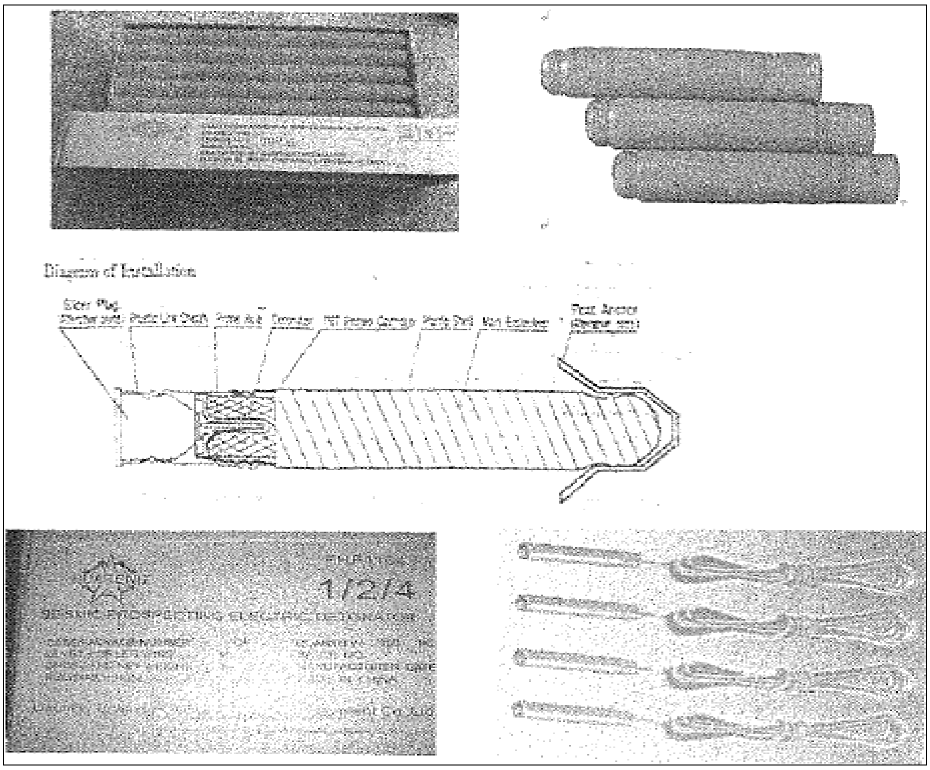
People in the areas that seismic lines will pass through will be informed by the working team on every step as shown in **Table 2-13** and described in more detail in the following sections.

Table 2-13: Survey Stages

Stakeholder	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
SEISMIC CONTRACTOR	Announcement 2 weeks before operation	Line survey, assess damages, estimate compensation, deal with compensation documents	Drill, check documents, pay for compensation	Shooting, recording, pay for compensation	Site restoration
Land owners	Receive project information	Receive documents on compensation, be informed about date of drilling	Be informed about date and time of shooting and recording	Receive compensation after operation	Check the site

2.7.6.3 Transport and Storage of Explosives

Explosives and detonators used for this project are imported from overseas. Both explosives and detonators will be transported over land. Examples of the explosives and detonators are shown in **Figure 2-21**.



Source: IEM, 2014

Figure 2-21: Seismic Explosives

The import of explosives and detonators requires appropriate documents and permission. The import, possessing, utilizing, and transporting licenses are to be provided by SEISMIC CONTRACTOR upon award of Seismic Contract. The number and quantity of explosives and detonators will be recorded by government officials upon entry to the country.

After official processes are completed, the explosives and detonators are transferred to be kept separately in the Storage Magazines (separate container) in Ayeyarwady Region (**Figure 2-22**). Their main storage magazines locations are to be determined. These storage magazines are the main storage facilities, with sub-storages to separate explosives and detonators. Military regulation provides strict security for these explosives. Temporary magazines will be located in Ayeyarwady Region. Explosives and detonators will be kept separately and guarded strictly according to military regulations.

Explosive transportation in the survey area will be carried out by explosive-transportation registered vehicles, which are required to install safety equipments, such as siren, handheld fire extinguisher and speed limit to 50 km/hour.

Explosives and detonators products will be transported separately in fully-enclosed, locked, fire-resistant fixed containers or compartments, separate from the passenger compartment. Passengers will not be permitted during explosives transport. Vehicles transporting explosives will operate in a safe manner consistent with prevailing road and weather conditions. In no case will a vehicle transporting explosives be operated at a speed in excess of 50 km/hour. Vehicles transporting explosives will not be operated at greater than 80% of the manufacturer’s rated carrying capacity. Photographs of explosives transportation and storage can be seen in **Figure 2-23**. Police cars escort will be the first and the last car of the explosive transportation convoy.

Withdrawal of explosives from the main magazines will be report to be used exactly as expected to be used. District officers and military officers will check the amount and correctness of explosives withdrawal. They will sign documents as evidence for each withdrawal. They will also sign inventory documents to confirm the total amount used and the remaining for the inventory report. Everyday a contractor convoy will bring the explosives from the field storage to the line. The collection of the remaining explosives will start at 3 pm to ensure that vehicles transporting explosives return before dark. At the work site, explosives and detonators will be contained in secured day-boxes until used or returned to storage magazines.

PCMI will employ SEISMIC CONTRACTOR for the explosive management and to purchase, import, transport and secure explosives.

Source: IEM, 2014

Figure 2-22: Example of Main Magazine

Source: IEM, 2014

Figure 2-23: Examples of Explosive Transport and Storage

2.7.6.4 Abandonment and Site Restoration

All equipment will be collected and removed from the site, and shot holes buried, which normally occurs as the earth collapse into the holes after shooting. Any remaining open drill holes will be backfilled. Wastes, obstacles, or any pollutant from the survey activities will be removed.

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2.7.7 Seismic Waste Management

2.7.7.1 General Waste Disposal Procedures

In accordance with the 3D seismic survey agreement, SEISMIC CONTRACTOR will dispose of waste according to the following procedures:

- Waste shall be well segregated at least into Hazardous waste, Non Hazardous waste and Recycled Waste. Hazardous Waste shall be disposed as per regulatory requirements.
- All waste disposals must comply with the local environmental requirements. All litter will be picked up along the seismic line. Litter will be disposed of properly in designated areas. No open burning will be allowed.
- The field office will be established in a hotel; therefore, wastewater management will be included in the hotel service.
- Waste from seismic field operations will be taken back by staff and send to rubbish bins in the camp. Domestic waste generation is estimated at 1 kg/day/worker.
- SEISMIC CONTRACTOR will correctly manage its own waste generated day to day (will consult with local municipality or local districts).
- Other forms of camp (i.e.: tires, waste oil, batteries, scrap metal, non-reparable equipment, explosive package box) will be logged on a disposal register and disposed by sell/back to suitable place/at an approved facility through Local government, Environmental department or qualified contractor or organization.
- Medical waste disposal needs special caution and will abide by local government rules and crew medical staff instructions.

Waste will be disposed by the following methods, according to its type:

- Wood, paper, plastic etc.: send to qualified contractor/organization/local government for disposal at site approved by the Local Authority.
- Food: send to qualified contractor/organization/local government for disposal at site approved by the Local Authority.
- Waste Oil: send to qualified contractor/organization/ local government for proper disposal other approved method.
- Metal Waste: send to qualified contractor/organization/ local government for proper disposal other approved method.
- Cells, batteries, pressure paint, explosive detonator etc: send to qualified contractor/organization/local government for disposal other approved method.
- Medical waste: send to qualified hospital/organization/local government for proper disposal other approved method.

2.7.7.2 Solid Waste

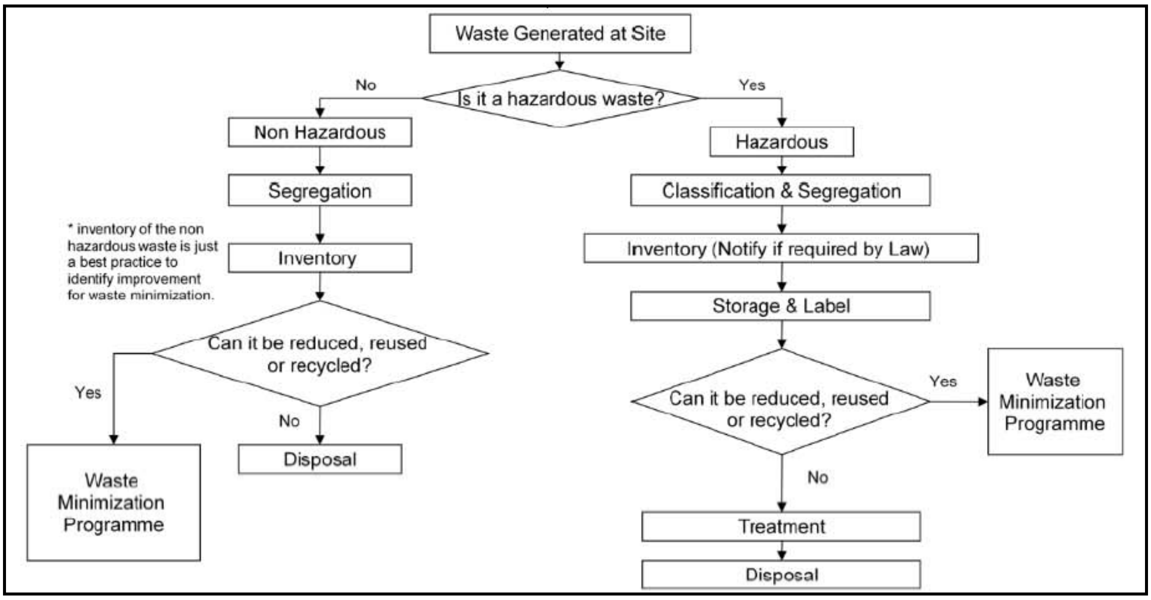
All rubbish will be stored in the survey vehicles for proper disposal. Domestic waste generation, estimated at 1 kg/day/worker, is expected to total 1000 kg/day or about 100 tonnes over the course of the seismic survey (assuming 5 months). Domestic solid waste will be disposed of daily by SEISMIC CONTRACTOR, using local municipal services. Any appropriate waste management fees will be paid. No waste will be left in the field. Moreover, there will be cleaners at the site to move equipment out of the site on a daily basis.

Any medical waste generated in a secondary camp will be brought to base camp a minimum of once a fortnight for correct disposal.

Cleaning and restoration of the camp will be carried out during and immediately after each phase of the survey and will be the responsibility of each team in their respective area of operation. A clean-up crew (usually called “Green Team”) will ensure that the site is properly and adequately restored after the survey operation is completed. The following measures will be taken in this regard:

- All restoration work will be conducted as per contract requirements.
- All survey markers and refuse will be removed.
- Erosion control measures will be taken where needed.
- Camp site will be cleaned so that no refuse or wastes are left behind; the waste will be properly disposed of at approved site.
- All ditches and sumps will be backfilled; an extra cap may be added at the top to account for compaction.
- Contaminated soil will be removed and properly disposed of at site approved by the Local Authority.
- Photographs will be taken before and after the restoration measures at the camp site and seismic lines.
- Following restoration, sites will be inspected to ensure the recommended measures have been strictly adhered to.

Waste disposal procedure is shown in **Figure 2-24.**



Source: PCMI, 2014

Figure 2-24: Waste Disposal Procedure

2.7.7.3 *Wastewater from Field Office*

The field offices will be located in Myanaung Township, Hinthada District, Ayeyarwady Region, which will use water utility system from the local municipality. The SEISMIC CONTRACTOR will be responsible to ensure all sewage will be send to the approved Sewage Treatment Plant (STP) in the area or any other site approved by the Local Authority.

2.7.7.4 *Air Emissions*

Air emissions will include combustion products from fuel use and dust generated during seismic shots and from vehicular traffic on un-surfaced roads. The air emissions generated from 3D-seismic survey activities include the combustion of approximately 61,029 litres/day of diesel, which will be required to operate 100 vehicles as shown in **Table 2-8** (53,212 litres/day), generators as specified in **Table 2-14** (2,232 litres/day), 50 flushing drillers (1,000 litres/day). This means that a total of approximately 9764.64 m^3 of diesel will be required throughout the project period (8 months, which includes 160 working days). Following the Tier 1 approach of IPCC (2006) for combined stationary and mobile combustion, the equivalent amount of CO_2 produced from this project will be about 26,834 tonnes CO_2.

2.7.7.5 *Noise*

Noise will be generated from project vehicles, generators, compressors and explosives used as the seismic source. Noise levels produced from survey trucks are estimated to be 55 dB (A) at 1 m from the source. Generator and compressor noise is estimated at 65 dB (A) at 1 m from the source.

Explosives used for seismic shots will be in small amounts and buried for use. Resulting noise will be brief and at low levels; seismic shots will only be conducted during daylight hours. In general, noise from the explosive shots will be 15~20 dB at 50 m from the hole.

2.7.8 Utilities

2.7.8.1 Water Use

2.7.8.1.1 Domestic and Potable Water

All domestic water will be trucked to the survey area on a daily basis by a local contractor who will obtain the supplies on a commercial basis from local municipal facilities. Water supply requirements are estimated to be approximately 80 m^3/day for the maximum workers of 800 workers on the project (100 L/person/day).

Domestic water is used for personal washing and cleaning needs of the staff on site.

All drinking (potable) water will be sourced from local retail suppliers. The demand from the operation will have a beneficial impact on the local sales of bottled drinking water.

2.7.8.2 Power Supply

During seismic operations, electricity will be supplied from gasoline and/or diesel-fuelled generators. A list of all generators required for the project is shown in **Table 2-14**. In total, generators for the project are expected to consume about 2,232 L of fuel per day.

Table 2-14: Generators to be used for the Project

Generator (Gasoline)	Estimated Full-Load Fuel Consumption (L/unit/hour)	QTY	Fuel Use (L/day)
Yamaha 1KW	1 L/hr[1]	40	960
Yamaha 5KW	3 L/hr[1]	8	576
Honda 20KW	6 L/hr[2,3]	3	432
Honda 30KW	11 L/hr[2,3]	1	264
Total			**2,232**

Source:
1 - http://powerequipment.honda.com
2 - http://www.dieselserviceandsupply.com
3 - http://www.perfectfuel.ca

2.8 Exploration Drilling

2.8.1 Project Location

2.8.1.1 Drill Site Location

The proposed exploration wells locations will be located in Block IOR-5. The well locations have not been determined. PCMI will update MOGE/Authority once the well coordinates have been identified.

2.8.2 Overview and Layouts of the project

2.8.2.1 Layout and Facilities in Well Site Area

2.8.2.2 Drilling Rig

PCMI intends to use a land drilling rig for this drilling campaign. An example of a land rig is shown in **Figure 2-25**. The rig's Drawworks has a power rating of 1,800 – 2,000HP. The rig is powered by four diesel driven generator sets and each rated 600 KVA to supply the rig site with power.

Source: PCMI 2014

Figure 2-25: Onshore Rig Example

2.8.2.2.1.1 Cellar and Rig Pad

Within the well pad, a hole will be dug and lined with steel to form the inline cellar 2.43 m x 2.43 m x 2.43 deep. This forms the rig "cellar", into which is fitted a short length of 30 inch steel pipe, extending 6 to 12 metres into the ground; this is the "conductor pipe" that acts as a guide to the drill bit and drill string while drilling the uppermost portion of the well. The cellar also houses the well-head and the blow out preventers.

A reinforced concrete rig pad, measuring approximately 20 m by 20 m will be constructed around the cellar. This acts as the foundation upon which the drilling rig, mud tanks, shakers, generators and fuel tanks sit on.

2.8.2.2.1.1 Cuttings & Dirty Water (Waste) Pit

For the IOR-5 drilling campaign – a combined waste / cutting and dirty water pit (waste pit) will be installed at the well site. All the cuttings/waste and dirty water from drilling activities will be channelled to this waste pit. This pit will measure approximately 40 m by 30 m by 4 m deep with a volume of 4800 m^3. The pit will be lined with a high density polyethylene (HDPE) plastic liner to form an impermeable barrier. The contaminated runoff water from well site will drain to the waste pit. All hazardous waste collected within the waste pit will be transported and disposed to approved government sites according to BMP's and as per PETRONAS Standard.

The estimated typical amount of runoff during a rain storm varies according to the month of the year from wet season to dry season. Runoff from the rig pad enters the waste pit. The pit is sufficient in size to contain any runoff from storms. It is not expected that discharge of water will be required unless there is unusually prolonged storm activity during the rainy season. If the pit becomes full from closely spaced heavy rain storms, water can be released at the down-slope side of the site from the water pit to the perimeter drain, first passing through a series of specially constructed oil traps. Assuming a rainfall intensity of the wettest month's equivalent rainfall (129 mm/hr) for a ½-hr duration storm, the runoff from the well site combined with rain falling on the waste pit totals 391.2 m^3. The waste pit has an actual holding capacity of 4,800 m^3. The pit can therefore contain much more rainfall than the rainfall intensity of a ½-hr duration storm with a return period of 50 years.

2.8.2.2.1.2 Well Site Drainage System

The drilling pad area is made of concrete, which prevents leakage of contaminated water to the surrounding area. Machines within the drilling pad area that could potentially release contaminated water include skip tank, dirty water & cuttings pit, cement mixer, drilling rig. Runoff within the drilling area will be drained via drainage track into the dirty water /cuttings pit, which will accumulate all of the runoff and contaminated water generated within the drilling area. Therefore, contaminated water from this area will go through a large oil trap and end up in the pit and won't escape to contaminate surrounding areas. The contaminated water, cuttings and mud will be properly disposed to approve government sites and at the cement kiln.

The volume of runoff from the well site is calculated from the volume of the heaviest rainfall within 30 minutes with a month's equivalent rainfall in one hour (129 mm/hr) as 391.2 m^3. The volume of the waste pit (4,800 m^3) is much more than the volume of the extremely heavy runoff. Therefore, the waste pit has the capacity to retain all the runoff within the drilling area even under heavy rainfall. The level of water in the waste pit will be monitored regularly. If water level in the waste pit is high, it will be pumped into another container (such as a tanker truck) to make sure that the water will not overflow from the pit.

2.8.2.2.1.3 Chemical and Equipment Storage Areas

Mud chemicals are stored on a concrete base with 20 m by 30 m area with tarpaulin covers or roof to protect mud chemicals from rain. Hazardous chemicals are segregated from the main chemicals and kept in appropriate containers.

Other storage areas such as parts, equipment and repair shops will be contained in converted portable 40 foot containers. These containers will sit on concrete blocks. Workshop (if to be sited in seismic block) for vehicles maintenance needs to be fitted with oil trap/separator.

2.8.2.2.1.4 Fuel Storage Area

The fuel tanks – one at the rig and another one near the camp (approximate 110 m^3 & 25m^3 capacity) will be set on the higher ground and will be completely surrounded with a bund to contain any spillage. The bund will be designed 110% of the total volume of the fuel tanks.

2.8.2.2.1.5 Flare Stack

The flare stack will be horizontal burner directed to an earth bermed flare pit to ensure the safety of workers at the well site. The nearest community will be located over 500 m away (for all the proposed well sites); thus, impact from light and sound from the flare stack should be minimal (detailed description in **Chapter 5 Impact Assessment**).

Once the well sites have been prepared and the exact positions of the outermost points of the drilling rig and flare stack have been established, the MOGE will be duly informed. Should MOGE require that the safety zone extends outside the limits of the security fencing around the well sites; the safety zone will be delineated and marked as required.

2.8.2.2.2 Accommodation Work Camp Layout

There is no suitable existing accommodation, such as hotels or guest houses, within a reasonable distance of the proposed well sites, so a temporary camp site will be established adjacent to the well sites.

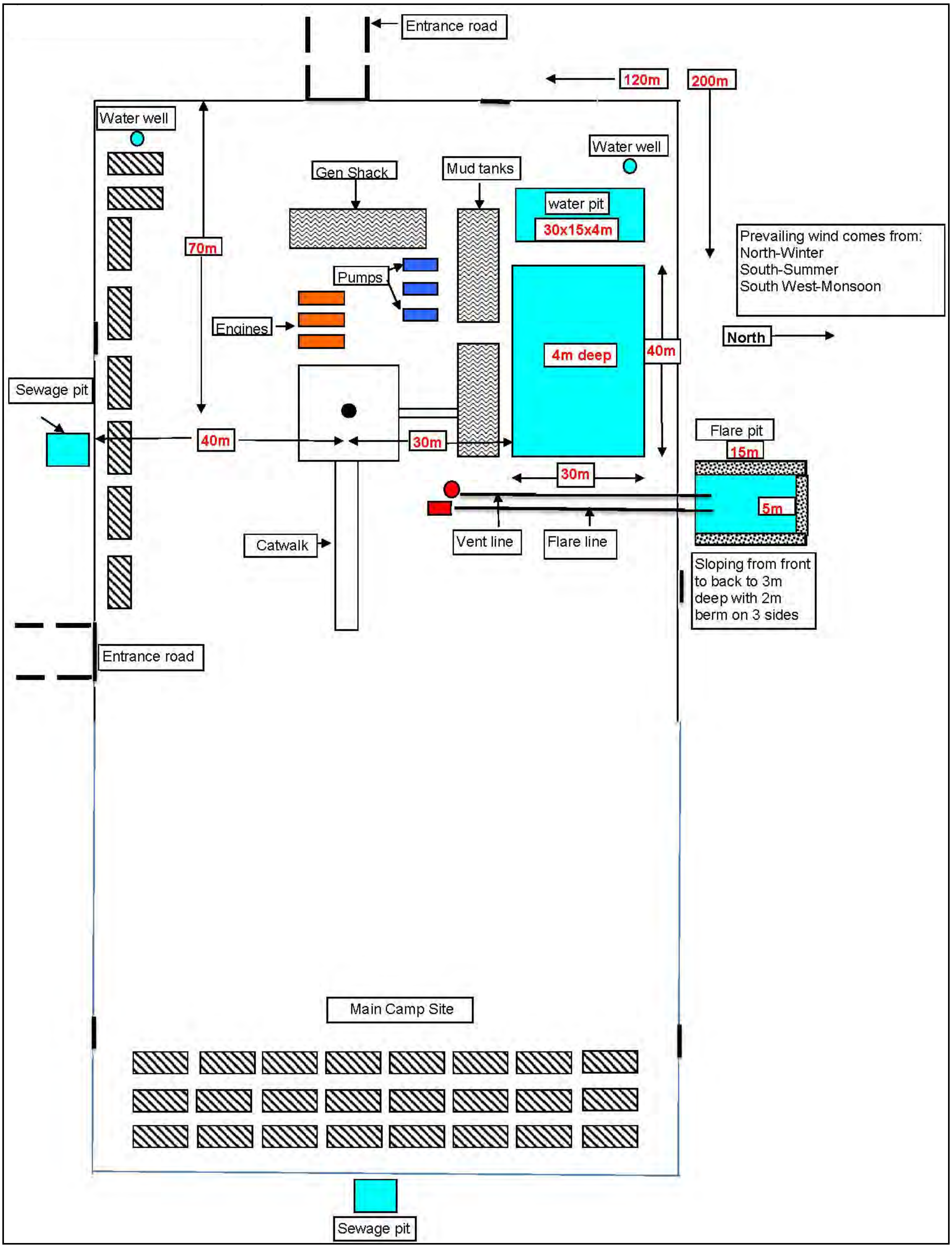
The camp site will be industry-standard, consisting of container-based sleeping and living quarters, messing and recreation facilities, with a capacity to accommodate up to 130 personnel. It will have its own cooking, freezer food storage, laundry and sanitation facilities as well as its own power generation by diesel powered generators.

2.8.2.2.2.1 Drainage Control within Camp Site

Any rainwater runoff from the work camp pad will be diverted to an oil trap before discharging offsite. There are no potentially harmful chemicals stored at the camp site that could drain offsite. The fuel tank for the camp generator will be placed on an impermeable membrane and bunded to contain potential fuel leaks.

2.8.2.2.2.2 Camp Site Sewage System

A set of septic tanks will be built into the work camp pad at the outer edges. They will have a combined capacity of 8000 litres (8 m^3). The minicamp and main camp will have septic tank and system installed. The Septic system will be a below ground “leach” drain type system. Sewage treatment and disposal will be covered under the general services contract with the drilling rig contractor.



Source: PCMI, 2014

Figure 2-26: Conceptual Drilling Well Site Layouts

Chemical storage area

Perimeter drain with weir and oil trap

Concrete rig pad with segregated drainage channel

Campsite in background (generators on rig concrete pad in foreground)

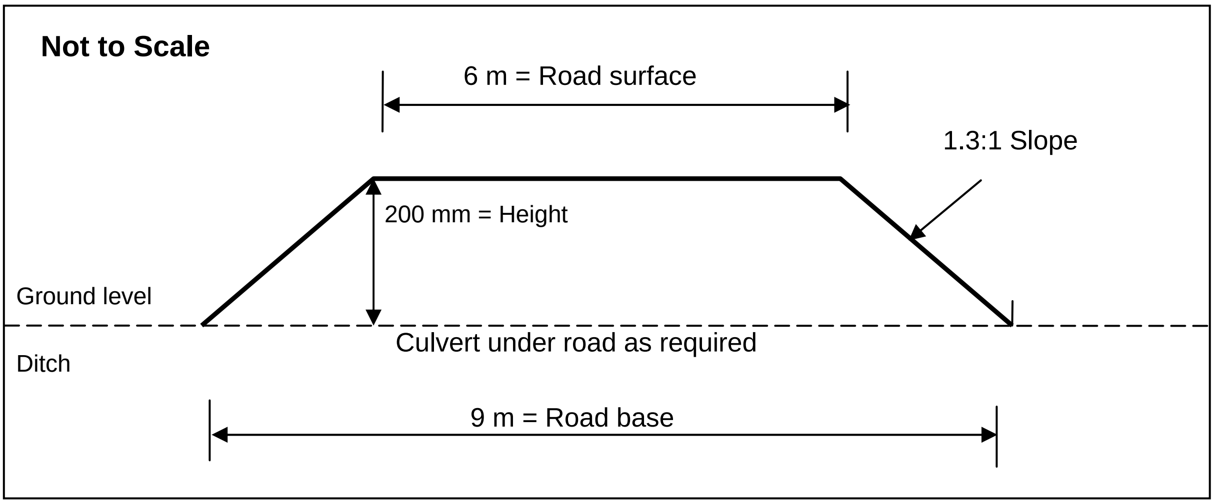
Source: Pictures provided by IEM, 2014

Figure 2-27: Photos of a Typical Exploration Drilling Well Site and Facilities

2.8.2.3 Access Roads

PCMI will use existing local roads for transportation as much as possible to each well site. However, due to the well sites being located in an agricultural area, PCMI will need to construct new access roads to connect the well sites to the existing main roads for transportation of drilling rig and drilling equipment. The access roads will be designed as dual lane, un-surfaced roads, constructed of compacted granular material. The roads will be 6 m with side slopes of 1.5 m for total width of 9 m, constructed with 200 mm of compacted granular material as shown in **Figure 2-28**. It is estimated that a maximum of 10 km of road will be required for each well location.

PCMI will obtain permission from the relevant local authorities and purchase the land from land owners prior to construction of the access roads.



Source: PCMI, 2014

Figure 2-28: Longitudinal-Section of Proposed Access Road

2.8.3 Stages of Operation

Major activities of project consist of Construction Operations, Drilling Operations, Well Testing Operations and Well Completion, Suspension, Abandonment or Contingency Well. The activity chart of the project is shown in **Figure 2-29.**

1. **Construction Phase**

   Details are preparation and construction of the drilling area, access road construction, rig and equipment installation and elements of the drill area.

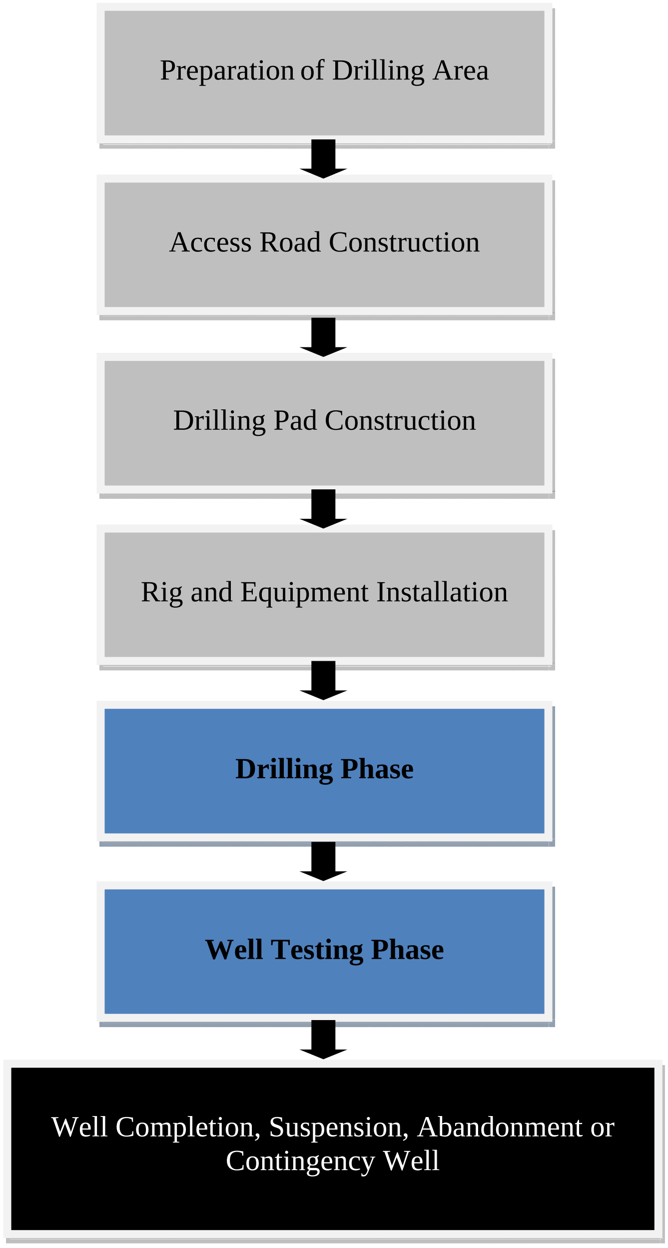
2. **Drilling Phase**

   Details are hole and casing design, drilling exploration methodology, types and components of drilling mud, drilling mud volume, volume of cutting from drilling and wire line logging.

3. **Well Testing Phase**

   Details are well testing equipment installation, well testing operation, waste management from well testing operation.

4. **Well Completion, Suspension, Abandonment or Contingency Well**



Note

⬜	Construction Phase	🟦	Drilling Phase
🟦	Well Testing Phase	⬛	Well Completion, Suspension, Abandonment or Contingency Well

Figure 2-29: Activity chart of project

2.8.3.1 *Construction Phase*

2.8.3.1.1 Well Pad and Work Camp Pad Construction and Access Road

Each well site will have a similar construction plan. The well site and adjacent accommodation camp site will be levelled and elevated by cut and fill methods and compacted using bulldozers, dump trucks, water trucks and graders. The compacted pad will be approximately 200 mm thick.

The entire well pad and work camp pad will be surrounded by a barbed wire fence to keep animals and unauthorized persons from entering the site. Security guards will also be employed and stay on site 24 hours per day, 7 days per week throughout rig mobilization, set up, drilling, optional testing operations and until the site is abandoned.

Dimensions of the well site and accommodation camp site to be constructed are summarised in **Table 2-15**.

Table 2-15: Dimensions of Well Pad, Work Camp Pad

Item	Dimensions	Area	Estimated Fill
Each Well Site			
Drilling and Work Camp pad	120 m x 200 m x (200 mm thick)	24,000 m^2	4,800 m^3 (1)

(1) Estimate based on an average of 200 m thick

All of the materials to be used for constructing the well pad and facilities are to be provided by the civil engineering contractor. This contract will be issued to a local construction company as per PCMI's policy of ensuring that the economic benefits of the project are concentrated within the Province. The civil engineering contractor will obtain fill materials from local extraction sites operating under permit from the relevant local authorities.

It will be the responsibility of the civil engineering contractor to source the fill materials and the materials must also be of a high quality grade for use as un-surfaced road building material and acceptable to PCMI for construction of the well pad.

2.8.3.1.2 Rig Installation

PCMI intends to use a typical land rig for this drilling campaign. The rig's Drawworks has a power rating of 1,800 to 2,000 HP. The rig is powered by four diesel driven generator sets and each rated 600 KVA to supply the rig site with power. Rig components can be described as follows:

1) **Hoisting system** consists a derrick and platform or derrick floor used for clinging and installing the drilling equipment to the tower. The drilling equipment include crown block handed on a cable which use to raise and lower a drill string in the well.

2) **Rotating system** consists of a hydraulic top drive to spin, raise and lower the drill string equipped with a drill bit.

3) **Mud & Cuttings circulating system**

During drilling operation, drilled cuttings and fluids are removed from the well. Mud is added to the pipe and flows out at the hole of drill bit to: carry cuttings to the surface, transmit power and lubrication to the drill bit; exert a hydrostatic head to help prevent caving or sloughing of the formation; prevent flow of formation fluids into the borehole; and maintain dense materials such as cuttings and barite in suspension in the borehole to maintain downward pressure in the well.

4) Mud mixing unit consist of mud mixing tank and mud pump. The equipment functions as chemical mixing unit for mud.

5) Cementing unit consists of cement mixing tank, cement storage tank and cement pump. The equipment functions as chemical mixing unit for cement. Cement will be used to prevent fluid infiltration to borehole.

6) Power system

Rig may be located far from main power supply (Electric Transmission Line). Therefore, three units of diesel electric generator must be installed in the rig to supply electricity.

7) Wireline logger

A mobile truck-mounted wireline logging unit will be used for geophysical tests. (Wireline logging).

8) Drill mud recorder

Drilling mud recorder will continuously monitor the drilled well by determining inner borehole condition.

9) Drilling mud laboratory

Drilling mud laboratory will be equipped with drilling mud testing equipment.

For rig installation cranes will be used and the procedure will take approximately 2 days.

2.8.3.2 Drilling Operations Phase

All operations on these wells will be carried out in accordance with the appropriate international API standards, PCMI Well-Site Operations Management System and the PCMI Well-Site Operations Management Plan, copies of which will be at the rig site and must be read and understood by everyone involved in these well operations.

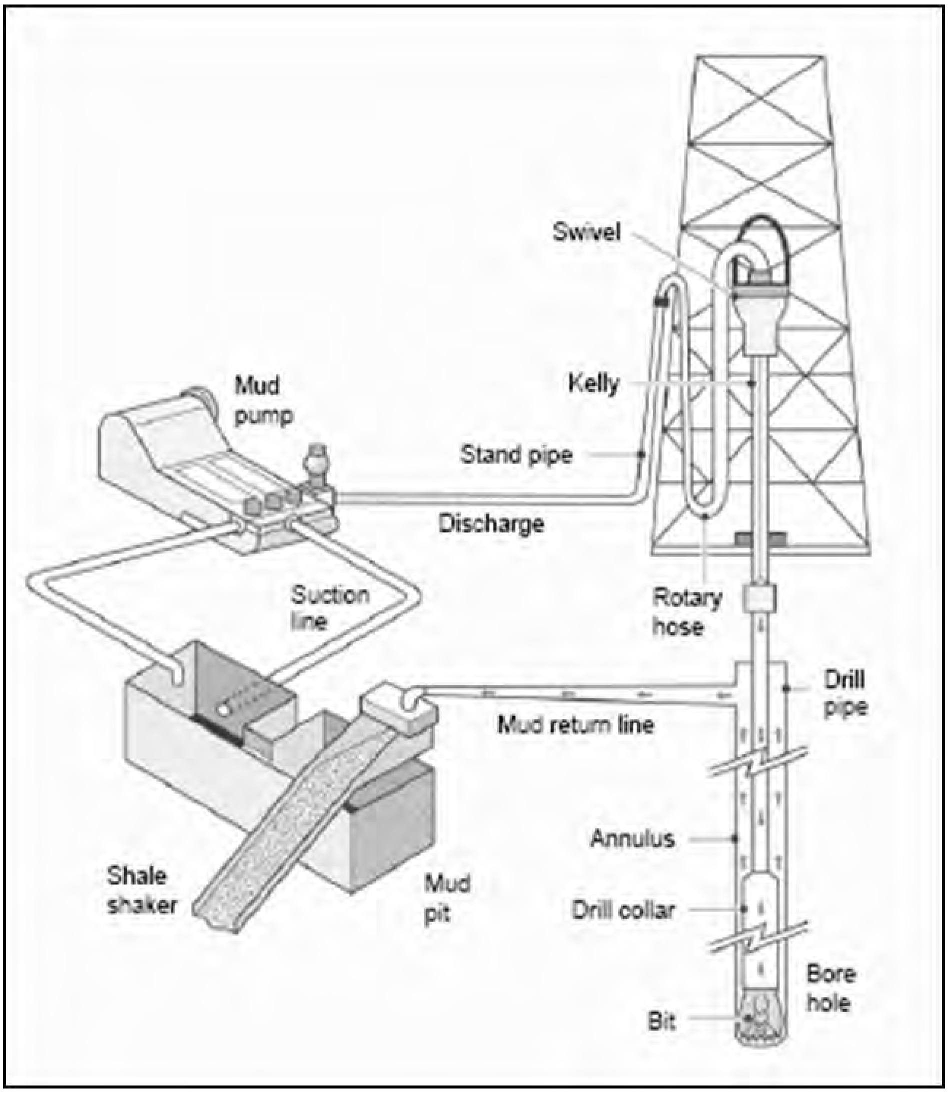
Drilling operations and associated services will be conducted on a 24-hour basis. Drill crews will work alternate 12-hour shifts rotated from duty on a maximum 60-day schedule.

For this exploration drilling program, a “conventional hole” well construction process will be used. The basic steps of drilling an exploration well are summarized below.

- Drilling the Hole - The drill string is a series of long, hollow steel pipes, which can be screwed together. The drill bit, which has a larger diameter than the drill string, is the cutting tool and is screwed to the end of the drill string. A hoist system within a derrick over the well allows the drill string to be assembled and broken down into manageable sections.
- Drilling Fluids System - The drill string and bit are lubricated and cooled by a drilling fluid, commonly referred to as mud. This mud is stored in large steel tanks beside the rig, from where it is pumped down through the drill string.
- Mud Cleaning Equipment - When the drilled cuttings are brought to the surface with the drilling fluids, they will first pass through a mud treatment system commonly consisting of shale shakers. This comprises of a vibrating frame fitted with a series of fine mesh screens, which separate the vast majority of the drill cuttings from the drilling mud. The mud passing through the screen is re-circulated while the cuttings are further processed using a cuttings dryer with recovered mud returned to circulation and the dried cuttings dumped to skips.

A typical drilling schematic is provided in **Figure 2-30**.

Casing and Cementing - Various sections of the hole will be drilled at different diameters, with the size of the borehole decreasing with depth. Each section of the hole will be lined with thick steel tubing, known as casing, which will be fully cemented in place. This ensures that the hole remains stable and that the surrounding geological formations, in particular those that may act as fresh water aquifers, are not contaminated. This casing also helps in the process of controlling the pressure of any gas that the well might penetrate, as it is prevented from flowing into shallower, less pressurised formations.



Source: PCMI 2014

Figure 2-30: Typical Drilling Rig and Mud System

2.8.3.2.1 Hole and Casing Design

The well design for each well will have 4 bore hole sizes of 26-inch (0.660 m), 17½-inch (0.445 m), 12 ¼-inch (0.311 m) and 8 ½-inch (0.216 m). Hole and casing dimensions are summarized in **Table 2-16**. Hole and casing schematic diagrams for each well are shown in **Figure 2-31**.

Table 2-16: Hole and Casing Design for each Well

Well sites	Interval	Hole Diameter (inches)	Casing Size (inches)	True Vertical Depth	
			External	feet	metres
Wells 1-2	Surface	26	20	1476.4	450
	Intermediate	17.5	13 3/8	4265.1	1300
	Production	12.25	9 5/8	7545.9	2300
	Hole	8.50	Open	9842.5	3000

Source: PCMI, 2014

2.8.3.2.2 Drill Exploration Process

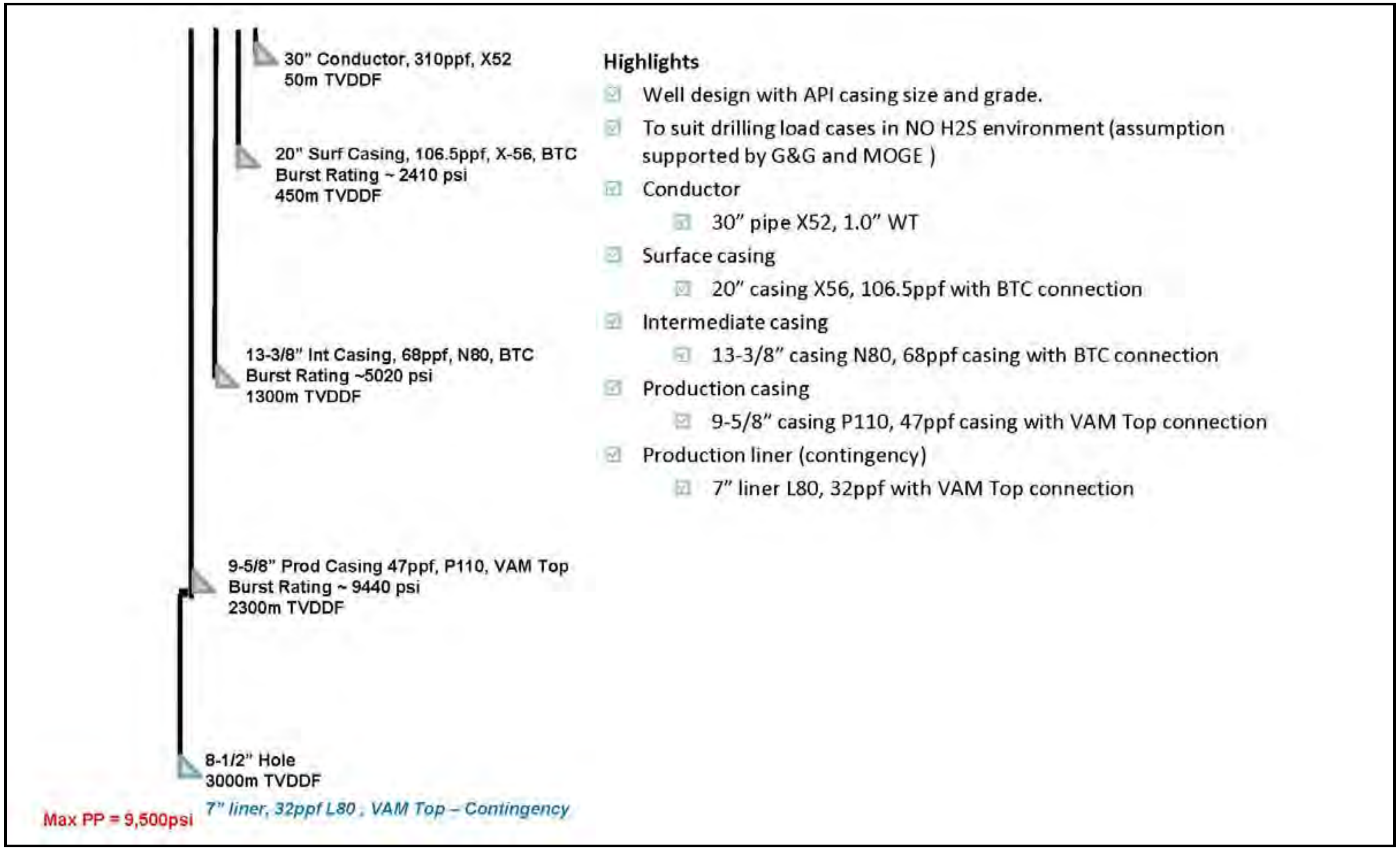
Drilling and Casing

- **26-inch Hole-** The well drilling operations will begin by drilling a 26-inch (0.660 m) hole from surface to the designated depth. This section will be drilled with a basic water-based mud system. Hi-viscosity mud sweeps will be pumped to clean the hole during connections. A 20-inch surface casing will be run and cemented to surface. A surface blowout prevention (BOP) stack will be installed before drilling the next section. No shallow gas is expected in this project.
- **17 ½-inch Hole -** A 17 ½ -inch hole will then be drilled to the designated depth. This section will be drilled with a low toxicity Water Based Mud (WBM). The 13 3/8" casing string will be run and set to the designated depth.
- **12 ¼-inch Hole -** The 8 ½ -inch hole will then be drilled to the designated depth. This section will be drilled with a low toxicity Water Based Mud (WBM) system as the previous section. The 9 5/8" casing string will be run and set to the designated depth.
- **8 ½ -inch Hole -** The 8 ½-inch hole (the reservoir section) will be drilled with Water Based Mud (WBM). A 7-inch production line will be used as a contingency.

Technical or operational constraints

The following operational constraints have been considered for thee well design:

a. Loss circulation at surface hole section (300m – 800m TVD)
b. Loss circulation at bottom hole section (2200m -2500m TVD)
c. Borehole stability due to earth’s stress



Highlights

- ☑ Well design with API casing size and grade.
- ☑ To suit drilling load cases in NO H2S environment (assumption supported by G&G and MOGE)
- ☑ Conductor
  - ☑ 30" pipe X52, 1.0" WT
- ☑ Surface casing
  - ☑ 20" casing X56, 106.5ppf with BTC connection
- ☑ Intermediate casing
  - ☑ 13-3/8" casing N80, 68ppf casing with BTC connection
- ☑ Production casing
  - ☑ 9-5/8" casing P110, 47ppf casing with VAM Top connection
- ☑ Production liner (contingency)
  - ☑ 7" liner L80, 32ppf with VAM Top connection

Source: PCMI 2014

Figure 2-31: Tentative Hole and Casing

Drill Cuttings

Drill cuttings are formation particles generated by the drill bit during the drilling process and vary in size from small slivers (less than 10 mm in length) to dispersed clays and ultra fine particulates (less than 0.002 mm). The exact nature of the cuttings will depend on the geological formations drilled though. After being processed by the Solids Removal Equipment (shale shakers) the drill cuttings are conveyed to a cuttings dryer for further treatment before dumping directly into skips, which are then transported to the kiln for incineration. **Table 2-17** provides the estimated drill cuttings volumes expected for the drilling per well.

As stated earlier, the drilling plan (including hole and casing design) for re-drilling an exploration well (contingency well) cannot be provided at this stage. However, based on a similar design to the planned wells, a similar amount of cuttings could be generated for each additional contingency well.

Table 2-17: Estimated Volume of Cuttings per Well

Hole Diameter	Section Length (m)	Total Cuttings (MT)
Per Well		
26” (0.660 m)	450	900
17 ½” (0.445 m)	850	1600
12” ¼ (0.311 m)	1000	
8 ½ “ (0.216 m)	7000	
Total	**3000**	**2500**

Drilling Mud

Mud performs a number of functions. Apart from carrying cuttings to the surface, it: transmits power and lubrication to the drill bit; exerts a hydrostatic head to help prevent caving or sloughing of the formation; prevents flow of formation fluids into the borehole (which could lead to a blowout); and maintains dense materials such as cuttings and barite in suspension in the borehole to maintain downward pressure in the well, when circulation is interrupted (as when adding a new joint of drill-pipe).

Summary of Drilling Mud

The drilling fluid used in exploration drilling plan is Water Based Mud (WBM). The components of the mud system are summarized below:

- WBM: Caustic Soda, Soda Ash, Bentonite, Polyanionic Cellulose, Xantangum, Potassium chloride, partially hydrolyzed polyacrylamide, sodium bicarbonate, graphite, calcium carbonate, cloud point glycol, potassium sulphate, sodium chloride, magnesium oxide, monoethaloamine, quartenary amine.

Drilling fluids will be circulated in a closed loop system to recycle the drilling mud and contain all wastes. Details of the expected mud volumes per well are shown in **Table 2-18** and Health and Safety Information for the WBM components are shown in **Table 2-19**. Full MSDS sheets are to be provided at the work site.

Table 2-18: Total Mud Volumes per Well

Hole Section	Total Mud Volumes (bbls)
26” (0.660 m)	8,250
17 ½” (0.445 m)	3,500
12” ¼ (0.311 m)	1,375
8 ½ “ (0.216 m)	1000
Total	**14,125**

Table 2-19: Health and Safety Information for the Additives to the Water-Based Drilling Mud

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Bentonite (clay)	• Not regarded as a health or environmental hazard under current legislation. • Contains a small quantity of quartz. IARC Monographs, Vol.68, 1997 concludes that there is sufficient evidence that inhaled crystalline silica (quartz or crystobalite) from occupational sources causes cancer in humans. IARC classification group 1.	• Dust may irritate respiratory system or lungs. Harmful: danger of serious damage to health by prolonged exposure through inhalation. • May cause discomfort if swallowed. • Powder may irritate skin. • Particles in the eyes may cause irritation. • Contains small quantity of quartz. Prolonged inhalation of high concentration may damage respiratory system. Because of quantity and composition, the health hazard is small.	• Do not allow to enter drains, sewers or watercourses.	• Shovel into dry containers. Cover and move the containers. Flush the area with water. May be slippery when wet.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Soda Ash (sodium carbonate)	• CONSIDERED A DANGEROUS SUBSTANCE ACCORDING TO DIRECTIVE 1999/45/EC AND ITS AMENDMENTS. • Irritating to eyes, respiratory system and skin. • Harmful by inhalation. • Classification: R20/36/37/38	• Oral (rat) LD50: 4090 mg/kg • The material may cause skin irritation • Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS)	• Do not allow to enter drains, sewers or watercourses. • If product enters drains, waterways or watercourses, flush at least ten (10) times the volume of water to the drain.	• Use dry clean up procedures and avoid generating dust. • Place spilled material in clean, dry, sealable, labelled container. • Collect residues and seal in labelled drums for disposal. • Wash spill area with large quantities of water.	The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Caustic Soda (sodium hydroxide)	• CONSIDERED A DANGEROUS SUBSTANCE ACCORDING TO DIRECTIVE 1999/45/EC AND ITS AMENDMENTS. • Reacts violently with water. • Causes severe burns. • Risk of serious damage to eyes. • Classification: R14/34/41	• The material can produce severe chemical burns within the oral cavity and gastrointestinal tract following ingestion. • The material can produce severe chemical burns to the eye following direct contact. • Vapours or mists may be extremely irritating. • The material can produce severe chemical burns following direct contact with the skin.	• Do not allow to enter drains, sewers or watercourses.	• Remove all ignition sources. • Avoid contact with skin and eyes with personal protective equipment. • Use dry clean up procedures and avoid generating dust. • Place in a suitable labelled container for waste disposal.	• CORROSIVE • ICAO/IATA, ADR/RID, IMDG Class: 8
Cellulose Polymer	• Not regarded as a health or environmental hazard	• Toxic dose 1-LD50: 27,000 mg/kg (oral rat). • Dust may irritate respiratory system or lungs. • May cause discomfort if swallowed. • Powder may irritate skin. • Particles in the eyes may cause irritation.	• Avoid discharge into drains.	• Collect in containers and seal securely. Flush area clean with lots of water. Be aware of potential for surfaces to become slippery. Avoid generation and spreading of dust.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Xanthan Gum	• Not regarded as a health or environmental hazard	• Dust may irritate respiratory system or lungs. • May cause discomfort if swallowed. • Powder may irritate skin. • Particles in the eyes may cause irritation.	• Do not allow to enter drains, sewers or watercourses.	• Avoid generation and spreading of dust. Collect in containers and seal securely. Flush area clean with lots of water. Be aware of potential for surfaces to become slippery.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Calcium Carbonate	• Not regarded as a health or environmental hazard	• Dust may irritate respiratory system or lungs. • May cause discomfort if swallowed. • Powder may irritate skin. • Particles in the eyes may cause irritation. • Contains a small quantity of quartz. Prolonged and repeated exposure by inhalation to concentrations of crystalline silica exceeding the maximum exposure limit may lead to chronic lung disease such as silicosis. Because of quantity and composition, the health hazard is small.	• Do not allow to enter drains, sewers or watercourses.	• Avoid generation and spreading of dust. Shovel up and place in a labelled sealable container for subsequent safe disposal	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Sodium Bicarbonate	• Not regarded as a health hazard.	• Toxic dose 1-LD50: 4220 mg/kg (oral rat). • Dust may irritate respiratory system or lungs. • May cause gastric distress, nausea and vomiting if ingested. • Powder may irritate skin. • Particles in the eyes may cause irritation and smarting.	• Do not allow to enter drains, sewers or watercourses.	• Shovel up and place in a labelled sealable container for subsequent safe disposal. Flush the area with water.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Potassium chloride	• Not regarded as a health hazard.	• Oral (man) LDLo: 20 mg/kg • Oral (rat) LD50: 2600 mg/kg • Ingestion may result in nausea, abdominal irritation, pain and vomiting. • material may cause eye irritation	• Do not allow to enter drains, sewers or watercourses.	• Wear impervious gloves and safety glasses. • Use dry clean up procedures and avoid generating dust. • Sweep up or Vacuum up (consider explosion-proof machines designed to be grounded during storage and use). • Place spilled material in clean, dry, sealable, labelled container.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Partially Hydrolyzed Polyacrylamide	• Not regarded as a health hazard.	• Dust may irritate eyes and skin.	• Do not allow to enter drains, sewers or watercourses.	• Wear suitable protective clothing. • Sweep up with clean equipment and place in appropriate container.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Graphite	• Not regarded as a health hazard.	• No significant acute toxicological data identified in literature search. • Do not breathe dust.	• Do not allow to enter drains, sewers or watercourses.	• Avoid contact with skin and eyes. • Wear impervious gloves and safety glasses. • Use dry clean up procedures and avoid generating dust. • Vacuum up (consider explosion-proof machines designed to be grounded during storage and use). • Do NOT use air hoses for cleaning • Place spilled material in clean, dry, sealable, labelled container.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Cloud Point Glycol	• Not considered a dangerous substance according to directive 67/548/EEC and its amendments.	• This product has no known adverse effect on human health. • May cause irritation to the eye.	• Do not allow to enter drains, sewers or watercourses.	• Shut of all ignition sources. • Contain the spill. • Soak up material by adding inert absorbent and shovel into an approved waste container. • Dispose of at an approved land disposal site in accordance with local authority requirements.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Potassium Sulphate	• Not considered a dangerous substance according to directive 67/548/EEC and its amendments.	• Oral (rat) LD50: 6600 mg/kg	• Do not allow to enter drains, sewers or watercourses.	• Avoid contact with skin and eyes. • Wear impervious gloves and safety glasses. • Use dry clean up procedures and avoid generating dust. • Sweep up or Vacuum up (consider explosion-proof machines designed to be grounded during storage and use). • Place spilled material in clean, dry, sealable, labelled container.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Sodium Chloride,	• Not considered a dangerous substance according to directive 67/548/EEC and its amendments.	• Oral (rat) LD50: 3000 mg/kg • Oral (human) TDLo: 12357 mg/kg/23d	• Do not allow to enter drains, sewers or watercourses.	• Clean up all spills immediately. Avoid contact with skin and eyes. • Avoid generating and breathing dust. • Sweep up. Place in suitable containers for disposal.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

Product Name Chemical Name	Hazards Identification	Toxicological Information	Environmental Precautions	Spill Clean Up Methods	Transport Information
Magnesium Oxide	• Not considered a dangerous substance according to directive 67/548/EEC and its amendments.	• Inhalation (human) TCLo: 400 mg/m • Accidental ingestion of the material may be damaging to the health of the individual	• Do not allow to enter drains, sewers or watercourses.	• Clean up all spills immediately. • Wear impervious gloves and safety glasses. • Avoid generating and breathing dust. • Vacuum up or sweep up. • Place in suitable containers for disposal.	• The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).
Monoethaloamine	• OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances. • Classification: R20/36/37/38	• ORAL (LD50): Acute: 1720 mg/kg [Rat.]. • Very hazardous in case of eye contact (irritant), of ingestion, skin contact, inhalation. • Mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract	• Do not allow to enter drains, sewers or watercourses.	• Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. • If necessary: Neutralize the residue with a dilute solution of acetic acid.	• D.O.T. Hazard Class: 8 • UN/NA: UN2491 Packing Group: III • International (Water, I.M.O.) 5-5
Quaternary Amine.	CONSIDERED A DANGEROUS SUBSTANCE ACCORDING TO DIRECTIVE 1999/45/EC AND ITS AMENDMENTS. Classification: R10/R65	• Ingestion may result in nausea, pain, vomiting • Toxic effects may result from skin absorption. • HARMFUL- May cause lung damage if swallowed.	• Do not allow to enter drains, sewers or watercourses.	• Slippery when spilt. • Remove all ignition sources. • Clean up all spills immediately.	• ADR/RID Class: 3 • ICAO/IATA Class: 3 • IMDG Class: 3

2.8.3.2.3 Wireline Logging Operations

A series of petrophysical logs will be run to identify the rock properties and hydrocarbon potential. The petrophysical tools are lowered into the well using a cable and winch. Some of the wireline tools run in the hole will contain a radioactive source. High safety standards are employed while handling and storing the source on the surface. It is stored in a lead container in a dedicated area away from personnel and the main working area.

In logging the well, typically four main types of equipment are used:

- The downhole instrument (which measures the data),
- The computerized surface data acquisition system (to store and analyze the data),
- The cable or wireline (which serves as both mechanical and data communication link with the downhole instruments), and
- The hoisting equipment to raise and lower the instruments.

The downhole instruments (also known as tools or sondes) are first lowered to the bottom of the well, then slowly retrieved, probing the formations continually by using various non-destructive techniques. This process provides a continuous stream of data up the wireline to the surface computer. Data are recorded on a "log" that displays information about the formation as a function of depth.

Well logs are used to:

1. Define physical rock characteristics such as lithology, porosity, pore geometry, and permeability;
2. Identify productive zones of hydrocarbons;
3. Determine the depth and thickness of zones;
4. Distinguish between oil, gas and water zones in a reservoir; and
5. Determine facies relationships.

A wireline logging operation will run into the borehole via cable in order to inspect the potential for hydrocarbon, geological condition and record geophysical properties of the formation and fluids in the bore: e.g. Electricity Conductivity (EC), porosity, resistivity, density, radioactive property etc. In some cases, samples of fluids will be taken in order to appraise potential of the petroleum reservoir. Wireline logging will take about 3-4 day for each section.

During the wireline logging operation, the following measurements are made: gamma rays log, resistivity log, density log and neutron log. Gamma rays will be used to identify rock type – a low ratio indicates sandstone, a high ratio indicates claystone. Neutron rays will be used to search for the volume of reflected fraction. Some fraction is absorbed by Hydrogen in the formation cavity. If a high ratio is found, it indicates the formation has low density or may have high porosity. Determination of EC in the formation, the equipment will generate electric current into the formation which will make the fluids act as a conductive. If a reading is low, it indicates the formation is a water bearing formation. If the reading is high, it indicates the formation may contain gas or oil. Results of the wireline operation are displayed in a graph format which requires interpretation to obtain information on type of petroleum and rock, porosity, density, and etc. which can determine if the well contains water, productive oil or natural gas.

The logging program tentatively planned for the wells is described below:

One logging run will be performed for 12 ¼” - 8 ½” and 7” hole.

Run 1: Induction-Density-Neutron-Spectral Gamma Ray-Caliper-Head Tension.

2.8.3.3 Well Testing

Oil and gas well testing (also known as drill stem testing) are performed at various stages of drilling, completion and production. Test objectives can be as simple as identification of produced fluids and reservoir productivity to the characterization of reservoir features. Current technology improvements in downhole sensors and better control of down-hole environment have significantly increase capabilities of well testing operation. A typical well testing arrangement is shown in **Figure 2-32**.

Generally, well tests are conducted to:

- ✓ Identify produced fluids
- ✓ Measure reservoir pressure & temperature
- ✓ Obtain representative samples, surface and downhole for PVT analysis
- ✓ Determine well productivity and flow performance i.e. productivity index, skin
- ✓ Obtain hydrocarbon composition and impurities i.e. Mercury, CO2 and H2S

There are two (2) main categories of drill stem test;

- ✓ **Open Hole Drill Stem Test -** provides rapid and economical means to quickly assess production potential of the formation. This technique requires hole to be in a very good condition and highly consolidated. Packer still needs to be set in casing/liner if annulus hydraulic operated tools are chosen. Mini drill stem test using straddle packer can be an alternative to full bore drill stem test.

- ✓ **Cased Hole Drill Stem Test-** also known as full-bore drill stem test. This technique utilizes pressure controlled system to eliminate the need for pipe manipulation which is crucial for offshore drilling with floating rigs. Moreover, services such as thru tubing perforating, slickline conveyed sampling and production logging can readily be programmed into the test sequence even as contingency measures.

2.8.3.3.1 Well Test Equipment

Well testing equipment consists of mainly four (4) parts;

1. Perforation

Perforating gun is a critical part of the well testing process which essential for better well productivity an operating efficiency. Two (2) basic perforating techniques are available for well test job:

- ✓ **Thru Tubing Gun -** Guns are lowered into the well thru test string using either wireline or coiled tubing. Mostly applicable for add-on perforation job.

- ✓ **Casing Gun -** Large diameter guns are lowered as part of the test string bottom-hole assembly in a conventional well test. The guns may be conveyed with wireline, drillpipe and etc. as well for shoot and pull before running in test string.

2. Drill Stem Test (DST) Tools

A set of drill stem test tools consist of down-hole hardware used for temporary completion of a well. They are run to provide a safe and efficient method of controlling formation during the well test operation. Basic tool functions cover well isolation, down-hole circulation, down-hole shut-in, pressure test, emergency shut-in / circulation and as gauge carrier.

DST tools are designed for a wide range of operating environments and to perform different functionalities.

- ✓ Retrievable / Permanent Packer
- ✓ Downhole Test Valve
- ✓ Reverse Circulation Valve
- ✓ Slip Joint
- ✓ Hydraulic Jar
- ✓ Safety Joint
- ✓ Safety Valve
- ✓ Gauge Carrier
- ✓ Downhole sampler

3. Subsurface Safety System

Well tests on semi-submersible and floating drilling vessels will require subsea control valve tool in the BOP. This tool is designed to allow the rig to shut-in the well, quickly disconnect from test string and safely move off location in the event of excessive heave.

Additional safety features of these tools have been incorporated into fixed and jack-up type drilling rigs as well.

4. Surface Well Test Equipment

Produced fluids during well test are normally handled using temporary production facilities / surface testing package. This equipment needs to be assembled and designed to safely and reliably fulfil a wide range of operations:

- ✓ Pressure control and shutting in the well
- ✓ Separate produced fluids into gas, oil and water phases allowing all constituents to be measured
- ✓ Allow representative samples of produced fluids to be taken
- ✓ Dispose of produced fluids in an environmentally acceptable manner
- ✓ Data acquisition

Each of surface components must be designed to expected operating conditions.

- ✓ Flowhead
- ✓ Choke Manifold
- ✓ Heater / Heat Exchanger
- ✓ Test Separator
- ✓ Gauge / Surge Tank
- ✓ Pumps and Manifolds
- ✓ Emergency Shutdown System
- ✓ Surface Safety Valve
- ✓ Burner head, vertical flare stack

2.8.3.3.2 Well Test Design

Design and implementation of well testing program has to be in line with the latest standard. Stringent safety requirements, environmental concerns and a greater need for cost efficiency require the entire testing sequence from design to data evaluation be conducted intelligently. Proper test design, correct handling of surface effluents, high performance gauges, flexible down-hole tools and perforating systems, well site validation and comprehensive interpretation are keys to successful well testing.

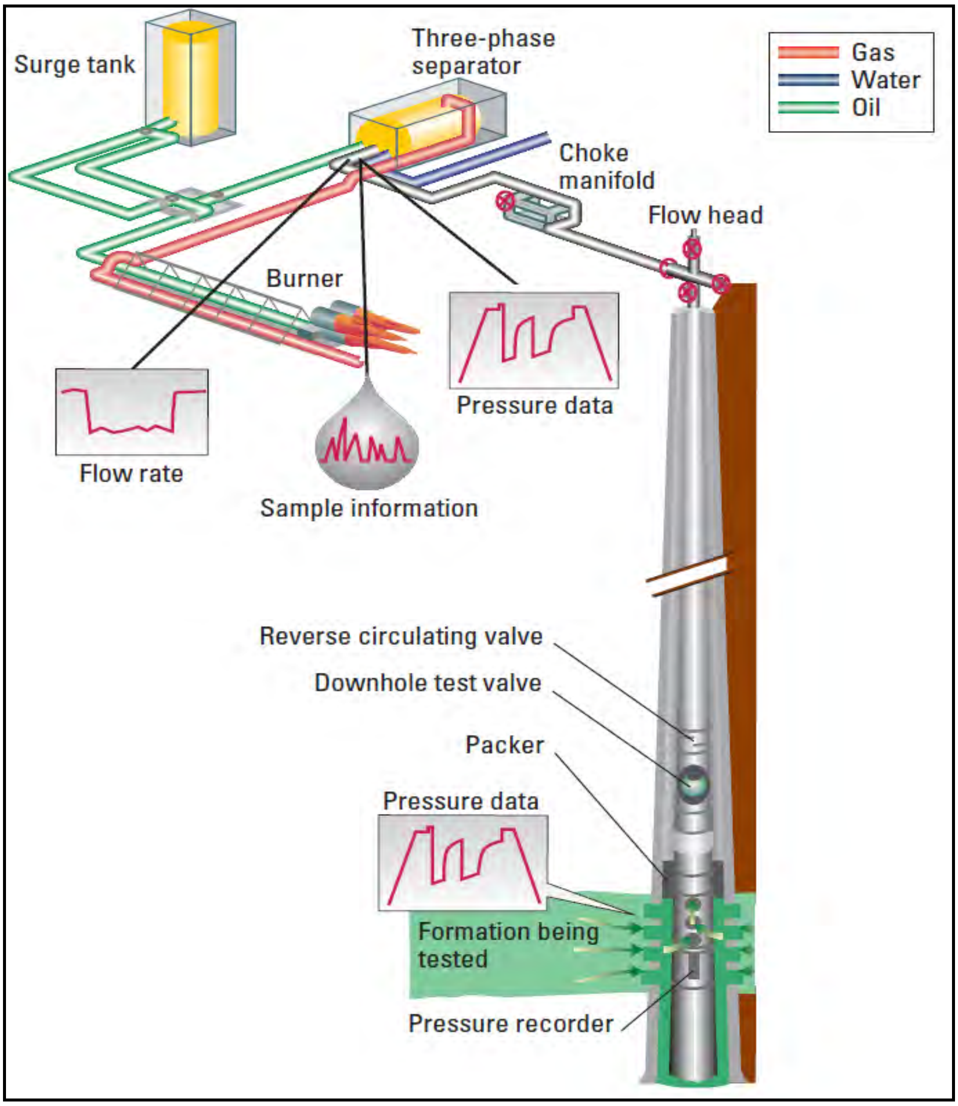
Types of well or reservoir data will drive the type of well test to be run i.e. conventional drill stem test, underbalanced drill stem test, etc. Later, sequence of flow and shut-in are determined with various flow rate and realistic duration as to generate the expected interpretation patterns. Different types of well tests can be achieved by altering production rates and shut-in well at downhole / surface.

- ✓ Initial Flow & Initial Build-up
- ✓ Clean-up Flow
- ✓ Main Flow (draw down test)
- ✓ Main Build-up (build-up test)
- ✓ Sampling Flow (bottom hole sampling)
- ✓ Multi Rate Test (recommended for oil testing)
- ✓ Modified Isochronal Test (recommended for gas testing)
- ✓ Maximum Flow

Diagnostic plots of simulated data should be examined to determine when essential features will appear i.e. wellbore storage effects, duration of infinite acting radial flow, emergence of external boundary effects, constant pressure boundary and etc. Final step of test design process is to select instrumentation and equipment for data acquisition.

In summary, surface and down-hole equipment should be versatile to allow for safe and flexible operations. Among of the key factors to consider:

- ✓ Controlling down-hole environment to minimize wellbore storage
- ✓ Combining perforation and testing technique to minimize rig time
- ✓ Choosing reliable down-hole recorders to ensure successful and good quality data retrieval
- ✓ Selecting surface equipment to safely handle expected rates and pressures
- ✓ Environmentally sound disposal of produced fluids



Source: PCMI, 2014

Figure 2-32: Well Testing Set-Up with Horizontal Flare Burner

2.8.3.3.2.1 Flaring

If it is decided to test the well (DST or LPT) a significant quantity of gas could be flared from the well. The actual flow rate of the reservoir at this location is a parameter which the drilling of the well is intended to determine.

The rate of gas production will range between 0-30 mmscfgd (30 mmscfgd being the maximum handling of the rig’s processing equipment). If a DST found less than 5 mmscfgd an LTP test would unlikely proceed. If an LTP test is to proceed, the drilling rig would be de-mobed and a smaller well testing package brought in to conduct the LTP test. During an LPT test flaring would be conducted at various rates and sustained rates combined with shut-ins to observe pressure build ups and flowed again. The data gathered is used to establish reservoir characteristics. The maximum flow during an LPT tests generally never exceed 10 mmscfgd. Thus a worst case scenario flaring is a sustained flow rate of 10 mmscfgd for 7 days.

2.8.3.3.2.2 Blowout Preventative Measures

A complex series of valves, known as the "blowout preventer" (BOP), is attached to the top of the conductor below the derrick floor. All further casing strings are also attached into this blowout preventer. These are powerful hydraulically-activated valves and rams that can be closed around the drill pipe to isolate the well bore should unexpectedly high formation pressure be encountered. If formation pressure exceeds the hydrostatic head of the drilling mud, it may cause the well to flow strongly, referred to as a "kick". A kick can also occur if a highly permeable formation, such as a naturally fractured limestone, is encountered and a large volume of mud is suddenly lost into the formation.

The blowout preventer is the primary safety mechanism for well control. The series of valves act independently and when closed in an emergency form a series of increasingly secure barriers that isolate the well so that a plan of action can be developed to bring it back under control.

Maximum pressure for the project prospect wells is expected to be not exceeding 9,500psi. PCMI will use a 5,000 psi rated 21-1/4" BOP and a 10,000 to 15,000 psi BOP with double ram preventers in the 13-5/8" section.

The BOP is tested and certified as per API standards to 10,000 psi before installation. Once the BOP stack is installed it is pressure tested to API specification (API RP 53) to 10,000 psi. Once in service the BOP stack must be tested ever 3 weeks as per API specification. PCMI's standard operation procedures require the BOP to be tested every 2 weeks which is more stringent than API specification. Also, every time a connection is made (i.e. wellhead connection) the BOP must be pressure tested again to as per API specification. BOP unit will have separate generator which will use power supply to generate pressure in the accumulator to operate BOP that is always available.

PCMI as part of its HSEMS system has a Blowout Contingency Plan (BOCP) for Myanmar operations. This BOPC defines the procedures that are to be used in the event of a well control emergency occurring in their onshore exploration drilling.

Blowout Preventer (Example)

Source: PCMI, 2014

2.8.3.4 *Well Completion, Suspension, Abandonment or Contingency Well*

If the well proves to be highly productive it is likely that the well will be completed and temporarily suspended rather than permanently abandoned, given the high cost of drilling a replacement well at a later date.

At the end of the drilling or the well completion operations, the rig and associated equipment will be broken down and loaded onto trucks to be moved to the next operator's drilling location.

2.8.3.4.1 Commercially Successful Well

2.8.3.4.1.1 Well Completion

A commercially successful well will be suspended for future completion. After testing, the well will be killed with clean brine at appropriate weight. (Calculated overbalance) Then a minimum of 1 mechanical retrievable or drillable bridge plug will be set above the perforated zone and pressure tested. A kill string will be run and landed in the well head with the tubing hanger and a BPV (Back Pressure Valve) The tubing hanger will be secured with the tie down screws. Then the BOP is removed and suspension cap installed.

2.8.3.4.1.2 Well Pad Suspension

If the well is completed as a future producer, the drilling rig, associated equipment, accommodation units and warehousing will be removed from the site. The entire site will be cleaned up and made ready for suspension. The waste pit will be emptied and cleaned out with any material extracted removed for treatment and disposal.

The concrete rig pad and other foundations will be left intact for future use. The internal and intermediate drains around the rig pad and well pad site will be cleaned and any material extracted removed for treatment and disposal offsite. The external flood water diversion drain around the well site will be cleaned out and put in a state of good repair.

An inspection will be made of the entire well pad by a civil engineer and any defects put right and any modifications made to ensure it will be able to withstand an entire rainy season without significant deterioration. The site will be inspected before and after each rainy season and any repair work conducted accordingly.

The well site will have 2 security guards on duty at all times 24/7.

2.8.3.4.2 Commercial Failure, Well Abandoned

It is considered unlikely that this well will be a commercial failure. However, if it is so decided then the well will be permanently abandoned and the well site restoration work commenced immediately. The requirements for the physical abandonment will follow best industry practices and as per PCMI PPGUA. The following procedure for plugging and abandoning the well bore will ensure that the land is returned as near as possible to its original state.

The procedure for abandonment and restoration of such a well site is long established and is a relatively routine operation.

The well abandonment will follow normal industry practices and procedures, conforming to all International regulations. A section of the 7" casing will be filled with heavy kill weight mud and a cement plug will be put in position, 30m below top of liner lap and 30m above as one 60m long plug. (Minimum length) After curing/thickening time, the position of the plug will be confirmed physically by tagging with the cementing string. It will then be pressure tested. Then a 30m (Minimum length) cement plug will be spotted at surface. Wellhead will then be removed and casing will be cut off at bottom of cellar. A steel plate will be welded on the top of the cut off casing. The cellar will then be removed and the cellar back filled with clean soil.

The well site will then be cleared of all equipment and cleaned up. The rig cellar will be removed and a steel plate welded on top of stump, a minimum 3 m below ground level. The concrete rig pad, other foundations and the water pit will be broken up and all material removed off site for disposal as normal building rubble.

The surface of the well pad, consisting of compacted fill will be broken up and the contours of the site restored to their original levels.

2.8.3.4.3 Contingency Wells

During drilling of the well, technical issues may occur that require the exploration well to be re-drilled. A contingency well would be in the form of a side track or a new hole next to the first hole within the same pad built for the well. Examples of some technical issues that could require drilling of a contingency well are: tools or drill string lost down hole; surface casing collapse or weakened; unexpected hydrocarbon reservoir encountered shallower than objective; poor quality reservoir. Although these issues are unlikely to occur, a second or third contingency well may have to be drilled from the well pad to meet the objectives of this project.

The technical issue encountered would be reviewed and PCMI would evaluate the best option to overcome the issue. Drilling a contingency well is just one of many possible options but would be a worst case and last resort scenario.

2.8.4 Employment and Accommodation

2.8.4.1 Employment

The workforce active on the project will vary with time, depending on the phase of the operation. Up to 110 to 130 personnel could be employed for this exploration drilling project. An estimate of the number of personnel active during each phase is provided in **Table 2-20**.

Table 2-20: Estimated Work Force

Project Phases	Number of Personnel
Construction Phase	30 - 50
Drilling Operations Phase	110-130
Well Testing Phase	20-30
Well Suspension or Abandonment Phase	15 - 25

The site construction and abandonment or restoration phases will be conducted using a civil engineering contractor and their local staff.

During drilling operations, the composition of the crew will depend on actual contracting companies, most of which will be local subsidiaries of international companies. Where possible it is PCMI's company policy to encourage the hiring of local staff. The expected ratio of skilled, semi-skilled and unskilled workers is 40:25:35. The expected number of local hires will be 40 to 50 persons.

2.8.4.2 Accommodation

Onsite accommodation will be provided by drilling rig contractor in the main camp, which will consist of a transportable-type mini camp and main camp. The mini camp and main camp will have septic tank and system installed. The Septic system will be a below ground “leach” drain type system. One will be a 30 man septic system for the “Mini Camp” at the rig site and the other a 110 man septic system at the “Main Camp”.

The rig crew and service personnel work 12-hour shifts and are rotated from duty on a maximum 28-day schedule, as is standard industry practice. Most of these personnel will be living at the adjacent accommodation camp site. Essential management and supervision staff will be accommodated at the well site. These will include the two Drilling Supervisors, the MOGE representative, the Well-Site Geologist, the Tool Pusher, and the Night Pusher. The site will also have up to 2 additional sleeping quarters to accommodate visits by the Drilling Manager and Drilling Engineer and other specialists normally based in Yangon.

PCMI will also ensure that a full time doctor will stay at the site 24 hours a day, 7 days a week during the drilling phase.

MOGE provides at its discretion an on-site representative, who observes operations and provides advice on compliance with Myanmar regulations.

2.8.5 Facilities and Utilities (Per Well Site)

2.8.5.1 Water Supply and Usage

2.8.5.1.1 Potable Water

Maximum daily usage is expected to be 10.4 m^3 per day during drilling (80L/person/day for maximum crew of 130) when the camp is accommodating a full crew. Potable water will be supplied by two deep tube well installed at the camp site. If tube type wells are not successful or water not suitable, water will be sourced and transported by tanker from near by reservoirs/rivers. Local authorities will be consulted before water hauling. All potable water for showering washing will be put through a filter system with black light and chlorine injection to prevent disease.

All drinking water will be sourced from local retail suppliers. The maximum demand from the operation, estimated to be 200 litres per day, will have a beneficial impact on the local sales of bottled drinking water.

2.8.5.1.2 Industrial Water

It is estimated that a total of 6000 m^3 of industrial grade fresh (non-potable) water will be required during the drilling operation (to be used as makeup water for the drilling mud, cement mixing and losses). Water will be supplied to each well site from two deep tube wells at the well site. If tube type wells are not successful or water supply rate not suitable, water will be sourced and transported by tanker from near by rivers. Local authorities will be consulted prior water hauling begins.

The industrial water will be stored on the well site in an in ground storage pit 30 m x 15 m x 4 m deep for a maximum capacity of 1,800 m^3.

2.8.5.2 Power Supply

2.8.5.2.1 Well Site Power

Estimated fuel consumption is 8 m^3 per day during drilling. On-site fuel storage capacity will consist of an 80 m^3 tank.

All electrical power for the well site, drilling rig and associated equipment will be provided by four diesel fuelled generator sets. Estimated total fuel usage is 704 m^3 (based on 88 days of drilling). During well testing phase, power consumption is minimal (i.e., only power for instruments and lights is required which can be powered from the work camp generators).

2.8.5.2.2 Work Camp Site Power

All power for the camp site will be provided by the camp's 350 KVA diesel-fuelled generators. Expected fuel consumption is 1.5 m^3 per day during full accommodation. On-site fuel storage capacity will consist of one 25 m^3 tank. Estimated total fuel usage is about 165 m^3 (based on 88 days of drilling and 22 days of well testing).

2.8.5.3 Drainage and Flooding Prevention

During construction, a civil engineering contractor will be required to survey the road to be upgraded and the driveway to be constructed. The contracted civil engineer will determine and recommend if culverts or additional ditches are necessary to manage surface water runoff. The local authorities and local land owners will also be consulted to address their requirements for any culverts or ditches to be installed at any point along the road. If culverts are required or requested, the size of culvert to be installed will depend on the civil engineer's recommendation and/or local authority's recommendation. Generally, culverts in this area are 60 cm in diameter, made of reinforced concrete and purchased prefabricated.

Drainage system in the rig pad (drilling) area

Water drained from the concrete rig pad on each well site will be channeled into the waste pit with dimensions 40 m x 30 m and a depth of 4 m. The pit has a capacity of 4,800 m^3. The pit with have an embankment enclosed to prevent the excess water drain into the pond.

The runoff from the well site combined with rain falling on the waste pit during extreme heavy rain (rainfall intensity of a ½-hr duration storm with a month's equivalent of rainfall) totals 391.2 m^3. The waste pit has an actual holding capacity of 4,800 m^3. The waste pit can therefore contain much more rainfall than the extreme heavy rain. In the unlikely event that the waste pit should become full and overflow, tanker trucks are prepared to drain rainwater from the pit. This can be stored for later use as mix water, or if contaminated, will be disposed of at approved government sites.

2.8.5.4 Transportation

Drilling Rig - PCMI plans to use a land rig for the drilling program. The exact transport route and duration of rig move is not available as no firm locations are determined and rig contract not yet awarded. The rig mobilization will include around 130 truck loads to complete. The maximum mobilization distance for the rig is estimated at about 500 km.

Drilling Materials will be transported from Yangon (Thaketa or MITT port) to IOR-5 via the public highway The estimated number of round trips for rig and support equipment is 30 trip per well. PCMI's strategy will be to send enough supplies for two wells (60 trips) to the first location and 'feed' what equipment, casing and chemicals we need in small convoys for the remaining wells.

The rig personnel will be transported overland to the well locations.

2.8.6 Exploration Drilling Emissions, Discharges and Waste Generation

Emissions, discharges and waste generation will conform to applicable government regulations in Myanmar.

All wastes produced will be assessed and classified by type prior to treatment, transport, disposal or recycling. Wastes are classified as:

- Drilling Mud and Cuttings;
- Wastewater (effluent);
- Hazardous waste (e.g., chemical waste, waste oil etc.);
- Non-hazardous solid waste (e.g., wood, paper, steel, food waste etc
- Air emissions;
- Noise;
- Fluids Produced from the Separators During Drilling and Testing.

2.8.6.1 Waste Drilling Mud and Cuttings

The major waste products from the drilling operations are used drilling mud and cuttings. As described in earlier sections the drilling rig equipment contains a standard closed mud circulation and treatment system, that takes the drilling mud as it leaves the well bore, removes the cuttings and suspended fine solids, and returns the cleaned mud to the rig's holding tanks for reuse. The subsequent treatment and disposal of the cuttings and drilling mud are discussed below.

2.8.6.1.1 Waste Drilling Mud

Some of the drilling fluid portion will be lost to porous rocks, such as sandstones, and some of the additive solids will be lost to form a mud-cake along the wall of the hole. The volume of these "losses" cannot be calculated accurately as they depend on the local geology.

A portion of the mud will be attached to the cuttings (the separation system is efficient but cannot remove all the mud from the cuttings). This section discusses the disposal of drilling mud separated from the cuttings. Disposal of cuttings is discussed in the next section.

At the end of drilling the surface hole, fresh water-based mud held in the rig storage tanks will need treatment and disposal. If the well is actually abandoned rather than completed as a producer, some of this mud will be used to make the kill weight spacer between the cement plugs as described in **Section 2.8.3.4.2.**

2.8.6.1.2 Waste Mud Treatment and Disposal

2.8.6.1.2.1 Water-Based Mud

The solid and liquid phases are separated on-site by industry standard physical and chemical means (shaking, centrifuging and flocculation). The solids from the shale shakers are moved to the cuttings dryer by an auger system.

The liquid phase is held in a series of settling tanks and will be analysed to determine if any additional treatment is necessary. If weather conditions permit, the fluids requiring disposal will be reduced by evaporation on-site and the residuals added to the dry cuttings for incineration at the kiln, or shipped to licensed landfill/wastewater treatment facility. If evaporation on-site is performed, the effect of this would be to delay the abandonment of the site in the case of a dry hole, but this delay is not expected to be more than a few months and will not increase the overall impact of the project.

If evaporation is not performed, the remaining liquid phase will be packaged in sealed skips or drums and sent to the kiln for incineration, licensed landfill/wastewater treatment facility.

The rig’s solid control equipment is then cleaned and all the extracted material is moved to the waste pit. A flocculant (Alcomer 1011) is added to the remaining liquid phase to remove the remaining fine solids by promoting the amalgamation and sedimentation of suspended solids while air is agitated into the liquid. This flocculation process will reduce the total suspended solids to less than 500 ppm.

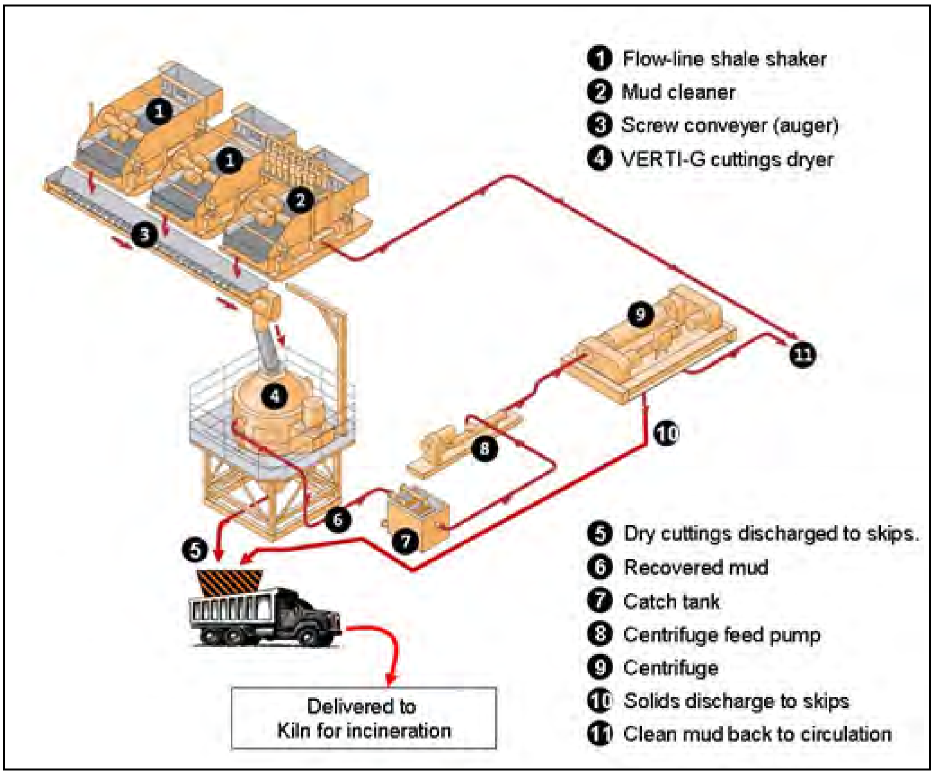
2.8.6.1.3 Waste Drilling Solids

After cuttings pass through the solids control treatment equipment, the cuttings from the shakers are conveyed to the cuttings dryer through a variety of site-engineered conveyance systems that include: gravity feed, pneumatic transfer, vacuum transfer and screw conveyor. The capacity of the cuttings dryer will be picked to be more than capable of treating all cuttings without the need for storage.

Essentially, an auger device transfers cuttings away from the shaker area into the cuttings dryer which then deposits dried cuttings into a lugger box (9 m^3 capacity) skip. Once a lugger box is full it is replaced with an empty lugger box. Once the lugger boxes are full, the waste hauling company will transport the full skip to the kilns for incineration (i.e. 9 m^3 per run). There will always be spare lugger boxes on-site ready to replace full ones so as not to interrupt drilling.

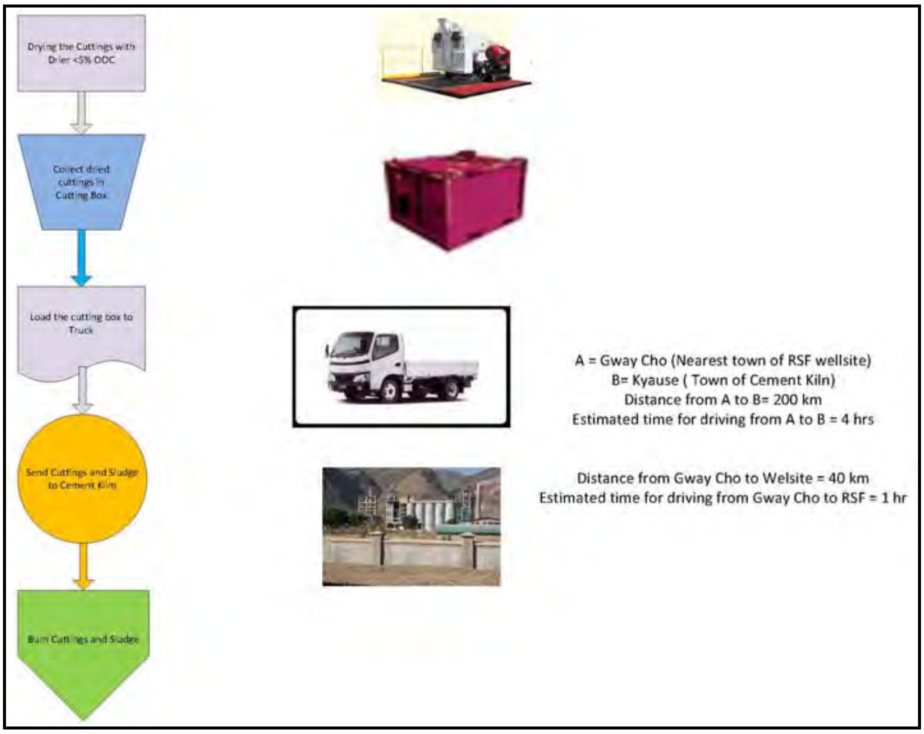
A flow diagram illustrating the process of cuttings treatment is provided in **Figure 2-33** and disposal plan in **Figure 2-34**.

For hazardous waste and cuttings sent to the incinerator, the kiln operator will be required to sign for acceptance of each shipment and the volume / weight tally matched with the rig count before disposal, plus sign to confirm actual incineration.



Source: PCMI 2014

Figure 2-33: Waste Drilling Solids Treatment Flow Diagram



A = Gway Cho (Nearest town of RSF wellsite)
B= Kyause (Town of Cement Kiln)
Distance from A to B= 200 km
Estimated time for driving from A to B = 4 hrs

Distance from Gway Cho to Welsite = 40 km
Estimated time for driving from Gway Cho to RSF = 1 hr

Source: PCMI 2014

Figure 2-34: Waste Drilling Disposal Plan

2.8.6.2 Wastewater

2.8.6.2.1 Contaminated Runoff

In case of rainfall during drilling operation, runoff may happen from the well site. The rainwater receiving area of each well site is 14,400 m^2, consisting of well site area (with Mud Tanks and Pumps, Cement Units, Generators, Solid Control Equipment and fill area.

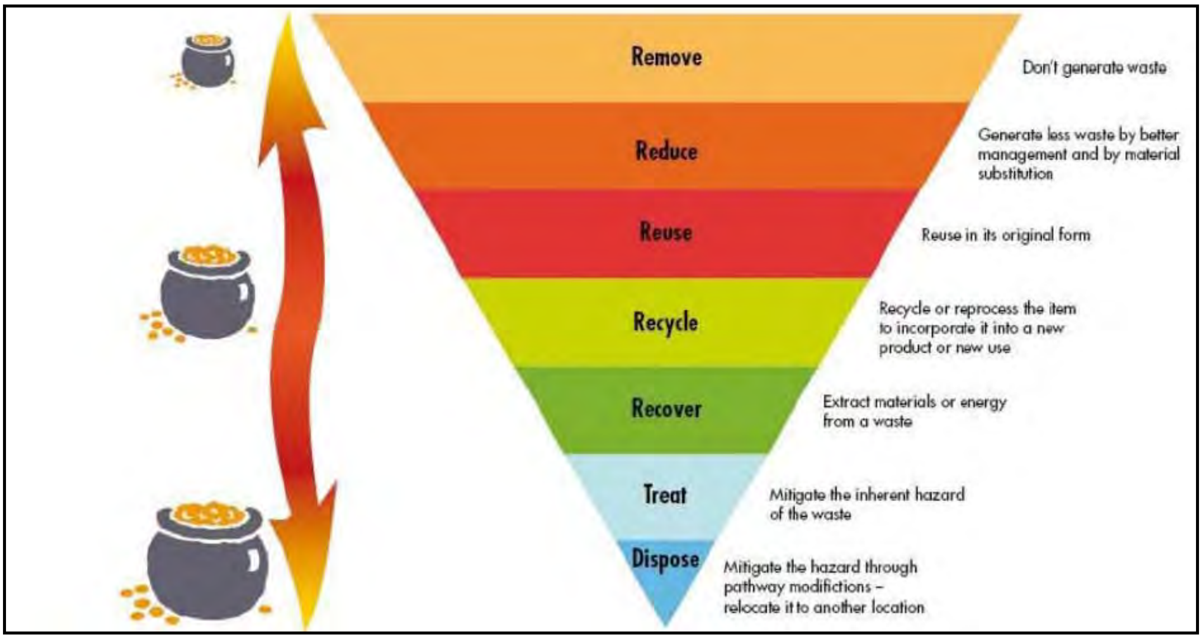
The well site area will drain into a waste pit with dimensions 40 m x 30 m and a depth of 4 m. The pit has a capacity of 4,800 m^3. Pit will be enclosed by an earth embankment to prevent the excess water drain into the pit.

2.8.6.2.2 Wastewater from consumption

The waste water and sewage will be collected in a plastic-lined sewage pit with a capacity of 8 m^3 (8000 litres). It is estimated that some 7.8 m^3 (7800 litres) of combined sewage and waste water will be produced each day during maximum manned operations The Septic system will be a below ground “leach” drain type system. One will be a 30 man septic system for the “Mini Camp” at the rig site and the other a 110 man septic system at the “Main Camp”. Wastewater and sewage treatment and disposal are planned to be covered under the Drilling Rig and Services contract.

2.8.6.3 Non Hazardous Waste and Hazardous Waste

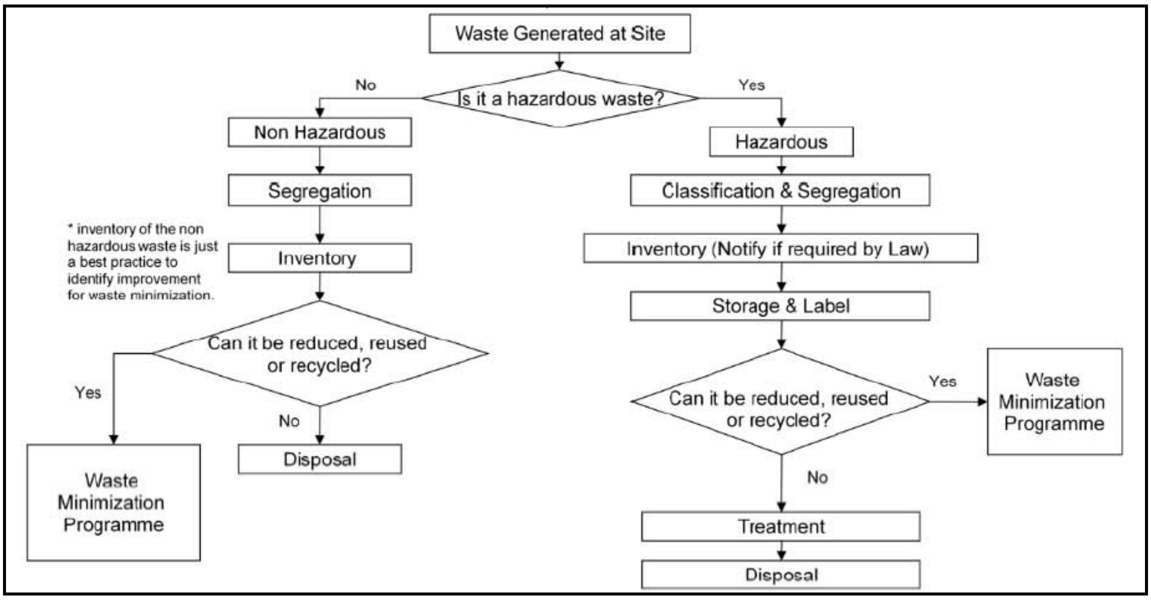
The PCMI exploration program will handle waste according to PETRONAS Standards. The waste management will follow the best practices shown in **Figure 2-35**.



Source: PCMI, 2014

Figure 2-35: Waste Management Best Practice

All wastes will be classified and segregated before responsible disposal. The classification and segregation process is shown in **Figure 2-36**.



Source: PCMI, 2014

Figure 2-36: Waste Classification and Segregation Process

2.8.6.3.1 Containers

All wastes will be collected, stored, and segregated in arranged containers. All provided containers will be as follows:

- Install adequately in the working area, accommodation and office area,
- Make from durable materials compatible with the waste to be collected, leakage proof, sturdy, stable and easily handled,
- Prevent the ingress of animals, escaping odor and place under cover to avoid leachate,
- Medical or clinical waste shall be separated from other wastes because, they may contain infectious agents and potentially toxic substance for example sharp objects shall be packed in puncture-proof containers.

Containers used for medical waste shall be marked prominently with universal warning signs and/or the word “Medical waste”. Used needles and syringes represent a particular threat as failure to dispose of them safely may lead to recycling and repacking. Where possible, management of medical/clinical wastes should be integrated into existing healthcare waste management system.

2.8.6.3.2 Non Hazardous Waste

Both the well site and the accommodation camp site will generate non-hazardous waste, consisting of “domestic” garbage such as food scraps, plastic packaging, paper, cardboard, tin cans and glass. In addition there will be “industrial” waste such as wooden cases, large glass containers, ferrous and non-ferrous metal items, plastic and metal drums and containers, plastic and cardboard packaging.

General waste will be separated on-site to facilitate recycling. This waste will be stored in separate skips to be transported off site for recycling, reuse, treatment and/or disposal.

Biodegradable waste (food waste) will be segregated and transferred to local government waste disposal facilities (like YCDC in Yangon).

Recycle waste shall be also handed over or sold to local for further recycle or reuse.

General Non-Hazardous waste except recycle and biodegradable waste shall be transferred to local government waste disposal facilities (like YCDC in Yangon) or send to qualified contractor/organization/local government for disposal at site approved by the Local Authority.

All wastes shall be handled and stored in a manner that reduces the risk which may escape to the environment. Wastes either at the source or after collection that require different treatments or disposal systems shall be segregated as much as possible at source for collection, storage, transportation, and disposal.

2.8.6.3.3 Hazardous Waste

The well site and accommodation camp site combined will generate a low volume of hazardous waste, estimated to be 0.5 tonnes per month. Those items that have been identified from previous drilling operations are:

- Medical Waste
- Used lubricating oil
- Used hydraulic oil
- Filters contaminated with oil
- Drums and containers used for oil or chemical transportation and storage
- Mud additive chemicals
- Rags, paper, plastics and other materials contaminated with oil

All materials brought onto the well site and accommodation camp site will be logged and all sources of potential toxic waste will be identified by the relevant supplier or contractor. Equipment or materials containing heavy metals, such as batteries, will be identified and a special container designated for their disposal as waste. All used chemical and lubricant containers will be collected in separate containers.

It is assumed that there will be only chemical/mud/additive containers and batteries. Some will be reused and the rest shall be returned to where they came from. Any oily contaminated waste will be sent to cement kiln for incineration.

Medical or clinical waste shall be separated from other wastes because, they may contain infectious agents and potentially toxic substance for example sharp objects shall be packed in puncture-proof containers. Then transfer to our contracted local hospital for further disposal.

2.8.6.4 Air Emissions

The air emissions from the well site would be from the following sources:

1. Dust
2. Combustion emissions

2.8.6.4.1 Dust

During construction and upgrading of access roads and well site construction, the main air quality issue will be control of dust. Standard operating procedures require the civil engineer contractor to ensure daily sprinkling of water on all non-sealed surfaces to subdue the amount of dust. The standard operation procedure will also limit the speed of traffic on site and to restrict speed of traffic on portions of the road that have not yet been sealed. Daily consultations by the construction contractor with the local villages will ensure that any significant problems are identified and resolved.

The handling and storage of bulk drilling mud additives, including barite, bentonite, calcium carbonate and cement powder will result in relatively minor fugitive dust emissions. Any emissions will be reduced significantly by the standard procedure of equipping all silos with bag filters.

2.8.6.4.2 Combustion Products

Combustion products from the proposed exploration drilling project consist of diesel combustion and flaring emissions.

2.8.6.4.2.1 Diesel Combustion

Diesel combustion from the on-site electrical power generation units and from vehicles will emit greenhouse gases. The amount of emissions will vary with time, depending on the operational activity and power demand. Emissions have been estimated using typical fuel consumption rates, with details provided in the Impact Assessment Chapter. The overall greenhouse gas emissions from diesel combustion are estimated including the potential worst case scenario of drilling two contingency wells per site. The emissions from diesel consumption per well site are provided in **Table 2-21**.

2.8.6.4.2.2 Flaring

If it is decided to test the well (DST or LPT), a significant quantity of gas could be flared. The actual flow rate of the reservoir at this location is a parameter which the drilling of the well is intended to determine.

The rate of gas production will range between 0-30 mmscfgd (30 mmscfgd being the maximum handling of the rig’s processing equipment). If a DST found less than 5 mmscfgd an LTP test would unlikely proceed. If an LTP test is to proceed, the drilling rig would be demobed and a smaller well testing package brought in to conduct the LTP test. During an LPT test flaring would be conducted at various rates and sustained rates combined with a shutin to observe pressure build ups and flowed again. The data gathered is used to establish reservoir characteristics. The maximum flow during an LPT tests generally never exceed 10 mmscfgd. Thus a worst case scenario flaring is a sustained flow rate of 10 mmscfgd for 7 days.

The overall greenhouse gas emissions from flaring per well site are provided in **Table 2-21**.

Table 2-21: Greenhouse Gas Emissions Per Well

Project Phase	Activity	One Time CO_2 Release (ton CO_2)
Site Preparation	Granular Fill Transport	65.7
Drilling	Drilling rig mobilization	32.3
	Equipment and Supplies	6.9
	Drill cuttings transport	57.3
	Transport (fuel, water, personnel)	57.1
	Heavy equipment use	3,898.6
	Generator to power drilling rig and camp site	5,713.0
Testing Activity	Generator to power beam pump	89.3
	Flaring	4,816.2
Abandonment and Restoration	Heavy Equipment and transportation.	276.5
Total per well		15,012.9

2.8.6.4.2.3 Total

This entire project is estimated to generate a worst case maximum of 30,025.8 tonnes of CO2 equivalent for two well sites, based on 88 days of drilling per well and 7 days of flaring at all well sites. Air emissions and their impacts are discussed in the Impact Assessment **Chapter 5**.

2.8.6.5 Noise

During the construction phase, noise will primarily be generated from project vehicles, generators, and construction equipment such as bulldozer, backhoe, grader, dump trucks and others (**Table 2-22**).

Table 2-22: Noise Level from Construction and Drilling Equipment

Source	Maximum dB(A) at source	Number of Sources at one time
Bulldozer	85	1
Backhoe	80	1
Grader	85	1
Compactor	82	1
Heavy trucks (dump trucks)	88	1
Water truck (Lmax truck)	84	1
Jack-hammer	80	1
Drilling Rig (auger)	85	1
Generator (for drilling & testing)	81	4
Flue gas.	77.6	1

Source: US Federal Highway Administration, US Department of Transportation, 2008; reference distance 50 ft (15.24 m); (http://ops.fhwa.dot.gov/wz/workshops/accessible/Schexnayder_paper.htm)

During drilling phase, noise will be generated from project vehicles, generators and drilling operations. Noise will be generated from equipment and flaring during well testing operations. Potential impacts from noise during the well abandonment phase will be virtually identical to those in the construction phase. The same mitigation measures should be applied, and the impact significance will be similar.

2.8.6.6 Fluids Produced from the Separators during Testing

Should testing be conducted, the produced reservoir fluids will be separated at the surface. The gas portion will be flared while the liquid portion will be separated into water and a condensate-water emulsion. The water portion will be stored in the waste pit. The condensate-water emulsion will be moved to a series of settling tanks where natural buoyancy of the emulsion breaks down, separating the water and condensate phases further. The separated water will be stored in the waste pit and the remaining condensate and emulsion will be collected in storage tanks for disposal.

2.8.6.6.1 Management and Disposal of Condensate

The expected condensate-to-gas ratio is 5 bbl (0.795 m^3) per 1 mmscfg. Based on a worst case of a 10 mmscfgd during a LTP test for 22 days – equating to an average condensate production of 50 bbl (7.95m^3) per day, the total condensate production potential could be 1,100 bbl (175 m^3).

Condensate will be decanted from the settling tanks and stored to await disposal. After analysis the condensate will be transported by road tanker to the kiln for incineration for directly flared on site. A detailed manifest and chain-of-custody will be maintained for the management of condensate. PCMI is in contractual negotiations with several waste management companies to provide waste disposal services.

2.8.6.7 Summary of Waste Inventories

A summary listing of wastes generated by this proposed project is provided in **Table 2-23**. Should the well encounter technical difficulties that require contingency wells to be drilled (**Section 2.8.3.4.3**), additional waste will be generated (drilling mud and cuttings, domestic waste, industrial waste, hazardous waste and sewage and grey water).

Table 2-23: Waste Inventory (per Well Site)

Waste Type	Estimated Quantity	Disposal Plan
1) Drill cuttings	2500 MT	Transported to a permitted cement kiln for incineration.
2) Water-Based Mud (WBM)	< 100 m3	Transported to a permitted cement kiln for incineration.
3) Unused chemicals	N/A	Returned to supplier or kept for future drilling campaigns.
4) Domestic waste	Construction: 50 kg/day Drilling: 130 kg/day Well abandonment: 30 kg/day Site restoration: 25 kg/day	**Biodegradable waste** (food waste) will be segregated and transferred to local government waste disposal facilities (like YCDC in Yangon)**.** **Recycle waste** shall be also handed over or sold to local for further recycle or reuse. **General Non-Hazardous waste except recycle and biodegradable waste** shall be transferred to local government waste disposal facilities (like YCDC in Yangon) or disposed at a site approved by Local Authority.
5) Industrial waste (scrap metal, plastic, paper, wood, glass etc.)	N/A	Recyclable or reusable waste to be sold or donated. Other non-recyclable or reusable waste will disposed at a site approved by Local Authority.
6) Hazardous waste	Drilling: 500 kg/month	**Medical or clinical waste** shall be transferred to contracted local hospital for further disposal. **General Hazardous Waste** - Transported to a permitted cement kiln for incineration. Batteries will be returned to source.
7) Sanitary wastewater	Construction: ~3 m3/day Drilling: ~7.8 m3/day Well abandonment: ~1.8 m3/day Site Restoration: ~1.5 m3/day	Treated on site by septic tank.

2.9 Health, Safety and Environmental Management

PETRONAS Carigali is committed to Health, Safety and Environment (HSE) and shall take reasonable and practicable steps to prevent and eliminate the risk of personal injury, occupational illnesses and damage to properties. PETRONAS Carigali shall take proactive steps and measures in the protection and the conservation of the environment.

In line with PETRONAS' Group Policy Statement on Health, Safety and Environment, PETRONAS Carigali shall therefore:

Comply with HSE legal requirements wherever we operate;

Implement effective risk control measures in all our activities; including operations covering acquisition, exploration, development, production and abandonment, which will eliminate, prevent or reduce risks to a level as low as reasonably practicable(ALARP);

Build an effective and resilient HSE Management System as an integral part of our business philosophy and cultivate a desired HSE Culture;

Provide competent workforce, adequate resources and organisation in all our activities in ensuring a safe environment at the workplace;

Promote HSE engagement between joint venture partners, regulatory authorities, Contractors and key stakeholders;

Drive and promote continuous improvement in HSE performance;

Establish effective crisis management and emergency response capabilities in all our operations.

PETRONAS Carigali requires all its employees, Contractors and others to strictly adhere to this policy at all times. Joint venture partners of PETRONAS Carigali are expected to implement an effective HSE Management System which is in line with industry best practices.

2.9.1 Potential for Accidents, Hazards and Emergencies

PCMI will ensure the contractor will have an Emergency Response Procedures Manual that includes response procedures for blowout, fire, earthquake, medical emergency, release of hazardous/toxic substances, etc. PCMI has an Emergency Response Plan (ERP) that will be updated specifically for each well site operations and site specific location.

This ERP is considered a standard E&P Emergency Management System and is based on Industry accepted standards and practices (e.g. ISO, BCI, EMI, BS etc.). Topics of the ERP are outlined in **Table 2-24.**

Table 2-24: Emergency Response Plan

Main Sections	Topics
Procedure & Responsibilities	Drilling Superintendent On-Scene Commander PIC (Person-In-Charge)
Emergency Organisation	Introduction Emergency Response Philosophy Overview of the Response Organisation
Emergency Arrangements And Facilities	Major gas release / H_2S Explosion / fire Accommodation fire Blow-out Oil spill land Hazmat spill Helicopter incident Man missing Loss or damage of radioactive source Traffic accident Medevac Bomb threat / terrorist act Fatality On-scene Commander Field Arrangements and facilities
Risk Management	Major Hazards Emergency Plans

In addition, PCMI has developed:

Blowout Contingency Plan

2.9.2 Emergency Response

2.9.2.1 Emergency Response Framework

During an emergency situation, the centre of operation is known as the Emergency Management Centre (EMC). All information and coordination, regarding emergency management operations, shall flow through the EMC. The centre is staffed by the Emergency Management Team (EMT) and shall include one Incident Commander and members of the appointed representatives.

Within this framework, the EMT can provide, equipment, supplies, facilities, managerial and technical services in support of site ERT mitigation and control efforts. The Incident Commander and the other team members shall be involved in providing all required supports.

Under PETRONAS Incident Command System, the HSE Department has been delegated with primary responsibility for coordinating PCML emergency preparedness, planning, management, and emergency assistance functions. The department also has been delegated with responsibility for establishing emergency assistance policy. In this stewardship role, the department has the lead in developing this plan.

2.9.2.2 Management of Efforts

The overall responsibility for the safety of the site rests with the PIC. He has the authority and responsibility to take the immediate response actions required to control any emergency; including directly mobilising or requesting the use of necessary resources such as aircraft, materials, etc., if required.

At Yangon office, the IC will be the overall in charge and responsible for directing key personnel, authorising or obtaining authorisation of any funds required for materials, equipment, contract services or specialist personnel necessary to bring the emergency under control. It is the IC responsibility to establish contact and advise the management at PCSB Head Office, brief them on the emergency and the actions being taken.

The IC shall respond to all requests for assistance from the PIC without delay. It is the sole responsibility of the PIC to identify such requirements, and of the IC and EMT to implement them. If outside assistance is required from other Agencies, such as for the use of equipment, all requests will be channelled through the IC. Requirements should subsequently be confirmed by fax or in writing. It will be the IC responsibility to ensure that all relevant authorities and organisations are informed and reports subsequently prepared and submitted.

2.9.2.3 Chain of Command

In the absence of the Duty Incident Commander for any reason, the replacement will be proposed by HSE Department and agreed by GM to act as IC. Once PCML EMT is exhausted, back up EMT will be notified by HSE Department and agreed by General Manager. Back up EMT team will keep on handling the emergency situation.

2.9.2.4 Resource Coordination and Management

To the maximum extent possible, internal local resources at site shall be used as the first line of support for emergency recovery operations. Arrangements and working collaboration should be made with other agencies as an additional option for resource support after an emergency declaration.

Once PCML resources and capabilities are exhausted, HQ EMT assistance may be provided to support operational requirements and priorities. Utilization can be requested from the EMT.

Resources are acquired using the standard company procurement vehicle such as a purchase order, blanket purchase agreement, or contract. Additionally, the IC may authorize purchase under the emergency provision power directing completion of a specific task.

2.9.2.5 Event Classification

PCMI three-tiered response definitions provide the following classification.

Tier 1- Minor

A situation where there is no danger to life and where risk of damage to property and environment is minimal. The emergency is within the control of the Facility/ vessel, Operation and OPU.

Tier 2 - Major

A situation where there is danger to life and risk of damage to property and environment. The emergency is within the control of the Facility/ vessel, Operation and OPU with limited external assistance.

Tier 3 - Crisis

A situation where there is a potential for multiple fatalities and severe damage to property and the environment involving neighbouring sites and surrounding communities. The emergency is clearly beyond the capacity of the Facility/ vessel, Operation, OPU and Business to control and consequently requires action from PETRONAS corporate, government or other external parties.

2.9.2.6 EMERGENCY RESPONSE ORGANISATIONS

All operational activities (such as site survey, seismic acquisition survey, drilling, construction and hook-up) are controlled by PCSB Office in Kuala Lumpur; Malaysia the Yangon Office shall always in direct contact with the site location on a day to day basis on operational matters.

Site Facility

The response to an emergency occurring at the site or facility is undertaken by the facility Emergency Response Team, under the direct supervision of the PIC. The site emergency response team comprises of personnel that are assigned to carry out specific emergency duties. (refer to site Emergency Response Plan for details).

At minimum, the composition of the site ERT are as follow:

For manned facilities, two (2) complete DCTs shall be in place consisting of the following:

a) 1 x OSC
b) 1 x Emergency Operation Centre (EOC) Support (e.g. RO)
c) 1 x DCT Commander
d) 2 x DCT Team, each comprising 1 x DCT Leader,
   2 x Fire Fighter,
   2 x Fire Fighter with Breathing Apparatus (BA) and
   1 BA Coordinator

The team shall be involved, when responding to emergency situation(s) and carry out mitigation and control (first responder), pending arrival of emergency assistance and supports.

PCML Emergency Control Centre (ECC)

The PCML Emergency Control Centre (ECC) is located at Training Building, Yangon Office. The ECC is utilized by the PCML Emergency Management Team (EMT) when managing emergencies occurring in Myanmar Operations.

The EMT comprises of core group and support personnel. These personnel are assisted (when mobilized) by the PCSB HQ-EMT, based at Head Office, Kuala Lumpur. The core team members are as follows and shown in **Figure 2-37** which is supposed to be Tier 1 & 2

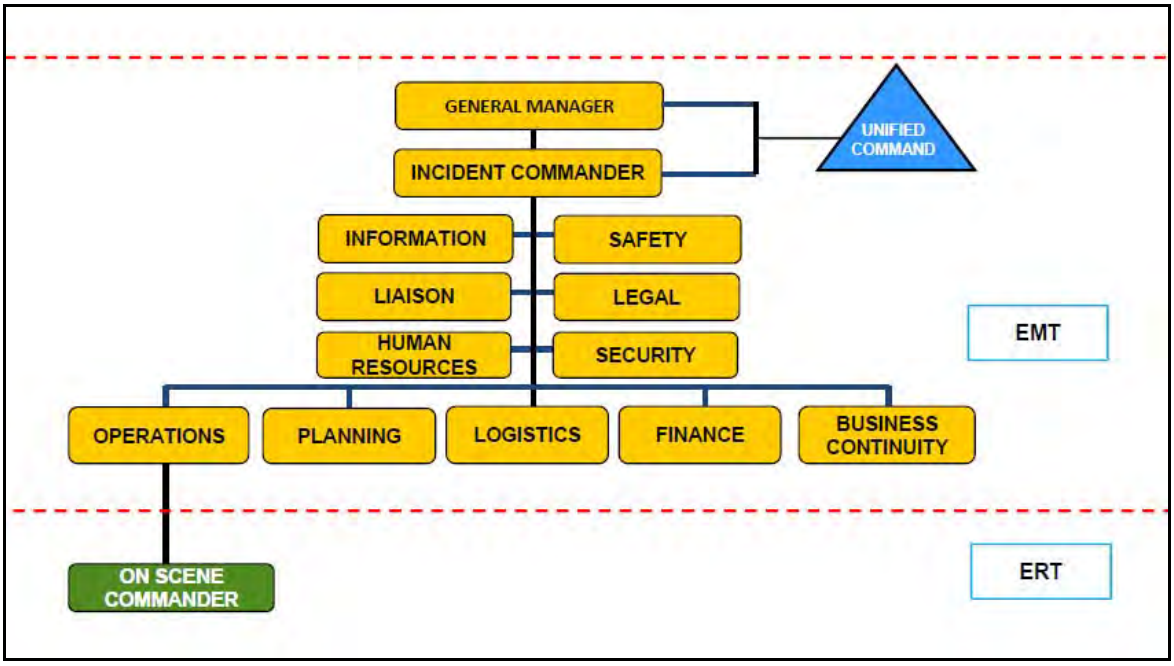
Emergency:

a) Incident Commander
b) Operations Section Chief
c) Planning Section Chief
d) Logistics Section Chief
e) Finance and HR Section Chief.
f) HSE & Liaison Officer
g) Computer Operator

The core group is supported by the following group but not limited to as IC can call out other subject matter experts upon agreed by GM.

a) Administration Support Team.
b) Next-Of-Kin Response Team
c) Media Response Team (Information)

d) IT/Telecommunications Team
e) Technical/Specialist Group
f) Contractor Representative



Source: PCMI, 2014

Figure 2-37: PCMI **Emergency Response and Coordination Parties**

2.9.2.7 PCSB HQ Office, Kuala Lumpur

The PCSB Emergency Control Centre (ECC) is at PCSB Head Office, Kuala Lumpur. The ECC is used by Head Office EMT, when coordinating emergency activities and providing supports to PCSB-OPU (local and International).

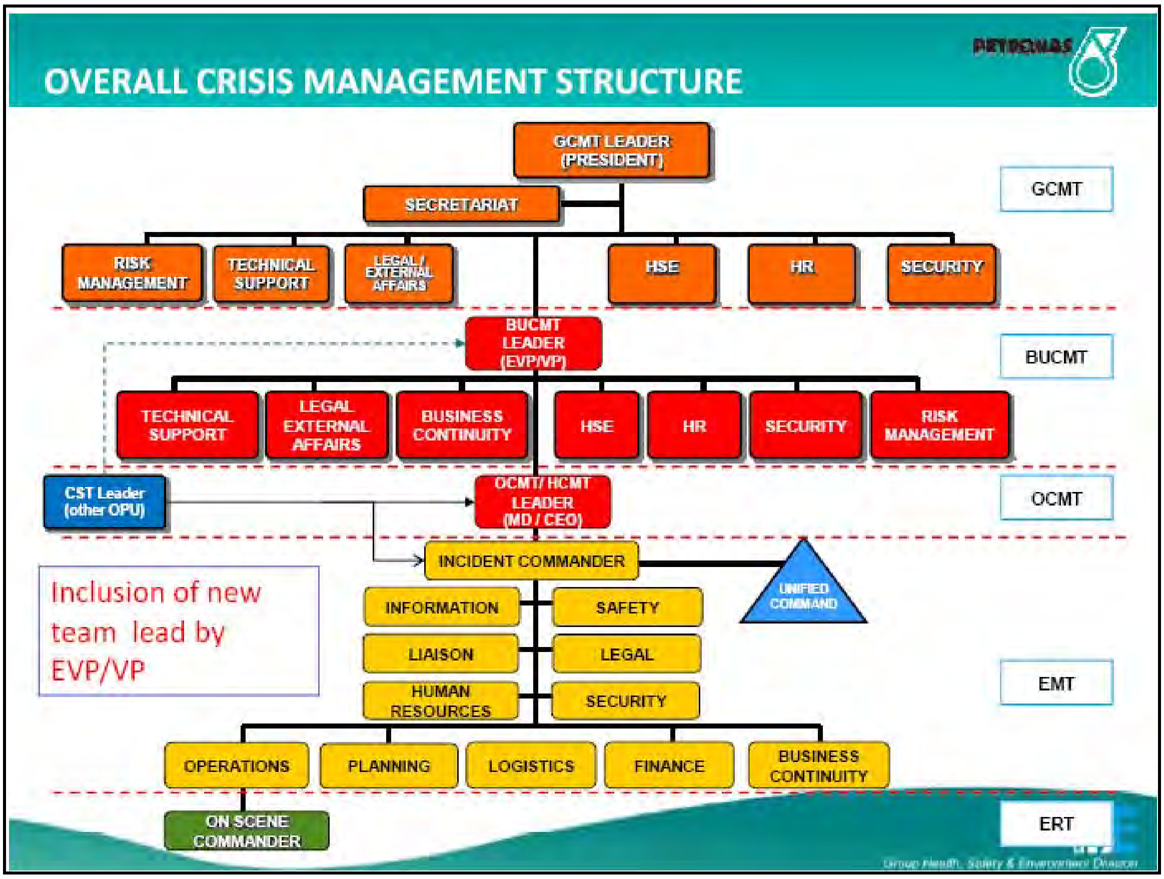
The corporate EMT is supported by appointed emergency support team members. The Corporate EMT will also organize supports from other OPUs to the affected OPU at the request of the Incident Commander.

2.9.2.8 PETRONAS Headquarters, Kuala Lumpur

The OPU Crisis Management Team (OCMT) at PETRONAS Headquarters is involved in an emergency, when it escalates into a crisis situation. The team primary roles are to address strategic/tactical group issues and policy guidance to PCSB and OPU team members, when necessary.

PETRONAS Head Office is notified of emergencies by PCSB-HQ IC. Press releases (beside the Holding Statement) must be approved by the President office before the official release.

The overall crisis management structure is as per **Figure 2-38**.



Source: PCMI, 2014

Figure 2-38: Overall Crisis Management Structure

2.9.2.9 Community and External Communication

In the event of any emergency it is necessary to notify the Myanmar Government. Unless specifically advised otherwise, the only government agency to be notified will be the Myanmar Oil & Gas Enterprise (MOGE) who is the official operator of each PSC (Production Sharing Contract).

MOGE require to be notified immediately of any incident. Initial contact should be bytelephone or radio. This should be followed up by fax as soon as possible. When cleared by the PCML General Manager, the EMT's IC on duty who has the necessary contact numbers will initiate contact with MOGE.

MOGE will then contact any other government agencies required i.e. police, medical, military, customs, immigration etc. Where required, MOGE should be asked to assist in dealing with other government agencies for issues such as arranging clearance for emergency flights, immigration matters and liaison with the Armed Forces if required. For example, the Armed Forces may be involved in assisting in maritime or land based search and rescue operations or in dealing with terrorist threat or other security issues.

Contact with Malaysian or other embassies in Myanmar may be necessary in connection with notification of Next of Kin, repatriation of casualties or fatalities, evacuation of personnel due to socio-political developments and other issues. The General Manager will decide whether or not and when such contact will be initiated.

2.9.3 Gas, Smoke and Fire Detection Systems

The following detection systems are installed at each drilling site.

2.9.3.1 Gas Detection

- **H_2S Monitoring System (portable and fixed)**
- **Combustible Gas Monitoring System (portable and fixed)**
- **Explosimeters**
- **CO_2 Gas Detectors (portable)**
- **O_2 Meter (portable)**
- **Fire/Smoke Detectors**
- **Fire detectors/alarms**
- **Smoke detectors/alarms**

2.9.3.2 Fire Fighting Systems

Rig Site

Each rig site will be equipped with two separate fire fighting systems designed for different purposes. The first is a comprehensive set fire extinguishers, the second is a water deluge system explained below.

Fire Extinguishers

A comprehensive set of dry chemical all-purpose fire extinguishers will be positioned around the well site, within accommodation cabins, equipment cabins, adjacent to equipment units and around the rig floor:

- The majority of these will be standard size 9 kg hand portable extinguishers, suitable for containing or extinguishing minor fires.
- A set of larger 25 kg extinguishers will be positioned strategically around the rig site to act as back-up in case of a larger fire or prolonged containment is required.
- A set of spare extinguishers will be kept at both the dry storage area and the equipment store.
- Larger 50-kg foam extinguishers will be positioned where fuel and lubricants are stored.

The rig contractor will be responsible for ensuring that all extinguishers are serviced and certified before mobilisation and periodically checked during the operation. PCMI’s rig manager will be responsible for verifying this process.

The rig contractor is responsible for training their crew in fire fighting techniques and to hold regular practice drills. PCMI’s rig manager will be responsible for verifying this process.

Water Deluge System

The rig will be equipped with a water deluge system, with banks of spray-heads surrounding the well head and BOP, the solids removal chokes of the drilling surface equipment and the flare stack.

Water for this deluge system will be provided from the water storage tanks by a series of electrical pumps, which will be permanently installed and equipped with independent diesel generators to ensure they continue to function even if the rig’s electrical generators are off line or power lines are severed during an incident.

This system is designed to contain or prevent a fire resulting from any leaks or ruptures in the hydrocarbon handling system when the well is flowing during well testing. It will protect the major pieces of equipment until the well is shut in by the blowout preventers and the flow of hydrocarbons stopped.

Accommodation Camp Site

A comprehensive set of dry chemical all-purpose fire extinguishers will be positioned around the accommodation camp site, within all accommodation cabins, utility cabins and adjacent to equipment units:

- The majority of these will be standard size 9 kg hand portable extinguishers, suitable for containing or extinguishing minor fires.
- A set of larger 25 kg extinguishers will be positioned strategically around the site to act as back-up in case of a larger fire or prolonged containment is required.
- A set of spare extinguishers will be stored on the site.
- Larger 50 kg foam extinguishers will be positioned where fuel and lubricants are stored.

The rig contractor, who is also providing the accommodation camp trailers and equipment, will be responsible for ensuring that all extinguishers are serviced and certified before mobilisation and periodically during the operation. PCMI’s rig manager will be responsible for verifying this process.

The rig contractor is responsible for training their crew in fire fighting techniques and to hold regular practice drills. PCMI’s rig manager will be responsible for verifying this process.

Fire fighting Facilities in Project Area

In the event of a large fire beyond the control of the designated crew fire team members on site, then necessary efforts must be made to seek professional fire fighting services.

2.10 Land Acquisition Plan

The land on which the well sites and access roads will be constructed is privately owned. The land for the project sites and access roads will be purchased from the owners as per mutual agreement between PCMI, MOGE and the owners.

The Land Acquisition needs to be carried out in a clear and transparent manner which is in accordance to national regulations and safeguards human rights of land owners.

A Grievance Mechanism has been established in the form of HSE Complaint Process Flow (**Section 6.5.7.3**). Grievance mechanism is a mechanism through which communities and individuals affected by the project activities can formally communicate or channel their concern and grievances to the company and facilitate resolutions that are mutually acceptable by the parties, within a reasonable timeframe. It is a management tool designed to help address stakeholder concerns promptly and facilitate a trustworthy and constructive relationship.

Also a Community Liaison Officers (CLO) will be appointed to facilitate the grievance process and also to provide information/clarification to the local community.

CHAPTER 3

ENVIRONMENTAL SETTING

3 ENVIRONMENTAL SETTING

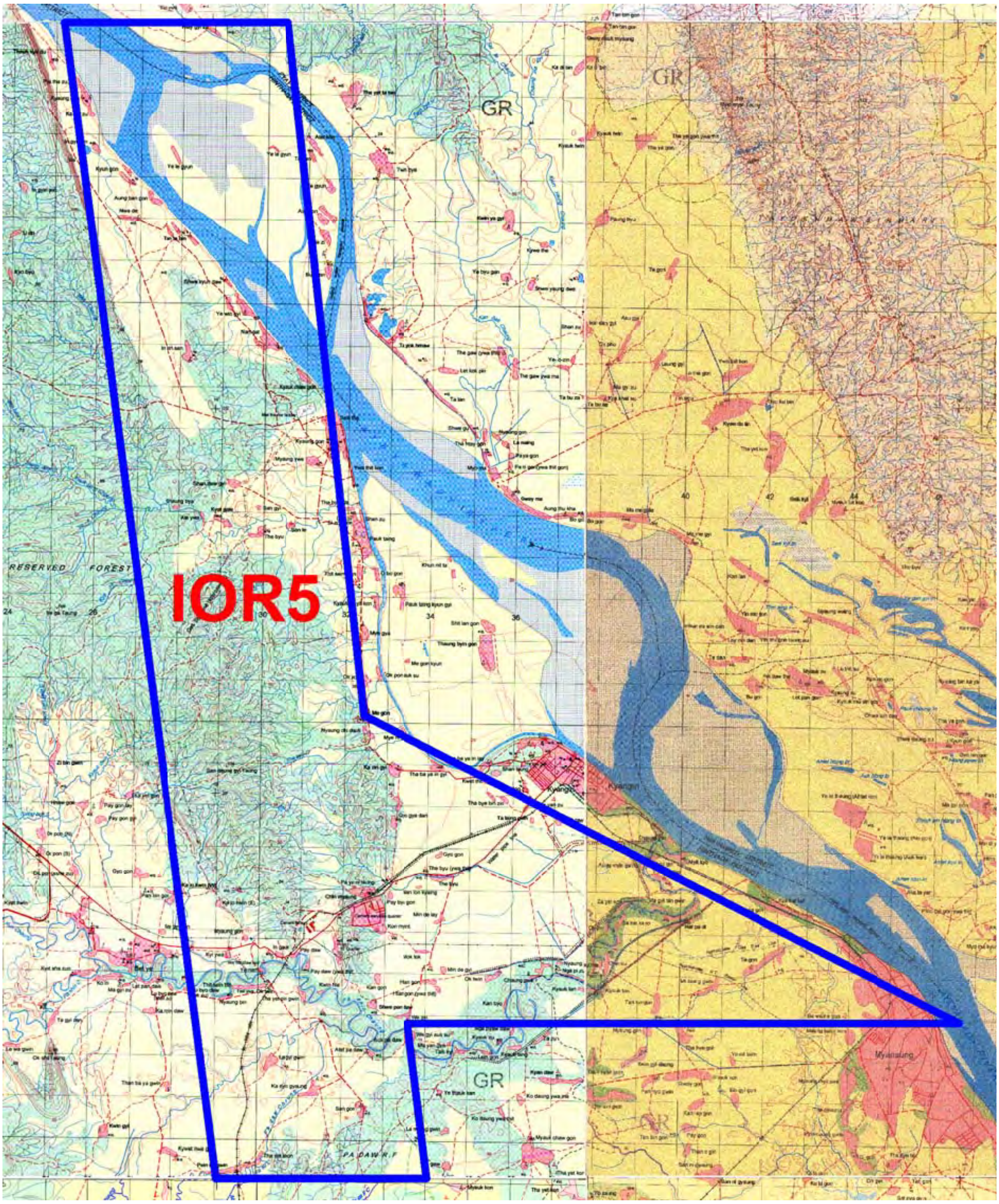
3.1 Introduction

This section presents the existing environmental, social, economic and health conditions of the project area, including physical and biological resources, human use values, and quality-of-life values.

3.1.1 Study Area

The project Study Area is centred on Block IOR-5 for the purpose of describing baseline environmental, socio-economic and health conditions potentially affected by the project and affecting the project (**Figure 3-1**). Where appropriate for the purpose of establishing context, data and observations from the region are also referenced. The Local Study Area’s focus is on the proposed seismic acquisition area and adjacent biophysical, and land use within 5 km of seismic boundary. The baseline sampling program was conducted throughout the seismic acquisition area.

Block IOR-5 is situated in primarily within Htantabin Area of the Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km. The block area includes land within Bago and Ayeyarwaddy regions. The surrounding area is predominantly agricultural with reserve-forested area and numerous small to medium sized communities. The Ayerwaddy River is flowing at the eastern boundary of the block. The nearest major town is situated towards the east of the block name Kyangin. While a smaller town name Bat Ye is situated towards the west of IOR-5.



Source: PCMI, 2014

Figure 3-1: Project Location

Scope of Study

The environmental setting of the Project consists of physical (earth, air, water, acoustic), biological, and human components. The human component includes land use, demographics, socio-economic, cultural and quality of life aspects. The study is focused on the conditions found within the block, however, broader regional information is provided where it provides relevant context to the assessment.

3.1.1.1 Data Sources

Primary Data

For the baseline survey, a detailed, field sampling plan was developed to supplement the existing secondary database for the Study Area.

A total of 8 community-based sampling locations were selected in the block (**Table 3-1**). Those locations were in or approximate to these communities. The sampling locations for soil, surface water and groundwater are shown in **Figure 3-2**.

Table 3-1: Community environmental and socio-economic sampling sites.

No.	Date	Village
1	7.11.2014	Shin Su
2	10.11.2014	Kone Myint
3	10.11.2014	Pan Pin Kone
4	11.11.2014	Lel Gyi Kwin
5	11.11.2014	San Kone
6	12.11.2014	Lein Khon
7	12.11.2014	Kyat Kha lay
8	13.11.2014	Chaung Hpyar

Primary data collected during the field survey included the following:

- Surface water samples
- Groundwater samples (from water wells)
- Local perception of water quality
- Air quality samples
- Local perception of air quality and climate change
- Soil samples
- Baseline Noise Measurements

- Flora and fauna (habitat and presence based on observations and local knowledge)
- Land Use and landscape observations
- Infrastructure and services
- Socio-economic and demographic data
- Health and Health Care Data
- Cultural heritage/archaeology
- Local perspective, concerns and interests regarding oil and gas development

The geographical scope of the baseline survey provided an overview of site conditions believed representative of the Block IOR-5 seismic survey and exploration drilling program.

The specific methodologies and results from the analyses performed for Block IOR-5 are discussed in the corresponding sections in this report.

Secondary Data Sources

Secondary data sources came from literature, relevant authorities in the project area.

The secondary data sources are cited throughout this report, and listed in the references section.

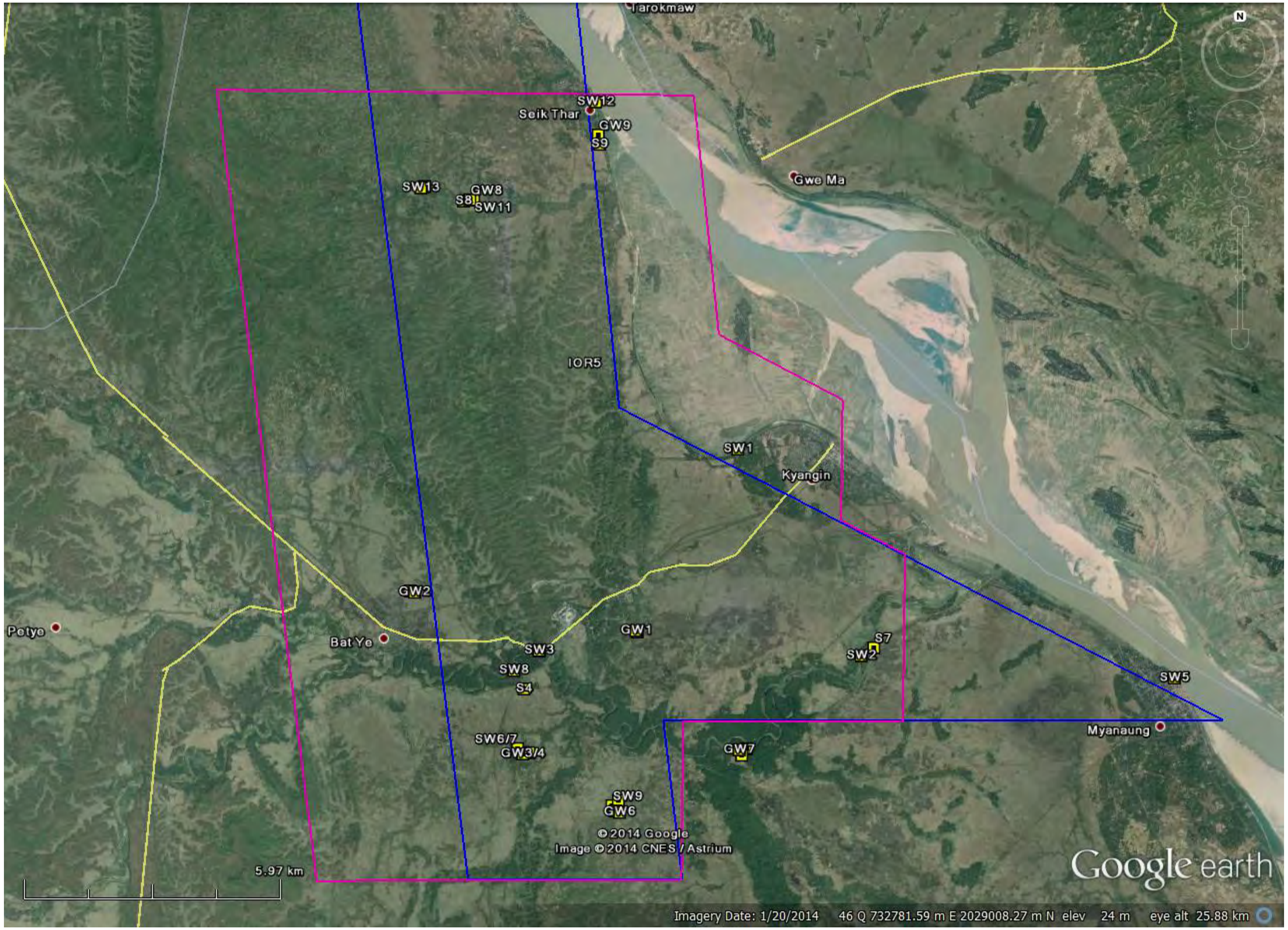


Figure 3-2: Baseline Sampling Program in IOR-5

3.2 Physical Environment

3.2.1 Topography

The main geographic features of Myanmar can be divided into four physiogeographic zones, characterized by elongated north-south topographic trends (**Figure 3-3**). The zones are:

- Rakhine Coastal Area
- Western Ranges (Rakhine Mountain Ranges)
- Central Lowlands
- Eastern Highlands

The PCMI seismic survey & exploration drilling project is located entirely in the Central Lowlands physiographic zone and predominantly occupies generally flat in the eastern part towards the Ayeyarwady River. The eastern flat land is mostly cultivated with paddy plant and it's the main source of income for the people in this area. Towards the North Western part of the block the topography is elevated and hilly (Htantabin anticline area) (**Figure 3-3**).

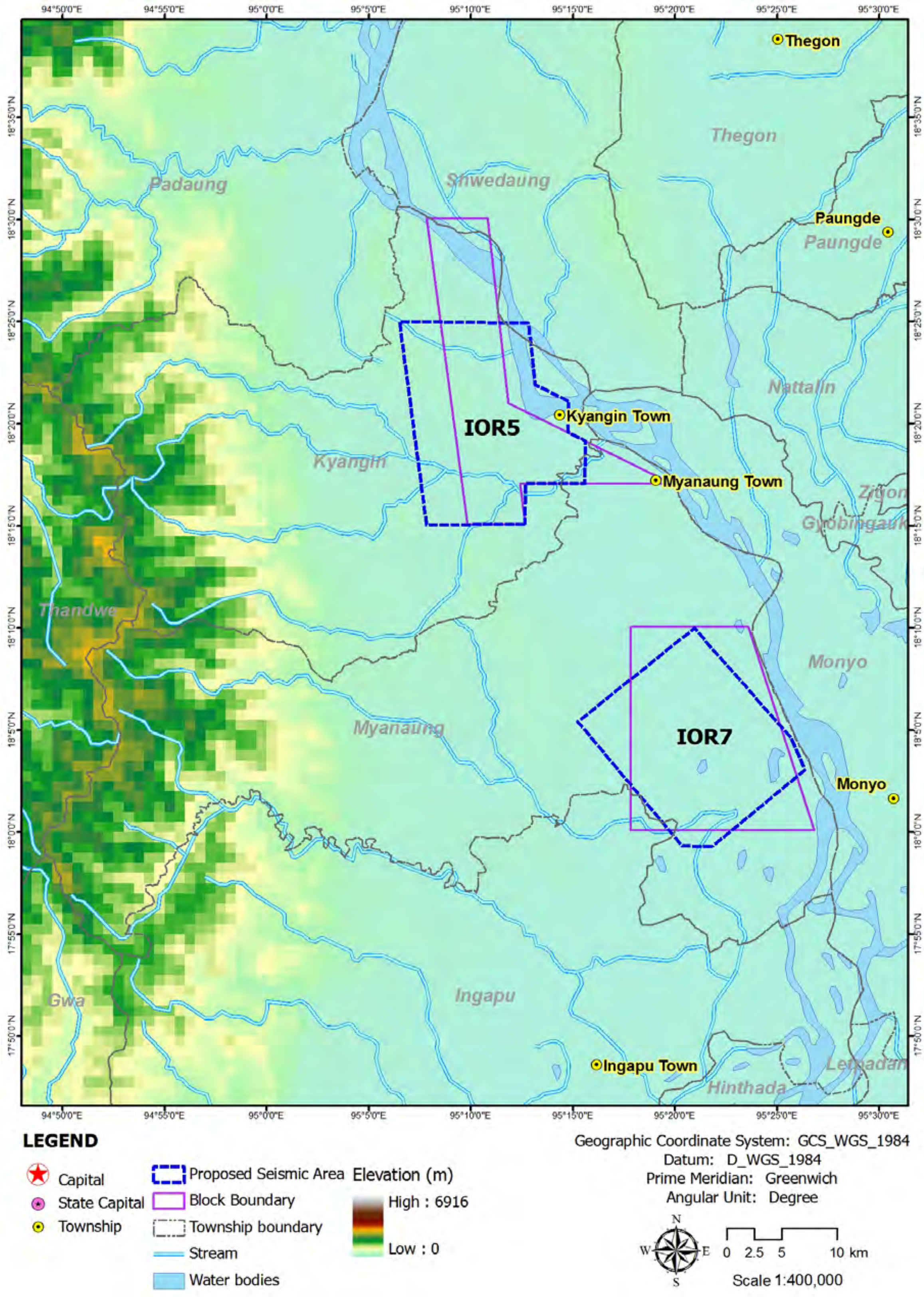


Figure 3-3: Myanmar’s Geographic Zones Showing Block IOR-5

3.2.2 Climate

The climate of the study area is controlled by the monsoon circulation system of South East Asia, which is also influenced by the presence of major landforms. The mountain ranges in Myanmar generally run north-south and act as effective climate barriers for the southwest monsoon (approx. end of May through October) in the summer and the northeast monsoon in the winter (approx. December through April). The Central Lowlands of Myanmar, which includes IOR-5, lies within the following climatic zones:

- Tropical savannah climate (around the Dry Zone) with more pronounced dry seasons between the monsoon rains and thus lower precipitation, but similar mean temperatures to those in the tropical monsoon climate.
- Tropical steppe climate (Dry Zone), semi-arid climate with less than 1,250 mm of precipitation per annum and mean annual temperatures in excess of 27° C.

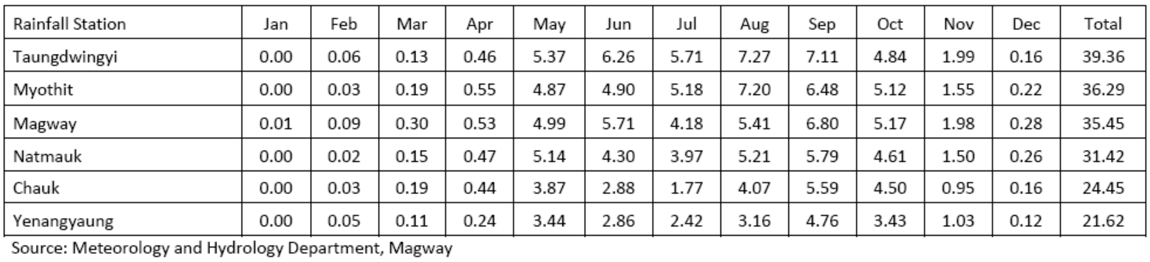
3.2.2.1 Temperature and Precipitation

Temperature condition of Magway District is described on reliable data obtained from Meteorology and Hydrology Department of Magway. Block IOR-5 lies partly in the Bago District of Magway Region. The area lies in the tropical zone and consequently it has a considerably high temperature. The temperature conditions are studied by using the data from Magway weather station. (REM, 2012)

During the 20-year period from 1988 to 2007, Magway has 37.74˚ C in average maximum temperature, 27.05˚ C in average mean temperature and 16.34˚ C in average minimum temperature. January is the coldest month with average mean temperature of 20.73 ˚C. The hottest month is May with average mean temperature of 31.76 ˚C.

In Magway District, the amount of average annual rainfall during the 20-year period from 1988 to 2007, vary from one township to another. According to (**Table 3-2**), Taungdwingyi receives the largest amount of rainfall amounting to 39.36 inches. Myothit and Magway receive the rainfall of 36.29 inches and 35.45 inches. Natmauk gets the rainfall of 31.42 inches. Chauk receives the rainfall of 24.45 inches. (REM, 2012)

Table 3-2: Township Average Annual Rainfall of Magway Region (1988 -2007)



Rainfall Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Taungdwingyi	0.00	0.06	0.13	0.46	5.37	6.26	5.71	7.27	7.11	4.84	1.99	0.16	39.36
Myothit	0.00	0.03	0.19	0.55	4.87	4.90	5.18	7.20	6.48	5.12	1.55	0.22	36.29
Magway	0.01	0.09	0.30	0.53	4.99	5.71	4.18	5.41	6.80	5.17	1.98	0.28	35.45
Natmauk	0.00	0.02	0.15	0.47	5.14	4.30	3.97	5.21	5.79	4.61	1.50	0.26	31.42
Chauk	0.00	0.03	0.19	0.44	3.87	2.88	1.77	4.07	5.59	4.50	0.95	0.16	24.45
Yenangyaung	0.00	0.05	0.11	0.24	3.44	2.86	2.42	3.16	4.76	3.43	1.03	0.12	21.62

Source: Meteorology and Hydrology Department, Magway

Source: REM, 2012

3.2.2.2 Wind

Dominant wind patterns in the Study Area are driven primarily by regular southwest monsoon wind in the rainy season and northeast monsoon wind in the winter or cold-dry season. These wind patterns are mediated by more mountainous terrain to the West and East. Localized meteorological conditions are also influenced by diurnal thermal cycles and cloud cover. Maximum sustained wind speeds can approach 40 km/hr under certain conditions.

3.2.2.3 Local Perception of Climate Change

During IEM's socio economic, health and opinion surveys of 400 households in 8 communities, residents were asked socio-economic questions as well as for information on their environmental perceptions. In regard to climate, 74% interviewed felt the climate had become warmer and 91% indicated that the climate has become drier during the time they have lived in the area (**Chart 3-1** and **Chart 3-2**).

Chart 3-1: Response of villagers in IOR-5 when asked whether they perceived the temperature to have changed since they had been living in the area.

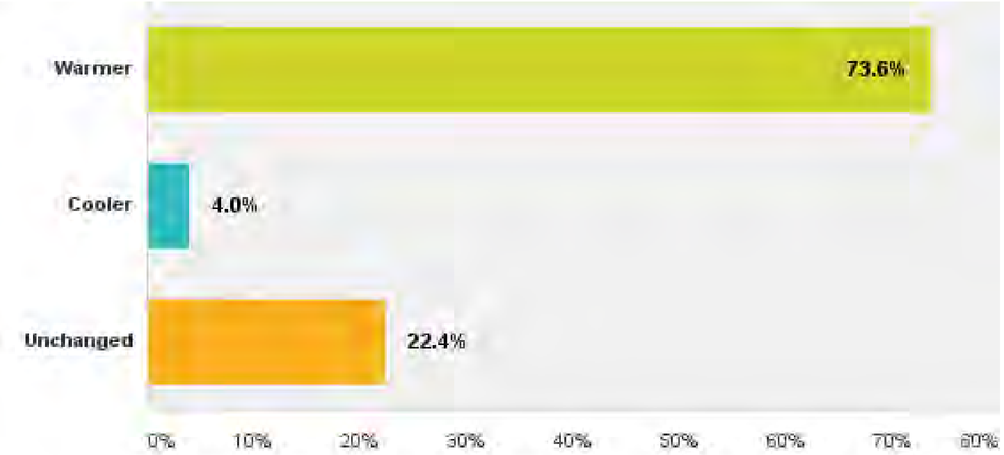
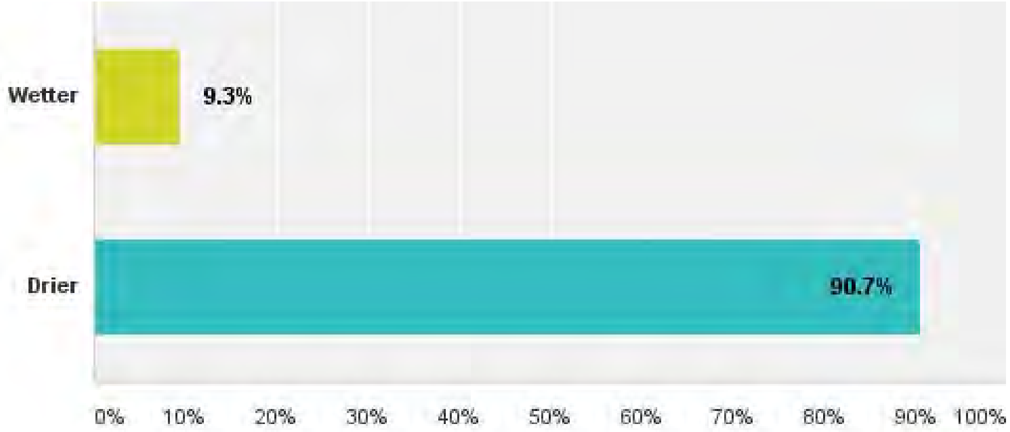


Chart 3-2: Response of villagers in IOR-5 when asked to whether the amount of precipitation had changed since they had been living in the area.



3.2.3 Air Quality

Air quality monitoring stations were deployed in IOR-5 from November 6 - December 6, 2014, to collect ambient air monitoring data along with meteorological data on wind speed, wind direction, temperature and relative humidity. These data are compared with the applicable standards (like the WHO).

3.2.3.1 Objective

The objectives of the assessment are:

- To reveal the existing baseline air quality status of the proposed project area;
- To assess the possible air impact of the proposed project activities in IOR-5;
- To recommend appropriate mitigating measures which could assist the company to comply with the ambient air quality standards.

3.2.3.2 Scope of work

The areas falling within the proposed project area have been considered as the baseline study area and the area within 50 km radius would be assessed for air impacts based on air dispersion model respectively.

The air quality investigations comprise the following components:

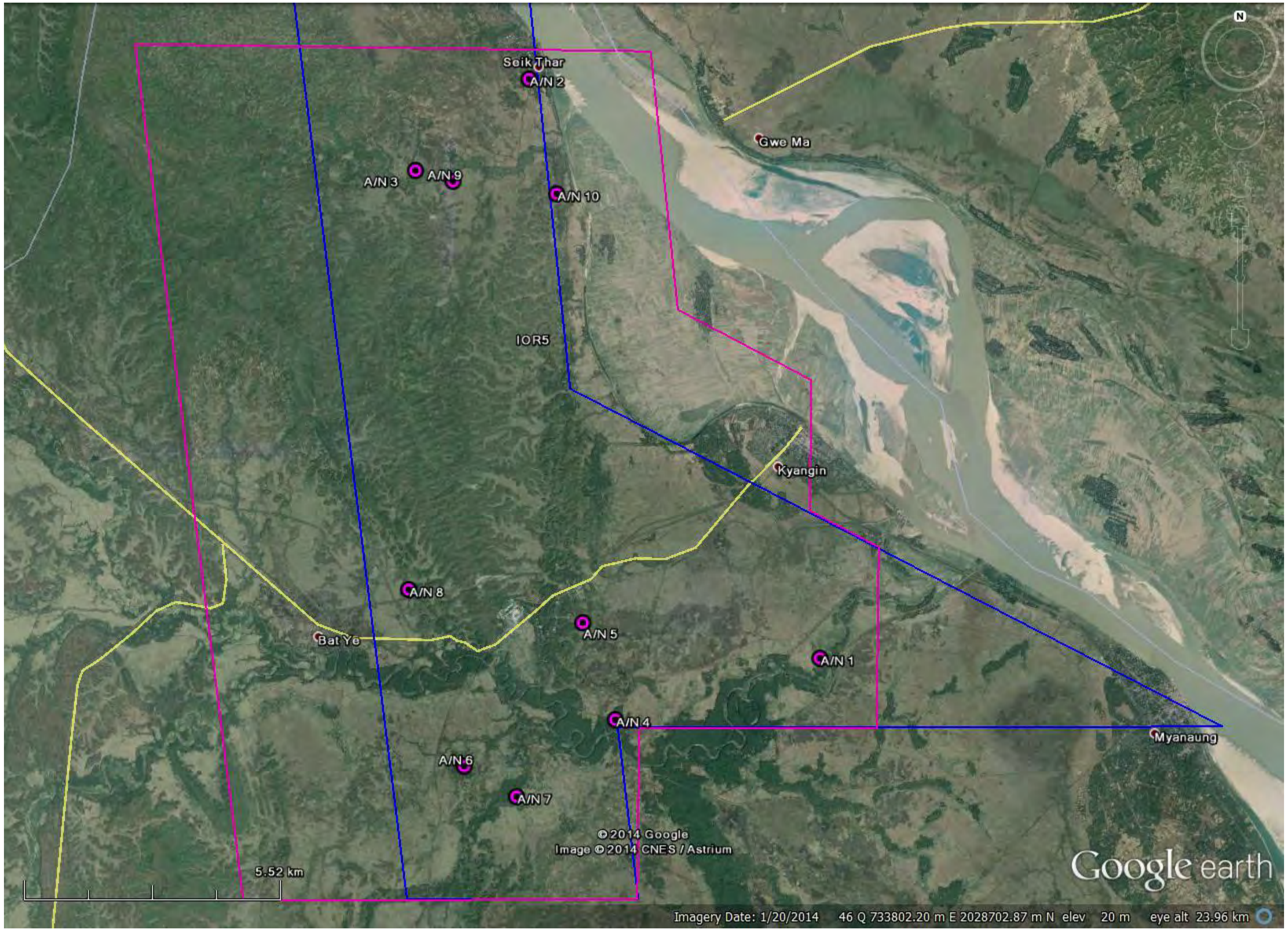
- Assessment on the existing status of the baseline ambient air quality in the vicinity of the proposed area by air quality monitoring along with the comparison with the standards and guidelines;
- Estimation of the potential impacts associated with the proposed project using emissions inventories and Gaussian Plume dispersion model;
- Analysis of the predicted concentration levels (i.e. compliance checking with relevant air quality legislations and guidelines) ;
- Recommendation of mitigation and control measures in order to minimize the potential negative impacts and to develop the environmental management plan as well.

3.2.3.3 Methodology for Study

Locations of air sampling stations is listed in **Table 3-3**, and shown in **Figure 3-4.** The air quality sampling methodology used for this project is described in the subsection which follows.

Table 3-3: Air Sampling Locations for IOR-5 Baseline Survey

Sample	Village	Coordinates (GCS WGS84)		Start Date	End Date
		Latitude	Longitude		
IOR5-V1	Shin Su	18°17'42.5"N	95°14'43.6"E	7.11.2014	8.11.2014
IOR5-V2	Seik Thar	18°24'25.4"N	95°11'35.3"E	27.11.2014	28.11.2014
IOR5-V3	Kyat Kha Lay	18°23'36.20"N	95°09'53.8"E	3.12.2014	4.12.2014
IOR5-V4	Lein Khon	18°16'36.6"N	95°13'25.5"E	25.11.2014	26.11.2014
IOR5-V5	Kone Myint	18°18'16.6"N	95°12'15.6"E	1.12.2014	2.12.2014
IOR5-V6	Lel Gyi Kwin	18°16'40.2"N	95°10'38.2"E	30.11.2014	1.12.2014
IOR5-V7	San Kone	18°16'02.3"N	95°11'42.1"E	24.11.2014	25.11.2014
IOR5-V8	Pan Pin Kone	18°18'43.9"N	95°09'10.4"E	29.11.2014	30.11.2014
IOR5-V9	Chaung Phar	18°23'48.3"N	95°09'20.1"E	2.12.2014	3.12.2014
IOR5-V10	Si Son Gone	18°05'19.3"N	95°20'43.8"E	5.12.2014	6.12.2014



Source: Google Earth and IEM, 2014

Figure 3-4: Air and Noise Sampling Stations in IOR-5

1. Ambient air monitoring instrument

The air monitoring survey will use the HAZ-SCANNER EPAS Wireless Environmental Perimeter Air Monitoring System (EPAS).

(i) Principles

The EPAS, manufactured by EDC/SKC (USA), is a light scattering photometer equipped with a filter sampling system. This dual capability allows for simultaneous real-time and filter measurement. Single-jet impactors are used for particulate size selection and the Total Suspended Particulate Matter (TSPM), Particulate Matter smaller than 10 micrometers (PM10) impactor would be used for this air quality survey.

The highly sensitive EPAS provides real-time determinations and data recordings of airborne particle concentration in $\mu g/m^3$. It provides the minimum, maximum and time-weighted average (TWA) monitoring of gases as well.

This instrument is factory calibrated with the appropriate USEPA certified target gas and correlated with USEPA methods. (Ref: Code of Federal Regulation 40CFR part 53).

The EPAS does not require laboratory analysis to determine concentrations. It operates maximum automation of data collection, uses the optional data logger including Dust Comm Pro Software for PC that provides statistical analysis, graphs, and detailed reports that can be printed for record keeping.

(ii) System Check

Prior to the survey, calibration span and system checks (system flow rate, sensor baseline levels for all parameters, etc.) will be performed on the EPAS to ensure it is operational and ready for monitoring.

The air monitoring instrument will be operated in accordance with the manufacture’s guidelines.

2. Ambient Air monitoring

(i) The sensor intakes

The survey would deploy the sensor intakes based on the sitting criteria as specified in the U.S. Code of Federal Regulations (40 CFR 58 Appendix E - Probe Siting Criteria for Ambient Air Quality Monitoring).The survey will comply with the following guidelines as follows:

- Particulates and gas sensor intakes will be located between 2-3 meters above the ground level;
- Keep unrestricted airflow located away from obstacles so that the distance from the sensor intake is at least twice the height that the obstacle protrudes above the probe;
- Keep unrestricted airflow in an arc of at least 270 degrees around the inlet probe, or 180 degrees if the probe is on the side of a building;
- Would be clear of optical obstructions, including potential obstructions that may move due to wind, human activity, growth of vegetation, etc.;
  - Spacing from trees (10-20 m);
  - Spacing from roadways (10-250 m) depending on the traffic;
- Observe temporary optical obstructions, such as rain, particles, fog, or snow.

(ii) Location of the monitoring sites

As specific well locations had not been selected by PCMI, the monitoring sites were selected based on their being broadly distributed within the seismic area and in proximity to the most sensitive receptors i.e. communities. Exploration drilling is not a long term, emissions intensive activity. It produces emission products typical from diesel combustion though can produce a range of other combustion by-products where well testing and flaring can occur.

(iii) Sampling time and frequency of measurements

The survey will monitor 24hr continuously except battery change after 8hr interval.

(IV) Ambient air parameters to be measured

1) Particulates: TSPM, PM10 } USEPA Criteria air pollutants

2) Gases: NO2, SO2, CO, VOC

3) Meteorology: Temperature, Relative Humidity, Wind Speed, Wind Direction which can have the influence on both local and regional air quality

Particulates (sensor: 90 degree Infra Red Light Scattering)

Calibration: Gravimetric reference NIST Traceable - SAE fine dust- ISO12103-1 Accuracy (± 10% to filter gravimetric SAE fine test dust which falls under the ACGIH/ ISO/CEN criteria.

Detection limit – 1- 20,000 ug/m^3

Gases (sensor: electrochemical)

Calibration: ppm equivalent change/year in lab air (24month warranted)

NO2, Detection limit – (0-5000) ppb

SO2, Detection limit – (0-5000) ppb

CO, Detection limit – (0-100) ppm

VOC (sensor: photoionisation), Detection limit: – (0-100) ppm

Meteorology (EPAS Meters)

Temperature, Detection limit - (-4°C to 140°F) / (-20°C - 60°C)

Relative Humidity, Detection limit – 90-100%

Wind Speed (sensor: 3-cup anemometer), Detection limit - (0 – 125 mph)

Wind Direction (sensor: continuous rotation on potentiometric wind direction vane), Detection limit - (5 – 355 degrees)

3.2.3.4 Relevant Air Quality Legislation and Guidelines

International Environmental Conventions / Protocols and Agreements signed by Ministry of Environmental Conservation & Forestry

In views of legal policies and framework, the Ministry of Environmental Conservation & Forestry has signed/ratified a number of International Environmental conventions / protocols and agreements relating to air quality as detailed in **Table 3-4**.

Table 3-4: International Environmental Conventions/Protocols/Agreements Signed/Ratified by Myanmar

International Environmental Conventions/Protocols/Agreement	Date of Signature	Date of Ratification	Date of Member	Cabinet Approval Date
1. United Nations Framework Convention on Climate Change, New York, 1992 (UNFCCC)	11-6-1992	25-11-1994 (Ratification)		41/94 9-11-1994
2. Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985		24-11-1993 (Ratification)	22-9-1994	46/93
3. Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987		24-11-1993 (Ratification)	22-9-1994	46/93
4. London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990		24-11-1993 (Ratification)	22-9-1994	46/93
5. ASEAN Agreement on Transboundary Haze Pollution	10-6-2002	13-3-2003 (Ratification)		7/2003 (27-2-2003)

The Environmental Conservation Law, 2012

The Pyidaungsu Hluttaw Law No. 9/2012 enacts this law. Among them, Chapter I [2 (e), (k)], Chapter VI [10 (d), (f)], Chapter VII [13 (f), 14, 15], Chapter VIII [17 (e)] are concerned with the ambient air pollution, control and management.

International Air Quality Guidelines and Standards

Air pollutants can have acute (short-term) and/or chronic (long-term) effects on human health/ecosystems. Therefore, air quality guidelines and thresholds are fundamental to effective air quality management at the proposed project site.

In terms of ambient air quality standard, there is no one air quality standard in Myanmar. For the purpose of this analysis baseline air quality conditions were compared with various international guidelines and standards (**Table 3-5**).

Concerning NO2 gas, there is no 24hr average standard for this parameter. Therefore the measured concentrations were compared to annual standards. The longer the averaging period of a standard value the lower the standard value becomes. The comparison of measured concentrations (over 24hr continuous) with an annual standard value is therefore a conservative comparison.

Table 3-5: International ambient air quality standards/guidelines

Pollutant	Averaging Period	Limit/Guideline Value/ Standards (µgm-^{3})	Relevant Standards/Guidelines
NO_2	24 hour	100	NAAQS (USEPA)
		150	World Bank
	1 hour	200	WHO Guideline
		200	EU (human health)
SO_2	24 hours	20	WHO Guideline
		80	NAAQS (USEPA)
		125	World Bank
		125	EU (human health)
	1 hour	365	NAAQS (USEPA)
		350	EU (human health)
CO	8 hour	10,000	WHO Guideline
		10,000	World Bank
		10,000	EU standard
	1 hour	30,000	WHO Guideline
		40,000	NAAQS (USEPA)
$PM_{2.5}$	24 hour	25	WHO
		35	NAAQS (USEPA)
PM10	24 hour	150	NAAQS (USEPA)
		50	WHO
TSPM	24 hour	100	WHO
CO		9 ppm (8hr)	USEPA (NAAQ)

3.2.3.5 Existing Baseline Ambient Air Quality (Gases) in IOR-5

Point (1) Shin Su Village (18°17'42.42"N, 95°14'53.71"E)

Shin Su Village is located in Myanaung Township, Ayeyarwady Region. Baseline NO_2 gas concentrations at Shin Su Village were found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations at Shin Su Village were found to be higher than the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990), but below the World Bank guideline (**Table 3-6, Plate 3-1**).

Table 3-6: Shin Su Village in IOR5-V1

Substance (μg/m^3)	**Date**	**Shin Su Village**	**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
NO_2 (ppb)	Start- 7.11.2014 End-8.11.2014	**43**[a] (3[b]-125[c])	40[1]	100[2]	150[2]
SO_2(ppb)		**81**[a] (1[b]-212[c])	20[2]	80[2]	125[2]
CO (ppm)		**112**[a] (1[b]-1569[c])	NA	9 ppm (8hr) 35ppm (one hr)	NA
VOC(ppm)		**201** [a] (1[b]-21229[c])	NA	NA	9 ppm (8hr)
NH_3 (ppm)		**0**[a] (0[b]-0[c])			
CH_4 (ppm)		**7063.4**[a] (5201[b]-7680[c])			
O_3 (ppb)		**7** [a] (0[b]-18[c])	100ug/m3 (8hr)	0.075ppm (8hr)	
Atomic Radiation (CPM)		**13**[a] (2[b]-26[c])	25-75 CPM (USEPA)		
Remark	(35) numbers of Motorcycle passed during air monitoring.				

[1] Annual mean, [2] 24hr average, NA – not available, [a] Average [b]Min [c]Max

Plate 3-1: Ambient air monitoring station at Shin Su Village

Point (2) Seik Thar Village (18°24'50.9"N, 95°11'26.03"E); IOR5-V2

Seik Thar village is located Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations in Seik Thar village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-7, Plate 3-2**).

Table 3-7: Baseline Gases Quality in Seik Thar village in IOR5-V2

Substance ($\mu g/m^3$)	**Date**	**Seik Thar village**	**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
NO_2 (ppb)	Start-27.11.2014 End-28.11.2014	**34**^{a} (11^{b}-64^{c})	40^{1}	100^{2}	150^{2}
SO_2(ppb)		**41**^{a} (1^{b}-353^{c})	20^{2}	80^{2}	125^{2}
CO (ppm)		**123**^{a} (1^{b}-5481^{c})	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**1** ^{a} (0^{b}-13^{c})			
NH_3 (ppm)		**1**^{a} (0^{b}-4.3^{c})			
CH_4 (ppm)		**5016**^{a} (91^{b}-5769^{c})			
O_3 (ppb)		**7**^{a} (0^{b}-270^{c})	100 ug/m3 (8hr)	0.075 ppm (8hr)	
Atomic Radiation (CPM)		**15**^{a} (4^{b}-30^{c})	25-75 CPM (USEPA)		
Remark	(8) Numbers of cars and (134) numbers of Motorcycle passed during air monitoring. There is an old methanol factory near Seik Thar Village.				

^{1} Annual mean,^{2} 24hr average, NA – not available,^{a} Average ^{b}Min ^{c}Max

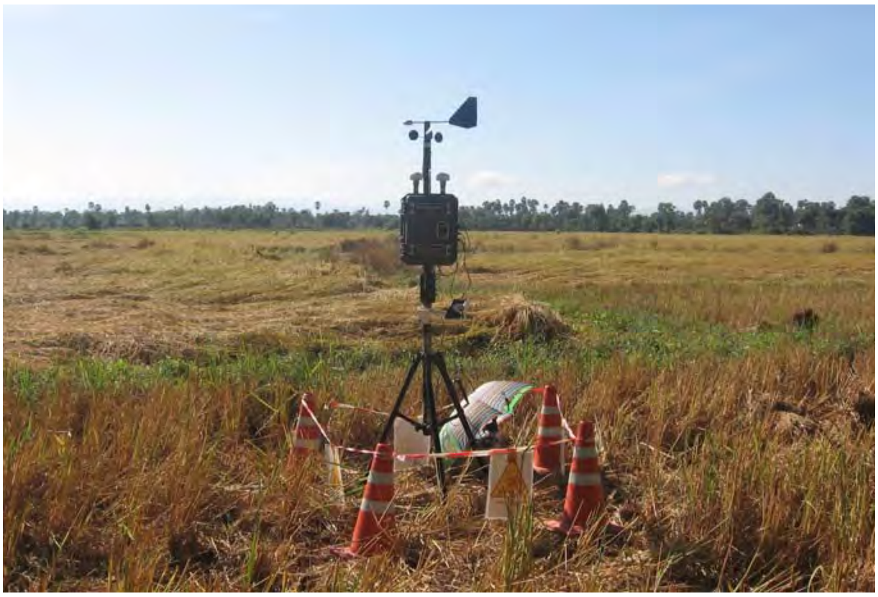


Plate 3-2: Ambient air monitoring station at Seik Thar village

Point (3) Kyat Kha Lay Village (18°23'33.65"N, 95°9'56.97"E); IOR5-V3

Kyat Kha Lay village is located in Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations in Kyat Kha Lay village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-8, Plate 3-3**).

Table 3-8: Baseline Gases Quality in Kyat Kha Lay Village in IOR5-V3

Substance (μg/m^3)	**Date**		**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
		Kyat Kha Lay Village			
NO_2 (ppb)	Start- 3.12.2014 End-4.12.2014	**33**^{a} (1^b-68^c)	40^1	100^2	150^2
SO_2(ppb)		**47**^{a} (1^b-465^c)	20^2	80^2	125^2
CO (ppm)		**137**^{a} (1^b-990^c)	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**346** ^{a} (1^b-11961^c)			
NH_3 (ppm)		**1** ^{a} (0^b-4^c)	NA	NA	9 ppm (8hr)
CH_4 (ppm)		**4941**^{a} (3829^b-5491^c)			
O_3 (ppb)		**5**^{a} (0^b-16^c)	100 ug/m3 (8hr)	0.075 ppm (8hr)	
Atomic Radiation (CPM)		**14**^{a} (4^b-26^c)	25-75 CPM (USEPA)		
Remark	(28) numbers of Motorcycle passed during air monitoring. Agricultural waste open burning is practiced by the villagers in Kyat Kha Lay Village.				

^{1} Annual mean,^{2} 24hr average, NA – not available,^{a} Average ^{b}Min ^{c}Max

Plate 3-3: Ambient air monitoring station at (Location-3) in Kyat Kha Lay in IOR5-V3

Point (4) Lein Khon Village (18°17'6.14"N, 95°12'25.53"E); IOR5-V4

Lein Khon village is located at Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations at Lein Khon village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-9, Plate 3-4**).

Table 3-9: Baseline Gases Quality in Lein Khon Village in IOR5-V4

Substance ($\mu g/m^3$)	**Date**	**Lein Khon Village**	**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
NO_2 (ppb)	Start25.11.2014 End-26.11.2014	**34^a** (20^b-82^c)	40^1	100^2	150^2
SO_2(ppb)		**31^a** (1^b-126^c)	20^2	80^2	125^2
CO (ppm)		**164^a** (1^b-915^c)	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**2^a** (1^b-180^c)	NA	NA	9 ppm (8hr)
NH_3 (ppm)		**1^a** (0^b-4^c)	NA	NA	9 ppm (8hr)
CH_4 (ppm)		**5245.2^a** (4378^b-6042^c)			
O_3 (ppb)		**7^a** (0^b-24^c)	100ug/m3 (8hr)	0.075ppm (8hr)	
Atomic Radiation (CPM)		**14^a** (4^b-28^c)	25-75 CPM (USEPA)		
Remark	No cars and No Motorcycle passed during air monitoring.				

^{1} Annual mean, ^{2} 24hr average, NA – not available, ^{a} Average ^{b}Min ^{c}Max

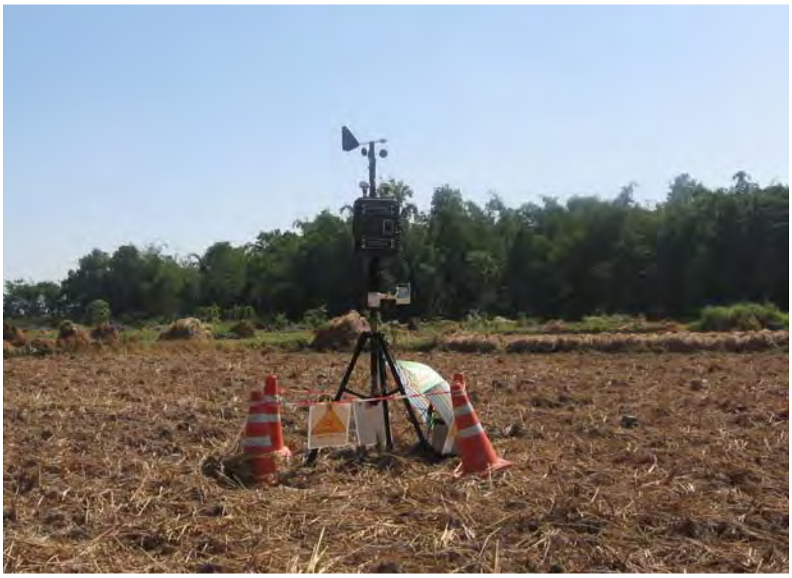


Plate 3-4: Ambient air monitoring station at (Location-1) in Lein Khon village.

Point (5) Kone Myint Village (18°18'18.10"N, 95°12'0.09"E); IOR5-V5

Kone Myint village is located at Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations at Kone Myint village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-10**, **Plate 3-5**).

Table 3-10: Baseline Gases Quality in Kone Myint village in IOR5-V5

Substance ($\mu g/m^3$)	Date	Kone Myint village	WHO Guideline	NAAQS (USEPA)	World Bank Guideline
NO_2 (ppb)	Start- 1.12.2014 End-2.12.2014	**38^a** (1^b-69^c)	40^1	100^2	150^2
SO_2(ppb)		**23^a** (1^b-117^c)	20^2	80^2	125^2
CO (ppm)		**149^a** (1^b-900^c)	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**1^a** (1^b-12^c)	NA	NA	9 ppm (8hr)
NH3 (ppm)		**1^a** (0^b-4^c)	**NA**	NA	9 ppm (8hr)
CH4 (ppm)		**4989^a** (4106^b-5764^c)			
O3 (ppb)		**7^a** (0^b-16^c)	100 ug/m3 (8hr)	0.075 ppm (8hr)	
Atomic Radiation (CPM)		**14^a** (4^b-26^c)	25-75 CPM (USEPA)		
Remark	(14) Number of cars and (337) number of Motorcycle passed during air monitoring. Lots of motorcycles are using in that current time due to traditional play in the village. There is Cement factory near Kone Myint Village.				

^{1} Annual mean, ^{2} 24hr average, NA – not available, ^{a} Average ^{b}Min ^{c}Max

Plate 3-5: Ambient air monitoring station at (Location-2) in Kone Myint village

Point (6) Lel Gyi Kwin Village (18°16'38"N, 95°10'32.96"E); IOR5-V6

Lel Gyi Kwin village is located at Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations at Lel Gyi Kwin village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-11, Plate 3-6**).

Table 3-11: Baseline Gases Quality in Lel Gyi Kwin Village in IOR5-V6

Substance ($\mu g/m^3$)	Date	Lel Gyi Kwin Village	WHO Guideline	NAAQS (USEPA)	World Bank Guideline
NO_2 (ppb)	Start30.11.2014 End-1.12.2014	**36**^{a} (18^{b}-67^{c})	40^{1}	100^{2}	150^{2}
SO_2(ppb)		**39**^{a} (1^{b}-136^{c})	20^{2}	80^{2}	125^{2}
CO (ppm)		**382**^{a} (1^{b}-2747^{c})	NA	9 ppm (8hr) 35ppm (one hr)	NA
VOC(ppm)		**1** ^{a} (1^{b}-38^{c})	NA	NA	9 ppm (8hr)
NH3 (ppm)		**1** ^{a} (0^{b}-4^{c})	**NA**	NA	9 ppm (8hr)
CH4 (ppm)		**4939**^{a} (4103^{b}-5760^{c})			
O3 (ppb)		**7**^{a} (0^{b}-18^{c})	100ug/m3 (8hr)	0.075ppm (8hr)	
Atomic Radiation (CPM)		**14**^{a} (4^{b}-30^{c})	25-75 CPM (USEPA)		
Remark	(2) Number of cars and (60) number of Motorcycle passed during air monitoring.				

^{1} Annual mean,^{2} 24hr average, NA – not available,^{a} Average ^{b}Min ^{c}Max

Plate 3-6: Ambient air monitoring station in Lel Gyi Kwin village

Point (7) San Kone Village (18°16'16.85"N, 95°11'11.42"E); IOR5-V7

San Kone village is located in Kyangin Township, Ayeyarwady Region. Baseline NO$_2$ gas concentrations at San Kone village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO$_2$ gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-12, Plate 3-7**).

Table 3-12: Baseline Gases Quality in San Kone Village in IOR5-V7

Substance (µg/m^3)	**Date**	**San Kone Village**	**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
NO$_2$ (ppb)	Start24.11.2014 End-25.11.2014	**32**[a] (17[b]-54[c])	40[1]	100[2]	150[2]
SO$_2$(ppb)		**44**a (1[b]-145[c])	20[2]	80[2]	125[2]
CO (ppm)		**65**[a] (1[b]-259[c])	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**1** [a] (1[b]-12[c])	NA	NA	9 ppm (8hr)
NH3 (ppm)		**0**[a] (0[b]-5[c])	**NA**	NA	9 ppm (8hr)
CH4 (ppm)		**5571**[a] (4652[b]-6315[c])			
O3 (ppb)		**6**[a] (0[b]-19[c])	100 ug/m3 (8hr)	0.075 ppm (8hr)	
Atomic Radiation (CPM)		**13**[a] (3[b]-27[c])	25-75 CPM (USEPA)		
Remark	No car and no motorcycle passed during air monitoring.				

[1] Annual mean,[2] 24hr average, NA – not available,[a] Average [b]Min [c]Max

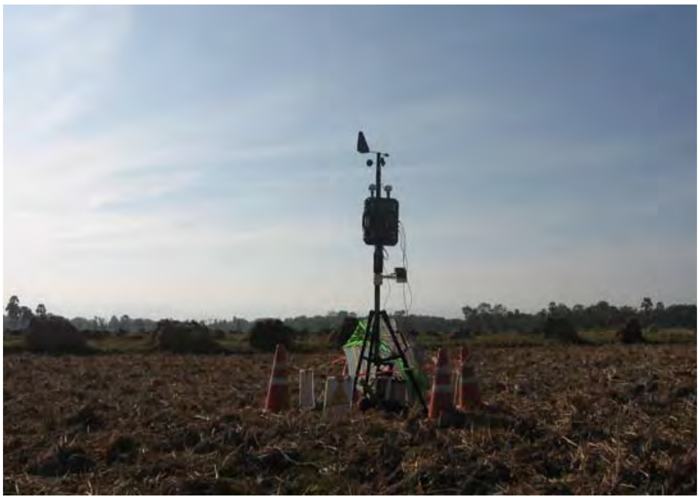


Plate 3-7: Ambient air monitoring station at San Kone village in IOR5-V7

Point (8) Pan Pin Kone Village (18°18'41.23"N, 95°9'52.13"E); IOR5-V8

Pan Pin Kone village is located in Kyangin Township, Ayeyarwady Region. Baseline gas concentrations in Pan Pin Kone village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-13, Plate 3-8**).

Table 3-13: Baseline Gases Quality in Pan Pin Kone Village in IOR5-V8

Substance ($\mu g/m^3$)	**Date**	**Pan Pin Kone Village**	**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
NO_2 (ppb)	Start29.11.2014 End-30.11.2014	**33^{a}** $(17^{b}-85^{c})$	40^{1}	100^{2}	150^{2}
SO_2(ppb)		**44^{a}** $(1^{b}-291^{c})$	20^{2}	80^{2}	125^{2}
CO (ppm)		**189^{a}** $(1^{b}-4702^{c})$	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**1^{a}** $(1^{b}-13^{c})$	NA	NA	9 ppm (8hr)
NH3 (ppm)		**2^{a}** $(0^{b}-120^{c})$	NA	NA	9 ppm (8hr)
CH4 (ppm)		**5005^{a}** $(4101^{b}-5767^{c})$			
O3 (ppb)		**8^{a}** $(0^{b}-98^{c})$	100 ug/m3 (8hr)	0.075 ppm (8hr)	
Atomic Radiation (CPM)		**15^{a}** $(3^{b}-33^{c})$	25-75 CPM (USEPA)		
Remark	(6) Number of cars and (70) number of Motorcycle passed during air monitoring.				

^{1} Annual mean, ^{2} 24hr average, NA – not available, ^{a} Average ^{b}Min ^{c}Max

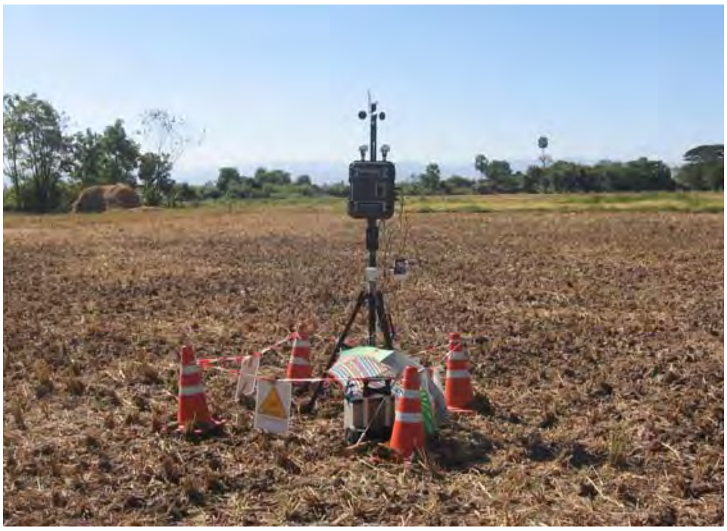


Plate 3-8: Ambient air monitoring station in Pan Pin Kone village.

Point (9) Chaung Hpyar Village (18°23'26.13"N, 95°10'25.59"E); IOR5-V9

Chaung Hpyar village is located in Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations at Chaung Hpyar village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-14, Plate 3-9**).

Table 3-14: Baseline Gases Quality in Chaung Hpyar Village IOR5-V9

Substance ($\mu g/m^3$)	**Date**	**Chaung Hpyar Village**	**WHO Guideline**	**NAAQS (USEPA)**	**World Bank Guideline**
NO_2 (ppb)	Start- 2.12.2014 End-3.12.2014	**33**[a] (1[b] -68[c])	40[1]	100[2]	150[2]
SO_2(ppb)		**47**[a] (1[b] -465[c])	20[2]	80[2]	125[2]
CO (ppm)		**137**[a] (1[b] -990[c])	NA	9 ppm (8hr) 35ppm (one hr)	NA
VOC(ppm)		**346** [a] (1[b] -11961[c])	NA	NA	9 ppm (8hr)
NH3 (ppm)		**1** [a] (0[b] -4[c])	**NA**	NA	9 ppm (8hr)
CH4 (ppm)		**4941**[a] (3829[b] -5491[c])			
O3 (ppb)		**5**[a] (0[b] -16[c])	100ug/m3 (8hr)	0.075ppm (8hr)	
Atomic Radiation (CPM)		**14**[a] (4[b] -26[c])	25-75 CPM (USEPA)		
Remark	No car and no motorcycle passed during air monitoring. Agricultural waste open burning is practiced in Chaung Hpyar Village.				

[1] Annual mean,[2] 24hr average, NA – not available,[a] Average [b]Min [c]Max

Plate 3-9: Ambient air monitoring station in Chaung Hpyar village

Point (10) Si Son Gone Village (18°23'17.39"N, 95°11'40.89"E); IOR5-V10

Si Son Gone village is located in Kyangin Township, Ayeyarwady Region. Baseline NO_2 gas concentrations at Si Son Gone village were found to be below the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline. Baseline SO_2 gas concentrations was found to be higher than the WHO guideline (updated 2005), but below the National Ambient Air Quality Standards (NAAQS, set by USEPA 1990) and the World Bank guideline (**Table 3-15**, **Plate 3-10**).

Table 3-15: Baseline Gases Quality in Si Son Gone Village in IOR5-V10

Substance ($\mu g/m^3$)	Date		WHO Guideline	NAAQS (USEPA)	World Bank Guideline
		Si Son Gone village			
NO_2 (ppb)	Start- 5.12.2014 End-6.12.2014	**40**^{a} (16^{b}-90^{c})	40^{1}	100^{2}	150^{2}
SO_2(ppb)		**28**^{a} (1^{b}-106^{c})	20^{2}	80^{2}	125^{2}
CO (ppm)		**129**^{a} (1^{b}-621^{c})	NA	9 ppm (8hr) 35 ppm (one hr)	NA
VOC(ppm)		**695** ^{a} (1^{b}-12280^{c})	NA	NA	9 ppm (8hr)
NH3 (ppm)		**1** ^{a} (0^{b}-5^{c})	NA	NA	9 ppm (8hr)
CH4 (ppm)		**4774**^{a} (3566^{b}-5491^{c})			
O3 (ppb)		**7**^{a} (0^{b}-16^{c})	100 ug/m^{3} (8hr)	0.075 ppm (8hr)	
Atomic Radiation (CPM)		**14**^{a} (4^{b}-28^{c})	25-75 CPM (USEPA)		
Remark	(40) Number of cars and (204) number of Motorcycle passed during air monitoring.				

^{1} Annual mean,^{2} 24hr average, NA – not available,^{a} Average ^{b}Min ^{c}Max

Plate 3-10: Ambient air monitoring station in Si Son Gone village

Table 3-16: Baseline Gases Quality in IOR-5 Block

Substance ($\mu g/m^3$)	IOR5(Average)	WHO Guideline	NAAQS (USEPA)	World Bank Guideline
NO_2 (ppb)	**36[a]± 1[d](32[b]-43[c])**	40[1]	100[2]	150[2]
SO_2(ppb)	**43± 5 (23-81)**	20[2]	80[2]	125[2]

a – average. b- minimum, c - maximum, d – standard error

3.2.3.6 Summary of the ambient gases level in IOR-5

Generally, based on the results monitored in the Block IOR5, Gases particular in NO2 and SO2 concentrations did not meet the WHO guidelines.

According to the observations on the vicinity located in the IOR5, ***open burning of the straw residues in the paddy fields, the existing running factories and local transportation using motorcycle, cars*** were observed during the air monitoring survey.

In IOR-5 Block, there is methanol factory in Seik-Tha (IOR5-V2). Cement factory and cement services quarter are existed in Kone Myint (IOR5-V5).

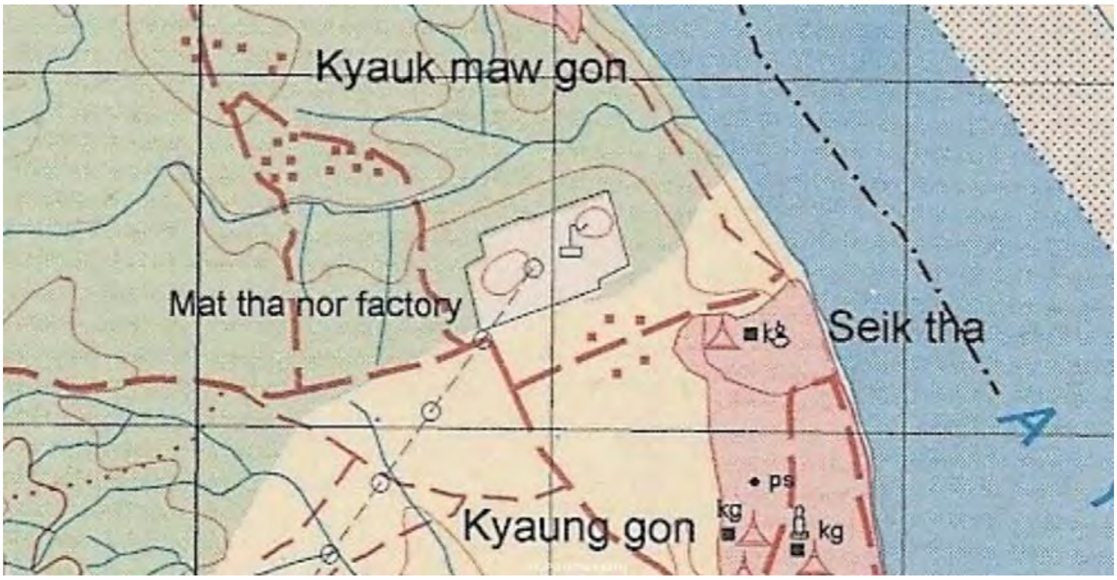


Figure 3-5: Methanol factory in Seik-Tha (IOR5-V2)

Figure 3-6: Cement factory and cement services quarter in Kone Myint (IOR5-V5)

These existing local activities are assumed as the main contributors for increased gases level in the ambient atmosphere.

3.2.3.7 Baseline Ambient Air Pollutants (Particulates) in IOR-5

Table 3-17 presents the results of dust concentrations with the EPAS air monitoring station over a 24hr period.

Table 3-17: Baseline PM10 and TSPM Concentrations proximate to proposed drilling locations In IOR-5

Location		TSPM 24-hr avg (range) µg/m^{3}	PM10 24-hr avg (range) µg/m^{3}	Remarks
IOR5-V1	Shin Su	**1329**^{a} (1^{b} -21344 ^{c})	**115**^{a} **(2^{b} -876^{c})**	(35) numbers of Motorcycle passed during air monitoring.
IOR5-V2	Seik Thar	**83**^{a} (1^{b} -3801 ^{c})	**47**^{a} **(2^{b} -176^{c})**	(8) Numbers of cars and (134) numbers of Motorcycle passed during air monitoring. There is an old methanol factory near Seik Thar Village.
IOR5-V3	Kyat Kha Lay	**264**^{a} (1^{b} -4338 ^{c})	**41**^{a} **(2^{b} -351^{c})**	(28) numbers of Motorcycle passed during air monitoring. Agricultural waste open burning is practiced by the villagers in Kyat Kha Lay Village.
IOR5-V4	Lein Khon	**172**^{a} (1^{b} -3601 ^{c})	**87**^{a} **(2^{b} -946^{c})**	No cars and No Motorcycle passed during air monitoring.

Table 3-17: Baseline PM10 and TSPM Concentrations proximate to proposed drilling locations In IOR-5

Location		TSPM 24-hr avg (range) µg/m^{3}	PM10 24-hr avg (range) µg/m^{3}	Remarks
IOR5-V5	Kone Myint	**192**^{a} (1^{b} -2025^{c})	**65**^{a} **(2^{b} -739^{c})**	(14) Number of cars and (337) number of Motorcycle passed during air monitoring. Lots of motorcycles are using in that current time due to traditional play in the village. There is Cement factory near Kone Myint Village
IOR5-V6	Lel Gyi Kwin	**91**^{a} (1^{b} -1236^{c})	**66**^{a} **(2^{b} -1067^{c})**	(2) Number of cars and (60) number of Motorcycle passed during air monitoring.
IOR5-V7	San Kone	**377**^{a} (1^{b} -9848^{c})	**112**^{a} **(20^{b} -1103^{c})**	No car and no motorcycle passed during air monitoring.
IOR5-V8	Pan Pin Kone	**265**^{a} (1^{b} -5408^{c})	**53**^{a} (2^{b} -346^{c})	(6) Number of cars and (70) number of Motorcycle passed during air monitoring.
IOR5-V9	Chaung Phar	**264**^{a} (1^{b} -4338^{c})	**41**^{a} **(2^{b} -351^{c})**	No car and no motorcycle passed during air monitoring. Agricultural waste open burning is practiced in Chaung Hpyar Village.
IOR5-V10	Si Son Gone	**112**^{a} (1^{b} -754^{c})	**42**^{a} **(2^{b} -393^{c})**	(40) Number of cars and (204) number of Motorcycle passed during air monitoring.
Average of IOR-5		**TSPM - 315**	**PM10- 67**	
WHO guideline^{1}		100	50	
NAAQS (USEPA)^{1}		NA	150	

Bold Higher than WHO air quality guidelines
^{a} Average^{b} SE ^{c} Min ^{d} Max
NS – non- significant

3.2.3.8 Summary of the ambient particulate levels in IOR-5

Baseline levels of TSPM did not meet the WHO guideline in all villages except Seik Thar Village (IOR5-V2). Baseline levels of PM10 did not meet the WHO guideline except Seik Thar (IOR5-V2), Kyat Kha Lay (IOR5-V3), Chaung Hpyar (IOR5-V9) and Si Sone Kone (IOR5-V10). However, According to the observations on the vicinity located in the IOR5, *open burning of the straw residues in the paddy fields, local transportation using motorcycle, cars and the existing operations of oil and gas drilling and exploration particularly in IOR5* was observed during the air monitoring survey.

These existing local activities are assumed as the main contributors for increased particulate levels in the ambient atmosphere.

3.2.3.9 Local Climate

The onsite meteorology data measured by the EPAS monitoring station indicates Temperature, Relative Humidity, Wind speed and Wind direction. **Table 3-18** presents the wind direction which generally comes from the south and southeast at the regions concerned. Generally, average ambient temperature was ***28 degree Centigrade***, wind speed was average ***1.3 kph*** and relative humidity was ***72%*** and wind direction mostly came from ***south, south-east. south south-east, south south-west*** during the one month monitoring period starting from November 6 to December 6, 2014.

Table 3-18:Meteorology data obtained from air quality sampling stations in IOR-5

Location		Temperature (Degree C)	Wind Speed (kph)	Wind Direction (Degree from North)	Relative Humidity (%)
IOR5-V1	Shin Su	**26[a]** **(23[b] -38[c])**	**0.5[a]** **(0[b] -6[c])**	**154.5** [a] (SSE)	**93[a]** **(0[b] -100[c])**
IOR5-V2	Seik Thar	**27[a]** **(18[b] -172[c])**	**1[a]** **(0[b] -9.5[c])**	**184.3** [a] (S)	**65[a]** **(20[b] -88[c])**
IOR5-V3	Kyat Kha Lay	**29[a]** **(21[b] -49[c])**	**1.4[a]** **(0[b] -23[c])**	**184.3** [a] (S)	**53[a]** **(26[b] -70[c])**
IOR5-V4	Lein Khon	**28[a]** **(19[b] -53[c])**	**0.7[a]** **(0[b] -11.7[c])**	**201.4** [a] (SSW)	**67[a]** **(24[b] -89[c])**
IOR5-V5	Kone Myint	**29[a]** **(19[b] -47[c])**	**3[a]** **(0[b] -17.1[c])**	**170.9** [a] (S)	**54[a]** **(24[b] -74[c])**
IOR5-V6	Lel Gyi Kwin	**29[a]** **(18[b] -50[c])**	**2[a]** **(0[b] -19.3[c])**	**133.8** [a] (SE)	**56[a]** **(23[b] -83[c])**
IOR5-V7	San Kone	**25[a]** **(18[b] -45[c])**	**2.3[a]** **(0[b] -21.4[c])**	**160.9** [a] (SSE)	**73[a]** **(0[b] -100[c])**
IOR5-V8	Pan Pin Kone	**25[a]** (17[b] -48[c])	**1.7[a]** (0[b] -14.9[c])	**145.1** [a] (SE)	**65[a]** (25[b] -95[c])
IOR5-V9	Chaung Phar	**29[a]** **(21[b] -49[c])**	**1.4[a]** **(0[b] -23[c])**	**184.3** [a] (S)	**53[a]** **(26[b] -70[c])**
IOR5-V10	Si Son Gone	**32[a]** **(21[b] -57[c])**	**1.6[a]** **(0[b] -23[c])**	**166.5** [a] (SSE)	**50[a]** **(20[b] -74[c])**

3.2.3.10 Summary of Air Quality Results

WHO air quality guidelines (updated 2005) and NAAQS (USEPA) which were designed as limits for protection of public health, welfare and environment were used to compare with the results of the baseline survey and to determine the existing baseline status of air quality at the locations within the proposed project areas (well - sites).

The selected villages where the air quality samples were collected were generally small to medium–sized, in agriculture-based areas. The baseline data gathered at these locations were considered to be representative and typical of other nearby locations. The variation in ambient air concentration will be more or less similar due to the same topography, land use and meteorological conditions.

The results from the baseline survey indicate that the 24-hour average levels of both PM10 and TSPM did not meet the WHO guideline. The existing baseline levels of dust (respirable PM_{10} and TSPM) in all regions can cause nuisance.

Air quality for the air pollutants: particularly in NO_2 and SO_2 did not meet in some regions within the proposed project area and likely to affect the health and environment of the exposed population.

It must be noted that during the time of sampling, extreme weather such as windy situations might affect the results were observed during the baseline air monitoring period. The soil types around the proposed project areas can be a predisposing factor to generate dust especially during dry conditions Therefore, the composition of aerosol particles was mainly from wind-blown dust of mineral oxides from natural sources, weather and the local existing activities such as open burning, transportations and operation of the oil and gas exploration wells are the main contributors affecting the ambient air quality.

3.2.3.11 Local perception of Air Quality

During IEM's comprehensive project socio-economic health and opinion survey of 400 households in 8 communities in IOR-5, residents were asked socio-economic questions as well as for information on their environmental perceptions. In regard to Air Quality most villagers interviewed (97%) have not noticed changes to air quality (**Chart 3-3**). Any change in air quality was perceived as being linked to bush burning (33%) and industry (67%) (**Chart 3-4**). This latter observation did not distinguish between industrial operations or air quality change related to vehicle traffic.

Chart 3-3: Response of villagers in regard to perceived changes observed in air quality.

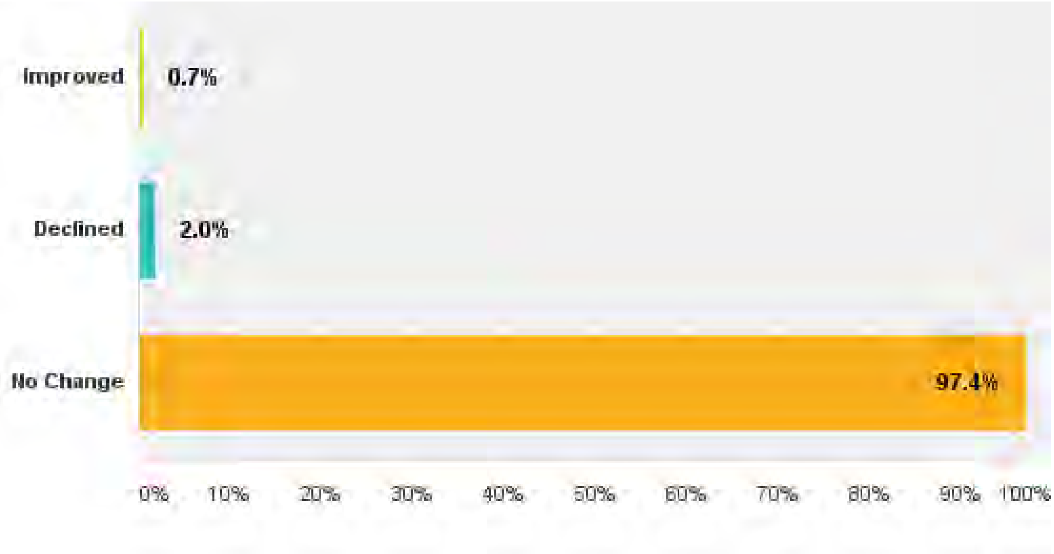
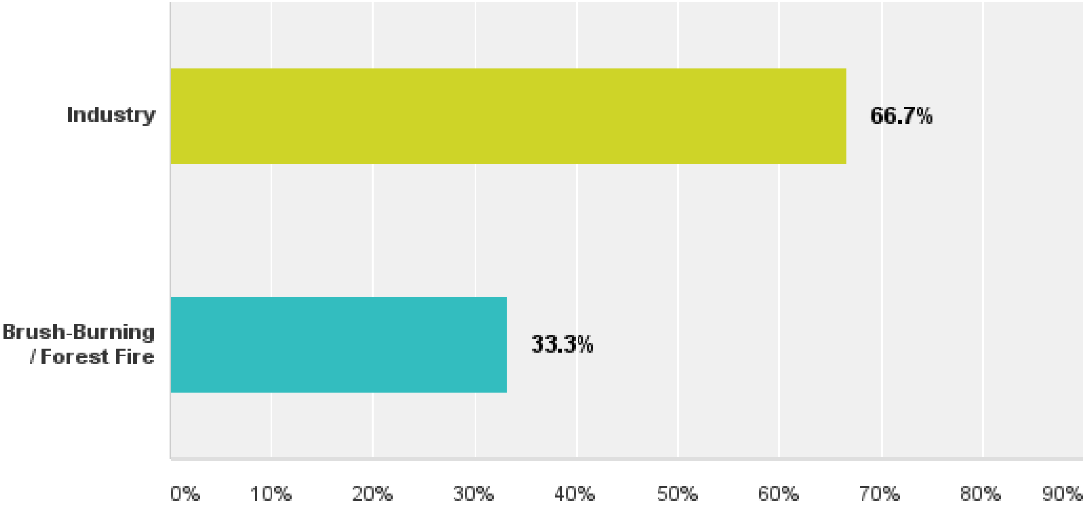


Chart 3-4: Response of villagers in IOR-5 in regard to the probable cause of any perceived changes in air quality.



3.2.4 Noise

3.2.4.1 Methodology for Study

Ambient noise monitoring surveys in IOR-5 were also undertaken in 10 community locations (same location with Air Quality) between November 7- December 6, 2014 (**Figure 3-4** and **Table 3-19**). The communities were:

- Shin Su
- Seik Thar
- Kyat Kha Lay
- Lein Khon
- Kone Myint
- Lel Gyi Kwin
- San Kone
- Pan Pin Kone
- Kyat Kha Lay
- Si Son Gone

The internationally recognised 'A' weighting scale (dBA) was used so that the measured noise corresponds roughly to the overall level of noise that is heard by the average human. 24-hour equivalent noise (L_{eq}) were taken every 5 minutes for one day, sound level Baseline noise was measured using a sound level meter model SL-4023SD.

Table 3-19: Ambient Noise stations from 10 rural communities in IOR-5

Village	Coordinates (GCS WGS84)		Station Name	Date	
	Latitude	Longitude		Start	End
Code : IOR5-V1 Name : Shin Su Township : Myanaung Region : Ayeyarwady	18°17'42.42"N	95°14'53.71"E	IOR5-A/N1	1:10 PM (7.11.2014)	12:30 PM (8.11.2014)
Code : IOR5-V2 Name : Seik Thar Township : Kyangin Region : Ayeyarwady	18°24'50.9"N	95°11'26.03"E	IOR5-A/N2	2:45 PM (27.11.2014)	10:45 AM (28.11.2014)
Code : IOR5-V3 Name : Kyat Kha Lay Township : Kyangin Region : Ayeyarwady	18°23'33.65"N	95°9'56.97"E	IOR5-A/N3	3:30 PM (3.12.2014)	11:30 AM (4.12.2014)
Code : IOR5-V4 Name : Lein Khon Township : Kyangin Region : Ayeyarwady	18°17'6.14"N	95°12'25.53"E	IOR5-A/N4	1:00 PM (25.11.2014)	9:00 AM (26.11.2014)
Code : IOR5-V5 Name : Kone Myint Township : Kyangin Region : Ayeyarwady	18°18'18.10"N	95°12'0.09"E	IOR5-A/N5	11:00 AM (1.12.2014)	7:30 AM (2.12.2014)
Code : IOR5-V6 Name : Lel Gyi Kwin Township : Kyangin Region : Ayeyarwady	18°16'38"N	95°10'32.96"E	IOR5-A/N6	11:20 AM (30.11.2014)	7:20 AM (1.12.2014)
Code : IOR5-V7 Name : San Kone Township : Kyangin Region : Ayeyarwady	18°16'16.85"N	95°11'11.42"E	IOR5-A/N7	3:00 PM (24.11.2014)	11:00 AM (25.11.2014)
Code : IOR5-V8 Name : Pan Pin Kone Township : Kyangin Region : Ayeyarwady	18°18'41.23"N	95°9'52.13"E	IOR5-A/N8	1:45 PM (29.11.2014)	9:45 AM (30.11.2014)
Code : IOR5-V9 Name : Kyat Kha Lay Township : Kyangin Region : Ayeyarwady	18°23'26.13"N	95°10'25.59"E	IOR5-A/N9	4:00 PM (2.12.2014)	12:00 PM (3.12.2014)
Code : IOR5-V10 Name : Si Son Gone Township : Kyangin Region : Ayeyarwady	18°23'17.39"N	95°11'40.89"E	IOR5-A/N10	2;30 PM (5.12.2014)	10:30 AM (6.12.2014)

3.2.4.2 Results

Ambient noise measurements taken within IOR-5 had 24-hour equivalent noise levels ranged from 35.6 dB (A) to 48.3 dB (A). These results indicate that on average ambient noise levels are below Thai National standards. The day noise levels for Pan Pin Kone and the night noise level for Seik Thar were above the WHO standards. This is most likely the result of motorbike traffic and diesel generator use for electricity. Ambient noise measurement data recorded in each community is summarized by community below and in **Table 3-20**.

Table 3-20: Results of Average Baseline Ambient Noise from 10 rural communities in IOR-5

Well site	Community	L_{eq}	L_{eq}-Day	L_{eq}-Night	L_{min}	L_{max}	L_{90}
IOR5-A/N1	Shin Su	40.5	40.5	-	31.0	53.8	43.4
IOR5-A/N2	Seik Thar	44.7	43.2	**47.9**	34.4	61.6	53.8
IOR5-A/N3	Kyat Kha Lay	40.5	38.5	44.4	26.7	54.0	46.3
IOR5-A/N4	Lein Khon	37.8	38.0	37.6	27.7	51.5	43.2
IOR5-A/N5	Kone Myint	42.7	39.9	44.6	29.7	58.1	48.7
IOR5-A/N6	Lel Gyi Kwin	41.1	45.2	38.0	29.6	62.3	50.5
IOR5-A/N7	San Kone	35.6	36.6	34.9	26.4	62.8	41.1
IOR5-A/N8	Pan Pin Kone	48.3	**59.3**	40.5	28.2	114.3	65.3
IOR5-A/N9	Chaung Phar	39.8	41.8	38.4	26.6	67.9	48.1
IOR5-A/N10	Si Son Gone	43.9	45.1	42.3	28.5	78.8	53.7
Thai Standard[1]		**70**	**-**	**-**	**-**	**115**	**-**
WHO/ World Bank guidelines[2]		**-**	**50**	**45**	**-**	**-**	**-**

[1] Notification of Environmental Board No. 15 B.E.2540 (1997) under the Conservation and Enhancement of National Environmental Quality Act B.E.2535 (1992) dated March 12, B.E.2540 (1997)

[2] Maximum allowable ambient noise levels 1hour Leq (dBA)

Bold indicates higher than guidelines

3.2.5 Geology

Geomorphologically, Myanmar can be divided into four regions which are north-south trending linear belts following the major structural trends of respective underlying rock units. These are, namely from west to east: Rakhine Coastal Plain; Western Ranges; Central Lowlands; and Eastern Highlands. Geology of the project area primarily corresponds with the Central Lowlands region (**Figure 3-7**).

Block IOR-5 is the first oil and gas field discovered in 1980 from a limestone reservoir in Myanmar. Stratigraphic rock units of the block are shown in the **Table 3-21**. In the Block IOR-5, the producing reservoir is the Lower Miocene shoal limestones of Pyawbwe Formation, which contains 5 pay zones with the net pay thickness of 150 ft. The hydrocarbon bearing limestone is developed as a wedge-shaped build up on the west flank. The maximum development of limestone formation attained 1,257 ft in well 2. The fracture porosity is about 10 – 22% with 30-40% of Sw. The peak production of the field is 530 BOPD and 10.056 MMSCFD in December, 1982. The total volume of oil in place is 2.508 MMSTB (P1) and 3.094 MMSTB (P2). Following the first oil and gas production in well 3, a total of 13 wells come in to produce from the limestone reservoir. In most of the wells initial production rates are good enough, however these are followed by rapid decline and even ceased-flowing after water incursion.

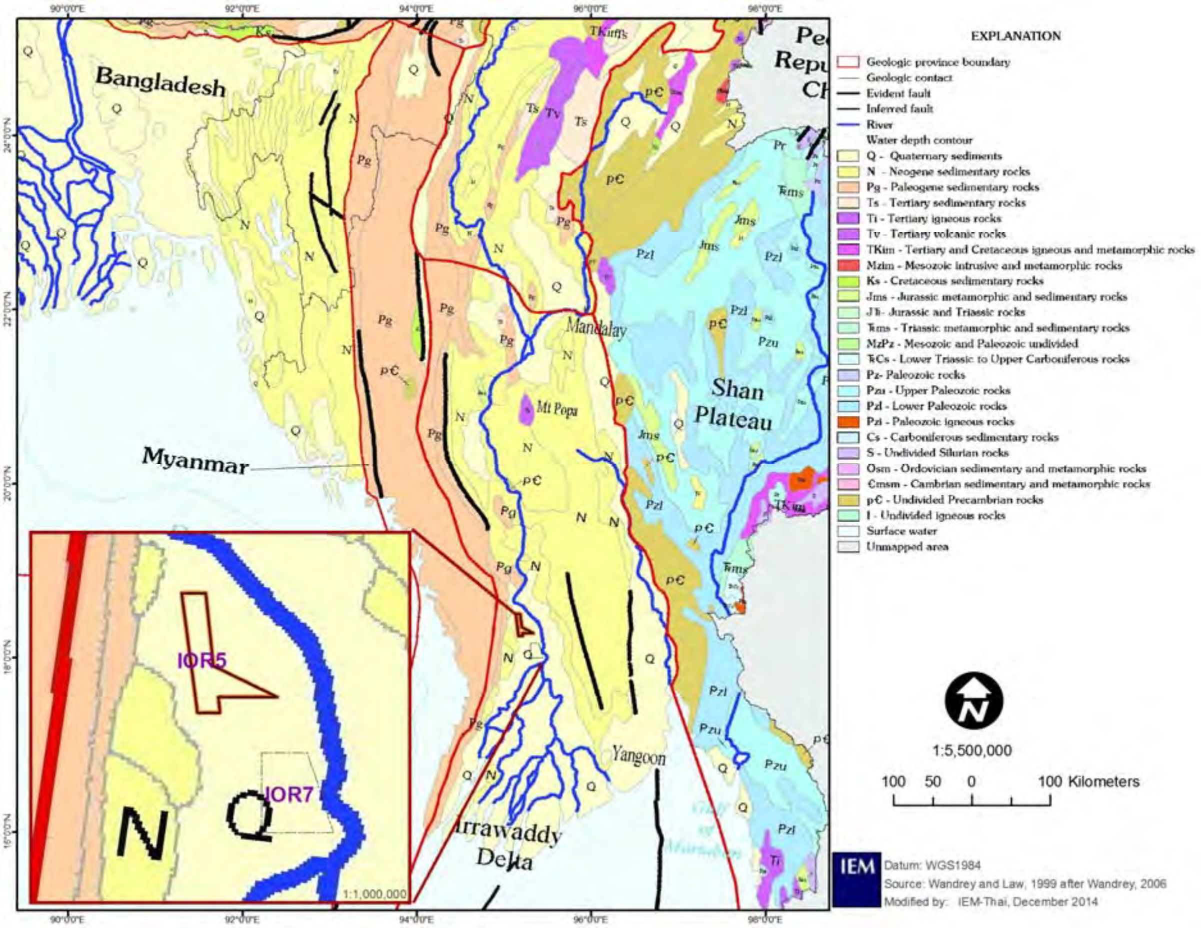


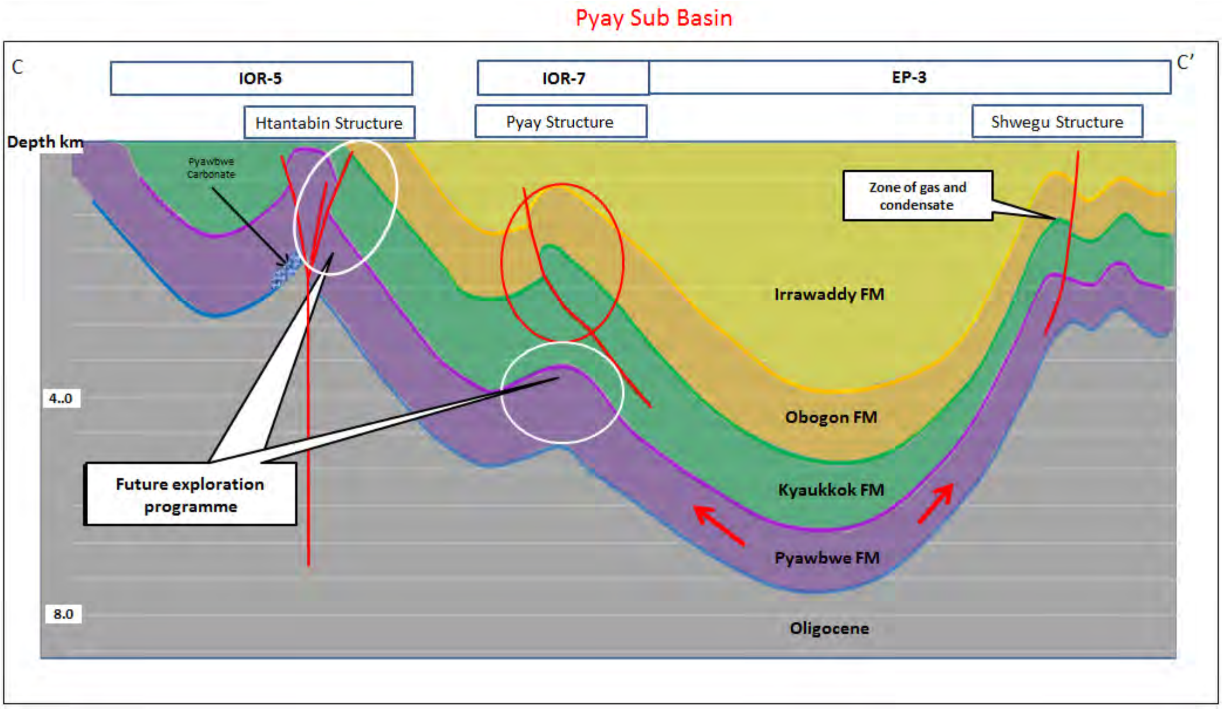
Figure 3-7: Generalized Geology and Structural Units in Proximity to IOR-5

Table 3-21. Generalized stratigraphy of the blocks IOR-5 (Modified after MOGE, 2013)

Stratigraphic Units	Stratigraphic Age	Dominant Lithology	Thickness (ft)
Irrawaddy Fm.	U. Miocene - Pliocene	Yellowish brown medium grained sandstones	1000+
Obogon Fm.	Middle to Upper Miocene	Fine sandstones, siltstones, clay-shales (Sandy alternations)	1280
Kyaukkok Fm.	M. Miocene	Yellowish brown, very fine, siltstone-sandstones, shales	1480+
Pyawbwe Fm.	L. Miocene	Grey – dark grey, bluish shale-clay, massive Foraminiferal limestones (grainstone – packstone – wackestone)	5080+

Geological Structure of the Block IOR-5

The block IOR-5 is situated on the west flank of the NNW-SSE trending Htantabin-Kyangin anticlines, a compressive thrust-related structure of the southern part of Pyay Sub-basin (**Figure 3-8**). To the north, the structure transforms into a crestally faulted anticline. It is broader in the north and narrow down gradually to the south. The very steep crestal belt is bordered to the east and shallower flanks to the west. Mud volcanoes are associated with the steep crestal belt in the northern part of the structure.

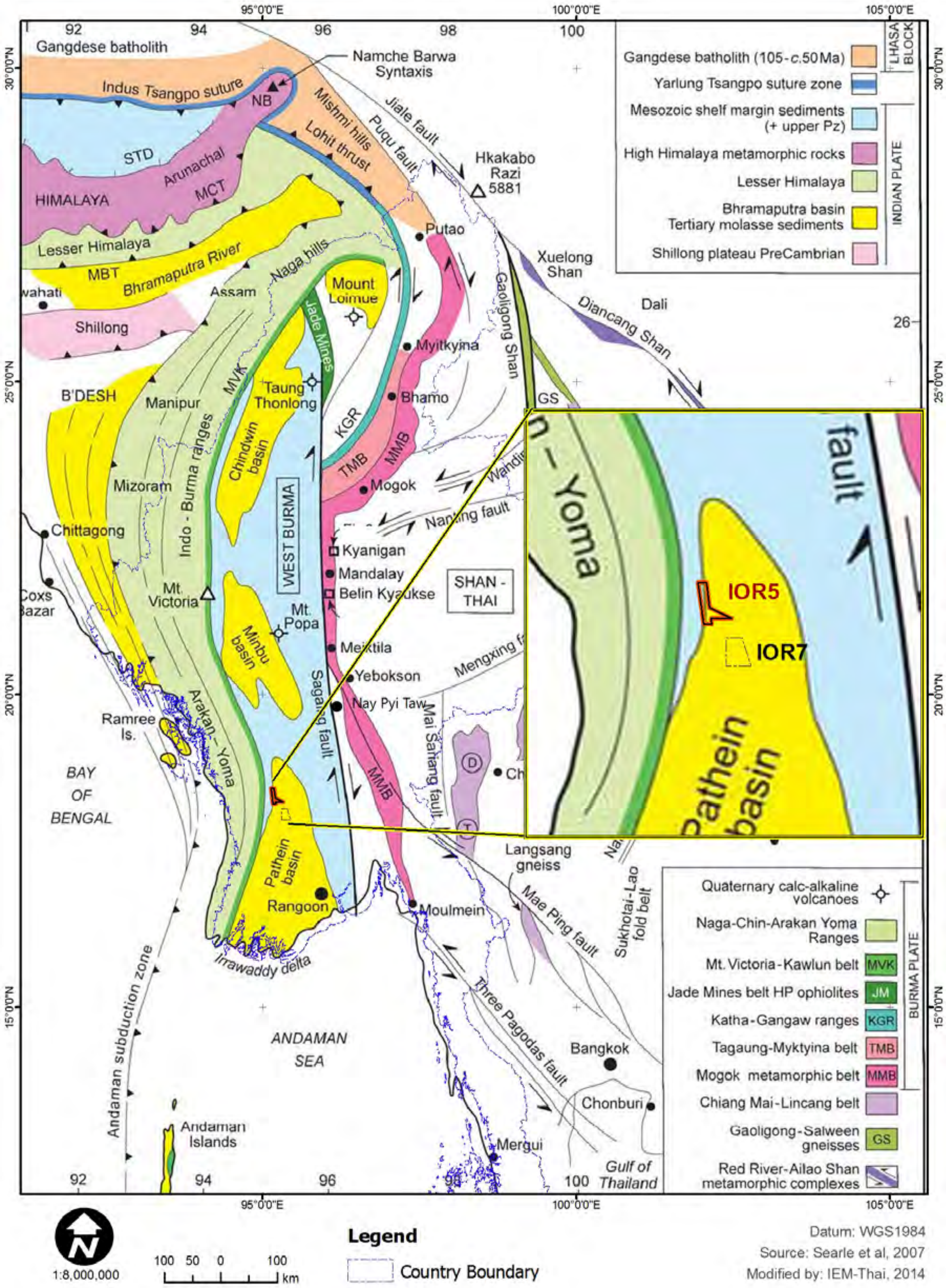


Source: PCMI, 2014

Figure 3-8. Schematic structural cross section of IOR-5 in the Pyay Sub-Basin showing the subsurface stratigraphic units and the structural styles.

3.2.5.1 Potential Geohazards (Tectonic Summary)

Present-day deformation and earthquakes in Myanmar and adjacent parts of Southeast Asia are driven by the northward movement of the Indian subcontinent as it collides with the Eurasian plate. Myanmar, on the eastern side of this collisional zone, lies east of the boundary between the Indian plate to the west, and the Sunda plate. Most of the differential motion between these two plates in Myanmar is concentrated on the Sagaing fault, which is a major north-striking, right-lateral fault that has a slip rate of approximately 18 mm/yr based on GPS data (**Figure 3-9**). The Sagaing Fault is located far to the east of Block IOR-5. Numerous large earthquakes have occurred on the Sagaing fault in the past century, including an M 6.9 event in February 1991, which caused 2 fatalities (USGS, 2012).



Datum: WGS1984
Source: Searle et al, 2007
Modified by: IEM-Thai, 2014

Figure 3-9: Structural Map showing the Sagaing fault, the Shan Scarp and the Mogok Metamorphic Belt relative to IOR-5

3.2.6 Soil

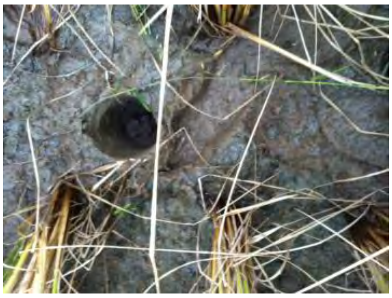
3.2.6.1 Methodology for Study

Interpretation of distribution of soil types in IOR-5 was based on internationally recognized soil maps from Bender (1983), FAO (2008) and Hla Tun Aung (2005) and a limited field sampling program focusing on primarily agricultural soils within the study area.

Soil samples were collected from drill-holes dug by a hand-auger drill. Soil sampling points in IOR-5 are shown in **Table 3-22.**

Each hand augured hole was dug to approximately 15 cm depth. Samples were packed in double-zipped plastic bags and sent to an accredited laboratory for characterization (**Table 3-23**). Parameters tested included basic soil chemistry as well as hydrocarbons and metals**.** During sample collection, soil samples were collected according to the standard procedure and kept in a cooling box at -4°C.

Table 3-22: Soil Sample Locations for the IOR Baseline Survey

ID	**Date**	**Coordinates**		**Photograph**	**Remark**
		Northing	**Easting**		
S1	10.11.2014	18˚18.210' N	095˚12.090' E		Paddy field
S2	10.11.2014	18˚18.720' N	095˚09.095' E		Paddy field
S3	11.11.2014	18˚16.689' N	095˚10.651' E		Paddy field

S4	11.11.2014	18˚17.487' N	095˚10.597' E		Paddy field
S5	11.11.2014	18˚16.092' N	095˚11.841' E		Paddy field
S6	12.11.2014	18˚16.654' N	095˚13.481' E		Bamboo forest
S7	12.11.2014	18˚18.005' N	095˚15.217' E		Paddy field

S8	12.11.2014	18˚23.623' N	095˚09.796' E		Paddy field
S9	12.11.2014	18˚24.347' N	095˚11.585' E		Paddy field
S10	13.11.2014	18˚23.800' N	095˚09.278' E		Forest area

Table 3-23: Laboratory Services For Soils Analysis Provided to Project

Laboratory	Parameters
ALS Hong Kong Laboratory	Total Petroleum Hydrocarbon (TPH including Oil & Grease), Benzene, Toluene, Ethylbenzene, Total Xylenes, Selenium (Se), Arsenic (As), Cadmium (Cd,), Nickel (Ni), Barium (Ba), Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn), pH, Soil Texture, ECe, Chloride

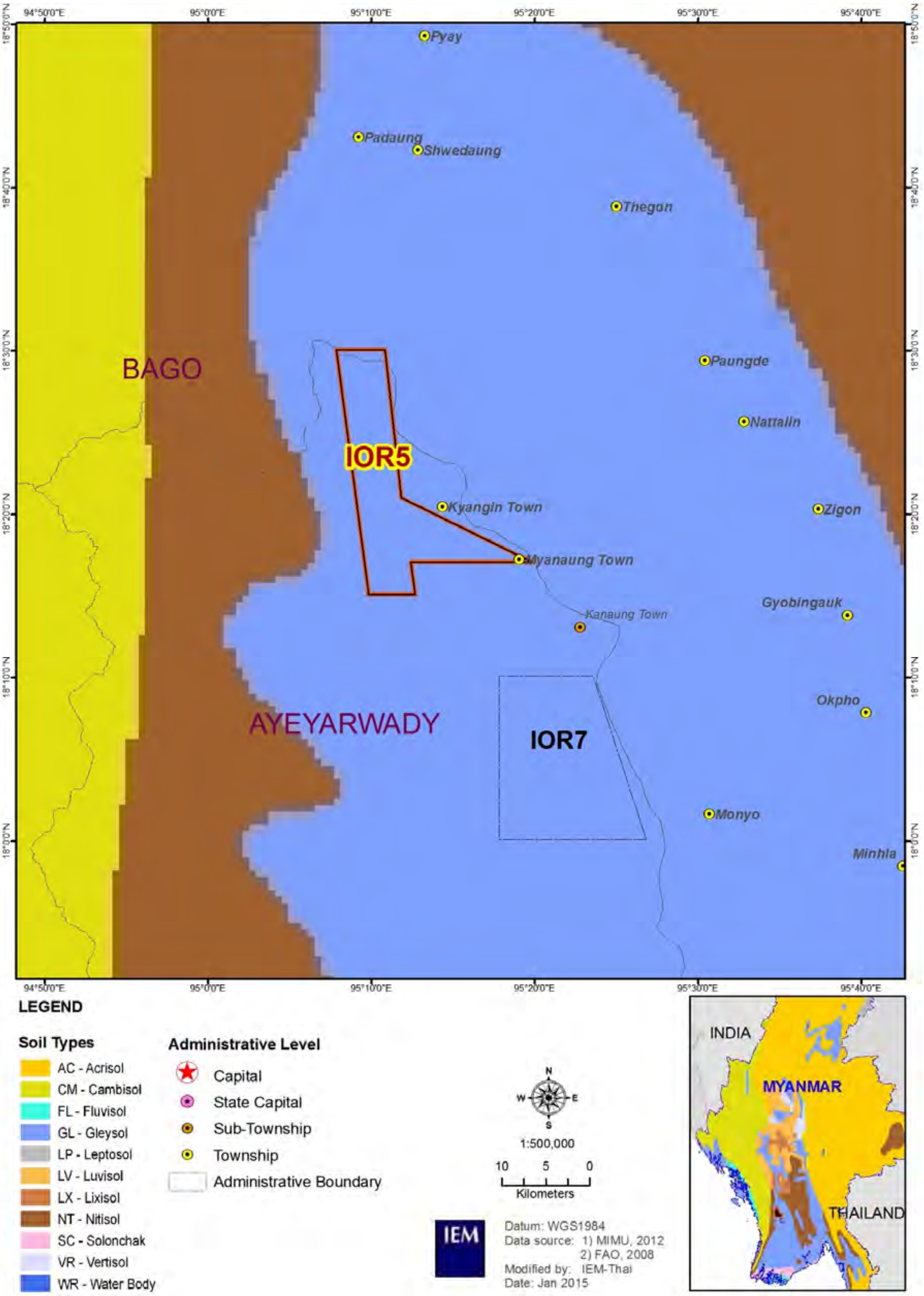


Figure 3-10: Soil Map of IOR-5 Study Area

3.2.6.2 Results

Soil types within the IOR-5 Study Area have been classified into one broad classification of Gleysols (**Figure 3-10**).

Gleysols are wetland soils that, unless drained, are saturated with groundwater for long enough periods to develop a characteristic gleyic colour pattern. They are azonal soils and occur in nearly all climates, from humid to arid. The main obstacle to utilization of Gleysols is the necessity to install a drainage system to lower the groundwater table. Adequately drained Gleysols can be used for arable cropping, dairy farming and horticulture. Soil structure will be destroyed for a long time if soils are cultivated when too wet. Therefore, Gleysols in depression areas with unsatisfactory possibilities to lower the groundwater table are best kept under a permanent grass cover or swamp forest.

Soil Quality

Soils were all consistent in being predominantly silt, 32% - 65% across the sites sampled with various proportions of sand and clay (**Table 3-24**). Soil pH ranged from 6.6 to 7.5 which are within a normal range to support plant growth. All soil samples were free from oil & grease and other hydrocarbon contamination.

There are no standards for soil quality in Myanmar. In the absence of local standards, soil quality results were compared against the regional Thailand National standards (Notification of the National Environment Board No 25 B.E 2547 (2004) issued under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) on Soil Quality Standard.

With the exception of Arsenic, metals data shows that all values are below standards for agricultural and residential purposes. Arsenic levels at most locations were above standards for agriculture and residential use (3.9 mg/kg). This could be due to natural processes, resulting in a high natural level of arsenic in the soils.

Table 3-24: Summary of Significant Soil Quality Results from IOR-5 Field Survey

Parameter	**Unit**	**IOR-5**										**Standard***	
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**1**	**2**
pH	-	7.5	7.3	6.6	6.7	6.6	6.6	7.2	6.8	7.4	7.4	-	-
ECe	µS/cm	52	32	47	8	24	21	13	21	19	23	-	-
Soil Texture	-	SCL	SC	SC	SCL	SC	SCL	SCL	SL	SCL	L	-	-
% sand	%	14	11	9	3	7	6	10	51	16	20	-	-
% silt	%	62	45	50	65	51	61	60	32	57	53	-	-
% clay	%	24	43	40	33	42	33	30	17	27	27	-	-
Chloride	mg/kg	<10	<10	20	20	20	20	<10	<10	10	10		
TPH C6-C9	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-
TPH C10-C14	mg/kg	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-
TPH C15-C28	mg/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	-
TPH C29-C36	mg/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	-
Benzene	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	6.5	15
Toluene	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	230	230
Ethylbenzene	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	520	520
Total Xylene	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	210	210
Arsenic (As)	mg/kg	**4**	**4**	**4**	**7**	**5**	**6**	**6**	3	**5**	**4**	3.9	27
Barium (Ba)	mg/kg	28	151	59	87	66	84	80	28	75	23	-	-
Cadmium (Cd)	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	37	810
Copper (Cu)	mg/kg	12	49	38	52	34	34	45	9	26	7	-	-
Manganese (Mn)	mg/kg	269	709	442	1080	322	1170	996	204	455	197	1800	32000
Nickel (Ni)	mg/kg	71	195	129	169	110	149	156	38	97	41	1600	41000
Selenium (Se)	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	390	10000
Zinc (Zn)	mg/kg	54	150	102	104	81	98	100	33	75	38	-	-
Iron (Fe)	mg/kg	29200	51500	44400	46700	42500	39800	42500	18700	35400	18900	-	-

Remarks: *Notification of the National Environment Board No 25 B.E 2547 (2004) issued under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) on Soil Quality Standard of Thailand

1 = Soil quality for residential and agriculture use, 2 = Soil quality for use other than residential and agriculture use

3.2.7 Surface Water Hydrology

IOR-5 lies in Lower Ayeyarwady watersheds (**Figure 3-11)**. The dominant hydrological feature in IOR-5 is the Ayeyarwady River which lies on the top northeast of the block. The other surface water features include the Pa Shing Chaung and Pa Daw Chaung streams in the south (**Figure 3-12**) The monthly distribution of river flow closely follows the pattern of rainfall, i.e., about 80% during the monsoon season (May – October) and 20% in the dry season (November – April).

3.2.7.1 Flooding

Fluctuating water levels with flooding risk has been identified along the Pa Shi Chaung and with the Ayeyarwady flood plain. The Ayeyarwady River can exhibit localized flooding in the IOR-5 area in the north of the block.

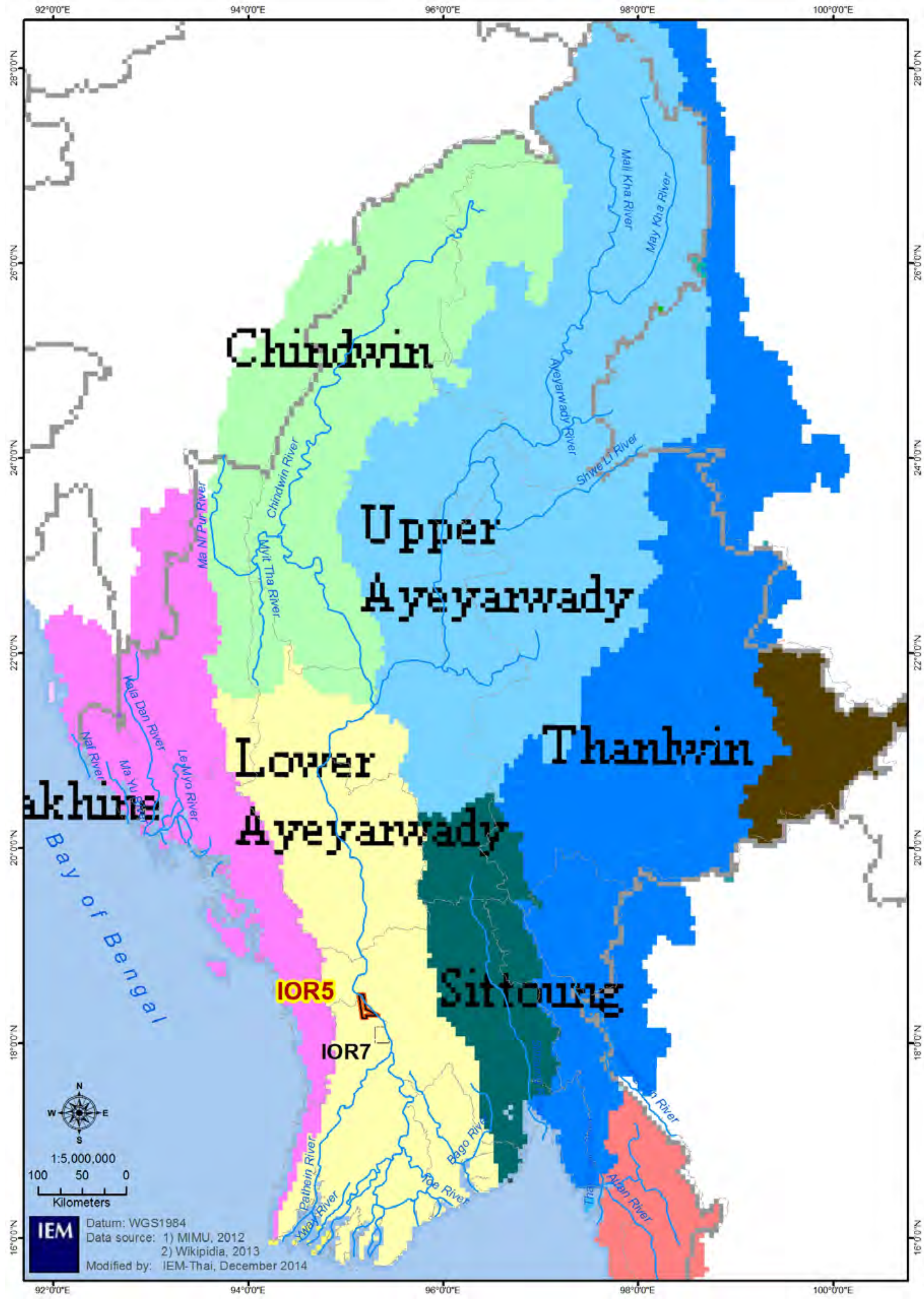
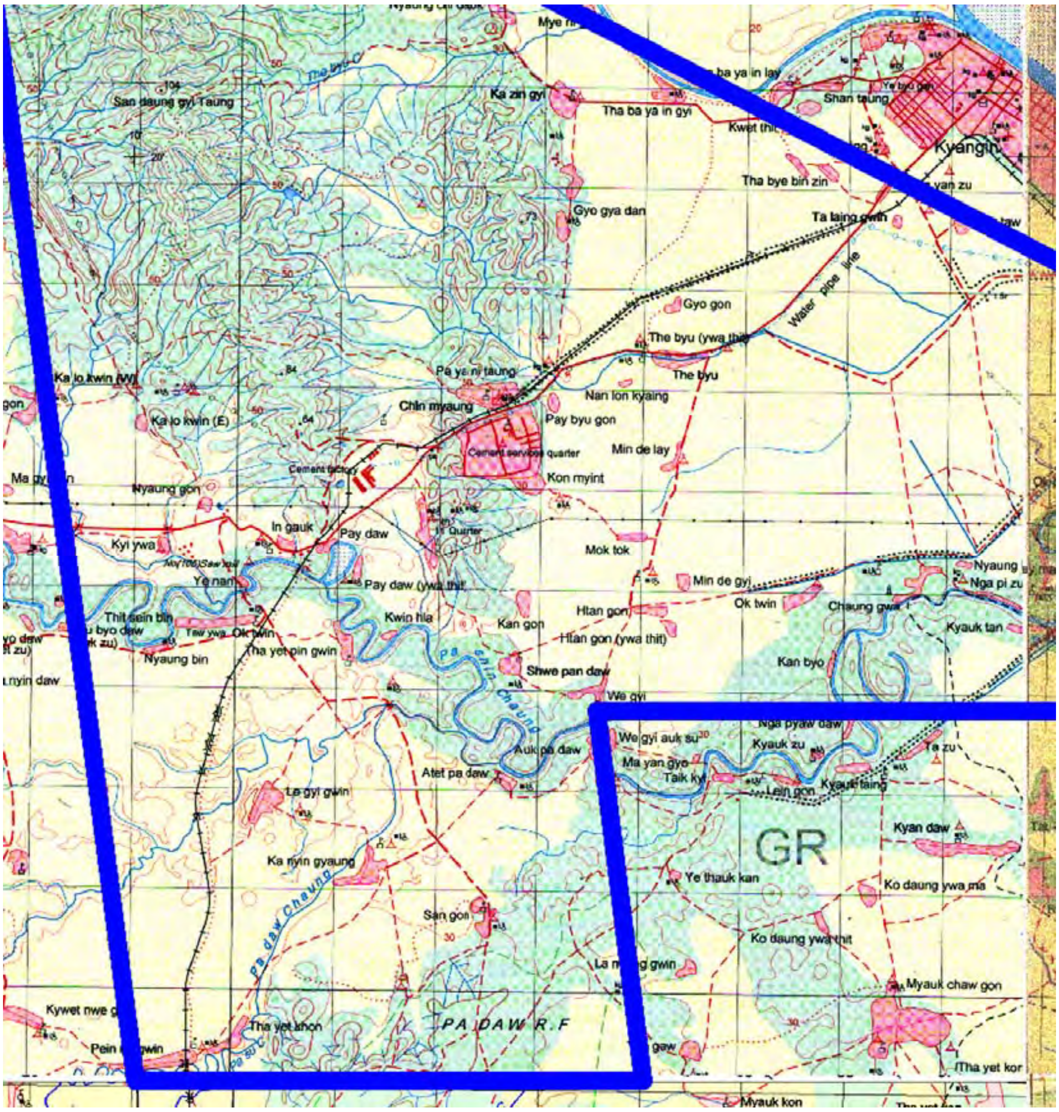


Figure 3-11: Myanmar River Basins showing IOR-5 Study Area



Source: PCMI, 2014

Figure 3-12: Surface Water Hydrology in the South of IOR-5

3.2.7.2 Surface Water Quality

Methodology for Study

IOR-5 surface water quality sampling was conducted at areas in the proposed seismic area boundary as well as one replicate (**Table 3-25).** Due to the sampling being conducted in the dry season the landscape surface water was generally restricted to impoundments, seasonal drainage, canals, rivers and stream. In general, either a grab pole or in some cases a bucket was used for collecting water in ponds or flowing water bodies (Direct immersion of meters and dipping sample bottles was used in others. During sample collection, water samples were collected according to the standard procedure and kept in a cooling box with ice.

The Total dissolved solid (TDS), electrical conductivity (EC), Dissolved Oxygen (DO), Temperature and pH value were measured on-site at the sampling stations and again at the laboratory along with numerous other parameters (**Table 3-26**).

Table 3-25: Surface Water Sampling Locations

ID	Date	Coordinates		Photograph	Remark
		Northing	Easting		
SW1	7.11.2014	18˚20.512' N	095˚13.432' E		Tributary of the Ayeyarwady River
SW2	7.11.2014	18˚17.909' N	095˚15.059' E		Stream
SW3	10.11.2014	18˚17.973' N	095˚10.785 E		Stream
SW4	10.11.2014	18˚17.971' N	095˚10.793' E		Canal

SW5	11.11.2014	18˚17.623' N	095˚19.207' E		Ayeyarwady River
SW6/7	11.11.2014	18˚16.737' N	095˚10.501' E		Stream
SW8	11.11.2014	18˚17.730' N	095˚10.456' E		Stream
SW9	11.11.2014	18˚16.018' N	095˚11.760' E		Small stream

SW10	12.11.2014	18˚16.747' N	095˚13.544' E		Pharnhit Kaung Stream
SW11	12.11.2014	18˚23.640' N	095˚09.918' E		Small unnamed stream
SW12	12.11.2014	18˚24.880' N	095˚11.540' E		Ayeyarwady River
SW13	13.11.2014	18˚23.792' N	095˚09.220' E		Chaung Phayr Lay Stream

Table 3-26: Laboratory Services for Surface Water Samples Collected Provided to Project

Laboratory	Parameters
ALS Hong Kong Laboratory	TSS, Total Petroleum Hydrocarbon (TPH including Oil & Grease), Benzene, Toluene, Ethylbenzene, Total Xylenes, Arsenic (As), Cadmium (Cd), Total Chromium (Cr), Lead (Pb), Nickel (Ni), Total Mercury (Hg), Selenium (Se), Barium (Ba), Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn)

3.2.7.3 Results

There are no standards for surface water quality in Myanmar. In the absence of local standards, surface water quality results were compared against the regional Thailand National Standard (Notification of the National Environmental Board, No 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) on Surface Water Quality Standard) (**Table 3-27**).

All parameters were within water quality standards. Petroleum hydrocarbons including Oil & Grease were not detected in any surface water samples in IOR-5.

Table 3-27: Summary of Surface Water Quality Results For IOR-5 Baseline Survey

Parameter	Unit	IOR-5													Standard			
		SW1	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SW11**	**SW12**	**SW13**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
pH		7.20	7.82	7.96	8.54	8.36	8.10	8.10	8.14	7.13	8.23	8.06	8.51	7.8	5.0-9.0	5.0-9.0	5.0-9.0	lower than class 4
Temp	°C	27.6	25.5	31.4	32.5	28.2	28.4	28.4	286	29.2	29.6	30.1	29.2	27.1	-	-	-	
Conductivity	µS	591.0	174.0	409	349	183.8	282	282	292	117.2	288	304	168.8	715	-	-	-	
Salinity	ppt	267	79.4	184	157	84.6	127	127	132	56.6	130	137	86.0	324	-	-	-	
TDS	mg/l	419	123	290	248	131	200	200	207	83.2	204	216	133	508	-	-	-	
TSS	mg/l	62	812	3	71	128	63	69	85	63	90	14	141	14	-	-	-	
DO	mg/l	3.2	7.1	4.7	5.5	5.2	6.1	6.1	5.5	6.4	4.9	4.7	5.6	5.4	≮6.0	≮4.0	≮2.0	
BOD	mg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	1.5	2	4	
TPH C6-C9	µg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-			
TPH C10-C14	µg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-			
TPH C15-C28	µg/l	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-			
TPH C29-C36	µg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-			
Benzene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-			
Toluene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-			
Ethylbenzene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-			
Total Xylene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-			
Arsenic (As)	µg/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	≯10			lower than class 4
Barium (Ba)	µg/l	47	6	8	15	13	21	22	8	16	8	17	12	13	-			
Cadmium (Cd)	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	≯50			
Total Chromium (Cr)	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-			
Copper (Cu)	µg/l	2	1	<1	2	1	1	1	<1	<1	<1	<1	<1	<1	≯100			
Lead (Pb)	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	≯50			
Manganese (Mn)	µg/l	711	3	9	4	5	2	3	5	1	4	14	<1	1	≯1000			
Nickel (Ni)	µg/l	<1	<1	<1	<1	<1	2	2	<1	3	<1	1	<1	1	≯100			
Selenium (Se)	µg/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	-			
Zinc (Zn)	µg/l	<10	39	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	≯1000			
Iron (Fe)	µg/l	<50	160	110	120	210	170	230	60	430	130	300	<50	<50	-			
Mercury (Hg)	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	≯2			

Remarks: Analytical Methods followed to Standard Methods for the Examination of water and Wastewater, recommended by APHA-AWWA-WEF. Classifications from Notification of the National Environmental Quality No.8, B.E. 2537 (1994) of Thailand

Classification of surface water **Class 2**: Very clean fresh surface water resources used for: 1) Consumption which requires conservational water treatment processes before use; 2) Aquatic organism conservation; 3) Fisheries; 4) Recreation

Classification of surface water **Class 3**: Medium clean fresh surface water resource used for: 1) Consumption, but passing through an ordinary treatment process before use; 2) Agriculture

Classification of surface water **Class 4**: Fairly clean fresh surface water resource used for: 1) Consumption, but requires special water treatment process before use; 2) Industry

Classification of surface water **Class 5**: The sources which are not classified in class 1-4 used for navigation

3.2.8 Groundwater

3.2.8.1 Methodology

Information on local groundwater conditions was collected based on literature review, site-specific sampling tube wells and dug wells at various locations within the IOR-5 study area as, well as during interviews with local villagers using groundwater resources.

Groundwater quality sampling was conducted during field surveys at community locations strategically selected within IOR-5 (**Table 3-28**). The Total dissolved solid (TDS), electrical conductivity (EC) and pH value were measured on-site at the sampling stations and again at the laboratory along with numerous other parameters (**Table 3-29**). During sample collection, groundwater samples were collected according to the standard procedure and kept in a cooling box with ice.

Results of the groundwater quality analysis and the analytical report are summarized in the subsection which follows.

Table 3-28: Groundwater Sampling Locations in IOR

ID	Date	Coordinates		Photograph	Remarks
		Northing	Easting		
GW1	10.11.2014	18˚18.223' N	095˚12.075' E		Dug well (70 ft w/ wl @ 55 ft)
GW2	10.11.2014	18˚18.703' N	095˚09.135' E		Dug well (22 ft w/ wl @ 3 ft)

GW3/4	11.11.2014	18˚16.676' N	095˚10.569' E		Tube well (70ft w/ wl @ 30 ft)
GW5	11.11.2014	18˚15.953' N	095˚11.815' E		Dug well (8ft deep and artesian)
GW6	11.11.2014	18˚15.947' N	095˚11.852' E		Dug well (30 ft w/ wl @6 ft)

GW7	12.11.2014	18˚16.721’ N	095˚13.447’ E		Tube well
GW8	12.11.2014	18˚23.640’ N	095˚09.871’ E		Tube well
GW9	12.11.2014	18˚24.460’ N	095˚11.572’ E		Tube well

Table 3-29: Laboratory Services for Groundwater Sample Analysis Provided to Project

Laboratory	Parameters
ALS Hong Kong Laboratory	Total Petroleum Hydrocarbon (TPH including Oil & Grease), Arsenic (As), Cadmium (Cd), Total Chromium (Cr), Lead (Pb), Nickel (Ni), Total Mercury (Hg), Selenium (Se), Barium (Ba), Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn)

3.2.8.2 Results

Groundwater is the principal source of potable domestic water supply in Blocks IOR-5. Groundwater is being exploited for domestic water. Impoundments are used primarily for watering livestock and some domestic use. A total of 13 major aquifer systems have been identified in Myanmar (**Figure 3-13**). The study area is underlain by the Alluvian aquifer.

On the basis of stratigraphy, there are six different types of aquifers in Myanmar, namely Alluvium, Irrawaddian, Peguan, Limestone, Igneous (or Volcanic) and Other Minor Aquifers. Quality and quantity of groundwater varies depending on the lithology and depositional environments. For instance, groundwater quality of Alluvial and Ayeyarwady aquifers is potable for both domestic and irrigation water use. However, in the water-scarce regions, groundwater from Pegu, Eocene and Plateau Limestone aquifers is not totally suitable for drinking purposes in terms of water quality, but is extracted for domestic use.

The groundwater table depth in the project area during the Blocks IOR-5 Survey varied from 0 m with artesian to 10 m (~30ft in tube well).

3.2.8.3 Groundwater Quality

There are no standards for groundwater quality in Myanmar. In the absence of local standards, groundwater quality results were compared against the regional Thailand National standards (Notification of the National Environment Board No 20 B.E 2543 (2000), issued under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) on Groundwater Quality Standard; and Notification of the Ministry of Natural Resources and Environment: Technical Criteria and Measures to Prevent Public Health and Environment Hazard B.E. 2551 (2008))Relatively high TDS levels, exceeding Maximum allowable levels were recorded at GW3/4 (**Table 3-20).** Heavy metals detected in groundwater were Arsenic (As), Barium (Ba), Chromium (Cr), Nickel (Ni), Selenium (Se) Zinc (Zn), Iron (Fe) and Manganese (Mn). Manganese greatly over the maximum allowable level was detected at (GW3/4) and GW7. No petroleum hydrocarbons including Oil & Grease were detected.

Additional discussion in regard to local perception of water quantity and quality is presented in **Section 3.5.4**.

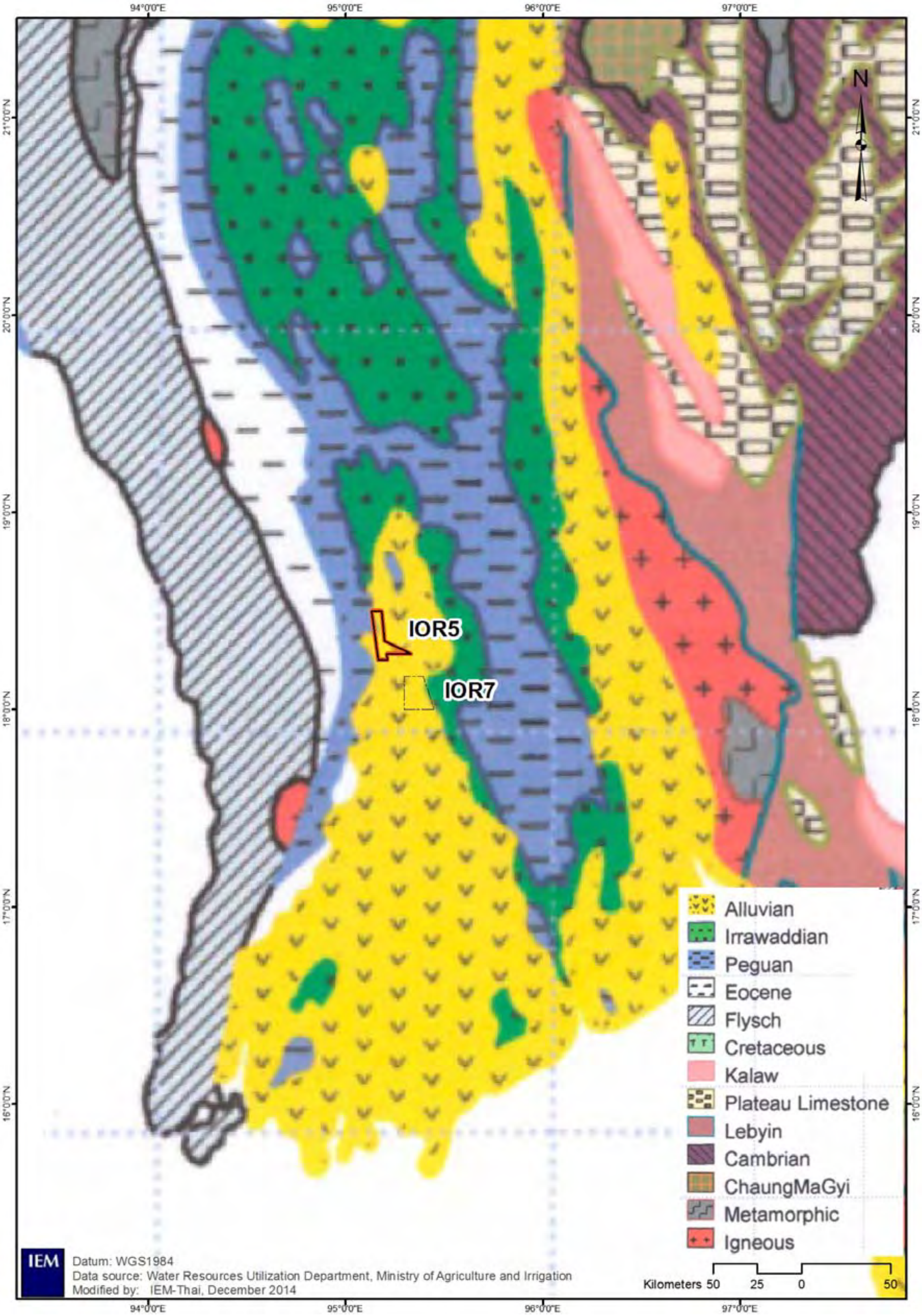


Figure 3-13: Major Aquifers of Myanmar Relative to IOR-5

Table 3-30: Summary of Ground Water Quality Results For IOR-5 Baseline Survey

Parameter	Unit	IOR-5									Standard	
		GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	Suitable Allowance	Maximum Allowable
pH	-	6.87	7.06	7.02	7.02	5.87	5.89	6.43	7.53	680	7.0-8.5	6.5-9.2
Temp	°C	27.9	27.2	27.6	27.6	28.6	27.9	27.2	27.8	28.4		
Conductivity	µS	699	956	2240	2240	72	65.9	426	703	1506		
Salinity	ppt	317	437	1060	1060	38.0	35.93	191	318	698	-	-
TDS	µg/l	497	679	**1590**	**1590**	51.1	46.9	302	498	1070	≯600	1,200
TPH C6-C9	µg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	-
TPH C10-C14	µg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-
TPH C15-C28	µg/l	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	-
TPH C29-C36	µg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-
Benzene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-
Toluene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-
Ethylbenzene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-
Total Xylene	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-
Arsenic (As)	µg/l	<10	<10	<10	<10	<10	<10	<10	<10	12	-	50
Barium (Ba)	µg/l	15	6	32	34	29	29	58	14	111	-	-
Cadmium (Cd)	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	10
Total Chromium (Cr)	µg/l	<1	<1	<1	<1	3	2	<1	<1	<1	-	-
Copper (Cu)	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	≯1000	1500
Lead (Pb)	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	50
Manganese (Mn)	µg/l	301	498	**1800**	**1830**	9	6	**2580**	215	433	≯300	500
Nickel (Ni)	µg/l	2	3	4	4	8	10	<1	<1	2	-	-
Selenium (Se)	µg/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	-	10
Zinc (Zn)	µg/l	<10	<10	<10	<10	12	<10	10	<10	<10	≯5000	15000
Iron (Fe)	µg/l	<50	<50	<50	80	<50	<50	<50	80	140	≯500	1000
Mercury (Hg)	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	1

Analytical Methods followed to Standard Methods for the Examination of Water and Wastewater, recommended by APHA-AWWA-WEF.

Standard from Notification of Ministry of Natural Resources and Environment B.E. 2551 (2008) from Thailand

3.3 Biological Environment

Ecoregions are biogeographic units, which are relatively large units of land or water that contain distinct assemblages of natural communities, sharing a majority of species, dynamics and environmental conditions. Under this classification scheme, ecoregions exist within “bioregions” and typically contain numerous “ecozones”. Within IOR-5, the *Irrawaddy Moist Deciduous Forest*, has been defined (**Figure 3-14)** (WWF 2004).

3.3.1 Flora

3.3.1.1 Methodology

Secondary data and a site reconnaissance were used as the primary sources of data. Previous project surveys, government records, available literature, were used as well as internet research. A site reconnaissance of IOR-5 was also carried out in November 2014.

The site reconnaissance involved review of Google Earth Imagery and observation and photography of habitat characteristics while going to and from communities distributed throughout the exploration blocks. Interpretation was further supplemented by information collected from the Traditional Ecological Knowledge study with personal interviews with local farmers.

3.3.1.2 Results

Regional mapping of native vegetation cover and land use in IOR-5 shows the predominance of land converted to agricultural purposes for most of the block (**Figure 3-15**).

Areas of native vegetation in IOR-5 support thorn scrub and mixed deciduous forest which in turn is fringed by moist semi-evergreen forest. Based on previous project surveys, the five dominant trees species are *Tectona hamiltoniana*, *Acacia catechu* Willd, *Anthocephalus cadamba* Miq., *Dalbergia paniculata* Roxb., and *Terminalia oliveri*. This general pattern was confirmed during the site reconnaissance. Presence of these tree species can be considered as ecological indicator species for the ecoregion and potentially have an associated faunal species complex.

Previous surveys have revealed that diversity indices in this region are very low (Shannon Wiener index (H) 2.76, Simpson’s index (D) 10.18, Brillouin (D) 2.59.

The relative importance of various tree species within the two ecoregions occupied by IOR-5 is presented in **Chart 3-5** and **Chart 3-6**.

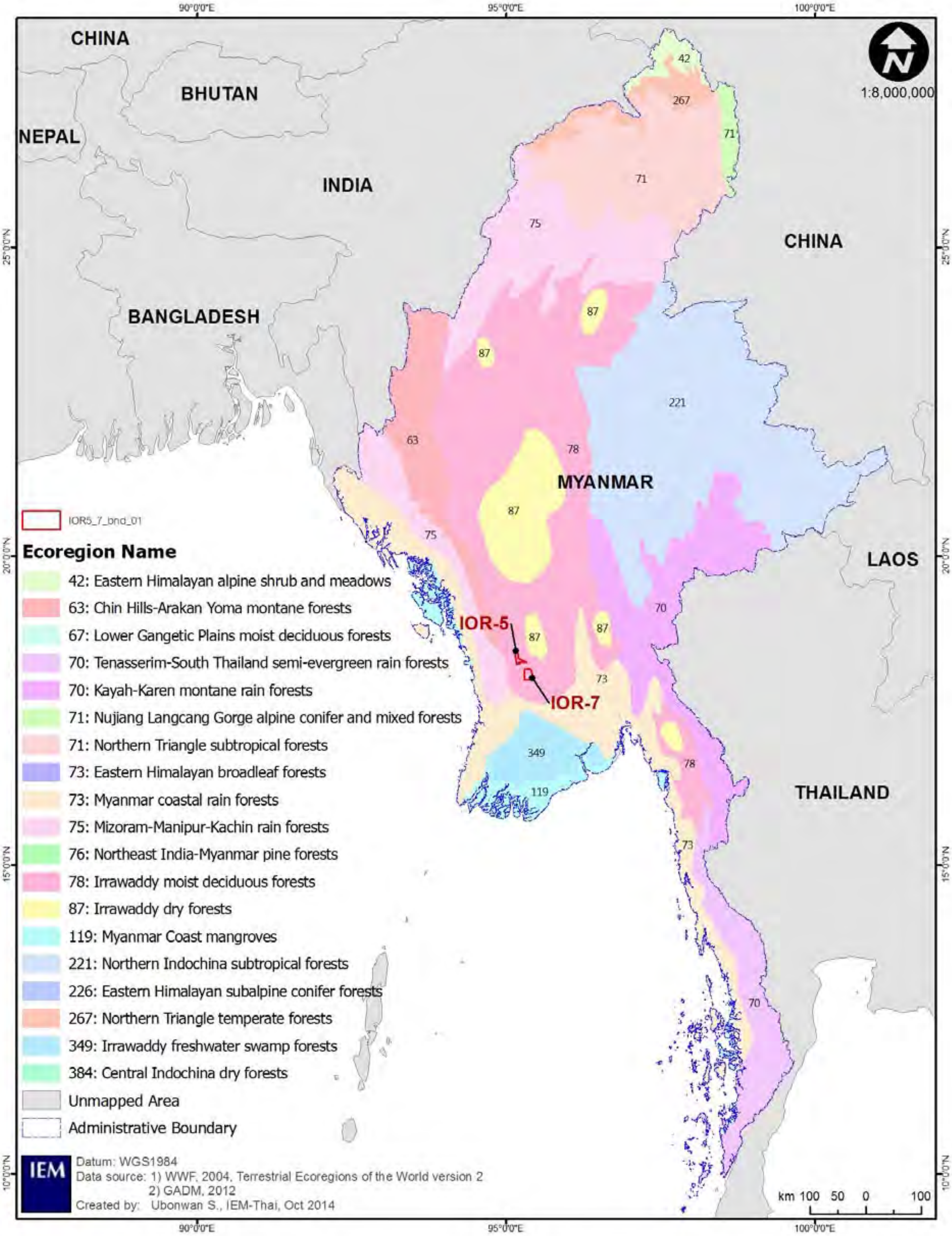


Figure 3-14: Terrestrial Ecoregions in Blocks IOR-5

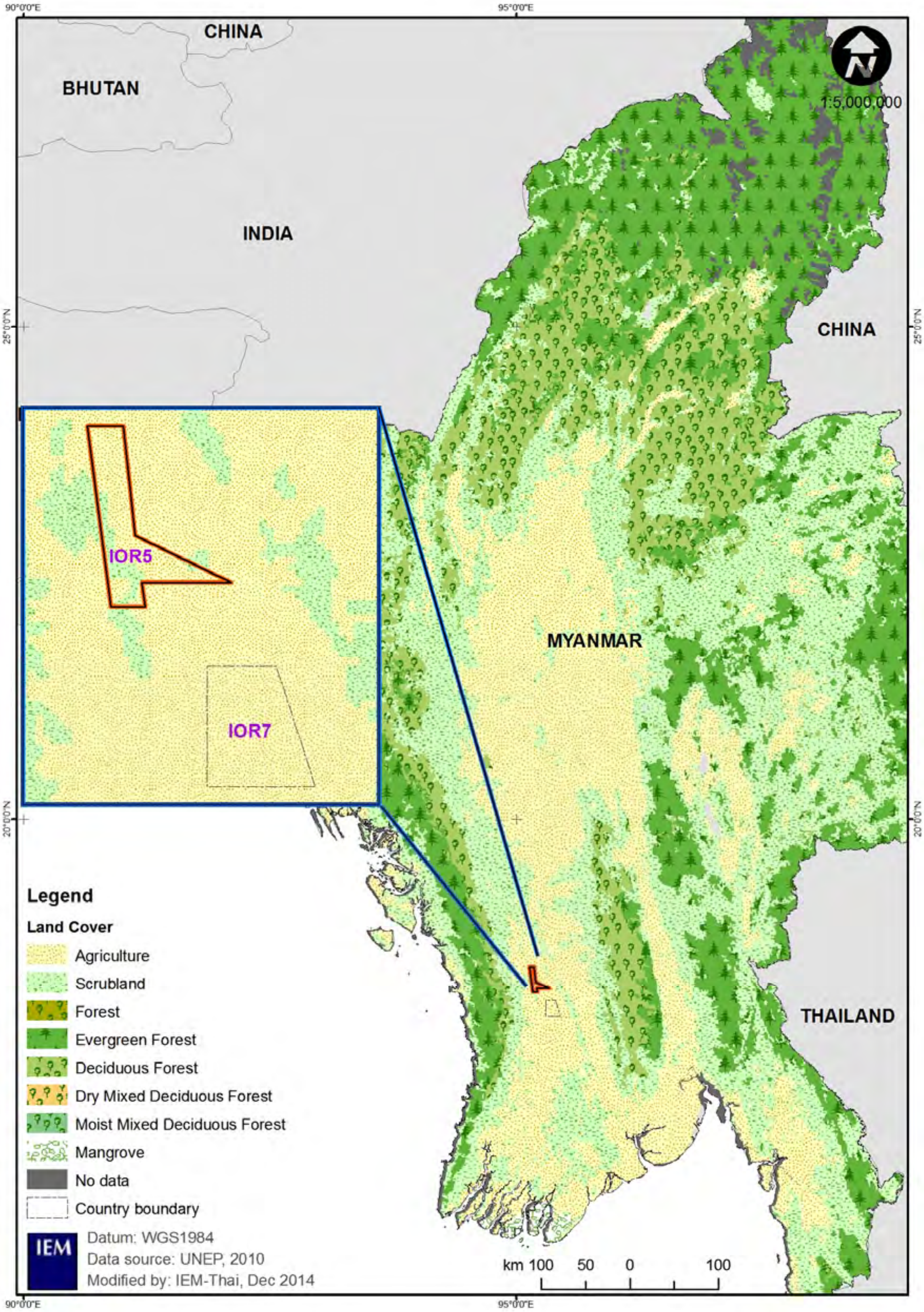
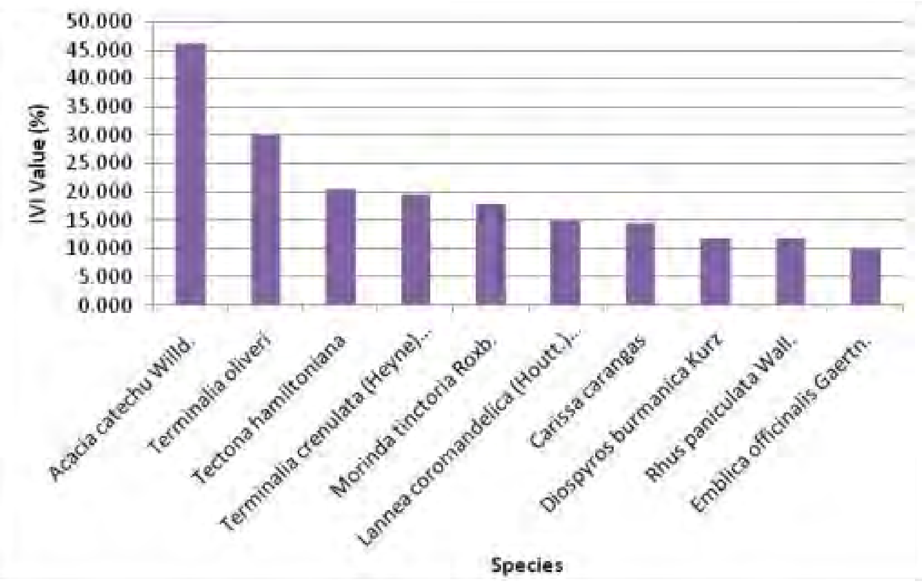


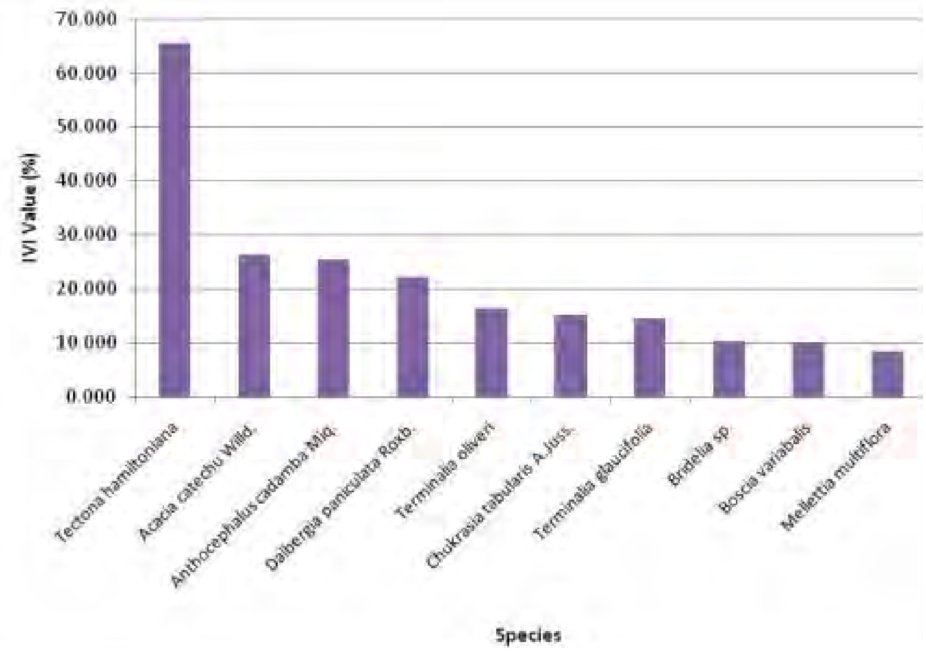
Figure 3-15: Forest Types in Myanmar

Chart 3-5: Importance Value Index of Top Ten Species in the Central Dry Zone Forest



Source: IEM, 2012

Chart 3-6: Importance Value Index of Top Ten Species in the Deciduous Forest



Source: IEM, 2012

3.3.2 Fauna

3.3.2.1 Methodology

The principal approach for establishing a baseline for fauna within the IOR-5 study area was through review of technical literature, previous surveys, internet search, interviews with long term residents and a field reconnaissance.

The site reconnaissance involved review of Google Earth Imagery and observation and photography of habitat characteristics while going to and from communities distributed throughout the exploration blocks. Interpretation was further supplemented by information collected from the Traditional Ecological Knowledge study with personal interviews with local farmers.

3.3.2.2 Results

Fauna typical of the ecoregion occupied by IOR-5 is discussed below:

Irrawaddy Moist Deciduous Forest Region

This ecoregion is located within the Ayeyarwady River Basin, the catchments of the Bago Yoma Mountains, and the foothills of Rakhine Yoma. The ecoregion is strongly expressed within the study area and covers the entire region. The forest region covers large areas in Myanmar. The westward extension is across Ayeyarwady River onto the Yakhine Yoma foothills, and the northern extension is up to the Kachin State. Trees reach a height of more than 30 m. The dominant species are teak (*Tectona grandis*) and Pyinkado or ironwood (*Xylia kerri*). Species composition is varied and intimately mixed with bamboo groves.

Wildlife is intensively exploited outside the protected areas. Asian elephants (*Elephas maximus*) survive in this ecoregion, but their numbers have slowly decreased as the habitat has been fragmented. Eld's deer (*Cervus eldi thamin*) occur in the ecoregion and listed as endemic species.

Species recorded include sambar (*Cervus unicolor*), masked palm civet (*Paguma larvata*), leopard cat (*Felis bengalensis),* and Sunda pangolin (*Manis javanica*). Many birds are found in this ecoregion, and they include both water and forest birds found in a wide variety of habitats. This ecoregion also corresponds to the Ayeyarwady Plains Endemic Bird Area (EBA). In addition to the white-throated babbler, it also identifies the hooded treepie (*Crypsirina cucullata*) as vulnerable. A total of 37 bird species were recorded in the area during a prior survey, with a population density was 159 birds/km^2. A total of 28 butterfly species were found in the region, with a population density of 53 butterflies/hectare.

This ecoregion remains under various threats. Conversion of forests to agriculture and shifting cultivation is prevalent. Intense poaching of protected animals, such as star tortoise, for trade is reducing the population in the forests.

3.4 PCMI IOR-5 Local Ecological Knowledge (LEK) Summary

3.4.1 Methodology

In November 2014, IEM conducted Traditional Ecological interviews with 128 householders in 8 villages in the Kyangin and Myanaung Districts, Hinthada District, Ayeyarwady Region, located within Block IOR-5. The interviews were conducted in focus group meetings of one to nine participants.

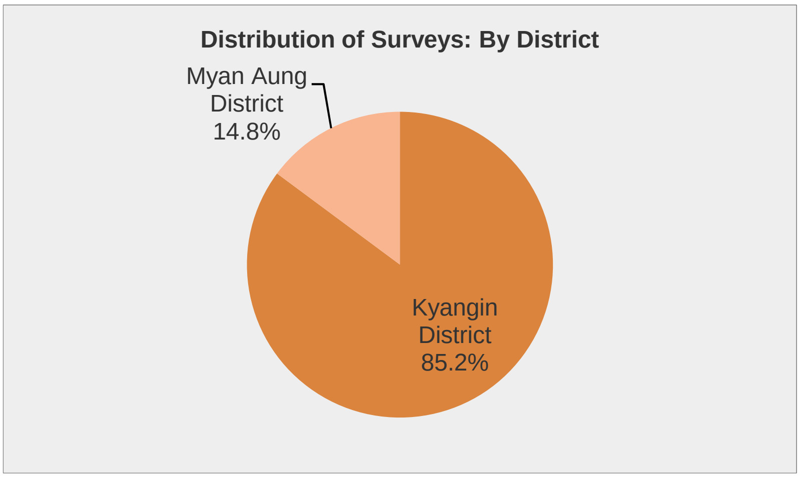
IEM’s Traditional Ecology team consisted of the Project Director/ESHIA Expert, and Biodiversity Assistants who were trained by IEM.

Participants were asked to characterize their observations in regard to their main crops and wild plants and animals in their area. Questions focused on whether they had observed any changes over the past ten years and whether they made use of any of the wild plants and animals. These data provide part of the ecological baseline against which future environmental change and impacts can be measured.

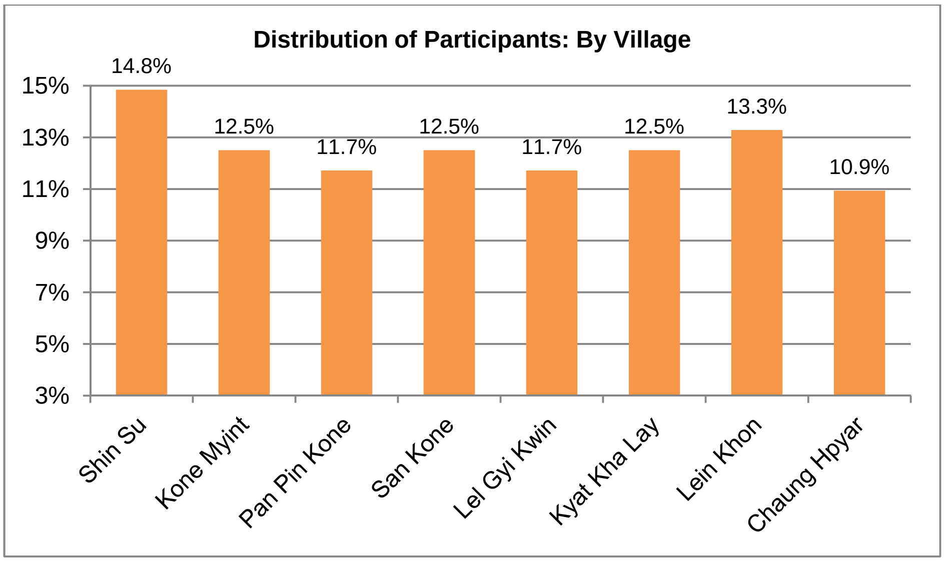
The following villages were included in the survey:

1. Shin Su
2. Kone Myint
3. Pan Pin Kone
4. San Kone
5. Lel Gyi Kwin
6. Kyat Kha Lay
7. Lein Khon
8. Chaung Hpyar

The following chart indicates the distribution of surveys among Kyangin and Myan Aung Districts. 109 participants (85%) were from Kyangin District, while 19 (15%) were from Myan Aung:



The following chart indicates the distribution of surveys among the villages. 14 to 19 participants came from each village (11 to 15% of all participants, respectively):

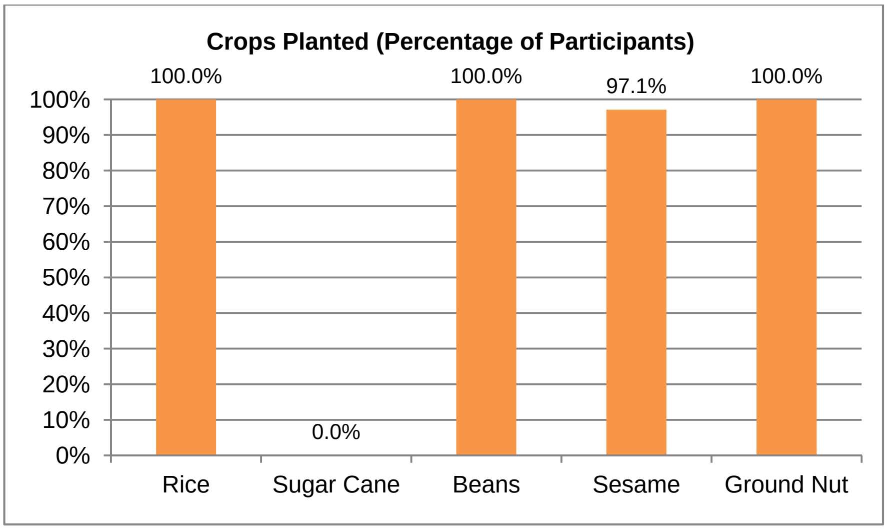


3.4.2 Traditional Ecology Survey Results:

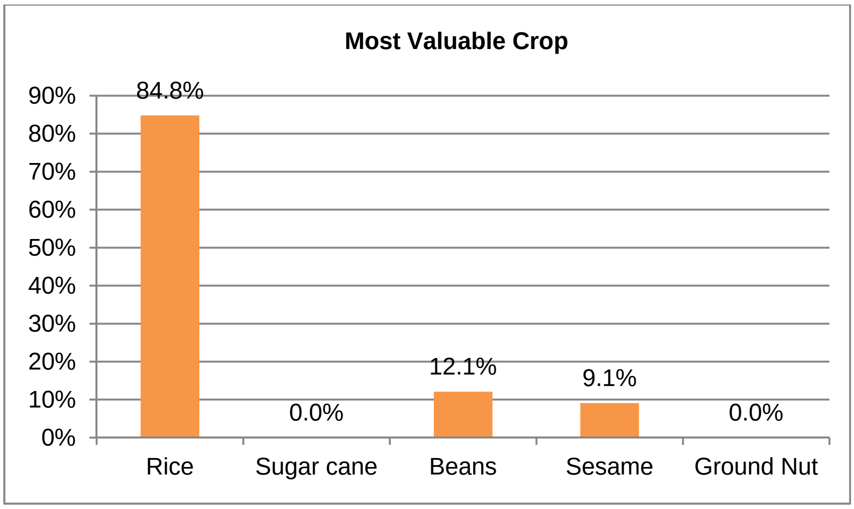
The traditional ecology survey consisted of 110 questions. The results of the surveys have been analyzed and a summary of the results is provided below:

3.4.2.1 Crops

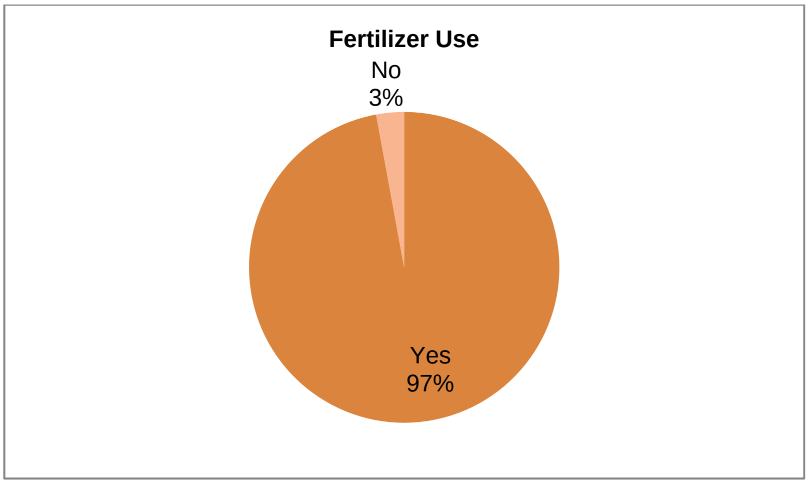
The following graph shows the percentage of participants who grow each crop. The three main crops planted are rice, beans and ground nut, which are planted by all participants:



The most valuable crop grown is rice (chosen by 85% of participants). The least valuable crops are sugar cane and ground nut (0%):

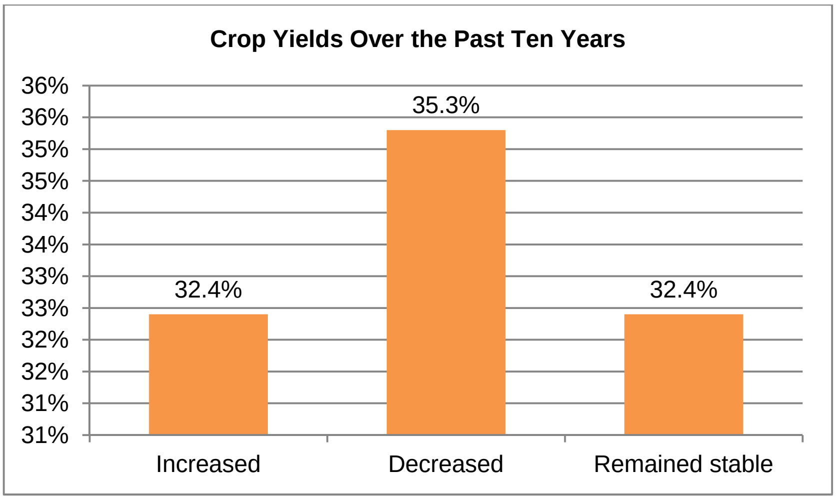


The majority of participants use fertilizers (97%):



All participants (100%) use pesticides.

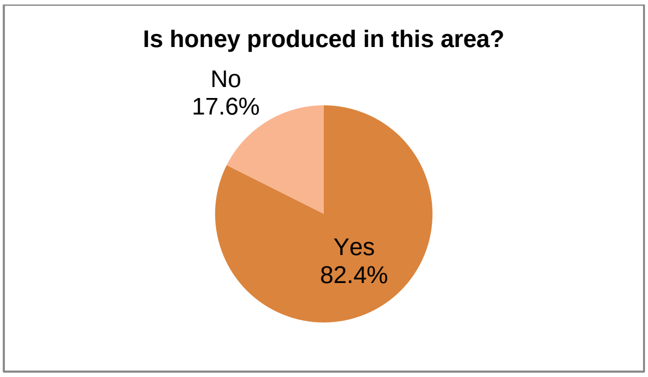
Participants were asked whether their crop yields increased, decreased, or remained stable in the past ten years. Participants had mixed responses: 35% observed a decrease, 32% an increase, and another 32% remained stable:



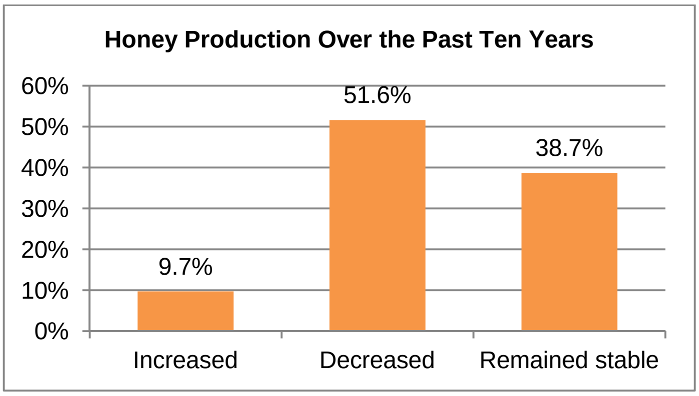
All participants (100%) attributed a change in crop yields to lack of water. All participants (100%) also consider their crops an important food source (i.e. crops are sold).

3.4.2.2 Honey

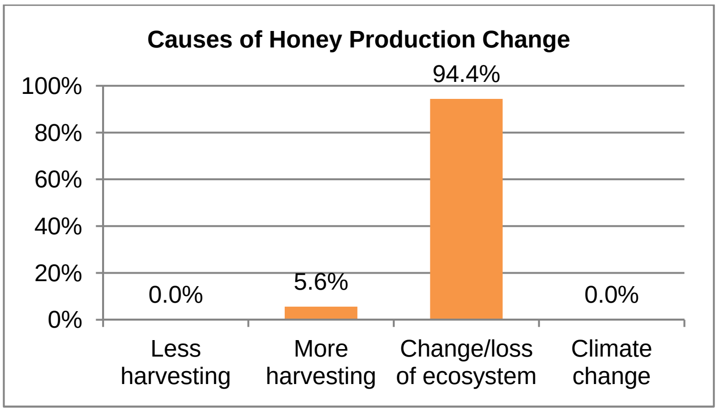
The majority of participants (82%) produced honey in their area:



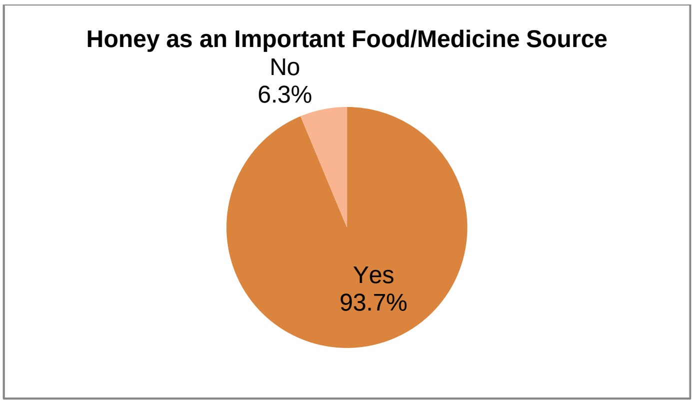
Participants were asked whether honey production increased, decreased, or remained stable in the past ten years. Most participants claimed honey production either decreased (52%) or remained stable (39%):



The majority of participants attributed a change in honey production to a change or loss in ecosystem (94%). None stated that less harvesting or climate change was the cause:

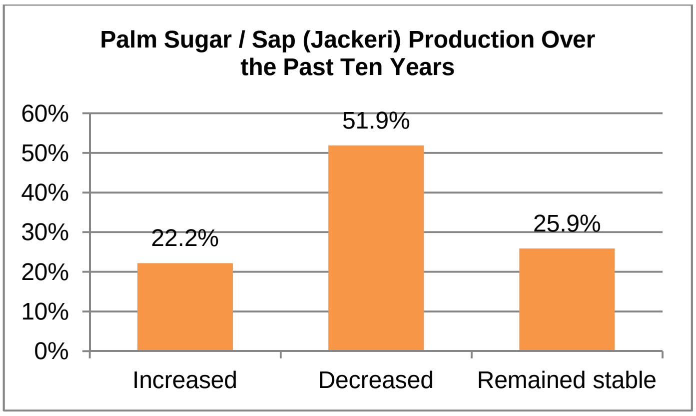


Most participants (94%) considered honey an important source of food or medicine:

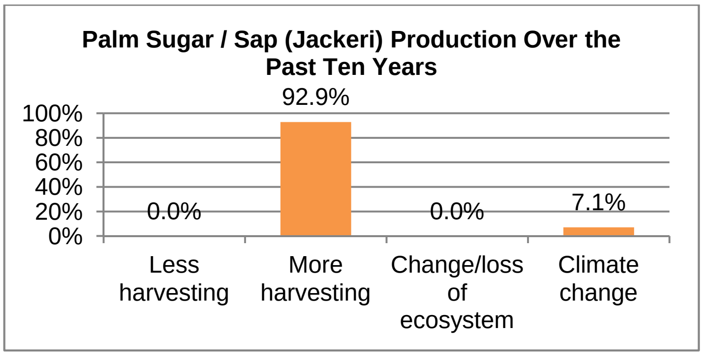


3.4.2.3 Palm Sugar / Sap (Jackeri)

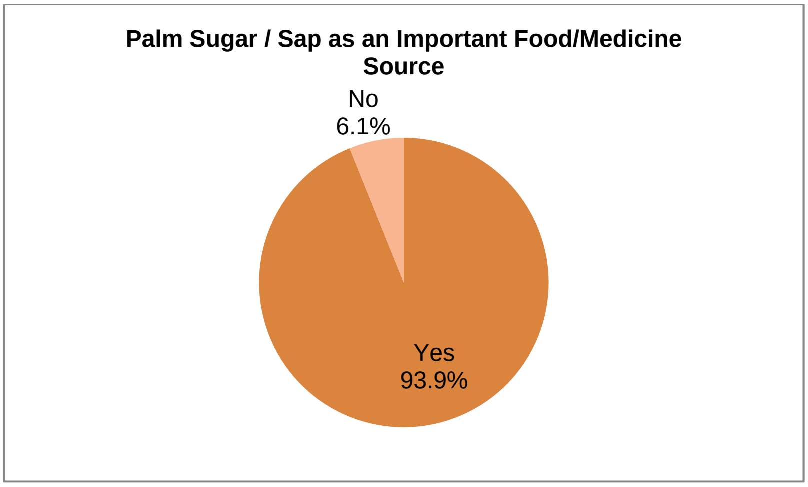
When participants were asked about palm sugar or sap (Jackeri) production in the past ten years, approximately half (52%) claimed production decreased:



Most (93%) attributed the change in production to more harvesting. None attributed less harvesting or a change or loss of ecosystem as a cause:

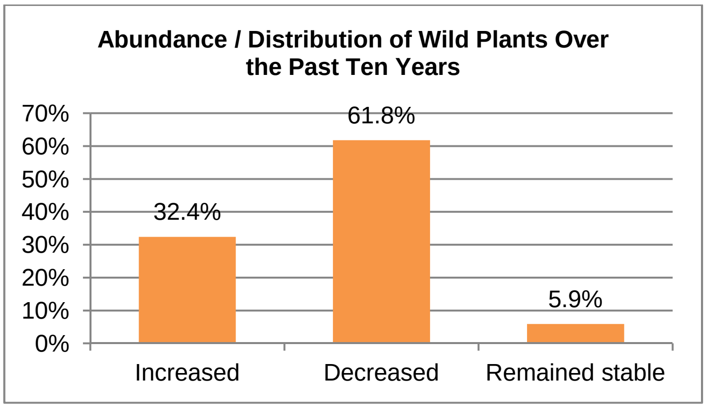


Palm sugar or sap is an important food or medicinal source to most (94%) participants:

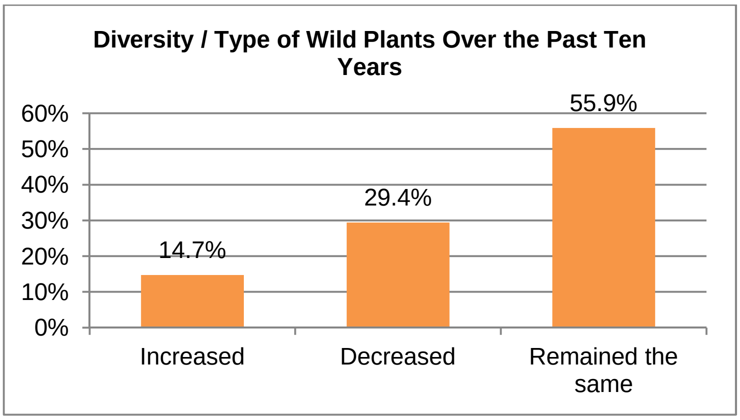


3.4.2.4 Wild Plants

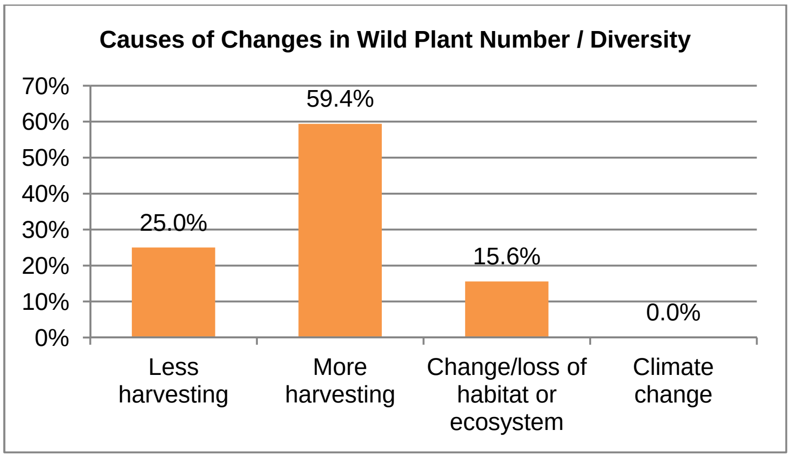
The majority of participants (62%) observed a decrease in the abundance or distribution of wild plants in the past ten years, while a substantial group (32%) observed an increase:



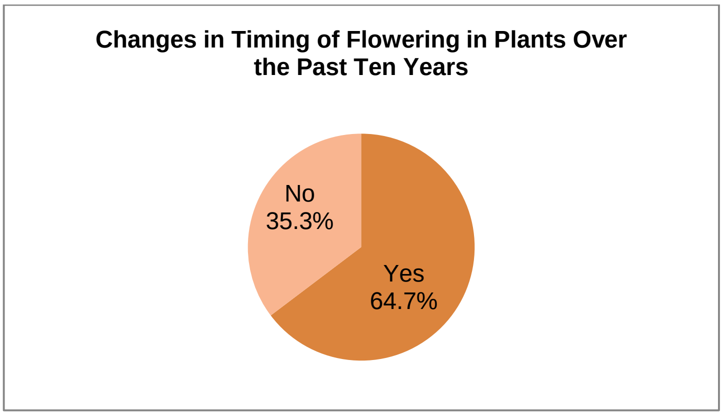
On the other hand, more than half of the participants (56%) claim that the diversity or type of wild plants had remained stable in the past ten years. Approximately a third of participants (29%) cited a decrease:



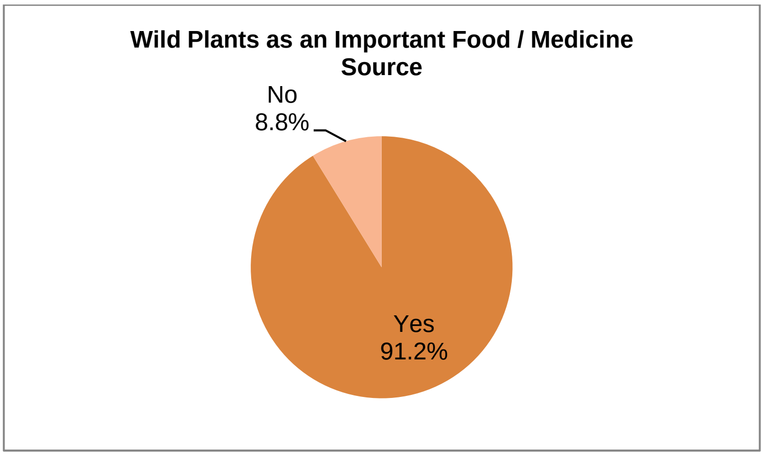
More than half (59%) of the participants who observed a change in the number and/or diversity of wild plants believed more harvesting to be the cause. A quarter (25%) of participants blamed it on less harvesting:



Over half (65%) of the participants observed a change in the timing of flowering in plants:

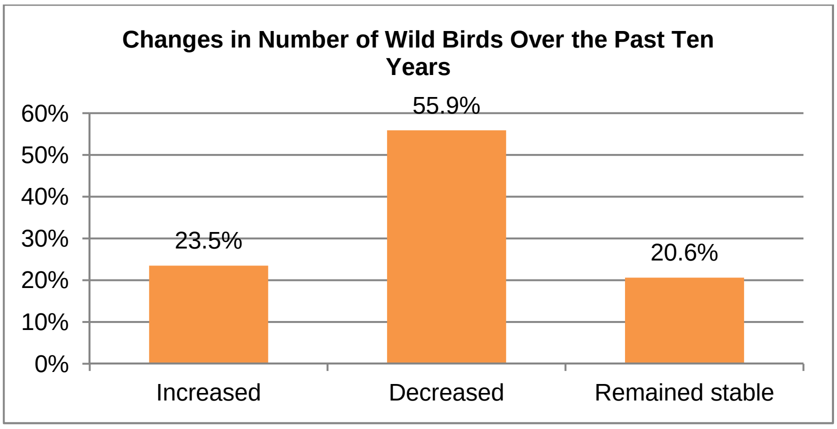


Wild plants are an important source of food or medicine for most participants (91%):

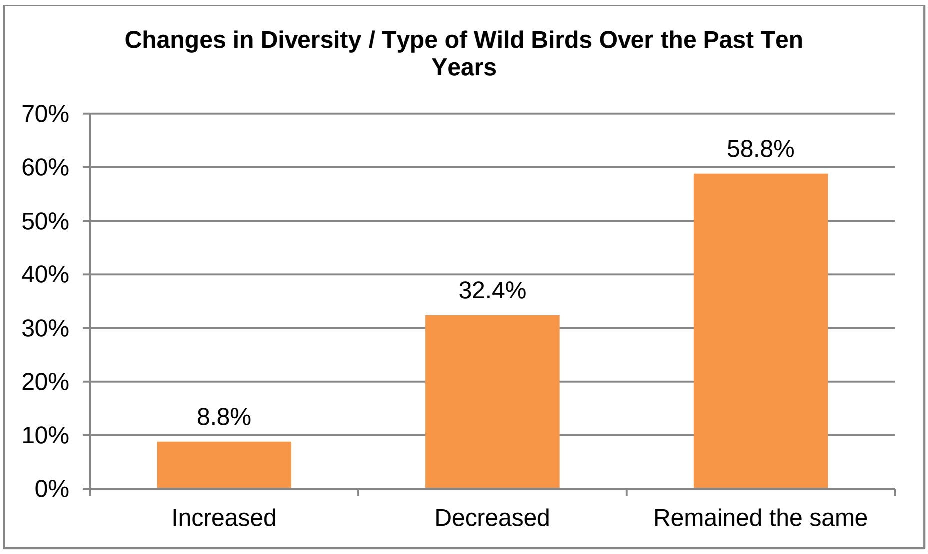


3.4.2.5 Wild Birds

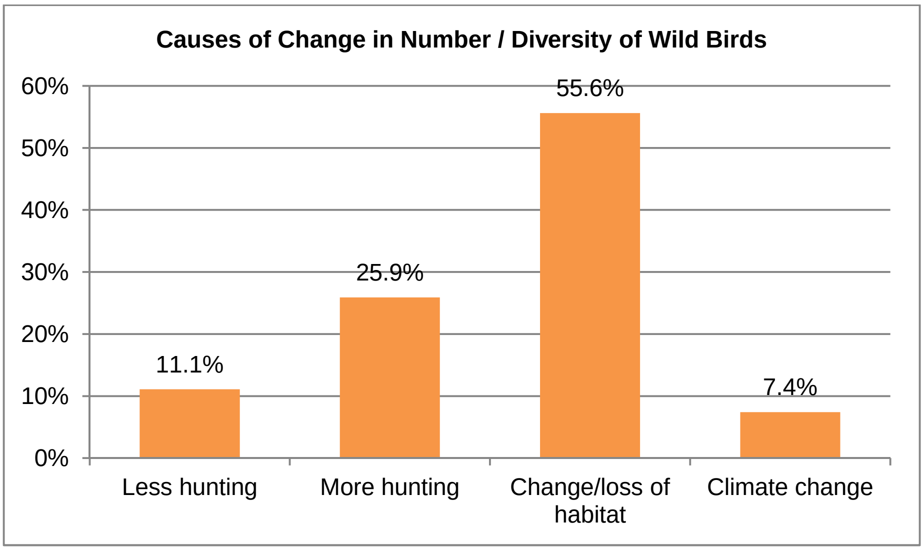
More than half of the participants (56%) claimed that the number of wild birds has decreased in the past ten years, while a quarter (24%) of participants cited an increase:



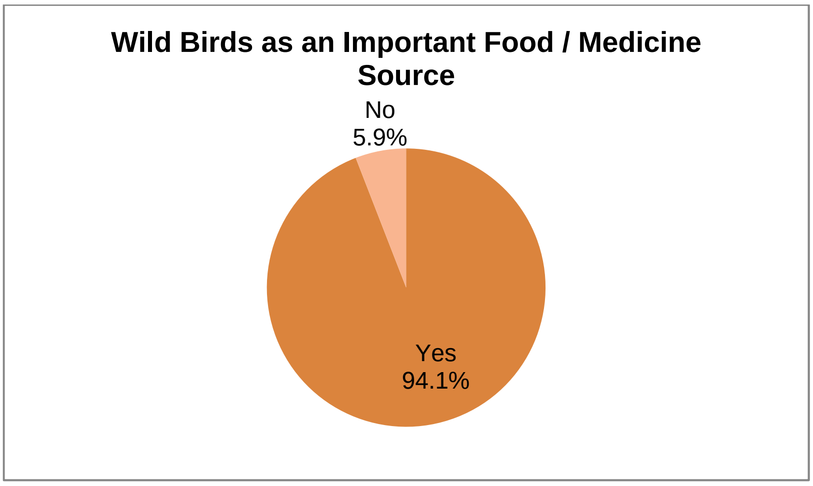
However, more than half of participants (59%) claimed that the diversity or type of wild birds has remained stable in the past ten years. Approximately a third of participants (32%) cited a decrease:



More than half (56%) of the participants who claimed a change in the number and/or diversity of wild birds believed it was due to a change or loss in habitat, while 26% blamed the change on increased hunting:

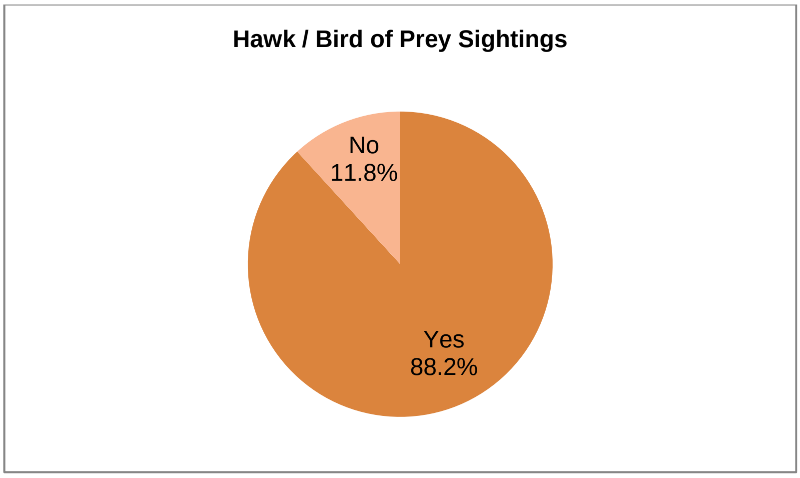


Wild birds are an important source of food or medicine to most participants (94%):

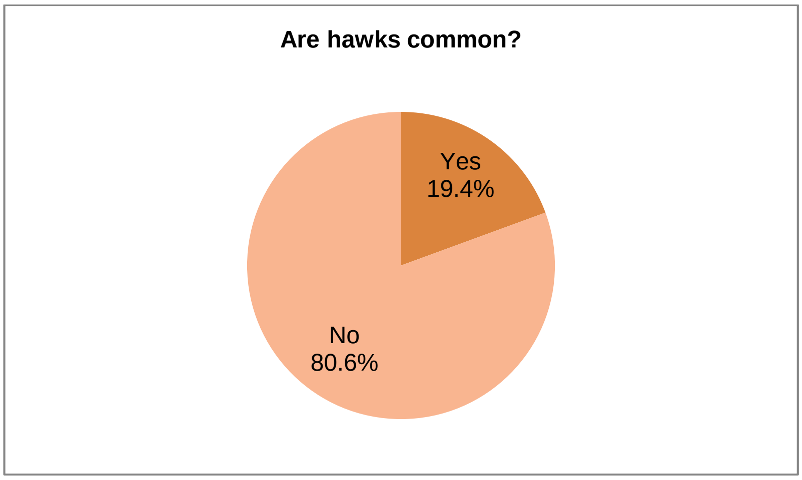


3.4.2.6 Hawks

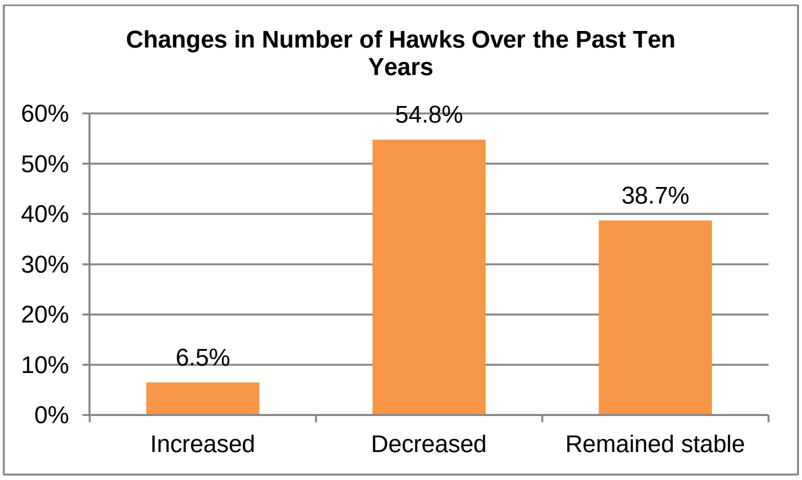
Most participants (88%) had sighted a hawk or bird of prey in their area:



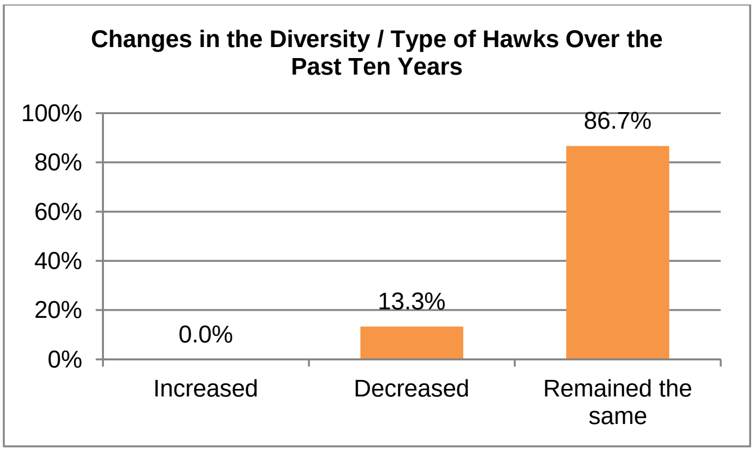
However, the majority (81%) claimed that hawks are not common:



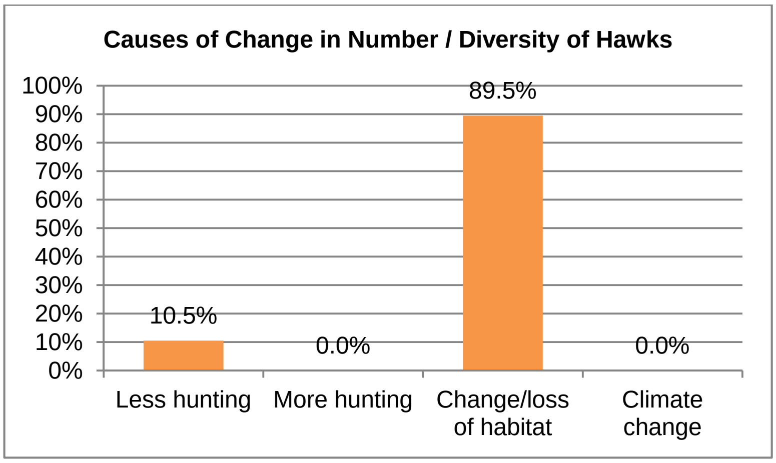
More than half (55%) of participants observed a decrease in the number of hawks in the past ten years, while 39% of participants claimed it remained stable:



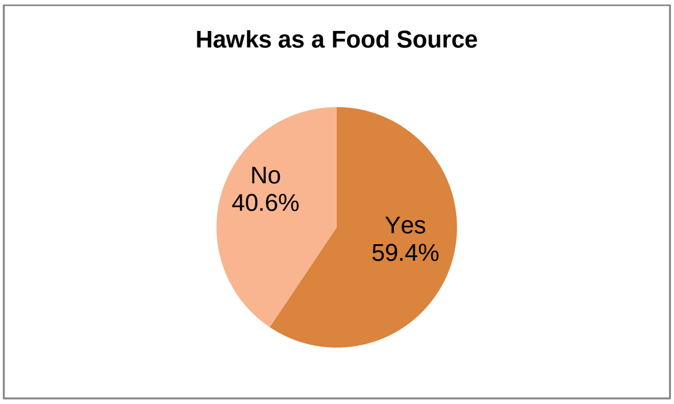
However, most participants (87%) claimed that the diversity or type of hawks has remained stable in the past ten years. A minority (13%) cited a decrease:



Most villagers surveyed (90%) who observed a change in the number and/or diversity of hawks believed it was due to a change or loss in habitat. None attributed it to increased hunting or climate change:

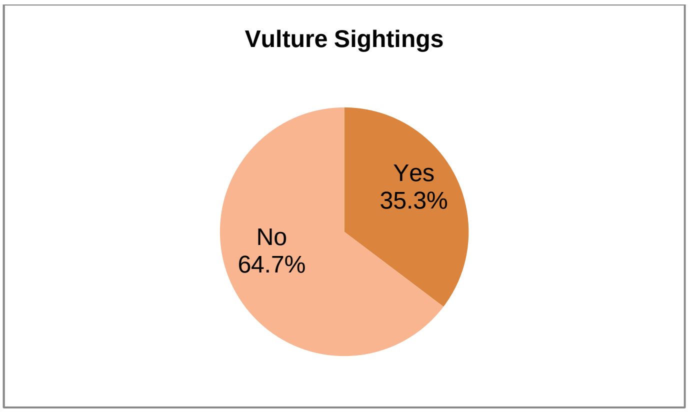


Hawks is a source of food to more than half (59%) of the villagers surveyed:

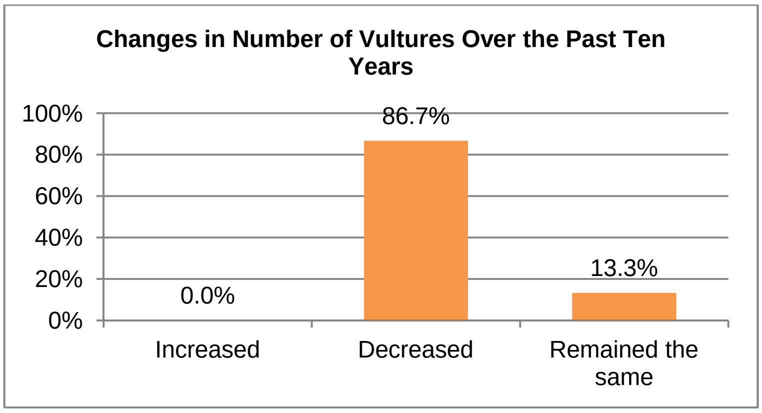


3.4.2.7 Vultures

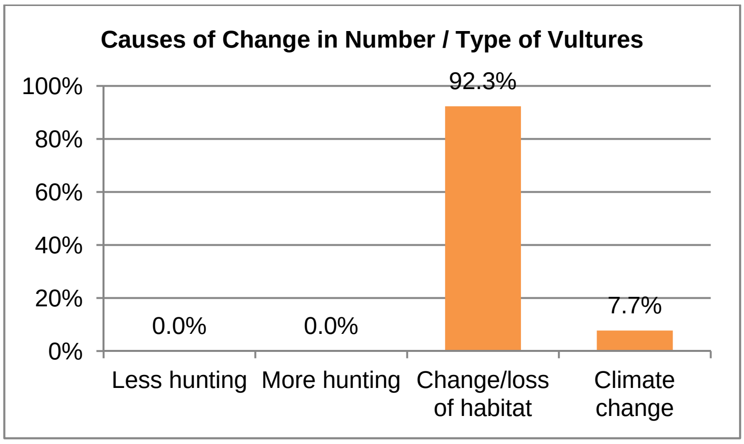
More than half (65%) of the villagers surveyed had spotted a vulture in their area:



However, all participants (100%) claimed they are uncommon within the area. Most (87%) claimed a decrease in the number of vultures in the past ten years:



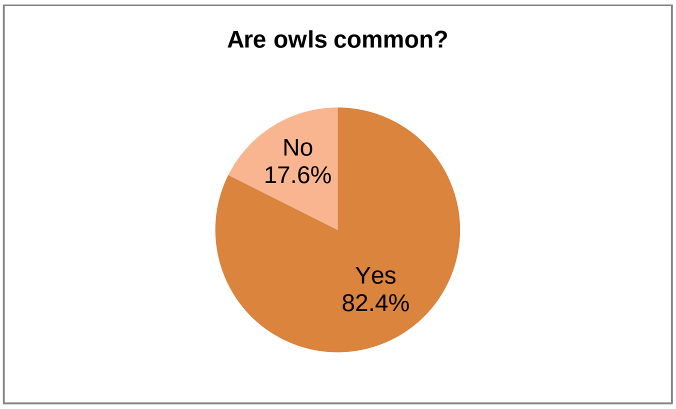
Most participants (92%) who observed a change in the number of vultures believed it was due to a change or loss in habitat. The remaining (8%) attributed it to climate change:



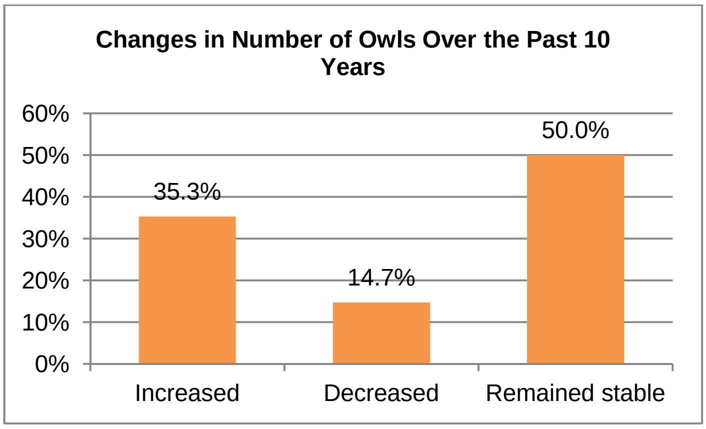
All participants (100%) did not consider vultures as a source of food or medicine.

3.4.2.8 Owls

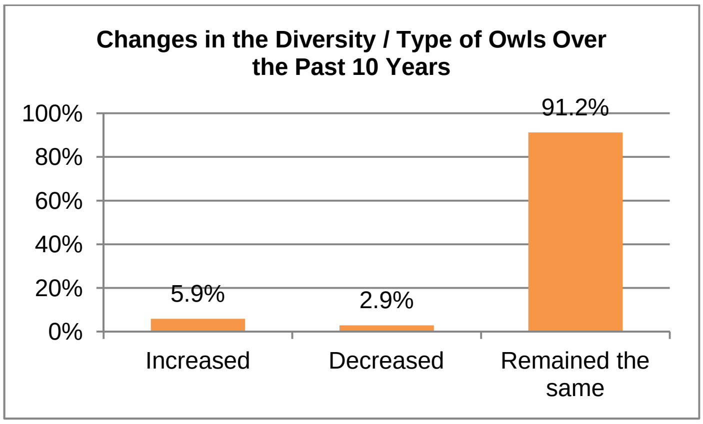
All (100%) of the villagers surveyed had sighted an owl within their area. The majority (82%) of them stated that owls are common:



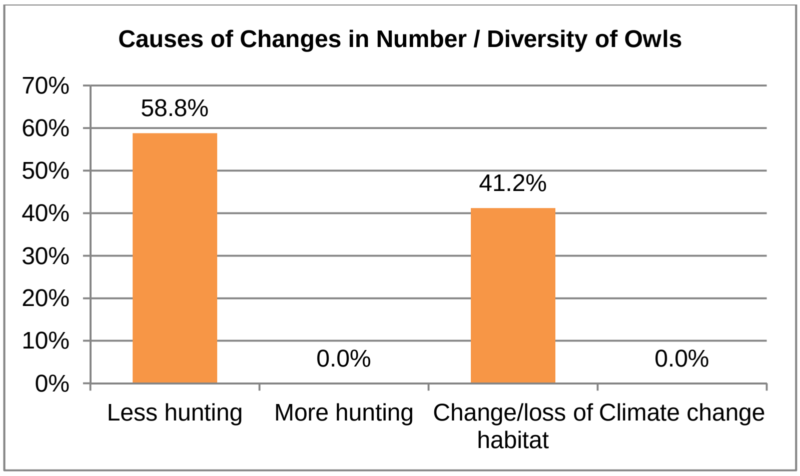
Villagers surveyed had mixed responses on changes in the number of owls in the past ten years. Half (50%) claimed the number remained stable, 35% claimed an increase, and 15% a decrease:



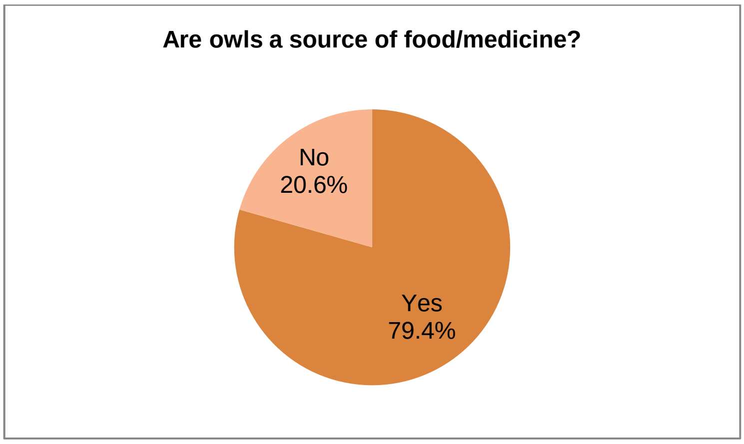
However, most participants (91%) claimed that the diversity or type of owls remained the same in the past ten years:



More than half (59%) of participants attributed the change in the number and diversity of owls to less hunting. The remaining (41%) attributed it to a change or loss of habitat:

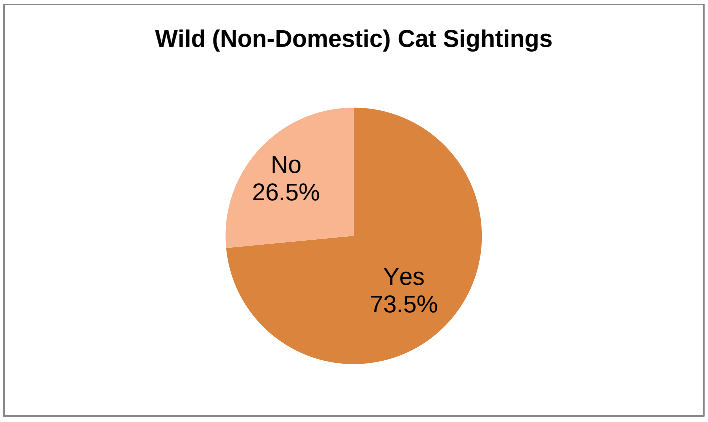


Owls are a source of food or medicine for a majority (79%) of participants:

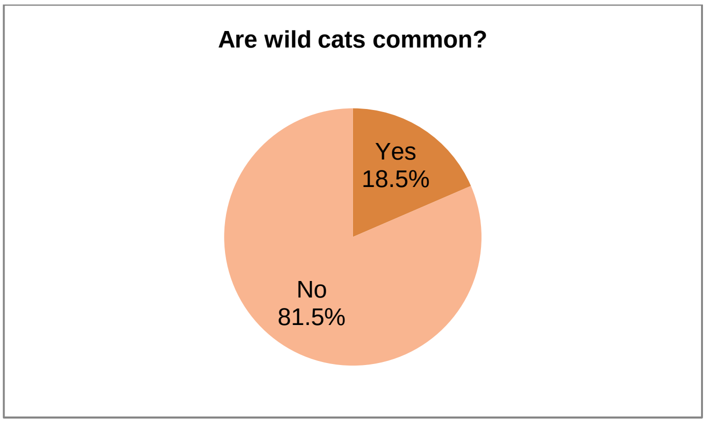


3.4.2.9 Wild Cats

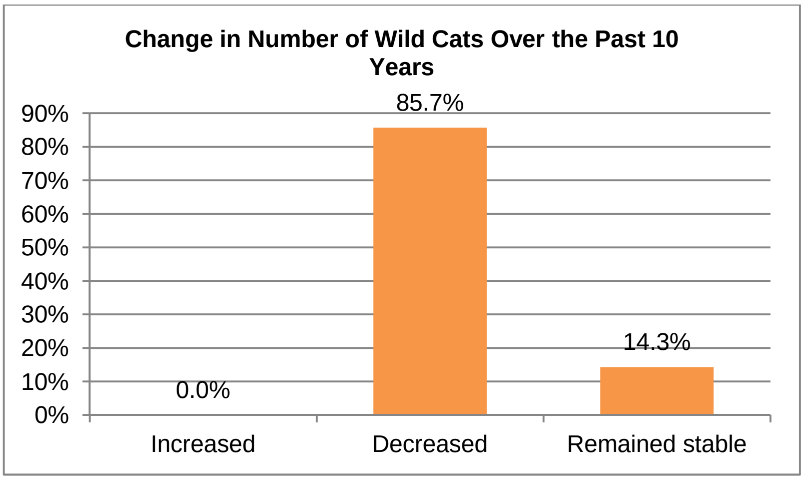
The majority of villagers surveyed (74%) had seen a wild cat within their area:



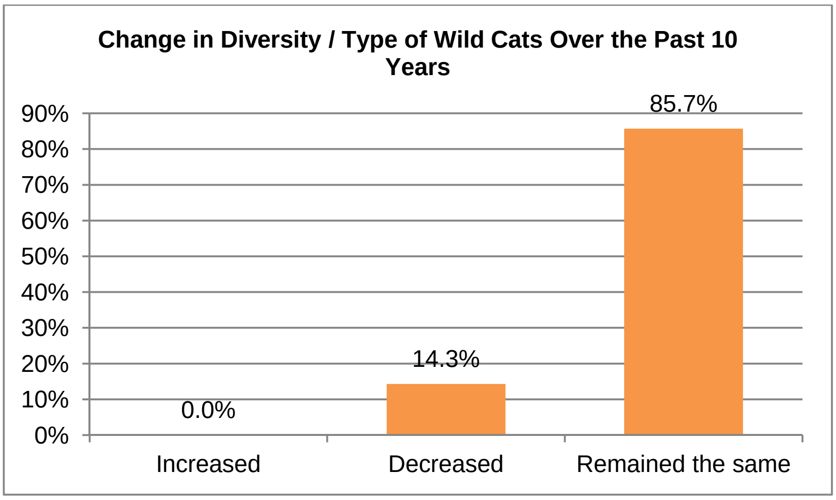
However, most (82%) stated that wild cats are uncommon within the area:



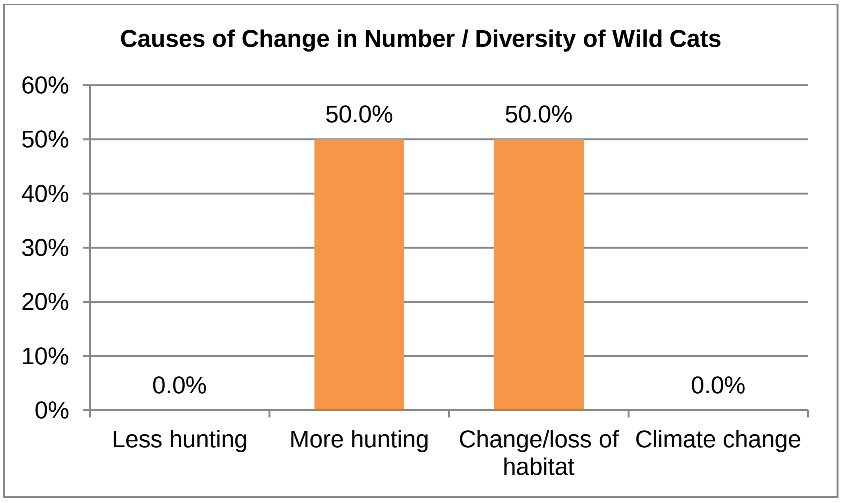
Most participants (86%) observed a decrease in the number of wild cats in the past ten years. The remaining (14%) claimed it has remained stable:



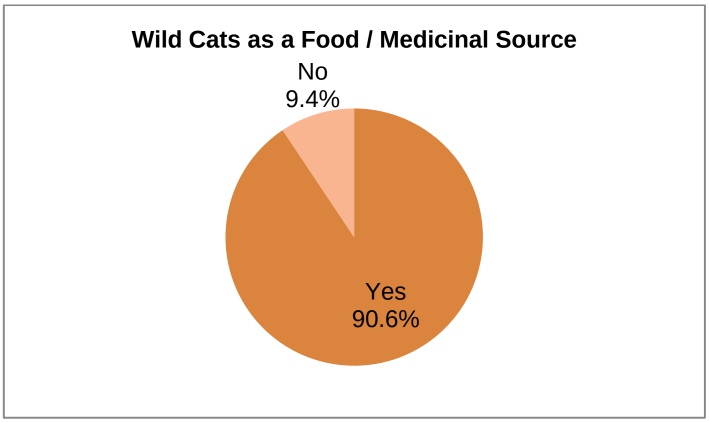
However, most participants (86%) believed that the diversity or type of wild cats has remained stable throughout the period:



Half of the participants (50%) attributed the change in number and/or diversity to a change or loss in habitat. The remaining half (50%) attributed the change to an increase in hunting:

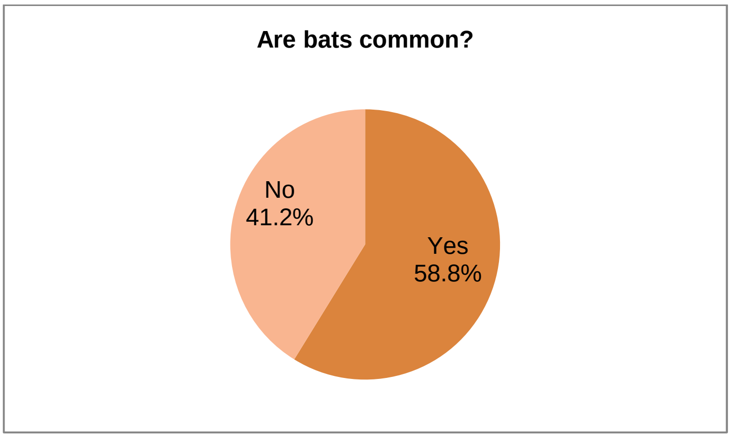


Most participants (91%) considered wild cats a source of food or medicine:

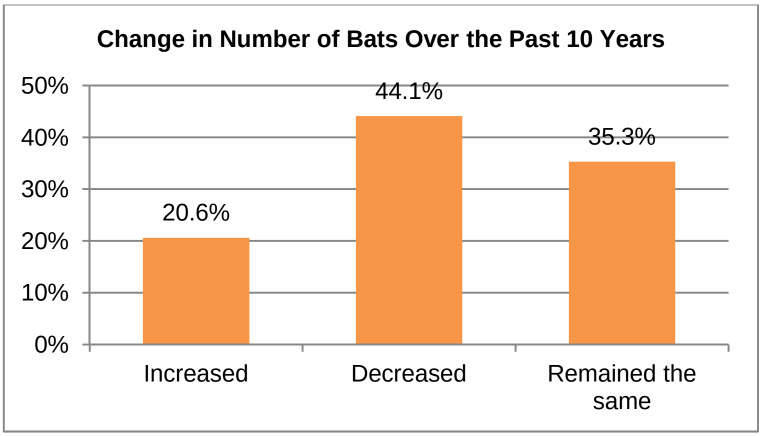


3.4.2.10 Bats

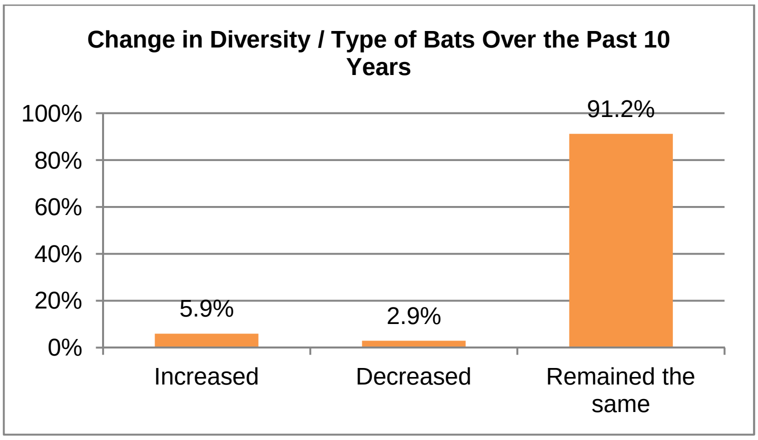
All (100%) of the villagers surveyed had seen a bat within their area. More than half (59%) stated that they are common:



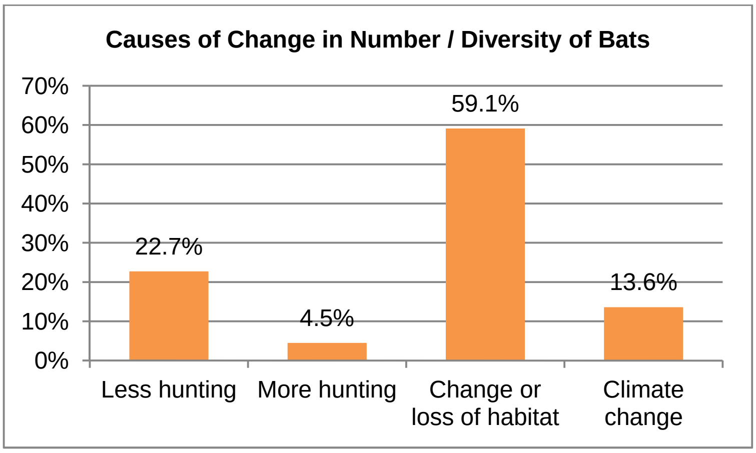
Participants had mixed responses on the change of bats over the past ten years: Almost half (44%) believed it had decreased, a third (35%) believed it remained the same, and a fifth (21%) an increase:



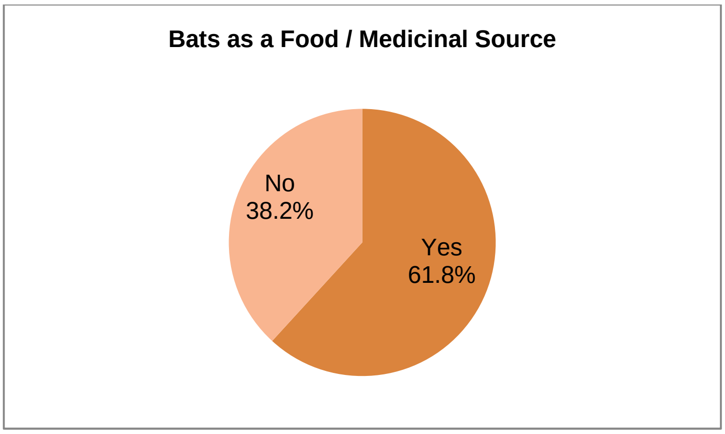
Most participants (91%) believed that the diversity or type of bats had remained the same throughout the period:



More than half of the participants (59%) attributed the change in number and/or diversity to a change or loss in habitat. Approximately a quarter (23%) attributed the change to a decrease in hunting:

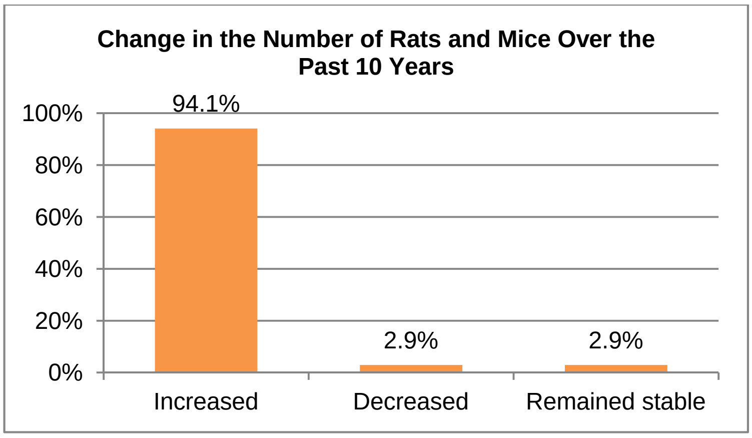


More than half (62%) of participants considered bats a source of food or medicine:

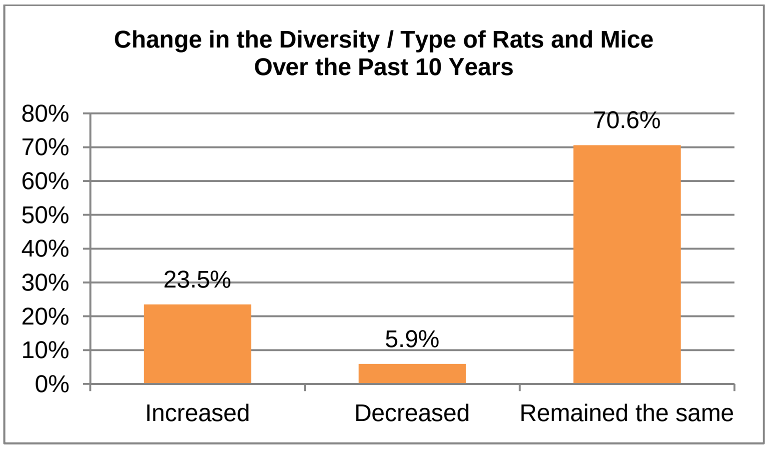


3.4.2.11 Rats and Mice

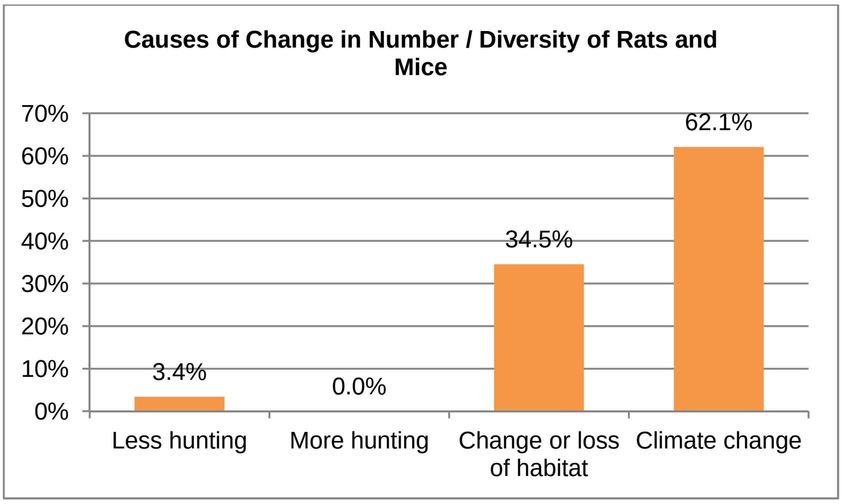
All villagers surveyed (100%) claimed they had seen rats and mice in their area, and all (100%) believed they are common. Most participants (94%) also believed the number of rats and mice had increased in the past ten years:



However, the majority (71%) claimed that the diversity or type of rats and mice has remained the same over this period:



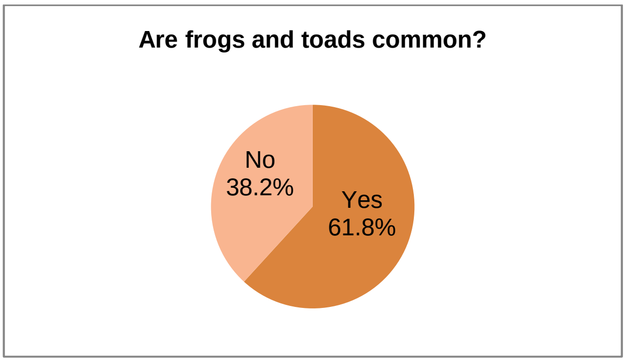
More than half (62%) of participants who observed a change in the number and/or diversity of rats and mice attributed it to climate change. Approximately one-third (35%) attributed it to a change or loss of habitat:



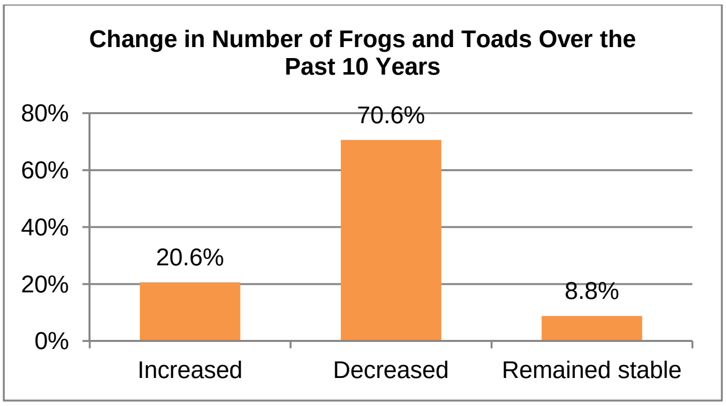
They are a source of food or medicine to all participants (100%).

3.4.2.12 Frogs and Toads

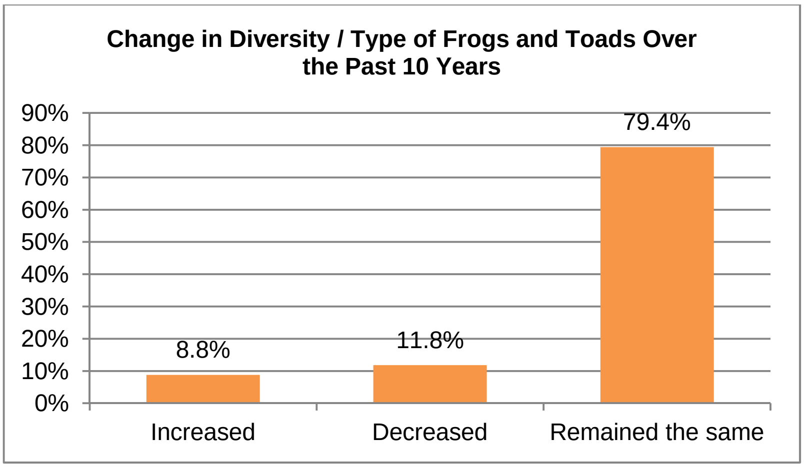
All participants (100%) had sighted frogs and toads in their area. More than half (62%) claimed they are common:



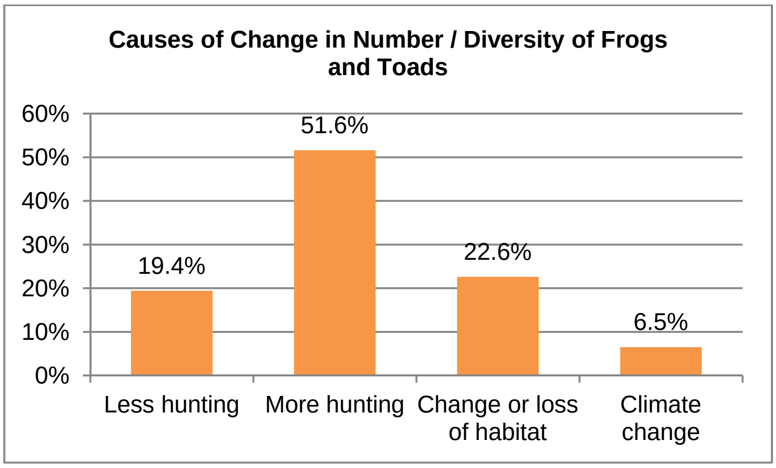
The majority (71%) of participants observed a decrease in the number of frogs or toads over the past ten years:



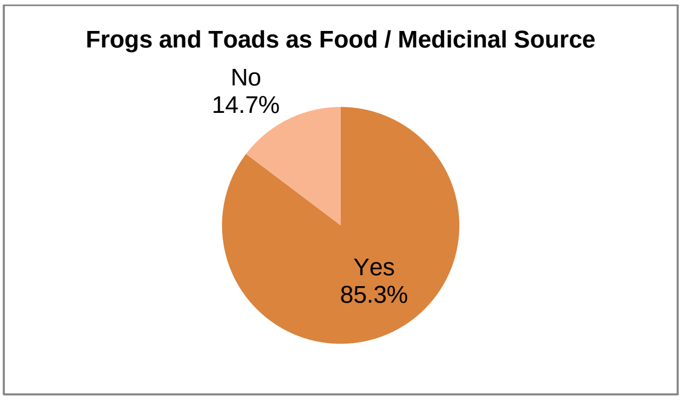
However, most participants (79%) claimed that the diversity or type of frogs and toads had remained the same throughout this period:



Of the participants who observed a change in number and/or diversity, approximately half (52%) attributed it to increased hunting, while approximately one-fifth (23%) attributed it to a change or loss of habitat:

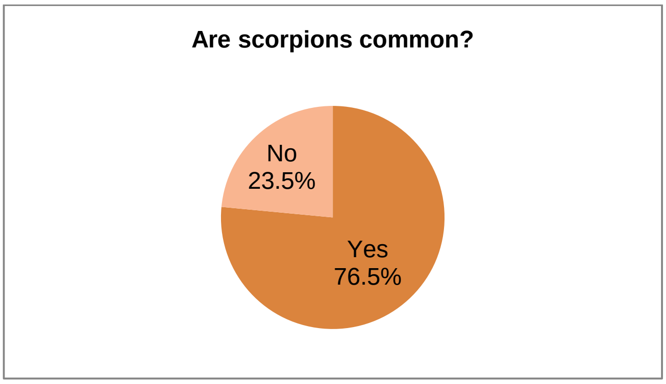


Frogs and toads are a source of food or medicine to most villagers surveyed (85%):

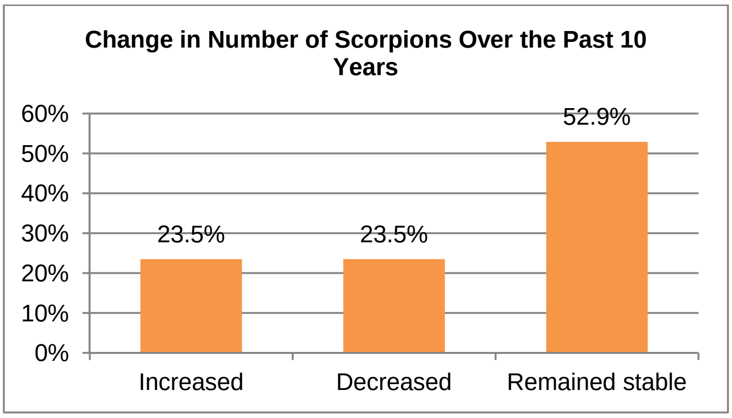


3.4.2.13 Scorpions

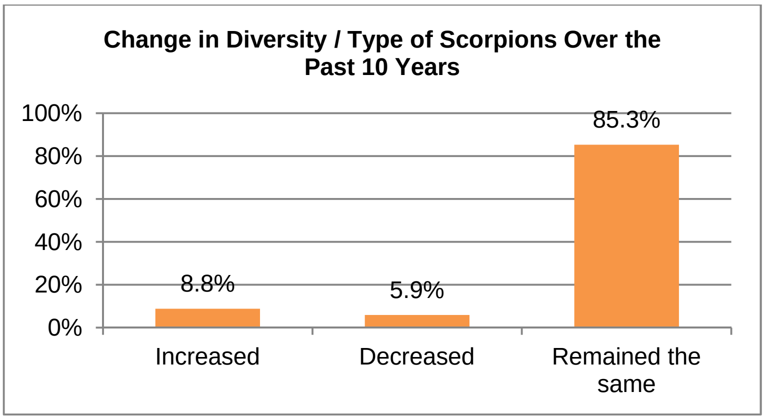
All participants (100%) had sighted scorpions within their area. Approximately three-fourths (77%) claimed they are common:



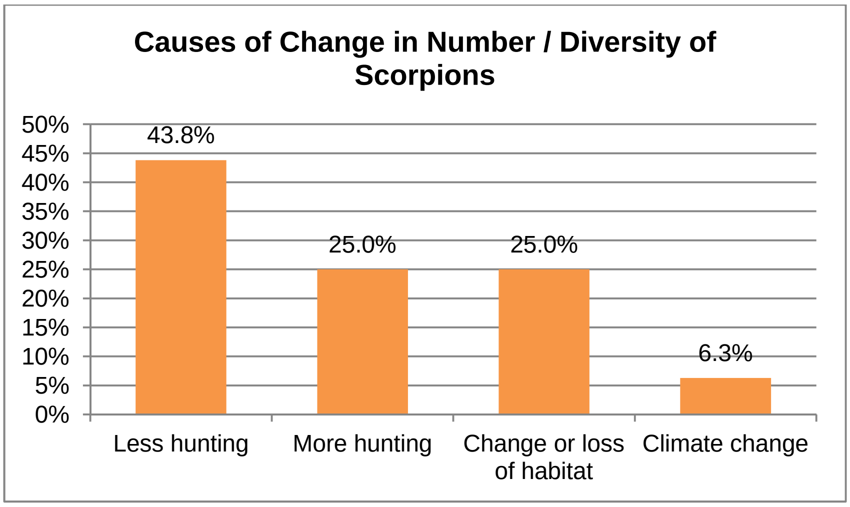
More than half (53%) believed the number of scorpions had remained stable over the past ten years:



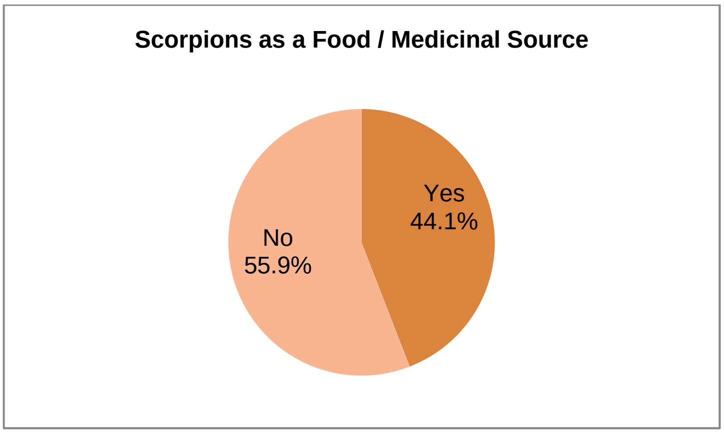
In addition, most participants (85%) claimed that the diversity or type of scorpions had remained the same over this period:



Fewer than half of the participants (44%) who believed there has been a change in the number and/or diversity of scorpions attributed it to a decrease in hunting. Most remaining participants attributed it to increased hunting (25%) or a change or loss of habitat (25%):

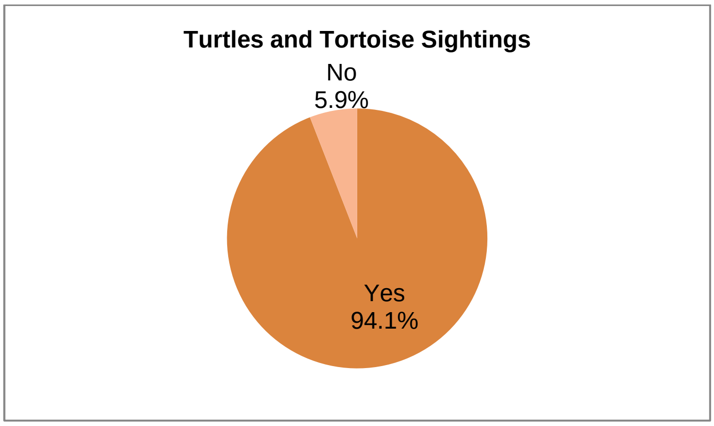


Scorpions are a source of food or medicine to less than half (44%) of the villagers surveyed:

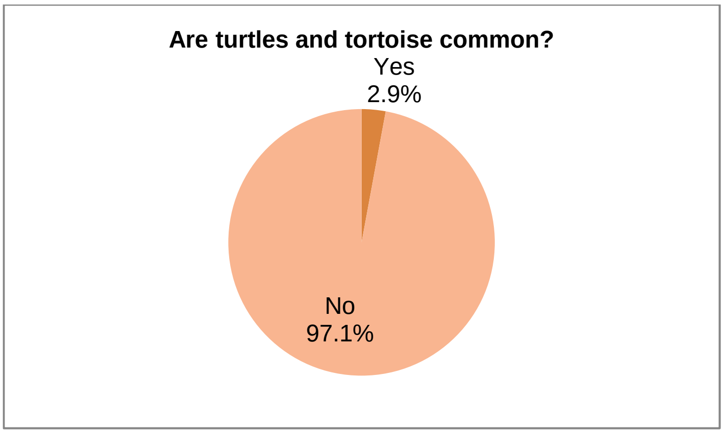


3.4.2.14 Turtles & Tortoise

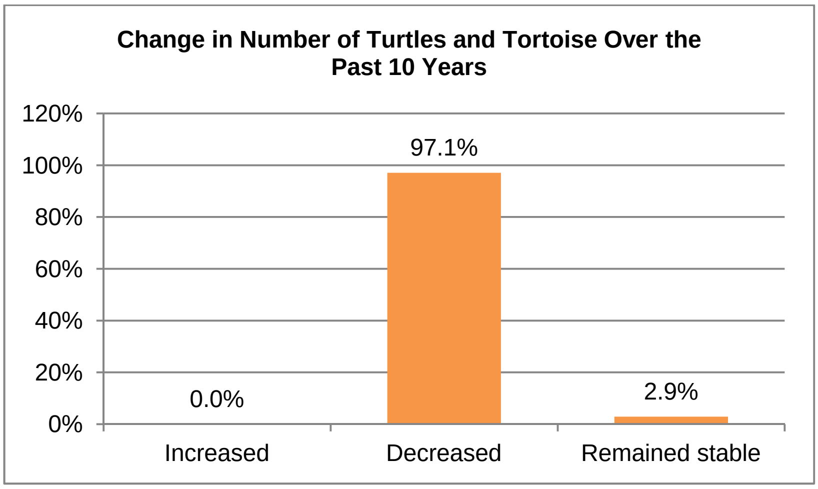
Most participants (94%) had sighted turtles and tortoises within their area:



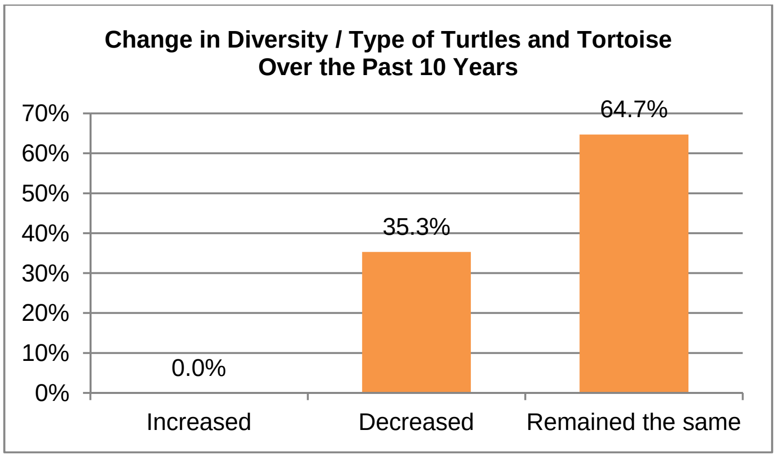
However, most (97%) claimed they are uncommon:



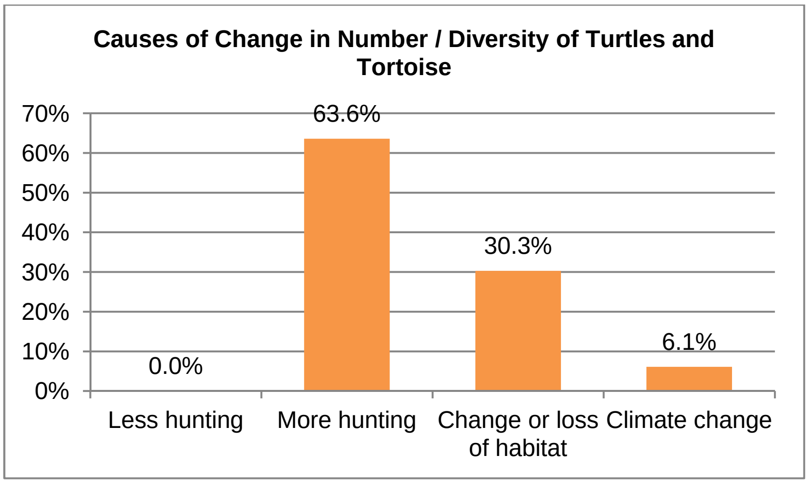
Most participants (97%) also agreed that the number of turtles and tortoise had decreased over the past ten years:



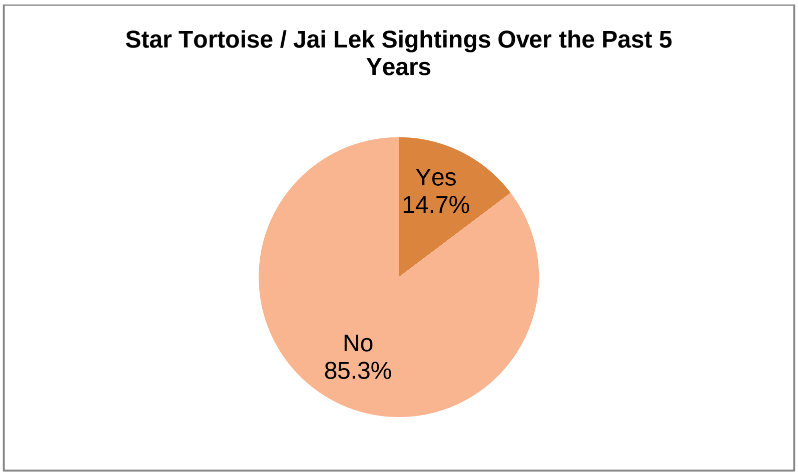
However, more than half (65%) of the participants claimed that the diversity or type of scorpions has remained the same over this period. Remaining participants (35%) observed a decrease:



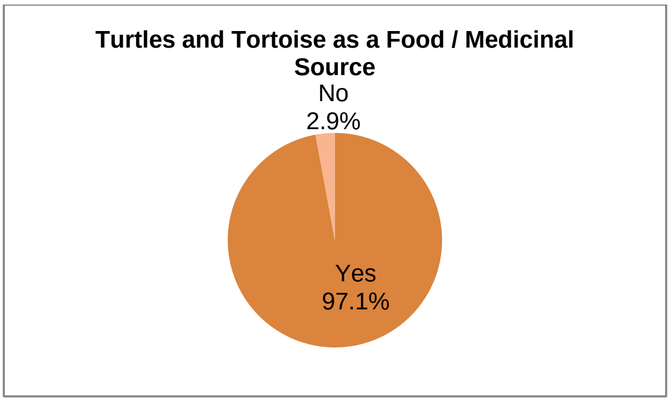
More than half (64%) of the participants who observed a change in the number and/or diversity of turtles and tortoise attributed it to an increase in hunting. The second-most attributed cause (30%) was the change or loss of habitat:



Over the past five years, few participants (15%) had sighted a Star Tortoise or jai lek:

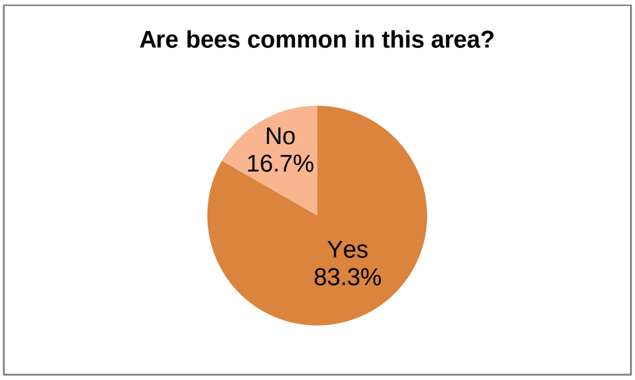


Turtles and tortoise are a source of food or medicine to the majority (97%) of participants:

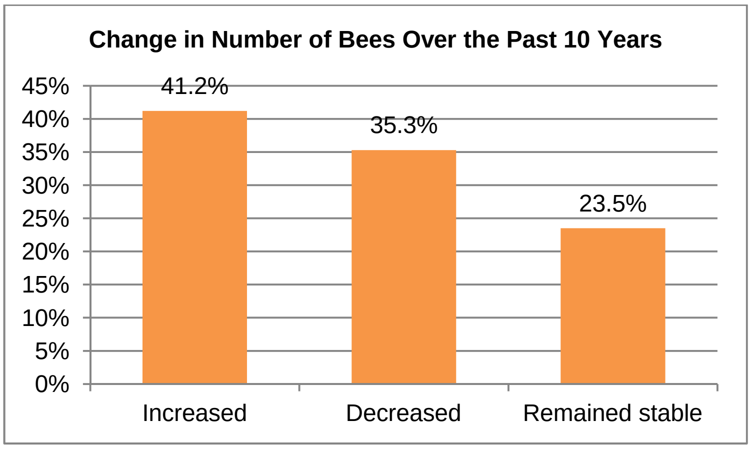


3.4.2.15 Bees

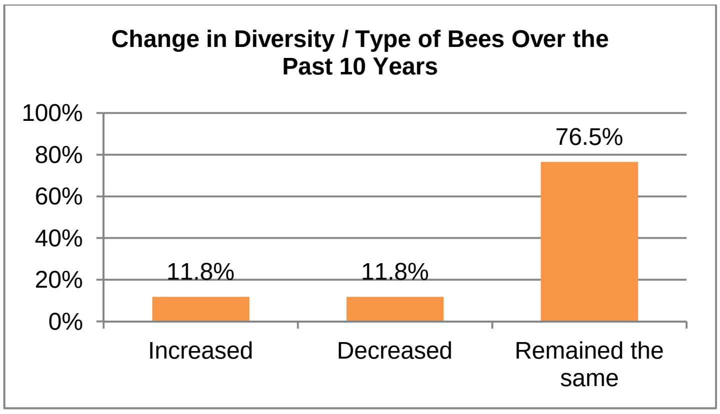
All participants (100%) had sighted bees within their area. The majority (83%) claimed they are common:



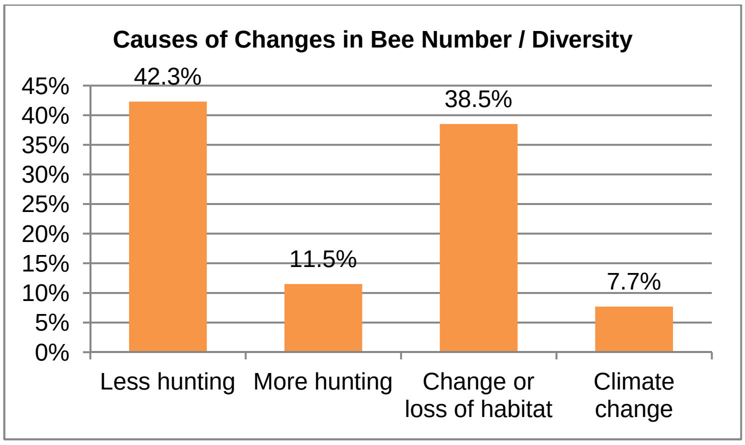
Participants had mixed responses on the number of bees over the past ten years: 41% believed it has increased, 35% were for a decrease, and 24% claimed it remained stable:



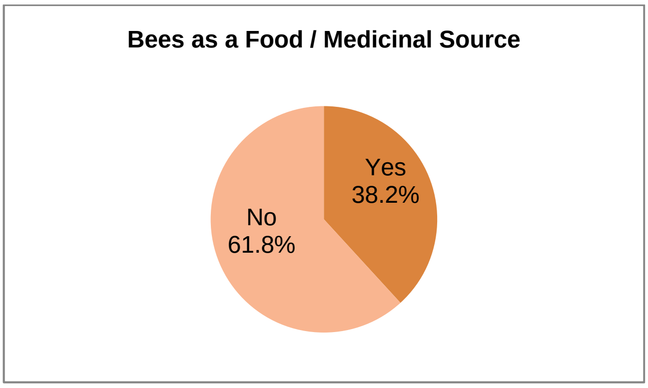
However, the majority (77%) claimed that the diversity or type of bees has remained the same over this period:



Less than half (42%) of the participants who observed a change in the number and/or diversity of bees attributed it to a decrease in hunting. More than one-third (39%) of participants attributed the change to a change or loss of habitat:

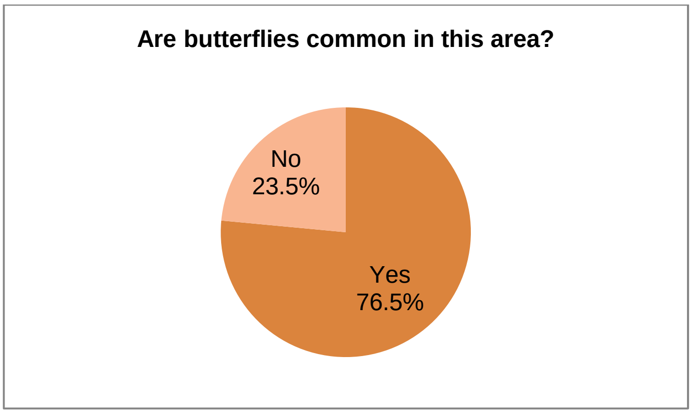


Bees are a source of food or medicine to fewer than half (38%) of the participants:

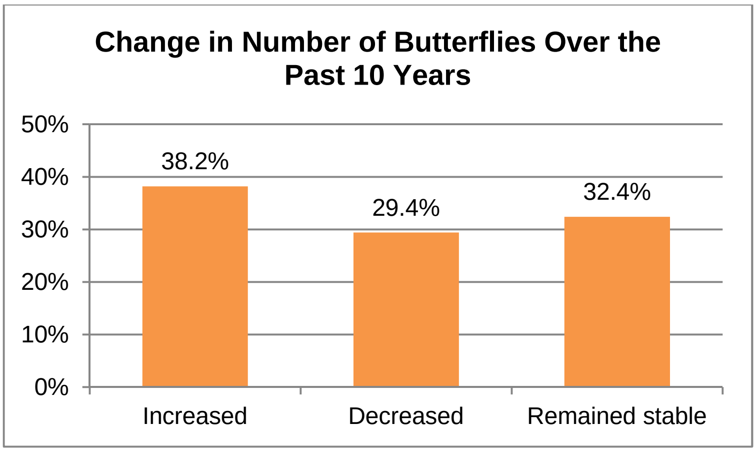


3.4.2.16 Butterflies

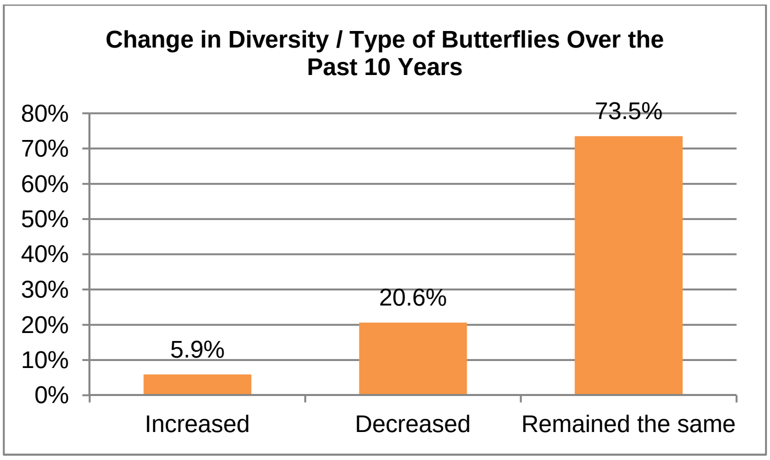
All participants (100%) had sighted butterflies within their area. The majority (77%) of participants claimed they are common:



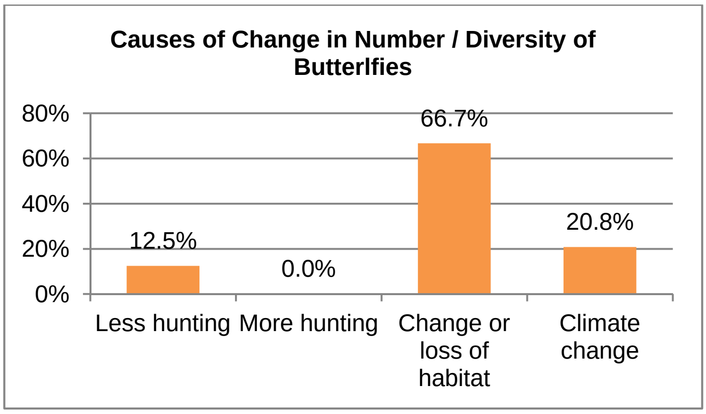
Participants had mixed responses on the number of butterflies over the past ten years: 38% believed it has increased, 32% believed it remained stable, and 29% a decrease:



However, the majority (74%) claimed that the diversity or type of butterflies had remained the same over this period:



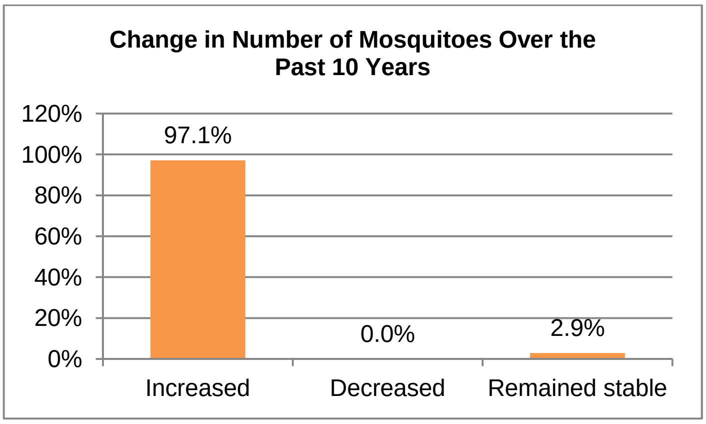
The majority (67%) of participants who believed there had been a change in the number and/or diversity of butterflies attributed it to a change or loss of habitat:



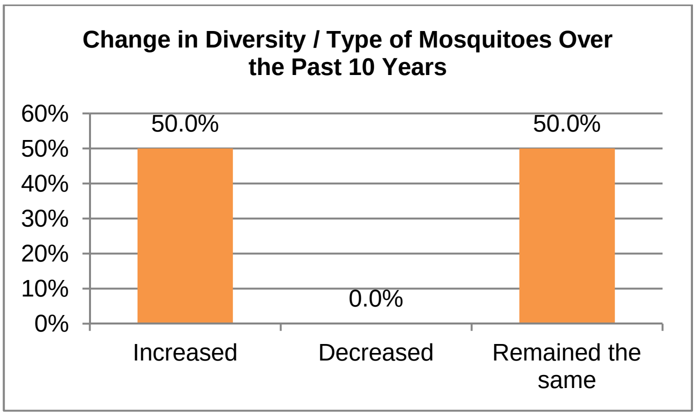
Butterflies are not a source of food, medicine or income to all participants (100%):

3.4.2.17 Mosquitoes

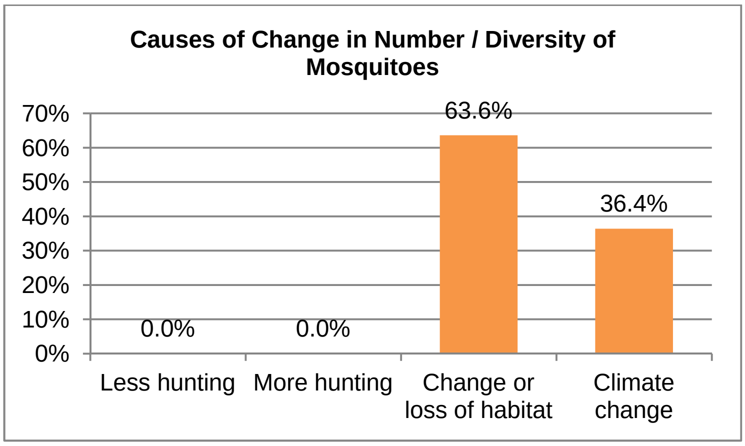
All participants (100%) had sighted mosquitoes within their area. All (100%) claimed they are common. Most participants (97%) observed an increase in mosquitoes over the past ten years:



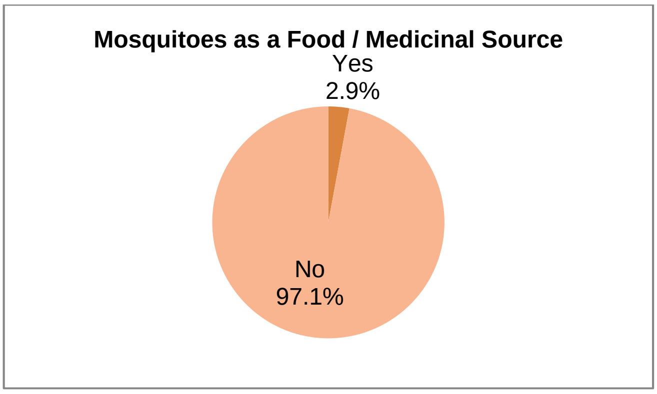
Half (50%) of participants believed there has been an increase in the diversity or type of mosquitoes; the remaining half (50%) claimed it remained the same:



More than half (64%) who observed a change in the number and/or diversity of mosquitoes attributed it to a change or loss of habitat. Remaining participants (36%) attributed it to climate change:

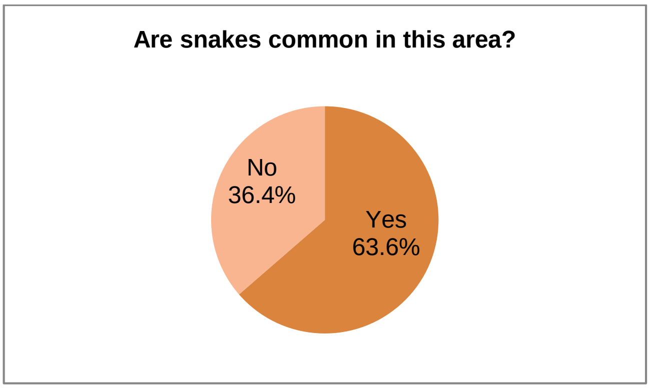


Mosquitoes are not a source of food or medicine to most participants (97%):

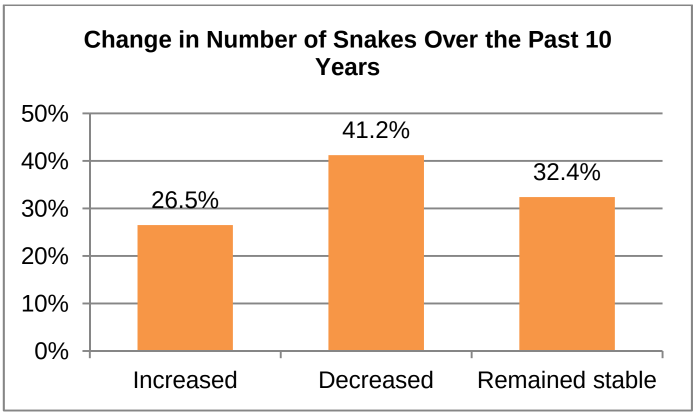


3.4.2.18 Snakes

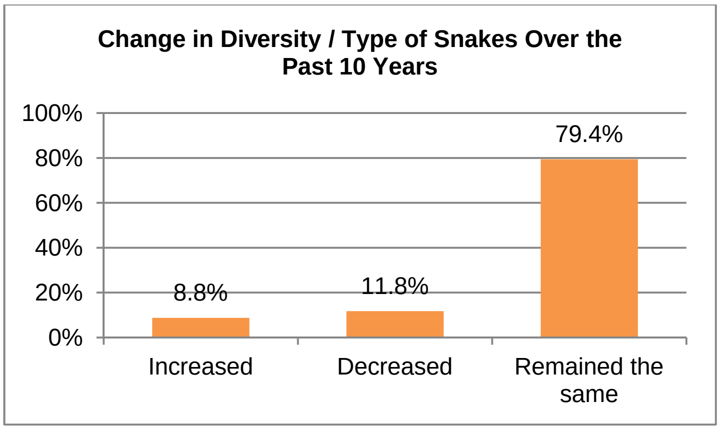
All participants (100%) had sighted snakes within their area. More than half (64%) claimed they are common:



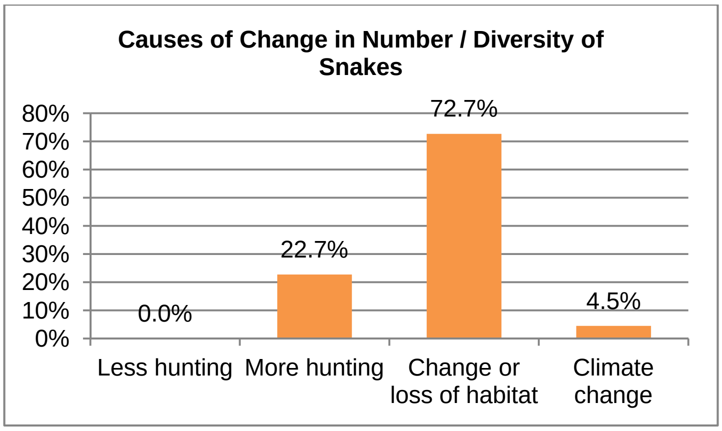
Participants had mixed responses on the number of snakes over the past ten years. 41% believed it had decreased, 32% believed it had remained stable, and 27% believed it had increased:



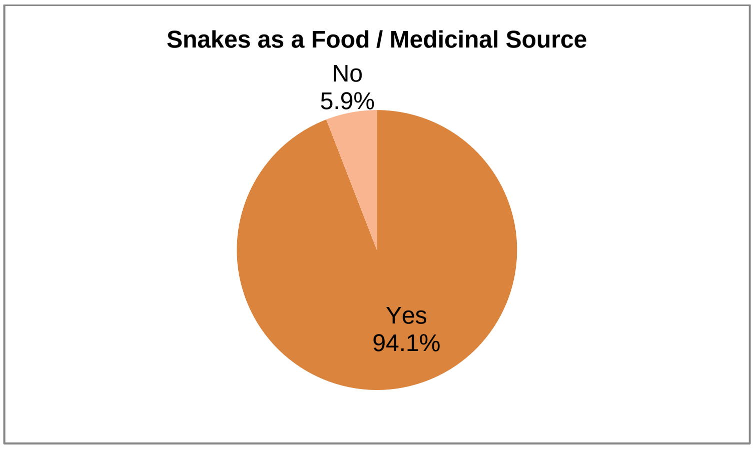
The majority (79%) of participants claimed that the diversity or type of snakes has remained the same:



The majority (73%) of participants who observed a change in the number and/or diversity of snakes attributed it to a change or loss of habitat. Most remaining participants (23%) attributed it to an increase in hunting:

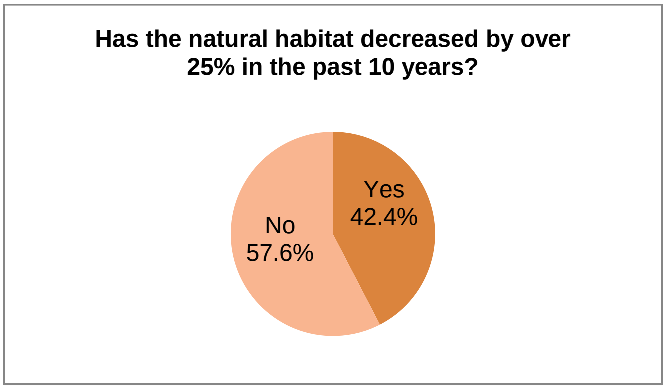


Snakes are a source of food or medicine to most participants (94%):

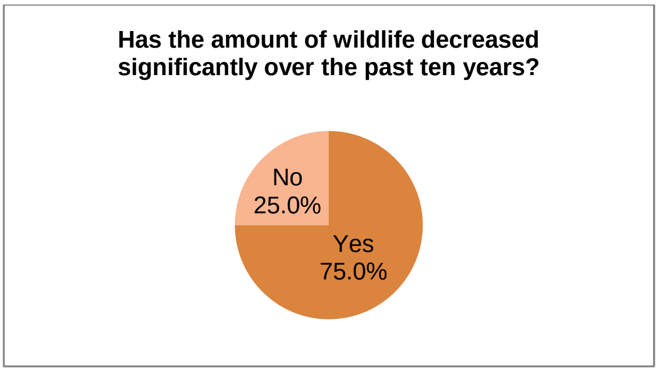


3.4.2.19 General

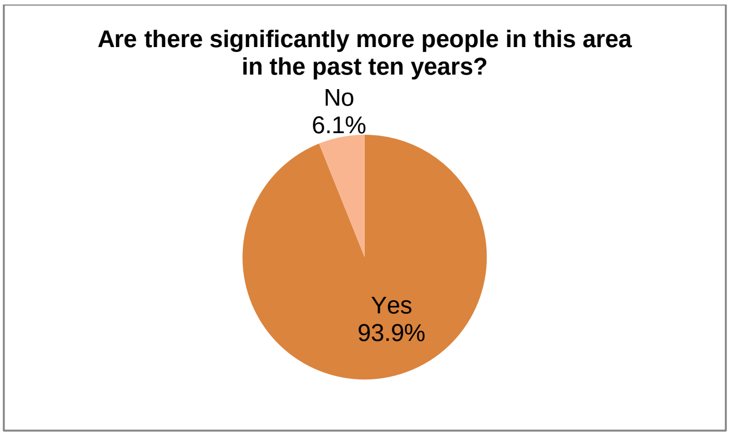
Fewer than half (42%) of participants had observed a more than 25% decrease in natural habitats over the past ten years:



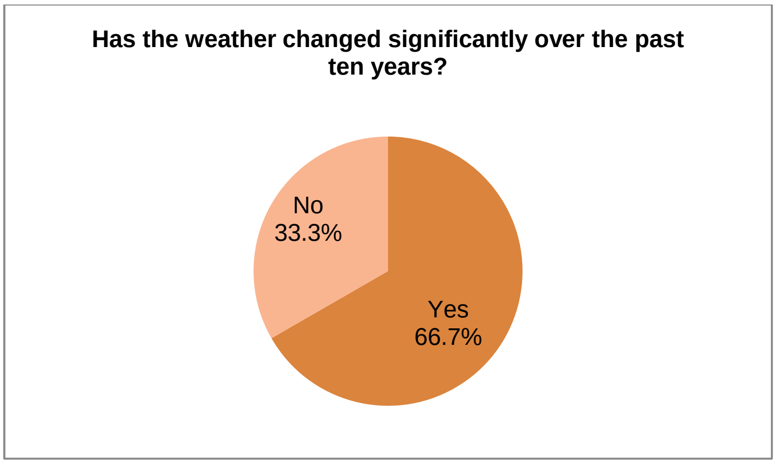
Moreover, three-quarters (75%) of participants had observed a significant decrease in the amount of wildlife:



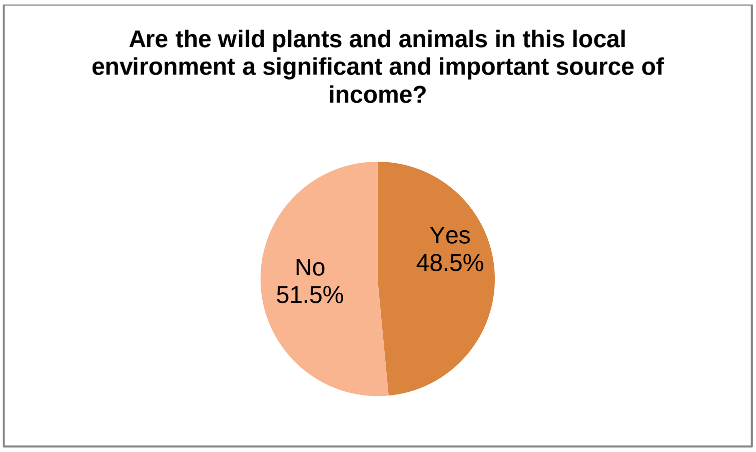
Most participants (94%) had also observed a significant population increase in the area in the past ten years:



More than half (67%) of the participants also claimed that the weather had changed significantly over the past ten years:



All participants (100%) stated that wild plants and animals in their local environment are a significant and important part of their food or medicine. However, approximately half (49%) of participants believe that wild plants and animals in the local environment are a significant and important source of their income:



3.4.3 Aquatic Biota

3.4.3.1 Methodology

Information on aquatic biota data was obtained from review of literature, internet, previous surveys and site reconnaissance.

3.4.3.2 Results

A total of at least 43 species of fish are likely present in Ayeyarwady River (Fishbase.org 2003). Do to the countries isolation it is likely that new species will continue to be discovered within this watershed and others. Recent discoveries include new species of spiny eel (*Macrognathus dorsiocellatus*). Fish is important food source of the local people. Among the most common species are the Indian Glass Fish (*Parambassis ranga*) and the (*Glossogobius giuris*). FAO (2003) reports 19 species of fish and 3 freshwater are harvested and raised or for food (**Table 3-31**).

Table 3-31: Captured and culture freshwater fish species observed in markets in Mandalay and Shan State

Common Name	***Scientific name***
Featherback	*Ompok/Notopterus*
Snakeskin gourami	*Trichogaster*
Snakehead	*Channa* spp.
Spiny eel	*Mastacembelus*
Catfish	*Clarias* spp.
Glass fish	*Amblypharyngodon*
Rasbora etc.	*Rasbora* spp., *Danio*
Gobies (sand)	*Glossobobius* spp.
Freshwater eel	*Anguilla* spp.
Various barbs	*Puntius* spp.
Rohtee	*Osteobrama* spp. *(Rohtee coti).*
Black shark minnow	*Morulius chrysophekadion*
Common carp	*Cyprinus carpio*
Rohu	*Labeo rohita*
Mrigal	*Cirrhinus mrigala*
Grass carp	*Ctenopharyngodon idellus*
Loaches	*Cobitidae*
Large river catfish	*Pangassius & Selonia*
Wallago	*Wallago attu*
Atyid shrimp	*Attidae* spp.
Freshwater prawn	*Macrobrachium rosenbergii*
Freshwater crabs	*Paratelphusa (?)*

Source: http://www.fao.org/docrep/004/ad497e/ad497e04.htm

Benthos

A total of 8 benthic species have been reported in recent previous surveys; 6 species from Ayeyarwady River and 9 species from the Myitnge river. Most of the benthic species were found to be dragonfly larvae. The actual number of benthic invertebrates species within flowing and stillwater habitats in the study area is likely in the hundreds.

Plankton

Recent previous surveys have reported 7 zooplankton species and 4 phytoplankton species. Two protozoan species, *Glaucoma scintillans* and *Coleps hirtus* were found as common zooplankton species. One diatom species, *Nitzschia brebissonii*, was also observed as common phytoplankton species in the studied rivers. The actual numbers of this species group is expected to substantially larger.

3.4.4 Priority Species for Conservation

Myanmarbiodiversity.org is an online international, multi-stakeholder organization which provides contemporary information on biodiversity and biodiversity conservation in Myanmar. In their most recent assessment of priority species for conservation they identified 38 species as Critically Endangered (CR), 65 species and Endangered (E), and 228 species as Vulnerable (V) (**Table 3-32**).

Priority species for conservation were assessed based on four criteria:

- Globally Threatened (GT) species;
- GT species with a globally significant population in Myanmar;
- GT species with globally significant populations in the area and society can have a meaningful role in their conservation;
- GT species with globally significant populations in the area and society can have a meaningful role in their conservation and/or it is urgent that current/committed contributions are stepped up.

The criteria follow those used by CEPF to assess species across the Indo-Burma Hotspot (Tordoff et al. 2011). In a few cases species that are not considered Globally Threatened but are at significant risk in the region, and have significant populations within Myanmar, are highlighted as conservation priorities for the country.

Table 3-32: Species with special conservation concern in Myanmar

Species Groups	CR	EN	VU
Mammals	3(4)	21(9)	25(26)
Birds	7(4)	11(8)	29(33)
Reptiles	7(4)	11(10)	9(7)
Plants	18(13)	16(12)	16(13)
Amphibians	-	-	-
Fishes	3	3	105
Aquatic Invertebrates	-	3	44
Totals	38	65	228

Remark: Conservation status (CR, EN, VU) is based on IUCN 2011 as accessed November 1, 2011

3.4.4.1 Potential for Species of Concern in IOR-5

IOR-5 occurs in the semi open, dry interior region of Myanmar. Wildlife habitats have been converted to agricultural lands over extensive area. Local inhabitants also make continued use of wildlife for food and medicine. The following subsections identify Species of Concern (SOC) which may occur in IOR-5.

Mammals of Particular Conservation Concern

The Hog Deer (*Axis porcinus*) and Fishing Cat (*Prionailurus viverrinus*) occur in non-forested areas usually outside existing protected areas. The hog deer is prefers tall grasslands and reed beds on floodplains bordering major rivers. It prefers more open habitats and will also enter scrubland and agricultural landscapes. It is not confirmed whether its range has extended into IOR-5, however some potentially suitable habitats exits. It is likely that *P. viverrinus* is among the species noted as some suitable habitat is available, albeit very limited. Local specialists have determined that specific conservation action targeting these species and their fragmented habitats is urgently needed (Than Zaw et al. in prep).

The two species of pangolin (scaly anteater) are found in Myanmar: Sunda Pangolin Manis javanica and Chinese Pangolin (*Manis pentadactyla*) are severely threatened by intensive harvesting for trade to China. This is occurring across the entire species range and it is likely that much of the Myanmar population has already been significantly reduced (Duckworth et al. 2008). The species feeds on ants and termites and is more likely where these preferred prey species are found. It’s presence in the study area is unconfirmed.

Protection of mammals from impacts from development relies on avoidance of critical habitats and implementing designs and practices which reduce the potential project specific hazards which may impact wildlife species.

Birds of Particular Conservation Concern

Myanmar is also still home to several populations of Critically Endangered vultures including White-rumped Vulture Gyps bengalensis, Slender-billed Vulture Gyps tenuirostris, and Red-headed Vulture Sarcogyps calvus, these species are all wide-ranging and heavily reliant on dead domestic animals to feed on. This reliance on livestock in human dominated landscapes highlights the need to consider conservation action beyond protected areas and consider threats and opportunities in the wider landscape to ensure these species can survive (Htin Hla et al. 2010).

As elsewhere in the region large water birds have decreased greatly across the country and continue to be threatened by persecution and human disturbance to their nesting and feeding areas. This includes Greater Adjutant (*Leptoptilos dubius)*, Lesser Adjutant (*Leptoptilos javanicus*), and Sarus Crane (*Grus antigone*).

Two poorly known and difficult to find babbler species are also of conservation priority in the country. Rufous-rumped Grass-babbler (*Graminicola bengalensis*) was previously found in Taninthayi (Tennasserim) but has not been found in recent times. Jerdon's Babbler (*Chrysomma altirostre*) was formerly found across the Ayeyarwady and Sittaung Plains but has not been seen since the mid-1940s.

Protection of bird species from unnecessary development impacts relies on avoidance of important habitats and creation of hazards which attract or otherwise place birds at risk (e.g., contaminated waste water pits, spills, unshielded or higher risk lighting, garbage etc).

Reptiles of Particular Conservation Concern

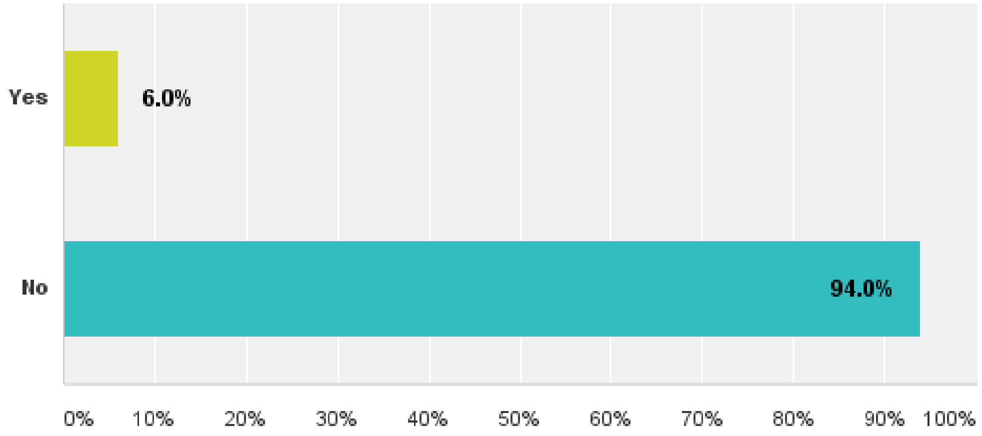
Tortoises

Four species of tortoises are known to occur in Myanmar: the Burmese Star Tortoise (*Geochelone platynota*), Asian Forest Tortoise (*Manouria emys*), Impressed Tortoise (*Manouria impressa*), and the Elongated Tortoise (*Indotestudo elongate*). All are threatened to some extent by a combination of subsistence and commercial harvesting, over-collection for the pet trade, and to a lesser extent, habitat destruction. Conversion of natural vegetation to agricultural land is primarily a threat to tortoises in the Dry Zone.

The Burmese Star Tortoise or “Jai Lek” (*Geochelone platynota*), has been reported as “ecologically extinct” in the wild (Platt et al. 2011b). However, the species adapts well to captivity and given appropriate husbandry methods, reproduces readily. A relatively new captive rearing facility is at Lawkananda Park in Bagan. At present over 1100 are maintained in assurance colonies and plans to reintroduce G. platynota to Minzontaung Wildlife Sanctuary and perhaps elsewhere are being developed (Platt et al. 2011a).

During the IOR-5 baseline survey, villagers were asked if they had ever seen this species in the wild (**Chart 3-7**). Only a few villagers had reported ever seeing the Star tortoise in the wild and these observations were all greater than 10 years ago. From a project perspective it is unlikely that occupied habitat is likely to be encountered, however, retention of native plant community areas and minimizing site contamination is still relevant.

Chart 3-7: Response of villagers in IOR-5 when asked whether they had ever seen the Burmese Star Tortoise (photograph provided during interview)



The Elongated Tortoise apparently occurs throughout much of Myanmar and uses a variety of habitats ranging from desert-like scrub of the Dry Zone to moist evergreen forest in the Rakhine Yomas. Healthy populations remain in some remote areas (e.g., Rakhine Yomas; Platt & Khin Myo Myo 2009), although this tortoise is subject to subsistence harvesting wherever it occurs in close proximity to humans. Large numbers are illegally exported to markets in southern China (Platt et al. 2000). Current harvest levels are clearly unsustainable and field surveys suggest many populations are declining, particularly in the Dry Zone (Platt et al. 2001b).

Turtles

Two large river turtles, the Northern River Terrapin (*Batagur baska)* and Burmese Roofed Turtle (*Batagur trivittata*), are known from Myanmar. Both species were historically common in the larger rivers (Thanlwin, Sittaung, Ayeyarwady, and Chindwin) and estuaries (Thorbjarnarson et al. 2000a; Platt et al. 2006). These turtles nest colonially on undisturbed sandbanks. Population declines due to chronic egg collecting were noted over 100 years ago. Human consumption and destruction of sandbank nesting habitat by seasonal cultivation during the dry season has caused these two species to be among the most endangered turtles in the world (Rhodin et al. 2011). Currently, a small remnant population of B. trivittata is known to inhabit a restricted stretch of the upper Chindwin River and a smaller population found on the Dokhtawady River (tributary of the Ayeyarwady) but both are facing immediate threats from industrial developments. Captive-breeding efforts have been quite successful to date, and almost 500 B. trivittata are maintained in assurance colonies at Yadanabon Zoological Garden, Lawkananda Wildlife Sanctuary near Bagan, and a remote camp on the Chindwin River. Plans to reintroduce B. trivittata in appropriate habitat are being developed. Project related concerns in IOR-5 would only arise where there was potential for disturbance or pollution of riverine and wetland habitats.

Six species of trionychid (soft-shelled) turtles occur in Myanmar (*Amyda cartilaginea*, *Nilssonia formosa*, *Chitra vandijki*, *Lissemys scutata*, *L. punctata*, and *Dogania subplana*), three of which are endemic; the Burmese Peacock Softshell (*Nilssonia Formosa*), Burmese Narrow-headed Softshell (*Chitra vandijki*), and the Burmese Flapshell Turtle (*Lissemys scutata*) and of conservation importance. Only *L. scutata* is currently secure. Its small size, rapid growth rate, frequent reproduction, and ability to live in anthropogenic habitats, appear to make *L. scutata* have made it more resilient than other species. All other soft-shelled turtles are heavily exploited for export to food markets in southern China (Platt et al. 2000; Kuchling et al. 2004). Populations throughout Myanmar are believed to be declining rapidly due to foreign market exploitation as well as accidental drowning in fishing gear, destruction of nesting beaches by seasonal cultivation, and nest losses due to trampling by livestock. As with the large river turtles, project-related concerns in IOR-5 would only arise where there was potential for disturbance or pollution of riverine and wetland habitats.

The Burmese Eyed Turtle (*Morenia ocellata*) is endemic to Myanmar, although virtually nothing is known regarding its ecology or conservation status. It’s has been reported from lower Myanmar and as far north as Mandalay and the Shweli River (Iverson 1992; Platt et al. 2005). As with other turtle species in Myanmar it is heavily exploited and its future is uncertain. *M. ocellata* is reported to be very difficult to maintain in captivity making effective ex-situ conservation unlikely. Again project activities which disturb riverine habitats and wetlands would be of greatest concern.

Amphibians of Particular Conservation Concern

Amphibians restricted to Myanmar include the Tanintharyi Stream Toad (*Ansonia thinthinae*), a toad (*Duttaphrynus crocus*), the Toungoo Frog (*Hylarana oatesii*), the Indoburman Torrent Frog (*Amolops indoburmanensis*), the tree frogs *Rhacophorus htunwini* and *Chiromantis punctatus*). From a project perspective, protection of amphibians hinges largely on avoiding direct disturbance to permanent and seasonal wetlands as well as preventing of offsite contamination of such locations.

Fishes of Particular Conservation Concern

The conservation status of fish in Myanmar is poorly understood. No specific references were identified for Central Myanmar and the project area; however, given the patterns of human exploitation, any species of fish present in these areas would be very vulnerable. There are at least 16 species of endemic freshwater fish in Myanmar and potential for the presence of endemic species in IOR-5 is considered high where permanent native surface water is present. Extraction of surface water and or intentional or accidental release of contaminated liquids could both pose a significant impact to native fish species.

Invertebrates of Particular Conservation Concern

Relatively little is known about invertebrate species within Myanmar sufficient to allow classification for the purpose of identifying conservation status and needs for protection. Pollinators such as wild bees and numerous others can play critical roles in ecosystem function as well as human food security and health. Some species groups can have very specific habitat requirements (e.g., butterflies) which, in the absence of knowledge could be locally extirpated. As a general guide, identification and avoidance of uncommon native plant assemblages and retention of native forest cover is a priority. Similarly, indiscriminate use of herbicides and pesticides and failure to control and manage other hazardous substance, and light pollution can increase risks to these and other native fauna.

Plants of Particular Conservation Concern

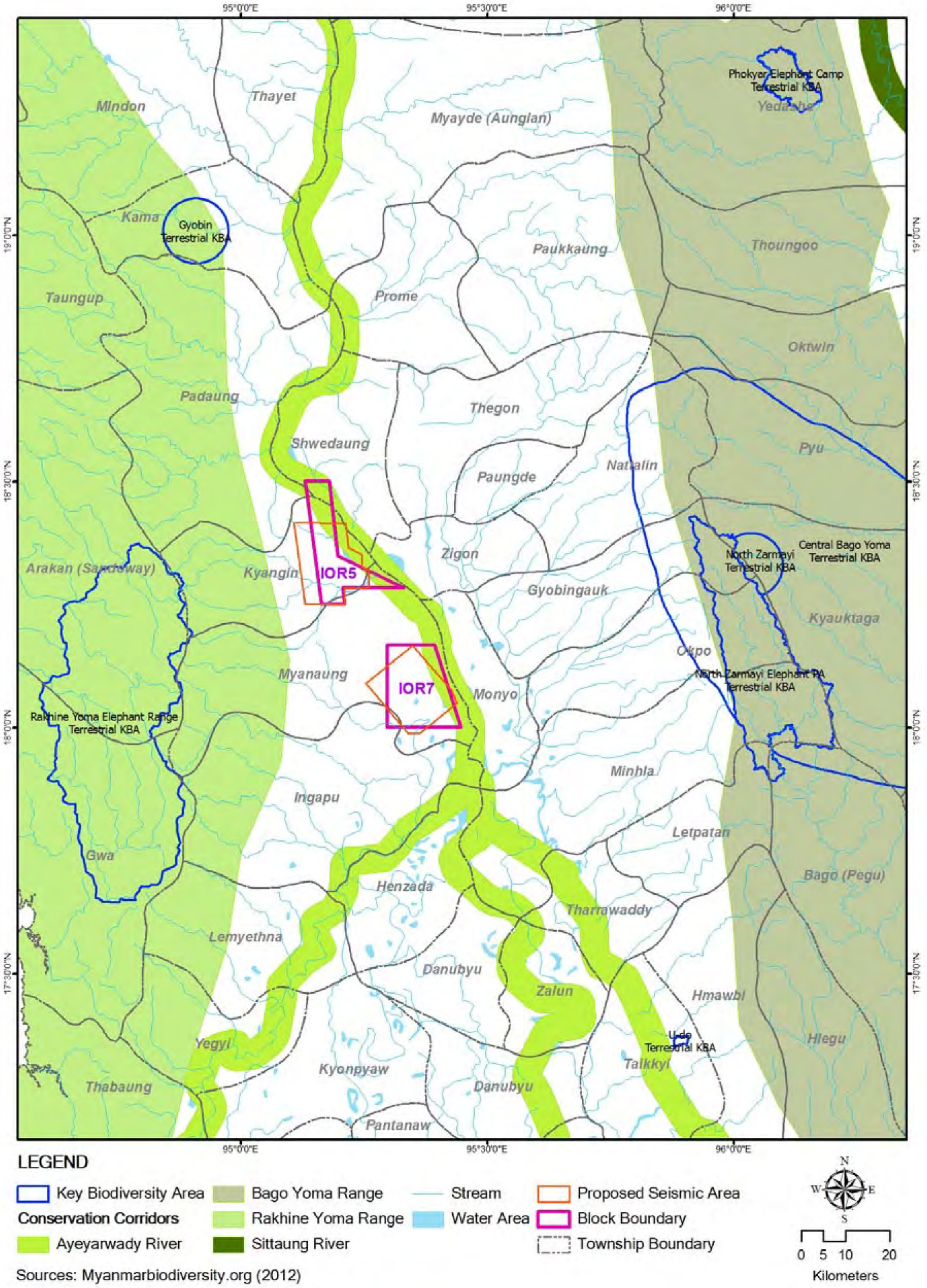
Deforestation and conversion of native plant communities in the project area and throughout much of central Myanmar has reduced the abundance and diversity of numerous species of wild plants. While detailed rare plant lists are not available it is fair to say that native trees and understory species particularly associated with these have been most greatly impacted by human activity. Species of trees belonging to the families: Caesalpiniaceae, Dipterocarpaceae, Magnoliaceae, Myristicaceae, Myrtaceae, Taxodiaceae, Theaceae, Thymelaeaceae have been highly threatened by habitat loss, degradation and fragmentation. Wherever feasible every effort should be given to avoiding further unnecessary loss of forest cover, including individual trees in IOR-5.

Key Biodiversity Areas

No recognized key biodiversity areas are located in the study area except the Ayeyarwady River corridor which runs along the north and east of the block. The Ayeyarwady River corridor has an area of 19,798 km^2 (**Figure 3-16**).

Local Perception of Important Ecological Areas

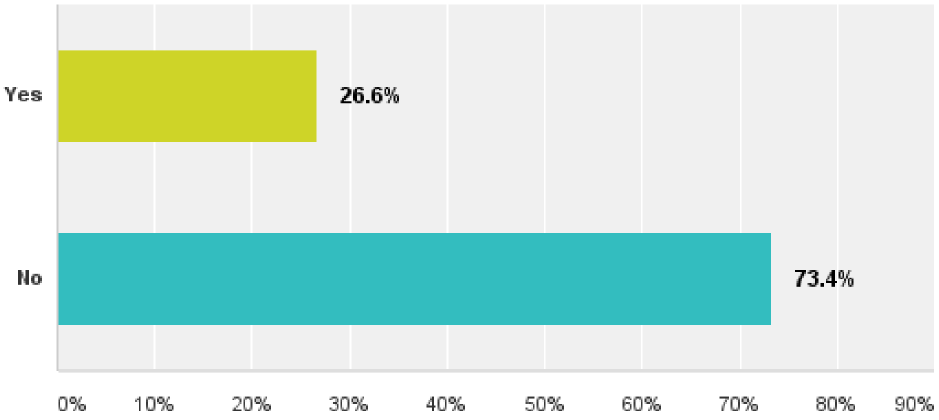
Of 400 villagers interviewed in 8 communities in IOR-5 most believed that no important areas for wild plants (73%) within 3 miles of the their village (**Chart 3-8**).



Sources: Myanmarbiodiversity.org (2012)

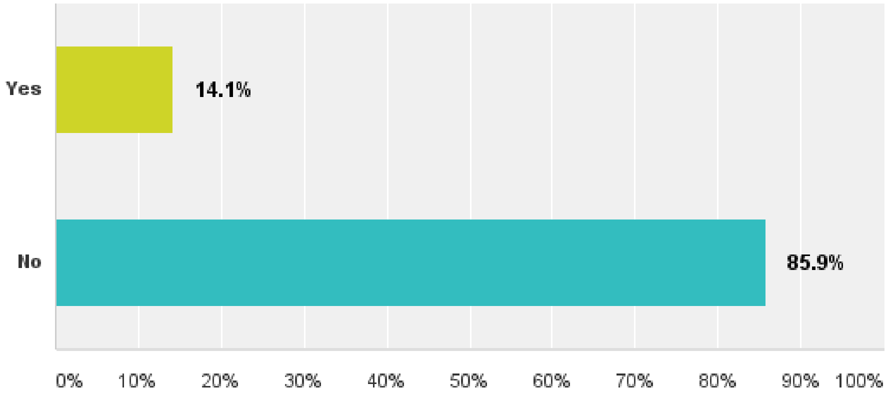
Figure 3-16: Key Biodiversity Areas

Chart 3-8: Response of villagers in IOR-5 when asked if there were important areas for wild plants within 3 miles of their village.



The majority (86%) of villagers claimed there were no important wild animals near the village (**Chart 3-9**).

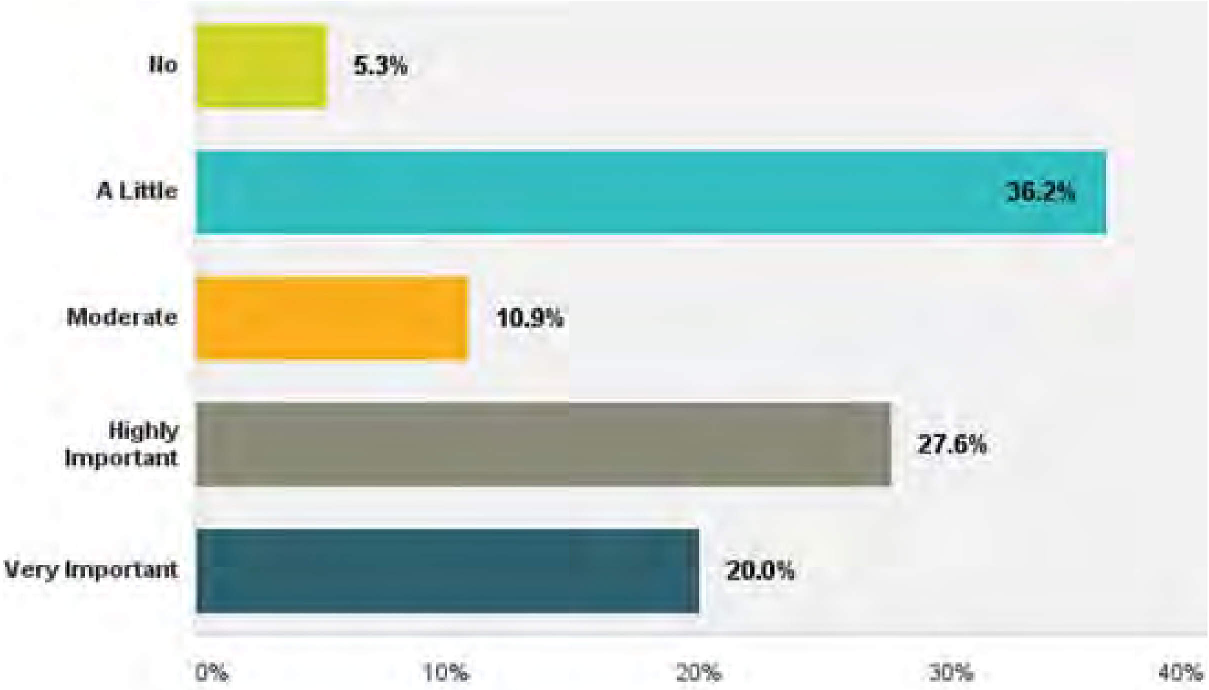
Chart 3-9: Response of villagers in IOR-5 when asked if there were important areas for wild animals within 3 miles of their village.



Local Importance of Wildlife Conservation

Approximately one-third (36%) of participants considered wildlife conservation as a little important, while 28% regarded it as highly important (**Chart 3-10**).

Chart 3-10: Response of villagers in IOR-5 when asked whether conservation of wildlife and wildlife habitat was important to them.

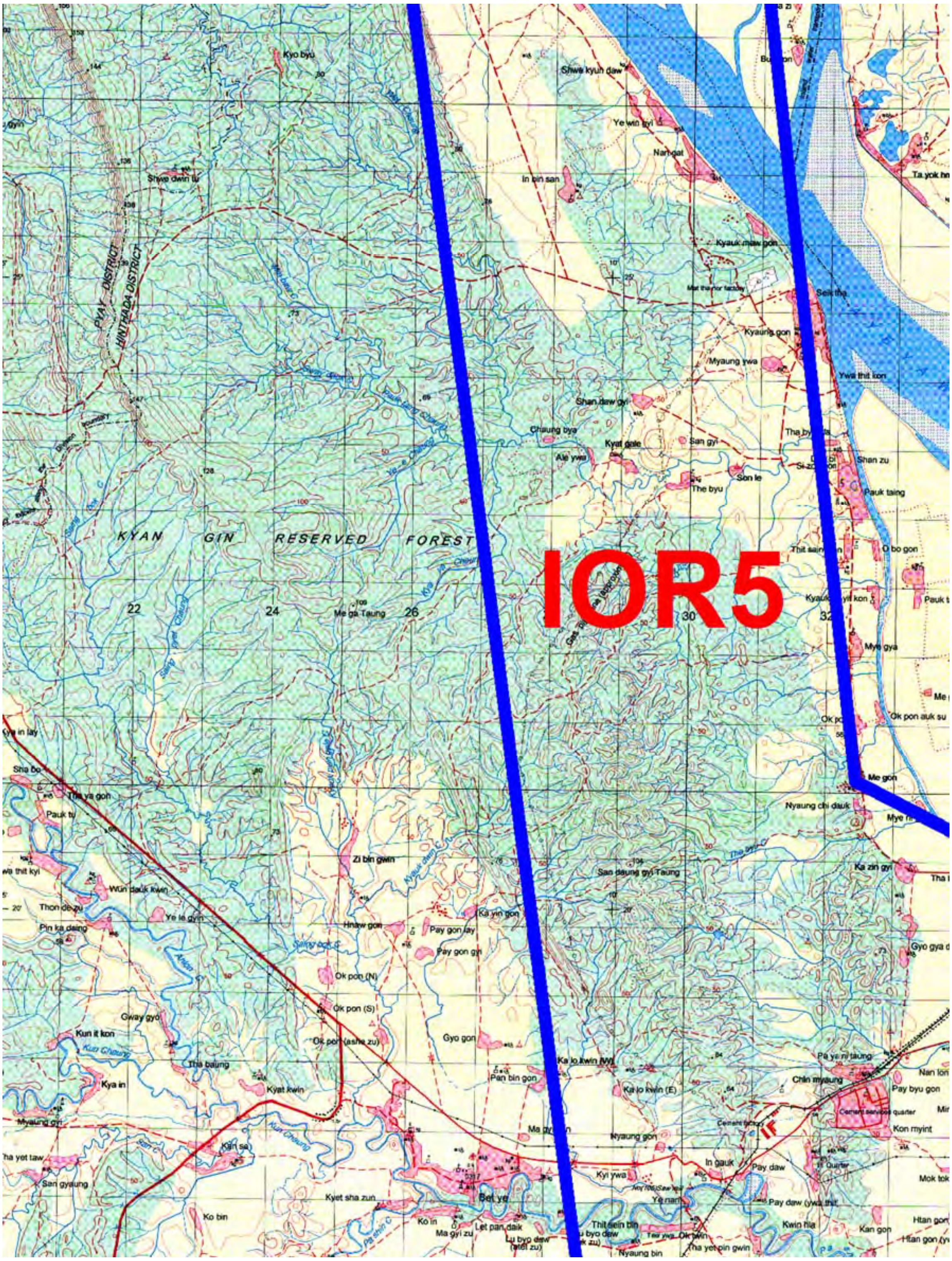


3.4.5 Protected Areas

A total of 45 protected areas have been established in Myanmar. The natural areas for protection are categorized as follows:

- Scientific Nature Reserve;
- National Park;
- Marine National Park;
- Nature Reserve;
- Wildlife Sanctuary;
- Geo-physically Significant Reserve; and
- Other Nature Reserve as determined by the Minister.

There are no officially established protected areas in Blocks IOR-5. There is the Kyan Gin Reserve Forest as shown in **Figure 3-17**.



Source: PCMI, 2014

Figure 3-17: Reserve Forest area in IOR-5

3.5 Human Use Values

3.5.1 Agriculture and Industry

Land use in IOR-5 study area is dominated by agricultural activities particularly dry land cultivation along with some irrigated cropland.

During the projects socio economic, health and opinion surveys of 400 villagers in 8 communities spread across IOR-5, respondents identified the main agricultural crops as rice, with beans and pulses being the next most common crop (**Chart 3-11).** Most households (76%) had livestock, of which over 53% have cows and 16.9% have oxen (**Chart 3-12**).

Chart 3-11: Primary agricultural crops grown in IOR-5

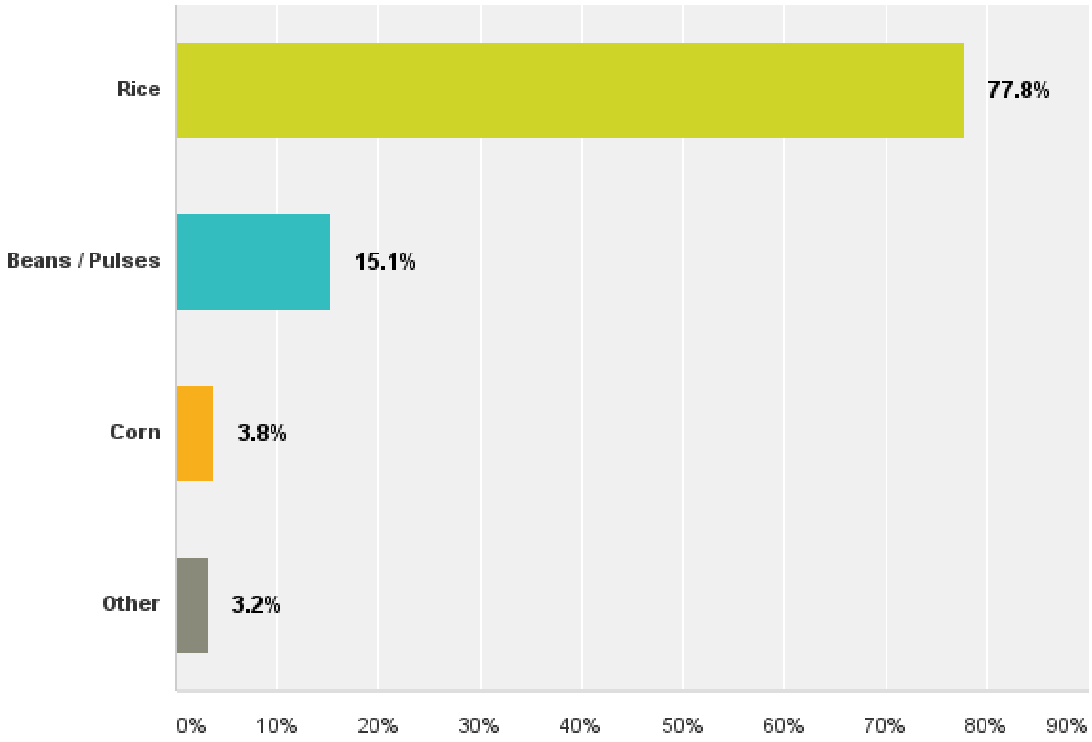
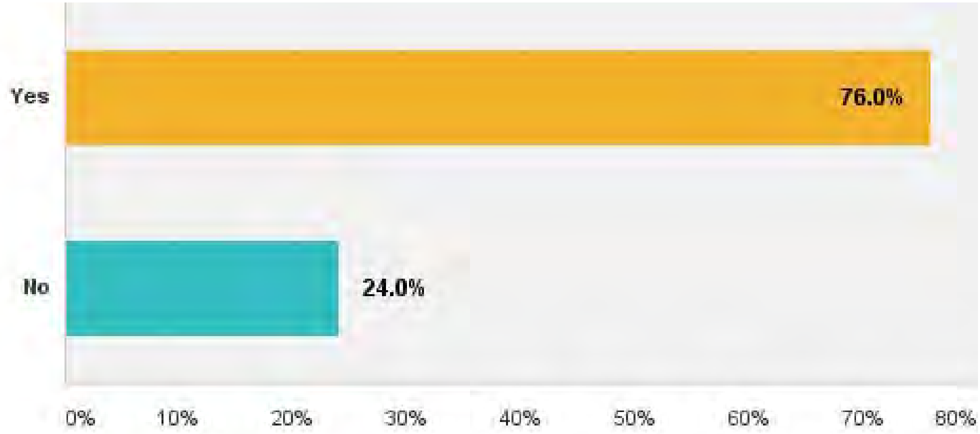


Chart 3-12: Livestock husbandry in IOR-5



3.5.2 Fishery and Aquaculture

Inland fisheries in Myanmar are mostly associated with riverine and estuarine systems. Inland water bodies, such as natural lakes, reservoirs, river systems and ponds, cover about 8.1 million hectares, of which 1.3 million hectares are permanent, the remainder being seasonally inundated floodplains. Ayeyarwady, Chindwin, Sittatung and Thanlwin are the main rivers, and extend from the eastern part of the Bay of Bengal to the Gulf of Martaban and along the eastern edge of the Andaman Sea.

For fisheries management (licensing and regulation) purposes, Myanmar divides its inland capture fisheries into two main categories:

- Leasable fisheries - These are important fishing grounds on floodplains, which are primarily fished through the erection of barrage fences around the lease area and collecting the catch with pens or traps. As of 2005, there were 3,722 designated leasable fisheries in Myanmar, of which 2,084 were licensed by the Department of Fisheries (DoF). These fisheries produced about 434,320 tons of fish and prawn in 2004. The leases have traditionally been auctioned annually, but DoF is extending the lease period up to nine years to promote improved long-term management.
- Open fisheries - This covers fisheries in all areas other than the leasable fisheries, with licenses issued on an annual basis by DoF. All fishing gear requires the respective implement license.

The fishing techniques used in inland fisheries are drift net, gillnet, traps and pots, pole-and-line, stationary traps, and bamboo stake traps in the near shore of rivers.

The aquaculture industry comprises freshwater culture, brackish-water systems, ornamental fish production and fingerling production. The Government of Myanmar has published a special plan to increase and develop shrimp culture. Currently 407,000 acres have been established for shrimp and freshwater fish farming in Myanmar. Of the total aquaculture production during the year 2005-2006, an estimated 563.14MT came from coastal aquaculture. As of 2004–2005, the total area of shrimp ponds was about 63,000 ha in the coastal regions (FAO, 2006).

Major fish species cultured include Roho (*Labeo rohita*), Catla (*Catla catla*), Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idellus*), Mrigal carp (*Cirrhinus mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Tilapia (*Tilapia spp.*), Striped catfish (*Pangasius sutchi*), Philippine catfish (*Clarias batrachus*). Recently, DoF successfully cultivated another three species of freshwater fish, namely *Piratus branchatus*, *Notopterus chitala* and *Osphronnemus gouramy*.

3.5.2.1 IOR-5

This region is very dry and is indicated by the fact that 97% of those surveyed is not involved in fishery. Similarly, 94% do not own fish or prawn ponds. **(Chart 3-13 and Chart 3-14).**

Chart 3-13: Response of villagers asked whether they participate in the fishery

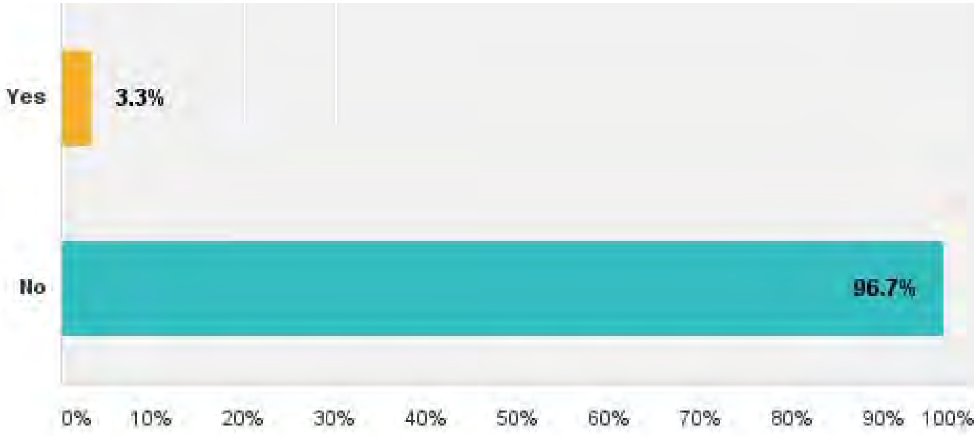
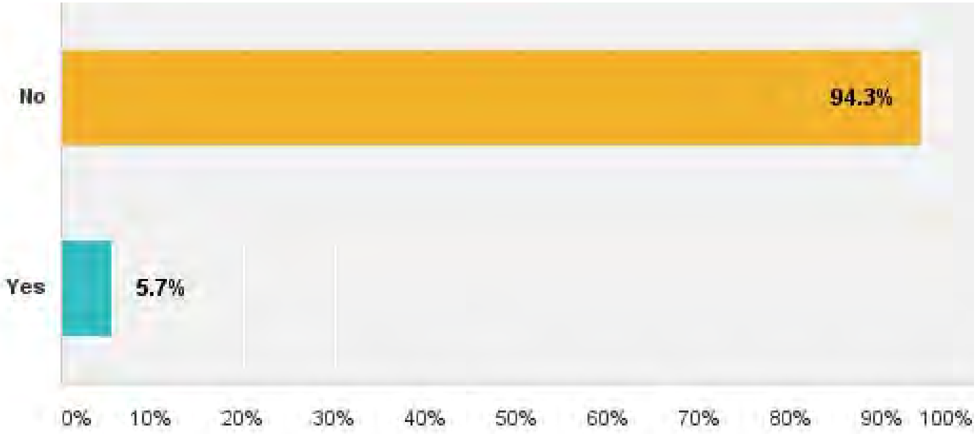


Chart 3-14: Response of villagers asked whether they own a fish/prawn Pond

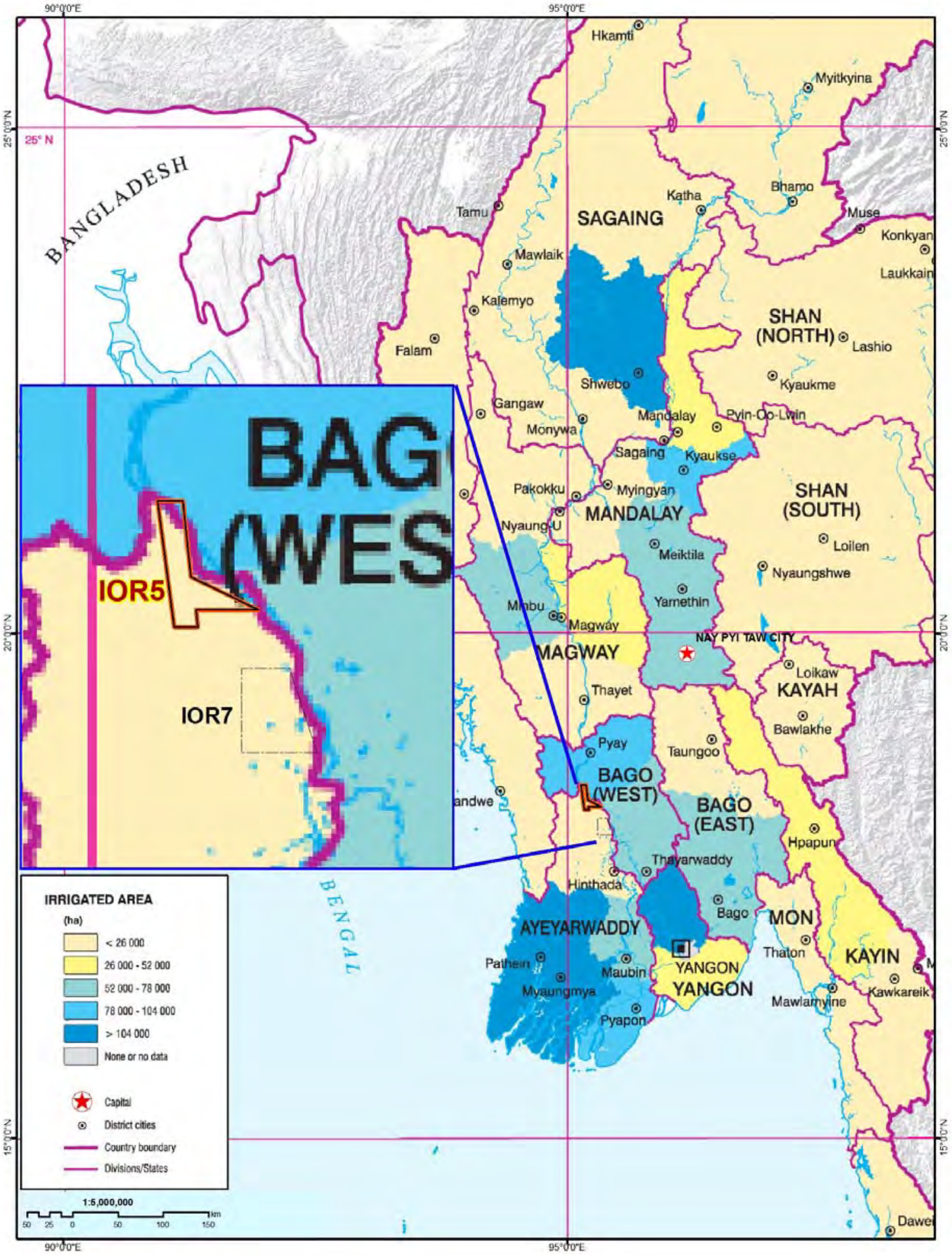


3.5.3 Irrigation and Agricultural Water Sources

Due to the rainfall and hydrological pattern of the country, the need for irrigation is highest in the central dry zone. The irrigation potential of Myanmar is estimated at 10.5 million ha, considering both water and soil resources (FAO, 1999). Current irrigated areas are estimated at 1,555,416 ha.

Irrigated areas were traditionally supplied through weirs for river diversion or dams and tanks, but wells and pumping in rivers have developed quite substantially in recent years (FAO, 1999). Pump irrigation was promoted in the 1980s by programmes implemented by the Agricultural Mechanization Department. Water Resources Utilization Department has been implementing pump irrigation water supply programme using high discharge capacity pumps since 1995. Other types of irrigation water supply include windmills, watermills, watering with buckets, ponds, etc. In the central dry zone, where most of the potential for economical run-of-the-river diversion schemes has been utilized, dams, irrigation projects and groundwater irrigation projects were started in the 1980s. Groundwater is mobilized mainly by diesel pumps. Salinization due to irrigation is mainly found in the central dry zone, near Meiktila in Mandalay Region, where groundwater is used for irrigation purposes (FAO, 2009).

Figure 3-18 shows a map of irrigated areas across Myanmar.



Source: FAO, 2005

Figure 3-18: Irrigated Areas in Myanmar

3.5.4 Water Access and Perception in IOR-5

During IEM's comprehensive project socio economic, health and opinion surveys of 400 households in 8 communities in IOR-5, questions were asked in regard to water source, availability and quality. In regard to water source, the main sources of water come from tube well (61%), unprotected dug wells (16%), protected dug wells (12%) and rivers or streams (6%) (**Chart 3-15**).

In regard to water quality and quantity, the majority (82%) of the villagers interviewed indicated that water quality has not changed over time (**Chart 3-16** and **Chart 3-17**).

Chart 3-15: Trends in Drinking Water Coverage in IOR-5

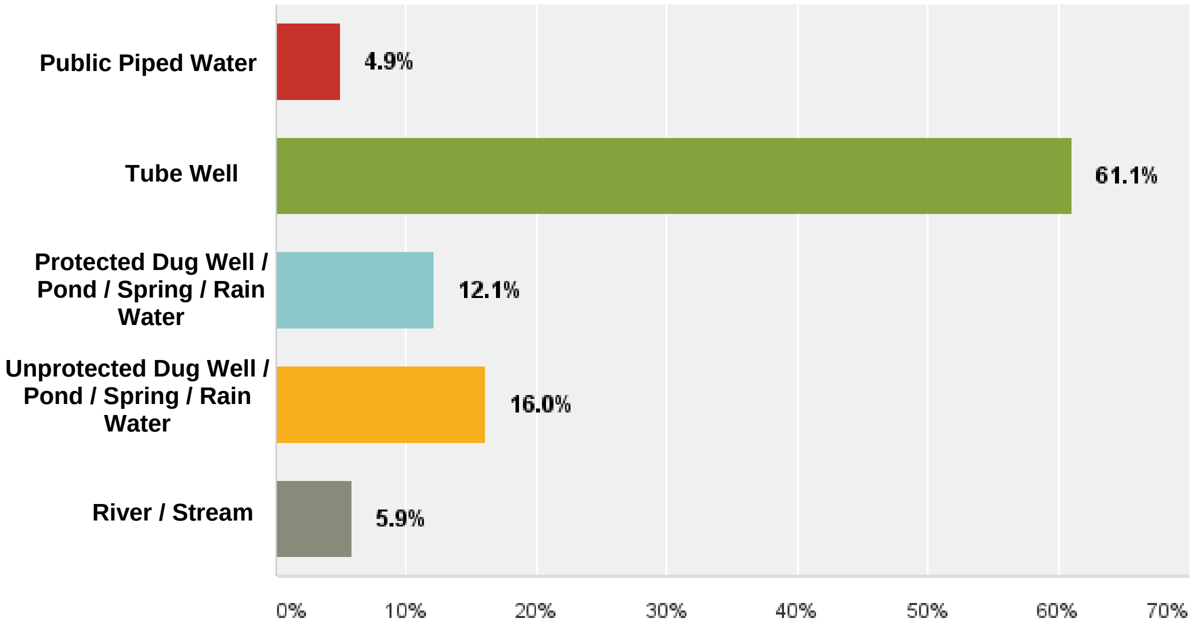


Chart 3-16: Responses for villagers in IOR-5 in regard to whether water quality had changed over time.

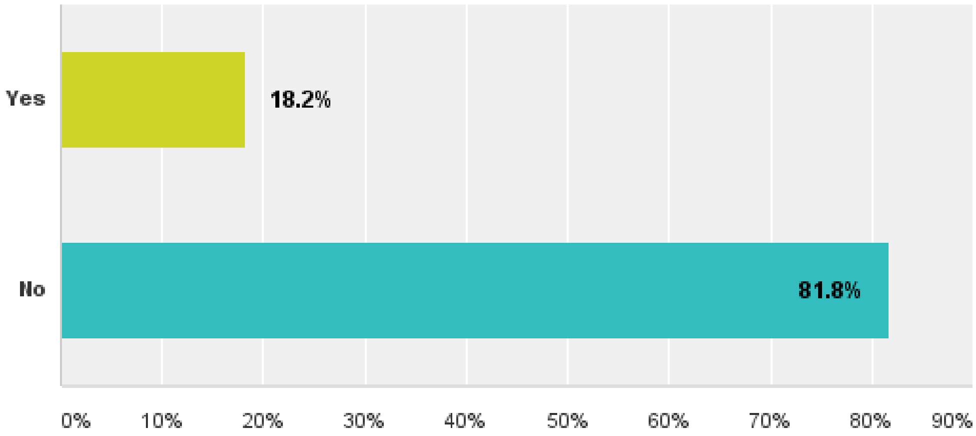
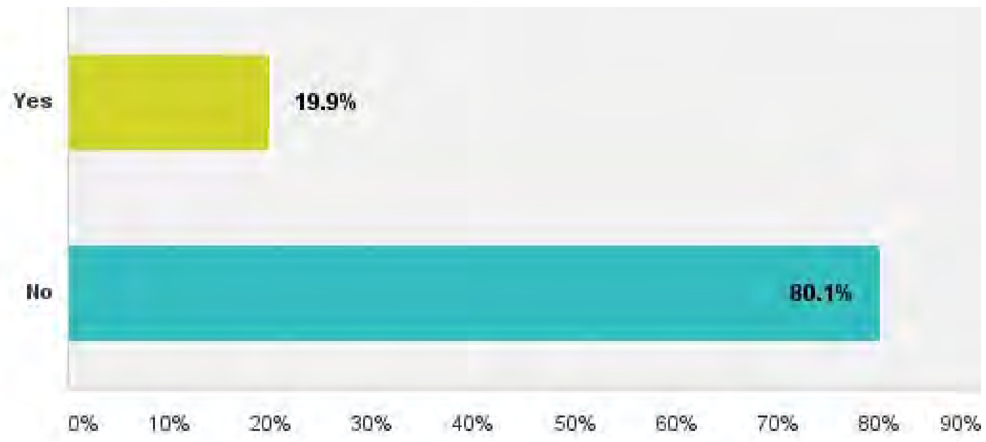


Chart 3-17: Response of villagers in IOR-5 in regard to whether water quantity was perceived to have changed.



The survey group indicated that most (94%) had access to drinking water within ¼ mile, 2% within 1 mile and 3% had to go more than one mile (**Chart 3-18). **Water treatment was reported by 80% of respondents (Chart 3-19**).** Fifty seven percent (49%) of respondents boil their drinking water to make it safe while 31% use ceramic/sand filters (**Chart 3-20).**

Chart 3-18: Response of villagers in IOR-5 in regard to the distance travelled to obtain drinking water.

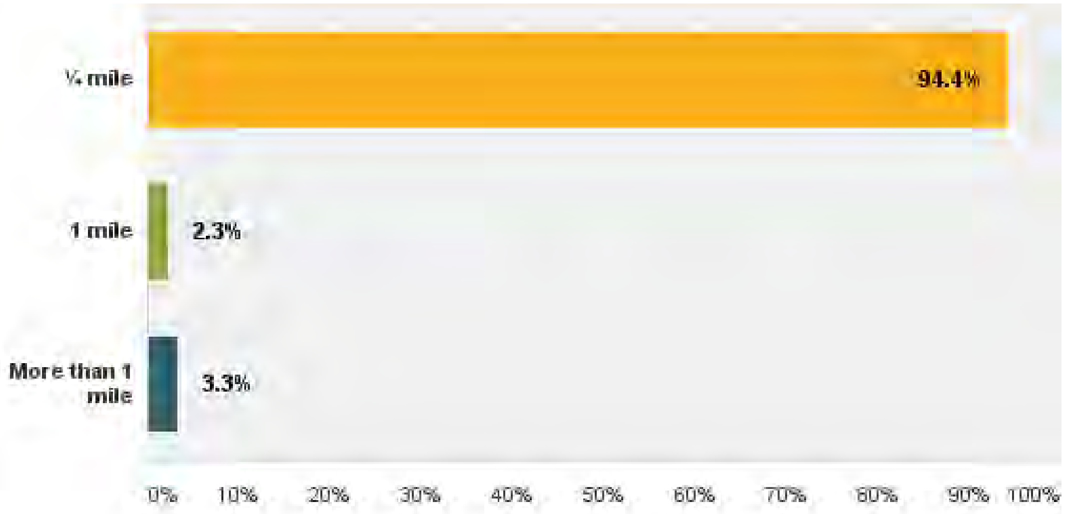


Chart 3-19: Response of villagers in IOR-5 in regard to whether their drinking water was treated.

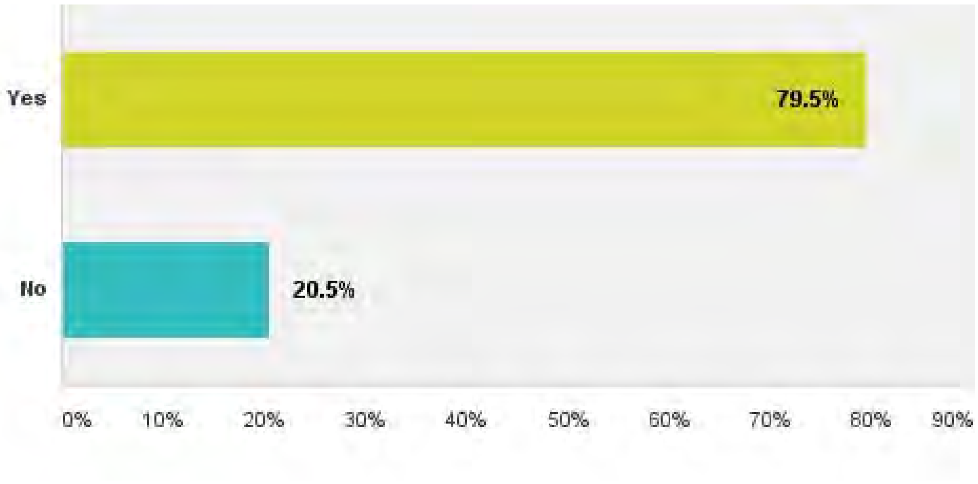
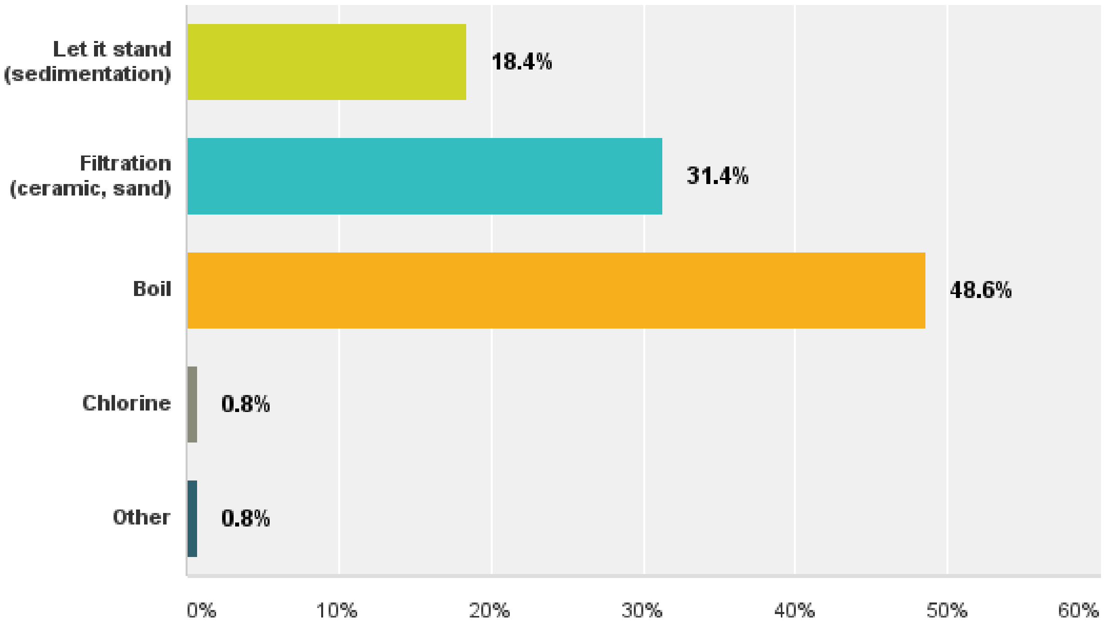


Chart 3-20: Response of villagers in IOR-5 in regard to how they treat their drinking water.



3.5.5 Wastewater Management

Depending on the location, human wastewater and grey water management in IOR-5 is disposed of variously by: flush/pour systems to piped sewer system/septic tank, pit latrine or open space. Slab toilets, composting toilets, bucket, hanging toilet, hanging latrine are used (DOH, 2010).

3.5.6 Solid Waste Management

Township Development Committees under the Department for Development Affairs (DDA), Ministry of Progress of Border Area Development and National Races and Development Affairs (MPBND), manage municipal waste collection and disposal, however, waste management is very rudimentary over much of the country. The most sophisticated systems are only in place in the more populated centres and even here significant gaps exist, particularly with regard to hazardous waste. The country is currently embarking on development of a country-wide waste management planning process.

In IOR-5 a de-centralized semi-landfill system is utilized for disposal. Some members of the private sector practice waste segregation on a small scale. Oil and gas companies currently relay on their own waste management systems e.g., on-site incinerator, land fill etc. Rural communities typically burn or surface landfill their solid waste.

3.5.7 Transportation

Central Myanmar has a relatively well developed transport system compared to other parts of Myanmar, including road, air, rail, and water. Due to its geography, central Myanmar, particularly Mandalay acts as the central hub for transport of people and goods with destinations further north, east and west in the country, as well as to China and India.

3.5.7.1 Roads

The major mode of transportation in central Myanmar is roads. As a result, central Myanmar has a sizable road transport network with Mandalay as the major hub. From Mandalay, the network extends into upper Myanmar to Kachin State and China (through Muse in northern Shan State), and to western Myanmar and India, and south to Yangon.

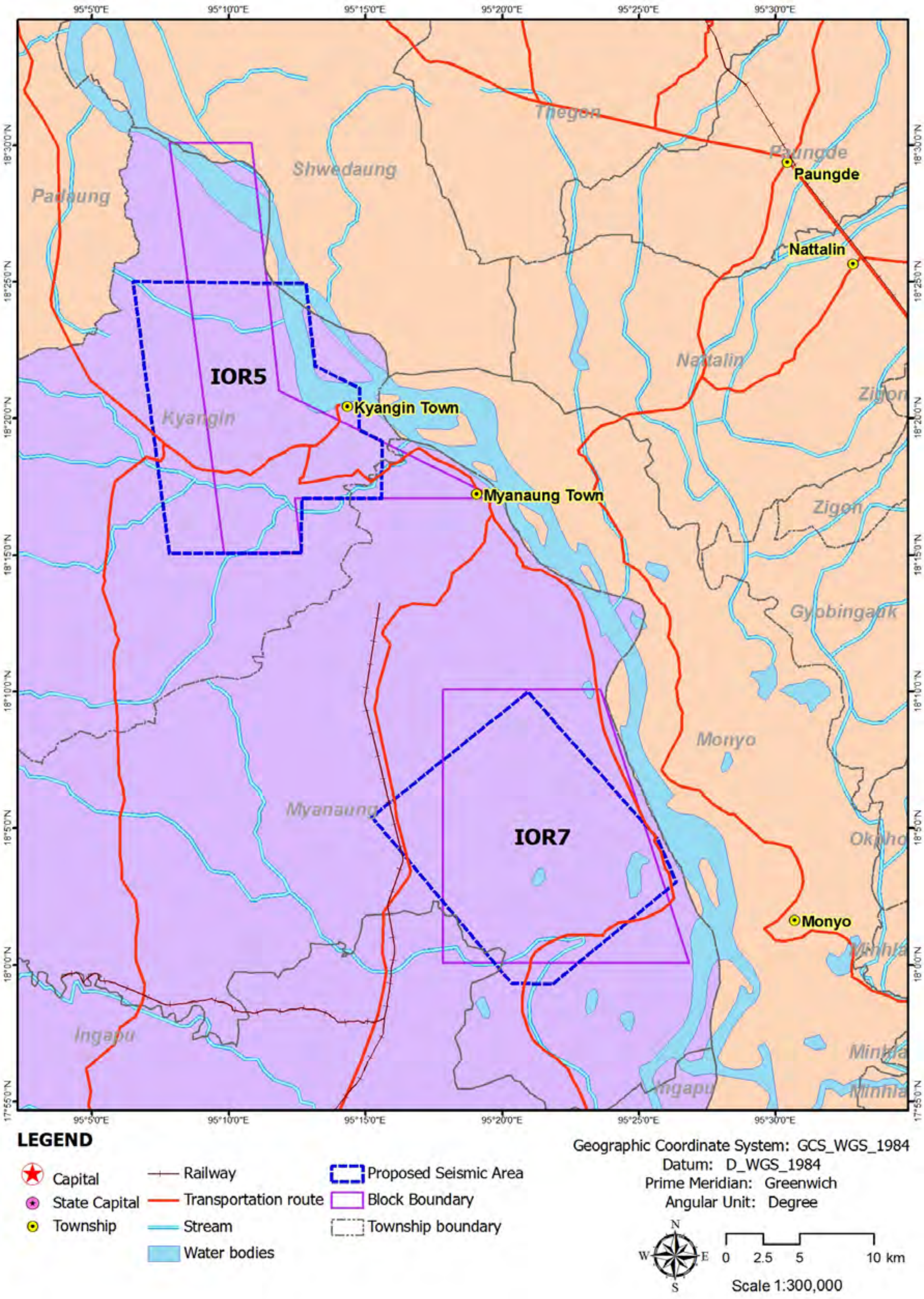


Figure 3-19: Transportation Routes in the Project Area

Local Transportation

During IEM's survey of households in IOR-5, 91% of villagers indicated they must travel more than one mile to see town administrators (**Chart 3-21**). Approximately 61% villagers travel to nearby towns by motorcycle followed by 28% using taxi/bus (**Chart 3-22**).

Chart 3-21: Response of villagers in IOR-5 in regard to distance travelled to the nearest administrative centre.

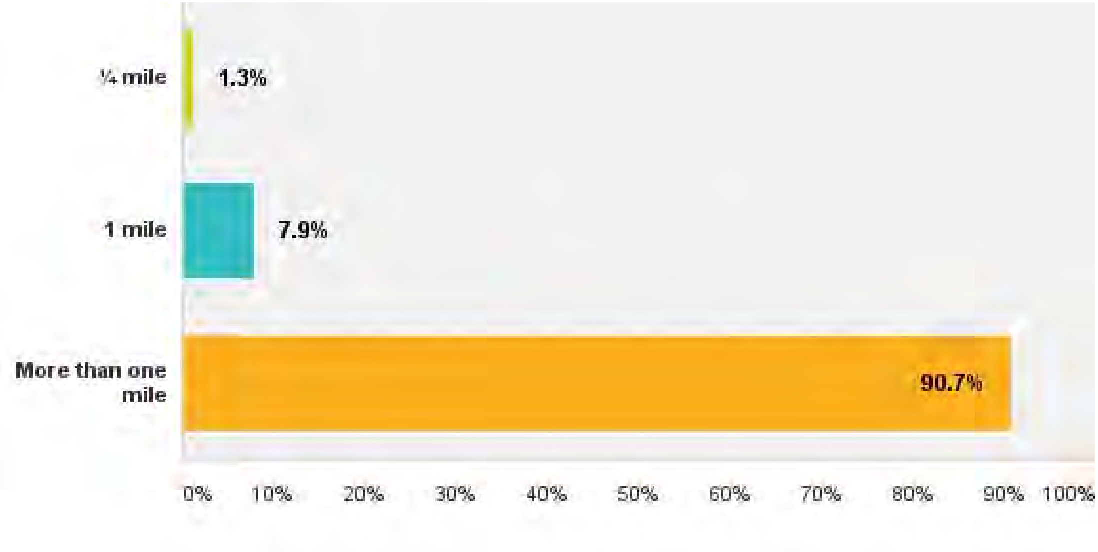
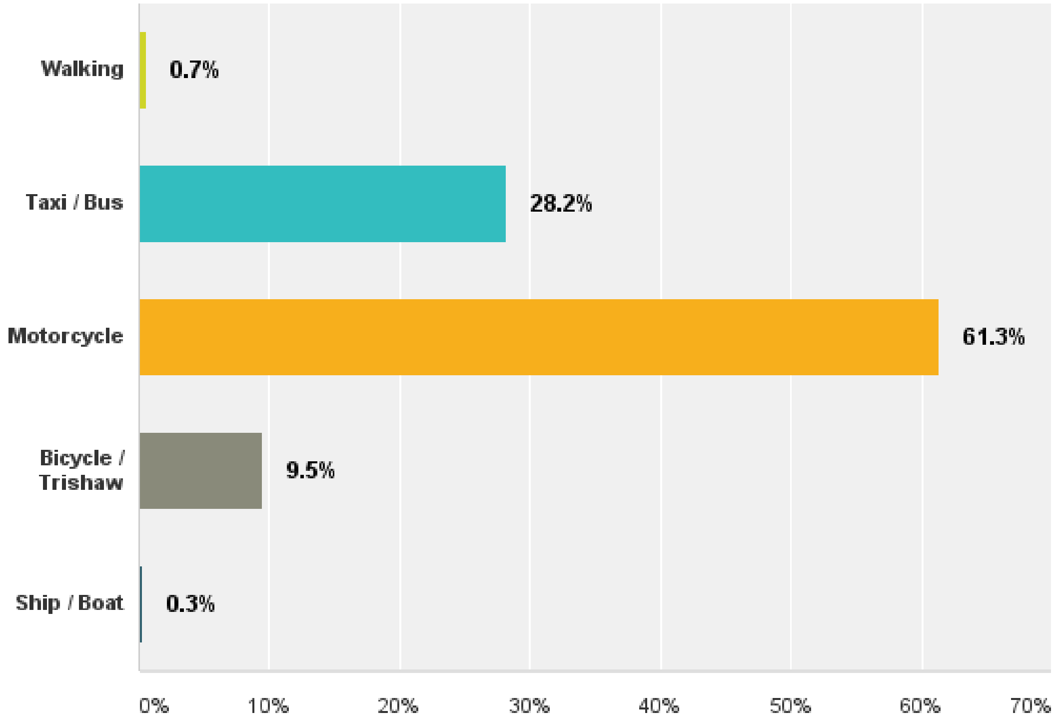


Chart 3-22: Response of villagers in IOR-5 in regard to mode of transportation when travelling to nearby towns.



3.5.7.2 Railroad

Railroads in Myanmar generally run south to north with branch lines to east and west, with the Central Railway Station in Mandalay as a major hub. The main rail line for passenger and cargo is between Yangon and Mandalay. From Mandalay, the railroads branch east to Shan State, and west to Magway Region and continuing north to Kachin State.

3.5.7.3 Air

Central Myanmar has two international airports – Mandalay International Airport, and Naypyidaw International Airport. Similar to the road and rail transport network, these two airports serve as a central hub from which many flights to the east (Shan State) and north (Kachin State) are taken.

3.5.7.4 River Transport

Water transport in middle Myanmar is on the Ayeyarwady River.

3.5.8 Power Supply, Electricity

The electricity production (MWh) in Myanmar was 5,850,000 in 2009, according to the World Bank (2010). Additional statistics relating to electricity in Myanmar are shown in **Table 3-33**.

Table 3-33: World Bank Electricity Information for Myanmar, 2009

Electricity production (billion kilowatt hours)	**Sources of electricity (% of total)**						**Access to electricity (% of population)**
	Coal	**Natural gas**	**Oil**	**Hydropower**	**Renewable sources**	**Nuclear power**	
5.9	0.0	19.6	8.9	71.5	0.0	0.0	13.0

Source: World Bank, 2009

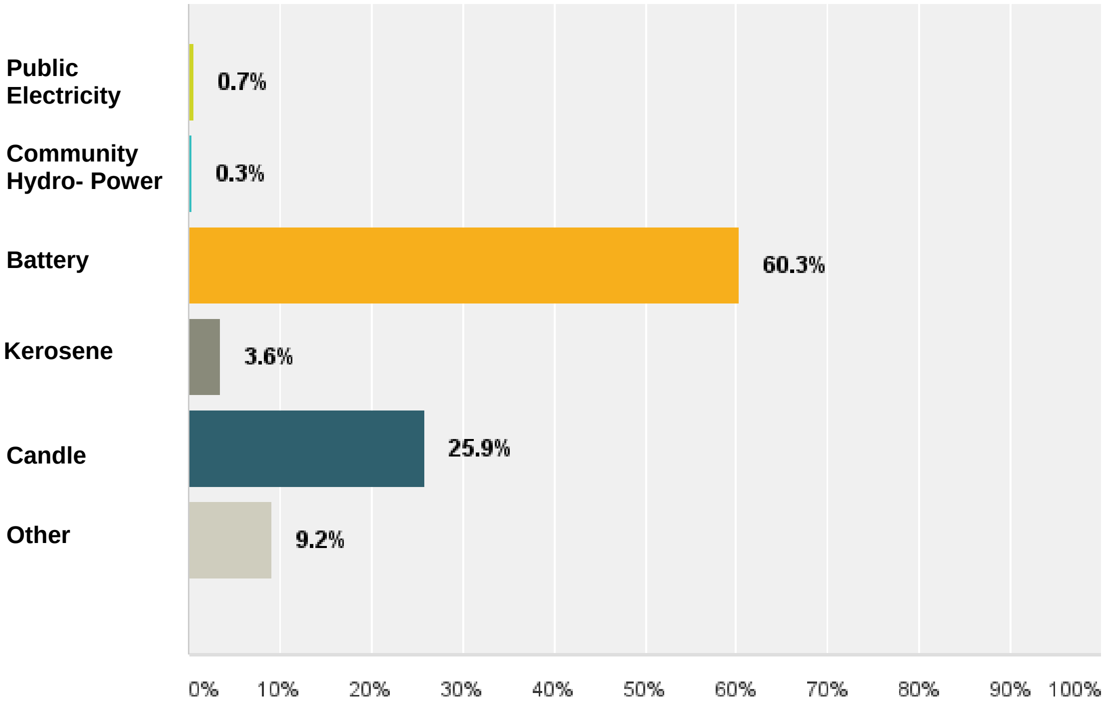
3.5.8.1 Ayeyarwady Region

Since 1975, the 34.7 MW gas turbine power station in Myaunang, with annual production of 200 GWh, has been running for power supply in Ayeyarwady. [1]

3.5.8.2 IOR-5

During socio-economic interviews in IOR-5 Respondents indicated that their source of light varied between battery (60%), candles (26%) and kerosene (4%) (**Chart 3-23**). Approximately (38%) of the respondents interviewed have power available with a ¼ mile from their residence, however (51%) have power available greater than 1 mile from residence (**Chart 3-24**). Most of the interviewee's (93%) cook with firewood **(Chart 3-25)**.

Chart 3-23: Response of villagers in IOR-5 in regard to source of lighting.



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[1] Energy Sector Initial Assessment Myanmar, Asian Development Bank, October 2012

Chart 3-24: Response of villagers in IOR-5 in regard to proximity to electricity.

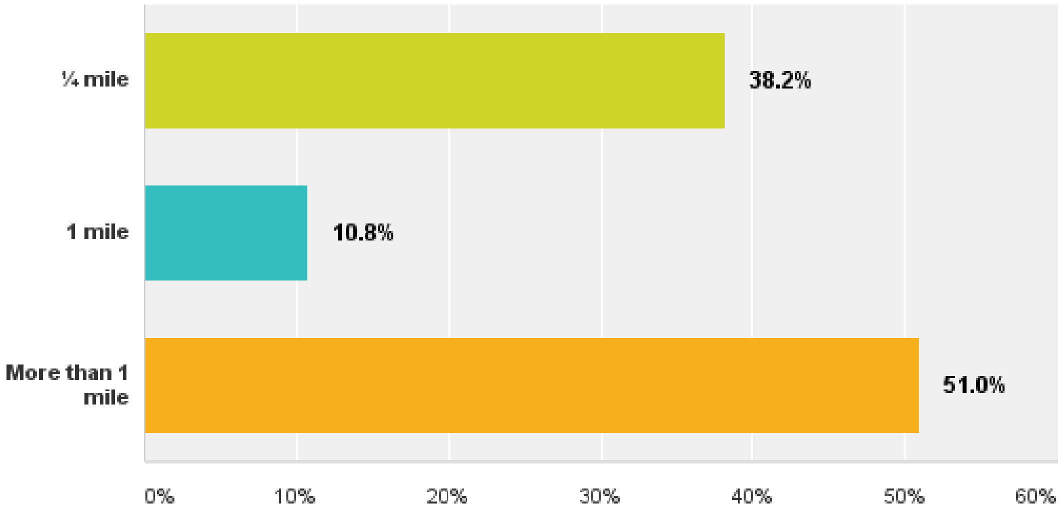
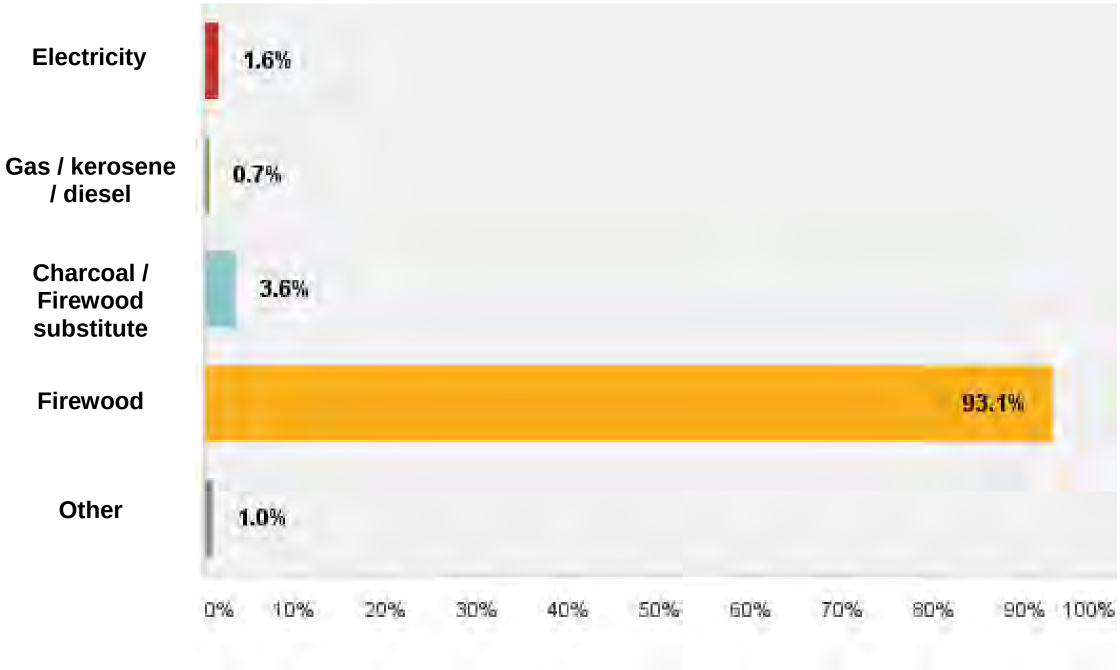


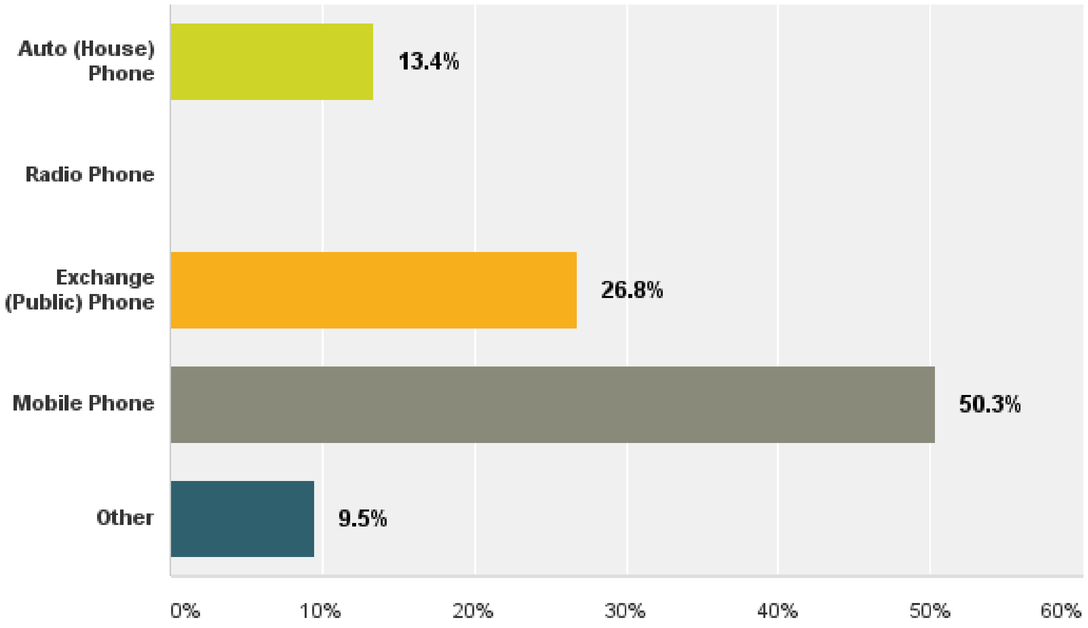
Chart 3-25: Response of villagers in IOR-5 in regard to source of energy for cooking.



3.5.9 Communications

Based on interviews with 400 villagers in 8 communities IOR-5 in, approximately 50% of villagers communicate with the use of mobile phones, 27% use exchange phones and 13% by house phones (**Chart 3-26**).

Chart 3-26: Response of villagers in IOR-5 in regard to use of telephone communications



3.6 Quality-of-Life Values

3.6.1 Local Administration

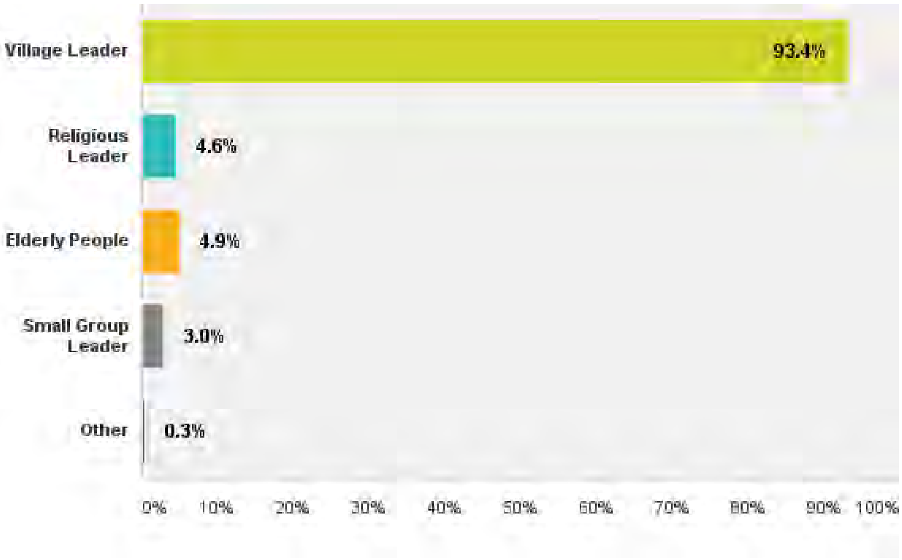
The wells are located in Ayeryarwady and Magway administrative regions (**Figure 3-20**).

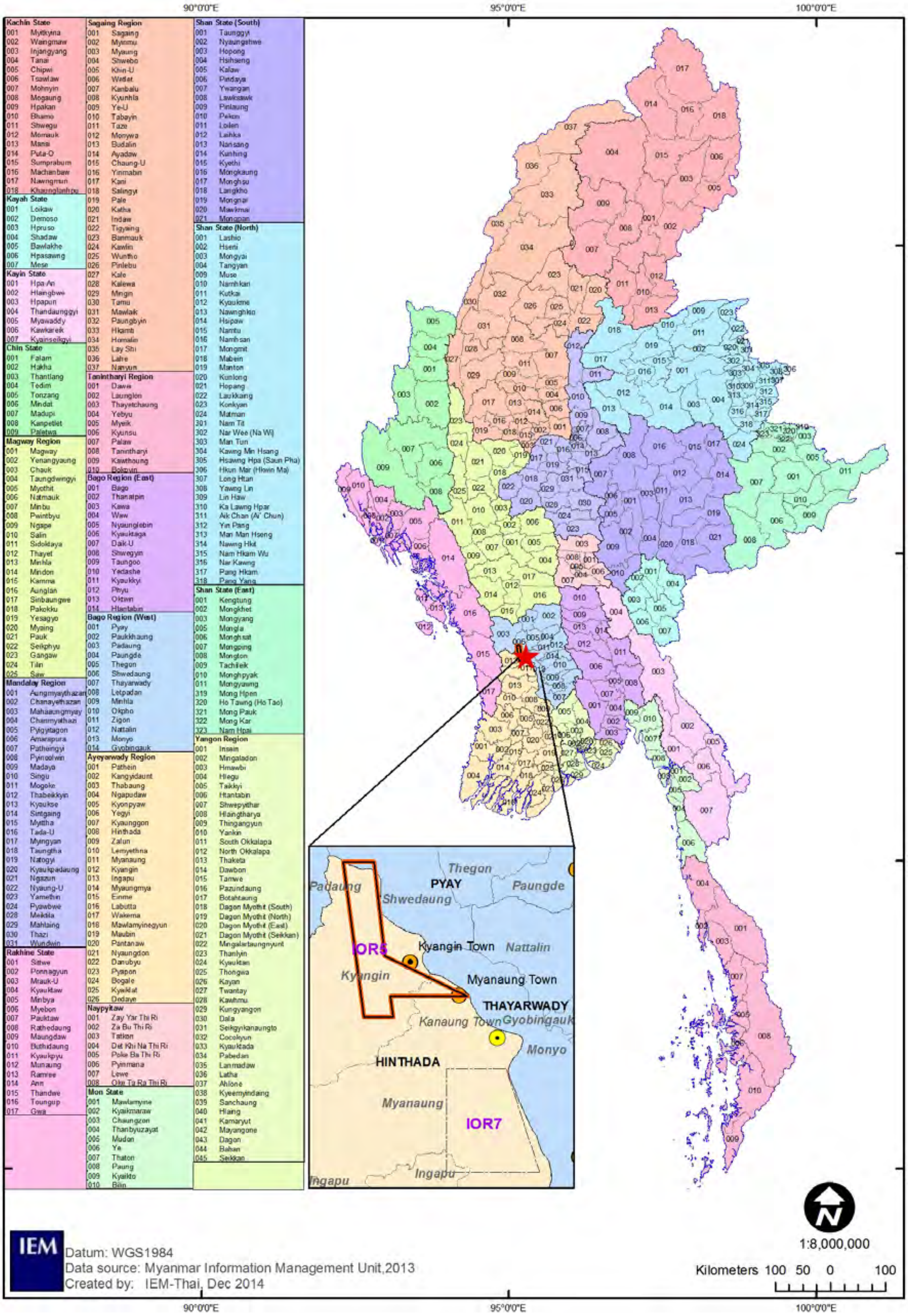
The regions were called divisions prior to August 2010. States and regions are divided into districts. These districts consist of townships that include towns, wards and village-tracts. Village-tracts are groups of adjacent villages. The administrative structure of the states, regions and self administering bodies is outlined in the new constitution adopted in 2008.

Each state or region has a Regional Government or a State Government consisting of a Chief Minister, other Ministers and an Advocate General. Legislative authority would reside with the State Hluttaw or Regional Hluttaw made up of elected civilian members and representatives of the Armed Forces.

At the community level, local villagers identified the elected Village Leader is responsible for most (93%) of community decision making (**Chart 3-27**).

Chart 3-27: Responsibility for community decision making in IOR-5





Datum: WGS1984
Data source: Myanmar Information Management Unit,2013
Created by: IEM-Thai, Dec 2014

Figure 3-20: IOR-5 Administrative Regions

3.6.2 Demographics

In the IOR-5 age structure of the respondent's families indicated that the majority (approx. 23%) of household members are between 30-40 yrs of age followed by those in the range of 50-60 and 40-50 yrs of age (**Chart 3-28);** 26% came from households with 4 family members followed by approximately 25% from 3 person families **(Chart 3-29)**.

Chart 3-28: Age structure of Population in IOR-5

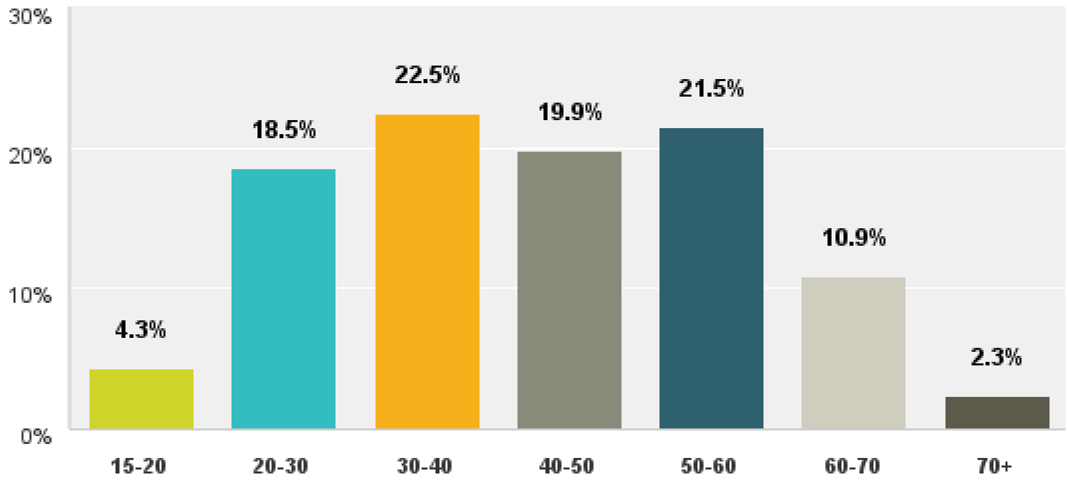
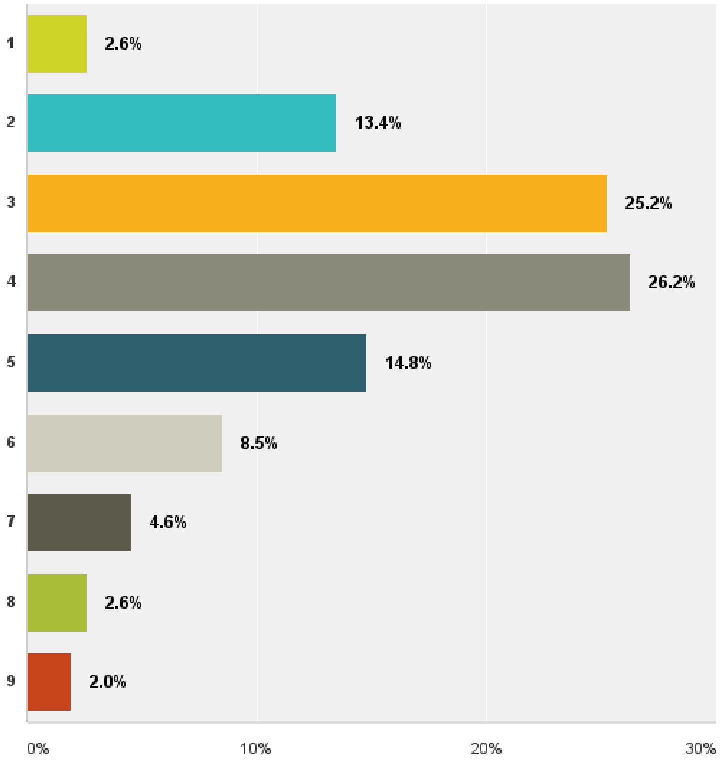


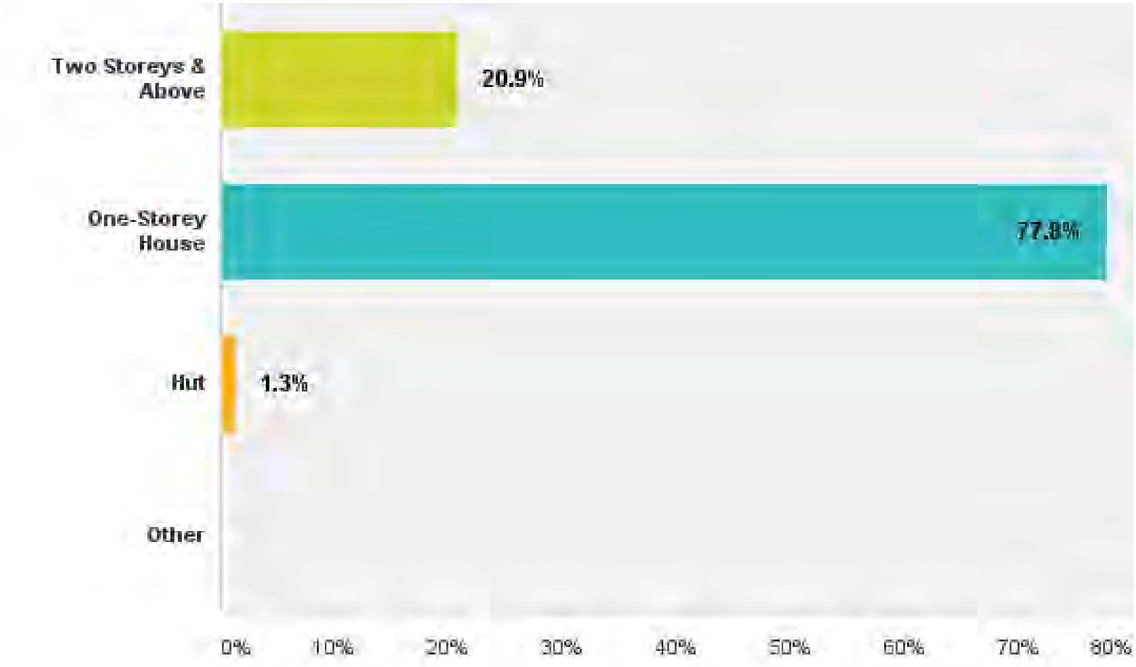
Chart 3-29: Number of household member reported in IOR-5



3.6.3 Housing

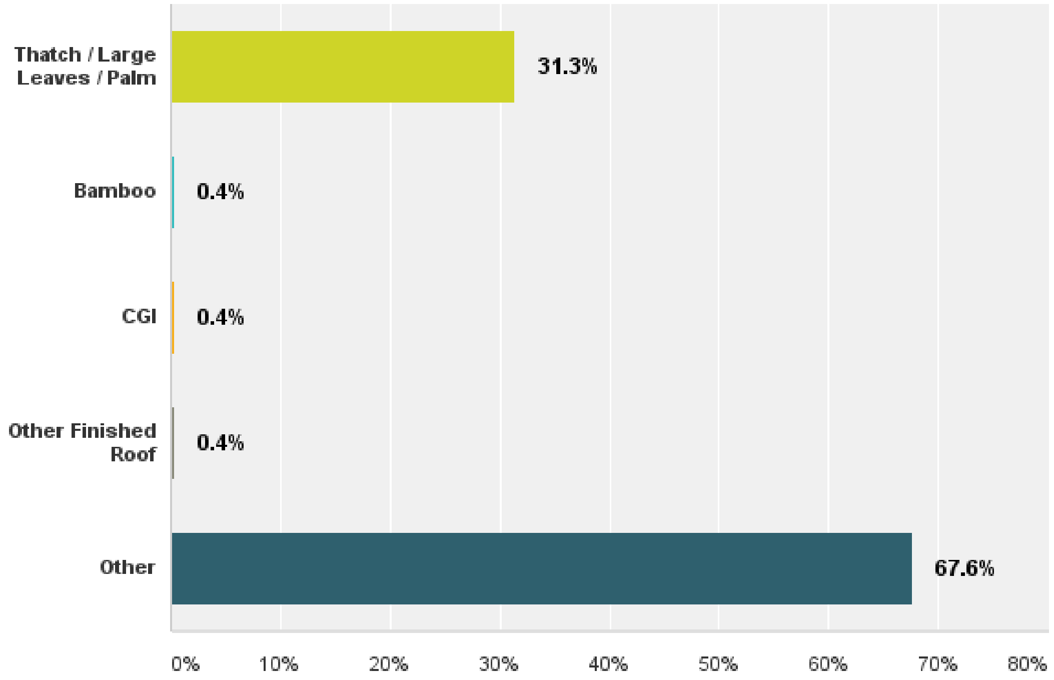
Approximately 78% of interviewees IOR-5 live in one-story houses and 21% were living in two-story houses (**Chart 3-30**).

Chart 3-30: Type of housing reported in IOR-5



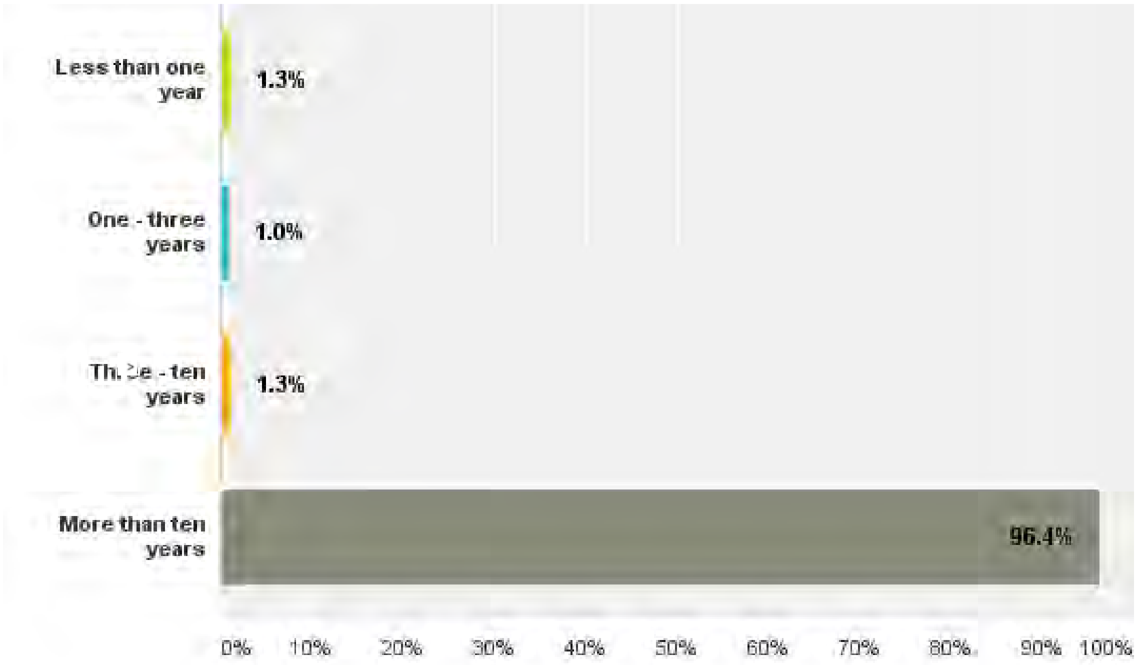
The roof type is an indicator of wealth. In this region, traditional thatched roofs (31%) were reported by the majority of respondents followed other roofing material being used on houses (67%), as reported by interviewees (**Chart 3-31**).

Chart 3-31: Primary roofing material reported in IOR-5



The vast majority (96%) of the villagers surveyed were long term residents of the area and had lived in their house for periods of over 10 years (**Chart 3-32**).

Chart 3-32: Duration of residency in house reported in IOR-5



3.6.4 Home Ownership

Within IOR-5 a substantial majority (94%) of the households surveyed own their land where they live (**Chart 3-33)**. They show ownership in varied ways: 43% of villagers have no formal land ownership documents but have permission, 36% have documents, and 21% have neither document nor permission (**Chart 3-34**).

Chart 3-33: House lot ownership reported in IOR-5

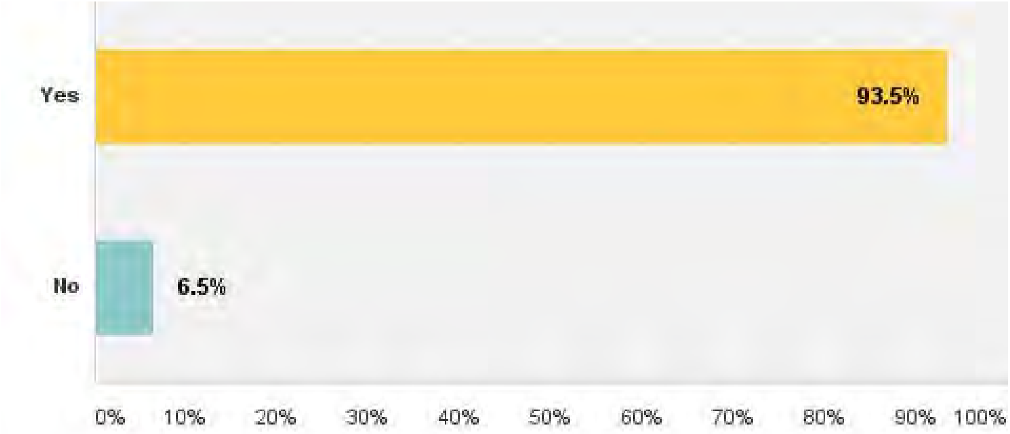
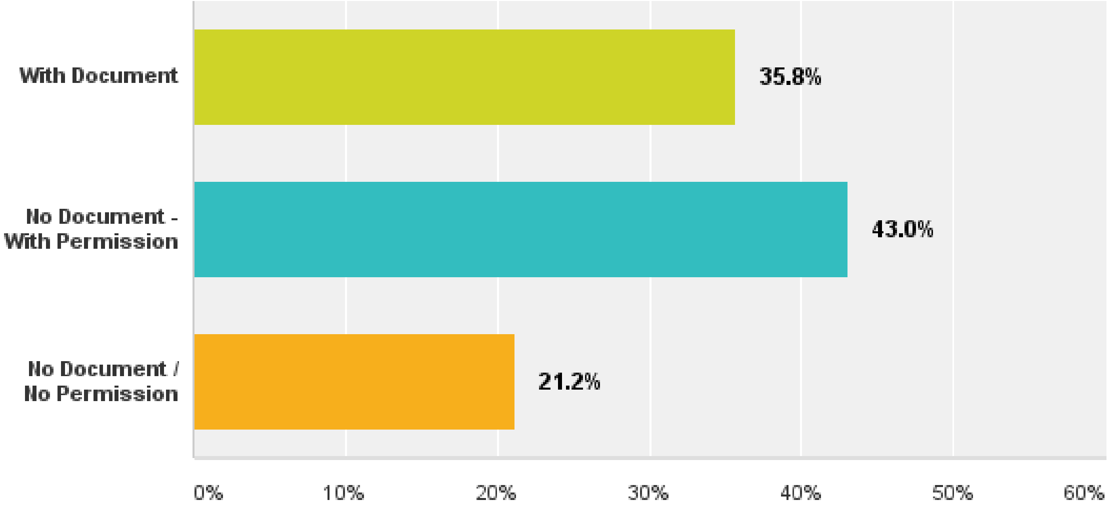


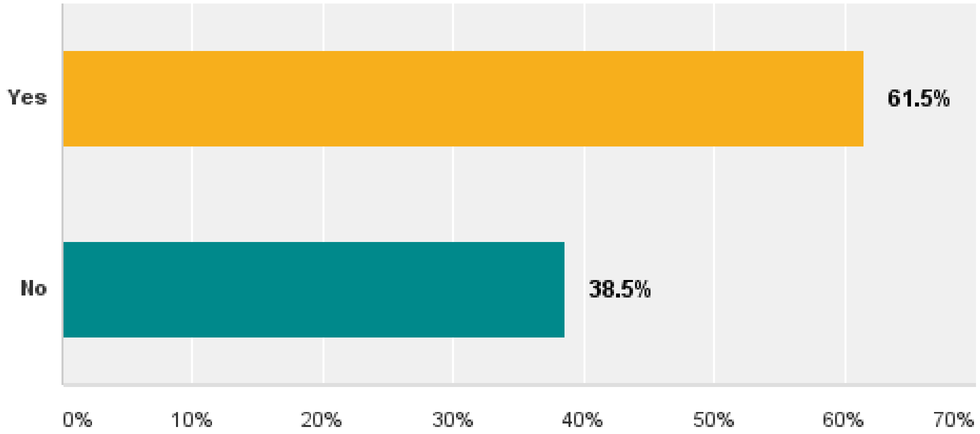
Chart 3-34: Ability to demonstrate land ownership in IOR-5



3.6.5 Farmland Ownership

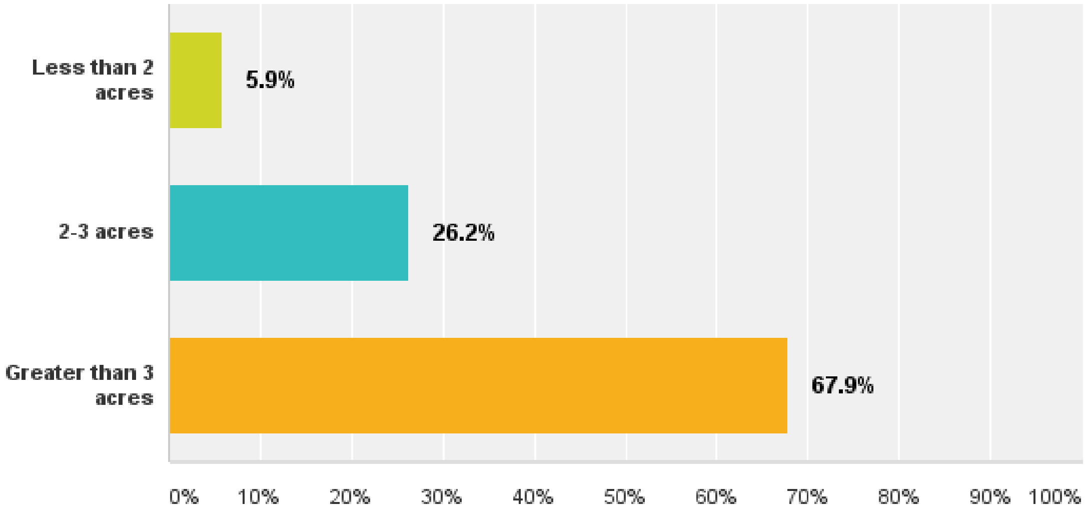
Land ownership patterns vary in central Myanmar. In some cases lack of rain has impoverished farmers with the result that lands may be sold and farmers and family members are forced to become tenants and or labour on other larger land holdings simply for survival. Within IOR-5 approximately 62% of the household owners own farmland (**Chart 3-35)**.

Chart 3-35: Farmland ownership by households reported in IOR-5



Approximately 70% of the farmers in IOR-5 own more than 3 acres (**Chart 3-36)**.

Chart 3-36: Area of farmland owned by households reported in IOR-5



3.6.6 Socio-Economy

Data for the socio-economic baseline of the Project area comes primarily from interviews of 400 households in 8 communities distributed throughout the block as well as review of various technical reports, government, and internet research.

3.6.6.1 General

Within IOR-5 socio-economic activity is based primarily on agriculture. The main crops grown are beans (peanut/groundnut and pulses), sesame, rice, and corn. Edible oil derived from sesame and peanut is an important secondary agricultural product.

Farmers are heavily dependent on products from the natural forest, especially fuel wood, pole, post and fodder to support their living and livestock. Poorer farm families and agricultural labourers supplement their incomes by cutting fuel wood or making "jiggery" (palm liquor), which contributes to overexploitation of forest resources and deforestation. Many landless people are working as seasonal farm labourers, migrating to urban regions during non-planting time to find temporary employment.

Ayeyarwady Region

The Ayeyarwady River (also known as Irrawaddy; length 2170 km; drainage area 413,710 Km2) is the largest river in Myanmar and has been described as the heart of the nation. The basin accounts for over 60% of Myanmar's landmass, accommodates 70% of its population, and transports 40% of its commerce. Groundwater resources in the basin are believed to be even greater than surface water resources. It is rich in natural resources particularly forests, land and water in addition to biodiversity.

In the Ayeyarwady Region, mangrove forest has been seriously degraded in recent years due to agricultural conversion and the high demand for firewood and charcoal from Yangon, with consequent decline of fish catches and increased vulnerability to natural disasters. It has been estimated that ~83% of mangroves in the Ayeyarwady Delta have been destroyed between 1924 and 1999 (NECC, 2012).

The Ayeyarwady river also has extensive wetlands in the interior of the country, which are mostly seasonally inundated floodplains, most of which have been reclaimed for permanent agriculture.
The swamp forest, found in the Ayeyarwady Delta is of high ecological importance for many bird species, which have suffered dramatic population declines across their global distributions. The Ayeyarwady River also has extensive wetlands in the interior of the country, which provide excellent feeding areas for large number of waterfowl and fertile spawning grounds for a number of fishes, such as carp, catfish and perch.

While the majority of the population in the Ayeyarwady River Basin is Bamar, the area is also home to many ethnic minority groups.[2]

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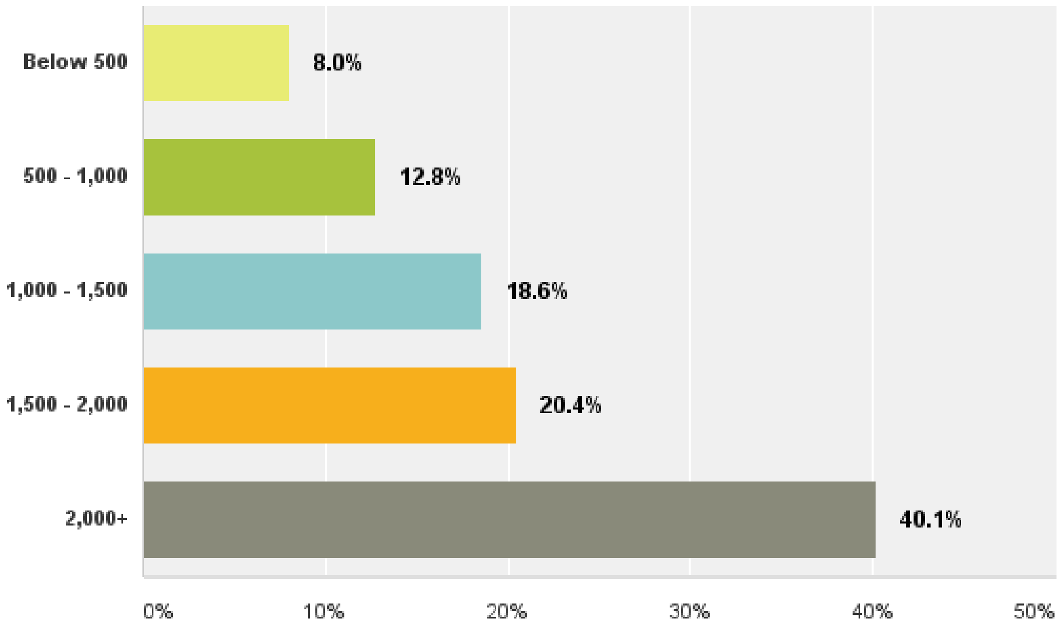
[2] World Bank. 2014. *Executive summary : final environmental and social management framework*. Myanmar : s.n.. http://documents.worldbank.org/curated/en/2014/10/20424397/myanmar-ayeyarwady-integrated-river-basin-management-project-resettlement-plan-vol-1-2-executive-summary-final-environmental-social-management-framework

3.6.6.2 Income and Employment in IOR-5

The IEM team surveyed a total of 400 households in 8 communities is IOR-5 in regard to income, employment and labour.

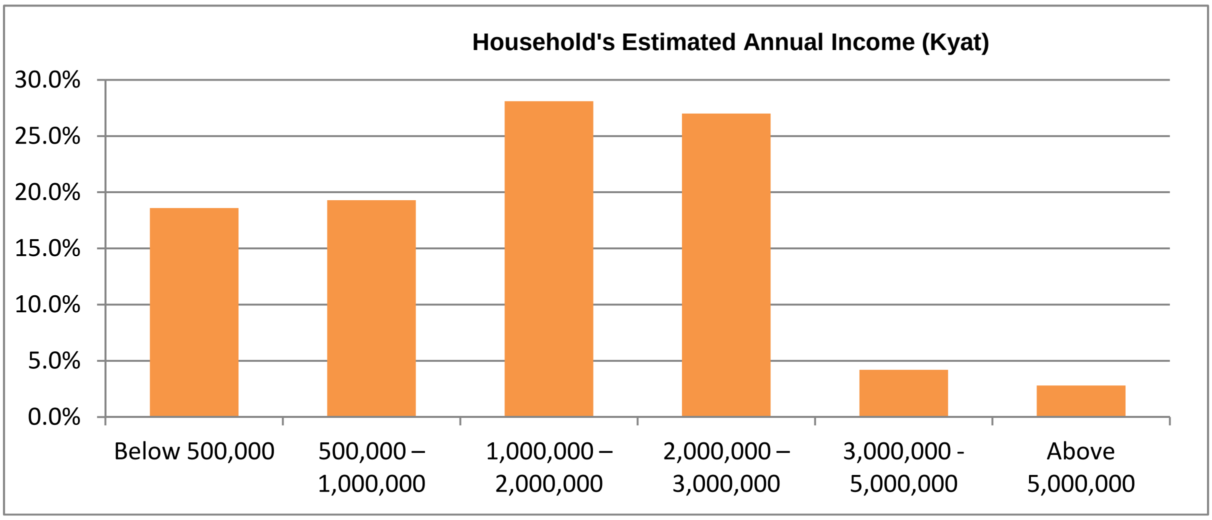
Approximately 40% of the villages had an average daily wage of over 2,000 kyat, with 20% having an average daily wage of between 1,500-2,000 kyat; and 19% with an average daily wage of between 1,000-1,500 kyat. (**Chart 3-37**).

Chart 3-37: Average daily income reported in IOR-5



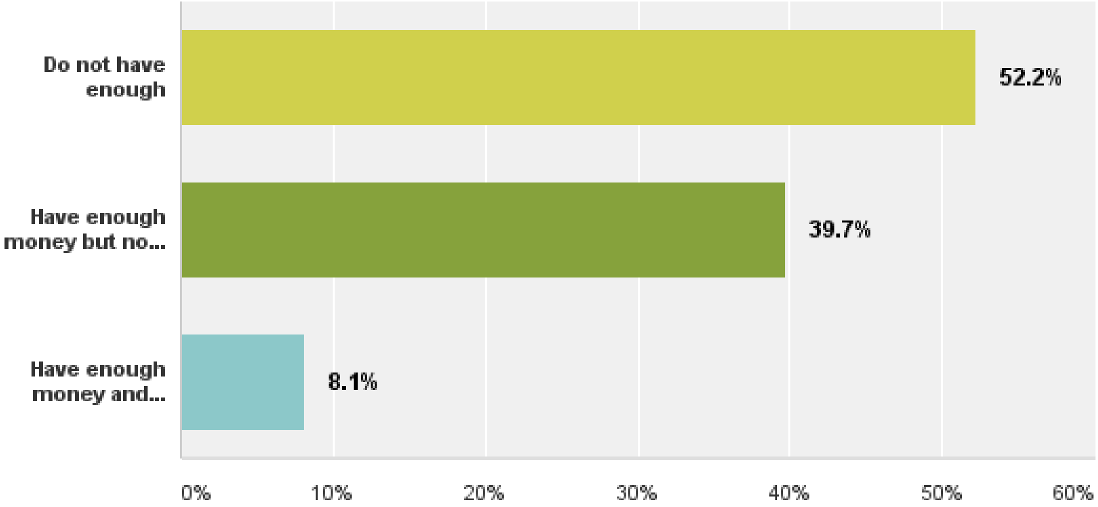
The survey group indicated that 28% had an annual income of 1,000,000-2,000,000 kyat; 27% had an annual income of 2,000,000-3,000,000 kyat; and 19% with an annual income of 500,000-1,000,000 kyat. (**Chart 3-38**).

Chart 3-38: Annual household income reported in IOR-5



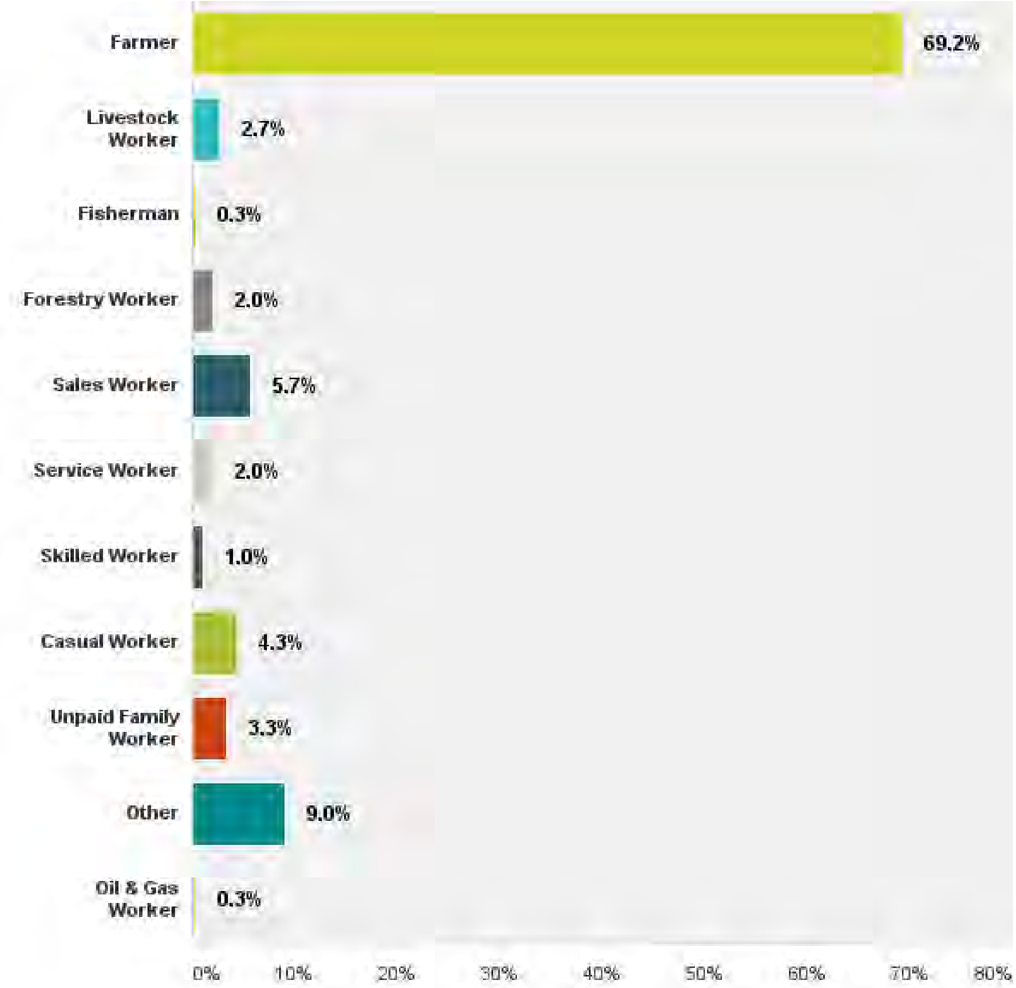
When asked whether they felt they had sufficient money respondents in IOR-5 indicated that 52% of them did not have enough money (**Chart 3-39**).

Chart 3-39: Personal monetary situation reported in IOR-5



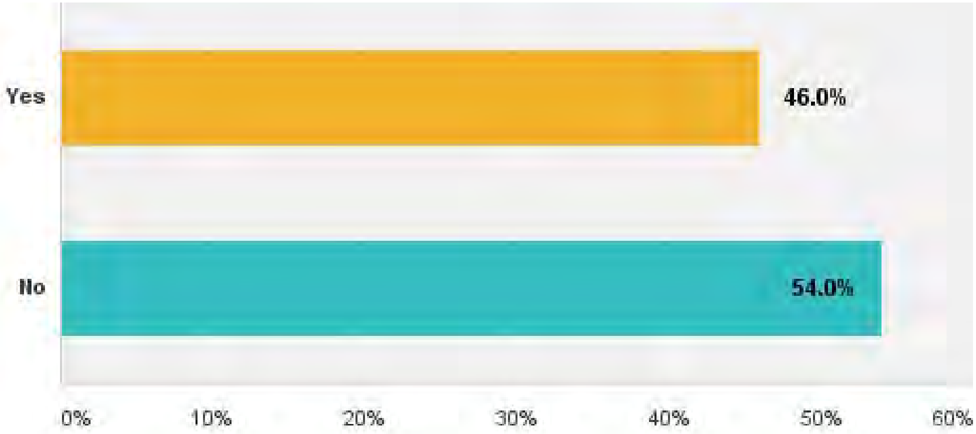
Over 69% of respondents described their primary occupation as "farmer" with the remainder of occupations typically accounting for about 10% or less of local employment (**Chart 3-40**). The oil and gas industry currently contributes to less than 1% of local employment.

Chart 3-40: Primary occupation reported in IOR-5



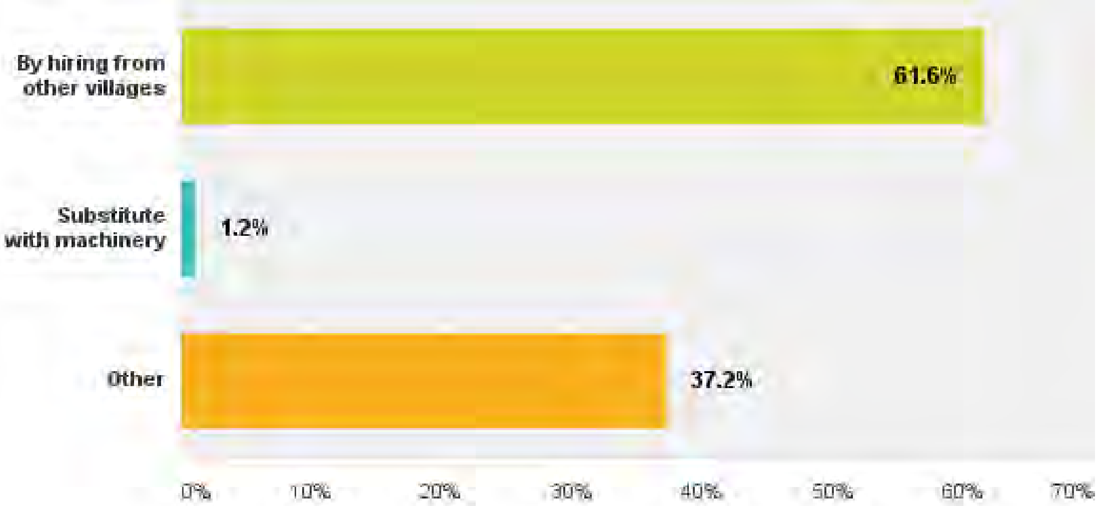
There was a perception among 46% of respondents that oil and gas development activity affects the availability of farm labour (**Chart 3-41**).

Chart 3-41: Perceived influence of oil and gas activity on labour reported in IOR-5



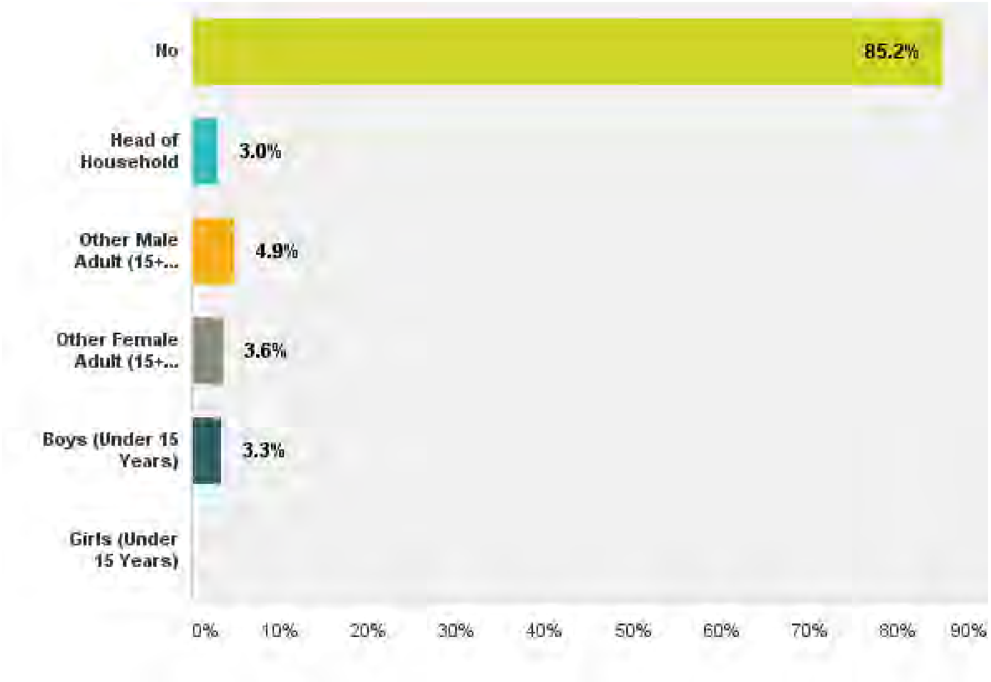
Of particular interest was the observation that by far the majority of farm labour appears to come from other communities than the ones being interviewed. In 62% of the cases respondents said labourers come from other communities (**Chart 3-42**).

Chart 3-42: Source of labourers reported by respondents IOR-5



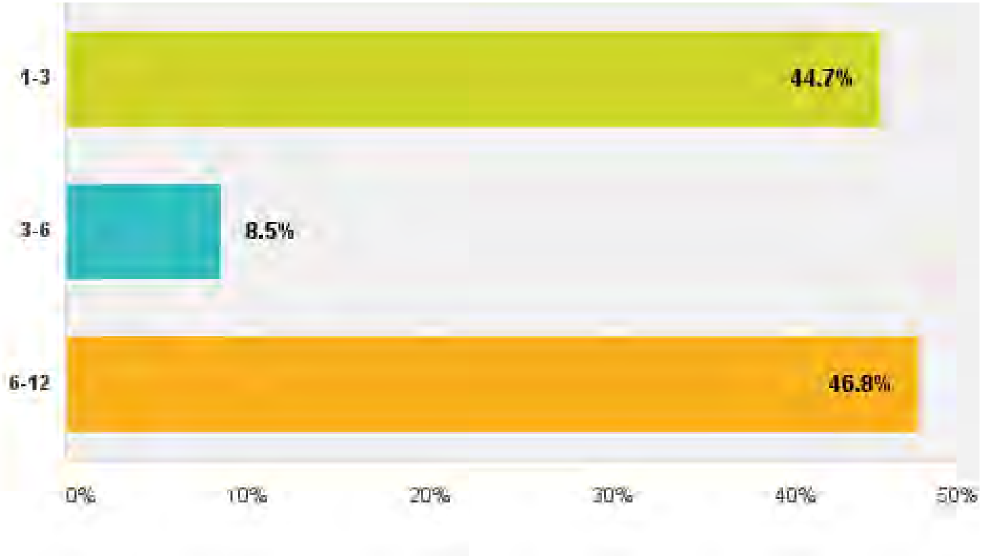
Of the survey group 85% did not migrate for work (**Chart 3-43**). Most migrants were the household head or older males (15+).

Chart 3-43: Pattern of migration reported in IOR-5



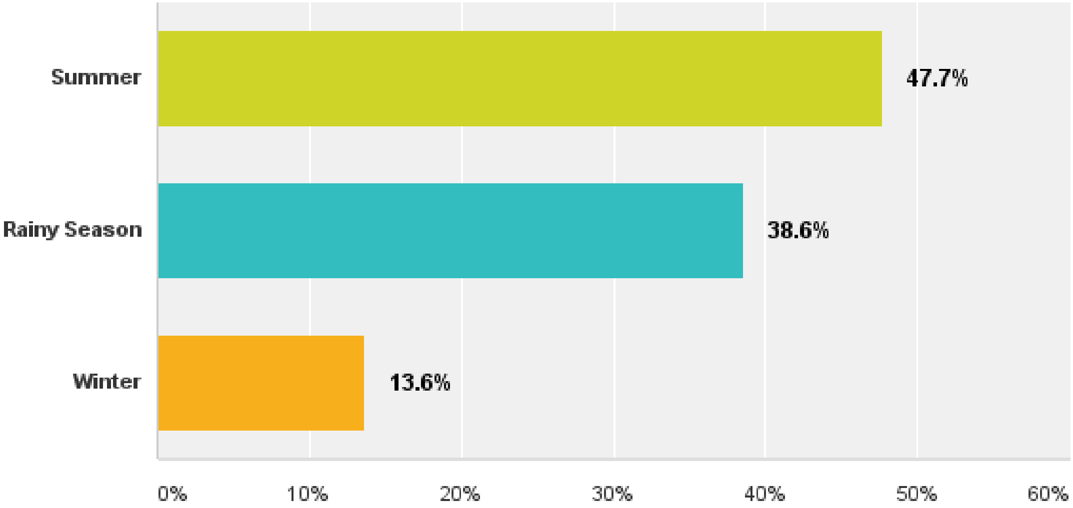
When individuals migrated for work approximately 47% of the time it was for periods of 6-12 months while for the remainder it was typically less than 6 months (**Chart 3-44**).

Chart 3-44: Period away from home by migrant workers reported in IOR-5



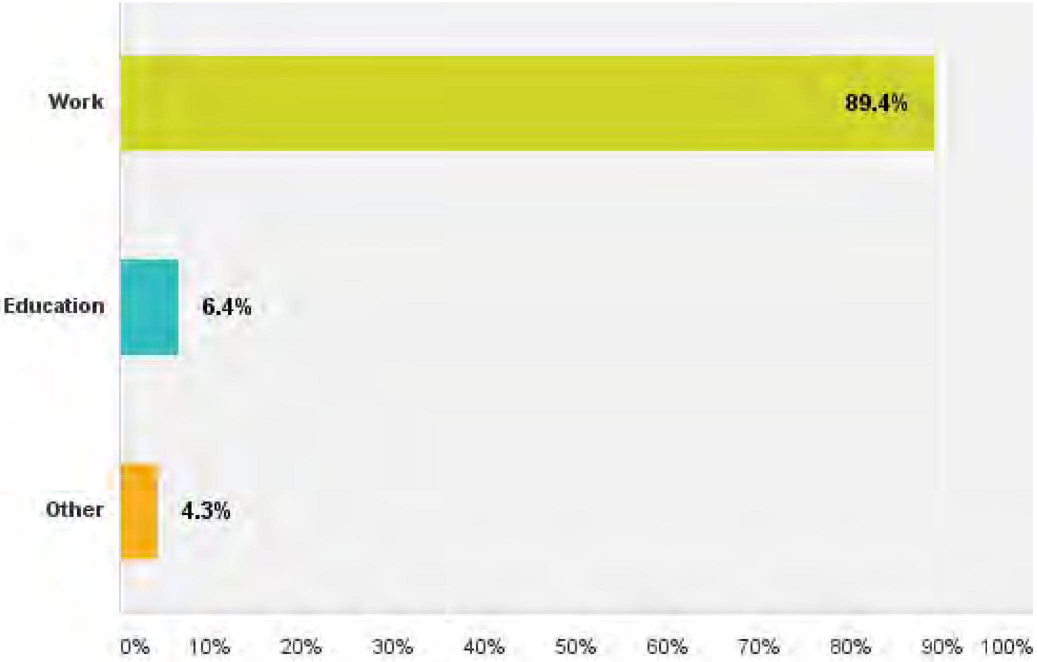
Most, 83% of migration for employment occurred during the summer season (**Chart 3-45**).

Chart 3-45: Season of job migration reported in IOR-5



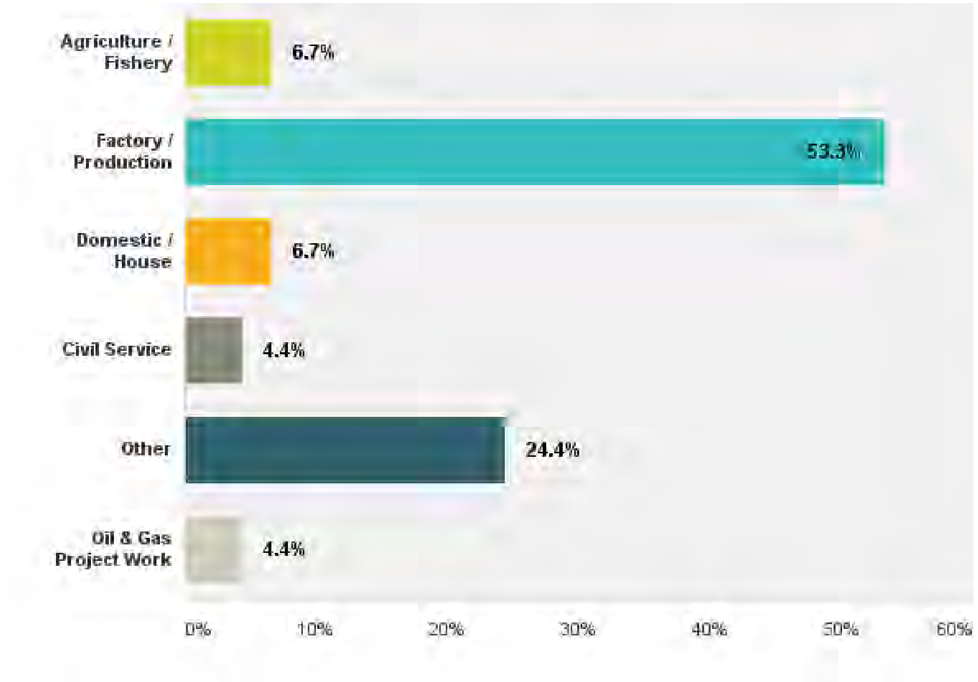
Over 89% of those that migrated did so for work related reasons (**Chart 3-46**).

Chart 3-46: Reason for migration reported in IOR-5



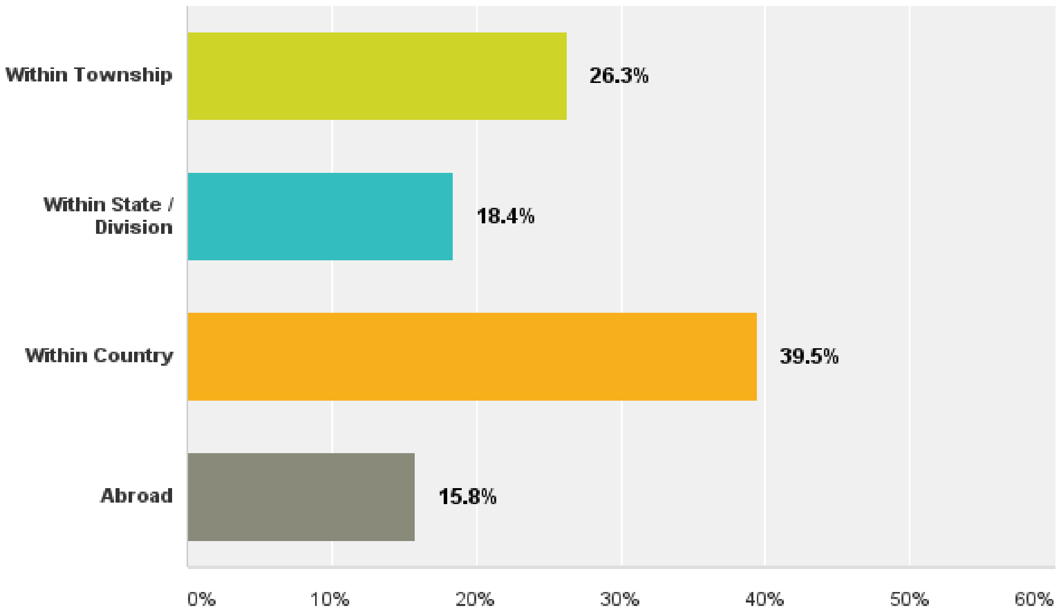
The main type of work that our survey group migrated was factory or production (53%). Only 4% moved to oil & gas project work (**Chart 3-47**).

Chart 3-47: Type of work pursued by migrating workers reported in IOR-5



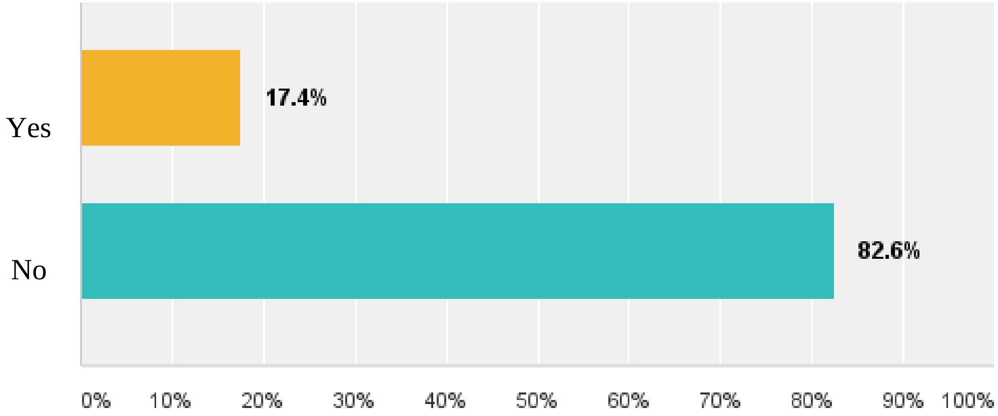
The greatest number (40%) of workers who migrated went to other areas within the country (**Chart 3-48**).

Chart 3-48: Destination of migrant workers reported in IOR-5



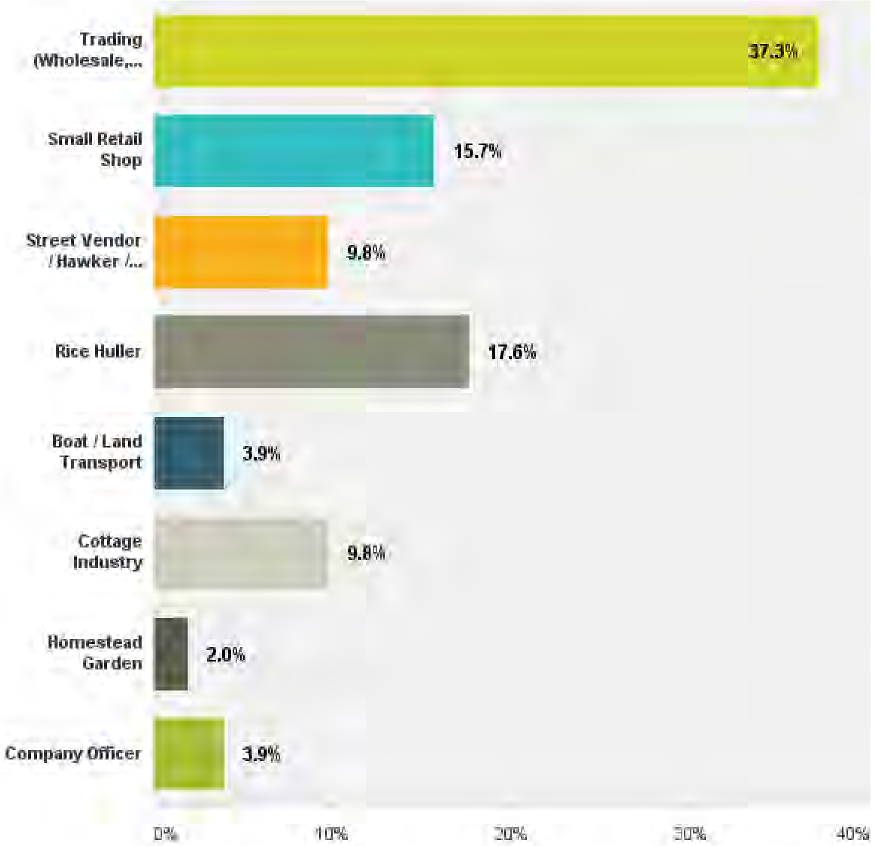
The majority of households (83%) do not participate in off-farm activities. (**Chart 3-49**).

Chart 3-49: Off farm activities reported in IOR-5



Of those involved in off-farm activities, 37% were involved in trading (wholesale or general trading) and 18% were involved in rice hulling (**Chart 3-50**).

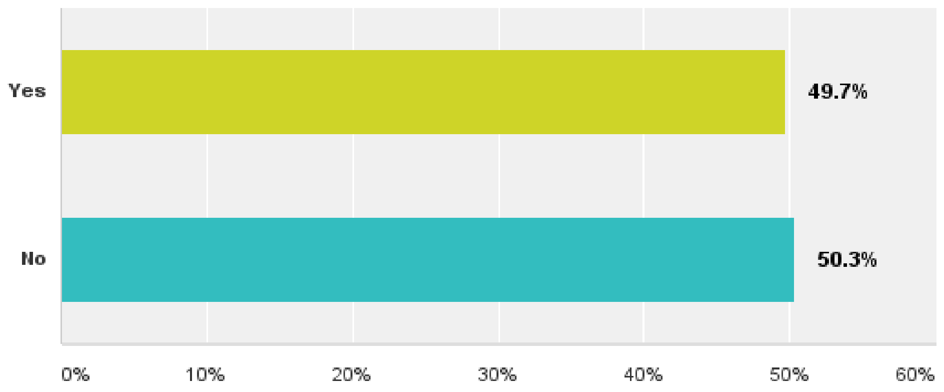
Chart 3-50: Type of household activity reported in IOR-5



3.6.6.3 Education in IOR-5

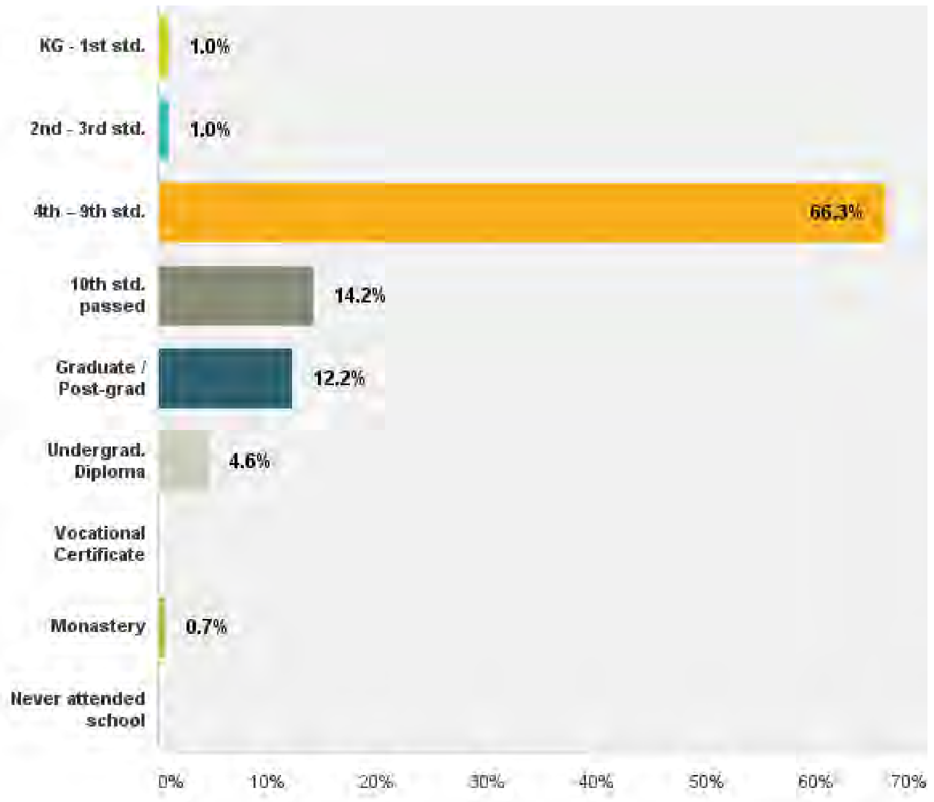
Over 50% of the household members indicated that education was not accessible for them (**Chart 3-51**).

Chart 3-51: Availability of access to education reported in IOR-5



Over 66% of those surveyed had an educational level between Grade 4-9 (**Chart 3-52**).

Chart 3-52: Education level reported in IOR-5



3.6.7 Public Health

In general villagers in IOR-5 did not suffer from high incidence of serious health issues or disability. Health care services in most communities were very basic and in most cases involved a midwife only. Midwives also performed at least some basic dental services.

Villagers, when asked what illnesses they had, 5% had none and other common sicknesses included the flu (32%), and colds (31%) (**Chart 3-53**). During Key Informant Interviews individuals mentioned that the most common illnesses were seasonal flu, cough, malaria, dengue and hypertension. Snake bites, eye disease and tooth aches were also reported in some communities. Based on national surveys, IOR-5 experiences only 0.51- 2.00 malaria mortalities per 100,000 people, the lowest classification in the system (HMIS, Dept of Health Planning, Ministry of Health, 2010).

Availability of health care is perceived as being somewhat limited within IOR-5. The survey group indicated that 95% does not have health care available to them (Chart 3-54). The following chart illustrates the most commonly used health services include Doctor services (45%), Health Assistant (23%) and Midwife (12%) (**Chart 3-55**). The majority (88%) indicated that health care in the village has not changed for the better or worse (**Chart 3-56**). Most (94%) of those surveyed did not have any physical disability (**Chart 3-57**). Almost 98% of those surveyed indicated that they had not had any accidents or injuries in the past 3 months (**Chart 3-58**). 93% of the survey group had problems with diarhea in the past month (**Chart 3-59**). All of the people (100%) in this region use a mosquito net while sleeping.

Chart 3-53: Health conditions reported by 400 villagers from 8 communities in IOR-5

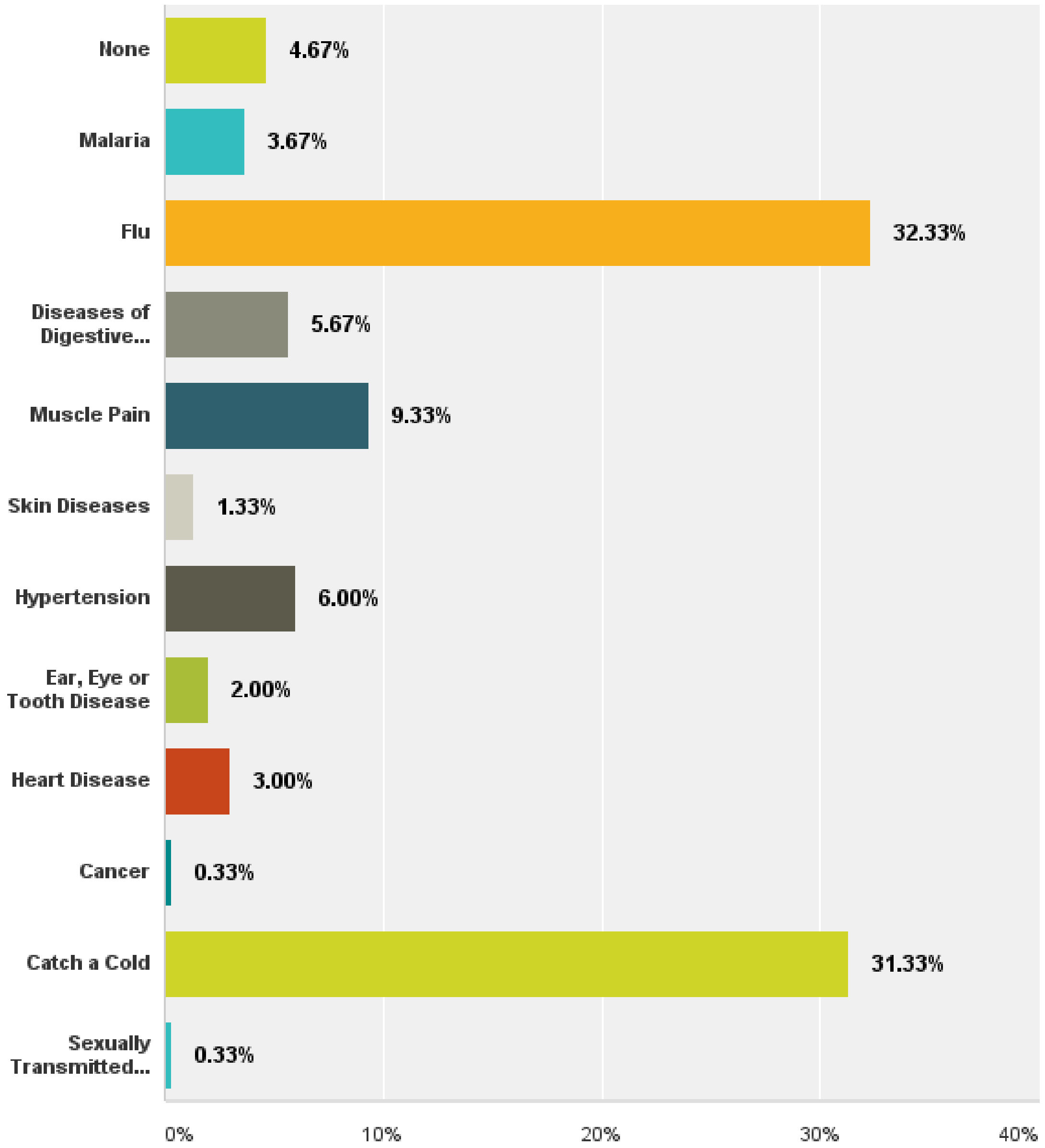


Chart 3-54: Availability of health care reported in IOR-5

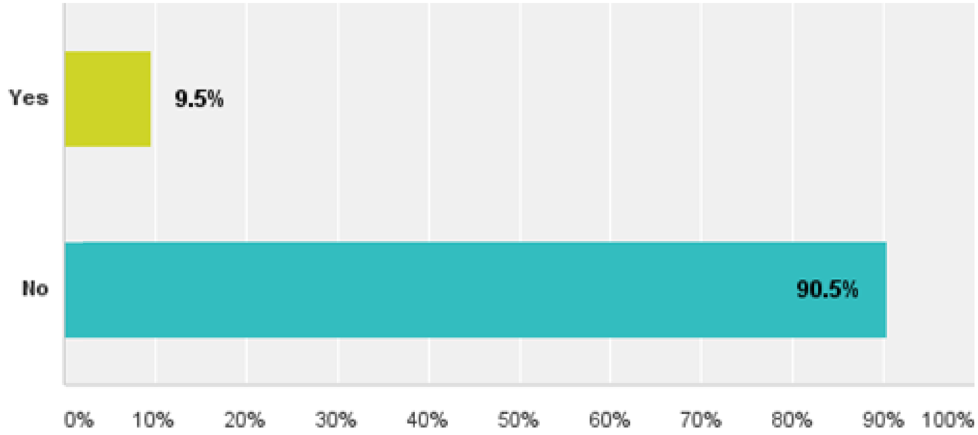


Chart 3-55: Use of health care providers in IOR-5

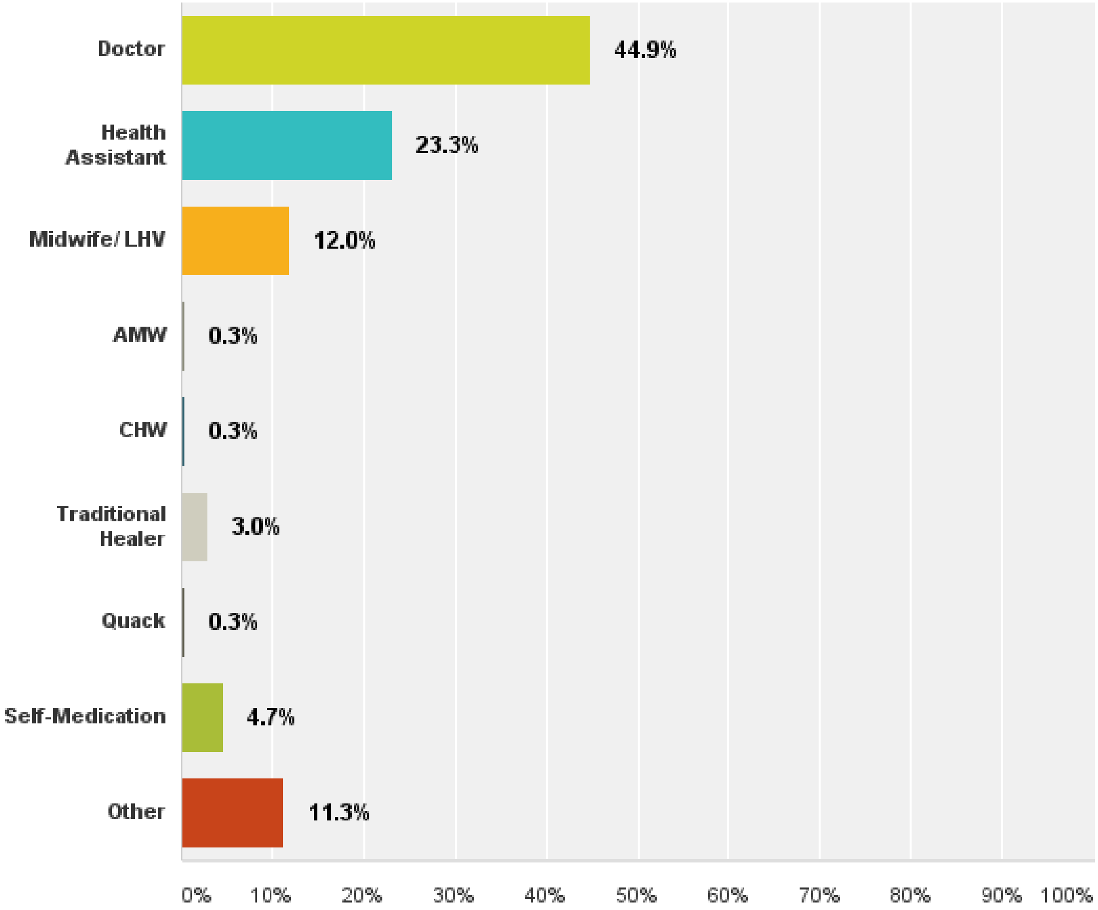


Chart 3-56: Trends in health care reported in IOR-5

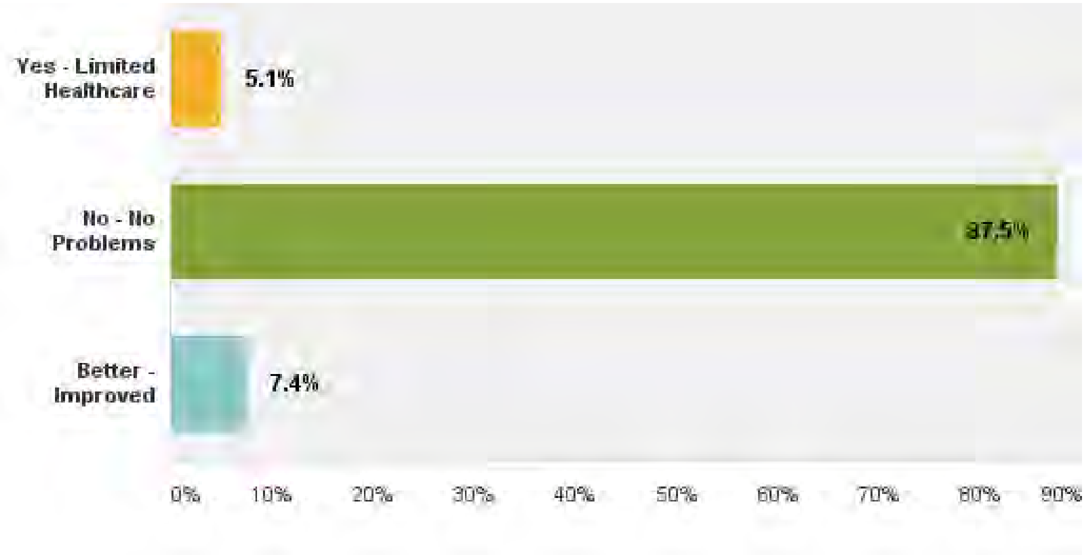


Chart 3-57: Disabilities reported in IOR-5

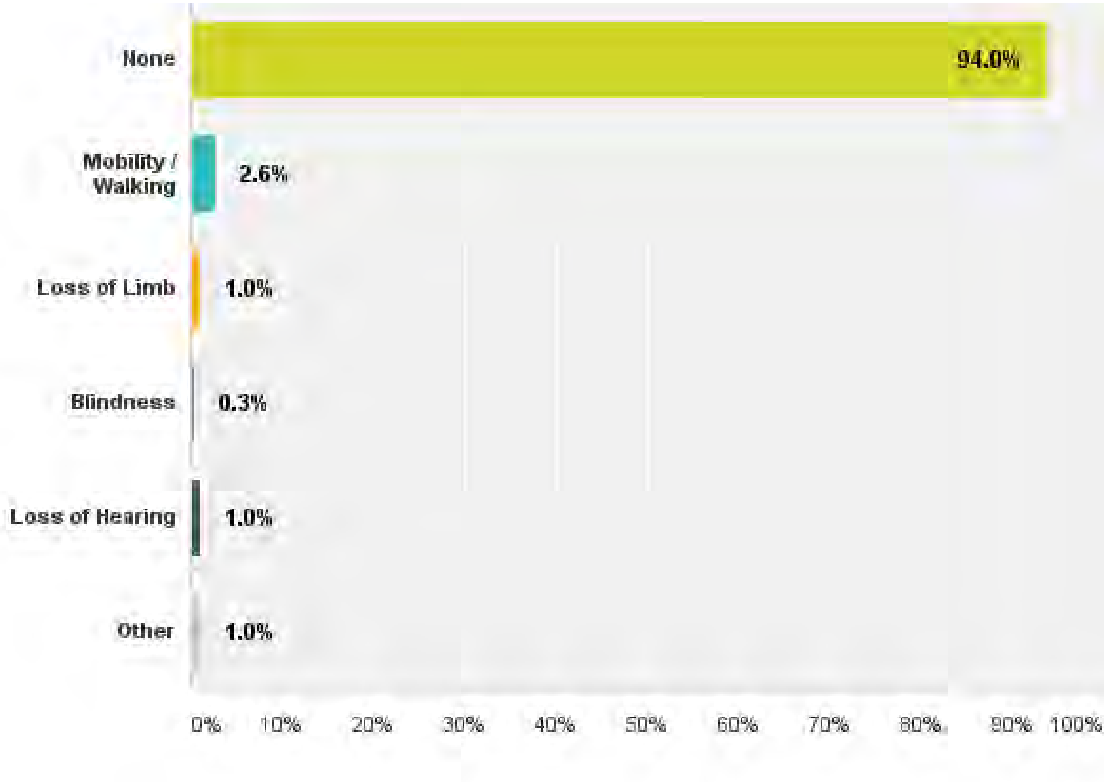


Chart 3-58: Occurrence of significant occupational injuries reported in IOR-5

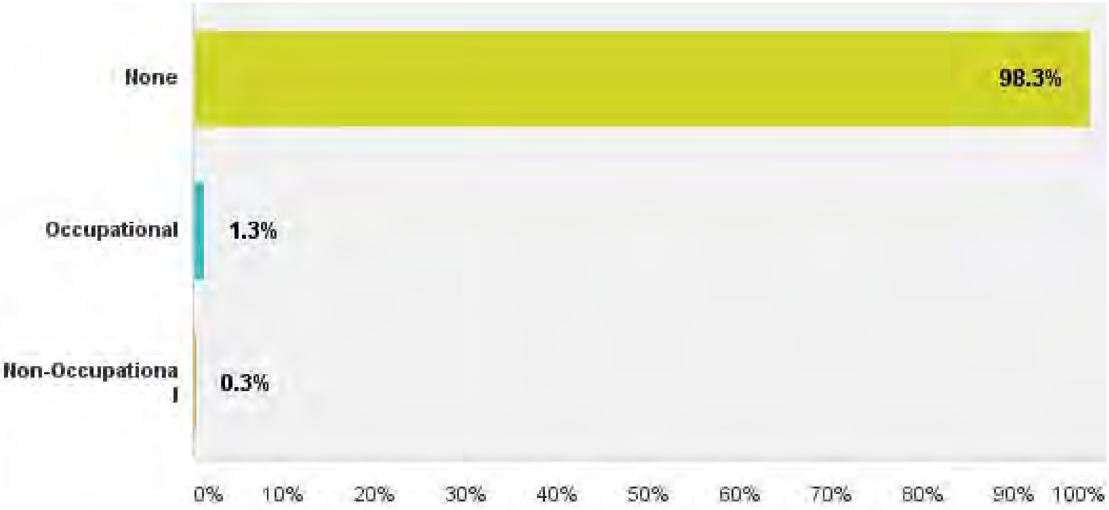
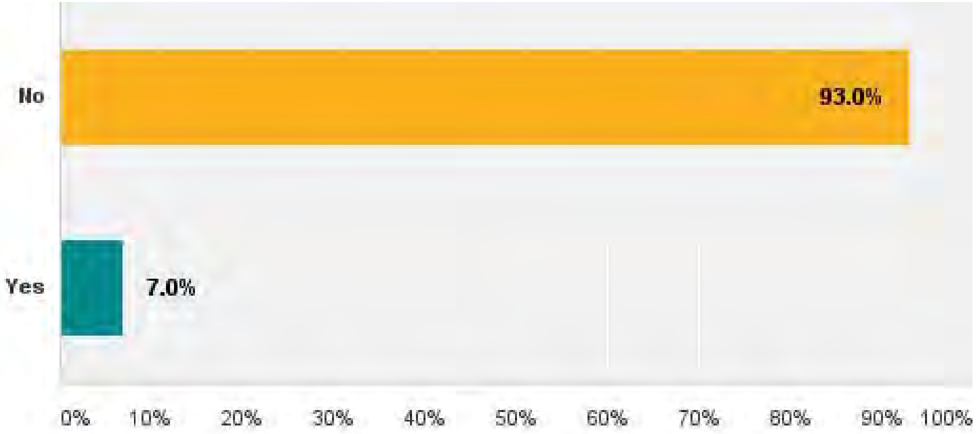


Chart 3-59: Occurrence of Diarrhea in IOR-5



3.6.7.1 Health Care Facilities

Ayeyarwady Region

According to the Ministry of Health, per 100,000 population, there are 37 hospital beds, 22 midwives, 21 nurses, and 9 medical doctors available in Ayeyarwady Region.

In 2010, the total numbers of Hospitals in Ayeyarwady Region increased to 93. Fatality rate per 1000 Discharge and Death are 16 in total (Annual Hospital Statistics Report, 2010). The closest government hospital to Block IOR-5 is Kyangin Hospital with 25 sanctioned beds and total available beds of 40.

Numbers of hospitals and beds in the region are shown in **Table 3-34**, and hospital resources are shown in **Table 3-35**.

Table 3-34: Total Number of Hospitals in Project Area, 2010

Region	Total Numbers of Hospitals
Ayeyarwady	91

Source: Annual Hospital Statistics Report, 2010

Table 3-35: Availability and Utilization of Hospital Resources, 2008

Region	**Population [,000]**	**Percentage Distribution**	**Total Number of Hospitals**	**Sanctioned Beds**	**Available Beds**	**Available Beds per 100,000 population**	**Daily Use of Hospital Beds per 100,000 population**	**Admissions**	**Admissions per 100,000 population**	**Discharge and Death**	**Discharge and Deaths per 100,000 population**	**Patient Days**	**Patient Days per 100,000 population**	**No of Death**	**Hospital Death Rate**
Ayeryarwady	8237	13.7	91	3001	2489	43	22.4	130486	16	130004	16	674767	82	2165	1.7

Source: Annual Hospital Statistics Report, 2010

3.6.8 Cultural Traditions and Historical, Archaeological Resources

The government and people of Myanmar place a very high degree of importance on their cultural traditions, religious and historic sites. Many active Buddhist sites are managed by trustees, sometimes with input from government authorities. Gazetted archaeological sites, such as Bagan, are managed by the Department of Archaeology, National Museum and Library, which is a division of the Ministry of Culture.

The ministry states in part that its mission is:

> *"to love and cherish the country and the people by taking pride in our traditions as well as by preserving, exposing and propagating Myanmar cultural heritage … to help develop unity, nationalistic spirit and patriotism among the people."*

The Archaeology Department employs conservators and engineers to maintain and repair buildings and their contents, as well as research officers, who conduct excavations.

The following information on historical and archaeological sites was obtained from previous field surveys and literature search conducted by expert Myanmar historians. A summary of the survey results is provided below.

In central Myanmar, Ayeyarwady Zone, recent discoveries have been made specifically in the Samon River Valley, which has shed more light into Myanmar ancient history. The discoveries included old Pyu cities of Maing-Maw (Pin-Le) in Myittha Township, Bain-na-ka in Pyawbwe Township and Waddi in Natogyi Township were discovered within the Region of Mandalay. There appear to be many village sites (mentioned in Win Maung 2002, and Elizabeth Moore, 2007) along the Samon River valley as Kha-bo in Tadau Township and Myogon in Mahlaing Township, located near the vicinity of the Project. According to Win Maung (Tampawaddy), recent information from field exploration; (Gothenburg Conference, Sweden 2002), and Elizabeth H. Moore, (Early Landscape of Myanmar, River books, 2007) there are altogether 31 early settlements recorded along the Samon River.

Previous archaeological works in this area suggested that plenty of artifacts have been discovered from "Samon Valley" (From the Townships of Tadau, Myinttha, Wandwin, Thazi, Maikhtila, Pyawbwe, Mahlaing, Yemethin and Tatkon in Mandalay Region). They include:

- Pot jar and vessel of various designs and sizes
- Polished stone axes
- Stone bracelets (Ring Stone)
- Blue glass bracelets
- Beads of stone-quartz, amethyst, agate, carnelian, chalcedony
- Bronze axes, adzes, arrow heads, spear blades
- Bronze container of many sizes and shapes
- Rattles, jingle bells, and bells made of bronze
- Bronze bracelets and anklets
- Shallow cones, stylized female figures, and sheets of bronze floral
- Iron sword of double edged blades
- Spear heads, sickle, grubbing hoe

- Bundles of small bronze wires

These artifacts were found to belong to late bronze and early iron ages (Win Maung, 2002). The discoveries have been initially made from local reports by digging whereabouts in various townships and some official excavation in this region were reported by the Department of Archaeology, Mandalay. There are many small sites in the Samon, with not all of those listed here having been excavated or explored.

The Ayeyarwady valley has been continuously inhabited by many cultures and civilization from Stone, Bronze and Iron ages to dynastic kingdoms up to mid 19th century. Historical and cultural heritage in central Myanmar can be summarized as follows:

- **Stone Age Anyarthian culture** (400,000-100,000 BP): This period represents hunter-gatherers habitation in Myanmar. However, only the Neolithic (2,500-1,500 BCE) and Bronze-Iron developments (circa 1,000 BCE) have been moderately explored in Myanmar. Recent discovery of artifacts belonging to the late bronze and early iron ages have shed light into the existence of prehistoric civilizations in middle Myanmar, including the Samon River Valley.
- **Pyu Kingdom** (4th - 10th Century): More than 40 ancient city wall enclosures have been identified from aerial photographs, although principal excavations and dating have been carried out at only three places in central Myanmar. The remains of the Kingdom show Hindu-Buddhist cultural influences where palace citadels were believed to exist inside the walled cities.
- **Bagan Kingdom** (11-13th Century): The Bagan Kingdom was founded on the banks of the Ayeyarwady River. At the height of its power, the Bagan Kingdom was known to cover upper and lower Myanmar. Many cultural and religious sites remain today from the Bagan era and include over 2,000 pagodas and temples, monasteries, *Sima* or Ordination Halls, over 600 stone inscriptions, and 42 garrison towns.
- **Inwa Dynasty** (14th -16th Century): Inwa Dynasty was founded in the central Ayeyarwady valley after the fall of the Bagan Kingdom. The Inwa Dynasty included 127 garrison towns and represented an important period when the Bagan culture was revived and Myanmar literature flourished.
- **Konbaung Dynasty** (18th - 19th Century): The last in the history of Burmese monarchy, the Kongbaung Dynasty covered large areas of modern Myanmar. Its capital moved several times for religious, political, and strategic reasons, and included Shwebo, Sagaing, Ava, Amarapura, and Mandalay.

The proposed Project is located in middle Myanmar, where archaeological remains have been reported, including through the northern section of the Samon River Valley.

3.6.8.1 Local Perspectives on Cultural and Historic Sites in IOR-5

During the field program for the present project local residents were canvassed in regard to their cultural activities and cultural sites. The most important cultural focus in the communities of those interviewed was local festivals (97%) (**Chart 3-60**). Villagers interviewed indicated that 57% of them were not aware of local historical sites near their community and villagers (59%) indicated that they feel local historic sites are adequately protected (**Chart 3-61** and **Chart 3-62**). The local cultural, traditional, religious and historic sites near the villages surveyed have been identified and recorded in **Appendix A**.

Chart 3-60: Response of villagers in regard to their most important cultural tradition in IOR-5

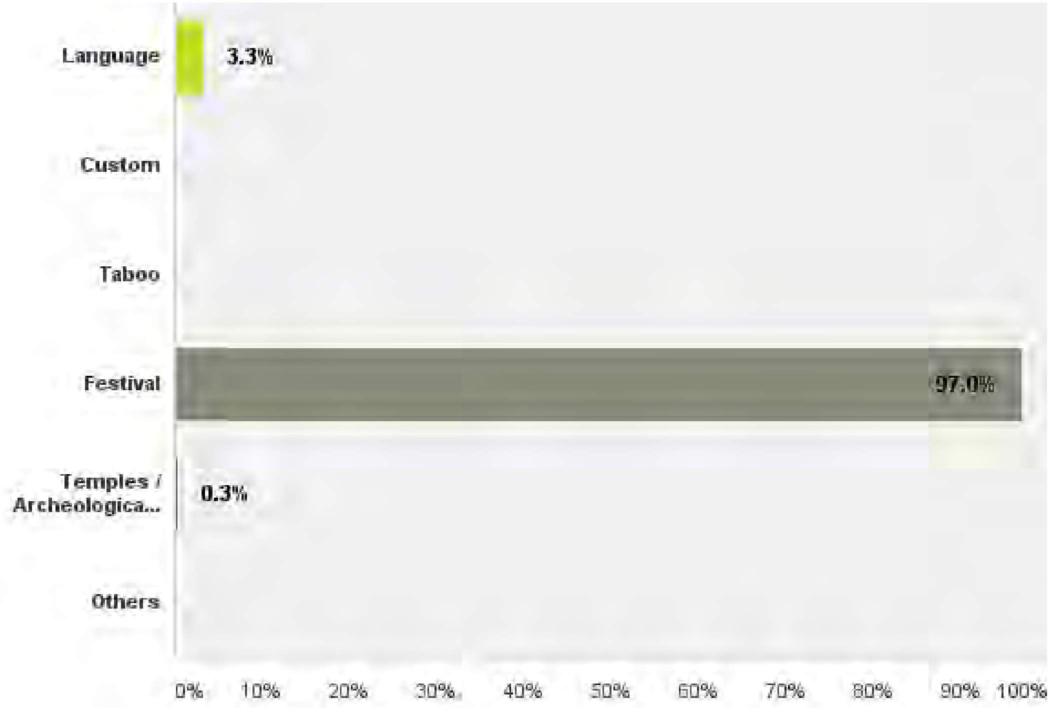


Chart 3-61: Awareness of proximate archaeological sites reported in IOR-5

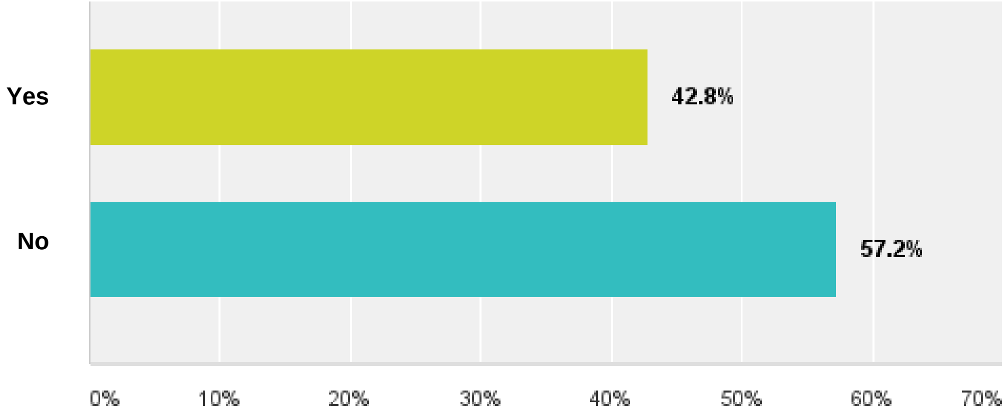
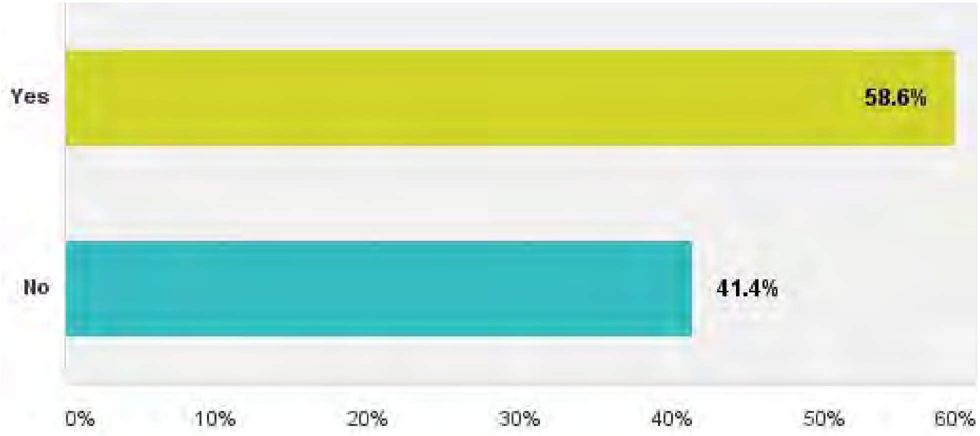


Chart 3-62: Perspectives on adequacy of protection of historic sites proximate to communities in IOR-5



3.6.9 Tourism and Scenery

In Myanmar, tourism is a relatively recent and developing sector, but the number of visitors is increasing yearly, and the government has been encouraging tourism. The total number of tourists arriving in Myanmar during 2007 - 2012 is shown in **Table 3-36**.

In the 2010-2011 fiscal year, tourists comprised 73.84% (313,127 arrivals) of overseas visitors.

Table 3-36: Number of Tourist Arrivals in Myanmar, 2007-2012

Year	Total[1]	Tourists[2]				Other Visitors[3]
		Total	by Air	by Sea	by Land	
2007-2008	363,976	288,776	131,784	2,492	154,500	75,200
2008-2009	334,954	255,288	100,439	1,879	152,970	79,666
2009-2010	394,427	298,556	164,000	1,458	133,098	95,871
2010-2011	424,041	313,127	216,861	2,414	93,852	110,914
2011-2012	329,724	228,201	166,022	1,417	60,762	101,523

Source: Central Statistical Organization, Ministry of National Planning and Economic Development, http://www.csostat.gov.mm/S30MA0201.asp

1 Includes visitors with visa and daily or overnight travellers with border pass.

2 Visitors with tourist visa only

3 Includes visitors with special re-entry visa, entry visa, entry visa (business, social, gratis official courtesy, multiple journey, gratis diplomatic courtesy and transit) were started from April, 2005.

3.6.9.1 Tourist Attractions near the Project Area

Ayeyarwady Region is also home to several beautiful beaches, among them, Chaungtha Beach. The drive along exposes you to a variety of landscapes; forested hills, a lush forest reserve, coconut groves, and rice paddies. Places of interest include:

1. Chaung Thar Beach Resort
2. Ngwe Saung Beach Resort
3. Inyegyi Pond
4. Shwe-mok-htaw Pagoda

With a population of seven million, spread out over 13,567 square miles, the 200,000 Myanmar who inhabit the capital city of Pathein, the fourth largest city in the nation, represent only a small percentage of the Region's residents. The city is home to a large number of Kayin and Rakhine. Pathein is known for its lively, hand-painted umbrellas; the city itself seems to take on new life during the Vesahka festival held during the full moon of Kason, during April and May.[3]

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[3] http://www.tourismmyanmar.com/ayeyarwaddy.htm

CHAPTER 4

PUBLIC CONSULTATION AND DISCLOSURE

4. PUBLIC CONSULTATION AND DISCLOSURE

Public involvement, in the form of stakeholder consultation and disclosure, is a critical component of an ESHIA. Its primary objective is to maximize public understanding of the project through information distribution and exchange between the project proponent and the communities that might be affected directly or indirectly by the proposed project activities.

The stakeholder involvement for this ESHIA will consist of four parts: focus group meetings, key informant interviews, household socio-economic and attitude surveys and traditional ecological knowledge surveys.

The comments and concerns of the stakeholders consulted during this ESHIA have been considered and incorporated into the project design and mitigation measures.

This chapter presents the key findings from public consultation and disclosure. It also provides recommendations for future consultation to be implemented throughout the execution of the project.

4.1 Stakeholder Identification

Stakeholders in the IOR-5 Block include:

Stakeholders	Likely interest/ Responsibilities
Farmers/Local Business	• Possible impact/benefit
Vulnerable Groups including landless farm labourers	• Possible impact/benefit
Government (Local - State and Regional)	
Chief Minister	• Administration
Member Ministers	
Ministry of Home Affairs	
General Administration Department	
District Commissioner	
Township Commissioner/Administrator	
Village Head	
Regional Police Force	
Township Police Officer	• Security • Civil jurisdictions
Government (Departments under concerned Ministry)	
Representative of Forestry Dept. / Ministry of Environmental Conservation and Forestry	• Protection, and conservation of the wildlife and sustainable management of the forest resources
Representative of Water Resources Utilization Department,/Ministry Of Agriculture and Irrigation	• Provision of irrigation water by pumping water from rivers and streams and also utilization of groundwater from feasible potentials for boosting crop production in the concerned area
Representative of Settlement and Land Records Department (SLDR), Ministry of Agriculture and Irrigation	• The only government agency with the mandate to collect and disseminate agricultural statistics. SLRD's statistical activities include;

Stakeholders	Likely interest/ Responsibilities
	• Monitoring the progress of land preparation and cropping; condition of weather and crops • Making crop forecasts, • Carrying out periodic crop surveys • Compiling data on farmer and farm size distribution • Taking annual inventory of agricultural machinery and implements • Compiling the annual Season and Crop Report which provides statistics on rainfall; land use; irrigation and flood protection; crop acreage, yield per acre and production; multiple cropping; inventory of agricultural machinery and implements.
Township Medical officer (TMO) Township Health Department or Township Hospital/ Ministry of Health	• Provision of all health care services • Collaboration with organizations such as WHO, UN and NGO etc.
Departmental Head of Labour Relations /Ministry of Labour	• Maintains peaceful workplace between the employer or employer organizations and the worker or the labour organizations
Fire Services Department /Ministry Of Social Welfare, Relief And Resettlement	• Protection and prevention of fire disaster and natural disaster
NGO	**Local NGOs** • Myanmar NGO Network • Mangrove Environmental Rehabilitation Network (MERN) • Renewable Energy Association Myanmar (REAM) • Social Vision Services (SVS) • Swanyee • Myanmar Bird and Nature Society (MBNS) • Water, Research and Training Centre (WRTC Myanmar) • Forest Resource Environment Development and Conservation Association (FREDA) **International NGOs** • Japan International Cooperation Agency • CARE Myanmar • Solidarities • Wildlife Conservation Society (WCS) • World Concern • Mercy Corps • Action Aids • Spectrum • Biodiversity & Natural Conservation Association (BANCA) • Istituto Oikos **UN Agencies** • FAO • UNICEF • WFP • UNDP • UN-HABITAT • UNESCO

4.2 Purpose of Public Involvement and Disclosure

Based on stakeholder mapping and information collected during EHS baseline surveys, this ESHIA has engaged the following stakeholder groups:

1. MOGE & MOCAF
2. Directly affected Stakeholders including Village heads and villagers
3. Civil Society, and
4. Authorities at the Township Level.

Stakeholder involvement allows for scoping of issues that are of significance to the communities. Their concerns can assist in identification of potential project impacts that are unique and specific to the communities where the project is situated. Similarly, recommendations from the affected communities on how to manage the potential impacts are essential in developing mitigation measures and management practices for eliminating/reducing negative impacts and enhancing positive impacts.

Consultations also maximize stakeholder understanding of the proposed project through information exchange between the project proponent and the communities that might be affected directly or indirectly by the proposed project activities.

In November 2014, IEM conducted focus group meetings with over 400 villagers in 8 villages in the Htantabin Area of the Ayeyarwady Region of Myanmar within Block IOR5 (total area of 202 sq. km).

Villages Consulted
Shin Su
Kone Myint
Pan Pin Kone
Lel Gyi Kwin
San Kone
Lein Khon
Kyat Kha lay
Chaung Hpyar

Topographically, the block is generally flat in the eastern part towards the Ayeyarwady River. The eastern flat land is mostly cultivated with paddy plants, and it’s the main source of income for the people in this area. Towards the north-western part of the block, the topography is elevated and hilly (Htantabin anticline area). The nearest production facilities are in Htantabin and Myanaung while the nearest refinery is in Seik Tha. The IOR-5 Production Sharing Contracts (PSCs) has PSC commitments of a total of of 217 sq km FF new 3D Land seismic data acquisition and drilling of 2 exploration wells within the stipulated 3 years exploration period.

Detailed socio-economic surveys were also completed for approximately 400 villagers, or approximately 40 interviews in each of the 8 villages within the Kyangin and Myanaung townships, Hinthada district (**Figure 4-1**). As part of the public involvement process, Key Informant Interviews were also conducted with village leaders and health providers. Further, 15 Traditional Ecological interviews and surveys were also conducted in each village to determine the importance of the local biodiversity.

IEM's socio-economic survey team consisted of the Senior Socio-economic Expert, three supervisors, 2 Trained Biodiversity Technicians, and 10 socio economic technicians who were trained by IEM.

The approach was based on meeting with and sampling those villages in the areas of PCMI's most likely seismic and exploration drilling program activity.

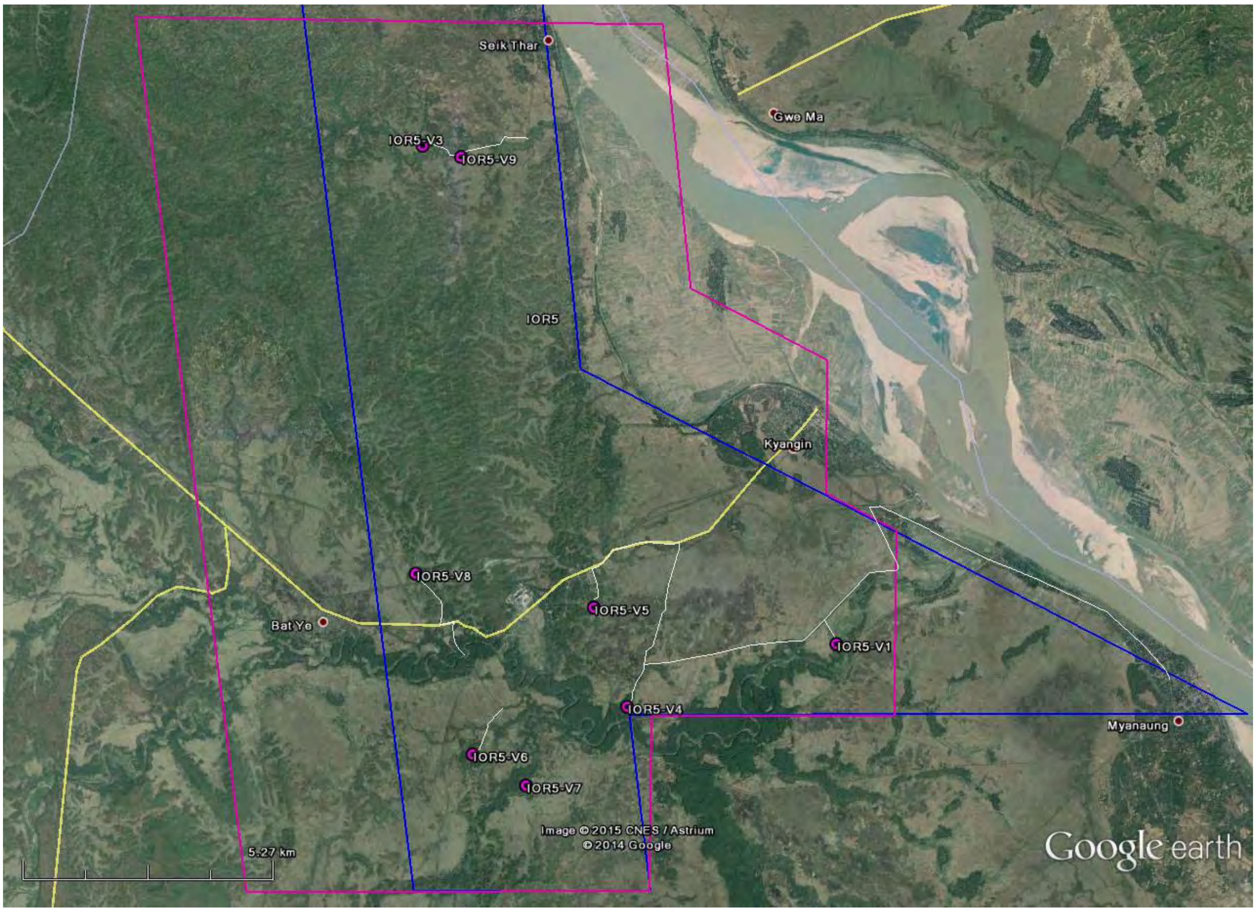


Figure 4-1: Villages Consulted in Block IOR-5

4.3 Consultation Process

Key issues and concerns were identified through:

- Experience of project team from past projects
- Discussions with PCMI
- Presentation of the Scoping Report to MOCAF
- Focus Group Meetings
- Socio economic, health and opinion Surveys
- Key Informant Interviews
- Traditional Ecological Knowledge Survey

4.3.1 Presentation of the Scoping Report to Ministry of Conservation and Forestry

At ESHIA project initiation a Scoping Report was prepared and meetings were arranged with the Ministry of Conservation and Forestry on 14 October, 2014. PCMI and IEM provided a project presentation on the planned ESHIA public involvement and disclosure program.

The objective of the meeting was to ensure that government agencies and regulators are clear on the seismic and exploration drilling plans and schedule, as well as the ESHIA TOR and schedule.

4.3.2 Focus Groups

At the focus group meetings prior to conducting the socio economic, health and opinion questionnaires, the villagers were informed that PCMI was planning to conduct a seismic program and drill two exploration wells in the IOR-5 block. The project schedule will last up to 6 months for the seismic program and 10 months for each exploration well. The purpose of the seismic and exploration drilling program is to determine if any oil or gas is present. If no oil or gas is found the wells will be abandoned and the area returned to its original state. If oil and gas is found, then the oil and gas will be produced for sale.

The villagers were informed that the focus group meetings and socio economic, health and opinion interviews were being conducted as part of an environmental, social and health impact assessment that is required to obtain approval for the project to proceed and to help guide PCMI to reduce any potential impacts.

The presentation/discussion topics for public involvement and disclosure included, but not limited to:

- Objective of Public Consultation
- Overview of project description/information
- Sensitive existing environmental conditions.
- Key impact aspects
- Proposed project mitigation measures and monitoring program
- Compensation

Presentation of Project Description

Focus Group Discussion with Villagers

Question and Answer

Figure 4-2: Focus Group Meeting Photographs

MOGE assisted IEM/PCMI by contacting local officials in each Township and village and made arrangements for our team to meet with them. MOGE too, participated in each focus group meeting and addressed those questions appropriate for the government to answer.

Prior to initiating community meetings, a presentation was provided to the Key Township Officials and Administrator to obtain understanding of the project, ESHIA objectives and support and approval for village meetings. A short discussion followed that focused on questions raised by the village relating to the planned project.

Compensation for land use was the key question raised. PCMI's noted that compensation for seismic currently involved a Representative from the Agriculture Department, MOGE and Local District/Township officials to determine fair compensation for crops lost due to seismic activities.

Compensation for drilling involved PCMI working with Agriculture Department, MOGE and Township officials to agree on price to buy or lease the land. PCMI will purchase or lease all land for roadway and drilling area. PCMI develops the road for the community to use. If requested, the roadway is left for the village use after the drilling is complete. PCMI will develop the communities further if hydrocarbon is found at the location. As an example, PCMI built a 7 km long roadway to one well site, this greatly improved access to the communities. On top of that, PCMI has conducted Engagement Session with the nearby villager, representatives from Township and MOGE personnel to provide regular briefs on drilling activities and other issues of importance. PCMI also distributed Safety pamphlets on road safety and hired local flagmen from villages to ensure road safety.

The following summary of questions and responses to village questions is provided below:

Village Name	Meeting Minutes
Chin Su Village Block - IOR 5 Code in map - IOR5-V1	Villager mentioned: they don't have anything to say because they can be satisfied due to the compensation, which will be systematically carried out by MOGE, Company and the authority.
Kone Myint Village Block - IOR 5 Code in map – IOR5-V5	Villagers don't know what they should ask.
Pann-Pin Kone Village Block - IOR 5 Code in map – IOR5-V8	Villager asked: Will explore again in the old oil and gas well? MOGE answered: We won't drill again at the old drilling site. Villager asked: about compensation? MOGE answered: PETRONAS Company will discuss with MOGE and responsive Land Records Department from township and region level. After discussion and negotiation, Company will announce the decision.
Lel-Gyi-Kwin Village Block - IOR 5 Code in map – IOR5-V6	Villager asked: about compensation for the land used? MOGE answered: PETRONAS Company will discuss with MOGE and respective Land Records Department from township and region level. After discussion and negotiation, Company will announce the decision. Villager mentioned: They will not allow the exploration if they aren't satisfied with the compensation. MOGE answered: will negotiate with the authority to be the best option.
San Kone Village Block - IOR 5 Code in map – IOR5-V7	Village Head asked: Will the farmers get the compensation? MOGE answered: Registered area will be compensated. Crops will be compensated.

Lane-Kone Village Block - IOR 5 Code in map – IOR5-V4	Villager asked: When will the exploration start? MOGE answered: Don't know. Villager asked: about the compensation? MOGE answered: PETRONAS Company will discuss with respective Land Records Department from township and region level. After discussion and negotiation, Company will announce the decision.
Kyat-Ka-Lay Village Block - IOR 5 Code in map – IOR5-V3	Villager asked: When will the project start? MOGE answered: Don't know. Villager asked: Does the oil and gas exploration company come to their place because the company knows there is oil? MOGE answered: We don't know whether there is oil or not in that village. It can be known only after seismic survey.
Chaung-Phyar Village Block - IOR 5 Code in map – IOR5-V9	Villager Asked: about compensation. MOGE answered: PETRONAS Company will discuss with respective Land Records Department from township and region level. After discussion and negotiation, Company will announce the decision.

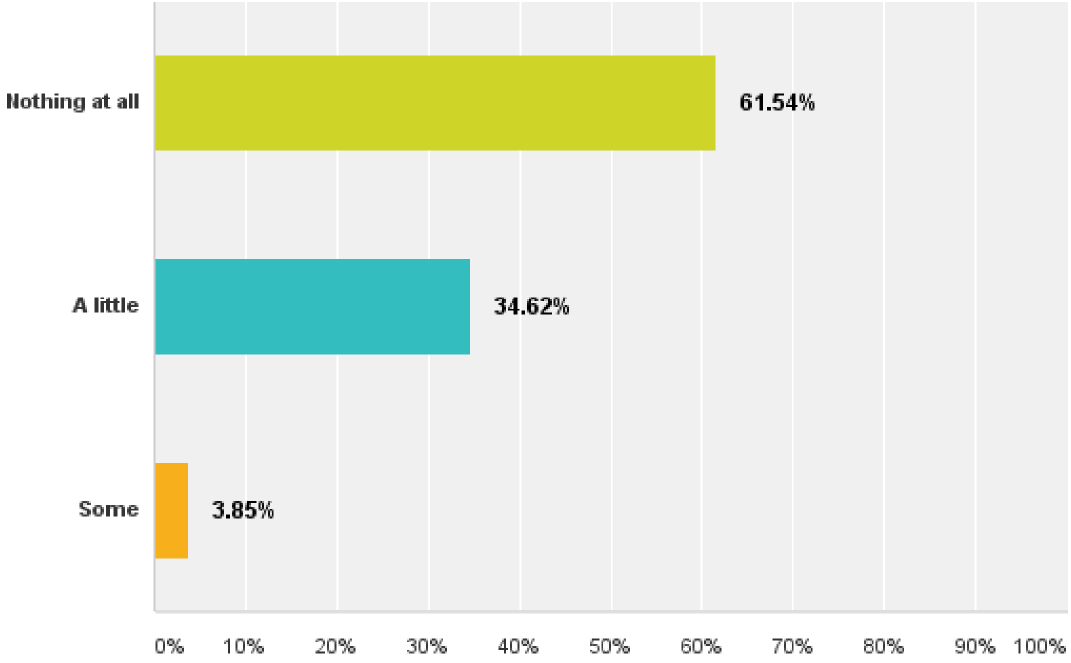
4.3.3 Key Informant Interviews

Key informant interviews were conducted with Village Leaders; Village Medical Officer and Village Education Officer in 8 villages within IOR5.

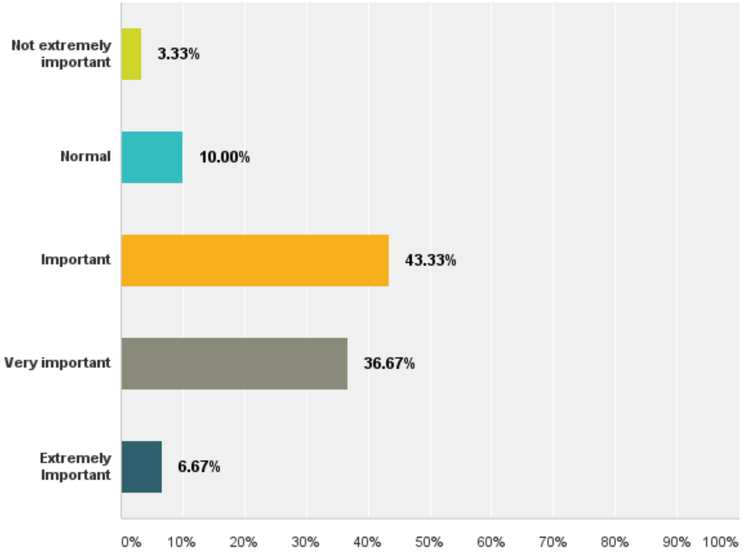
To ensure the ability to correlate data, a targeted subset of the socio economic and attitude survey was used as a basis for Key Informant Interviews.

Some key results include the following:

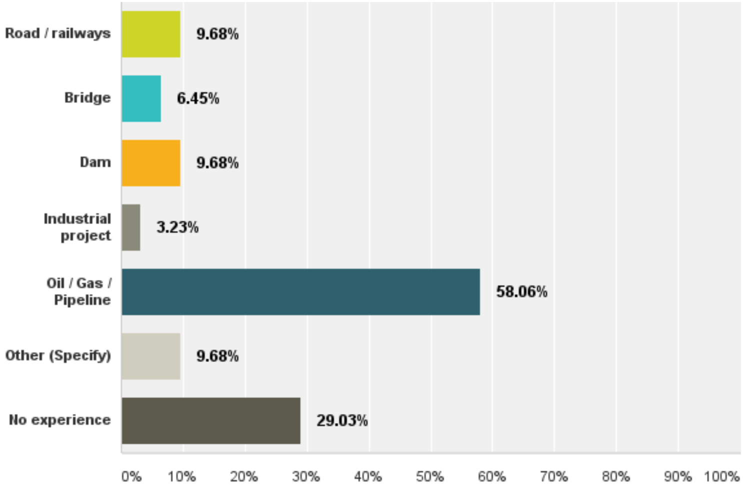
4.3.3.1 Project Awareness was relatively low at 37%



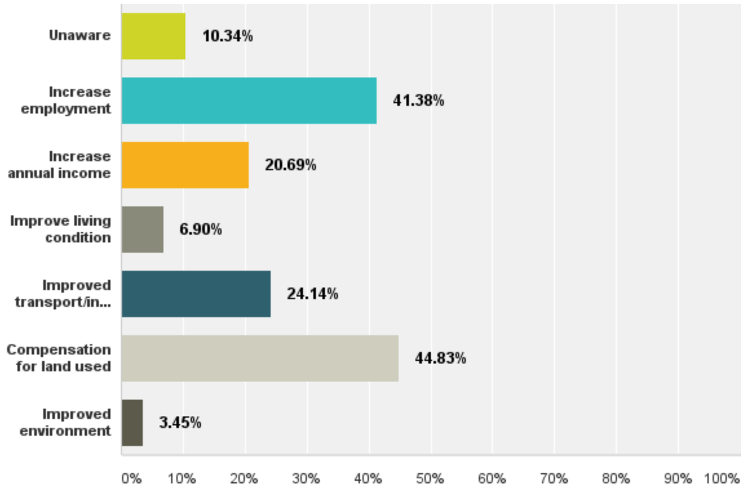
4.3.3.2 Importance of Oil and Gas to the community was high at 87%



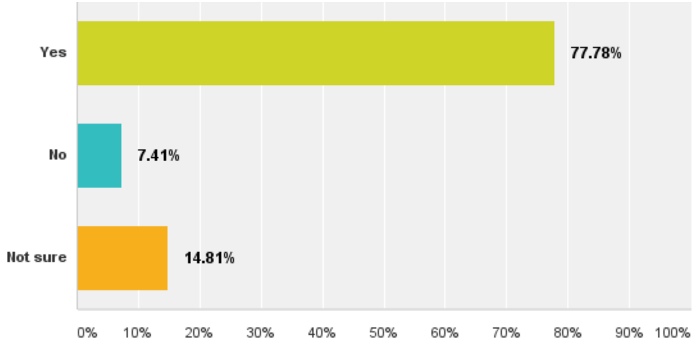
4.3.3.3 Quite high experience with Oil and Gas Projects before at 58%



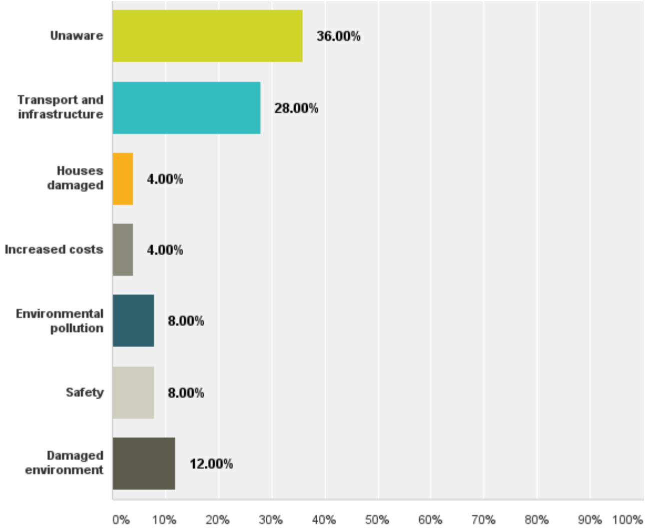
4.3.3.4 Project expectations included increased employment 42% and compensation for land used 45%



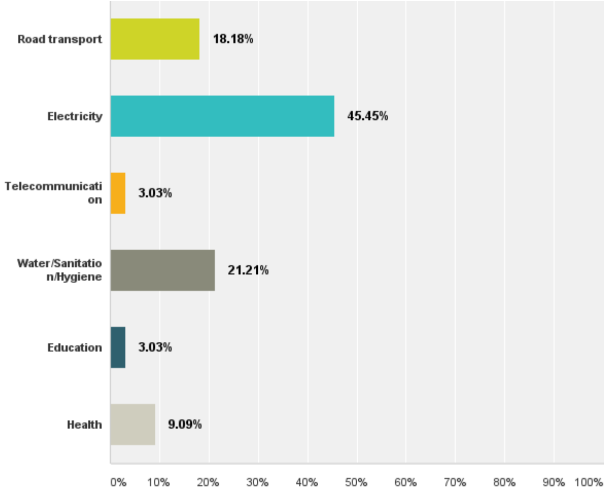
4.3.3.5 Support for the project was high at 78%



4.3.3.6 Project concern was focused on the negative impacts of Transport and Infrastructure at 28%

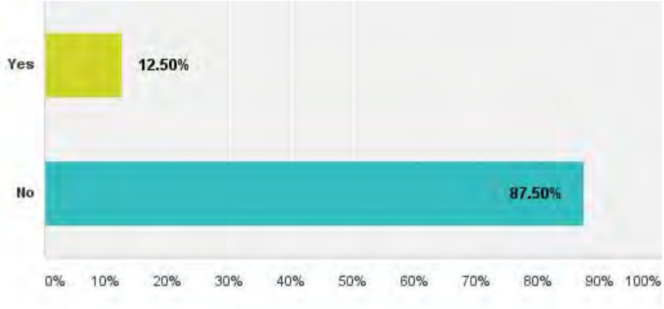


4.3.3.7 Priority development initiatives for the community were electricity 45%, water/sanitation/hygiene 21%, and road transport 18%



4.3.3.8 Compensation

As compensation was an important topic of the focus group meetings it is interesting to note that while only 7% of those surveyed have received compensation, 88% were not satisfied with the compensation.



4.3.4 Purpose of Socio Economic, Health and Opinion Surveys

Within Block IOR-5, 8 villages were identified for participation in the socio economic, health and opinion survey. A total of 400 household socio economic, health and opinion surveys were conducted.

The socio economic, health and opinion questionnaires collected socio economic, health and opinion information in this area and the opinions and understanding of PCMI's planned seismic and drilling program.

The Socio economic, health and opinion Survey are designed to focus on gaining household member information and opinions on:

- The structure and demographics of the household
- Household living standard, employment, income and social and economic condition
- Household and individual health
- Information on the natural environment and human use of the environment; and
- Opinions on the prospective impacts of project during and after construction

Socio-Economic Surveys with Household Leaders

Socio-Economic Surveys with Household Leaders

Traditional Ecological Knowledge Survey With Villagers

Figure 4-3: Socio-Economic and Traditional Knowledge Photographs

4.4 Results of Socio Economic Survey

4.4.1 Stakeholder Involvement Location and Populations

Within Block IOR-5, 8 villages were identified for participation in the socio-economic survey. The following villages were included in the survey:

Friday November 7, 2014

Shin Su

Monday, November 10, 2014

Kone Myint

Pan Pin Kone

Tuesday, November 11, 2014

San Kone

Wednesday, November 12, 2014

Lel Gyi Kwin

Lein Khon

Thursday, November 13, 2014

Kyat Kha Lay

Chaung Hpyar

4.5 Socio Economic, Health and Opinion Surveys Results

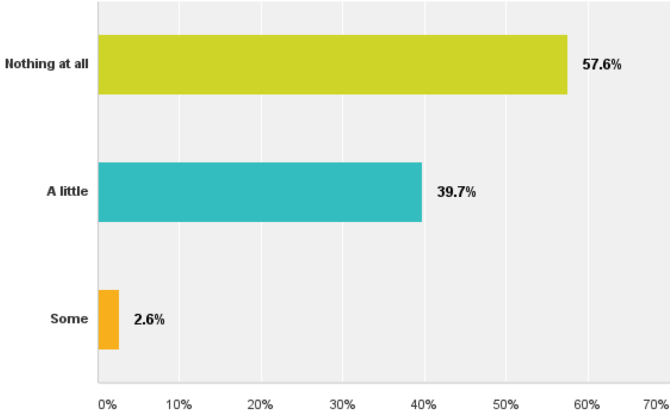
The socio economic, health and opinion survey consisted of 93 questions. The results of the surveys have been analyzed and the results are presented in **Chapter 3 Environmental Setting**.

4.5.1 Opinions about the Project

The following summary of the opinions obtained from the survey is provided below.

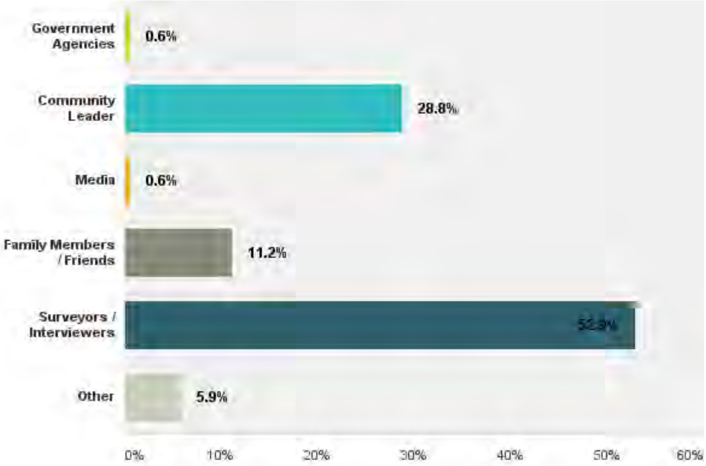
4.5.1.1 Knowledge About the Project

Of the villagers interviewed 42% had some knowledge about the project.



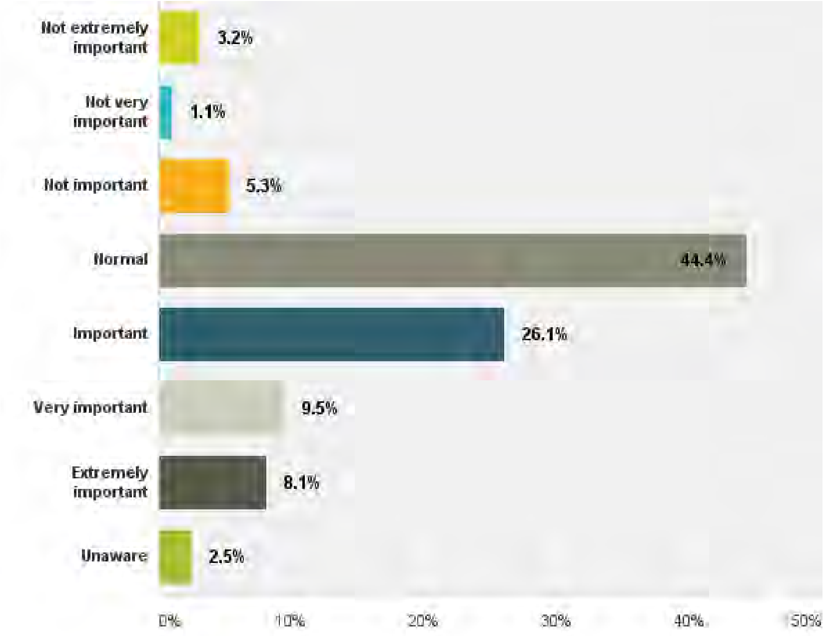
4.5.1.2 Knowledge About the Project

Villagers had learned of the project from surveyors and interviewers (53%) and community leaders (29%).



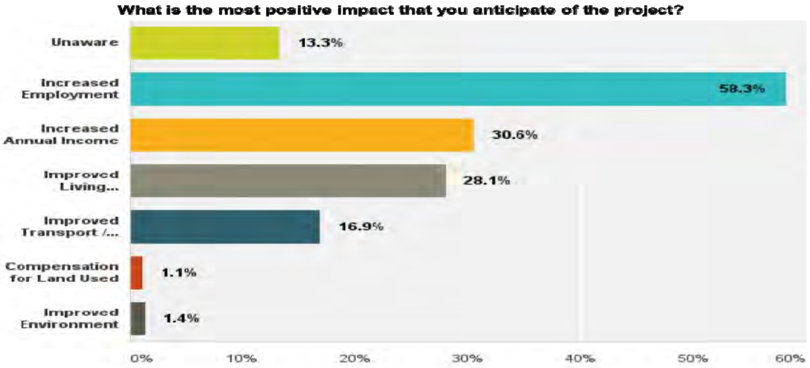
4.5.1.3 Importance of the Project to the Villagers

Of those interviewed, 8.1% indicated that the seismic and drilling project would be extremely important; while 9.5% indicated that the project would be very important to the community, and 26% indicated that oil and gas drilling would be important to their community.



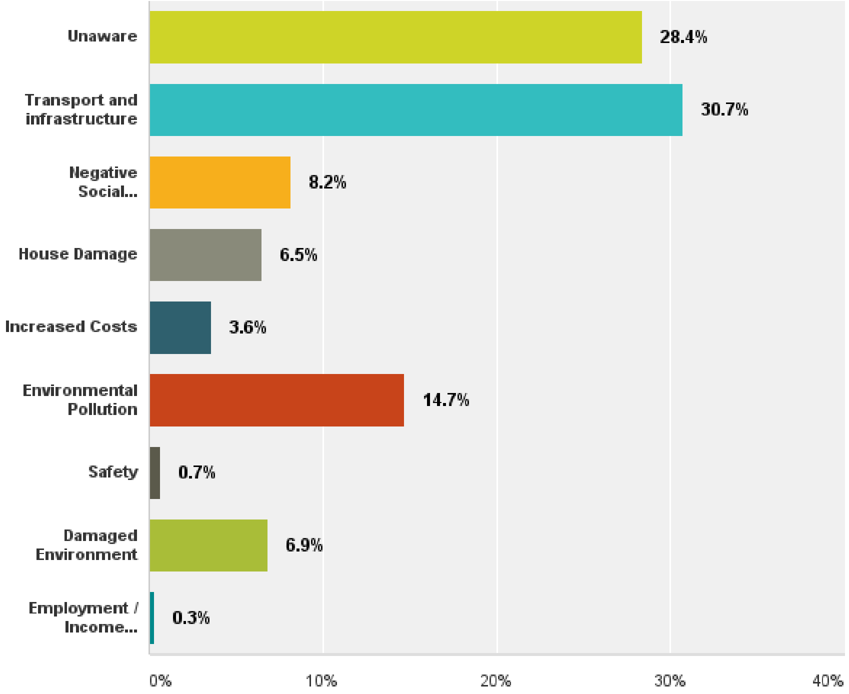
4.5.1.4 Opinions of Possible Project Benefits

Villagers anticipated increased employment (58%), annual income (31%) and improved transport and infrastructure (17%).



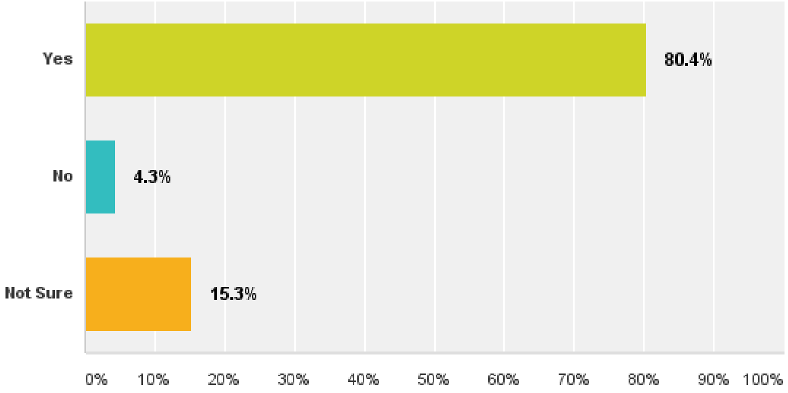
4.5.1.5 Opinions of Possible Project Impacts

One-third of villagers (31%) claimed they were concerned of transport and infrastructure, while 28% was unaware, 15% were concerned about environmental pollution.



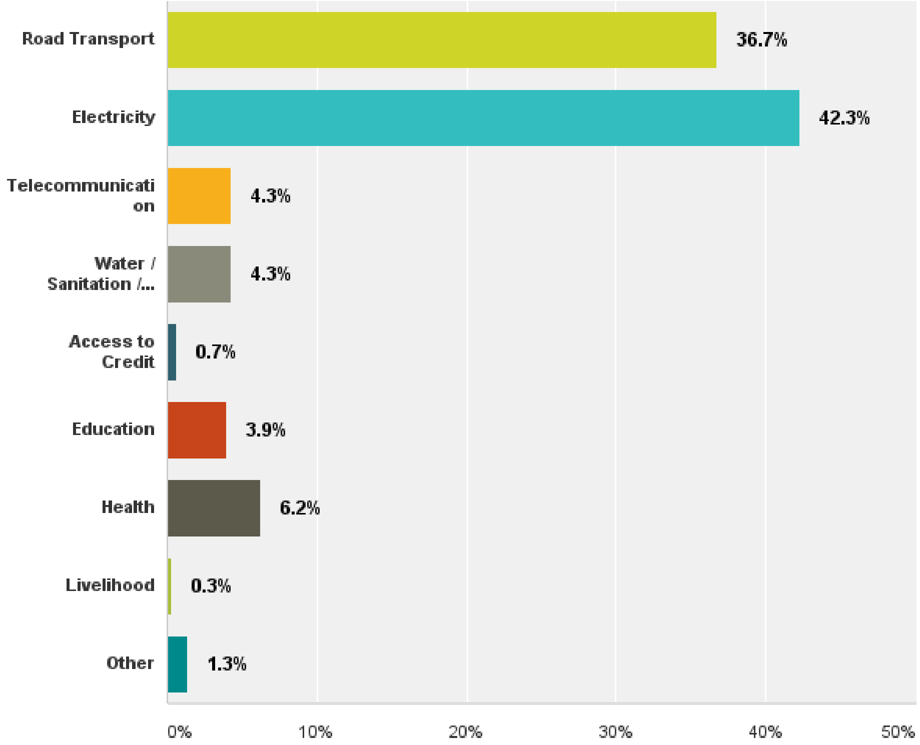
4.5.1.6 Household Support for Project

Of those interviewed, 80% agree with the planned seismic and exploration drilling program.



4.5.2 Community Priorities

42% of villagers consider electricity as a priority development initiative, while 37% consider road transport.



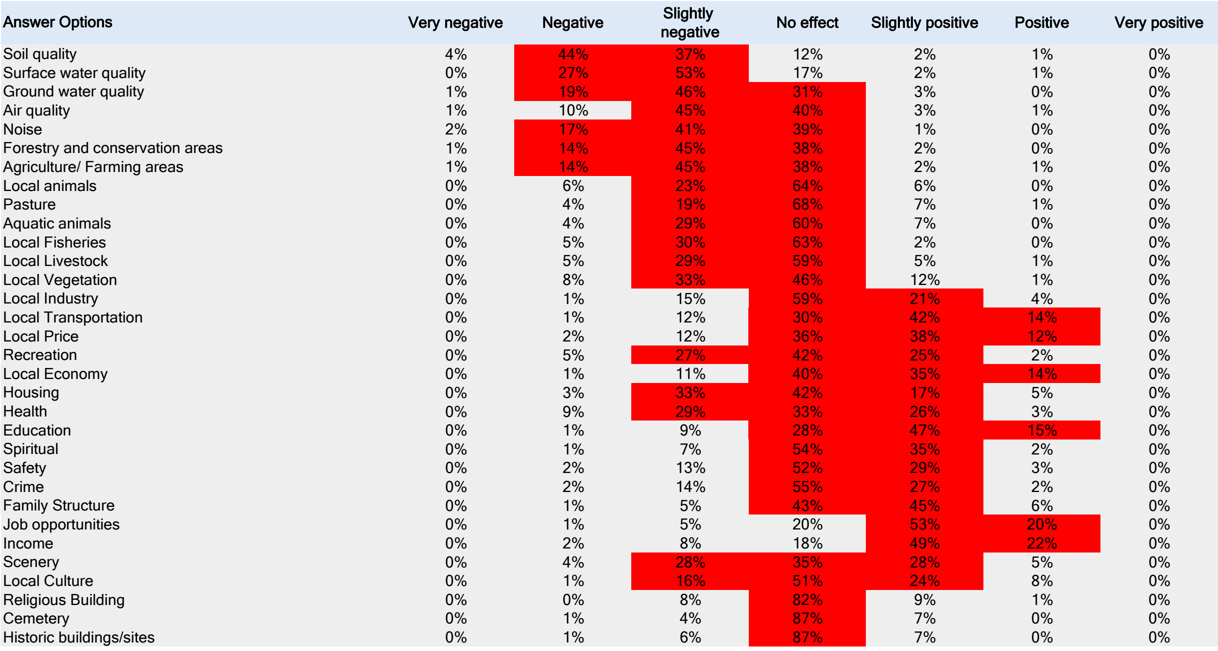
4.5.3 Issues to Discuss with Community Stakeholders

The opinion survey results identify the opinions of the level of impact potentially caused by the planned development activities. This assists the company to understand how the stakeholders view the project. If responses to certain issues are determined to be significant, then they should be further addressed to ensure that the stakeholder have factual information about the project and clearly understand the likely effect of the project.

When read a statement describing the planned project, the interviewees were asked their opinions about the positive and negative impacts of the project. Those significant issues perceived to be negatively and positive impacts are highlighted in red in the **Table 4-1** below.

Table 4-1 : Opinions of Potential Impacts of the Project

Those numbers highlighted in red are considered to be significant.



Answer Options	Very negative	Negative	Slightly negative	No effect	Slightly positive	Positive	Very positive
Soil quality	4%	44%	37%	12%	2%	1%	0%
Surface water quality	0%	27%	53%	17%	2%	1%	0%
Ground water quality	1%	19%	46%	31%	3%	0%	0%
Air quality	1%	10%	45%	40%	3%	1%	0%
Noise	2%	17%	41%	39%	1%	0%	0%
Forestry and conservation areas	1%	14%	45%	38%	2%	0%	0%
Agriculture/ Farming areas	1%	14%	45%	38%	2%	1%	0%
Local animals	0%	6%	23%	64%	6%	0%	0%
Pasture	0%	4%	19%	68%	7%	1%	0%
Aquatic animals	0%	4%	29%	60%	7%	0%	0%
Local Fisheries	0%	5%	30%	63%	2%	0%	0%
Local Livestock	0%	5%	29%	59%	5%	1%	0%
Local Vegetation	0%	8%	33%	46%	12%	1%	0%
Local Industry	0%	1%	15%	59%	21%	4%	0%
Local Transportation	0%	1%	12%	30%	42%	14%	0%
Local Price	0%	2%	12%	36%	38%	12%	0%
Recreation	0%	5%	27%	42%	25%	2%	0%
Local Economy	0%	1%	11%	40%	35%	14%	0%
Housing	0%	3%	33%	42%	17%	5%	0%
Health	0%	9%	29%	33%	26%	3%	0%
Education	0%	1%	9%	28%	47%	15%	0%
Spiritual	0%	1%	7%	54%	35%	2%	0%
Safety	0%	2%	13%	52%	29%	3%	0%
Crime	0%	2%	14%	55%	27%	2%	0%
Family Structure	0%	1%	5%	43%	45%	6%	0%
Job opportunities	0%	1%	5%	20%	53%	20%	0%
Income	0%	2%	8%	18%	49%	22%	0%
Scenery	0%	4%	28%	35%	28%	5%	0%
Local Culture	0%	1%	16%	51%	24%	8%	0%
Religious Building	0%	0%	8%	82%	9%	1%	0%
Cemetery	0%	1%	4%	87%	7%	0%	0%
Historic buildings/sites	0%	1%	6%	87%	7%	0%	0%

The villagers surveyed did not perceive any of the issues as very negative or positive. However, significant issues that were perceived as receiving a negative impact are soil, surface water and groundwater qualities, noise, forestry and conservation and agriculture or farming areas. Significant issues that were perceived as receiving a positive impact are local transportation, price, economy, education, job opportunities and income.

PCMI should consider the above perceptions of the planned project and provide an information program to address these issues and provide accurate information to the public prior to project initiation. If stakeholders understand the likely effects of the project and have realistic expectations, it will reduce the risk of negative reaction by directly affected stakeholders and increase project manageability.

4.6 Future Consultation and Disclosure Plan

Additional public consultations and disclosure prior to project implementation are required. Once the project is initiated and throughout project execution a communication process and schedule must be defined. Consultations conducted early on prior to project commencement will assist to ensure that the concerns of the stakeholders are considered, and that mitigation measures are developed to address them.

Similarly, ongoing stakeholder consultations throughout project execution are essential in order to identify and address new impacts, as well as assess the effectiveness of mitigation measures through stakeholder comments and complaints. Overall, stakeholder consultations promote increased understanding between the project owner and affected communities, resulting in stakeholder acceptance of the project.

A Grievance Mechanism has been established in the form of HSE Complaint Process Flow that is provided in the ESHIA Management Plan. A Stakeholder Engagement Log will be kept to document engagement carried out throughout the entire life cycle of the project. A Community Liaison Officers (CLO) will be appointed to facilitate the grievance process and also to provide information/clarification to the local community.

Stakeholder consultations throughout project implementation (construction, operation, and decommissioning) will be handled through the Stakeholder Involvement Program as provided in **Chapter 6: Environmental Management Plan**.

CHAPTER 5

ENVIRONMENTAL, SOCIAL, AND HEALTH IMPACT ASSESSMENT

5. ENVIRONMENTAL, SOCIAL, AND HEALTH IMPACT ASSESSMENT

5.1. Methodology

An Environmental, Social and Health Impact Assessment (ESHIA) seeks to identify and, to the extent possible, quantify the potential negative impacts and positive benefits of a proposed project with respect to the environment (physical, ecological, human use, quality of life, and health values). Once these impacts have been identified, prevention, mitigation, and monitoring measures are proposed to prevent and/or mitigate possible negative impacts, and enhance positive impacts.AnEnvironmental, Social, and Health Impact Assessmentprocess incorporates a number of key steps as shown in **Figure 5-1** and discussed in detail in the following sections:

- Seismic & Exploration Drilling Project –**Chapter 2**
- Environmental, Social and Health Setting – **Chapter 3**
- Stakeholder Involvement – **Chapter 4**
- Screening and Scoping–**Chapter 5**
- ESH Impact Assessment – **Chapter 5**
- Prevention & Mitigation Measures – **Chapter 5**
- Environmental, Social and Health Management Plan **– Chapter 6**

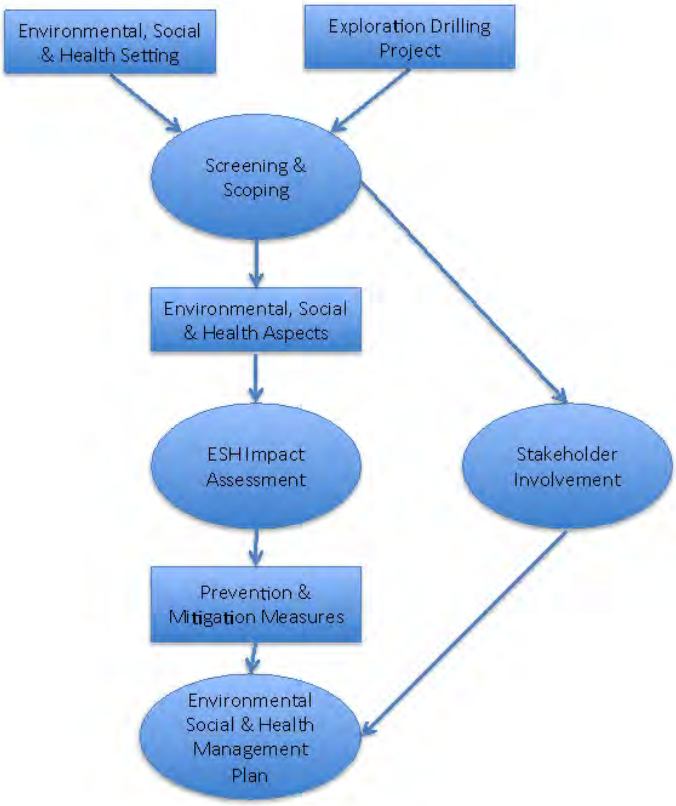


Figure 5-1: Method for Environmental, Social, and Health Impact Assessment

The assessment approach is risk-based, with the objective to make a conclusion on the level of risk development activities will pose to environmental, socio-economic and health receptors. This section describes the impact assessment process undertaken to evaluate the level of risk to environmental, socio-economic and health receptors from activities associated with the planned seismic and exploration drilling program. This description provides an account of the identification of potential impacts and benefits and the evaluation of their significance (scale of Risk Ranking). The ESHIA methodology applied is slightly modified from PCMI's Health, Safety and Environment Management System (Rev.2, March 11). Specifically, more detailed criteria were added to focus the social assessment for this project.

Activities associated with the seismic and exploration drilling program have been assessed to systematically identify potential impacts and the associated level of risk. This process assists in prioritising the development of management measures to achieve an overall acceptable level of risk.

Environmental Impact Assessment Terminology

Definitions for commonly used environmental impact assessment terminology are provided below:

Activity - Work associated with the Upstream Development during construction, commissioning, operation and decommissioning. For exampling: drilling, road construction.

Aspect - Associated with each activity are a number of aspects (or stressors). These are components of an activity that may have a potential to impact on the biological, socio-economic or cultural environment. For example: emissions, waste, noise.

Risk Ranking - The level of impact associated with an aspect.

Cumulative impact - Impacts that act together with other impacts to affect the same receptor.

Direct impact - Impact that results from a direct interaction between an activity and the receiving environment (e.g. between occupation of an area of seabed and the habitats which are lost).

Factor- The physical, ecological, socio-economic and cultural components of the environment. For example: water quality. Impact - Any change to the environment, whether adverse or beneficial, resulting from an environmental aspect. Impacts can be direct or indirect.

Indirect impact - Impacts that result from other activities that may occur as a Risk Ranking of the development (e.g. development implementation promotes service industries in the region).

Inherent risk level - The level of risk before the application of management measures.

Likelihood - The probability or frequency of an environmental impact actually occurring.

Mitigation - Management measure that minimize and manage undesirable Risk Rankings.

Prevention - Management measure that reduces the likelihood of an aspect occurring.

Receptor – See Factor

Residual risk level - The level of risk after the application of preventative and mitigation measures.

Risk - The chance of something happening that will have an impact on objectives.

5.1.1. Screening

Screening of issues is an important first step in an ESHIA. The purpose of the screening step is to systematically review all proposed project activities in order to identify potential environmental, social and health issues.

This screening step enables the detailed impact assessment component of this ESHIA to focus on the key issues that are relevant to people and the environment.

In this report, a matrix checklist was used in screening for key issues of environmental, social and health impacts both in a normal situation for each project phase (preparation phase before drilling, drilling phase, and well abandonment phase) and emergency situation for unplanned events.

5.1.1.1. Screening Methodology

In order to ensure a systematic evaluation of project activities and their possible impact on the environment, a summary matrix was designed to identify each possible impact. A thorough listing of project activities and environmental, social and health elements was obtained by the following means:

- ✓ Consultations with the PCMI planning the project activity;
- ✓ Applying International guidelines for onshore oil and gas exploration;
- ✓ Applying International guidelines for health impact assessment;
- ✓ Applying the World Bank checklist for onshore oil and gas development (**Table 5-1**)**;** and
- ✓ IEM's experience with similar projects.

Each of the activities carried out during the phases of the project was screened against each of the parameters using the ranking criteria shown in **Table 5-2**.

5.1.1.2. Screening Matrix

A screening matrix is used to summarize the results of the screening process (**Table 5-4**).

In the screening matrix:

Columns represent **environmental, social and health elements**, categorized as:

- Physical Resources
- Ecological Resources
- Human-Use Values
- Quality-of-Life Values
- Health

Rows represent **project activities/events**, classified into project activities and events.

The resulting project activities and environmental, social and health elements with identified potential interactions are shown in white, green, and yellow cells. The values in this table represent "total significance" which is the product of the scores for magnitude, scope, and frequency.

Cells with a value of 6 or +6 or more suggest a potentially significant impact (negative or positive, respectively) and it is these project activities and environmental, social, and health elements for which the detailed impact assessment is described in the following sections. The white cells indicate values of less than 6 and are not significant; green cells are significant potential positive impacts; while yellow and red cells are potential negative impacts.

Table 5-1: Onshore Oil and Gas Development Checklist (World Bank, 1991)

Project Activities

- Geological Zones: Reserves, depth, area, structure, oil/gas/water ratios, oil type, gas type, pressures.
- Operations: Site preparation, well spacing, start-up period (pressure, testing, flaring, mud & cuttings, produced water, sour gas, wastes, sanitary wastes), pollution control, monitoring, spill response and reclamation plans.
- Air Emissions: Emissions quantity and, where applicable, composition: venting, flaring, burning, combustion, equipment emissions, oil spills and leakage, evaporation from spills.
- Services: Utilities (type, source, load), roads, fire protection, security.
- Water Discharge: Projected quantity and composition; treatment/disposal method (production water, sanitary wastes, oil spill and leakage).
- Land Use: Area of field, transportation and utility routes, pipelines, buildings and structures.
- Equipment: Type and number for site preparation, drilling, waste haulage, pumping, transport of supplies and workers.
- Supplies: Drilling mud &, pipe, chemicals, water, fuel.
- Staffing: Number and skills, source, housing plans.

Environmental Resources

- Geology: Stratigraphy, structure, fracture patterns, seismic history.
- Groundwater: Depth and thickness of aquifers, quality and quantity, hydraulics, recharge, uses.
- Surface Water: Quantity, quality, seasonal variations, and uses.
- Soil: Soil profile (depth, type, characteristics).
- Vegetation: Types, density, rare or significant species or communities, wetlands.
- Wildlife: Resident and casual, populations, rare or significant species, significant habitat.
- Topography: Drainage patterns, elevations and slopes, prominent features.
- Climate: Precipitation patterns, air quality, wind patterns, temperature, climatic zone.

Socio-Economic Factors

- Nearby Communities: Location, access, population, demography; economy (employment rate, income, taxes); services (types, capacity, adequacy) and housing; the ability to (a) provide workforce, (b) service new development, (c) absorb and adjust to growth.
- Land Use: Intensive and casual, full time and seasonal, actual and projected, specially designated areas (parks, refuges, and reservations), man-made features (structures, roads, utilities).
- Cultural: Historic sites, archaeological sites.

Regulatory Framework

- Applicable environmental laws: Regulations, policies, standards, requirements; monitoring and enforcement: air, water, waste, noise, reclamation, land use controls and approval, cultural/historical resources.
- Designation and protection of special areas and resources: Parks, refuges, wilderness, sensitive ecological communities, threatened species of flora and fauna, native communities (including religious sites and harvesting/hunting or subsidence areas).
- Authority/willingness to require special mitigation: Community assistance staged or phased development, isolate development workforce, pre- and post-development studies and monitoring (with corrective action as needed), worker training, mass transit of workforce.

Table 5-2: Environmental, Social & Health Ranking Criteria

<table>
<tr><th>Category/Score</th><th colspan="3">Criteria</th></tr>
<tr><td colspan="4">M : Magnitude (severity)</td></tr>
<tr><td>Score = 1</td><td colspan="3">Both conditions are met: slight <i>and</i> short-term effects</td></tr>
<tr><td>Score = 2</td><td colspan="3">One of the two conditions is met: <i>either</i> moderate <i>or</i> medium-term effects</td></tr>
<tr><td>Score = 3</td><td colspan="3">One of the two conditions is met: <i>either</i> major <i>or</i> long-term effects</td></tr>
<tr><td colspan="2"><i>Level of Impact</i></td><td colspan="2"><i>Impact duration</i></td></tr>
<tr><td>Slight Impact</td><td>Low level of severity
If positive, a benefit of <1 million dollars</td><td>Short-Term</td><td>Recovery within 6 months of activity cessation</td></tr>
<tr><td>Moderate Impact</td><td>Moderate level of severity
If positive, a benefit of 1-10 million dollars</td><td>Medium-Term</td><td>Recovery 6 months to 2 years after cessation</td></tr>
<tr><td>Major Impact</td><td>High level of severity
If positive, a benefit of >10 million dollars</td><td>Long-Term</td><td>Recovery longer than 2 years after cessation</td></tr>
<tr><td colspan="4"><i>Note: when screening the health and safety impacts of project activities, the level of impact should be determined by the number of LTA’s (lost time accidents) (i.e. L 0- 5 LTA’s; M 6-10 LTA’s; H >10 LTA’s and/or 1 death or more)</i></td></tr>
<tr><td colspan="4">S: Scope (geographical distribution)</td></tr>
<tr><td>Score = 1</td><td colspan="3">Onshore : area of impact is in immediate vicinity (or < 25m^2)
If positive impact at a local level</td></tr>
<tr><td>Score = 2</td><td colspan="3">Onshore: area of impact is within the site (or 25 - 100m^2)
If positive impact at a local and regional level</td></tr>
<tr><td>Score = 3</td><td colspan="3">Onshore: area of impact is beyond the site boundary (or > 100m^2)
If positive impact at a local, regional and national level</td></tr>
<tr><td colspan="4"><i>Note: for positive impacts consideration should also be given to the number of activities generating income and/or benefits</i></td></tr>
<tr><td colspan="4">F: Frequency or Probability</td></tr>
<tr><td>Score = 0</td><td colspan="3">No to extremely low probability</td></tr>
<tr><td>Score = 1</td><td colspan="3">Low probability, heard of in similar projects but unlikely to occur in this project</td></tr>
<tr><td>Score = 2</td><td colspan="3">Medium probability, may occur in this project</td></tr>
<tr><td>Score = 3</td><td colspan="3">High probability, highly likely to occur in this project</td></tr>
<tr><td>TOTAL Significance = M x S x F</td><td>Score</td><td colspan="2">Aspect significance</td></tr>
<tr><td>Low level of significance</td><td>< 6</td><td colspan="2">Not significant/insignificant</td></tr>
<tr><td>Medium level of significance</td><td>6 – 12</td><td colspan="2">Significant – to be managed</td></tr>
<tr><td>High level of significance</td><td>> 12</td><td colspan="2">Significant – to be managed</td></tr>
<tr><td colspan="4">NOTE: Aspects related to activities, procedures or services that have regulatory prescriptions shall be considered to be significant and will be given a minimum score of 6.</td></tr>
</table>

Table 5-3: Seismic Screening Matrix of Key Issues for for Identification of Key Issues for Environment, Social, and Health Impact Assessment

		Environmental, Social and Health Elements																			
		Environmental											**Social**							**Health**	
		Physical							**Biological**				**Human Use**				**Quality of Life**			**Health**	
	Project Activity	Topography	Air Quality	Noise and Vibration	Soil	Surface Water Hydrology	Surface Water Quality	Hydrology and Groundwater Quality	Terrestrial Flora	Terrestrial Fauna	Aquatic Flora	Aquatic Fauna	Land Use	Transportation	Water Supply	Local Waste Management	Employment and Income	Socio-Economy	Historical and Cultural Resources	Public Health and Safety	Worker Health and Safety
	Line Survey& Clearance	1	1	1	6	6	6	0	3	1	2	2	3	3	1	3	+9	+1	2	2	2
	Drilling of Shot Holes	1	3	9	3	1	6	2	3	1	1	1	3	1	2	2	+9	+1	2	2	2
	Transport of Equipment	0	9	9	3	1	3	1	1	1	1	1	1	2	1	1	+9	+1	3	3	6
A cq ui	**Base Camp**	0	9	9	3	1	3	1	1	1	1	1	1	3	1	1	+9	+1	3	3	6
	Transport of Surveyors &Equipment	0	9	9	3	1	3	1	1	1	1	1	1	3	1	1	+9	+1	3	3	6
	Shooting/ Recording	0	3	9	3	1	2	2	1	2	1	1	1	1	1	3	+9	+1	9	2	6

Source: Adapted from Department of Environment, Ministry of Natural Resources and Environment, Malaysia (2007) and European Commission (2001)

Shading indicates potentially significant impacts: green shading potentially positive impact; orange potentially negative impact.

Table 5-4: Exploration Drilling Screening Matrix for Identification of Key Issues for Environment, Social, and Health Impact Assessment

⬜ No impact – Not significant
🟧 Potential Impact – Significant negative
🟩 Positive impact – Significant Positive

				Project Activity																														
				Construction Phase										Drilling Phase						Well Testing Phase						Well Abandonment				Unplanned Events				
				Provision of temporary site facilities	Transportation of Materials and Equipment	Labour	Soil Excavation and Soil Filling	Construction of Access Road, Camp and Well Site	Fuel Combustion	Waste Management	Wastewater Drainage	Construction Material Storage	Use of Public Utility	Transportation of Materials and Equipment	Hazardous/non-hazardous waste management	Labour	Drilling	Fuel Combustion	Wastewater Drainage	Hazardous/non-hazardous waste management	Use of Public Utility	Handling of Materials and Chemicals	Labour	Well Testing	Flaring of Excess gas	Wastewater Drainage	Hazardous/non-hazardous waste management	Shut-in Well	Fuel Combustion	Blowout	Fire and Explosion	Chemical/Hydrocarbon/ Hazardous waste/ Material Spill	Transportation Accident	Earthquake
Environmental, Social, and Health Aspects	Environment	Physical Resources	Topography	🟧			🟧	🟧																										🟧
			Air Quality/Climate	🟧	🟧		🟧	🟧	🟧					🟧			🟧	🟧						🟧	🟧				🟧	🟧	🟧			
			Noise	🟧	🟧		🟧	🟧						🟧			🟧													🟧	🟧			🟧
			Heat and Light	🟧													🟧							🟧	🟧					🟧	🟧			
			Geology																															🟧
			Soil	🟧			🟧	🟧		🟧	🟧				🟧				🟧	🟧		🟧		🟧		🟧	🟧			🟧		🟧		
			Surface Water Hydrology	🟧			🟧	🟧			🟧								🟧							🟧								🟧
			Surface Water Quality				🟧	🟧		🟧	🟧				🟧				🟧	🟧		🟧				🟧	🟧			🟧		🟧	🟧	🟧
			Groundwater Quality							🟧	🟧				🟧		🟧		🟧	🟧		🟧		🟧		🟧	🟧			🟧		🟧		
		Biological Resources	Flora and Fauna	🟧		🟧	🟧	🟧		🟧	🟧				🟧	🟧			🟧	🟧		🟧	🟧		🟧	🟧	🟧			🟧	🟧	🟧	🟧	🟧
			Aquatic Flora and Fauna			🟧	🟧	🟧		🟧	🟧				🟧	🟧			🟧	🟧		🟧	🟧			🟧	🟧			🟧		🟧	🟧	🟧
	Social	Human Use Values	Land Use	🟧				🟧																										
			Transportation	🟧	🟧	🟧		🟧		🟧				🟧	🟧	🟧	🟧			🟧			🟧				🟧							🟧
			Water Supply	🟧									🟧								🟧													🟧
			Power Supply										🟧								🟧													🟧
			Drainage and Flooding	🟧				🟧			🟧								🟧							🟧								🟧
			Agriculture	🟧				🟧		🟧	🟧				🟧				🟧	🟧		🟧			🟧		🟧			🟧	🟧	🟧	🟧	🟧
			Aquaculture					🟧		🟧	🟧				🟧				🟧	🟧		🟧					🟧			🟧		🟧	🟧	🟧
			Waste Management	🟧						🟧					🟧					🟧							🟧			🟧		🟧		
			Tourism					🟧									🟧							🟧						🟧	🟧		🟧	🟧
		Quality of Life Values	Socio-Economy	🟩	🟩	🟩	🟩	🟩		🟩		🟩		🟩	🟩	🟩	🟩			🟩		🟩	🟩				🟩							
			Historical/Archaeological Sites				🟧	🟧									🟧																	🟧
			Attractions/Recreational Sites					🟧									🟧							🟧						🟧	🟧		🟧	🟧
	Health		Public Health		🟧	🟧	🟧	🟧	🟧	🟧	🟧			🟧	🟧	🟧		🟧	🟧	🟧		🟧	🟧		🟧	🟧	🟧		🟧	🟧	🟧	🟧	🟧	🟧
			Health Service																											🟧	🟧	🟧	🟧	🟧
			Occupational Health and Safety	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧

5.1.2. Scoping of Environmental, Social, and Health Impacts

The scoping of environmental, social and health impacts consists of determining how the potentially significant issues identified during the screening process apply to the project site. Characteristics of impacts, extent of impact, proximity/location of sensitive receptors in relation to the project activity and project site(s) are used to determine the scope of assessing impacts.

The study area for the environmental impact assessment includes the area within a 1 km and up to a 5 km radius of the project site(s). The study area for the social impact assessment includes the project stakeholders and communities near the project site(s). For the health impact assessment, workers employed for construction, drilling, testing and abandonment, as well as people who live in close proximity to the project site(s) are included in the assessment.

5.1.3. Environmental, Social, and Health Impact Assessment

5.1.3.1. Assessment of Potential Environmental Impacts

The assessment of potential environmental impacts is based on quantitative and qualitative data and professional judgment. Factors used to analyze potential environmental impacts include comparison with standard values, nature of environmental change, duration, reversibility, extent/scale, magnitude and Risk Ranking (linked to the sensitivity of the receptor) of the potential impact.

Also important to determining impact risk is to understand the probability of a specific event occurring. This can be determined by statistics or its historical context as follows:

Table 5-5: Probability of a Specific Event Occurring

Increasing Probability				
Remote	Unlikely	Possible	Likely	Very Likely
A	B	C	D	E
Never Heard of Incident in E&P Industry	Heard of Incident in E&P Industry but not likely to occur during this project	Has Occurred once or twice in Company and may occur during this project but only under exceptional conditions	Has occurred frequently in company and could also occur during this project	Commonly occurs in the company and Is expected to occur during project

The severity of potential environmental impacts is ranked as no impact, slight impact, minor impact, localized impact, major impact, and massive impact using the criteria outlined in **Table 5-6**.

The following factors will be considered for various impact scenarios and used qualitatively to assist in determining the severity levels for environmental, social and health aspects.

Table 5-6: Factors Considered in Environmental, Social and Health Impact Assessment

Factor	Detail
Standard Values	• **High** - Potential impact **does not meet** standard values/guidelines. • **Moderate** – Potential impact is likely meet standard values/guidelines with appropriate management measures. • **Low** - Potential impact **meets** standard values/guidelines
Magnitude	• **Major** - impact causing persistent and severe environmental, social or health damage. • **Moderate** - impact large enough to cause environmental, social or health damage • **Minor -** impact that may cause some minor environmental, social or health damage
Extent/Scale	• **Regional** - area of potential impact is > 1km radius from the site boundary. • **Moderate** - area of potential impact is between 100 m and 1 km radius from the site boundary. • **Localised** - area of potential impact is in the project area within a radius of 100 m from the site boundary.
Duration	• **Permanent** – Impact likely to be permanent with no environmental recovery. • **Long Term** - Potential impact occurs over long-term duration (>5 years) before recovery. • **Medium Term** - Potential impact occurs over medium-term duration (1-5 years) before recovery. • **Short term** - Potential impact occurs only during part of project operations or only during a short term project up to one year, before recovery.
Reversibility	• **No Recovery** - Permanent impact • **Long Term** Recovery - Recovery longer than 5 years after cessation • **Medium Term** Recovery - Recovery within 1 - 5 yr. after cessation • **Short Term** Recovery - Recovery within 1 yr. after cessation
Importance	• **Major** - Potential impact impacts area with rare/endangered species. • **Moderate** - Potential impact disturbs the area that has a value for conservation. • **Minor** - Potential impact disturbs degraded area or slightly disturbs area with value for conservation.

Table 5-7: Potential Environmental Impact Categories and Criteria

HARM TO ENVIRONMENT		
Severity	**Potential Impact**	**Definition**
0	No impact	No environmental damage. No change in the environment. No financial consequences.
1	Slight impact	Slight effect - Local environmental damage within the fence and within systems. Negligible financial consequences.
2	Minor impact	Minor effect - Contamination. Damage sufficiently large to attack the environment. Single value above statutory limit or prescribed criterion. Single complaint. No permanent effect on the environment.
3	Localized impact	Localized effect - Limited loss of discharges of known toxicity. Repeated values above statutory or prescribed limit. Affecting neighbourhood.
4	Major impact	Major effect - Severe environmental damage. The company is required to take extensive measures to restore the contaminated environment to its original state. Extended values above statutory or prescribed limits.
5	Massive impact	Massive effect - Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservancy, a major economic loss for the company. Constant, high values above statutory or prescribed limits.

Potential environmental impacts are inherently variable because the degree of vulnerability is heavily dependent on local environmental conditions. The significance designation for potential environmental impacts takes into consideration environmental information and environmental science expertise.

5.1.3.2. Assessment of Potential Social Impacts

The assessment of potential socio-economic impacts is based on quantitative and qualitative data and professional judgment. Factors used to analyze potential social impacts are similar to those used above, such as likelihood, duration, reversibility, and magnitude of the potential impact.

Additional factors include consideration of changes in the value of assets that households depend upon for their livelihoods, manageability of the change and potential for it to lead to further changes beyond the control of the project, and whether the effects are acute or chronic. The significance of the potential social impact is ranked as Beneficial, No Impact, Slight Impact, Minor Impact, Localized Impact, Major Impact and Massive Impact using the criteria outlined in **Table 5-8**.

Table 5-8: Potential Social Impact Categories and Criteria

Impact on Social		
Severity	**Potential Impact**	**Definitions**
🟩	Beneficial	• Improvement in the ability of households or settlement to maintain or improve its livelihood or store of assets • Enhancement in quality or availability of resources resulting in improvement in quality of life. For example: ✓ Enhancement in physical capital including availability of infrastructure ✓ Enhancement in social capital, including skills for future employment ✓ Enhancement of relationship between Project Proponent, Contractor and communities
0	No Impact	• No social effects
1	Slight	• Slight & temporary (0-1 yr) term decrease in availability of resource or access to infrastructure affecting livelihood • Potential short term decrease in quality of life of household or settlement not affecting long term outcomes • No discernible effect of the local economy • No discernible perception of missed opportunity, frustration or disappointment nor tension between project proponent, contractor and communities
2	Minor	• Moderate & temporary (1-5yrs) term effect on ability of household to maintain livelihood/store of assets • Potential reduction in quality of life in medium term • Potential disruption to lifestyle in medium term • Perception of missed opportunity to improve • Possible decrease in access to infrastructure to which community is unable to adapt in the medium term • Potential impacts which may result in high levels of complaint
3	Localized	• Medium impact on ability of households to maintain livelihood/store of assets to an extent not acceptable to affected people over the 1-5 yrs term • Some reduction in quality of life over the 1-5 yrs term • Some cultural change to which the communities are unable to adapt over the 3-5 yrs term • Some perception of missed opportunity to improve quality of life, resulting in some frustration and disappointment resulting in significant tension between project proponent, contractor and communities
4	Major	• Severe long (> 5 yrs) term effect on ability of households to maintain livelihood/store of assets to an extent not acceptable to affected people • Long (> 5 yrs) term reduction in quality of life • Long (> 5 yrs) term cultural change to which the communities are unable to adapt • Significant perception of missed opportunity to improve quality of life, resulting in frustration and disappointment resulting in significant tension between project proponent, contractor and communities
5	Massive	• Significant and permanent effect on ability of households to maintain livelihood/store of assets to an extent not acceptable to affected people • Significant and permanent reduction in quality of life • Significant and permanent cultural change to which the communities are unable to adapt • Significant and widespread perception of missed opportunity to improve quality of life, resulting in frustration and disappointment resulting in significant tension between project proponent, contractor and communities which

Potential social impacts are inherently variable because community response to a potential impact, perceptions of existing and changing conditions, and the degree of vulnerability is heavily dependent on local conditions. The significance designation for potential social impacts takes into consideration social science expertise and previous experience regarding the relationships between individuals, communities, government agencies, NGOs and special interest groups, and the oil and gas industry.

5.1.3.3. Assessment of Potential Health Impacts

The potential impact on health is assessed for nearby communities and people close to project operations. Factors used to analyze the scale of potential health impacts are similar to the criteria used for environmental and social impact analysis such as extent, duration, reversibility, and magnitude of the potential impact.

Additional factors unique to health aspects are provided in **Table 5-9**. The method of assessing the *significance* of health involves an evaluation of the probability or likelihood of the potential health impact occurring, and also the severity of the potential impact.The significance of potential health impact can be ranked as negligible, no injury, slight injury, minor injury, major injury, single fatality, or multiple fatalities criteria outlined in **Table 5-10**.

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Table 5-9: Factors Considered in Health Impact Assessment

Factor	Detail
Hazardous Chemicals or Health Threats	• Chemicals: heavy metals, toxic organic compounds. • Physical: noise and vibration • Biological: viruses, bacteria • Psychological: stress, annoyance, and nuisance
Environment Resulting in a Potential Health Impact	• Change of environmental quality: water quality, air quality resulting in a potential health impact • Change of utilization or acquiring resources: water use resulting in a potential health impact • Physical: noise, dust, radiation and vibration resulting in a potential health impact
Factors of Exposure	• Exposure pathway: eating or skin exposure • Risk group: people around the project area
Potential Health Impact	• Death rate • Injury rate from infectious diseases or non-infectious diseases, acute or chronic effects • Rate of emotional impact, stress • Injuries and accidents • Impacts on the next generation • Impacts to high-risk groups • Stimulate or enhance the severity of the disease • Cumulative impacts
Potential Impacts on Medical Services	• Overall increase in the demand for health care • Demand for special health care • Changes to existing medical services

Table 5-10: Health Impact Categories and Criteria

HARM TO PEOPLE		
Severity	**Potential Impact**	**Definition**
0	No injury	No injury or damage to health.
1	Slight injury	Slight injury or health effects (including first aid case and medical treatment case) – Not affecting work performance or causing disability.
2	Minor injury	Minor injury or health effects (Lost Time Injury) - Affecting work performance, such as restriction to activities (Restricted Work Case) or a need to take a few days to fully recover (Lost Workday Case). Limited health effects which are reversible, e.g. skin irritation, food poisoning.
3	Major injury	Major injury or health effects (including Permanent Partial Disability) - Affecting work performance in the longer term, such as a prolonged absence from work. Irreversible health damage without loss of life, e.g. noise induced hearing loss, chronic back injuries.
4	Single fatality	Single fatality - From an accident or occupational illness (poisoning, cancer).
5	Multiple fatality	Multiple fatalities - From an accident or occupational illness (poisoning, cancer).

To determine potential public health impacts, the public which could be exposed to various aspects of the project is taken into consideration, whether it is a permanent resident continuously exposed to the project area or a periodically exposed farmer visiting or transiting through the project area. The significance determination of a potential public health impact takes into consideration local and regional public health expertise and previous experience regarding the relationships between individuals, communities, health care providers, government agencies, NGOs, and the oil and gas industry.

5.1.3.4. Assessment of Potential Reputation Impacts

The potential impact of unplanned events is assessed on reputation is assessed for the effect various activities are perceived by the public and how it reflects on the companies' reputation. Factors used to analyze the scale of potential reputation impacts are similar to the criteria used for environmental social and health impact analysis such as extent, duration, reversibility, extent/scale and magnitude of the potential impact. The significance of potential reputation impacts is ranked as insignificant, no impact, slight impact, minor impact, considerable impact, national impact and international impact using the criteria outlined in **Table 5-11**.

Table 5-11: Reputation Impact Categories and Criteria

IMPACT ON REPUTATION		
Severity	**Potential Impact**	**Definition**
0	No impact	No impact - No public awareness
1	Slight impact	Slight impact – Public awareness may exist, but there is no public concern.
2	Minor impact	Limited impact – Some local public concern. Some local media and/or local political attention with potentially adverse aspects of company reputation
3	Considerable impact	Considerable impact – Regional public concern. Extensive adverse attention in local media. Slight national media and/or local/regional political attention. Adverse stance of local government and/or groups
4	National impact	National impact – National public concern. Extensive adverse attention in the national media. Regional/national policies with potentially restrictive measures and/or impact grant of license. Mobilization of action groups.
5	International impact	International impact – International public attention. Extensive adverse attention in international media. National/international policies with potential severe impact on access to new areas, grants of license and/or tax legislation.

5.1.3.5. Assessment of Potential Asset Impacts

The potential impact of unplanned events is assessed on assets for the effect various activities and impacts have on the companies' assets. Factors used to analyze the scale of potential reputation impacts are similar to the criteria used for environmental social and health impact analysis such as extent, duration, reversibility, extent/scale and magnitude of the potential impact. The significance of potential asset impacts is ranked as insignificant, no damage, slight damage, minor damage, local damage, major damage, and extensive damage using the criteria outlined in **Table 5-12**.

Table 5-12: Asset Impact Categories and Criteria

ASSET DAMAGE		
Severity	**Potential Impact**	**Definition**
0	No damage	Zero damage
1	Slight damage	Slight damage - No disruption to operation (costs less than USD 10,000).
2	Minor damage	Minor damage - Brief disruption (costs less than USD 100,000).
3	Local damage	Local damage - Partial shutdown (can be restarted but costs up to USD 500,000).
4	Major damage	Major damage - Partial operation loss (2 weeks shutdown costs up to USD 10,000,000).
5	Extensive damage	Extensive damage - Substantial or total loss of operation (costs in excess of USD 10,000,000).

5.1.4. Identification of Management Measures

The aim of the environmental impact assessment process is to reduce negative impacts and enhance the benefits from an activity. As part of the assessment process management measures are identified to minimise the level of risk to 'as low as reasonably practicable'. The following hierarchy of control was used to identify appropriate management measures:

- Eliminate the risk by removing the hazard.
- Substitute of a hazard with a less hazardous one.
- Prevention of potential events.
- Control the magnitude of an impact.
- Mitigation of the impact of an event on the environment e.g. (bunding for potential hydrocarbon spills).
- Emergency response and contingency planning to enable recovery from the impact of an event.

For activities where the risk level is higher than low, management measures are required to prevent or mitigate the risk to an acceptable level. Prevention measures are put in place to prevent a hazard or event from occurring such as avoidance or reduction at source and pollution control equipment. Mitigation measures are put in place to avoid or minimise the actual impact of the event after it has occurred. This can include spill response plans, monitoring and offsets.

Measures to prevent or mitigate (reduce) the severity of potentially significant impacts will be developed and linked back to the related activities, and an Environmental, Social and Health Management Plan (ESHMP) will be prepared. The ESHMP brings together the environmental, social and health management requirements needed to prevent or reduce potential impacts from activities and accidental events, and will form part of the ESHIA Report and company commitment to the project. This forms the substance of **Chapter 6**.

5.1.5. Determine the Residual Risk

The residual risk is determined by assessing the environmental, social and health Risk Ranking and the likelihood of that risk occurring with effective management measures in place. The residual risk is an indication of the significance of an environmental, social or health impact.

Where no meaningful measurable environmental, social or health impact can occur, a rating of negligible has been given. Where a positive impact has been identified a rating of positive impact has been given.

The probability of a specific event occurring can be determined either in terms of historical precedence or by calculation. Probability has been categorized in **Table 5-5**.

The potential Risk Ranking of an event occurring is determined according to the following themes:

- Environment (physical and ecological);
- Social;
- Health;
- Reputation; and
- Assets .

Impact Risk Ranking levels for each of these has been defined above.

The level of risk is identified using a matrix evaluating probability against Risk Ranking (**Table 5-13**). The risk level can be separated into three levels: low, medium, or high (**Table 5-14)**. For each aspect identified a residual risk ranking will be defined.

If the risk is determined to be “medium” or “high”, it needs to be managed to reduce the frequency of occurrence or to mitigate any potential risks to achieve a risk which is low, or if it cannot be mitigated to a low level, to a level that is “As Low As Reasonably Possible” (ALARP). If the risk is determined to be “high” (i.e. unacceptable), specific actions must be developed to reduce the risk, which may involve a full Quantified Risk Assessment (QRA).

Table 5-13: Risk Assessment Matrix

	Consequence					**Increasing Probability**				
Severity	**Environmental**	**Social**	**Health (People)**	**Asset**	**Reputation**	**A** **Remote** Never Heard of Incident in E&P Industry	**B** **Unlikely** Heard of Incident in E&P Industry but not likely to occur during this project	**C** **Possible** Has Occurred once or twice in Company and may occur during this project but only under exceptional conditions	**D** **Likely** Has occurred frequently in company and could also occur during this project	**E** **Very Likely** Commonly occurs in the company and Is expected to occur during project
0	No impact	No impact	No injury	No damage	No Impact	🟩	🟩	🟩	🟩	🟩
1	Slight impact	Slight impact	Slight injury	Slight damage	Slight Impact	🟩	🟩 Low Risk	🟩	🟩	🟩
2	Minor impact	Minor impact	Minor injury	Minor damage	Minor Impact	🟩	🟩	🟩	🟨	🟨
3	Localized impact	Localized impact	Major injury	Localized damage	Considerable impact	🟩	🟩	🟨 Medium Risk	🟨	🟥
4	Major impact	Major impact	Single fatality	Major damage	National impact	🟩	🟨	🟨	🟥	🟥
5	Massive impact	Massive impact	Multiple fatality	Extensive damage	International impact	🟨	🟨	🟥	🟥	🟥 High Risk

Table 5-14: Significance of Risk

Risk Level	Definition
Low	Low level risk does not require additional management
Medium	The risk must be controlled to prevent increased risk
High	The risk must be managed/ reduced

5.1.6. Outcomes of Screening and Scoping

The Screening Matrix identifies potential impacts that may occur as a result of planned project activities and unplanned events.

Each of the potential impacts, shown by a square in the matrix, was assessed qualitatively based on our screening methodology. The colour scale, amber, green, and white, shows the results of this screening. The amber squares indicate a potential for negative impacts, the green indicates possible positive impacts, and the white squares indicate insignificant impact.

The amber and green squares show the combination of activities/unplanned events and environmental elements that may result in potential impacts, and these aspects are discussed further in the following section. Each impact section includes:

- Description of the source and characteristic of the potential impacts.
- Identification of receptors sensitive to potential impacts.
- Description and evaluation of potential impacts.
- Identification of management measures to reduce potential impacts.
- Concluding statement regarding the significance of the potential impacts and residual risk.
- Summary table.

Identification of the environmental, social and health factors and related aspects was conducted via:

- Review of project description and planned/unplanned activities.
- Information obtained through stakeholder consultation.
- Knowledge developed by IEM company’s extensive prior experience in assessing oil and gas facilities.
- Data from studies and surveys.

Potential impacts from activities during all phases of the Seismic and Exploration Drilling Program have been considered and aspects relevant to each development phase, as determined from screening, have been summarised as relevant in the following impact assessment sections for environment, social, health and unplanned events section. The detailed impact assessment of each aspect will be conducted in the main ESHIA. A summary of aspects identified at the scoping phase are provided below:

5.2. Environmental, Social and Health Aspects For Seismic

Table 5-15: Environmental Aspects for Seismic

Aspect	Activity	Potential Impact
Land & Habitat Disturbance	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to local topography Soil Disturbance and Erosion Disturbance to local Terrestrial Flora Disturbance to local terrestrial fauna Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration Localized change in water quality Localized sediment deposition and disturbance to benthic habitats and associated biota.
Air Emissions	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Deterioration of Air Quality due to dust Minor deterioration of local and regional air quality due to emission of pollutants such as NOx and SOx and CO. GHG Release contributing to climate change
Noise	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Behavioral disturbance to fauna
Vibration	• Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Behavioral disturbance to fauna
Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Contamination of water and soils and injury to fauna Nutrient enrichment of surrounding water and soils
Odour	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Attraction of fauna such as rats and birds.
Fuel Storage	• Base camp/ Fly camp Construction	Contamination of water and soils and injury to fauna

Table 5-16: Social Aspects by Project Phase

Aspect	Activity	Potential Impact
Change in Land Use	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss of agriculture potential Project operation effects on nearby land productivity Loss of employment for displaced workers that do not own land
Traffic	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Increase in and disruption of local traffic
Water Use	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Reduction of local community water supply
Wastewater	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Potential impact to agriculture, aquaculture and fisheries
Waste Disposal	• Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Increased waste disposal overloading local infrastructure
Tourism and Recreational experience	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance and reduction of tourism and recreational experience
Employment & Income	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential increase in jobs and related income for local communities
Labour In-migration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential conflict between workers from other regions and local communities
Historical, Archaeological & Cultural Resources	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss or damage to historical and archaeological sites Potential disturbance of local culture

Table 5-17: Health Aspects by Project Phase

Aspect	Activity	Potential Impact
Dust	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Respiratory irritation Exacerbation of asthma
Noise	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Hearing impairment for workers and Annoyance for public
Traffic	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance of psychological wellbeing
Non-hazardous waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Clean up and Site Restoration	Food safety, gastroenteritis Increase in vector-borne diseases: malaria, typhus and dengue and others.
Hazardous waste	• Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Acute exposure such as skin and eye irritation, inhalation exposure etc.
Communicable diseases	• Base camp/ Fly camp Construction • Seismic Team Mobilization	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.

Table 5-18: Unplanned Event Aspects by Project Phase

Aspect	Activity	Potential Impact
Fire or Explosion	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible explosion or fire at campsite, or fuel storage area, or during seismic operation
Chemical, Fuel or Hazardous Waste/Materials Spill	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people
Transportation Accidents	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible injury or death to personnel; and localized contamination of environment
Earthquakes	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential physical disruption cause building collapse, fires or spills

5.3. Environmental, Social and Health Aspects for Drilling

Table 5-19: Environmental Aspects for Drilling

Aspect	Activity	Potential Impact
Land & Habitat Disturbance	Installation of Infrastructure Road construction Camp site construction Well site construction Well abandonment and site restoration	Disturbance to local topography
		Soil Disturbance and Erosion
		Disturbance to local Terrestrial Flora
		Disturbance to local terrestrial fauna
		Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration
		Localized change in water quality
		Localized sediment deposition and disturbance to benthic habitats and associated biota.
Vehicle and Rig Movements	Vehicle Movements	Disturbance to Fauna
	Rig Movement	Disturbance to traffic
Air Emissions	Installation of infrastructure	Deterioration of Air Quality due to dust
	Drilling Well Testing Flaring	Hydrogen sulphide released
	Power Generation for Drilling and Flaring Well Testing and Flaring	Minor deterioration of local and regional air quality due to emission of pollutants such as NOx and SOx and CO.
	Transportation Road Construction and rehabilitation of Drill Site and Camp Site Construction Power Generation for Drilling Flaring Fugitive emissions	GHG Release contributing to climate change
Noise	Installation of infrastructure Drilling and infield operations Well Testing and Flaring	Behavioral disturbance to fauna
Artificial Light	Functional lighting on vehicles and drill rig, camp site and well site	Potential impact on terrestrial fauna
	Flaring	Potential impact on terrestrial flora
Heat	Flaring	Potential impact on local fauna
Liquid Waste	Drill site drainage	Localized change in water quality or contaminated soils from oil and grease
	Sewage and sullage	Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water
	Infiltration	Infiltration from the cuttings and dirty water waste pit may deteriorate groundwater quality
Solid Waste	Disposal of non-hazardous wastes from drilling activities	Contamination of water and soils and injury to fauna
	Disposal of food and other kitchen wastes from camp site	Attraction of fauna such as rats and birds. Nutrient enrichment of surrounding water and soils
	Disposal of Hazardous Solid Wastes	Contamination of water and soils and injury to fauna
Drill Cuttings and Fluids	Disposal of drill cuttings and sludge	Localized change in water quality and soil quality from chemical composition of drill fluids
	Loss of circulation	Deterioration of shallow and deep groundwater

Table 5-20: Social Aspects for Drilling

Aspect	Activity	Potential Impact
Change in Land Use	Purchase of land for access roads, drill and camp site	Loss of agriculture potential Project operation effects on nearby land productivity Loss of employment for displaced workers that do not own land
Traffic	Transportation of equipment, people and services	Increase in and disruption of local traffic
Water Use	Water for construction exploration drilling and domestic use	Reduction of local community water supply
Power Use	Power for drilling operations and work camp	Increase or decrease of available power for local community
Water Drainage	Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure
Wastewater	Project operation effects on water quality	Potential impact to agriculture, aquaculture and fisheries
Waste Disposal	Disposal of waste in project area	Increased waste disposal overloading local infrastructure
Tourism and Recreational experience	Project construction and operation effects on tourism and recreation	Disturbance and reduction of tourism and recreational experience
Employment & Income	Employment & income for nearby communities	Potential increase in jobs and related income for local communities
Labour In-migration	In-migration of labour and social interaction	Potential conflict between workers from other regions and local communities
Historical, Archaeological & Cultural Resources	Project construction potentially destroying historical and archaeological sites	Loss or damage to historical and archaeological sites

Table 5-21: Health Impact Aspects for Drilling

Aspect	Activity	Potential Impact
Dust	Access/upgrade roads, Site construction, Transportation of granular fill, workers, equipment	Respiratory irritation Exacerbation of asthma
Noise	Generator, Transportation, Construction Drilling	Hearing impairment for workers and Annoyance for public
Non-hazardous waste	Waste disposal, Leaks/spills, Standing water	Food safety, gastroenteritis Increase in vector-borne diseases: malaria, typhus and dengue and others.
Mud Chemicals and drilling waste	Mixing of drilling chemicals, Leak/spill of mud chemicals	Acute exposure such as skin irritation, inhalation exposure etc.
Hazardous waste	Material contaminated with oil or chemicals, Lubricating and hydraulic oil, Drum and containers used for chemical transportation and storage	Acute exposure such as skin and eye irritation, inhalation exposure etc.
Communicable diseases	Migration/influx of outside workers	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.
Light and heat	Flaring	Heat exposure Nuisance light
Flare emissions	Flaring	Increase in respiratory illnesses/diseases Exacerbation of asthma Disturbance psychological wellbeing H2S Fatalities

Table 5-22: Unplanned Event Aspects for Drilling

Aspect	Activity	Potential Impact
Blowout	Drilling	Release of uncontrolled volumes of hydrocarbons, Fire, Explosion causing impact to the environment and possible injury or death to personnel.
Fire or Explosion (not associated with Blowout)	Fuel Storage Flare Testing	Possible explosion or fire of drilling rig or at campsite, or fuel storage area
Chemical, Fuel or Hazardous Waste/Materials Spill	Storage of chemicals, hazardous materials or waste	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people
Transportation Accidents	Transportation of equipment, personnel, granular fill, mud and cuttings, and waste	Possible injury or death to personnel; and localized contamination of environment
Earthquakes	Physical shifting of earth’s surface	Potential physical disruption cause building collapse, blowouts, fires or spills, injury or death to personnel

The assessment of each aspect will be conducted during the ESHIA and will include the following components:

- Description of the source and characteristic of the potential impacts.
- Identification of receptors sensitive to potential impacts.
- Description and evaluation of potential impacts.
- Identification of management measures to reduce potential impacts.
- Determinations of the residual risk after management measures are included.
- An aspect summary assessment table with a residual risk ranking.

The study area for the environmental impact assessment includes the area within a 1 km and up to a 5 km radius of the project site(s). The study area for the social impact assessment includes the project stakeholders and communities near the project site(s). For the health impact assessment, workers employed for construction, drilling, testing and abandonment, as well as people who live in close proximity to the project site(s) are included in the assessment.

5.4. Seismic Environmental Impact Assessment

5.4.1. Land & Habitat Disturbance

Land and habitat disturbance could happen as the result of clearance of campsite, construction of access roads, some physical disturbance along the seismic lines and at shot hole locations.

The campsite will be constructed to house the workers and provide an area for storing equipment during the night. All new access roads will need to be constructed, although these will be minimal. The roads will be constructed with a 6 m wide top and 1.5 m side slope for a total width of 9 m a height of approximately 20 to 30 cm before compaction with granular fill. The construction of the campsite and access road would affect plants within an area.

There will be minimal disturbance along the seismic lines itself about a meter wide. The actual shot hole locations about every 50 m along the seismic line will occupy a 10 m^2area in which vegetation will be cut and over impacted. This is a direct and short-term impact.

During the decommissioning phase, the potential for impacts associated with land/habitat disturbance will be of a lesser scale than during the construction phase as the decommissioning strategy is to restore the site to its original condition.

Impact Assessment

The potential impacts from land and habitat disturbance associated with the seismic campaign are:

- Impact to Topography
- Soil Disturbance and Erosion
- Impact to Terrestrial Flora
- Impact to Terrestrial Fauna
- Impact to Surface Water Hydrology
- Impact to Water Quality and Aquatic Habitat

5.4.1.1. Impact to Topography

The accommodation campsite will be levelled and elevated by cut and fill methods and compacted using bulldozers, dump trucks, water trucks and graders. The compacted laterite pad will be 200 mm thick.

The source of impact from the site preparation is caused by soil excavation/filling and construction of access road activity. The project area mainly consists of rice farming, agricultural and forested areas with agriculturally dominated communities and access roads. The agriculture areas are used to grow primarily rice and beans.

The project will cause changes to the topography of the campsite and surrounding areas. The effect will be limited to the campsite and access roads.

The abandonment will follow normal industry practices and procedures, conforming to all internal PCMI regulations and MOGE requirements.

Without mitigation measures, the impact on topography will be local in extent, short-term in duration, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of the impact occurring is determined to be very likely (E).

The Risk Ranking of impacts to topography is rated as medium.

Severity	Probability	Risk Ranking
Minor Impact	Very Likely	Medium
2	E	2E

Management Measures

Impacts from construction activities on topography can be mitigated through the use of the following measure:

- Limit construction activities to campsites and access roads only.
- Restore the site to its original condition on site abandonment.
- Minimize cutting along seismic lines.

Residual Risk

With these management measures, the likelihood of impacts from a change in topography is determined to be likely D; while there will be slight impacts (1) on environment, resulting in low residual negative risk (1D).

5.4.1.2. Soil Disturbance and Soil Erosion

Activities such as traffic to the project area, site preparation, drilling of shot holes, and shooting/recording may impact soil resources. In particular, these activities may cause soil compaction or enhance soil erosion.

Soil impact from access to the project area

Vehicles and people treading on agricultural areas to access the seismic lines can compact soils and decrease infiltration of water into subsurface soil. These may lead to water-logging or increase surface run-off and can also cause soil erosion. Moreover, soil compaction can also result in decreased seed germination, root expansion, and growth. The potentially impacted area is the treaded area along seismic lines. Given a treading area of approximately 1 m, the temporary impacted area amounts to an insignificant percentage of the Concession Block area.

Soil impact from site preparation for laying of seismic lines and preparation of shot holes

The majority of the project area consists of a low slope; therefore, excavation or soil filling will not be required. Nevertheless, the survey team needs to cut some grass or clear soil surface of about 10 m^2 per shot hole in order to drill shot holes. Therefore, the temporary impact area considering the total Concession Blocks area is insignificant.

Soil impact from drilling of shot holes and loading of explosives

The drilling team will drill shot holes that have a diameter of 3 inches (7.62 cm) and a depth of 10-30 m. Drilling of the shot holes create cuttings around the mouth of the holes every 50 m. The maximum amount of cuttings from drilling of a single-hole can create approximately 0.137 m^3 of cuttings/hole. The amount of cuttings from a single hole is negligible in relation to the total project area. After drilling, explosives will be loaded into the drilled holes, and the cuttings from the holes will be buried back into the same holes. Therefore, only a small amount of cuttings will be left, which will have minimal effect.

Soil impact from shooting/recording

Shooting of shot holes may affect the soil structure at low levels and in limited areas. The main composition of explosives used in this seismic work is ammonium nitrate, which is normally used as fertilizer. There are no documented cases of pollution from its residuals. The components of the detonator include 10% of $Pb(N_3)_2$, and 60% other compounds. The lead from $Pb(N_3)_2$ in one detonator (the weight of detonator is 1 mg) would remain in the soil as estimated at 0.07 mg/kg soil. This estimated value is much lower than the standard of Pb in soil (less than 400 mg/kg soil). Therefore, this residual does not affect the environment. The contractor for seismic survey, will pick up gab wire residues from each shot hole after every explosion and the residues will be re-used or disposed. Therefore, changes to the chemical properties of soil from the shooting/recording would be slight.

Soil impact from seismic trucks

Seismic support trucks can compact soils and decrease infiltration of water into subsurface soil, which can cause soil erosion. The potentially temporarily impacted area is the treaded area of 1 m wide along the seismic lines. Assuming the seismic support trucks or other support vehicles are used for 50% of the length of the seismic lines, with a 10 m clearance path for trucks, this is equivalent to approximately 0.1 % of the Concession Blocks area, which is insignificant.

Without mitigation measures, physical disturbance and soil erosion impacts are expected to be local in extent, short-term in duration, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of these impacts occurring is ranked as Possible C.

The Risk Ranking of impacts from soil disturbance and soil erosion is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to soils can be mitigated through the use of the following measures:

- Limit soil compaction only to campsites and access roads.
- Exposed site areas should be kept to a minimum during construction or re-vegetated as soon as possible.
- Reduce erosion by preventing/reducing off-site sediment transport through the use of settlement ponds, silt fences and water treatment, and modifying or suspending activities during extreme rainfall and high winds.
- Provide effective construction site run-off control and design.
- Minimize vehicle traffic along seismic line.
- Minimize compaction at shot hole locations.

Residual Risk

With these management measures, the likelihood of impacts from soil disturbance and erosion is determined to be unlikely B; while there will be Slight impact (1) on environment, resulting in low residual negative risk (1B).

5.4.1.3. Impact to Terrestrial Flora

The project area consists of agricultural (i.e., paddy field and crop) and forested (i.e., grass and shrubs, mixed deciduous forest/disturbed deciduous forest, dry evergreen forest/disturbed evergreen forest, disturbed deciduous forest, deciduous dipterocarp forest, and dense deciduous forest).

For a 3D-seismic survey, the survey team must tread on agricultural land on a path with a width of 1 m along the approximately seismic lines to access the shot holes. Operation of the seismic support trucks may lead to soil compaction that might inhibit root penetration and reduce water infiltration. However, the impacts will be localized, short-term, and only slightly alter the original state. Thus, it is unlikely that vegetation growth will be significantly reduced. Only crop species will be impacted but they will be replanted with the next planting cycle. The survey team may need to cut some vegetation for drilling of shot holes which may cause some vegetation loss in that area. The vegetation will be replanted soon after completion of the survey as appropriate.

As standard practice, PCMI will ensure that its staff and contractors will not cut trees or forage in the area surrounding the campsites during.

The vegetation removed is expected to recover naturally when complete. Any potential loss of tree habitat from the campsite or seismic lines will be compensated at that stage.

The impact will therefore be local in extent, short-term in duration, reversible and of low-magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. Probability is determined to be Possible C.

The Risk Ranking of impacts to terrestrial flora is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to terrestrial flora can be mitigated through the use of the following measures:

- High valued habitat to be avoided where practicable in the design process.
- Remove vegetation in project areas only (roads, camp site, shot hole site). Avoid cutting Riparian trees.
- Mark well sites clearly and prohibit vehicles from moving off site onto surrounding land.
- Mark trees to be cut prior to constructing campsite/seismic lines to prevent the cutting of other trees.
- Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to vegetation.

Residual Risk

With these management measures, the likelihood of impacts to terrestrial flora is determined to be Unlikely B; while there will be slight impact (1) on environment, resulting in low residual negative risk (1B).

5.4.1.4. Kyan Gin Reserved Forest Protected Area

Impacts to forest resources and wildlife in the Kyan Gin Reserved Forest protected area will be similar to those flora and fauna described above.

All impacts along the seismic line within the Protected Area will be monitored and will require compensation to be paid.

Without mitigation measures, impacts on the Kyan Gin Reserved Forest from the seismic survey are expected to be local in extent, short-term in duration, reversible and of small magnitude.

Human activity will be confined to the access road, seismic lines and shot hole sites. Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to wildlife. In addition, hunting and trapping will be specifically prohibited and violations are grounds for termination of contract and dismissal.

The impacts on protected areas will be local in extent, short-term in duration, reversible and of low magnitude. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of impacts occurring to terrestrial fauna is determined to be Possible C.

The Risk Ranking of impacts to terrestrial fauna is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to terrestrial fauna can be mitigated through the use of the following measures:

- Mark trees to be cut prior to constructing camp site, access road and seismic lines to prevent the cutting of other trees.
- Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to wildlife.
- Hunting and trapping will be specifically prohibited and violations grounds for termination of contract and dismissal.
- Remove vegetation at shot hole location areas only.
- Mark seismic lines and shot hole sites clearly and prohibit personnel from moving off site onto surrounding land.

Residual Risk

With these management measures, the likelihood of impacts to protected areas is determined to be unlikely B; while there will be slight impact (1) on people, environment, assets or reputation, resulting in low residual risk (1B).

5.4.1.5. Impact to Surface Water Hydrology

Impact Assessment

Vegetation removal, construction of campsites and access roads can alter surface water hydrology by reducing interception, evaporation/ transpiration and infiltration, which in turn can increase runoff and change local drainage patterns. Heavy rains can intensify changes in surface water hydrology; these changes are also enhanced on steep slopes.

Construction of the access roads and campsite for this project will result in some vegetation removal. The area of vegetation removal will be small and site preparation will be conducted on flat terrain. In addition, PCMI will install culverts under the access roads if required or requested to maintain natural drainage. No changes in surface water hydrology are therefore expected.

Surface Water Runoff to Access Road

The overall landscape around the project well site is expected to be flat with agricultural and forested areas.

All access roads will be 9-m wide. In consultation with adjacent landowners, roads will incorporate culverts to allow the flow of natural surface drainage and prevent any ponding of water around the access road. The required permission will be obtained from all relevant agencies.

Without mitigation measures, impact on hydrology will be local in extent and transient, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of is determined to be Possible C.

The Risk Ranking of impacts on surface water hydrology is rated as medium.

Severity	Probability	Risk Ranking
Localized Impact	Possible	Medium
3	C	3 C

Management Measures

Impacts from runoff can be mitigated through the use of the following measures:

- Avoid construction of campsites and access roads in areas that may cause obstacles to water drainage.
- Construct water drainage lines (culverts) to maintain natural drainage. The required permission will be obtained from all relevant agencies.

Residual Risk

With these management measures, the likelihood of impacts from a change surface hydrology is determined to be Unlikely B; while there will be localized impact (3) to the environment resulting in low residual negative risk (3 B).

5.4.1.6. Impact to Water Quality and Aquatic Habitat

Some activities may affect surface water quality, such as campsite preparation, shot hole drilling, and use of explosives. These activities may damage some vegetation covering soil and may also enhance soil erosion from the project area to surface water. However, most of the project area consists of a low slope, this seismic survey will take place during the dry season and the disturbed area for each line or shot hole is small; thus, soil erosion from the project area to surface water will be negligible. For these reasons, the quality of surface water around the project area will not change. If changes occur during the wet season, surface water could increase in turbidity resulting from an increase in suspended solids (SS) and could decrease in dissolved oxygen, which could conceivably lead to impacts on aquatic biota.

These impacts would only affect the project area over a short period of time and vegetation will recover. In addition, the project will take place during the dry season and suitable mitigation measures will be prepared and strictly followed during the seismic survey duration. The company will drill holes for explosives at least 50 meters away from water resources. This will effectively eliminate potential impacts on surface water quality.

Both runoff volume and suspended solids concentrations can increase during and after construction. The typical suspended solids (SS) concentration from different areas is provided in **Table 5-23**.

Table 5-23: Typical Suspended Solids Concentration in Runoff

Source Area	Suspended Solids Concentration
Landscaped area	500 mg/L
Construction site	10,000 mg/L
Unpaved parking	250 mg/L
Detention pond water	10 mg/L

Source: Pitt and Clark. 2002[1]

Any siltation from surface runoff generated during construction activities is unlikely to travel far. Sustained elevated turbidity levels from runoff can reduce transmission of sunlight, thus limiting photosynthesis. In turn, this can reduce the level of oxygen in the water. Organic matter introduced into a watercourse can lead to further de-oxygenation as the organic matter is decomposed by micro-organisms and result in eutrophication. If oxygen levels fall below the natural DO variability in a system, flora phytoplankton, zooplankton and benthos diversity and abundance could decline.

Without mitigation measures, impacts to water quality and aquatic habitat are therefore expected to be local in extent, short-term in duration, reversible, and of medium magnitude. The importance of a runoff event (if it occurs) impacting these species is medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of is determined to be Possible C.

The Risk Ranking of impacts to on surface water quality and aquatic biota is rated as medium.

Severity	Probability	Risk Ranking
Localized Impact	Possible	Medium
3	C	3C

Management Measures

Impacts to water quality and aquatic biota can be mitigated through the use of the following measures:

- The proposed campsite and access roads will be selected to minimize areas requiring soil stabilization.
- Provide drip pans and absorbents to contain any spillage.
- Provide drainage and sediment traps around project area to reduce suspended particles in runoff from the well site and to contain minor oil spills.
- Avoid construction of the campsite and/or access road in areas where such construction obstructs water drainage.
- Prohibit workers from cleaning machines/equipment in/near a public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources.
- Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil).

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[1] Pitt, R. and S. Clark. 2002. Emerging stormwater controls for critical areas. Pp. 104-136. In Wet weather flow in the urban watershed. Technology and Management. Field, R. and D. Sullivan. (Eds)

Residual Risk

With these management measures, the likelihood of impacts to water quality and aquatic habits is determined to be Unlikely B; while there will be Minor impact (2) on environment resulting in low residual negative risk (2B).

5.4.1.7. Hydrology and Groundwater Quality

Hydrogeology within the project area varies depending on the characteristics of geology and topography. Groundwater sources can be divided into two types of aquifers: groundwater embedded in unconsolidated aquifers and groundwater embedded in consolidated aquifers. Aquifers in the Central Region vary widely in quantity and quality due to the irregularity in both lateral and vertical directions, and varying lithological and hydrological conditions of Alluvial and Ayeyarwady aquifers. During the Blocks Baseline Survey, groundwater table depths were found to vary from 5 m to 100 m. Groundwater quality also varies, but is generally saline east of the Ayeyarwady River.

There are two main activities that can impact the hydrology and quality of groundwater, namely drilling of shot holes and shooting/recording.

Groundwater hydrology and quality impacts from drilling of shot holes

The shot holes are to be drilled to a depth of 10-30 m, which is in the range of groundwater level (5-100 m). There is a potential for drilling to impact groundwater quality by introducing sediment or other contaminants to the groundwater from the surface.

However, the project team has specified a 100 m safety distance from a shot hole to groundwater well (**Table 5-30**). Additionally, if PCMI discovers groundwater in the course of seismic operations, they will report to MOGE. In the unlikely case of drilling into a groundwater well that produces water, this hole will be plugged with heavy muds, typical of maintaining pressure when drilling oil or gas wells.

Groundwater hydrology and quality impacts from shooting/recording

If shooting/recording operates close to a groundwater well (less than safety distance), the structure of the groundwater well could be affected, such as increase clogging of soil pores.

In 1978 several major studies were commissioned in Alberta to determine the effects of seismic shooting on water wells. Twenty areas were selected by The Alberta Research Council, The Alberta Department of Energy and Natural Resources and The University of Alberta. A basic objective was to establish seismic parameters such as charge size and setback distance which would demonstrably change the properties of a domestic water well. A down-the-hole TV camera was used to monitor physical damage in the wells. All projects started with one or two kilograms of explosive at distances of 180 metres or more. This was then intensified by shooting increasingly larger charges closer and closer to wells. All wells were eventually subjected to bombardment which peaked at 22 kilograms only six metres from wells. In one study, a charge of 15 kilograms was detonated only 3.9 metres from a well. No damage was ever observed, and no permanent changes were observed which would have been noticeable in a domestic well. (Summary Of Previous Studies Of The Effect Of Seismic Shooting On Water Wells In Alberta, I. C. Ross ICI Canada Inc. Calgary March 1995)

The project team has specified a safety distance from shot holes to any groundwater well; therefore, this impact is expected to be minimal.

After shooting/recording, explosives and detonators are almost completely burned. The major residuals will be nitrogen compounds, carbon dioxide, and water. These remains will be collected and disposed. Therefore, shooting/recording will not affect groundwater quality.

Without mitigation measures, impacts on groundwater hydrology and quality from shooting/recording are expected to be local in extent, short-term in duration, reversible and of small magnitude.

Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. Probability is determined to be Possible C.

The Risk Ranking of impacts to terrestrial flora is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to ground water quality and hydrology can be mitigated through the use of the following measures:

- Should water flow from the shot hole, the hold must be plugged with suitable weight muds.
- Use suitable charge and shot hole depth for local geology.
- Provide drip pans and absorbents to contain any spillage.
- Provide drainage and sediment traps around project area to reduce suspended particles in runoff from the well site and to contain minor oil spills.
- Prohibit workers from cleaning machines/equipment in/near a public water source.
- Line waste pits.
- Collect sewage in septic tanks.
- Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil).

With these management measures, the likelihood of impacts to hydrology and ground water quality is determined to be unlikely B; while there will be slight impact (1) on people, environment, assets or reputation, resulting in low residual risk (1B).

5.4.2. Vehicle Movements

Impact Assessment

The potential impacts from the movement of vehicles associated with the seismic campaign are:

- Disturbance leading to behavioral changes or displacement of fauna.
- Disturbance to traffic
- Increased likelihood of incidents

5.4.2.1. Disturbance Leading to Behavioural Changes or Displacement of Fauna

The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation. Some behavioural disturbance may occur for short periods if fauna are present or near access road and project site.

Without mitigation measures, impacts to terrestrial fauna are therefore expected to be local in extent, short-term in duration, reversible, of low magnitude. The importance of vehicle movements impacting these species is low. Given these impact criteria considerations the severity is determined to be a **Slight impact** for environment. The probability of these impacts occurring is Likely (D).

The Risk Ranking of impacts to terrestrial fauna is rated as medium.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1 D

5.4.2.2. Disturbance to traffic

The mobilization and demobilization of the seismic personal and the construction of the campsite may cause disruption to local traffic. This is also dealt further in the Social Impact Assessment.

Management Measures

In order to minimize potential impacts to fauna from vehicle and rig movements associated with the project the following management measures will be adhered to:

- Vehicles will take direct routes where possible and avoid significant habitat areas.
- Construction vehicles will follow speed limits.
- Escort vehicles for wide load that have wide load signs and flashing warning lights.
- Follow local transportation laws and regulations.

Residual Risk

With these management measures, the likelihood of impacts from vehicle and equipment movements is determined to be Possible C; while there will be slight impact (1) environment, resulting in low residual negative risk (1 C).

5.4.3. Air Emissions

Air quality impacts from the operation of a 3D-seismic survey consist of dust dispersion (from vehicles, vehicles transporting equipment, materials, and personnel; and clearing of vegetation from the sites) and air pollutants (vehicle transportation and energy use for drilling shot holes). The air quality impacts are assessed below.

5.4.3.1. Dust dispersion from vehicle use

For this project, dust will be generated from transportation on unpaved roads. Equipment, materials and workers will be transported in light 4-wheel drive and pick-up trucks. Approximately 100 general-use vehicles and trucks will be used for the seismic survey each day, There are 2 main highways and at least 5 laterite or unpaved roads that can be used to access the project area. However, suspended dust particles from these roads are relatively large, and thus they are expected to disperse little and settle rapidly to the ground.

The concentrations of total suspended particulate (TSP) and particulate matter with a diameter of 10 micrometers or less (PM-10), averaged over 24 hours, and were recorded during the environmental baseline Survey. The average daily monitoring results showed that TSP concentrations measured at the three sampling stations ranged from 0.080 – 0.174 mg/m^3.

There are no air quality standards in Myanmar. Therefore both WHO air quality guidelines (2000, updated 2005) and NAAQS (USEPA) which were designed as limits for protection of public health, welfare and environment were used to compare with the results of the baseline survey and to determine the baseline status of air quality

Measured TSP concentrations in some stations in the project area were over the ambient air standard according to WHO air quality guidelines (2000, updated 2005) (not exceeding 0.100 mg/m^3). Average daily concentrations of PM10 measured at the sampling stations ranged from 0.080 – 0.154 mg/m^3, all of those which exceed the WHO air quality guidelines (2000, updated 2005) (not exceeding 0.050 mg/m^3. The air quality is consistent with that of a sparsely-populated rural setting. It is conceivable that without mitigation measurement, there will be short-term increase in dust near certain roads and along the seismic lines as a result of the project activities. This might lead to slight increases in TSP and PM10 near those roads. But those increases would be short-term in duration and no different from any other vehicles currently travelling these roads.

Without mitigation measures, air quality impacts from transportation and vehicle use are thus expected to be local in extent, short-term in duration, reversible and of small magnitude. The project team specifies mitigation measures for decreasing dust dispersion by limiting car velocity and sprinkling water on unpaved roads. These mitigation measures will reduce the amount of dust dispersing into the atmosphere.

5.4.3.2. Dust dispersion from shooting/recording

For this 3D-seismic survey, each shot hole will have a diameter of 3 inches (7.62 cm) and depth of 10-30 m and the shooting area for each shot hole will be approximately10 m^2; shooting will be done by a field recorder. This activity may cause dust dispersion around the mouth of the shot holes. It is expected that the contractor will cover 12.5 km/day and space each shooting point about 50 m apart. Therefore, shooting will total about 250 points/day. Each hole will be shot until the shooting for each area is completed as planned before moving to the next area.

The amount of dust dispersion from this activity can be estimated from an equation for mine explosion (US EPA, 1985) as shown below.

$$Emission = \frac{961\,A^{0.8}}{D^{1.8} * M^{1.9}}$$

Where Emission = Amount of dust dispersion with a particle size less than 30 micron (in pound/shooting point; 1 pound = 0.454kg)

A = Shooting area (in ft^2; 1 m^2 = 10.764 ft^2)

D = Depth of shot hole (in ft; 1 m = 3.281 ft)

M = Percentage of soil moisture, with a range of 8-37% (In this case, 9.35% (from survey) is used)

Table 5-23 gives the estimation of dust dispersion (dust emission) generated from a single hole.

Table 5-23: Dust Emissions Generated from Shot Holes

Type of shot hole	Depth of shot hole (m)	Dust emission (kg/shooting point)	Total dust emission (kg/day)[1] (Calculated from 250 shooting point/day)
Single-hole	10-30	0.11-0.81	30-203

The total amount of dust dispersion generated per day from all shot holes is 30-203 kg/day. Dust dispersion will only occur near the line survey over a short period of time and this dust will quickly settle out near the shot hole. Moreover, community health will not be affected as the survey team will avoid community areas in accordance with the safety distance standard.

5.4.3.3. Greenhouse gases (GHG) generated by fuel combustion

The main impacts from fuel combustion are greenhouse gas (GHG) emissions. GHG emissions from energy use, in the form of diesel generators, drillers, and mobile combustion, are estimated following the Tier 1 approach of IPCC (2006) for stationary combustion and mobile combustion. GHG emissions are estimated using emission factors and global warming potentials for the three main greenhouse gases (CO_2, CH_4 and N_2O).

Energy Use by Generators and Drillers (Stationary Combustion)

Fuel consumption of the generators is estimated to amount to approximately 2,232 L/day (see **Section 2.7.8.2**), and the flushing drillers are expected to consume about 20 L/day each, with 50 drillers totalling 1,000 L/day.

Greenhouse gas emissions in terms of CO_2 equivalent are estimated according to the emission factors presented in **Table 5-24** (IPCC, 2006), and the following equation:

$$Emissions_{GHG,\,fuel} = Fuel\ Consumption_{fuel} \text{ x } Emission\ Factor_{GHG,\,fuel} \qquad \text{Equation 5-1}$$

where:

$Emissions_{GHG,\,fuel}$ = emissions of a given GHG by type of fuel (kg GHG)

$Fuel\ Consumption_{fuel}$ = amount of fuel combusted (TJ)

$Emission\ Factor_{GHG,\,fuel}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ)

Using unit conversion factors of 1 kg = 10^{-3} tonne = 10^{-6} Gg, and the IPCC default net calorific value for gas/diesel oil of 43.33 TJ/Gg, fuel consumption (in terms of energy) can be calculated as follows:

$$\begin{aligned} Fuel\ Consumption_{Diesel} &= \text{Diesel Use (L/day) x Diesel Density (0.8397 kg/L}^{2}\text{) x } 10^{-6} \text{ Gg/kg x 43.33 (TJ/Gg)} \qquad \text{Equation 5-2} \\ &= 3{,}232 \text{ (L/day) x 0.8397 kg/L x } 10^{-6} \text{ Gg/kg x 43.33 (TJ/Gg)} \\ &= 0.118 \text{ TJ/day} \end{aligned}$$

$Emission\ Factor_{CO2,\,Diesel}$ = 74,346.6 kg CO_2 eq/TJ (from **Table 5-24**)

resulting in:

$$\begin{aligned} Emissions_{CO2,\,Diesel} \text{ (kg)} &= 0.118 \text{ TJ/day x 74,346.6 kg } CO_2 \text{ eq/TJ} \\ &= 8{,}743 \text{ kg } CO_2\text{/day} \\ &= 8.74 \text{ tonnes } CO_2\text{/day} \end{aligned}$$

For a total of 160 days of operation, the total emission of greenhouse gases from generators during the seismic operation is therefore estimated to be at a maximum of 1398 tonnes.

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[2] IEA (2004), Density of Oil Products, Energy Statistics Working Group Meeting

Table 5-24: Emission Factor for Fuel Use by Generators (Stationary Combustion)

Types	Unit	CH_4	N_2O	CO_2	Total GHG
Diesel	kg/TJ	3	0.6	74,100	
	kg CO_2 eq*/TJ	69	177.6	74,100	74,346.6

Source: IPCC (2006)
* Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

Energy Use for Vehicle Transportation

General-use vehicles, assuming they are Class 2A (2,722 – 3,856 kg, light duty trucks) will consume an average of 5.95 L/km (U.S. Department of Energy, 2010, http://cta.ornl.gov/data/chapter4.shtml). Assuming an approximate distance travelled of 80 km/day, and 100 vehicles, the general-use vehicles for the project will consume approximately 53,312 L/day.

GHG emissions from general vehicle transportation are estimated following the Tier 1 approach of the IPCC guideline (**Equation 5-1**) for mobile on road combustion, with an emission factor for mobile road combustion of 74,853 kg CO_2 eq/TJ (from **Table 5-25**) and fuel consumption of 53,312 L/day (1.94 TJ/day, estimated using **Equation 5-2**). This results in CO_2 emission of 145.19 tonnes CO_2 eq/day. For a total of 160 days of seismic operations, the maximum total emission of greenhouse gases from general vehicle use is therefore estimated to be 23,230 tonnes.

Table 5-25: Emission Factor for Fuel Use by Generators (Mobile Combustion – Road Transportation)

Types	Unit	CH_4	N_2O	CO_2	Total
Diesel	kg/TJ	3.9	3.9	74,100	
	kg CO_2 eq*/TJ	89.7	1,154.4	74,100	75,344.1

Source: IPCC (2006)
* Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

Energy Use for Seismic Support Trucks

The seismic support trucks consume approximately 95.53 L/hour (at 400 kW power) for each truck, corresponding to a worst case of 4,585 L/day, assuming operation of 4 trucks for 12 hours per day.

GHG emissions from seismic operation are estimated following the Tier 1 approach of the IPCC guideline (**Equation 5-1**) for mobile off-road combustion, with an emission factor for mobile off-road combustion of 82,661.1 kg CO_2 eq/TJ (from **Table 5-26**) and fuel consumption of 4,585 L/day (0.167TJ/day, estimated using **Equation 5-2**). This results in CO_2 emission of 13.79 tonnes CO_2 eq/day. For a total of 160 days of seismic operations, the maximum total emission of greenhouse gases from general vehicle use is therefore estimated to be 2,206 tonnes.

Table 5-26: Emission Factor for Fuel Use by Generators (Mobile Combustion – Offroad Transportation, Industry)

Types	Unit	CH_4	N_2O	CO_2	Total
Diesel	kg/TJ	4.15	28.6	74,100	
	kg CO_2 eq*/TJ	95.45	8,465.6	74,100	82,661.1

Source: IPCC (2006)
* Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

Total Combined GHG Emissions

The total release of equivalent CO_2 during the seismic operations is estimated to be 26,834 tonnes of CO_2 eq, as shown in **Table 5-27**. Compared to Myanmar's CO_2 release of 12,775,830 ton in 2008 (World Bank, 2008), the total GHG releases from the preparation phase of this project are insignificant (approximately 0.21%), and therefore will not significantly impact the environment.

Table 5-27: Estimated Total GHG Emissions for Site Preparation Phase

Project Phase	Activity	One Time CO_2 Release (ton CO_2)
Entire Seismic Operation	Generators and drillers (stationary sources)	1,398
	General vehicle transportation	23,230
	Seismic Support trucks	2,206
	Total	26,834

Without mitigation measures, air quality impacts from air pollutants generated by the combustion of engines are thus expected to be local in extent, short-term in duration, reversible and of small magnitude.

Without mitigation measures, the impact from greenhouse gas emissions during the seismic program are considered to be a global issue, short-term in duration, reversible and of low magnitude. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of the impact occurring is determined to be Likely D.

The Risk Ranking of impacts from GHG emissions is low.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1D

Management Measures

Impacts from GHG emissions can be mitigated through the use of the following measures:

- Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer.
- Maintain road going vehicles to ensure that fuel use is efficient and emissions are within acceptable limits.
- Instruct drivers on the benefits of driving practices that reduce the risk of accidents, fuel consumption and dust generation.
- Turn off all vehicles and equipment when not in use as well as prohibit vehicles from idling.
- To maximize energy efficiency and design facilities to minimize energy use.

Residual Risk

With these management measures, the likelihood of impacts from GHG emissions is determined to be Possible C; while there will be a slight impact (1) on environment at a global level, resulting in low residual negative risk.

5.4.4. Noise and Vibration

Noise

Noise during 3D-seismic survey will be generated from transportation of equipment, material, and personnel, from explosives, and from drilling and seismic equipment. Noise levels at various distances from the sources described below, were calculated according to:

$$Lp_2 = Lp_1 - 20 \log (r_2/r_1)$$

Where Lp_1 = Noise level at a distance of r_1 from the point source (dB(A))
Lp_2 = Noise level at a distance of r_2 from the point source (dB(A))
r_1 = Distance from a point source to a noise level point at Lp_1 (m)
r_2 = Distance from point source to a noise level point at Lp_2(m)

The equation above assumes that there is no buffer from vegetation or topography between a source and a receptor and is therefore considered to represent the worst-case scenario.

Noise levels produced from surveyvehicles are estimated to be at most 60 to 70 dB(A) at 1 m from the source. When compared to the Thailand noise level standard of a vehicle at less than 85 dB(A) at 7.5 m from the source (the Notification of Ministry of Natural Resource and Environment: the specification of noise level of vehicle on 7 July, 2003), the noise level of vehicles for the Project would not exceed the standard value (**Table 5-28**). The further distance from the noise source, the less noise is detected (**Table 5-28**). Moreover, survey activities are scheduled for daylight hours thus, vehicle noise will not contribute to noise levels at night when the ambient noise is the lowest. Therefore, vehicle noise will not occur continuously and will not affect people in the project area.

Table 5-28:Project Noise Decay

Distance from Source (m)	Noise Level (dB(A))	
	Seismic Vehicles	Drilling Equipment (i.e. jackhammer with compressor)
1	70.0	112
7.5	52.4	94.5
100	30.0	72.0
250	22.0	64.0
500	16.0	58.0
750	12.5	54.5
1000	10.0	52.0

Drilling equipment will generate noise in daylight hours during the drilling of shot holes. The noise will be about 112 dB(A) at 1 m from the source (Federal Transit Administration, 2006), declining to lower limits of ambient noise (approximately 72 dB(A)) at 100 m from the source (**Table 5-28**).

Terrestrial fauna can be affected by noise from vehicles transporting equipment and personnel, and noise from drilling equipment. Noise level exceeding 55 dB is known to affect terrestrial fauna through physiological and behavioral changes (Checker, 1980), diminish habitat value, and disrupt survival activities (e.g., injury, energy loss, decreased food intake, disturbed habitat avoidance, and reproductive loss).

Noise level generated by vehicles and drilling equipment are about 60-70 dB (A) and 112 dB (A), respectively, at 1 m from the source. Noise level from vehicles would decrease to less than 55 dB (A) within a distance of 10 m from vehicles while noise level from drilling equipment can decrease to less than 55 dB (A) at 710 m from the source. This applies to protected areas as well, therefore impact is considered to be low. However, the terrestrial fauna has a wide range of habitat and is mobile and can adapt to changing conditions by moving away temporarily. Moreover, large perennial vegetation, which is habitat for small animals, will not be cut. Ecology around the project area is also capable of recovering rapidly after the survey.

Explosives used for shooting will be small in amount and will be buried at a depth of 10-30m. Therefore, the generated noise will be brief and at low levels. Moreover, seismic shots will only be conducted during daylight hours. Noise and vibration monitoring has been previously conducted during shot hole tests as part of a similar 3D-seismic survey as shown in **Table 5-29** (CGG Veritas, 2008). The noise generated from firing two shot holes were monitored at a distance of 50 m. The measured noise levels were detectable but were only slightly above ambient background; and the maximum noise (L_{max}) measured was 72.4 dB (A). The measured L_{max} values were well below the ambient noise standards (L_{max} not more than 115 dB (A)).

Table 5-29: Noise and Vibration Measurement from Shot Hole Testingat 50 m from shot hole

No. of Shooting	Depth of Shot Hole (Meter)	Charge Size (Kilograms)	Noise Level (dB(A))		Vibration	
			Background Noise	L_{max}	PPV (mm/s)	Frequency (Hz)
1	9	1.5	64.2	72.4	4.45	14
2	9	1.5	61.5	67.1	4.64	11

Source: CGGVeritas, 2008

Noise generated during the seismic survey is expected to be small, localised and confined to daytime only.

Vibration

Vibrations can damage the structure of buildings and cause human responses such as stress and annoyance. The vibration assessment focuses on shooting/recording as an important activity. This assessment is based on the peak particle velocity from explosion.

Peak particle velocity (*V*) is a measure of the maximum rate of displacement of ground particles (with vertical, longitudinal and transverse components) resulting from vibrations produced by blasts. *V* is an industrial standard used to describe the effects of vibration from explosion and can be calculated using the formula (Department of Mineral Fuels, Thailand):

$$V = 600\left(\frac{r}{\sqrt{W}}\right)^{-1.4}$$

Where V = Peak particle velocity (mm/sec)
r = Distance from charge to measured point (m)
W= Weight of explosive (kg) (In this case, 2.0 kg)
600 = Coefficient with a unit of √kg/sec

For this project, safety distances from shot holes to various sensitive areas have been set at a range of 10 to 500 m. At these safety distances, the peak particle velocity is estimated to range from 0.16 to 38.80 mm/sec (**Table 5-30**).

Table 5-30: Explosion Vibration Level Measurement from Shot Hole to Sensitive Area at a Safety Distance

Safety distance for explosive source (m)	Sensitive area	Peak particle velocity (mm/sec)	Safety standard[1] (mm/sec)	Safety standard[2] (mm/sec)
10	- Dirt roads/tracks	38.80	Less than 50.8	-
20	- Metal and PVC piped water well - Telephone lines - Main roads/highways	14.70		-
50	- Oil or gas well - Wooden house - Brick or concrete house - Cemetery - Concrete bridge - Canals (concrete) - Railway tracks - Water resources	4.08		Less than 10
60	- Pipeline	3.16		-
100	- Concrete ring water well - Dams (earth or concrete) - High voltage power lines (large towers)	1.55		Less than 25
	- Monastery/school/medical nursing place/government offices	1.55		Less than 10
500	Ancient monuments/archaeological sites	0.16		Less than 2

Note: (1) Safety standard of vibration of soil layer from explosion, Department of Mineral Resources, 1991
(2) Safety standard of vibration from explosion followed by Australian Standard AS 2187-1983

The predicted peak particle velocities estimated for the project safety distances are all considerably lower than the safety standard values specified by the Department of Mineral Resources and the Australian Standard.

More specific information on building damage and vibration is given in **Table 5-31**. It is noted that the lowest limit for minor damage (13 mm/s) might be expected at a distance of 22 m from the shot hole. For this project, the only sensitive areas that are likely to be closer than 22 m are dirt roads.

Table 5-31: Expected Damage at Various Peak Particle Velocities

Expected Damage	PPV (mm/s)
Lower limit for damage to plaster walls	13
Lower limit for dry wall structures	19
Minor damage	70
Greater than 50% chance of minor damage to structures	140
50% chance of major damage	190

Source: Australian Standards Explosive Code AS2187.2-1993

The frequency of vibrations is also important in assessing the effects of explosion on structures and human responses: lower frequencies typically cause higher levels of impacts. The standard of vibrations from mining and quarrying relates peak particle velocity to the vibration frequency and absolute displacement, e.g., the peak particle velocity is not to exceed 4.7 mm/s with 0.75 mm displacement at 1 Hz and the peak particle velocity is not to exceed 50.8 mm/s with 0.20 mm displacement at 40 Hz.

Vibration monitoring data were collected from previous 3D-seismic survey tests (**Table 5-30**). At a distance of 50 m, all vibration levels were well below the Vibration from Mining and Quarry Standards. The maximum vibration recorded was 4.64 mm/sec at frequency of 11 Hz, much lower than the standard of 27.6 mm/s at frequency of 22 Hz.

Assuming the frequency of vibration generated from shot hole firing of this project is similar to that generated from shot hole firing during the previous project, it can be concluded that vibration generated from shot hole firing of 3D-seismic survey will not exceed the vibration standard and will not affect the structure of buildings.

From the above assessment, shooting of shot holes will not impact building structures or communities provided the safety distances are adhered to.

Thus, impacts from noise and vibrations created by the seismic survey are expected to be local in extent, short-term in duration, reversible and of small magnitude.

The importance of noise and vibration impacts is low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of impacts occurring is determined to be Very Likely E.

The Risk Ranking of impacts to terrestrial fauna is rated as medium.

Severity	Probability	Risk Ranking
Minor Impact	Very Likely	Medium
2	E	2E

Management Measures

Impacts from noise and vibration can be mitigated through the use of the following mitigation measures:

- Vehicles and equipment transportation will avoid sensitive environmental areas.
- Construction activities and Vehicle/equipment movements will be restricted to daylight hours.
- Limit vegetation removal to a minimum.
- Schedule operation of noisy construction equipment at different times.
- Ensure use of mufflers on diesel/gas driven machinery.
- Use low noise equipment.
- Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer.
- Turn equipment off when not in use.
- Use enclosures when possible to contain noise on site.
- Implement transportation plan.
- Materials should be lowered when practical and not dropped.
- Conduct PPV testing and follow Shot Hole set back distances.

Residual Risk

With these management measures, the likelihood of impacts noise and vibration is determined to be likely D; while there will be slight impact (1) environment, resulting in low residual negative risk (1 D).

5.4.5. Light

Project components of the seismic program are to be artificially lit to varying extents during all phases of the project, therefore generating light spill. Light emissions will occur from vehicles and the camp site. Site preparation and abandonment will be carried out in daylight. Hence, light impacts will not be relevant during these project phases. The seismic program is planned to be conducted during the day only. Lighting on the site will be kept to a minimum and directed so that, consistent with safety and security, as little as possible falls outside the campsite area and should be partly or fully hidden by scattered trees, thickets and topography.

Artificial light can disrupt biological processes that rely on natural light for visual cues. Terrestrial fauna that are known to be sensitive to light and may be disorientated, attracted to or repelled by light spill, include mammals, reptiles and birds. The amount of light spill emanating from project activities will vary according to the number of light sources, wavelength and intensity of light sources, location of and/or placement of fittings and the method of light switching (rapid or gradual turning on of light sources).

This section discusses the impacts of light spill on ecological receptors identified within or adjacent to the project area.

Light Sources

Sources of artificial light for project will include:

- Functional lighting on vehicles and at the camp site

Functional Lighting

Functional lighting is required on vehicles and at the camp site that provides a safe working environment for personnel. Lighting typically consists of bright white lights, used in accordance with safety requirements. Working lights will be directed into the site so that impacts from working lights will be minimized off-site.

Impact Assessment

Fauna that use visual cues for orientation, navigation, or other purposes may be disoriented by, attracted to, or repelled by artificial light sources. Potential impacts from artificial lighting associated with the project are:

- Disturbance to fauna

5.4.5.1. Disturbance to Terrestrial Fauna

Any impacts from light on wildlife will be limited to the immediate vicinity of the campsite. Animals that are disturbed will avoid the area during the period of occupation. Insects will be attracted to the lights, which is likely to provide an easy food source for birds and other wildlife species.

Without mitigation measures, impacts to terrestrial fauna are expected to be local in extent, short-term in duration, reversible, of low magnitude. Therefore, the importance of a light impacting these species is low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of these impacts occurring is determined to be Likely (D).

The Risk Ranking of impacts to terrestrial fauna is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1D

Management Measures

Impacts from light on terrestrial fauna can be mitigated through the use of the following mitigation measures:

- Campsite located in area distant to sensitive receptors.
- Keep night lighting to a minimum, consistent with safety and security.
- Direct lighting to the inside of the well sites.

Residual Risk

With these management measures, the likelihood of impacts to terrestrial fauna is determined to be Possible C; while there will be slight impact (1) environment, resulting in low residual negative risk (1 C).

5.4.6. Liquid Waste

Liquid wastes will be generated during the seismic program in varying quantities and contain both hazardous and non-hazardous materials. Liquid wastes discussed in this section are:

- Sewage and sludge
- campsite drainage
- Infiltration

Impact Assessment

5.4.6.1. Sewage and Sludge

Sewage and sludge (grey water generated from domestic processes such as dish washing, laundry and showers) will be generated at the campsite. The disposal of sewage and sludge will be managed in accordance with PETRONAS Waste Management Standards.

Sewage from on-site workforce has the potential to pollute soil, surface and ground water resources unless controlled. Sewage will be collected in concrete lined septic tanks; the greywater will discharge below ground “leach” drain type system. The sewage sludge will be removed once the tanks are full and treated at an approved treatment facility.

Without mitigation measures, impact from sewage and sludge will be local in extent and transient, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment.

The Risk Ranking of impacts from sewage and sludge is rated as low.

Severity	Probability	Risk Ranking
Minor Impact	Possible	Low
2	C	2C

Management Measures

Impacts from sewage and sludge liquid waste can be mitigated through the use of the following measures:

- Install 1-2 concrete lined septic tanks on each well site for holding sewage. Grey water to be discharged to infiltration and to an evaporation pit away from site and away from community water supplies.
- The personnel camp will collect and transport to an approved treatment plan.

Residual Risk

With these management measures, the likelihood of impacts from sewage and sludge liquid waste is determined to be possible C; while there will be a slight impact (1) on environment, resulting in low residual negative risk 1 C.

5.4.6.2. Campsite Drainage

The campsite will have drainage from rainwater and wash down water that may contain minor quantities of oil, grease and detergents. For the campsite, a perimeter drainage system will be constructed around the levelled area to direct runoff into one waste pit.

The uncontaminated runoff water from the campsite will be discharge to a drainage system surrounding the area passing with an offsite flow rate for the extreme ½ hr storm. Runoff after campsite construction is greater than runoff prior to construction; the compacted granular fill will inhibit infiltration compared to pre-construction conditions.

The contaminated runoff water will drain to a waste pit. The waste pit will be designed to contain more rainfall than the rainfall intensity of a ½-hr duration storm or a month's equivalent rainfall in one hour. In the unlikely event that the waste pit should become full and overflow, tanker trucks are prepared to drain rainwater from the pit. This will be disposed of at approved disposal site.

On site fuel will be stored in steel tanks that sit on the concrete rig pad which is further in an area lined with a tarpaulin and surrounded by a bund wall with 110-120% containment capacity.

Without mitigation measures, impact from campsite drainage will be local in extent, short-term in duration, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of the impact occurring is considered to be Unlikely (B).

The Risk Ranking of impacts from drill site drainage is rated as low.

Severity	Probability	Risk Ranking
Minor Impact	Unlikely	Low
2	B	2B

Management Measures

Impacts from runoff can be mitigated through the use of the following measures:

- Prohibit workers from cleaning machines/equipment nearby public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources.
- Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil).
- Construct one lined waste pit on each well site for potentially contaminated runoff and spills, surrounded by 0.2 m high bund that will help prevent run-off into the environment. Monitor and transport waste to prevent any overflow from the waste pit.
- Store fuel storage tank on concrete rig pad. The storage units will be surrounded by a bund wall that is able to contain 110-120% of the capacity of the tank, in case of spill.
- Construct drainage system (that includes a series of oil traps) around campsite including the concrete pad for generators to divert any spills into the waste pit.
- If treatment systems are not available or cannot meet the oil-in-water content specification, the contaminated water will be stored in suitable containers and transported for treatment and/or disposal by a certified waste oil disposal contractor.

Residual Risk

With these management measures, the likelihood of impacts from drill site drainage is determined to be unlikely B; while there will be slight impact (1) on environment, resulting in low residual negative risk.

5.4.7. Solid Waste & Hazardous Waste

Impact Assessment

Solid wastes produced will consist of both hazardous and nonhazardous materials. For all solid wastes, a policy of reduce, reuse and recycle will be implemented, where possible, across all phases of the project.

Management of solid waste will be undertaken by PCMI in accordance with PETRONAS standards. For each solid waste type generated the most appropriate method of management will be determined and documented in a Waste Management Plan. Solid wastes to be produced during the seismic program will consist of:

- Non-hazardous waste.
    - General non-hazardous wastes.
    - Food and kitchen wastes.
- Hazardous waste.
    - General hazardous wastes (paints, batteries, medical waste etc.)

5.4.7.1. Non-Hazardous Solid Waste

Types of waste and potential impact caused are summarised in **Table 5-32**.

Table 5-32: Types of Solid Waste and Potential Impacts

Waste Type	Potential Impacts
Food Waste	• Odour • Attraction of pests and disease vectors
Paper and plastic packaging, rags, plastic, glass	• Fire hazard • Wind-blown litter • Fouling of surface water
Metal and plastic drums, sacks and bags	• Fire hazard • Wind-blown litter • Fouling of surface water • Contamination of soil and water
Wooden packaging	• Fire hazard
Scrap Metal	• Contamination of soil and water • Public Safety

5.4.7.1.(1). General non-hazardous wastes

General non-hazardous waste will be generated from the campsite and vehicles during the seismic program. General non-hazardous wastes may include scrap metal, packaging, wood, cardboard, paper and empty containers. Improper handling and disposal of non-hazardous materials may cause adverse effects by materials spills or (as in the case of domestic wastes) being carried away by wind, vectors, etc. Burning some types of innocuous-looking waste types (especially plastics) may create toxic tar or even extremely toxic dioxin. Depending on their pathway, the end result would be air, soil, groundwater, freshwater life contamination. General non-hazardous solid wastes will be segregated at source into recyclable and non-recyclable wastes and stored in marked containers. Recyclable materials will be given to local recycling facilities for a net economic benefit and the remaining materials will disposed at a site approved by the Local Authority.

Without mitigation measures, impact from non-hazardous waste disposal will be local in extent and transient, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of this impact occurring is determined to be Likely (D).

The Risk Ranking of impacts from general non-hazardous solid waste is rated as medium.

Severity	Probability	Risk Ranking
Minor Impact	Likely	Medium
2	D	2 D

Management Measures

Impacts from general non-hazardous waste contamination can be mitigated through the use of the following measures:

- Waste reduction at the source will be considered in tenders by supply and construction contractors.
- A PCMI Waste Management Plan for this seismic campaign will be developed.
- Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site.
- Non-hazardous wastes will be sent to an approved dump site.

Residual Risk

With these management measures, the likelihood of impacts from general non-hazardous waste is determined to be Possible C; while there will be slight impact (1) on environment, resulting in a low residual negative risk (1 C).

5.4.7.1.(2). Food and kitchen waste

Food and kitchen wastes will be produced from the campsite. Organic refuse, if not stored properly, attracts vectors (rats, mosquitoes, flies, cockroaches, etc.) causing health threats and unsightliness. Food scraps will be segregated and transferred to local Township waste disposal facilities approved by Local Authority.

Without mitigation measures, impact from kitchen and food waste will be local in extent and transient, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **Slight impact** for environment and a slight benefit. The probability of this impact occurring is determined to be Likely (D).

The Risk Ranking of impacts from food and kitchen waste is rated as low and a slight benefit.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1 D

Management Measures

Impacts from food waste contamination can be mitigated through the use of the following measures:

- Food scraps and other kitchen wastes will be segregated and transferred to local government waste disposal facilities.
- Cooking oils and greases from the kitchen will be collected and transported to local Township waste disposal facilities for disposal.

Residual Risk

With these management measures, the likelihood of impacts from food and kitchen waste is determined to be Possible C; while there will be no impact (1) on environment, resulting in Low residual negative risk (1 C).

5.4.7.2. Hazardous Solid Waste

Impact Assessment

5.4.7.2.(1). Hazardous Wastes

The campsite will generate a low volume of hazardous waste including:

- Excess or spent chemicals.
- Paints and paint cans.
- Biological waste from medical facilities.
- Oil contaminated materials (e.g. sorbents, filters and rags).
- Waste oils.
- Drums and containers used for oil or chemical transportation and storage;
- Batteries.
- Fluorescent light tubes.

General hazardous solid wastes will be segregated at source into recyclable and non-recyclable wastes and stored in covered skips prior to transfer to an approved recycling contractor wherever practicable, or waste disposal site.

Hazardous wastes will be handled and stored in accordance with the material safety data sheets (MSDS) and tracked from source to its final destination. The estimated quantity of hazardous waste generated is 0.25 tonnes per month of activities.

Without mitigation measures, the impact from hazardous waste will be local in extent and transient, reversible and of medium magnitude, the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of these impacts occurring is determined to be Possible (C).

The Risk Ranking of impacts from general hazardous waste disposal is rated as low.

Severity	Probability	Risk Ranking
Localized Impact	Possible	Medium
3	C	3 C

Management Measures

Impacts from general hazardous waste contamination can be mitigated through the use of the following measures:

- Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS.
- General non-hazardous solid wastes will be managed in accordance with accepted international standards.
- Waste reduction at the source will be considered in tenders by supply and construction contractors.
- A PCMI Waste Management Plan for this seismic campaign will be developed.
- Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site.
- Hazardous wastes will be transported for disposal at a cement kiln.

- Hydrocarbons will be securely stored and use governed by safe operating procedures.
- Hydrocarbon spill containment and recovery equipment will be available near hydrocarbon storage.
- Procedures for response to hydrocarbon spills will be included in PCMI’s ERP.
- MSDS Sheets will be posted in areas where hydrocarbon is stored and with the ESH Officer.
- Construct lined waste pit at each campsite for potentially contaminated runoff and spills, lined with HPDE plastic to form an impermeable barrier that will help prevent run-off into the environment.
- Construct drainage system around campsite to divert any spills into the waste pit.
- Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious floor (e.g. tarpaulin sheet).
- Provide drip pans and absorbents to contain any spillage.

Residual Risk

With these management measures, the likelihood of impacts from hazardous waste is determined to be Unlikely B; while there will be minor impact (2) on environment, resulting in **Low** residual negative risk (2 B).

5.5. Seismic Social Impact Assessment

The purpose of a social impact assessment is to study the potential impacts from the project that might affect communities, and social issues. The social impact assessment in this report will assess impacts from the project to:

- human use values: land use, transportation, water supply and waste management;
- quality of life values: socio-economy, historical, archaeological and cultural resources; and

5.5.1. Change in Land Use

The project area mainly consists of agricultural and forested areas; other areas include communities, water sources, unoccupied areas, roads, etc. The main project activity that affects land use is site preparation for laying of seismic lines. The drilling team will drill shot holes far from sensitive areas (i.e., community, water source, road, archaeological sites, and etc.) according to specified safety distances. Most drilling will be in agricultural areas. To access the project area, the survey team may tread on crops along a 1-m wide path for the length of each seismic line. For drilling of one shot hole, the area of about 10 m^2 will be cleared of vegetation. Additionally, the path of the seismic support trucks will require cleared vegetation and will compact soil. The project team will assess these impacts and compensate stakeholders with the market price of their agricultural products for any lost crops resulting from the seismic survey. Severe or long-term damage to soils is not anticipated. Moreover, the project team will recover the seismic survey area by filling and leveling the ground to prepare for the following agricultural cycle.

In terms of compensation, if there is any impact on properties or crops of communities, PCMI will cooperate with MOGE and Local Authorities to address these impacts on land use and resolve any disputes.

The purchase of the land for the campsite will provide a significant financial benefit to landowners. While this land will be temporarily lost from agriculture production. If hydrocarbon resources are not found the land will be given back to the original land owners and restored to its original state However, for farm workers who do not own land, they may be displaced and possibly lose employment. The compensation program needs to specifically address this potentially vulnerable group.

The impacts from changes in land use will be local in extent, short term in duration, of major magnitude, reversible and of low to medium importance. The likelihood of land use impacts occurring is very likely. Given the short-term impact of this aspect and its return to its original state, it is determined to be a positive benefit as a result of the financial benefit to land owners.

The risk ranking of change in land use is ranked as low.

Severity	Probability	Risk Ranking
Positive	Likely	Positive
	D	D

Management Measures

Impacts from construction activities on land use can be mitigated through the use of the following measures:

- Transparent and fair compensation to land owners and users.
- Consider issue of displaced workers who may lose employment and who are not land owners.

- Ensure all permissions are obtained from land owners and local authorities. Provide summary to MOGE.
- Notify surrounding landowners 2 weeks before on location and time of project activities.
- Restoration of land to its original state within 6 months of project completion, where applicable.

Residual Risk

With these management measures, the likelihood of impacts from a change in land use is determined to be likely D; while there will be no negative effects (0) on the social environment, resulting in an overall positive benefit and no residual negative risk.

5.5.2. Transportation

Impact from transport of personnel and equipment

Transportation for the seismic survey consists of personnel and equipment transportation. Transportation of personnel and equipment is expected to occur with various size trucks, amounting to approximately 100 trips/day. There are several highways within the project area that will be used for this project. Local roads within districts and villages will also be used during the project period.

Transportation of personnel and equipment is not a continuing activity throughout the day. Getting to and from the working area will result in a temporary and local increase in vehicles on the roads. The increase of 100 trips per day will not result in a major increase in traffic.

Impacts from transportation of personnel and equipment can be mitigated through the use of the following measures:

- Follow speed limits of 80 km/hour on highways (unless otherwise posted), 60 km/hour on lateritic roads, 20 km/hour in villages or communities, and 80 km/hour on paved roads outside Yangon within the project site and on main roads.
- Ensure all vehicles are in good operating condition and comply with project safety standards. Drivers must be healthy, have valid licenses, and by no means allowed to drink alcohol or take forms of medicine or illicit drugs that can affect performance.
- Weight of the trucks shall not exceed the limit set by the Myanmar regulations to reduce damage to road surfaces or structures.
- Safety equipment and communication equipment must be installed on vehicles such as VHF radio, safety belts and portable fire extinguisher etc. as per company standards.
- Maintain and repair all public and private roads that are damaged by project activities.
- All vehicles must be left hand drive.

By following these mitigation measures, the potential impact on transportation can be minimized during site preparation.

Table 5-33: Speed Limits for PCMII Motor Vehicles

Vehicle Type	Highway (unless otherwise posted)	Normal Public Roads (Outside Yangon City)	Service Track, Laterite & Asphalt Roads	Villages & Community
Light Duty Vehicles	80 km/h	80 km/h	60 km/h	20 km/h
Heavy Duty Vehicles	80 km/h	80 km/h	60 km/h	20 km/h

Source: PCMI, 2014

Impact from transport of explosives

This seismic survey uses explosives as the seismic source. Explosives and detonators will be imported from overseas. After arrival, explosives and detonators will be transported by truck to a temporary storage area. The storage site will be approximately 50-km away from the field office. Without proper mitigation measures, this transport could be highly dangerous.

Explosives, detonators and accessories have been imported into Myanmar through PCMI. PCMI will especially pay serious attention to the security of explosives and detonators to be used in the seismic works. The seismic contractor under the contract with PCMI, will take care of the transportation and security through the cooperation by MOGE and any other relevant authorities. PCMI and the Seismic Contractor have to manage the explosive and detonator inventory records strictly and 24 hour security will be kept at the explosive magazine sites.

The project contractor has implemented mitigation measures for dangerous explosives transportation. Explosives transportation to the project site will use registered vehicles that comply with transportation of dangerous materials requirements.

Every day a contractor convoy will bring the explosives from the field storage to the line. The collection of the remaining amount will finish before dark. At the work site, explosives and detonators will be contained in secured day-boxes until used or returned to storage magazines. Explosive and detonator products will be transported separately in fully-enclosed, locked, fire-resistant fixed containers or compartments, separate from the passenger compartment. The use of trailers will not be permitted during explosives transport. Vehicles transporting explosives will operate in a safe manner consistent with prevailing road and weather conditions. In no case will a vehicle transporting explosives be operated at a speed in excess of 50 km/h. Vehicles transporting explosives will not be operated at greater than 80% of the manufacturer’s rated carrying capacity for the vehicle.

The mitigation measures required by laws and implemented by the contractor will reduce impacts from explosives transportation for the seismic survey to people who live along transportation routes. Should the unlikely event of an accident occur, it is conceivable that traffic could be affected for a short-time only.

Impacts from transportation of explosives transportation are expected to be local in extent, short-term in duration and of moderate magnitude.

Impact from shooting/recording

Most vehicles using these highways are personal cars, pick-ups, and motorcycles. The vehicles may generate noise and vibration that can disturb the recording. During the shooting, the project team will coordinate with traffic police for temporary road closures. All drivers must switch-off engines in order to prevent noise and vibration interference.

The impacts from increased traffic and traffic disruption will be local in extent, short-term in duration, reversible quickly, of minimal importance and of medium magnitude. As a result of these impact criteria considerations, severity is ranked as Slight (1). The probability of traffic increase/disruption without mitigation measures is ranked as Possible (C).

The Risk Ranking of increased traffic and traffic disruption is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from transportation can be mitigated through the use of the following measures:

- Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr on unsealed road).
- Notify the local authority on the oversized load and put a escort in-front of this convoy with horn and hazard lights.
- Restrict/ avoid movement of heavy equipment during rush hours.
- Provide traffic signs or flags at junction of access roads and main roads.
- Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.
- If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices.
- Strictly enforce training programs to reduce transport incident cases by its contractors.
- Restore any damage to roads as caused by contractor or company.
- Purchase or lease land for road access to campsite.
- Restrict local traffic on PCMI private access roads.
- Cooperate with Military for storage and transport of explosives.

Residual Risk

As the access road will be the busiest road, this now private road will restrict other local traffic. The project is short term.

With these management measures in place, the probability of impacts from increased traffic and traffic disruption is minimized to a ranking of Possible (C). The severity of the impact is considered to be slight. Therefore the overall residual risk of this impact occurring is considered as Low 1 C.

5.5.3. Water Supply

Water supply will be required for drilling of shot holes and for workers' activities. For general activities, water will be used from local portable water system. Water for drilling of shot holes will come from nearby natural water sources via pumping system. Using water for the project will not impact natural water sources in the area. If there is no natural water source near the survey site, a water truck will transport water to the site.

During the camp construction phase, water use will consist of water for dust suppression and cleaning and potable water for workers.

Access to and availability of water is an important issue to all communities. Community water wells are a critical piece of local infrastructure, and access to water to support domestic and farming requirement is critical.

Maximum daily water usage is expected to be 80 m^3 per day during drilling when the camp is accommodating a full crew (800 people).

All drinking water will be sourced from local retail suppliers and potable water will be from a deep water well installed on site so that it will not affect water supply for agricultural activities and communities within project area. If tube type wells are not successful or water not suitable, water will be sourced and transported by tanker from nearby reservoirs/rivers. Local authorities will be consulted before water hauling.

The impacts from water use by the project will be local in extent, short-term in duration, reversible, importance is low and of medium magnitude. These factors result in a Localized severity ranking (3).

The probability of impacts from water use without mitigation measures is determined to be Likely (D).

The Risk Ranking of water use is ranked as Medium.

Severity	Probability	Risk Ranking
Localized	Likely	Medium
3	D	3 D

Management Measures

Impacts from construction activities on water use will be mitigated through the use of the following measures:

- Obtain local approval for drilling a ground water well.
- PCMI to drill their own ground water well.
- Consult local community leaders before water hauling (if required).
- Potable water and industrial water, if taken by tube wells or tanker from nearby reservoirs/rivers, should not affect the availability of water to locals.

With these mitigation measures, the likelihood of impacts from water use is minimized during construction.

Residual Risk

Primarily as a result of the decision by PCMI to drill their own ground water well if possible, the probability of impacts occurring is considered to be ranked as Possible (C). The severity of impacts is determined to be 3 Localized Impact. With these management measures in place the residual risk is ranked as 3 C Medium.

5.5.4. Power Use

Impacts Assessment

All power for the campsite will be supplied by Project-supplied diesel powered generators. No public power utilities will be required at the campsite.

No power-use impacts will occur from power use by the project. All electrical power for the well site, drilling rig and associated equipment will be provided by 1800 - 2000hp diesel fuelled generator sets.

As the magnitude, extent, duration, importance are all negligible, the severity ranking too is ranked as negligible. The likelihood of impacts from power use is non-existent. As a result there is no residual risk.

Management Measures

To prevent and or mitigate power use activities from having any social impacts, the following measures will be implemented:

- Purchase and install diesel powered generators to supply all project power related needs.

Residual Risk

As PCMI will install their own power generators to supply electricity there will be no residual risk to social impact.

5.5.5. Water Drainage

Impact Assessment

Surface runoff from roads and campsite may result in increased drainage potentially affecting roads and infrastructure. Vegetation removal, campsite and access road construction can alter surface water hydrology by reducing interception, evaporation/ transpiration and infiltration, which in turn can increases runoff and change local drainage patterns. Heavy rains can intensify changes in surface water hydrology and cause changes in drainage patterns.

Agriculture and water sources around project sites could be affected from water drainage during campsite construction. However, a civil engineering contractor will be hired to survey the site and upgrade the road. The contracted civil engineer will determine and recommend if culverts or additional ditches are necessary to manage surface water runoff. Local authorities and local land owners will also be consulted to address their requirements for any culverts or ditching to be installed at any point along the road. If culverts are required or requested, the size of culvert to install will depend on the civil engineer’s recommendation and/or local authority’s recommendation. Generally, culverts in this area are 60 cm in diameter, made of reinforced concrete and purchased prefabricated.

The impacts on surface hydrology and drainage will be local in extent, transient, reversible and of low magnitude. As a result the severity is ranked as slight (1). The probability of water drainage impacts occurring without mitigation is considered to be ranked as C Possible.

The Risk Ranking of drainage impacts occurring is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from drainage can be mitigated through the use of the following measures:

- Local authority and land owner/user consultation on well site and access road construction design.
- Follow civil engineer’s recommendation on well site and access road construction design.
- Avoid construction of well sites and access roads in areas that may cause obstacles to water drainage.
- Water drainage lines (culverts) will be constructed to maintain natural drainage. The required permission will be obtained from all relevant agencies.

Residual Risk

With the above management measures implemented, the likelihood of impacts on drainage is minimized. Therefore probability of drainage impacts occurring is ranked as unlikely (B). Severity is considered to be slight (1). The overall residual risk from drainage is ranked as low.

5.5.6. Waste Management

Management of wastes from worker activities

Wastes generated from the project are leftovers, plastic bags, foam box, paper, etc. The 1,000-person work crew is expected to generate about 1.0 tonnes of waste/day or 100 tonnes of waste over the six-month survey (20 working days per month, waste generation is estimated at 1 kg/day/worker).Workers will collect waste to dispose in a communal bin at the field office, which will be collected and disposed by the municipal government. The project will pay fee for waste collection and disposal to local government according to municipal regulations.

Management of wastes from shooting

Most of the explosives will be completely burned during shooting; therefore, visible waste generated from shooting will only be a gab wire from the detonator. After shooting, the shooting team will collect gab wires to dispose or to re-use. Therefore, only a small amount of waste will remain in shot holes. The recovery team will check or collect some residues remaining in the shooting area to ensure that only minimal waste remains in the area.

Disposal of waste in project area may overload local disposal infrastructure. Waste from the campsite construction phase consists of: domestic waste, such as food scraps, plastic packaging, paper, cardboard, tin cans and glass, and industrial waste, such as wooden cases, large glass containers, metal items, plastic and metal drums and containers, plastic and cardboard packaging. Other than fuel and lubricants there will be no hazardous substances at the campsite.

General waste will be separated on-site to facilitate recycling. This waste will be stored in separate skips to be transported off site for recycling, reuse, treatment and/or disposal.

All hazardous wastes will be stored in covered skips for collection and disposed to approved government sites or at the cement kiln.

All materials brought onto the campsite will be logged and all sources of potential hazardous waste will be identified by the relevant supplier or contractor. Equipment or materials containing heavy metals, such as batteries, will be identified and a special container designated for their disposal as waste. All used chemical and lubricant containers will be collected in separate containers.

The impacts from waste management by the project will be local in extent, short-term in duration, reversible and of low magnitude. As a result of these considerations severity is ranked as slight (1). The probability of impacts occurring from waste management is ranked as Likely (D).

Therefore the Risk Ranking of waste disposal is ranked as low.

Severity	Probability	Risk Ranking
Slight	Likely	Low
1	D	1 D

Management Measures

Impacts from activities required for waste management can be mitigated through the use of the following measures:

- Ensure treatment and disposal according to accepted international standard. Keep waste manifest.
- Enforce “Good Housekeeping” practices.
- Segregate and store waste in appropriate, secure properly labelled containers.
- Dispose of waste in labelled containers for possible recycling.
- No burning of waste on site.

- Implement requirements for waste management and related laws.
- Store hazardous waste in appropriately designed areas and safe containers that are suitable for transporting/transferring.
- Always check and record the type(s) and amount of waste generated.
- Provide Waste Manifest System.

Impacts of waste water on agriculture and aquaculture/fisheries can be mitigated through the use of the following measures:

- Consider compensation in case PCMI activities result in damage to agriculture crops.
- Avoid construction of the access roads and campsite in areas where this would obstruct water drainage.
- Prohibit workers from cleaning machines/equipment in/near a public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources.
- Fuel storage tanks to be placed on concrete pad surrounded by bund wall.
- Construct drainage system around concrete pad or HDPE liner for fuel storage tanks and generator to divert any spills into waste pit.
- Isolate any area(s) that might be contaminated from non-contaminated areas. Provide water drainage system around the contaminated area for collecting water into the sump pit or for treatment.
- Construct oil traps along perimeter drainage ditch to prevent any spills from flowing off site.
- Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to their MSDS.
- Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious surfaces (i.e. on tarpaulin sheet).
- Provide spill cleanup kits and training for designated rapid response teams to clean up any spills.
- In the event of oil or chemical spill, implement spill response plan.
- Install septic tanks for holding sewage and grey water.
- Pump septic tank fluids to sewage treatment plant on a regular basis to prevent overflow.

Residual Risk

With these management measures, the probability of impacts from waste disposal is minimized during construction, operations and abandonment and is ranked as C Possible. The Risk Ranking should these impacts occur is ranked as 1 Slight. Therefore the residual risk ranking is determined to be 1 C Low.

5.5.7. Tourism and Recreational Experience

Impact Assessment

Project operation effects on tourism and recreation may reduce the tourism and recreational experience.

This area is currently a restricted area and little tourism or recreational areas exist. The project will not directly affect tourism and recreation through either land use changes or vibration. The main potential impacts would be increased traffic activity on major corridors which has been ranked as a Low Residual Risk.

The project effects impact on tourism and recreation experience will be local in extent, reversible, short duration and of low magnitude. Given these considerations the severity level is ranked a Slight. The probability of impacts on tourism and recreation experience is ranked as Possible (C).

Therefore the Risk Ranking of the project on tourism and recreational experience is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from project activities on tourism and recreation can be mitigated through the use of the transportation mitigation measures:

- Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr on unsealed road).
- Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights.
- Restrict/ avoid movement of heavy equipment during rush hours.
- Provide traffic signs or flags at junction of access roads and main roads.
- Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.
- If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices.
- Strictly enforce training programs to reduce transport incident cases by its contractors.
- Restore any damage to roads.
- Purchase or lease land for road access to site and land needed for campsite.
- Restrict local traffic on PCMI private access road.
- When project complete, promptly (within 6 months) restore land to its original state and return to original owners.

Residual Risk

With these management measures, the probabilityof impacts from project activities on tourism and recreation is minimized and is ranked as B Unlikely. The severity of impacts, should they occur is ranked as 1 Slight. Therefore the residual risk of project impacts on tourism and recreation is determined to be 1 B Low.

5.5.8. Employment and Income

Impact Assessment

Project employment and business opportunities will increase jobs and related income for local communities.

During camp construction, 30 – 50 workers will be employed and supplies (such as laterite, selected fill material, fuel, water) and services (accommodation, waste management) will be required. The composition of the crew will depend on actual contracting companies, most of which will be Myanmar subsidiaries of international companies. An onsite camp will be developed for workers.

During seismic operations, maximum of 800 workers will be employed and supplies (such as fuel, food and water) and services (accommodation, waste management) will be required.

IEM surveyed 400 households in this region. Results indicated that 22% had an annual income less than 500,000 kyat ($500 USD); 33% had an annual income of 500,000-1,000,000 kyat ($500 - $1000 USD); and 26% had an annual income of over 1,000,000 to 2,000,000 kyat (USD 1,000 to $2,000).

Of those interviewed 8% indicated that oil and gas drilling will be extremely important to the community; 10% indicated it would be very important; while 26% indicated that oil and gas drilling would be important to their community.

When asked what positive impacts from the project they anticipated, the Villagers response included: increased employment 58%, increased annual income 31%, improved living condition 28%.

PCMI has a policy to encourage the hiring of local staff and contractors. Advance meetings with local authorities on approaches to hiring will help PCMI design hiring to maximise the positive effects and limit the loss of labour availability to local businesses at critical times (i.e. harvest).

The impacts on the employment and income from the project will be local in extent, short-term in duration, reversible and of medium magnitude with a positive (benefit). The probability of positive employment and income benefits resulting from the project is ranked as E Very Likely.

Therefore the Risk Ranking of the project on employment and income is ranked as low positive.

Severity	Probability	Risk Ranking
Positive	Very Likely	Positive
	E	E

Management Measures

Impacts from project activities on the socio-economy are positive and can be further enhanced by the following measures:

- Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons.
- Employ qualified local workers.
- Purchase local supplies and services, whenever possible.
- Host a pre-project local community awareness program with communities to facilitate awareness of opportunities and benefits.
- Terms of contract for recruitment of manpower in these companies needs to include emphasis on hiring locals, especially for unskilled and semi-skilled workforce.

Residual Risk

With these management measures, the probabilityof impacts from project activities on employment and income is maximized and is ranked as E Very Likely. The severity of impacts is considered to be Positive. Therefore the residual risk of project impacts on employment and income is determined to be Positive (E).

5.5.9. Labour In-Migration

Impact Assessment

During the seismic survey, 1,000 workers will be employed. Most of the workers for non-skilled jobs will be from the communities around the project area. This employment will increase income of the local people and also stimulate local businesses and services. Workers will be employed for 6 months.

In-migration of labour and social interaction may result in conflict between workers from other regions and local communities.

During camp construction, 30 – 50 workers will be employed and supplies (such as granular fill, fuel, water) and services (accommodation, waste management) will be required. The composition of the crew will depend on actual contracting companies, most of which will be Myanmar subsidiaries of international companies. An onsite camp will be developed for workers.

The baseline household survey showed that:

- 46% felt that oil and gas projects have affected labour availability for traditional businesses.
- 35% of villagers were concerned about migrant workers near their village
- 41% felt that projects development had a negative effect on their community.

The receptors of impact from the project are:

- businesses that trade and provide services near the project area and people who live in the surrounding area. The project would provide opportunities for additional work and business
- businesses and trade who lose access to employees and contractors during the construction phase
- vulnerable social and ethnic groups who are exposed to migrant project employees and contractors

PCMI has a policy to encourage the hiring of local staff and contractors. Hiring local provides opportunities for local communities while reducing increased levels of migrant worker interaction. Advance meetings with local authorities on approaches to hiring will help PCMI design hiring to maximise the positive effects and limit the loss of labour availability to local businesses at critical times (i.e. harvest).

Pre-project awareness programs with migrant workers on local community, social and ethnic group sensitivities will help create increased understanding and, where advisable, limit interactions during campsite construction.

The impacts on in-migration of workers from the project will be local in extent, short-term in duration, reversible and of low magnitude. As a result of these considerations the severity level is ranked as slight (3). The probability of impacts occurring as a result of in-migration is ranked as Possible (C).

Therefore the Risk Ranking of labour in-migration is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from project activities on employment and income can be further enhanced by the following measures:

- Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons.
- Employ qualified local workers.
- Purchase local supplies and services, whenever possible.

- Host a pre-project local community awareness program with migrant workers to facilitate sensitivity and limit interactions, where advisable, between migrant workers and local communities.
- Restrict workers to within project boundaries and do not allow local interaction within the communities.

Residual Impact

With these management measures, the probabilityof impacts from in-migration of workers are minimized and are ranked as B Unlikely. The Risk Ranking of impacts is considered to be Slight Impact. Therefore the residual risk of project impacts on employment and income is determined to be 1 B Low.

5.5.10. Historical, Archaeological and Cultural Resources

There are historical, archaeological and cultural resources around the project area. The main activity affecting these resources will be shooting/recording, which can cause a vibration impact. Ancient remains/archaeological sites can be divided into two classes: ancient remain/archaeological sites with high risk and ancient remain/archaeological sites with low risk or no risk. The distinction of high and low risk is based on the distance to the seismic line. A safety distance as determined by international guidelines or a Peak Particle Velocity must be followed to prevent damage to archaeological sites/features, historical sites or cultural resources. Implementation of these safety distances will result in undetectable vibration.

Work in the vicinity of any historical or archaeological structures will be determined based on following setback distances that ensures that particle velocity of <2 mm/sec is maintained.

A detailed topographic surveying of the seismic lines will be done prior to shooting. This topographic survey will determine the exact location of the seismic lines and distance to each of the archaeological sites. If any archaeological sites are within the safety distance, the project team will shift the seismic line or shot hole to an appropriate location to meet the safety distance and to minimize the potential impact from vibration.

If the seismic line cannot be easily relocated to the safety distance and the information is crucial to the integrity of the survey, a vibration test including PPV and Frequency will be conducted to determine the vibration values at various distances within 2,000 m using the same kg. charge. The data will be used to determine a site-specific safety distance for this project to prevent any damage to archaeological sites.

Impact on residents/houses in community

Activities during seismic survey (i.e., vehicle transportation, site preparation, drilling of shot holes, and shooting/recording) may cause annoyance to the communities from dust, noise and vibration, and accidents. The significance of such impacts is assessed to be low. The project team will publicize relevant information about the project to the community prior to the start of the project and throughout the project duration. Moreover, the project team has prepared mitigation measures to prevent and minimize impacts. Impacts on tranquility in communities are expected to be correspondingly minor.

The company will also obtain local infrastructure plans to ensure that all underground cable systems and water pipes are avoided. Set back distances have also been defined for these and will be applied.

PCMI will consider the seismic lines near communities and take into account setback distance for residences in the vicinity of the lines, and will modify their shooting plan accordingly.

It is not expected that either construction activities will disrupt any culturally important activities or cause any damage to the archaeological resources, as the well sites and roads are at least 1 km away from the nearest known archaeological feature. Therefore, the project will not directly impact the archaeological resources through vibration or direct land use.

Local authorities within the study Area will be consulted to see if there are any culturally important festivals planned during project operations and efforts will be made to ensure transportation, construction and drilling activities will limit any impacts.

However, prehistoric communities existed in the area and additional artefacts may be recovered during construction of the well sites and access roads.

The impacts on historical, archaeological and cultural resources will be local in extent, long-term, permanent and of low-medium magnitude. These factors result in a severity ranking of Minor (2). The probability of these impact occurring are ranked as Possible (C).

Therefore the Risk Ranking of project impact to historical, archeological and cultural resources is determined to be low.

Severity	Probability	Risk Ranking
Minor	Possible	Low
2	C	2 C

Management Measures

Impacts from construction activities on historical, archaeological and cultural resources can be mitigated through the use of the following measures:

- Comply with establish shot hole set back distances.
- Watch for artefacts during site construction and inform the Ministry of Culturebefore commencement of drilling.
- Report to the Local Archaeological Department if any archaeological evidence is discovered at the well sites or access roads. The project proponent will cease all activity until the local Archaeological Department verifies and considers the evidence. Through consultation, a plan to proceed will be developed.
- If artefacts are found during the construction phase, PCMI will inform the responsible local office within 7 days.
- Consult with local authorities to identify culturally important festivals and plan transportation, construction and drilling activities to avoid impact.
- PCMI community liaison officer to monitor possible impact/change on local cultural heritage of any nature.
- Review any records for site specific location.
- Conduct a visual inspection of the site by qualified personnel (e.g. experienced consultant, government archaeologist etc.).
- Monitor earthwork during construction using qualified/trained inspector.
- Notify Department of Archaeology, National Museum and Library, Ministry of Culture within 48 hours if significant or suspicious remains are detected.
- If work is suspended implement approved plan for mitigation (e.g. documentation and salvage, develop immediately adjacent site if feasible etc).

Residual Impacts

With these management measures implemented, the probability of impacts from project construction and operation impacts to historical, archeological and cultural resources is minimized and is ranked as B Unlikely. The Risk Ranking of impacts is considered to be 2 Minor. Therefore the residual risk of project impacts on historical, archeological and cultural resources is determined to be 2 B Low.

5.6. Seismic Health Impact Assessment

5.6.1. Dust

Impact Assessment

During the construction of the campsite, new access roads will be constructed, while some sections of roads will be upgraded. Granular fill transport and construction activities may increase dust concentrations in air.

The potential health effects of dust are closely related to particle size. Particle sizes are normally measured in microns, and the size range of airborne particles is typically from less than 0.1 microns up to about 500 microns, or half a millimetre. Human health effects of airborne dust are mainly associated with particles less than about 10 microns in size (PM_{10}), which are small enough to be inhaled. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20 microns.

Many forms of dust are considered to be biologically inert, and hence the primary effects on people relate to our sense of aesthetics. There can also be minor health effects, such as eye irritation, when the dust is airborne. Indirect stress-related health effects could also arise, especially if dust problems are allowed to persist for an unreasonable length of time.

Some nuisance dust may have the potential to cause other types of health effects because of the presence of specific biologically active materials. For instance, some mineral dusts contain quantities of quartz, which can cause the lung disease known as silicosis when persistent at high concentrations. Other dusts may contain significant amounts of toxic metals such as mercury or lead.

There is also the potential for contamination of roof-collected water supplies. Dusty conditions can also affect people’s ability to enjoy their outdoor environment. For most people, a major effect of a dust nuisance problem is annoyance at the increased requirement for cleaning.

Airborne dust can have effects on visibility, although dust is usually less regionally significant. Visibility effects from dust are usually only a concern in the immediate vicinity of a specific source.

Visibility effects are largely a matter of aesthetics. However, it should also be recognised that visibility is one of the main ways by which people commonly judge air quality. Loss of visibility is also a safety concern under extreme conditions, especially for road traffic.

Dust may result in respiratory irritation of construction workers and respiratory irritation and worsen asthma of people living nearby.

Dust impacts are considered to be localized, i.e. Health impact extends < 100 m radius from the site boundary; and short term i.e. Health impact expected to last from 0 to 1 year, reversibility quickly, and magnitude is considered to be medium. As a result of these considerations, the severity is ranked as minor.

The probability of these impact occurring are ranked as Likely. Therefore the Risk Ranking of project impact to health from Dust is determined to be medium.

Severity	Probability	Risk Ranking
Minor Injury	Likely	Medium
2	D	2 D

Management Measures

PCMI will implement the following mitigation measures to reduce dust dispersion:

- Spray water on un-surfaced access roads of project transportation route during dry conditions at least twice a day (morning and afternoon).
- Post speed limits on project access route and limit vehicle speed to 30 km/h on un-surfaced roads.
- Use vehicles with dust flaps.
- Cover loose dry loads.

Residual Risk

With the implementation of management measures, the probability of residual risks due to dust from road and site construction and transportation are rated as Possible (C). The Risk Ranking of impacts from Dust should they occur are ranked as 1 Slight. This results in a residual risk ranking of 1C Low for health impacts from Dust.

5.6.2. Noise& Vibration

Impact Assessment

During the campsite construction and rehabilitation phase, noise will primarily be generated from project vehicles for transportation of granular fill, workers, construction equipment, and generators.

Construction is expected to result in nuisance noise at some communities but is not expected to exceed the ambient noise standard.

Transport of campsite and road fill will be on local roads. Heavy trucks are expected to emit noise levels of 88 dB (A) at 50 ft from the source. Houses are located approximately 50 m away from the road. The noise calculated for these houses is approximately 77.7dB (A). The impact however takes place only during the time the truck passes the house. Ambient noise standards do not apply for this type of noise.

Noise levels from construction equipment do not exceed the 90 dB (A) noise standard in the workplace for an 8-hr exposure time. However, a combination of several construction machines could result in a compounded noise level 91 dB (A), exceeding the workplace standard.

The noise levels estimated at communities assumed a worst-case scenario of hemispherical spreading with no attenuation from the surrounding area. However, the presence of trees, vegetation, and the topography will attenuate the noise levels.

Impacts from shooting/recording

During shooting/recording, generated noise and vibration may affect workers. However, the project team has specified a safety distance between shot holes and shooting/recording team of 50 m. Noise measurements at 50 m from shot holes during shooting/recording found the noise level at approximately 65 dB(A). This noise level will not impact the health and safety of workers. In addition, shooting/recording will occur over a short time period (a few minutes) and the project team will provide ear plugs or ear muff to the shooting/recording team as a protective gear.

Noise impacts are considered to be localized, i.e. Health impact extends < 100 m radius from the campsite boundary; and short term i.e. Health impact expected to last from 0 to 6 months, reversibility quickly, and magnitude is considered to be small. As a result of these considerations the severity is ranked as Slight (1). The probability of these impact occurring are ranked as Very Likely (E).

Therefore the Risk Ranking of project impact to health from Noise is determined to be low.

Severity	Probability	Risk Ranking
Slight	Very Likely	Low
1	E	1 E

Management Measures

PCMI will implement the following mitigation measures to reduce noise impacts:

- Vehicles will avoid sensitive environmental areas.
- Construction activities and Vehicle movements will be restricted to daylight hours.
- Limit vegetation removal to a minimum.
- Schedule operation of noisy construction equipment at different times.
- Ensure use of mufflers on diesel/gas driven machinery.
- Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer.
- Implement transportation plan.
- The campsite must be located a minimum of 500 m from the nearest community.
- Select shot hole locations at safe distances from nearest community or sensitive receptor.

Residual Risk

With the implementation of management measures, the probability of residual risks due to noise from road and site construction, shot holes and transportation are rated as D Likely. The severity of impacts from Noise should they occur are ranked as 1 Slight. This results in a residual risk ranking of 1 D Low for Noise impacts.

5.6.3. Non-Hazardous Waste

Impact Assessment

Non-hazardous wastes during the seismic program include food waste, paper, plastic and wooden packaging, rags, glass, metal and plastic drums, sacks, and scrap metal.

Solid wastes may impact physical health, mental health, and quality of life: for example, food remains cause foul smell, unpleasant ambience, act as a fire hazard and provide habitat for disease carriers including bacteria, flies and rats. This increases the chance of bringing diseases to local people.

Myanmar is a tropical country prone to vector borne disease outbreaks, such as gastrointestinal diseases and dengue and malaria. Malaria is the leading cause of morbidity and mortality, with over 538,000 cases and 1,647 deaths reported in 2006. Dengue and dengue haemorrhagic fever cases have seasonal epidemics. Due to inadequate facilities, the number illnesses due to lack of water supply and sanitation has been increasing. In 2003, there were 45,095 reported cases of diarrhea, 4,255 cases of hepatitis, 84 cases of cholera, and 3,162 cases of typhoid fever.

Statistics indicate that the situation of communicable vector-borne disease in the project districts is a public health concern.

Impacts from non-hazardous wastes are considered to be local in extent,potential medium term, reversible over time, and magnitude is considered to be major. As a result of these considerations the severity is ranked as 5 Multiple Fatalities. The probability of these impact occurring are ranked as C Possible.

Therefore the Risk Ranking of project impact to health from non-hazardous waste is determined to be High.

Severity	Probability	Risk Ranking
Multiple Fatalities	Possible	High
5	C	5 C

Management Measures

PCMI will implement the following mitigation measures to reduce impacts from non-hazardous waste:

- Provide septic tank for domestic sewage.
- Ensure treatment and disposal according to accepted international standard. Keep waste manifest.
- Enforce “Good Housekeeping” practices.
- Segregate non-hazardous and hazardous waste, store each type of waste in closed containers and make sure all containers are clearly labeled.
- Dispose of waste in labelled containers for possible recycling.
- Prohibit open burning of any waste at project site.
- Implement requirements for waste management and related laws.
- Store waste in appropriate and safe containers that are suitable for transporting/transferring.
- Always check and record the type(s) and amount of waste generated.

Residual Risk

With the implementation of management measures, the probability of residual risks due to non-hazardous wastes are rated as B Unlikely. The Risk Ranking of impacts should they occur are ranked as 5Multiple Fatality. This results in a residual risk ranking of 5 B Medium.

5.6.4. Hazardous Chemicals and Waste

Impact Assessment

The seismic program will generate a low volume of hazardous waste including lubricating and hydraulic oil, rags and other materials used at the campsite such as batteries, clinic wastes etc.

Community health may be impacted through spills and subsequent contamination of soil, surface and groundwater resources. Consumption of such water may result in bioaccumulation of contaminants and various health impairments. Bathing and washing in it may cause skin irritation. Indirect public health impacts could occur through soil contamination by oils, chemicals and the bioaccumulation of heavy metals impacting crop yields and food quality. Worker health is affected in similar ways. Because workers are closer to and handle hazardous waste, the likelihood of exposure is higher of workers than for the public.

Impacts from hazardous chemicals and waste may affect both occupational health and community health, and are considered to be local in Extent, of medium term duration, reversible over time, and of medium magnitude. Given these considerations severity is ranked as major injury (3). The probability is considered to be possible (C). *Therefore the Risk Rankingof project impact to health is determined to be medium*

Severity	Probability	Risk Ranking
Major	Possible	Medium
3	C	3 C

Management Measures

PCMI will implement the following mitigation measures to reduce impacts from hazardous waste:

- Segregate and store hazardous chemicals and waste in appropriate, labelled and safe containers that are suitable for transporting/transferring. Containers having hazardous waste must be kept in safe areas.
- All hazardous waste will be collected in skips ready for treatment and disposal and sent directly to a cement kiln.
- Provide Manifest System for transportation of hazardous waste to treatment area or disposal area.
- Always check and record the type(s) and amount of hazardous waste generated.

Residual Risk

With the implementation of management measures, residual risks due to hazardous chemicals and waste from material contaminated with oil or chemicals, lubricating and hydraulic oil, drum and containers are rated as 3 B, where probability is considered to be Unlikely; should an impact occur the Risk Ranking is considered to be Major Injury (3). Therefore the overall residual risk rating is considered to be Low.

5.6.5. Communicable Diseases

Impact Assessment

The seismic program will require a maximum of 800 workers. Some of these workers will temporarily move into the area. Experiences from other parts of the world have shown that oil and gas development activities introduced or increased incidence of communicable diseases, such as HIV/AIDS and malaria, in communities where these projects are located. Although the PCMI project is not a large-scale development, the influx of outside workers could contribute to proliferation of communicable diseases in local communities.

The structures at the campsite can conceivably contribute to vector-borne diseases such as malaria, dengue by providing breeding grounds for mosquitoes if they are not properly maintained. These structures include a perimeter drainage trench and an intermediate drainage trench.

Unhygienic practices in the work place may also promote spread of gastrointestinal diseases amongst project employees.

The potential health impacts from an influx of workers could contribute to proliferation of communicable diseases in local communities and the work force.

National statistics on HIV/AIDS are provided in **Table 5-34**. Detailed information on HIV/AIDS is limited.

Table 5-34: National HIV/AIDS Statistics

Number of people living with HIV	240,000 [160,000 – 370,000]
Adults aged 15 to 49 prevalence rate	0.7% [0.4% - 1.1%]
Adults aged 15 and up living with HIV	240,000 [150,000 – 360,000]
Women aged 15 and up living with HIV	100,000 [63,000 – 150,000

In Myanmar dengue fever (DF)/dengue hemorrhagic fever (DHF) is one of the leading causes of morbidity and mortality among children under the age of 10 years, with approximately 85% of cases occurring in this age group. Some adult cases have been reported, especially from rural areas. An annual average of 7,000-10,000 cases of DF/DHF are reported nationwide. However, in recent epidemic years (2001, 2002 and 2007), the number has risen to over 15,000 cases. National figures indicate that the largest number of cases are from Yangon Region. In 2007, Yangon (31%), Ayeyarwady Region (16%) and Mon State (15%) accounted for 62% of all reported cases.

Malaria is a major public health problem in Myanmar, particularly in forested and hilly areas (WHO, 2008).

In the surveyed area, malaria infection rate was said to be high. Most surveyed respondents claimed to have slept under a mosquito net the previous night.

Malaria is the main cause of morbidity and mortality in Myanmar. It is a re-emerging public health problem due to climate changes, uncontrolled population migration, ecological changes, and existence of multi-drug resistant P. falciparum parasites and appearance of insecticide resistant vector. Total malaria cases recorded in 2003, were 98, 584 with 2,243 resulting in death. About 11,534 dengue/dengue haemorrhagic fever cases were also recorded in 2003 with 111 deaths (WHO, 2004).

Impacts from communicable disease may affect both occupational health and community health, and are considered to be local in Extent, of medium term duration, reversible over time, and of medium magnitude. Given these considerations severity is ranked as major injury (3). The probability is considered to be Possible (C).

Therefore the Risk Ranking of impact from communicable diseases to health is determined to be medium

Severity	Probability	Risk Ranking
Major	Possible	Medium
3	C	3 C

Management Measures

PCMI will implement the following mitigation measures to reduce the spread of communicable diseases:

1. Implement mitigation measures for non-hazardous waste.
2. Clearing of overgrowth in perimeter.
3. Keep waste manifest.
4. Drainage and removal of waste from waste pit upon completion of drilling.
5. Health screening of workers before employment.
6. On-site health clinic (seismic acquisition) and referral system during all of project operations with external health agencies to ensure timely diagnosis and treatment of workers' illness and injury.
7. Maximize hiring of qualified local workers to reduce reliance on outside labour and increase local employment.
8. Do not allow workers to enter communities near the drill site.
9. Provide awareness to workers on preventive measures for the prevention of communicable and local diseases.

Residual Risk

With the implementation of management measures, residual risks due to communicable diseases are rated as 3 B, where probability is considered to be Unlikely; should an impact occur the Risk Ranking is considered to be Major Injury (3). Therefore the overall residual risk rating is considered to be Low

5.7. Seismic Unplanned Events Impact Assessment

5.7.1. Fire or Explosion

Impact Assessment

Potential sources of explosion include dynamite shots, burning of garbage, discarded cigarettes, and the presence of diesel fuel on site during testing. Burning of garbage will be prohibited and smoking will be restricted to safe areas. Diesel is not easily ignited as shown in flash point of diesel in range of 40 to 100 ^{0}C which above the normal room temperature, so the likelihood of a fire occurring is unlikely. Furthermore, the lower explosive limit (LEL) of diesel fuel is 0.6 percent that equals concentration approximately 6,000 ppm. It is unlikely that a fuel spill would cause this concentration when occurred in an open area.

Use of explosives for seismic work has an inherent risk of explosion. However, records of the Occupational Safety & Health Administration (OSHA) of the US Department of Labour indicate only one incident during seismographic work in 1985 resulting in fatalities as a result of misfiring of explosives (OSHA, 2003). In addition, a fatality was recorded in 2000 as a result of detonation of a charge (IAGC, 2000). Other incidents have resulted in injuries (IAGC, 2003). No injuries have been reported in Myanmar.

There have not been any explosions recorded under PCMI's previous operations, as a result, the probability of an explosion has been rated as (Unlikely).

A fire or explosion may result in multiple on-site fatalities (5); Major damage to Assets - Partial operation loss, 2 weeks shutdown, costs up to USD 1,000,000 (4); Localized effect on environment (3); International impact on reputation – International public attention (5); Minor Social Impact. As probability of a fire or explosion is unlikely (B).*The Risk Ranking of impacts on people, reputation, environment and assets result in therefore ranked as medium.*

Severity	Probability	Risk Ranking
Reputation International Impact/Multiple Facilities	Unlikely	Medium
5	B	5 B

Management Measures

Fires will be managed under existing emergency plans. The risk significance of fire will be reduced by using the following mitigation measures:

- PCMI's HSE Integrated Management System Procedures and operational controls to prevent a fire/explosion.
- PCMI's Emergency Response Plan including specific management procedures to mitigate the impacts if a fire/explosion occurs.
- Install fire extinguishers, alarms and windsocks (to be audible and visible from whole site).

Residual Risk

With the implementation of management measures, the probability of residual risks due to a fire is rated as B Unlikely. The the severity is ranked as 5 possible multiple fatalities, and international impact on reputation, while ranked a 4 possibly have a major impact on assets, and a ranking of 3 for a localized impact on the environment, and minor social impact. This results in a residual risk ranking of 5 B Medium for fires and related explosion.

5.7.2. Chemical or Hazardous Waste/Materials Spill

Chemicals and hazardous waste materials present potential risk of spills to the environment and spillage could affect air quality, soil quality, surface water, groundwater, biota and people.

The quantity of the hazardous waste/chemicals that will be used at campsite is minimal; therefore, the impact on the environment in the case of a spill would be limited in area and likely to be transitory.

A chemical or hazardous waste/materials spill may result in major injury (3); Local damage to Assets (3); Localized impact on environment (3); and considerable impact on reputation (3); slight social impact (1). As probability of a chemical or hazardous waste/material spill is Possible (C), *the Risk Ranking of impacts on people, reputation, environment and assets result in therefore ranked as medium.*

Severity	Probability	Risk Ranking
Major	Possible	Medium
3	C	3 C

The impact of a chemical or hazardous waste/materials spill will be reduced by using the following mitigation measures:

- Proper training in the use and handling of the relevant chemicals and standard safety procedures implemented by all contractors.
- Appropriate medical care will be provided, clean-up will be carried out, and incident or accident reports will be filed.
- PCMI’s HSE Integrated Management System Procedures and operational controls will be in place to prevent spills.
- PCMI’s Emergency Response Plan will set out the management procedures to be put in place to mitigate the impact if a spill occurs.
- Provide spill cleanup kits and training for designated rapid response team to clean up any spills.
- Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall.
- Handle all chemicals according to their MSDS.

Residual Risk

With the implementation of management measures, the probability of residual risks due to a chemical or hazardous waste/materials spill is rated as B Unlikely. The the Risk Ranking of impacts should they occur are ranked as 3 possible major impact to people, considerable impact to reputation, major impact on assets, slight social impact and major impact on the environment. This results in a residual risk ranking of 3 B Low.

5.7.3. Transportation Accidents

Transportation accidents associated with PCMI’s project may occur during transportation of equipment, personnel, granular fill, and waste.

No data on accidents is available for the area. However, this part of the county has a relatively small number of vehicles (including motorcycles) per capita.

Impacts from transportation accidents are considered to be localized in extent, possibly with permanent implications, and of medium magnitude. As a result of these considerations the severity is ranked as: possible multiple fatalities (5) for People, Localized (3) impact to environment, minor social impact (2), local damage (3) to assets, and Considerable (3) impact to reputation.

The probability of these impact occurring are ranked as Possible C. Therefore the Risk Ranking of transportation accidents is 2 C Low for social impact, 3 C Low for environment, assets and reputation; and 5 C High for People.

Severity	Probability	Risk Ranking
Multiple Fatality on People	Possible	High
5	C	5 C

The risk significance of a transportation accident will be reduced by using the following management measures:

- HSE Integrated Management System Procedures.
- Limit the speed of project vehicles, according to the road condition (on unpaved road to 30 km/h).
- Maintain construction equipment and vehicles to regulatory standards.
- Notify the local authority on the oversized load and put a escort in-front of this convoy with horn and hazard lights.
- Restrict/ avoid movement of heavy equipment during rush hours from 07.30 to 08.30 am and 3.30 to 4.30 pm.
- Provide traffic signs or flags at junction of access road and main road.
- Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.
- Strictly enforce training programs to reduce transport and drilling incidents by its contractors.
- Restore any damage to roads caused by project vehicles.
- Implement emergency response training, fire training and response drills.
- Install adequate fire extinguishers around the well sites.
- Test safety devices weekly.
- Provide PPE to workers on site.
- Provide medic, First Aid kits and First Aid trained personnel at drilling site.
- Restrict smoking to controlled areas.
- Prohibit trespassers from entering the construction site.
- Referral system with external medical facilities for serious injuries or emergencies.

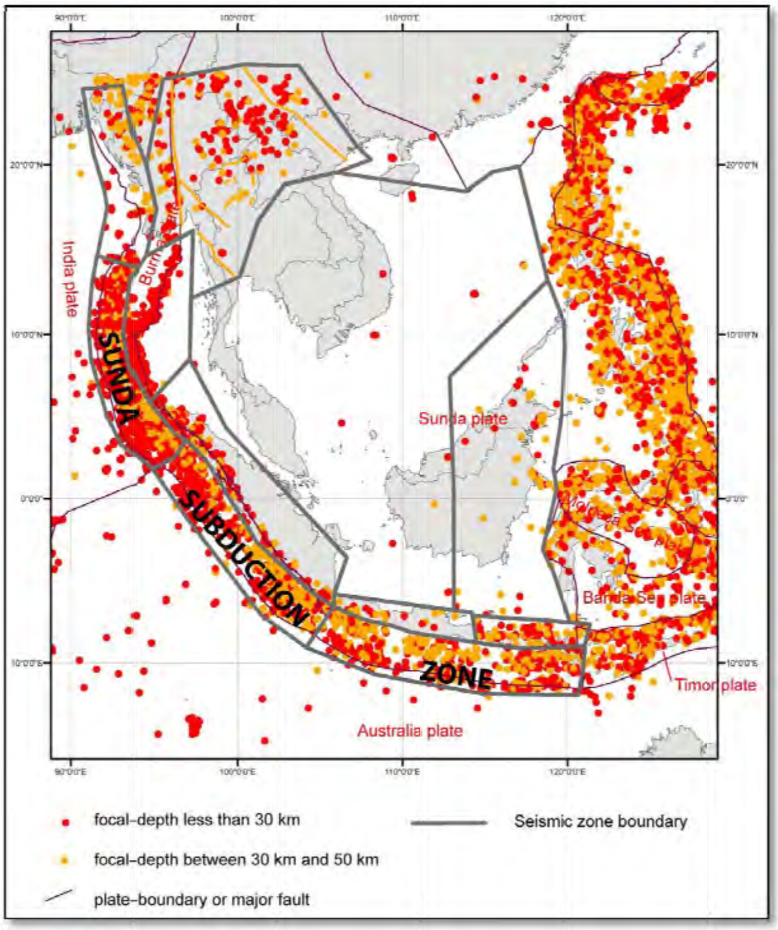
Residual Risk

With the implementation of management measures, the probability of residual risks due to transportation accidents is rated as B Unlikely. The severity is ranked as: possible multiple fatalities (5) for People, Localized (3) impact to environment, local damage (3) to assets, and Considerable (3) impact to reputation, and Slight (2) social impact. This results in a residual risk ranking of 5 B Medium for possible transportation accidents and related impacts.

5.7.4. Earthquakes

Central Lowlands in the vicinity of IOR5 have potential to thrust, and contains transpressional active faults such as Chauk-Tangyitaung and Gwecho faults. IOR5 is located at 20 km east of Arakan-Yoma mountain range and 110 km west of Sagiang fault.

A map of earthquakes in the SE Asian region is shown in **Figure 5-2**.



Source: USGS, 2007

Figure 5-2: Map of Earthquakes with Shallow-Focus Epicentre for Period 1965-2005

Impacts from an earthquake could result in effects to people, assets, environment and reputation. The worst case scenario would be similar to a fire or explosion.

As earthquakes are an unlikely occurrence in the region, their frequency has been rated as "Unlikely"**.** Their Risk Rankings are potentially very serious in terms of People, with possible multi fatalities (5); Massive (5) Social Impact; Reputation being affected internationally (5); potentially massive environmental impacts (5); and extensive asset damage (5); resulting in an overall medium risk. Although earthquakes cannot be directly mitigated, the effects on operations can be managed through design and management measures.

The Risk Ranking of impacts on people, reputation, environment and assets result in therefore ranked as medium.

Severity	Probability	Risk Ranking
Massive, Multiple Fatality, Extensive Damage, and International Impact on Reputation	Unlikely	Medium
5	B	5 B

Management Measures

Although earthquakes cannot be directly mitigated, the effects on operations can be managed through design and management measures as follows:

- Implement PCMI's Earthquakes: Evacuation Plan and Emergency Response Plan.
- Proper training and safety procedures will be the main preventative measures to reduce the potential risk.
- In the unlikely event an accident should occur, the Emergency Response Plan would be implemented, which includes evacuation of personnel during severe circumstances.

Residual Risk

With the implementation of management measures, the probability has been rated as "Remote"**.** Their Risk Rankings are potentially very serious in terms of People, with possible multi fatalities (5); Reputation being affected internationally (5); potentially massive environmental impacts (5); Massive Social Impact (5); and extensive asset damage (5); resulting in an overall medium residual risk 5A.

5.8. Summary Impact Table

Table 5-35 summarises the potential impacts identified during the assessment of the 3D-seismic survey activities. All impacts are addressed through standard operating procedures and/or through identified contingency plans.

Table 5-35: Summary of Seismic Survey Impacts

Environmental Aspect

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Land & Habitat Disturbance	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to local topography	2	E	Med.
		Soil Disturbance and Erosion	1	C	Low
		Disturbance to local Terrestrial Flora	1	C	Low
		Disturbance to local terrestrial fauna	1	C	Low
		Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration	3	C	Med.
		Localized change in water quality	3	C	Med.
		Localized sediment deposition and disturbance to benthic habitats and associated biota.			
Vehicle Movements	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to Fauna	1	C	Low
		Disturbance to traffic	1	D	Low
Air Emissions	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Deterioration of Air Quality due to dust	2	C	Low
		Minor deterioration of local air quality due to emission of pollutants such as NOx and SOx and CO.	1	D	Low
		GHG Release contributing to climate change	1	D	Low
Noise& Vibration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data AcquisitionClean up and Site Restoration	Behavioral disturbance to fauna	2	E	Med.
Light	• Functional lighting on vehicles and camp site	Potential impact on terrestrial fauna	1	D	Low
Liquid Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Localized change in water quality or contaminated soils from oil and grease	2	B	Low
		Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water	2	D	Low
		Contamination of water and soils and injury to fauna	2	D	Med.

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Solid Waste & Hazardous Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Attraction of fauna such as rats and birds. Nutrient enrichment of surrounding water and soils	1	D	Low
		Contamination of water and soils and injury to fauna	3	C	Med.
		Temporary localized decline in water quality. Temporary localized decline in soil quality. Temporary minor toxicity to flora and fauna.	2	B	Low

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Social Aspects

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Change in Land Use	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss of agriculture potential Project operation effects on nearby land productivity Loss of employment for displaced workers that do not own land	0	D	Positive
Transportation	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Increase in and disruption of local traffic	1	C	Low
Water Supply	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Reduction of local community water supply	3	D	Medium
Power Use	• Power for campsite	Increase or decrease of available power for local community			None
Water Drainage	• Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure	1	C	Low
Wastewater	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Potential impact to agriculture, aquaculture and fisheries	1	D	Low
		Potential impact to agriculture, aquaculture and fisheries (Cont.)	1	D	Low
Waste Disposal	• Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Increased waste disposal overloading local infrastructure	1	D	Low
Tourism and Recreational experience	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance and reduction of tourism and recreational experience	1	C	Low
Employment & Income	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential increase in jobs and related income for local communities	0	E	Positive

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Labour In-migration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential conflict between workers from other regions and local communities	1	C	Low
Historical, Archaeological & Cultural Resources	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss or damage to historical and archaeological sites	2	C	Low

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Occupational Health/Public Health

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Dust	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Respiratory irritation Exacerbation of asthma	2	D	Med.
Noise& Vibration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Hearing impairment for workers and Annoyance for public	1	E	Low
Non-hazardous waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Clean up and Site Restoration	Food safety, gastroenteritis Increase in vector-borne diseases: malaria, typhus and dengue and others.	5	C	High
Hazardous waste	• Material contaminated with oil or chemicals, • Lubricating and hydraulic oil, • Drum and containers used for chemical transportation and storage	Acute exposure such as skin and eye irritation, inhalation exposure etc.	3	C	Med.
Communicable diseases	• Base camp/ Fly camp Construction • Seismic Team Mobilization	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.	3	C	Med.

Note: C - Consequence: 0 – No Injury, 1 - Slight Injury, 2 – Minor Injury, 3 – Major Injury, 4 – Single Fatality, 5 – Multiple Fatalities

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Unplanned Events

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Fire or Explosion	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible explosion of dynamite or fire at campsite, or fuel storage area	5	B	Medium
Chemical or Hazardous Waste/Materials Spill	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people	3	C	Medium
Transportation Accidents	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible injury or death to personnel; and localized contamination of environment	5	C	High
Earthquakes	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential physical disruption cause building collapse, fires or spills	5	B	Medium

Note: C - Consequence: 3 - Localized Impact, Major Injury, Localized Damage and Considerable Impact,
5 - Massive Impact, Multiple Fatalities, Extensive Damage, International Impact
P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

5.9. Exploration Drilling Environmental Impact Assessment

5.9.1. Land/Habitat Disturbance

Land and habitat disturbance could happen as the result of clearance of site, construction of access roads, campsite and well site installation of rig and drilling equipment, and physical disturbance.

The estimated well site area will be 120 x 200 m; including the well site and camp site in the same area for a total area of 24,000 m^2per well site. This may vary slightly due to local topography. All new access roads will need to be constructed. The roads will be constructed with a 6 m wide top and 1.5 m side slope for a total width of 9 m a height of approximately 20 to 30 cm before compaction with granular fill. The construction of the road would affect plants within an area of 90,000 m^2 for each well sites (assuming all new roads for 10 km distance).

During the decommissioning phase, the potential for impacts associated with land/habitat disturbance will be of a lesser scale than during the construction phase as the decommissioning strategy will involve the site being restored to its original condition.

Impact Assessment

The potential impacts from land and habitat disturbance associated with the exploration drilling campaign are:

- Impact to Topography
- Soil Disturbance and Erosion
- Impact to Terrestrial Flora
- Impact to Terrestrial Fauna
- Impact to Surface Water Hydrology
- Impact to Water Quality and Aquatic Habitat

5.9.1.1. Impact to Topography

Each well site will have similar construction plans. The well site and adjacent accommodation camp site will be levelled and elevated by cut and fill methods and compacted using bulldozers, dump trucks, water trucks and graders. The compacted laterite pad will be 200 mm thick.

The source of impact from the site preparation is caused by soil excavation/filling and construction of access road/well pad activity. The project area mainly consists of farming, agricultural and forested areas with agriculturally dominated communities and access roads. The agriculture areas are used to grow mostly rice, beans/pulses, peanuts and sesame.

The project will cause changes to the topography of the well site and surrounding areas. The effect will be limited to the construction areas and access road. The topography of the area within a 5-km radius of the exploration well site will be largely unaffected, because the construction areas for the well site and access road consist of only 0.1 % of the total area.

The well abandonment will follow normal industry practices and procedures, conforming to all internal PCMI regulations and MOGE requirements. The well site will be cleared of all equipment and cleaned up. The rig cellar will be broken down and removed; the well pipe will be cut 3 m below grade and capped with a steel plate before being backfilled with the rubble and soil. The concrete rig pad, other foundations and the water pit will be broken up and all material removed off site for disposal as normal building rubble. The surface of the well pad, consisting of compacted granular fill will be broken up and the contours of the site restored to their original levels.

Without mitigation measures, the impact on topography will be local in extent, short-term in duration, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of the impact occurring is determined to be very likely (E).

The Risk Ranking of impacts to topography is rated as medium.

Severity	Probability	Risk Ranking
Minor Impact	Very Likely	Medium
2	E	2E

Management Measures

Impacts from construction activities on topography can be mitigated through the use of the following measure:

- Limit construction activities to well sites and access roads only.
- Restore the site to its original condition on site abandonment.

Residual Risk

With these management measures, the likelihood of impacts from a change topography is determined to be likely D; while there will be slight impacts (1) on environment, resulting in low residual negative risk (1D).

5.9.1.2. Soil Disturbance and Soil Erosion

General construction activities have the potential to result in adverse impacts on soil resources as a result of soil loss due to erosion. Sources of impact on soil properties during construction include soil excavation, land clearing, improvement/construction of access roads, and contamination such as machine repairing and changing of lubricating oil. Impacts of accidental spills are discussed in **Section 5.12.4**.

The well pad will be levelled and the soil will be protected by a granular fill cover. If well testing indicates that the oil or gas reserves are not commercially viable to produce, the site will be restored to its original condition on site abandonment.

Without mitigation measures, drilling site might erode during construction phase due to runoff. Lower land might be consequently washed away by soil erosion and surrounded agricultural area might be affected.

Without mitigation measures, physical disturbance and soil erosion impacts are expected to be local in extent, short-term in duration, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of these impacts occurring is ranked as Possible C.

The Risk Ranking of impacts from soil disturbance and soil erosion is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to soils can be mitigated through the use of the following measures:

- Limit soil compaction only to well sites and access roads.
- Exposed site areas should be kept to a minimum during construction and completed areas should be hard surfaced or re-vegetated as soon as possible.
- Reduce erosion by preventing/reducing off-site sediment transport through the use of BMP's.
- Provide effective construction site run-off control and design.

Residual Risk

With these management measures, the likelihood of impacts from soil disturbance and erosion is determined to be unlikely B; while there will be Slight impact (1) on environment, resulting in low residual negative risk (1B).

5.9.1.3. Impact to Terrestrial Flora

Sources of potential impact on flora in the construction phase include clearance of site, installation of rig and drilling equipment, constructing new access roads and physical disturbance. Soil compaction can inhibit root penetration and reduce water infiltration, which can increase runoff and erosion or cause ponding. These conditions limit or inhibit plant growth.

The Kyan Gin Reserved Forest covers a large portion of IOR5. Once drill site locations are identified, a careful site selection process will be implemented using recommended site selection criteria to ensure that no endangered floral species and threatened flora species will be affected. Existing agricultural areas will be preferred.

As standard practice, PCMI will ensure that its staff and contractors will not cut trees or forage in the area surrounding the well sites during any phase of the project.

The vegetation removed is expected to recover naturally after drilling and testing is complete.

The impact will therefore be local in extent, short-term in duration, reversible and of low-magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. Probability is determined to be Possible C.

The Risk Ranking of impacts to terrestrial flora is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to terrestrial flora can be mitigated through the use of the following measures:

- High valued habitat to be avoided where practicable in the design process.
- Remove vegetation in project areas only (roads, camp site, well site). Avoid cutting Riparian trees.
- Mark well sites clearly and prohibit vehicles from moving off site onto surrounding land.
- Mark trees to be cut prior to constructing well pads to prevent the cutting of other trees.
- Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to vegetation.
- Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.

Residual Risk

With these management measures, the likelihood of impacts to terrestrial flora is determined to be Unlikely B; while there will be slight impact (1) on environment, resulting in low residual negative risk (1B).

5.9.1.4. Impact to Terrestrial Fauna

Sources of impacts on fauna in the construction phase include clearance, installation of drilling equipment, access road construction, noise and human activity. Clearance activities could result in a direct loss of habitat, and increase in disturbance. Human activity causes disturbance to fauna.

The Kyan Gin Reserved Forest covers a large portion of IOR5. Once drill site locations are identified, a careful site selection process will be implemented using recommended site selection criteria to ensure that no endangered species and threatened species will be affected.

The value of the study area as habitat is significantly affected by its current use as agriculture areas which are used to grow rice, beans/pulses, peanuts and sesame, rice, corn, vegetables, thanakha. Trees and vegetation are an important habitat for wildlife. Compared to the surrounding available habitats, the project area is small.

Human activity will be confined to the access road and well sites and will not constitute a new impact on the area, which is already regularly visited by people. Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to wildlife. In addition, hunting and trapping will be specifically prohibited and violations are grounds for termination of contract and dismissal. Once specific locations are identified the impacts to fauna will be assessed including the following:

- Disorientation of least mobile animals
- Loss of forest ecosystem
- Trap hazards for animals
- Disturbance to animals
- Disoriented animals that are attracted to lights.
- Degradation of habitats

The impacts on fauna will be local in extent, short-term in duration, reversible and of low magnitude. The value of the study area as habitat is significantly affected by its current use for agricultural crops and continued human activity; the importance is rated as low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of impacts occurring to terrestrial fauna is determined to be Possible C.

The Risk Ranking of impacts to terrestrial fauna is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts to terrestrial fauna can be mitigated through the use of the following measures:

- Habitat surveys to be undertaken of infrastructure locations to identify unique or sensitive habitats and biota.
- Mark trees to be cut prior to constructing well site, camp site and access road to prevent the cutting of other trees.
- Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to wildlife.
- Hunting and trapping will be specifically prohibited and violations grounds for termination of contract and dismissal.

- Remove vegetation in road areas only.
- Mark well sites clearly and prohibit vehicles from moving off site onto surrounding land.
- Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.

Residual Risk

With these management measures, the likelihood of impacts to terrestrial fauna is determined to be unlikely B; while there will be slight impact (1) on people, environment, assets or reputation, resulting in low residual risk (1B).

5.9.1.5. Impact to Surface Water Hydrology

Impact Assessment

Vegetation removal, construction of well sites and access roads can alter surface water hydrology by reducing interception, evaporation/ transpiration and infiltration, which in turn can increase runoff and change local drainage patterns. Heavy rains can intensify changes in surface water hydrology; these changes are also enhanced on steep slopes.

Construction of the access roads, campsite and well sites for this project will result in some vegetation removal. The area of vegetation removal will be small and site preparation will be conducted on flat terrain. In addition, PCMI will install culverts under the access roads if required or requested to maintain natural drainage. No changes in surface water hydrology are therefore expected

Runoff calculation

The runoff from a single well site is calculated with **Equation** 5-3. In the project area the wettest month is September with a monthly rainfall of 129 mm. Therefore, runoff was calculated using a rainfall intensity derived from a worst case scenario of a month’s equivalent of rain intensity in a ½-hr duration storm. (129 mm/hr)

Runoff from the well site is calculated using **Equation** 5-3, which is valid for runoff areas not larger than 25 km^2.

$$Q = 0.278x10^{-6}CIA \qquad \text{Equation 5-3}$$

where:

Q = runoff, m^3/second

A = area, m^2

I = rainfall density, mm/hour

C = runoff coefficient (**Table 5-36**)

Table 5-36: Runoff Coefficient of Various Catchment Areas

Land Use	Coefficient (C)	Surface	Coefficient (C)
Business		**Streets**	
- Downtown area	0.70-0.95	- Asphalt or concrete	0.70-0.95
- Neighbourhood areas	0.50-0.70	- Bricks	0.70-0.85
Residential		**Roofs**	0.75-0.95
- Single family areas	0.30-0.50	**Lawns (sandy soil)**	
- Multi unit, detached	0.40-0.60	- Flat with 2%slope	0.05-0.10
- Multi unit, attached	0.60-0.75	- 2-7% slope	0.10-0.15
- Suburban	0.25-0.40	- Over 7% slope	0.15-0.20
- Apartments	0.50-0.70	**Lawns (heavy soil)**	
Industrial		- Flat with 2% slope	0.13-0.17
- Light areas	0.50-0.80	- 2-7% slope	0.18-0.22
- Heavy areas	0.60-0.90	- Over 7% slope	0.25-0.35
Parks, cemeteries	0.10-0.25		
Playgrounds	0.20-0.35		
Railroad yard areas	0.20-0.35		
Unimproved areas	0.10-0.30		

Source: Kriangsak Udomsinrot (1994), Environmental engineer, Mitnarakanpim, Bangkok
Thongchai Pansawad (1995), Guideline for waste water treatment system and rainfall

Pre-Construction-Surface water drainage before the construction of a well site for the project can be calculated as follows:

$$\text{Q (existing condition)} = (0.278\text{x}10^{-6})\ (0.17)\ (129)\ (24{,}000)\ \text{m}^3/\text{s}$$

$$= 228.25\ \text{m}^3 \text{ for the ½ hr storm,}$$

with the following parameters inserted into Equation 5-3:

A = well site area 14,400 m^2 and camp site area 6,400 m^2

I = 129 mm/h (using a monthly rainfall storm).

C = 0.17 for garden (heavy soil), flat with 2% slope (**Table 5-36**)

Therefore, the volume of runoff for an extreme ½ hour duration storm before the well pad is constructed will be 228.25 m^3 for a single well site.

Construction- Surface water drainage during construction of the project site can be calculated with Eq. 5-1 as for pre-construction with a runoff coefficient (C) of 0.30 for unimproved area (**Table 5-36**) as $(0.278\text{x}10^{-6})\ (0.30)\ (129)\ (24{,}000)\ (1800)\ \text{m}^3 = 402.8\ \text{m}^3$.

Therefore, the volume of runoff for an extreme 1/2 hour duration storm during construction is projected to be 402.8 m^3 per well site.

Surface Water Runoff to Access Road

The overall landscape around the project well site is expected to be flat with agricultural and forested areas. The agriculture areas are used to grow rice, beans/pulses, corn, peanuts and sesame.

All access roads will be 9-m wide. In consultation with adjacent landowners, roads will incorporate culverts to allow the flow of natural surface drainage and prevent any ponding of water around the access road. The required permission will be obtained from all relevant agencies.

Without mitigation measures, impact on hydrology will be local in extent and transient, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of is determined to be Possible C.

The Risk Ranking of impacts on surface water hydrology is rated as medium.

Severity	Probability	Risk Ranking
Localized Impact	Possible	Medium
3	C	3 C

Management Measures

Impacts from runoff can be mitigated through the use of the following measures:

- Avoid construction of well sites and access roads in areas that may cause obstacles to water drainage.
- Construct water drainage lines (culverts) to maintain natural drainage. The required permission will be obtained from all relevant agencies.
- Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.
- Try to complete the construction of well sites within the dry season if possible.

Residual Risk

With these management measures, the likelihood of impacts from a change surface hydrology is determined to be Unlikely B; while there will be localized impact (3) to the environment resulting in low residual negative risk (3 B).

5.9.1.6. Impact to Water Quality and Aquatic Habitat

Sources of impact on surface water quality from land and habitat disturbance are soil erosion in the construction area that might wash soil into surrounding surface water; and contamination such as machine repairing and changing of lubricating oil. Impacts from accidental spills are discussed in **Section 5.12.4.**

Some erosion and soil loss are unavoidable during land-disturbing activities. While proper sitting and design will help prevent areas prone to erosion from being developed, construction activities will invariably produce conditions where erosion may occur. However, the flat slope of the land and the timing of construction will limit downstream impacts.

Both runoff volume and suspended solids concentrations can increase during and after construction. For this project, the maximum runoff volume for an extreme rain event increases from 228.25 m^3 for pre-construction to 402.8 m3 during construction (detailed calculation are provided under Surface Water Hydrology, **Section 5.9.1.5**). The typical suspended solids (SS) concentration from different areas is provided in **Table 5-37**.

Table 5-37: Typical Suspended Solids Concentration in Runoff

Source Area	Suspended Solids Concentration
Landscaped area	500 mg/L
Construction site	10,000 mg/L
Unpaved parking	250 mg/L
Detention pond water	10 mg/L

Source: Pitt and Clark. 2002[3]

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[3] Pitt, R. and S. Clark. 2002. Emerging stormwater controls for critical areas. Pp. 104-136. In Wet weather flow in the urban watershed. Technology and Management. Field, R. and D. Sullivan. (Eds)

The suspended runoff load from the project site before and during construction is outlined in **Table 5-38**. The overall suspended solids load during construction is substantially higher than before construction. Construction is expected to start on January, 2017 and last 2.5 months per well site. The Actual maximum annual rainfall will be well below the worst case of a maximum month's equivalent rainfall event of 129 mm/hr used the calculate runoff from the project well site.

The typical SS concentrations from different surfaces from **Table 5-37** are combined with the rainfall intensity of a ½-hr duration storm with a return period of 10 years to determine the maximum runoff load in **Table 5-38**.

Table 5-38: Suspended Solids (SS) Runoff from the well site

Period	Max. Runoff Volume (m^3)	SS Concentration (mg/L)	Max. SS Load (kg)
Pre-Construction	228.3	500	114
Construction	402.8	10,000	4,028

The calculations indicate that the runoff volume and levels of maximum suspended solids in runoff is potentially much higher during construction than before construction. It should be noted that the values calculated in **Table 5-38** are based on an extreme rainfall. The chance that this extreme event would happen within the construction window for this project is very small.

Any siltation from surface runoff generated during construction activities is unlikely to travel far. Sustained elevated turbidity levels from runoff can reduce transmission of sunlight, thus limiting photosynthesis. In turn, this can reduce the level of oxygen in the water. Organic matter introduced into a watercourse can lead to further deoxygenation as the organic matter is decomposed by micro-organisms and result in eutrophication. If oxygen levels fall below the natural DO variability in a system, flora phytoplankton, zooplankton and benthos diversity and abundance could decline.

Without mitigation measures, impacts to water quality and aquatic habitat are therefore expected to be local in extent, short-term in duration, reversible, and of medium magnitude. The importance of a runoff event (if it occurs) impacting these species is medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of is determined to be Possible C.

The Risk Ranking of impacts to on surface water quality and aquatic biota is rated as medium.

Severity	Probability	Risk Ranking
Localized Impact	Possible	Medium
3	C	3C

Management Measures

Impacts to water quality and aquatic biota can be mitigated through the use of the following measures:

- The proposed drill site and campsite will be selected to minimize areas requiring soil stabilization.
- Provide drip pans and absorbents to contain any spillage.
- Provide drainage and sediment traps around project area to reduce suspended particles in runoff from the well site and to contain minor oil spills.
- Avoid construction of the well pad and/or access road in areas where such construction obstructs water drainage.
- Prohibit workers from cleaning machines/equipment in/near a public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources.

- Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil).
- Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.

Residual Risk

With these management measures, the likelihood of impacts to water quality and aquatic habits is determined to be Unlikely B; while there will be Minor impact (2) on environment resulting in low residual negative risk (2B).

5.9.2. Vehicle and Drilling Rig Movements

This section details the impacts associated with the movement of vehicles and the drilling rig through all phases of the exploration drilling campaign. The construction phase of the project will see an increase in vehicle and heavy equipment activity that will then decrease during the operations phase.

Drilling Rig - PCMI plans to use a land rig for the drilling program. The exact transport route and duration of rig move is yet to be determined. PCMI will update the authority if required on the rig move once the route is confirmed. The rig mobilization will include around 130 truck loads to complete. The maximum mobilization distance for the rig is estimated at about 500 km.

Drilling Materials will be transported from Yangon (Thaketa or MITT port) to IOR-5 via the public highway. The estimated number of round trips for rig and support equipment is 30 trip per well. PCMI’s strategy will be to send enough supplies for two wells (60 trips) to the first location and ‘feed’ needed equipment, casing and chemicals in small convoys for the remaining wells.

The rig personnel will be transported overland to the well locations.

Impact Assessment

The potential impacts from the movement of vehicles and drilling rigs associated with the exploration drilling campaign are:

- Disturbance leading to behavioural changes or displacement of fauna
- Disturbance to traffic
- Increased likelihood of incidents

5.9.2.1. Disturbance Leading to Behavioural Changes or Displacement of Fauna

The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation. Some behavioural disturbance may occur for short periods if fauna are present or near access road and project site.

Without mitigation measures, impacts to terrestrial fauna are therefore expected to be local in extent, short-term in duration, reversible, of low magnitude. The importance of vehicle and rig movements impacting these species is low. Given these impact criteria considerations the severity is determined to be a **Slight impact** for environment. The probability of these impacts occurring is Likely (D).

The Risk Ranking of impacts to terrestrial fauna is rated as medium.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1 D

5.9.2.2. Disturbance to traffic

The rig mobilization and demobilization may cause disruption to local traffic. This is dealt further in the Social Impact Assessment in **Section 5.10.4**.

Management Measures

In order to minimize potential impacts to fauna from vehicle and rig movements associated with the project the following management measures will be adhered to:

- PCMI will conduct Road Hazard Assessment for the road in the boundary of IOR-5.
- Vehicles will take direct routes where possible and avoid significant habitat areas.
- Construction vehicles will follow speed limits.
- Escort vehicles for wide load that have wide load signs and flashing warning lights.
- Follow local transportation laws and regulations

Residual Risk

With these management measures, the likelihood of impacts from vehicle and rig movements is determined to be Possible C; while there will be slight impact (1) environment, resulting in low residual negative risk (1 C).

5.9.3. Air Emissions

5.9.3.1. Dust Emissions

Dust will be dispersed by vehicles driving on gravel/dirt roads during all project phases. Vehicles grind dust into fine particles lifted into the air by tire rotation and eddy air currents (Hesketh et al., 1983).

Dust dispersion can lead to a temporary deterioration in air quality by increasing TSP (Total Suspended Particulates) and PM_{10} (Particulate Matter <10 microns, units mg/m^3) concentrations.

During transportation of materials and equipment, site clearing including soil excavation/filling and construction of access road/well pad, well site, camp, sensitive receptors within a 2-km radius of the well sites may be affected by impacts to air quality. These receptors are mostly located in rural area and include:

- Village Households
- Pagodas, Monasteries
- Schools
- Fields (rice and crops oil seed: ground nuts, sesame etc)

Impact Assessment

During the construction phase, fugitive dust may be generated by transport of materials and personnel, site preparation, excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind.

Dust will be dispersed by vehicles driving on laterite roads or off road: vehicles grind dust into finer particles, and tire rotation and eddy air currents lift particles into the air (Hesketh *et al.*, 1983). Dust dispersion will also be caused by filling and compaction during construction.

According to AP-42 of U.S.EPA (Compilation of Air Pollution Emissions Factors, 1977):

"The level of dust dispersion normally depends on working characteristic, soil humidity, wind speed, and construction period. On site construction with medium activities, 30% of silt and 50% ofPrecipitation Evaporation Index generates **1.2 tons/acre/month**[4] **of dust dispersion on average (or 15.8 kg/rai/day)**.These particles **(greater than 10 micron)** will disperse following wind direction and will fall off in the **distance of 6-9 meters from construction site**".

Well site (well site and camp site construction)

There would be no communities located within a radius of 500 m from the project well sites. For particulate matter smaller than 10 microns, the dispersion distance could be greater than this, and the sensitive receptors are considered to be those within a 2 km radius of the well sites.

The emission rate (Q) and dust concentration (C) can be estimated as follows:

Emission Rate (Q)

The dust emission rate can be estimated according to **Equation 5-4**:

$$Q\ (mg/s) = \frac{15.8\ (kg/rai/d) * area\ (rai) * 10^6\ (mg/kg)}{24*60*60\ (s/d)} \qquad \text{Equation 5-4}$$

Each well site covers an area of **24,000 m^2**for **well pad and camp pad (120 x 200 m**) provided by the developer or 15rai total for each well. In addition, the access road needs to be constructed.

On the basic of above equation, emission at source would be **2,377.3mg/s**

Q = 2,377.3 mg/s, Area = 24,000 m^2 (**15 rai**)

Dust Concentration (C)

The dust concentration is estimated by using **Equation 5-5**:

$$C\ (mg/m^3) = \frac{Q\ (mg/s)}{d\ (m) * W\ (m/s) * M\ (m)} \qquad \text{Equation 5-5}$$

Where C = Dust Concentration (mg/m3)
Q = Emissions at Source (mg/s)
d = Width (the smallest dimension is used for worst case scenario) (m)
W = Average maximum wind speed (m/s)
M = Mixing Height (m)

The mixing height data is not available yet in the Meteorology Department in Myanmar. Therefore, this measurement is adopted from the atmospheric simulation models(European Commssion, n.d.). The use of simple default values related to wind speed and stability class as in **Table 5-39**.

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[4] http://www.epa.gov/ttn/chief/old/ap42/3rd_edition/ ap42_3rdsup 1_7_aug 1977.pdf

Table 5-39: Default Mixing Heights related to Wind Speed and Stability Class

Atmospheric Stability	Horizontal wind speed, m/s	Default Mixing Height, m
A very unstable	0.5-2	2000
B unstable	0.5-2	1500
C slightly unstable	2-10	1000
D neutral	3-10	750
E stable	2-5	300
F very stable	0.5-3	250
G extremely stable	0.5-1	250

Source: European Commission, n.d.

For this dust impact assessment, the **stable condition** is selected as the **worst case scenario.**

$Q = 2{,}377.3 mg/s$

$d = 120$ m

$W = 2$ m/s (stable wind)

$M = 300$ m (stable wind)

$C = 0.064647\ mg/m^3$

Access road (constructed)

The off-road distance (10 km or 10,000 m), between the main road and one well site, would be needed to be constructed and upgraded based on the PCMI drilling superintendent. This off-road distance has been assumed the worst case scenario for constructed and upgraded road. **Table 5-40** shows the distance and area for the upgraded road length.

Table 5-40: The access road to be constructed for the well site

Off-road to well site(m)	d (m)	Area (m2)	Area (Rai)
10,000	8	80,000	50

Table 5-41shows the dust construction emitted from the one well site using the equations **Equation 5-4** and **Equation 5-5**.

Table 5-41: Dust Concentration from Well Site associated Road Construction (one well-site)

Location		Area (m2)	Area (rai)	Q (mg/s)	d (m)	C (µg/m3)	Ambient PM-10 (µ g/m^3)*
Well	1 Well site	24,000	13	2,377.31	120	33.02	**(89-91)**
Drive way (between Off-road and the well site)							
Access road (constructed and upgraded)	Off-road leading to well site	80,000	50	9,143.52	8	1905	**(89-91)**

* Ambient PM-10 concentrations are 24hr average baseline values measured at the total (8) locations in the whole proposed project area. The findings are more detailed in ambient air baseline section.

The dust concentration resulting from the well site and access road construction is added to the ambient concentration. **The highest combined dust concentration** would be during **upgrading of the access roads for the well site** (with a wind parallel to the road and driveway): In actual situation, road construction would be carried out section by section. Therefore, it could not emit all dust emission at the same time.

Without mitigation measures the impacts to air quality from nuisance dust are expected to be local in extent, short-term in duration, reversible and of high magnitude. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of is determined to be Likely D.

The Risk Ranking of impacts to air quality from nuisance dust is rated as medium.

Severity	Probability	Risk Ranking
Localized Impact	Likely	Medium
3	D	3D

In general, the potential impact is estimated for a worst case scenario; in reality vehicles and equipment will only be used intermittently. Therefore, the emissions will be the less than presented above.

Based on the ranking, nuisance dust from the construction phase is considered as medium. Dust emissions from the construction activities are expected to potentially deteriorate the existing status of air quality around the project area especially during the dry season and when winds blow from the construction site to nearby communities.

The impacts would be short-term and limited to localized areas. But, if there were no mitigation measures, dust emissions can cause nuisance close to the construction sites, so would potentially affect construction workers, villagers and the environment.

Management Measures

Potential impacts from dust dispersion can be mitigated by application of the following measures:

- Minimize emission exposure by locating the project site away from communities, shortening the construction/abandonment duration.
- Minimize land clearance to a minimum especially during the drier months.
- Reduce air emissions by regular maintenance.
- Limit vehicle speed (approximately a speed limit of 30 km/hr) especially on unpaved roads during dry conditions.
- Cover trucks transporting materials with tarpaulins or plastic to prevent any loose material from blowing away and also to prevent dust dispersion.
- Cover construction materials.
- Spray water on roads twice a day to keep dust down.
- Clean tires of the vehicles before leaving site if needed.
- Practice correct storage and usage of covers and/or control equipment (water suppression, bag house, or cyclone) in handling of materials such as conveyors and bins to prevent nuisance dust emissions.
- Re-vegetate disturbed areas as soon as practicable to limit exposed soil areas.
- Provide personal protective equipment (masks and gloves) to exposed field workers.
- Use vehicles with dust flaps.

Residual Risk

With these management measures, the likelihood of impacts from nuisance dust determined to be possible C; while there will be a minor impact (2) on environment, resulting in low residual negative risk.

5.9.3.2. Hydrogen Sulphide

Gas produced from the wells is constantly analysed for its composition and for the presence of hydrogen sulphide (H_2S). Hydrogen sulfide is a colorless, flammable, highly toxic gas. US Occupational Safety and Health Administration's (OSHA) occupational standard in the workplace is 10 ppm (8hr.TWA (time weighted average) and 15ppm (15min. STEL (short term exposure limit)); NIOSH IDLH (immediately dangerous to life or health) = 100 ppm. The potential for H_2S is a possibility but unlikely.

H_2S detection and safety equipment is standard issue (see **Section 2.9.3** and **Chapter 6).** PCMI's emergency response plan (ERP) includes an H_2S Contingency Plan. Furthermore, the drilling contractor will have their own H2S Contingency Plan.

Without mitigation measures, hydrogen sulphide impacts during drilling and well testing will be local in extent, short-term in duration, reversible and of medium magnitude. The importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of is determined to be Unlikely B.

The Risk Ranking of impacts from hydrogen sulphide release is rated as low.

Severity	Probability	Risk Ranking
Minor Impact	Unlikely	Low
2	B	2B

Management Measures

Standard mitigation measures to reduce impacts from hydrogen sulphide release will be implemented:

- Install H_2S sensors at the flow line.
- If H_2S levels exceed 10 ppm in the gas stream, implement appropriate safety zones.
- All crew are instructed and rehearsed in H_2S procedures.

Residual Risk

With these management measures, the likelihood of impacts from hydrogen sulphide release is determined to be unlikely B; while there will be a slight impact (1) on environment, resulting in low residual negative risk.

5.9.3.3. Air Pollutants

These come from various sources: fugitives and exhausts, fuel combustion, gas and oil processing, evaporation, flaring, waste incineration, refrigerators and freezers, vaporization from drilling muds, etc.

Potential concerns are:

- personnel safety
- global greenhouse effect
- ozone depletion
- fire hazards

Gaseous emissions may not deteriorate local air quality, but may contribute to the global problems of greenhouse warming and ozone depletion. The primary gaseous emission concerns are hydrocarbons, nitrogen oxides, sulphur oxides and carbon monoxide, and the contribution they will make to onshore levels of those gases or to existing problems, e.g., photochemical smog. Mercury vapour, sulphur dioxide and carbon monoxide in confined space present serious personnel health threats, while combustible gases may constitute fire hazards.

Impact Assessment

Fuel use for construction activities causes emission of pollutants. Emissions include CO, CO_2, NO_X and SO_2. Potential impacts of these and engine emissions are summarized in **Table 5-42**.

Table 5-42: Potential Impacts of Combustion Emissions

Emission Species	Environmental Impact
CO	Contributes indirectly to climate change by enhancing low-level of ozone formation.
CO_2	A GHG. Contributes to climate change.
NO_X	Contributes to the formation of acidic species that can be deposited by wet and dry processes, impacting aquatic and terrestrial ecosystems.
SO_2	Contributes to the formation of acidic species that can be deposited by wet and dry processes, impacting aquatic and terrestrial ecosystems.
CH_4	A GHG. Contributes to climate change. Reactant of ozone. Impact on respiratory system and circulatory system of living creature
N_2O	A GHG. Contributes to climate change.

Based on compilation of air pollution emission factors established by the U.S. Environmental Protection Agency (EPA), air pollutants generated from diesel oil combustion will consist of carbon monoxide, nitrogen dioxide, sulphur dioxide, and methane. The major contributor of air pollutants will be the diesel generators on site during drilling and from flaring. Estimated carbon dioxide emissions are discussed under Greenhouse Gases in **Section 5.9.3.4** below.

Drilling Rig Diesel Generators

Diesel generators will be used as a source of power supply for drilling. The generators will operate 24 hr/day throughout a drilling period of 88 days for each well.

Based on compilation of air pollution emission factors established by the U.S. Environmental Protection Agency (EPA), air pollutants generated from diesel oil combustion of 8 m^3/day for the Land Drilling Rig.

This will consist of carbon monoxide, nitrogen dioxide, sulphur dioxide, and methane at estimated concentrations shown in **Table 5-43**.

The total emission values are a worst case scenario for two wells. The rig is powered by 4 diesel driven generator sets and each rated 400KVA to supply the rig site with power.

Table 5-43: Air pollution emissions from Drilling

Air Pollutant	Emission Factor (kg/TJ)	Emission of Air Pollutant (tonne/day/well)	Total Emission (tonnes)
Drilling Rig Century Generator and Camp Site – (8 m^3/day/well), 88 days per well, 2 wells			
Nitrogen Oxides (NO_x)	1,896	0.552	**97.2**
Sulphur Oxides (SO_x)	126	0.037	**6.5**
Carbon Monoxide (CO)	410	0.119	**20.9**

*Includes 88 days of drilling/well x 2 wells

Sources: US.EPA, "Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources", Fifth Edition, January 1995; http://www.epa.gov/ttn/chief/ap42/ch03/bgdocs/b03s03.pdf.

Emissions during Well Testing Phase

Diesel generators will be used as a source of power supply for testing. The generators will operate 24 hr/day throughout a testing period of 22 days per well. The maximum flow during a DST test generally never exceeds 10 mmscfgd. Thus a worst case scenario flaring is a sustained flow rate of 10 mmscfgd for 22 days for one well at each of the four well sites.

Based on compilation of air pollution emission factors established by the U.S. Environmental Protection Agency (EPA), air pollutants generated from diesel oil combustion will consist of carbon monoxide, nitrogen dioxide, sulphur dioxide, and methane at estimated concentrations shown in **Table 5-44**. Estimated carbon dioxide emissions are discussed under Greenhouse Gases below.

Table 5-44: Estimated Total Air Pollutant Emissions for Well Testing Phase

Air Pollutants – Fuel Use	**Emission Factor (kg/TJ)**	**Emission of Air Pollutant (tonne/day/well)**	**Total Emission (tonnes)**
350-KVA Camp Site Generator (1.5 m^3/day/well) – 22 days per well, 2 wells			
Nitrogen Oxides (NO_x)	1,896	0.103	4.5**
Sulphur Oxides (SO_x)	126	0.007	0.3**
Carbon Monoxide (CO)	410	0.022	1.0**
Air Pollutants – Flaring	**Emission Factor ($lb/10^6$ Btu)**	**Emission of Air Pollutant (lb/day)**	**Total Emission (tonnes)***
Flaring max 10 mmscfgd or 10 x 10^9 BTU/day/well – 7 d/well for 2 wells			
Carbon Monoxide (CO)	0.37	3700	23.5
Total Hydrocarbons**	0.14	1400	8.9
Nitrogen Oxides (NO_x)	0.068	680	4.3

**Includes 22 days of testing/well x maximum of 2 wells
Sources: US.EPA, "Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources", Fifth Edition, January

Without mitigation measures, the impact from air pollutants will be local in extent, short-term in duration, reversible and of medium magnitude. However, the impact could be important on a local level; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of is determined to be Likely D.

The Risk Ranking of impacts from air pollutants is medium.

Severity	**Probability**	**Risk Ranking**
Minor Impact	Likely	Medium
2	D	2D

Management Measures

Impacts from air pollutants can be mitigated through the use of the following measures:

- Energy conservation measures will be taken into account during rig selection.
- Process control to minimize flaring.
- Diesel used in vessels will have a low sulphur content.
- Reporting of atmospheric emissions as per PCMI requirements.
- Maintain scheduled maintenance program.

Residual Risk

With these management measures, the likelihood of impacts from air pollutants is determined to be likely D; while there will be a slight impact (1) on environment, resulting in low residual negative risk.

5.9.3.4. GHG Emissions

The potential sources of deterioration of air quality are fuel combustion from:

- Vehicle Emissions
- Well Testing
- Diesel Generators (Drilling Rig and Camp site)

The sensitive receptors for greenhouse gas emissions are the same as those listed for dust emissions (within a 2 km radius of well sites).

Impact Assessment

The GHG emissions are estimated following the Tier 1 approach of IPCC (2006). Full details of the calculations are shown in **Appendix B**. GHG emissions are estimated using emission factors and global warming potentials for the three main greenhouse gases (CO_2, CH_4 and N_2O). The estimated GHG emissions for each well are shown in **Table 5-45**.

Total greenhouse gas emissions during for the project (2 exploration wells) amounts to 30,025.8 ton eq CO_2. The latest CO_2 release of Myanmar was 12,775,830 ton in 2008 (World Bank, 2008), the total GHG releases from the project are almost insignificant (approximately 0.2350%), and therefore will not significantly impact the environment.

Table 5-45: Estimated Total GHG Emissions per Well

Project Phase	Activity	One Time CO_2 Release (ton CO_2)
Site Preparation	Granular Fill Transport	65.7
Drilling	Drilling rig mobilization	32.3
	Equipment and Supplies	6.9
	Drill cuttings transport	57.3
	Transport (fuel, water, personnel)	57.1
	Heavy equipment use	3,898.6
	Generator to power drilling rig and camp site	5,713.0
Testing Activity	Generator to power beam pump	89.3
	Flaring	4,816.2
Abandonment and Restoration	Heavy Equipment and transportation.	276.5
Total per well		15,012.9

Without mitigation measures, the impact from greenhouse gas emissions during drilling are considered to be a global issue, short-term in duration, reversible and of low magnitude. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of the impact occurring is determined to be Likely D.

The Risk Ranking of impacts from GHG emissions is low.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1D

Management Measures

Impacts from GHG emissions can be mitigated through the use of the following measures:

- Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer.
- Maintain road going vehicles to ensure that fuel use is efficient and emissions are within acceptable limits.
- Instruct drivers on the benefits of driving practices that reduce the risk of accidents, fuel consumption and dust generation.
- Turn off all vehicles and equipment when not in use as well as prohibit vehicles from idling.
- To maximize energy efficiency and design facilities to minimize energy use.
- Operating flare to control odor and visible smoke emissions (no visible black smoke).
- Locate flare at a safe distance from local communities and the workforce including workforce accommodation units.
- Implementation of burner maintenance and replacement, programs to ensure continuous maximum flare efficiency.
- Metering flare gas.
- Keep installation and functioning of flare gas system safe according to the good engineering practice.
- Ensure flare system has efficient combustion.
- Maintain pilot flame at the flare tip to ensure that flame is not extinguished by strong wind.
- Verify the operation’s flaring system.
- Minimize the duration and rate of flaring as much as possible.

Residual Risk

With these management measures, the likelihood of impacts from GHG emissions is determined to be Possible C; while there will be a slight impact (1) on environment at a global level, resulting in low residual negative risk.

5.9.4. Noise

This section assesses the potential impacts of noise from the exploration drilling campaign to sensitive receptors. The level of noise from project activities that is audible to a receptor (received level) will depend on the following:

- Background (ambient) noise.
- Noise level generated by an activity at the source (source level).
- The distance the receptor is from the noise source (range), and the level of transmission loss between the noise source and the receptor.
- The hearing threshold and frequency sensitivity of the receptor.

Noise will be generated during all project stages by vehicles, generators, equipment and drilling rig operations at levels shown in **Table 5-46**.

Table 5-46: Noise Level from Construction and Drilling Equipment

Source	Maximum dB(A) at source	Number of Sources at one time
Bulldozer	85	1
Backhoe	80	1
Grader	85	1
Compactor	82	1
Heavy trucks (dump trucks)	88	1
Water truck(Lmax truck)	84	1
Jack-hammer	80	1
Drilling Rig (auger)	85	1
Generator (for drilling & testing)	81	2

Source: US Federal Highway Administration, US Department of Transportation, 2008; reference distance 50 ft (15.24 m); (http://ops.fhwa.dot.gov/wz/workshops/accessible/Schexnayder_paper.htm)

Impact Assessment

The impact assessment for noise from project activities evaluates impacts to fauna during the different phases of the project. Noise is expected to be greatest during construction and commissioning due to the higher number of vehicle movements and heavy machinery use.

Construction activities will progress slowly along the access road and project site as the site is prepared and infrastructure installed. Any one area will therefore be subject to the maximum sound levels for only a short period as the construction activities pass that area.

During the drilling phase of the project, noise sources will include the drilling rig, generators and occasional vehicle movements.

Noise associated with decommissioning is expected to result primarily from the operation of the heavy machinery required to decommission the facilities and remove infrastructure. Noise impacts are anticipated to be similar to those from construction and commissioning activities. A decommissioning plan will be developed at the time of project decommissioning which will assess noise impacts of associated activities in more detail.

Like humans, the effect of noise on wildlife is highly varied and is dependent on the noise intensity, its frequency, and its duration; the sensitivity of the species or individual affected; and the environment in which the noise is perceived. Sounds exceeding 55 dB are known to cause physiological and behaviour changes in terrestrial fauna (Checker, 1980) and diminishes habitat value and disrupts terrestrial fauna activity (e.g. injury, energy loss, decreased food intake, habitat avoidance, and reproductive loss). Unusual, loud, and/or intermittent will generally startle and stress most species of wildlife, although they may quickly get used to continuous noise. They may avoid the area for varying lengths of time; once the noise ceases they will return. The area around the well sites provides habitat for many animals and birds temporarily disturbed by the noise of this operation.

Increased stress and/or movement during a critical period such as nesting or birthing will generally cause greater adverse effects to wildlife than the same stress outside of such critical times. If nesting birds leave the nest for even a short period of time, their nesting success may be reduced; if they abandon the nest, that nesting attempt will fail.

5.9.4.1. Construction

There will be a temporary increase in traffic levels and operation of heavy equipment, which will cause an increase in the noise levels and an increase in disturbance. This will have an impact on the surrounding wildlife (mainly birds) as they will tend to avoid the area.

Noise levels at various distances from these sources were calculated using **Equation 5-6**:

$$L_r = L_w - 20*Log_{10}(D/D_0) \qquad \text{Equation 5-6}$$

Where L_r = Sound level at distance D (dB(A))

L_w = Sound level at source D_0 (dB(A))

D = Distance from point source (m)

D_0 = Reference distance where the source noise emission level was measured

(Source: http://www.fhwa.dot.gov/environment/noise/highway/hcn03.htm)

The total noise level from several construction sources is calculated using **Equation 5-7**:

$$Lp_{Total} = 10 * Log_{10}(\sum_{i=1}^{n} 10^{Li/10}) \qquad \text{Equation 5-7}$$

Where $L_{p\ total}$ = Noise level from n sources
n = Number of sources

Li = Noise level from ith source, dB (A)

Not all construction equipment will be operating at the same time. Using data from **Table 5-46** for the three noisiest construction machines (dump truck, grader and bulldozer), the total construction noise is

$Leq_{(Total)}$=10 Log [(2)($10^{85/10}$) + (1)($10^{88/10}$)] = 91.0dB(A) at 50 feet from noise source

The nuisance noise during construction activities is calculated using **Equation 5-8**.

Nuisance Noise = Specific Noise Level- Background Noise Level Equation 5-8

Construction noise levels at sensitive receptors at 500 m and 1 km using **Equation 5-6** are 60.68 and 54.65 dB (A), respectively. The average ambient noise levels measured for the villages in IOR5 was 51.6 dB (A). The construction noise levels are combined with ambient noise levels using **Equation 5-7** into a specific noise level. The specific noise levels at the sensitive receptors at a range of 500 m and 1km are 61.64 and 57.63 dB(A), respectively.

The estimated noise levels present an absolute worst-case condition. Not all equipment is likely to operate at the same time. In addition, the surrounding trees and other vegetation and the topography are expected to lead to a far more rapid attenuation of noise. Construction activities are expected to last approximately 5.5 months per well site; noise levels at the sensitive receptors will return to baseline levels upon cessation of construction activities.

Without mitigation measures, noise impacts during construction will be medium in extent and transient, reversible and of low magnitude. The nuisance noise level does not exceed the nuisance noise standard of 10 dB (A). The importance of the impact is rated low as noise only results in small changes and small disturbances.

5.9.4.2. Drilling

The compounded noise level will be generated during drilling operations will last for 88 days.

During drilling operations, the highest compounded noise level at the site is expected from the drilling rig and two generators working simultaneously. Using **Equation 5-7**, the compounded noise level is:

$$\mathrm{Leq}_{(\mathrm{Total})} = 10 \text{ Log } [(2)\,(10^{81/10}) + (1)\,(10^{85/10})] = 87.5 \text{ dB (A) at 50 feet from noise source}$$

Drilling activities will last 88 day for each well. Noise levels have been calculated for the sensitive receptors in the vicinity of the well sites at 500 m and 1 km using **Equation 5-6** to generate the worst-case scenario for exposure. Drilling noise levels at sensitive receptors within 500 m radius is 57.18 dB (A). Drilling noise levels at sensitive receptors within 1 km radius is 51.16 dB (A). The drilling noise levels are combined with ambient noise levels using **Equation 5-7** into a specific noise level.

The specific noise level at the sensitive receptors within 500 m is 59.09 dB (A). The specific noise level at the sensitive receptors within 1 km is 56.23 dB (A). The specific noise level at all well sites does not exceed the ambient noise standard of 70 dB (A).

The nuisance noise levels from the well sites at sensitive receptors at 500 m and 1km are 7.49 and 4.63 dB(A), respectively. The nuisance level at all well site not exceeds the nuisance noise level of 10 dB (A).

The estimated noise levels present an absolute worst-case condition: the surrounding trees and other vegetation and the topography will lead to a far more rapid attenuation. Drilling activities are expected to last approximately 88 days for each well; noise levels will return to previous levels upon cessation of drilling activities.

On the well site itself, all workers will be issued with standard safety equipment, including ear protectors, and their use will be strictly enforced where required by regulations in areas with high levels of noise and vibration. This is the standard industry practice on all rigs and part of the routine health and safety procedures.

5.9.4.3. Well Testing (Flaring)

During well testing (22 days/well), the flare and use of a generator may contribute to increased noise levels, however, at the flaring rate of 10 mmscfgd at the well site, noise during testing is not expected to be a significant source beyond about 500 m.

Without mitigation measures, impacts to terrestrial fauna are expected to be local in extent, short-term in duration, reversible, of low magnitude. The importance of noise impacting these species is low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of impacts occurring is determined to be Very Likely E.

The Risk ranking of impacts to terrestrial fauna is rated as medium.

Severity	Probability	Risk Ranking
Minor Impact	Very Likely	Medium
2	E	2E

Management Measures

Impacts from noise can be mitigated through the use of the following mitigation measures:

- Vehicles and rig transportation will avoid sensitive environmental areas.
- Construction activities and Vehicle/rig movements will be restricted to daylight hours.
- Limit vegetation removal to a minimum.
- Schedule operation of noisy construction equipment at different times.
- Ensure use of mufflers on diesel/gas driven machinery.
- Use low noise equipment.
- Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer.
- Turn equipment off when not in use.
- Use enclosures when possible to contain noise on site.
- Implement transportation plan.
- Materials should be lowered when practical and not dropped.

Residual Risk

With these management measures, the likelihood of impacts terrestrial fauna is determined to be likely D; while there will be slight impact (1) environment, resulting in low residual negative risk (1 D).

5.9.5. Light

Project components of the exploration program are to be artificially lit to varying extents during all phases of the project, therefore generating light spill. Light emissions will occur from vehicles, drill rig, well site and campsite. Site preparation and abandonment will be carried out in daylight. Hence, light impacts will not be relevant during these project phases. Drilling will be conducted on a 24-hour basis. Lighting on the site will be kept to a minimum and directed so that, consistent with safety and security, as little as possible falls outside the pad area and should be partly or fully hidden by scattered trees, thickets and topography.

Artificial light can disrupt biological processes that rely on natural light for visual cues. Terrestrial fauna that are known to be sensitive to light and may be disorientated, attracted to or repelled by light spill include mammals, reptiles and birds. The amount of light spill emanating from project activities will vary according to the number of light sources, wavelength and intensity of light sources, location of and/or placement of fittings and the method of light switching (rapid or gradual turning on of light sources).

This section discusses the impacts of light spill on ecological receptors identified within or adjacent to the project area.

Light Sources

Sources of artificial light for project will include:

- Functional lighting on vehicles and drill rig, camp site and well site
- Flaring

Functional Lighting

Functional lighting is required on vehicles, drill rigs, campsite and well site at levels that provide a safe working environment for personnel. Lighting typically consists of bright white lights, used in accordance with safety requirements. Working lights will be directed into the site so that impacts from working lights will be minimized off-site.

Flaring

If drilling results indicate the presence of sufficient petroleum hydrocarbons, well testing will be performed. Flaring during well testing will constitute a potentially significant light source.

Impact Assessment

Fauna that use visual cues for orientation, navigation, or other purposes may be disoriented by, attracted to, or repelled by artificial light sources. Potential impacts from artificial lighting associated with the project are:

- Disturbance to fauna
- Disruption to flora

5.9.5.1. Disturbance to Terrestrial Fauna

Drilling will occur 24 hours per day for 88 days per well. Lighting on the site at night will be kept to a minimum and directed so that as little as possible falls outside the confines of the pad, consistent with safety and security.

Any impacts from light on wildlife will be limited to the immediate vicinity of the well sites. Animals that are disturbed will avoid the area during the period of occupation. Insects will be attracted to the lights, which is likely to provide an easy food source for birds and other wildlife species.

Without mitigation measures, impacts to terrestrial fauna are expected to be local in extent, short-term in duration, reversible, of low magnitude. Therefore, the importance of a light impacting these species is low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of these impacts occurring is determined to be Likely (D).

The Risk ranking of impacts to terrestrial fauna is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1D

Management Measures

Impacts from light on terrestrial fauna can be mitigated through the use of the following mitigation measures:

- Drill Rig located in area distant to sensitive receptors.
- Keep night lighting to a minimum, consistent with safety and security.
- Direct lighting to the inside of the well sites.

Residual Risk

With these management measures, the likelihood of impacts to terrestrial fauna is determined to be Possible C; while there will be slight impact (1) environment, resulting in low residual negative risk (1 C).

5.9.5.2. Disturbance to Terrestrial Flora

Flaring during well testing will cause light and smoke. The light and smoke may have an impact on crop productivity around the well sites. Vegetation within this radius may be displaced but this safety zone will prevent fire spreading to nearby fields. The value of the well sites as habitat is significantly affected by its current use as agriculture areas are used to grow beans/pulses, peanuts and sesame, rice, corn, vegetables, thanakha and continued human activity.

Without mitigation measures, impacts to terrestrial flora and fauna are expected to be local in extent, short-term in duration, reversible, of low magnitude. Therefore, the importance of a light impacting these species is low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of the impact occurring is considered to be Possible (C).

The Risk Ranking of impacts to terrestrial flora is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Possible	Low
1	C	1C

Management Measures

Impacts from light on terrestrial flora can be mitigated through the use of the following mitigation measures:

- Drill Rig located in area distant to sensitive receptors.
- Keep night lighting to a minimum, consistent with safety and security.
- Direct lighting to the inside of the well sites.

Residual Risk

With these management measures, the likelihood of impacts terrestrial fauna is determined to be Unlikely B; while there will be slight impact (1) environment, resulting in low residual negative risk (1 B).

5.9.6. Heat

Heat can disrupt terrestrial fauna within the project area. This section discusses the impacts of heat on terrestrial fauna within or adjacent to the project area.

Impact Assessment

The volume of gas to be flared from the wells in an LTP test is expected to be a maximum of 10 mm scfgd per well. The recommended safe distance for heat radiation was calculated from the API equation (**Equation 5-9**):

$$D = \sqrt{\frac{F * Q}{4 * \pi * K}} \qquad \text{Equation 5-9}$$

Where

D is minimum distance in feet from midpoint of flame to the object;

F is fraction of radiated heat (0.2 for methane API RP 521)

Q is total heat content (BTU/hr) – 10 mmscfgd ÷ 24 hr/d * 1000 BTU/scf

K is allowable radiation (BTU/hr-sqft)

The calculated safe distances are provided in **Table 5-47**.

Table 5-47: Safe Distance from Flare

Exposure	F	Q	K	D	
				ft	m
Continuous exposure with no protection	0.2	416,666,667	500	115	35.1
Continuous exposure with minor discomfort	0.2	416,666,667	1000	81	24.8
Emergency access – several minutes	0.2	416,666,667	1500	66	20.3

The flare stack will be located a reasonable distance from site facilities and the area will be cleared of vegetation. Furthermore, a constant fire watch will be posted during flaring and testing operations to specifically watch this area and ensure that in the event of any fire the operation is immediately shut down and the ground fire extinguished before it can spread. This follows the standard operational procedure when testing a well. Wildlife within this radius will be displaced due to a loss of habitat (including insects and birds feeding on the insects), but wildlife will avoid any adverse heat effects. Heat is therefore not expected to affect wildlife off site.

Without mitigation measures, impacts to terrestrial fauna are expected to be local in extent, short-term in duration, reversible, of low magnitude. The importance of a heat impacting these species is low. Given these impact criteria considerations the severity is determined to be a **slight impact** for environment. The probability of these impacts occurring is determined to be Likely (D).

The Risk Ranking of impacts to terrestrial flora and fauna is rated as low.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1D

Management Measures

Impacts from heat can be mitigated through the use of the following measures:

- Clear vegetation around the flare stack.
- Minimize flare rate and duration.
- Post constant fire watch during flaring operations.
- Maintain safety distance between flare stack and well site facilities and adjacent crops.

Residual Risk

With these management measures, the likelihood of impacts terrestrial fauna is determined to be Possible C; while there will be slight impact (1) on environment, resulting in low residual negative risk.

5.9.7. Liquid Waste

Liquid wastes will be generated during all stages of the exploration drilling campaign in varying quantities and contain both hazardous and non-hazardous materials. Liquid wastes discussed in this section are:

- Sewage and sludge
- Drill site drainage
- Infiltration

Impact Assessment

5.9.7.1. *Sewage and Sludge*

Sewage and sludge (grey water generated from domestic processes such as dish washing, laundry and showers) will be generated at the campsite and well site. Estimated volumes were discussed in **Section 2.8.6.2**. The disposal of sewage and sludge will be managed in accordance with PETRONAS Waste Management Standards.

Sewage from on-site workforce has the potential to pollute soil, surface and ground water resources unless controlled. Sewage will be collected in concrete lined septic tanks; the greywater will discharge below ground “leach” drain type system. The sewage sludge will be removed once the tanks are full and treated at an approved treatment facility.

Without mitigation measures, impact on from sewage and sludge will be local in extent and transient, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment.

The Risk Ranking of impacts from sewage and sludge is rated as low.

Severity	Probability	Risk Ranking
Minor Impact	Likely	Low
2	D	2D

Management Measures

Impacts from sewage and sludge liquid waste can be mitigated through the use of the following measures:

- Install 1-2 concrete lined septic tanks on each well site for holding sewage. Grey water to be discharged to infiltration and evaporatory pit away from site and away from community water supplies.
- Drill site and personnel camp will collect and transport to an approved treatment plant.

Residual Risk

With these management measures, the likelihood of impacts from sewage and sludge liquid waste is determined to be possible C; while there will be a slight impact (1) on environment, resulting in low residual negative risk.

5.9.7.2. *Drill Site Drainage*

The well pad and camp pad have drainage which is derived from rainwater and wash down water that may contain minor quantities of oil, grease and detergents if present on the site. For each well site, a perimeter drainage system will be constructed around the leveled area to direct runoff into one waste pit with dimensions 40 m x 30 m and a depth of 4 m. The pit has a capacity of 4,800 m^3.

Calculation of surface water drainage from a well site after construction is subdivided based on the various surfaces. Drainage calculated from each distinct area is outlined in **Table 5-48**.

Table 5-48: Runoff Distribution from Well Site and Capacity of Receiving Areas

Areas	Project Site Areas	Catchment Area (A)	Runoff Coefficient (C)	Runoff (Q) for extreme ½ hr storm	Receiving Area
Well Site					
Rig Pad	Rig Pad: Drilling Rig, Mud Tanks and Pumps, Cement Units, Generators, Solid Control Equipment (reinforced concrete pad)	20x20 m = 400 m^2	0.95	24.5 m^3	Waste pit Capacity 4,800 m^3/pit (1 pit/site)
	Waste Pit (plastic lined)	40 m x 30 m = 1,200 m^2	1	77.5 m^3	
Well Pad and Camp Pad	Well Pad Pipe Storage, Work Shops, Offices	14,400m^2 (well pad) –400 m^2(rig pad) – 1200 m^2 (waste pit) = 12,800 m^2	0.35	289.2 m^3	Waste pit Capacity 4,800 m^3/pit (1 pit/site)
	Accommodation camp (compacted fill)	80 m x 120 m = 9,600 m^2	0.35	144.6	Off site through drainage system with weir and oil trap

The uncontaminated runoff water from the well pad and camp pad area will discharge to a drainage system surrounding the area passing with an offsite flow rate of 144.6 m^3 for the extreme ½ hr storm. Runoff after campsite construction is greater than runoff prior to construction; the compacted granular fill will inhibit infiltration compared to pre-construction conditions.

The contaminated runoff water from rid pad and shaker area will drain to waste pit (capacity 4,800 m^3). The runoff from the rig pad and well pad combined with rain falling on the waste pit for a ½-hr duration storm totals 391.2 m^3. The waste pit has an actual holding capacity of 4,800 m^3. The waste pit can therefore contain much more rainfall than the rainfall intensity of a ½-hr duration storm a month's equivalent rainfall in one hour. In the unlikely event that the waste pit should become full and overflow, tanker trucks are prepared to drain rainwater from the pit. This can be stored for later use as mix water, or if contaminated, will be disposed of at approved disposal site.

Runoff containing certain chemicals or drill fluid additives can cause water quality deterioration by increasing nutrient and/or organic matter loads (which can lead to eutrophication of water bodies from organic matter decomposition by micro-organisms), and by introducing toxic material into the water bodies. The potential for impacts from silt in runoff from the well site is minimal once the construction is complete; the suspended solid load following construction is practically identical to the pre-construction load.

On site fuel will be stored in steel tanks that sit on an area lined with a tarpaulin and surrounded by a bund wall with 110-120% containment capacity. The well site area of including the mud tanks and pumps, cement units, generators and solid control equipment is designed with an intermediate drainage system to drain all rainwater run-off into the waste pit.

These measures will create a zero-discharge well site and should ensure there is no release of contaminated water from the well sites. In the event of a spill, spill kits provided on site will be used to remove and contain the spill immediately. Any contaminated water will be collected in the waste pit through a drainage system around the project site, and will be disposed of by the local authority.

Without mitigation measures, impact from drill site drainage will be local in extent, short-term in duration, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of the impact occurring is considered to be Unlikely (B).

The Risk Ranking of impacts from drill site drainage is rated as low.

Severity	Probability	Risk Ranking
Minor Impact	Unlikely	Low
2	B	2B

Management Measures

Impacts from runoff can be mitigated through the use of the following measures:

- Prohibit workers from cleaning machines/equipment nearby public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources.
- Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil).
- Construct one waste pit on each well site for potentially contaminated runoff and spills (4,800 m^3 each), surrounded by 0.2 m high bund that will help prevent run-off into the environment. Monitor and transport waste to prevent any overflow from waste pit.
- The storage units will be surrounded by a bund wall that is able to contain 110-120% of the capacity of the tank, in case of spill.
- Construct drainage system (that includes a series of oil traps) around well site including the concrete rig pad, mud tanks and pumps, cement units, generators and solid control equipment on each well site to divert any spills into the waste pit.
- Contaminated drainage from site, machinery spaces or bunded areas will be contained.
- If the oil-in-water content specification is not met, the contaminated water will be stored in suitable containers and transported for treatment and/or disposal by a certified waste oil disposal contractor.
- Extracted hydrocarbons from oil-in water separator systems will be stored in suitable containers and transported for treatment and/or disposal by a certified waste oil disposal contractor in consultation with MOGE.

Residual Risk

With these management measures, the likelihood of impacts from drill site drainage is determined to be unlikely B; while there will be slight impact (1) on environment, resulting in low residual negative risk.

5.9.7.3. Infiltration

Infiltration from the cuttings and dirty water waste pit may deteriorate groundwater quality. The impacts on groundwater would be indirect as contamination would have to infiltrate through the soil or surface water.

The cuttings and dirty water waste pit will be 40 m long by 30 m wide and 4 m deep. It will be lined with an impervious HDPE liner. The pit will be surrounded by 0.2 m high bund that will help prevent run-off into the environment. These measures should ensure there is no infiltration into the groundwater from the waste pit.

Without mitigation measures the impacts to groundwater quality from infiltration are expected to be local in extent, potentially long-term in duration, reversible and of medium magnitude. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment.

The Risk Ranking of impacts to groundwater quality is rated as low.

Severity	Probability	Risk Ranking
Localized Impact	Unlikely	Low
3	B	3B

Management Measures

Impacts to groundwater from infiltration from cuttings and dirty water waste pit can be mitigated through the use of the following measures:

- Install an impervious HDPE liner in the cuttings and dirty water waste pit. Monitor liner for tears or leaks during installation and operations.

Residual Risk

With these management measures, the likelihood of impacts to groundwater from infiltration from the cuttings and dirty water waste pit is determined to be unlikely B; while there will be minor impact (2) on environment, resulting in low residual negative risk.

5.9.8. Solid Waste

Impact Assessment

Solid wastes will be generated during all phases of the project. Solid wastes produced will consist of both hazardous and nonhazardous materials. For all solid wastes, a policy of reduce, reuse and recycle will be implemented, where possible, across all phases of the project.

Management of solid waste will be undertaken by PCMI in accordance with PETRONAS standards. For each solid waste type generated the most appropriate method of management will be determined and documented in a Waste Management Plan. Solid wastes to be produced during exploration drilling campaign will consist of:

- Non-hazardous waste.
  - General non-hazardous wastes.
  - Food and kitchen wastes.
- Hazardous waste.
  - General hazardous wastes.
  - Drill Cuttings and Fluids
  - Naturally Occurring Radioactive Material.

5.9.8.1. Non-Hazardous Solid Waste

Types of waste and potential impact caused are summarised in **Table 5-49**.

Table 5-49: Types of Solid Waste and Potential Impacts

Waste Type	Potential Impacts
Food Waste	• Odour • Attraction of pests and disease vectors
Paper and plastic packaging, rags, plastic, glass	• Fire hazard • Wind-blown litter • Fouling of surface water
Metal and plastic drums, sacks and bags	• Fire hazard • Wind-blown litter • Fouling of surface water • Contamination of soil and water
Wooden packaging	• Fire hazard
Scrap Metal	• Contamination of soil and water • Public Safety

5.9.8.1.(1). General non-hazardous wastes

General non-hazardous waste will be generated from the drill site, campsite and vehicles during all phases of the project. General non-hazardous wastes may include scrap metal, packaging, wood, cardboard, paper and empty containers. Improper handling and disposal of non-hazardous materials may cause adverse effects by materials spills or (as in the case of domestic wastes) being carried away by wind, vectors, etc. Burning some types of innocuous-looking waste types (especially plastics) may create toxic tar or even extremely toxic dioxin. Depending on their pathway, the end result would be air, soil, groundwater, freshwater life contamination. General non-hazardous solid wastes will be segregated at source into recyclable and non-recyclable wastes and stored in marked containers. Recyclable materials will be given to local recycling facilities for a net economic benefit and the remaining materials will be sent to approved landfill facilities.

Without mitigation measures, impact from non-hazardous waste disposal will be local in extent and transient, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of this impact occurring is determined to be Likely (D).

The Risk Ranking of impacts from general non-hazardous solid waste is rated as medium.

Severity	Probability	Risk Ranking
Minor Impact	Likely	Medium
2	D	2 D

Management Measures

Impacts from general non-hazardous waste contamination can be mitigated through the use of the following measures:

- Tenders for supply and construction contractors will require waste reduction at the source.
- A PCMI Waste Management Plan for this drilling campaign will be developed.
- Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site.
- Non-hazardous wastes will be taken to an approved waste site.

Residual Risk

With these management measures, the likelihood of impacts from general non-hazardous waste is determined to be Possible C; while there will be slight impact (1) on environment, resulting in a low residual negative risk (1 C).

5.9.8.1.(2). Food and kitchen waste

Food and kitchen wastes will be produced from the campsite and well site during all phases of the project. Organic refuse, if not stored properly, attracts vectors (rats, mosquitoes, flies, cockroaches, etc.) causing health threats and unsightliness.Food scraps will be segregated and transferred to local government waste disposal facilities.

Without mitigation measures, impact from kitchen and food waste will be local in extent and transient, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **Slight impact** for environment and a slight benefit. The probability of this impact occurring is determined to be Likely (D).

The Risk Ranking of impacts from food and kitchen waste is rated as low and a slight benefit.

Severity	Probability	Risk Ranking
Slight Impact	Likely	Low
1	D	1 D

Management Measures

Impacts from food waste contamination can be mitigated through the use of the following measures:

- Food scraps and other kitchen wastes will be segregated and transferred to local government waste disposal facilities.
- Cooking oils and greases from the kitchen will be collected and transported to local government waste disposal facilities for disposal.

Residual Risk

With these management measures, the likelihood of impacts from food and kitchen waste is determined to be Possible C; while there will be no impact (1) on environment, resulting in Low residual negative risk (1 C).

5.9.8.2. Hazardous Solid Waste

Each well-site will generate a low volume of hazardous waste throughout all project phases including:

- Excess or spent chemicals.
- Paints and paint cans.
- Biological waste from medical facilities.
- Oil contaminated materials (e.g. sorbents, filters and rags).
- Waste oils.
- Drums and containers used for oil or chemical transportation and storage;
- Batteries.
- Fluorescent light tubes.

General hazardous solid waste will be generated during all phases of the project. General hazardous solid wastes will be segregated at source into recyclable and non-recyclable wastes and stored in covered skips prior to transfer to an approved recycling contractor wherever practicable, or waste disposal site.

Hazardous wastes will be handled and stored in accordance with the material safety data sheets (MSDS) and tracked from source to its final destination. The estimated quantity of hazardous waste generated is 0.5 tonnes per month of activities.

Without mitigation measures, impact hazardous waste will be local in extent and transient, reversible and of medium magnitude, the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of these impacts occurring is determined to be Possible(C).

The Risk Ranking of impacts from general hazardous waste disposal is rated as low.

Severity	Probability	Risk Ranking
Localized Impact	Possible	Medium
3	C	3 C

Management Measures

Impacts from general hazardous waste contamination can be mitigated through the use of the following measures:

- Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS.
- General non-hazardous solid wastes will be managed in accordance with accepted international standards.
- Tenders for supply and construction contractors will require waste reduction at the source.
- A PCMI Waste Management Plan for this drilling campaign will be developed.
- Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site.
- Hazardous wastes will be transported for disposal at a cement kiln.

Residual Risk

With these management measures, the likelihood of impacts from hazardous waste is determined to be Unlikely B; while there will be minor impact (2) on environment, resulting in low residual negative risk (2 B).

5.9.9. Drill Cuttings and Fluids

5.9.9.1. Drill Cuttings and Sludge

Impact Assessment

Water-based muds contain bentonite, caustic soda, caustic potash, soda ash polymers, scale inhibitors, drilling lubricants and, occasionally, oxygen scavengers and biocides. The company plans to use potassium chloride (KCl) water based mud (WBM) for the drilling. The drilling fluids that are used for the well will be returned to the surface from the annulus of the drill with rock cuttings, and may also contain small quantities of other fluids, such as hydrocarbons and produced water. Shakers will separate the fluids from the cuttings. The cuttings will be washed, sieved and placed into 9 m^3 skips, where they are to be temporarily held before being sent to a local cement kiln for incineration.

The mud will be reused. Approximately 2500 MT of cuttings would be disposed during the drilling process. Discharged cuttings will contain some residual water-based mud, and residual hydrocarbons and any other contaminants such as heavy metals.

The cuttings and fluids contain potassium chloride, which are saline and residual hydrocarbons. The entry of saline and hydrocarbon contaminated fluids into the ground water may affect the growth of agricultural crops and be potentially toxic to terrestrial and aquatic flora and fauna. The cuttings and fluids may also contain heavy metals, which may contaminate soils and affect the growth of agricultural crops.

The volumes of cuttings produced during this project are unlikely to cause major local environmental impacts, particularly as cuttings will be incinerated at a cement kiln before disposal. Salinity levels are not predicted to be high, and the short duration of the drilling activity will not allow for the excessive evaporation levels required to concentrate and produce highly saline liquids.

Without mitigation measures, impact from drill cuttings and sludge will be local in extent and transient, reversible and of medium magnitude, the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **minor impact** for environment. The probability of this impact occurring is determined to be Likely (D).

The Risk Ranking of impacts from drill cuttings disposal is rated as low.

Severity	Probability	Risk Ranking
Minor Impact	Likely	Medium
2	D	2 D

Management Measures

Impacts from drilling waste contamination can be mitigated through the use of the following measures:

- Drill cuttings and adhered fluids will not be discharged to surrounding area.
- All drilling activities will be conducted in accordance with approved Environment Management Plan.
- Volume of cuttings and fluids discharged will be minimised through use of solids control equipment.
- Use non-hazardous water-based mud system. Inform MOGE in case of change in mud chemicals.
- Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to its MSDS.
- Provide spill cleanup kits and training for designated rapid response teams to clean up any spills. In the event of oil or chemical spill, implement spill response plan. Handle all chemicals according to its MSDS.
- Deposit treated cuttings into 9 m^3 skips, where they are to be temporarily held before being sent to cement kiln for incineration. Keep waste manifest.
- Implement transportation plan.

Residual Risk

With these management measures, the likelihood of impacts from food and kitchen waste is determined to be Possible C; while there will be minor impact (2) on environment, resulting in low residual negative risk.

5.9.9.2. Lost Circulation

Once the well is spudded, the mud circulates in an essentially closed system. The practice of casing sections of the well with steel tubing, cemented in place as it is drilled, will prevent significant losses of mud to the formation and prevent groundwater contamination.

In the event of lost circulation, mud may be released into the surrounding formations via fractures. As lost circulation normally occurs in the reservoir section, which is much deeper than the surface aquifers, mud is not likely to impact aquifers. In addition, the mud system to be used is a water based mud (WBM) which is the least toxic to the environment.

If mud loss should occur, a series of steps will be taken to seal the well bore as follows:

- Pump in Lost Circulation Material (LCM) such as mica;
- If this does not work, try to drill through it with water and LCM;
- If this does not work, the well will be plugged with cement and re-drilled.

Without mitigation measures the impacts to groundwater quality from loss of circulation are expected to be local in extent, potentially long-term in duration, reversible and of medium magnitude. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment.

The Risk Ranking of impacts to groundwater quality is rated as medium.

Severity	Probability	Risk Ranking
Localized Impact	Likely	Medium
3	D	3D

Management Measures

Impacts to groundwater from lost circulation can be mitigated through the use of the following measures:

- Case sections of the well with steel tubing
- Cement steel casing in place

Residual Risk

With these management measures, the likelihood of impacts from lost circulation is determined to be unlikely B; while there will be a minor impact (2) on environment, resulting in low residual negative risk.

5.9.9.3. Naturally Occurring Radioactive Materials

No produced formation water is expected for the exploration drilling campaign. Produced water can contain small quantities of naturally occurring radioactive materials (NORMS). Under certain conditions (high salinity, together with the presence of sulphates and/or carbonates, calcium, barium and strontium) NORMS can become bound to scale deposits in production wells, pipelines and process equipment. Maintenance of wells, pipelines and process pipework or equipment may require the disposal of scale if it has built up as a solid. However, since no produced formation water is expected and the exploration wells will be drilled over a short time frame (88 days) the potential for scale deposition containing NORMS to build up has been assessed as **negligible**.

5.10. Exploration Drilling Social Impact Assessment

The purpose of a social impact assessment is to study the potential impacts from the project that might affect social issues. The social impact assessment in this report will therefore assess impacts from the project to human use values and quality of life issues.

5.10.1. Social Aspects

Preliminary impact screening and scoping of social issues identified social aspects in **Table 5-16** for detailed impact assessment.

These preliminary scoping results were used to design of the socio-economic surveys and focus group meetings as a part of the consultation with communities in and around the project area which might be affected by the project activities (see **Section 4.2**).

Table 5-50: Social Aspects

Social Aspects	Road &Site Construction	Exploration Drilling & Testing	Restoration and Abandonment
Change in Land Use	✓	✓	✓
Traffic	✓	✓	✓
Water Use	✓	✓	✓
Power Use	✓	✓	✓
Water Drainage	✓	✓	✓
Wastewater	✓	✓	✓
Waste Disposal	✓	✓	✓
Tourism and Recreational experience	✓	✓	✓
Employment & Income	✓	✓	✓
Labour In-migration	✓	✓	✓
Historical, Archeological & Cultural Resources	✓	✓	✓

5.10.2. Criteria and Method for Social Impact Assessment

Project information is used to assess the environmental impact on social issues. The impacts can be divided into 2 categories:

1) Positive Impact (+): The project activities increase the human use values and quality of life values or bring something desirable to group/community.

2) Negative Impact (-): The project activities decrease the human use values and quality of life values or bring unwanted things to group/community.

Impact factors considered include magnitude, extent, duration, reversibility, importance and assist in determining severity of impact. The likelihood of impact and the severity of the impact will allow us to determine the risk ranking of the impact.

The assessment of potential socio-economic impacts is based on quantitative and qualitative data and professional judgment.

Additional factors include consideration of changes in the value of assets that households depend upon for their livelihoods, manageability of the change and potential for it to lead to further changes beyond the control of the project, and whether the effects are acute or chronic. The risk ranking of the potential social impact is ranked as beneficial, low negative, medium negative or high negative as defined in **Section 5.1.3.2**.

The assessment of each aspect includes the following components:

- Description of the source and characteristic of the potential impacts.
- Identification of receptors sensitive to potential impacts.
- Description and evaluation of potential impacts.
- Identification of management measures to reduce potential impacts.
- Determinations of the residual risk after management measures are included.
- An aspect summary assessment table.

5.10.3. Change in Land Use

Impact Assessment

The project area mainly consists of agricultural and forested areas with agriculturally dominated communities and access roads.

The main project activity that affects land use is the well pad, camp site and access road construction as well as any granular fill pit development. All land needed for the project will be purchased by PCMI. Each well site will have a similar construction plan. The well pad and work camp pad will be built adjacent to each other. The well site area for the well pad and camp pad will be 120 x 200 m for a total the land area of 24,000 m^2that will be disturbed per well site. The maximum distance of access roads needed to be purchased to access the well site is 10 km.

The well site and adjacent accommodation camp site will be levelled and elevated by cut and fill methods and compacted using bulldozers, dump trucks, water trucks and graders. The compacted granular pad will be 150 to 200 centimeters thick. In the event that the results of the well testing conclude that the wells are non-commercial, the well site, camp site and roads will be restored to its original state.

Landowners of well site and access road locations and granular pit locations will be contacted and a negotiation for purchasing or leasing the land before construction starts. 83% of households surveyed in the Regional Study Area stated they were not satisfied with the compensation received from previous project developments and many comments were made in community focus groups on the issue of compensation.

The purchase or lease of the land will provide a significant financial benefit to landowners. While this land will be temporarily lost from agriculture production. Project operations too may degrade the nearby land and reduce agriculture productivity in those areas (i.e. dust, flares, drainage previously discussed). If hydrocarbon resources are not found the land will be restored to its original state. However, for farm workers who do not own land, they may be displaced and possibly lose employment. The compensation program needs to specifically address this potentially vulnerable group.

The impacts from changes in land use will be local in extent, short term in duration, of major magnitude, reversible and of low to medium importance. The likelihood of land use impacts occurring is very likely. Given the short term impact of this aspect and its return to its original state, it is determined to be a positive benefit as a result of the financial benefit to land owners.

The risk ranking of change in land use is ranked as low.

Severity	Probability	Risk Ranking
Positive	Likely	Positive
	D	D

Management Measures

Impacts from construction activities on land use can be mitigated through the use of the following measures:

- Transparent and fair compensation to land owners and users.
- Compensation program to specifically address issue of displaced workers who may lose employment and who are not land owners.
- Ensure all permissions are obtained from land owners and local authorities. Provide summary to MOGE.
- Notify surrounding landowners 2 weeks before on location and time of project activities.
- Restoration of land to its original state within 6 months of project completion.

Residual Risk

With these management measures, the likelihood of impacts from a change in land use is determined to be likely D; while there will be no negative effects (0) on the social environment, resulting in an overall positive benefit and no residual negative risk.

5.10.4. Traffic

Impact Assessment

Transportation of equipment, people and services will increase traffic volume in the local area of the planned project and may disrupt of community traffic. Transportation during drilling consists of rig mobilization, transport of workers and supplies, transport of industrial water supply, transport of mud and cuttings.

Transport of the rig and associated equipment to the proposed project area will be by trucks and trailers travelling in convoys. It is estimated that the entire rig move will consist of 130 round trips per well. A full transport risk assessment is conducted before each mobilization and demobilization.

The transportation routes for materials and chemicals to the well site will use the old North South public highway to the region and then local access/roadways to the well site. It is expected that 30 round trips will be required per well for materials and chemicals.

The impact of transportation of the project affects the people that use the same route used for the project and around the project area. The transportation of personnel and equipment and materials from well site to well sites will be from Yangon to well site.

The maximum amount of cuttings per each well is 2500 MT each. Dried cuttings are deposited into a lugger box (9 m^3 capacity) skip. Once a lugger box is full it is replaced with an empty lugger box. Once the lugger box is full, the waste hauling company will transport the full skip to the kilns for incineration; up to 125round trips/well will be required.

Testing will produce emulation-condensate that requires disposal by about 6 trucks per well over the 22 day testing period.

There will be no restrictions on movement of the local population along the Highway during drilling.

The impacts from increased traffic and traffic disruption will be local in extent, short-term in duration, reversible quickly, of minimal importance and of medium magnitude. As a result of these impact criteria considerations, severity is ranked as Slight (1). The probability of traffic increase/disruption without mitigation measures is ranked as Possible (C).

The Risk Ranking of increased traffic and traffic disruption is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from construction activities on traffic can be mitigated through the use of the following measures:

- Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr on unsealed road).
- Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights.
- Restrict/ avoid movement of heavy equipment during rush hours.
- Provide traffic signs or flags at junction of access roads and main roads.
- Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.
- If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices.
- Strictly enforce training programs to reduce transport incident cases by its contractors.
- Restore any damage to roads that is caused by contractors or Company.
- Purchase or lease land for road access to site and land needed for drill site and camp.
- Restrict local traffic on PCMI private access road.
- Ensure all vehicles are left hand drive as feasible.

Residual Risk

As the access road will be the busiest road, this now private road will restrict other local traffic. The project is short term.

With these management measures in place, the probabilityof impacts from increased traffic and traffic disruption is minimized to a ranking of Possible (C). The severity of the impact is considered to be slight. Therefore the overall residual risk of this impact occurring is considered as Low 1 C.

5.10.5. Water Use

Impact Assessment

During the construction phase, water use will consist of water for dust suppression and cleaning and potable water for workers. There is a construction camp at the well site.

Access to and availability of water is an important issue to all communities in the Regional Study Area. Community water wells are a critical piece of local infrastructure, and access to water to support domestic and farming requirement is critical.

Maximum daily water usage is expected to be 7.8 m^3 per day during drilling when the camp is accommodating a full crew (130 people); water use during construction is expected to be less than 1.8 m^3 (pro-rated according to a construction workforce of 30 people).

Industrial water will be required only during the drilling phase. It is estimated that an amount of 6,000 m^3 per well, or a total of 12,000m^3 for 2 exploration wells, of industrial grade water will be required during the drilling operation (to be used as makeup water for the drilling mud and cement mixing). The industrial water will be stored in water pits with 1800 m^3 capacity. The water will be supplied by a deep water tube well on site. If tube type wells are not successful or water not suitable, water will be sourced and transported by tanker from nearby reservoirs/rivers. Local authorities will be consulted before water hauling.

The drilling water will be supplied from new water wells to be installed in well pad area (if available). In addition, treated water from the mud cleaning system will be recycled and used to supplement the water required to make up the drilling mud.

All drinking water will be sourced from local retail suppliers and potable water will be from a deep water well installed on site so that it will not affect water supply for agricultural activities and communities within project area.

The impacts from water use by the project will be local in extent, medium-term in duration, reversible, importance is low and of medium magnitude. These factors result in a localized severity ranking (3).

The probabilityof impacts from water use without mitigation measures is determined to be Likely (D).

The Risk Ranking of water use is ranked as Medium.

Severity	Probability	Risk Ranking
Localized	Likely	Medium
3	D	3 D

Management Measures

Impacts from construction activities on water use will be mitigated through the use of the following measures:

- Obtain local approval for drilling a ground water well.
- PCMI to drill their own ground water well.
- Consult local community leaders before water hauling (if required).
- Potable water and industrial water, if taken by tube wells or tanker from nearby reservoirs/rivers, should not affect the availability of water to locals.

With these mitigation measures, the likelihood of impacts from water use is minimized during construction.

Residual Risk

Primarily as a result of the decision by PCMI to drill their own ground water well if possible, the probability of impacts occurring is considered to be ranked as Possible (C). The severity of impacts is determined to be 3 Localized Impact. With these management measures in place the residual risk is ranked as 3 C Medium.

5.10.6. Power Use

Impacts Assessment

All power for drilling operations and work camp will be supplied by Project-supplied diesel powered generators. No public power utilities will be required at the drilling site.

No power-use impacts will occur from power use by the project. All electrical power for the well site, drilling rig and associated equipment will be provided by 1800 - 2000hp diesel fuelled generator sets.

As the magnitude, extent, duration, importance are all negligible, the severity ranking too is ranked as negligible. The likelihood of impacts from power use is non-existent. As a result there is no residual risk.

Management Measures

To prevent and or mitigate power use activities from having any social impacts, the following measures will be implemented:

- Purchase and install diesel powered generators to supply all project power related needs.

Residual Risk

As PCMI will install their own power generators to supply electricity there will be no residual risk to social impact.

5.10.7. Water Drainage

Impact Assessment

Surface runoff from roads and camp site will result in increased drainage potentially affecting roads and infrastructure. Vegetation removal, construction of well sites and access roads can alter surface water hydrology by reducing interception, evaporation/ transpiration and infiltration, which in turn can increases runoff and change in local drainage patterns. Heavy rains can intensify changes in surface water hydrology and cause changes in drainage.

Agriculture and water sources around project well sites could be affected from water drainage during construction of the well sites. However, a civil engineering contractor will be hired to survey and upgrade the road. The contracted civil engineer will determine and recommend if culverts or additional ditches are necessary to manage surface water runoff. Local authorities and local land owners will also be consulted to address their requirements for any culverts or ditching to be installed at any point along the road. If culverts are required or requested, the size of culvert to install will depend on the civil engineer's recommendation and/or local authority's recommendation. Generally, culverts in this area are 60 cm in diameter, made of reinforced concrete and purchased prefabricated.

There will also be a waste pit measuring approximately 30 m by 40 m by 4 m deep with about 4,800 m^3 capacity. The waste pit will be lined with a HDPE liner to form an impermeable barrier.

The impacts on surface hydrology and drainage will be local in extent, transient, reversible and of low magnitude. As a result the severity is ranked as slight (1). The probability of water drainage impacts occurring without mitigation is considered to be ranked as C Possible.

The Risk Ranking of drainage impacts occurring is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from drainage can be mitigated through the use of the following measures:

- Local authority and land owner/user consultation on well site and access road construction design.
- Follow civil engineer's recommendation on well site and access road construction design.
- Avoid construction of well sites and access roads in areas that may cause obstacles to water drainage.
- Water drainage lines (culverts) will be constructed to maintain natural drainage. The required permission will be obtained from all relevant agencies.

Residual Risk

With the above management measures implemented, the likelihood of impacts on drainage is minimized. Therefore probability of drainage impacts occurring is ranked as unlikely (B). Severity is considered to be slight (1). The overall residual risk from drainage is ranked as low.

5.10.8. Wastewater

Impact Assessment

Project operation may affect on water quality and has the potential to impact agriculture, aquaculture and fisheries. Most households are engaged in agriculture. The important economic crops are rice, beans/pulses, peanuts, vegetables and sesame.

Accidental release of drill cuttings and drilling mud, spills, overflow of the cuttings and dirty water waste pit could affect soil quality and vegetation (agriculture), surface water quality and aquatic biota (aquaculture). Wastewater released from the sites could result in impacts on agriculture crops, fish farms and river fishing.

Impacts on soil, surface water quality, vegetation and aquatic biota from accidental spills are discussed **Section 5.12.4**. The Risk Ranking of impacts from spills on these environmental aspects was rated as low to medium.

The impacts on agriculture and aquaculture will be local in extent, short term duration, reversible and of low magnitude. Given these considerations the severity ranking is determined to be slight (1). The probability of water quality impacts on agriculture and aquaculture without mitigation is ranked as Possible (C).

The Risk Ranking of degraded water quality on agriculture and aquaculture is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts of waste water on agriculture and aquaculture/fisheries can be mitigated through the use of the following measures:

- Avoid construction of the well pads and/or access roads in areas where this would obstruct water drainage.
- Prohibit workers from cleaning machines/equipment in/near a public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources.
- Use non-hazardous water-based mud and synthetic based mud system. Inform MOGE in case of change in mud chemicals or type of mud.
- Fuel storage tanks to be surrounded by bund wall.
- Construct drainage system around concrete rig pad and mud tanks to divert any spills into the waste pit.
- Monitor level of cuttings and dirty water in waste pit.
- Isolate any area(s) that might be contaminated from non-contaminated areas. Provide water drainage system around the contaminated area for collecting water into the sump pit or for treatment.
- Construct oil traps along perimeter drainage ditch to prevent any spills from flowing off site.

- Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to their MSDS.
- Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious surfaces (i.e. on tarpaulin sheet).
- Provide spill cleanup kits and training for designated rapid response teams to clean up any spills.
- In the event of oil or chemical spill, implement spill response plan.
- Install septic tanks for holding sewage and grey water.
- Pump septic tank fluids to Township approved sewage treatment plant on a regular basis to prevent overflow.

Residual Risk

With these management measures, the probability of an impact occurring is ranked as Unlikely (B) and the severity is ranked as Slight (1). Therefore the Risk Ranking is Low 1 B.

5.10.9. Waste Disposal

Impact Assessment

Disposal of waste in project area may overload local disposal infrastructure. Waste from the construction phase consists of: domestic waste, such as food scraps, plastic packaging, paper, cardboard, tin cans and glass, and industrial waste, such as wooden cases, large glass containers, metal items, plastic and metal drums and containers, plastic and cardboard packaging. Other than fuel and lubricants there will be no hazardous substances at the construction site.

It is estimated that each well site will generate 3.9 tonnes of “domestic” waste per month/well site. The amount of hazardous waste is estimated to be 0.5 tonnes per month/well site. These estimates are based on PCMI experience of previous exploration drilling well sites.

General waste will be separated on-site to facilitate recycling. This waste will be stored in separate skips to be transported off site for recycling, reuse, treatment and/or disposal.

All hazardous wastes will be stored in covered skips for collection and disposed to approved government sites or at the cement kiln.

All materials brought onto the well site and accommodation campsite will be logged and all sources of potential toxic waste will be identified by the relevant supplier or contractor. Equipment or materials containing heavy metals, such as batteries, will be identified and a special container designated for their disposal as waste. All used chemical and lubricant containers will be collected in separate containers.

The impacts from waste management by the project will be local in extent, short-term in duration, reversible and of low magnitude. As a result of these considerations severity is ranked as slight (1). The probability of impacts occurring from waste management is ranked as Likely (D).

Therefore the Risk Ranking of waste disposal is ranked as low.

Severity	Probability	Risk Ranking
Slight	Likely	Low
1	D	1 D

Management Measures

Impacts from activities required for waste management can be mitigated through the use of the following measures:

- Provide septic tank for sewage.
- Ensure treatment and disposal according to accepted international standard. Keep waste manifest.
- Enforce "Good Housekeeping" practices.
- Segregate and store waste in appropriate, secure properly labelled containers.
- Dispose of waste in labelled containers for possible recycling.
- Implement requirements for waste management and related laws.
- Store hazardous waste in appropriately designed areas and safe containers that are suitable for transporting/transferring.
- Always check and record the type(s) and amount of waste generated.
- Provide Waste Manifest System.

Residual Risk

With these management measures, the probability of impacts from waste disposal is minimized during construction, operations and abandonment and is ranked as C Possible. The Risk Ranking should these impacts occur is ranked as 1 Slight. Therefore the residual risk ranking is determined to be 1 C Low.

5.10.10. Tourism and Recreational Experience

Impact Assessment

Project operation effects on tourism and recreation may reduce the tourism and recreational experience.

As this area is a restricted area, little tourism and recreation currently exists in IOR5. The project well sites will not directly affect tourism and recreation through either land use changes or vibration. The main potential impacts would be increased traffic activity on major corridors which has been ranked as a Low Residual Risk.

The project effects impact on tourism and recreation experience will be local in extent, reversible, short duration and of low magnitude. Given these considerations the severity level is ranked a Slight. The probability of impacts on tourism and recreation experience is ranked as Possible (C).

Therefore the Risk Ranking of the project on tourism and recreational experience is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from project activities on tourism and recreation can be mitigated through the use of the transportation mitigation measures:

- Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr on unsealed road).
- Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights.

- Restrict/ avoid movement of heavy equipment during rush hours.
- Provide traffic signs or flags at junction of access roads and main roads.
- Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.
- If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices.
- Strictly enforce training programs to reduce transport incident cases by its contractors.
- Restore any damage to roads if caused by contractor or company.
- Purchase or lease the land for road access to site and land needed for drill site and camp.
- Restrict local traffic on PCMI private access road.
- When project complete, promptly (within 6 months) restore land to its original state and return to original owners.

Residual Risk

With these management measures, the probabilityof impacts from project activities on tourism and recreation is minimized and is ranked as B Unlikely. The severity of impacts, should they occur is ranked as 1 Slight. Therefore the residual risk of project impacts on tourism and recreation is determined to be 1 B Low.

5.10.11. Employment and Income

Impact Assessment

Project employment and business opportunities will increase jobs and related income for local communities.

During construction, 30 – 50 workers will be employed and supplies (such as laterite, selected fill material, fuel, water) and services (accommodation, waste management) will be required. The composition of the crew will depend on actual contracting companies, most of which will be Myanmar subsidiaries of international companies. An onsite camp will be developed for workers.

During drilling, around 110-130 workers will be employed and supplies (such as fuel and water) and services (accommodation, waste management) will be required. Most of the workers are expected to be experienced drillers and rig crews, not locally available.

IEM surveyed 400 households in this region. Results indicated that 22% had an annual income less than 500,000 kyat ($500 USD); 33% had an annual income of 500,000-1,000,000 kyat ($500 - $1000 USD); and 26% had an annual income of over 1,000,000 to 2,000,000 kyat (USD 1,000 to $2,000).

Of those interviewed 8% indicated that oil and gas drilling will be extremely important to the community, 10% very important; while 26% indicated that oil and gas drilling would be important to their community.

When asked what positive impacts from the project they anticipated, the Villagers response included: increased employment 58%, increased annual income 31%, improved living condition 28%.

PCMI has a policy to encourage the hiring of local staff and contractors. Advance meetings with local authorities on approaches to hiring will help PCMI design hiring to maximise the positive effects and limit the loss of labour availability to local businesses at critical times (i.e. harvest).

The impacts on the employment and income from the project will be local in extent, short-term in duration, reversible and of low magnitude but positive (benefit). The probabilityof positive employment and income benefits resulting from the project is ranked as E Very Likely.

Therefore the Risk Ranking of the project on employment and income is ranked as low positive.

Severity	Probability	Risk Ranking
Positive	Very Likely	Positive
	E	E

Management Measures

Impacts from project activities on the socio-economy are positive and can be further enhanced by the following measures:

- Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons.
- Employ qualified local workers.
- Purchase local supplies and services, whenever possible.
- Host a pre-project local community awareness program with communities to facilitate awareness of opportunities and benefits.
- Terms of contract for recruitment of manpower in these companies needs to include emphasis on hiring locals, especially for unskilled and semi-skilled workforce.

Residual Risk

With these management measures, the probabilityof impacts from project activities on employment and income is maximized and is ranked as E Very Likely. The severity of impacts is considered to be Positive. Therefore the residual risk of project impacts on employment and income is determined to be Positive (E).

5.10.12. Labour In-Migration

Impact Assessment

In-migration of labour and social interaction may result in conflict between workers from other regions and local communities.

During construction, 30 – 50 workers will be employed and supplies (such as granular fill, fuel, water) and services (accommodation, waste management) will be required. The composition of the crew will depend on actual contracting companies, most of which will be Myanmar subsidiaries of international companies. An onsite camp will be developed for workers.

During drilling, around 110-130 workers will be employed and supplies (such as fuel and water) and services (accommodation, waste management) will be required. Most of the workers are expected to be experienced drillers and rig crews, not locally available.

The baseline household survey (see **Sections 3.5** and **3.6**) showed that:

- 46% felt that oil and gas projects have affected labour availability for traditional businesses.
- 35% of villagers were concerned about migrant workers near their village
- 41% felt that projects development had a negative effect on their community.

The receptors of impact from the project are:

- businesses that trade and provide services near the project area and people who live in the surrounding area. The project would provide opportunities for additional work and business.
- businesses and trade who lose access to employees and contractors during the construction phase.
- vulnerable social and ethnic groups who are exposed to migrant project employees and contractors.

PCMI has a policy to encourage the hiring of local staff and contractors. Hiring local provides opportunities for local communities while reducing increased levels of migrant worker interaction.

Advance meetings with local authorities on approaches to hiring will help PCMI design hiring to maximise the positive effects and limit the loss of labour availability to local businesses at critical times (i.e. harvest).

Pre-project awareness programs with migrant workers on local community, social and ethnic group sensitivities will help create increased understanding and, where advisable, limit interactions during project construction.

The impacts on in-migration of workers from the project will be local in extent, short-term in duration, reversible and of low magnitude. As a result of these considerations the severity level is ranked as slight (3). The probabilityof impacts occurring as a result of in-migration is ranked as Possible (C).

Therefore the Risk Ranking of labour in-migration is ranked as low.

Severity	Probability	Risk Ranking
Slight	Possible	Low
1	C	1 C

Management Measures

Impacts from project activities on employment and income can be further enhanced by the following measures:

- Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons.
- Employ qualified local workers.
- Purchase local supplies and services, whenever possible.
- Host a pre-project local community awareness program with migrant workers to facilitate sensitivity and limit interactions, where advisable, between migrant workers and local communities.
- Restrict workers to within project boundaries and do not allow local interaction within the communities.

Residual Impact

With these management measures, the probabilityof impacts from in-migration of workers are minimized and are ranked as B Unlikely. The Risk Ranking of impacts is considered to be Slight Impact. Therefore the residual risk of project impacts on employment and income is determined to be 1 B Low.

5.10.13. Historical, Archaeological and Cultural Resources

Impacts Assessment

Potential impacts to the local historical, archaeological and cultural resources during the construction phase include possible damage or demolition of historical buildings or archaeological sites during construction of the access roads and well sites. Of the households surveyed (41%) felt that historic sites are not adequately protected.

Myanmar’s predominantly Buddhist culture has a substantial archaeological heritage. Religious buildings, some dating back to the first millennium CE, number in the thousands. Many active Buddhist sites are managed by trustees, sometimes with input from government authorities. Gazetted archaeological sites are managed by the Department of Archaeology, National Museum and Library, which is a division of the Ministry of Culture. The Archaeology Department employs conservators and engineers to maintain and repair buildings and their contents, as well as research officers, who conduct excavations.

IEM conducted interviews and identified and located all important cultural sites in 8 village areas during the environmental, social and health baseline survey.

It is not expected that either construction activities will disrupt any culturally important activities or cause any damage to the archaeological resources, as the well sites and roads are at least 1 km away from the nearest known archaeological feature. Therefore, the project will not directly impact the archaeological resources through vibration or direct land use.

Local authorities within the study Area will be consulted to see if there are any culturally important festivals planned during project operations and efforts will be made to ensure transportation, construction and drilling activities will limit any impacts.

However, prehistoric communities existed in the area and additional artefacts may be recovered during construction of the well sites and access roads.

The impacts on historical, archaeological and cultural resources will be local in extent, long-term, permanent and of low-medium magnitude. These factors result in a severity ranking of Minor (2). The probability of these impact occurring are ranked as Possible (C).

Therefore the Risk Ranking of project impact to historical, archeological and cultural resources is determined to be low.

Severity	Probability	Risk Ranking
Minor	Possible	Low
2	C	2 C

Management Measures

Impacts from construction activities on historical, archaeological and cultural resources can be mitigated through the use of the following measures:

- Watch for artifacts during site construction and inform the Local Authorities before commencement of drilling.
- Report to the Local Archeological Department if any archaeological evidence is discovered at the well sites or access roads. Through consultation, a plan to proceed will be developed.
- If artifacts are found during the construction phase, PCMI will inform the responsible local office within 7 days.
- Consult with local authorities to identify culturally important festivals and plan transportation, construction and drilling activities to avoid impact.
- Review any records for site specific location.
- Monitor earthwork during construction using qualified/trained inspector.

Residual Impacts

With these management measures implemented, the probabilityof impacts from project construction and operation impacts to historical, archaeological and cultural resources is minimized and is ranked as B Unlikely. The Risk Ranking of impacts is considered to be 2 Minor. Therefore the residual risk of project impacts on historical, archeological and cultural resources is determined to be 2 B Low.

5.11. Exploration Drilling Health Impact Assessment

The HIA assesses the significance of potential health impacts on the community around the well site, and on occupational health. The Risk Ranking of impacts is considered from various factors such as type of threat, environmental factor, health status, impact on medical services and livelihood.

Health impacts for key issues, which are obtained from the screening procedure, are assessed.

The Health Impact Assessment (HIA) for this hydrocarbon development project is carried out following the methodology outlined at the beginning of **Chapter 5**.

This follows the same sequence that is used for both environmental and social impact assessments. In addition potential factors for determining scope and type of health impact include: hazardous chemicals or health threats, environment, factors of exposure, health impact, impacts on medical services and impacts on society and lifestyle. Details are shown in **Table 5-51**.

Table 5-51: Factors for Determining Scope and Type of Health Impact

Factor	Detail
Hazardous Chemicals or Health Threats	• Chemicals: heavy metals, toxic organic compounds. • Physical: noise and vibration • Biological: virus, bacteria. • Ergonomic: lifting of heavy material and inappropriate posture • Psychological: stress, annoyance, and nuisance • Social: lack of community relationship
Environment	• Change of environment quality: water quality, air quality • Change of utilization or acquiring resources: water use • Physical: noise, dust, radius, vibration
Factors of Exposure	• Exposure pathway: mouth or skin • Risk group: workers or people around the project area
Health Impact	• Death rate • Injury rate from infectious diseases or non-infectious diseases, acute or chronic effect • Rate of emotional impact, stress • Injuries and accidents • Impacts on next generation • Impacts on high-risk groups • Stimulate or enhance the severity of the disease • Cumulative impacts
Impacts on Medical Services	• Overall increase in demand for health care • Demand for special health care • Changes of existing medical services
Impacts on Society and Lifestyle	• Impacts on income, employment, and socio-economics • Impacts on local income, industrial sector and local agriculture • Impacts on migration and settlement • Impacts on environmental health • Impacts on society, culture, and lifestyle. • Impacts on education • Impact on social support network • Benefits to health from project operation

Stakeholder participation through meetings with local communities and relevant agencies is an integral part of the HIA process: it provides local communities and relevant agencies an opportunity to participate and provide their comments before project implementation.

The aim of screening and scoping was to identify and prioritize health-related issues and areas of concern considered most important. The study area boundary for the HIA varies based on the issues being examined: **Area Scoping**

- Occupational health impacts will be limited to the well sites and transportation activities.
- Assessment on community health impacts will be initially determined within a 1-km radius boundary of the well sites. This is in line with the ESHIA, where communities within a 1-km radius are considered as sensitive receptors.
- Transportation impacts on communities will be studied along local transportation routes in the project area within 5 km of the well site.

Project activities may affect the health of communities and workers. Project activities in each phase, such as the transportation of equipment/machines during construction phase, rig mobilization, installation, drilling phase, well testing and well abandonment, may cause acute or chronic impact to the health of workers and communities. However, the duration of each activity is short. For the well site, the construction phase is 5.5 months, the drilling phase is 88 days, well testing is 22 days and well abandonment and site restoration is 30 days. The total estimated time per well is about 10.5 months.

Project scoping identifies project activities with the potential to impact health from various factors: type of threat (chemical, physical, biological); environment; factors of exposure (population at risk, worker and public exposure); type and nature of impact (acute/chronic, direct/indirect, cumulative); and impact on medical services, socio-economics, and livelihood. The potential health aspects identified for each project phase are presented in **Table 5-52**.

Table 5-52: Health Aspects by Project Phase

Health Aspects	Site Construction	Exploration Drilling & Testing	Restoration and Abandonment
Dust	✓	✓	✓
Noise	✓	✓	✓
Accidents	✓	✓	✓
Non-Hazardous Waste	✓	✓	✓
Hazardous Waste	✓	✓	✓
Mud Chemicals and Drilling Waste		✓	
Communicable Diseases	✓	✓	✓
Light and Heat	✓	✓	✓
Flare Emissions		✓	

The health impact assessment for this project considers:

- Project information and environment setting (**Chapter 2** and **Chapter 3**) which include health profiles, attitude surveys and sensitive groups.
- Assessment and rating of health impacts. The Health Impact Assessment for this project uses a Risk Assessment Matrix considering the probability and severity of the health impact.
- Probabilityscore is assigned by considering past data and calculating the probability based on existing information on health threats.
- Severity rating is assigned by evaluating the Risk Ranking of possible heath impacts, either by an assessment of the impact or considering a worst case scenario.
- The Risk Ranking rating of health impacts is determined using the probability and severity of a particular health impact in the health matrix. If the Risk Ranking of risk is rated as medium, suitable management or mitigation measures must be set to minimize impacts. If the significance of risk is rated as high, specific mitigation measures must be adopted to reduce the impacts to an acceptable level.

Potential health aspects are assessed below. The assessment of each aspect includes the following components:

- Description of the source and characteristic of the potential impacts.
- Identification of receptors sensitive to potential impacts.
- Description and evaluation of potential impacts.
- Identification of management measures to reduce potential impacts.
- A determination of the residual risk after management measures is included.
- An aspect summary assessment table.

5.11.1. Dust

Impact Assessment

During the construction phase, new access roads and 2 well sites will be constructed, while some sections of roads will be upgraded. Granular fill transport and construction activities may increase dust concentrations in air. The types of equipment used during construction include ten wheel dump trucks, graders, rollers and water trucks. The construction time will be up to 3 months per well site.

The potential health effects of dust are closely related to particle size. Particle sizes are normally measured in microns, and the size range of airborne particles is typically from less than 0.1 microns up to about 500 microns, or half a millimetre. Human health effects of airborne dust are mainly associated with particles less than about 10 microns in size (PM_{10}), which are small enough to be inhaled. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20 microns.

Many forms of dust are considered to be biologically inert, and hence the primary effects on people relate to our sense of aesthetics. There can also be minor health effects, such as eye irritation, when the dust is airborne. Indirect stress-related health effects could also arise, especially if dust problems are allowed to persist for an unreasonable length of time.

Some nuisance dust may have the potential to cause other types of health effects because of the presence of specific biologically active materials. For instance, some mineral dusts contain quantities of quartz, which can cause the lung disease known as silicosis when persistent at high concentrations. Other dusts may contain significant amounts of toxic metals such as mercury or lead.

There is also the potential for contamination of roof-collected water supplies. Dusty conditions can also affect people's ability to enjoy their outdoor environment. For most people, a major effect of a dust nuisance problem is annoyance at the increased requirement for cleaning.

Airborne dust can have effects on visibility, although dust is usually less regionally significant. Visibility effects from dust are usually only a concern in the immediate vicinity of a specific source.

Visibility effects are largely a matter of aesthetics. However, it should also be recognised that visibility is one of the main ways by which people commonly judge air quality. Loss of visibility is also a safety concern under extreme conditions, especially for road traffic.

Dust may result in respiratory irritation of construction workers and respiratory irritation and worsen asthma of people living nearby. Dust levels during construction were evaluated in **Section 5.9.3.1**. Baseline levels of TSPM did not meet the WHO guideline in all villages except Seik Thar Village (IOR5-V2). Baseline levels of PM10 did not meet the WHO guideline except Seik Thar (IOR5-V2), Kyat Kha Lay (IOR5-V3), Chaung Hpyar (IOR5-V9) and Si Sone Kone (IOR5-V10).

Dust calculations in **Section 5.9.3.1** indicate that construction of access roads to well sites could increase dust levels further beyond the ambient air standard. The ambient air standard is set to protect public health.

Dust impacts are considered to be localized, i.e. Health impact extends < 100 m radius from the site boundary; and short term i.e. Health impact expected to last from 0 to 1 year, reversibility quickly, and magnitude is considered to be medium. As a result of these considerations, the severity is ranked as minor.

The probability of these impact occurring are ranked as Likely. Therefore the Risk Ranking of project impact to health from Dust is determined to be medium.

Severity	Probability	Risk Ranking
Minor Injury	Likely	Medium
2	D	2 D

Management Measures

PCMI will implement the following mitigation measures to reduce dust dispersion:

- Spray water on un-surfaced access roads of project transportation route during dry conditions at least twice a day (morning and afternoon).
- Post speed limits on project access route and limit vehicle speed to 30 km/h on un-surfaced roads.
- Use vehicles with dust flaps.
- Cover loose dry loads.

Residual Risk

With the implementation of management measures, the probability of residual risks due to dust from road and site construction and transportation are rated as Possible (C). The Risk Ranking of impacts from Dust should they occur are ranked as 1 Slight. This results in a residual risk ranking of 1C Low for health impacts from Dust.

5.11.2. Noise

Impact Assessment

During the construction and rehabilitation phase, noise will primarily be generated from project vehicles for transportation of granular fill, workers, construction equipment, generators and the drilling rig. During the drilling phase, noise will primarily be generated from the drilling rig and generators.

Construction is expected to result in nuisance noise at some communities but is not expected to exceed the ambient noise standard (See **Section 5.9.4.1**)

Transport of road fill and the drilling rig will be on local roads. Heavy trucks are expected to emit noise levels of 88 dB (A) at 50 ft. from the source. Houses are located approximately 50 m away from the road. The noise calculated for these houses is approximately 77.7dB (A). The impact however takes place only during the time the truck passes the house. Ambient noise standards do not apply for this type of noise.

Noise levels from construction equipment do not exceed the 90 dB (A) noise standard in the workplace for an 8-hr exposure time. However, a combination of several construction machines could result in a compounded noise level 91 dB (A), exceeding the workplace standard.

The noise levels estimated at communities assumed a worst-case scenario of hemispherical spreading with no attenuation from the surrounding area. However, the presence of trees, vegetation, and the topography will attenuate the noise levels.

Drilling is expected to result in nuisance noise at some communities but not exceed the ambient noise standard. (See **Section 5.9.4.2**)

Noise levels from drilling equipment and generators do not exceed the 90 dB (A) noise standard in the workplace for an 8-hr exposure time. In addition, the compounded noise level of the drilling rig and two generators. (87.5 dB (A), does not exceed the workplace standard).

Noise impacts are considered to be localized, i.e. Health impact extends < 100 m radius from the site boundary; and short term i.e. Health impact expected to last from 0 to 6 months, reversibility quickly, and magnitude is considered to be small. As a result of these considerations the severity is ranked as Slight (1).The probability of these impact occurring are ranked as Very Likely (E).

Therefore the Risk Ranking of project impact to health from Noise is determined to be low.

Severity	Probability	Risk Ranking
Slight	Very Likely	Low
1	E	1 E

Management Measures

PCMI will implement the following mitigation measures to reduce noise impacts:

- Limit vegetation removal to a minimum.
- Schedule operation of noisy construction equipment at different times.
- Ensure use of mufflers on diesel/gas driven machinery and vehicles.
- Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer.
- Provide ear plugs to drilling workers.
- Select drill site locations at safe distances from nearest community (a minimum of 500 m).
- Should complaints over noise be received, consideration will be given to the provision of noise barriers.

Residual Risk

With the implementation of management measures, the probability of residual risks due to noise from road and site construction and transportation are rated as D Likely. The severity of impacts from Noise should they occur are ranked as 1 Slight. This results in a residual risk ranking of 1 D Low for Noise impacts.

5.11.3. Non-Hazardous Waste

Impact Assessment

Non-hazardous wastes during drilling include food waste, paper, plastic and wooden packaging, rags, glass, metal and plastic drums, sacks, and scrap metal. It is estimated that up to 3.9 tons/month of domestic rubbish and 7.8 m^3/day of sewage and grey water will be produced at each well site for a period of 88 days during drilling, 22 during well testing, and during abandonment and site restoration an estimated 15-25 kg/day of domestic rubbish and 3-4 m^3/day of sewage and grey water will be produced for a period of 30 days per well site.

Solid wastes may impact physical health, mental health, and quality of life: for example, food remains cause foul smell, unpleasant ambience, act as a fire hazard and provide habitat for disease carriers including bacteria, flies and rats. This increases the chance of bringing diseases to local people.

Myanmar is a tropical country prone to vector borne disease outbreaks, such as gastrointestinal diseases and dengue and malaria. Malaria is the leading cause of morbidity and mortality, with over 538,000 cases and 1,647 deaths reported in 2006. Dengue and dengue haemorrhagic fever cases have seasonal epidemics. Due to inadequate facilities, the number illnesses due to lack of water supply and sanitation has been increasing. In 2003, there were 45,095 reported cases of diarrhea, 4,255 cases of hepatitis, 84 cases of cholera, and 3,162 cases of typhoid fever.

Statistics indicate that the situation of communicable vector-borne disease in the project districts is a public health concern.

Impacts from non-hazardous wastes are considered to be local in extent,potential medium term, reversible over time, and magnitude is considered to be major. As a result of these considerations the severity is ranked as 5 Multiple Fatalities. The probability of these impact occurring are ranked as C Possible.

Therefore the Risk Ranking of project impact to health from non-hazardous waste is determined to be High.

Severity	Probability	Risk Ranking
Multiple Fatalities	Possible	High
5	C	5 C

Management Measures

PCMI will implement the following mitigation measures to reduce impacts from non-hazardous waste:

- Provide septic tank for domestic sewage.
- Ensure treatment and disposal according to accepted international standard.
- Keep waste manifest.
- Enforce “Good Housekeeping” practices.
- Segregate non-hazardous and hazardous waste, store each type of waste in closed containers and make sure all containers are clearly labeled.
- Dispose of waste in labelled containers for possible recycling.
- Implement requirements for waste management and related laws.

- Store hazardous waste in appropriate and safe containers that are suitable for transporting/transferring.
- Always check and record the type(s) and amount of waste generated.

Residual Risk

With the implementation of management measures, the probability of residual risks due to non-hazardous wastes are rated as B Unlikely. The Risk Ranking of impacts should they occur are ranked as 5Multiple Fatality. This results in a residual risk ranking of 5 B Medium.

5.11.4. Mud Chemicals and Drilling Waste

Impact Assessment

Drilling requires the use of water-based drilling mud the project. All components of the drilling mud are classified as non-hazardous with the exception of five chemicals: Soda Ash (sodium carbonate), Caustic Soda (sodium hydroxide), Calcium Chloride, Quartenary Amine and Monoethaloamine. The available workplace standards are shown in **Table 5-53**.

Table 5-53: Permissible Exposure Limits (PEL) over 8-hour TWA

Chemicals	Permissible Exposure Limit (8-hr TWA)
Soda Ash (sodium carbonate)	The following materials had no OELs on our records
Caustic Soda (sodium hydroxide),	2 mg/m3 (WEL-TWA, respirable dust)
Calcium chloride	4 mg/m3 (WEL-TWA, respirable dust)
Quartenary Amine	N/A
Monoethaloamine	OSHA (PEL) [UnitedStates] TWA: 6 (mg/m3)

Source: 1. MSDS, Chemical Data Bank, Pollution Control Department of Thailand
2. Occupational Safety and Health Administration (OSHA), USA

Mud chemicals and drilling waste may impact community health should spillage contaminate soil, surface water or groundwater. Health may be impacted by accumulation of contaminants in the body if contaminated water is consumed and may cause irritation if used for bathing and washing. Local communities in the vicinity of the project site, particularly people who use and consume local water resources are potentially at risk. In addition, the public is concerned about chemicals and drilling waste.

Potential exposure to chemicals under normal conditions is limited to workers within the well site boundary. Workers can be exposed to the chemicals through the following exposure routes: inhalation, dermal or eye contact, and ingestion. However, accidental spills (including during transport) and leaks may release chemicals and drilling waste into the environment and impact nearby community health or contaminate their water and land resources.

Impacts from mud chemicals and drilling can have minor health effects, which are reversible e.g. skin irritation, food poisoning for occupational health; and for community health, extent of health effect limited to rare individual cases within worker and/or local community; and of medium magnitude; medium term in duration. As a result of these considerations severity is ranked as 3 Major Injury.The probability of these impact occurring are ranked as C Possible.

Therefore the Risk Ranking of project impact to health is determined to be medium.

Severity	Probability	Risk Ranking
Major Injury	Possible	Medium
3	C	3 C

Management Measures

PCMI will implement the following mitigation measures to reduce impacts from mud chemicals and drilling waste:

- Treat cuttings in cuttings dryer, deposit dried cuttings in 9 m^3 skips and transport skips to cement kilnto help prevent run-off into the environment. Keep waste manifest.
- Use non-hazardous water-based mud system. Inform MOGE in case of change in mud chemicals.
- Construct drainage system around concrete rig pad, mud tanks and pumps, cement units, generators and solid control equipment on each well site to divert any spills into the waste pit.
- Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to its MSDS.
- Provide spill cleanup kits and training for designated rapid response teams to clean up any spills.
- In the event of chemical spill, implement spill response plan.
- Deposit cuttings into 9 m^3lugger boxes, where they are to be temporarily held before being sent to cement kiln for incineration. Keep waste manifest.
- Implement transportation plan.
- Cement steel casing in place.
- Implement awareness training on the hazards of the chemicals.
- Enforce use of PPE, such as dust masks or respirators, gloves, overalls, and eye glasses.
- Handle chemicals only in well ventilated and controlled areas.

Residual Risk

With the implementation of management measures, residual risks due to mud chemicals and drilling wastes from drilling are rated as 3 B, where probability is considered to be Unlikely; while the Risk Ranking of impact is considered to be a potential Major Injury. The overall residual risk level is considered to be low.

5.11.5. Hazardous Chemicals and Waste

Impact Assessment

Drilling activities will generate a low volume of hazardous waste including lubricating and hydraulic oil, rags and other materials contaminated with chemicals, and drums and containers used for chemical transportation and storage. The project is expected to produce about 0.5 tons/month/well of hazardous waste, consisting of used lubricating oil, oily rags, containers, and contaminated soils from minor spills.

Community health may be impacted through spills and subsequent contamination of soil, surface and groundwater resources. Consumption of such water may result in bioaccumulation of contaminants and various health impairments. Bathing and washing in it may cause skin irritation. Indirect public health impacts could occur through soil contamination by oils, chemicals and the bioaccumulation of heavy metals impacting crop yields and food quality. Worker health is affected in similar ways. Because workers are closer to and handle hazardous waste, the likelihood of exposure is higher of workers than for the public.

Any spills on the drill pad would be directed into the waste pit. An oil trap will prevent oil from flowing into the waste pit.

Impacts from hazardous chemicals and waste may affect both occupational health and community health, and are considered to be local in Extent, of medium term duration, reversible over time, and of medium magnitude. Given these considerations severity is ranked as major injury (3). The probability is considered to be possible (C). *Therefore the Risk Rankingof project impact to health is determined to be medium*

Severity	Probability	Risk Ranking
Major	Possible	Medium
3	C	3 C

Management Measures

PCMI will implement the following mitigation measures to reduce impacts from hazardous waste:

- Segregate and store hazardous chemicals and waste in appropriate, labelled and safe containers that are suitable for transporting/transferring. Containers having hazardous waste must be kept in safe areas.
- All hazardous waste will be collected in skips ready for treatment and disposal and sent directly to a cement kiln.
- Provide Manifest System for transportation of hazardous waste to treatment area or disposal area.
- Always check and record the type(s) and amount of hazardous waste generated.

Residual Risk

With the implementation of management measures, residual risks due to hazardous chemicals and waste from material contaminated with oil or chemicals, lubricating and hydraulic oil, drum and containers used for chemical transportation and storage are rated as 3 B, where probability is considered to be Unlikely; should an impact occur the Risk Ranking is considered to be Major Injury (3). Therefore the overall residual risk rating is considered to be Low.

5.11.6. Communicable Diseases

Impact Assessment

Drilling activities will require 110 to 130 workers. Because these are specialized positions, most of these workers will temporarily move into the area. Experiences from other parts of the world have shown that oil and gas development activities introduced or increased incidence of communicable diseases, such as HIV/AIDS and malaria, in communities where these projects are located. Although the PCMI project is not a large-scale development, the influx of outside workers could contribute to proliferation of communicable diseases in local communities.

The structures at the project well sites can conceivably contribute to vector-borne diseases such as malaria, dengue by providing breeding grounds for mosquitoes if they are not properly maintained. These structures include a perimeter drainage trench and an intermediate drainage trench and a HDPE lined waste pit at each well site.

Unhygienic practices in the work place may also promote spread of gastrointestinal diseases amongst project employees.

The potential health impacts from an influx of workers could contribute to proliferation of communicable diseases in local communities and the work force.

National statistics on HIV/AIDS are provided in **Table 5-54**. Detailed information on HIV/AIDS is limited.

Table 5-54: National HIV/AIDS Statistics

Number of people living with HIV	240,000 [160,000 – 370,000]
Adults aged 15 to 49 prevalence rate	0.7% [0.4% - 1.1%]
Adults aged 15 and up living with HIV	240,000 [150,000 – 360,000]
Women aged 15 and up living with HIV	100,000 [63,000 – 150,000

In Myanmar dengue fever (DF)/dengue haemorrhagic fever (DHF) is one of the leading causes of morbidity and mortality among children under the age of 10 years, with approximately 85% of cases occurring in this age group. Some adult cases have been reported, especially from rural areas. An annual average of 7,000-10,000 cases of DF/DHF are reported nationwide. However, in recent epidemic years (2001, 2002 and 2007), the number has risen to over 15,000 cases. National figures indicate that the largest number of cases are from Yangon Region. In 2007, Yangon (31%), Ayeyarwady Region (16%) and Mon State (15%) accounted for 62% of all reported cases.

Malaria is a major public health problem in Myanmar, particularly in forested and hilly areas (WHO, 2008).

In the surveyed area during the Blocks IOR5 Baseline Survey, malaria infection rate was said to be high. Most surveyed respondents claimed to have slept under a mosquito net the previous night.

Malaria is the main cause of morbidity and mortality in Myanmar. It is a re-emerging public health problem due to climate changes, uncontrolled population migration, ecological changes, and existence of multi-drug resistant P. falciparum parasites and appearance of insecticide resistant vector. Total malaria cases recorded in 2003, were 98, 584 with 2,243 resulting in death. About 11,534 dengue/dengue hemorrhagic fever cases were also recorded in 2003 with 111 deaths (WHO, 2004).

Impacts from communicable disease may affect both occupational health and community health, and are considered to be local in Extent, of medium term duration, reversible over time, and of medium magnitude. Given these considerations severity is ranked as major injury (3). The probability is considered to be Possible (C).

Therefore the Risk Ranking of impact from communicable diseases to health is determined to be medium

Severity	Probability	Risk Ranking
Major	Possible	Medium
3	C	3 C

Management Measures

PCMI will implement the following mitigation measures to reduce the spread of communicable diseases:

- Implement mitigation measures for listed for non-hazardous waste (**Section 5.9.8.2**).
- Clearing of overgrowth in perimeter.
- Deposit cuttings into 9 m^3 skips, where they are to be temporarily held before being sent to cement kiln for incineration.
- Keep waste manifest.
- Drainage and removal of waste from waste pit upon completion of drilling.
- Health screening of workers before employment.
- On-site health clinic (drilling operations) and referral system during all of project operations with external health agencies to ensure timely diagnosis and treatment of workers’ illness and injury.
- Maximize hiring of qualified local workers to reduce reliance on outside labour and increase local employment.

- Do not allow workers to enter communities near the drill site.
- Provide awareness to workers on preventive measures for the prevention of communicable and local diseases.

Residual Risk

With the implementation of management measures, residual risks due to communicable diseases are rated as 3 B, where probability is considered to be Unlikely; should an impact occur the Risk Ranking is considered to be Major Injury (3). Therefore the overall residual risk rating is considered to be Low.

5.11.7. Light and Heat

Impact Assessment

Testing will be conducted for those exploration wells showing promising hydrocarbon presence. During the well testing process (22 days/well), flaring will create high temperatures near the flare. Flaring during well testing will constitute a potentially significant light source where gas will be burnt off via a flare stack. The flare stack will be a horizontal flare directed into a protected flare pit to ensure the safety of workers at the well site. The nearest community is expected to be located more than 500m away (for all the proposed well sites); thus, impact from light and heat from the flare stack will be minimal.

Residents close to the well testing sites will be affected from flaring, mainly through disturbance of psychological wellbeing and annoyance if the flare is visible. However the flare will not be an issue if hydrocarbons are not found, and if found the testing phase will last only 22 days.

Workers could however be affected by heat from the flare. An assessment of heat impacts was done in **Section 5.9.6**. According to **Table 5-47** the safe distance for continuous exposure without protection is 35 m.

Light and heat impacts are considered to be local in extent, of short-term duration, reversible, and magnitude is considered to be small. As a result of these considerations the severity is ranked as 2 Minor Injury. The probability of these impact occurring are ranked as Likely (B).

Therefore the Risk Ranking of impact from light and heat is determined to be low.

Severity	Probability	Risk Ranking
Minor Injury	Likely	Low
2	B	2B

Management Measures

PCMI will implement the following mitigation measures to reduce light and heat impacts:

- Post constant fire watch during flaring operations.
- Maintain safety distance between flare stack and well site facilities and adjacent crops.
- Implement PCMI’s Emergency Response Plan including specific management procedures to mitigate the impacts if a fire occurs.
- Install fire extinguishers, alarms and windsocks (to be audible and visible from whole site).
- Heat impacts from the flare stack will be minimised by having a protected flare pit.
- Maintain a safe distance from nearest sensitive receptor.

Residual Risk

With the implementation of management measures, the probability of residual risks due to light and heat are rated as C Possible. The Risk Ranking of impacts from light and heat should they occur are ranked as 2 Minor. This results in a residual risk ranking of 2 C Low.

5.11.8. Flare Emissions

Impact Assessment

Pollutants emitted from the flare include Carbon dioxide, Hydrocarbons and Nitrogen oxides. These pollutants may affect the respiratory system, circulatory system and central nervous system, depending on the concentration of pollutants and period of contact. Evaluation of the rate of emission of air pollutants caused by flaring in the well testing phase found greenhouse gas emissions from the activities of well testing phase is 30,273 tons of carbon dioxide equivalent per year of primary greenhouse gases (GHGs) (e.g. carbon dioxide $CO2$ and methane $CH4$) and varying amounts of other pollutants such as carbon monoxide (CO), oxides of nitrogen (NO_X) and sulphur (SO_X), volatile organic compounds (VOCs), and particulate matter (PM) will be released to the atmosphere during the drilling programme. This volume is considered low and not expected to have adverse health effect for the people who live around project site. The well testing process is short term (22 days/well).

Flare emission impacts are considered to be local in extent, of short-term duration, reversible, and magnitude is considered to be high. As a result of these considerations the severity is ranked as 5 Multiple Fatalities.

The probability of these impact occurring are ranked as Remote (A).*Therefore the Risk Ranking of impact from flare emissions is determined to be Medium.*

Severity	Probability	Risk Ranking
Multiple fatality	Remote	Medium
5	A	5 A

Management Measures

PCMI will implement the following mitigation measures to reduce impacts from flare emissions:

- Ensure flare system has efficient combustion.
- Maintain pilot flame at the flare tip to ensure that flame is not extinguished by strong wind.
- H_2S detection and safety equipment is standard issue (see **Section 2.9.3** and **Chapter 6**). PCMI's emergency response plan (ERP) includes an H_2S Contingency Plan. Furthermore, the drilling contractor will have their own H_2S Contingency Plan.
- Standard mitigation measures to reduce impacts from hydrogen sulphide release during well testing will be implemented:
    - Install H_2S sensors at the flow line.
    - If H_2S levels exceed 10 ppm in the gas stream, implement appropriate safety zones.
    - The initial flow of hydrocarbons to surface will be timed to coincide with daylight hours.
- Staff trained in H_2S procedures.

Residual Risk

With the implementation of management measures, the probability of residual risks due to flare emissions is rated as (A) Remote. The Risk Rankings of impacts from flare emissions should they occur are ranked as 4 Single fatality. This results in a residual risk ranking of 4A Low.

5.12. Exploration Drilling Unplanned Events Impact Assessment

5.12.1. Criteria and Method for Unplanned Events Impact Assessment

The impacts associated with unplanned events during implementation of the PCMI Exploration Drilling Project are evaluated by determining the likelihood (or probability) of an event occurring; the severity of the event on the environment, social, health, assets and reputation; and its Risk Rankings.

Unplanned Events Considered

For the PCMI Exploration Drilling Project, the unplanned events considered were:

(1) Blowout (with subsequent fire and/or explosion);
(2) Fire or Explosion (not Associated with Blowout);
(3) Chemical or Hazardous Waste/Materials Spill; and
(4) Transportation Accidents
(5) Thunderstorms
(6) Earthquakes

These unplanned events will be assessed by determining possible causes, likely receptors affected, probability and Risk Rankings of the events. Residual risks will be evaluated after management measures are defined.

If the risk is determined to be “High”, it is considered to be intolerable and must be reduced. If the risk is determined to be medium, risk reduction measures need to be implemented to reduce the frequency of occurrence or to mitigate any Risk Rankings to achieve a risk which is “As Low As Reasonably Possible” (ALARP). If the risk is determined to be “Low”, the activity must be managed for continuous improvement.

The following table lists potential unplanned events affecting this exploration drilling program and identifies the aspects by project phase.

Table 5-55: Unplanned Event Aspects by Project Phase

Health Aspects	Site Construction	Exploration Drilling & Testing	Restoration and Abandonment
Blowout (with subsequent fire and/or explosion)		✓	
Fire or Explosion (not associated with Blowout)	✓	✓	✓
Chemical or Hazardous Waste/Material Spill	✓	✓	✓
Transportation Accidents	✓	✓	✓
Earthquakes	✓	✓	✓

The assessment of each aspect includes the following components:

- Description of the source and characteristic of the potential impacts.
- Identification of receptors sensitive to potential impacts.
- Description and evaluation of potential impacts.
- Identification of management measures to reduce potential impacts.
- A determination of the residual risk after management measures is included.
- An aspect summary assessment table.

5.12.2. Blowout (with subsequent Fire and/or Explosion)

Impact Assessment

Blowouts during exploration drilling and testing have an inherent risk of fire due to the flammability of hydrocarbon gas when mixed with air. The main risk is to the health and safety of the concessionaire’s employees and contractors (People) working at the well site at the time of any incident and damage to equipment and structures (Assets). As the gas in this field is known to consist almost entirely of methane, fires and explosions would have a relatively minor impact on local air quality.

A kick is an uncontrolled flow of formation fluids into the borehole and a blowout is the uncontrolled release at the surface. Not all kicks involve hydrocarbons; commonly they involve fresh or salty water. A kick can be controlled in the first instance by increasing the specific gravity of the drilling mud, which increases the effective pressure exerted by the mud on the formation, or by shutting in the well at the surface and increasing the mud weight. The ultimate response to a kick is to close the blow-out preventer (BOP) valve (pipe rams) to completely shut-in the well.

A blowout only occurs if all of the measures taken to control a kick fail and the pressure cannot be contained by the BOPs or the well casing ruptures. The most common cause of a blowout is that the well encounters unexpectedly high formation pressures or there is a rapid loss of the drilling mud into fractures or caverns in the formation. In areas where previous wells have already been drilled, the maximum formation pressures and depths of any over-pressured zones or lost circulation zones have been determined. The well plan is designed based on this information and ensures that the BOPs are sized to contain the pressure and the casing is positioned to establish control. Thus, there are numerous control systems, plans and procedures that have to fail in order for a blowout to occur. Nevertheless, they do occur and are a constant hazard that every well faces. Consequently, all drilling operations are planned taking into account the blowout risk and all personnel are trained and experienced in the procedures needed to control a kick and prevent a blowout.

Maximum pressure for the NPH and SPH prospect wells is expected to be not exceeding 5,500psi. PCMI will use a 10,000 psi rated BOP.

The BOP is tested and certified as per API standards to 10,000 psi before installation. Once the BOP stack is installed it is pressure tested to API specification (API RP 53) to 10,000 psi. Once in service, PCMI’s standard operation procedures require the BOP to be tested every 2 weeks which is more stringent than API specification. Also, every time a connection is made (i.e. wellhead connection) the BOP must be pressure tested again as per API specification. The BOP unit will have a separate generator which will supply power to generate pressure in the accumulator to ensure the BOP operates at all times.

If a blowout contains hydrocarbons, these have the potential to mix with the air, providing oxygen, and a spark can cause the mixture to ignite. As the fluids flowing from the well will be under significant pressure, the result will be a ‘jet’ of flame that will shoot out in the direction of any holes in the well head (usually this is directed vertically).

The impact of a blowout will depend on the amount of hydrocarbons flowing from the well and their pressure. Thermal radiation of 8.5 kW/m^2, can result in pain after about 8 seconds exposure and second degree burns after about 20 seconds of exposure. A blowout could have the potential to create a significant hazard to anyone without protective clothing. Even if a fire does not ignite, the released gas can lead to suffocation or poisoning. Thus, the first response to any blowout is to evacuate personnel to a safe distance before planning commences for containment and well control. With the exception of the personnel on site, the nearest people to any of the sites must be greater than 350 feet (about 100 meters). Therefore there is no immediate hazard to the local population in the unlikely event a blowout should occur, allowing time for evacuation in a severe situation.

Although standard precautions are taken on all wells drilled to prevent, control or contain a blowout, blowouts do occur, but rarely.

An escape of large quantities of gas could result in notable reduction in local air quality causing a temporary stress to those exposed. Natural gas can cause headaches, nausea and dizziness in a high concentration when inhaled.

Small leaks of gas will not be toxic and any irritation would be minor to workers. In addition, a blowout is very likely to cause damage to equipment and injuries to drill rig workers.

Liquid hydrocarbon impacts in the event of Blowout, which would lead to contamination of soil and groundwater, and also surface water.

The frequency of a blowout is at about 1 in 1000 wells drilled worldwide (E&P, 1996), and much lower for wells drilled into normal formations i.e. not known to have high pressure gas. The likelihood is therefore rated Unlikely.

Nevertheless, as is standard emergency response/contingency procedures will be implemented.

Impacts from a possible blowout are considered to be localized; short term in duration, possible having permanent implications, and major negative magnitude. As a result of these considerations the severity is ranked as 5 possible multiple fatalities, Minor Social Impact (2) and international impact on reputation, while ranked a 4 possibly have a major impact on environment and a major impact n assets.

The probability of these impact occurring are ranked as B Unlikely. *Therefore the Risk Ranking of blowout is determined to be medium for people, environment, assets, and reputation.*

Severity	Probability	Risk Ranking
Environment, Assets (4); People and Reputation (5), Social 2	Unlikely	Medium
2, 4 & 5	B	5 B

Management Measures

PCMI as part of its HSEMS system has a Blowout Contingency Plan (BOCP) for it Myanmar operations. This BOPC defines the procedures that are to be used in the event of a well control emergency occurring in their exploration drilling program.

PCMI’s Emergency Response Plan sets out the specific management procedures to be implemented to mitigate the impact if a blowout/explosion occurs.

A full set of preventative measures will be in place to reduce the risk significance of a blowout occurring, including:

- Careful planning of drilling operation.
- Examination of existing seismic lines and nearby wells to identify shallow gas hazards.
- Drilling and Well Control Standard Operating Procedures and extensive HSE Management System procedures and operational controls in place.
- Internal hazardous operations reviews and “Table Top drilling” exercises to test procedures and individual personnel performance against the drilling plan.
- Select proper drill fluid formulation, provide well kill fluids/systems, loss control and weighting agents.
- Very careful monitor downhole conditions and mud returns.
- Use of appropriate, high quality materials in well construction (casing and cement grades).
- Provide a blowout preventer (BOP) stack that is sized appropriately in proportion to the maximum formation pressure; and test as per procedures.

- Provide of a high-pressure water-spray dousing system around the wellhead, solids removal chokes and flare stack.
- PCMI's Emergency Response Plan.
- PCMI's HSE Integrated Management System Procedures and operational controls will be in place to prevent a blowout/explosion.
- PCMI BOCP in place prior to spudding.

Residual Risk

Impacts from a possible blowout are considered to be localized; short term in duration, possible having permanent implications, and major negative magnitude. As a result of these considerations the severity is ranked as 5 possible multiple fatalities, and international impact on reputation, while ranked a 4 possibly have a major impact on environment and a major impact on assets, while having a minor social impact.

The probability of these impact occurring are ranked as B Unlikely. Therefore the residual risk of blowout is determined to be low for social impacts, and medium for people, environment, assets, and reputation.

5.12.3. Fire or Explosion (not Associated with Blowout)

Impact Assessment

Potential sources of fire other than from a release of hydrocarbons from the well include the burning of garbage, discarded cigarettes, the presence of diesel fuel on site and the flare during testing. Burning of garbage will be prohibited and smoking will be restricted to safe areas. Diesel is not easily ignited as shown in flash point of diesel in range of 40 to 100 ^{0}C which above the normal room temperature, so the likelihood of a fire occurring is unlikely. Furthermore, the lower explosive limit (LEL) of diesel fuel is 0.6 percent that equals of the concentration of approximately 6,000 ppm. It is unlikely that a fuel spill would cause this concentration to ignite and explode when it occurs in an open area, such as PCMI's well site.

Incident statistics for the onshore oil and gas sector are general and not specific for onshore oil wells, similar to PCMI's proposed project. For instance, statistics for all oil and gas workers in the United States indicated that there were 404 fatalities between 2003 and 2006: 36 fatalities from explosions and 27 from fires[5]. Employment during this period ranged from 292,846 to 385,803 workers. Other statistics indicate an incident (injuries and illness) rate of 1.7 (per 100 workers) in the crude oil and natural gas extraction industry[6].

A fire or explosion may result in multiple on-site fatalities (5); Major damage to Assets - Partial operation loss, 2 weeks shutdown, costs up to USD 10,000,000 (4); Localized effect on environment (3); International impact on reputation – International public attention (5); Minor Social Impact. As the probability of a fire or explosion is unlikely (B), *The Risk Ranking of impacts on people, reputation, environment and assets result in therefore ranked as medium.*

Severity	Probability	Risk Ranking
Reputation International Impact	Unlikely	Medium
5	B	5 B

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[5] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5716a3.htm#tab1

[6] http://www.bls.gov/iif/oshwc/osh/os/ostb1917.txt

Should a fire occur, there are numerous fire extinguishers on site, and staffs are trained in their use, so any fire from these sources would quickly be brought under control. In an event of a major fire, PCMI would alert and cooperate with the local fire brigades.

Management Measures

Fires will be managed under existing emergency plans. The risk significance of fire will be reduced by using the following mitigation measures:

- PCMI's HSE Integrated Management System Procedures and operational controls to prevent a fire/explosion.
- PCMI's Emergency Response Plan including specific management procedures to mitigate the impacts if a fire/explosion occurs.
- Install fire extinguishers, alarms and windsocks (to be audible and visible from whole site).
- Pre-arranged call out support from local fire brigades.

Residual Risk

With the implementation of management measures, the probability of residual risks due to a fire is rated as B Unlikely. The the severity is ranked as 5 possible multiple fatalities, and international impact on reputation, while ranked a 4 possibly have a major impact on assets, and a ranking of 3 for a localized impact on the environment, and minor social impact. This results in a residual risk ranking of 5 B Medium for fires and related explosion.

5.12.4. Hydrocarbon, Chemical or Hazardous Waste/Materials Spill

Hydrocarbon, chemicals and hazardous waste materials present potential risk of spills to the environment and spillage could affect air quality, soil quality, surface water, groundwater, biota and people.

Drilling operations have not had a chemical and hazardous waste spill on site. Only a limited amount of hazardous material is to be held at the project site and only during drilling.

All components of the drilling mud are classified as non-hazardous with the exception of Soda Ash (sodium carbonate), Caustic Soda (sodium hydroxide), Calcium Chloride, Quartenary Amine and Monoethaloamine. Concentrations of these chemicals used in the drilling mud are however non-toxic.

The quantity of the hazardous chemicals that will be used at well site is minimal; therefore, the impact on the environment in the case of a spill would be limited in area and likely to be transitory.

5.12.4.1. Hydrocarbon Spills

Hydrocarbon spills from storage and handling could happen during all phases of the exploration campaign.

Impact Assessment

The potential impacts from spills of fuel or lubricant oils area:

- Decline in groundwater quality
- Temporary localized decline in surface water quality and aquatic biota
- Temporary localized decline in soil quality.
- Temporary minor toxicity to flora and fauna

5.12.4.1.(1). Hydrocarbon Spills Impacting Groundwater

On-site fuel will be stored in steel tank, with a concrete bund wall with 110-120% containment capacity.

The areas of the well pad where oil, lubricants and drilling mud may spill are isolated by a drainage system designed to keep all rain water run-off on rig pad site in the waste pit, which is lined a HDPE liner.

These measures should ensure that there is no accidental release of hydrocarbons into the groundwater. In the event of a spill, spill kits provided on site will be used to remove and contain the spill immediately. Any contaminated water will be collected in the waste pit through a drainage system around the project site.

Without mitigation measures, impact on groundwater will be local in extent, potentially long-term in duration, reversible and of medium magnitude. The groundwater table in the project area is very deep (except near seasonal drainage areas and water courses); the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. However, shallow unconfined aquifer may be tapped as water source in certain villages, so the severity of impact depends on the location of well site to community wells.

5.12.4.1.(2). Hydrocarbon Spills Impacting Surface Water Quality and Aquatic Biota

The areas of the well pad where oil and lubricants may spill are isolated by an intermediate drainage system designed to drain all rainwater run-off on site into the waste pit, which is lined with HDPE plastic lined. An oil trap will prevent oil from flowing into the waste pit.

On-site fuel will be stored in steel tanks and surrounded by a bund wall with 110-120% containment capacity. On site separated emulsion-condensate will be stored in separate tanks placed within the intermediate drainage system. These measures should ensure there is no release of contaminated water to the area outside the site. In the event of a spill, spill kits provided on site will be used to remove and contain the spill immediately.

These measures should ensure there is no release of contaminated water to the area outside the site. In the event of a spill, spill kits provided on site will be used to remove and contain the spill immediately. Any contaminated water will be collected in the waste pit through a drainage system around the project site. This will be disposed of as hazardous waste.

Without mitigation measures, impacts to surface water quality and aquatic biota are expected to be local in extent, potentially long-term in duration, reversible and of medium magnitude. However, the impact could be important on a local level; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **major impact** for environment. The probability of this impact occurring is determined to be unlikely

5.12.4.1.(3). Hydrocarbon Spills Impacting Soils

Fuel spills can increase soil toxicity and/or decrease soil fertility.

Fuel spills may occur during fuelling of vehicles or tanks at the drilling site, or because of leaks from the fuel storage tank at the drilling site. All spills will be cleaned up immediately with the spill kits on site which include shovels, absorbents (sand) and steel containers. Fuel will be stored in steel tanks and placed on the concrete rig pad with bunding, capable of accommodating 110-120% of the capacity of the tank in the event of a leak. At the end of the project, all oily wastes classified as hazardous will be transported and disposed in a cement kiln.

Fuelling during drilling operations will be conducted within the prepared site. The oil traps on each side of the location will ensure that any spills are contained within the site and do not contaminate any soil surrounding the location.

Without mitigation measures, impacts to soils from accidental spills are expected to be local in extent, short-term in duration, reversible and of low magnitude. The impact disturbs an area currently used for agriculture with limited conservation value; the importance of the impact is rated low. Given these impact criteria considerations the severity is determined to be a **major impact** for environment. The probability of this impact occurring is determined to be Unlikely (B).

5.12.4.2. Hydrocarbon Spills Impacting Flora and Fauna

As described in **Section 5.12.4.1.(3)**,impacts to soil from accidental spills or leaks are expected to be medium. Resulting impacts to terrestrial flora and fauna are expected to be correspondingly medium.

Without mitigation measures, impacts to terrestrial flora and fauna are expected to be local in extent, potentially long-term in duration, reversible and of medium magnitude. The value of the study area as habitat is significantly affected by its current use as agriculture areas are used to grow beans/pulses, peanuts and sesame, rice, corn, vegetables and continued human activity; the importance is rated as low. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of an impact occurring is determined to be Unlikely (B).

5.12.4.3. Mud and Chemical Spills

Mud and chemical spills from storage and handling could happen during all phases of the exploration campaign.

Impact Assessment

The potential impacts from mud and chemicals are:

- Decline in groundwater quality
- Temporary localized decline in surface water quality and aquatic biota
- Temporary localized decline in soil quality.
- Temporary minor toxicity to flora and fauna.

5.12.4.3.(1). Mud and Chemical Spill Impacting Groundwater

All components of the drilling mud are classified as non-hazardous with the exception of five chemicals: Soda Ash (sodium carbonate), Caustic Soda (sodium hydroxide), Calcium Chloride, Quartenary Amine and Monoethaloamine (**Table 2-8**). Concentrations of these chemicals used in the drilling mud are however non-toxic. Environmental toxicity information is provided in **Table-5-56**.

On-site chemicals will be stored on tarpaulin sheets in bunded areas with the toxic chemicals segregated and placed on an impervious base and protected from the weather. Any spills will be immediately cleaned up using the spill kits provided on site.

Drilling waste (cuttings and associated mud) is placed into 9 m^3 skips, where they are to be temporarily held before being sent to the cement kiln for incineration.

These measures should ensure that there is no accidental release into the groundwater. In the event of a spill, spill kits provided on site will be used to remove and contain the spill immediately. Any contaminated water will be collected in the waste pit through a drainage system around the project site.

Without mitigation measures, impact on groundwater will be local in extent, potentially long-term in duration, reversible and of medium magnitude. The groundwater table in the project area is very deep (except near seasonal drainage areas and water courses); the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. However, shallow unconfined aquifer may be tapped as water source in certain villages, so the severity of impact depends on the location of well site to community wells.

5.12.4.3.(2). Mud and Chemical Spill Impacting Surface Water and Aquatic Biota

For this exploration drilling program, PCMI will drill the exploration well with Water Based Mud (WBM).The well site facilities used to mix and hold the mud are made from steel and constructed according to industry standards. The drilling cuttings and fluid will pass through shakers that will separate the fluids from the cuttings. The cuttings will be washed, sieved and placed into 9 m^3 skips, where they are to be temporarily held before being sent to a local cement kiln for incineration.

The areas of the well pad where oil, lubricants and drilling mud may spill are isolated by a drainage system designed to drain all rainwater run-off on site into the waste pit, which is lined with re-a HDPE lined. An oil trap will prevent oil from flowing into the sump pit.

On-site chemicals will be stored on tarpaulin sheets in bunded areas with the toxic chemicals segregated and placed on an impervious base and protected from the weather. Any spills will be immediately cleaned up using the spill kits provided on site.

Accidental spills may deteriorate surface water quality and aquatic biota. Some chemicals from drilling operation may be toxic to aquatic biota and cause eutrophication or dissolved oxygen depletion of water bodies (**Table-5-56**). Containment measures are installed at the well sites to ensure that there is no release of spilt material off-site. These measures include: drainage systems around the rig and areas of the well pad where oil, lubricants and drilling mud may spill, waste pit sufficient in size to contain any spills and storm rainfall event.

Table-5-56: Environmental Characteristics of Components in the Drilling Fluids

Chemical Compound	Biota Affected	Toxicity
Caustic Soda (sodium hydroxide)	Fish	Fish LC50 (96h): 43mg/l[2]
Soda Ash (sodium carbonate)	N/A	Not acutely toxic to fish, mollusks, nematodes, phytoplankton, zooplankton[3]
Calcium chloride	Fish	LC50/96-hour values for fish are over 2000 mg/l[1] Not acutely toxic to fish, mollusks, nematodes, phytoplankton, zooplankton[3]
Quartenary Amine.	N/A	N/A
Monoethaloamine	N/A	Not acutely toxic to fish, mollusks, nematodes, phytoplankton, zooplankton[3]

Source: [1]Ecotox: http://cfpub.epa.gov/ecotox/help.cfm?sub=about, [2]MSDS, [3]http://www.pesticideinfo.org/List_ChemicalsAlpha.jsp

Without mitigation measures, impacts from surface water quality and aquatic biota contamination are expected to be local in extent, potentially long-term in duration, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value. However, the impact could be important on a local level; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **major impact** for environment.

5.12.4.3.(3). Mud and Chemical Spill Impacting Soil

With the necessary drainage isolation, capture systems, protected storage in place, together with good housekeeping, the risk of contaminants release into the soil around the site is minimal. The mud chemicals held on site are largely non-toxic and biodegradable, limiting both the severity and the duration of any impact.

Without mitigation measures, impacts from soil contamination during drilling are expected to be local in extent, potentially long-term in duration, reversible and of medium magnitude. The impact disturbs an area currently used for agriculture with limited conservation value. However, the impact could be important on a local level; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of this impact occurring is determined to be Possible (C).

5.12.4.3.(4). Mud and Chemical Spill Impacting Terrestrial Flora and Fauna

The containment systems chemicals and drilling mud are comprehensive and the likelihood of any of these substances reaching terrestrial flora and fauna off-site is remote. A complete list of the mud chemical properties and environmental toxicity is provided in **Table-5-56**. The mud chemicals held on site are largely non-toxic and biodegradable, limiting both the severity and the duration of any impact from an on-site spill.

Hazardous chemicals are segregated from the main chemicals and kept in appropriate containers during drilling. Spills during transportation however have the potential to affect soils and surface water quality and thus terrestrial flora and fauna.

Without mitigation measures, impacts to terrestrial flora and fauna from accidental spills are expected to be local in extent, long-term in duration, reversible and of medium magnitude. The value of the study area as habitat is significantly affected by its current use as agriculture areas are used to grow beans/pulses, peanuts and sesame, rice, corn, vegetables, thanakha and continued human activity. However, the impact could be important on a local level; the importance of the impact is rated medium. Given these impact criteria considerations the severity is determined to be a **localized impact** for environment. The probability of this impact occurring is determined to be Possible (C).

A hydrocarbon, chemical or hazardous waste/materials spill may result in major injury (3); Local damage to Assets (3); Localized impact on environment (3); and considerable impact on reputation (3); slight social impact (1). As probability of a chemical or hazardous waste/material spill is Possible (C), *the Risk Ranking of impacts on people, reputation, environment and assets result in therefore ranked as medium.*

Severity	Probability	Risk Ranking
Major	Possible	Medium
3	C	3 C

The impact of a hydrocarbon, chemical or hazardous waste/materials spill will be reduced by using the following mitigation measures:

- Chemicals, Hydrocarbons and hazardous materials or waste will be securely stored and use governed by safe operating procedures.
- Spill containment and recovery equipment will be available near storage areas.
- Procedures for response to Chemicals, Hydrocarbons and hazardous materials or waste spills will be included in PCMI’s ERP.
- MSDS Sheets will be posted in areas where Chemicals, Hydrocarbons and hazardous materials or waste is stored and with the ESH Officer.
- Construct lined waste pit at each well site for potentially contaminated runoff and spills (4,800 m^3 each), lined with HPDE plastic to form an impermeable barrier that will help prevent run-off into the environment.
- Construct drainage system around well sites and concrete rig pad which mud tanks, shakers, generators and fuel tanks sit on to divert any spills into the waste pit.
- Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious floor (e.g. tarpaulin sheet).
- Provide drip pans and absorbents to contain any spillage.
- Provide spill cleanup kits and training for designated rapid response teams to clean up any spills. In the event of oil or chemical spill, implement ERP.
- Prohibit workers from cleaning machines/equipment in/near a public water source.
- Prohibit workers and contractors discharging or discarding project waste, chemicals, and oil into public water sources.
- Maintain oil traps along perimeter drainage ditch to prevent any spills from flowing off site.
- Isolate any area(s) that might be contaminated from non-contaminated areas. The ground of areas where possible contamination occurs will be covered with plastic sheet.

- Store Chemicals, Hydrocarbons and hazardous materials or waste storage tanks on concrete rig pad. The storage unit will be surrounded by a bund wall that is able to contain 110-120% of the capacity of the tanking case of spill.
- Transport produced emulsion-condensate to a licensed wastewater treatment facility using dedicated tanker trucks.
- The use of chemicals will be avoided through appropriate design where practicable.
- During the procurement process, chemicals will be evaluated for environmental, safety, technical, and commercial performance. As far as practicable, least hazardous chemicals will be selected.
- Procedures for response to chemical spills will be included in PCMI's ERP.
- Use non-hazardous water-based mud system. Inform MOGE in case of change in mud chemicals.
- Deposit treated cuttings into 8 m^3 skips, where they are to be temporarily held before being sent to cement kilns for incineration. Keep waste manifest.
- Implement transportation plan.

PCMI's Emergency Response Plan will set out the management procedures to be put in place to mitigate the impact if a spill occurs.

Residual Risk

With the implementation of management measures, the probability of residual risks due to a hydrocarbon, chemical or hazardous waste/materials spill is rated as B Unlikely. The the Risk Ranking of impacts should they occur are ranked as 3 possible major impact to people, considerable impact to reputation, major impact on assets, slight social impact and major impact on the environment. This results in a residual risk ranking of 3 B Low.

5.12.5. Transportation Accidents

Transportation accidents associated with PCMI's project may occur during transportation of equipment, personnel, granular fill, mud and cuttings, and waste.

No data on accidents is available for the area. However, this part of the county has a relatively small number of vehicles (including motorcycles) per capita.

Impacts from transportation accidents are considered to be localized in extent, possibly with permanent implications, and of medium magnitude. As a result of these considerations the severity is ranked as: possible multiple fatalities (5) for People, Localized (3) impact to environment, minor social impact (2), local damage (3) to assets, and Considerable (3) impact to reputation.

The probability of these impact occurring are ranked as Possible C. Therefore the Risk Ranking of transportation accidents is 2 C Low for social impact, 3 C Low for environment, assets and reputation; and 5 C High for People.

Severity	Probability	Risk Ranking
Multiple Fatality on People	Possible	High
5	C	5 C

The risk significance of a transportation accident will be reduced by using the following management measures:

- HSE Integrated Management System Procedures.
- Limit the speed of project vehicles, according to the road condition (on unpaved road to 30 km/h).

- Maintain construction equipment and vehicles to regulatory standards.
- Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights.
- Consult with community leaders on plan and transportation route before movement of large equipment.
- Restrict/ avoid movement of heavy equipment during rush hours from 07.30 to 08.30 am and 3.30 to 4.30 pm.
- Provide traffic signs or flags at junction of access road and main road.
- Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.
- Strictly enforce training programs to reduce transport and drilling incidents by its contractors.
- Restore any damage to roads caused by project vehicles.
- Implement emergency response training, fire training and response drills.
- Install adequate fire extinguishers around the well sites.
- Test safety devices as determined appropriate.
- Provide PPE to workers on site.
- Provide medic, First Aid kits and First Aid trained personnel at drilling site.
- Restrict smoking to controlled areas.
- Prohibit trespassers from entering the construction site.
- Referral system with external medical facilities for serious injuries or emergencies.

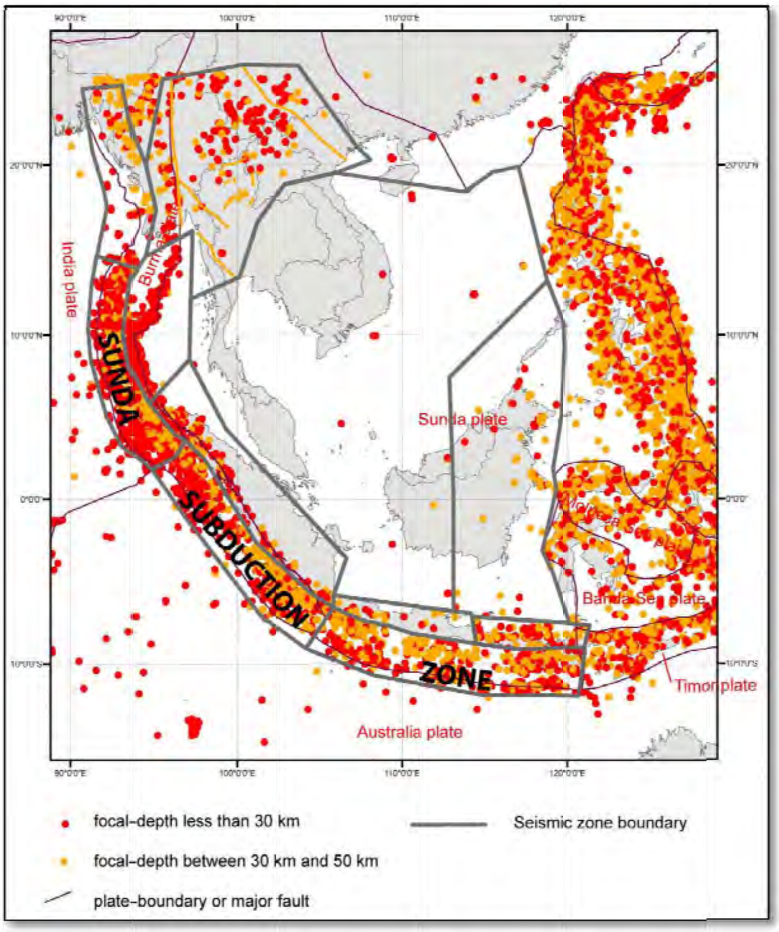
Residual Risk

With the implementation of management measures, the probability of residual risks due to transportation accidents is rated as B Unlikely. The severity is ranked as: possible multiple fatalities (5) for People, Localized (3) impact to environment, local damage (3) to assets, and Considerable (3) impact to reputation, and Slight (2) social impact. This results in a residual risk ranking of 5 B Medium for possible transportation accidents and related impacts.

5.12.6. Earthquakes

Central Lowlands in the vicinity of IOR5 have potential to thrust, and contains transpressional active faults such as Chauk-Tangyitaung and Gwecho faults. IOR5 is located at 20km east of Arakan-Yoma mountain range and 110km west of Sagiang fault.

A map of earthquakes in the SE Asian region is shown in **Figure 5-3**.



Source: USGS, 2007

Figure 5-3: Map of Earthquakes with Shallow-Focus Epicentre for Period 1965-2005

Impacts from an earthquake could result in effects to people, assets, environment and reputation. The worst case scenario would be similar to a blowout, fire or explosion.

As earthquakes are an unlikely occurrence in the IOR5 Region, their frequency has been rated as "Unlikely"**.** Their Risk Rankings are potentially very serious in terms of People, with possible multi fatalities (5); Massive (5) Social Impact; Reputation being affected internationally (5); potentially massive environmental impacts (5); and extensive asset damage (5); resulting in an overall medium risk. Although earthquakes cannot be directly mitigated, the effects on operations can be managed through design and management measures.

The Risk Ranking of impacts on people, reputation, environment and assets result in therefore ranked as medium.

Severity	Probability	Risk Ranking
Massive, Multiple Fatality, Extensive Damage, and International Impact on Reputation	Unlikely	Medium
5	B	5 B

Management Measures

Although earthquakes cannot be directly mitigated, the effects on operations can be managed through design and management measures as follows:

- Implement PCMI's Earthquakes: Evacuation Plan and Emergency Response Plan.
- Proper training and safety procedures will be the main preventative measures to reduce the potential risk.
- In the unlikely event an accident should occur, the Emergency Response Plan would be implemented, which includes evacuation of personnel during severe circumstances.

Residual Risk

With the implementation of management measures, the probability has been rated as "Remote"**.** Their Risk Rankings are potentially very serious in terms of People, with possible multi fatalities (5); Reputation being affected internationally (5); potentially massive environmental impacts (5); Massive Social Impact (5); and extensive asset damage (5); resulting in an overall medium residual risk 5A.

5.13. Cumulative Effects Assessment

The objective of the cumulative impact assessment is to identify those environmental, social or health aspects that may not on their own constitute a significant impact but when combined with impacts from past, present or reasonably foreseeable future activities associated with this and/or other projects, result in a larger and more significant impact(s).

The screening of planned and unplanned project related activities to identify potential environmental, social, health aspects assisted to highlight potential areas where cumulative impacts could possibly occur. These areas include: Community and Occupational Health; Agriculture; Transportation; Flora and Fauna (including aquatic); Ground Water Quality; Surface Water Quality, Soil, and Air Quality. The key activities potentially causing these cumulative effects include: hazardous and non-hazardous waste; wastewater; road and site construction; traffic, and unplanned events (blowout, fire and explosion, chemical/hazardous materials spill).

From the impact analysis of the environmental, social, health and unplanned events and the determination of the residual risk, it is concluded that the management measures defined for each aspect will prevent cumulative effects from occurring for this planned exploration drilling project. The ESHIA Management Plan too outlines monitoring measures that will ensure that mitigation measures are effective and that any change or impact to the environment is detected.

5.14. Summary of Residual Risk Rankings

The residual risk rankings of the impact assessment of the project operations and unplanned events environmental, social, health and unplanned aspects are summarized below in **Table 5-57** to **Table 5-60**.

Table 5-57: Environmental Aspects Residual Risk Rankings

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Land & Habitat Disturbance	Installation of Infrastructure Road construction Camp site construction Well site construction Well abandonment and site restoration	Disturbance to local topography	2	E	Medium
		Soil Disturbance and Erosion	1	C	Low
		Disturbance to local Terrestrial Flora	1	C	Low
		Disturbance to local terrestrial fauna	1	C	Low
		Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration	3	C	Medium
		Localized change in water quality	3	C	Medium
		Localized sediment deposition and disturbance to benthic habitats and associated biota.			
Vehicle and Rig Movements	Vehicle Movements Rig Movement	Disturbance to traffic	1	D	Low
Air Emissions	Installation of infrastructure	Deterioration of Air Quality due to dust	3	D	Medium
	Drilling Well Testing Flaring	Hydrogen sulphide released	2	B	Low
	Power Generation for Drilling and Flaring Well Testing and Flaring	Minor deterioration of local and regional air quality due to emission of pollutants such as NOx and SOx and CO.	2	D	Medium
	Transportation Road Construction and rehabilitation of Drill Site and Camp Site Construction Power Generation for Drilling Flaring Fugitive emissions	GHG Release contributing to climate change	1	D	Low

Aspect	Activity	Potential Impact	Residual Risk		
			C	P	RR
Noise	Installation of infrastructure Drilling and infield operations Well Testing and Flaring	Behavioral disturbance to fauna	2	E	Medium
Artificial Light	Functional lighting on vehicles and drill rig, camp site and well site Flaring	Potential impact on terrestrial fauna	1	D	Low
		Potential impact on terrestrial flora	1	C	Low
Heat	Flaring	Potential impact on local fauna	1	D	Low
Liquid Waste	Drill site drainage	Localized change in water quality or contaminated soils from oil and grease	2	B	Low
	Sewage and sulllage	Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water	2	D	Low
	Infiltration	Infiltration from the cuttings and dirty water waste pit may deteriorate groundwater quality	3	B	Low
Solid Waste	Disposal of non-hazardous wastes from drilling activities	Contamination of water and soils and injury to fauna	2	D	Medium
	Disposal of food and other kitchen wastes from camp site	Attraction of fauna such as rats and birds. Nutrient enrichment of surrounding water and soils	1	D	Low
	Disposal of Hazardous Solid Wastes	Contamination of water and soils and injury to fauna	3	C	Medium
Drill Cuttings and Fluids	Disposal of drill cuttings and sludge	Localized change in water quality and soil quality from chemical composition of drill fluids	2	D	Medium
	Loss of circulation	Deterioration of shallow and deep groundwater	3	B	Medium

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact
P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table 5-58: Social Aspects Residual Risk Rankings

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Change in Land Use	Purchase of land for access roads, drill and camp site	Loss of agriculture potential Project operation effects on nearby land productivity Loss of employment for displaced workers that do not own land	0	D	Positive
Traffic	Transportation of equipment, people and services	Increase in and disruption of local traffic	1	C	Low
Water Use	Water for construction exploration drilling and domestic use	Reduction of local community water supply	3	D	Medium
Power Use	Power for drilling operations and work camp	Increase or decrease of available power for local community			None
Water Drainage	Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure	1	C	Low
Wastewater	Project operation effects on water quality	Potential impact to agriculture, aquaculture and fisheries	1	C	Low
Waste Disposal	Disposal of waste in project area	Increased waste disposal overloading local infrastructure	1	D	Low
Tourism and Recreational experience	Project construction and operation effects on tourism and recreation	Disturbance and reduction of tourism and recreational experience	1	C	Low
Employment & Income	Employment & income for nearby communities	Potential increase in jobs and related income for local communities	0	E	Positive
Labour In-migration	In-migration of labour and social interaction	Potential conflict between workers from other regions and local communities	1	C	Low
Historical, Archeological & Cultural Resources	Project construction potentially destroying historical and archaeological sites	Loss or damage to historical and archeological sites	2	C	Low

Note: C - Consequence: 0 – No Impact, 1 - Slight Impact, 2 – Minor Impact, 3 – Localized Impact, 4 – Major Impact, 5 – Massive Impact

P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table 5-59: Health Impact Summary

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Dust	Access/upgrade roads, Site construction, Transportation of granular fill, workers, equipment	Respiratory irritation Exacerbation of asthma	2	D	Medium
Noise	Generator, Transportation, Construction Drilling	Hearing impairment for workers and Annoyance for public	1	E	Low
Non-hazardous waste	Waste disposal, Leaks/spills, Standing water	Food safety, gastroenteritis Increase in vector-borne diseases: malaria, typhus and dengue and others.	5	C	High
Mud Chemicals and drilling waste	Mixing of drilling chemicals, Leak/spill of mud chemicals	Acute exposure such as skin irritation, inhalation exposure etc.	3	B	Low
Hazardous waste	Material contaminated with oil or chemicals, Lubricating and hydraulic oil, Drum and containers used for chemical transportation and storage	Acute exposure such as skin and eye irritation, inhalation exposure etc.	3	C	Medium
Communicable diseases	Migration/influx of outside workers	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.	3	C	Medium
Light and heat	Flaring	Heat exposure Nuisance light	2	B	Low
Flare emissions	Flaring	Increase in respiratory illnesses/diseases Exacerbation of asthma Disturbance psychological wellbeing H2S Fatalities	5	A	Medium

Note: C - Consequence: 0 – No Injury, 1 - Slight Injury, 2 – Minor Injury, 3 – Major Injury, 4 – Single Fatality,
5 – Multiple Fatalities
P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

Table 5-60: Unplanned Events Residual Risk Rankings

Aspect	Activity	Potential Impact	Residual Risk		
			C	L	RR
Blowout	Drilling	Release of uncontrolled volumes of hydrocarbons Fire Explosion	5	B	Medium
Fire or Explosion (not associated with Blowout)	Fuel Storage Flare Testing	Possible explosion or fire of drilling rig or at campsite, or fuel storage area	5	B	Medium
Hydrocarbon Chemical or Hazardous Waste/Materials Spill	Storage of chemicals, hazardous materials or waste	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people	3	C	Medium
Transportation Accidents	Transportation of equipment, personnel, granular fill, mud and cuttings, and waste	Possible injury or death to personnel; and localized contamination of environment	5	C	High
Earthquakes	Physical shifting of earths surface	Potential physical disruption cause building collapse, blowouts, fires or spills	5	B	Medium

Note: C - Consequence: 3 - Localized Impact, Major Injury, Localized Damage and Considerable Impact,
5 - Massive Impact, Multiple Fatalities, Extensive Damage, International Impact
P - Probability: A – Remote, B – Unlikely, C – Possible, D – Likely, E – Very Likely

5.15. Conclusion

All environmental issues are ranked as low and can be managed to minimize potential impacts. There is one social issue that is considered to have a medium residual risk. Water use needs for the drilling program could potentially impact community water resource supplies. While PCMI plans to drill separate water wells for its needs, this could impact nearby community water supplies, if it is from the same source. This potential issue needs to be carefully planned to ensure adequate water resources are available for the project that does not impact the local community.

One health aspect has a medium residual risk. Non-hazardous wastes and in particular liquid wastes have the potential to enhance vector borne diseases, which are already an issue in this region. A specific waste management plan needs to be prepared to ensure that all wastes are managed to international standards. Hydrogen Sulphide too, while unlikely is a potentially serious issue that requires monitoring equipment to be installed and tested, as well as having personnel trained on use of emergency response equipment.

Unplanned Events classified as having a medium residual risk include blowouts, fire or explosions, transportation accidents and earthquakes. With respect to transportation accidents, the potential for accident related fatalities exists and specific management procedures and training need to be implemented. Drug testing too is recommended, as this is a known issue in the region.

To mitigate the potential for a blowout, a BOP needs to be installed and tested. Drilling procedures need to be carefully implemented. The risk of fire and related explosions requires that regular monitoring and inspection measures are in place, as well as fire extinguishers strategically placed to minimize any damage should a fire occur.

This region has had earthquakes in the past and design considerations need to be taken to minimize the impact of an earthquake should it occur. Site specific emergency response procedures for all unplanned events need to be in place and training conducted for all staff as appropriate prior to the start of the exploration drilling program.

Recommendations:

The following recommendations are provided:

- Conduct proposed site assessment following proposed site evaluation guidelines once specific drilling targets are identified.
- Conduct recommended environmental and socio economic baseline program for site specific location, as appropriate.
- Implement recommended stakeholder engagement program at least one month before site construction.
- Prepare a site specific waste management plan.
- Prepare a site specific emergency response plan.
- Conduct recommended training program prior to project initiation.
- Evaluate water resource potential to ensure it does not impact local community.
- Identify, clean-up and restore any legacy well sites located within the block.
- Adopt and implement the EMP provided in **Chapter 6**.

CHAPTER 6

ENVIRONMENTAL, SOCIAL AND HEALTH MANAGEMENT PLAN (ESHMP)

6 ENVIRONMENTAL, SOCIAL AND HEALTH MANAGEMENT PLAN (ESHMP)

6.1 Introduction

This environmental, social and health management plan has been developed to prevent, minimize and monitor potential environmental, social and health impacts associated with PCMI’s planned seismic and exploration drilling program.

For each project activity, management measures have been defined to prevent and/or reduce the likelihood or magnitude of impacts and/or to limit the extent of an impact if one does occur. The proposed management measures will take into account applicable policies, guidelines, regulations, industry best practices, expert judgement, design techniques, and operational control. Monitoring measures too have been defined to determine if there are changes to the environment and to ensure that mitigation measures are effective.

The following hierarchy of control will be used to identify appropriate management measures:

- Eliminate the risk by removing the hazard.
- Substitute of a hazard with a less hazardous one.
- Prevention of potential events.
- Control the magnitude of an impact.
- Mitigation of the impact of an event on the environment e.g. (bunding for potential hydrocarbon spills).
- Monitoring environmental change and mitigation effectiveness.
- Emergency response and contingency planning to enable recovery from the impact of an event.
- Public consultation and disclosure.

6.2 Project Description

Myanmar’s Ministry of Energy has announced and awarded onshore Block IOR-5 to PETRONAS Carigali Myanmar Inc. (‘PCMI’) to explore, appraise, and develop the oil/gas fields within the blocks.

The IOR 5 Production Sharing Contracts (PSCs) has PSC commitments of a total of 217 sq km new 3D Land seismic data acquisition and drilling of 2 exploration wells within the stipulated 3 years exploration period.

The seismic survey is the first step in the oil and gas exploration and development cycle. Seismic exploration programs are needed to obtain high-resolution images of subsurface layers of the earth, providing detailed information on subsurface structures and formations. Energy sources and receivers are arranged along carefully surveyed lines of various lengths, widths, orientation and spacing, directly above geological formation of interest. Energy is directed into the ground and return waves are captured by geophones. The data is recorded and processed, producing images that can be interpreted to assess the potential of the resource.

These seismic activities are using two-dimensional (3D) seismic program. A 3D seismic program requires several lines with the energy source and receivers on the same line. The energy sources used for land-based seismic programs will use explosives. When explosives are used, shot holes, typically 8 – 10 cm in diameter and 6 – 30 m deep, are drilled and the holes are loaded with a charge that varies in size according to the depth of the target.

Seismic programs require the use of land to place and transport the energy sources and receivers. In forested areas, access can require clearing lines, whereas above the tree line, access is usually directly across the area. Due to the remote location of most programs and limited road access, a base camp or fly camp will be required to support operational crews.

PCMI's seismic program in Block IOR-5 includes the following activities:

1. Pre-Planning and Land Permitting
2. Seismic Line Surveying
3. Seismic Line Clearance
4. Base camp/ Fly camp Construction
5. Seismic Team Mobilization
6. Up hole / Shot hole Drilling and Loading
7. Data Acquisition
8. Clean up and Site Restoration

Based on the results of the seismic program, PCMI will then plan to drill 2 wells in each block. PCMI's exploration drilling program in Block IOR-5 includes the following activities:

1. Construction and Installation
2. Exploration Drilling
3. Well Testing (If any)
4. Shut-in Well, Well Abandonment, and Site Recovery

IOR-5 lies within Htantabin Area of Ayeyarwady Region. The total area of this block is 78 sq. mile or 202 sq. km.

6.3 Project's Environmental and Social Policies, Legal Requirements and Institutional Arrangements

6.3.1 Environmental Management of PCMI

PCMI is committed to ensuring that its business operates in an environmentally responsible manner. The company recognises that it can have its PSC revoked by the Minister, if MOGE considers that it is not conducting operations in a safe and environmentally responsible manner consistent with established industry best practices. For the construction and exploration drilling program, PCMI will adopt the following environmental guidelines:

Ensure compliance with all relevant Corporate and Myanmar government policies and regulations:

- Maintain manifests for all wastes (solids, liquids) and continue to identify methods to reduce such wastes where practicable;
- Ensure emissions result in air quality meeting International Environmental Conventions/Protocols/Agreement for Ambient Air Quality standards;
- Minimize particulate emissions to prevent harm to people and the environment;
- Account for all industrial and domestic waste and dispose of these wastes in an environmentally appropriate manner;
- Prevent spills and loss of potential contaminants to soil, groundwater and streams;
- Restore the environment impacted by the Company to a condition appropriate to its use or remediation "in-kind";
- Define recovery procedures for all potential incident scenarios;
- Ensure efficient energy use and conservation;
- Where possible, provide local employment, training and skill upgrading to the local workforce;
- Ensure all contractors and subcontractors adhere to HSE policy guidelines and procedures; and
- Maintain up-to-date management and monitoring objectives.

6.3.2 Environmental Management of Contractors

Contractors will be required to provide specific procedures to meet the criteria described in this report. Procedures will be required to cover the following areas:

- Health and Hygiene;
- HSE Training, Drills and Exercises;
- Reporting of Occupational Accident / Incident and Unsafe Act and/or Conditions;
- HSE Reviews and Audits;
- Hazardous Materials Handling and Personal Protective Equipment (PPE);
- Emergency Procedures and Contingency Plans;
- Worker Codes of Conduct; and
- Transportation Policies and Procedures.

6.3.3 Roles and Responsibilities

6.3.3.1 Responsibilities for Managing Environmental Issues

For the effective implementation of PCMI HSE Management System, the HSE roles, responsibilities and accountabilities of managers are outlined below with the onsite roles and responsibilities shown in **Table 6-1**.

Heads – Operations

(1) Heads shall have the responsibility and accountability for the implementation of HSE Management System within Myanmar operation.

(2) They are responsible and accountable for the provision of adequate resources, including competent personnel, to implement the arrangements specified in the HSE Management System within Myanmar operation.

(3) In the execution of HSE-critical activities, they are responsible and accountable for the conduct of the required HSE risk assessment, including the identification and implementation of HSE controls, such that harm to people, environment, asset and reputation are eliminated and/or minimised.

(4) They are responsible and accountable for ensuring the technical and operational integrity of facilities and equipment that PCMI design, procure, fabricate, install, acquire, operate and maintain; including facilities and equipment used by Contractors engaged in work for the Company.

(5) They, in turn, delegate the responsibility for the implementation of the HSE Management System in their respective Myanmar operation, including agreed HSE objectives, plans and targets to the respective Senior Managers/Managers within Myanmar Operation.

(6) In addition, the Heads - Operations shall also meet the HSE roles, responsibilities and accountabilities as specified in their respective Position Description.

Senior Managers – Exploration Project and Development Project

(1) Heads (Myanmar Operation)/Senior Managers shall have the responsibility and accountability for the implementation of HSE Management System within Myanmar operation.

(2) They are responsible and accountable for the provision of adequate resources, including competent personnel, to implement the arrangements specified in the HSE Management System within Myanmar operation.

(3) In the execution of HSE-critical activities, they are responsible and accountable for the conduct of the required HSE risk assessment, including the identification and implementation of HSE controls, such that harm to people, environment, asset and reputation are eliminated and/or minimised.

(4) They are responsible and accountable for ensuring the technical and operational integrity of facilities and equipment that PCMI design, procure, fabricate, install, acquire, operate and maintain; including facilities and equipment used by Contractors engaged in work for the Company.

(5) They, in turn, delegate the responsibility for the implementation of the HSE Management System in their respective Country and/or Department, including agreed HSE objectives, plan and targets to the respective Senior Managers/Managers within Myanmar operation.

(6) In addition, the Senior Managers – Exploration Project and Development Project shall also meet the HSE roles, responsibilities and accountabilities as specified in their respective Position Description.

Senior Managers/Managers – Human Resource, Supply Chain, Finance, and Other Support Functions

(1) Senior Managers/Managers shall have the responsibility and accountability for the implementation of HSE Management System within Myanmar operation.

(2) They are responsible and accountable for the provision of adequate resources, including competent personnel, to implement the arrangements specified in the HSE Management System within Myanmar operation.

(3) They, in turn, delegate the responsibility for the implementation of the HSE Management System in their respective Myanmar operation, including agreed HSE objectives, plans and targets to the respective Senior Managers/Managers within Myanmar operation.

(4) They are responsible for providing advice on the respective functional areas (e.g. competency, legal compliance, procurement, finance, etc.) to support the effective implementation of the HSE Management System throughout PCMI operations.

(5) In addition, the Senior Managers/Managers – Human Resource, Supply Chain, Finance, and Other Support Functions shall also meet the HSE roles, responsibilities and accountabilities as specified in their respective Position Description.

Senior Managers/Managers – Production, Maintenance, Petroleum Engineering and Reliability Engineering

(1) Senior Managers/Managers shall have the responsibility and accountability for the implementation of HSE Management System within their respective operational areas.

(2) They are responsible and accountable for the provision of adequate resources, including competent personnel, to implement the arrangements specified in the HSE Management System within their respective operational areas.

(3) In the execution of HSE-critical activities, they are responsible and accountable for the conduct of the required HSE risk assessment, including the identification and implementation of HSE controls, such that harm to people, environment, asset and reputation are eliminated and/or minimised.

(4) They are responsible and accountable for ensuring the technical and operational integrity of facilities and equipment within the respective operational areas, through reliability analysis and execution of required maintenance activities.

(5) They, in turn, delegate the responsibility for the implementation of the HSE Management System in their respective operational areas, including agreed HSE objectives, plans and targets to the respective Senior Managers/Managers within their respective operational areas.

(6) In addition, the Senior Managers/Managers – Production, Maintenance, Petroleum Engineering and Reliability Engineering shall also meet the HSE roles, responsibilities and accountabilities as specified in their respective Position Description.

Company Site Representative

(1) Onshore Company Site Representative shall have the responsibility and accountability for the implementation of HSE Management System, including the associated procedures and guidelines, within their respective facility/worksite.

(2) They are responsible for ensuring that employees and Contractors personnel under their supervision are fully competent to carry out tasks allocated to them, including emergency response preparedness capabilities.

(3) In the execution of HSE-critical activities, they are responsible and accountable for the conduct of the required HSE risk assessment, including the identification and implementation

of HSE controls, such that harm to people, environment, asset and reputation are eliminated and/or minimised.

(4) They are responsible and accountable for ensuring the technical and operational integrity of facilities and equipment within the respective facility/worksite, through execution of required maintenance activities.

(5) They, in turn, delegate the responsibility for the implementation of the HSE Management System in their respective facility/worksite, including agreed HSE objectives, plan and target to the respective Supervisors and/or Team Leaders within the facility/worksite.

(6) In addition, the Onshore Company Site Representatives shall also meet the HSE roles, responsibilities and accountabilities as specified in their respective Position Description.

Manager, Health, Safety and Environment (HSE)

(1) Manager HSE shall have the responsibility and accountability in driving the implementation of HSE Management System within his respective facility/area of responsibility.

(2) They are responsible and accountable for providing the required advice on HSE, towards attaining full compliance to the requirement of the HSE Management System within their respective facility/area of responsibility.

(3) They are responsible for engagement/contact on HSE matters with regulatory authorities and industry associations within their respective facility/area of responsibility.

(4) They are responsible for maintaining an HSE assurance program, including for Contractors, to support the effective implementation of the HSE Management System within facility/area of responsibility.

(5) They are responsible for maintaining an effective crisis management and emergency response capabilities within facility/area of responsibility.

(6) In addition, the Senior Managers/Managers, Health, Safety and Environment (HSE) shall also meet the HSE roles, responsibilities and accountabilities as specified in their respective Position Description.

HSE Liaison/Focal Person

(1) HSE Liaison/Focal Person is an employee in line departments appointed to coordinate HSE matters for their respective Department. The appointment of HSE Liaison/Focal Person shall be made in writing by the respective Head (Myanmar Operation)/Senior Manager.

(2) HSE Liaison/Focal Person should be responsible for the followings:

    (a). Disseminating HSE information within the respective Department:
    (b). Coordinating the provision of HSE advice to Department;
    (c). Tracking to closure the implementation of HSE Recommended Action Items (HSERAI) for the Department;
    (d). Tracking the implementation of HSE trainings for the Department;
    (e). Compiling and submitting HSE performance reports (e.g. incident report, man-hours); and
    (f). Coordinating and/or conducting HSE briefing to new staff and transferees within the Department.

Daily Site Operations Meeting

The Person-in-Charge of all facility/worksite shall conduct daily site operations meeting to discuss daily planned activities, as well as sharing of HSE-related information, e.g. incidents, unsafe acts and unsafe conditions, lesson learnt, etc. Emphasis shall be given to potential impact of hazardous activities, including concurrent activities, such that harm to people, environment, asset and reputation are eliminated and/or minimised.

Toolbox Meetings

Supervisors shall conduct daily toolbox meeting involving all personnel, both Company and Contractors, covering planned topics, amongst others, the followings:

(1) Daily work programme including changes in work activities;

(2) Reminders on hazard as well as control measures associated with the work activities; and

(3) Incident reports and lesson learnt.

Table 6-1:Onsite Roles and Responsibilities

Position	Role	Responsibilities	Specific Tasks
Seismic/Drilling Site Manager	Management commitment	Promote commitment to HSE and Waste Management Procedure (WMP) among all staff and contractors	• Ensure HSE and WMP is on Management agenda and discussed where appropriate at weekly Operations meeting Guidance for efficient disposal
Third Party Consultant	Auditing	Ensure HSE and WMP is implemented property	• Conduct HSE and WMP auditing as part of ESHMP
HSE Focal (Safety Officer)	Responsibility for HSE Monitoring and Reporting	• Ensure HSE and WMP is implemented property • Oversee implementation of HSE and WMP • HSE and WMP Education	• Educating on site staffs, visitor and contractors. • Track waste being disposed • Arrange for disposal and prepare datasheet. • Ensure that segregated waste is disposed of as described in this manual. • Audit waste disposal facilities every 6 months • Identify waste in terms of categories • Update the nature and quantity of waste disposal data. • Finding ways to get more storage space and to utilize recycle methods • Report monthly as part ESHMP
Seismic/Drilling Safety Officer	Monitoring and Reporting	• Oil/ diesel waste • Chemical waste • Scheduled waste	• Making sure that all chemicals come to the site with correct MSDS. • Making sure that all expired chemicals and unidentified chemicals are not in the site. • Report monthly as part of ESHMP
Seismic/Drilling Medical Officer	Monitoring and Reporting	Medical waste	• Track waste being disposed • Arrange for disposal • The safe disposal of sanitary products • Inspect disposal facilities every 6 months • Report monthly as part of ESHMP

Position	Role	Responsibilities	Specific Tasks
Seismic/Drilling Supervisor	Supervision & Control	Non-hazardous waste Waste to be buried in landfill	• Keep clean camp and disposing site. • Fixing time for emptying or rubbish bins and collection of disposed materials. • Record all non-hazardous waste before dispose. • Safe disposal of waste at approved disposal site. • No buring at site. • Report monthly as part of ESHMP
Seismic/Drilling Material & Logistics Coordinator	Monitoring and Reporting	Identifying and tracking	• Completion of required transfer notes/ waste manifest/ waste consignment notes. • Keeping accurate records of skip contents for the cargo. • Safe packing and transportation of hazardous waste when required. • Ensuring items sent from site/ Yangon is correct and liaison with relevant parties in the event of unidentified items. • Making sure that all chemicals come to the site with correct MSDS.
Catering Camp Boss	Contractor	Follow HSE and WMP for site related works	• Keep clean camp and disposing site. • Record canteen waste and remove all kitchen waste daily from site. • Report weekly as part of EMS
Representative	Contractor	Follow HSE and WMP for site related works	• Ensure that all received items are correct as mentioned in the cargo manifest. • Keep all cargo manifests as record for auditor. • Ensuring that follow the instruction in waste disposing.
Representative	Recycle/ Re-User (third party)	Follow HSE and WMP for related works	• Ensure that all received items are correct as mentioned in the cargo manifest. • Keep all cargo manifests (copy) as record for auditor. • Ensuring that follow the instruction in waste recycling/ reusing

6.3.4 Training Requirements

The following training is required for this project.

HSE Induction

All new employees and transferees, including Contractors, shall be given a formal induction of the facility/worksite, including familiarisation with emergency procedures.

Pre-Mobilisation The key HSE requirements and/or deliverables during the pre-mobilisation phase shall include, amongst others, the followings:

Training and review of standard Work Procedures/Work Instructions, incorporating the identified HSE controls will be conducted prior to project start up.

A training program for HSE requirements and/or deliverables during this phase (e.g. HSE Plan, HSE Training, Emergency Response Plan, etc.) shall be implemented accordingly, as specified in the contract.

Mobilisation A seminar will be provided to review all HSE requirements and/or deliverables during the mobilisation phase shall include, amongst others, the followings:

(1) Communication of HSE Plan, including HSE Key Performance Indicators and Target;
(2) Verification of personnel competencies, including HSE training; and
(3) Personnel screening for drug and alcohol, in accordance with PETRONAS Carigali Drug and Alcohol Policy.

Additionally, as part of the mobilization, an audit should be carried out to verify conformance to HSE requirements as specified in the contract.

Training shall be conducted to ensure personnel are aware of the existence of procedures and work instructions, understand their applicability and are competent to apply their requirements.

6.3.5 Standards and Regulations

HSE Legislation, International Convention and Protocol

All relevant HSE legislations and applicable international conventions and protocols shall be fully complied with throughout PCMI operations. Where PCMI HSE standards are more stringent, the requirement of the Company HSE standards shall apply.

Line management shall ensure that HSE Legal Register, incorporating all relevant provisions, shall be developed and maintained for PCMI's Facilities and/or Work Locations, including offices.

For Contractors' facilities, full compliance to legislative requirements shall be demonstrated, either through HSE Legal Register or equivalent.

The HSE Legal Register shall indicate the status of compliance, including detailed information on compliance, for all applicable provisions. For cases of non-compliance, if any, detail information of the non-compliance as well as proposed action plans to ultimately attain compliance, shall also be documented accordingly.

Verifications

Compliance to the above expectations may be demonstrated by the following documentations:

(1) Availability and comprehensiveness of HSE Legal Register, or equivalent (for Contractors);
(2) Records of work practices conform to legal requirements;
(3) Relevant HSE monitoring reports/records e.g. records on Noise Monitoring programme, equipment certificate, Environmental Monitoring Reports, etc.; and
(4) Minutes of HSE Committee Meeting.

6.4 Summary of Environmental, Social and Health Impacts and Mitigation Measures

During the environmental impact assessment, a number of potentially significant impacts were identified. In some cases, even though the impacts were of low significance, mitigation measures were provided as part of PCMI's environmental management guidelines. This section outlines the mitigation measures that are to be employed to reduce the likelihood of impacts and/or to limit the extent of impact if one does occur. In addition, environmental monitoring measures will be undertaken to assess whether the mitigation measures are effective and if performance meets EIA commitments; these are outlined in the next section.

6.4.1 General Mitigation Measures for Project Operation

Table 6-2 shows the general mitigation measures for project operation.

Table 6-2: General Mitigation Measures for Project Operation

General Measures
1. Mitigation and monitoring measures set forth in this document must be incorporated into contractual agreements for all contractors, including: design, construction, and operation in order to obtain practical and effective execution of the project.
2. Report compliance with these mitigation and monitoring measures to MOGE in congruence with schedule.
3. Provide stakeholder relation plans to explain the project description before starting (at least 15 days prior), including schedule for construction and drilling periods, mitigation and monitoring measures for affected communities located near the project area.
4. Operator must set up a contact point to receive any complaints from the stakeholder regarding its exploration activities. Further, the Operator must provide assistance and rectify the cause of such complaints as determined appropriate, as soon as possible.
5. If impacts and/or damages result from project activities, the Operator must implement all necessary measures to mitigate these impacts and/or damages as soon as possible.
6. MOGE will investigate complaints lodged by people living in the surrounding area concerning any disturbance by project activities, or any damage of public infrastructure resulting from project operations. The Operator will inform the public within 30 days if the investigation proves that the Operator did not comply with mitigation and monitoring measures.
7. During the project period, if archaeological finds or fossils are encountered in the project area, the project team must stop all activities immediately and report the findings to the appropriate government office, e.g. Local Archeological Department, Fossil Research Center and Geological Museum within 7 days of the discovery. In addition, the project team must cooperate with the government agencies in an effort to verify the findings in the project area. If it is proven that these findings are archaeological finds or fossils, the Operator must follow the regulations strictly.
8.Should the Operator wish to make changes to the exploration activities, or change the methodology of operations, or conduct the activities significantly different from what was proposed in the EIA; details regarding the changes, along with revised mitigation and monitoring measures in accordance with such change(s) will be submitted to the MOGE for approval before commencing.
9. The Operator will start operations only when the Operator has received the necessary approval, permit or agreement from the landowner or responsible agency. Moreover, the Operator will improve or construct access roads when approved by the authorized local government agencies and/or landowner. All activities will operate under the control of MOGE.

6.4.2 Environmental, Social, and Health Impacts and Mitigation Measures

A summary of EHS impact and mitigation measures for the onshore seismic and exploration drilling project are shown in **Table 6-3 and Table 6-4.**

Table 6-3: Summary of Environmental, Social and Health Seismic Impacts and Mitigation Measures

Environmental Aspect

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Land & Habitat Disturbance	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to local topography	• Limit construction activities to camp sites and access roads only. • Restore the site to its original condition on site abandonment. • Minimize cutting along seismic lines.	2	E	Med.
		Soil Disturbance and Erosion	• Limit soil compaction only to drill sites and access roads. • Exposed site areas should be kept to a minimum during construction or re-vegetated as soon as possible. • Reduce erosion by preventing/reducing off-site sediment transport through the use of settlement ponds, silt fences and water treatment, and modifying or suspending activities during extreme rainfall and high winds. • Re-turf all cleared slope areas. • Provide effective construction site run-off control and design. • Minimize vehicle traffic along seismic line. • Minimize compaction at shot hole locations.	1	C	Low
		Disturbance to local Terrestrial Flora	• High valued habitat to be avoided where practicable in the design process. • Remove vegetation in project areas only (roads, camp site, and shot hole site). Avoid cutting Riparian trees. • Mark well sites clearly and prohibit vehicles from moving off site onto surrounding land. • Mark trees to be cut prior to constructing campsite/seismic lines to prevent the cutting of other trees. • Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to vegetation.	1	C	Low
		Disturbance to local terrestrial fauna	• Mark trees to be cut prior to constructing campsite, access road and seismic lines to prevent the cutting of other trees. • Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to wildlife. • Hunting and trapping will be specifically prohibited and violations grounds for termination of contract and dismissal. • Remove vegetation at shot hole location areas only. • Mark seismic lines and shot hole sites clearly and prohibit personnel from moving off site onto surrounding land.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
		Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration	• Avoid construction of campsite and access roads in areas that may cause obstacles to water drainage. • Construct water drainage lines (culverts) to maintain natural drainage. The required permission will be obtained from all relevant agencies.	3	C	Med.
		Localized change in water quality	• The proposed campsite and access roads will be selected to minimize areas requiring soil stabilization. • Provide drip pans and absorbents to contain any spillage. • Provide drainage and sediment traps around project area to reduce suspended particles in runoff from the well site and to contain minor oil spills. • Avoid construction of the campsite and/or access road in areas where such construction obstructs water drainage. • Prohibit workers from cleaning machines/equipment in/near a public water source. • Prohibit workers and contractors from discharging or discarding project waste, chemicals, and oil into public water sources. • Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e. paint and thinner), and oil (i.e. fuel and lubricating oil).	3	C	Med.
		Localized sediment deposition and disturbance to benthic habitats and associated biota.				
		Alteration of groundwater hydrology and quality	• Should water flow from the shothole, the hold must be plugged with suitable weight muds. • Use suitable charge and shothole depth for local geology. • Provide drip pans and absorbents to contain any spillage. • Provide drainage and sediment traps around project area to reduce suspended particles in runoff from the well site and to contain minor oil spills. • Prohibit workers from cleaning machines/equipment in/near a public water source. • Line waste pits. • Collect sewage in septic tanks. • Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil).	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Vehicle Movements	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Disturbance to traffic	• Vehicles will take direct routes where possible and avoid significant habitat areas. • Construction vehicles will follow speed limits. • Escort vehicles for wide load that have wide load signs and flashing warning lights. • Follow local transportation laws and regulations.	1	D	Low
Air Emissions	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	GHG Release contributing to climate change	• Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer. • Maintain road-going vehicles to ensure that fuel use is efficient and emissions are within acceptable limits. • Instruct drivers on the benefits of driving practices that reduce the risk of accidents, fuel consumption and dust generation. • Turn off all vehicles and equipment when not in use as well as prohibit vehicles from idling. • To maximize energy efficiency and design facilities to minimize energy use.	1	D	Low
Noise& Vibration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading	Behavioral disturbance to fauna	• Vehicles will avoid sensitive environmental areas. • Construction activities and Vehicle/equipment movements will be restricted to daylight hours. • Limit vegetation removal to a minimum. • Schedule operation of noisy construction equipment at different times. • Ensure use of mufflers on diesel/gas driven machinery. • Use low-noise equipment. • Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer. • Turn equipment off when not in use.	2	E	Med.

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
	• Data AcquisitionClean up and Site Restoration		• Use enclosures when possible to contain noise on site. • Implement transportation plan. • Materials should be lowered when practical and not dropped. • Conduct PPV testing and follow Shot Hole set back distances.			
Light	• Base camp/ Fly camp Construction	Potential impact on terrestrial fauna	• Campsite located in area distant to sensitive receptors. • Keep night lighting to a minimum, consistent with safety and security. • Direct lighting to the inside of the well sites.	1	D	Low
Liquid Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Localized change in water quality or contaminated soils from oil and grease	• Prohibit workers from cleaning machines/equipment nearby public water source. • Prohibit workers and contractors discharging or discarding project waste, chemicals, and oil into public water sources. • Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil). • Construct one lined waste pit on each well site for potentially contaminated runoff and spills, surrounded by 0.2 m high bund that will help prevent run-off into the environment. Monitor and transport waste to prevent any overflow from the waste pit. • Store fuel storage tank on concrete pad. The storage units will be surrounded by a bund wall that is able to contain 110-120% of the capacity of the tank, in case of spill. • Construct drainage system (that includes a series of oil traps) around campsite including the concrete pad for generators in order to divert any spills into the waste pit. • If treatment systems are not available or cannot meet the oil-in-water content specification, the contaminated water will be stored in suitable containers and transported for treatment and/or disposal by a certified waste oil disposal contractor.	2	B	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
		Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water	• Install 1-2 lined septic tanks on each well site for holding sewage. Grey water to be discharged to infiltration and evaporator pit away from site and community water supplies. • The personnel camp will collect and transport to an approved treatment plan.	2	D	Low
Solid Waste & Hazardous Waste	• Seismic Line Clearance • Base camp/ Fly camp Construction • Up hole / Shot hole Drilling and Loading • Clean up and Site Restoration	Contamination of air, soil groundwater and freshwater life by non-hazardous solid wastes	• Waste reduction at the source will be considered in tenders by supply and construction contractors. • A PCMI Waste Management Plan for this seismic campaign will be developed • Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site. • Non-hazardous wastes will be sent to an approved dump site. • Collect all plastic casing for the explosive left at shot holes and disposed of at appropriate disposal site.	2	D	Med.
		Attraction of fauna such as rats and birds. Nutrient enrichment of surrounding water and soils	• Food scraps and other kitchen wastes will be segregated and transferred to local government waste disposal facilities. • Cooking oils and greases from the kitchen will be collected and transported to local Township waste disposal facilities for disposal.	1	D	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
		Contamination of water and soils and injury to fauna from general hazardous waste	• Waste reduction at the source will be considered in tenders by supply and construction contractors. • A PCMI Waste Management Plan for this seismic campaign will be developed. • Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site. • Hazardous wastes will be transported for disposal at a cement kiln. • Hydrocarbons will be securely stored and use governed by safe operating procedures. • Hydrocarbon spill containment and recovery equipment will be available near hydrocarbon storage. • Procedures for response to hydrocarbon spills will be included in PCMI's ERP. • MSDS Sheets will be posted in areas where hydrocarbon is stored and with the ESH Officer. • Construct lined waste pit at each campsite for potentially contaminated runoff and spills, lined with HPDE plastic to form an impermeable barrier that will help prevent run-off into the environment. • Construct drainage system around campsite to divert any spills into the waste pit. • Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious floor (e.g. tarpaulin sheet). • Provide drip pans and absorbents to contain any spillage.	3	C	Med.

Social Aspects

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Change in Land Use	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	• Loss of agriculture potential • Project operation effects on nearby land productivity • Loss of employment for displaced workers that do not own land	• Transparent and fair compensation to land owners and users. • Consider issue of displaced workers who may lose employment and who are not land owners. • Ensure all permissions are obtained from landowners and local authorities. Provide summary to MOGE. • Notify surrounding landowners 2 weeks before on location and time of project activities. • Restoration of land to its original state within 6 months of project completion, where applicable.	0	D	Positive
Transportation	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Increase in and disruption of local traffic	• Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr on unsealed road). • Notify the local authority on the oversized load and put a escort in-front of this convoy with horn and hazard lights. • Restrict/ avoid movement of heavy equipment during rush hours. • Provide traffic signs or flags at junction of access roads and main roads. • Investigate any complaints and handle appropriately. Keep records of complaints and follow-up. • If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices. • Strictly enforce training programs to reduce transport incident cases by its contractors. • Restore any damage to roads as caused by contractor or company. • Purchase or lease land for road access to camp site. • Restrict local traffic on PCMI private access roads. • Cooperate with Military for storage and transport of explosives.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Water Supply	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Reduction of local community water supply	• Obtain local approval for drilling a ground water well. • PCMI to drill their own ground water well if needed. • Consult local community leaders before water hauling (if required). • Potable water and industrial water, if taken by tube wells or tanker from nearby reservoirs/rivers, should not affect the availability of water to locals.	3	D	Medium
Power Use	• Power for campsite	Increase or decrease of available power for local community	• Purchase and install diesel-powered generators to supply all project power related needs.			None
Water Drainage	• Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure	• Local authority and land owner/user consultation on well site and access road construction design. • Follow civil engineer's recommendation on well site and access road construction design. • Avoid construction of well sites and access roads in areas that may cause obstacles to water drainage. • Water drainage lines (culverts) will be constructed to maintain natural drainage. The required permission will be obtained from all relevant agencies.	1	C	Low
Wastewater	• Base camp/ Fly camp Construction • Clean up and Site Restoration	Increased waste disposal overloading local infrastructure	• Ensure treatment and disposal according to accepted international standard. Keep waste manifest. • Enforce "Good Housekeeping" practices. • Segregate and store waste in appropriate, secure properly labelled containers. • Dispose of waste in labelled containers for possible recycling. • No burning of waste on site. • Implement requirements for waste management and related laws. • Store hazardous waste in appropriately designed areas and safe containers that are suitable for transporting/transferring. • Always check and record the type(s) and amount of waste generated. • Provide Waste Manifest System.	1	D	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
		Potential impact to agriculture, aquaculture and fisheries	• Consider compensation in case PCMI activities result in damage to agriculture crops. • Avoid construction of the access roads and campsite in areas where this would obstruct water drainage. • Prohibit workers from cleaning machines/equipment in/near a public water source • Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources. • Fuel storage tanks to be placed on concrete pad or HDPE liner surrounded by bund wall. • Construct drainage system around concrete pad for fuel storage tanks and generator to divert any spills into waste pit. • Isolate any area(s) that might be contaminated from non-contaminated areas. Provide water drainage system around the contaminated area for collecting water into the sump pit or for treatment. • Construct oil traps along perimeter drainage ditch to prevent any spills from flowing off site. • Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to their MSDS. • Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious surfaces (i.e. on tarpaulin sheet). • Provide spill cleanup kits and training for designated rapid response teams to clean up any spills. • In the event of oil or chemical spill, implement spill response plan. • Install septic tanks for holding sewage and grey water. • Pump septic tank fluids to sewage treatment plant on a regular basis to prevent overflow.	1	D	Low
Tourism and Recreational experience	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization	Disturbance and reduction of tourism and recreational experience	• Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr on unsealed road). • Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights. • Restrict/avoid movement of heavy equipment during rush hours. • Provide traffic signs or flags at junction of access roads and main roads. • Investigate any complaints and handle appropriately. Keep records of complaints and follow-up.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
	• Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration		• If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices. • Strictly enforce training programs to reduce transport incident cases by its contractors. • Restore any damage to roads. • Purchase or lease land for road access to site and land needed for campsite. • Restrict local traffic on PCMI private access road. • When project complete, promptly (within 6 months) restore land to its original state and return to original owners.			
Employment & Income	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential increase in jobs and related income for local communities	• Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons. • Employ qualified local workers. • Purchase local supplies and services, whenever possible. • Host a pre-project local community awareness program with communities to facilitate awareness of opportunities and benefits. • Terms of contract for recruitment of manpower in these companies needs to include emphasis on hiring locals, especially for unskilled and semi-skilled workforce.	0	E	Positive
Labour In-migration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential conflict between workers from other regions and local communities	• Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons. • Employ qualified local workers. • Purchase local supplies and services, whenever possible. • Host a pre-project local community awareness program with migrant workers to facilitate sensitivity and limit interactions, where advisable, between migrant workers and local communities. • Restrict workers to within project boundaries and do not allow local interaction within the communities.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Historical, Archeological & Cultural Resources	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Loss or damage to historical and archeological sites	• Comply with establish shot hole set back distances. • Watch for artefacts during site construction and inform the Ministry of Culture before commencement of drilling. • Report to the Local Archeological Department if any archaeological evidence is discovered at the well sites or access roads. The project proponent will cease all activity until the local Archeological Department verifies and considers the evidence. Through consultation, a plan to proceed will be developed. • If artefacts are found during the construction phase, PCMI will inform the responsible local office within 7 days. • Consult with local authorities to identify culturally important festivals and plan transportation, construction and drilling activities to avoid impact. • PCMI community liaison officer to monitor possible impact/change on local cultural heritage of any nature. • Review any records for site specific location. • Conduct a visual inspection of the site by qualified personnel (e.g. experienced consultant, government archaeologist etc.). • Monitor earthwork during construction using qualified/trained inspector. • Notify Department of Archaeology, National Museum and Library, Ministry of Culture within 48 hours if significant or suspicious remains are detected. • If work is suspended implement approved plan for mitigation (e.g. documentation and salvage, develop immediately adjacent site if feasible etc).	2	C	Low

Occupational Health/Public Health

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Dust	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	• Respiratory irritation • Exacerbation of asthma	• Spray water on un-surfaced access roads of project transportation route during dry conditions at least twice a day (morning and afternoon). • Post speed limits on project access route and limit vehicle speed to 30 km/h on un-surfaced roads. • Use vehicles with dust flaps. • Cover loose dry loads.	2	D	Med.
Noise & Vibration	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Hearing impairment for workers and Annoyance for public	• Vehicles will avoid sensitive environmental areas. • Construction activities and Vehicle movements will be restricted to daylight hours. • Limit vegetation removal to a minimum. • Schedule operation of noisy construction equipment at different times. • Ensure use of mufflers on diesel/gas driven machinery. • Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer. • Implement transportation plan. • The campsite must be located a minimum of 500 m from the nearest community. • Select shot hole locations at safe distances from nearest community or sensitive receptor.	1	E	Low
Non-hazardous waste	• Seismic Line Clearance • Base camp/ Fly	• Food safety, gastroenteritis • Increase in vector-borne	• Provide septic tank for domestic sewage. • Ensure treatment and disposal according to accepted international standard. Keep waste manifest. • Enforce “Good Housekeeping” practices.	5	C	High

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
	camp Construction • Clean up and Site Restoration	diseases: malaria, typhus and dengue and others.	• Segregate non-hazardous and hazardous waste, store each type of waste in closed containers and make sure all containers are clearly labeled. • Dispose of waste in labelled containers for possible recycling. • Prohibit open burning of any waste at project site. • Implement requirements for waste management and related laws. • Store waste in appropriate and safe containers that are suitable for transporting/transferring. • Always check and record the type(s) and amount of waste generated.			
Hazardous Chemicals and Waste	• Material contaminated with oil or chemicals, • Lubricating and hydraulic oil, • Drum and containers used for chemical transportation and storage	Acute exposure such as skin and eye irritation, inhalation exposure etc.	• Segregate and store hazardous chemicals and waste in appropriate, labelled and safe containers that are suitable for transporting/transferring. Containers having hazardous waste must be kept in safe areas. • All hazardous waste will be collected in skips ready for treatment and disposal and sent directly to a cement kiln. • Provide Manifest System for transportation of hazardous waste to treatment area or disposal area. • Always check and record the type(s) and amount of hazardous waste generated. • Collect all plastic casing for the explosive left at shot holes and disposed of at appropriate disposal site.	3	C	Med.
Communicable diseases	• Base camp/ Fly camp Construction • Seismic Team Mobilization	Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.	• Implement mitigation measures for non-hazardous waste. • Clearing of overgrowth in perimeter. • Keep waste manifest. • Drainage and removal of waste from waste pit upon completion of drilling. • Health screening of workers before employment. • On-site health clinic (seismic acquisition) and referral system during all of project operations with external health agencies to ensure timely diagnosis and treatment of workers' illness and injury. • Maximize hiring of qualified local workers to reduce reliance on outside labour and increase local employment. • Do not allow workers to enter communities near the drill site. • Provide awareness to workers on preventive measures for the prevention of communicable and local diseases.	3	C	Med.

Unplanned Events

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Fire or Explosion	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible explosion of Dynamite or fire at campsite, or fuel storage area	• PCMI's HSE Integrated Management System Procedures and operational controls to prevent a fire/explosion. • PCMI's Emergency Response Plan including specific management procedures to mitigate the impacts if a fire/explosion occurs. • Install fire extinguishers, alarms and windsocks (to be audible and visible from whole site).	5	B	Medium
Chemical or Hazardous Waste/Materials Spill	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota and people	• Proper training in the use and handling of the relevant chemicals and standard safety procedures implemented by all contractors. • Appropriate medical care will be provided, clean-up will be carried out, and incident or accident reports will be filed. • PCMI's HSE Integrated Management System Procedures and operational controls will be in place to prevent spills. • PCMI's Emergency Response Plan will set out the management procedures to be put in place to mitigate the impact if a spill occurs. • Provide spill clean up kits and training for designated rapid response team to clean up any spills. • Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. • Handle all chemicals according to their MSDS. • Collect all plastic casing for the explosive left at shot holes and disposed of at appropriate disposal site.	3	C	Med.

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Transportation Accidents	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Possible injury or death to personnel; and localized contamination of environment	• HSE Integrated Management System Procedures. • Limit the speed of project vehicles, according to the road condition (on unpaved road to 30 km/h). • Maintain construction equipment and vehicles to regulatory standards. • Notify the local authority on the oversized load and put a escort in-front of this convoy with horn and hazard lights. • Restrict/ avoid movement of heavy equipment during rush hours from 07.30 to 08.30 am and 3.30 to 4.30 pm. • Provide traffic signs or flags at junction of access road and main road. • Investigate any complaints and handle appropriately. Keep records of complaints and follow-up. • Strictly enforce training programs to reduce transport and drilling incidents by its contractors. • Restore any damage to roads caused by project vehicles. • Implement emergency response training, fire training and response drills. • Install adequate fire extinguishers around the well sites. • Test safety devices weekly. • Provide PPE to workers on site. • Provide medic, First Aid kits and First Aid trained personnel at drilling site. • Restrict smoking to controlled areas. • Prohibit trespassers from entering the construction site. • Referral system with external medical facilities for serious injuries or emergencies.	5	C	High
Earthquakes	• Seismic Line Surveying • Seismic Line Clearance • Base camp/ Fly camp Construction • Seismic Team Mobilization • Up hole / Shot hole Drilling and Loading • Data Acquisition • Clean up and Site Restoration	Potential physical disruption cause building collapse, blowouts, fires or spills	• Implement PCMI's Earthquakes: Evacuation Plan and Emergency Response Plan. • Proper training and safety procedures will be the main preventative measures to reduce the potential risk. • In the unlikely event an accident should occur, the Emergency Response Plan would be implemented, which includes evacuation of personnel during severe circumstances.	5	B	Medium

Table 6-4: Summary of Environmental, Social and Health Drilling Impacts and Mitigation Measures

Environmental Aspect

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Land & Habitat Disturbance	Installation of Infrastructure Road construction	Disturbance to local topography	• Limit construction activities to well sites and access roads only. • Restore the site to its original condition on site abandonment.	2	E	Med.
	Camp site construction Well site construction Well abandonment and site restoration	Soil Disturbance and Erosion	• Limit soil compaction only to well sites and access roads • Exposed site areas should be kept to a minimum during construction and completed areas should be hard surfaced or re-vegetated as soon as possible. • Reduce erosion by preventing/reducing off-site sediment transport through the use of BMP's. • Provide effective construction site run-off control and design.	1	C	Low
		Disturbance to local Terrestrial Flora	• High valued habitat to be avoided where practicable in the design process. • Remove vegetation in project areas only (roads, camp site, and well site). Avoid cutting Riparian trees. • Mark well sites clearly and prohibit vehicles from moving off site onto surrounding land. • Mark trees to be cut prior to constructing well pads to prevent the cutting of other trees. • Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to vegetation. • Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.	1	C	Low
		Disturbance to local terrestrial fauna	• Habitat surveys to be undertaken of infrastructure locations to identify unique or sensitive habitats and biota. • Mark trees to be cut prior to constructing well site, camp site and access road to prevent the cutting of other trees. • Contractors and personnel will not be allowed off site where they could cause unnecessary disturbance to wildlife. • Hunting and trapping will be specifically prohibited and violations grounds for termination of contract and dismissal. • Remove vegetation in road areas only. • Mark well sites clearly and prohibit vehicles from moving off site onto surrounding land. • Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Land & Habitat Disturbance (Cont.)	Camp site construction Well site construction Well abandonment and site restoration (Cont.)	Alteration of surface water hydrology by reducing interception, evaporation/ transpiration and infiltration	• Avoid construction of well sites and access roads in areas that may cause obstacles to water drainage. • Construct water drainage lines (culverts) to maintain natural drainage. The required permission will be obtained from all relevant agencies. • Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.	3	C	Med.
		Localized change in water quality Localized sediment deposition and disturbance to benthic habitats and associated biota.	• The proposed drill site and campsite will be selected to minimize areas requiring soil stabilization. • Provide drip pans and absorbents to contain any spillage. • Provide drainage and sediment traps around project area to reduce suspended particles in runoff from the well site and to contain minor oil spills. • Avoid construction of the well pad and/or access road in areas where such construction obstructs water drainage. • Prohibit workers from cleaning machines/equipment in/near a public water source. • Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources. • Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil). • Site selection criteria provided in the ESHIA Management Plan will be followed to identify the most suitable drilling site.	3	C	Med.
Vehicle and Rig Movements	Vehicle Movements Rig Movement	Disturbance to traffic	• PCMI will conduct Road Hazard Assessment for the road in the boundary of IOR-5. • Vehicles will take direct routes where possible and avoid significant habitat areas. • Construction vehicles will follow speed limits. • Escort vehicles for wide load that have wide load signs and flashing warning lights. • Follow local transportation laws and regulations.	1	D	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Air Emissions	Installation of infrastructure	Deterioration of Air Quality due to dust	• Minimize emission exposure by locating the project site away from communities, shortening the construction/abandonment duration. • Minimize land clearance to a minimum especially during the drier months. • Reduce possible air emissions by using new vehicles or regular maintenance. • Limit vehicle speed (approximately a speed limit of 30 km/hr) especially on unpaved roads during dry conditions. • Cover trucks transporting materials with tarpaulins or plastic to prevent any loose material from blowing away and also to prevent dust dispersion. • Cover construction materials. • Spray water on roads twice a day to keep dust down. • Clean tires of the vehicles before leaving site if needed. • Practice correct storage and usage of covers and/or control equipment (water suppression, bag house, or cyclone) in handling of materials such as conveyors and bins to prevent nuisance dust emissions. • Re-vegetate disturbed areas as soon as practicable to limit exposed soil areas. • Provide personal protective equipment (masks and gloves) to exposed field workers. • Use vehicles with dust flaps. • Hoarding should be constructed to contain dust within the well site.	3	D	Med.
	Drilling Well Testing Flaring	Hydrogen sulphide released	• Install H_2S sensors at the flow line. • If H_2S levels exceed 10 ppm in the gas stream, implement appropriate safety zones. • All crew are instructed and rehearsed in H_2S procedures.	2	B	Low
	Power Generation for Drilling and Flaring Well Testing and Flaring	Minor deterioration of local and regional air quality due to emission of pollutants such as NOx and SOx and CO.	• Energy conservation measures will be taken into account during rig selection. • Process control to minimize flaring. • Diesel used in vessels will have low sulphur content. • Reporting of atmospheric emissions as per PCMI requirements. • Maintain scheduled maintenance program.	2	D	Med.

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Air Emissions (Cont.)	Transportation Road Construction and rehabilitation of Drill Site and Camp Site Construction Power Generation for Drilling Flaring Fugitive emissions	GHG Release contributing to climate change	• Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer. • Maintain road-going vehicles to ensure that fuel use is efficient and emissions are within acceptable limits. • Instruct drivers on the benefits of driving practices that reduce the risk of accidents, fuel consumption and dust generation. • Turn off all vehicles and equipment when not in use as well as prohibit vehicles from idling. • To maximize energy efficiency and design facilities to minimize energy use. • Operating flare to control odor and visible smoke emissions (no visible black smoke). • Locating flare at a safe distance from local communities and the workforce including workforce accommodation units. • Implementation of burner maintenance and replacement, programs to ensure continuous maximum flare efficiency. • Metering flare gas. • Keep installation and functioning of flare gas system safe according to the good engineering practice. • Ensure flare system has efficient combustion. • Maintain pilot flame at the flare tip to ensure that flame is not extinguished by strong wind • Verify the operation’s flaring system. • Minimize the duration and rate of flaring as much as possible.	1	D	Low
Noise	Road Construction Camp Site Construction Well Site Construction Rig Mobilization Drilling Well Testing and Flaring Rig demobilization Abandonment and Site Restoration	Behavioral disturbance to fauna	• Vehicles and rig transportation will avoid sensitive environmental areas. • Construction activities and Vehicle/rig movements will be restricted to daylight hours. • Limit vegetation removal to a minimum. • Schedule operation of noisy construction equipment at different times. • Ensure use of mufflers on diesel/gas driven machinery. • Use low-noise equipment. • Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer. • Implement transportation plan. • Materials should be lowered when practical and not dropped.	2	E	Med.

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Artificial Light	Functional lighting on vehicles and drill rig, camp site and	Potential impact on terrestrial fauna	• Drill Rig located in area distant to sensitive receptors. • Keep night lighting to a minimum, consistent with safety and security. • Direct lighting to the inside of the well sites.	1	D	Low
	well site Flaring	Potential impact on terrestrial flora	• Drill Rig located in area distant to sensitive receptors. • Keep night lighting to a minimum, consistent with safety and security. • Direct lighting to the inside of the well sites.	1	C	Low
Heat	Flaring	Potential impact on local fauna	• Clear vegetation around the flare stack. • Minimize flare rate and duration. • Post constant fire watch during flaring operations. • Maintain safety distance between flare stack and well site facilities and adjacent crops.	1	D	Low
Liquid Waste	Drill site drainage	Localized change in water quality or contaminated soils from oil and grease	• Prohibit workers from cleaning machines/equipment nearby public water source. • Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources. • Provide a suitable storage area for construction materials (such as soil, sand, and stone), chemicals (i.e., paint and thinner), and oil (i.e., fuel and lubricating oil). • Construct one lined waste pit on each well site for potentially contaminated runoff and spills (4,800 m3 each), surrounded by 0.2 m high bund that will help prevent run-off into the environment. Monitor and transport waste to prevent any overflow from waste pit. • Store fuel storage tank on concrete rig pad. The storage units will be surrounded by a bund wall that is able to contain 110-120% of the capacity of the tank, in case of spill. • Construct drainage system (that includes a series of oil traps) around well site including the concrete rig pad, mud tanks and pumps, cement units, generators and solid control equipment on each well site to divert any spills into the waste pit. • Contaminated drainage from site, machinery spaces or bunded areas will be contained and treated prior to discharge. • If treatment systems are not available or cannot meet the oil-in-water content specification, the contaminated water will be stored in suitable containers and transported for treatment and/or disposal by a certified waste oil disposal contractor. • Extracted hydrocarbons from oil-in water separator systems will be stored in suitable containers and transported for treatment and/or disposal by a certified waste oil disposal contractor in consultation with MOGE.	2	B	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Liquid Waste (Cont.)	Sewage and sludge	Localized nutrient enrichment and pollution of surrounding soil, surface water and ground water	• Install 1-2 lined septic tanks on each well site for holding sewage. Grey water to be discharged to infiltration and evaporator pit away from site and away from community water supplies. • Drill site and personnel camp will collect and transport to an approved treatment plant.	2	D	Low
	Infiltration from the cuttings and dirty water waste pit	Deterioration of shallow Groundwater	• Install an impervious HDPE liner in the cuttings and dirty water waste pit. Monitor liner for tears or leaks during installation and operations.	3	B	Low
Solid Waste	Non-hazardous solid waste	Contamination of water and soils and injury to fauna	• Tenders for supply and construction contractors will require waste reduction at the source. • A PCMI Waste Management Plan for this drilling campaign will be developed. • Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site. • Non-hazardous wastes will be taken to an approved hazardous waste site.	2	D	Med.
	Food and kitchen waste	• Attraction of fauna such as rats and birds. • Nutrient enrichment of surrounding water and soils	• Food scraps and other kitchen wastes will be segregated and transferred to local government waste disposal facilities. • Cooking oils and greases from the kitchen will be collected and transported to local government waste disposal facilities for disposal.	1	D	Low
	Hazardous Solid Waste	Contamination of water and soils and injury to fauna	• Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS. • General non-hazardous solid wastes will be managed in accordance with accepted international standards. • Tenders for supply and construction contractors will require waste reduction at the source. • A PCMI Waste Management Plan for this drilling campaign will be developed. • Waste will be segregated at source into recyclable and non-recyclable wastes, where a net environmental benefit is likely, and stored in clearly marked containers for transport to a recycling contractor wherever practicable, or waste disposal site. • Hazardous wastes will be transported for disposal at a cement kiln.	3	C	Med.

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	P	RR
Drill Cuttings and Sludge	Disposal of drill cuttings and sludge	Localized change in water quality and soil quality from chemical composition of drill fluids	• Drill cuttings and adhered fluids will not be discharged to surrounding area. • All drilling activities will be conducted in accordance with approved Environment Management Plan. • Volume of cuttings and fluids discharged will be minimized through use of solids control equipment. • Use non-hazardous water-based mud system. Inform MOGE in case of change in mud chemicals. • Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to its MSDS. • Provide spill clean up kits and training for designated rapid response teams to clean up any spills. In the event of oil or chemical spill, implement spill response plan. Handle all chemicals according to its MSDS. • Deposit treated cuttings into 9 m^3 skips, where they are to be temporarily held before being sent to cement kiln for incineration. Keep waste manifest. • Implement transportation plan.	2	D	Med.
	Loss of circulation	Deterioration of shallow and deep Groundwater	• Case sections of the well with steel tubing. • Cement steel casing in place.	3	B	Med.

Social Aspects

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Change in Land Use	Purchase of land for access roads, drill and camp site	• Loss of agriculture potential • Project operation effects on nearby land productivity • Loss of employment for displaced workers that do not own land	• Transparent and fair compensation to land owners and users. • Compensation program to specifically address issue of displaced workers who may lose employment and who are not land owners. • Ensure all permissions are obtained from landowners and local authorities. Provide summary to MOGE. • Notify surrounding landowners 2 weeks before on location and time of project activities. • Restoration of land to its original state within 6 months of project completion.	0	D	Positive
Traffic	Transportation of equipment, people and services	Increase in and disruption of local traffic	• Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr. on unsealed road). • Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights. • Restrict/ avoid movement of heavy equipment during rush hours. • Provide traffic signs or flags at junction of access roads and main roads. • Investigate any complaints and handle appropriately. Keep records of complaints and follow-up. • If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices. • Strictly enforce training programs to reduce transport incident cases by its contractors. • Restore any damage to roads. • Purchase or lease land for road access to site and land needed for drill site and camp. • Restrict local traffic on PCMI private access road. • Ensure all vehicles are left hand drive as feasible.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Water Use	Water for construction exploration drilling and domestic use	Reduction of local community water supply	• Obtain local approval for drilling a ground water well. • PCMI to drill their own ground water well. • Consult local community leaders before water hauling (if required). • Potable water and industrial water, if taken by tube wells or tanker from nearby reservoirs/rivers, should not affect the availability of water to locals.	3	D	Medium
Power Use	Power for drilling operations and work camp	Increase or decrease of available power for local community	• Purchase and install diesel-powered generators to supply all project power related needs.			None
Water Drainage	Surface runoff from roads and camp site	Increased drainage potentially affecting roads and infrastructure	• Local authority and land owner/user consultation on well site and access road construction design. • Follow civil engineer's recommendation on well site and access road construction design. • Avoid construction of well sites and access roads in areas that may cause obstacles to water drainage. • Water drainage lines (culverts) will be constructed to maintain natural drainage. The required permission will be obtained from all relevant agencies.	1	C	Low
Wastewater	Project operation effects on water quality	Potential impact to agriculture, aquaculture and fisheries	• Avoid construction of the well pads and/or access roads in areas where this would obstruct water drainage. • Prohibit workers from cleaning machines/equipment in/near a public water source. • Prohibit workers and contractors discharging or discarding project waste, chemicals, oil into public water sources. • Use non-hazardous water-based mud and synthetic based mud system. Inform MOGE in case of change in mud chemicals or type of mud. • Fuel storage tanks to be placed on concrete pad surrounded by bund wall. • Construct drainage system around concrete rig pad and mud tanks to divert any spills into waste pit. • Monitor level of cuttings and dirty water in waste pit. • Isolate any area(s) that might be contaminated from non-contaminated areas. Provide water drainage system around the contaminated area for collecting water into the sump pit or for treatment. • Construct oil traps along perimeter drainage ditch to prevent any spills from flowing off site. • Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to their MSDS.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
			• Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious surfaces (i.e. on tarpaulin sheet). • Provide spill cleanup kits and training for designated rapid response teams to clean up any spills. • In the event of oil or chemical spill, implement spill response plan. • Install septic tanks for holding sewage and grey water. • Pump septic tank fluids and transport to approved sewage treatment plant on a regular basis to prevent overflow.			
Waste Disposal	Disposal of waste in project area	Increased waste disposal overloading local infrastructure	• Provide septic tank for sewage. • Ensure treatment and disposal according to accepted international standard. Keep waste manifest. • Enforce “Good Housekeeping” practices. • Segregate and store waste in appropriate, secure properly labeled containers. • Dispose of waste in labeled containers for possible recycling. • Implement requirements for waste management and related laws. • Store hazardous waste in appropriately designed areas and safe containers that are suitable for transporting/transferring. • Always check and record the type(s) and amount of waste generated. • Provide Waste Manifest System.	1	D	Low
Tourism and Recreational experience	Project construction and operation effects on tourism and recreation	Disturbance and reduction of tourism and recreational experience	• Post and enforce speed limit (follow traffic law on highway and community area, 30km/hr. on unsealed road). • Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights. • Restrict/ avoid movement of heavy equipment during rush hours. • Provide traffic signs or flags at junction of access roads and main roads. • Investigate any complaints and handle appropriately. Keep records of complaints and follow-up. • If the project needs to construct, upgrade or reroute access roads, the Operator must get permission from the appropriate government offices. • Strictly enforce training programs to reduce transport incident cases by its contractors. • Restore any damage to roads if caused by contractor or company. • Purchase or lease land for road access to site and land needed for drill site and camp.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
			• Restrict local traffic on PCMI private access road. • When project complete, promptly (within 6 months) restore land to its original state and return to original owners.			
Employment & Income	Employment & income for nearby communities	Potential increase in jobs and related income for local communities	• Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons. • Employ qualified local workers. • Purchase local supplies and services, whenever possible. • Host a pre-project local community awareness program with communities to facilitate awareness of opportunities and benefits. • Terms of contract for recruitment of manpower in these companies needs to include emphasis on hiring locals, especially for unskilled and semi-skilled workforce.	0	E	Positive
Labour In-migration	In-migration of labour and social interaction	Potential conflict between workers from other regions and local communities	• Meet with local authorities to discuss and design local employment hiring to limit impacts on local businesses and key agricultural seasons. • Employ qualified local workers. • Purchase local supplies and services, whenever possible. • Host a pre-project local community awareness program with migrant workers to facilitate sensitivity and limit interactions, where advisable, between migrant workers and local communities. • Restrict workers to within project boundaries and do not allow local interaction within the communities.	1	C	Low

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Historical, Archeological & Cultural Resources	Project construction potentially destroying historical and archaeological sites	Loss or damage to historical and archeological sites	• Watch for artifacts during site construction and inform the Ministry of Culture before commencement of drilling. • Report to the Local Archeological Department if any archaeological evidence is discovered at the well sites or access roads. Through consultation, a plan to proceed will be developed. • If artifacts are found during the construction phase, PCMI will inform the responsible local office within 7 days. • Consult with local authorities to identify culturally important festivals and plan transportation, construction and drilling activities to avoid impact. • Review any records for site specific location. • Conduct a visual inspection of the site by qualified personnel (e.g. experienced consultant, government archaeologist etc.). • Monitor earthwork during construction using qualified/trained inspector.	2	C	Low

Occupational Health/Public Health

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Dust	• Access/upgrade roads, • Site construction, • Transportation of granular fill, workers, equipment	• Respiratory irritation • Exacerbation of asthma	• Spray water on un-surfaced access roads of project transportation route during dry conditions at least twice a day (morning and afternoon). • Post speed limits on project access route and limit vehicle speed to 30 km/h on un-surfaced roads. • Use vehicles with dust flaps. • Cover loose dry loads.	2	D	Med.
Noise	• Generator, Transportation, Construction • Drilling	Hearing impairment for workers and Annoyance for public	• Limit vegetation removal to a minimum. • Schedule operation of noisy construction equipment at different times. • Ensure use of mufflers on diesel/gas driven machinery. • Ensure all machinery and vehicles are properly maintained and serviced as per maintenance schedule recommended by manufacturer. • Provide ear plugs to drilling workers. • Select drill site locations at safe distances from nearest community (a minimum of 500 m). • Should complaints over noise be received, consideration will be given to the provision of noise barriers.	1	E	Low
Non-hazardous waste	• Waste disposal, Leaks/spills, • Standing water	• Food safety, gastroenteritis • Increase in vector-borne diseases: malaria, typhus and dengue and others.	• Provide septic tank for domestic sewage. • Ensure treatment and disposal according to accepted international standard. • Keep waste manifest. • Enforce “Good Housekeeping” practices. • Segregate non-hazardous and hazardous waste, store each type of waste in closed containers and make sure all containers are clearly labeled. • Dispose of waste in labeled containers for possible recycling. • Implement requirements for waste management and related laws. • Store hazardous waste in appropriate and safe containers that are suitable for transporting/transferring. • Always check and record the type(s) and amount of waste generated.	5	C	High
Mud Chemicals and drilling waste	• Mixing of drilling chemicals, • Leak/spill of mud chemicals	Acute exposure such as skin irritation, inhalation exposure etc.	• Treat cuttings in cuttings dryer, deposit dried cuttings in 9 m3 skips and transport skips to cement kiln to help prevent run-off into the environment. Keep waste manifest. • Use non-hazardous water-based mud system. Inform MOGE in case of change in mud chemicals.	3	B	Low

<table>
<tr><th rowspan="2">Aspect</th><th rowspan="2">Activity</th><th rowspan="2">Potential Impact</th><th rowspan="2">Prevention/Mitigation Measure</th><th colspan="3">Residual Risk</th></tr>
<tr><th>C</th><th>L</th><th>RR</th></tr>
<tr><td></td><td></td><td></td><td>• Construct drainage system around concrete rig pad, mud tanks and pumps, cement units, generators and solid control equipment on each well site to divert any spills into the waste pit.
• Store all chemicals in secured storage area with impervious (cement or plastic sheet) floor and bund wall. Handle all chemicals according to its MSDS
• Provide spill clean up kits and training for designated rapid response teams to clean up any spills.
• In the event of chemical spill, implement spill response plan.
• Deposit cuttings into 9 m3lugger boxes, where they are to be temporarily held before being sent to cement kiln for incineration. Keep waste manifest.
• Implement transportation plan.
• Cement steel casing in place.
• Implement awareness training on the hazards of the chemicals.
• Enforce use of PPE, such as dust masks or respirators, gloves, overalls, and eye glasses.
• Handle chemicals only in well ventilated and controlled areas.</td><td></td><td></td><td></td></tr>
<tr><td>Hazardous waste</td><td>• Material contaminated with oil or chemicals,
• Lubricating and hydraulic oil,
• Drum and containers used for chemical transportation and storage</td><td>Acute exposure such as skin and eye irritation, inhalation exposure etc.</td><td>• Segregate and store hazardous waste in appropriate, labeled and safe containers that are suitable for transporting/transferring. Containers having hazardous waste must be kept in safe areas.
• All hazardous waste will be collected in skips ready for treatment and disposal and sent directly to a cement kiln.
• Provide Manifest System for transportation of hazardous waste to treatment area or disposal area.
• Always check and record the type(s) and amount of hazardous waste generated.</td><td>3</td><td>C</td><td>Med.</td></tr>
<tr><td>Communicable diseases</td><td>• Migration/influx of outside workers</td><td>Increased incidence and prevalence of HIV/AIDS, hepatitis Band C, syphilis, etc.</td><td>• Implement mitigation measures for non-hazardous waste (Section 5.9.8.3)
• Clearing of overgrowth in perimeter.
• Deposit cuttings into 9 m^3 skips, where they are to be temporarily held before being sent to cement kiln for incineration.
• Keep waste manifest.
• Drainage and removal of waste from dirty water waste pit upon completion of drilling.
• Health screening of workers before employment.
• On-site health clinic (drilling operations) and referral system during all of project</td><td>3</td><td>C</td><td>Med.</td></tr>
</table>

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
			operations with external health agencies to ensure timely diagnosis and treatment of workers' illness and injury. • Maximize hiring of qualified local workers to reduce reliance on outside labour and increase local employment. • Do not allow workers to enter communities near the drill site. • Provide awareness training to workers on how to prevent communicable and local diseases.			
Light and heat	• Flaring	Heat exposure Nuisance light	• Post constant fire watch during flaring operations. • Maintain safety distance between flare stack and well site facilities and adjacent crops. • Implement PCMI's Emergency Response Plan including specific management procedures to mitigate the impacts if a fire occurs. • Install fire extinguishers, alarms and windsocks (to be audible and visible from whole site). • Heat impacts from the flare stack will be minimized by having a protected flare pit. • Maintain a safe distance from nearest sensitive receptor.	2	B	Low
Flare emissions	• Flaring	Increase in respiratory illnesses/diseases Exacerbation of asthma Disturbance psychological wellbeing	• Ensure flare system has efficient combustion. • Maintain pilot flame at the flare tip to ensure that flame is not extinguished by strong wind. • H_2S detection and safety equipment is standard issue (see **Section 2.9.3** and **Chapter 6**). PCMI's emergency response plan (ERP) includes an H_2S Contingency Plan. Furthermore, the drilling contractors will have their own H_2S Contingency Plan. • Standard mitigation measures to reduce impacts from hydrogen sulphide release during well testing will be implemented: o Install H_2S sensors at the flow line. o If H_2S levels exceed 10 ppm in the gas stream, implement appropriate safety zones. o The initial flow of hydrocarbons to surface will be timed to coincide with daylight hours. • Staff trained in H_2S procedures.	5	A	Med.

Unplanned Events

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Blowout	Drilling	• Release of uncontrolled volumes of hydrocarbons • Fire • Explosion	• Careful planning of drilling operation. • Examination of existing seismic lines and nearby wells to identify shallow gas hazards. • Drilling and Well Control Standard Operating Procedures and extensive HSE Management System procedures and operational controls in place. • Internal hazardous operations reviews and “Table Top drilling” exercises to test procedures and individual personnel performance against the drilling plan. • Select proper drill fluid formulation, provide well kill fluids/systems, loss control and weighting agents. • Very careful monitor down hole conditions and mud returns. • Use of appropriate, high quality materials in well construction (casing and cement grades). • Provide a blowout preventer (BOP) stack that is sized appropriately in proportion to the maximum formation pressure; and test as per procedures. • Provide of a high-pressure water-spray dousing system around the wellhead, solids removal chokes and flare stack. • PCMI’s Emergency Response Plan. • PCMI’s HSE Integrated Management System Procedures and operational controls will be in place to prevent a blowout/explosion.	5	B	Medium
Fire or Explosion (not associated with Blowout)	Fuel Storage Flare Testing	Possible explosion or fire of drilling rig or at campsite, or fuel storage area	• PCMI’s HSE Integrated Management System Procedures and operational controls to prevent a fire/explosion. • PCMI’s Emergency Response Plan including specific management procedures to mitigate the impacts if a fire/explosion occurs. • Install fire extinguishers, alarms and windsocks (to be audible and visible from whole site). • Pre-arranged call out support from local fire brigades.	5	B	Medium
Fuel, Chemical or Hazardous Waste/Materials Spill	Storage of Fuel, chemicals, hazardous materials or waste	Potential risk of spills to the environment affecting air quality, soil quality, surface water, groundwater, biota	• Chemicals, Hydrocarbons and hazardous materials or waste will be securely stored and use governed by safe operating procedures. • Spill containment and recovery equipment will be available near storage areas. • Procedures for response to Chemicals, Hydrocarbons and hazardous materials or waste spills will be included in PCMI’s ERP. • MSDS Sheets will be posted in areas where Chemicals, Hydrocarbons and hazardous materials or waste is stored and with the ESH Officer.	3	C	Medium

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<tr><th>C</th><th>L</th><th>RR</th></tr>
<tr><td></td><td></td><td>and people</td><td>• Construct lined waste pit at each well site for potentially contaminated runoff and spills (4,800 m³ each), lined with HPDE plastic to form an impermeable barrier that will help prevent run-off into the environment.
• Construct drainage system around well sites and concrete rig pad which mud tanks, shakers, generators and fuel tanks sit on to divert any spills into the waste pit.
• Use oil catch pans under vehicles when performing maintenance. Conduct maintenance only on impervious floor (e.g. tarpaulin sheet).
• Provide drip pans and absorbents to contain any spillage.
• Provide spill cleanup kits and training for designated rapid response teams to clean up any spills. In the event of oil or chemical spill, implement ERP.
• Prohibit workers from cleaning machines/equipment in/near a public water source.
• Prohibit workers and contractors discharging or discarding project waste, chemicals, and oil into public water sources.
• Maintain oil traps along perimeter drainage ditch to prevent any spills from flowing off site.
• Isolate any area(s) that might be contaminated from non-contaminated areas. The ground of areas where possible contamination occurs will be covered with plastic sheet.
• Store Chemicals, Hydrocarbons and hazardous materials or waste storage tanks on concrete rig pad. The storage unit will be surrounded by a bund wall that is able to contain 110-120% of the capacity of the tanking case of spill.
• Transport produced emulsion-condensate to a licensed wastewater treatment facility using dedicated tanker trucks.
• PCMI's Emergency Response Plan will set out the management procedures to be put in place to mitigate the impact if a spill occurs.
• The use of chemicals will be avoided through appropriate design where practicable.
• During the procurement process, chemicals will be evaluated for environmental, safety, technical, and commercial performance. As far as practicable, least hazardous chemicals will be selected.
• Procedures for response to chemical spills will be included in PCMI's ERP.
• Use non-hazardous water-based mud system. Inform MOGE in case of change in mud chemicals.
• Deposit treated cuttings into 8 m³ skips, where they are to be temporarily held before being sent to cement kilns for incineration. Keep waste manifest.
• Implement transportation plan.</td><td></td><td></td><td></td></tr>
</table>

Aspect	Activity	Potential Impact	Prevention/Mitigation Measure	Residual Risk		
				C	L	RR
Transportation Accidents	Transportation of equipment, personnel, granular fill, mud and cuttings, and waste	Possible injury or death to personnel; and localized contamination of environment	• HSE Integrated Management System Procedures. • Limit the speed of project vehicles, according to the road condition (on unpaved road to 30 km/h). • Maintain construction equipment and vehicles to regulatory standards. • Notify the local authority on the oversized load and put an escort in-front of this convoy with horn and hazard lights. • Consult with community leaders on plan and transportation route before movement of large equipment. • Restrict/ avoid movement of heavy equipment during rush hours from 07.30 to 08.30 am and 3.30 to 4.30 pm. • Provide traffic signs or flags at junction of access road and main road. • Investigate any complaints and handle appropriately. Keep records of complaints and follow-up. • Strictly enforce training programs to reduce transport and drilling incidents by its contractors. • Restore any damage to roads caused by project vehicles. • Implement emergency response training, fire training and response drills. • Install adequate fire extinguishers around the well sites. • Test safety devices as determined appropriate. • Provide PPE to workers on site • Provide medic, First Aid kits and First Aid trained personnel at drilling site. • Restrict smoking to controlled areas. • Prohibit trespassers from entering the construction site. • Referral system with external medical facilities for serious injuries or emergencies.	5	C	High
Earthquakes	Physical shifting of earths surface	Potential physical disruption cause building collapse, blowouts, fires or spills	• Implement PCMI's Earthquakes: Evacuation Plan and Emergency Response Plan. • Proper training and safety procedures will be the main preventative measures to reduce the potential risk. • In the unlikely event an accident should occur, the Emergency Response Plan would be implemented, which includes evacuation of personnel during severe circumstances.	5	B	Medium

6.5 Management and Monitoring Plans

Environmental monitoring measures the key parameters that may be significantly impacted by the proposed project. Monitoring will provide:

(1) Data on waste-stream emissions to ensure an ongoing assessment of operating standards and to measure performance against established requirements (objectives, targets, and performance criteria)

(2) Data on the environment to measure changes from the original environmental conditions.

Monitoring therefore includes ambient monitoring of the environment and monitoring of discharges, as outlined below.

An independent third party real time monitor, who will be in the field for the duration of project activities, will audit compliance with guidelines and mitigation measures. Monitoring measures for the seismic, construction, drilling, and abandonment are outlined in **Table 6-5** and **Table 6-6**.

6.5.1 Ambient Monitoring

The baseline survey reported in this EIA provided information on the relevant chemical, biological and social environment before start-up of operations. Follow-up monitoring will be done to determine any possible changes as a result of the proposed PCMI Exploration Drilling Project.

6.5.1.1 Air Quality Monitoring

Air quality monitoring will be conducted once during construction and drilling phase. If communities are located in close proximity to drilling sites, regular monitoring (instead of once) of air emissions may be necessary during drilling and construction. In addition, if complaints are received, an additional air quality monitoring may be conducted in response to specific complaints. Air quality monitoring will be conducted at the same location previously measured during the baseline survey (**Figure 3-4**) and/or at the location of the complaint. The monitoring shall be conducted as defined by the Myanmar standards and or international guidelines. The parameters measured will be NOx, SOx, CO, TSP, PM10 and other parameters as specified and agreed by the COMPANY.

6.5.1.2 Noise Monitoring

Noise will be measured once during seismic and once during drilling phase to monitor noise level generated from drilling activities. If communities are located in close proximity to drilling sites, regular monitoring (instead of once) of noise may be necessary during drilling and construction. In addition, if complaints are received, an additional noise measurement may be conducted in response to specific complaints. Noise levels (24 hour Leq) will be monitored at the same location previously measured during the baseline survey (**Figure 3-4**) and/or at the location of the complaint. If monitoring indicates noise levels over the WHO standards (70 dB (A)) at the receptor as a result of drilling, specific mitigation measures will be implemented. The noise levels will be measured as defined by the Myanmar or international standards.

6.5.1.3 Vibration

To determine safety distances, vibration will be tested in advance or at the first seismic shooting location to measure the PPV.

Peak particle velocity (*V*) is a measure of the maximum rate of displacement of ground particles (with vertical, longitudinal and transverse components) resulting from vibrations produced by blasts. *V* is an industrial standard used to describe the effects of vibration from explosion and can be calculated using the formula (Department of Mineral Fuels, Thailand):

$$V = 600\left(\frac{r}{\sqrt{W}}\right)^{-1.4}$$

Where V = Peak particle velocity (mm/sec)
r = Distance from charge to measured point (m)
W= Weight of explosive (kg) (In this case, 2.0 kg)
600 = Coefficient with a unit of √kg/sec

A safety standard of 2 mm/sec must be maintained for Ancient monuments/archaeological sites.

6.5.1.4 Soil

Under normal circumstances there is no pathway for contaminants to reach soils off-site. However, soils will be sampled once within one month after well shut-in (**Figure 3-2**) or as determined appropriate. In addition, soils will be sampled in the event of spillage or leakage.

6.5.1.5 Surface Water

Monitoring of surface water in the immediate vicinity of the sites should be conducted at appropriate regular intervals (monthly or quarterly) during exploration drilling to monitor any adverse changes to surface water quality. This is particularly important if the well sites are located in close proximity to areas where there are beneficial uses of surface water (**Figure 3-2**). However, in the event of spillage or leakage, potentially affected watercourses will be sampled and analysed for substance spilt.

6.5.1.6 Groundwater

Monitoring of groundwater in the immediate vicinity of the sites should be conducted at appropriate regular intervals (monthly or quarterly) during exploration drilling to monitor any adverse changes to groundwater quality. This is particularly important if the well sites are located in close proximity to areas where there are beneficial uses of groundwater **(Figure 3-2**). In addition, groundwater will be sampled in the event of spillage or leakage.

6.5.2 Discharges and Emissions Monitoring

Discharges and emissions from the proposed Project are monitored to determine compliance with regulations and/or company standards.

6.5.2.1 Mud and Cuttings

Prior to disposal, each batch of drilling waste will be analysed to determine if it is hazardous and to obtain specifications required by the contractor.

6.5.2.2 Hazardous and Non-Hazardous Waste

A Manifest System of all waste leaving the site will be maintained and licensed contractors will track the waste to its point of disposal.

Table 6-5: Environmental, Social, and Health Seismic Monitoring Measures

Factors	Index	Procedure	Proposed Duration and Frequency of Monitoring	Location
Noise	• L_{eq}24 hr. • L_{max} • L_{dn} • Nuisance noise	Method • Measure background noise level, residual noise level, specific noise level and calculation of noise using a Type 1 or 2 sound level meters meeting all appropriate IEC standards • Following the Guidelines for Community Noise, World Health Organization (WHO), 1999	**Duration:**1 days continuously **Frequency:** • Once during seismic • If within 1 km of a community regular monitoring will be required • In case of a complaint regarding noise from project site, an additional noise measurement may be conducted (if necessary)	100 meter from Seismic Shooting Site
Vibration	• Peak Particle Velocity (PPV)	• Vibration Test to determine PPV measured at 25m, 50m, 100m, and 200m	• At first seismic shooting site	• At first site
Hazardous and Non-hazardous waste	• Manifest Disposal and Tracking Report	• Track waste volume by type and disposal location daily	• All phases	• At all project locations
Social	• Complaint • Monitoring and solving	• Record complaint • Monitor, investigate and implement suitable solutions	• All phases	• Project area, community around project area, and transportation route
Occupational health and safety	• Accidental statistics • cause of accidents • Mitigation measures	• Record accidents or near misses generated during construction by identifying cause(s) and severity of impact(s), as well as operated mitigation measures • Conduct summary report for accident investigation	• All phases	• Project area, community around project area, and transportation route
Third Party Audit of Management Measure Implementation	• Audit of Management Measures	• Conduct Audit of management measure implementation	• Post Project	• At all project locations
Post Project Opinion Survey	• Opinion Survey of Communities near project area	• Post project opinion survey to determine community attitude toward the project	• Post Project	• Nearby community

Table 6-6:Environmental, Social, and Health Drilling Monitoring Measures

Factors	Index	Procedure	Proposed Duration and Frequency of Monitoring	Location
Air Quality	• TSP • PM-10 • NOx, • SOx, • CO	Method • Following the WHO guideline (updated 2005) and the National Ambient Air Quality Standards (NAAQS, set by U.S. Environmental Protection Agency USEPA, 1990)	**Duration:** 1 days continuously **Frequency:** • Once during construction and drilling phase • If within 1 km of a community regular monitoring will be required • In case of any complaint regarding air quality, an additional air quality measurement may be conducted in response to specific complaints (if necessary)	Nearest sensitive receptor or downwind of complaint area (if necessary).
Noise	• L_{eq}24 hr. • L_{max} • L_{dn} • Nuisance noise	Method • Measure background noise level, residual noise level, specific noise level and calculation of noise using a Type 1 or 2 sound level meters meeting all appropriate IEC standards • Following the Guidelines for Community Noise, World Health Organization (WHO), 1999	**Duration:** 1 days continuously **Frequency:** • Once during construction and drilling phase • If within 1 km of a community regular monitoring will be required • In case of a complaint regarding noise from project site, an additional noise measurement may be conducted (if necessary)	Nearest sensitive receptor

Factors	Index	Procedure	Proposed Duration and Frequency of Monitoring	Location
Soil	Physical parameters: • pH • Soil texture • Salinity • Conductivity • Temperature • Cl^- Chemical Parameters: • Petroleum Hydrocarbons • Benzene • Toluene • Ethyl benzene • Total xylene • Metals:As, Cd and Cd-compound, Cr^{6+}, Pb, Hg, Ni, Se, Ba, Cu, Zn, Fe, Mn and Mn-compound	Method • Follow U.S. EPA Analytical Method per parameter • Compare results to Soil Quality Standards, Notification of the National Environmental Board No. 25, B.E. 2547 (2004), published in the Royal Government Gazette, Vol. 121 special part 119D, dated October 20, B.E. 2547 (2004)	• Once after project completion	Project site At the spillage or leakage areas
Surface water	Physical parameters: • pH • Conductivity • Temperature • SS • TDS • Salinity Chemical Parameters: • DO • BOD • TPH and Oil and Grease • Cl, SO_4 • Metals:As, Cd, Total Cr, Pb, Total Hg, Ni, Se, Ba, Cu, Zn, Fe, Mn Biological parameters: • TCB	Method • Analytical Methods followed to Standard Methods for the Examination of Water and Wastewater, recommended by APHA-AWWA-WEF • Compare to EPA's National Recommended Water Quality Criteria and standards from Notification of the National Environmental Quality No.8, B.E. 2537 (1994)	• Regular intervals (monthly or quarterly) • In an event of spillage and leakage	• At the same surface water sampling station before having project (Baseline) (**Figure 3-2**) • Water sources which are potentially affected (in case of spillage of leakage)

Factors	Index	Procedure	Proposed Duration and Frequency of Monitoring	Location
Groundwater	Physical parameters: • pH • Conductivity • Temperature • TDS • Salinity Chemical Parameters: • TPH and Oil and Grease • Benzene • Toluene • Ethyl benzene • Total xylene • Cl, SO_4 • Metals : As, Cd, Total Cr, Pb, Hg, Ni,Se, Ba, Cu, Zn, Fe, Mn	Method • Analytical Methods followed to Standard Methods for the Examination of Water and Wastewater, recommended by APHA-AWWA-WEF • Compare to Standards from Notification of Ministry of Natural Resources and Environment B.E. 2551 (2008)	• Regular intervals (monthly or quarterly) • In event of spillage and leakage	• Nearest groundwater well or just off well pad area • Area of possible spill
Cuttings from drilling (in case of further using cuttings)	Cuttings from surface section • pH • Conductivity • Salinity • Cl^- Cuttings from middle and reservoir section • pH • Conductivity • Salinity • Cl^- • Soluble Threshold Limit Concentration (STLC) • Total Threshold Limit Concentration (TTLC)	Method • Soil quality standards for habitat and agriculture and other purposes from Notification of the National Environmental Board No. 25, B.E. 2547 (2004), published in the Royal Government Gazette, Vol. 121 special part 119D, dated October 20, B.E. 2547 (2004) • STLC and TTLC are analyzed by Waste Extraction Test Method and Leaching Test Method[1] and also classify that analyzed cuttings sample is non-hazardous waste or hazardous waste by using an analysis method Number of Samples • At least 2 samples per section of drilling	• During exploration drilling	• Exploration drilling well

Factors	Index	Procedure	Proposed Duration and Frequency of Monitoring	Location
Chemical use for drilling	• Type of chemical • Volume of use	• Daily record type of chemicals and volume used	• Daily and report after drilling is completed	• Project area
Hazardous and Non-hazardous waste	• Manifest Disposal and Tracking Report	• Track waste volume by type and disposal location daily	• All phases	• At all project locations
Social	• Complaint • Monitoring and solving	• Record complaint • Monitor, investigate and implement suitable solutions	• All phases	• Project area, community around project area, and transportation route
Occupational health and safety	• Accidental statistics • cause of accidents • Mitigation measures	• Record accidents or near misses generated during construction by identifying cause(s) and severity of impact(s), as well as operated mitigation measures • Conduct summary report for accident investigation	• All phases	• Project area, community around project area, and transportation route
Third Party Audit of Management Measure Implementation	• Audit of Management Measures	• Conduct Audit of management measure implementation	• Post Project	• At all project locations
Post Project Opinion Survey	• Opinion Survey of Communities near project area	• Post project opinion survey to determine community attitude toward the project	• Post Project	• Nearby community

1 = Extracted by using Waste Extraction Test Method and Leaching Test Method and also classify that analyzed cuttings is non-hazardous waste or hazardous waste by using analysis method and standard values

6.5.3 Waste Management

6.5.3.1 Waste Type

Table 6-7: Waste Type

Waste Type	Description
(1) Non-Hazardous	• Combustible general waste (plastic, paper, rags, packing, material, etc.,) • General rubbish generated from office and dormitory, cut grass, etc., • Food scraps / canteen waste
(2) Non – hazardous and recyclable	• Scrap metal • Vehicle tire and tube
(3) Non - hazardous and recyclable	• Fluorescent tubes / bulbs
(4) Hazardous and recyclable	• Waste oil from vehicle/ equipment maintenance • Batteries • Aerosol can • Empty drums and tins (containing oils, solvent, cleaning chemicals) that can be cleaned by flushing.
(5) Hazardous and not recyclable	• Medical waste • Chemical waste • Expired or unidentified chemicals • Laboratory waste • Empty drums and tins (containing paints, oil, solvent, cleaning chemicals) that cannot be cleaned by flushing • Waste from draining / depressurizing and cleaning equipment • Waste from drainage and cleaning of a diesel tank, filter dust • Sewage Sludge

6.5.3.2 Waste Segregation System

Table 6-8: Waste Segregation System

Colour	Waste Description
White	Non-hazardous waste – plastic, paper rage, packing material, etc.,
Blue	Non-Hazardous and recyclable waste – Plastic bottles, cans etc.
Green	Non-hazardous and non-recyclable waste – Fluorescent tubes, bulbs etc.
Red	Non-hazardous and recyclable waste – Scrap metal only
Yellow	Hazardous and recyclable waste – Aerosol can only

6.5.3.3 Waste Disposal Method

Table 6-9: Waste Disposal Method

Group	Content	Disposal Method
1. Non hazardous	1.1. Food scraps/ canteen waste (Domestic wastewater/ sewage)	• Record and removed from site for recycling by catering camp boss
	1.2. Combustible general waste (plastic, paper, rags, packing material, etc.)	• Record and recycling
	1.3. Scrap metal	• Record and recycling by Contractor/ local people
	1.4. Used tires and inner tubes	• Record and send back to its origin (Yangon) or recycling by local people with controls
	1.5. Fluorescent tubes/ bulbs	• Record and send back to its origin (Yangon) or buried at approved landfill area
2. Medical waste	2.1. Infections solid wet waste (soaked cotton wool, gauze, used plaster, bacterial tested tray, etc.,)	• Record and send to local Hospital for proper disposal
	2.2. Biohazards solid dry waste (medicine vials, ampoules, used syringes etc.) and sharp objects (needles, scalpels, etc.)	• Record and send to local Hospital for proper disposal
3. Hazardous	3.1. Waste oil from vehicle used engine oil, hydraulic oil, grease, diesel, etc.,) 3.2. Oil Soaked material (sawdust, rags, etc.,)	• Record and send to cement kiln for incineration
	3.3. Chemical waste, expired chemicals, unidentified chemicals 3.4. Used or expired printer toner	• Record and send back to its origin (Yangon) • Keep in designated area at site while waiting for transportation to Yangon
	3.5. Equipment maintenance such as used filters	• Send to approved disposal site
	3.6. Filter dust	• Send to approved disposal site
	3.7. Aerosol cans	• Send to approved disposal site
	3.8. Batteries (non-recyclable) 3.9. Batteries (recyclable)	• Send back to its origin (Yangon) by Safety Officer • Keep in designated area at site while waiting for transportation to Yangon
	3.10. Empty drums and tins (containing paints, oils, solvent, cleaning chemicals)	• Record and recycle if recyclable or send back to its origin (Yangon) if non-recyclable
	3.11. Waste from drainage and cleaning of a diesel tank	• Disposed at approved disposal site
	3.12. Chemical waste(Expired or unidentified chemicals)	• Send back to its origin (Yangon)
	3.13. Sewage Sludge	• Send to approved disposal site

Remarks:Tires will be rendered non-usable as a vehicle tyre.

6.5.4 Emergency Response Plan

Emergency Management Policy PCMI policy on contingency planning and response to emergencies take cognizance of both existing Company and statutory requirements as they relate to the handling of emergencies relevant to the Company operations, as well as to satisfy all moral obligations of the Company. It is the policy of PCMI that:
In the event of any emergency occurring in any of its operations, the respective Site Emergency Response Team shall be immediately mobilized to deal with the emergency.

(a) Additionally, the respective Regional Emergency Management Team as well as Corporate Emergency Management Team (both headed by management), shall also be mobilized, as necessary, to provide whatever support required by the site Emergency Response Team.

(b) Both Teams shall give their total support to the site Emergency Response Team with a view to effectively minimizing the harmful effect and to overcome the emergency as quickly as possible. When managing the emergency, the following priorities shall prevail:

  a. Saving of lives and safety of personnel;
  b. Preserving public health and safety;
  c. Preserving the environment;
  d. Protecting the property and investment; and
  e. Maintaining the company reputation;

(c) Consistent with the overall policy, it is also a requirement that the Emergency Response Procedures of Contractors working for, and on behalf of PCMI, shall conform to the contractual requirement and policy on emergency response.

(d) Additionally, regular training of all personnel, both Company and Contractors personnel, shall be conducted to ensure an effective emergency response preparedness exist throughout the Company's operations.

Facility Emergency Response Organisation

The Heads of the Myanmar Operation shall establish the Facility Emergency Response Organisation to respond to emergency that may occur at the facility.

The Facility Emergency Response Team responds to all emergencies occurring on the facility. In cases where additional resources and technical support are required, these shall be mobilised by the MO Emergency Management Team.

The Facility Emergency Response Team shall comprise an On Scene Commander, who is the Person-in-Charge of the facility, as well as the required numbers of team members from amongst the personnel on the facility.

The Facility Emergency Response Team shall be provided with adequate resources, information, procedures and guidelines, including contingency plans, to ensure the effective response to all emergencies on the facility.

To ensure and maintain emergency response preparedness, the Facility Emergency Response Team shall be provided with the required training and exercises.

Contingency Plans

The Head, of the Myanmar Operation shall develop the required Contingency Plans, as necessary, to prepare for major emergencies that may occur within their respective Myanmar Operation. This may include the following contingency plans:

(1) Business Continuity Plan;
(2) Emergency Management Plan;
(3) Medical Evacuation Plan;
(4) Natural Disaster Contingency Plan;
(5) Inclement (Severe) Weather Contingency Plan;
(6) ERP;
(7) Facility Abandonment and Evacuation Plan;
(8) Influenza Pandemic Preparedness Plan;
(9) Security Risk and Evacuation Plan; and
(10) Blow-out Contingency Plan.

6.5.5 Site Specific Impact Assessment Requirements

In cases where drill site locations have not yet been selected the following will apply:

1. Compare selected site to existing environmental baseline and socio economic data collection sites to determine the comparative benefits of the two sites.
2. If the selected site is greater than 10 km away from previous data collections sites or if there is any activity (particularly industrial) that may contribute to a change in the environmental baseline condition, then conduct an environmental and socio economic baseline data collection program as described below.

Environmental Baseline

A baseline description of the environmental, socio-economic, and archaeological setting is required. Sampling will be undertaken in the vicinity of the proposed operations. Primary data parameters to be collected and analysed include, but not limited to, the following:

Table 6-10: Primary Data Parameters

Environmental Components	Physio-chemical parameters to analyze
Ground Water	pH, heavy metals, oil & grease, total petroleum hydrocarbon, total aromatic hydrocarbon, other parameters as specified and agreed by the COMPANY.
Surface Water	Turbidity, color, temperature, total suspended solids, electrical conductivity, pH, dissolved oxygen, BOD, COD, Ammonia, Nitrate, Total nitrogen, Phosphate, heavy metals, oil & grease, total petroleum hydrocarbon, total aromatic hydrocarbon, other parameters as specified and agreed by the COMPANY.
Soil quality	Heavy metals, oil & grease, total petroleum hydrocarbon, total aromatic hydrocarbon, other parameters as specified and agreed by the COMPANY.
Ambient air quality	NOx, SOx, CO, “TSP (PM10)” and other parameters as specified and agreed by the COMPANY.
Ambient Noise	Day time and Night time.

As a minimum, the following sample numbers are required.

Project Area	Air	Noise	Ground Water	Surface Water	Soil
Well Site	2	2	2	2	4

Surface water samples will be collected from sampling stations within or near the project area. Surface water may include natural water sources such as streams, rivers, ponds, or lakes as well as man-made water sources such as water reservoirs or irrigation canals.

Groundwater wells will be sampled near the project area. Generally, the nearest existing groundwater well or community wells to the project site will be sampled.

Air quality testing and noise measurements will be collected from locations near the project site. The test locations will be determined after site investigation. Generally, the site chosen for air and noise sampling will be the nearest to a major sensitive receptor such as a school, hospital, temple or community. Environmental consultant will rank the nearest sensitive receptors to determine which receptor to sample. Generally, downwind receptors have a higher ranking.

Soil samples will be taken within or near the project area. Number of soil samples to be taken will also relate to the soil classification in the project area.

Laboratories

All samples will be collected according to standard sampling protocols and procedures.

Samples will be analysed at laboratories accredited by one or more of the following: Standards Council of Canada/CAEAL, BCMELP, EDQA, WA DOE, and ISO Guide 25. Analytical quality control for test quality determination are done by: (1) using acceptable analytical procedures; and (2) confirming the accuracy of the analytical procedures by using either *Certified Reference Materials (CRMs)* or *Recovery Test* by spiking samples with known standard solutions.

Ecological Survey

The objective is to conduct a survey of wildlife, endangered species, bird and ecology and forest which may be affected / caused by the well site construction and drilling exploration activities. The survey area shall cover the prospect boundaries approximately 1 kilometers radius of each prospect. The ecological survey will indicate the extent to which the local community is dependent on the forest as a source of livelihood. The impact assessment needs to take into consideration how ecosystem services will be further impacted by the project, given the current pressure from local population. Once specific locations are identified the impacts to fauna will be assessed including the following:

- Disorientation of least mobile animals
- Loss of forest ecosystem
- Trap hazards for animals
- Disturbance to animals
- Disoriented animals that are attracted to lights
- Degradation of habitats

Flora impacts will be assessed in relation to the existing baseline – important species, species of commercial/livelihood values.

The description would identify the following:

1) The main types of native vegetation community in the area (referencing the species involved, use scientific, English and Myanmar names if possible).
2) Species of wildlife and plant with special conservation status or concern that may be associated with and or depend on these plant communities and or be potentially found in the area of interest. Include reference to any seasonality of occurrence.
3) Areas within the block that may be more likely to support species with special conservation status/concern.
4) Name and location of any areas likely to have exceptionally high biodiversity. (If these areas are easy to define then draw rough polygons on a map and send scans).
5) The name and location of any major wetlands and or watercourses in the area of interest.
6) Reference to any ecological or biological research or surveys that may have taken place in the area.
7) The name and contact information of any local conservation NGOs that may have an interest in the area.

Stakeholder Involvement

Stakeholder involvement, in the form of stakeholder consultation and disclosure, is a critical component of an ESHIA. Its primary objective is to maximize stakeholder understanding of the project through information distribution and exchange between the project proponent and the communities that might be affected directly or indirectly by the proposed project activities.

Prior to initiating community meetings, a presentation will be provided to the Key Township Officials/Governor prior to stakeholder meetings being conducted to obtain support and approval.

Stakeholder engagement will be conducted with communities within 2-km of the drill site locations.

Activities will include the following:

- Key Informant Interview with key government officials and community leaders;
- Stakeholders Meeting/Focus Group Discussions with communities, non-governmental organizations (NGOs), international NGOs, and community interest groups in urban and rural areas;
- Socio-economic and Attitude Survey of households (optional).

6.5.6 HSE Site Selection Criteria

To assist PCMI in picking the drill site location that optimizes EHS values, the following site selection criteria will be applied as a guideline.

Table 6-11: Site Selection Criteria

Site Selection Criteria (Well Site, Camp, Access Road)	**Score**			
	Unsuitable	**Less Suitable (1)**	**Suitable (2)**	**Most Suitable (3)**
Topography *(Concern – slope stability, additional space required for spoil, reclamation)*	• > 15% slope or > 15m cut • Evidence of significant geotechnical instabilities • Very low lying area prone to flooding	• 10% - 15 % slope or > 15m vertical cut • Extensive grading or fill required	• 2% - -10% slope • Minor to Moderate grading and or fill required	• 0% - 2% slope • Negligible grading and or fill required
Hydrology and water quality *(Concern - risk of flooding to project, risk of water pollution, impacts to fish)*	• Site or new site access within 100m of floodplain (1in 100 yr. flood) • Site within 100m of water well or community water supply	• > 100m < 1 km from 1 in 100yr. floodplain with slope or drainage features leading to water body • Will require establishment of new permanent water course crossing and significant disturbance to bed or banks of watercourse	• 100m < 1km from 1 in 100 yr. floodplain, with slope or drainage features that do not lead to water body • Site access will require minor disturbance to banks and or bed of watercourse	• 1km from 1 in 100 year floodplain. • Site access will not require disturbance to banks and or bed of watercourse
Soils *(Concern – site stability, drainage interference, ease of reclamation, loss of highly productive soils)*	• Deep organic soils (e.g.> 1m), peat	• Moderately deep (0.5m - 1m) organic soils • Vegetated, very sandy soils with minimal organic content • Soils with very high productivity, well developed organic topsoil layer	• Mineral soils with low to moderate depth of organic topsoil • Poorly vegetated soils	• Mineral soils with moderate to moderately high development of organic topsoil layer • Barren soils
Fauna *(Concern – loss of habitat, disturbance, increased human access, direct mortality)*	• Native vegetation site connected to and <1 km from habitat for species with special conservation status • Site development will require destruction of wetland	• Site >1 km < 2km from habitat for species with special conservation status • Previously undisturbed and or well established significant native vegetation • Forest cover • Site access may interfere with significant species migration.	• >2 km from habitat for species with special conservation status • Poorly developed and or very common native vegetation • Non forested • Not in riparian zone	• >2 km from habitat for species with special conservation status. • Previously disturbed or barren site • Crop land • Industrial site

Site Selection Criteria (Well Site, Camp, Access Road)	Score			
	Unsuitable	Less Suitable (1)	Suitable (2)	Most Suitable (3)
		• Site < 1km from known wildlife concentration area • Site or site access in riparian zone		
Native Flora *(Loss or disturbance of rare native plants or plant communities, deforestation)*	• Habitat occupied plant or plant community with special conservation status.	• Site occupied by uncommon or particularly valuable native plant community • Site forested • Site development will require destruction of wetland /riparian vegetation	• Site occupied by common native vegetation • Site non-forested	• Site not occupied by native vegetation
Parks, Reserves & Sanctuaries *(Violation of land use conditions, compromise of integrity and ecological buffer to protected area.)*	• Site or site access will require new disturbance inside protected area	• Site < 0.5 km from protected area	• Site > 0.5 km < 1 km from protected area	• Site > 1 km from protected area
Communities *(Concern – light pollution, noise, safety)*	• Site inside community boundary	• Site outside community boundary but <1km-radius from community	• Site > 1 km < 2 km from community	• Site > 2 km from community
Agricultural Land *(Loss of productive farmland, economic hardship to landowner/tenant)*	• Site will require destruction of productive orchard	• Will require new disturbance in unique and highly productive crop land • Landowner reluctant to sell • Landowner/Tenant has very small holdings (i.e. development will take > 25% of holding)	• Site is moderately productive or typical cropland, native pasture • Land owner reluctant to sell • Landowner/Tenant has moderate holdings (i.e. Development will take > 5 < 25% of landowner/tenant holding	• Site in marginally productive cropland/non-native pasture • Landowner very willing to sell. • Landowner/Tenant has large land holdings • Development will take < 5% of landowner/tenant holdings
Cultural/religious resources *(Disturbance to spiritual and tourist activities)*	• Within boundary of religious or cultural site. • Will result in the disturbance of significant archaeological remains	• <1km from significant cultural site and access road has to pass through cultural site	• 1-2km from cultural resources and access road does not pass through cultural site	• >2km from cultural resources and access road does not pass through cultural site
Visual Landscape *(Loss of landscape aesthetic)*	• Site will be highly conspicuous and in line with view of cultural site or significant natural landscape feature	• Site moderately conspicuous and in line with view of cultural site or significant natural landscape	• Site very slightly visible and in line with view of cultural site or significant natural landscape feature	• Site not visible and not in line with view of cultural site or significant natural landscape feature

6.5.7 Public Consultation and Disclosure

Prior to both the initiation of seismic and/or drilling activities, as part of the ongoing stakeholder consultation and engagement plan and in response to suggestions voiced at the stakeholder meetings, PCMI will undertake the following activities prior to and during the proposed operations:

- Appoint a community liaison officer;
- Dissemination of Information; and
- Feedback and Community Attitudes.

6.5.7.1 Engagement with Communities

Engagement with local communities that may be impacted by PCMI business activities shall be conducted to create awareness on Company's operations, including the associated HSE controls and recovery measures. Where there are legislative requirements to conduct such engagements, these requirements shall be fully complied with. To facilitate information exchange a community liaison officer will be appointed. The local village leader could possibly fulfill this role. Villages near project activities must be advised 2 weeks in advance of project initiation.

6.5.7.2 Dissemination of Information

The objective of these activities is to distribute information to affected stakeholders and communities within the project area. A combination of communication methods will be used to ensure the target groups within the project area are reminded and aware of the proposed plans. PCMI will periodically inform the local authorities the project plans throughout all phases of the project.

Before project commencement, the Local Authority will be formally notified of the upcoming project. A meeting with the village heads will be conducted at least 2 weeks before project launch. This meeting will be used to inform the community leaders of transportation routes, drilling operations and potential disturbances from these activities. The meeting will also introduce key staff members and ensure contact details are exchanged. The community leaders will be asked to relay the information to their communities.

6.5.7.3 Feedback and Community Attitudes

PCMI understands the importance of listening to stakeholder concerns and addressing any valid issues to maintain good relations and demonstrate respect for the neighbouring communities in which it operates.

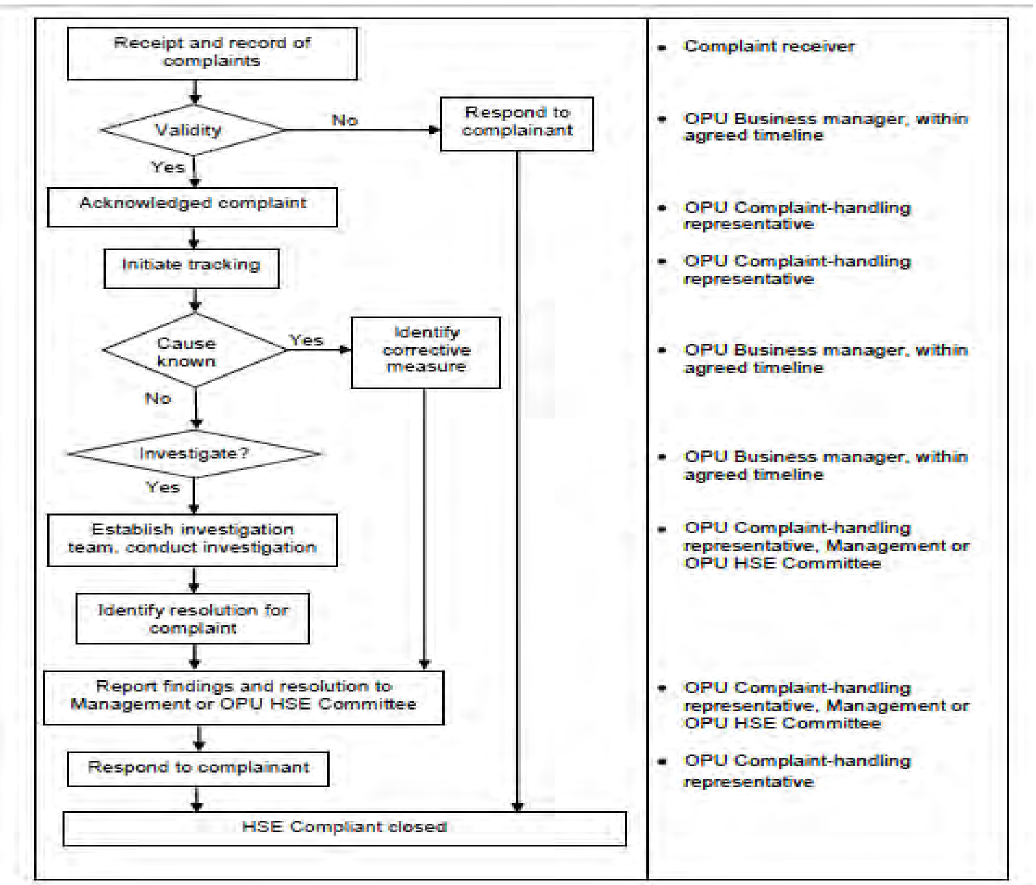
The following techniques and mechanisms will be utilized to ensure effective feedback:

Handling a Stakeholder Complaint

All HSE Complaint should be processed immediately and according to PTS Stakeholder Complaint Procedure. Access to complaint-handling process should be free-of-charge to the complainant. All Complainants should be treated courteously and be kept informed of the progress of their complaint, being addressed in an equitable, objective and unbiased manner through the complaint-handling process.

The flow of activities in HSE Complaint process is shown in **Figure 6-1** below.

Figure 6-1: HSE Complaint Process Flow



6.5.7.4 Study Area, Duration and Responsible Agencies

Study Area

The study area includes local communities within a 1-km radius of the well site (for all phases of the project).

Duration

The Stakeholder Relations Plan will be conducted during all phases of the project’s operations. Four weeks prior to site operations, the stakeholder (village headman, household representatives and community leaders) will be informed about project activities. PCMI will attend monthly meetings at the district office with village headman, household representatives to address any issues regarding PCMI’s project if required.

Responsible Agency

PETRONAS Carigali Myanmar Inc.

CHAPTER 7

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7 REFERENCES

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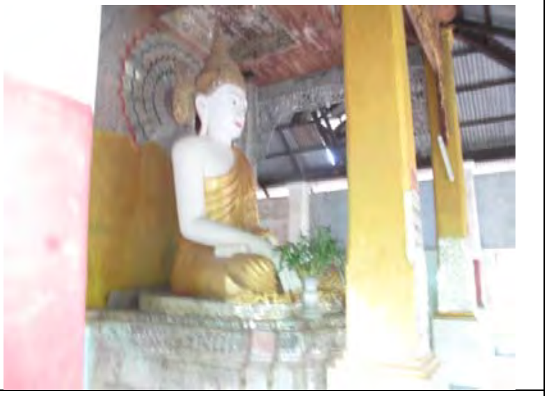
Appendix A

Cultural, Heritage and Archeological Summaries

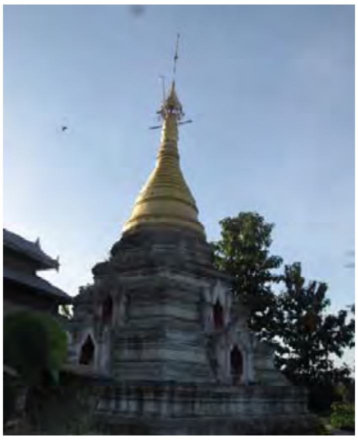
APPENDIX A – CULTURAL, HERITAGE & ARCHEOLOGICAL SUMMARIES

DATE: 07-November-2014 (Friday)
VILLAGE: Block IOR5-V1 – Shin Su

No.	Description
1.	**Actual location of Pagodas and Monasteries:** • Aung Minglar Ordination Hall, Law Ka Oha Shawn Pagoda, Kyuak Tan Monastery – Location: N 18° 17’ 28.8” E 095° 14’ 57.5”
	 
	• Chin Su Monastery – Location: N 18° 17’ 58.3” E 095° 15’ 08.3”
	 
2.	**Location of Cultural Heritage Places:** • Kyuak Tan Rest House – Location: N 18° 17’ 28.5” E 095° 14’ 59.2”
	 

<table>
<tr><td rowspan="2">3.</td><td colspan="2">Location of Cemeteries:
• Kyuak Tan & Chin Su uses same cemetery –
Location: N 18° 17’ 44.0” E 095° 15’ 06.4”</td></tr>
<tr><td></td><td></td></tr>
<tr><td>4.</td><td colspan="2">Location of Local Archeological Sites:
• Aung Minglar Ordination Hall, Law Ka Oha Shawn Pagoda, Kyuak Tan Monastery
Location: N 18° 17’ 28.8” E 095° 14’ 57.5”</td></tr>
<tr><td>5.</td><td colspan="2">Dates of Important Cultural Activities:
• Law Ka Oha Shawn Pagoda Festival (March)</td></tr>
</table>

DATE: 10-November-2014 (Monday)
VILLAGE: Block IOR5-V8 – Pan Pin Kone

No.	Description	
1.	**Actual location of Pagodas and Monasteries:** • Ka Lo Kwin Monastery & Ka Lo Kwin Pagoda – Location: N 18° 18' 46.3" E 095° 09' 25.9"	
		
	• Jyo Kone Monastery & Jyo Kone Pagoda – Location: N 18° 18' 48.2" E 095° 08' 55.5"	
		
2.	**Location of Cultural Heritage Places:** None	
3.	**Location of Cemeteries:** • Pan Kone's Cemetery – Location: N 18° 18' 36.5" E 095° 09' 22.7"	
		

4.	**Location of Local Archeological Sites:** • Jyo Kone Pagoda (about 100 years old) – Location: N 18° 18' 48.2" E 095° 08' 55.5"	
		
5.	**Dates of Important Cultural Activities:** • Swan Ta Gyi Donation Festival – Full Moon Day (March)	

DATE: 10-November-2014 (Monday)
VILLAGE: Block IOR5-V5 – Kone Myint

No.	Description
1.	**Actual location of Pagodas and Monasteries:** - Kone Myint Monastery & Mahar Law Ka Mu Ni Pagoda - Location: N 18° 18’ 13.4” E 095° 12’ 11.2”
	 
	- Su Na Ma Ni Shrine – Location: N 18° 18’ 48.4” E 095° 12’ 00.2”
	 
2.	**Location of Cultural Heritage Places:** - Kone Myint’s Chapel – Location: N 18° 18’ 37.3” E 095° 11’ 59.3”
	 

3.	**Location of Cemeteries:** • Kone Myint’s Cemetery – Location: N 18° 18’ 51.5” E 095° 12’ 05.6”
	 
4.	**Location of Local Archeological Sites:** • Mahar Law Ka Mu Ni Pagoda (about 165 years old) – Location: N 18° 18’ 13.4” E 095° 12’ 11.2”
	 
5.	**Dates of Important Cultural Activities:** • De Pan Ka Ya Pagoda Festival – 8 days following Full Moon Day (November) • Swan Taw Gyi Donation Festival – Thadingyut Full Moon Day (October)

DATE: 11-November-2014 (Tuesday)
VILLAGE: Block IOR5-V7 – San Kone

No.	Description
1.	**Actual location of Pagodas and Monasteries:** • San Kone Monastery – Location: N 18° 15’ 56.5” E 095° 11’ 50.2”  
2.	**Location of Cultural Heritage Places:** • Nine’s Duchy Net Nan and Banyan – Location: N 18° 16’ 00.0” E 095° 11’ 47.0”  
3.	**Location of Cemeteries:** • San Kone’s Cemetery – Location: N 18° 15’ 53.6” E 095° 11’ 56.2”  
4.	**Location of Local Archeological Sites:** None
5.	**Dates of Important Cultural Activities:** No special days, but they follow regular Myanmar activities.

DATE: 12-November-2014 (Wednesday)
VILLAGE: Block IOR5-V6 – Lei Gyi Kwin

No.	Description
1.	**Actual location of Pagodas and Monasteries:** • Lei Gyi Kwin Monastery – Location: N 18° 16’ 32.7” E 095° 10’ 44.5”
	 
	• Lei Gyi Kwin Pagoda – Location: N 18° 16’ 31.7” E 095° 10’ 45.6”
	 
	• Temple (Photo No. 5035-5054) – Location: N 18° 16’ 43.5” E 095° 10’ 33.3”
	 
2.	**Location of Cultural Heritage Places:** None

3.	**Location of Cemeteries:** - Lei Gyi Kwin Cemetery – Location: N 18° 16’ 46.2” E 095° 10’ 37.9”
	 
4.	**Location of Local Archeological Sites:** - Lei Gyi Kwin Pagoda (about 100 years old) – Location: N 18° 16’ 31.7” E 095° 10’ 45.6”
	 
5.	**Dates of Important Cultural Activities:** - No special days; follow regular Myanmar activities

DATE: 12-November-2014 (Wednesday)
VILLAGE: Block IOR5-V9 – Kyat Ka Lay

No.	Description
1.	**Actual location of Pagodas and Monasteries:** - Kyat Ka Lay Monastery and Kyat Ka Lay Pagoda – Location: N 18° 23’ 32.3” E 095° 09’ 56.3”  
2.	**Location of Cultural Heritage Places:** - Kyat Ka Lay Pagoda – Location: N 18° 23’ 32.3” E 095° 09’ 56.3”  
3.	**Location of Cemeteries:** - Kyat Ka Lay’s cemeteries – Location: N 18° 23’ 26.5” E 095° 10’ 06.6”  
4.	**Location of Local Archeological Sites:** No location of local archeological sites
5.	**Dates of Important Cultural Activities:** Nothing special Days but they follow regular Myanmar activities.

DATE: 12-November-2014 (Wednesday)
VILLAGE: Block IOR5-V4 – Lane Kone

No.	Description
1.	**Actual location of Pagodas and Monasteries:** • Su Taung Pyae Temple and Lane kone Monastery Temple – Location N 18° 16’ 43.0” E 095° 13’ 15.5” • Temple – Location: N 18° 16’ 41.2” E 095° 13’ 33.1”
	 
2.	**Location of Cultural Heritage Places:** No, location of cultural Heritage Places.
3.	**Location of Cemeteries:** No location of Cemeteries
4.	**Location of Local Archeological Sites:** No location of local archeological sites
5.	**Dates of Important Cultural Activities:** Nothing special Days but they follow regular Myanmar activities.

DATE: 13-November-2014 (Thursday)
VILLAGE: Block IOR5-V3 – Chaung Hpyar

No.	Description
1.	**Actual location of Pagodas and Monasteries:** None
2.	**Location of Cultural Heritage Places:** None
3.	**Location of Cemeteries:** None
4.	**Location of Local Archeological Sites:** None
5.	**Dates of Important Cultural Activities:** • No special days; follow regular Myanmar activities

Appendix B

Air Emission Calculations

Appendix B - Emission from Onshore Petroleum Exploration in Block IOR-5

Emissions from Construction Phase

Greenhouse Gases (GHG)

The main source of GHG emissions during construction are from transportation of granular fill for well site and access road construction. These GHG emissions are estimated following the Tier 1 approach of IPCC (2006) mobile combustion (transportation). GHG emissions are estimated using emission factors and global warming potentials for the three main greenhouse gases (CO_2, CH_4 and N_2O).

To calculate the amount of each of these gases emitted, the following calculations can be used, using emission factors presented in **Table 1** and a conversion factor of 10^{-6} to convert g into ton:

$$CH_4 Emission\,(tonne\ CH_4) = \#\ truck\ trips\ x\ distance/trip\ (km)\ x\ 0.08 x\, 10^{-6}\ (tCH_4/km)$$

$$N_2O Emission\,(tonne\ N_2O\ \ ) = \#\ truck\ trips\ x\ distance/trip\ (km)\ x\ 0.03\ x\, 10^{-6}\ (tN_2O/km)$$

$$CO_2 Emission\,(tonne\ CO_2) = \#\ truck\ trips\ x\ distance/trip\ (km)\ x\ 753.6\ x\, 10^{-6}\ (tCO_2/km)$$

To calculate the total CO_2 equivalent GHG emissions, global warming potentials need to be used as some gases have a much greater greenhouse gas effect. The total CO_2 equivalent GHG emissions from transportation of mostly heavy-duty diesel vehicles are obtained using an emission factor of 0.000764 tCO_2 eq/km (**Table 1**). Emissions are calculated based on number of trips completed and distance travelled:

$$CO_2 Emission\,(tonne\ CO_2) = \#\ truck\ trips\ x\ distance/trip\ (km)\ x\ 0.000764\ (tCO_2/km)\quad \textbf{\textit{Eq. 1}}$$

Table 1: Emission Factor for Mobile Combustion (Transportation)

		CH_4	N_2O	CO_2	Total	tCO_2 eq/km
European diesel heavy-duty vehicle	g/km	0.08	0.03	753.60*		
	gCO_2 eq/km**	1.84	8.88	753.60	**764.32**	**0.000764**

Source: IPCC (2006) & EMEP/EEA air pollutant emission inventory guidebook (2009)[1]
* Tier 1: 240 g fuel/km*3.14 gCO_2/g fuel = 753.6
** Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296[2]

2.3.1.2: Granular Fill Transportation:
GHG emissions from fill transportation are obtained using the emission factor of **0.000764 tCO_2 eq/km** (**Table 1**), number of trips completed and distance travelled (**Eq.1**).
Total distance (round trip for each well) = 50 km

Trucks will transport approximately 20 m^3 per trip from a granular source within 25 km of each location. The GHG emissions vary per well site due to different fill volumes and distance from the source: the emissions during construction total **65.7 (t CO_2 eq)** per well (**Table 2**)

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[1] http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-road-transport.pdf

[2] http://www.grida.no/publications/other/ipcc_tar/

Table 2: GHG Emissions for Granular Fill Transport

Well Site	Fill Volume well pad, work camp and access road (m^3)	Number of trips	Total Distance (round trip - km)	CH_4 emission ($t\ CH_4$)	N_2O emission ($t\ N_2O$)	CO_2 emission ($t\ CO_2$)	CO_2 emissions ($t\ CO_2$ eq)
1 well	34,400	1,720	86,000	0.0069	0.0026	64.8096	**65.704**

Gaseous Emissions during Drilling phase

Drilling Rig Diesel Generators

Diesel generators will be used as a source of power supply for drilling. The generators will operate 24 hr/day throughout a drilling period of 88 days for each well.

Based on compilation of air pollution emission factors established by the U.S. Environmental Protection Agency (EPA), air pollutants generated from diesel oil combustion of 8 m^3/day for the Land Drilling Rig.

This will consist of carbon monoxide, nitrogen dioxide, sulphur dioxide, and methane at estimated concentrations shown in **Table 3**.

The total emission values are a worst case scenario for 2 drilling wells per block. The rig is powered by 4 diesel driven generator sets and each rated 400KVA to supply the rig site with power.

Table 3: Air pollution emissions from Drilling

Air Pollutant	Emission Factor (kg/TJ)	Emission of Air Pollutant (tonne/day/well)	Total Emission (tonnes)
Drilling Rig Century Generator and Camp Site – (8 m^3/day/well), 88 days per well, 2 wells			
Nitrogen Oxides (NO_x)	1,896	0.552	**97.2**
Sulphur Oxides (SO_x)	126	0.037	**6.5**
Carbon Monoxide (CO)	410	0.119	**20.9**

*Includes 53 days of drilling/well x 4 wells (including 8 contingency wells)

Sources: US.EPA, "Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources", Fifth Edition, January 1995; http://www.epa.gov/ttn/chief/ap42/ch03/bgdocs/b03s03.pdf.

Greenhouse Gases (GHG)

Combustion products from fuel use are the same whether the fuel is used for drilling, well testing or transportation. Regular maintenance of the power generators and equipment will be conducted to minimize fuel use and emissions. The main impact from these emissions is the emission of greenhouse gases and their contribution to climate change.

GHG emissions from diesel generators are estimated following the Tier 1 approach of IPCC (2006) for stationary combustion. GHG emissions are estimated using emission factors and global warming potentials for the three main greenhouse gases (CO_2, CH_4 and N_2O) according to:

$$CH_4\ Emission\ (kg) = Fuel\ Consumption\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgCH_4/TJ)$$

$$N_2O\ Emission\ (kg) = Fuel\ Consumption\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgN_2O/TJ)$$

$$CO_2\ Emission\ (kg) = Fuel\ Consumption\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgCO_2/TJ)$$

$$CO_2\ eq\ Emission\ (kg) = Fuel\ Consumption\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgCO_2\ eq/TJ)$$

where

CO_2 Fuel consumption = diesel use (L) x diesel density (0.8397 kg/L[3]) x 10^{-6} Gg/kg x 43.33 (TJ/Gg) x 10^{-3} (tonne/kg)

Default Fuel Emission Factors are 3 kg CH_4/TJ, 0.6 kg N_2O/TJ and 74,100 kg CO_2/TJ.

To calculate the total CO_2 equivalent GHG emissions, global warming potentials need to be used as some gases have a much greater greenhouse gas effect. The total CO_2 equivalent GHG emissions from fuel use by generators are obtained using an emission factor of 74,346.6 kg CO_2 eq/TJ (**Table 4**)

resulting in

$$CH_4\ Emission\,(tonnes\ CH_4) = Diesel\ Use\,(L)\ \ x\,1.0915\,x\,10^{-7}\ (tonneCH_4/L)$$

$$N_2O\ Emission\,(tonnes\ N_2O) = Diesel\ Use\,(L)\ \ x\ 2.183\,x\,10^{-8}\ (tonneN_2O/L)$$

$$CO_2\ Emission\ (tonnes\ CO_2) = Diesel\ Use\ (L)\ \ x\ 0.002696\ (tonneCO_2/L)$$

$$CO_2\ Emission\ (tonnes\ CO_2\ eq) = Diesel\ Use\ (L)\ \ x\ 0.002705\ (tonneCO_2\ eq/L) \quad \textbf{Eq. 2}$$

Table 4: Emission Factor for Fuel Use by Generators (Stationary Combustion)

Types	Unit	CH_4	N_2O	CO_2	Total
Diesel	kg/TJ	3	0.6	74,100	
	kg CO_2 eq*/TJ	69	177.6	74,100	74,346.6

Source: IPCC (2006)
* Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

GHG emissions are estimated following the Tier 1 approach of IPCC (2006) for stationary combustion (generators), mobile combustion (transportation), and fugitive emissions (flaring).

GHG emissions are estimated using emission factors for the three main greenhouse gases (CO_2, CH_4 and N_2O) and converted to carbon dioxide equivalent using global warming potentials using the procedures and equations described above and for the construction phase.

a) Estimated number of round trips for rig and support equipment: 130 trip per well.

b) Proposed transport route and duration of rig move: no firm location yet to move the rig.

An assumed value of 500 km will be used for worst case scenario. It is presumed that proposed transport route and duration for equipment & material move: Yangon (Thaketa or MITT port) to well site via the public highway.

Drilling Rig Transport:

It is estimated that the total number of truck trips required for equipment and supplies 130 trips per well for a maximum distance of 500 km. The distance between well sites is assumed to be a maximum of 100 km. The IOR-5 & IOR-7 drilling programs will be done with the same rig mobilization. Therefore the rig moves between all 4 well sites will be included in calculations (2 wells per block).

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[3] IEA (2004), Density of Oil Products, Energy Statistics Working Group Meeting

Table 5: Estimation of the distances between Yangon and rig sites

Location	Distance	Total Distance
Rig Mobilization	500 km * 130 trip	65,000 km
Rig Move	100 km * 130 trips * 3 moves	39,000 km
Rig Demobilization	500 km* 130 trips	65,000 km
	Total rig move distance	**169,000 km**

Total CH_4 released = 169,000 km x 0.08 x 10^{-3} kg CH_4/km = 13.52 kg CH_4

Total N_2O released = 169,000 km x 0.03 x 10^{-3} kg N_2O/km = 5.07 kg N_2O

Total CO_2 released = 169,000 km x 753.6 x 10^{-6} tCO_2/km = 127.36 t CO_2

Total CO_2 eq. released = 169,000 km x 0.000764 tCO2 eq/km = 129.12 ton eq. CO_2 (II)

CO_2 eq. released per well (129.12 ton eq CO_2 / 4 well sites) = 32.3 ton eq. CO_2

Equipment and Supplies

The drilling equipment and supplies will be transported to the site from Yangon (Thaketa or MITT port) to well site via the public highway. It is estimated that the total number of truck trips required for equipment and supplies is 30 trips per well. The total distance is 300 km per trip (Yangon to Myanaung). Therefore the total distance for equipment transportation is a total of 36,000 km. Using the mobile combustion emission factor (**Table 1** and **Equation 1**),

Table 6: Estimation of the distances between Yangon and rig sites

Location	Distance	Total Distance
Yangon to Myanaung	300 km * 30 trip * 2 well	18,000 km
	Total rig and equipments transport distance	18,000 km

Total CH_4 released = 18,000 km x 0.08 x 10^{-3} kg CH_4/km = 1.44 kg CH_4

Total N_2O released = 18,000 km x 0.03 x 10^{-3} kg N_2O/km = 0.54 kg N_2O

Total CO_2 released = 18,000 km x 753.6 x 10^{-6} tCO_2/km = 13.57 t CO_2

Total CO2 eq. released = 18,000 km x 0.000764 tCO2 eq/km = 13.75 ton eq. CO2(II)

CO_2 eq. released per well (13.75 ton eq. CO_2 / 2 wells) = 6.9 ton eq. CO_2

Drill Cuttings Transport:

Drilled cuttings and solid sludge will be generated by drilling the hole & centrifuging the and drying drilling mud, respectively. The dried drill cutting will be sent to a cement kiln or disposed as per PCMI BMP standards. The distance from well site to cement kiln is estimated to be a maximum of 300 km one way or 600 km roundtrip.

Each well will generate 2500 MT of cuttings to be incinerated. The cuttings will be transported via 9 m^3 skips. Each trip will contain 20 tonnes. Therefore each well will require 125 round trips to incinerate cuttings.

Location	Distance	Total Distance
Well site to Cement Kilrn (other other approved disposal site)	600 km * 125 trip * 2 well	150,000 km

Total CH_4 released = 150,000 km x 0.08 x 10^{-3} kg CH_4/km = 12.00 kg CH_4

Total N_2O released = 150,000 km x 0.03 x 10^{-3} kg N_2O/km = 4.50 kg N_2O

Total CO_2 released = 150,000 km x 753.6 x 10^{-6} tCO_2/km = 113.04 t CO_2

Total CO_2 eq released = 150,000 km x 0.000764 tCO_2 eq/km = 114.6 ton eq. CO_2(II). The CO_2 eq released per well is 57.3 ton eq. CO_2.

Additional Transportation

During the drilling phase, additional transportation involves fuel delivery and transport of water and personnel to and from the well site. Based on similar onshore project, diesel consumption for these additional transportation needs is 80L/day (2400 L/month). Total diesel consumption for drilling two well over a period of 12 months (88 days X 2 wells – not including contingency wells) is 14080 liters. Using the fuel use equations. (**Eq. 2**),

Total CH_4 released = 14,080 L X 1.0915 x 10^{-4} kg CH_4/L= 1.54 kg CH_4

Total N_2O released = 14,080L X 2.183 x 10^{-5} kg N_2O/L= 0.31 kg N_2O

Total CO_2 released = 14,080L X 0.002696 tCO_2/L= 37.96 ton CO_2

Total CO_2 eq released = 14,080L X 0.002705 tCO_2 eq/L= 38.09 ton eq CO_2

Drilling a maximum 2 contingency wells per site would triple the amount to 114.27 ton eq CO_2.

Total CO_2 eq. released is 38.09 ton eq CO_2.(III). The CO_2 eq. released per well is 57.14 ton eq. CO_2.

Heavy Equipment Use:

Based on previous experience, diesel consumption would be for operating heavy equipment, such as cranes, air compressors, cement pump unit, wireline logging, etc. Moreover, based on (“Air Quality – Health Risk Analysis of Onshore Pipeline Construction,” n.d.), diesel consumption for operating heavy equipment such as Trenching, pipelay and shore crossing construction is approximately total 120,104 gallon or 480,416 liters per well for approximately 90 days (88 days per well is mentioned by PCMI). Thus, total diesel consumption for drilling two wells (not including contingency wells) is 960,832 L Using the fuel use emission equations (**Eq. 2**),

Total CH_4 released = 960,832 L X 1.0915 x 10^{-4} kg CH_4/L= 104.9 kg CH_4

Total N_2O released = 960,832 L X 2.183 x 10^{-5} kg N_2O/L= 20.9 kg N_2O

Total CO_2 released = 960,832 L X 0.002696 tCO_2/L= 2590.4 ton CO_2

Total CO_2 released = 960,832 L X 0.002705 tCO_2 eq/L) = 2599.1 ton eq CO_2

Drilling a maximum 2 contingency wells per site would triple the amount to 7797.2 ton eq CO_2.

Total CO_2 eq. released = 7797.2 ton eq. CO_2(IV). The CO_2 eq released per well is 3898.6 ton eq. CO_2.

Diesel Generators to Power Drill Rig and Camp Site:

During drilling operations, generator for the drill rig and camp site consume 8,000 L/day (mentioned by PCMI) of diesel over a period of 88 days/well (mentioned by PCMI) of drilling for drilling 2 wells (not including contingency wells). Total fuel use is therefore 1,408,000 L. Using the fuel use emission equations (***Eq. 2***),

Total CH_4 released = 1,408,000 L X 1.0915 x 10^{-7} t CH_4/L= 0.15 t CH_4

Total N_2O released = 1,408,000 L X 2.183 x 10^{-8} t N_2O/L= 0.03 t N_2O

Total CO_2 released = 1,408,000 L X 0.002696 t CO_2/L= 3,795.7 t CO_2

Total CO_2 eq released = 1,408,000 L x 0.002705 tCO_2 eq/L = 3,808.6 ton eq. CO_2

The total release of CO_2 during the drilling phase is estimated to be as a worst case maximum of **3,808.6 ton of CO_2 eq.**

Drilling maximum 2 contingency wells per site would triple the amount to 11,425.9 ton eq CO2.

Total CO_2 eq. released = 11,425.9 ton eq. CO_2(V). The CO_2 eq. released per well is 5713.0 ton eqCO_2.

Summary of the Emissions

Table 7: Estimated GHG Emissions for Drilling phase per well

Project Phase	Activity	One Time CO_2 Release (ton CO_2)
Drilling	Drilling rig mobilization	32.3
	Equipment and Supplies	6.9
	Drill cuttings transport	57.3
	Transport (fuel, water, personnel)	57.1
	Heavy equipment use	3,898.6
	Generator to power drilling rig and camp site	5,713.0
Total per well		9,765.2

Emissions during Well Testing Phase

Diesel generators will be used as a source of power supply for testing. The generators will operate 24 hr/day throughout a testing period of 22 days per well.

The maximum flow during a DST test generally never exceeds 10 mmscfgd. Thus a worst case scenario flaring is a sustained flow rate of 10 mmscfgd for 7 days for one well at each of the two well sites.

Based on compilation of air pollution emission factors established by the U.S. Environmental Protection Agency (EPA), air pollutants generated from diesel oil combustion will consist of carbon monoxide, nitrogen dioxide, sulphur dioxide, and methane at estimated concentrations shown in **Table 8**. Estimated carbon dioxide emissions are discussed under Greenhouse Gases below.

Table 8: Estimated Air Pollutant Emissions for Well Testing Phase

Air Pollutants – Fuel Use	Emission Factor (kg/TJ)	Emission of Air Pollutant (tonne/day/well)	Total Emission (tonnes)
350-KVA Camp Site Generator (1.5 m^3/day/well) – 22 days per well, 2 wells			
Nitrogen Oxides (NO_x)	1,896	0.103	4.5**
Sulphur Oxides (SO_x)	126	0.007	0.3**
Carbon Monoxide (CO)	410	0.022	1.0**
Air Pollutants – Flaring	**Emission Factor ($lb/10^6$ Btu)**	**Emission of Air Pollutant (lb/day)**	**Total Emission (tonnes)***
Flaring max 10 mmscfgd or 10 x 10^9 BTU/day/well – 7 d/well for 2 wells			
Carbon Monoxide (CO)	0.37	3700	23.5
Total Hydrocarbons**	0.14	1400	8.9
Nitrogen Oxides (NO_x)	0.068	680	4.3

**Includes 22 days of testing/well x maximum of 4 wells

Sources: US.EPA, "Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources", Fifth Edition, January1995; http://www.epa.gov/ttn/chief/ap42/ch03/bgdocs/b03s03.pdf; http://www.eppo.go.th/ref/UNIT-OIL.html.

Note: Density of diesel oil is 0.8397 kg/L for calculation, IEA (2004), Densities of Oil Product, Energy Statics Working Group Meeting; Net Calorific Values is 43.33 TJ/Gg for calculation, IEA (2009), CO_2 Emission From Fuel Combustion, Documentation For Beyond 2020 Files

Greenhouse Gases (GHG)

Greenhouse gas emissions were calculated using the same methods described for the construction phase.

Diesel Generators to Power Equipment During Testing

Well Testing is assumed to perform 22 days/well. During testing, a generator typically consumes an estimate of 1,500 L/day of diesel over a period of 44 days of testing (22 days testing/well for a maximum of 2 wells), for a total of 66,000 L. Using the fuel use emission equations (**Eq. 2**):

$$\text{Total } CH_4 \text{ released} = 66{,}000 \text{ L X } 1.0915 \times 10^{-4} \text{ kg } CH_4/L = 7.2 \text{ kg } CH_4$$

$$\text{Total } N_2O \text{ released} = 66{,}000 \text{ L X } 2.183 \times 10^{-5} \text{ kg } N_2O/L = 1.4 \text{ kg } N_2O$$

$$\text{Total } CO_2 \text{ released} = 66{,}000 \text{ L X } 0.002696 \text{ t}CO_2/L = 177.9 \text{ ton } CO_2$$

Total CO_2 eq released = 66,000 L x 0.002705 tCO_2 eq/L = 178.5 ton eq CO_2(VI). The CO_2 eq released per well is 89.3 ton eqCO_2.

Condensate Transport during Testing

During testing, the produced reservoir fluids will be separated at the surface: the gas portion will be flared and the liquid portion will be further separated into water and condensate. The separated water will be stored in the dirty water pit or steel tanks and the separated emulsion-condensate will be stored in storage tanks and disposed by the proper method or directly flared on site. Therefore, the transport for condensate will not be included in the estimation.

The expected condensate-to-gas ratio is 25 bbl per mmscfd with flow rate of 10 mmscfd based on the data of the similar projects.

Source: The condensate-to-gas ratio is 20-30 bbl/mmscfd in DST tested well of West Katakolon onshore block *("Status of existing and possible new production in Greece," 2006) with flow rate of 15.7 mmscfd, and it is 20 bbl/mmscfd with flow rate of 5-7 mmscfd of DST tested well in Papua New Guinea* (Andrews, 2010).

*http://www.elliny.gr/includes/event/Xenopoulos_Roussos_AAPG_presentation.pdf

*http://www.interoil.com/investor-relations-news-and-press-releases/2010-2/antelope-2-horizontal-drill-stem-test-5-confirms-stabilized-condensate-to-gas-ratio-at-20-4-bblsmmcf/

Flaring During Testing:

GHG emissions from diesel generators are estimated following the Tier 1 approach of IPCC (2006) for stationary combustion. GHG emissions are estimated using emission factors and global warming potentials for the three main greenhouse gases (CO_2, CH_4 and N_2O) according to:

$$CH_4\ \mathit{Emission\ (kg) = Gas\ Flared\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgCH_4/TJ)}$$

$$N_2O\ \mathit{Emission\ (kg) = Gas\ Flared\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgN_2O/TJ)}$$

$$CO_2\ \mathit{Emission\ (kg) = Gas\ Flared\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgCO_2/TJ)}$$

$$CO_2\ \mathit{eq\ Emission\ (kg) = Gas\ Flared\ (TJ)\ x\ Fuel\ Emission\ Factor\ (kgCO_2\ eq/TJ)}$$

where

Gas flared = gas (10^6 scf) x 0.0283168 (m^3/scf) x 0.9 kg/m^3 x 10^{-6} Gg/kg x 48 (TJ/Gg) x 10^{-3} (tonne/kg)

Default Fuel Emission Factors are 5 kg CH_4/TJ, 0.1 kg N_2O/TJ and 56,100 kg CO_2/TJ (**Table 9**)

To calculate the total CO_2 equivalent GHG emissions, global warming potentials need to be used as some gases have a much greater greenhouse gas effect. The total CO_2 equivalent GHG emissions from fuel use by generators are obtained using an emission factor of 56,244.6 kg CO_2 eq/TJ resulting in

$$CH_4\ \mathit{Emission\,(tonnes\ CH_4) = Gas\ Flared}\ (10^6\ \mathit{scf})\ \ x\ 0.00612\,\mathit{(tonneCH_4/}10^6\ \mathit{scf)}$$

$$N_2O\ \mathit{Emission\,(tonnes\ N_2O) = Gas\ Flared}\ (10^6\ \mathit{scf})\ \ x\ 0.000122\,\mathit{(tonneN_2O/}10^6\ \mathit{scf)}$$

$$CO_2\ \mathit{Emission\,(tonnes\ CO_2) = Gas\ Flared}\ (10^6\mathit{scf})\ \ x\ 68.626\,\mathit{(tonneCO_2/}10^6\ \mathit{scf)}$$

$$CO_2\ \mathit{Emission\,(tonnes\ CO_2) = Gas\ Flared}\ (10^6\mathit{scf})\ \ x\ 68.8032\,\mathit{(tonneCO_2\ eq/}10^6\mathit{scf)}\ \ \textbf{Eq. 3}$$

Emissions are calculated based on volume of gas flared per day and the number of flaring days.

Table 9: Emission Factor for Flaring Natural Gas (Stationary Combustion)

Types	Unit	CH_4	N_2O	CO_2	Total
Natural Gas	kg/TJ	5	0.1	56,100	
	kg CO_2 eq*/TJ	115	29.6	56,100	56,244.6

Source: IPCC (2006)

* Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

GHG emissions from flaring during well testing are estimated by the amount of gas production (max 10 million scf/d/well) for a maximum 14 days (7 days * 2 well) to be tested, for a total of $140x10^6$ scf. Using the gas flare equations (***Eq. 3***):

Total CH_4 released = 140 x 10^6 scf x 0.00612 t $CH_4/10^6$ scf = 0.86 t CH_4

Total N_2O released = 140 x 10^6 scf x 0.000122 t $N_2O/10^6$ scf = 0.02 t N_2O

Total CO_2 released = 140 x 10^6 scf x 68.626 t $CO_2/10^6$ scf = 9,607.64 t CO_2

Total CO_2 eq released = 140 x 10^6 scf x 68.8032 t CO_2 eq/10^6 scf = 9,632.45 ton eq CO_2

The total release of CO_2 during the flaring phase is estimated to be as a worst case maximum of **9,632.45 ton of CO2 eq.**

Total CO_2 eq. released = 9,632.45 ton eq. CO_2(VII). The CO_2 eq. released per well is 4816.23 ton eq. CO_2.

Summary of Emissions

A worst case maximum gas flaring of 10 mmscfd/d was used in the calculation. It is quite likely that the amount of gas flared is less, which would reduce the amount of CO_2 emissions.

Table 10: CO2 emissions from Flaring per well

Project Phase	Activity	One Time CO_2 Release (ton CO_2)
Testing Activity	Generator to power beam pump	89.3
	Flaring	4,816.2
Total per well		**4905.5**

Emissions from Well Abandonment Phase

During abandonment and restoring well, similar onshore project used 140,000 L per site for 120 m* 120 m well pad, and it is estimated to use 102,200 L per site. Total fuel usage for 2 wells will be 204,400 L. Using the fuel use emission equations (***Eq. 2***),

Total CH_4 released = 204,400 L X 1.0915 x 10^{-7} t CH_4/L= 0.02 t CH_4

Total N_2O released = 204,400 L X 2.183 x 10^{-8} t N_2O/L= 0.004 t N_2O

Total CO_2 released = 204,400 L X 0.002696 t CO_2/L= 551.06 t CO_2

Total CO_2 eq released = 204,400 L x 0.002705 tCO_2 eq/L = 552.90 ton eq CO_2

The total release of CO_2 during the abandonment phase is estimated to be 552.90 ton of CO_2 eq. (IX). The CO_2 eq released per well is 276.5 ton eqCO_2.

Reference

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