EXECUTIVE SUMMARY

1. INTRODUCTION

This report presents the findings of the holistic Environmental Impact Assessment (EIA) carried for new pipelines installation and replacement Project in tandem with the SKO Pipeline Rejuvenation Project. The Project areas are in the Baram Delta Operations (BDO) Field located about 25km offshore Miri and the Balingian Field located about 40km offshore Bintulu. The EIA Report is prepared in an integrated manner to holistically assess the potential environmental impacts that may arise from the pipelines installation and replacement; and the platform topside modification activities to support the Pipeline Corrosion Management Program.

This EIA Study is undertaken as a response to the comments by the Department of Environment Sarawak that a holistic and integrated approach to environmental impact assessment would provide a comprehensive view of the environmental status of the marine environment in Sarawak waters as compared to very localize environmental impact assessment from individual pipeline installation and replacement project.

Project Title

This Environmental Impact Assessment (EIA) report has been prepared for the "**NEW PIPELINES INSTALLATION AND REPLACEMENT PROJECT IN TANDEM WITH SKO PIPELINES REJUVENATION PROJECT WITHIN SARAWAK WATERS BETWEEN 2012 - 2014**", hereinafter to be referred as the 'Project'.

Environmental Legislative Requirement

The ***Environmental Quality (Prescribed Activities)(Environmental Impact Assessment) Order 1987***, has identified 19 types of project development activities as "prescribed activities", the implementation of which shall be preceded by the submission of an environmental impact assessment (EIA) report to the Director General of Environment for approval. Two (2) of the pipelines in this Project fall under item 12(b) Petroleum - *Construction of offshore and onshore pipelines in excess of 50km in length*.

The Pipeline Rejuvenation Project for the remaining 13 of the identified pipeline candidates for replacement ranges between 1 - 32km in length, and is required by DOE to conduct a holistic EIA to address the overall Project activities in a comprehensive manner. This holistic EIA will address the environmental requirements of the 15 pipelines in an integrated manner in tandem with the execution of the SKO Pipelines Rejuvenation Master Plan and also in compliance to the requirements of Carigali Pipeline Integrity Management System (CPIMS).

Project Proponent

The Project Proponent is **PETRONAS Carigali Sdn. Bhd.** with their correspondence address and contact person as follows:

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Project Location

PETRONAS Carigali – SKO operates platforms and pipeline networks in Sarawak waters offshore of Miri and Bintulu; and two (2) onshore crude oil terminals, namely, Miri Crude Oil Terminal (MCOT) and Bintulu Crude Oil Terminal (BCOT). The Project areas for this holistic EIA Study cover the Baram Delta Operations (BDO) Field and the Balingian Field. The BDO Field is located approximately 25km offshore Miri in water depths from 30m – 76m whilst the Balingian Field is located approximately 40km offshore Bintulu in water depths ranging from 85m to 92m. **Figure 1** shows the overall Project areas where PETRONAS Carigali operates in Sarawak.

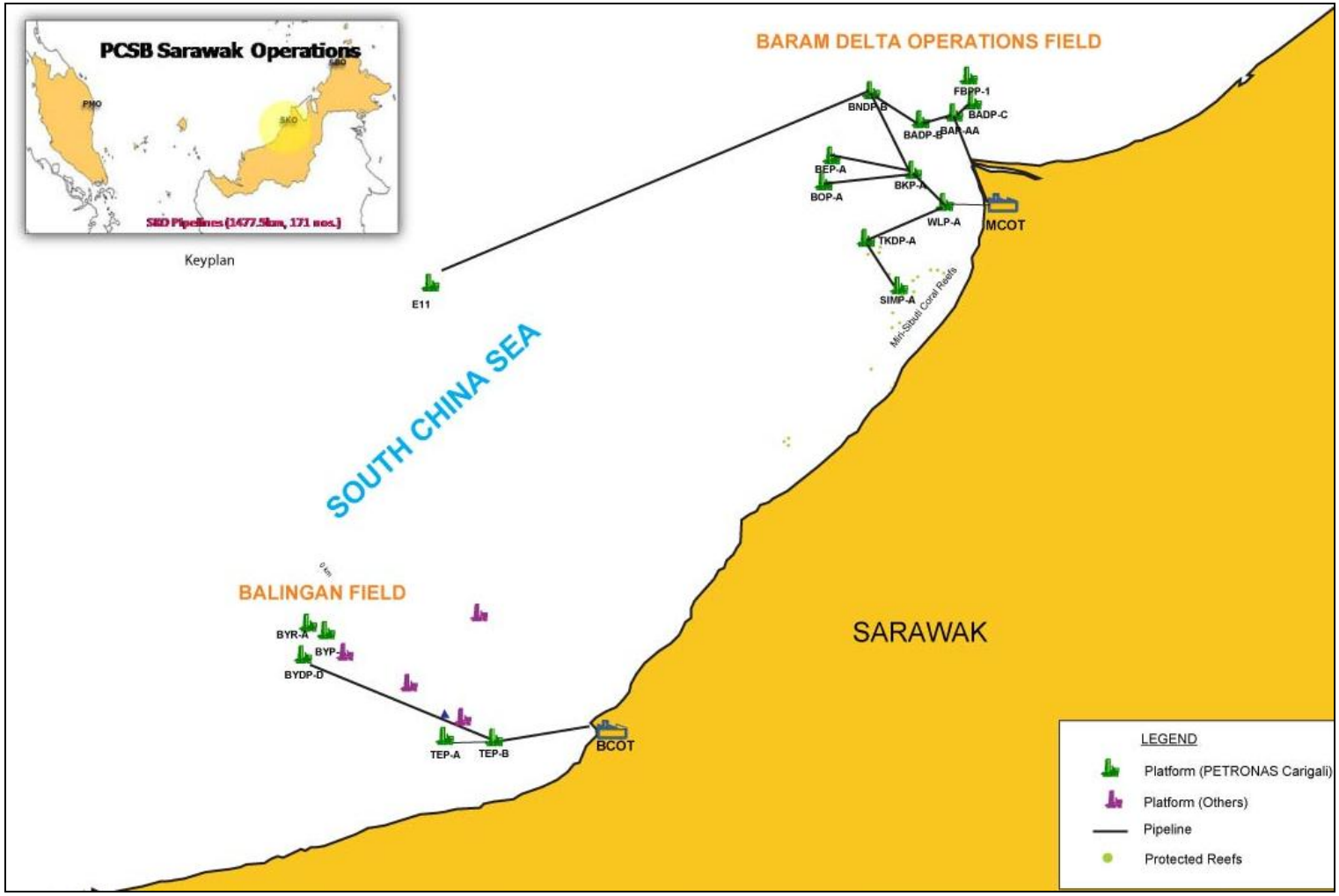

Figure 1: PETRONAS Carigali Operating Areas

Statement of Need

The facilities including pipelines operated by PETRONAS Carigali – SKO are aging and majority of the pipelines are more than 25 years old and some are being categorized as high risk pipelines that may potentially leak. In 2007, PETRONAS Carigali – SKO formed a dedicated Pipeline Team for Integrity Management to address key issues related to high risk pipelines such as Sulphate Reducing Bacteria (SRB), basic corrosion monitoring and chemical injection facilities. The Team conducted an intensive Risk Based Inspection (RBI) and put in place corrosion monitoring and maintenance program for all the facilities and pipelines.

The Pipeline Team for Integrity Management continues to undertake vigorously pipeline corrosion mitigation improvement and embarks on a **Five (5) Years SKO Pipelines Rejuvenation Master Plan** (2010 - 2014). The execution of the Pipeline Rejuvenation Master Plan includes new pipeline installation and replacements, pig traps installation, Chemical Injection Skids installation, and sampling/monitoring points. With the efforts in place, the Pipeline Risk Assessment conducted in 2010 saw a reduction of high risk pipelines from 41% in 2008 to 34% in 2010.

PETRONAS Carigali aims to maintain pipeline leak risk to be medium/low and no high risk pipelines or pipeline failure by the year 2014. To realize this, PETRONAS Carigali has made this Pipeline Rejuvenation Project a priority to install two (2) new pipelines and replace the 13 high risk pipeline candidates between 2012 and 2014.

2. PROJECT DESCRIPTION

PETRONAS Carigali has taken a proactive initiative by regularly conducting reviews of its operations and maintenance philosophy in managing the integrity of all pipelines and associated facilities by application of risk management principals and techniques in accordance with the Carigali Pipeline Integrity Management System (CPIMS). This also provides assurance to key stakeholders that existing pipelines and facilities are operated and manage as per PETRONAS Carigali enhanced operations and maintenance procedures to reduce the environmental risk to As Low As Reasonably Possible (ALARP).

2.1 Project Components

The Project comprises four (4) components:

a) Installation of two (2) new pipelines in BDO area for production optimization;
b) Replacement of two (2) high risk pipelines of length greater than 50km;
c) Replacement of 11 high risk pipelines of length less than 50km in BDO area; and
d) Platform topsides modification to enable effective implementation of Corrosion Management Plan (CMP) for each pipeline in the pipeline network.

2.2 Overview of Carigali Pipeline Integrity Management System (CPIMS)

CPIMS provides the principal framework for the management of the technical integrity of pipelines. The framework is to comply with the requirements of Malaysian Legislation and PETRONAS Carigali's operational, societal and environmental objectives.

The objective of the CPIMS is to assure the ongoing fitness for purpose of all PETRONAS Carigali pipelines by means of a risk management approach, and the implementation of procedure to ensure compliance with all applicable Malaysian Legislation.

2.2.1 Pipeline Integrity Management Process

By implementing an integrated approach to pipeline integrity management comprising rigorous inspections, Fitness For Service (FFS) assessments and risk assessments; a risk based asset integrity management programme has been developed which has enabled PETRONAS Carigali to prioritise and optimise pipeline integrity management with the objective of reducing incidents of pipeline failures and at the same time achieve life extension.

Pipeline Integrity Management involve:

- Operations and Safety Systems;
- Pipeline Inspection;
- Corrosion Management; and
- Modification Management.

2.2.1.1 Operations and Safety Systems

Process parameters such as pressure, temperature, product composition, etc. are monitored to ensure pipeline operation is within specified limits, inspected and tested at appropriated intervals. Systems provided to secure the safe operation of the pipelines such as:

- Over-pressure Protection Systems;
- Emergency Shutdown Systems; and
- Leak Detection Systems.

2.2.1.2 Pipeline Inspection

Inspection of the various sections of pipelines is carried out to determine the pipeline current conditions. The inspection activities may involve direct physical measurements (e.g. wall thickness survey by Intelligent Pipeline Internal Gauging or Intelligent Pigging (IP), visual examinations of the condition (e.g. external corrosion or surface defects) or surveys (e.g. side-scan sonar of sub-sea pipelines).

In order to have a continuous smooth flow of production and problem free operations, the Inspection and Maintenance Guidelines of CPIMS outlines the pipeline system inspection planning process which is:

- Time Based Inspection - fixed inspection methods at fixed intervals;
- Condition Based Inspection - extension of Time-Based where the inspection interval is determined based on remaining life estimates; and
- Risk Based Inspection or RBI which uses risk assessment methodologies to identify hazards and critically determine the inspection methods. The inspection intervals are based on pipeline risk criticality in addition to remaining life estimates.

2.2.1.3 Corrosion Management

Corrosion management involves a range of activities which is designed to prevent, control, inspect and monitor. The corrosion deterioration that the pipeline may be subject to is either internal or external corrosion. As part of the pipeline Integrity Management Program, a specific Corrosion Management Plan (CMP) is developed for each pipeline to determine the optimum approach for corrosion control.

Corrosion Management during Design Stage

The pipeline corrosion issue is addressed in the early stage of pipeline engineering design as documented in the *PETRONAS Technical Standards for Design and Engineering Practice: Recommended Practice for Pipeline and Riser Engineering* (PTS 20.214). Corrosion control practice is given high priority during the early planning and design stage as corrosion can have a heavy cost implication in terms of financial as well as environmental and safety concerns.

Corrosion Management during Operational Stage

Pipeline maintenance which includes corrosion prevention activities is carried out as per the Corrosion Management Plan (CMP). This maintenance and monitoring exercise which is part of the operating standards and CMP, is to ensure the safety of the facilities and workers, as well as the protection of the environment. Typical CMP which is created specifically for each pipeline include program on internal and external corrosion control and monitoring.

Depending on the corrosion type and criticality, each pipeline will have a customized CMP to address the corrosion risks. The objective of the CMP is for the pipelines to be able to maintain, achieve design life and/or prolong design life.

Control of Microbial Induced Corrosion – Sulfate Reducing Bacteria

The predominant integrity threat to pipeline is the microbial induced corrosion (MIC) caused by Sulphate Reducing Bacteria (SRB). SRB are group of bacteria that are

commonly found in the natural marine environment that cause pitting corrosion and failures of equipment and pipelines. The SRB bacteria releases enzyme which converts the sulfur compound found in the environment and in the hydrocarbon into hydrogen sulfide which is the corroding factor on the pipeline and the associated facilities.

The most practical and proven technology to monitor the presence of SRB activity leading to internal corrosion is an online analyzer for hydrogen sulfide which is the by-product of SRB activity in crude oil.

2.2.1.4 Modifications Management

Modifications to a pipeline can take the form of either a physical modification (e.g. installation of an additional valve or a rectification to pipeline integrity, such as installation of a repair sleeve and/or installation of a grout bag support) or an operating modification (e.g. change to the maximum allowable operating pressure or change of service). Any major modifications and rectification work must be managed and controlled in the context of the whole system as it can directly affect the ongoing integrity of the pipeline system.

2.3 SKO Pipeline Rejuvenation Master Plan

Based on the Pipeline Risk Assessment, the Pipeline Team for Integrity Management has embarked on a **Five (5) Years SKO Pipelines Rejuvenation Master Plan** between the years 2010 to 2014. This Project aims to continually undertake vigorously pipeline corrosion mitigation improvement and pipeline rejuvenation works. The implementation of the Pipeline Rejuvenation Master Plan includes new pipeline installation and replacements, pig traps installation, Chemical Injection Skids installation, and sampling/monitoring points.

2.3.1 Selection of Pipeline Candidate for Replacement

Potential pipeline candidates for replacement are based on the following factors:

- High risk pipelines based on RBI and FFS;
- High wall loss throughout the pipeline observed during Intelligent Pigging Inspection and verified with underwater Ultrasonic (UT) Test Results; and
- Declared “Not Fit for Service” during the FFS Assessment with the data obtained from the verified IP Results.

2.3.2 Topside Modification

Based on preliminary reviews of the existing topside facilities related to pipeline integrity management, several topside modifications have been identified in order to meet the CMP requirements. The modifications involved in each platform vary from one to another mainly to:

- Provide internal corrosion mitigation and condition assessment facility;
- Provides complimentary internal corrosion mitigation facility to pig traps;
- Enables pipeline content to be collected for analysis to confirm effectiveness of corrosion;
- Corrosion rate and scaling tendency determination to confirm effectiveness of internal corrosion mitigation actions;
- Minimise sea water ingress from sump/caisson operations thus reducing MIC risk from sea water contamination in the pipeline;
- Monitoring H_2S levels at inlet and outlet of pipelines to determine effectiveness of internal corrosion mitigation for MIC. H_2S is an indication of MIC activities; and
- Protection of pipeline risers from external impact.

2.4 SKO Management Assurance

Dedicated teams have been formed to focus, manage and monitor the SKO Pipeline Rejuvenation Project which is an assurance from PETRONAS Carigali Management on the implementation of the Project in an organized manner and to ensure compliance to all technical, management and statutory requirements.

The Pipeline Integrity Working Team (PIWT) provides updates, highlights critical issues and proposes solution for management endorsement and approval whilst the Pipeline Integrity Management Team (PIMT) will provide the venue for management intervention to pipeline critical issues and provides direction, support and approval.

2.5 Standard Operating Procedures (SOP) for Pipeline Operations

All pipelines that are in operations will undergo the routine pipeline inspection as well as the Risk Based Inspection process which is part of the pipeline integrity management. When a pipeline has reached the design life or experiences corrosion issues the pipelines are automatically ranked as high risk.

RBI will then be carried out and from the outcome; the pipeline will be ranked very low risk, low risk, medium risk, high risk or very high risk categories. Based on the risk levels and information obtained from the RBI process, an Inspection and Maintenance Plan are derived.

Following the RBI result, the high risk pipeline will be further assessed for Fitness For Service (FFS) which determine the corrosion growth rate, metal loss features, etc and the outcome is used to prioritize the pipeline candidate for replacement. When a pipeline has been identified as high risk, extra measures are carried out such as increase in IP frequency and in the frequency of inspection and maintenance until the pipeline is being replaced.

2.6 Project Activities

The Project activities are classified into the following three (3) stages:

- Installation stage – nearshore and offshore;
- Pre-Commissioning and Commissioning stage; and
- Decommissioning stage.

The nearshore activities involve:

- Site preparation at the shore approach/beach crossing location. This includes construction of rock berm to allow passage for pipelines;
- Construction of cofferdam from Lowest Astronomical Tide (LAT) to the shoreline;
- Pre-trenching within the cofferdam to the tie-in location;
- Preparation and execution of beach pull;
- Pipeline tie-in;
- Post-lay trenching; and
- Site re-instatement.

The offshore activities involve:

- Line pipes and risers transportation;
- Line pipes and risers installation works;
- Pre-commissioning and commissioning; and
- Decommissioning and abandonment of the existing pipeline.

The pipelines are to be laid on the seabed floor by S-lay methods. Pipeline near the BCOT or MCOT shore approach segment (from 1km offshore to the shoreline) will be buried at a minimum depth of 2m below the seabed and shallow water pipelay barge moored at the shore approach will pull the pipeline onto shore.

2.7 Project Implementation Schedule

The SKO Pipelines Rejuvenation Plan has identified 18 high risk pipelines to be replaced between 2010 and 2014. In 2010, two (2) pipelines have been replaced and in 2011, two (2) out of three (3) pipelines which were scheduled to be replaced will be carried over to 2012 due to unsafe sea condition. Amongst the remaining, four (4) will be replaced in 2012, another four (4) will be replaced 2013 and five (5) will be replaced in 2014, respectively. The topside modification will also be carried out between 2012 – 2014.

The pipeline candidates identified to be replaced between 2012 - 2014 may be reprioritized and new candidates added based on updated pipeline integrity status identified from the continuous RBI and FFS exercises.

3. EXISTING ENVIRONMENT

Landuse

The existing landuse within 3km radius of the BCOT area are mainly industrial area with no residential areas. Whilst in MCOT, the existing landuse within 3km radius are mainly residential, educational and industrial area.

Bathymetry

The proposed Project site at both BDO and Balingian fields experience similar seabed profile and features such as lithology, water depth and slope gradient. The soil type is made up of very soft to soft, grey silty CLAY which could be encountered dipping between northwest to north-northwest. The seabed in the referred pipeline route surveys, were free of bathymetry anomalies that may have adverse effects on the pipeline installation activities.

Geology

Based on the geological information, the Project site is not located within the critical unstable seismic zone such as earth quake, volcano, etc. that may cause adverse impact for the pipelines and other oil and gas operation structures.

Oceanography

The tidal regime in Bintulu and Miri is predominantly diurnal, implying that there is one high tide and one low tide occurring during a tidal day. The Highest Astronomical Tide in Bintulu and Miri is 2.4m and 2.3m, respectively. The scalar mean wind speed is relatively strong from December to February in Bintulu, while in Miri it is strong from November to February which is during the Northeast monsoon. The highest wind speed at the Bintulu area is about 15 knots in December. The highest wind speed in Miri is in January with 17.3 knots. The wind wave and swell waves are high from November to March which is also during the Northeast monsoon.

Meteorology

The proposed Project site experiences a typical tropical climate with uniform temperatures (approx. 27°C), high humidity and heavy rainfall (4159.3mm annually in Bintulu and 2913.9mm in Miri). The climate is strongly influenced by the Southwest and Northeast Monsoons.

Baseline Study

The secondary data used to establish existing baseline condition for marine water, seabed sediment and marine biology was based on 17 previous environmental studies conducted within the vicinity of the Project area between 2009 to 2011. The studies were conducted throughout different phases of project development which include prior to project commencement (environmental baseline survey), during project execution (environmental monitoring) and after project completion (environmental audit). These

secondary data would be supplemented by the actual baseline survey for the proposed Project scheduled in March 2012 aligns with the Environmental Monitoring Program proposed for the Project.

Marine Water Quality

Secondary marine water quality data for the BDO Field and Balingian Field are presented based on minimum and maximum values. The values are compared against the Marine Water Quality Criteria and Standards for Malaysia (Class 3 – Ports, Oil & Gas Field) (MWQCS), as well as with others study conducted at the vicinity.

Based on the analysis made from the secondary data, most of the parameters were within the limit stipulated in the MWQCS and comparable to other study.

Seabed Sediment

Generally most of the parameters levels were within the DIV standard and other study conducted in the vicinity of the Project area.

Marine Biology

- *Phytoplankton and Zooplankton*

The phytoplankton and Zooplankton data show that there are no obvious spatial trend in its densities indicating uniform distribution throughout the BDO Field and Balingian Field. The Shannon-Wiener Diversity Index (H') at both fields can be classified as low pollution and the Equitability Index (J') values at both fields indicates a naturally good distribution of species.

- *Macrobenthos*

The Equitability Index values derived from macrobenthos densities ranged from 0.77 to 0.99 for the BDO Field and 0.92 to 0.99 for the Balingian Field, indicating the naturally good distribution of the species.

All the studies indicate no deterioration of marine water and sediment quality and no significant changes in marine biology species and distribution throughout Sarawak waters even though seven (7) pipeline replacements activities had taken place between 2009 to 2011 in both fields. It can be concluded that the pipeline installation and replacement activities thus far have no adverse impact on the existing environment and project proponent will continue to apply appropriate mitigation measures throughout project implementation to ensure that the project activities shall pose no significant impact to the environment.

Coral

The Project in BDO area is not within the coral reefs area, with the nearest coral reefs from BDO Field is the Miri-Sibuti Coral Reef National Park (MSCRNP) (approximately 20km to nearest pipeline). In Balingian area, the nearest small coral reef, known as Batu Mandi is located approximately 35km from BCOT.

Turtle

There are five main species of turtles found in Sarawak. 95% of all turtle landings in Sarawak are found at the Turtle Island, which consists of Talang-Talang Besar, Talang-Talang Kecil, Satang Besar, and along Kampung Puguh off Semantan and off the Similajau near Bintulu. The Project site is far away from all these landing areas and also from turtle migration route.

Fishery

In Sarawak, fisheries can generally be categorised as traditional and commercial. Traditional fishing is usually conducted in near shore waters (3-5km from shore). Commercial fisheries comprises inshore fisheries (55km from shore) and offshore fisheries (>55km from shore). However the Project site is not within the fishing activity area.

Environmental Sensitivity Index

The most sensitive area that is categorized as ES10 is in Kuala Baram as it is a spawning ground for tiger prawns as well as the habitat for a large number of shore birds at its mudflat. Kuala Sibuti is also ranked ES10 as the area is near to the coral reefs area, marine protected areas and Sibuti Wildlife Sanctuary.

Marine Traffic

Two (2) main ports nearest to the Project site are Bintulu Port and Miri Port. The distance from Temana Platform B (TEP-B) to Bintulu Port is about 30km whilst the distance from West Lutong Platform A (WLP-A) to Miri Port is approximately 11km.

4 SOCIO-ECONOMY

The objective of socio-economic assessment is to understand the social and economic conditions of individuals, households, groups, and communities within the vicinity of the Project area. This data collection effort is to generate baseline information on the demographic and important socio-economic conditions of the communities surrounding the onshore operations at Miri and Bintulu.

The methodology adopted was collection of data from secondary and primary sources. The secondary data was mainly the 2010 Census from the Department of Statistics.

The primary data and information was collated through the Socio-economic Survey, interview with the village heads and site visit.

Findings of the survey indicated that this proposed Project would not likely to cause major significant impact considering the past experiences of the projects in the area as well as the existing operations. The resident welcome the Project as it could generate job and business opportunities for the local communities. This was evident as more than one-third of the working residents in the surrounding BCOT and MCOT areas are workers in the oil and gas industry.

5 IMPACT AND MITIGATION MEASURES

The Project will be implemented from 2012 to 2014 with the installation of four (4) pipelines in 2012, another four (4) in year 2013 and five (5) pipelines for 2014 or may overflow to year 2015.

In assessing the potential impact that may arise from execution of the project, all points below are considered:

- More than 70% of the pipelines to be replaced are equal or less than 16km (11 pipelines) two (2) are 32km in length, and only two (2) pipelines exceed 50km;
- The project will be implemented in phases, i.e. by years, with average number of five (5) pipelines to be replaced in a year;
- Duration of each pipeline replacement activity will vary depending on the pipeline length; and
- There is only one pipeline being replaced at one time (no multiple replacement activity at the same time).

With implementation of recommended mitigation measures throughout project implementation as summarized in **Table ES-1**, the assessment on potential environmental impacts that may arise from project activities has been found to be mainly localized, short-term and insignificant.

Table ES-1: Summary of Potential Environmental Impacts and Mitigation Measures

Project activity	Impact assessment	Proposed mitigation measures
INSTALLATION STAGE		
Nearshore Activity Pipeline installation works at the shore approach comprises the following activities: • Site preparation at the shore approach. This includes construction of rock berm to allow passage for pipelines; • Construction of cofferdam from Lowest Astronomical Tide (LAT) to the shoreline;; • Pre-trenching within the cofferdam to the tie-in location; • Preparation and execution of beach pull; • Pipeline tie-in to MCOT and BCOT; • Post-lay trenching; and • Site re-instatement.	**Air Quality** - The primary pollutant emission associated with shore approach activities would be dust generated from site preparation activities. It is expected the impact will be localised and temporary; and will be not significant. - Exhaust emissions such as sulphur dioxide (SO_2) and nitrogen oxides (NO) from transport vehicles and construction machinery.	- Wetting down of Project Site to minimize fugitive dust-emission in and around the storage and construction areas; - All engines and machinery used must be well maintained subject to schedule and periodic inspections to ensure complete combustion of fuel to reduce or eliminate black smoke and other pollutant.
	Noise - Low-level noise from transport vehicles and construction machinery.	- Proper vehicle and machinery maintenance to limit noise level.
	Traffic (on land) - Such a marginal increase of 20 vehicles during the shore approach activities is not expected to cause any congestion to the existing traffic condition.; and - Soiling of public roadways due to soil-laden tyres of transport vehicles.	- Vehicular movements especially heavy and slow-moving vehicles, shall avoid peak traffic hours; and - To prevent dirt from being carried to the public roads, wheel wash facilities should be installed at the exit point of the project site.
	Marine Traffic - It is envisaged that the ROW of the nearshore approach at the BCOT and MCOT areas may pass through the Bintulu Port and Miri Port areas. This may have an impact in terms of marine traffic movement and safety implications during the installation duration.	- PETRONAS Carigali and its contractors shall communicate with Bintulu and Miri Port authority on Project activities (especially marine spread activities) within the port limit.

Project activity	Impact assessment	Proposed mitigation measures
INSTALLATION STAGE		
Nearshore Activity (cont')	**Water quality** - The primary impact of the Project on soils is an increase in the erosion potential in areas where soil becomes exposed by vegetation removal and areas where soils are physically disturbed by excavation. It may subsequently lead to increased sedimentation and increase turbidity level in beach area; - Marine water quality may be impacted during post-lay trenching. The jetting process will temporarily increase the total suspended solids and turbidity levels.	- Clearing should be scheduled for period with low rainfall so as to reduce rain-induced erosion of the exposed land; - PETRONAS Carigali and its contractors shall comply with relevant Local Authorities requirement (when applicable), e.g. BDA and NREB requirement on land clearing activity, trenching, stockpile management, etc; and - During the jetting activity, the water jet shall be directed parallel to the pipeline route to reduce spread or distribution of sediments perpendicular to the pipeline route.
	Marine Biological System - The pipeline installation at the shore approach will result in some destruction of the soft bottom benthos due to the impact of smothering by displaced sediment. However, upon completion of the backfilling operations following pipeline placement, the benthic communities are usually expected to recover through the natural process of re-colonization from neighbouring areas. This recovery process usually occurs within a span of several months.	- The installation period should be optimized to reduce the installation time; thus re-colonization or reestablishment of new communities will occur in a shorter duration.

Project activity	Impact assessment	Proposed mitigation measures
INSTALLATION STAGE		
Offshore Activity Pipeline installation works at the offshore comprises the following activities: - Line Pipes and Risers Transportation - Line pipes using conventional lay barge and risers installation	**Air Quality** - Emission sources to the atmosphere during the pipe laying activities are mainly from generators, welding equipment and barge exhaust. Other sources of emission are fugitive release of volatile organic compounds from fuel bunkering activities and cleaning solvent. Impacts from these emission sources are not expected to be significant since the emission will be mainly transient in nature	- All engines and machinery used must be well maintained to ensure complete combustion of fuel to reduce or eliminate black smoke emission; and - Volatile chemicals containers must be tightly closed and stored in a cool room all the time.
	Seabed Sediment - Seabed disturbance, both direct disturbance along anchor drag corridor and indirect disturbance from suspended particles in the water column may increase the turbidity which could disturb and smothered sedentary organisms. This may result in loss of benthic and bottom feeding organisms. Non sedentary organisms will not be affected to the benthic communities will be temporary and localized only during the installation period; and - Extent of this impact will only be experienced at the anchor drop location along the pipeline route. Therefore, the potential impact will not be significant since about 70% of pipelines being replaced are less than 16km.	- Optimizes/shorten pipeline installation duration to minimize impact on the marine environment; - Anchors should be placed at pre-determined locations as per approved anchor pattern to minimize the risk of anchors dragging which could smother the benthic organism; and - Minimize anchor usage.

Project activity	Impact assessment	Proposed mitigation measures
INSTALLATION STAGE		
Offshore Activity (cont')	**Water Quality** - The use of the conventionally moored lay barge, which involves the use of large anchors for vessel positioning, can be expected to cause some disturbances to the bottom sediment and consequently a minor and transient increase in the turbidity in the lower water column. The impacts will be short-term due to rapid re-settlement of the sediment released to the water column; and - The laying of the pipeline on the seabed floor will also cause an increase in the turbidity of the water column in areas of close proximity to the path of the pipeline and in the segment of the water column immediately above the seabed floor. The increase in water column turbidity due to pipeline-laying will be localized and the effects transient, mainly occurring within a limited area. close to the pipeline segment being laid. The duration of the impacts will be short-term.	- The installation activity should be optimized to reduce the installation time to reduce disturbance to marine life; - Planning of anchoring pattern to avoid unnecessary scars and to minimize the risk of anchors dragging which could smother the benthic organism. Avoid soft grounds which are prone to anchor dragging; - Pre-determine selected pipeline routes and tow path to minimize impact to the bottom sediment; and - Deploy ROV to visually inspect the pipelines are installed properly on the seabed.
	Marine Biology - During the pipeline installation, selected activities such as anchoring and physical placements of the pipelines on the seabed may increase the turbidity level which could disturb and smothered sedentary organisms. This may result in loss of benthic and bottom feeding organisms. However, these changes to the benthic communities will be temporary impact to marine biological ecosystem.	- The installation activity should be optimized to reduce the installation time to reduce disturbance to marine life; - Planning of anchoring pattern to avoid unnecessary scars and to minimize the risk of anchors dragging; and - Pre-determine selected pipeline routes and tow path to minimize impact to the bottom sediment.

Project activity	Impact assessment	Proposed mitigation measures
INSTALLATION STAGE		
Offshore (cont')	**Solid Waste Management** - Domestic waste generated from lay barge, includes food and kitchen waste. The organic and biodegradable wastes will be macerated and disposed into the sea. The estimated food waste generation is 0.15kg per person per day. The impact of the macerated food wastes on the marine water quality and biological system would be not significant, temporary and localized; and - Solid waste includes packaging material, plastic, bottle, paper etc will be brought back to onshore.	- Waste minimization should be implemented whenever possible; - The barge will be equipped with waste macerators where organic, biodegradable wastes will be macerated to 2mm prior disposal to sea; and - Solid waste should be stored in proper containers at work place and brought back to onshore for proper onshore disposal.
	Scheduled Waste Management - Scheduled wastes such as contaminated rags and used oil shall be transported to onshore for disposal according to set procedures; and - Scheduled wastes shall be stored, handled, transported and disposed in accordance to the requirements of the Environmental Quality (Scheduled Wastes) Regulations, 2005.	- All scheduled waste under the Environmental Quality (Scheduled Wastes) Regulations 2005 such as oil and grease, hydraulic oil from machineries and solvents; shall be handled and stored appropriately on site; - Scheduled wastes shall be brought back to onshore for disposal at the DOE's licensed scheduled waste disposal facility; and

Project activity	Impact assessment	Proposed mitigation measures
INSTALLATION STAGE		
Offshore Activity (cont')	**Marine Traffic** - The Project area is not within the shipping lanes, therefore there will be no significant impact on the marine traffic.	- PETRONAS Carigali and its contractors shall sent out early notification of their activities to the Marine Department and Navy Headquarters so that "Notice to Mariners" can be issued timely; - All pipe laying barge and standby vessels must have adequate navigational equipment to provide sufficient warning to vessels approaching the pipe laying activities area; and - All barges and workboat shall be sufficiently lighted up so that they are visible at night especially in poor weather conditions.
PRE- COMMISSIONING AND COMMISSIONING STAGE		
The final stage of the pipeline installation is pre-commissioning and commissioning. A hydrotest will be carried out to check the integrity of the pipeline. The seawater used for the hydrostatic testing will contain the following type of chemicals: - corrosion inhibitor, - biocide and - oxygen scavenger After the pressure test, the treated sea water will be discharged offshore.	**Marine Water and Seabed Sediment** - The discharged water will release colored plume into the sea resulting from the use of tracer dye. The color will disappear after a couple of hours after being released. - The chemicals selected for these activities are environmental friendly and listed as Offshore Chemical Notification Scheme (OCNS) – Category B. Based on study conducted on hydrotest water discharge into marine environment at Samarang field, it shows no significant changes or deterioration of the marine water quality at the immediate discharge point, 250m, 500m, and 1000m downstream of discharge point.	- Chemical selected will be of the environmentally friendly type with low toxicity. In addition, these chemicals should be listed on the OCNS list and preferable be in the gold or silver categories where possible; - The dewatering of hydrotest water into the sea must be at regulated rate over period of time; - Concentration of any chemicals used must be the lowest effective concentration as possible; and - The commissioning team must adhere strictly to the instruction and precaution in the Material Safety Data Sheet.

Project activity	Impact assessment	Proposed mitigation measures
PRE- COMMISSIONING AND COMMISSIONING STAGE		
Chemicals are stored in skid tanks with 34 days supplies for chemical injection activities. For continuous use of chemical on the platforms, spare chemicals are stocked in 200L drums for 17 days supply in contingency for late delivery from supplier. The chemicals in drums are sent by the suppliers on supply vessel to the platforms where they are kept for about 17 days. The chemicals are replenished into the skid tank and the empty drums are taken back by the suppliers.	**Chemical Handling** Any accidental spillage of chemicals from jacket and ships during operation and/or maintenance activities into the water will pollute the water column. Inappropriate chemical handling also has the potential to cause a range of adverse effects on risk of workers health and toxic effects or physical damage to marine organisms. However, the level of impact will depend on the types of chemical and the amount spilled.	- Personnel shall be adequately trained in chemical handling to minimize spills occurrence due to human error; - Must adhere strictly the Operation and maintenance procedures during chemical handling; - Chemicals container shall be placed within a contained area and regularly inspected for any leakage or corrosion; and - The expiry date of the chemicals should be monitored and all expired batches must be transported to supplier or licensed onshore facilities for proper disposal.
DECOMMISSIONING AND ABANDONMENT STAGE		
The existing pipelines will be decommissioned based on the following sequence: • Cleaning and removal of hydrocarbon residual inside the pipeline; • Removal of riser from platform; • Removal of about 150m subsea pipeline or the extent possible of the pipeline set on the sea bed starting from the riser bend. Removal of the pipeline section will be carried out using hot cut method i.e: BROCO; and • In-situ abandonment whereby both ends of the pipelines will be sealed/ plugged and kept at its original place.	- For pipeline replacement the existing pipeline will be abandoned in-situ as the areas along the pipeline are being colonized by marine lives, hence it is considered as a positive impact.	- The Marine and Hydrographic Department must be informed on the location of the decommissioned pipeline; - The decommissioning team must adhere strictly to the instruction and precaution in the decommissioning procedure; and - Oil absorbent pads shall be made available onsite, which can be used to arrest spills onboard the vessel, preventing contamination of the deck area and thereby minimizing the discharge of oily deck runoffs into the marine.

6 RESIDUAL IMPACTS

Residual Impact is environmental impacts that may still persist, although mitigation measures to minimize the impacts are fully complied with and implemented. Overall, there is no adverse residual impacts anticipated from this project while the *in-situ* abandonment of old pipeline will provide habitat for the marine life and create new spawning areas for the fished.

7 ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) with appropriate monitoring program will be prepared to ensure that all EIA Approval Conditions are complied with, and all regulations and standards are being met. It is also to guide the project proponent in managing the environmental impacts during Project implementation.

In this chapter, an Environmental Monitoring Programme is proposed with its proposed sampling frequency, sampling points and parameters.

8 EMERGENCY RESPONSE PLAN

A general Emergency Response Plan (ERP) for the proposed Project is established with reference to SKO Emergency Response Manual (MY SKO S 07 001 Rev. 3 July 2007) to provide a basic guideline on handling any emergency incidents or accidents that may occur during the installation and operations of the pipelines.

9 CONCLUSION

The assessment of the potential environmental impacts that would be generated during the installation, commissioning and operation of the Pipeline Rejuvenation Project has been found to be mainly insignificant, short-term and localized. This can be further minimized with the appropriate mitigation measures as proposed in Chapter 5 of this EIA Report.

This Holistic Environmental Impact Assessment (EIA) shows that, with the incorporation of mitigation measures, corrosion management measures right from the design stage up until the operations stage of the facilities together with sound pipeline installation methods and mitigation measures, the proposed Pipeline Rejuvenation Project by PETRONAS Carigali can be implemented in an environmental acceptable manner. The positive contribution of the proposed Project to the economy of the country as well as the continued production of the oil and gas resources will benefit the social well being of the people of this country.