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ระบบการจัดการสิ่งแวดล้อม





**ECO ORIENT ENERGY (THAILAND) LTD.
ECO ORIENT RESOURCES (THAILAND) LTD.**


ENVIRONMENTAL MANAGEMENT SYSTEM

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FOREWORD

ECO Orient Energy (Thailand) Limited and ECO Orient Resources (Thailand) Limited ("The Company") recognises that effective health, safety and environmental management contributes significantly to its long-term business success.

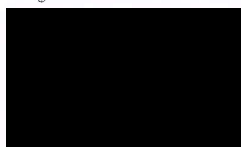
This document sets out The Company's social and environmental management system. It emphasises the systematic approach in the way we manage our business activities and our belief that our performance can always be improved over time. The integration of social responsibility and environmental protection into our day-to-day activities is the key to successful management.

The application and success of this system requires the participation and commitment of management, employees and contractors at all levels.

This policy and management system has the Board's full support but we require your commitment through a personal understanding of this document and full participation in the effective implementation of the system.

It is imperative that everyone involved in the business of The Company familiarise themselves with their roles and responsibilities in this document. Only by total commitment by everyone can we ensure the best possible protection of our personnel, contractors, the public, our assets and the environment.

Signed




General Manager

Date: 25 July 2013

Area of Application

The policies and associated Environmental Management System (EMS) apply to the activities of ECO Businesses in Thailand.


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Environmental Management System

**ECO Orient Energy (Thailand) Ltd.
ECO Orient Resources (Thailand) Ltd.**

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Executive Summary

It is the policy of The Company to conduct its activities in such a way as to take foremost account of the health and safety of employees and all other persons that come into contact with its activities. The Company will endeavour to give dutiful consideration to the protection of the environment, and to pursue a policy of continual improvement of all health, safety, social and environment issues.

The company also strives to maximize public understanding of the proposed projects and activities through information and exchange between the project proponent and the communities in the vicinity of its operations that might be affected directly or indirectly by the proposed project activities.

The Company's Environmental Management System is designed around its operating experience in the SW1, L33/43 and L44/43 concession, basing it on known hazards, existing controls and building on the existing principals and guidelines. It enables the Company's management to obtain assurance that hazards and effects are identified and controlled to an agreed standard.

The Company's Environmental Management System Manual is divided into six sections, described briefly below:

Section 1:

Identifies the Company's personnel who are directly involved in the Social and Environmental Management System particularly highlighting senior staff members and those involved in operational or onsite supervisory roles.

Section 2:

The Company's HSE Policy Statement is presented in Section 2.


Section 3:

Sets out the Company's Oil Spill Contingency Plan (OSCP). This is designed in such a way that in the event of an oil spill, either on location or off-site, a clean-up process can be quickly and efficiently initiated and the appropriate authorities notified. The OSCP includes listings of priorities, the level of response required related to the severity of the spill and provides a list of emergency contact numbers. Oil spill clean-up techniques and oil spill equipment available both on and off-site are provided in the appropriate appendices.

Section 4:

The Company's environmental management plan is presented in this section. The management plan is based on the outcome of the environmental impact assessments performed by certified independent third party consultants. Methods of mitigating the risks are subsequently employed so that their potential impact can be prevented or reduced.

The establishment of baseline monitoring stations and the systematic monitoring of environmental parameters, at each phase of the operations, are performed to assess the on-going environmental conditions which measure any changes from the original environmental conditions. Follow up procedures including internal and third party audits are also performed to access the performance and effectiveness of the mitigation measures.

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Corrective or remedial actions are performed in the event of non-compliance issues or if parameters are found to be in excess of environmental quality standards due to the Company's activities.


SECTION 1:

1. Listing of Concerned Personnel in Environment Management System

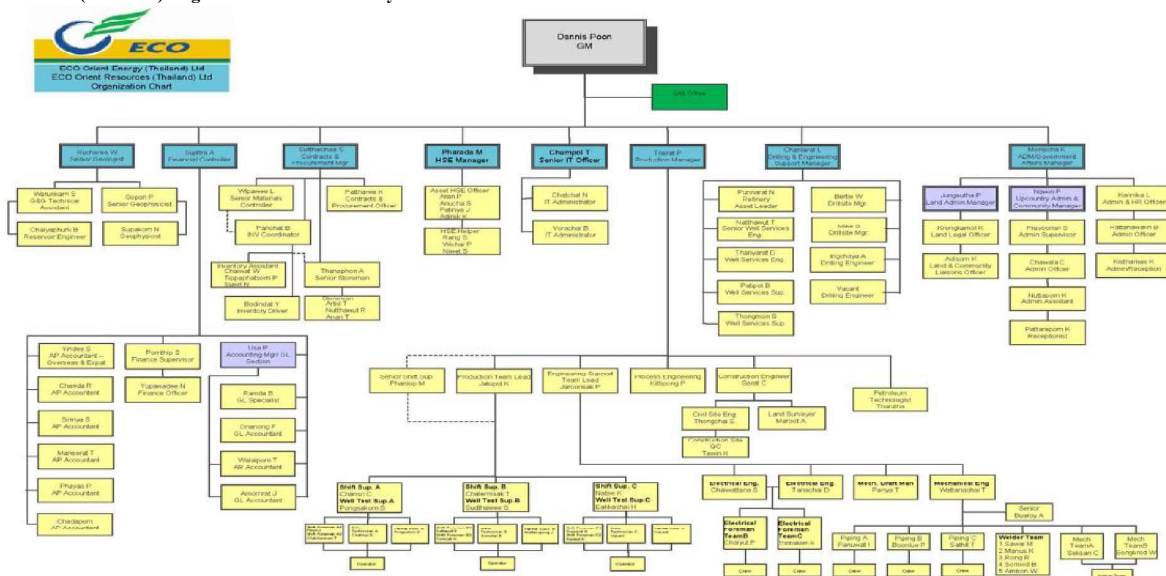
The protection of the environment and the impact of the Company's operations have upon the environment represents a fundamental concern for all personnel employed by the Company.

The key to the successful management of environmental concerns, however, lies with those in management and supervisory positions, who are also directly involved with the production and drilling operations at SW1, L33/43 and L44/43 concessions. Such staff members have a direct impact on the environmental decision making process and may use their expertise and supervisory roles to convey the Company's environmental policy and environmental management procedures to other on-site employees, contractual staff as well as those involved in off-site activities such as transportation.


Company staff with a pivotal role in the environmental management process are shown in highlighted boxes on the Organization Chart attached.

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ECO (Thailand) Organization Chart January 2013



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SECTION 2:

2. ECO Orient Energy Health, Safety and Environmental Policy & Objectives


Health, Safety and Environment (HSE) Policy

ECO & ECOR pledges to conduct its operations in a manner which poses no risk to the health, well-being and safety of its employees, contractors, customers and the public at large and to make every effort to protect the environment and ensure sustainable development.

Therefore, ECO & ECOR strives for achieving the following HSE objectives:

- To strive for ensuring health & safety at work and to minimize HSE and climate change risks;
- To achieve a standard of zero accidents and high standard of environmental care through continuous improvements;
- To eliminate HSE hazards in its operations, applications and services;
- To carry out necessary HSE assessments to all major projects and to conduct periodic HSE audits to its operations;
- To promote HSE awareness and consciousness among employees, contractors and business associates through education and training;
- To achieve full compliance with all relevant legislation;
- To use environmentally-friendly materials and technologies, promote economic recycling of materials and conserve resources.

We ask that managers ensure that this Policy is fully explained to and then observed by subordinates and by all contractors under their supervision. Managers' performance is judged, in part, by the HSE performance of their unit.




All employees and contractors are responsible for:

- Assuring their own health and safety and the health and safety of others affected by their actions;
- Following HSE rules and procedures and obeying statutory HSE regulations;
- Exercising professional judgment and cautiousness in order to prevent accidents;
- Identifying and eliminating HSE risks in their work environment.

The HSE Department is responsible for the development and periodic review of this Policy, for designing and administering HSE programmes and training courses, for distributing HSE information, for monitoring and auditing the performance of this Policy. The HSE Department is also an advisory and consultative resource for managers and employees to interpret and implement this Policy.

We ask that all employees actively support this Policy and do all they can to fulfill its objectives.

1 February 2013
Issue No.1

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Section 3:

3. Oil Spill Contingency Plan (OSCP)

The Company as Operator has a financial responsibility and legal requirement to clean-up any pollution arising from its operations. The Company is committed, however, to operate at all times in such a manner as to minimize the risk of oil spills, blowouts or chemical leakage. In the unlikely event that such an incident occurs, the following OSCP provides guidance on the appropriate actions that will be undertaken.

During petroleum exploration, testing and production there are risks for minor and major oil spills. Due to the high viscosity and pour point, the crude oil is not very mobile and can be easily contained and removed with shovels. However, other spills such as fuels and motor oils are also considered.

The Company has developed an oil spill contingency plan covering all drilling, testing and loading operations. The plan identifies three levels of response and the Emergency Organization and actions required to successfully coordinate the Company's clean-up to the response.

Priorities

The following priorities need to be observed:

1. The prevention of emergencies;
2. The safety and saving of life;
3. Protection of the environment; and
4. Salvage of equipment and installations

Levels of Response and Procedures


There are four levels of response relating to accidental discharges:

Oil Spill Classification:

- Housekeeping Oil Spill <1 to <3 bbls, that can be dealt with using onsite equipment deployed by local staff;
- Level 1: (Minor Oil Spill) >3 to < 50 bbls, that can be readily be cleaned-up by field personnel using locally available equipment;
- Level 2 (Significant Oil Spill) >50 bbls to <100 bbls, that requires additional manpower and supplemental resources or third party companies;
- Level 3 (Major Oil Spill) >100 bbls, that overwhelms the response capability of operator, requiring mobilization of personnel and resources of the central executive bodies and international specialized responders.

Housekeeping Spills:

This refers to on-site spills less than 3 bbls, which are contained and can readily be cleaned-up by field personnel using equipment maintained on site.

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Housekeeping Response Procedures:

Emergency Organisation

Operations Co-ordinator: On-site Shift Supervisor

Job Responsibilities of Operations Co-ordinator

1. Ensure safety of all personnel
2. Ensure that the discharge is cleaned-up properly and that the sites containment facilities have not been breached.
3. Fill out an Incident Report Form. The completed form should be sent to the Production Leaders, Production Manager, HSE Manager and GM respectively.

Level 1:

Minor spills from 3 bbls to 50 bbls that do not affect normal operations and can readily be cleaned-up by field personnel using locally available equipment.

Level 1 Response Procedures

Emergency Organisation

Operations Co-ordinator: On-site Shift Supervisor

Job Responsibilities of Operations Co-ordinator

1. Ensure safety of all personnel
2. Ensure that the discharge is cleaned-up properly and that the sites containment facilities have not been breached.
3. Fill out an Incident Report Form. The completed form should be sent to the Production Leaders, Production Manager, HSE Manager and GM respectively.

Level 2:

- Significant spills from 50 bbls to 100 bbls when the discharge can still be contained but requires additional manpower and supplemental resources or third party companies to clean up the spill. An example of this would be a ruptured tank.


Level 2 Response Procedures

Emergency Organisation

Operations Co-ordinator: On-site Production Leader

Bangkok Office:

Production Manager
HSE Manager
General Manager

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A press statement may be arranged between the General Manager (Thailand) and the Executive VP & GM of ECO Environmental Investment Ltd. (Hong Kong).

Emergency Services Contact Numbers and Call-out Procedures

The Production Manager from the site should contact the Emergency Services.

Police

In the event of a major discharge, the Police provide control of traffic to and from the incident area. Where a number of services are involved and no suitable communications centre is available, the police can provide a control and co-ordination post to facilitate clearance operations.

Wichian Buri: 056 791-306
056 754-075

Fire Brigade

The Fire Brigade should attend all incidents where a risk of fire or ignition is present. If a fire occurs, the Senior Fire Service Officer assumes control of the incident until the fire is extinguished.

Wichianburi: 056 791-388

Hospital

The Hospital Service should be called as necessary.

Wichian Buri : 056 791-211

Clean-up Contractors

ECO Orient Energy/Resources (Thailand) Ltd. has made arrangements with government licenced hazardous waste transporters and disposal companies to provide oil spill containment and clean-up and disposal services in the event of a Level 3 incident.

Call-out Procedure

In the event of a Level 3 incident, clean-up contractors should be called and told what level of response is required (e.g. standby, full call-out).


Government Departments

In the event of a Level 3 incident, the General Manager should notify:

Department of Mineral Fuels (DMF)

Dr. Songpope Polachan

Director General
555/2 Energy Complex B, 21th Floor

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Viphavhadi-Rangsit Road,
Chatuchak, Bangkok 10900
Fax: (662) 202 3702 Ph: (662) 793 8300
Cellphone: (668) 1810 1054

Local Authority Contact Numbers

The Emergency Controller should notify the following agencies in the event of any offsite spills Level 1, 2 or 3 incidents, if appropriate:

L33/43 and L44/43 Concession Areas

District Offices
Muang Phetchabun: 056 721-853 / 056 711-030
Wichian Buri: 056 791-567
Si Thep: 056 799-497

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Section 4

4. Environmental Management System

The Environmental Management System is divided into five main categories as follows:

1. Identifying potential environmental impact and risks;
2. Managing and mitigating the potential impacts;
3. Environmental Monitoring and Mitigation Compliance Auditing;
4. Reporting and Documentation;
5. Environmental Management for Potential Impacts;

4.1 Identifying Potential Environmental Impacts and Risks

An environmental impact assessment (EIA), encompassing risk assessment and social impacts, is performed by a third party consultant for each exploration and production project. In addition, community attitude surveys are performed twice a year and a health impact assessment is performed and updated on a yearly basis.

4.2 Managing and mitigating the potential impacts

The potential impacts identified in the EIA studies can be prevented or reduced by employing the mitigation measures recommended in the EIA. Mitigation measures have been

4.3 Environmental Monitoring and Mitigation Compliance Auditing


The regular internal and third party auditing schedule ensures the environmental management plan stated in the EIA is implemented. This includes the monitoring of environmental components and the measures required to

The auditing system consists of the following:

4.3.1 Monitoring

The monitoring measures stated in the EIA are comprised of:

- Environmental Monitoring;
- Social Attitude Monitoring;

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Environmental monitoring measures the key characteristics of operations that can have a significant impact on the environment. It provides the means of measuring performance against established requirements (objectives, targets, and performance criteria).

Baseline surveys are conducted to provide information on the chemical and biological environment relevant to the field before start-up of production or drilling operations. Subsequent, on-going monitoring provides data on waste-stream emissions in order to ensure an on-going assessment of operating standards and data to measure any recordable changes from the original environmental conditions.

Monitoring determines:

- The types and quantities of substances entering the environment
- Where the substances go
- The effect of substances on the biota
- Environmental change over time

The following is monitored during exploratory drilling:

- Weather
- Drilling waste volumes and type

During production, the following is monitored:

- Quantities of water disposed
- Volumes of other waste generated and disposed

The following surveys are undertaken and reported on prior to the start-up of any SW1A operation that requires the construction of a new site. The surveys continue during the operation and also for a given specific time-period after the decommissioning of any particular site.

4.3.1.1 Groundwater Quality Monitoring

Although surface casing is set at around 80 to 100m to protect surface aquifers, groundwater quality is monitored to determine whether locally used aquifers have been contaminated by drilling or production activities. As a potassium sulphate drilling fluid is used, SO₄ monitoring can act as a useful tracer to determine seepage of any drilling fluid into aquifers.

Sampling is undertaken as follows:

Monitoring Stations:


Exploration Phase: Nearest available groundwater wells up and down flow from the proposed wellsite location.

Production Phase: Onsite monitoring wells up-flow and down-flow from the wellhead.

Frequency and Duration

Drilling Phase:

- During the EIA study prior to a site preparation (for areas with now previous baseline data);
- One week after any drilling activity ceases;

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Production Phase:

- After site construction;
- One week after production drilling;
- Annually thereafter.

In addition, groundwater samples are taken in the event of a level 2 spill at onsite monitoring wells (in the event of an onsite spill) and at groundwater wells within 50 to 100m of any offsite level 2 spills.

Parameters

pH,
Conductivity,
Total Petroleum Hydrocarbon (TPH),
HMs; Cu, As, Cd, Cr, Hg, Mn, Pb, Zn, SO₄, Fe, Ni

Samples are analysed for the following parameters:

- Salinity parameters: total alkalinity, fluoride, orthophosphate-phosphorus, pH, specific conductivity, chloride, nitrate-nitrogen, sulphates, total dissolved solids.
- Oil parameters: oil & grease, diesel hydrocarbons (C10-C28), heavy oil (C28-C36), gasoline hydrocarbons (2-methylpentane to 1,2,4-trimethylbenzene) and BTEX (benzene, toluene, ethylbenzene, xylenes).
- Other parameters: calcium, iron, magnesium, potassium, sodium, arsenic, barium, cadmium, chromium, copper, lead, manganese, selenium, zinc, mercury, cyanide.

Dissolved metals are analysed in the initial sampling run only. Because the majority of these parameters had low levels in the baseline surveys, sampling and the produced water sample did not contain any metals. A further analysis is carried out to confirm these trends. If levels are similarly low, then further analysis of dissolved metals is not carried out for any remaining sampling runs.

4.3.1.2 Surface Water Quality

Water quality is sampled at the same location as follows:

Frequency


- Immediately prior to a site preparation
- Immediately prior to drilling
- Immediately after drilling ceases
- Annually thereafter during production

Parameters

Samples are analysed for the following parameters:

- Salinity parameters: total alkalinity, fluoride, orthophosphate-phosphorus, pH, specific conductivity, chloride, nitrate-nitrogen, sulfate, total dissolved solids.
- Oil parameters: oil & grease, diesel hydrocarbons (C10-C28), heavy oil (C28-C36), gasoline hydrocarbons (2-methylpentane to 1,2,4-trimethylbenzene) and BTEX (benzene, toluene, ethylbenzene, xylenes).
- Dissolved metals: calcium, iron, magnesium, potassium, sodium, arsenic, barium, cadmium, chromium, copper, lead, manganese, selenium, zinc, mercury and cyanide.

Dissolved metals are analysed in the initial sampling run only. Because the majority of these parameters had low levels in the baseline surveys, sampling and the produced

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water sample did not contain any metals. A further analysis is carried out to confirm these trends. If levels are similarly low, then further analysis of dissolved metals is not carried out for any remaining sampling runs.

4.3.1.3 Soil Quality Monitoring

Soil quality is sampled at two locations outside the boundary of any new site in preparation, 1 upstream of the groundwater gradient, the other downstream.

Frequency

- Immediately prior to site preparation
- At the end of the first year of operations
- Every 5 years thereafter

Parameters

Samples are analysed for the following parameters:

- Oil parameters: oil & grease, diesel hydrocarbons (C10-C28), heavy oil (C28-C36), gasoline hydrocarbons (2-methylpentane to 1,2,4-trimethylbenzene) and BTEX (benzene, toluene, ethylbenzene, xylenes).
- Total metals: calcium, iron, magnesium, potassium, sodium, arsenic, barium, cadmium, chromium, copper, lead, manganese, selenium, zinc, mercury.
- Conventional chemistry parameters: cyanide, sulphates, orthophosphate-phosphorus.

4.4 Reporting and Documentation

The following reports are generated on a daily basis and cover the day-to-day operations at all concessions.

4.4.1 Daily Production Report

A Daily Production Report includes the amount crude oil produced over the last 24 hours and its properties and the amount of BS&W. Also recorded are any incidents, accidents, unsafe acts or environmental issues that have occurred at the production sites.

4.4.2 Daily Drilling Report


For well control purposes it is standard practice to monitor the time breakdown of activities at the rig site. The current depth of the well, geological prognosis, weather, mud volumes, mud weight and circulation rate are recorded. Also included are any mud volumes and the amount and nature of cuttings that have been produced into the sump.

4.4.3 Other Reports related to Environmental Issues

The following reports are produced by ECOE/R at the conclusion of drilling a well or in the event of an incident:

End of Well Report

Daily data is supplemented by end of well reports (after the well has been drilled and flow tested), which contain information on the composition and properties of the hydrocarbon (volumes of gas, condensate, oil and water; chemical content; oil gravity; gas gravity etc.).

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Accident/Incident Report

Should any accident or incident occur during the day-to-day operational activities then the on-site company representative files an accident/incident report to the Bangkok office. Such a report may record an environmental incident, its causes and its immediate impact on the environment. The report should also include any clean-up measures that have been undertaken and their effectiveness in reducing or cancelling the impact of the incident.

4.5 Environmental Management for Potential Impacts;

4.5.1 Management of Pollution from Noise and Vibration - Exploration

Sources of Impact

During drilling significant noise and vibration is emitted from the drilling rig, the drilling rig engine and generators. The noise is characterized as a continuous monotone, low pitch emission. Other sources of noise and vibration emissions include medium pitch noise and vibration emissions from the diesel powered generators on the rig site and variable pitch noise and vibration emissions from the rig engine as it is engaged to power the draw-works and rotary table.

Evaluation of Impact

The General low pitch of the drilling noise is such that it is difficult to detect during normal daytime activity only a small distance from the drilling site. The 24 hour nature of drilling means that during quiet night time hours there is more potential for the local community to hear the drilling noise at levels above that of the normal ambient background noise.

The distance to the nearest village and the nature of the sound of drilling activity indicates that the environmental impact is likely to be minimal even in the quiet hours of darkness. Similarly vibrations from drilling activities, emanating from the rig engines, drill bit and the drill string will be only detectable within close proximity (less than 500m) to the drilling rig. It is expected that the environmental impact of vibrations on the nearest communities will be minimal.

Management Controls


In the event of drilling activity being unacceptably close to a rural settlement as far as noise and vibration levels are concerned, then ECOE/R will erect temporary sound barriers between the drilling rig and the settlement so that the effect from noise and vibration from the rig is reduced to more acceptable levels.

4.5.2 Management of effects from drilling

Cuttings and Drilling Fluids – Water-based Muds

Sources and Evaluation of Impact

Leakage or overflow of cuttings and waste drilling fluids has the potential to contaminate surface waters, soils and ground water, with subsequent effects on agricultural crops and aquatic flora and fauna.

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The cuttings and fluids contain potassium chloride and possibly 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. Cuttings and fluids may also contain heavy metals, which may contaminate soils and affect the growth of agricultural crops.

The relatively low volumes of cuttings produced during the 1000m +/- wells drilled by ECOE/R are unlikely to cause major local environmental impacts, particularly as storage capacity is well in excess of the volumes expected. 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.

Examination of the local geology indicates that high levels of potentially polluting heavy metals are not expected. The greatest quantities of component chemicals in the drilling fluids mud are normally PHPA polymer and potassium chloride. Reference to chemical safety data sheets for these constituents shows that both these chemicals are of low or zero toxicity.

Management Controls

ECOE/R plans to use potassium sulphate PHPA water based mud (WBM) for exploration appraisal and development wells. Water based muds have been shown to be non-toxic and have negligible impact on the environment. However, to ensure that minimal amounts of mud will be discharged to the sump, the cuttings are separated from the mud via a solids control system-vibrating shale shakers and a centrifuge system. The mud is not disposed of, but is stored in drums or tanks for reuse in future drilling campaigns.

ECOE/R permanently disposes of cuttings and associated fluids into a specially compacted and impermeable PVC-lined sump on-site. The sump is constructed to a height one meter above the site, which is above the wet weather groundwater level. This will ensure that contaminants will not be able to leach into the groundwater or soils.

Exhaust and GHG Emissions


Sources and Evaluation of Impact

The air emissions will be the products of combustion from the diesel engines, carbon dioxide (CO₂), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulphur dioxide (SO₂). Emissions will only continue during the short 2-week drilling program.

Exhaust fumes emissions will disperse quickly into the clear rural air and cause no discernable air pollution.

4.5.3 Management of the effects of production processing

Facilities Installation

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Sources of Impact

The activities involved in establishing a site for production include the digging of trenches for the installation of electricity and water lines to the site. It also involves setting up buildings on site, and the establishment of the oil/gas heater and separation equipment vessels, pipe work and storage tanks.

The installation phase of any production facilities project will be marked by a short phase of transport activity where the processing and supporting infrastructure will be trucked to the site. Production chemicals will also be brought in to the site by truck. The transportation activity will usually have a relatively short duration of 1 to 2 days. The number of truck movements is about 5 to 6 per day.

Evaluation of Impact

There is expected to be some mild dust emissions due to the truck movements on the rural roadways leading to the site. For the majority of the journey of trucks will be on sealed roads, but often a compacted, laterite rig road lies between the highway and the site (up to 1 km). The potential for dust emissions is estimated as moderate, and may result in a short-term reduction in air quality, although the reduction in air quality is likely to be localized and of short duration.

The transport activity is also likely to cause a certain amount of localised noise of short duration. The noise levels will not be more than that associated with the movement of large trucks. The noise levels are expected to be similar to the agricultural-related which operate in the area.

The establishment of the production site has the potential to affect the local aesthetics. The effects are considered moderate, as the current production facilities do not dominate the local landscape, even if slightly visible from the main highway. The nearest village is 2km away from current production facility sites.

Management Controls


Vehicle movements would normally be restricted to daylight hours and should not disturb villagers during the hours of darkness, the time of lowest ambient noise. The number of vehicle movements will also be kept to the safe minimum; this will have the effect of:

1. reducing the exposure time of the drivers to traffic
2. reducing the amount of dust, noise and exhaust emissions
3. reducing the number of transport loads through settlements

Petroleum Extraction

Sources of Impact

The physical extraction of hydrocarbons and associated fluids from the reservoir could have a number of impacts. There is a possibility of very slight noise from the continuous operation of beam pumps and moderate noise from at surface jet pump delivery pumps.

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Soil quality could possibly be environmentally impacted, through contamination of the area around the well bore by oil.

Evaluation of Impact

Noise emissions from beam pumps, although long-term, are low and are not expected to rise above background ambient levels, even during the hours of darkness. The nearest community is too far away from any current production sites for noise to become a nuisance. The impact from noise can best be described as moderate to minimal. Jet pump delivery pumps will possibly require sound proofing in the longer term depending on the noise profile.

Soil around a well bore may well become contaminated with oil. This oil may contaminate the soil on the laterite pad, and wash off during storm events to the liquid storage sump. The contamination of the laterite pad is of minimal significance as the soil can be removed and treated offsite. The compacted nature and design of the pad will not allow oil to permeate to groundwater. Oil will wash to the sump during rainfall events, and be captured. Overflow from the sump, however, may allow hydrocarbon-contaminated waters onto adjacent agricultural land if not cleaned up regularly.

Management Control

ECO/R ensures that any crude oil leaked or spilled via the extraction process on to the laterite pad is immediately cleaned. Should a beam pump need to be located close to a settlement such that the noise from the pump rises above the ambient noise of the settlement, then ECO/R will provide a shield between the pump and the settlement.

Produced Sand Disposal

Sources of Impact

Sands will be produced during the production phase of any project. The sand is brought up with the crude oil. Burning it in a small high temperature incinerator treats the sand. Waste incinerator gases will be released to atmosphere and the resultant incinerator ash will be land filled on site.

Evaluation of Impact


The use of an incinerator leads to the release of combustion product gaseous emissions to atmosphere. Carbon monoxide, carbon dioxide, nitrogen dioxide and sulphur dioxide will be released in small quantities when sand is being burnt.

The relatively small volume of sand produced implies that the volumes of waste gasses produced will also be too small to have a major impact local air quality.

Separation Processes

Sources of Impact

The separation process involves the transfer of well fluids via pipes to the heater-treater, where produced gas is used to heat and separate the oil from water. The crude

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oil is then piped to heated storage tanks and separated produced water is disposed to the sump.

Evaluation of Impact

The operation of pumps and other machinery will emit combustion gases resulting in localized air quality reduction, and will also generate localized noise. Air emissions are likely to be small and will disperse quickly in the atmosphere. There may be some small process emissions during the operational phase but these will be small and will also not adversely impact the local air quality.

If there is a leak or spill during the separation process, then there is the potential for contamination of the laterite pad. Wash during storm events may carry the oil into the sump or into neighboring agricultural areas. This may cause some impacts on aquatic and terrestrial flora and fauna. Small leaks are likely to cause only moderate impacts on soil and surface water quality. Air emissions, and the potential for spills, are predicted to have only moderate potential environmental impacts.

Management Control

An Oil Spill Contingency Plan is in place (see Section 3). Oil spill equipment is available both onsite and available locally (Appendix I and II) should a leak or spill occur during the separation process.

Product Storage and Transfer

Sources of Impact

The transfer of crude oil from the storage tanks to the transport vehicles may lead to the minor spillage of product.

Evaluation of Impact

If there is a leak or spill during these operations, then there is the potential for contamination on the laterite pad. Wash through during storm events may carry the oil into the sump or into neighboring agricultural areas. This may cause some impacts on aquatic and terrestrial flora and fauna. Small leaks are likely to cause only moderate impacts on soil and surface water quality.


Management Control

An Oil Spill Contingency Plan is in place (see Section 3) and Oil spill equipment (Appendix I & II) is available onsite should a leak or spill occur during the separation process.

All bunding should be checked for coherency and capacity to contain at least the volume of fluids in storage.

4.5.4 Management of other wastes

Waste Gas Flaring and Venting

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Sources of Impact

The flaring of waste gas as a result of the production separation processes has the potential to negatively impact the local air quality. Crude oil is heated and the liquid fractions separated from the gaseous phase. Much of the gas produced, however, is recycled to heat the separation equipment, but a small proportion of the gas is flared. The emissions to air will be carbon dioxide, carbon monoxide, nitrogen dioxide and sulphur dioxide, along with negligible amounts of methane and ethane.

Evaluation of Impact

The local air quality is good, although periodic wide-scale agricultural burning occurs. The use of flaring does, however, almost entirely eliminate the need to vent off volatile hydrocarbon gases which are more likely to have an effect on workers or community health and safety. The health and safety impacts of the comparatively small-scale flaring occurring at the SW1A concession are considered negligible.

The main impacts surround the emission of greenhouse gases such as carbon dioxide and gases of concern such as oxides of sulphur and nitrogen. The amount of gas flared is miniscule in comparison with other oil and gas, and industrial applications and flare height is usually less than one meter. This taken together with limited other air pollution sources suggests that local dispersion and replenishment rates should easily exceed the emission rates from the site. Also of significance is the large buffer zone between SW1A exploration and production sites and local villages. This zone allows for sufficient dispersion so that odour or poor air effects are not likely to be encountered by the local population.

Also of note are the chemical characteristics of the production gas. The gas is comprised of light fraction hydrocarbons, which will be completely combusted on flaring. This will result in the very small levels of particulate matter, which will help to eliminate soot and dust fall out. For this reason ground based effects are considered likely minimal, and the removal of hydrocarbon smokes reduces the potential for negative visual impacts.

Fugitive emissions from a plant of this small scale are considered to be too small to produce significant impacts.

Air pollution impacts from production gas flaring are moderate to minor, with no ground-based or visual impacts.

Management Control

A daily record is kept of the height and quality of burning of the flares.

Produced Water Treatment and Disposal

Sources of Impact

Water is separated from the crude oil by an oil/water separator and the heat separation processes. After treatment the produced water still contains some residual hydrocarbons, metals and other contaminants from the geological formation and the production process.


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Table 1 : Comparison of produced water with baseline groundwater monitoring results

Parameter	Units	Reporting Limit	Produced Water	Groundwater
Total Alkalinity	mg/L	5.0	759	101
Fluoride	mg/L	0.100	0.700	0.16
Orthophosphate-phosphorus	mg/L as P	0.020	0.0540	0.087
pH	pH units		8.56	6.31
Specific Conductivity	uS/cm	1.00	3750	200.96
Chloride	mg/L	0.100	729	8.6
Nitrate-Nitrogen	mg/L as N	0.0500	0.288	0.63
Sulphate	mg/L	2.00	5.25	2.4
Total Dissolved Solids	mg/L	10	2190	182
Oil & Grease	Mg/l	2	21-51	3.6

Source: NCALABS Co., Ltd (Thailand), July 99

A comparison of the data provided in Figure 5-1 above indicates that the levels of specific conductivity, chloride and total dissolved solids are significantly higher in the produced water than the in the baseline groundwater quality. Alkalinity and pH data also indicate the produced water may be slightly alkaline, compared to the baseline groundwater. Finally the results show that oil & grease levels in the produced water are higher than the background groundwater quality.

Evaluation of Impact

Storage of produced waters in sumps will allow for evaporation, as a result salinity levels will increase as the liquids concentrate. Spillage and or high rainfall could cause the sump to overflow and as a result the produced water may be potentially polluting, and cause detrimental effects to soil, surface and groundwater if discharged. Saline and alkaline discharges to soil may affect rice crops and other sensitive terrestrial flora in the area. Hydrocarbons may affect crops, flora and some terrestrial species. Spillage and overflow are considered to be a moderate impact risk. It is planned to re-inject the produced water into a sealed sub-surface geological structure, thus further reducing the risk of surrounding land and water contamination.


Management Control

Sumps have been designed so that they are above the local water table and are lined with an impermeable PVC liner. In General the sumps have also been designed to carry a capacity of approximately 2 years of production water. This volume allows for seasonal rainfall, without overflow. The levels of produced water in the sumps are monitored on a daily basis.

On-site Sewage Systems

Sources of Impact

Sewage is produced from the toilet facilities in place on-site. The waste domestic sewage is treated in septic tanks. The septic tank system has a herringbone drainage

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system with a sand filter at its base. This septic tank effluent soaks away to the surrounding soil where it receives natural biological treatment.

Evaluation of Impact

The potential impacts are related to a degradation of soil, surface and ground water quality. The main issues are biological contamination and an increase in water nutrient levels. As the groundwater and surface waters at the site are not used for drinking purposes, no impacts are expected from the natural drainage of septic tank effluent. The toilet facilities are only used for a short period of time during drilling operations (up to four weeks), or used only sporadically during the production phase.

Management Control

Septic tank levels are regularly monitored by ECOE/R. Local contractors are employed to empty full tanks.

4.5.5 Management of effects from a well blow out

ECOE/R employs a number of measures in order to prevent a petroleum blow-out. As well as using standard Well Control Procedures and staff trained in well control procedures, ECOE/R employs:

- Seismic surveys and archive well database to accurately determine potential risk
- A mud system
- A Blow-out Preventer Stack (BOP) with shear rams
- A qualified Drilling Supervisor

These measures are described in more detail below.

Seismic surveys and archive well database


The thorough interpretation of the available 3D seismic survey over the SW1A concession, combined with data gathered from previous wells drilled in the area ensures that a detailed database exists of the geology and formation pressures likely to be encountered by drilling. This enables the design of the mud program, where mud-weights will be maintained higher than the predicted formation pressures. Interpretation of the seismic surveys may also indicate if an area selected for drilling is prone to shallow gas pockets.

The Mud System

If sufficient pressure were not maintained on porous and permeable formations while drilling, the pressured fluid contained within the reservoir units (hydrocarbon or water combinations) would enter the well bore and flow to surface. The normal method of maintaining control pressure is to provide a full column of mud in the well bore in order to exert sufficient excess pressure at the formation face. This overbalances the natural pressure in the formation and holds formation fluids in place.

Loss of overbalancing pressure from a column of drilling mud can occur in one of two ways:

- The bit can penetrate an unexpectedly high-pressure, porous and permeable formation, the fluids from which can lift the mud column. Should higher than

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anticipated pressures be encountered in the formation being drilled, extra weight is added to the mud to counter that pressure.

- The bit can penetrate a low-pressure “thief” zone, which carries the mud away into the formation. Loss of circulation occurs as annular mud stops returning to the surface. Reduced column pressure allows higher pressure hydrocarbon fluids from other zones into the well bore and up the hole, lifting the remaining mud out. Should mud volume be lost to a thief zone, circulating additives including LCM pills (Loss Circulating Material) to the mud are required in an attempt to seal the zone.

The Blowout Preventer Stack

Should the mud system fail to maintain sufficient over-pressure to contain the flow of hydrocarbons into the well, then the blowout preventer (BOP) stack affords a further line of defense. The BOP stack includes three separate sets of valves, each of which can seal off the well independently of the others. Once closed, the BOP valves are designed to withstand all subsequent hole pressures.

If a well control incident, such as a blowout, occurred and control could not be regained through use of the BOP stack and mud, then well blowout specialists would be mobilised to implement special well-kill procedures.

Such an incident would inevitably lead to drilling fluids and possibly crude oil being lost to the environment. If such an incident occurred then the Oil Spill Contingency Plan (Section 3) will be immediately activated.

4.5.6 Management of hazardous gas

Hazardous gases such as H₂S have been encountered within the some wellsites. Hence there is need for hazardous gas detection equipment on the rig, or the special training of the on-site crew in the H₂S survival techniques.

4.5.7 Management of the storing and transportation of hazardous materials


Storage and Handling of Hazardous Materials

Sources of Impact

Chemicals such as fuels, paints, grease, oil, detergents, waxes and emulsions are stored on-site. During storage there is a potential for chemicals to leak, contaminating soil, surface and groundwater. During handling the potential exists for minor spills and personnel contact with chemicals, causing occupational health hazards (if inhaled, ingested or contacted by the skin).

Evaluation of Impact

Chemical spills, depending on their size, have the potential to cause contamination of soils, surface and groundwater. Secondary effects include mortality and sub-lethal effects (ecological, physiological and behavioural) among a wide range of organisms in the receiving environment. Contact with chemicals can also lead to occupational health and safety impacts. Volatile chemicals may evaporate and cause a health hazard and a reduction in the local air quality.

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The chemicals being used during drilling and production operations, however, are for the most part inert.

Drilling Mud Constituents

Drilling mud constituents such as barite, calcium carbonate, potassium chloride and various polymers are relatively non-toxic, particularly from a human health perspective.

Fuel

Fuels such as diesel, and hydrocarbon breakdown products can be toxic, particularly in the water environment. It is planned that diesel will be stored in purpose made enclosed tanks and will not be in contact with the atmosphere.

Environmental Impacts

Due to the small volumes of chemicals stored and handled on site, and their relatively non-toxic nature, the environmental impact of a leak, or spillage is considered moderate.

Management Controls

Mitigation measures include storing chemicals on a concrete pad with drains to a separate cement sump, to collect any spills or leaks during storage. To ensure safe handling, the chemical material safety data sheets (MSDS) will be kept on site at all times.

Spills and leaks can be minimised by good housekeeping practices, such as routine maintenance on equipment, proper storage and handling, routine checks of stored chemicals and the use of drip trays or bunding.

Transportation of Hazardous Materials

Safety and spills are linked in that a properly trained driver should have a lower incidence of accidents and therefore spills.


Driver training and the choice of haulage contractor is the most important factor in minimizing potential risk. The contractor used will be obliged by the terms of the contract to have equipment of high integrity and a formal driver-training program. The contractor will have an oil spill contingency plan, notification procedures and first aid spill equipment on each truck.

Explosives

The explosives will not be stored on-site at any time. They will be stored in a military magazine under supervision in Petchabun. They will be brought on-site immediately prior to use, and handled by a specialist contractor.

4.5.8 Management of pollution from accidental petroleum leakages

ECO/R's Oil Spill Contingency Plan (OSCP) for all Concession Blocks is incorporated within Section 3 of this Manual. The OSCP is consistent with the requirements of the National Oil Spill Response Plan for Thailand. The OSCP covers ECO/R's exploration and production drilling activities, indicates how to cope with emergencies, details the actions to

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be taken in the event of more serious and widespread occurrences and lists the clean-up equipment.

4.5.9 Management of pollution from voice, light and odours

Voice

Pollution to the adjacent environment by the voices of employees is not considered a major issue at the current ECOE/R concession locations. Usually the noise emanating from machinery such as generators, production equipment and the drilling rig will far exceed and be more noticeable than those of the workers on-site. There are also no nearby settlements that will be close enough to the ECOE/R sites to be disturbed by the voices of the personnel working on-site.

While off-site, ECOE/R employees are expected to behave in such a manner as to not disturb the local community.

Light

Sources of Impact

The most powerful source of light during the hours of darkness emanates from the drilling rig, and drilling rig mast. These lights can be clearly seen from the highway by passing motorists. The remoteness of the drilling locations from nearby settlements, however, means that the lights of the drilling rig is usually obscured by trees and hedges and do not interfere with the normal ambient/domestic lighting of the villages.

Only a limited amount of light emanates from the production stations, such as perimeter and security lighting, which is comparable to similar light industrial complexes. Light emanating from the production flares is also visible from passing vehicles on the highway during hours of darkness. The size of the flare is comparable to that of a small bonfire.

Evaluation of Impact

The light sources of the drilling rig and production stations and flare are not considered to be above those of similar small industrial complexes, or contribute significantly or adversely to the illumination of the area. The nearest settlements are located at a distance too far from the light sources to be noticeable. Due to the relative remoteness of the area, the increase in light levels provided by the WB1 production facilities may indeed act as a marker for passing motorists and somewhat help to illuminate the otherwise unlit road.


Odours

Sources of Impact

Petroleum type odours from both the drilling and production facilities are noticeable when on-site. The odour is not strong and dissipates until it is unnoticeable only a short distance from the sites.

Management Controls

Chemicals and diesel fuel are kept in sealed containers that help to limit any dispersion of odours in to the surrounding atmosphere.

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4.5.10 Management of the abandoning of a wellsite

Well abandonments, either after logging or at the end of a production life-cycle, will involve placing cement plugs to seal all potential aquifers within the well bore and the conductor will be cut off below ground level. The well will also be sealed at the surface and covered in soil.

The sump will be abandoned as follows: liquids will be drained out of the sump and either re-injected into designated injector wells or spread across the site, mixing them with cement will solidify the sump contents. A cement cap will then be placed over the top to seal the entire pit. Finally, a layer of soil will be placed over the top. ECOE/R will then plant the entire site in trees.

Sources of Impact

The activities involved in decommissioning a site include: the removal of production equipment, the removal of concrete pads and the chemical storage containers. It may also involve the sealing and plugging of the well and the solidification and sealing of the produced water sump.

The abandonment phase will have some transportation activity, although the duration should be only a few days. The transportation will be light and will be in the form truck movements.

Evaluation of Impact

There is expected to be some mild dust emissions due to truck movements on the rural roadways leading to the sites. The majority of the journey of trucks, however, will be on sealed roads.

The potential for dust emissions is estimated as minimal, and is unlikely to cause any reduction in air quality.


The transport activity is also likely to cause a certain amount of noise. Again the noise will be localized and of very short duration. The noise levels will not be more than that associated with the movement of a large truck. The noise levels are expected to be similar to the agricultural vehicles and trucks, which operate in the area. Vehicle movements are also planned to be restricted to daylight hours and should not disturb villagers during the hours of darkness, the time of lowest ambient noise.

Noise Impacts will be of short duration and levels are unlikely to be above the daytime ambient noise created by local agricultural and truck activity.

The digging up of trenches to remove infrastructure and the removal of the concrete pad may produce small quantities of dust into the atmosphere. Dust emissions are likely to be small and confined to the immediate vicinity of the digging activity, although the movement of digging machinery may move loose earth onto roadways spreading the potential for dust.


The effects of dust emissions are likely moderate, due to the short- term nature of the activity, and will be localized.

The machinery involved in the digging and pipe and cable laying may produce some noise. Again the noise levels are not expected to exceed the noise generated by local agricultural

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activity, and will be of short duration. The activity will also be limited to daylight areas, which will minimize the nuisance caused by the noise emissions.


Noise Impact will be of short duration and levels are unlikely to be above the daytime ambient noise created by local agricultural and truck activity.

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Appendix 1: Oil Spill Equipment Held On-site

The oil spill contingency equipment held locally is of a basic nature, but should prove adequate for most purposes:

1. Shovels, (6).
2. Open top oil drums for the storage of contaminated soil or recovered soil. Some on-site and readily available locally.
3. Sand bags (or grain/rice bags as a good substitute). Quantity held on-site.
4. Sand for absorption of spills. Small quantity held onsite for minor spills but large quantities (20 ton loads) available from various local building merchants. Rice husks act as good absorbent material and can be sourced locally although none is held on-site.
5. Quantities of timbers (planks etc) to form barriers and temporary dams. Some held on-site.
6. Bow saws, hammers and nails, rope, tarpaulins etc. Quantity held onsite.
7. Electric submersible pumps (two held onsite) for transfer of water etc. complete with hoses.
8. 40 KVA portable electric generator set.
9. Quantity of plastic drainage pipe to form temporary ducts.
10. 2 x Karcher steamer/high pressure jet wash.
11. Heavy plant ie. Excavators, Tractors, Trucks, available locally.
12. Labour: Site personnel available but additional local personnel can be hired direct.
13. 5 x sorbent booms; 3 x bales sorbent material
14. SKO55 SPC Spill Kit
15. 64 x 5gal drums 3% aqueous film-forming foam

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Appendix 2: Oil Spill Equipment Held Elsewhere

1. Small vacuum tankers are available for lease in Wichian Buri village.
2. Flat bed trucks are available for lease from Wichian Buri village.