CHAPTER I
INTRODUCTION

1.1 BACKGROUND

The Tangguh LNG Plant is located on the southern shores of Bintuni Bay in Teluk Bintuni Regency, West Papua Province, as shown in **Figure I-1**.

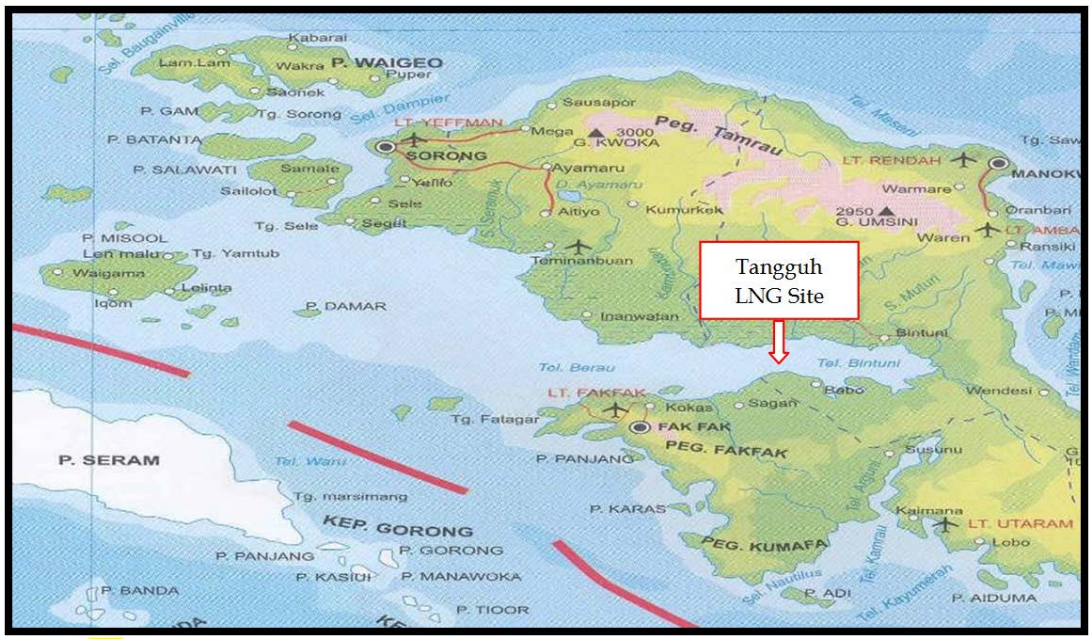


Figure I-1 Location of the Tangguh LNG in Teluk Bintuni Regency, West Papua Province, Indonesia

The current operations of Tangguh LNG include offshore gas production facilities and onshore LNG processing facilities. The offshore gas production facilities encompass production facilities, collection and transmission facilities for natural gas and associated liquids from the Vorwata gas field. The gas is produced from 14 production wells at two offshore platforms (VRA and VRB) and transported through two subsea pipelines to an onshore LNG Plant to be purified and processed into Liquefied Natural Gas (LNG) for export by LNG tankers.

The onshore facilities include two LNG processing trains (LNG Train 1 and 2) with a maximum production capacity of 7.6 mtpa (million tons per annum), LNG Jetty, Combo Dock, and other supporting facilities, including accommodations and administrative offices. The current Tangguh LNG plant has been fully operational since July 1st, 2010.

Tangguh LNG currently has a long-term LNG sales contract with four buyers, namely CNOOC Fujian LNG Co. Ltd. from China, K-Power Co. Ltd. from Korea, POSCO from Korea, and Sempra Energy LNG Marketing Corp. from Mexico.

Tangguh LNG comprises of three Production Sharing Contract (PSC) namely Berau PSC, Muturi PSC, and Wiriagar PSC ("Tangguh PSC"). BP Berau Ltd. ("BP") has been

appointed as the operator to run Tangguh LNG for and in the name of all participating interest holders under Tangguh PSC ("Tangguh Affiliates"). Presently, Tangguh Affiliates comprise a number of business entities as denoted within **Table** I-1**.**

Table I-1 Participating Interest Holders under Tangguh PSC

No	Name of Company	Interest in Tangguh LNG (%)
1.	BP Berau Ltd.	34.24
2.	BP Wiriagar Ltd.	8.56
3.	BP Muturi Holding BV	16.30
4.	MI Berau BV	12.23
5.	CNOOC Muturi Ltd.	0.21
6.	Nippon Oil Exploration (Berau), Ltd.	13.90
7.	KG Berau Petroleum Ltd.	7.35
8.	KG Wiriagar Petroleum Ltd.	2.71
9.	Indonesia Natural Gas Resources Muturi, Inc	1.44
10.	Talisman Wiriagar Overseas Ltd.	3.06

Tangguh LNG is planning to expand its operations by developing LNG Train 3, and future development which involves the development of LNG Train 4 and other supporting facilities. The Tangguh LNG expansion project is aims to optimize LNG production of the existing reserve, thus could provide benefits for the Government of Indonesia, the community, and proponent, among others:

- Contribute in fulfilling domestic gas needs, considering that 40% of LNG Train 3's production will be allocated to the domestic market;
- Support local governments (West Papua Province, Teluk Bintuni Regency, Fakfak Regency) in fulfilling local electricity demand by allocating a certain amount of gas produced under the Tangguh LNG Expansion Project as fuel for electric generators to be constructed in West Papua. For this purpose, Tangguh LNG will support feasibility studies for the construction of gas-powered generator that will, among others, address the economics of reserves and fields, preparedness of the infrastructure, opportunities in the gas market, national energy policies, and public interest. Tangguh LNG understands that a recommendation from the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) and approval from the Minister of Energy and Mineral Resources (ESDM) to allocate specific amounts of gas under the Tangguh LNG Expansion Project are needed before gas can be supplied and sold;
- Support the improvement of local livelihoods in Teluk Bintuni Regency by selling excess power produced by Tangguh LNG to the State Electricity Company (PLN). A 4 MW power has been ready and started to be distributed in February 2014, and the next 4 MW is being prepared to be distributed in the coming year;
- Increase revenue for the national and local governments based on LNG sales and the related taxes;

- Open up job and business opportunities for the local community, which would help to boost income levels and promote livelihood diversification;
- Strengthen existing partnerships and continue investments in economic and social development of the local community and the community in Teluk Bintuni;
- Strengthening the capacity and expertise of Indonesian manpower, especially local Papua community, in the oil and gas technology sector through training and assistance; and
- Increasing access to healthcare and education through community investment programs.

In an effort to increase production capacity, BP and Tangguh Affiliates are planning to gradually develop Tangguh LNG facilities, which henceforth will be referred to as the "Tangguh LNG Expansion Project". The scope of Tangguh LNG Expansion Project can be outlined as follows:

- **Initial development**:

  Encompasses the construction of a new LNG train ("LNG Train 3"), two offshore platforms and subsea pipelines, drilling of 13 gas production wells, three reinjection wells and four infill wells, the construction of supporting facilities, including an additional LNG tank, an additional condensate tank, a Bulk Offloading (BOF) jetty, and a combined LNG-condensate jetty.

- **Future development (further gas supply to LNG Train 3 and development of LNG Train 4):**

  The future development covers the development of up to nine offshore platforms with a total of up to sixteen well slots each platform (including one DCRI well for each platform if this option is considered feasible), the development of up to nine subsea pipelines, supporting facilities, including an additional LNG tank and an additional condensate tank, and the development of LNG Train 4 if, based on the considerations of BP, Tangguh Affiliates and the Government of Indonesia, this is feasible.

Tangguh PSC comprises of five production fields: Vorwata, Wiriagar Deep, Roabiba, Ofaweri, and Ubadari. The Vorwata field is estimated to hold 75% of the total existing gas resource, and the current production of this field supplies gas to LNG Train 1, LNG Train 2, and part of LNG Train 3. The development of other fields, including Wiriagar Deep, Roabiba and Ofaweri, as well as the proposed development of the prospective fields of Ubadari, Kepe-Kepe and Teteruga (if proven, and if economical), will be needed to supply additional gas to LNG Train 3 and ensuing trains.

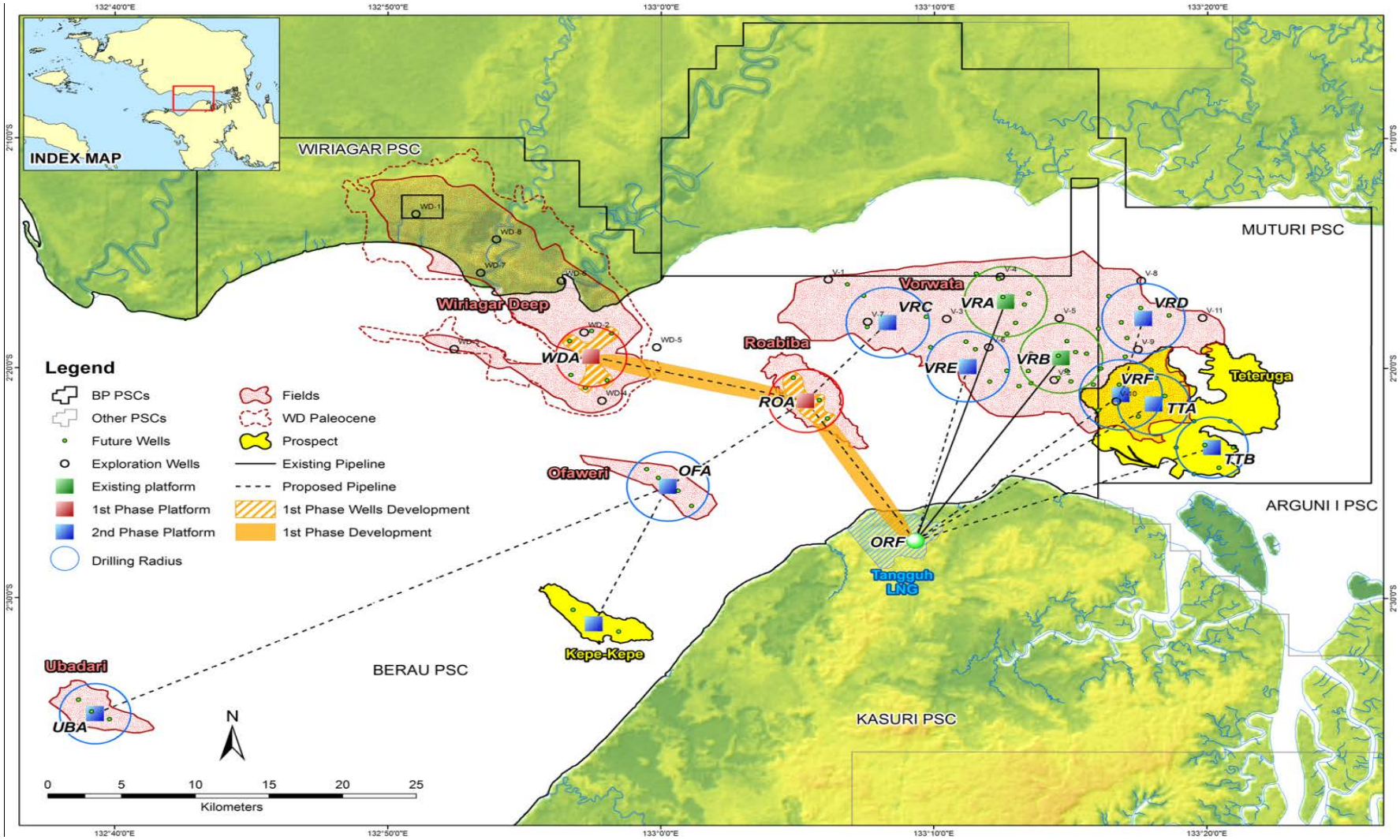


Figure I-2 Conceptual Development Scenario (Initial Development and Future Development) (Without Scale)

The Tangguh LNG Expansion Project was encouraged by the increased discovery of reserves in the Vorwata gas production field, indicated by its dynamic performance and its recertification by local third-party consultants. The recertification of reserves of the Vorwata field indicated the total proven reserve to amount of 16.9 Tcf, which could potentially increase to up to 20.8 Tcf if the potential reserves of the Wiriagar Deep, Roabiba, Ofaweri, and Ubadari fields are taken into consideration.

Further exploration or delineation/appraisal activities under the Tangguh Exploration and Appraisal Program (TEAP), which conducted from 2012 to 2013, are expected to assuage any uncertainties and/or provide proof for the existence of additional resources in the Vorwata, Roabiba, and Ofaweri fields. Exploration or appraisal activities at the Roabiba and Wiriagar Deep gas fields under the preliminary stage of the Tangguh LNG Expansion Project shows the proven reserves of 0.4 Tcf at Roabiba and 2.8 Tcf at Wiriagar Deep. The TEAP exploration project that is currently underway has produced additional proven reserves in the gas fields of Vorwata, Roabiba, and Ofaweri, which may increase the economic value of LNG Train 3.

With the maximum capacity of each LNG Train at 3.8 mtpa and to meet the present commitment made towards LNG buyers, LNG Trains 1 and 2 will need a total gas reserve of 11.2 Tcf. Considering that Tangguh PSC has a proven reserve of 16.9 Tcf, and the fact of potentially new LNG buyers lining up, the Tangguh PSC has a surplus gas reserve large enough to supply a single LNG Train. With a production capacity of 3.8 mtpa, LNG Train 3 requires a gas supply of 3.2 Tcf. So that should all three LNG trains operate at full capacity, the gas reserve required will be 14.4 Tcf. The gas reserve for the proposed development of LNG Train 4 may be sourced from an existing reserve or from one yet to be discovered in the area.

This Environmental Impact Statement (EIS or ANDAL) document was prepared according to the EIS Terms of Reference (ANDAL-ToR) agreed by the Central AMDAL (EIA) Commission of Ministry of the Environment on July 24th, 2013 based on Deputy Minister of the Environment Decree No. 30 Year 2013.

The EIS for the Integrated Activities of the Tangguh LNG Expansion Project was conducted in parallel with the FEED process and the development of the Detail Engineering Design. The final design of the gas exploitation facility, the gas transmission facility, the LNG Train and its supporting facilities, and the marine facilities will be further confirmed and fixed following completion of the FEED process and the Detail Engineering Design.

1.2 DESCRIPTION OF THE PROPOSED PROJECT ACTIVITY

An indicative schedule of the Tangguh LNG Expansion Project activities for the initial development is shown in Figure **I**-3. The schedule for future development will be subsequently determined.

Early works activities will be conducted in 2014 as preliminary works prior to the commencement of main construction activities. The scope of early works will include the followings:

- Initial stage of harvesting and land clearing in area of approximately 125 Ha (the remaining will be conducted further with total land clearing of maximum 500 Ha;
- Bulk Offloading Facility (BOF) including dredging;
- Access/haulage road construction;
- Shorebase improvement *(*open area storage, as well as temporary and permanent storage*)*;
- Combo dock enhancement;
- Camp construction for about 2.000 construction workers, including solid waste management facilities (for construction) and wastewater management facility (for camp); and
- Provision of new fuel storage at BOF for construction activities that equipped with appropriate facility of spillage preventive.

The detail of each early work will be described further in the description of the proposed LNG Plant activities.

As part of the AMDAL study for the Tangguh LNG Expansion Project, the Tangguh LNG will assess the possibility of reviewing the policy of Diversified Growth Strategy, including Closed/Open Camp Strategy. The assessment will consider the condition of local community development in the Bintuni Bay area, aspiration of the local government to create direct economic effects from the operations of Tangguh LNG to support regional development, and the presence of other industrial activities in the Bintuni Bay area.

Thorough assessment needs to be performed before the final decision-making for the future Tangguh LNG. This assessment aims to ensure that the new strategy will take into account potential impacts on the sensitive environment and address the concerns and aspirations of the indigenous people and for the safe and assured operations of Tangguh LNG and its supporting facilities.

Assessment, planning and implementation of this strategy will later need to involve and receive support from relevant local government institutions and the local communities.

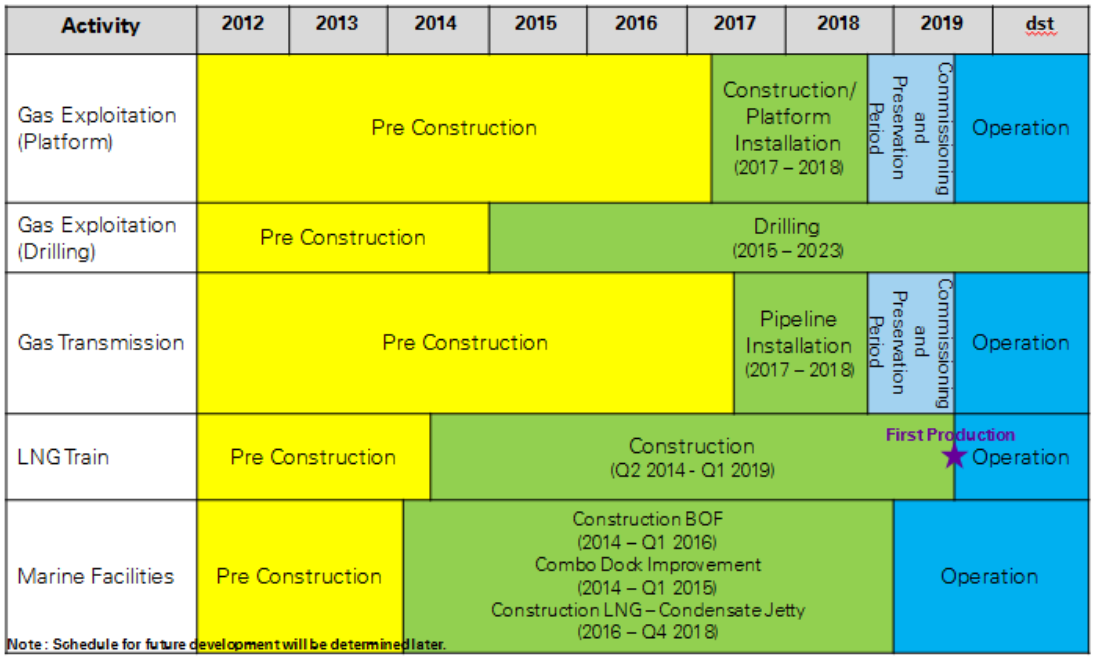


Figure I-4 the Activities Schedule of the Tangguh LNG Expansion Project

1.2.1 Gas Exploitation Activity

Currently there are two offshore platforms which deliver feed gas from wells to existing trains, which are VRA and VRB. Both platforms are Normally Unattended Installation (NUI) with no processing facility. Gas delivery to shore is carried out through multiphase subsea pipelines. Power supply, control and chemical injection are provided from the onshore. The offshore facilities of the Tangguh LNG Expansion Project will be developed by adopting standardized strategy from the existing facility considering improvements from lesson learned that is obtained from the existing design optimization.

Inherently safe design (ISD) features which will be applied for the proposed constructed platform are;

- Platform/topside piping designed to withstand the wellhead shut-in pressure for eliminating large over pressure protecting system; and
- Utilization of Corrosion Resistant Alloy (CRA) for the piping and equipments.

The expansion of the offshore production facility which will supply feedgas for LNG Train 3 and development option of LNG Train 4 consist of up to eleven offshore platforms and subsea pipeline for the full scope of the expansion. Two offshore platforms (ROA and WDA) will be installed as part of initial development and the additional for up to nine platforms (VRF, OFA, VRD, VRC, TTA, TTB, KKA, UBA and VRE) will be installed as part of the future development plan Subsea pipelines will be described in Section 1.2.2 Gas Transmission Activities.

Expandable hub platform concept will be used to allow multiphases liquid mixing from different gas fields and future tie-in. Basically, this hub platform is also a Normally Unattended Installation (NUI) similar with the existing platform with several improvements incorporating lessons learned from existing operation to reduce maintenance visit requirement.

During initial development, infill wells from existing platforms, VRA and VRB are also planned to provide additional feedgas to the existing LNG Train 1 and 2. The offshore development of the Tangguh LNG Expansion Project also includes integrated subsea power and fibre optic cables which will be installed on ring-main topology to supply electrical power, communication and control capability of platform operation.

Existing and development plan of offshore facility as part of the Tangguh LNG Expansion Project is summarized at Table **I**-2 below.

Table I-3 Existing and Development Plan of Offshore Facility as part of the Tangguh LNG Expansion Project

No.	Facility	Existing Facility	Initial Development (LNG Train 3)	Future Development (Further Gas Supply for LNG Train 3 and Development of LNG Train 4)
1.	Offshore platform (NUI)	2 offshore platforms (VRA and VRB)	2 offshore platforms (ROA and WDA) Jacket = 4-6 legged	Up to 9 offshore platforms (VRF, OFA, VRD, VRC, TTA, TTB, KKA, UBA, VRE) Jacket = 4-6 legged
2.	Production wells and DCRI wells	15 production wells : VRA Drilled = 6 wells Active = 6 wells VRB Drilled = 9 wells Active = 8 wells (one well is temporarily abandoned due to technical problem)	ROA Current drilling plan = 3 production wells + 1 DCRI well Technically feasible to be drilled up to 9 wells as per total well slot in platform design. WDA Current drilling plan = 4 WDJ production wells + 4 WDP production wells + 1 DCRI well + 1 DCRI well (optional) + 2 WDJ production wells Technically feasible to be drilled up to 16 wells as per total well slot in platform design. Infill wells (for further development of LNG Train 1 and 2) • VRA = 2 infill wells + potential annular DCRI • VRB = 2 infill wells + potential annular DCRI Initial development is planned to use 1 rig campaign (2015-2023)	**Engineering study is still ongoing.** However, the initial plan are as follow : Initial estimation of total production well on each platform: VRF = up to 7 wells OFA = up to 4 wells VRD = up to 6 wells VRC = up to 5 wells TTA = up to 7 wells TTB = up to 7 wells KKA = up to 2 wells UBA = up to 3 wells VRE = up to 5 wells Technically feasible to be drilled to total wells 16 as per total well slots in platform design.
			Note : DCRI well will be drilled on each platform, if DCRI option is deemed to be feasible. Drilling mud, drill cuttings and associated drilling waste will be reinjected into this reinjection well.	
3	Solid waste and hazardous waste management	**Operation :** Solid waste generated from offshore facility is very limited (NUI) and only generated from maintenance activity, hence waste from platform will be	**Drilling and Platform Installation:** Hazardous Waste Hazardous waste will be sent to licensed waste management facility. Hazardous waste will be managed in accordance with applicable Indonesia regulation, which is Government Regulation No. 18 jo 85 Year 1999 regarding Hazardous Waste Management.	

No.	Facility	Existing Facility	Initial Development (LNG Train 3)	Future Development (Further Gas Supply for LNG Train 3 and Development of LNG Train 4)
		sent to Tangguh site for further management.	Non Hazardous Waste Food waste will be macerated prior to offshore disposal in accordance with MARPOL *Annex V Prevention of Pollution by Garbage from Ships* of 2012 requirement. Non organic waste will not be disposed offshore, but will be treated onshore or sent to waste management facility and in accordance with applicable Indonesian regulation, among others Law No. 18 Year 2008 regarding Waste Management. Non hazardous waste will be managed according to applicable Indonesian regulation, which is Law No. 18 Year 2008 regarding Waste Management and MARPOL Annex V Year 2012 regarding Prevention of Pollution by Garbage from Ships (for food waste disposal to sea). Mud and Cutting Reinjection to subsurface formation or offshore discharge (if reinjection is technically not feasible). Management will be conducted in accordance with applicable Indonesian regulation, which is Ministry of Energy and Mineral Resources No. 45 Year 2006 regarding Management of Drilling Mud, Mud Waste and Drill Cuttings from Oil and Gas Drilling Activity; applicable IFC requirement, which is Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development. **Operation :** Solid waste generated from offshore facility is very limited (NUI) and only generated from maintenance activity, hence the management will be sent to the Tangguh LNG site for further management.	

No.	Facility	Existing Facility	Initial Development (LNG Train 3)	Future Development (Further Gas Supply for LNG Train 3 and Development of LNG Train 4)
4	Waste water management	**Operation :** Wastewater generated from offshore facility is very limited and managed accordingly based on the wastewater type, i.e.sewage will be collected in holding tank and to be discharged directly to sea, meanwhile for oily contaminated water will be collected and sent to LNG Tangguh site for further management using CPI unit or temporarily stored in temporary hazardous waste storage for shipment to licensed hazardous waste management facility.	**Drilling and Platform Installation:** Drainage Non contaminated water from deck drainage are collected and discharged directly to sea. Potentially hydrocarbon contaminated water from deck drainage will be channelled to OWS for reinjection into DCRI well or collected into tote tank to be sent to licensed waste management facility. Sewage Sewage will be treated in sewage treatment plant prior to discharge to sea in accordance with applicable Indonesian regulation, which is Regulation of Minister of Environment No. 19 Year 2010 and MARPOL Annex IV Prevention of Pollution by Sewage from Ships year 2012 requirement. All wastewater during drilling and platform installation, will be treated in accordance with applicable Indonesian regulation, which is Regulation of Minister of Environment No. 19 Year 2010 regarding Waste Water Quality Standard for Oil and Gas and Geothermal Industry/Activity; and MARPOL requirement Annex IV Prevention of Pollution by Sewage from Ships Year 2012. **Operation :** Closed drain system will be provided on the platform which includes closed drain drum to separate liquids from vented gas. Liquid in the closed drain drum will be removed from the platforms using a tote tank as required. No toilet will be provided on the new platforms. Vessel (OSV) Toilet, clean water and sanitation facilities shall be available in the OSV during visits to platform.	

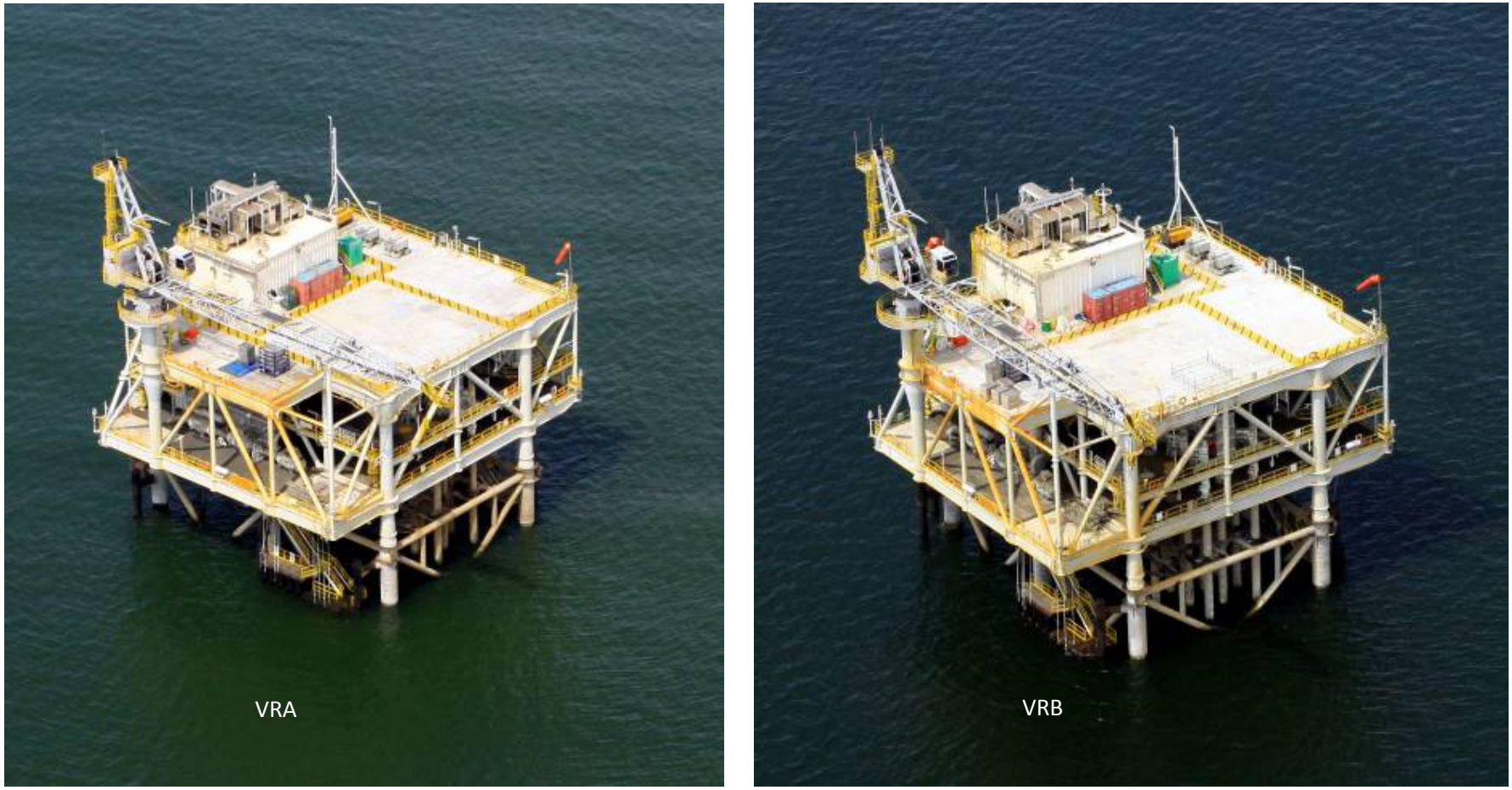


Figure I-1 Existing Offshore Platform

Gas production for the Tangguh LNG Expansion Project, both initial and future development are produced from existing gas fields, which are Wiriagar Deep, Roabiba, Vorwata, Ofaweri, Ubadari and other potential gas fields, such as Teteruga and Kepe-Kepe.

Location of offshore development and initial plan of production well drilling for the Tangguh LNG Expansion Project is shown in **Figure I**-2.

Offshore platform locations are selected based on the following criteria :

- Gas reservoir characteristic that will be developed, is identified based on exploration and appraisal result, 2-dimensional and 3-dimensional seismic data interpretation, well testing, geological data, and other data which is obtained during drilling and exploration;
- Risk and hazard evaluation of shallow rock layer above reservoir (shallow hazard evaluation);
- Geological surface condition of drilling location (Geotechnical condition); and
- Mobile Offshore Drilling Unit (MODU) approach envelope.

Initial configuration of the offshore developmemt will provide three gas supply corridors:

- Center – VRA and VRB platform (existing operation), and VRE platforms with pipelines to shore.
- West – ROA, WDA and third pipeline from OFA and VRC platforms to be connected to ROA platform, including KKA and UBA platforms.
- East – including other platforms from VF (VRD/VRF) and prospective development to Teteruga (if exploration is successful).

Final schedule and location of platform installation and well drilling will depend on reservoir performance and may change from is the figure shown in **Figure I**-2.

	2015				2016				2017				2018				2019				2020				2021				2022				2023			
	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
1 Drilling Rig Campaign			VRB (Infill) Q3 2015 – Q1 2017										WDJ (5 wells) Q1 2018 – Q2 2019						O2 (Apprs)				Rig Mntnc .				VRA (Infill) Q1-Q3 2022							
									ROA (4 wells) Q1 2017 – Q1 2018								KKA (Expl.)				WDP (4 wells) Q4 2019 – Q4 2020				WDJ + WDP (2+1 wells) Q1 2021 – Q1 2022						VRD – VRC (Apprs)			

As per AsPac GWO Integrated Rig Schedule (31th May 2013)

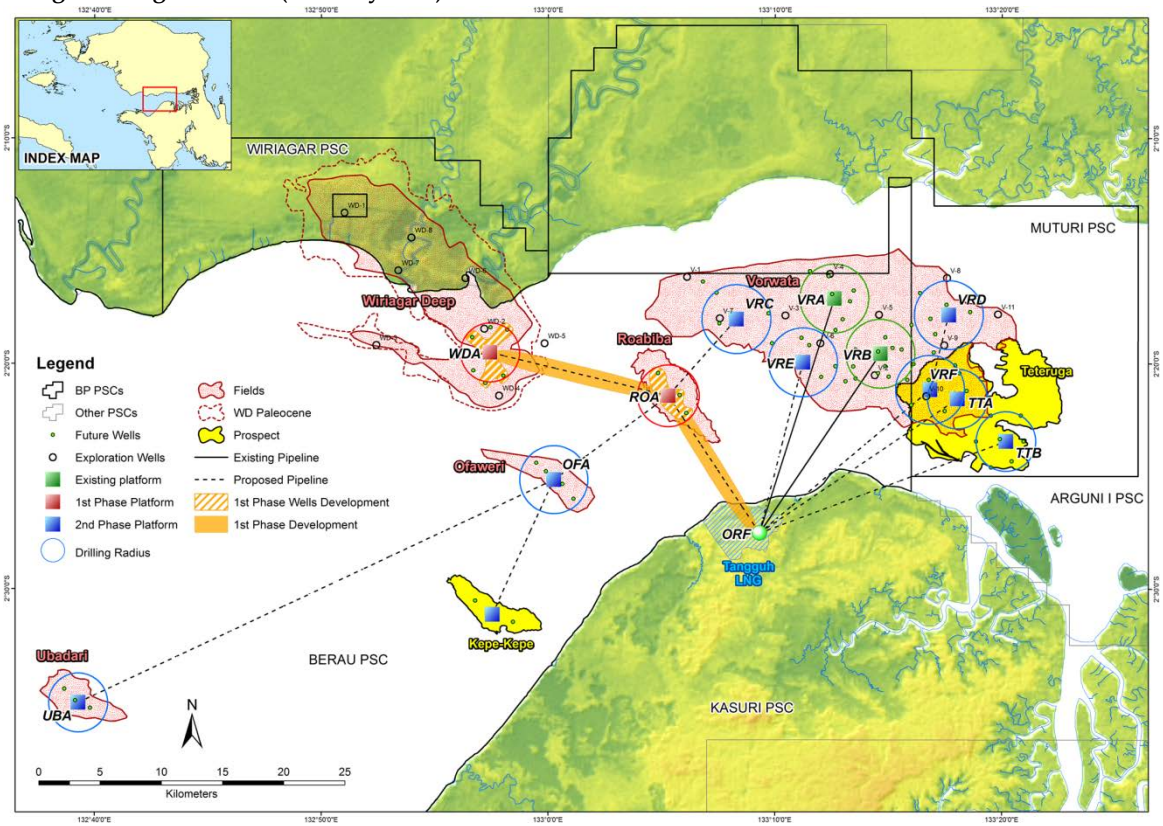


Figure I-2 Initial Development of Offshore and Production Wells Drilling Activities

Table I-1 Potential Coordinate of Offshore Platform Development

Platform	Latitude	Longitude
ROA	2° 21′ S	133° 5′ E
WDA	2° 19′ S	132° 57′ E
VRC	2° 18′ S	133° 8′ E
VRD	2° 17′ S	133° 17′ E
VRF	2° 21′ S	133° 16′ E
OFA	2° 25′ S	133° 0′ E
UBA	2° 35′ S	132° 39′ E
TTA	2° 21′ S	133° 18′ E
TTB	2° 23′ S	133° 20′ E
VRE	2° 19′ S	133° 11′ E
KKA	2° 31′ S	132° 57′ E

Note : Platform design and location are still in finalization stage and may change according to design and project progress.

A. Pre-Construction Phase

A1. Socialization of the Proposed Activity

Socialization of the proposed activity will be conducted to the community prior to commencement of main activity, such as production well drilling and platform installation. This socialization will be conducted with respect to local norms and traditions.

B. Construction Phase

B1. Workforce Mobilization and Demobilization

Production Well Drilling

Majority of the drilling workforce will reside in shorebase and rig accommodation. Logistic and other material will be provided from onshore. Shorebase support will be required to supply other consumable goods to rig.

Estimation of workforce required for production well drilling activity is summarized in **Table I-**2 below.

Table I-2 Estimated Workforce Number for Drilling Activity

Activity	Estimated Workforce
Drilling Rig (MODU)	100 – 120
Shorebase : Tangguh LNG & Security Personnel	10 – 20
Shorebase : Warehouse	10 – 20
Shorebase : Vendor (Mud, Cement, E-line)	20 – 40
Shorebase : Supporting Personnel	100 – 110
Shorebase : Others	15 – 20

Workforce qualification will be determined through workforce management study result and will be described in RKL-RPL. Offshore activity mostly required skilled workforce.

After drilling and platform installation finished, the workforce will be demobilize to their origin.

Offshore Platform Installation

Construction phase consists of offshore platform installation. Most of platform construction workforce will reside in barges and support vessel during construction phase. Logistic and other materials will be provided from onshore.

Total workforce estimation required during this phase is summarized on **Table I**-3 below.

Table I-3 Estimated Workforce for Platform Installation Activity (Construction Phase)

Activity	Location	Estimated Total Workforce
Derrick barge for jacket and topside platform installation	Berau/Bintuni Bay	150 – 300
Transportation barges and towing tugs	Berau/Bintuni Bay	20 – 30
Survey vessels	Berau/Bintuni Bay	20 – 40
Anchor handling tugs	Berau/Bintuni Bay	20 – 30
Construction barge/dive spread	Berau/Bintuni Bay	60 – 80

Workforce qualification will be determined through workforce management study result and will be described in RKL-RPL. Offshore activity mostly required skilled workforce.

After drilling and offshore platform installation finished, the workforce will be demobilized to their origin.

B2. Sea Transportation for Workforce, Equipment and Material

During offshore construction phase and production well drilling, platform deck and its jacket will be fabricated and assembled in the onshore fabrication yard, which located outside project area and will be transported to project site using barges.

All resources required for construction activity will be supplied by barges and supporting vessels, with only some logistic and material supply required from onshore. Fuel and other consumption material including temporary workforce shelter is expected to be provided from onshore supporting facility. Installation and construction of subsea pipelines and nearshore pipelines to ORF will only required small team to be placed in shore area.

Type of vessel operated during drilling and construction activities, among others LCT (for initial mobilization of equipment), tug boats (for towing rig

and other heavy equipments) and support vessels. Additional vessels may be required to transport mud generated from well drilling at final depth to the licensed waste management facility, if reinjection and overboard discharge are deemed not applicable.

Component required for offshore construction facility will be transported to Bintuni Bay using barges and will stay on barges until it is utilized for construction. Several equipment and material may be stored at the Tangguh LNG site to be used for offshore facility construction activity.

Drilling vessel will be in Bintuni Bay for approximately 3-6 months per one well drilling. Construction vessel will be mobilised from various origin ports and will be operated in Bintuni Bay for approximately 3-6 months per one platform installation.

Vessel traffic movement frequency will be higher during construction phase compared to operation phase. Vessel movement to support the Tangguh LNG project is required to pass on designated marine traffic corridor. Traffic and vessel arrival will also be scheduled to ensure efficiency of offshore facility construction and avoid excessive vessel traffic in Bintuni Bay area.

Vessel movement activity for mobilization/demobilization of equipment and material during production well drilling and offshore platform installation is summarized in below table.

Table I-4 Estimated Sea Transportation Equipment during Construction Phase of Gas Exploitation Activity

Drilling (up to 3-6 months/well)	Platform Installation (up to 3-6 months/platform)
LCT for first equipment mobilization to drilling site	5 Material Barges and 5 Tug Boats
4 Support Vessel (2 AHTV and 2 PSV)	3 Support Vessels
Crew Boats	1 Derrick barge for jacket and topside platform installation
	1 Survey Boat
	3 Anchor Handling Tugs
	1 Construction barge, including hook up barge.
	Crew Boat

Figure I-3 Potential Vessel during Construction Phase of Gas Exploitation Activity

B3. Transportation and Installation of Offshore Platform

Major components of offshore platforms include :

- Jacket - submerged structural frame that support the deck;
- Pile - substructure part act as foundation in the seabed inserted to the jacket legs; and
- Deck - the structural frame that supports the functional facility with associated appurtenances, technical building, etc.

The structural members of the platforms will be fabricated, assembled and tested as a comprehensive integrated functional unit at a fabrication yard outside project site. Deck components will be fabricated and assembled at individual vendor shops and delivered to the platform shop as a complete unit. The deck will be re-assembled to the maximum extent, as limited by the lifting capacity of the marine construction equipment.

The pre-assembled platforms will be transported from the fabrication yard(s) in Indonesia by offshore deck barges assisted by large dedicated tug boats.

Platform and deck fabrication facility outside Tangguh LNG is excluded from TEP AMDAL Scope. Project Proponent will ensure that the appointed fabrication yard has had environmental document, licence and approval in compliance to applicable Indonesia regulations.

Platform installation work will be divided into the following major phases :

- Fabrication workshop (outside Tangguh LNG site) - the jacket and deck will be fabricated and assembled at the fabrication yard outside Papua Barat.
- Transportation of the platform to Tangguh LNG project site uses specialised large tug boat, the platform will be transported from the fabrication yard on to conventional offshore barges and lashed (sea-fastened) prior to be transported.
- Offshore platform installation – Offshore construction phase covers setting of jacket, installation of foundation pile, and lifting of deck with its installed equipment.
- A derrick barge will be used to install the facilities, firstly setting the platform jacket (support structure) and then drive the pile foundations. The boat landings, decks, cantilevered vent booms, and helidecks will then be set. Finally, all equipment and piping components will be hooked up and made ready for commissioning. The derrick barge or the MODU may install the well conductors. A support vessel for diving activity will be available on the installation barge.
- Hook up and commissioning will be carried out upon the mechanical completion and pre-commissioning of all systems. Non-destructive

methods such as radiographic examination, ultrasonic testing, and hydrotesting will be used to confirm the integrity of the systems. Some pre-commissioning works will be carried out onshore and will involve the checking and testing of all topside equipment to evaluate its correct operation prior to installing the deck on the jacket. Final pre-commissioning and commissioning checks will be conducted offshore before hydrocarbons are introduced into the facilities.

Conceptual design of offshore platform is shown in **Figure I**-4.

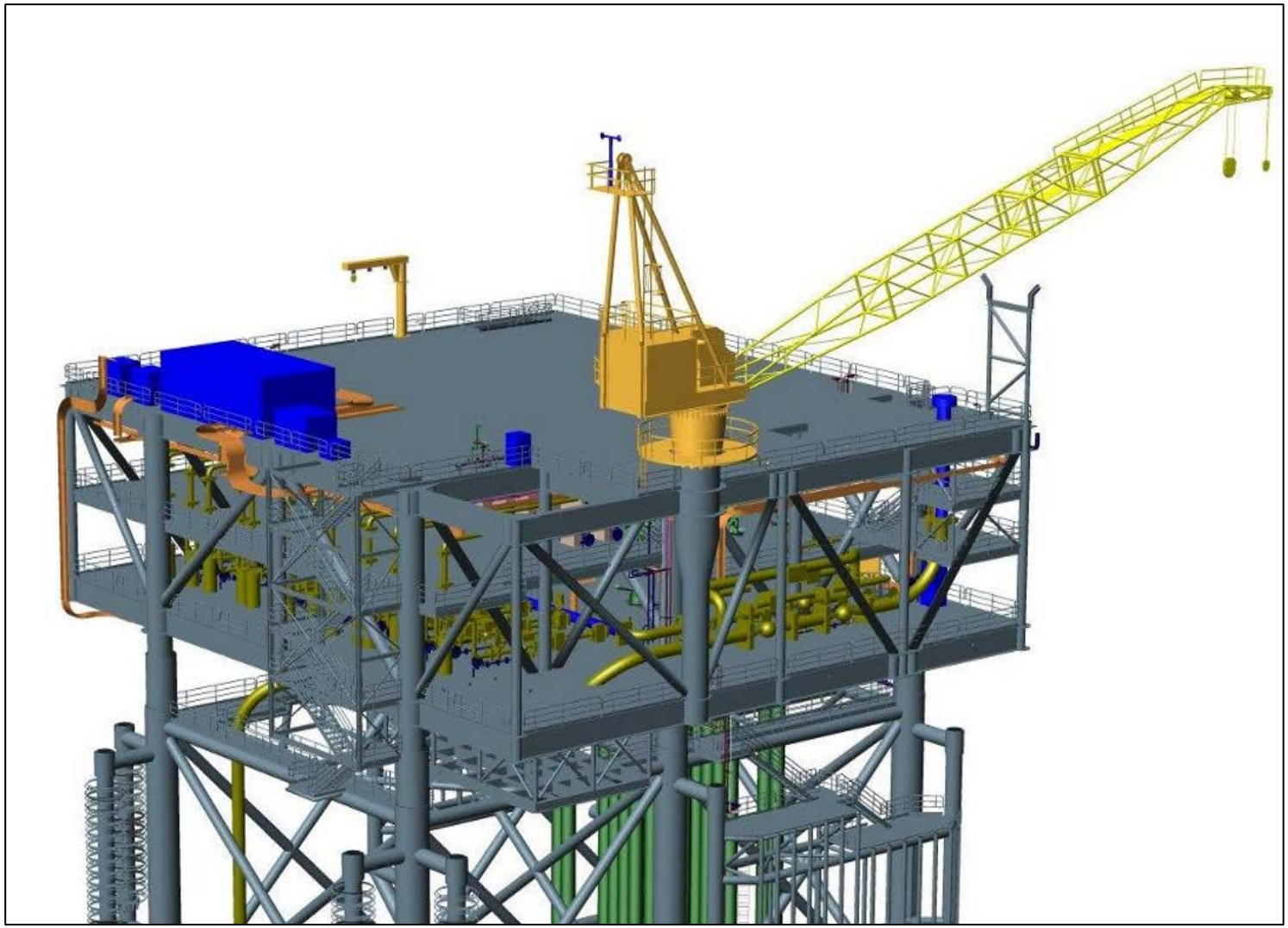


Figure I-4 Conceptual Design of Offshore Platform

Major facilities at platform consists of:

- Safety Facility : one complete set of safety equipment will be available in each platform for response to emergency shutdown and personnel evacuation.
- Electrical Power Generator : Electrical power generator will potentially be supplied from one or combination of sources as follow : electrical power supply from LNG Train through subsea cables, battery, and/or diesel generator.
- Pigging facility : Launcher and receiver facility for pigging will be installed to facilitate activity of testing, cleaning and survey implementation of the pipeline network.

The integrated subsea power cables and fibre optic cables from LNG Train will be installed and buried in a ring-main topology. This integrated cable will be installed at pipeline corridor and buried in trench for protection with horizontal directional drilling at shore crossing.

Anchor/mooring buoys will be installed surrounding each platform location. Installation of the buoys were meant to mark the safety exclusion zone. Wells monitoring and measurement device will also be installed on platform.

B4. Production Wells Drilling

Wells Design (Casing and Completion)

Gas wells will be drilled from Mobile Offshore Drilling Unit (MODU) with jack up or other suitable rig type. It will be self-sufficient and not rely on platform facilities. Estimated duration of drilling for each well is approximately 3 - 6 months.

For the Tangguh LNG Expansion Project, wells will be drilled up to maximum approximately 10,000 – 20,000 feet (3,000 – 6,000 meter). Typically a well is drilled in stages from bigger diameter to smaller diameter, and tubular steel pipe (casing) is inserted and cemented into place at the completion of each section. The casing stabilizes the well bore hole and prevents the flow of fluids between the well and the surrounding formations.

It is possible that all wells will be drilled one by one to total depth or only the first well that will be drilled to total depth and other wells will be drilled using batch drilling mode. Batch drilling mode means, all wells will be drilled to the same depth, casing is installed and cemented before the next stage is drilled prior to sections of other wells being drilled.

In general, sequence of well drilling, casing and completion is summarized as follow :

1) **30″ Conductor**

Driven to 50 ft BML

2) **Drilling of 24″ hole**

3) **18-5/8″ casing**

To cover weak and unconsolidated shallow formation

4) **Drilling of 17 ½″ hole**

5) **13-3/8″ casing**

Isolate Lower Steenkool and minimize exposure to Kais

6) **Drilling of 12¼″hole (*losses*)**

For DCRI well, drilling will stop here and the well will be used for re-injection purpose.

7) **10-3/4″x 9-7/8″ casing**

Cover losses zone and minimize exposure to Paleocene

8) **Drilling of 8 1/2″ hole**

9) **7″ liner**

Cover losses zone and minimize exposure to Paleocene

10) **Production Tubing**

Base case - 7″. Equipped with PDHG (P & T)

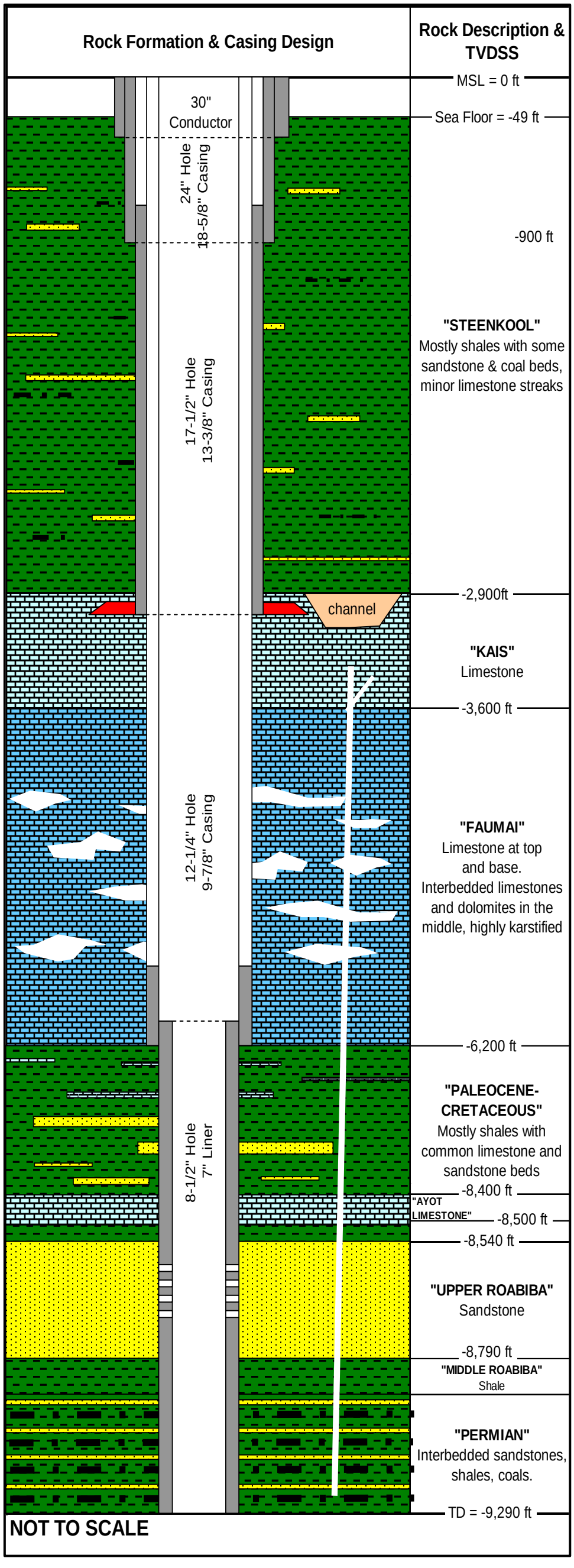


Figure I-5 Cross Section of Well Drilling

Drilling Fluids

The base case plan is for all drilling depth sections (except for the reservoir section) of each production well to useWater Based Mud (WBM) while the last section (reservoir section) is planned to use Synthetic Based Mud (SBM) or Oil Based Mud (OBM). However, the option to use SBM or OBM in the 17.5" interval (in addition to the reservoir section) is currently being evaluated and will depend on hole conditions.

For delineation/appraisal and exploration well, non-toxic WBM may be used for entire well sections. However, SBM and OBM is an option for reservoir section and 17.5"interval, if required.

The utilization of OBM is being evaluated by considering the technical and economical aspect. However, when OBM is used, the drilling mud and drill cuttings shall not be discharged overboard but shall be reinjected to the subsurface formation through DCRI well. If due to any technical reason, reinjection is not feasible, the drilling mud and drill cuttings generated from drilling with OBM will be sent to licensed waste treatment facility.

Seawater and fresh drill water are the base fluid from the major component of the drilling mud. Other, as yet to be determined, mud additives may be used among others as viscosities, water loss control agents, oxygen and H_2S scavengers, surfactants, and lost circulation material.

Summary of initial drilling fluid usage and its objective for exploitation drilling plan for the Tangguh LNG Expansion Project is summarized in table below :

Table I-5 The Use of Drilling Fluids and its Objectives

Diameter :	The Use of Drilling Fluids and its Objectives:
24" Hole Section	• Drill 24" hole from top of Lower Steenkool layer and run 18 5/8" casing to bottom section • Use seawater or pre-hydrated gel + sweep • Avoid/minimize well bore stability problems • Achieve good quality hole cleaning • Achieve optimum ROP.
17½" Hole Section	• Drill 17 ½" hole to Top Kais run 13 3/8" casing to bottom section • Use inhibitive mud + sweep • Avoid/minimize well bore stability problems • Achieve good quality hole cleaning • Achieve optimum ROP • Avoid stuck pipe due to differential sticking and losses circulation • More economical interval drilling fluid • Use of SBM/OBM may be required due to possibility of drilling may cross shale formation which will be reactive to WBM and could cause bit and stabilizers balling which could extend drilling period due to : a) slow ROP (rate of

Diameter :	The Use of Drilling Fluids and its Objectives:
	penetration) and could result longer drilling period; b) several trips may require to change or unball balled up bit and stabilizers; c) balled up BHA (Bottom Hole Assembly) and bad bit could become a challenge in performing directional trajectory steering to reach the intended target.
12¼" Hole Section	• Drill through Kais and Faumai layer, and total depth at Top Paleocene, run 10-3/4" x 9-7/8" to bottom section • Use of inhibitive mud and sweep which will be changed to seawater in case of losses • Achieve good quality hole cleaning • Avoid stuck pipe due to differential sticking and losses circulation • Execute Annular Pressure Management operation • Avoid well control incident • Achieve optimum ROP • More economical interval drilling fluid • Mitigate drill string corrosion
8½" Hole Section	• Drill to total depth at base of Roabiba/ Paleocene formation • Run 7" liner to bottom and get good cement quality (zonal isolation) • Use of SBM as reservoir drill-in fluids (SBM) • Engineer the drilling fluid for reservoir preservation (minimize reservoir damage) • Avoid stuck pipe due to differential sticking • Achieve good quality hole cleaning • Achieve optimum ROP • Use of SBM/OBM may be required due to a) use of SBM/OBM could increase ROP (rate of penetration); b) based in previous experience in Tangguh Phase 1 (pre-drilling laboratory test result), formation damage could be reduced if SBM/OBM were used; c) to stabilize shale layer in Paleocene, SBM/OBM will give benefit to stabilize the hole.
6" Hole Section	• Use of SBM/OBM may be required due to a) use of SBM/OBM will fix lubrication and reduce friction factor to help reach further well target; b) to stabilize Paleocene shale, SBM/OBM will give benefit in stabilizing the hole.

The use and composition of drilling fluids may change to adapt with drilling layer condition.

Detail casing design, drilling fluids and cementing is shown in **6** Summary of Well Design (Casing).

Gas reservoirs of the Tangguh LNG Expansion Project have been extensively evaluated through 2-Dimensional and 3-Dimensional seismic program, exploration and appraisal drilling, logging measurements (well logs), extensive coring characteristic measurement program and well testing activities. These data will be incorporated into the overall development well design. Key well design components include casing design, logging program, drilling mud program, cementing program and MODU criteria. The well design have calculated potential flow condition of reservoir fluids into the well and its mitigation measures, hence the risk of blowout can be minimized.

Primary well control which being drilled, will use drilling mud, so that the hydrostatic pressure from the surrounding well hole will not be higher than the hydrostatic pressure from the drilling mud itself. Secondary well control will be provided by installing a shallow gas diverter prior to commencing drilling of the surface section and a Blow Out Preventer (BOP) prior to drilling is iniated in the deeper sections. The installation of these devices enable secondary well control to allow the regulated discharge of any fluids and adjustment of the hydrostatic pressure exerted by the drilling muds.

If the well take a kick, then well control method will be activated. Well will be shut-in and continue with circulating out the kick using kill mud and the well will be monitored afterwards. If all parameters return back to normal, then drilling operation will be continued.

Worst case, if the kick cannot be uncontrolled or blowout happened, emergency response is required to evacuate personnel out of the rig and the operation will be continued with different rig/MODU to kill the well by drilling relief wells.

Relief well design and all required equipment to drill relief well will be provided prior to drilling development program commenced.

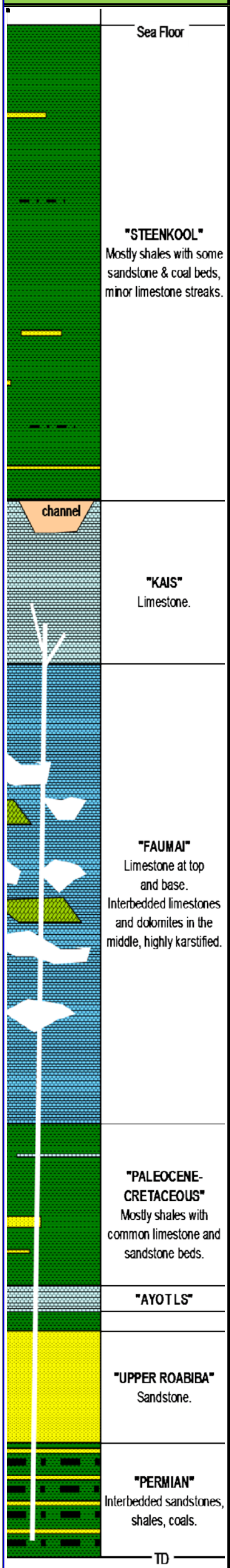
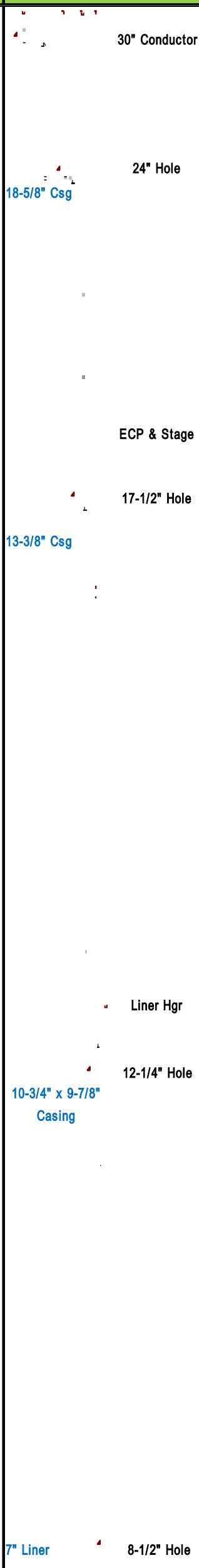
Lithology	Casing Schematic	Casing Design	Drilling Fluids	Cementing
		30" Conductor driven to ~200 ft TVD BML - TBD on Conductor Analysis - Grade : 310 lb/ft, X-52, 1" WT, Butt Welded - TBD on Drivability Study		
		18-5/8" Casing set at base of Upper Stenkool - Grade : 94.5 lb/ft, X-56, Connection - TBD	General • Sea Water with sweeps. • Heavy fluid displacements. WD-Jur & WD-Pal • Heavier mud might be required to avoid WBS issues vs ECD limitations. • Inhibited mud might be required.	Objective • To allow sufficient integrity to drill 17-1/2" hole section. • To act as pressure containment and allow sufficient integrity from well control condition. Slurry • Lead 12.6 ppg, Tail 15.8 ppg (150 ft above shoe). TOC 100 ft BML.
		13-3/8" Casing set at Top Kais - Grade: 72.0 lb/ft, Special Drift, P-110, Connection - TBD	• Inhibited mud (8% KCl, concentration TBD) • Strict fluid loss control to avoid differential sticking in Kais. • Heavier mud might be required to avoid WBS issues. • Strictly requires optimization on mud lower rhelogy characteristics (6 RPM).	General • To act as pressure containment and allow drilling to Faumai Slurry • Lead 12.6 ppg, Tail 15.8 ppg (500 ft above shoe). TOC 500 ft above 18-5/8" casing shoe.
		10-3/4" x 9-7/8" Casing Set below Faumai (ensure no more lost circulation) and above over pressured zone in Early Paleocene/ Late Cretaceous. - 10-3/4" Casing : 65.7 lb/ft, T-95, Connection - TBD - 9-7/8" Casing : 62.8 lb/ft, T-95, Connection - TBD	• Drill with mud from 17-1/2" hole section until loss rate is consider technically and economically unpractical; THEN use sea water with sweeps. • Formulate better method for drill string corrosion mitigation. • Re-visit mud/ fluid cap methods and drilling practices when drilling w/ total losses to avoid high torque, well control incidents and stuck pipe incidents due to poor hole cleaning/ packing off. • Adding torques reduction material to drilling fluids.	General • To isolate potential gas sand in Kais (DPZ-1) Slurry • Stage-1: Lead 12.6 ppg, Tail 15.8 ppg (500 ft above shoe). • Stage-2: Single slurry 15.8 ppg, minimum 500 ft above ECP (inside 13-3/8" x 9-7/8" shoe)
		7" Liner set at Permian or TD - Grade : 32.0 lb/ft, 13Cr95, Integral joint - TBD	• Heavier mud might be required to avoid WBS issues in potentially over pressured Paleocene & Cretaceous. • Develop Reservoir Drill-In Fluids that help preserve reservoir properties (non/ less damaging). • Strictly requires optimization on mud lower rhelogy characteristics (6 RPM). • Strict fluid loss control to avoid differential sticking in Kais.	General • To isolate Cretaceous/ Paleocene (DPZ-2) and Roabiba (DPZ-3) Slurry • Single slurry 15.8 ppg, TOC at Top of Liner.

Figure I-6 Drilling Activities Summary and the Use of Drilling Fluids

B5. Drilling Mud and Drill Cuttings Management

Prior to usage, toxicity test will be conducted to drilling mud and drill cuttings (WBM and SBM). Toxicity test will be performed in accordance with Government Regulation No. 18 Year 1999 (JO Government Regulation No. 85 Year 1999) regarding Hazardous Waste Management, also Guideline of Minister of Energy and Mineral Resources No. 45 Year 2006 regarding Drilling Mud Management in Oil and Gas and Geothermal Industry.

Toxicity test result of drilling mud from previous well will also be used as reference.

The base case plan is for all drilling depth sections (except for the reservoir section) of each production well to use Water Based Mud (WBM) while the last section (reservoir section) is planned to use Synthetic Based Mud (SBM) or Oil Based Mud (OBM). However, the option to use SBM or OBM in the 17.5" interval (in addition to the reservoir section) is currently being evaluated and will depend on hole conditions.

Approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings are expected to be produced and will be discharged from each well. In principle, drilling mud will be reused as much as possible during drilling period.

There are two alternatives of drilling mud and drill cuttings management that are assessed in this AMDAL study, which are :

1. *Reinjection of drill cuttings and final drilling mud into subsurface formation through dedicated reinjection well (one well per platform) or into the annulus of production well that being drilled*

   Reinjection of drilling mud and drill cuttings into subsurface formation is the most preferable alternative.

   Currently the Tangguh LNG is assessing the possibility to perform reinjection of drill cuttings and final drilling mud to a dedicated reinjection well that will be constructed at each platform or into annulus between casing of 13-3/8" and 9-7/8" from production well being drilled as undertaken successfully in the previous drilling activities of 15 wells at VRA and VRB.

   Should reinjection is deemed feasible, the following drilling waste will also be reinjected :

   - Drilling mud (WBM, SBM and OBM) from final depth and/or cannot be reused;
   - Drill cuttings (WBM and SBM);
   - Sludge from sludge tank;
   - Viscous pre-flush and following over-flush for drilling;

- Invert Emulsion Mud contaminant waste from the drill base;
- Cement mix spacer;
- Cement mix returned to the surface;
- Cleaning fluid from the annulus;
- Extra KCL brine;
- Produced water during well testing;
- Produced solid during well testing;
- Sludge from mud plant tank;
- Sludge from drilling mud tank on the vessel;
- Potential hydrocarbon contaminated water.

Although the alternative of reinjection of drilling mud and drill cuttings is preferred to be applied, there is possibility that there would be technical problems during drilling then the option cannot be applicable.

Several examples of technical problem that may be encountered are as follow :

1. In the case where the target formation rejects the re-injected material, therefore drilling mud and drill cuttings will be discharged overboard;
2. For the initial well which will be drilled on each platform, whether it is reinjection well or production well, reinjection cannot be done. Therefore, there is only one possibility can be performed, which is to discharged the drilling mud and drill cuttings overboard;
3. The volume of generated drilling cuttings is in excess of the injection equipment capacity and the drilling operation cannot be shut down. Therefore, the excess will be discharged overboard;
4. Failure on the injection equipment, with consideration of drilling schedule and/or on critical periods during the drilling operations, shut down of drilling operation may not be able to be done;
5. Catastrophic failure subsurface such as tubular collapse and formation partially or fully plugged;
6. Blow out and shallow gas, which are diverting operation situations; and
7. If reinjected drilling mud and drill cuttings affect the integrity of the producing wells.

Some technical studies are performed to confirm if one (or more) formations have been identified for appropriate reinjection of drilling mud and drill cuttings (reinjection zone). At this stage, the Faumai formation is

the preferred interval for reinjection of drilling mud and drill cuttings and, the study is being perfomed to elaborate the possibility of this option.

The technical studies are being conducted to investigate the following technical issues :

- Do the selected formations have sufficient injectivity, technically safe?
- Do the potential formations for reinjection provide sufficient storage for the volume of injected mud and cuttings?
- Do the potential formations for reinjection have a strong compartments and be able to isolate the injected drilling mud and drill cuttings from the formations above to the surface and below to potential hydrocarbon zones?
- Is there any risk of contaminating groundwater aquifer resource above it?
- Is there any risk of contaminating potential hydrocarbon layer resource?
- Is there any impact to other PSC's reservoir nearby?

Final decision on whether the reinjection will be done through a dedicated well or annulus (between casing 13-3/8" and 9-5/8") of production well is not yet defined.

2. *Overboard discharge*

If DCRI is not technically feasible due to geological consideration or other technical consideration, or there is technical problem during DCRI operations, the final drilling mud (only WBM) and drill cuttings can be discharged overboard at the drilling location.

Therefore, dispersion and potential impact generated from final drilling mud and drill cuttings overboard discharge has been evaluated. Drilling mud and drill cuttings discharge modelling has been conducted as part of AMDAL study and being used as a basis of impact evaluation in Chapter III. The Complete modelling results can be seen in Attachment IV.1.

The drilling mud and drill cuttings overboard discharge shall be conducted in compliance with the applicable Indonesian regulations (ESDM Regulation No 45 of 2006) and the permit provided for this activity, as well as relevant Environmental Health and Safety Guidelines of IFC Year 2007 for Offshore Oil and Gas Development.

Water Based Mud (WBM) discharge of well drilling from the final depth and/or not reusable can be done if the mud passes toxicity test (≥30,000ppm, 96 hours LC-50) and comply with applicable Indonesian regulation and IFC Guidelines as mentioned above. LC-50 test will be conducted prior to the mud being used for gas well drilling.

If DCRI option is not feasible, synthetic-based drilling cutting (SBM) can be discharged overboard if the oil content is less than or equal to 6.9% (≤ 69,000ppm). Meanwhile, oil-based drilling mud and drill cuttings (OBM) will not be discharged overboard, but will be sent to licensed waste management facility, if the DCRI option is not feasible.

If there is technical problems with the DCRI process, and the drilling mud or drill cuttings do not meet the requirement for the overboard discharge option, then the drilling mud and drill cuttings will be sent to licensed waste management facility.

Other potential drilling wastes that may be discharged are brine water and seawater including small amount of cuttings from sand blasting during drilling operation.
The Tangguh LNG will apply a permit for DCRI option or Overboard Discharge option to the Ministry of the Environment in accordance with applicable regulations.

Drilling mud and drill cuttings management will be conducted in accordance with all requirements stipulated in the permit, applicable Indonesian regulations (ESDM regulation No. 45 Year 2006) and IFC 2007 Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development.

DCRI option will only be applied for drilling activity of production well. Meanwhile, for well drilling exploration activity, preferred option for the management is overboard discharge.

During drilling activity, there will be cementing stage for every section interval. In this well drilling, it is not expected to have cement excess from cementing process. This is because the all supplied cements will be adjusted according to well design, thus all the cement produced will enter the casing as required. No cement on the surface at all times.

There will be a possibility of residual cement from cement tank clean-up process, maximum waste water volume from this process is 100 bbls (15,000 L) for each cementing activity. This residual cement will be discharged overboard through a discharge pipe. However, cement waste could not be produced and there would be no potential excess during cement circulation from other section due to cement process will not reach mud line. Cement will be prepared as per design and cement tank is not designed for dead volume.

Mud Type	DCRI*) - Dedicated Well - Annulus of production well		Overboard Discharge*)	
	Mud	Cutting	Mud	Cutting
Water Based Mud (WBM)	√	√	√ LC50 ≥ 30.000 ppm	√
Synthetic Based Mud (SBM)	√	√	X	√ Oil Content ≤ 6,9%
Oil Based Mud (OBM)	√	√	X	X

Note :

*) : required permit

If both options cannot be done, drilling mud and drill cuttings will be treated in accordance with applicable regulation.

Figure I-7 Summary of Drilling Mud and Drill Cuttings Management

B6. Production Well Clean Up (*Flaring*)

During production well clean up which will be conducted prior to production stage, there will be flaring on drilling rig for 48-72 hours period for each drilled well. Flaring rate during production well clean up can reach up to 100 MMSCFD.

As mentioned previously, it is possible that all wells will be drilled one by one up to the final depth or by using batch mode (except for the first well of each drilling location). Therefore, on each platform a period of flare test will be conducted for 48 to72 hours at the end of each well drilling. There is also possibility to conduct batch flaring if batch drilling mode was used.

B7. Non Hazardous and Hazardous Waste Management

Well drilling and platform installation activity will generate hazardous and non hazardous waste. Hazardous waste which will be generated such as used oil, contaminated oil/grease, used chemical substance and its packaging, paint and thinner can. Meanwhile, non hazardous waste generated include organic waste (food waste) and non organic waste (plastic, can, scrap metal, styrofoam, etc.).

Hazardous and non hazardous waste will be segregated and managed in accordance with applicable Indonesian regulation and MARPOL 2012 requirement (for food waste disposal to sea only).

Detail waste management strategy is currently being developed, with considered management plan are as follow :

- Hazardous Waste

  Hazardous waste generated will be sent to licensed waste management facility. Hazardous waste will be managed in accordance with applicable Indonesian regulation; Government Regulation No. 18 jo 85 Year 1999 regarding Hazardous Waste Management.

- Non Hazardous Waste (Organic)

  One of organic waste which will be generated during drilling and platform installation activity is food waste. Food waste generated from those activity will be disposed overboard following the MARPOL 2012 Requirement Annex V Prevention of Pollution by Garbage from Ships. According to MARPOL Annex V, comminuted food waste are allowed to be disposed overboard at minimum distance of 3 nautical miles from the nearest shore. Food waste must be comminuted and pass through a screen with a mesh size no larger than 25 mm prior to disposed overboard.

- Non Hazardous Waste (Non-organic)

  Non organic waste generated during drilling include plastic, can, scrap metal and Styrofoam. Non organic waste will not be disposed overboard, but will be managed in the onshore facility or sent to external waste

management facility in accordance with applicable Indonesian regulation, including Law No. 18 Year 2008 regarding Waste Management. Currently, considered option for non-organic waste is to be managed in the Tangguh LNG site along with other waste from LNG Plant activity and in accordance with applicable regulation.

Summary of estimated waste generated during drilling and offshore platform installation activities is shown in **Table I**-6 below.

Table I-6 Solid Waste from Drilling Activity

Type of Waste	Estimated Quantity	Treatment Facility (if applicable)
Domestic waste (food waste)	60 tonnes/ month	Comminuted and discharged according to MARPOL 2012 requirement
Scrap metal	15 tonnes/ month	Sent to scrap metal treatment facility
Wood	20 tonnes/ month	Sent to waste treatment facility
Non organic waste	1,5 tonnes/ month	Sent to waste treatment facility
Used oil (hazardous waste)	60 tonnes/ month	Sent to licensed waste management facility
Other hazardous waste (non-oily)	65 tonnes/ month	Sent to licensed waste management facility

Source : Environmental Data of Tangguh Exploration and Appraisal Program (TEAP) – June 2013

Detail of waste management implemented in the Tangguh LNG is described in Sub Chapter 1.2.3 LNG Plant Activity Section B8 Non Hazardous and Hazardous Waste Management.

Drilling mud and drill cuttings management has been described previously in Section B5 Drilling Mud and Drill Cuttings Management.

B8. Wastewater Management

Wastewater generated during drilling and platform installation activities include deck drainage, sewage, cooling water and brine water. All wastewater generated during drilling and platform installation will be managed (at the minimum) in accordance with applicable Indonesian regulation and MARPOL 2012.

Detail of main wastewater source and its management during drilling and platform installation are described as follow :

- Surface drainage from rig/platform decks – Deck drainage from uncontaminated areas will be collected and discharged directly overboard. Potential Hydrocarbon contaminated runoff from equipment washdown water, any diesel, chemicals, or lubricants spill contaminated runoff will be reinjected into DCRI or annulus of production well (during drilling) or collected in tote tank and sent to licensed waste management facility.
- Sewage – Drilling rigs and support vessels that are manned, resulting in the generation of sewage to be treated in a a sewage treatment plant prior

to be discharged overboard. The discharge will comply with Indonesian regulations, Minister of the Environment Regulation No. 19 Year 2010 regarding Wastewater Quality Standard for Oil and Gas and Geothermal Activities, also provisions in MARPOL 2012 Annex IV Prevention of Pollution by Sewage from Ships.

Table I-7 Wastewater from Drilling Rig

Activity	Estimated Wastewater Volume	Discharge Option
Desalination (Brine Water Reject)	140 m^3/day	Brine water is discharged overboard
Sewage Treatment Plant	120 m^3/day	Effluent will be treated to meet effluent quality standard prior to discharge overboard
Oily Water Separator (OWS)	130 m^3/day	Oily contaminated water which has been separated from its oil layer in OWS unit will be discharged overboard in accordance with applicable standard. Separated oil layer will be reinjected to DCRI well or annulus of production well or sent to licensed hazardous waste facility.
Well Test (Produced Water/ Brine Water)	20 m^3/day	Produced water will be flown into oil diverter to be discharged to sea in accordance with applicable quality standard. Separated oil will be reinjected to DCRI well or annulus of production well or sent to licensed hazardous waste facility.
Cooling System	1,200 m^3/day	The effluent is directly discharged overboard
Deck Drainage	180 m^3/day	Deck runoff is directly discharged overboard

Source : Estimation based on information from TEAP 2013 data

B9. Storage and Loading of Fuel and Chemicals

Production Well Drilling

Fuel and chemicals storage for drilling activity will be located in shore base area. Existing combo dock facility will be enhanced and used for liquid mud (brine) and dry bulk plant.

Refueling will be required for the drilling rig, once it is in its final drilling position. The refueling process will be conducted using an appropriate vessel; this activity will be in accordance with Refueling Procedures that are applicable at Tangguh LNG.

Offshore Platform Installation

During offshore platform installation, fuel and chemicals storage will be located in the offshore construction barge.

During the offshore platform installation, vessels will transport fuel and chemicals that are required to execute its construction activities. Potentially there will be offshore re-fuelling or chemical loading during platform installation activity.

B10. Power Generator (Diesel Generator)

Electrical power during drilling and platform installation/construction activity including during preservation period will be supplied by diesel-fuelled power generator which it will be removed after completion of the activity.

C. Operation Phase

C1. Workforce Mobilization

During operation phase, the platform will be operated in NUI concept, which means there is no personnel works on platform, except during inspection or maintenance. Total workforce required for platform inspection and maintenance activity are included in total workforce required for LNG Plant operations.

Detail of recruitment process, mobilization and demobilization of workforce during operation phase are described in Sub Chapter 1.2.3 LNG Plant Activity Section C1. Workforce Mobilization.

C2. Gas Exploitation and Offshore Platform Operations

Each offshore platform is designed as a Normally Unattended Installation (NUI) with 4 or 6 jacket legs. These platforms are essentially "wellhead" installation with 9, 12 or 16 well slots with 35 m – 65 m water depth for Bintuni Bay. Where appropriate, an expandable "hub" NUI design will be adopted to allow commingling of fluids from different gas fields and enable future tie-ins. This "hub"will be operated as "normally unattended" and lessons learned from existing operation will be considered in the design to minimize visit frequency and to allow future tie-in to be performed safely.

For initial development, ROA and WDA platform will be installed with an inter-field connector to direct gas from the outlying WDA platform to the ROA platform where fluids will be commingled and sent from ROA to ORF onshore.

The NUI platforms are designed with no major processing equipment on the offshore platforms except riser, launcher and/or receiver, pedestal crane, hydraulic power units and technical building. Wells are operated remotely from control room located in LNG Plant onshore. Local control station will be provided on platform, particularly for evaluation system when maintenance team are on platform.

Control and communications between onshore and the offshore platforms will be via fibre optic cable. Additionally, security boats will perform patrols around the facility on a regular basis.

Each well will be equipped with a subsurface safety valve that can be closed in the unsafe event or failure on control system.

The full wellhead pressure shut-in design does not require flaring of hydrocarbon vapors in the event of a process upset (equipment malfunction, blowdown, depressuring-blowdown, etc.). However, process piping vents will be installed for maintenance activity. On the contrary, minimum facilities which are not designed for full wellhead shut in pressure, require ventilation system to release hydrocarbon vapor. Future compression facility on platform, when installed, will also use ventilation system.

During the operation phase of the Tangguh LNG, compressor booster will be required to be installed to compress the gas and compensate reservoir pressure decline. The compressor will be driven by gas turbine. At this stage, the location of the compressor will be subject to further technical assessment. The option of compressor locations will be at onshore area close to the ORF or at offshore on platform.

There will normally be operational personnel only at the onshore facility. However, a fast crew boat will be utilized to provide emergency response in the event of offshore platform shut-in.

C3. Existence of Offshore Platforms

Physical existence of the offshore platforms will potentially constitute hazards to marine activity, as well as impacts on sea transportation and fishery activity. All applicable Indonesian maritime regulations and relevant International Maritime Organization (IMO) requirements for the provision of navigational aids will be provided on the platforms.

Safety exclusion zone will be applied for each platform to ensure no disruption to production operation and thus safety of non operational personnel not interrupted as well. As part of platform security, a 500 m radius Safety Exclusion Zone will be applied for each platform. These Safety Exclusion Zones will be indicated with marker buoys installed on location and also marked on the appropriate navigation charts. Socialization program will be conducted to neighbouring villages within offshore platform locations.

As described previously, during normal operations the offshore platforms will normally be unattended. A daily patrol to the offshore platforms may be required to ensure the safety of the facility. Access to the offshore platforms is via boat landings or walk to work gangway. The operations and maintenance personnel associated with the offshore platforms activity are currently stationed at the onshore Tangguh LNG.

Since it is designed as NUI, no waste is expected to be generated from offshore platform during operation, limited volume of waste will be generated during maintenance activity of offshore platform and production wells.

Possible venting on platform for emergency intervention is currently being studied.

C4. Maintenance of Production Wells and Offshore Platforms

There will be a comprehensive preventative maintenance and inspection program for each platform to assure the mechanical, electrical, and instrumentation systems as well as the structures to function well. This program will include lubrication, calibration, non-destructive testing, and replacement of equipment, when required. Additionally, an independent contractor will perform verification activities to establish that the facilities are being operated and maintained in accordance with the Safety and Risk Management Guidelines developed by the Tangguh LNG Expansion Project.

Although the inspection and maintenance program will be thorough, it is not possible to undertake all activities while the platform is operating. Operation shutdown for maintenance purposes will be scheduled to maintain the continuity of system and equipment integrity on the platform or if health, safety, and environment considerations shall require it. The schedule of GPF operation activity shutdown will be planned in alignment with planned schedule of LNG plant shutdown (turn around period - TAR).

Production well maintenance during operation phase consists of well intervention programs, which include wire line (from offshore platform) and coiled tubing activity (from jack up vessel).

During the life time of project, if required, well work-over programs will be performed involving the removal of sand, well stimulations, casing repair, re-perforating, and shutting off flow from specific formations.

C5. Non Hazardous and Hazardous Waste Management

No waste are expected to be generated from offshore platform during normal operation, because it is designed as NUI. Waste will only be generated during maintenance visit with estimated domestic waste quantity of approximately 5 kg per visit.

No waste management facility at offshore platform. All waste generated will be sent to an integrated waste management facility in Tangguh LNG site for handling and further management.

Detail non hazardous and hazardous waste management is described in Sub Chapter 1.2.3 LNG Plant Activity Section B8. Non Hazardous and Hazardous Waste Management.

C6. Wastewater Management

During operation phase, wastewater generated from production well and offshore platform activities are very limited. The wastewater generated is mostly from offshore platform maintenance activity, such as seawater/brine water from well work-over and lubricants. Hydrocarbon contaminated water will be reinjected into DCRI well or annulus of production well.

Closed drain system will be provided on the platform which include closed drain drum to separate liquids from vented gas. Liquid in the closed drain drum will be removed from the platforms via a tote tank as required.

No toilet will be provided on the new platforms. Vessel Toilet (OSV), clean water and sanitation facilities shall be available in the OSV during visits to platform.

C7. Storage and Loading of Fuel and Chemical

During operation phase of offshore platform, refueling facility is available at the combo dock area. The use of these facilities will be limited to vessels under direct control of the Tangguh LNG and is most likely to be limited to transport and maintenance vessels traveling periodically to the offshore platforms.

Chemicals transfer during normal operation will be conducted using Multipurpose Support Vessel (MPSV) with connection to platform which only occurred for well intervention activity.

Loading and unloading of chemicals into chemical tanks will be conducted onshore.

Currently, Tangguh LNG operations are equipped with an Oil Spill Contingency Plan (OSCP). This OSCP will be updated to reflect the additional activity scope. Accidental diesel spill could occur from offshore platform or vessel. Emergency response plan for fuel spill will be described in the OSCP.

D. Post Operation Phase

Post operation phase will include but not limited to decommissioning of facilities and workforce demobilization.

D1. Workforce Demobilization

At the completion of operation phase, there will be demobilization of operation workforce. Detail process will be determined later and will be conducted in accordance with applicable regulation.

D2. Decommissioning of Offshore Platform Facilities

The facilities decommissioning plan will be developed to obtain approval from the government. The decommissioning activity of offshore platform facilities will be carried out in accordance with applicable Indonesian regulation and industrial standard recommended by the Government of Indonesia at that time.

The offshore platforms and their facilities will be decommissioned and dismantled in accordance with Indonesian regulations and PSC obligations. Currently the applicable regulation for dismantling of offshore installation is Minister of Energy and Mineral Resources Regulation No. 01 Year 2011.

Several options that being considered for project decommissioning are as follow :

a. Well abandonement procedure also will follow Indonesian regulation (*Standar Nasional Indonesia* No. 13-6910-2002) and standard procedure applied in PSCs. Cement plugs will be installed in each production well to isolate each reservoir layer, cement plug between reservoir layer, cement plug at final production casing and cement plug at surface. Each cement plug will be tested to ensure it has suitable strength which complies with cement plug standard. Then, casing conductor will be cut off in the depth of 150 feet below sea level.

b. Platform piles may be cut and brought onshore, or as alternative may be left for growing coral reefs. A decommissioned platform would be left temporarily at least until several platforms have been decommissioned and therefore it becomes more economic to proceed with their removal. A site clearance survey will be conducted as part of the removal process to assist in removal of all debris. Remaining chemicals will be managed in accordance with applicable Indonesian regulations and best industrial practice.

c. Subsea pipeline will be flushed and left on site.

1.2.2 Gas Transmission Activity

Currently there are two subsea pipelines that have been installed to connect two offshore platforms to Onshore Receiving Facility (ORF), VRA-ORF and VRB-ORF. Those subsea pipelines have a diameter of 24" with length of 19 km (VRA-ORF) and 18 km (VRB-ORF).

As mentioned briefly in Sub Chapter 1.2.1 Gas Exploitation Activity, up to eleven subsea pipeline will be installed as part of overall Tangguh Expansion Project. Two subsea pipelines will be installed as part of initial development to connect the first two initial platforms, WDA to ROA then ROA to ORF.

In future development stage, up to nine subsea pipelines will be installed to connect offshore platform to other offshore platform (hub platform) or directly to ORF. Design of each pipelines will be determined during FEED and Detail Engineering Design, which includes design of pipeline mechanics, stability, route, burial depth requirement, etc.

The material used for pipelines is Corrosion Resistant Alloy (CRA) with various diameter between ranging from 16-24". CRA pipelines will transport the multiphase well stream to shore with high CO_2 content combined with the high temperature and water vapour that makes the fluid highly corrosive. The CRA to be used is designed to reduce corrosion during the life of the operating facilities.

Existing subsea pipelines illustration and future development scenario of Tangguh LNG Expansion Project is shown in **Figure I**-8.

Geographical and geotechnical survey in potential pipelines corridor will be done to identify seabed condition. With regards to that, thus the impact from pipeline activities will be assessed within corridor of 2 km (1 km left side and 1 km right side) from pipeline corridor as shown in **Figure I**-8 to anticipate potential shift of pipeline channel due to technical problem, such as seabed condition is too steep or other causes.

Gas supply pipeline of the Tangguh LNG Expansion Project are divided into three different parts, which are :

- Offshore pipelines
- Near shore approach (shore pipelines), with alternative methods :
  - Trenching and shore pull
  - Horizontal Directional Drilling (HDD)
- Onshore pipelines

Additional study is also performed to assess pipeline installation method in near shore and feasibility to use HDD method in comparison to trenching and shore pull, to minimize environmental impact and taking into account technical and financial aspect. If HDD method is technically feasible, hence it will minimize impact to seabed and nearshore area, also to minimize physical impact to mangrove in that particular area.

Conceptual illustration of nearshore and onshore pipeline connection is shown in **Figure I**-8 below.

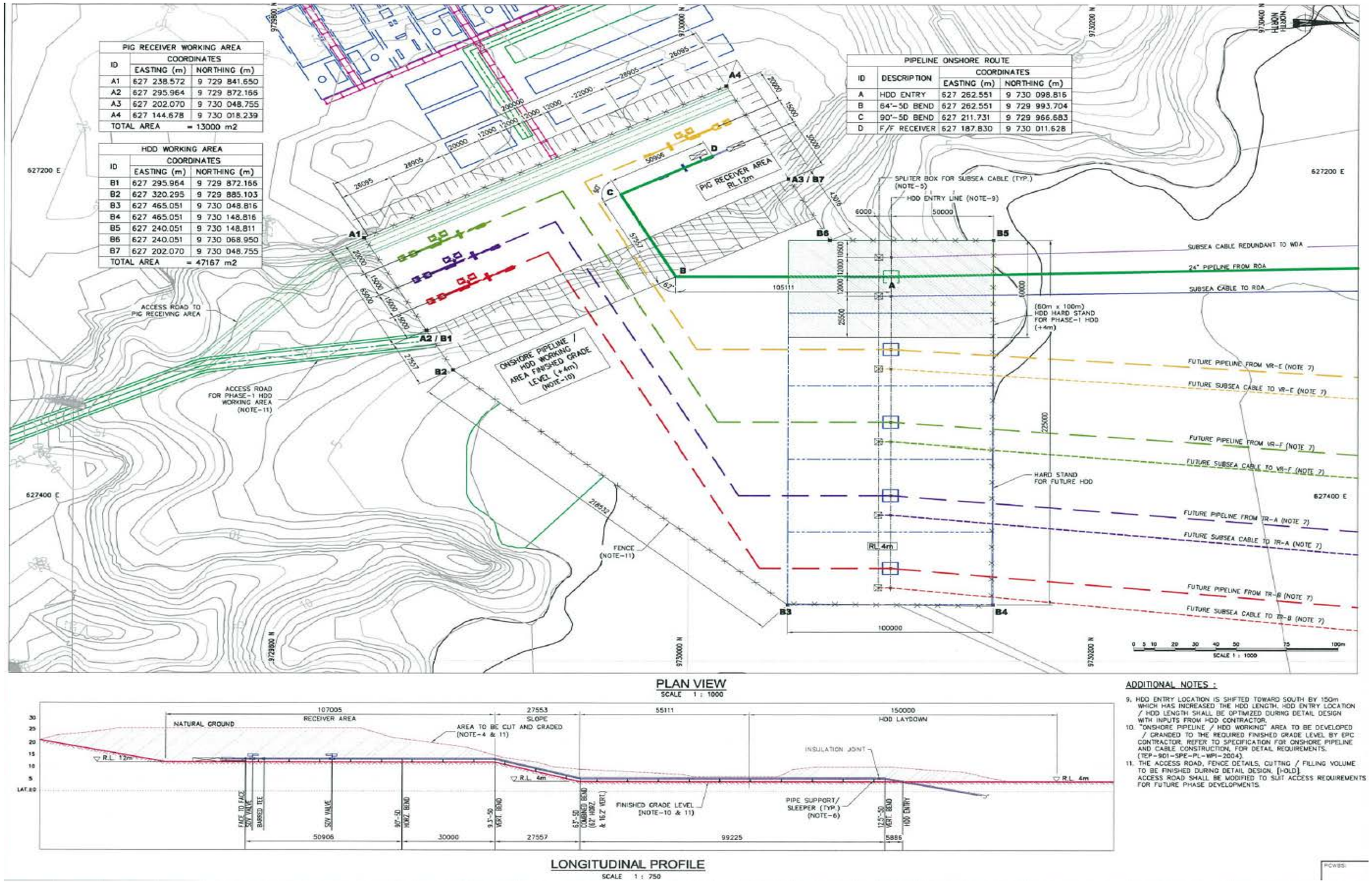


Figure I-8 Conceptual illustration of Nearshore and Onshore Pipeline Connection-

Summary of gas transmission activity is provided in **Table I**-8 below.

Table I-8 Existing Gas Transmission Facility and Development Scenario of Tangguh Expansion Project

No.	Facility	Existing Tangguh LNG Facility	Initial Development (LNG Train 3)	Future Development (upto LNG Train 4)
1	Subsea Pipelines	2 subsea pipelines: VRA to ORF Diameter = 24″ Length = 20.5 km VRB to ORF Diameter = 24″ Length = 19 km	2 subsea pipelines: WDA to ROA (hub platform) Diameter = 24″ Length = ± 16 km ROA ke ORF Diameter = 24″ Length = ± 12 km	Up to 9 subsea pipelines. Engineering study is in progress, with initial plan as follow : Diameter = 16″- 24″ Length up to approximately 30 km Initial plan are as follow : - VRF to ORF (Ø 24" , approx. 21 km length) - OFA to ROA (Ø 16", approx. 13 km length) - VRD to VRF (Ø 24", approx. 7 km length) - VRC to ROA (Ø 24", approx. 9 km length) - TTA to ORF (Ø 24", approx. 20 km length) - TTB to ORF (Ø 24", approx. 20 km length) - UBA to OFA (Ø 24", approx. 30 km length) - VRE to ORF (Ø 24", approx. 15 km length) - KKA to OFA (Ø 24", approx. 30 km length) Those pipeline route are the initial plan and will be finalized according to engineering study result that currently ongoing. Parallel pipeline, size is not yet defined, but the diameter is estimated to be 20″-24″. Initial plan of parallel pipeline are as follow: - ROA – WDA - ROA – ORF - VRA – ORF - VRB – ORF

No.	Facility	Existing Tangguh LNG Facility	Initial Development (LNG Train 3)	Future Development (upto LNG Train 4)
				- VRF – ORF - TTA – ORF - TTB – ORF - KKA - ORF Finalization of parallel pipeline will be done according to engineering study result that currently ongoing. During Tangguh LNG operation phase, compressor booster will be required to be installed to compress the gas and compensate reservoir pressure decline. The compressor will be driven by gas turbine. At this stage, the location of the compressor will be subject to further technical assessment. The option of compressor location includes at onshore area close to the ORF or at offshore on platform. The ORF will be expanded to accommodate additional future pipelines (expandable ORF). The system design life for structure and pipeline is 40 years.
2	Solid waste management facility	**Operation** : No solid waste generated from pipeline operation.	**Pipeline Installation:** Hazardous Waste Hazardous waste, such as used oil and chemical, will be sent to licensed waste management facility. Hazardous waste will be managed according to applicable Indonesian regulation, which is Government Regulation No. 18 jo 85 Year 1999 regarding Hazardous Waste Management. Non Hazardous Waste Food waste will be macerated prior to overboard discharge according to MARPOL 2012 Annex V Prevention of Pollution by Garbage from Ships. Non organic waste will not be discharged oberboard, but will be treated onshore or sent to waste management facility and will follow applicable Indonesian regulation, among others Law No. 18 Year 2008 regarding Waste Management.	

No.	Facility	Existing Tangguh LNG Facility	Initial Development (LNG Train 3)	Future Development (upto LNG Train 4)
			Non hazardous waste will be managed (at minimum) according to applicable Indonesian regulation, which is Law No. 18 Year 2008 regarding Waste Management and MARPOL 2012 Annex V regarding Prevention of Pollution by Garbage from Ships (for offshore discharge of food waste). HDD waste and onshore pipeline HDD waste will be disposed to construction landfill in Tangguh LNG area. Meanwhile, waste from onshore pipeline installation will be managed along with waste from LNG construction activity. **Operation :** No waste generated from gas transmission operation.	
3	Wastewater management facility	**Operation** : No wastewater generated from gas transmission operation.	**Pipeline installation :** Drainage Non hydrocarbon contaminated deck drainage will be collected and discharged directly to sea. Hydrocarbon contaminated run off will be collected into skimmer/tote tank to be sent to licensed wste management facility. Sewage Treated in biological treatment facility and chlorinated prior to overboard discharge according to MARPOL and applicable Indonesian regulation, which is Regulation of Minister of Environment No. 19 Year 2010 regarding Wastewater Quality Standard for Oil and Gas and Geothermal Industry/Activity; and MARPOL 2012 requirement Annex IV Prevention of Pollution by Sewage from Ships. All wastewater during pipeline installation will be managed according to applicable Indonesian regulation, which is Regulation of Minister of Environment No. 19 Year 2010 regarding Wastewater Quality Standard for Oil and Gas and Geothermal Industry/Activity; and MARPOL 2012 requirement Annex IV Prevention of Pollution by Sewage from Ships. **Operasi :** No wastewater generated during operation stage of gas transmission.	

A. Pre-Construction Phase

A1. Socialization of the Proposed Activity

Socialization of proposed activity will be conducted to the community prior to commencement of pipeline installation activity. This socialization will be conducted with respect to local norms and traditions

B. Construction Phase

B1. Workforce Mobilization and Demobilization

Estimated workforce required for pipeline installation activity for initial development of the Tangguh Expansion Project is summarized in **Table I**-9. Total required workforce demand for pipeline installation during future development will be similar with this estimated number.

Table I-9 Estimated Workforce Required for Pipeline Installation

Activity	Location	Workforce
Pipeline barges and support tugs	Bintuni/Berau Bay	20 – 30
Pipelay vessel	Bintuni/Berau Bay	200 – 300
Shore approach and onshore pipeline construction team	Bintuni/Berau Bay	150 – 200
Trenching vessel	Bintuni/Berau Bay	25– 35
Rock dump vessel	Bintuni/Berau Bay	30– 50
Rock transport barges and support tugs	Bintuni/Berau Bay	30– 50
Survey vessel	Bintuni/Berau Bay	20– 40
Support vessel (diving support vessel, LCT, Pre commissioning)	Bintuni/Berau Bay	30– 60

Workforce qualification will be determined from study result of workforce requirement an will be described in detail in RKL-RPL. Offshore activities is mostly required skilled workforce.

After pipeline installation finished, workforce will be released and demobilized to their point of hire.

B2. Sea Transportation for Workforce, Equipment and Material

The line-pipe joints will be fabricated at pipe fabrication facility and will be delivered to coating yard for anti corrosion coating and concrete weight coating application. The line-pipe concrete weight coating will include installation of anodes to mitigate corrosion risks and ensure integrity of the pipeline. Some of the pipes may be double joint at fabrication yard. Once the pipelines are ready, they will be transported to Bintuni Bay by cargo barges for installation.

Subsea spools tie-in will be pre-fabricated onshore. Final adjustment/fabrication will be performed during offshore facility construction based on the spool metrology.

The fabrication yards will be at locations that will most likely be in or around industrial zones or ports.

Most pipelines will be transferred to pipelay barge or to combined construction lay barge in the bay. Pipe joints with designated length will be required for onshore pipeline.

The offshore pipelines will be installed from the lay barge, using the S-lay method. The gas transmission pipelines will be laid on the seabed, either directly on the natural seabed floor or in areas that may already have been trenched. The requirement for trenching and rock dumping will be defined based on the engineering assessment.

Vessel traffic may occur in Bintuni Bay during the commencemet of pipeline installation activity . Estimated construction period for pipeline installation is approx. 10-12 months per pipeline with estimated length of 30 km (pipe lay ± 4 months, trenching ± 2 months and rock dumping ± 6 months).

During construction, initial estimation of vessel type required are as follow :

- Approximately 10 material barges, including tug boats;
- Approximately 3 anchor handling tugs;
- Approximately 3 supply boats;
- Approximately 2 crew boats, and
- Construction vessels, including: pipelay barge, trenching barge, rock dumping barge, cable lay vessel, survey vessel, support vessel (including diving work, LCT, pre commissioning), HDD support vessel.

Type and number of vessel which will be used during construction will depend on construction method and actual field condition .

Side Dump Vessel **Pipelay Barge**

Figure I-9 Example of Construction Vessels (left : Side Dump Vessel, right : Pipelay Barge)

B3. Land Clearing and Site Preparation

In Tangguh Integrated AMDAL which was approved in 2002, Tangguh LNG is allowed to clear areas of 800 Ha. Approximately 400 Ha of 800 Ha have been cleared for existing Tangguh LNG facility. Additional area of maximum 500 Ha will be cleared as part of Tangguh LNG Expansion Project.

For pipeline installation, land clearing and site preparation are required for shore approach and onshore pipeline (depending on location).

If HDD option is applied, estimated area for HDD pad and onshore pipeline is approximately 100 m x 100 m for each campaign.

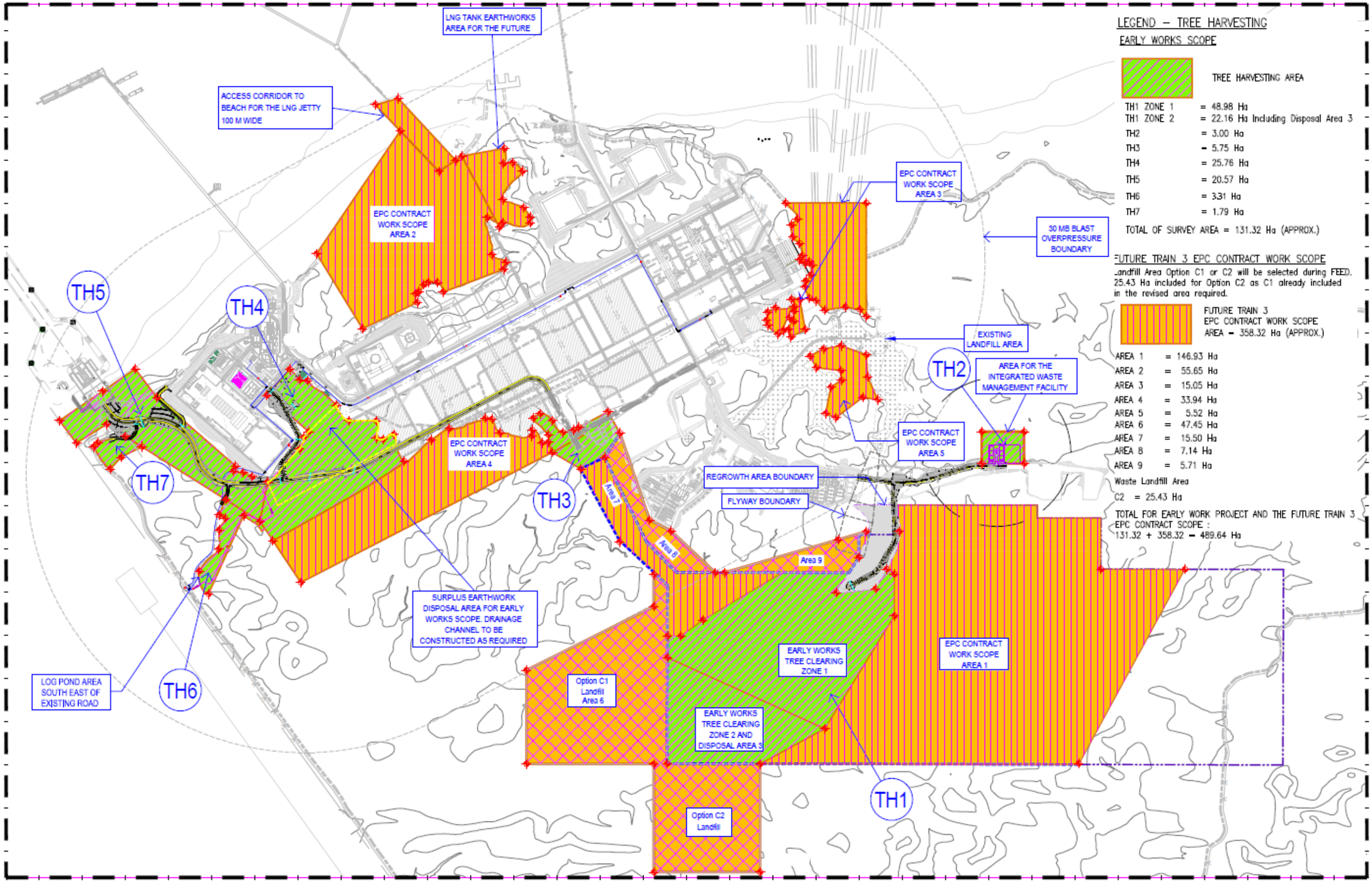
If shore pull option is applied, estimated area needed for hold back anchor is approximately 30 m x 20 m.

Onshore pipeline will require laydown and temporary storage area approximately 80 m x 120 m, potentially located adjacent to ORF area.

Final location will be further assessed as the project progresses.

HDD entry points are in the south further away from shoreline and intended to be established adjacent to ORF facilities. Estimated total area which will be cleared for HDD option is approx. 16 Ha as shown in **Figure I**-10.

For shore pull option, the area of mangrove to be cleared is estimated 40 m width for each shore pull. Total mangrove area to be cleared depend on the depth of mangrove in the specific area, with current estimation approximately 3 to 5 Ha Winch will be positioned on an area similar to HDD pad, at location closer to the shore near the mangrove area.



Note : *) Project land clearing map plan which at this stage is in completioin design stage and may change subject to design and project development

Figure I-10 Land Clearing Area Map

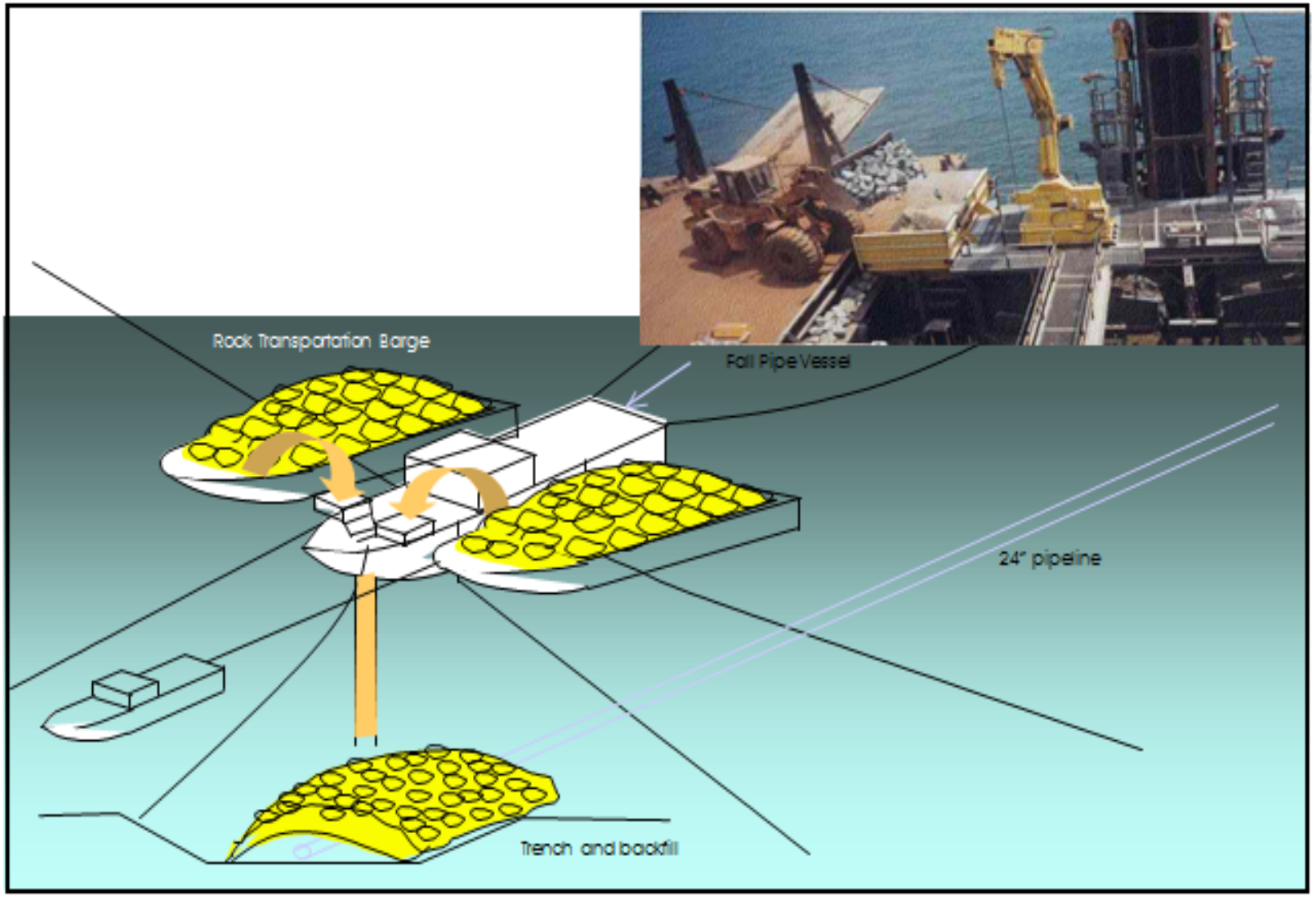


Figure I-11 Conceptual Trenching and Rock Dumping (Trench Backfill) Operation

B4. Pipeline Installation, Seabed Trenching and Rock Dumping

As described previously, offshore pipeline will be laid on seabed within designated corridor using lay barge with S-lay conventional method.

Offshore pipeline installation for initial development phase, such as ROA and WDA pipelines, will be installed in one campaign using one pipelay barge.

Due to the temperature of the gas, the pipeline may need to be trenched and rock dumped to mitigate buckling issues.

Further engineering study will be performed to determine the extent of trenching and rock dumping, including burial requirement for the pipeline. The assessment will consider gas properties, seabed condition, stabilization, protection and integrity of the pipeline during operation.

Depending on the result of the engineering study, there could be possibility of the pipeline required to be trenched and rock dumped for the full length, partial trenched and rock dumped, or no trenched and rock dumped.

In the case where trenching and rock dump is required for the pipeline offhore, the activities will involve pipe-lay, trenching and rock dumping.

For nearshore pipeline, prior to installation it will potentially be required to trench a channel (pre-trenched/pre-dredged) for pipeline stabilisation purpose during installation due to strong current in shore area and also for pipeline protection. Channel size will be a depth ofup to 3m deep from seabed and between 5 m to 10 m width. Method of channel trench/dredge will use cutter-section dredger, clamp shell or similar equipment depending on thesoil type.

For HDD method option, channel will be dredged/trenched approximately 500m long, from HDD exit point in seafloor to water depth of approximately -13m. Estimated spoiled soil for this option is approximately 15,000m^3 and will be placed on the trench sides or at the approved dredged material disposal location. For trenching and shore pull method option, channel will be made along the shore with the same depth. Estimated spoiled soil for this method is approximately 105,000m^3, which some could be used for fill material and the remaining spoiled soil will be disposed at approved dredged material disposal location. After the pipeline is placed in the channel, if technically required or for pipeline protection, the pipeline will be rock dumped. Trenching requirements will be determined through further study.

For pipeline in deeper area, once pipeline installed on the seabed, trenching will be conducted below pipeline using jetting, ploughing or other mechanical cutting technique. Those trenching methods will require to place the trenched material at the trench sides. Current plan is to conduct trenching for pipeline installation using water jetting. Trencher or cutter suction dredger may be used for pre-lay seabed intervention prior to pipe lay.

Trenching requirement for pipeline installation will be determined with considerations of applicable regulation and local site specific condition, such as vessel route and geotechnical condition.

For design requirement at this stage, the target of trenching depth is 1 – 2 m (on top of pipe), then rock dumped with 0.3 – 2 m high.

Estimated displaced soil for trenching activity will range between 2 – 4 m^3/m for 1 m deep trench.

Rock quantity which was used during previous Tangguh LNG construction, for VRA and VRB pipeline is 360,000 tonnes for pipeline with diameter of 24" and length of 35 km. Based on pre-FEED design, estimated rock quantity for pipeline installation of ROA and WDA with 0.3 – 2 m high is approximately 300,000 tonnes. Estimated rock quantity for future pipeline installation will be determined later subject to pipeline length.

Pipeline installation will be performed in compliance with applicable Indonesian regulation and other relevant international requirement.

Prior to pipeline installation, risk assessment, especially along pipeline route near the shipping lane. This will be conducted to anticipate shipping activity that may have impacts to the pipeline integrity such as anchor drop, anchor drag and ensure safety as well as integrity of the pipeline.

Prior to pipeline installation, a pre-construction survey will be carried out, which include magnetometer survey to confirm no risk of UXO along the pipeline route.

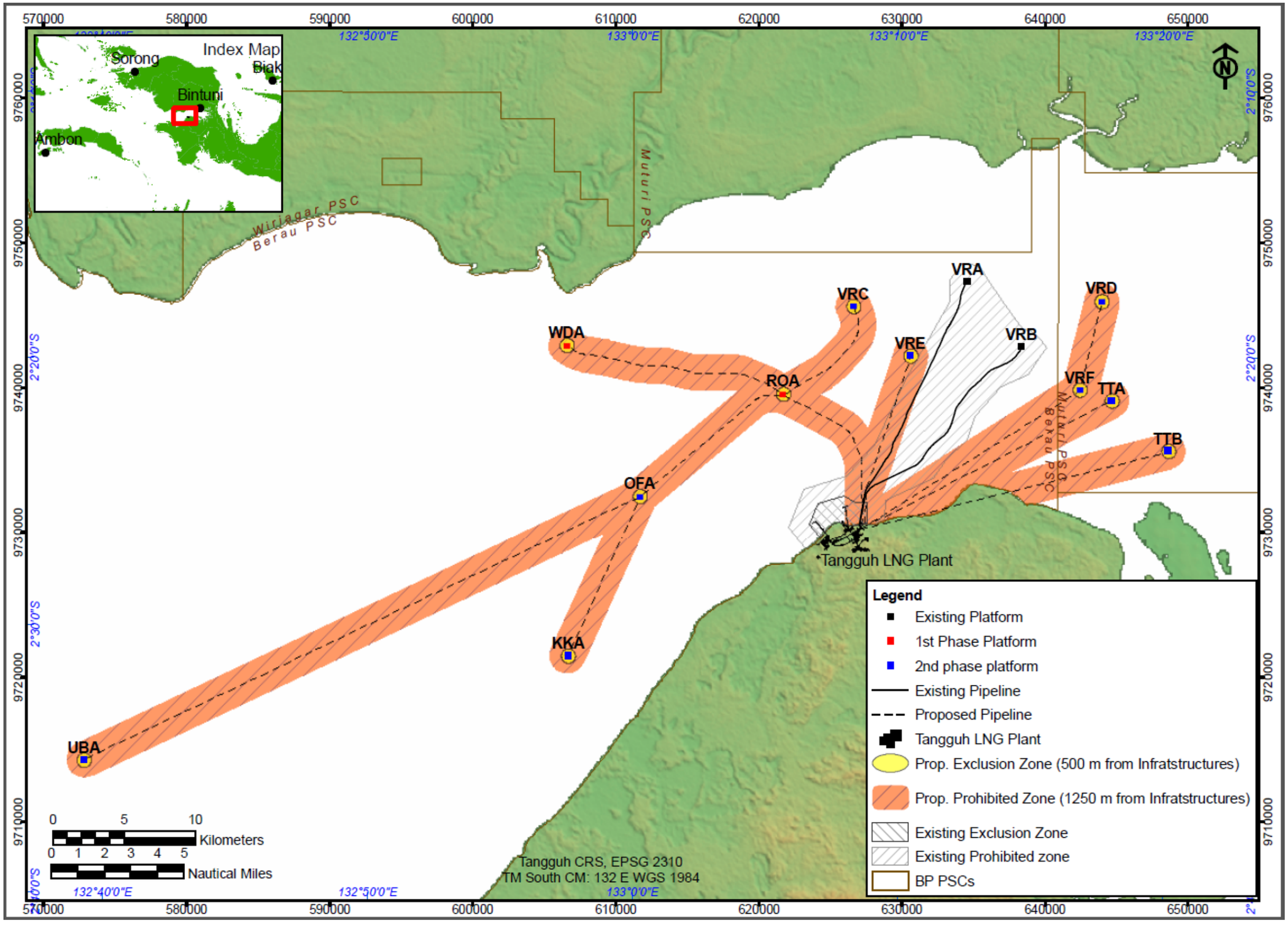
After pipelines installed, pipe route and platform location will be included in marine chart. Refer to Law No. 1 Year 1973 regarding Indonesian Continent Base and Government Regulation No. 175 Year 1974 , Government Regulation No.5 Year 2010 and Minister Regulation No. 5 Year 2011, the safety exclusion zone for the offshore facilities is as follows :

- Prohibited zone is 500 m measured from the outermost point of offshore facility/oil and gas installation;
- Restricted zone is 1,250 m measured from the outermost point of the prohibited zone or offshore facility/oil and gas installation.

Potential safety exclusion zone for new platforms and pipeline is shown in **Figure I**-12.

In the case of pipeline burial is required for technical purpose, the offshore pipeline will be buried using trenching and rock dumping or other method that meet the design criteria.

During pipe-laying activities, a temporary exclusion zone with approximate width of 1km to 1.5km radius of anchor area (or total diameter up to 3km) around the pipe-lay barge will be required for safety reason. It should be noted that the temporary exclusion zone will be applied at the location where the pipe-laying barge is performing its activity, which will be moving progressively as the pipe-laying is performed.


Index Map
Sorong
Biak
Bintuni
Ambon
Wiriagar PSC
Berau PSC
Muturi PSC
VRA
VRC
VRD
VRE
VRB
VRF
TTA
TTB
WDA
ROA
OFA
KKA
UBA
Tangguh LNG Plant
Legend
Existing Platform
1st Phase Platform
2nd phase platform
Existing Pipeline
Proposed Pipeline
Tangguh LNG Plant
Prop. Exclusion Zone (500 m from Infratstructures)
Prop. Prohibited Zone (1250 m from Infratstructures)
Existing Exclusion Zone
Existing Prohibited zone
BP PSCs
0 5 10
Kilometers
0 1 2 3 4 5
Nautical Miles
Tangguh CRS, EPSG 2310
TM South CM: 132 E WGS 1984
570000
580000
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132°40'0"E
132°50'0"E
133°0'0"E
133°10'0"E
133°20'0"E
2°10'0"S
2°20'0"S
2°30'0"S

Figure I-12 Potential Safety Exclusion Zone for New Platforms and Pipeline

B5. Near Shore Pipeline Installation (Shore Approach)

Pipeline from water depth of -13 m LAT will be buried to minimum depth of 2 m below the natural seabed.

There are two alternatives that currently being considered for near shore pipeline installation, which are :

a. Horizontal Directional Drilling (HDD)

This method allows the pipeline to be drilled under the shore to a point 1 to 2 km offshore and it is normally used in sensitive environment. HDD can greatly reduce the exposure to weather change and has minimal environmental impact on the coast line. HDD is also used for Tangguh LNG construction phase 1 (LNG Train 1 and 2) with good result.

In this method, a drilling rig and associated equipment will be transferred ashore by barge to BOF, and then placed on trucks/loaders to landfall location. A hole will then be horizontally drilled under the coastline. The transmission pipeline will then be pulled through the drilled hole to the landfall at the shore from the back of a pipelay barge located in the nearshore. Alternatively, the drill equipment may be located on crane barge offshore, and the pipe string will be assembled onshore and pulled from the offshore drill rig.

Typically, for a large diameter pipeline (up to 24”), new HDD pipeline length of up to 2,000 m may be achieved, depending on the pipeline parameters and environmental conditions. HDD pipeline is expected to be drilled approximately to 30-45 m deep. HDD for cable and umbilical will use the same method with the smaller diameter (up to 10-12”) in the same location.

The pipe will be welded on the laybarge station at -10 m water depth and pulled by HDD rig. If offshore HDD pulling by is selected, an onshore pipeline fabrication area will be required to fabricate 2,000 m of pipeline subject to availability of suitable area for pipe stringing.

Figure I-13 Near Shore Pipeline Installation Method (Shore Approach): Shore Pull Trenching (left) and HDD (right)

Figure I-14 shows the approximate location for the onshore drilling rig and associated storage areas used for the installation of the existing pipeline. For initial development, the HDD entry points were located on the beach with consideration on lesson learnt from Tangguh LNG previous construction.

Figure I-15 shows the conceptual layout of the HDD site. As mentioned above, worksite will be approximately 10,000 m² (100 m x 100 m). Storage tanks will be used to separate the bentonite drilling mud from drill cuttings. Drill cuttings will settle to the bottom of the tank and will be removed.

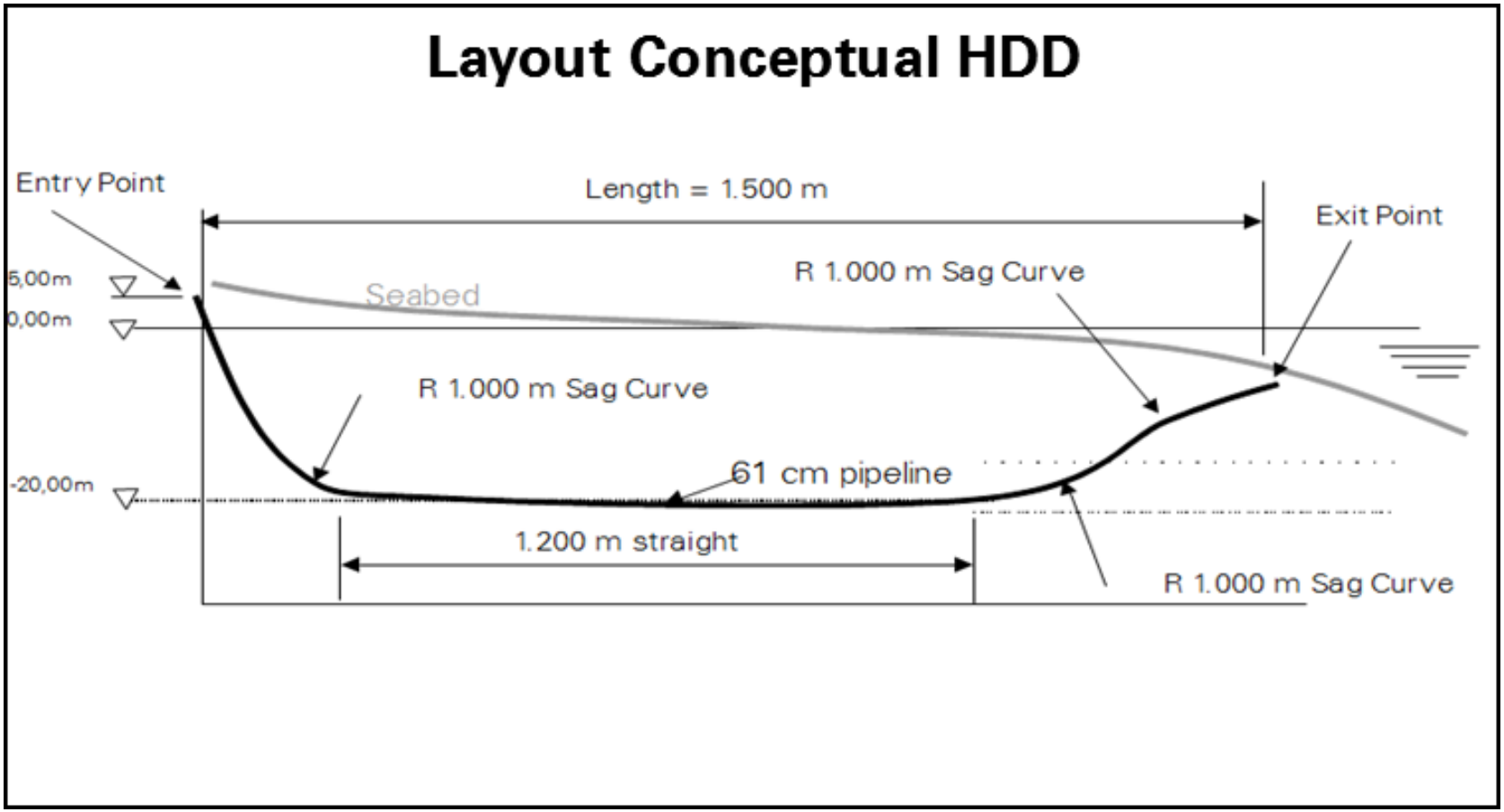


Figure I-14 Conceptual HDD Layout

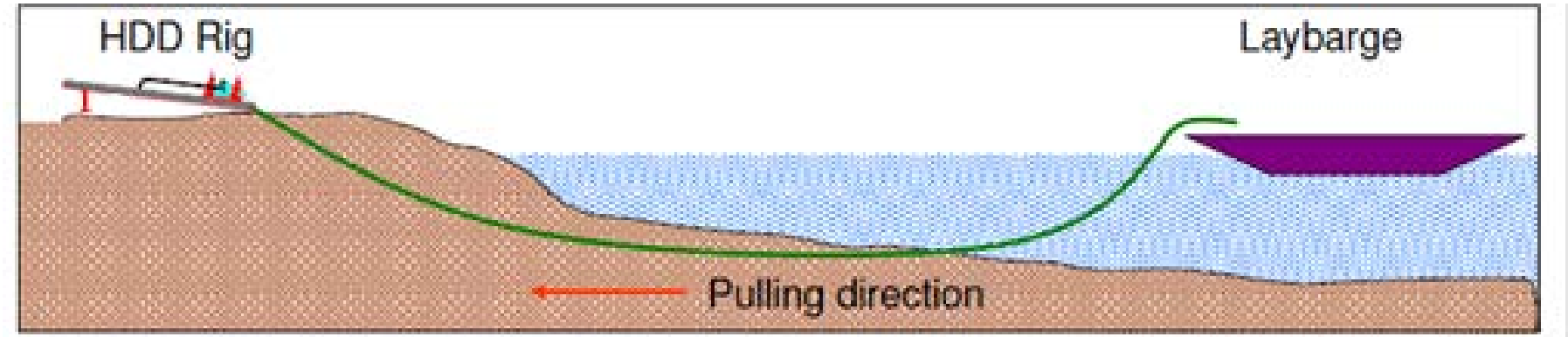


Figure I-15 Conceptual HDD Layout

Figure I-16 Conceptual Trenching and Shore-pull Activity

b. Trenching and Shore Pull

If HDD option is technically not feasible, trenching and shore pull method will be used. If this option is selected for shore approach pipeline, the area required for hold back anchor is approximately 30 m x 20 m.

Critical factor that may affect the method selection for trench method is water depth, distance from shore and seabed condition. For nearshore area and mudflat, channel can be trenched using excavator, such as backhoe or grab crane.

Trenched material will be placed on trench sides or placed in a barge to be disposed offshore. Pipeline will be installed in the trench and followed by backfilling using trenched soil that previously placed on trench sides, and rock dumped or combination of both.

Figure I-16 shows conceptual design and cross section of trenching and shore pull. In deeper water which normally passes by vessel with higher draft, trenching can be done using pre-lay trenching or post-lay trenching as described below.

The trenched crossing is constructed by building a cause way across the tidal zone to provide access for equipment.

Sheet piles are driven down each side of the trench. The trench is then excavated to provide 2 to 4 m high coverage at the beach. A winch is set up onshore and the lay barge moves into position as close as possible for pipe lay. During pipelay, winch applies tension and pulls the pipe string to shore along the trench.

Once the laydown head is ashore, the pipe is layed and is back filled in the near shore section using excavators and all sheet piling removed.

Estimated trenched material generated from this method is approx. 4.5 m x 40 m x 500 m = 90,000 m^3 in tidal area and 3 m x 10 m x 500 m = 15,000 m^3 for deeper area (total 105,000 m^3).

B6. Onshore Pipeline Trenching

The onshore pipeline will start from shoreline to pigging receiving facility at ORF.

After crossing shore, the onshore pipeline will be designed to include options of buried pipeline or above ground pipeline.

For buried option, the onshore pipe will be placed inside the trench, then buried with depth of 1.2 m on top of pipe. For pipe aboveground option, the onshore pipeline will be installed on the sleepers.

B7. Pre-commissioning/Commissioning Activity

Pre-commissioning/commissioning activity sequence are as follow:

a. Flooding, Cleaning and Gauging

- To remove all free air which may accumulated at the various high points along the pipelines.
- To remove any debris.

Water is pumped into the pipeline to fill the pipe with water. Requires the use of pigs to eliminate air along the pipelines. Two bi-directional pigs fitted with multiple sealing discs shall be used for this process.

The flooding operation will be followed by cleaning and gauging which will be performed with gauging pig operations. The discharged water from this process will be at sea bed as the pig trap (lay down head) location is on sea bed. During pipeline flooding, cleaning and gauging, some water oxygen scavenger and biocide content will be disposed offshore on seabed. If required, this activity will be repeated several times to ensure pipeline cleanliness from debris.

Gauging is a process of passing a gauging aluminium plate – aluminium disc with a minimum diameter 95% of pipe, to confirm there are no deformation, unintended intrusions (dents, gouges, etc.) and the ovality of the pipeline within acceptable limits).

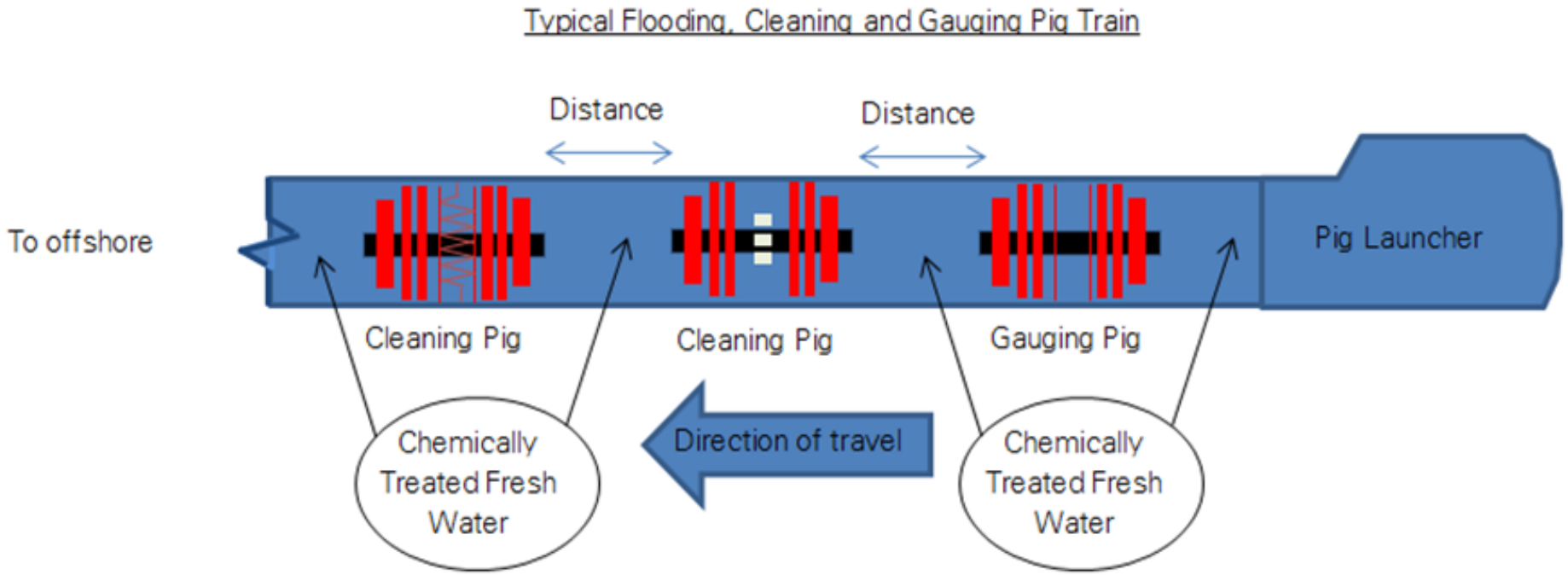


Figure I-17 Conceptual of Pipeline Flooding, Cleaning and Gauging Activity

b. Baseline Inspection

This activity is conducted after hydrotest to collect initial data of pipeline, including and to detect size and locate any features which could have a negative effect on the integrity of the given line.

This activity requires bi-directional pig and intelligent pig train. This series will be pushed through the pipe using pumped water. The water will be neutralized and chemical will be used as corrosion inhibitor. The water will be discharged to sea during pumping process. If required, this activity can be repeated several times to obtain the required parameter.

c. Hydrotest

Hydrotest will be conducted to ensure the integrity of the pipeline prior to commissioning.

After pipeline flooded with water, the pipeline strength will be tested using pressurized water. Water will be pumped to 1.25 of design pressure and hold for 24 hours to test the strength of the pipeline from the inside pressure. Once hydrotest completed, it will be depressurized until reaching positive pressure to avoid free air ingress.

Detail explanation related to hydrotest dewatering is described in Sub Chapter B8 Hydrotest Water Discharge (Dewatering).

d. Depressurize

After hydrotest, water in pipeline will be depressurized, but still maintain the condition to avoid free air and seawater ingress into the pipeline. There will be treated freshwater discharge from this process.

e. Dewatering (commissioning activity)

Dewatering is done to remove ex-hydrotest water from the pipeline. The main scenario is to use hydrocarbon gas or nitrogen as propelling medium, will be done during start-up.

Detail explanation related to hydrotest dewatering is described in Sub Chapter B8 Hydrotest Water Discharge (Dewatering).

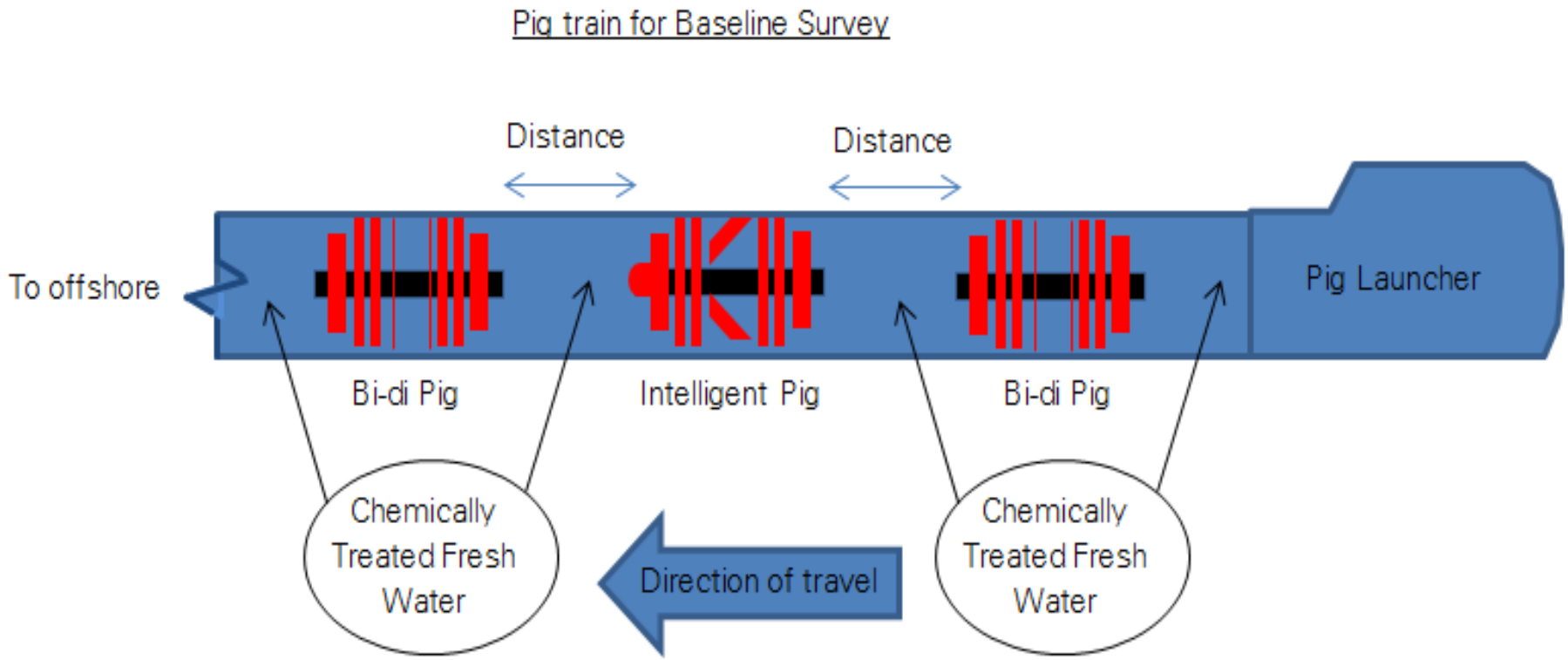


Figure I-18 Conceptual of Pipeline Baseline Survey

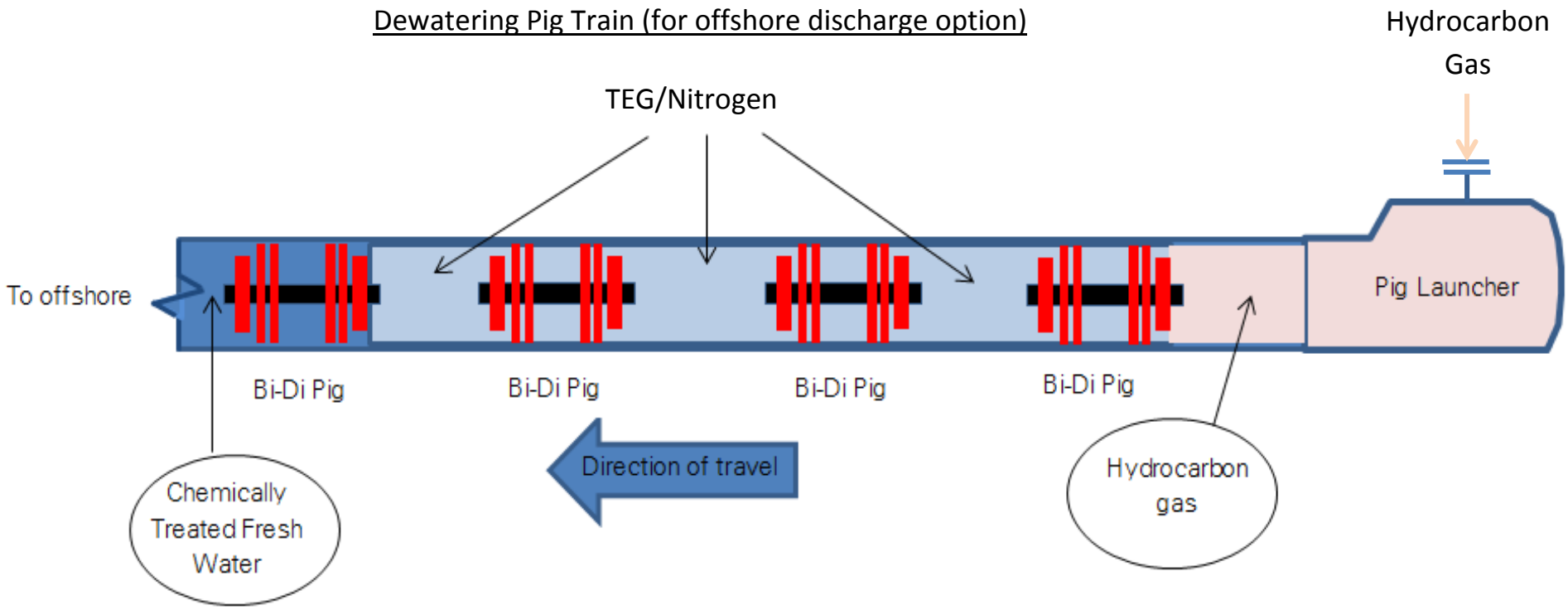


Figure I-19 Conceptual of Pipeline Dewatering

B8. Hydrotest Water Discharge (Dewatering)

Pipelines will be hydrotested using freshwater which preliminary treated with chemical. Chemicals used for hydrotest include oxygen scavengers, biocide and fluorescein dye. Potential type of oxygen scavenger that will be used for hydrotest are Ammonium Bisulphite orSodium Bisulphite.

Hydrotest will use groundwater or other freshwater source (not seawater) which will be stored in temporary water storage prior usage.

Hydrotest is done to ensure the integrity of pipelines prior to commissioning. Estimated hydrotest water volume depends on diameter and length of pipe. For 24"diameter pipe, estimated water volume required for one hydrotest is approx. 250 m^3/km. Estimated water volume required for one hydrotest for initial development is approx. 8,000 m^3 – one system volume (3,500 m^3 – ROA to ORF and 4,500 m^3 – WDA to ROA). Hydrotest volume per kilometre of pipe length for future development is expected to be similar with initial development (250 m^3/km), however, the total volume will depend on diameter and length of pipe, and other relevant factor. Discharge flow rate estimated 450 m3/hour (based on assumption of pig speed 0.5 m/s and 24" diameter). If required, hydrotest and dewatering can be repeated several times.

During hydrotest, water will contain oxygen scavenger, fluorescence dye and biocide.

Pipeline preservation method will be performed based on following options subject to further engineering assessment:

- After hydrotest, the water remains in the pipeline until start-up. It is recommended to change the water every 6 month until start-up or adjusted with chemical effectivity. Hydrotest water discharge will be done during start-up after feed gas enter the pipeline.
- After hydrotest, the pipeline will be dewatered. After pipeline dewatered then it will be filled with positive pressure with air or N2 until start-up.

Preservation period between 6-24 months.

Conceptual hydrotest activity is shown in **Figure I**-20 below.

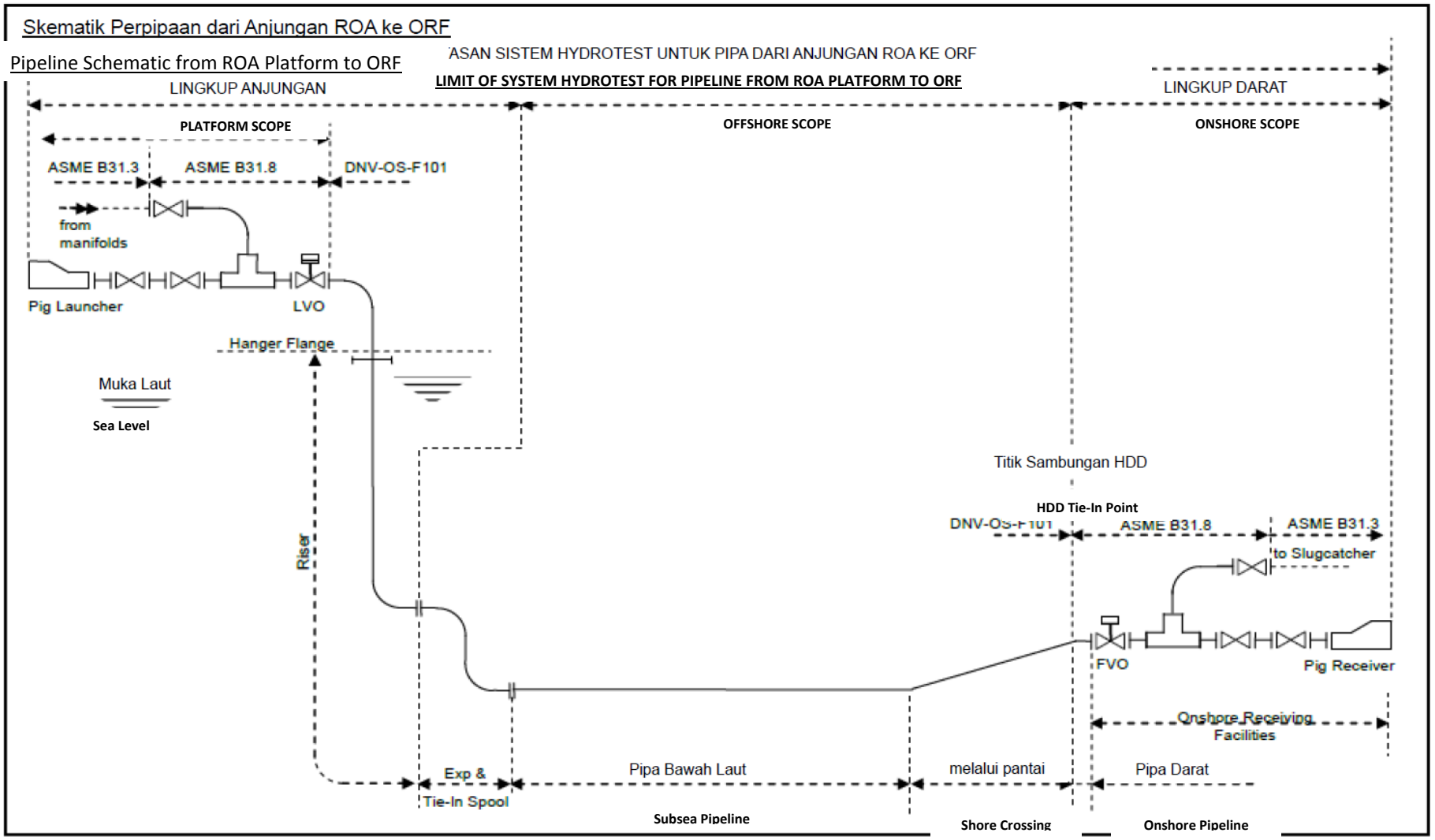


Figure I-20 Conceptual of Hydrotest Activity

Dewatering will be performed by running pig trains with chemical for pipeline drying and inerting. Pipelines will be cleaned, gauged and pressure tested prior to dewatering. During pipeline flooding, cleaning and gauging, some water (with small quantity of oxygen scavenger and biocide) will be disposed offshore at seabed.

Dewatering will be by field gas or Nitrogen using a series of pig trains with supporting chemical, i.e Nitrogen approximately 50 m^3 and Tetra Ethylene Glycol (TEG) approximately 40 m^3 (current estimation) in media between pigs.

The actual implementation and required chemical volume will be subject to further hydrotest and dewatering study align with project progress.

Hydrotest and dewatering for one pipeline segment will require approximately one week duration. Final duration is subject to further study which will determine the pump rates and pig velocity requirement.

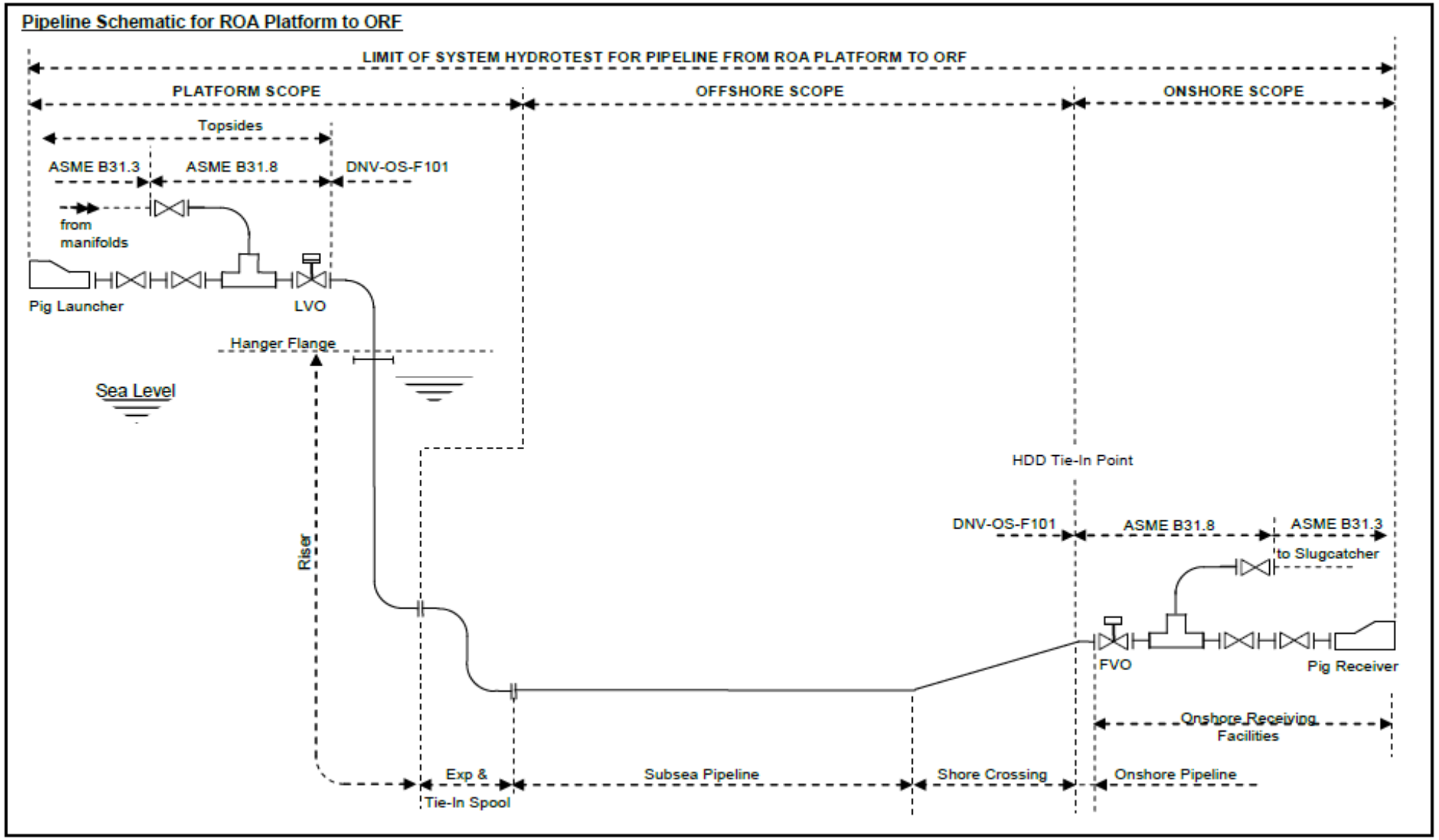


Figure I-21 Conceptual of Dewateting Activity

Two alternatives of hydrotest water discharge that currently being considered are offshore discharge and onshore discharge. Hydrotest water discharge will contain oxygen scavenger (100 ppm), biocide (550 ppm) and fluorescein dye (30 ppm). Additive chemical will be used in a low concentration and dissolved in hydrotest water, thus no expected environmental impact. Freshwater for hydrotest will be tested prior to use to ensure the suitability and safe for pipeline material.

Hydrotest water discharge method that being considered and assessed in this ANDAL document are as follow :

- Offshore discharge
  - If offshore disposal is the preferred option, discharge is likely to occur around the platform location (-3 m LAT) with estimated flowrate (for pipe with diameter of 24") is approx. 500 m^3/hour. As described previously, there will be additional chemical that will be discharged as part of hydrotest flow and dewatering.
- Onshore Storage and Discharge to Common Outfall
  - The onshore disposal option would involve storage and/or treated the water in a temporary water pit/storage to be located onshore to meet the applicable discharge requirement (stabilization time) prior to discharge to common outfall (-6 m LAT). Water storage will be designed with adequate capacity to contain water from hydrotest and dewatering process. During Tangguh phase 1 construction experience, hydrotest water pit has the capacity of approx. 15,000 – 22,500 m^3, while estimated volume of the new pit that will be constructed will be confirmed after FEED.
  - As mentioned above, to meet permitting requirements, some treatment may require and this may involve chemical treatment of the water or retention until the required discharge quality is achieved.

The material used for pipelines is Corrossion Resistance Alloy (CRA), hence the water that will be used for pre-commissioning and hydrotest purpose have to comply with several specification to maintain the pipeline integrity. Therefore, laboratory analysis is required to control the quality of water that will be used. Currently, the plan is to use imported water from outside Tangguh LNG area, such as Sorong and Fakfak, or to use groundwater, as long as it meets the water specification requirement. However, final decision on hydrotest water source is subject to further study and will be aligned with project progress.

If possible, the water which used for hydrotest of one pipeline, will be stored and later on will be used for hydrotest of other pipelines or be used for other suitable needs, depending on the water quality.

B9. Non Hazardous and Hazardous Waste Management

Pipeline installation and platform hook up will generate hazardous and non hazardous waste. Hazardous waste generated from the process are used oil, hydraulic oil, paint, thinner, blasting grit, hydrocarbon contaminated/grease, used chemical and its packaging, also radioactive source. While non hazardous waste consists of organic waste (food waste) and non organic waste (plastic, can, steel waste, scrap metal, styrofoam, etc.).

Hazardous and non hazardous waste will be segregated and managed accordingly. Hazardous and non hazardous waste management will be done in compliance with applicable Indonesian regulation and MARPOL.

Detail waste management strategy is currently being developed, with potential management plan that being considered are as follow :

- Hazardous Waste

  Generated hazardous waste will be sent to certified waste management facility. Hazardous waste will be managed according to applicable Indonesian regulation, which is Government Regulation No. 18 jo 85 Year 1999 regarding Hazardous Waste Management.

- Non Hazardous Waste (organic)

  Generated organic waste during pipeline installation activity is food waste. Generated food waste can be disposed to sea in compliance with MARPOL 2012 requirement Annex V Prevention of Pollution by Garbage from Ships. Based on MARPOL Annex V, comminuted food waste are allowed to be disposed offshore at minimum distance of 3 nm from the nearest shore. Comminuted food waste must pass through a screen with a mesh size no larger than 25 mm prior to disposed offshore.

- Non Hazardous Waste (non-organic)

  Generated non organic waste pipeline installation activity include plastic, can, scrap metal and styrofoam. Non organic waste will not be disposed offshore, but will be sent onshore or to external waste management facility to be managed according to applicable Indonesian regulation, including Law No. 18 Year 2008 regarding Waste Management. Currently, considered option for non-organic waste is to be managed in Tangguh LNG location along with other waste from LNG construction activity and according to applicable regulation

- HDD waste and onshore pipeline installation waste

  HDD waste will be disposed to construction landfill inside Tangguh LNG site. While the waste generated from onshore pipeline installation will be managed along with the waste generated from LNG plant construction.

Detail of waste management in Tangguh LNG is described in Sub Chapter 1.2.3 LNG Plant Activity Section B8 Non Hazardous and Hazardous Waste Management.

B10. Wastewater Management

Wastewater generated during pipeline installation activity includes deck drainage, sewage, cooling water and brine water. All wastewater generated during drilling and platform installation will be managed (at the minimum) according to applicable Indonesian regulation and MARPOL 2012 (for overboad discharge).

Detail of wastewater source and its management during platform installation are described as follow :

- Surface drainage from rig decks – Deck drainage from uncontaminated areas will be collected and disposed of directly overboard. Contaminated wastewater from equipment washdown water, any contamination of diesel, chemicals, or lubricants will be collected in skimmer tank and sent to certified waste management facility.
- Sewage – support vessels that are used for this activity will generate sewage that would be treated in a treatment unit prior to discharge to the sea. The discharge will meet Indonesian regulations, Regulations of Minister of the Environment No. 19 Year 2010 regarding Wastewater Quality Standard for Oil and Gas and Geothermal Industry, also MARPOL 2012 requirement Annex IV Prevention of Pollution by Sewage from Ships.
- Wastewater generated from HDD and onshore pipeline installation activity will be managed along with wastewater generated from LNG Plant construction activity.

Detail of wastewater management in Tangguh LNG is described in Sub Chapter 1.2.3 LNG Plant Activity Section B9 Wastewater Management.

Hydrotest and dewatering will be conducted as part of pipeline construction. Detail description of hydrotest and dewatering, including other related water management is described separately in Section B8. Hydrotest Water Discharge (Dewatering).

B 11. Storage and Loading of Fuel and Chemical

During construction, fuel will be stored on LCT or construction vessel for offshore storage and in fuel tank for onshore storage.

Construction vessels are required to have an adequate fuel to perform the activity, or in other word, those vessels are required to do the refueling in other area, outside Tangguh LNG site, such as in their local logistic base.

If additional fuel is required, offshore refuelling can be conducted with appropriate control. If required, vessel can refuel in existing fueling facility in Tangguh area.

Chemicals required during construction will either be stored onboard the vessels or could potentially be stored onshore at Tangguh site and transferred to construction vessels when required.

C. Operation Phase

After construction and pre-commissioning of the gas transmission pipeline, the pipeline system will be ready for commissioning and transfer of gas to LNG plant. Initially, one pipeline will be operated at very low flow rates to fulfil the requirements of the LNG plant commissioning phase. Once the LNG plant is fully operational, gas will be transmitted through the pipelines to maintain LNG production.

The gas stream from well will be transmitted through pipeline to ORF in a three-phase mixture of gas, condensate and formation water. During low flow rates along the pipeline routes, the produced water plus the condensate in the pipelines may collect at low points. Normally, these liquids would be swept to the ORF under the pressure of the gas. During period of low flow, these liquids may require removal of operational pigging. This type of pigging would involve introducing spheres into the pipelines that are then forced along by gas pressure sweeping the majority of accumulated liquids. All produced liquids will be collected and separated at the ORF.

C1. Workforce Mobilization

During operation phase, no specific personnel required for gas transmission activity, except for inspection and maintenance. Total workforce required for inspection and maintenance already included in total workforce required for operate LNG train and covered in LNG Activity Section.

Detail of recruitment process, mobilization and demobilization of workforce during operation phase are described in Sub Chapter 1.2.3 LNG Plant Activity Section C1. Workforce Mobilization.

C2. Existence and Operation of Offshore Pipelines

Pipeline will be designed with consideration to safety during its operation. Pipeline Leak Detection System (PLDS) will be installed in pipeline system for early detection in case of leak. This device is installed in main control building onshore which will be monitored continuously 24 hours per day. If pipeline leak were detected, emergency response action to prevent leaking impact will be initiated. If pipeline pressure were dropped to a certain level, the valves in pipeline system will automatically closed and platform operation will be shutdown automatically to prevent further impact. In addition, due to pipeline is using CRA material which is not resistant to sea water, it is important to prevent sea water ingress into pipeline to ensure the pipeline

integrity. The emergency procedure will be developed with consideration to above subject.

In addition, emergency response procedure to manage further impact of leak will be prepared, including the availability of pollution prevention equipment, response team and its supporting facilities.

As reference from current operation, emergency response system for pollution prevention is already developed, which include :

- Pollution prevention procedure and strategy;
- Incident Management Team;
- Pollution prevention equipment;
- Supporting facilities (oil spill modelling, deployment boats, etc.).

Those procedure will be further developed in accordance with offshore development sequence of Tangguh Expansion Project.

For the safety purpose, the pipeline will have exclusion zone during operation. Safety exclusion zone for pipelines will not be marked using buoys on site (subject to result of risk assessment), but the pipeline safety exclusion zone will be requested to the Directorate General Sea Communication and plotted on the marine charts.

C3. Pipeline Maintenance

A risk-based program of internal and external inspections will be implemented during operations of the pipelines. The behaviour, responses, burial requirements and routing of the pipelines and the behaviour of the seabed will be investigated during detailed design of the pipeline system and enhanced further during operation. During detailed design phase, a risk-based inspection program will be developed. Typically, this include the following :

- Route survey leak inspection along the pipeline routes by patrol boats;
- Subsea inspection along the pipeline route using remotely operated vehicles (ROV) where feasible including riser, tie-in spool and rock cover inspection;
- Cathodic protection (attached to the pipeline and buried) external survey will be conducted where feasible;
- Internal inspections using intelligent pigs; and
- Location survey using geometry-type pigs.

The inspection program may result in some form of local remediation along the pipeline routes. This may include, but not limited to, installation of pipeline supports, rock dumping at localized areas, repair of concrete coatings, retrofitting anodes, and removal of sediment build ups.

Inspection activity will be done once in the first five years and is expected to be less afterward, depending on the pipeline condition and risk assessment. Inspection activity will be commenced using intelligent pig as internal riser, tie-in spool and rock cover using ROV for external. In addition, for accessible location, such as onshore pipeline, inspection will be done as per MIGAS Certification program as stipulated in relevant regulation.

C4. Non Hazardous and Hazardous Waste Management

No waste generated from gas transmission activity during operation phase.

C5. Wastewater Management

No wastewater generated from gas transmission activity during operation phase, limited volume of wastewater will be generated only during maintenance activity.

D. Post Operation

Post operation phase will include but not limited to facility decommissioning and workforce release.

D1. Workforce Demobilization

There will be workforce release at the end of operation phase. Detail process of workforce release will be determined later and will be done according to applicable regulation

D2. Decommissioning of Gas Transmission Facilities

Decommissioning of offshore facility including pipeline will be conducted according to applicable Indonesian regulation and industrial standard which recommended by Government of Indonesia at that time. Decommissioning plan will be consulted with relevant parties, particularly national and local government.

Currently applicable regulation for offshore decommissioning including pipeline is Regulation of Minister of Energy and Mineral Resources No. 01 Year 2011.

1.2.3 LNG Plant Activity

The existing Tangguh LNG comprised a two train natural gas liquefaction facility with capacity of each train is 3.8 MTPA. The plant was designed to produce a single LNG product and a stabilized condensate product that meet the product specifications. No Liquefied Petroleum Gas (LPG) products are exported. There are two LNG Tank and two existing condensate storage tanks. The condensate production capacity 6,000 bbls/day.

The expansion GPF and LNG plant will be designed to handle ranges of feed gas compositions e.g. lean & rich condensate, CO_2 composition between 10 to 15%, to allow adequate flexibility and design margin in the plant's design. Design feed gas flow into ORF is 808 tonnes/hour per train.

The LNG plant can be considered to be composed of two general sections, which are:

- a natural gas purification section; and
- a natural gas liquefaction section.

Purification of the natural gas is required to avoid corrosion and freezing problems in the Liquefaction Unit. Each of trains includes an Acid Gas Removal Unit (AGRU), a Dehydration Unit and a Mercury Removal Unit (MRU).

The main objectives of the Liquefaction Facilities are to remove the heavier hydrocarbon components (C_5^+) of the produced gas and to liquefy the natural gas yielding the LNG product. Removal of the heavier hydrocarbon (C_5^+) components is required to avoid freezing problems during the actual liquefaction step. Each liquefaction trains will include a Refrigerant andLiquefaction Unit, a Fractionation Unit and a Stabilization Unit.

In term of the LNG facilities, the Tangguh Expansion scope include the development of Train 3 and its supporting facilities with future development to include further gas supply for Train 3 and development of Train 4. The Tangguh Expansion scope also includes upgrade and expansion to utility facilities such as water supply, wastewater treatment, power supply, offices, accommodation facilities,etc.

Feed gas composition which enter the ORF is shown in these below Table **I**-10s

Table I-10 Feed Gas Composition*)

Gas Composition	Average (%)	Gas Composition	Average (%)
CO_2	13.2984%	**Xylenes***	0.0216%
N_2	0.7523%	**C9***	0.0100%
C1	83.4094%	**C10***	0.0154%
C2	1.6207%	**C11***	0.0097%
C3	0.3579%	**C12***	0.0081%
iC4	0.0671%	**C13***	0.0077%
nC4	0.0873%	**C14***	0.0057%
iC5	0.0411%	**C15***	0.0082%
nC5	0.0314%	**C16***	0.0070%
C6*	0.0335%	**C17***	0.0061%
Benzene*	0.0244%	**C18***	0.0055%
C7*	0.0373%	**C19***	0.0051%
Toluene*	0.0319%	**C20+ WD***	0.0665%

C8*	0.0304%	**C20+ V***	0.0000%

Table I-11 Other Reservoir Fluid Contaminants*)

Component	Composition
H_2S	10 ppm
R1SH (Mercaptan)	25 ppm
R2SH	15 ppm
R3SH	7 ppm
COS	3 ppm
CS_2	10 ppm
Mercury	100 µg/Nm^3

Note :
*) : Detail regarding gas composition is currently being assessed and may be changed according to the assessment result and project progress. The data will be updated using the assessment result.

Overal LNG Process Block Flow Diagram is shown in **Figure I**-22 and Gas Production Profile for Two Trains and Development of Three Trains is shown in **Figure I-26**. Gas production profile for four train is currently being assessed.**Figure I**-23.

LNG process block flow and emission/waste generated from the process is shown in **Figure I**-24.

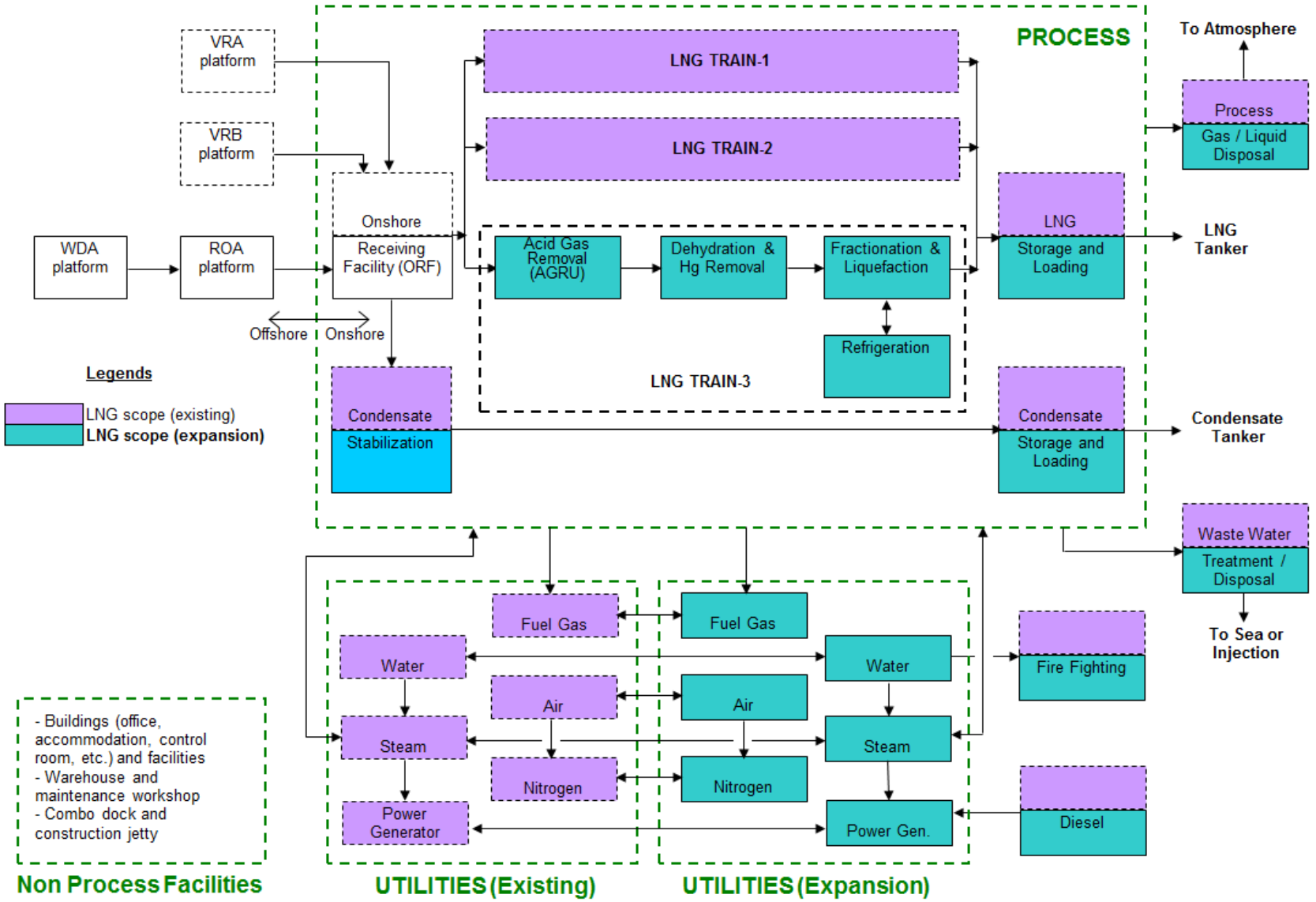


Figure I-22 Overall LNG Process Block Flow Diagram

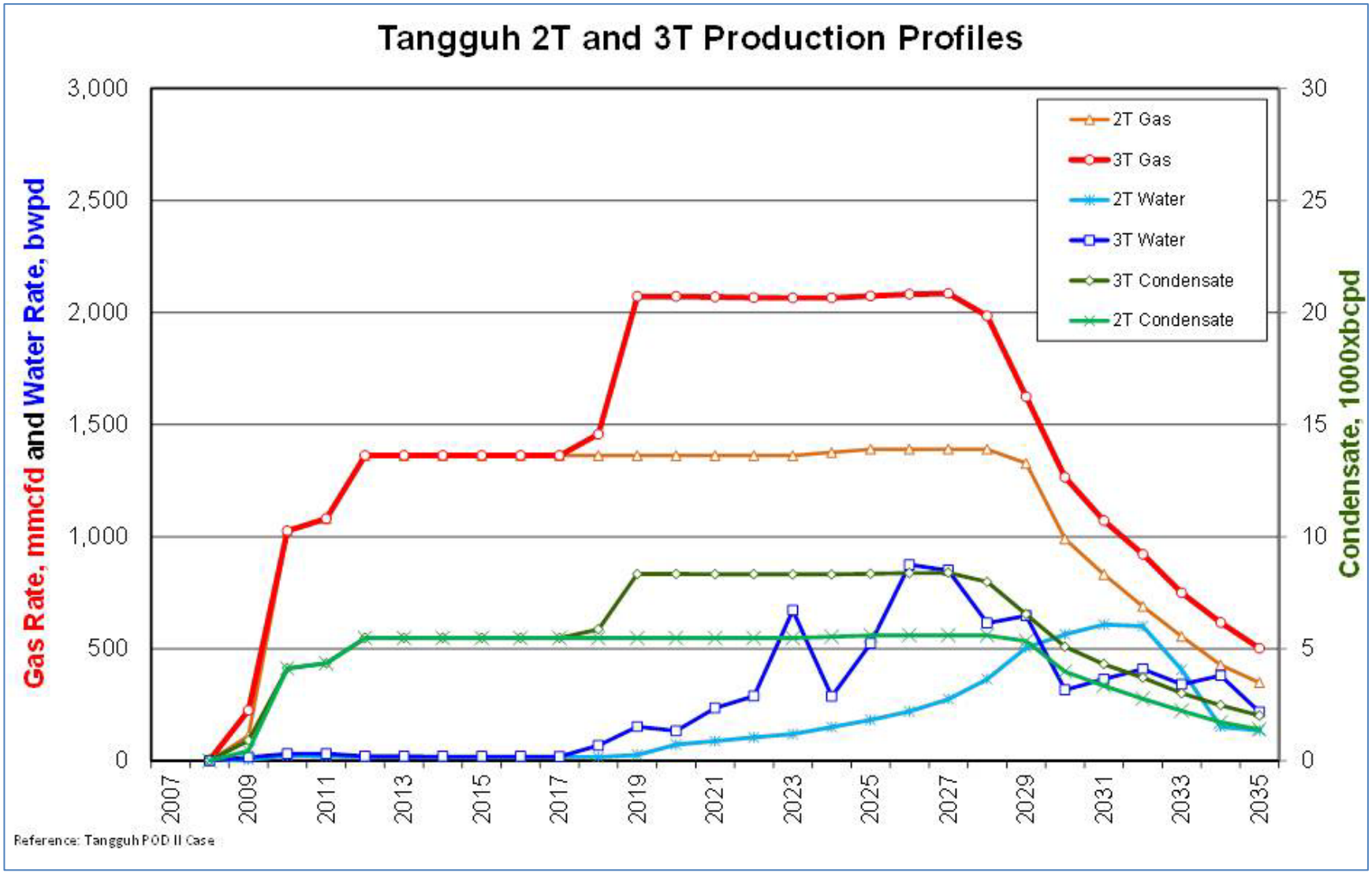


Figure I-23 Gas Production Profile from Two LNG Trains and Development of LNG Train 3

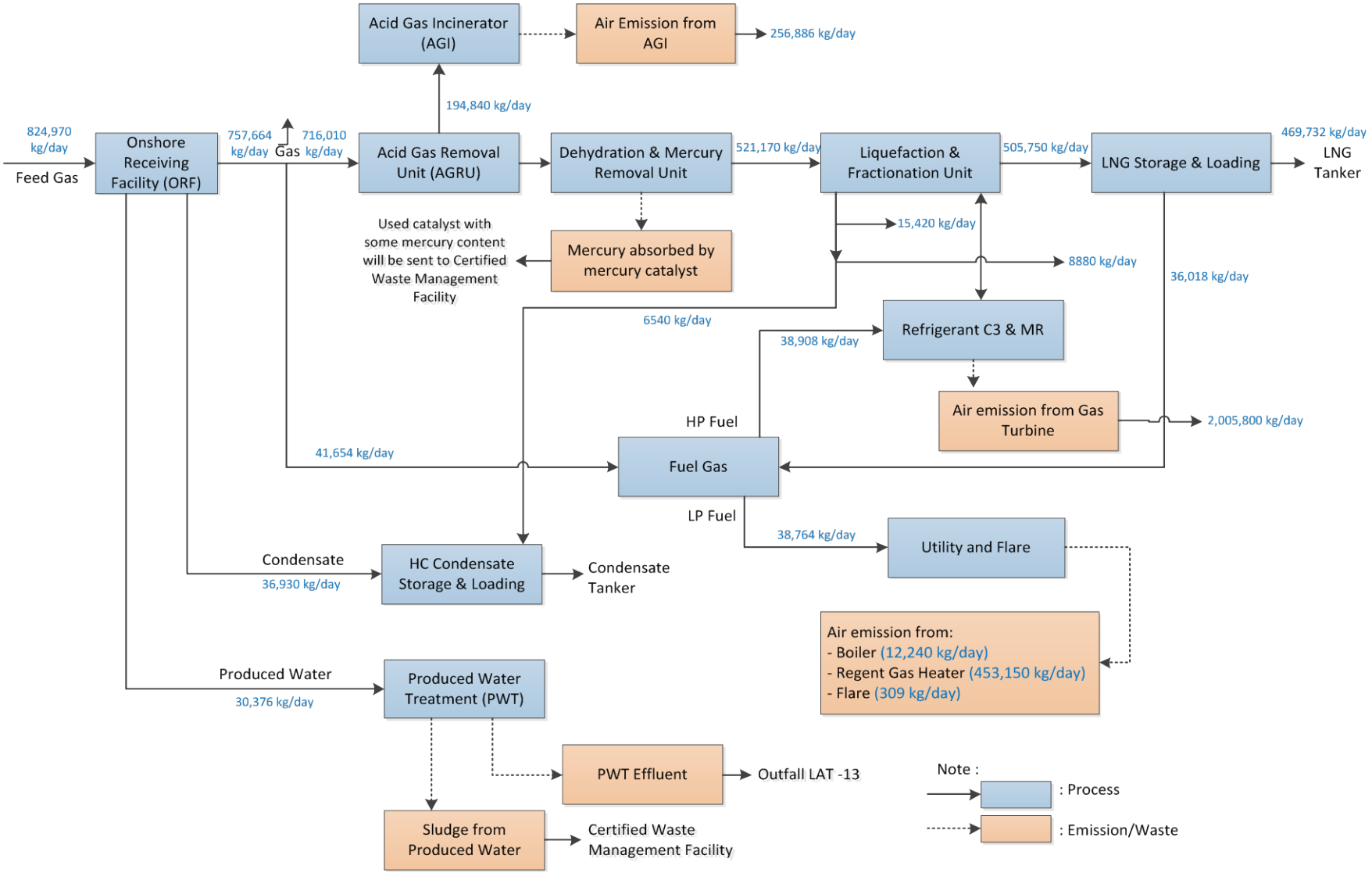


Figure I-24 Flow Chart of LNG Process and its Emission/Waste Diagram

Onshore Receiving Facility (ORF)

The Onshore Receiving Facilities (ORF) is where three-phase feedstock from the offshore gas production facilities is separated into gas, hydrocarbon liquid and water phases.

The unit has sufficient volume to accommodate liquid slugs produced during non-steady state operations to ensure the gas feed rate to the LNG trains remains steady.

The three-phase feedstock enters the new slug catcher where the gas is cooled, followed by pressure reduction valves and routed to a gas scrubber to remove any liquids formed.

The gas is then passed and feed to the ORF Outlet Gas Header to the LNG Trains.

The liquids are routed to a three phase separator from the slug catcher via LP steam heaters in order to melt any incoming wax and to assist the separation of the condensate and produced water in the inlet liquid - liquid separators prior to any pressure reduction to avoid formation of stable emulsions and suspensions. Condensate is fed to Condensate Stabilization Unit and Produced Water to the Waste Water Treatment Unit via new Produced Water Storage Tank.

One expandable ORF will be built as part of the Tangguh Expansion Project to serve the Train 3 and the future Train 4.

Condensate Stabilitation Unit

Liquid condensate from the ORF, Dehydration and Mercury Removal Unit and Acid Gas Removal Unit shall be routed to the Condensate Stabilization Unit to be processed to meet the product specification.

The existing unit consists of two Condensate Stabilizer columns and a Condensate product cooler to meet the "N+1" sparing philosophy.

One additional Condensate Stabilizer Column and one new condensate product cooler shall be required for the Tangguh Expansion Project to maintain the "N+1" sparing philosophy.

The stabilized condensate is run-down to atmospheric storage tanks prior to being pumped onto tankers via a loading arm located on the product export jetty.

Acid Gas Removal Unit (AGRU)

The feed gas stream passes through the Acid Gas Removal Unit (AGRU) where CO2 and trace amounts of sulphur components are removed from the feed gas, by absorption by aqueous activated MDEA solvent, to meet the product specifications. Removal of these components prevents their freezing out in the downstream cryogenic liquefaction process, which could cause blockages and corrosion.

The acid gas absorbed by the solvent is then flashed in the HP and then LP drums, before being subsequently stripped in the stripper. The acid gas from the stripper

overheads is routed to acid gas incinerator to avoid emission of BTEX contaminants to atmosphere.

Feed gas is dissolved with amine solution which will bind the CO_2 in feed gas. CO_2 will be released through AGI in regeneration of amine solution. In Tangguh Expansion Project, maximum CO_2 composition in feed gas before being liquefied into LNG is 150,000 ppm and after being processed in AGRU, the CO_2 composition in feed gas is reduced to 50 ppm.

CO2 composition in feed gas which enter the LNG plant is natural condition of the reservoir. CO2 reduction program which aim to minimise the greenhouse gas effect is currently being assessed.

Dehydration Unit and Mercury Removal Unit (MRU)

The feed gas is dehydrated to prevent freeze-out or hydrate formation in the downstream liquefaction process. Treated gas from the acid gas removal unit is cooled to 22^{o}C by propane chilling to condense the bulk of the water which is removed in separator vessel.

Gas from the separator is then passed over molecular sieve beds, removing the water to below 1 ppmv. A three-vessel arrangement has been selected, with two vessels in adsorption mode and one in regeneration mode.

Regeneration of the molecular sieve bed is achieved by means of BOG, which is heated using a fired regeneration gas heater. After cooling and water removal the regeneration gas is routed to supply the primary source of fuel gas for the Gas Turbine.

Water and condensed hydrocarbons are separated and depressurized separately and are routed to the acid gas removal unit and condensate stabilization unit respectively.

Elemental Mercury from the feed gas can cause rapid corrosion of aluminum in the Main Cryogenic Heat Exchanger (MCHE).

Since the mercury concentrations in the feed gas will exceed the maximum allowable levels for the cryogenic system, a mercury removal bed will be included downstream of the Dehydration drier drums.

Mercury concentrations in feed gas before being processed is 100 microgram/Nm3 and will be processed through catalyst in mercury removal drum to 0.01 microgram/Nm3 which will be stay in the gas to be further processed. No mercury release to air.

As illustrations of mercury concentration reduction, in **Table I**-12 is result of mercury measurement before and after passing through Mercury Removal Unit.

Table I-12 Mercury Measurement Result Before and After MRU

Month	MRU	LNG Train 1				LNG Train 2			
		W1	W2	W3	W4	W1	W2	W3	W4
Dec-13	Inlet (µg/Nm³)	3.91	3.53	2.69	N/A	N/A	0.71	1.78	2.10
	Output (max. 0,01 µg/Nm³)	0.001	0.001	0.002	N/A	N/A	0.0021	0.0015	0.0008
Jan-14	Inlet (µg/Nm³)	5.82	4.20	2.09	2.54	2.25	2.54	1.41	2.33
	Output (max. 0,01 µg/Nm³)	0.001	0.001	0.002	0.002	0.001	0,001	0.002	0.004
Feb-14	Inlet (µg/Nm³)	2.50	5.43	2.81	4.24	2.17	2.41	1.39	0.54
	Output (max. 0,01 µg/Nm³)	0.002	0.002	0.003	0.004	0.001	0.003	0.002	0.005

Note :
N/A : Plant shutdown.

Mercury catalyst will be used to its saturation point then will be replaced with a new one. The saturated mercury catalyst will be handled as hazardous waste and will be sent to certified waste management facility.

Liquefaction/Fractination Unit

The Liquefaction unit will remove heavy hydrocarbons and chill the natural gas to a temperature suitable for storage at virtually atmospheric pressure.

The dry, sweet natural gas will first be chilled against propane refrigerant, and then fed to the reboiled scrub column where C5+ components are removed. In order to assist the C5+ removal, the warm bundle of the Main Cryogenic Heat Exchanger MCHE is utilized as a reflux condenser.

The scrub column reflux drum overheads are then routed to the MCHE and liquefied using a mixed refrigerant (MR) composed of nitrogen, methane, ethane and propane. The bottoms from the scrub column are processed in the deethanizer, depropanizer and debutanizer columns and a portion of the ethane and propane is recovered for use as refrigerant in the process.

The remaining overheads from the three columns are chilled in a dedicated tube circuit in the MCHE and re-injected into the LNG product stream which is routed to storage. Condensate from the debutanizer will be rundown to the condensate storage tanks. Main Cryogenic Heat Exchanger (MCHE) is used as condenser reflux.

Refrigeration Unit

The Refrigeration Unit provides the refrigeration to cool and liquefy the feed gas in the Liquefaction and Fractionation Unit.

There are two main refrigeration compressor systems (refrigeration with compression system) which are driven by two GE Frame 7 gas turbines, each with a starter/helper backpressure steam turbine. Two main refrigerant system consist of proporane and mixed refrigerant compression system. The mixed refrigerant compression system includes MR low pressure, medium pressure and high pressure.

One refrigerant compressor string shall consist of a 4-stage propane compressor plus a HP mixed refrigerant compressor. The other refrigerant compressor string shall include the LP and MP mixed refrigerant compressors.

The propane refrigerant circuit is used to pre-cool the natural gas, mixed refrigerant and some fractionation system chillers at four pressure levels. Propane vapour streams from the propane kettles are routed via knock-out drums to the centrifugal propane compressor. De-superheating, condensation and sub-cooling of the propane is achieved by using air coolers.

The mixed refrigerant circuit is used to liquefy the natural gas in the MCHE. The mixed refrigerant vapour from the shell side of the MCHE is compressed in three centrifugal compressors in series.

Inter-cooling and initial de-superheating is achieved by air cooling. Further de-superheating and partial condensation is achieved by the propane pre-cooling cycle. The mixed refrigerant vapour and liquid are separated and further cooled in the MCHE.

The vapour mixed refrigerant stream inside the MCHE is condensed and sub-cooled to approximately minus 153°C after which it is let down in pressure and returned to the shell side of the heat exchanger, cooling the natural gas and the high pressure MR vapour.

The liquid mixed refrigerant is sub-cooled to approximately minus 125°C and after expansion in a liquid expander, returned to the shell side of the MCHE to liquefy the natural gas and the high pressure vapour MR and cool the liquid MR.

LNG Storage and Loading

Prior to shipment, the LNG from the new Train will be stored in LNG Tanks. Two LNG Tanks with working volume of 170,000 m^3 currently exist as part of existing operation. Additional one LNG Tank, with a working volume of 170,000 m^3 will be required to support the each expanded LNG Trains.

Two new motor driven BOG compressors will recompress boil-off gas together with the existing two BOG compressors. The compressed BOG will be used as regeneration gas for the LNG Trains dehydration system and will then discharge into the main HP fuel gas system.

The loading facilities will be extended with a second berth for loading LNG on a new jetty. The loading facilities will operate in two main modes. 'Holding mode' is the period between loadings with part of the rundown LNG circulating through the loading system and back to the tanks, in order to keep the piping cold. 'Loading mode' is the period when a ship is on a berth and receiving LNG.

During loading, the loading pumps in each tank will transfer the LNG via the loading lines to the LNG loading arms at the jetty head loading platforms.

Simultaneous loading of two LNG ships will be possible from the existing and new loading berths, LNG berth 1 and 2.

All vapors generated by displacement, heat input to the loading and storage system and cool down of the ship will be routed back via a vapour return line. The vapours will be compressed in the existing and new BOG compressors and routed to the fuel gas system via the LNG Train Dehydration units.

Condensate Storage and Loading

Stabilized condensate produced in the Condensate Stabilization Unit and the Fractionation Units will be routed to the Condensate Storage Tanks. The fractionation condensate will be blended with that from the condensate stabilization unit in order to meet the product specification.

There are one existing condensate tanks, a working volume of 19,000 m3, with another one to be constructed in 2013 as part of the existing Tangguh LNG operations. Additional Condensate Storage tanks, will be provided as part of the Tangguh Expansion Project scope.

One condensate loading berth will be required. This berth will be shared with the new LNG loading berth on the new jetty which will be built as part of Tangguh Expansion Project.

Refrigerant Storage and Loading

Ethane and propane will be stored in pressurized refrigerant storage bullets which will be used as refrigerant media in the MCHE unit. Ethane and propane will be produced from the Fractionation Unit. The existing storage and unloading unit will be expanded to cater for additional demand from Tangguh Expansion, with interconnecting lines to existing system. The refrigerants are rundown/filling from the Fractionation Unit of the LNG trains

CO_2 Emission from Tangguh LNG Plant Operation

CO_2 from existing Train 1 and 2 operation are generated from flaring, fuel gas, gas to AGI/flare, vehicle fuel, diesel and avtur (<1%) with total CO2 emission as shown in **Table I**-13 below.

Table I-13 CO_2 from LNG Train 1 and 2 Operation

Year	CO_2 (million tonnes)
2013	5.15
2012	4.66
2011	4.51
2010	4.56
2009	2.50

Based on above data, it is estimated that CO_2 emission which will be generated from LNG train 3 (one train) operation are as follow :

- Flare = 0.25 million tonnes/year (8.1% of total);
- Fuel gas = 0.79 million tonnes/year (25.5% of total);
- Gas to AGI/flare (CO_2 from wellhead) = 1.96 million tonnes/year (63.2% of total); and
- Fuel consumption dan CH_4 emission (converted to CO_2) = 0.097 million tonnes/year (3.2% of total);
- Total CO_2 from Train 3 operation = 3,1 million tonnes/year.

It is predicted that LNG Train 4 operation will emitted similar CO_2 emission with LNG Train 3 operation, which is 3.1 million tonnes per year.

Table I-14 below is summary of existing and additional expansion plan of LNG plant and its supporting facilities as part of Tangguh Expansion Project, both initial and future development.

Table I-14 Existing LNG Plant and its Supporting Facilities and Development Scenario of Tangguh Expansion Project

No.	Facility	Existing Tangguh	Initial Development (Train 3)	Future Development (Further Gas Supply for Train 3 and Development of Train 4)
1	LNG Plant	Feed gas to ORF = 1,465 tonnes/hour Anticipated CO_2 composition up to 12% Production capacity = 2 x 3,8 MTPA, including : 1 ORF 2 AGRUs – 2 AGIs 2 Flare Stacks (wet flare stack dan dry flare stack) 2 BOG compressors 1 Tankage flare	Feed gas to ORF = 808 tonnes/hour Anticipated CO_2 composition 10% to 15% Production capacity = 1 x 3,8 MTPA, including : 1 ORF 1 AGRU – 2 AGIs (1 spare) 1 demountable flare for 6 plants with 3 flare stacks (wet flare stack, dry flare stack, and common spare stack) 1 BOG compressor 1 Tankage flare	Feed gas to ORF = 808 tonnes/hour Anticipated CO_2 composition 10% to 15% Production capacity = 1 x 3,8 MTPA, including : 1 ORF 1 AGRU
2	LNG Tank	2 x 170,000 m^3	1 x 170,000 m^3	1 x 170,000 m^3
3	Condensate Tank	2 x 19,000 m^3 (1 operational & 1 will be constructed in 2013)	1 x 31,800 m^3	
4	Condensate Production	6,000 bbls/day	10,000 bbls/day (maximum expected condensate production)	10,000 bbls/day (maximum expected condensate production)

No.	Facility	Existing Tangguh	Initial Development (Train 3)	Future Development (Further Gas Supply for Train 3 and Development of Train 4)
	Supporting facilities :			
5	Freshwater Supply	Freshwater demand = 70 m^3/hour Desalination Capacity = 3 x 28 m^3/hour Production = 43 m^3/hour Reverse Osmosis Capacity = 86 m^3/hour Production = 27 m^3/hour	Freshwater demand Construction = 512 m^3/hour Operation = 79 m^3/hour (LNG Train 3-4) Desalination Design capacity = 3 x 28 m^3/hour Groundwater Design capacity = 172 m^3/hour	Potential additional desalination unit with design capacity = 1 x 28 m^3/jam
6	Produced Water Treatment (PWT)	2 x 25 m^3/hour	1 x 25 m^3/hour	1 x 25 m^3/hour
7	Sewage Treatment Plant (STP)	140 m^3/day	Will be established based on peak POB during construction and will be used during operational phase (will be built in modular type) (10,500 POB x 400L/day x 90% = 4,000m^3/day)	Will be determined later
8	Neutralization Pit	5 m^3	5 m^3	Will be determined later
9	Corrugated Plate Interceptor	100 m^3/hour	100 m^3/hour	Will be determined later
10	Solid Waste Management Facility	- Hazardous waste storage (temporary storage) - Incinerator (non hazardous) - Landfill (non hazardous) - Composter - etc.	Integrated waste management facility: - Hazardous waste storage (temporary storage) - Incinerator (hazardous and non hazardous) - Landfill (non hazardous) - Composter - dll	

Note : These facilities are designed based on the current available technology. Should better technology becomes available in the future, the design may change to adopt the new technology as long as it still complies with applicable regulations.

A. Pre-Construction Phase

A1. Socialization of the Proposed Activity

Socialization of the proposed activity will be conducted to the community prior to commencement of construction activity. This socialization will be conducted with respect to local norms and traditions.

B. Construction Phase

B1. Workforce Mobilization and Demobilization

A significant amount of labor will be temporarily mobilized to Tangguh site. Based on conceptual construction study, approximately 10,500 workers will be on site during peak construction of LNG and its supporting facilities, including marine facilities.

A construction camp will be built and operated to provide accommodation for 10,500 construction workforce. The camp facilities will include, medical care facilities and other needs of workforce.

EPC contractor is expected to endeavor the workforce minimization effort through pre-fabrication outside Tangguh site and other effort in order to minimize total workforce on site during construction.

Workforce qualification will be determined through Workforce Management Study and will be described in RKL-RPL.

After construction period is completed, the workforce will be demobilized to their origin.

B2. Sea Transportation for Workforce, Equipment and Material

Sea transportation during construction phase will be required to support manpower, equipment and material mobilization. Potentially, the type of vessel that will be used during construction are support vessel, tug boat, material barge, crane barge, crew boat and LCT.

Estimated vessel intensity during construction period of LNG Train and its supporting facility are as follow :

- 2014 : 550 movements;
- 2015 : 600 movements;
- 2016 : 750 movements;
- 2017 : 600 movements; and
- 2018 : 400 movements.

List of main construction equipment that will be used for construction of LNG Trains and its supporting facilities is shown in **Table I**-15 below.

Equipment, its number during peak of construction, total on-site period and source of construction equipment depends on implementation of construction strategy, schedule and availability of the equipment from the main construction contractor. Most of the equipment will be mobilized to site using barge and will enter the site through BOF and combo dock.

Table I-15 Potential Construction Equipment for LNG Train Construction

Equipment	Estimated Quantity during Peak Construction
Civil Work	
Bulldozer, under 20 ton	18
Bulldozer, above 20 ton	12
Backhoe	21
Excavator	21
Wheel loader	18
Motor grader	15
Dump truck	43
Roller (tandem, tire, vibration)	14
Compactor (plate, trench, d frog)	24
Concrete batch plant	2
Concrete pump	2
Mixer truck	20
Water truck/fuel truck	17
Pile driving rig	19
Mechanical Work	
Ringer crane, 1.200 to 1.500 ton	2
Heavy lift crane, 800 ton	2
Heavy lift crane, 450 or 500 ton	4
Crane, 150 ton	7
Crane, 100 to 120 ton	12
Crane, 30 to 50 ton	18
Crane, under 30 ton	70
Prime mover and or self propelled transporter with power pack	9
Low bed trailer, 60 to 100 ton	11
Flat bed trailer, 30 to 50 ton	63
Boom truck	47
Fork lift	25
Welding generators	274
Power generators	50

Equipment	Estimated Quantity during Peak Construction
SPMT (Self Propelled Modular Transporter) Peak Number of axle lines	200 Axles
Pipe Bending Machines	4
Pipe Rollers	2
Plasma Arc Cutters	4
Oxy Acetylene Plate Cutting Machines	4
All Terrain Telescopic Fork Lifts 5T	4
Air Compressor	20

B3. Land Clearing

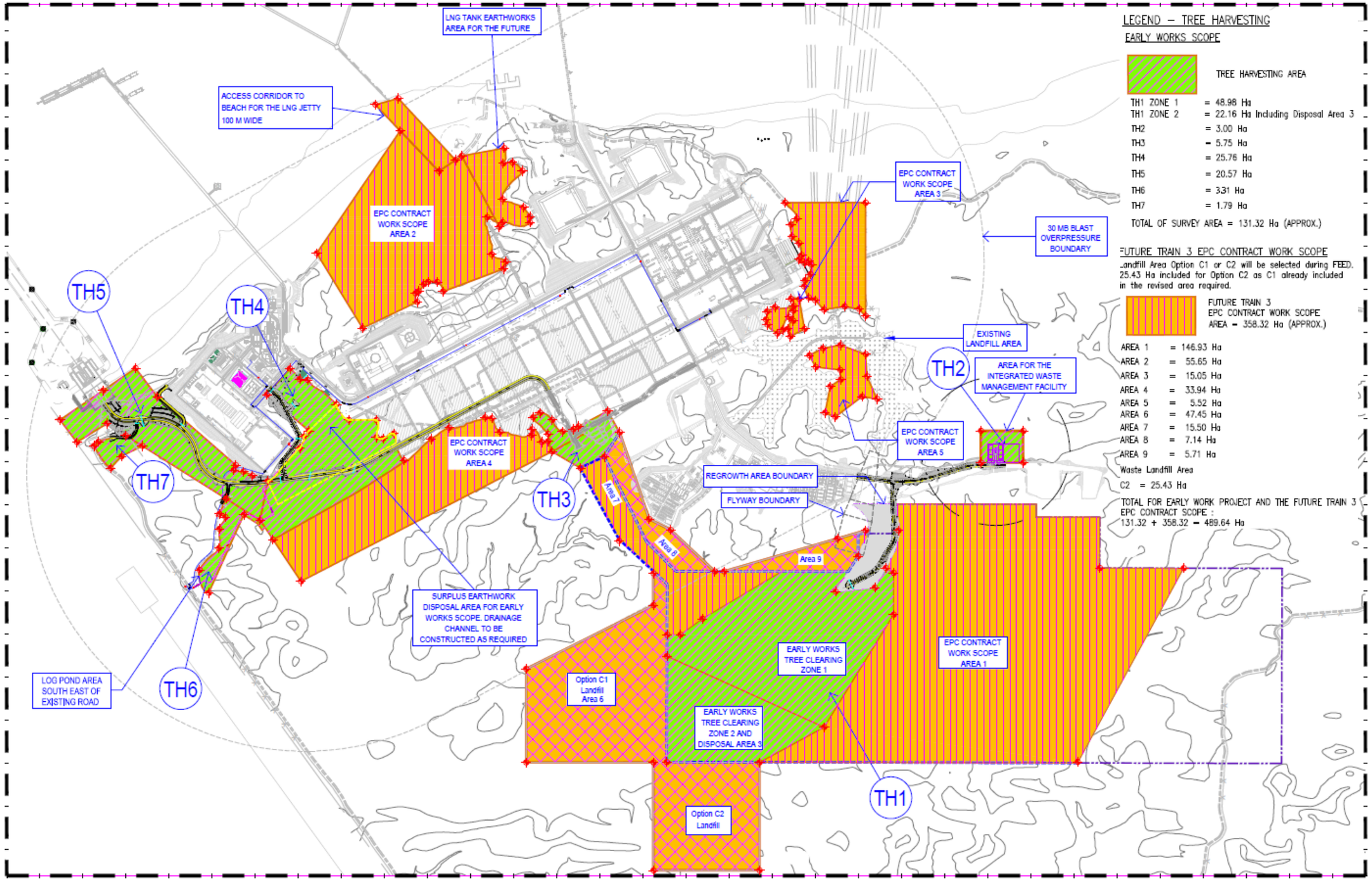
In Integrated AMDAL of Tangguh LNG which approved on 2002, Tangguh LNG is allowed to clear area of 800 Ha. Around 400 Ha of 800 Ha have been cleared for existing Tangguh LNG facility, which include two LNG trains and its supporting facilities, while the remaining 400 Ha were not being cleared.

As part of Tangguh Expansion Project plan, an additional area of maximum 500 Ha will be cleared. This additional area is required for the development of the new LNG train, LNG and condensate tanks, marine facilities, flare, new accommodation, maintenance facility, etc.

Project planned to expand the existing log pond area to temporarily store logs (timber) from Tangguh Expansion clearing. Additional area (approx. 20 m width) at the eastern side of the log pond will be cleared to install the cables to the PLN sub-station.

Total area that will be cleared for Tangguh Expansion Project is already include clearing of mangrove area approximately 10 Ha for marine facilities ((± 5 Ha for LNG-Condensate Jetty 2) and near shore pipeline installation (± 3 to 5 Ha for overall shorepull method).

Location of land clearing area of Tangguh Expansion Project is shown in **Figure I**-25.



Note : Land clearing area map is currently being finalized and may be changed as per project design progresses.
Landfill Option B is currently being considered and requires further assessment should this option is preferred.

Figure I-25 Land Clearing Area Map

B4. Site Preparation

After tree cutting activity completed, a series of earthwork, such as cut and fill, grading and compaction will be conducted for site preparation.

Based on current design plan, estimated volume for earthwork (cut and fill) activities are as follow :

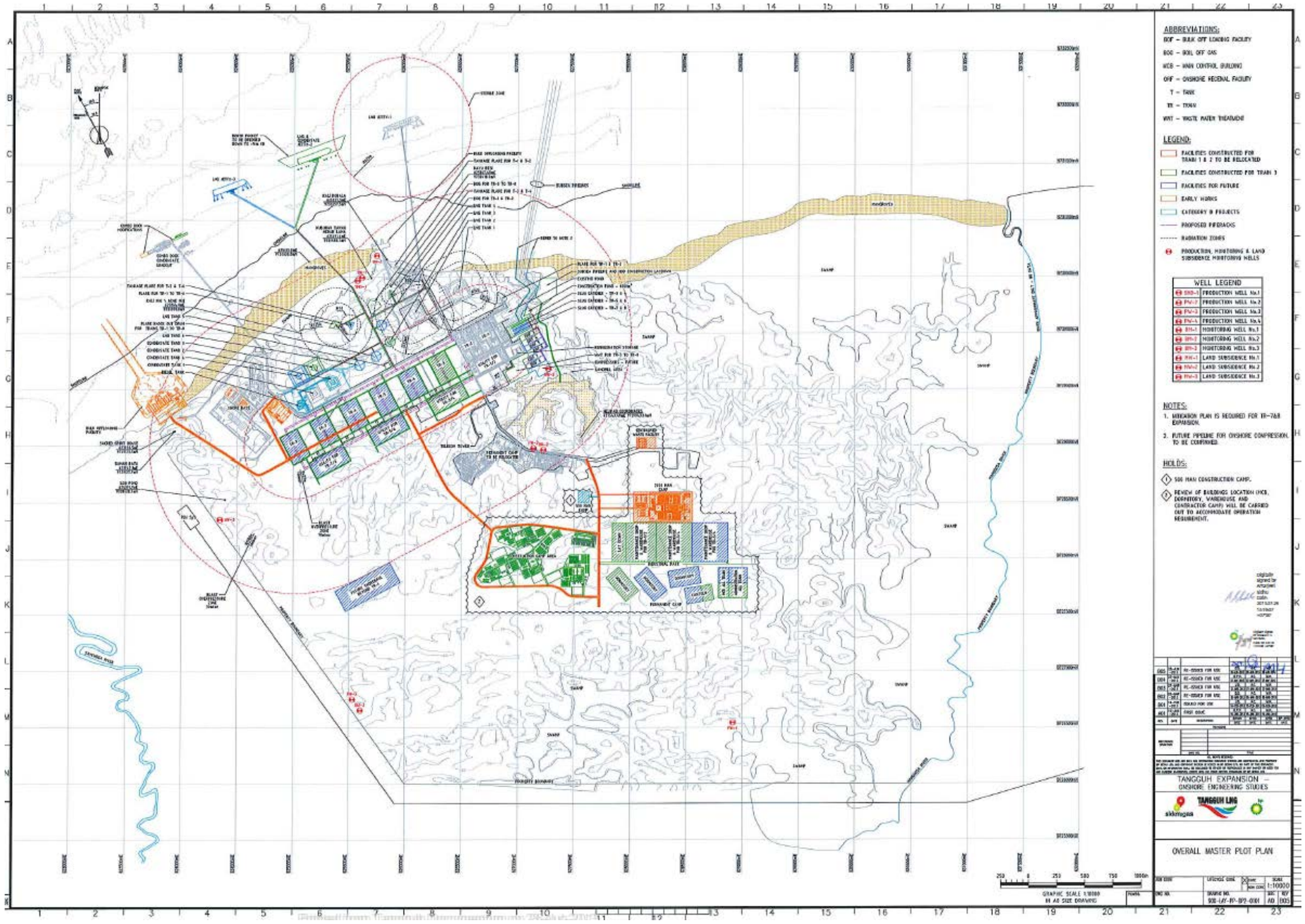
- Future LNG Tank, BOG, Flare, LNG Jetty Access and Condensate Tank areas North West of Train 3 = 2,200,000 m^3 (of earthwork);
- The Bulk Offloading Facility (BOF), approximately 6 km Access Road, Construction Camps, Dormitory/Warehouse, Centralized Waste Facility and ORF = 2,100,000 m^3 (of earthwork); and
- Train 3 plant site and construction laydown areas = 2,200,000 m^3

Total volume of earthwork is estimated to be approximately 6,500,000 m^3.

The earthwork material will be weathered "Steenkool" clay material with some thin layers (approximately 1 m thick) of sandy/gravel deposits on the ridge areas comprising less than 5% of the bulk earthwork volume.

Current plan is to balance the cut and fill volumes as much as possible within the work areas. Where possible surplus cut earthwork will be used to raise the elevation of the future train areas to avoid the need for additional areas for disposal.

The areas in the future dormitory/camp area and future train areas that are currently proposed for the disposal of unsuitable earthwork materials. These area are marked on the tree harvesting plan with total area approximately 50 ha. Excess soil disposal location is shown in Figure **I**-25.



Note : *) Master plot plan proyek is currently in finalization stage and may be changed according to project and design progresses. This drawing will be updated to reflect the final design result.

Figure I-26 Master Plot Plan of the Tangguh Expansion Project*)

B5. Quarry

After further consideration, to minimize the environmental impact and the project footprint, the option to have dedicated quarry locations within the buffer zone area outside the areas of forest being cleared for construction access and project physical footprint has been cancelled. Quarry material required will be mostly imported from outside Tangguh LNG site area.

The suitable granular materials discovered within the TEP tree clearing and cut and fill area will be used for construction, this will reduce the area to be cleared, project physical footprint and at the same time reduce the volume of materials to be disposed from the cut and fill activities.

B6. Construction of LNG Plant and its Supporting Facilities

One EPC contractor will be appointed to manage construction of all Tangguh LNG Expansion Project facilities, including:

- LNG Train;
- LNG Tank;
- Condensate Tank;
- Utilities: steam, air system, nitrogen system, etc;
- Freshwater supply system (desalination and/or groundwater extraction);
- Flare;
- Power generation;
- Solid waste and wastewater management facilities.

Layout of facilities that will be built as part of the Tangguh Expansion Project is shown in **Figure I**-26 Overall Master Plot Plan of the Tangguh Expansion Project.

Conceptual strategy of overall construction plan is currently being developed. A detail construction strategy for Tangguh Expansion development will be developed as well.

Some of the main facility components to fabricated outside Tangguh area and shipped to site using barge. These components will be assembled, installed and commissioned on site. This fabrication activity (if any) is excluded from this AMDAL study scope. Project proponent will ensure the selected fabrication facilities already obtained the required environmental permit and approval as per applicable regulation.

Hydrotest for LNG tank, condensate tank and utilities will be done during commissioning stage with estimated volume as follow :

Table I-16 Hydrotest Water Volume for Tanks and Utilities

Facility	Volume (m^3)
Tanks :	
LNG tank	105,000
Condensate tank	31,000
Desalination tank	16,000
Produced water buffer tank	10,500
Potable water tank	1,500
Demineralized tank	800
Diesel tank	2,000
Recovered oil tank	50
Admin & dormitory service reservoir tank	900
Chemical cleaning :	
Soda Boiling Boiler	700
Passivation & cleaning *:* - Heat exchanger - CWSS	5,700
Degreasing : a. Step-1 water recirculating b. Chemical dilution for degreasing c. First water flushing after degreasing d. Second water flushing after degreasing e. Water make up *f.* Preparation of amine solution	 a. 2,600 b. 2,600 c. 2,600 d. 2,600 e. 400 f. 1,000

B7. Freshwater Supply

Estimated freshwater demands during construction of LNG Train 3 and 4 is 512 m3/hour. Water quality shall comply to Government Regulation No. 82 Year 2001 regarding Water Quality Management and Water Pollution Control.

There are two alternatives freshwater supply will be assessed in this AMDAL study, which are :

1. Groundwater abstraction; and
2. Desalination.

Groundwater abstraction is the preferred option for freshwater supply during construction. Should the groundwater capacity is not sufficient to fulfil the water needs, a combination between groundwater extraction and desalination will be used for freshwater supply. Detail explanation on freshwater supply option is described in Sub-Chapter 1.2.3 LNG Plant Activity Section C6. Freshwater Supply.

B8. Non Hazardous and Hazardous Waste Management

Waste management facility will be built as part of the Tangguh Expansion. Incorporating lessons learned from waste management during previous construction and existing operation, project has identified the need to have an integrated waste management facilities to manage waste generated from Tangguh LNG construction, drilling and operation activities. This also include improvement of existing waste management facilities.

Current plan is to provide an Integrated Waste Management Facility (IMWF) to manage waste from construction, drilling and operation activity. Location criteria of integrated waste management facility are :

- Near the STP;
- Near the landfill to minimise the total vehicle movements;
- In an area accessible to the accommodation camp but not so close as to cause odour, smoke, litter or visual nuisance;
- In an area accessible by road; and
- In an area with access to necessary power, water and drainage infrastructure.

The proposed location if integrated waste management facility is to the northeast of the existing accommodation and north of STP, outside of 30 mbar LNG train blast zone. Proposed location is shown in **Figure I**-27.

Integrated waste management facility which will be established during early works, includes non hazardous waste incinerator and hazardous waste temporary storage. Other facilities will be built during main construction stage, including provision of hazardous waste incinerator and additional non hazardous waste landfill capacity for organic and inert waste. At handover to operation (after construction), some reconfiguration may be required to meet long term requirements.

Non Hazardous Solid Waste

Estimated non hazardous solid waste volume generated during construction stage is shown in

Table I-17 below.

Table I-17 Non Hazardous Waste Volume

No	Non Hazardous Waste	Waste Production Rate (m^3/POB/month)	Total Mandays during Construction	Cumulative Waste Volume Generated (m^3)
1	Organic waste	0.065	266,800	17,500
2	Recyclable waste	0.02	266,800	5,400
3	Combustible waste	0.17	266,800	45,500
4	Food waste			50,000
5	Inert waste			15,000

Note : the above volume are for two trains construction

Proposed facilities for non hazardous solid waste are as follow :

- Non hazardous waste incinerator : for combustible waste, e.g. paper, carton, etc.;

  Incinerator capacity = ± 2 x 3 tonnes per day (1 operated and 1 spare)
- Composter and food dewatering : for food waste
- Wood chipper;
- Can compactor and plastic shredder;

  Recyclable waste, such as pressed food can and shredded plastic bottle are planned to be sent to waste recycling facility.
- Non hazardous waste landfill (for inert and organic waste)

Landfill will be constructed to accommodate 110% of predicted waste volume generated during construction. Currently there are four alternative area which being considered as landfill location. From logistical perspective, option A represents the most favourable by virtue of the close proximity of both the proposed IWMF and STP and access to necessary infrastructure. However, the final landfill location will be determined after a series of relevant studies are performed, such as topography, hydrology, hydrogeology, geology, geotechnical, environmental assessment and other relevant studies. Considered alternative landfill locations are shown in **Figure I-27**.

Possibility to use food macerator and discharge to STP is currently being assessed. This option is aimed to reduce the waste that goes into landfill. If it is proven to be effective, macerator will be used as one of non hazardous waste treatment facility.

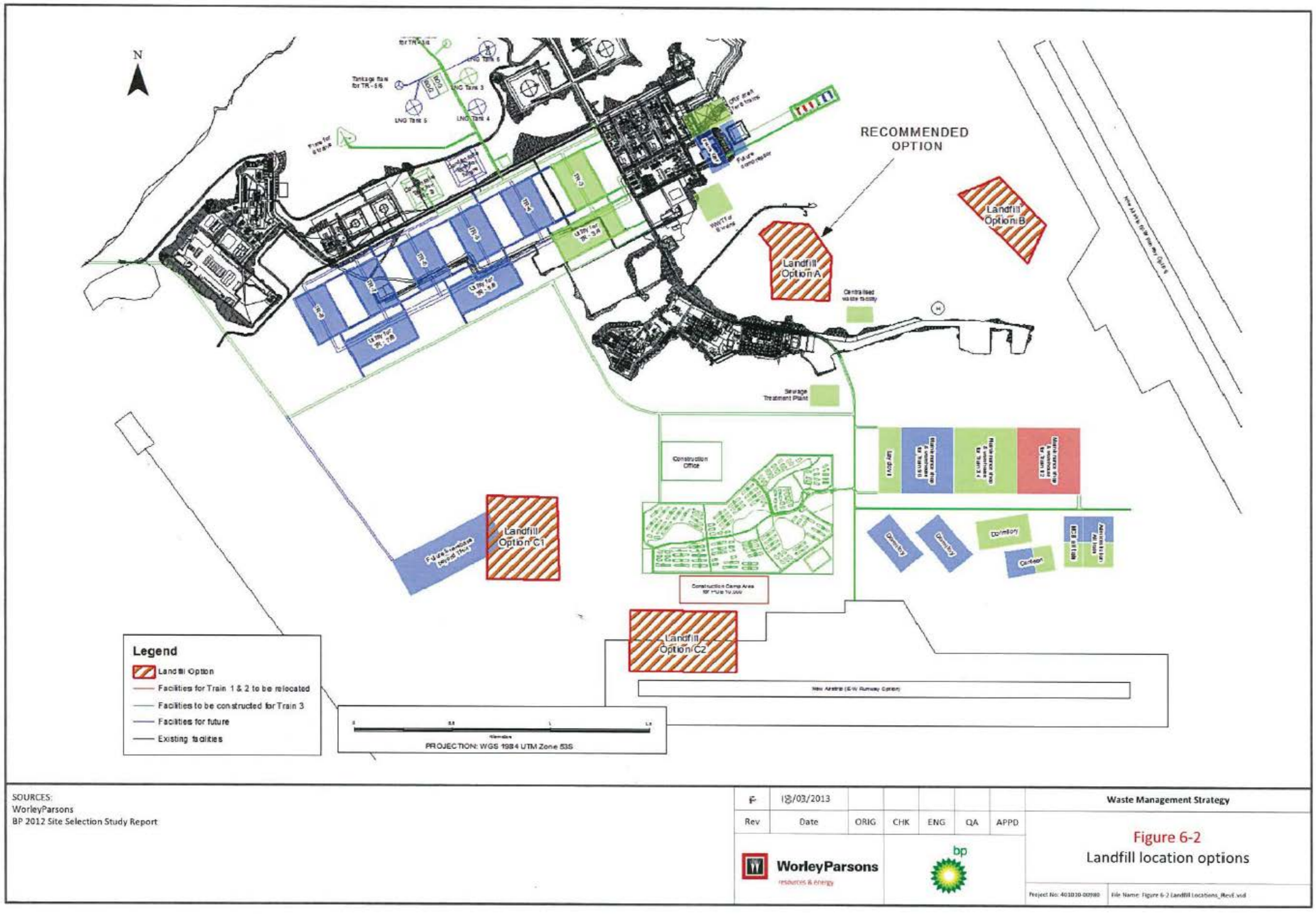


Figure I-27 Alternative Non Hazardous Waste Landfill Locations (for organic and inert waste)

Hazardous Waste

Estimated hazardous waste volume generated during construction stage is shown in **Table I**-18 below.

Table I-18 Estimated Hazardous Waste Volume

Hazardous Waste Type	Volume per month (m^3) during construction
Used packaging/container	900
Used oil	350
Chemical cans	180
Used/spent chemicals	90
Others	250
Total	**1,770**

Note: the above volume are for two trains construction

Proposed facilities and equipment to manage hazardous waste are as follow :

- Hazardous waste incinerator **(**for combustible hazardous waste);
- Hazardous waste storage (for incombustible hazardous waste including ashes from hazardous waste incinerator) prior to sending to certified waste management facility.

Hazardous waste incinerator and hazardous waste storage will be designed according to applicable Indonesian regulation and relevant IFC requirement, taking into account lessons learned from previous construction and existing operation.

Waste management facilities will be designed incorporating lessons learned from waste management from previous construction and existing operation. Detail design of waste management plan and its facilities are currently being assessed and will be included in RKL-RPL.

Some of the waste treatment facility which are constructed to handle construction waste will be preserved (not demolished) for long term utilization (operation phase).

B9. Wastewater Management

Wastewater during construction phase will be discharged at the same discharge point with existing wastewater discharge. Wastewater during construction phase will be discharged through GRP-HDPE (or similar type) pipe with diameter of 18″ and approximately 5 km length.

Main wastewater generated during construction phase are as follow :

Sewage – sewage generated from construction camp will be treated in a sewage treatment plant in project location. TEP construction will have an

integrated sewerage unit, which will be used during operational phase after the construction phase with an adjusted POB number.

Current plan is to use aerobic biological treatment with a disinfectant unit. The design capacity will be based on peak POB during construction phase. Estimated sewage volume generated during construction is approx. 3,800 m^3/day.

Effluent from the STP will be contained for possible reuse, such as irrigation, road watering and other similar usage. Sludge generated from STP will be handled by the non-hazardous waste system in IMWF (potential non-hazardous landfill).

Storm water/Runoff water – Storm water will be managed throughout the Construction Phase to minimize erosion and discharge of sediment to surrounding waterways. Typical storm water management practices include treatment and conveyance structures, retention and detention basins, filters, and oil/water separators. Temporary drainage systems and sediment and erosion control measures to minimize erosion, such as riprap, re-vegetation, slope stabilization, and so forth, will be implemented as needed.

Storm water runoff from clean areas will be allowed to flow through natural or manmade ditches to the nearest natural watercourse. Runoff from areas potentially subject to contamination will be diverted to a holding basin. Water collected in the basin will be tested prior to final discharge. If found to be acceptable for direct discharge, basin contents will be released to the outfall. If unacceptable for direct discharge, water will be treated prior to discharge.

Effluent from batching plant – The effluent water from batching plant usually contain Alkaline and high TSS characteristic. This effluent water will be treated in (temporary) neutralization pond to meet applicable quality standard for pH and TSS prior discharge to environment.

During construction, there will be temporary neutralization pond to treat the effluent water from batching plant.

However, this is not considered as main source of wastewater from Tangguh LNG activity due to the small volume (not more than 10 m^3/day) and it is intermitten (not a continual activity) hence it is not considered as main wastewater source in Tangguh LNG activity. The wastewater can also be reused for similar purpose. The wastewater that cannot be reused will be treated in neutralization pond to comply with quality standard prior to discharge to sea.

Hydrotest – During the commissioning of LNG train and its supporting facilities, hydrotest will be done for vessels and piping. Disposal option and location, including possibility to reuse the water (if not contaminated) is still being assessed.

Brine Water Reject – Should Tangguh decide to build new desalination unit/RO to fulfil freshwater needs during construction, the discharge of brine water reject will be increased.

Estimated volume of brine water reject during construction is approx. 3000 m^3/day during peak with RO efficiency of 0.4. Discharge of brine water reject will be significantly reduced, if Tangguh LNG is allowed to use groundwater extraction as freshwater supply.

B10. Power Generator/Diesel Generator

During construction, temporary diesel generators will be used for electrical supply.

B11. Storage and Loading of Fuel and Chemical

Fuel and chemical storage for construction activity will be managed by EPC Contractor. Fuel and chemical storage for the Tangguh Expansion Project construction activity will be built separately from the existing fuel and chemical storage for operation. Fuel will be transported to site using LCT or other similar vessel. Fuel and chemical will be stored in fuel storage facility in onshore storage.

Up to this stage, the volume of stored fuel and chemical have not been predicted yet. The storage and loading requirement during construction will be defined during Detail Engineering Study.

C. Operation Phase

C1. Workforce Mobilization

Existing Tangguh operation employs approximately 1800 workers. This number could increase by maximum 30% during TAR (heavy maintenance). This includes workforce requirement for operation and maintenance of LNG trains, offshore platforms, gas pipelines and other supporting facilities.

Approximately additional 500 – 1000 personnel will be required to operate and maintain Train 3 and its supporting facilities. For further development (Train 4), additional personnel requirement could be double from this estimation.

Base case is to absorb the operation and maintenance of the additional facilities in the current population (i.e. no increase in workforce size) by building capability in existing workforce. It is recognized that some increase in workforce may be required. Hence this provision of the numbers listed in this AMDAL document, should not be interpreted as an indication of increased employment opportunities.

Workforce qualification will be determined through Workforce Management Study and will be described in RKL-RPL.

C2. Flare Gas Emission

In order to provide 100% availability of the wet and dry flare systems, a common flare shall be provided. In this case, the common spare flare stack installed (one spare) shall be designed to handle both the wet and dry flare loads. These stacks, wet, dry and common spare, should be installed in one derrick structure and shall be possible to retract one flare stack while others remains in operation, without personnel having to work above the riser removal/replacement platform.

New flaring installation will be designed using demountable flaring method which can accommodate multiple riser flare up to six trains.

Benefit of demountable flare are :

- Multiple risers allow flare tip to be maintained at grade while the flare system and plant remain in operation;
- Multiple risers allow for smaller plot space;
- Extra space on derrick allows for the addition of risers for future expansion.

The new flaring installation (demountable flare) will consist of flare headers, KO drums and flare stacks for dry, wet and common spare flare for exising LNG Trains and its development up to LNG Train 6.

Schematic flare diagram for six trains operation is shown in **Figure I-**28. This new demountable flare will be located to the west area (north of the existing condensate tank) as shown in **Figure I-**29 with stack height of 130 m and diameter of 48 inch.

The existing flare systems for train 1 and 2 will be tied in to the new flare system.

A new tankage flare is provided at the north of LNG storage tank area, including a stainless steel flare header and elevated flare stack. Additional KO drum is not required for the new tankage flare system.

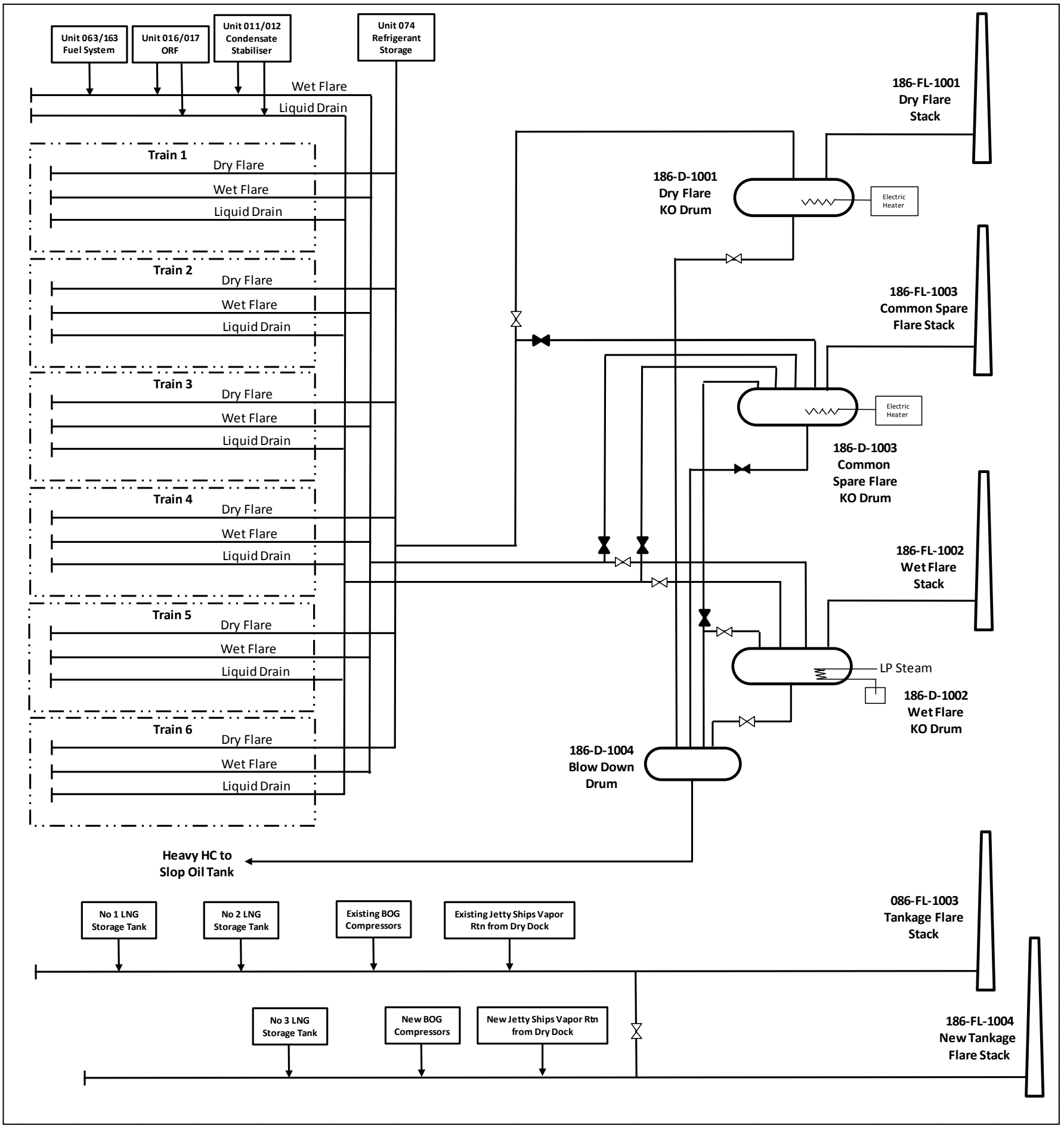
There will be purge gas and pilot flaring needed for safety reason. In addition, there will be some routine flaring required e.g. during dry dock ship, warm LNG ship, mixed refrigerant composition, train start up after TAR/trip. The amount of flaring will be significantly higher during initial start up and commissioning.

Based on existing operation (train 1 and 2), annual amount of flaring from normal operation as follow:

Table I-19 Flaring per Year (2011 – May 2013)

Year	Total Feed Gas (mmscf)	Flare (mmscf)	Flare vs Feed Gas (%)
2011	394,637	9,222	2.34
2012	421,395	6,668	1.58
2013 (YTD Jan-May) Estimate 5,500 mmscf	172,937	1,573	0.91

For Train 3 and 4, the annual amount of flaring is estimated to be 5,500 mmscf based on existing operation experience. However, the new design of LNG trains will be improved incorporating lesson learned from existing operation to reduce flaring.



Source : Tangguh Expansion Onshore Flare and Blow Down Basis of Design (186-DBS-PS-0001 Rev. B01)

Figure I-28 Schematic Figure of Demountable Flaring for 6 Trains

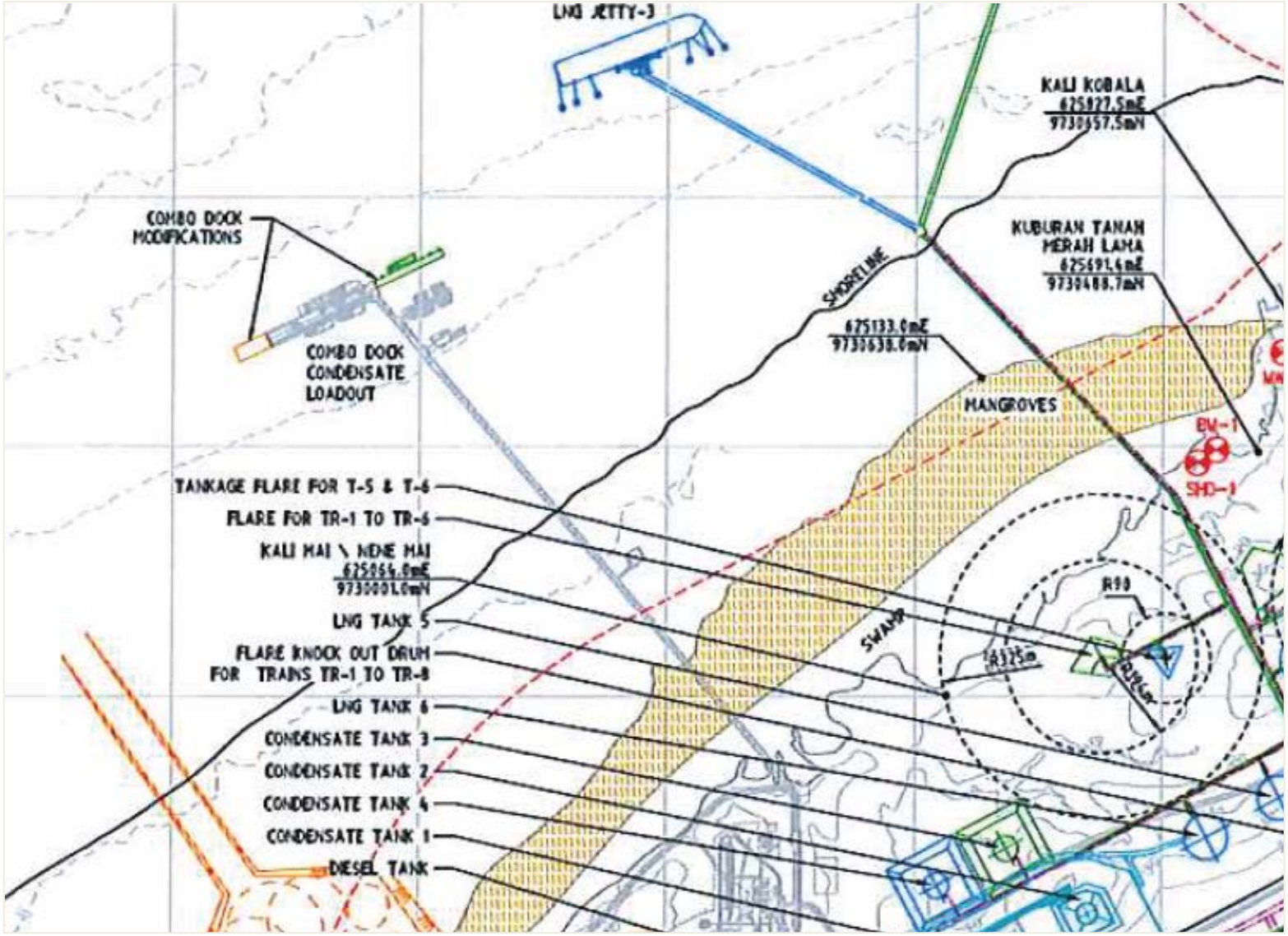


Figure I-29 Proposed New Flare Location

C3. Power Generator (Gas Turbine)

The Tangguh Expansion Project will provide additional three units of steam turbine generator with each capacity of 35 MW to generate electricity power required for the project operation. Electric power is generated by steam turbine driven power generator (STG) packages supplied with high pressure steam from the steam system and located in the utility area. Each steam turbine generator runs at 11 kV, 3 phase, 50 hertz and the voltage is stepped-up to 33 kV for distribution. The existing power generation system comprises three 35 MW STGs.

The emergency power will be generated from diesel engine driven generator (EDG) units and distributed from emergency switchboard. The new emergency power supply system for TEP will be using the same design as existing which comprise of four 2,3 MW EDG units.

C4. Boiler

High pressure (HP) steam is produced at 40 kg/cm²G and 400°C in the Heat Recovery Steam Generators (HRSG) installed in the exhaust stacks of the Frame-7 Gas Turbines driving the main refrigerant compressors in the LNG trains and is supplemented by Package Boilers. HP saturated steam is produced by injecting the boiler feed water under temperature control to decrease the temperature to the almost saturated condition of 251°C at 40 kg/cm²G.

Medium pressure (MP) steam (24 kg/cm2G, 223°C) is produced from the medium pressure let down station (pressure reduction and de-superheating). In this letdown station, high pressure steam is reduced to 24 kg/cm2G under pressure control then boiler feed water is injected under temperature control to decrease the temperature to the almost saturated condition of 223°C.

Low pressure (LP) steam (3.5 kg/cm2G, 148°C) is produced from the exhaust of the back-pressure starter/helper steam turbines of driving the refrigeration compressors in the process trains. The condition of low pressure steam from the turbines is slightly superheated. Therefore boiler feed water is injected under temperature control to de-superheat the steam at a temperature of 148 °C. The low pressure let-down station is also provided with a boiler feed water injection system to produce saturated LP steam from the HP steam.

Steam is distributed through the steam headers to the steam consumers. HP steam is mainly used to drive Starter/Helper the Steam Turbines on the refrigerant compressors in the LNG trains. These provide power for start-up of the Frame-7 gas turbines driven compressor strings as well as additional power during normal operation. Since the turbines are back pressure type, the outlet stream from the turbines is low pressure steam. Other main users of HP steam are the Steam Turbine Generator sets in utility area.

The steam losses in the system will be replaced by boiler make-up water. This comprises fresh water mixed with steam condensate which is then treated in the demineralization package.

The Steam unit will be expanded to generate and distribute additional steam required by the Tangguh Expansion facilities, and will include interconnection to exiting system. The potential Steam Equipment as described in **Table I-**20.

Table I-20 Potential Steam Equipment

Description	Existing Equipment in Tangguh LNG	Initial Development (LNG Train 3)
Steam Supply		
Boilers	1 set (3 x boilers)	1 set (3 x boilers)
HRSG	2 set (2 x trains)	2 set (2 x trains)
BFW (system)	1 set	1 set
Steam Consumers		
Process Reboilers	2 set (2 LNG trains)	1 set (1 LNG train)
STGs	1 set (3 x 35MW)	1 set (3 x 35MW)

Notes:

1. Plot plans/layout for the steam system expansion shall be located within the available space on the western side of the existing utilities block. The new boilers will be located adjacent to the existing units.
2. Further development is required to determine if an additional STG is required with LNG Train 4. Simple summation of the design electrical loads indicates one additional 35 MW machine would be required, whereas operational data suggests this would not be needed.
3. Space will be allocated for the additional facilities anticipated to be required for Train 4. This includes one STG package, one package boiler, two de-aerator, one steam turbine condenser, one condensate recovery drum, one condensate pump and one boiler feed water make-up package. It is assumed all these items will be of the same design and capacity as the corresponding Train 3 facilities.

C5. Acid Gas Incinerator (AGI)

Acid gas from the Amine Flash Reflux Drum contains a small amount of light hydrocarbon, aromatic compound such as benzene, toluene, xylene, and a variety of sulphur compounds, which must be oxidized prior to releasing them to the atmosphere. This oxidation process is performed in the Acid Gas Incinerator.

A thermal combustion unit will be provided to burn the Acid Gas Removal Unit vent gas. Acid gas from the top of the Amine Flash Reflux Drum is sent to the incinerator; all combustibles substances will be converted into oxidized products.

The additional heat required to achieve the required flame temperature will be provided by an auxiliary burner, firing fuel gas or flash gas from the Unit.

The maximum H_2S content in the flue gases is 5 ppmv. In case of trip or other non-availability of the incinerator, acid gas is vented directly to atmosphere and flash gas is routed to the flare as it contains hydrocarbons.

C6. Freshwater Supply

Estimated freshwater demands during Train 3 and 4 operation is 79 m^3/hour. Water quality shall comply to Government Regulation No. 82 Year 2001 regarding Water Quality Management and Water Pollution Control.

There are two alternatives freshwater supply will be assessed in this AMDAL study, which are :

1. Groundwater Abstraction

   The option to use groundwater supply to replace or supplement the current desalination system are considered as part of the Tangguh Expansion Project and included in this AMDAL study scope.

   Option to have groundwater production well within Tangguh fence and possibility to obtain freshwater supply from outside Tangguh, or combined both options are currently being considered.

   Use of groundwater would reduce the volume of wastewater discharge (brine water reject) into Bintuni Bay, providing an environmental benefit. It would also be more energy efficient and reduce the emission of greenhouse gases.

   A number of groundwater investigations have been conducted previously at Tangguh site, including desk top study, groundwater modeling, drilling, pilot hole, and geophysical surveys.

   The result of those studies identified fresh water aquifer that may be suitable to supply water for Tangguh construction and operations. A field

investigation including drilling of some production and monitoring wells and pumping test was recommended and approved by MoE in 2006 to confirm the desk top study finding. Due to several reasons including the peak construction activities at that time, Tangguh decided to postpone this programs.

An additional desktop study has recently been completed which confirms the previous findings and recommends to proceed with the previous programme with some amendments. A field investigation is conducted as part of this AMDAL study.

As part of this AMDAL study, one production well with depth of 400 m and one monitoring well with depth of 150 m for 10 days pumping test will be drilled. Should the test indicates the positive result and groundwater option is confirmed to be feasible and approved in the AMDAL, Tangguh will drill additional production wells up to 400 m depth and additional two monitoring wells up to 300 m depth, to monitor potential impact of seawater intrusion and land subsidence, also to monitor the availability of groundwater resource for the community. The numbers of groundwater production wells to be drilled to supply constructions and operations water needs will be determined based on the result of groundwater study.

2. Desalination

Existing Tangguh LNG operation use desalination system to fulfil its freshwater demands. Currently, freshwater for Tangguh LNG are provided by desalination (capacity of 3 x 28 m^3/hour) and reverse osmosis (86 m^3/hour) units.

Should TEP decide to use desalination as freshwater supply, 4 x 28 m3/hour (3x28 m3/hour for initial phase and potentially additional 1x28 m3/hour unit as part of future development) desalination unit will be constructed. Brine water reject will be discharged directly to sea comingled with other treated wastewater.

Groundwater abstraction is the preferred option for freshwater supply during construction, subject to local government approval. Should the groundwater capacity is not sufficient to fulfil the water needs, a combination between groundwater abstraction and desalination will be used for freshwater supply

Detail of this program is described in Sub-Chapter 2.1.5 Hydrogeology and Groundwater Quality.

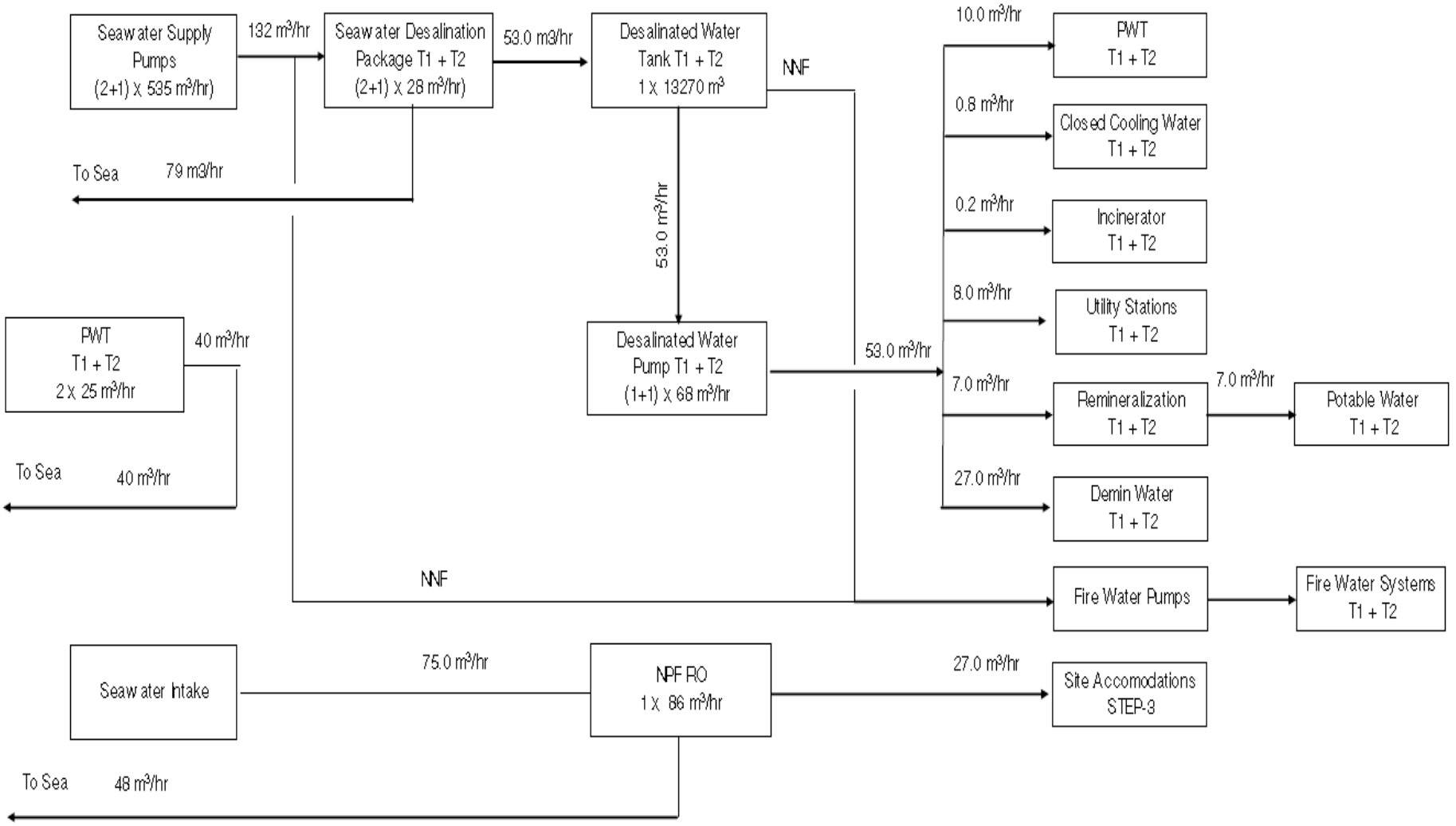


Figure I-30 Water Balance of Existing Tangguh LNG Operation

C7. Wastewater Management

Estimated wastewater volume generated from four trains operations are as follow :

Table I-21 Estimated Wastewater Volume from Four Trains Operation

Wastewater Type	Treatment Unit	Volume (m^3/day)
Produced Water	Produced Water Treatment (PWT)	1,200
Oily Contaminated Water	Corrugated Plate Interceptor (CPI)	4,800
Chemically Contaminated Water	Neutralization Pit	3,400
Sewage	Sewage Treatment Plant (STP)	1,320
Brine water reject	-	32,832
Total		**43,552**
Total (m^3/hour)		**1,851**

Produced Water

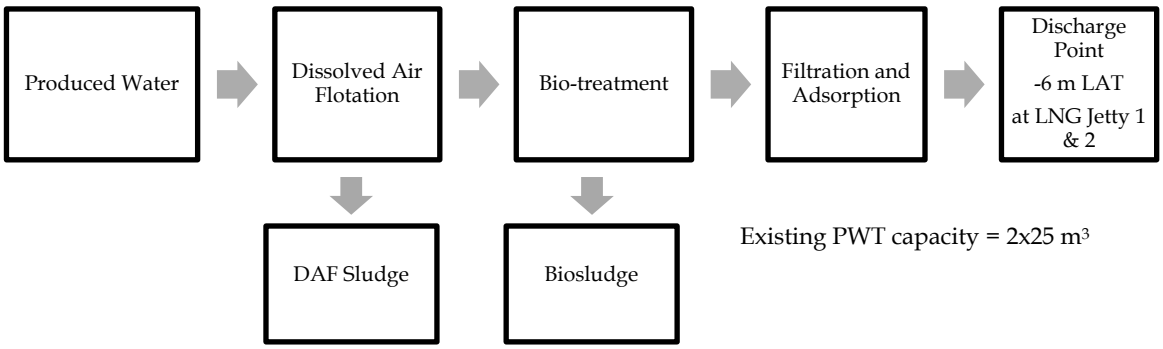


Figure I-31 Block Flow Diagram of Produced Water Management

The existing Produced Water Treatment (PWT) unit received wastewater streams from the following source :

- Produced water from ORF pre-treated and collected in produced water tank;
- Pipeline unloading water stored in dewatering pit;
- Water from well start-up activity stored in dewatering pit;
- Treated water from CPI; and
- Recycled water from bio-treatment section of PWT (aerobic conventional type.

In existing operation, the pre-treated produced waste water stored in the Produced Water Tank and Off-Spec Produced Water Tank is fed to PWT Plant for further treatment. PWT unit consists of :

- Dissolved Air Floation (DAF) – oil and grease removal – primary treatment;
- Biological treatment – secondary treatment;
- Sand filter – tertiary treatment;
- Activated carbon filter – tertiary treatment;
- Sludge treatment; and
- Chemical injection facilities.

The existing PWT plant does not have the capacity to handle the anticipated increase in wastewater from the Tangguh Expansion Project facilities. Therefore, an additional unit of similar design to the two existing units (25 m^3/hour) will increase total plant capacity to 75 m^3/hour for three LNG Trains. Addition of PWT unit will be aligned with trains expansion.

The locations of the new PWT plant will be built at the east side of the Main Control Building (MCB). Design of the integrated system shall address flow distribution between the new and existing PWT plant.

As proven during the performance test to effluent water of PWT plant, it is identified that the effluent water from the PWT has the potential to be further treated/polished to reach the quality of utility water.

There will still be some wastewater to be discharged, though the quantity will be reduced. Should the PWT flow rate is not sufficient to meet utility water demand, water supply from other source (groundwater or desalination) will still required.

Study to assess the possibility of produced water reinjection is being considered to be conducted in the future. However, this possibility is not included in this AMDAL scope. Should this reinjection option is selected, Tangguh LNG will coordinate with relevant institution to have guidance on further process.

DAF sludge will be managed according to the study result and/or will be used as soil enricher and/or incinerated in hazardous incinerator and/or sent to certified waste management facility. Bio-sludge will be treated as raw material of soil enricher and/or other similar utilization according to the ongoing study result. Should the study result shows that this option is not applicable, other option that being considered is to incinerated bio-sludge in incinerator and/or sent to certified waste management facility.

Oily Contaminated Water

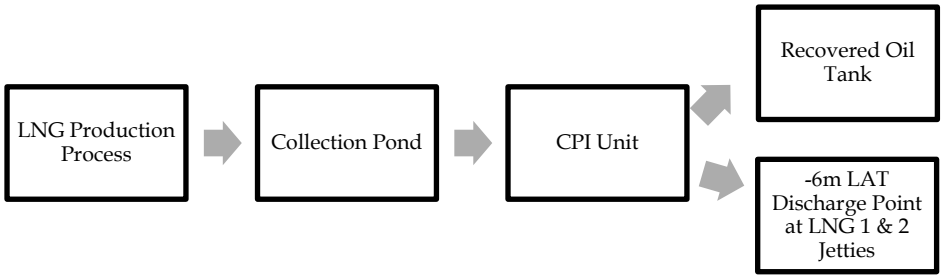


Figure I-32 Block Flow Diagram of Oily Contaminated Water

Oily contaminated water during operation phase are produced from several sources, which are :

- Process/train area;
- Utility/offsite area;
- ORF area;
- Area within condensate tank;
- BOG compressor area;
- Seawater intake area;
- Potential contaminated runoff area.

Oily contaminated water has different discharge specification/requirement with produced water, therefore a separate treatment unit shall be provided (i.e. Corrugated Plate Interceptor – CPI). There will be a back up line to **tie-in** to PWT unit which allow the oily contaminated water to flow to PWT in case of trip/downtime in CPI unit.

Design consideration as stated above is based on lesson leard from the current Tangguh LNG operations. CPI unit will be improved to separate hydrocarbon more effectively.

CPI sludge management will be conducted as per study result and/or as soil enricher and/or incinerated in hazardous waste incinerator and/or sent to certified waste management facility.

Chemically Contaminated Water

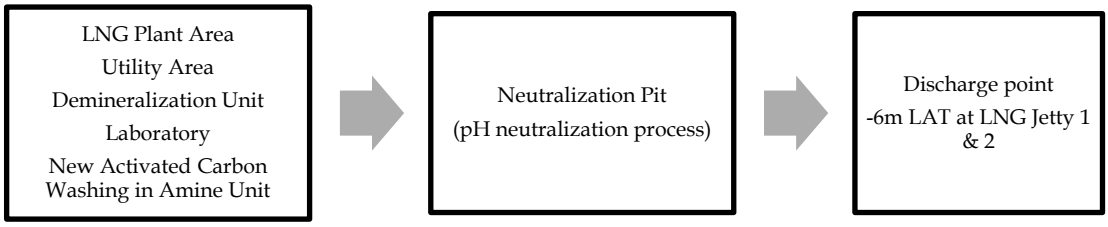


Figure I-33 Block Flow Diagram of Chemically Contaminated Water

Chemically contaminated water are generated from the following source:

- Utility/offsite area;
- Process/train area;
- Laboratory.

An adequate neutralization pit will be provided to receive chemically contaminated water stream and neutralized it to meet discharge water quality standard. Similar with the existing unit, a sufficient neutralization pit will be built to accommodate all chemically contaminated water from TEP.

Sewage

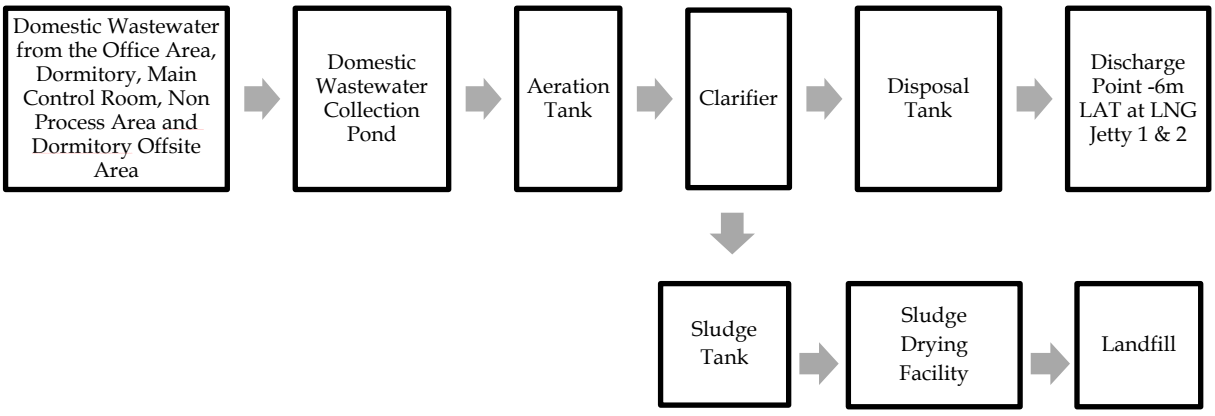


Figure I-34 Block Flow Diagram of Sewage Management

New permanent STP unit that will be built during construction phase will also accommodate the sewage generated during operation phase (including commissioning) of Tangguh Expansion Project, with some POB adjustment during operation phase.

In addition, STP unit will be used to treat leachate from organic landfill.

Treated sewage water (STP effluent) will be collected for possible reuse, such as for irrigation, road watering and other similar usage. However, the treated sewage water will not be reused for human consumption.

Sludge from treatment will be disposed to landfill and/or as compost material and/or as soil enricher and/or other similar utilization as per the ongoing study result and/or incinerated.

Brine Water Reject

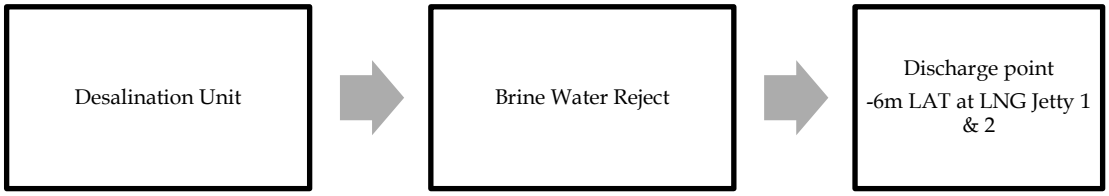


Figure I-35 Block Flow Diagram of Brine Water Reject Management

Discharge of brine water reject will be increased, should Tangguh decide to build new desalination unit to fulfil freshwater need during construction and operation of Tangguh Expansion Project. Discharge of brine water reject will be significantly reduced, if Tangguh will use groundwater extraction as freshwater supply.

Wastewater generated during operation phase will be discharged to sea to common outfall at -6 m LAT through the new wastewater discharge line in the new LNG-condensate jetty 2 location. This new discharge line will be tied in to the existing line to minimize potential risk of downtime due to blockage or maintenance at existing/new discharge line. Location of the new wastewater discharge line is shown in **Figure I**-36.

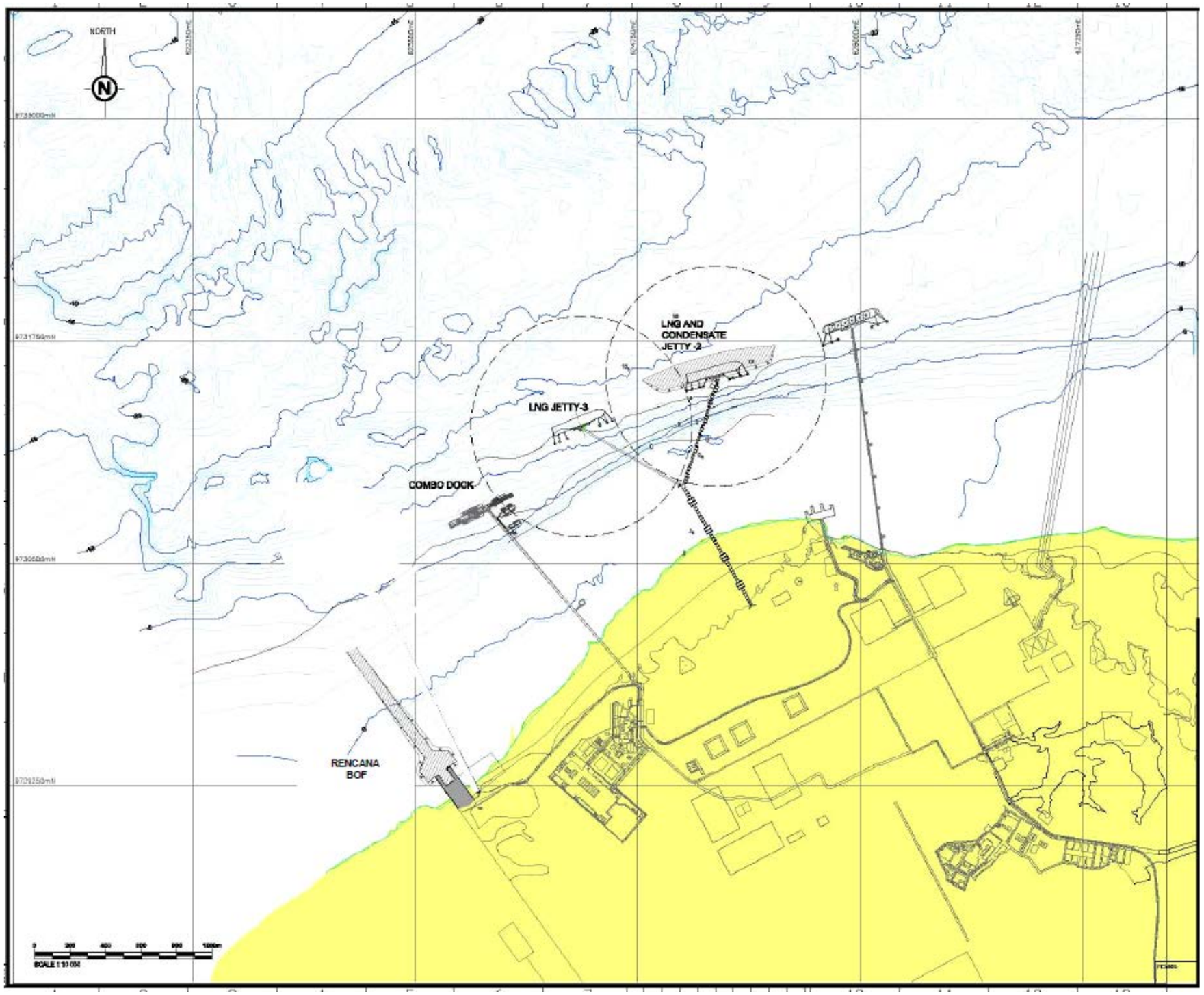


Figure I-36 Wastewater Discharge Location at LNG-Condensate Jetty 2 (A)

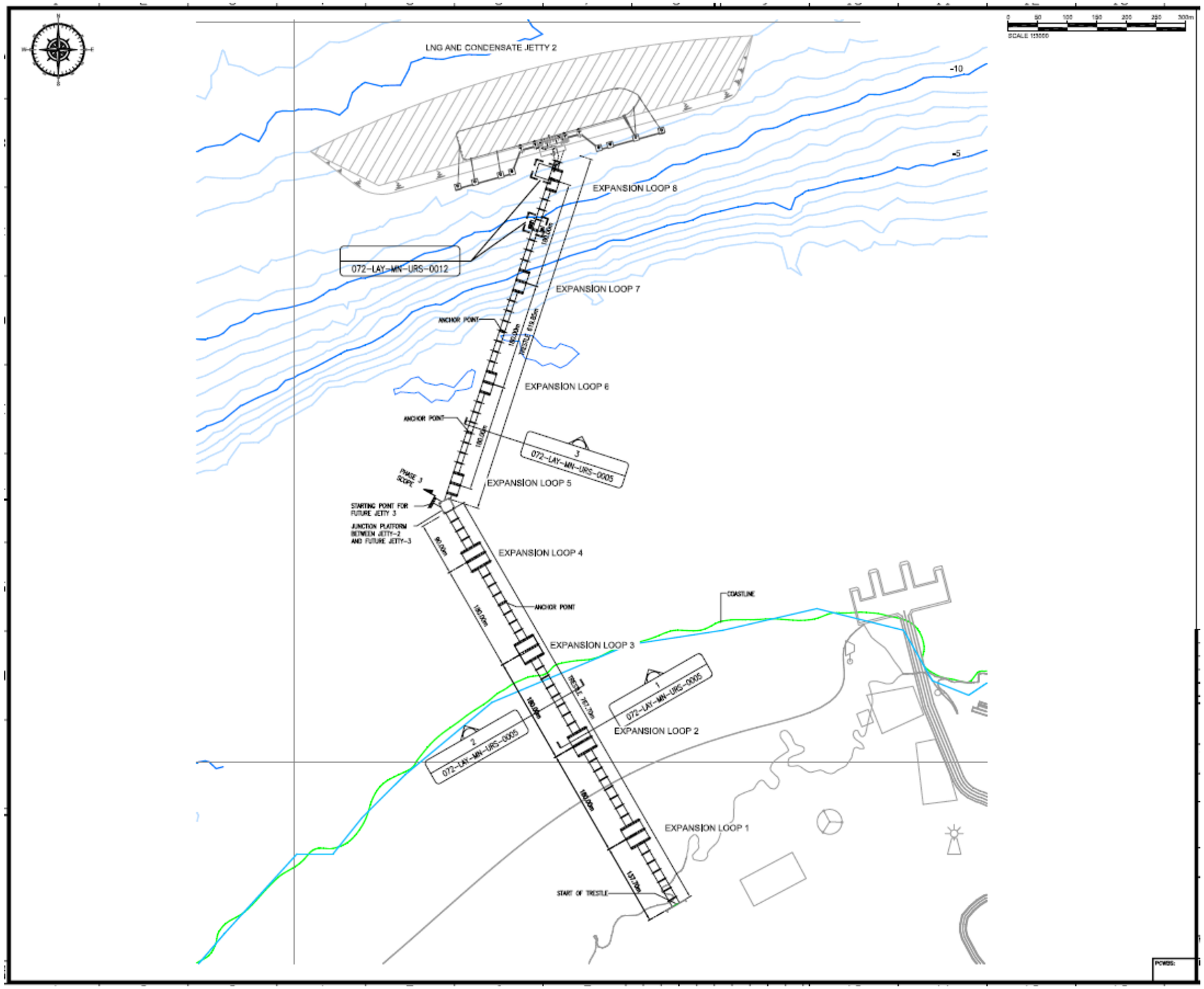


Figure I-37 Wastewater Discharge Location at LNG-Condensate Jetty 2 (B)

C8. Non Hazardous and Hazardous Waste Management

As described in Sub-Chapter 1.2.3 LNG Plant Activity Section B8. Non Hazardous and Hazardous Waste Management, an integrated waste management facility will be provided as part of Tangguh Expansion Project in order to provide an integrated facility to manage waste from construction, drilling and operation activity.

Non Hazardous Waste

Estimated volume of non hazardous solid waste generated during operation phase is shown in **Table I**-22 below.

Table I-22 Estimated Volume of Non Hazardous Solid Waste

Type of Solid Waste	Volume per month (m^3)
Organic waste	100
Recyclable waste	85
Combustible waste	500
Wood	90
Inert waste	60
Total	**835**

Source: Waste Management Strategy Worley Parsons Rev. B03

Hazardous Waste

Estimated volume of hazardous waste generated during operation phase is shown in **Table I**-23 below.

Table I-23 Estimated Volume of Hazardous Waste

Type of Hazardous Waste	Volume
Solid waste	60 m^3/month
Liquid waste	60 m^3/ month
Chemical cans	-
Used/spent chemical	60 m^3/ month
Others	110 m^3/ month
Mercury contaminated waste	100 m^3/ month

Source: Waste Management Strategy Worley Parsons Rev. B03

Hazardous waste generated from Tangguh LNG operation includes solid waste from process, liquid waste from process and mercury catalyst which generated during Turn Around (TAR) activity. TAR will be conducted regularly, however mercury catalyst replacement will only be done if necessary. Mercury catalyst waste will be sent to certified waste management facility.

Hazardous waste management will be done in compliance with applicable Indonesian regulation (Government Regulation No. 18 jo 85 Year 1999),

current plan is to use hazardous incinerator to incinerate combustible hazardous waste or will be stored temporarily in Hazardous Waste Storage prior to be sent to certified waste management facility.

Tangguh currently assessed possibility to recycle PWT sludge to be used as compost or other potential usage. A preliminary study will be done prior utilization of hazardous waste.Should the study result shown this option is feasible, Tangguh LNG will consult with MOE to ensure this option can be done in compliance with applicable regulation.

Some of the waste treatment facility which are constructed to handle construction waste will be preserved (not demolished) for long term utilization (operation phase).

Tangguh LNG waste management diagram and flow is shown in **Figure I-**38 and **Figure I-**39.

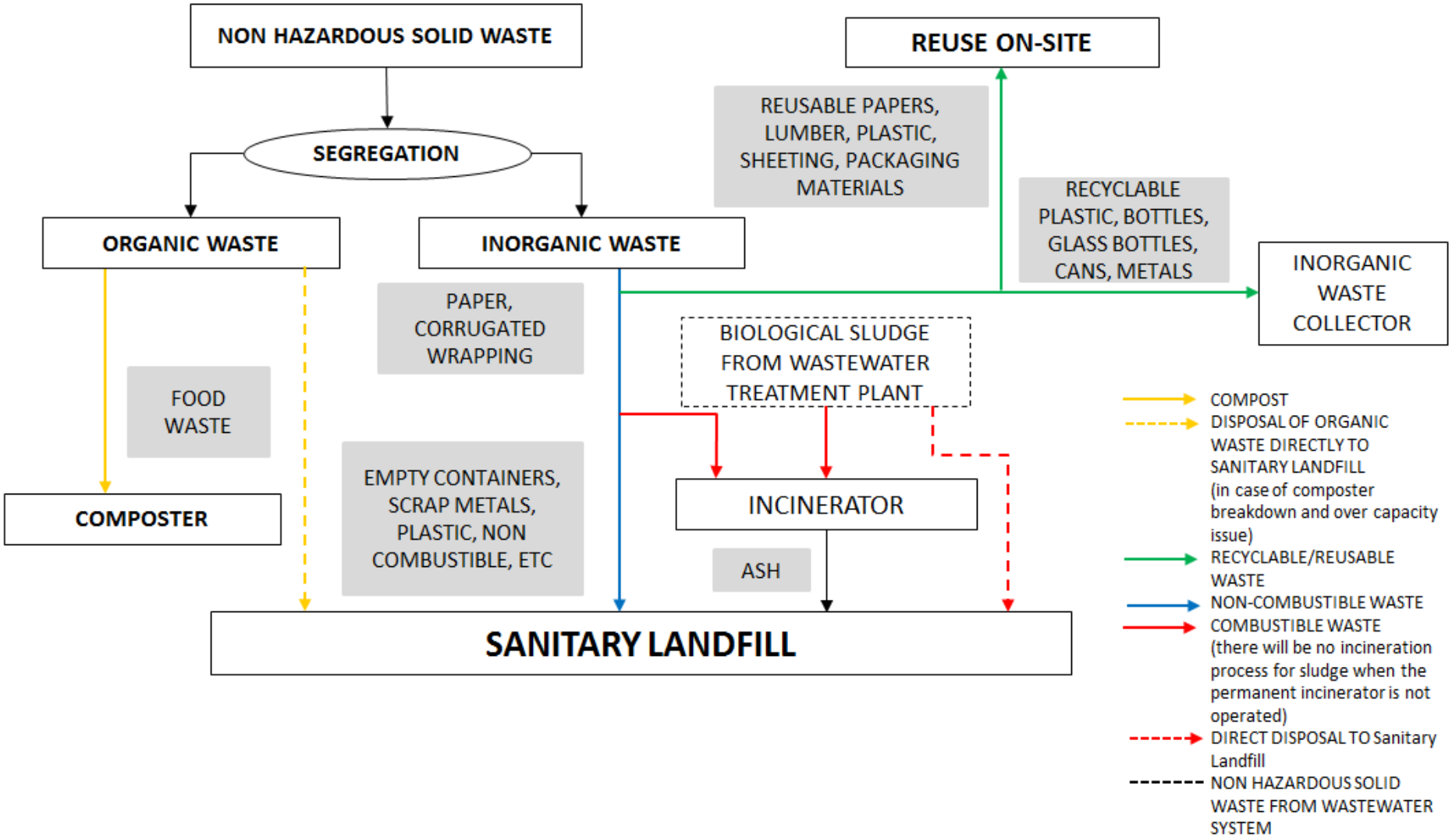


Figure I-38 Existing Non Hazardous Solid Waste Management Diagram in Tangguh LNG Site

Figure I-39 Existing Waste Management Facilities in Tangguh LNG Site

C9. Non Production Facilities (NPF)

Supporting facilities will be built to support Tangguh LNG operation. Those facilities are include :

- Accommodation;
- Office;
- Warehouse;
- Maintenance workshop;
- Laboratory;
- Clinic;
- Worship facility;
- Sport facility.

C10. Storage and Loading of Fuel and Chemical

Tangguh LNG existing operation already equipped with fuel and chemical storage and loading facility and procedure.

Diesel oil is supplied by ship (local LCT transporter) from the off-site vendor to the Tangguh LNG plant. Existing operation consumes approxmately 900,000 L/month of diesel fuel for vessel fuel, equipment and operational vehicle. The diesel is currently offloaded at the Combo Dock using a dockside pump or ship pump to transfer the diesel to diesel storage tanks.

A new hydrocarbons un-loading berth will be installed as part of the Tangguh LNG Expansion Project for this purpose. Existing Tangguh operation only use one diesel type. The diesel fuel is subsequently distributed to the following end-users via a small tanker truck, as there is no direct distribution by permanent piping. Following are facilities and equipment inside Tangguh LNG which use diesel fuel :

- Diesel driven sea water supply pump;
- Diesel driven main firewater pump;
- EDGs;
- Vehicle fuel stations:
  - One in the GPF Shore Base (GPFSB) area to refuel equipment used to support the GPF Shore Base and plant activities
  - Two on the Combo Dock. One is used for refuelling small marine craft, e.g. the pilot boat, security boats and water taxis, as well as to refuel the motorised equipment and vehicles that are used on the Combo Dock. The other one is used for refuelling large marine craft, e.g. tugs, crew boats and offshore supply vessels, although the offshore supply

vessels will generally refuel at the supply depot at Sorong, or at another convenient site.

Should it deemed necessary, storage and fuel distribution system will be supplemented to fulfil fuel requirement for Tangguh Expansion Project. New fuel tank with capacity approximately 2000 m^3 and transfer/loading pump (2 x 60 m^3/hour) will be added for TEP in new location which will be determined later.

Chemical for LNG production and GPF is being offloaded at combo dock and will be stored in dedicated storage.

All diesel/fuel storage shall be provided with an adequate secondary containment system (e.g. 110% of its capacity).

D. Post Operation Phase

Post operation phase are include but not limited to facility decommissioning, remediation and workforce release.

D1. Workforce Demobilization

There will be workforce release in the end of operation phase. Detail process of workforce release will be determined later and will be done according to applicable regulation

D2. LNG Plant and Its Supporting Facilities Decommissioning

Facility decommissioning plan will be developed to obtain approval from Government. The decommissioning plan will be developed according to applicable regulation on decommissioning at that time.

Most of LNG Plant and supporting facilities will be removed. However, discussion with stakeholders will be ongoing to determine if any of these facilities will be left behind to be used in the future or will be abandoned. A clear plan and legal understanding of the transfer of responsibility for the facilities will be determined through this process. Some remediation of the areas is expected and will be completed prior to release.

D3. Revegetation

Revegetation will be done in former area of demolished LNG plant and supporting facilities. Detail revegetation program will be developed once decommissioning plan is completed.

1.2.4 Marine Facilities Activity

The existing marine facilities in Tangguh LNG currently consist of an LNG jetty, a construction jetty, and a combo dock (condensate/cargo/passenger-crew jetty) (**Figure I-**40). These facilities are used for various operational activities including LNG and Condensate loading, the wastewater discharge outfall, equipment laydown and transportation, manpower mobilization, sea water intake, bulk fuel

and chemical delivery and for servicing offshore maintenance, operational and exploration activities.

Tangguh LNG has conducted a design study to investigate possible marine expansion options to facilitate the additional requirements of the Tangguh Expansion Project. The primary marine infrastructure requirements identified are :

- LNG-Condensate Jetty 2;
- Bulk Offloading Facility; and
- Combo dock enhancement.

All marine facilities are design with no causeways establishment. The interface between the trestle and the land are supported with an abutment which also incorporates some erosion protection in the form of a concrete and boulders, as shown in **Figure I**-41.

Figure I-40 Existing Marine Facilities in Tangguh LNG

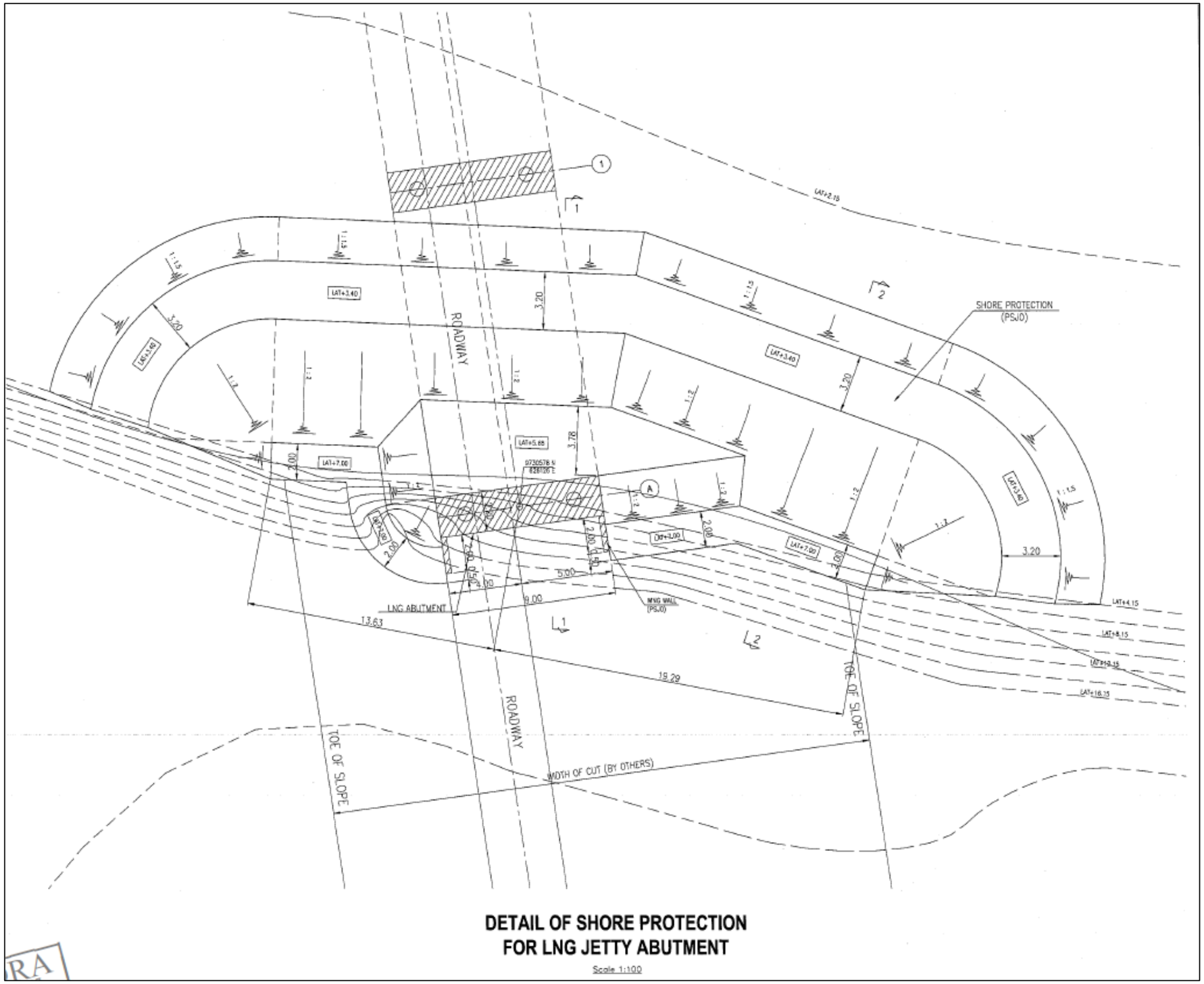


Figure I-41 Detail of Shore Protection for LNG Jetty Abutment

Development scenario of marine facilities is shown in **Table I**-24 below:

Table I-24 Existing Marine Facilities and Development Scenario of Tangguh Expansion Project

No.	Facility	Existing Tangguh	Initial Development (Train 3)	Future Development (Future Gas Supply for Train 3 and Development of Train 4)
1.	Marine Port	Marine facilities: - 1 construction jetty - 1 combo dock as condensate/ cargo/ passenger dock - 1 LNG Jetty for 2 trains	Marine facilities: - 1 Bulk Offloading Facility – permanent - Combo Dock enhancement - 1 LNG-Condensate Jetty	Not considered yet
2	Dredging		LNG-Condensate Jetty 2 = 130,000 m^3 BOF = 750,000 m^3 Combo dock enhancement = 180,000 m^3 Maintenance = 400,000 m^3	
3	Waste Management	Solid waste from marine facilities are managed at Tangguh LNG site. Solid wastes from vessel are managed on vessel and follow MARPOL requirement Annex V Prevention of Pollution by Garbage from Ships Year 2012 (for discharge of food waste to sea).	Solid waste from marine facilities will be managed at Tangguh LNG site. Solid waste from vessel will be managed on vessel and follow MARPOL requirement Annex V Prevention of Pollution by Garbage from Ships Year 2012 requirement (for discharge of food waste to sea).	

No.	Facility	Existing Tangguh	Initial Development (Train 3)	Future Development (Future Gas Supply for Train 3 and Development of Train 4)
4	Wastewater Management	Wastewater from marine facilities are managed at Tangguh LNG site. Wastewater from vessel are managed on vessel and follow MARPOL requirement Annex IV Prevention of Pollution by Sewage from Ships Year 2012.	Wastewater from marine facilities are managed at Tangguh LNG site. Wastewater from vessel will be managed on vessel and follow MARPOL requirement Annex IV Prevention of Pollution by Sewage from Ships Year 2012.	

According to Government Regulation No. 5 Year 2010 regarding Navigation, Safety Exclusion Zone will be established for safety purpose, which are :

- Prohibited zone : 500 meter measured from the outermost point of installation or marine navigational aid facility.
- Restricted zone : 1250 meter measured from the outermost point of the prohibited zone or 1750 meter from the outermost of installation or marine navigational aid facility.

Existing safety exclusion zone around Tangguh LNG marine facilities are shown in **Figure I**-42 and **Figure I**-43.

During operation, a 500-m area on all sides of the LNG vessel and 150-m area for the combo dock are determined as Safety Exclusion Zone for other vessel traffic for safety reasons

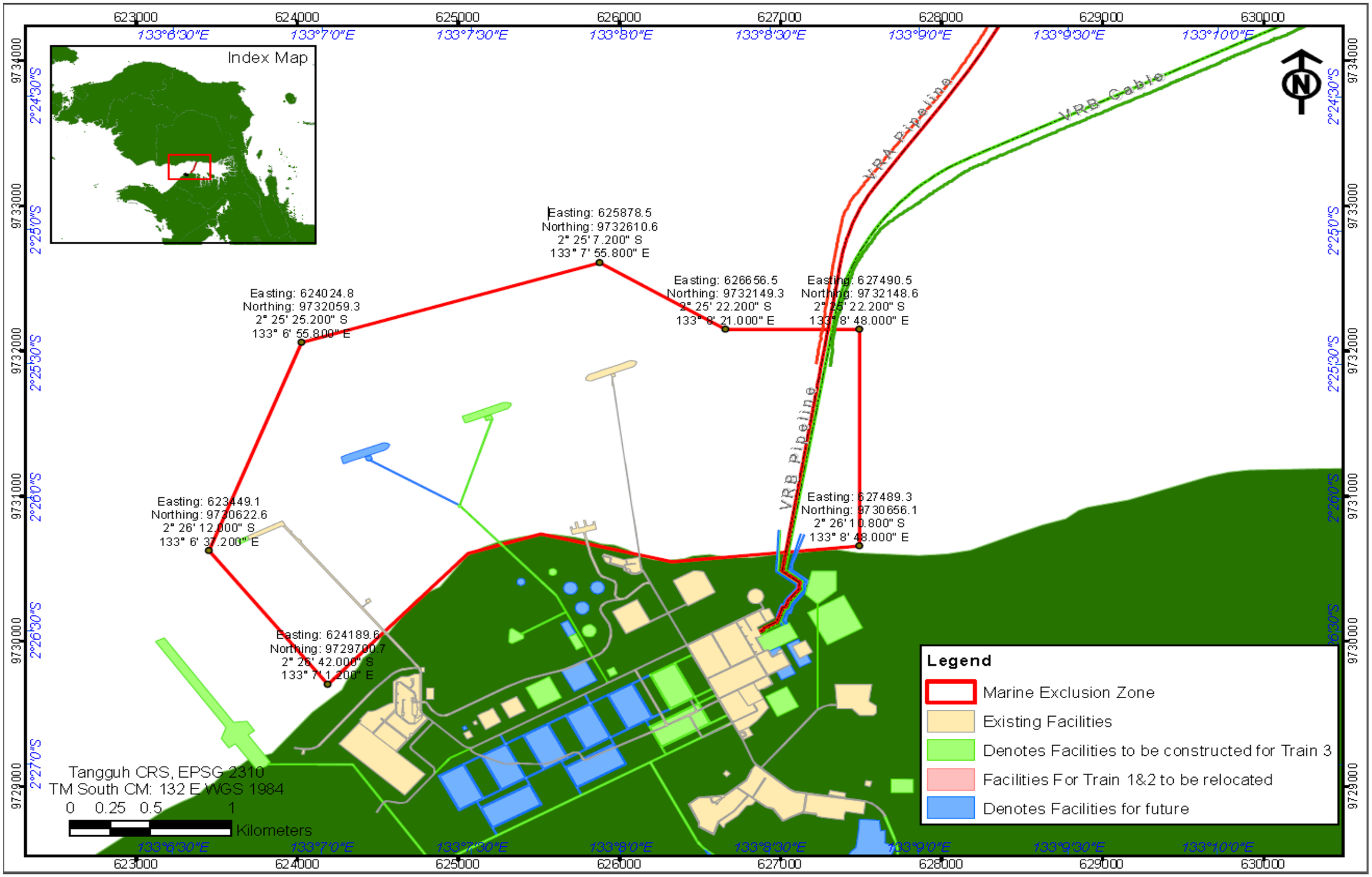


Figure I-42 Marine Restricted Zone of the Existing Tangguh LNG

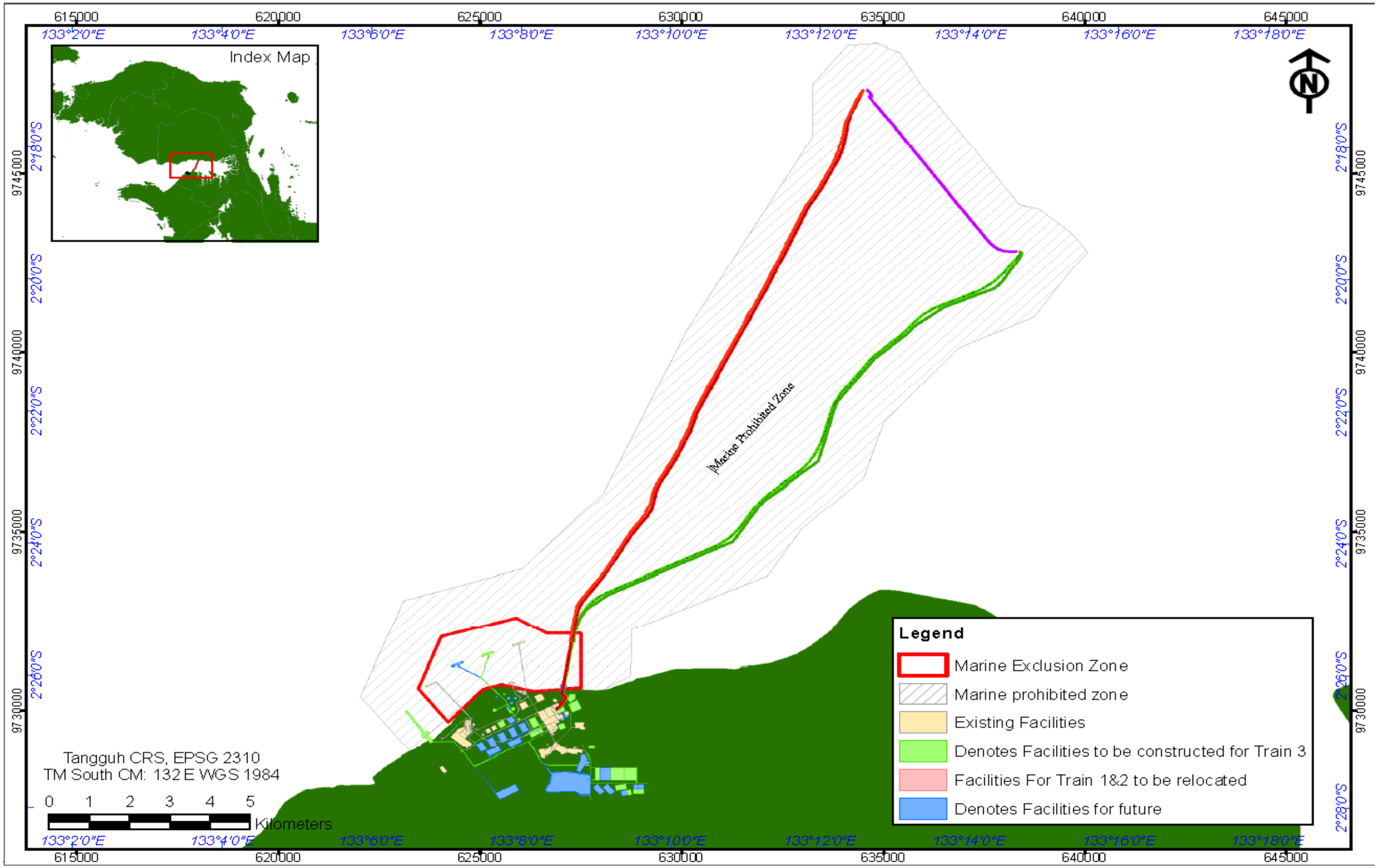
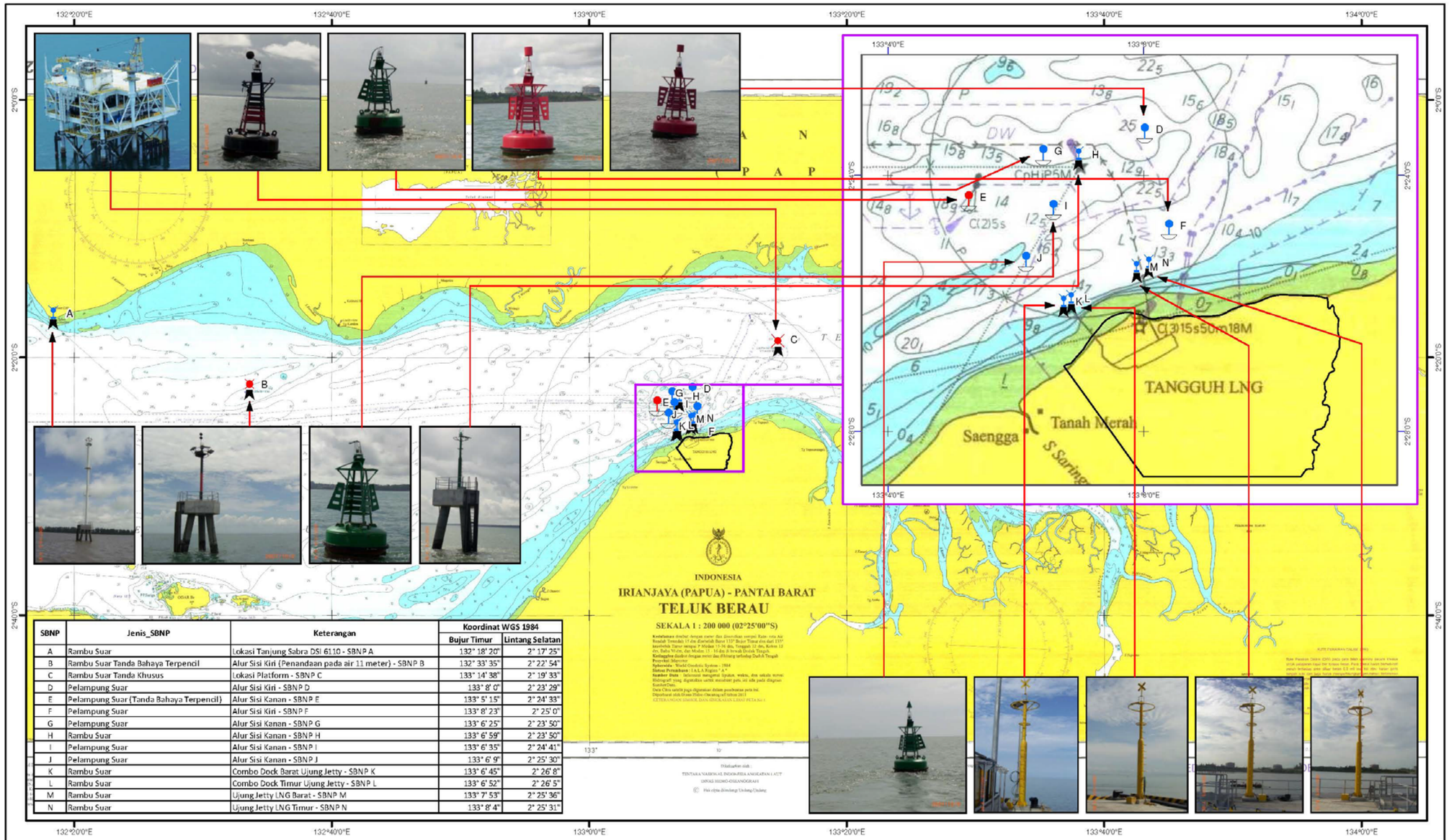


Figure I-43 Marine Prohibited Zone of the Existing Tangguh LNG



SBNP	Jenis_SBNP	Keterangan	Koordinat WGS 1984	
			Bujur Timur	Lintang Selatan
A	Rambu Suar	Lokasi Tanjung Sabra DSI 6110 - SBNP A	132° 18' 20"	2° 17' 25"
B	Rambu Suar Tanda Bahaya Terpencil	Alur Sisi Kiri (Penandaan pada air 11 meter) - SBNP B	132° 33' 35"	2° 22' 54"
C	Rambu Suar Tanda Khusus	Lokasi Platform - SBNP C	133° 14' 38"	2° 19' 33"
D	Pelampung Suar	Alur Sisi Kiri - SBNP D	133° 8' 0"	2° 23' 29"
E	Pelampung Suar (Tanda Bahaya Terpencil)	Alur Sisi Kanan - SBNP E	133° 5' 15"	2° 24' 33"
F	Pelampung Suar	Alur Sisi Kiri - SBNP F	133° 8' 23"	2° 25' 0"
G	Pelampung Suar	Alur Sisi Kanan - SBNP G	133° 6' 25"	2° 23' 50"
H	Rambu Suar	Alur Sisi Kanan - SBNP H	133° 6' 59"	2° 23' 50"
I	Pelampung Suar	Alur Sisi Kanan - SBNP I	133° 6' 35"	2° 24' 41"
J	Pelampung Suar	Alur Sisi Kanan - SBNP J	133° 6' 9"	2° 25' 30"
K	Rambu Suar	Combo Dock Barat Ujung Jetty - SBNP K	133° 6' 45"	2° 26' 8"
L	Rambu Suar	Combo Dock Timur Ujung Jetty - SBNP L	133° 6' 52"	2° 26' 5"
M	Rambu Suar	Ujung Jetty LNG Barat - SBNP M	133° 7' 53"	2° 25' 36"
N	Rambu Suar	Ujung Jetty LNG Timur - SBNP N	133° 8' 4"	2° 25' 31"

Map I-1 Marine Navigation Aid (*Sarana Bantu Navigasi Pelayaran* - SBNP)

A. Pre-Construction Phase

A1. Socialization of the Proposed Activity

Socialization of the proposed activity will be conducted to the community prior to commencement of construction activity. This socialization will be conducted with respect to local norms and traditions

B. Construction Phase

B1. Workforce Mobilozation and Demobilization

The number of workforce required to construct and operate marine facilities are already included in total workforce required for LNG construction and operation activity. Detail workforce recruitment and release are described in Sub-Chapter 1.2.3 LNG Plant Activity Section B1 Workforce Mobilization and Demobilization.

Based on conceptual construction study result, total workforce for marine facilities during peak construction is estimated around 800 workers.

Workforce requirement and its qualification are described in detail in RKL-RPL.

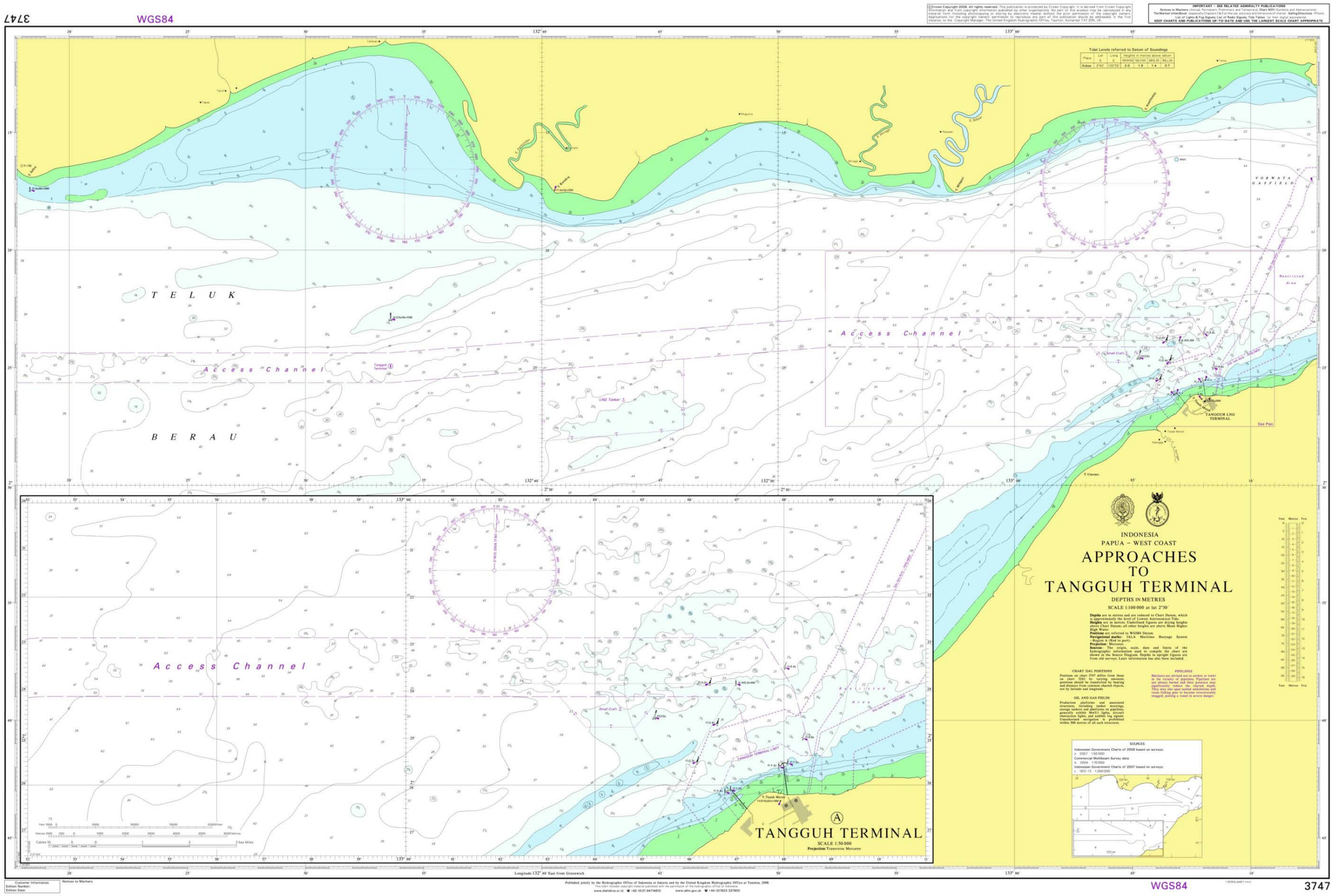
B2. Sea Transportation for Workforce, Equipment and Material

Sea transportation during construction phase (approx. 1-4 years, 24 hours per day) will be required to support workforce, material and equipment mobilization and working vessels. The potential vessels required in construction phase for example are to support vessels, tug boats, material barges, crane barges, dredging vessels, dredging barges, and LCTs.

Vessel route during construction will use the existing access channel that currently used for LNG tanker to enter the site. The access channel is shown in **Map I**-2.

There will be extension of existing anchorage area to accommodate construction vessel and additional mooring for barge, as shown in **Figure I**-44.

Equipments and material construction for marine facilities will be mobilized through sea transportation using vessels and barges. EPC contractor will use exising construction jetty, particularly to support BOF construction. EPC contractor will construct the new BOF and will be used for further mobilization of equipments/material for marine facilities and other construction activity. Existing Combo Dock will be utilized for supporting mobilization of heavy equipment.



Map I-2 Map of Shipping Lane to Tangguh LNG

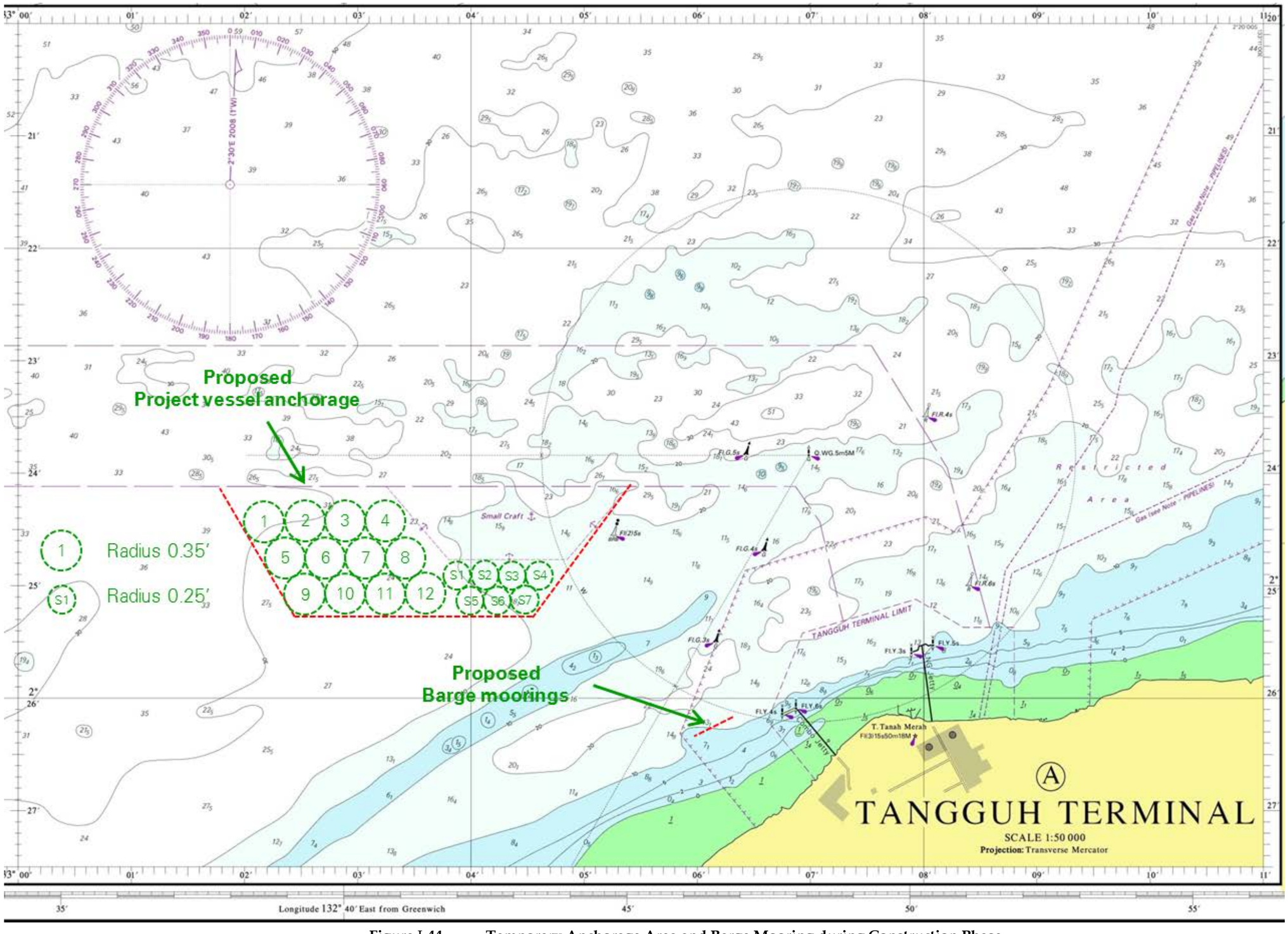


Figure I-44 Temporary Anchorage Area and Barge Mooring during Construction Phase

B3. Land Clearing

Some land clearing may be required for construction of marine facilities. For LNG – Condensate Jetty 2 construction, there will be mangrove clearing approximately 5 Ha.

The area required is already included in total area cleared for LNG construction and described in LNG Plant activity section.

B4. Site Preparation

Onshore cut and fill for the marine facilities will be limited to the construction of the LNG jetty abutment and the construction of access roads from the new berths to existing road infrastructure.

BOF construction will be from sheet piling, filled with granular material which may be sourced from onshore or outside Tangguh area. Volumes of fill are not known at this stage because the design of the BOF is not finalized, however it is anticipated that at minimum 200,000 m^3 of material will be required for the sheet piling infill. Estimated excavation volume is approx. 95,000 m^3.

B5. Dredging and Dredge Material Disposal

The foreshore at Tangguh is a mix of silts, sands and some gravel fractions, typical of mangrove areas. Sediments are likely to come from the many small rivers that are prevalent throughout Bintuni Bay and the dendritic channels further east.

Tidal currents in the area are sufficient to mobilise and carry significant volumes of the finer sediments in suspension on a daily basis, with deposition occurring during periods of slack tide. Siltation can occur in dredged areas and where flows are obstructed.

BOF channel, combo dock enhancement area and LNG-Condensate Jetty 2 will be dredged during construction phase (within approx. 1-4 years). Dredging may be required to form berthing pocket in front of the new LNG-Condensate Jetty. Dredge channel through mud flats to shore will be required to allow loading-unloading equipment in BOF.

Volume of dredge material from LNG-Condensate Jetty berth is estimated to be 130,000 m^3, from combo dock enhancement around 180,000 m^3, while for BOF approximately 750,000 m^3.

All dredged area, will require regular maintenance dredging to maintain the water depth as per design. Maintenance dredging is planned to be done once a year or depends on field condition, with dredging period of 3 months dredging activity per year. Estimated dredge material volume from maintenance activity is 400,000 m^3. Maintenance dredging activity will include

dredging at LNG Jetty 1, LNG-Condensate Jetty 2, combo dock, BOF and construction jetty.

Dredge material will be disposed at the similar location as approved in AMDAL 2002. Two potential area have been identified for dredge material disposal. Those sites are West Disposal Site (02^{0}26'46.40" S, 132^{0}52'06.56" E, with 50 m depth) and East Disposal Site (02^{0}19'31.97" S, 133^{0}07'15.99" E, with 60 m depth). Those sites were chosen based on water depth to minimize impact.

Disposal method can be done by direct disposal to designated dredge material disposal site or temporarily stored onshore near dredging location prior to be disposed to dredge material disposal site. Decision on temporary storage location and design will be made based on risk assessment. Temporary storage design shall take into account suspended solid management and other relevant factor based on risk assessment.

Safety exclusion zone will be applied during dredging around dredged area.

Dredging method will be determined and proposed in detail by dredging contractor based on safety and environmental requirement as stated in the contract and consideration on available equipment. Tangguh LNG will establish a stringent and straightforward requirement in work contract with relevant contractor related to work safety which can also minimise environmental impact from dredging operation including dredge material disposal as stipulated in this AMDAL. Disposal location set in this AMDAL is similar with previous disposal location which has been approved by General Director of Marine Transportation, Ministry of Transportation Republic of Indonesia. Designated location is shown in **Figure I**-45 Potential Dredge Material Disposal Area.

In order to assess the impact from seabed dredging activity which will be done to : (i) entrance and port channel of BOF, (ii) combo dock enhancement area and (iii) LNG-condensate jetty 2; during planning stage a hydrography study (mathematical model) has been performed, therefore any impact (such as sedimentation and erosion) which may by occurred can be predicted and minimized.

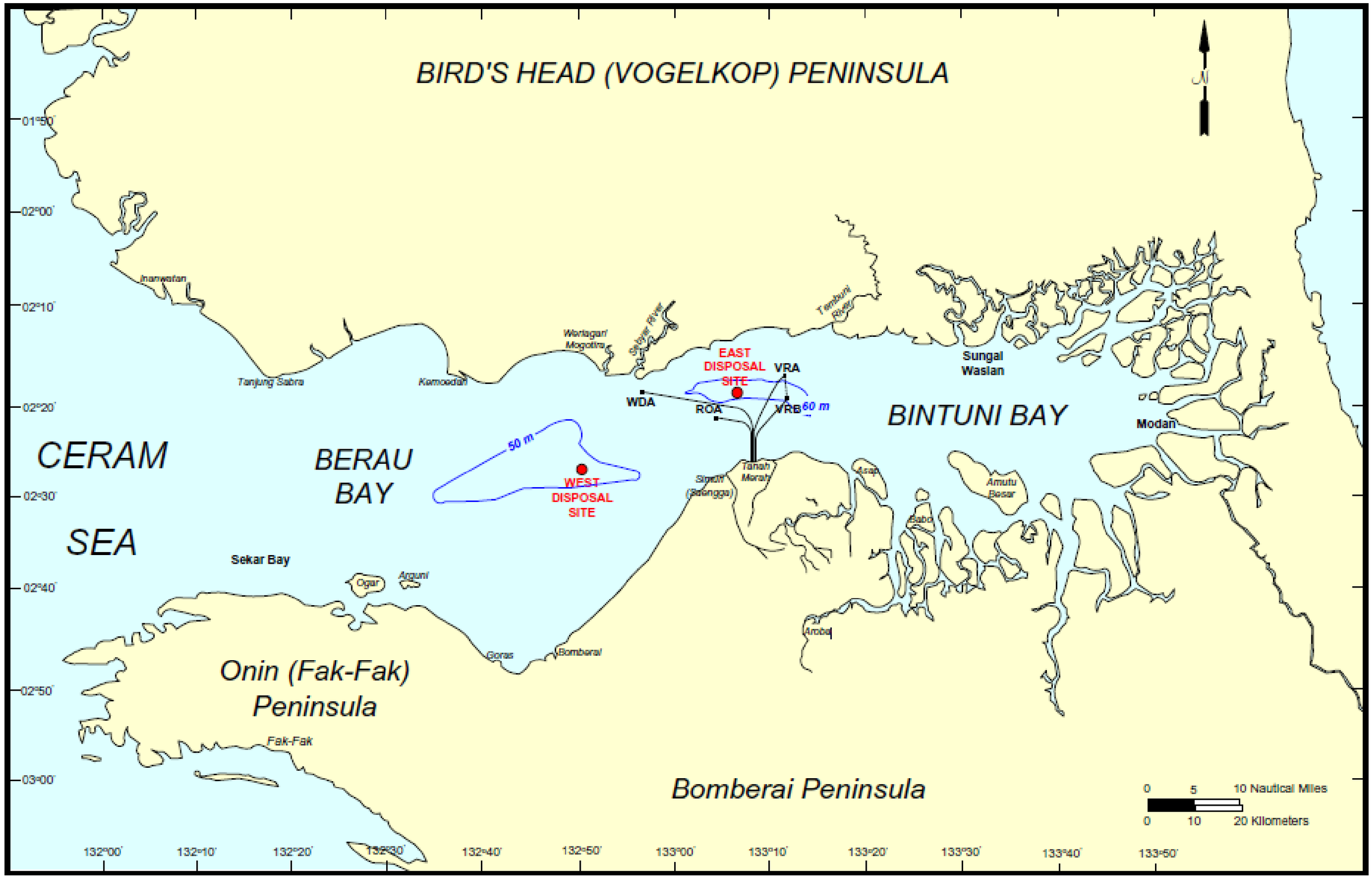


Figure I-45 Potential Areas for Dredged Material Disposal

B6. Bulk Offloading Facility

A new construction or Bulk Offloading Facility will be constructed during early works to provide a safe and efficient facility for all vessels associated with construction activities.

BOF and all elements of the dredged channel and manoeuvring area will be located within the western boundary of the site, as shown in **Figure I**-46. All elements of the berth will be configured to avoid all interfaces between construction and LNG plant operation.

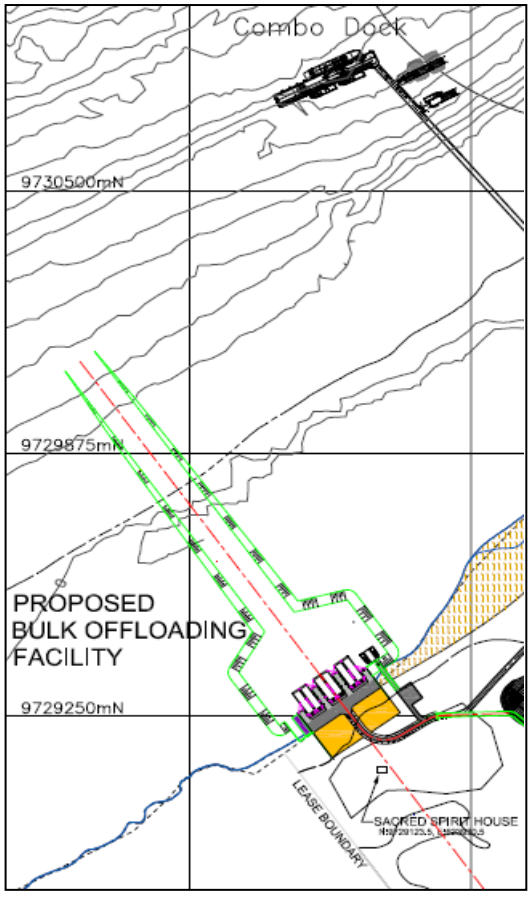


Figure I-46 Bulk Offloading Facility Location

Unlike the construction jetty during Tangguh LNG phase one construction, the BOF will be operated within the boundaries of an operational LNG plant. Safety considerations therefore include the risks associated with working in an area where hydrocarbon transfer and routine transport operations are being conducted.

A primary consideration in selecting the location of the BOF is to ensure that its future operation would not adversely affect existing LNG and condensate export operations.

Following are some areas which considered to be BOF location and its primary consideration :

- Area A

  Located between pipeline corridor to existing LNG jetty (within 700 m of the pipelines). Primary consideration is safety issue related to risk of pipeline damage due to drop anchor and dragged anchor.

- Area B

  Located between LNG Jetty 1 (existing) and future LNG-Condensate Jetty 2. Location is currently occupied by the existing construction jetty and it is too close with existing and future marine facilities. Potential restrictions of vessel movement may occur in the future.

- Area C

  Located between LNG-condensate jetty 2 and 3 with combo dock. Risk of environmental damage as it is located in the mangrove fringe of approximately 200 m and in close proximity to existing and future marine facilities. The BOF may be unusable for the construction of LNG Train 4 and new facility will be required in the future, if BOF is constructed in this location.

- Area D

  Located between Tangguh LNG site boundary and combo dock.

  East side : potential impact to sacred stone in the location and potential risk of combo dock damage, from out-of-control vessel.

  West side : has no such restrictions, and lies within area of Tangguh LNG marine authority area. Access to the onshore construction areas is good and would not encroach into any plant operating areas. Therefore, this location is deemed as the most suitable location for BOF construction.

All alternative BOF location are shown in **Figure I**-47.

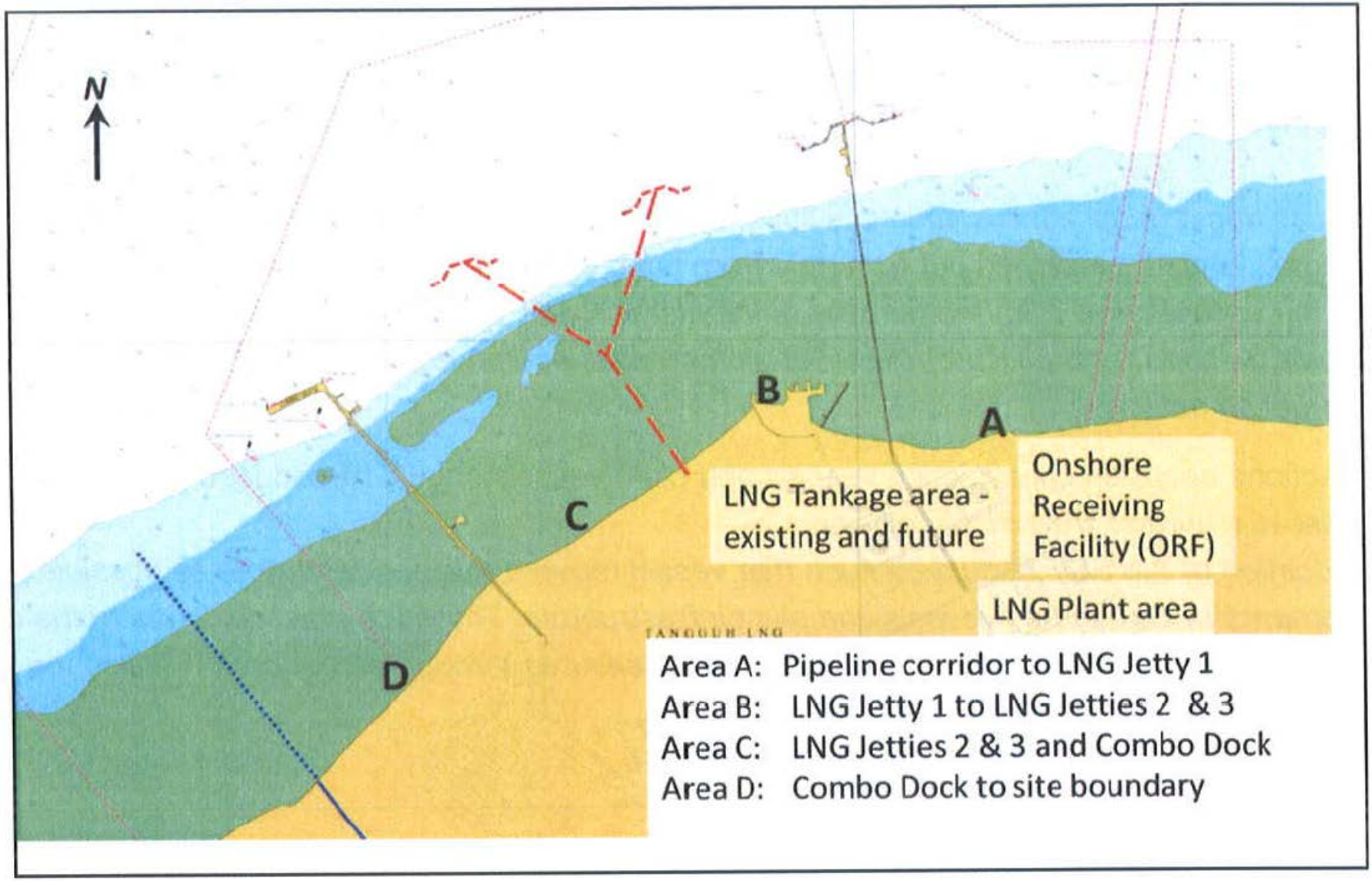


Figure I-47 Alternative Locations of Bulk Offloading Facility

BOF is designed in a similar way to the existing construction jetty which was utilized during previous Tangguh LNG construction. The BOF will be designed as a permanent structure with a 25 year design life (with continuous usage), and will be configured to accommodate a minimum of six berths for construction barges and LCTs in three basins between wing walls.

The elevations of the berth working and laydown areas shall be appropriate to the size and type of vessels operated at the berth. Elevations shall take into consideration the risk of tsunami, and the berth should be designed for inundation if necessary.

The facility will be designed for the import of heavy loads up to 300 te in weight, it has been assumed that larger loads will be imported over the Combo Dock. A laydown area will be provided for the short-term storage of off-loaded materials.

The BOF will be located in a depth of 1.0 mCD and dredged to a level of -0.4 m CD at the berths to accommodate barges and LCTs for the import of bulk materials and equipment. All the berth structures will be designed for a dredged depth of -3.5 mCD with an over-dredge allowance of at least 0.5 m to permit future expansion if required.

In addition to the six barge/LCT berths, a berth for the import of diesel fuel and for re-fuelling vessels will be provided on the west side of the western finger of the BOF. Berths for construction tugs and small vessels will located on the east side of the eastern finger. These berths will be dredged to a depth of at least -2.5 m CD.

An area on the east side of the BOF, also dredged to -2.5 mCD, will be provided for the operation of ferries for the disembarkment, mustering and transport of personnel to and from the site in ferries. This area will be remote from the cargo handling areas to avoid interaction between this activity and personnel in transit.

A manoeuvring area will be provided, dredged to a depth of -2.5 m CD for barges and tugs, LCTs, personnel ferries and other vessels using the BOF. The manoeuvring area will be linked to deep water by a channel, also dredged to a depth of -2.5 m CD. Navigation marks will be provided at the outer end of the channel to delineate its width, and leading marks to delineate the channel centreline shall be provided at the inner end.

This facility will be constructed using sheet piles which driven into the ground and hoarded to provide strong structure.

As mentioned previously, BOF construction will be part of early work scope and estimated to take between one to two years period with 9 months of piling activity (or longer if soft hammer were used).

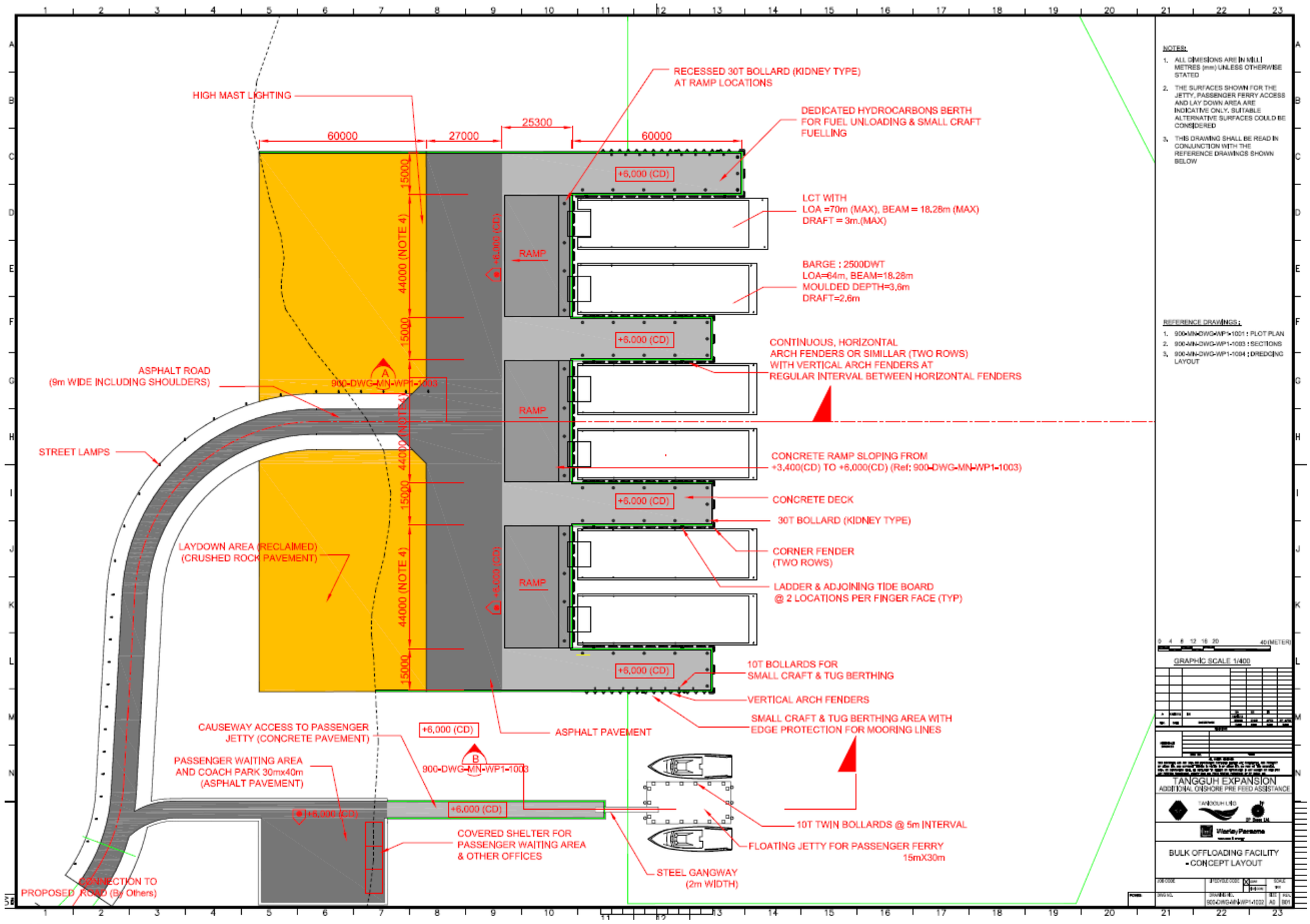
BOF is critical to start the construction of LNG plant and other facilities, such as loading-unloading area for construction equipment, e.g. bulldozer, excavator, loaders, backhoe and dump truck; also as loading-unloading area for construction equipment and LNG plant component.

The BOF is designed to accommodate the vessels summarised in **Table I**-25 below.

Table I-25 Design Vessels for BOF

Vessel Type	Maximum Size	Minimum Size
Construction Barge	2,500 DWT	1,600 DWT
Maximum Construction Barge	Approx. 90 m LOA and 27 m Beam	
Landing Craft Tanker (LCT)	Approx. 1,600 DWT	-
Passenger Ferry	Approx. 30 m LOA	-
Tug for mooring and assistance	Approx. 15 m LOA	-

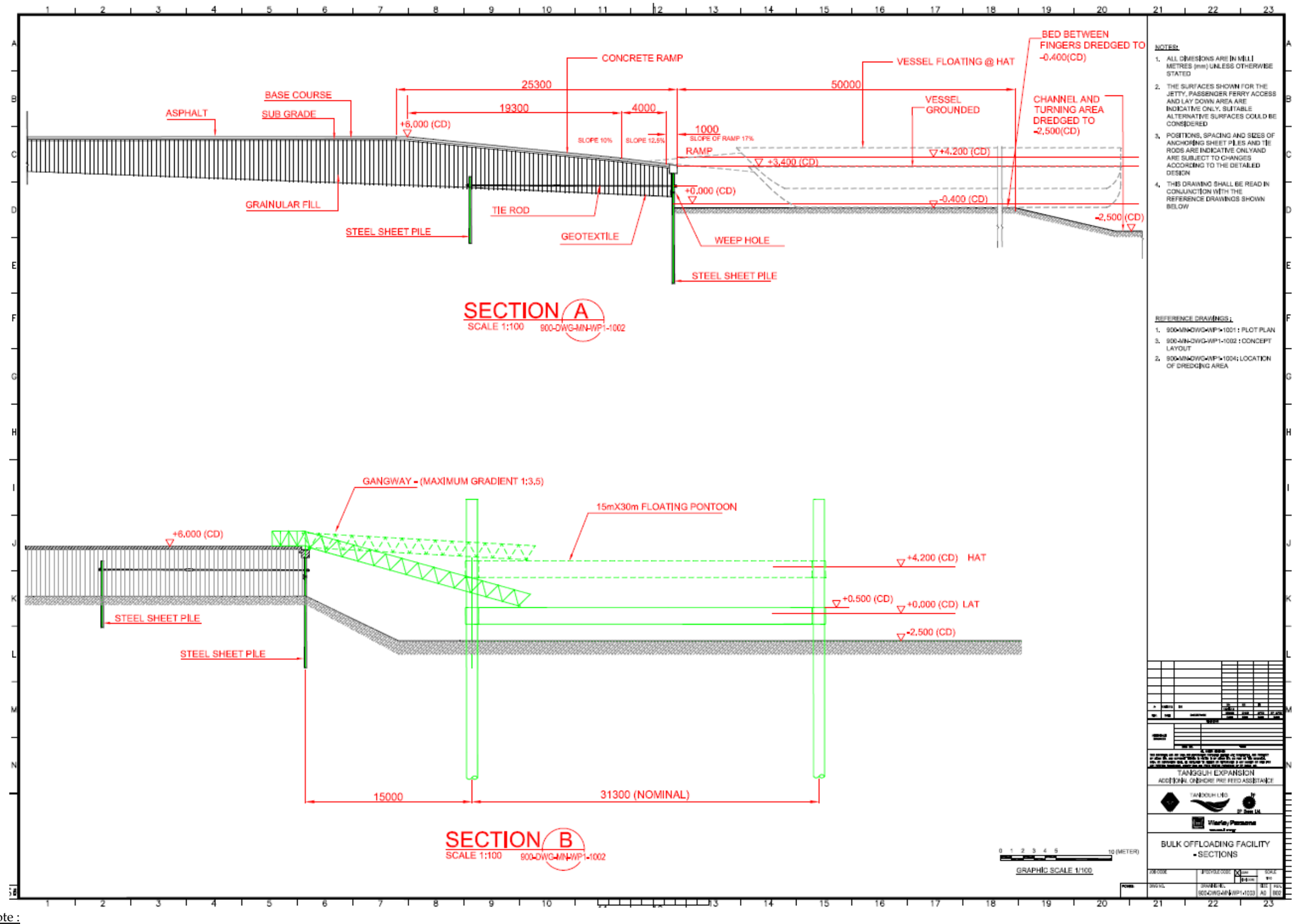
Source : Bulk Offloading Facility (BOF) Basis of Design – Rev. B03 - June 2013



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

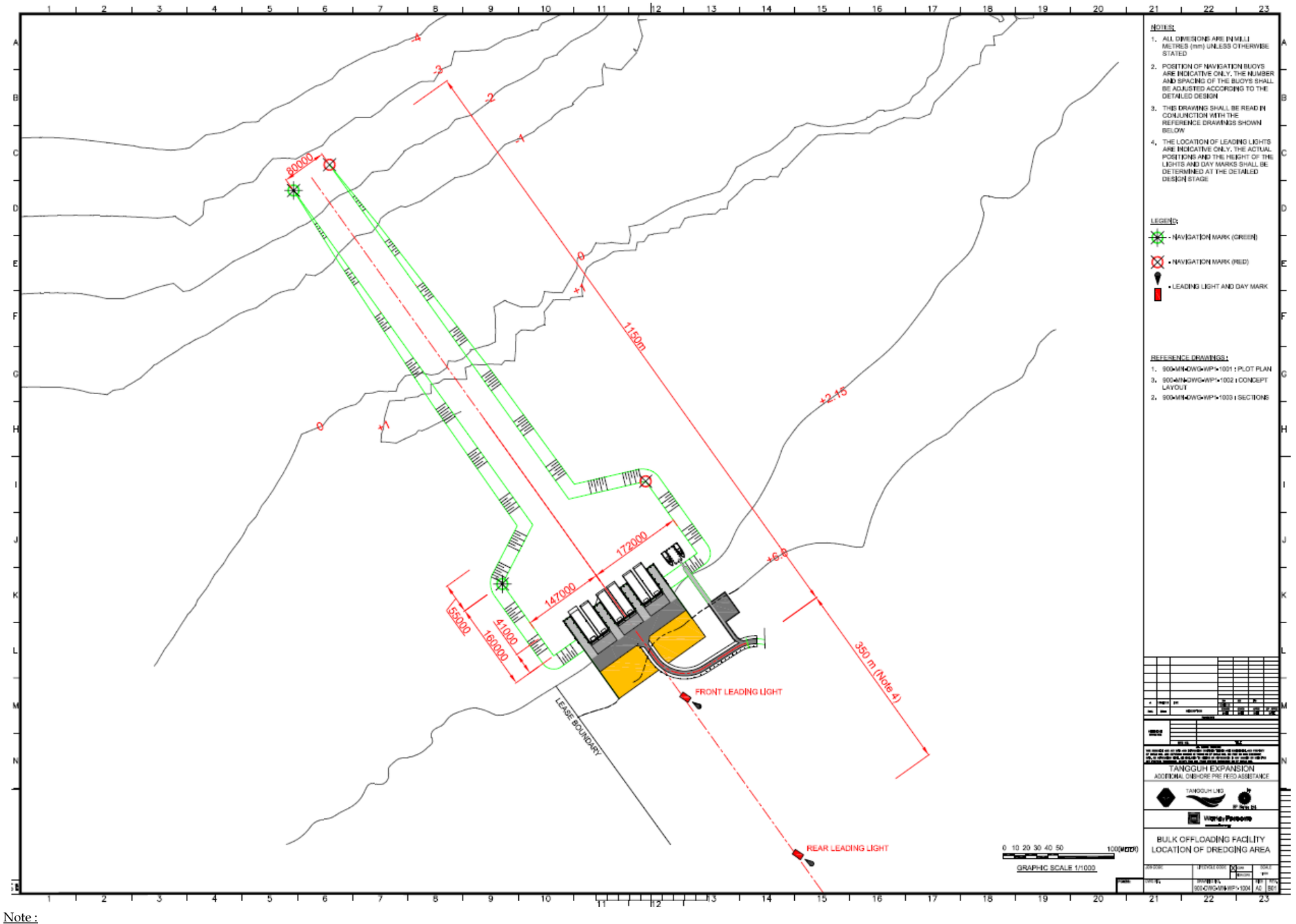
Figure I-48 Layout BOF*)



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

Figure I-49 BOF Sections*)



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

Figure I-50 BOF – Dredging Location*)

B7. LNG Jetty 2 (Combined LNG-Condensate Jetty)

LNG Jetty 2 (Combined LNG-Condensate Jetty) will be built to the west side of existing LNG Jetty and will require approximately 2-3 years for its construction.

LNG-Condensate Jetty 2 is designed to be able to :

- Provide a secure, safe and efficient deep-water berthing for the size range of LNG and condensate vessels as shown in **Table I**-26 regarding Type and Capacity of Vessel to be Accommodated in Marine Facilities.
- Provide a loading platform to support the mechanical equipment, piping and manifolding and safety equipment required to load LNG carriers and condensate vessels.
- Provide access and support for piping, services, vehicles and personnel from onshore to the platform by means of a trestle.

In addition, LNG-Condensate Jetty 2 may be expanded if the agreement with the potential buyer achieved for LNG sales using smaller LNG tanker. This objective of the expansion is to provide additional capacity to LNG-Condensate Jetty 2 to be able to accommodate LNG tanker with capacity of ±10,000 – 20,000 m^3. This additional facility will have similar function with the proposed LNG-Condensate Jetty 2. To minimize the impact from LNG-Condensate Jetty 2 and its additional facilities, several jetty facilities will be design to be able to be used by LNG-Condensate Jetty 2 and its additional facilities.

The water depth at the berthing line shall be not less than -14m below CD. If necessary, this water depth shall be achieved through dredging to allow LNG shipping of 125,000 m^3 up to Aframax Size.

There will be one access road for LNG Jetty 1, 2 and 3 which will be constructed later. Where there will be some adjustment on manoeuver area for these LNG jetties access.

The new LNG-Condensate Jetty 2 is designed to be able to accommodate LNG and condensate tanker, therefore the jetty head, mooring and breasting dolphins will be different with conventional layout (adjustment to offset berth centerlines from LNG and condensate jetty) with maximum 8 mooring dolphins and 4 berthing (breasting dolphins).

A trestle with approximately 1 km long, with road and pipe tracks will be the access to jetty head for LNG and condensate loading. An abutment will be provided for shore linked. LNG trestle will be built using open piled structure to minimize the siltation impact.

Trestle shall provide structural support from the shore abutment to the loading platform for product piping, mechanical auxiliary and electrical systems, also an access roadway.

The new LNG trestle for LNG Jetty 2 (and future LNG Jetty 3) will be lengthen to outside shore line above the open piled structured with decline road in the middle and designated pipe track area on its both sides. This trestle will be branched, with one branch out to LNG Jetty 2 Platform and additional access road to LNG Jetty 3 that will be built later.

The LNG jetty will be of open piled construction with a concrete and steel superstructure. The construction methodology and plant will be determined by the EPC contractor, the options considered include the following :

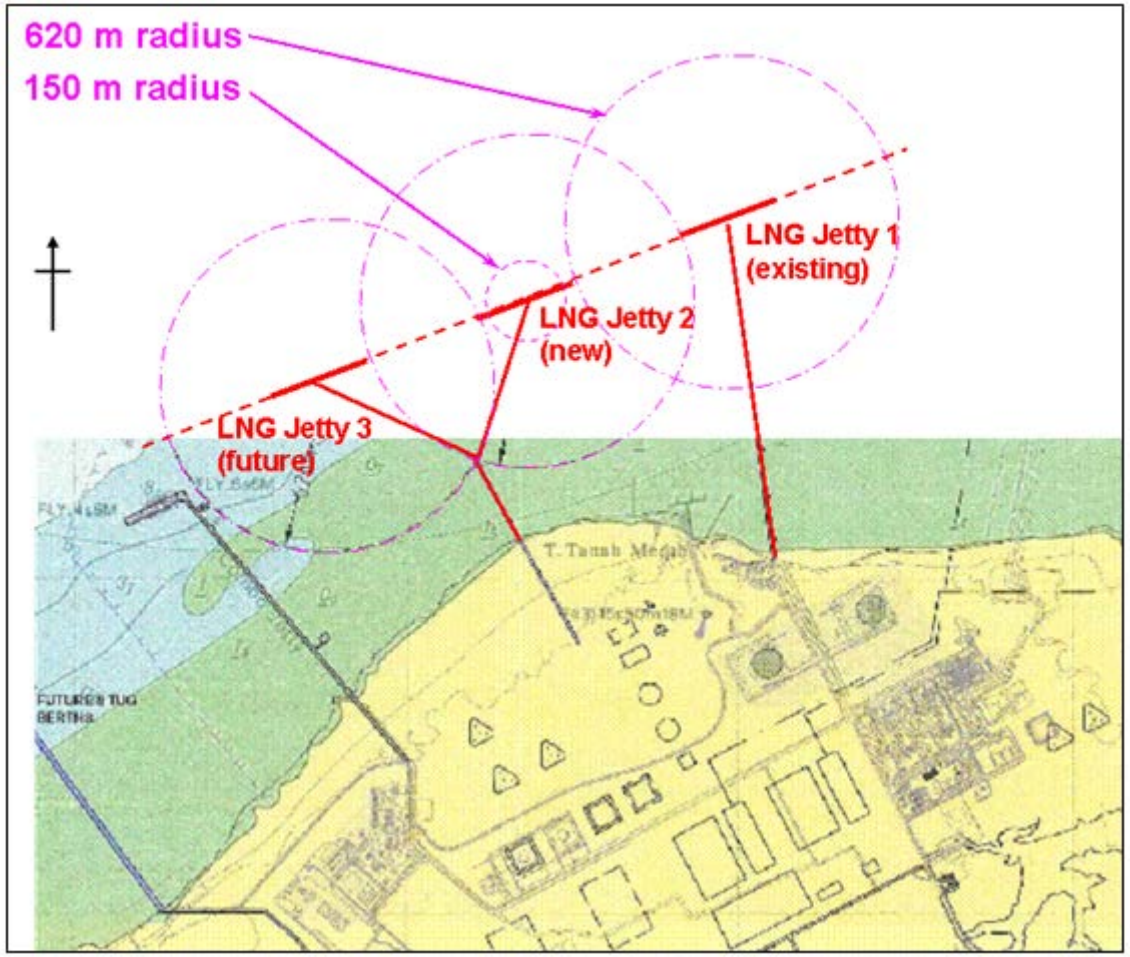
- Piling for the loading platform and trestle will be carried out by conventional pile driving plant, using either a floating or jack-up barge;
- Alternatively, piling for the trestle could employ the "end-over-end" or "cantilever bridge" method. This method would be more efficient in shallow water depths less than approximately 3 m at Chart Datum (CD).

Jetty topsides including piping and equipment may be constructed in modular form. Modules could weigh up to approximately 1,000 tons, requiring a large floating crane for their installation. Such modules could be used for all elements of the topside facilities, including the loading platform equipment or the pipetrack (including piping).

The trestle roadway shall accommodate one-way traffic, and shall have a minimum width of 4 m. Turning points and parking areas shall be provided at each end of the roadway and at other appropriate locations. A 2 m wide walkway for pedestrians shall be provided between the roadway and the eastern pipe track. Crash barriers shall be provided throughout and on both sides of the roadway to protect each pipe track from vehicle impact.

Pipetrack will be required to accommodate LNG and other piping for LNG jetty and condensate loading facility in LNG Jetty 2. Each pipetrack shall be designed to support all process, services and utility piping to the respective loading platform. Power and instrument cables shall be run separately on trays which may be run adjacent to the walkway or in cable trenches/ducts.

A water intake and associated facilities for the water intake shall be constructed in a water depth not less than -11 m CD. It shall be located on the west side of the trestle and adjacent to trestle. A working area shall be provided for the operation of a 40 te crane for maintenance of the facility.



Note : LNG Jetty 3 will be developed as part of LNG Train 5 development and is excluded from this AMDAL scope.

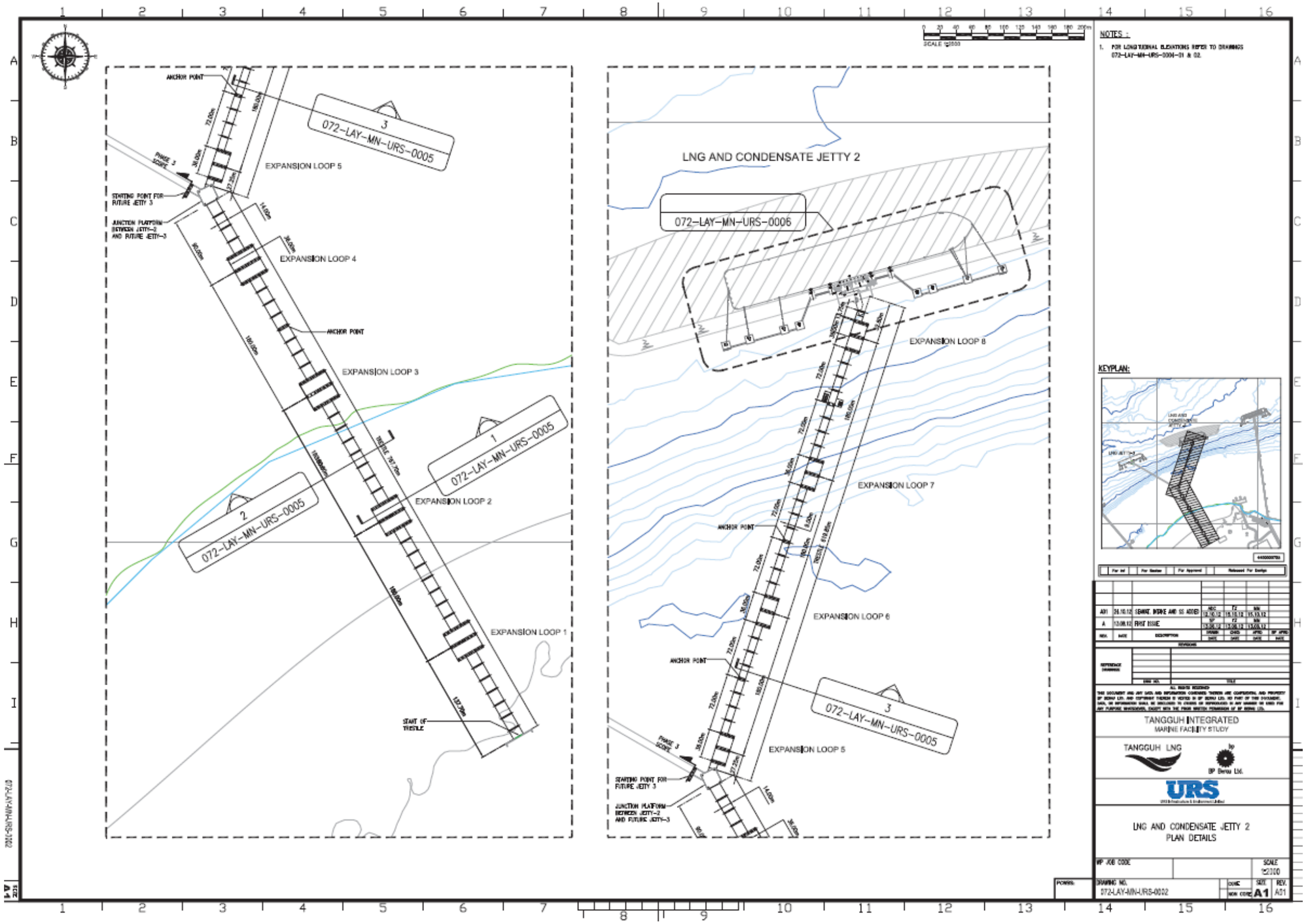
Figure I-51 LNG Jetty Location

Figure I-52 Jetty Topside

The intake facility shall be designed to support pumps, screens and filters for the extraction of water from the sea and transfer to shore. The filters are required in order to remove the high level of suspended solids from the seawater. As far as possible the facilities shall be designed to be operated and maintained without the need for divers.

Provision for a seawater outfall shall be made at the rear side of the loading platform. The seawater discharge line will be run along the pipe track to the discharge point, where it will discharge through a vertical leg into a water depth of -6 m LAT.

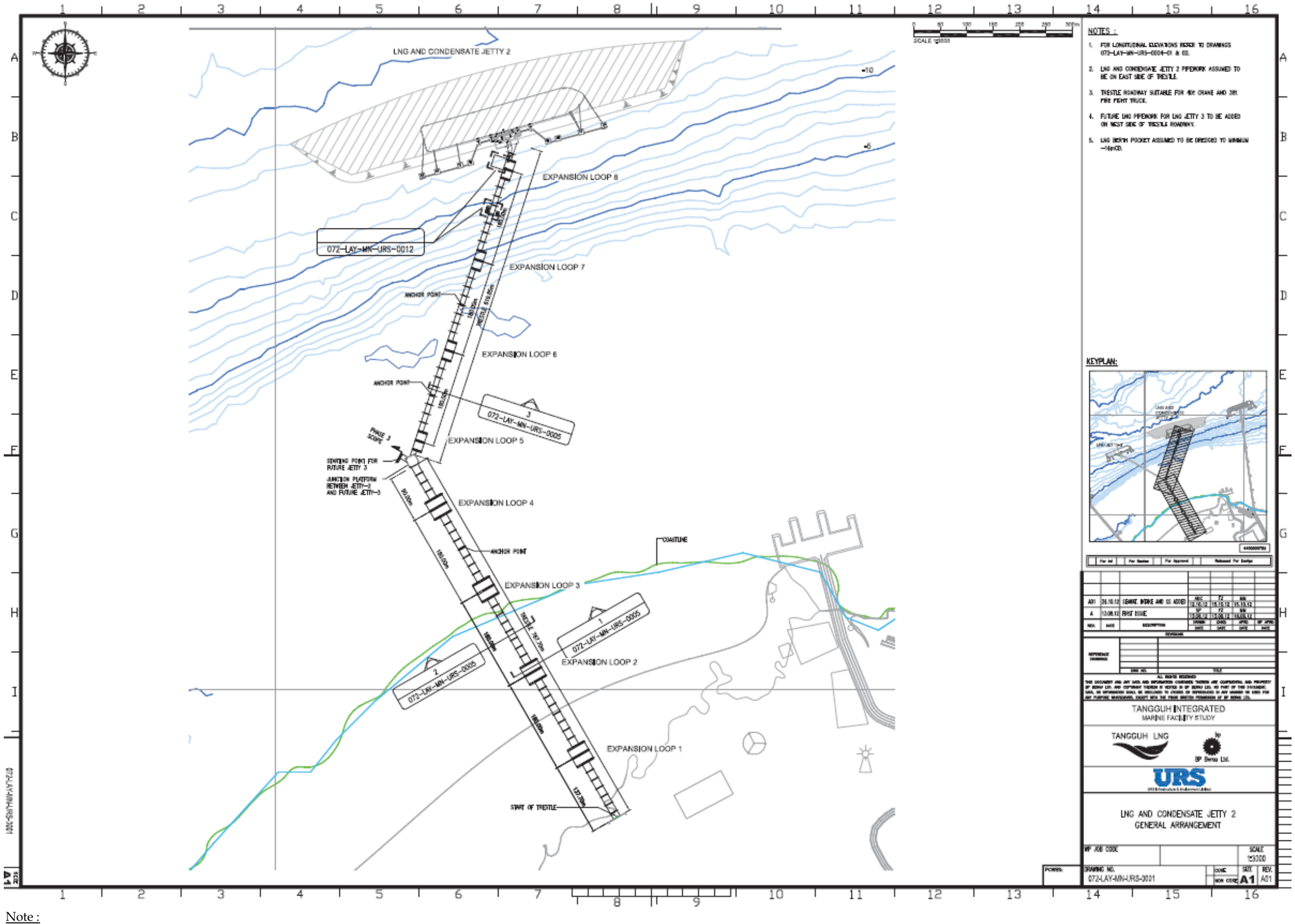
Figure I-53 Existing LNG Jetty



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

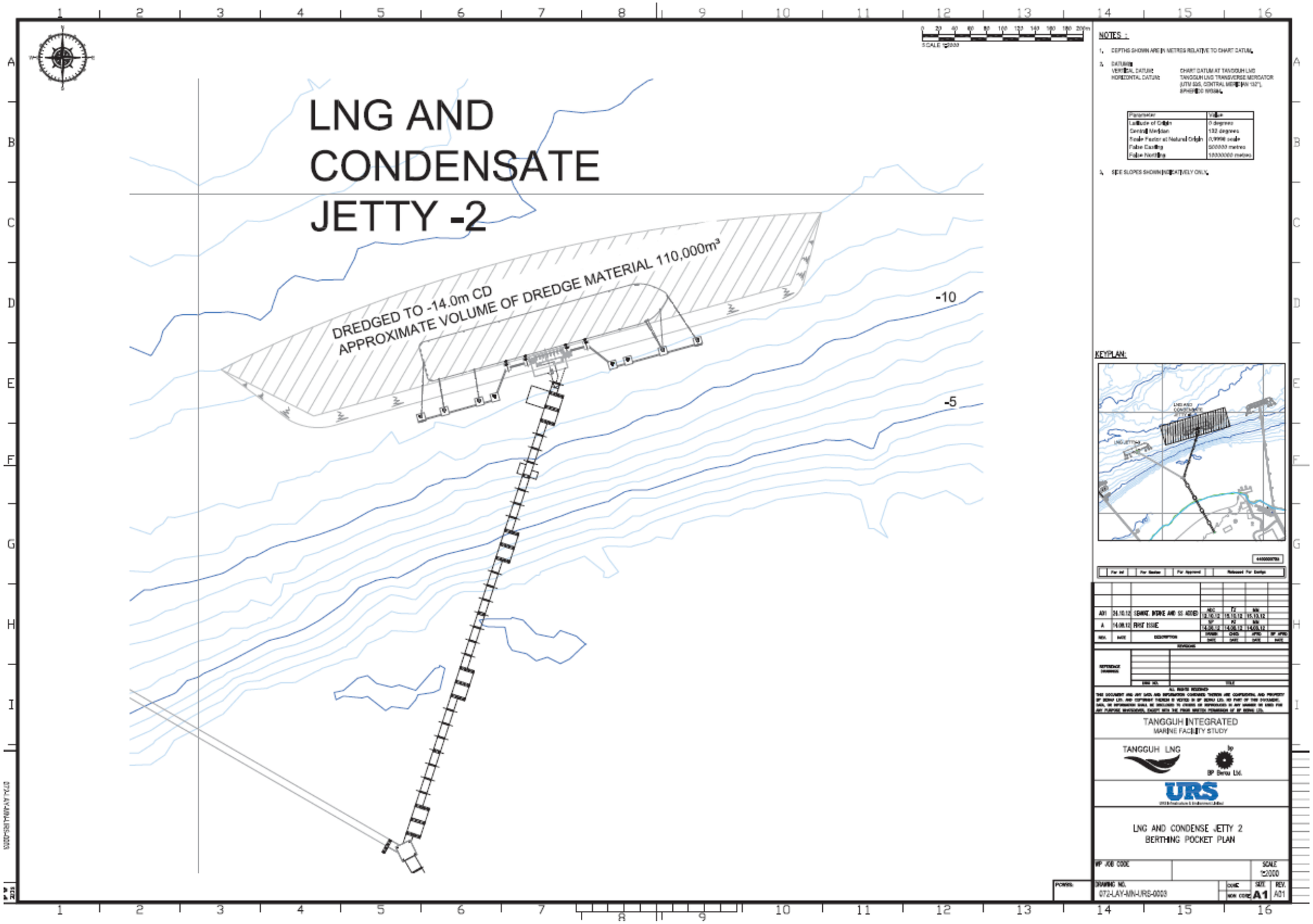
Figure I-54a LNG and Condensate Jetty 2 – Plan Details *)



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

Figure I-57b LNG and Condensate Jetty 2 – General Arrangement *)



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

Figure I-57c LNG and Condensate Jetty 2 – Berthing Pocket Plan *)

B8. Combo Dock Enhancement

A number of modifications and additions shall be made to the Combo Dock structure in order to enhance Tangguh LNG operations activities. Several main modifications that will be performed to combo dock are as follow :

- Drilling operations berth

  A facility shall be provided to accommodate a mud plant for the support of offshore drilling operations. It will be constructed as part of the Early Works Project scope.

  It shall be constructed as an extension to the west end of the Combo Dock jetty head and will share the common shore approach structure and existing jetty head for vehicular and personnel traffic. The extension shall be configured as an open piled structure, and the elevation of the platform shall be the same as the existing Combo Dock.

  The platform shall be approximately 81 m long and 30 m wide and shall provide two berths for OSVs, one each on the north and south sides of the platform. The water depth at the north berth should be at least 9 m CD, with provision to increase this to 11 m by dredging in the future.

- Wave Screen

  A wave screen shall be constructed at the east end of the Combo Dock jetty head to provide protection from wave action to the Small Boat Haven located on its south side. The wave screen shall be designed such that wave heights at the small boat berths do not exceed 0.5 m for a deep water wave height of 1.5 m.

  It is envisaged that the screen will be at least 200 m long in order to accommodate the length of the small boat haven pontoons behind.

- Diesel Berth

  A new Small Hydrocarbons Berth shall be constructed as a finger pier at the east end of the Combo Dock jetty head. Hydrocarbon operations that are currently undertaken on the south berth of the Combo Dock will be transferred to this new facility :

  - The north side of the berth shall be used for the import of diesel fuels loading for the refuelling of OSVs and tugs;
  - The south side of the berth shall be used for fuelling small boats.

  The berth shall be at least 120 m long and approximately 15 m wide; the structure shall incorporate the wave screen.

  Hydrocarbon transfer operations will be by hose. A bunded area shall be provided around each hose handling and manifold area to prevent any spillage of hydrocarbons entering the marine environment.

Hydrocarbon transfer will comply to relevant procedure to ensure no spill occur to environment during transfer process.

The proposed hydrocarbons berth would allow berthing of product tankers of approximately 2,500DWT on the outside (north side), with small craft using the inside (south) for refuelling. The deck would be lower than the present Combo Dock (+6m), to suit operations of small craft, and more open to allow overwash/avoid uplift during storms or tsunami. The existing electrical substation/LCR (Local Control Room) could be relocated to the root of this new area at +7m, to provide more working space on the main Combo Dock.

- Small Boat Haven

  A safe haven will be design to accommodate small boats in adverse weather conditions on the south face for refuelling small boats . Boats include crew boats, small ferries and security boats can use this facility.

- Tug Berth

  The existing tug berth shall be removed and replaced with a pontoon berth (up to 4 pontoons). The berth shall be designed to accommodate up to large tugs and pilot boats.

- Extension to Crew Boat Pontoon

  The existing passenger ferry pontoon shall be extended by the addition of a new, linked pontoon. The new pontoon shall be the same size and construction as the existing pontoon.

  Another pontoon similar with existing will be added to east side of existing pontoon ferry, to handle bigger vessel in the future.

- Coach Parking Area

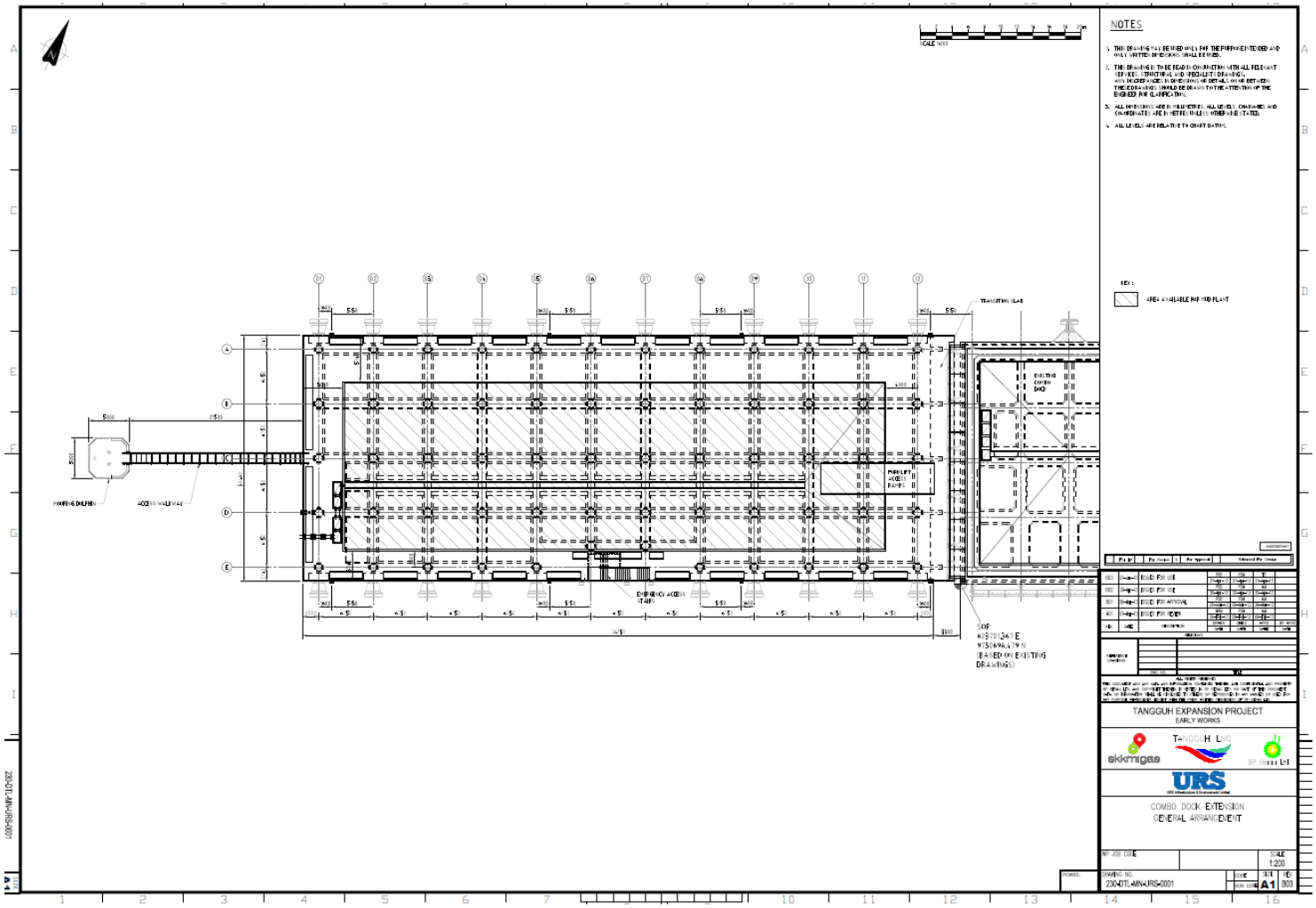
  A piled platform shall be constructed on the landward side of the passenger ferry pontoons to provide a waiting and embarkation area for passengers arriving by ferry.

  A covered waiting area shall be provided for passengers, and parking and turning areas, where currently it is still difficult for buses to take turn on the existing trestle.

- Oil Spill Response Support

  The storage and deployment facility for the "Ready use" oil spill response equipment currently stored on the east end of the existing ferry pontoon will not be modified. Storage and deployment facility will also be provided on other location in Tangguh LNG area.

Figure I-55 Existing Combo Dock



Note :

*) : Detail design of marine facilities is currently being finalized and may be changed as per project and design progresses. This figure will be updated later to reflect the final design.

Figure I-56 Combo Dock Enhancement General Arrangement*)

B9. Non Hazardous and Hazardous Waste Management

Solid waste management, both hazardous and non hazardous waste during marine facilities construction will be transported and managed onshore, in Tangguh LNG location.

Detail of solid waste management in Tangguh LNG location is described in Sub Chapter 1.2.3 LNG Plant Activity Section B8 Non Hazardous and Hazardous Waste Management.

Non hazardous waste disposal to sea by construction vessel shall comply with MARPOL 2012 requirement Annex V regarding Prevention of Pollution by Garbage from Ships. This include but not limited to :

- Non hazardous solid waste disposal to sea only allowed while the ship is en-route;
- Non hazardous waste disposal to sea only allowed in not less than ≥ 3 nautical mil from the nearest land for food wastes which have been comminuted or grounded. Such comminuted or grinded food waste shall be capable of passing through a screen with openings no greater than 25 mm.

Other non hazardous waste generated by construction vessel and cannot be disposed offshore, will be sent onshore or to waste management facility, while for hazardous waste will be sent to certified waste management facility.

B10. Wastewater Management

General type of wastewater generated from vessel activity are sewage, bilge water and ballast water. For small vessel (crew change boat, security boat) will be equipped with oily water separated system. Disposal of oily contaminated wastewater from vessel will be using vacuum truck to transfer and managed the wastewater in wastewater treatment plan onshore.

For large vessel (LNG tanker, condensate tanker), the wastewater (bilge water, oily contaminated water, ballast water, sewage) will be managed independently outside Tangguh LNG area, according to Government Regulation No. 21 Year 2010 regarding Marine Environment Protection and MARPOL 2012 requirement Annex IV Prevention of Pollution by Sewage from Ships. Normally, large vessel is already equipped with sanitary wastewater treatment and oily wastewater treatment facility according to MARPOL requirement.

Wastewater generated from marine facilities onshore will be managed along with other wastewater from LNG plant and its supporting facilities. Detail of wastewater management in Tangguh LNG is described in Sub Chapter 1.2.3 LNG Plant Activity Section B9 Wastewater Management.

Ballast water management during construction will be conducted in compliance with MARPOL 2012 requirement Annex VI, but it is expected that number of ballast water change in Tangguh LNG area will be less, due to most of the vessels will arrive in loaded condition to Tangguh LNG location.

B11. Storage and Loading of Fuel and Chemical

Management of fuel and chemical storage during marine facilities construction will be similar to fuel and chemical storage and loading management during LNG plant construction.

There will be small fuel and chemical storage at combo dock to support drilling activities.

Detail of fuel and chemical storage and loading is described in Sub Chapter 1.2.3 LNG Plant Activities Section B11 Storage and Loading of Fuel and Chemical.

C. Operation Phase

C1. Workforce Mobilization

During operation, marine facilities will be operated as supporting facilities of Tangguh LNG operation. Workforce requirement for marine facilities operation already absorbed in total workforce required for LNG plant operation.

Detail regarding workforce recruitment and mobilisation on operation stage are described in Sub Chapter 1.2.3 LNG Plant Activities Section C1. Workforce Mobilization.

C2. Maintenance Dredging and Dredge Material Disposal

All dredged area will require a regular maintenance dredging to maintain the water depth as per design requirement. Current prediction, the maintenance dredging will be conducted annually for approximately 3 months period.

Current estimation for dredge material volume is approximately 400,000 m^3 per year. It is predicted that the maintenance dredging will be minimum in LNG jetty area, but may be significant in BOF as the consequences of its location at the shallow water depth.

Dredge material disposal will be in the same location as previously mentioned in Construction Phase.

C3. LNG and Condensate Loading and Transfer

LNG product from existing Tangguh LNG and the Tangguh LNG Expansion Project will be exported through LNG Jetty 1 and 2. LNG Jetty 1 is normally used for LNG tanker with size around 85,000 m^3 to 165,000 m^3. LNG Jetty 2 will be located at a water depth of -14 m CD, allowing for LNG shipping from

125,000 m^3 and up to Qflex and condensate shipping up to Aframaz size (but not simultaneously with LNGC).

During LNG loading to a ship, LNG is pumped from the storage tanks through the loading lines using in-tank pumps. The BOG from the ship returns via the vapor return header and is combined with the boil off gas from the tanks in the equalization header, which in turn is connected to the boil-off compressor suction drum.

The integrated LNG loading system (existing plus new facilities) shall be designed with the ability to load two LNG ships simultaneously, one from each berth.

To accommodate future development, tie-in points will be provided to minimize operational impact when LNG Jetty 3 (future) is constructed.

It is estimated that there will be approximately 50 - 60 LNG ships per year per train. There will be no fueling of these ships while in Berau/Bintuni Bay. Product loading will be performed by pumping LNG from the product tanks to the tankers through LNG loading arms. There will be a 500 m radius area around the LNG vessel where other vessels will be prohibited for safety reason.

Estimated total number of tanker visit to serve the existing tangguh (three LNG Plant operational) is as follows :

- LNG Tanker – four times per week;
- Condensate Tanker – once a month.

Figure I-57 LNG Loading

Condensate Loading

Condensate loading will be moved from the combo dock to the new LNG Jetty 2 as part of the Tangguh LNG Expansion. The condensate loading will be performed using fixed loading arms. Condensate loading will require approximately 15 hours. There will be no fueling of these ships while in Berau/Bintuni Bay. A prohibited area (150-m radius) will be needed during ship loading. It is anticipated that there will be two condensate shipments per week. The condensate ships capacity will be about 310,000 bbl and the cargo ships capacity will be up to 600,000 bbl.

C4. Sea Transportation during LNG Plant Operation

Vessel type and capacity which will be accommodated in marine facilities area are listed in **Table I**-26.

Table I-26 Type and Capacity of Vessel which will be Berthing in Marine Facilities

Vessel Type	Capacity
LNG Tanker	125,000 m^3 – 165,000 m^3 and QFlex
Condensate Tanker	80,000 bbls – 600,000 bbls
General Cargo	5,000 te – 10,000 te
Heavy Lift Cargo (for construction)	14,000 te
LCT	1,500 te
Small Tanker	2,500 te
OSV	800 – 1,000 te

Sea Transportation for Gas Production Well and Offshore Platform Operation

Vessels to be used during offshore platform operation will be less in number and type compared to drilling and offshore installation phase. Medium size vessel will be required, such as Multi Purpose Support Vessel (MPSV) will be used for maintenance of offshore platform and gas production well, crew boat and security boat.

Vessel movement frequency will be higher during construction phase compared to operation phase. Vessel traffic for Tangguh LNG project shall pass through designated corridor.

Prediction of sea transportation movement during gas exploitation operation is summarized in

Table **I**-27 below.

Table I-27 Prediction of Sea Transportation Movement during Operation Phase of Gas Exploitation Activity

Operation (continuously during operation)	Total	Vessel Frequency
Supporting Vessel : Multipurpose Support Vessel (MPSV)	2 Vessels	12 hour/day
Crew Boat	2 Vessels	12 hour/day
Security Boat	4 Vessels	24 hour/day

Sea Transportation for Inspection and Maintenance of Gas Transmission Pipeline

Sea transportation for operation phase of gas transmission activity will be limited to inspection and maintenance activity of gas transmission pipeline.

Inspection activity will be conducted once in the first five year and will be less often afterward, depending on the pipeline condition and risk assessment. The inspection will be conducted using intelligent pig for internal and riser, tie in spool, and rock cover using ROV for external.

Sea Transportation for Workforce, Material and Equipment to Support LNG Plant Operation

During operation phase, beside LNG and condensate export, sea transportation also required to support workforce mobilisation, logistic transportation and fuel transfer.

Type of vessel operated during operation phase will be similar with type of vessels that currently operating in Tangguh LNG area, which are :

- Ferry for crew change;
- Logistic boat;
- Fuel tanker.

Similar to current operation, supporting vessels for LNG plant operation will berth in existing combo dock.

Table I-28 Type, Number and Frequency of Vessel Movement during Operation Phase

No.	Operation (Continuous)	Number of Vessel	Frequency
1	Small Personal Transfer Boat (SPTB)	6 Vessels	12 hour/day
2	Crew Boat	2 Vessels	12 hour/day
3	Offshore Support Vessel (OSV)	2 Vessels	12 hour/day

4	Security Boat	4 Vessels	24 hour/day
5	Pilot Boat	1 Vessels	6 hour/day
6	Tug Boat	6 Vessels	6 hour/day
7	LCT	3 LCTs	3 x /week
8	Cargo Boat (big cargo)	2 Vessels	4 x/month
9	Fuel tanker	1 Vessel	4x/ month
10	LNG Tanker	15 Vessels	15x/ month
11	Condensate Tanker	3 Vessels	3x/ month
12	Mooring Boat	2 Vessels	6 hour/day

C5. Non Hazardous and Hazardous Waste Management

During operational phase, all waste (non hazardous and hazardous) generated by vessel operation (except tanker ship) will be collected and transported to integrated waste management facility in Tangguh LNG for further treatment.

Detail of waste management in Tangguh LNG is described in Sub Chapter 1.2.3 LNG Plant Activity Section C9 Non Hazardous and Hazardous Waste Management.

While waste management practice for LNG and condensate tanker will refer to MARPOL 2012 requirement Annex V Prevention of Pollution by Garbage from Ships.

C6. Wastewater Management

General type of wastewater generated from vessel activity are sewage, bilge water and ballast water. For small vessel (crew change boat, security boat) will be equipped with oily water separated system. Disposal of oily contaminated wastewater from vessel will be using vacuum truck to transfer and managed the wastewater in wastewater treatment plant onshore.

For large vessel (LNG tanker, condensate tanker), the wastewater (bilge water, oily contaminated water, ballast water, sewage) will be managed independently outside Tangguh LNG area, according to Government Regulation No. 21 Year 2010 regarding Marine Environment Protection and MARPOL 2012 requirement Annex IV Prevention of Pollution by Sewage from Ships. Normally, large vessel is already equipped with sanitary wastewater treatment and oily wastewater treatment facility according to MARPOL requirement.

Wastewater generated from marine facilities onshore will be managed along with other wastewater from LNG plant and its supporting facilities. Detail of wastewater management in Tangguh LNG is described in Sub Chapter 1.2.3 LNG Plant Activity Section C8 Wastewater Management.

C7. Storage and Loading of Fuel and Chemical

Management of fuel and chemical storage during marine facilities operation will be similar to fuel and chemical storage and loading management during LNG plant operation.

Detail of fuel and chemical storage and loading is described in Sub Chapter 1.2.3 LNG Plant Activities Section C11 Storage and Loading of Fuel and Chemical.

C8. Existence of Marine Facilities

The existence and operation of marine facilities is permanent during lifetime of Tangguh LNG operation.

D. Post Operation Phase

D1. Workforce Release

There will be workforce release in the end of operation phase. Detail process of workforce release will be determined later and will be done according to applicable regulation.

D2. Decommissioning of Marine Facilities

Post operation phase will include but not limited to facility decommissioning, remediation and workforce demobilisation. Facility decommissioning plan will be developed to obtain approval from Government.

The decommissioning plan will include all marine facilities. Potential closure for marine facilities are removal/demolition of the facilities or remain for future land uses by other stakeholder.

A discussion with stakeholders will be ongoing to determine the final decision on the facilities. A clear plan and legal understanding of the transfer of responsibility for the facilities will be determined through this process.

D3. Revegetation

Revegetation will be done in former area of marine facilities. Detail revegetation program will be developed once decommissioning plan is completed.

1.2.5 Survey, Seismic and Exploration and Appraisal Well Drilling Activities

A. Regional, Geophysical and Geotechnical Survey Activity

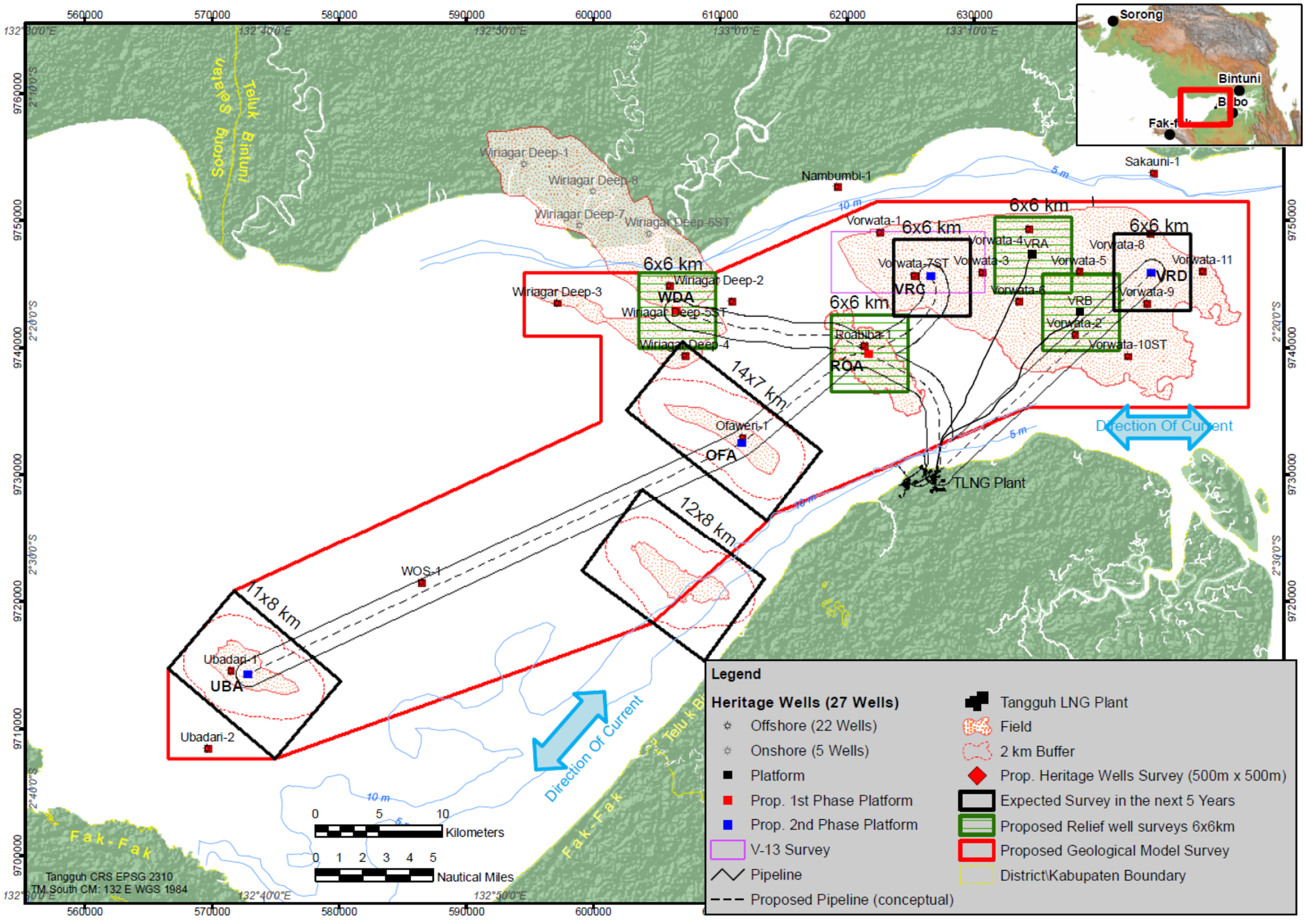
Regional, geophysical and geotechnical survey is planned to be conducted in Berau and Muturi PSC work area as shown in **Figure I**-58. Total survey area is approximately 1,500 km^2. The activity is planned to be commenced in 2015, and may be repeated in Berau and Muturi PSC work area, if necessary.

The objective of this survey is to acquire sufficient geophysical data of the whole areas in order to map sea bed and shallow strata conditions which will be required for well, platform and pipeline planning.

In addition, this survey also aim to obtain full geophysical and shallow seismic (single or multi streamer) over development (field) areas with sufficient tie lines to allow for correlation from one field to another. Geophysical in other areas suitable for use for pipeline planning.

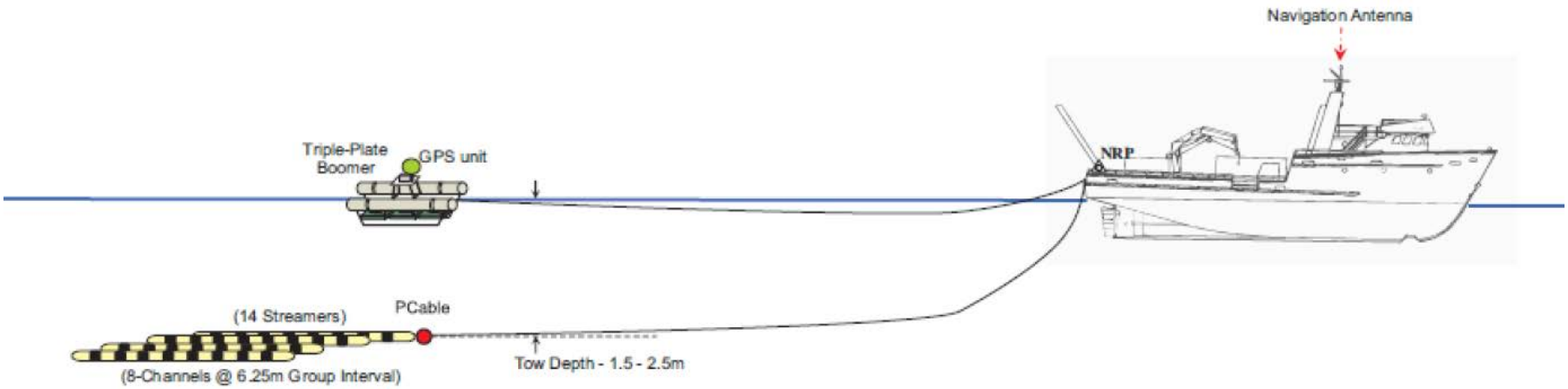
This regional, geophysical and geotechnical survey may involve approximately 3 vessels. Type of equipment to be used in this activity is shown in **Figure I**-59.

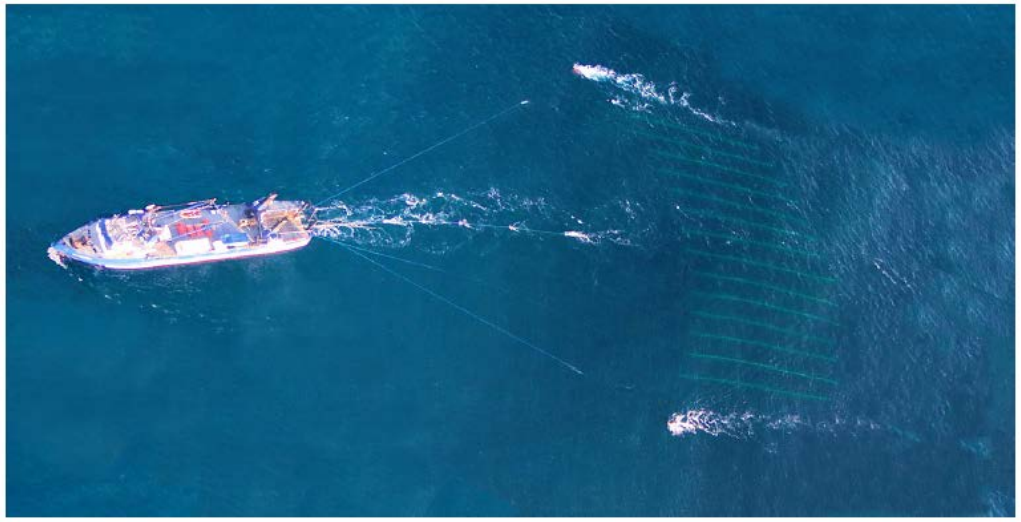
Currently, this regional, geophysical and geotechnical survey are still in planning stage and may evolve in line with design and planning progresses.



Note : regional, geophysical and geotechnical activity is currently in planning stage and may evolve in line with design and project progresses.

Figure I-58 Proposed Coverage Area of Regional, Geophysical and Geotechnical Survey





Note : regional, geophysical and geotechnical survey activity is currently in planning stage and may evolve in line with design and project progresses, also technology/methodology used by the Contractor.

Figure I-59 Potential Equipment operated for Regional, Geophysical and Geotechnical Survey

B. Seismic Survey Activity (3D and 2D)

Marine seismic survey is a well established method to aquire seismic data and has been applied for many thousands of times in diverse marine environments around the world. During data acquisition, a seismic vessel streams along the pre-determined straight paths over the gas field coverage area. For streamer seismic survey method, vessel will tow one or more long streamer cables with cable length for up to several kilometers long. The vessel travels as far as needed to completely cover the area of interest.The streamer cable is normally underwater, hence the streamer cable will not be visible during survey activity.

The seismic vessel, which is configured to tow streamers below the water surface, also tows an array of air guns, which is used to generate sound waves by the sudden, periodic release of a few thousand cubic inches of compressed air. Sensors along the length of the cable are used to detect and record the reflection of sound waves from the seabed and from successively deeper layers of the earth. During the operation, several chase crafts are employed both in front of and behind the seismic vessel and streamers to keep the path clear from obstruction and to warn other approaching vessels.

At the end of each path, the seismic vessel turns around to continue survey on the following path. Sufficent sweeps/survey path must be made to cover the entire area of interest. The entire operation can last for several months.

Schematic figure of seismic activity using Stream Method is shown in **Figure I**-60.

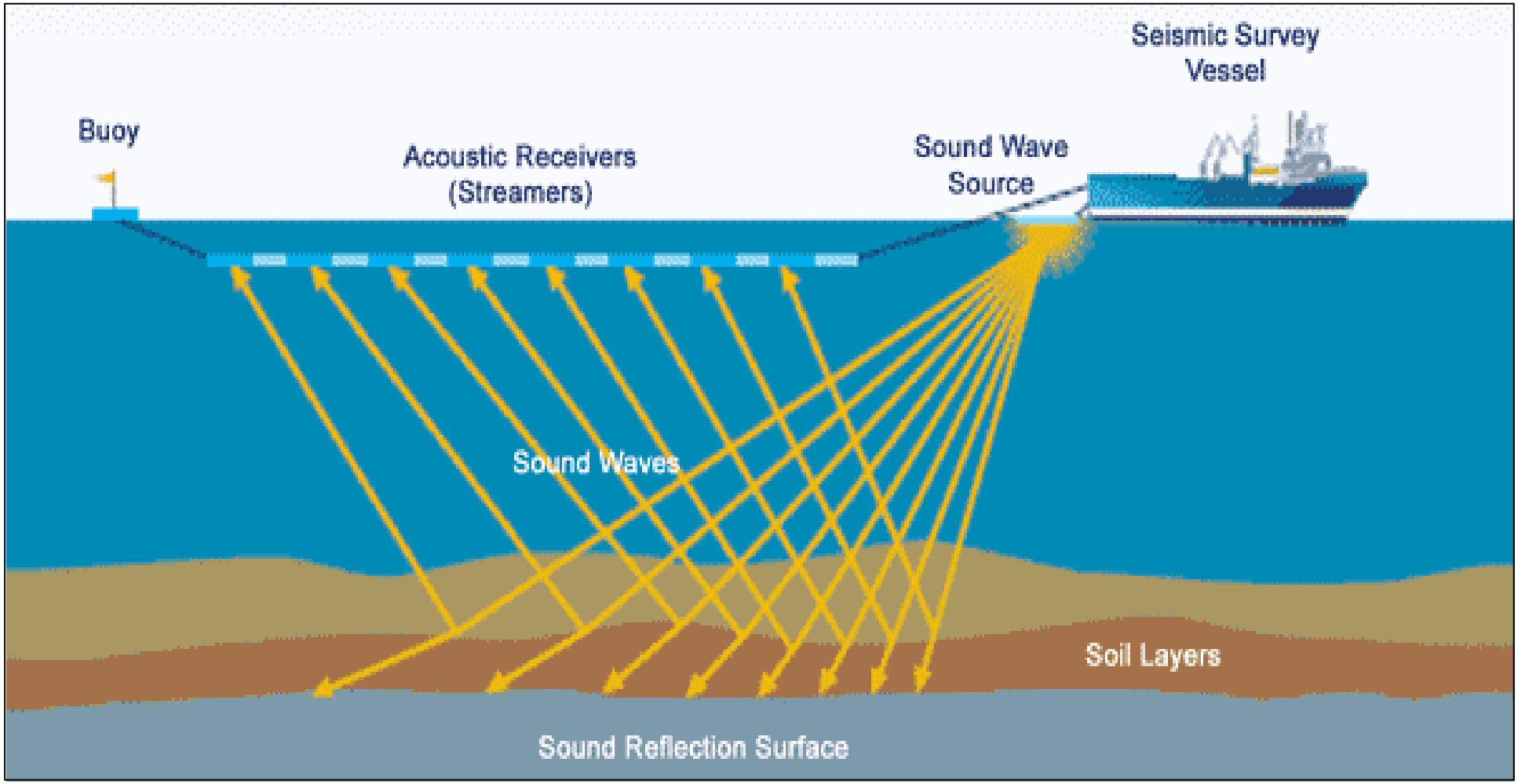
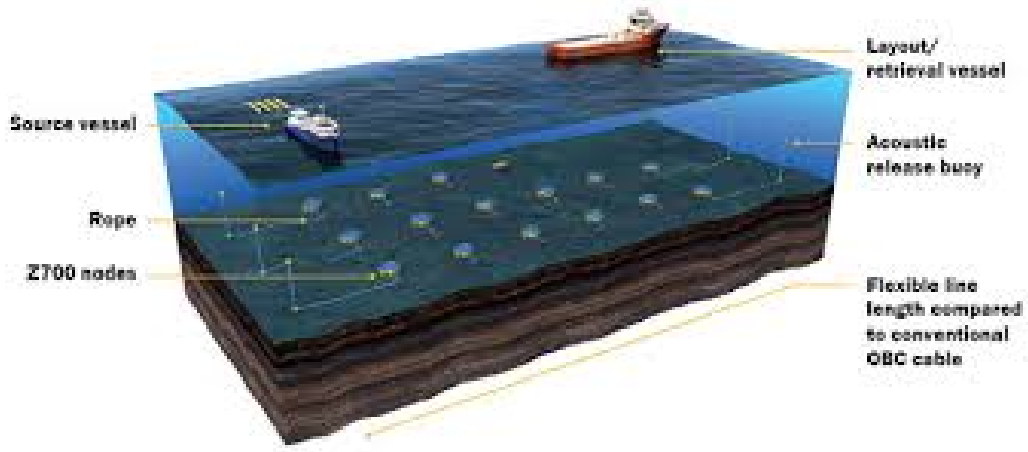


Figure I-60 Schematic Figure of Seismic Survey using Stream Method

One variation of this technique that has already been applied in Berau/Bintuni Bay is ocean bottom cable (OBC), unlike cable streamers, the cables containing sensors are not towed but will be placed in a stationary position directly on the seabed. Using an advance technology, the ocean bottom cable that normally use cable to connect one sensor with another, can be replaced with separated sensors without cable connection or also called as nodes. This method is called ocean bottom node (OBN). To simplify the deployment and lifting process from the seabed, these nodes are connected with rope between one nodes to another.

Source vessel will not tow the sensor cable as in marine seismic survey using streamer. The source vessel will perform source release process or called as shooting on designated points and will be on top of OBC or OBN sensor which have been placed on seabed.

Schematic seismic figure using Ocean Bottom Node (OBN) is shown in **Figure I**-61.



Source : www.fairfieldnodal.com

Figure I-61 Schematic Seismic Activity using Ocean Bottom Node (OBN) Method

Typically, for ocean bottom node or ocean bottom cable seismic survey, will employ several type of vessels: source vessel, vessel for deployment and lifting cable or node, chase craft, fast craft for supporting activity, accommodation barge or vessel and fuel carrier. Total vessel may reach for up to 12-15 vessels as required. Example of vessel configuration for ocean bottom cable survey is shown in **Figure I**-62.

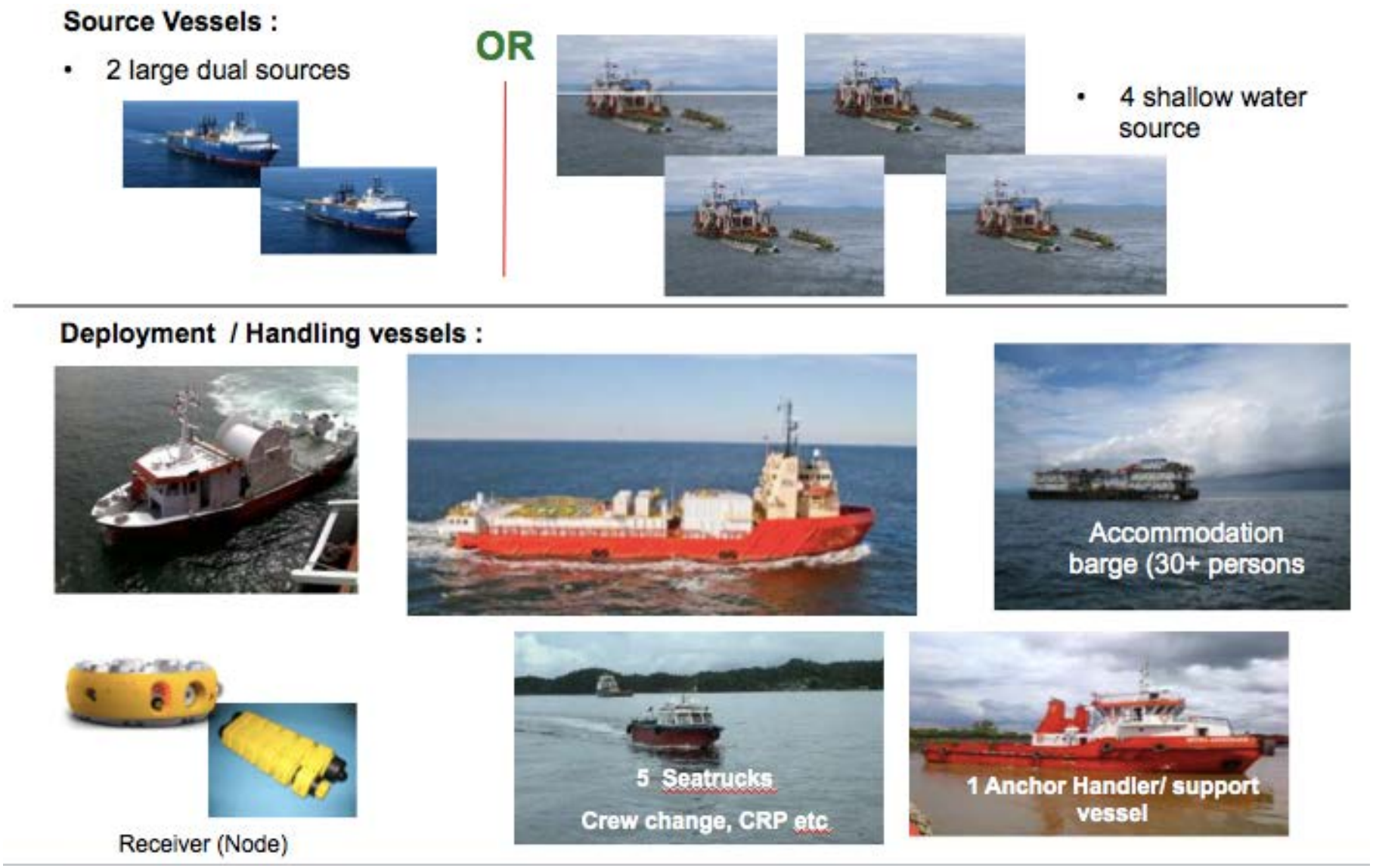


Figure I-62 Example of Vessel Configuration for Ocean Bottom Cable (OBC) Survey

Recording result data will bein a unit data and saved in special magnetic tape. This data will be sent to seismic data processing centre in Jakarta. The process result normally can be completed within 5– 8 months.Processed seismic data can image geological subsurface layer condition in seismic survey area.

This data will be combined with other data to be used for exploration of oil or gas source.

Seismic survey activity is planned to be conducted in 2015 to 2016 as shown in **Table I**-29. Seismic survey area is shown in **Figure I**-63.

Table I-29 Seismic Survey Schedule Plan

Description	2015												2016					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
	1Q			2Q			3Q			4Q			1Q			2Q		
Premob Planning																		
Mobilization																		
Execution																		
Demob																		

Note : currently, seismic survey is in planning stage, the above schedule may evolve in line with planning progresses.

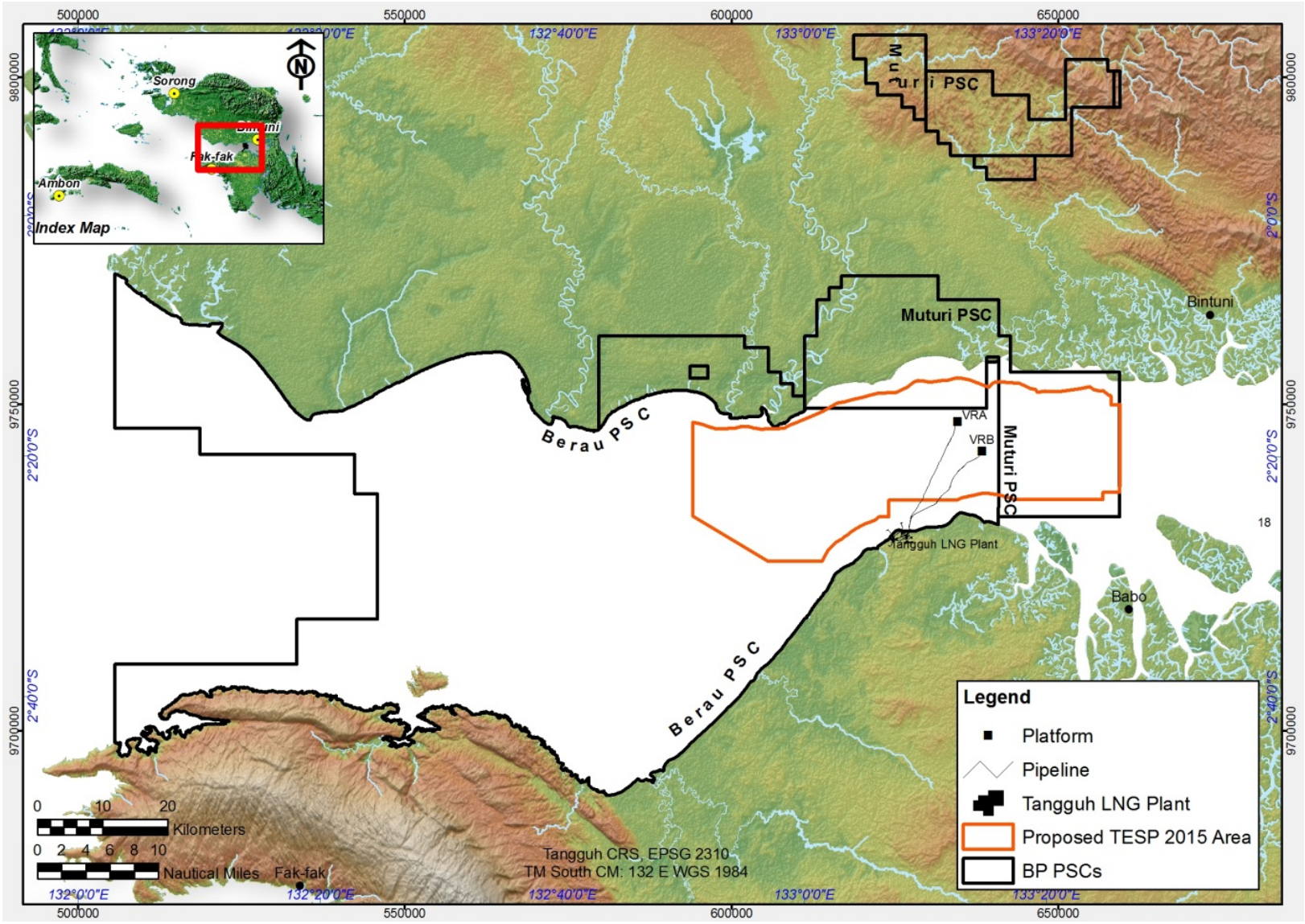


Figure I-63 Seismic Survey Area

C. Vertical Seismic Profiling (VSP) Survey Activity

This survey is conducted at the final stage during drilling activity in order to obtain a more accurate geological subsurface condition data as with this VSP survey, acoustic data is directly recorded to sensor in the borehole. Unlike seismic survey, where the sensor is placed on the land or on the seabed, VSP is performed by placing the sensor directly into the subsurface on the desired target depth (normally up to 2,000 m – 4,000 m as per requirement). After the completion of drilling activity, where the borehole is available and in good condition, the sensor will be inserted to the hole.

For VSP activity in WDA, 3D VSP survey will be performed, which the wave source comes from certain boat/vessel equipped with airgun and moves around the platform or borehole. This activity will last for 7-10 days. VSP survey activity illustration is shown in **Figure I**-64.

VSP survey will be conducted in parallel with production well drilling in offshore platform.

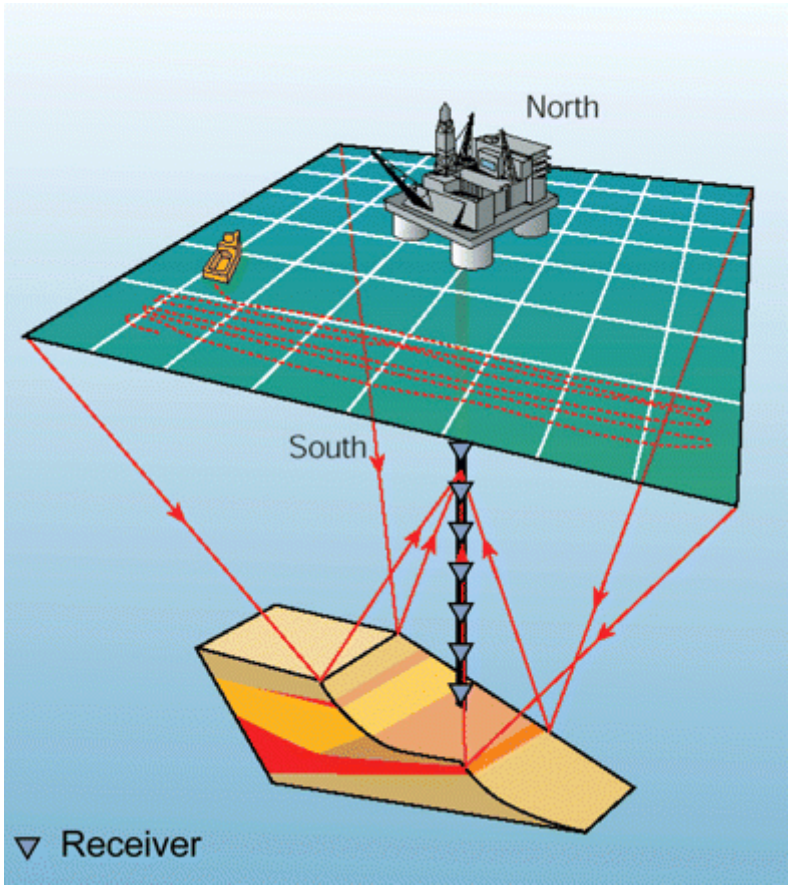


Figure I-64 Illustration of 3D Vertical Seismic Profiling (VSP) Activity

D. Exploration and Appraisal Well Drilling Activity

The Tangguh LNG Expansion Project was driven by the increase in discovering proven reserves in the Vorwata gas field which has been re-certified by local consultant as third party. Final recertification of Vorwata reserves is 16.9 Tcf of total proven reserves and 20.8 Tcf proven reserves to which were added estimated reserves from the Vorwata, Wiriagar Deep, Roabiba, Ofaweri and Ubadari fields.

Currently, Berau PSC still have exploration commitment to drill one exploration well. In accordance with PSC Contract Agreement the well has to be drilled before 2019. Based on current assessment, there are three leads that become drilling target option to fulfill the Berau PSC exploratory commitment, which are Ubadari, Inos and Kepe-kepe. The area of well location options are as follow and shown in **Figure I**-65.

In addition to realizisation of this commitment, future exploration and appraisal drilling program activities will be conducted in Berau PSC and Muturi PSC work area which include Vorwata, Wiriagar Deep, Roabiba, Ofaweri, Ubadari gas fields and other gas fields included in the scope of the AMDAL study.

Some appraisal wells that are planned to be drilled are O-2 and V-13 which are located in Ofaweri and Vorwata gas fields.

Schedule and total number of appraisal well drilling will depend on the success of the previous drilling program.

The sequence of exploration and appraisal well drilling activity is as follows :

a) Rig Preparation

After arrived in location, rig will be positioned according to well coordinates plan and will be prepared for drilling. All preparation activity before spud will be done on rig.

b) Drilling Process (conductor installaton, drilling process, casing installation, and cementing)

Activity will be started by conductor pipe installation with diameter of 76 cm into approximately 45 m depth below seabed using hammer pile. The conductor is used to protect the well head and all well casings that will be installed, from seawater pressure load. In addition, conductor can also be used to protect well structure around the surface and to protect water in well surface from drilling mud.

Drilling will be conducted from the bigger hole then the casing will be installed which it will be cemented between the borehole and annulus. Cemented casing installation is aimed to protect the borehole so that it will not collapse (maintain borehole stability) and prevent unexpected

flow, either from surrounding formations into the borehole or from mud that is used for drilling into the surrounding formation.

The type of drilling mud that is planned to be used for exploration and appraisal well drilling is water based mud that will be used to drill the whole stage of the well to the final depth. Main composition of drilling mud is seawater and natural mud generated during drilling.

Although current plan is to use drilling mud with water as its base fluid which known as a Water Based Mud (WBM) to drill the whole sections, however the use of Non Aqueous Drilling Fluid (non water based) such as Synthetic Based Mud (SBM) and/or Oil Based Mud (OBM) will also be considered during planning process, if the preliminary study results necessitate to use this type of mud.

Based on appraise stage calculation, approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings are estimated to be generated and will be discharged from each well. Drilling mud will be reused as much as possible during drilling period.

During drilling activity, there will be cementing stage for every section interval. In the well drilling, it is not expected to have excess cement from the cementing process. This is because the all supplied cements will be adjusted according to well design, thus all the cement produced will enter the casing as required. No cement on the surface at all times.

There will be potential residual cement from cement tank clean up process, maximum waste water volume from this process is approximately 100 bbls (15,000 L) for each cementing activity. The residual cement waste will be discharged through a discharge pipe to seawater. However, cement waste could not be occured and there will be no potential excess during cement circulation from other section due to cement process will not reach mud line. Cement will be prepared as per design and cement tank is not designed for dead volume.

c) Well Completion (logging/well evaluation, perforation, well test)

In exploration and appraisal well drilling program, well evaluation process is conducted using wireline logging after target depth of each sections is reached, before casings are installed.

Specific for final section or reservoir, besides wireline logging, normally logging process is also conducted during drilling process (Logging While Drilling – LWD).

After liner installation, well perforation will be done through DST test string in line with proposed target, continued with well testing to appraise well performance and the future prospect of well and gas field.

During well test, there will be gas flaring for well testing during 48-72 hours for each drilled well. Flaring rate during well clean up can reach between 30-100 MMSCFD for each drilling zone. Detail assessment will be conducted further based on the latest data.

d) Plug and abandon well

After the completion of well test, the test pipe will be pulled out and the well will be shut down through "kill well" process and well will be permanently plugged and abandoned in accordance with applicable guideline and regulation. Subsequently, the entire pipe casings will be cut to the base of well with minimum distance of 4.5 m (15 ft) below the seabed.

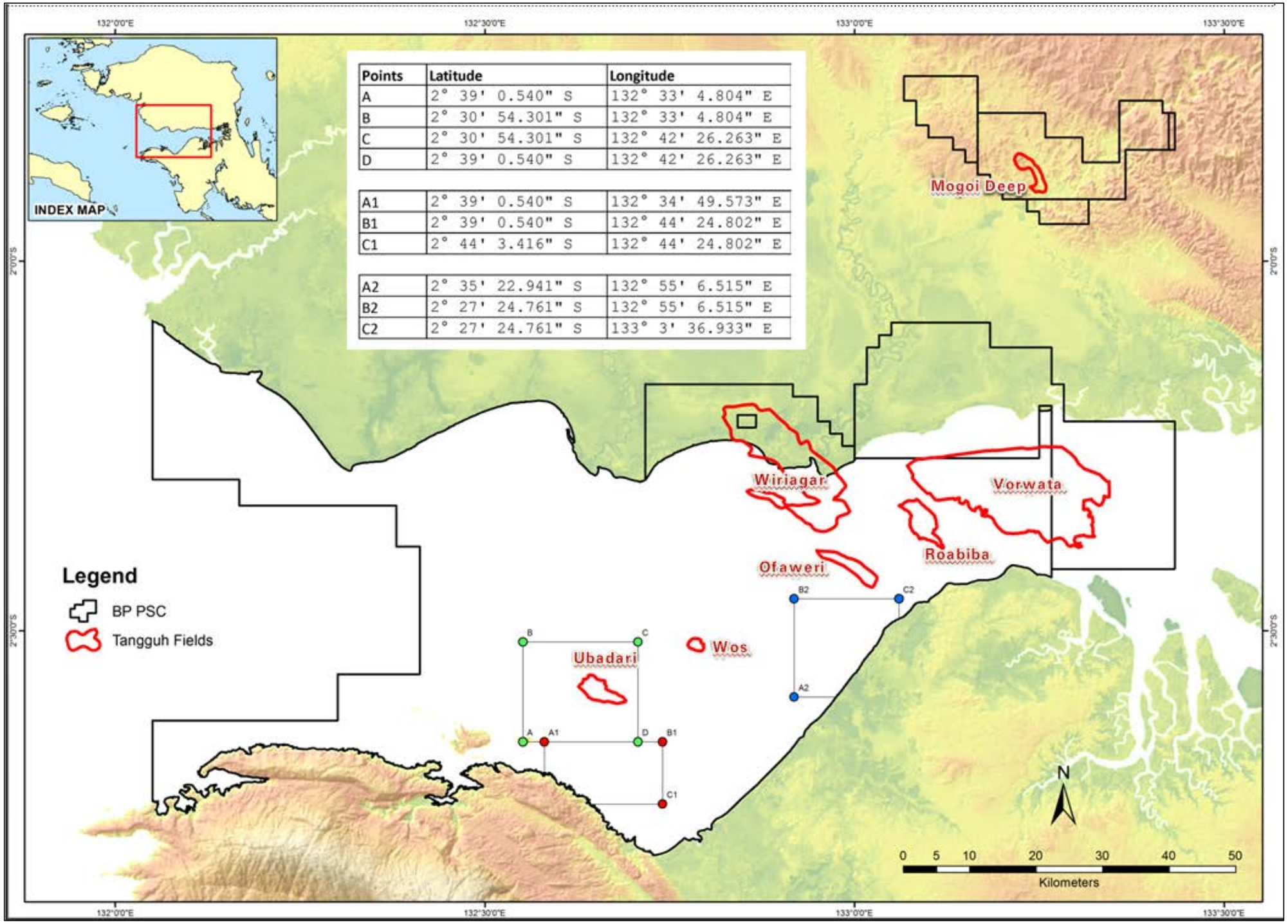


Figure I-65 Potential Exploration Well Location for 3 Targetted Leads: Ubadari, Inos dan Kepe-kepe