5 Project Description

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5.1 Introduction

This Chapter of the Environmental and Socio-economic Impact Assessment (ESIA) describes the construction and operational activities associated with the Shah Deniz Stage 2 (SD2) Project. The description presents the technical design basis for the project facilities and associated planned activities for the following project phases:

- MODU drilling and completion activities;
- Onshore construction and commissioning of Terminal facilities;
- Onshore construction and commissioning of offshore and subsea facilities;
- Platform installation, hook up and commissioning;
- Installation, hook up and commissioning of subsea export and MEG pipelines;
- Subsea infrastructure installation, hook up and commissioning;
- Offshore operations and production;
- Subsea operations;
- Onshore operations and production; and
- Decommissioning.

Estimated emissions, discharges and wastes from the SD2 Project are presented for each project phase; emission estimate assumptions are provided in full within Appendix 5A.

This Chapter provides the basis for the ESIA as presented in Chapters 9-12 and was prepared during the 'Define' stage of the project. During later stages of the SD2 Project, there may be a need to change a design element. The Management of Change Process that will be followed should this be required is presented in Section 5.16 of this Chapter.

The Base Case design of the SD2 Project (refer to Figure 5.1) includes:

- A fixed SD Bravo (SDB) platform complex including a Production and Risers (SDB-PR) and a Quarters and Utilities (SDB-QU) platform, bridge linked to the SDB-PR;
- 10 subsea manifolds and 5 associated well clusters, tied back to the fixed SDB platform complex by twin 14" flowlines to each cluster;
- Subsea pipelines from the SDB-PR platform to the Terminal comprising:
  - Two 32" gas pipelines (for export to the Terminal);
  - One 16" condensate pipeline (for export to the Terminal); and
  - One 6" mono ethylene glycol (MEG) pipeline (for supply to the SDB platform complex).
- Onshore SD2 facilities at the Terminal located within the SD2 Expansion Area.

The SD2 Project comprises up to 26 producer wells. The activities associated with the drilling 10 of the wells were assessed within the NF1, WF1 and SD2 Predrill ETNs[1]. Drilling of the additional 16 wells and completion of all 26 wells are described in this Chapter.

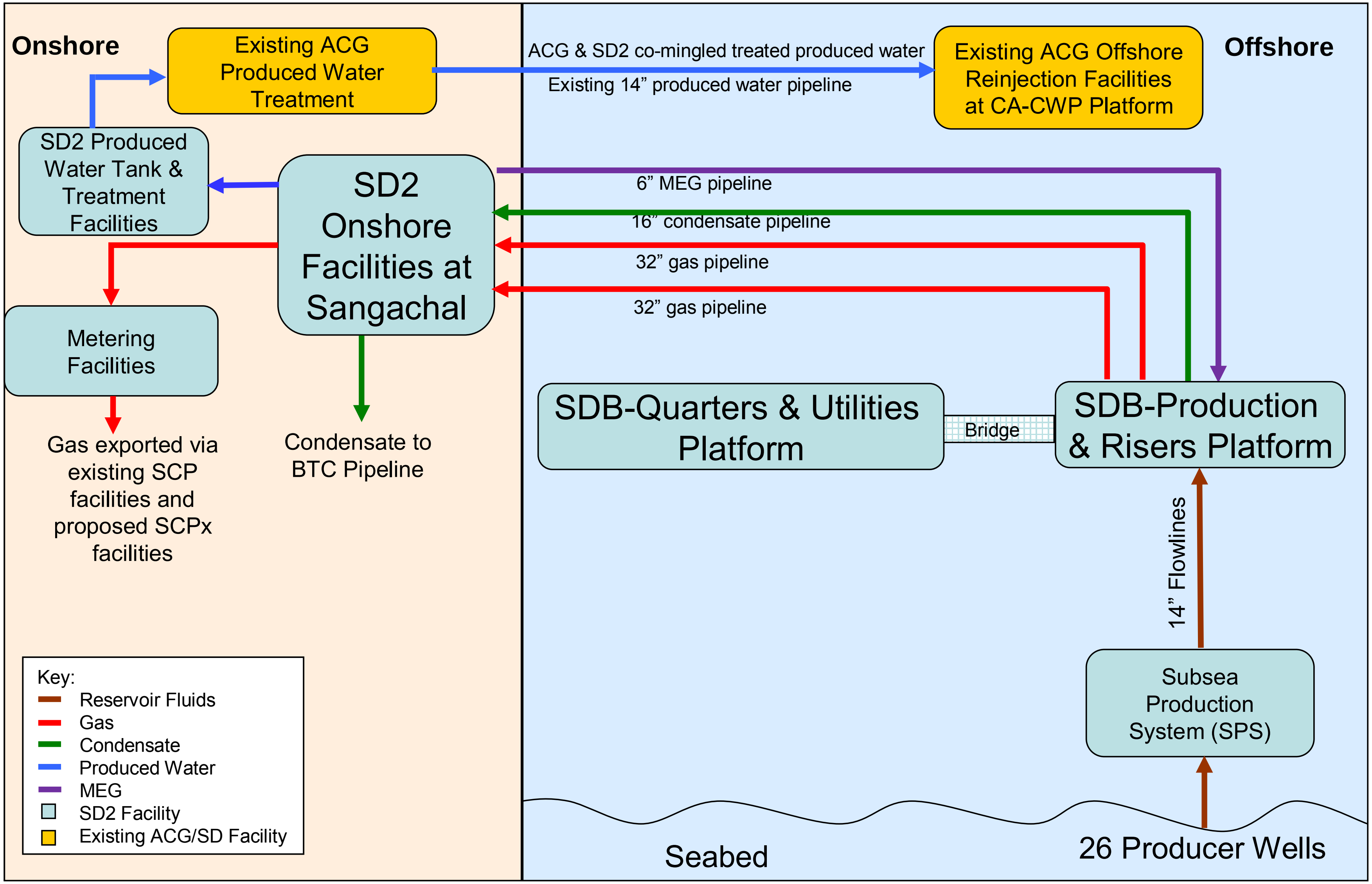
The Early Infrastructure Works (EIW)[2] (currently ongoing) to be completed at the Terminal prior to installation of the SD2 onshore facilities include:

- A new access road;
- Clearance and terracing of the SD2 Expansion Area; and
- Installation of storm water drainage and surface water/flood protection berms.

It is currently anticipated that a number of the EIW elements will be passed to and become the responsibility of the Main SD2 Construction Works contractor. These works are described within this Section 5.5 of this Chapter.

[1] NF1 Environmental Technical Note (ETN) (2009), WF1 ETN (2011) and SD2 Predrill ETN (2012)
[2] Assessed within the SD2 Infrastructure Project ESIA (2011)

Figure 5.1 Overview of SD2 Project

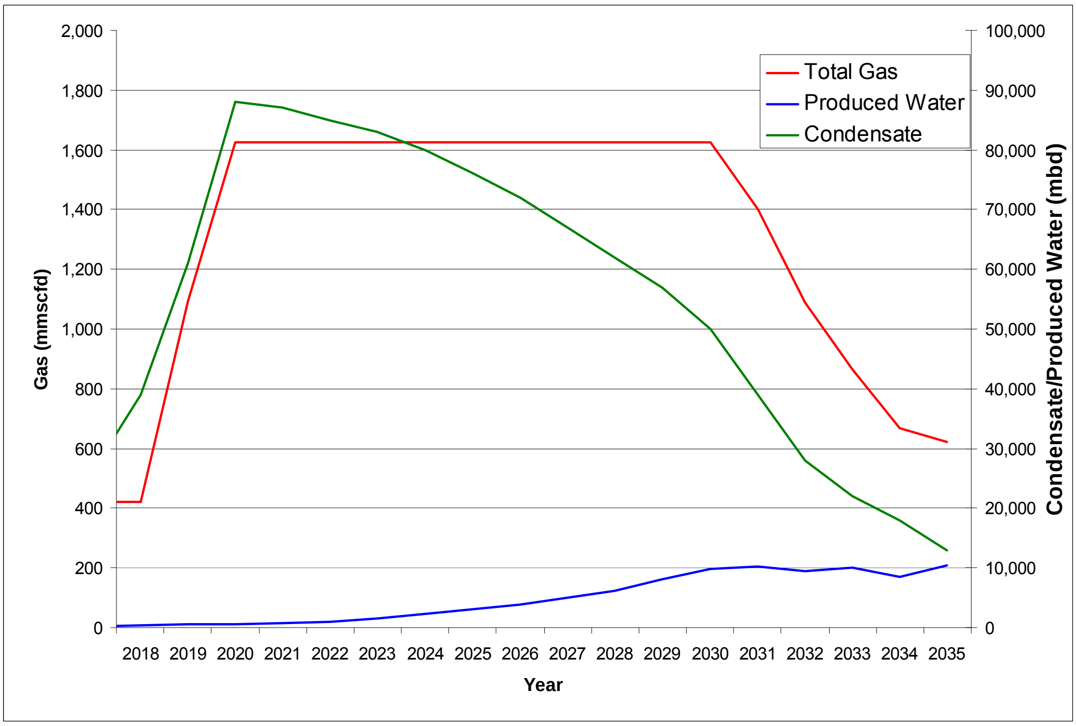


Planned first gas for the SD2 Project is 2018 following the tie in of the wells in the north flank (NF) to the SDB platform complex. The wells in the remaining four flanks (WF, ES, EN and WS) will be tied in sequentially. Peak production is anticipated in 2020. The SD2 field contains estimated 33.1Tcf gas initially in place (GIIP) and 2.4Bstb of condensate initially in place (CIIP). The SD2 Project aims to develop the known appraisal reservoir intervals (Balakhany VIII through to Fasila D) across the SD field. The SD2 Project facilities have been designed to process up to:

- 1,800 million standard cubic feet per day (MMscfd) gas to provide an export gas rate of 1,777MMscfd;
- 107 thousand barrels per day (Mbd) of condensate; and
- 25 thousand barrels per day (Mbd) of produced water.

Figure 5.2 illustrates the estimated SD2 gas, condensate and produced water production profile over the Production Sharing Agreement (PSA) period.

Figure 5.2 Estimated SD2 Project Production Profiles Across the PSA Period

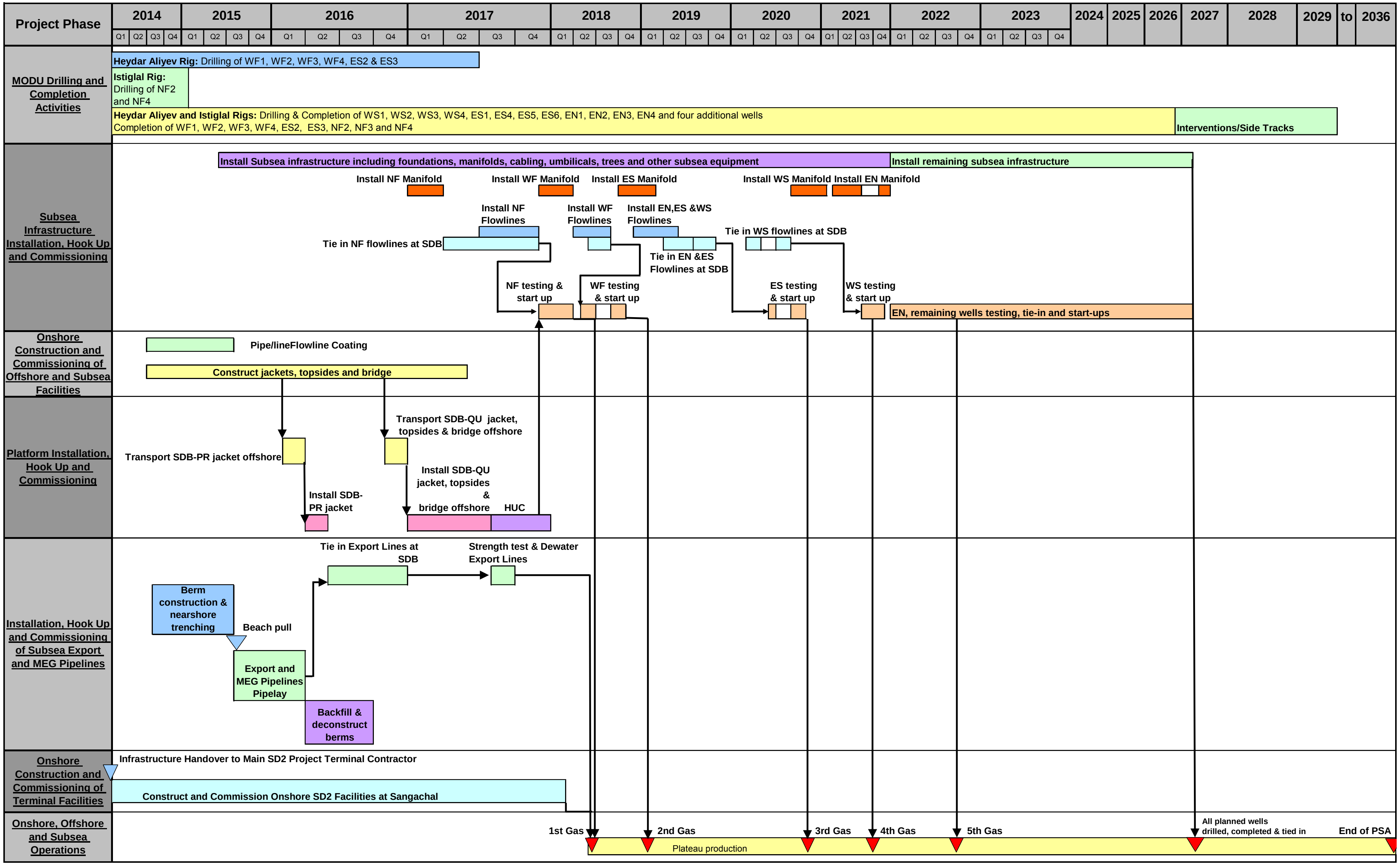


5.2 Project Schedule

Key SD2 Project activities and milestones are shown in Figure 5.3, which is based on the best available knowledge at the time of writing. The timing for each will be finalised when the final investment decision is made in 4Q 2013.

The following sections discuss key activities associated with each phase of the project.

Figure 5.3 Indicative SD2 Project Schedule



5.3 Logistics and Material Supply

Prior to commencing works, equipment and materials will be transported to the ST and the topside, subsea facilities, pipeline and jacket construction yards.

Preference will be given to source equipment (such as plant and construction vehicles) and materials which meet the required project specifications from Azerbaijan wherever possible. Where international procurement is required, materials and equipment will arrive by road, rail, sea and air using the transportation routes established for the previous ACG and SD construction programmes.

Goods arriving via sea can travel by two main routes. From the Mediterranean and Black Sea, vessels must pass through the Don-Volga canal system. Cargoes following the Baltic Sea route, would be transhipped at St. Petersburg and travel along the Baltic-Volga system. These routes are not available during the ice season (November - April). Rail links are available from Poti in Georgia and Riga in Latvia. Deliveries by road from Europe would be through Turkey and Georgia and via Iran.

5.4 MODU Drilling and Completion Activities

5.4.1 Mobile Drilling Rig Activities

It is anticipated that the SD2 Project wells will be drilled using two semi-submersible rigs:

- “Istiglal”; and
- “Heydar Aliyev” (previously known as the “Maersk Explorer”).

The Istiglal mobile drilling rig (MODU) has been used on all of BP’s pre-drilling activities in the SD Contract Area.

It is planned to drill a total of 26 wells in the SD Contract Area. Approval has already been obtained for 10 of these wells (within the northern, western and eastern south flanks of the Contract Area). 12 of the remaining wells will be located on the following flanks and at the following approximate depths below sea level:

- Western south flank: WS1, WS2, WS3, WS4 - approximate depth of 390 - 470m;
- Eastern south flank: ES1, ES4, ES5 and ES6 - approximate depth of 490 - 530m; and
- Eastern north flank: EN1, EN2, EN3, and EN4 – approximate depth of 395 – 480m.

The locations of the final four wells has not yet been confirmed. Their location will be determined once additional well performance and subsurface information becomes available. A Letter of Information will be sent to the MENR confirming the locations of the wells when known.

In the event that problems are encountered while drilling the surface hole, the well may be re-drilled within 50m of the original seabed location. In addition, if there is uncertainty around the geotechnical properties of the surface rocks, up to 4 geotechnical holes may be drilled within each flank where drilling has not been completed to date (in close proximity to the planned wells) to confirm geotechnical properties. A lower pilot hole may also be drilled in the same locations from bottom of the 28” liner to a depth of 1400m to obtain additional geological and log data.

5.4.1.1 MODU Positioning

Support vessels will tow each MODU to the drilling location and move the MODU into position prior to anchoring using 8 anchors at each location. The positioning and set up of each MODU is expected to take up to 4 days and a further 4 days per well to demobilise the rig at the end of the drilling programme. A mandatory 500m exclusion zone will be established around the rigs while drilling is in progress.

5.4.1.2 MODU Logistics and Utilities

In addition to the MODU, vessels will be required throughout the drilling and completion programme to supply consumables such as drilling mud to the MODU and ship solid and liquid waste to shore for treatment and disposal. Table 5.1 summarises the MODU and support vessel utilities. The estimated number and function of the vessels is provided in Appendix 5F.

Table 5.1 Summary of the MODU and Vessel Utilities

Utility/Support Activity	Heydar Aliyev Description	Istiglal Description
MODU Power Generation	• Main Power provided by 4 Wartsila 16CV W200 diesel engines rated at 2800kW • Emergency diesel generator rated at 750kW	• Main Power provided by 4 Wartsila 12CV W200 diesel engines rated at 2400kW • Emergency diesel generator rated at 635kW
MODU and Support Vessels Grey Water and Sanitary Waste	• Grey water will be discharged to sea (without treatment) as long as no floating matter or visible sheen is observable • Under routine conditions black water will be treated within the MODU sewage treatment system to MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards: Five day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable. • Under non routine conditions when the MODU sewage treatment system is not available black water will be managed in accordance with the existing AGT plans and procedures and reported to the MENR as required • Sewage sludge will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.	
MODU and Support Vessels Galley Waste	Depending on the availability of the system, galley food waste will either be: • Contained and shipped to shore for disposal; or • Sent to vessel maceration units designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards prior to discharge.	
MODU Seawater/ Cooling Water Systems	• Seawater used onboard within the engine and compressor systems (for cooling) • 6 seawater lift pumps, but typically 2 used which are designed to lift up to 960m^3/hr from a depth below sea level of between 17.5 and 19.5m • Design incorporates a Wilson Taylor Antifouling System for Cathodic protection and corrosion control system • Cooling system: o Designed to typically discharge up to 960m^3/hr at a depth below sea level of between 10.9 and 12.9m; and o Based on the results of thermal plume dispersion modelling for cooling water discharge undertaken for similar facilities, the temperature at the edge of the cooling mixing zone (assumed to be 100m from discharge point) will be no greater than 3 degrees more than ambient water temperature	• Seawater used onboard within the engine and compressor systems (for cooling) • Seawater lift pumps designed to lift up to 230m^3/hr from a depth below sea level of 9.8m • Design incorporates anodic biofouling and corrosion control system • Cooling system: o Designed to discharge up to 630 m^3/hr and at the depth below sea level of 12.5 m (depends on drilling draft); and o Based on the results of thermal plume dispersion modelling for cooling water discharge undertaken for similar facilities, the temperature at the edge of the cooling mixing zone (assumed to be 100m from discharge point) will be no greater than 3 degrees more than ambient water temperature.
MODU/ Vessel Fresh Water	• Fresh water supplied from shore by supply vessels and stored onboard for use.	
MODU Drainage	• Deck drainage and wash water will be discharged to sea as long as no visible sheen is observable. • Rig floor runoff, including WBM spills, collected via rig floor drains will be recycled to mud system or if not possible for technical reasons, diluted and discharged to sea (>60cm from sea surface) in accordance with applicable PSA requirements i.e. there shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water. • In the event of a spill, main MODU deck drainage will be diverted to hazardous drainage tank for spills including LTMOBM, oil/diesel/cement and oily water. Contents of hazardous waste tank will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures. Onboard the Heydar Aliyev rig: • Waste oil collected from the drainage system will be sent to waste oil tank. The contents of the tank will be incinerated using the rig's incinerator. • Bilge water will be sent to an oily water separator. Treated bilge water with an oil content less than 15ppm will be discharged to sea. • Drains within the drilling area are connected to the mud system. If it is not possible to send runoff including mud to the mud system it will be directed to a zero discharge centrifuge. Treated water from the centrifuge with an oil content less than 15ppm will be discharged to sea. Separated sludge will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures and separated oil sent to the waste oil tank.	
MODU Ballast System	• The MODU Ballast System will be operated so that ballasting, which uses untreated seawater, will be undertaken daily to maintain stability of the MODU for effective drilling.	
Support Vessel Drainage	• Oily and non oily drainage and wash water will be segregated. • Non oily drainage (deck drainage and wash water) may be discharged as long as no visible sheen is observable. • Oily water will either be treated to 15ppm or less oil in water content and discharged or contained and shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.	

Notes: 1. For the Istiglal the sewage treatment system comprises a Hamworthy Membrane Bioreactor. The Heydar Aliyev rig currently have two Hamworthy Super Trident Sewage Treatment Units. It is planned to install a Hamworthy Membrane Bioreactor system to replace the existing unit 4Q 2013. The Membrane Bioreactor system will be designed to MARPOL 73/78 Annex IV MEPC. 159 (55) standards - total suspended solids- 35 mg/L, BOD5 - 25 mg/l, COD- 125 mg/L, pH- between 6 and 8.5, thermotolerant coliforms (faecal coliforms) - 100 thermotolerant coliforms/100 ml. No chlorination of the effluent will be required.

Estimated volumes of waste and greenhouse gas (GHG) and non GHG gas atmospheric emissions generated during the drilling programme are summarised within Section 5.4.9 below.

Consumables such as drilling mud and diesel will be provided to the MODUs by vessel from the existing onshore facilities previously used during ACG and SD pre-drilling programmes and which also supply the operational ACG and SD platforms.

5.4.2 Drilling Operations and Discharges

Mobile drilling rig activities during the SD2 Project drilling programme include:

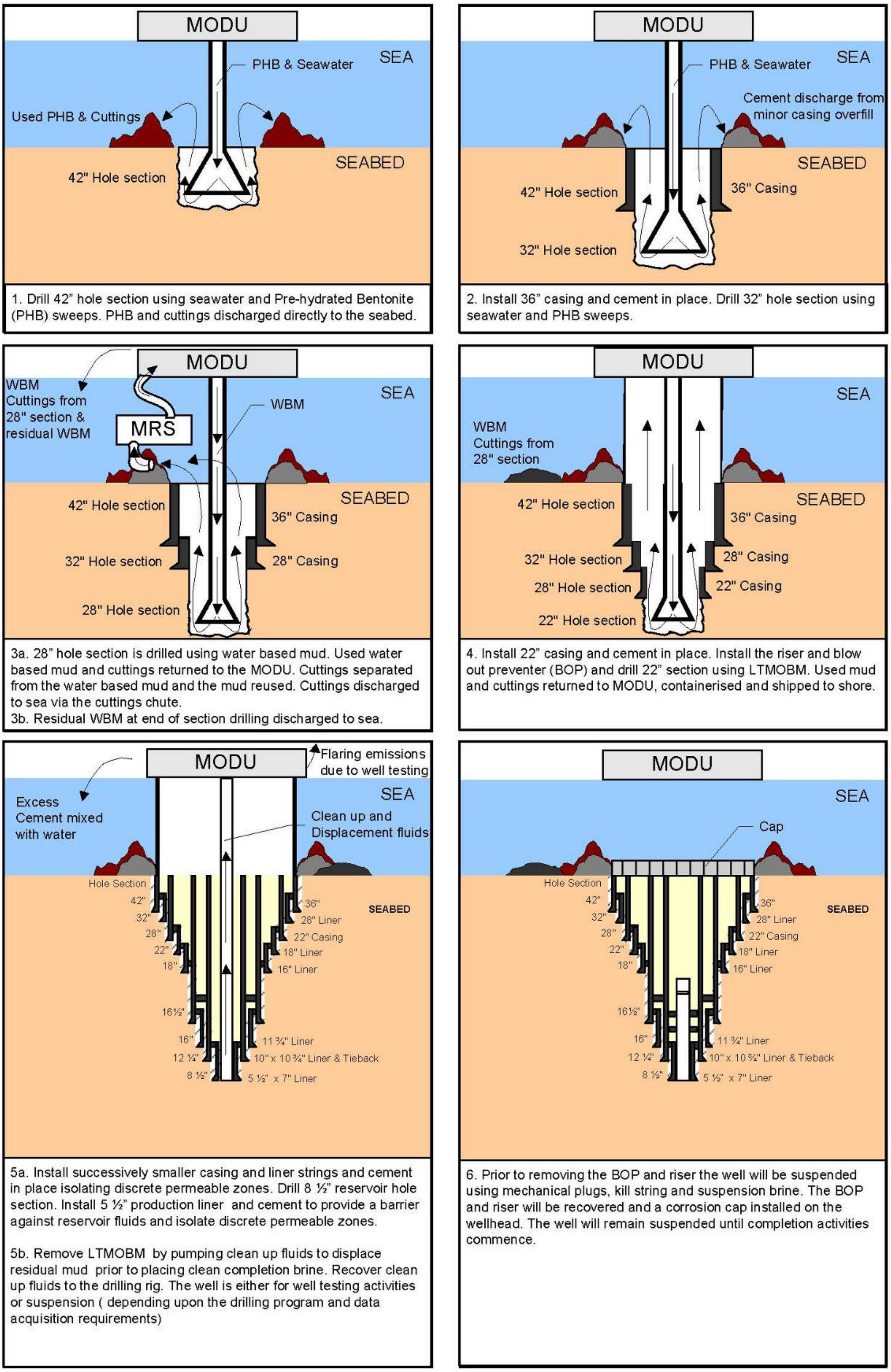
- Preparation of drilling equipment;
- Drilling of geotechnical holes (if required);
- Drilling of conductor, surface and lower well hole sections;
- Installing and cementing casings;
- Cleaning and testing; and
- Well suspension.

The activities associated with well re-entry and completion are discussed in Section 5.4.7 below. A summary of discharge types and the associated discharge scenarios associated with drilling activities is provided in Table 5.2. The SD2 drilling activities associated with the producing wells are illustrated in Figure 5.4 below.

Table 5.2 Summary of Drilling Discharge Types and Scenarios

Step (as per Figure 5.4)	Activity	Composition	Discharge Scenario
-	Application of pipe dope to drilling equipment joints	Pipe dope	Discharge very small amount of pipe dope with seawater/PHB sweeps/WBM when drilling geotechnical holes and prior to riser installation (42", 32" and 28" hole sections).
-	Drilling of geotechnical holes	Cuttings with water based mud (WBM)	Discharge WBM and cuttings directly to seabed.
-	End of drilling each geotechnical hole	WBM	Residual WBM remaining in the rig mud system after drilling each geotechnical hole that cannot be recovered will be discharged to sea via the MODU cuttings chute in accordance with PSA requirements[1,2].
1 and 2	Drilling of upper hole sections (42" and 32")	Cuttings and seawater with pre-hydrated bentonite (PHB) sweeps	Discharge seawater/PHB sweeps and cuttings directly to seabed.
3a	Drilling of 28" hole section (riserless)	Cuttings with WBM	Return WBM and cuttings to MODU using riserless MRS, separate mud from the cuttings. Recovered WBM will be reused whenever possible. Discharge WBM cuttings to the sea via the MODU cuttings chute, in accordance with PSA requirements[1,2]. If as a result of shale hydration the MRS hoses become plugged , then mud may be discharged at the seabed while the well is made safe and the hoses are unblocked.
3b	End of drilling 28" hole section	WBM	Residual WBM remaining in the rig mud system after completion of 28" hole section drilling that cannot be recovered will be discharged to sea via the MODU cuttings chute in accordance with PSA requirements[1,2].
4 and 5	Drilling of lower hole sections (22", 18" 16.5" 16" 12.25" & 8.5") (with riser)	No planned discharge	
2, 4 and 5a	Casing cementing	Cement	Discharge small amount of cement, due to slight overfill (required to ensure the casing is fully cemented to the seabed), directly to seabed following cementing of each casing and liner.
5a	End of cementing	Cement	Excess cement remaining in cement system on completion of cementing activities cannot be feasibly recovered and will be mixed with water and discharged to sea via the MODU cuttings chute[2].
5b and 6	Well clean up/ displacement, well testing and well suspension	No planned discharge	
Notes: 1 There shall be no discharge of drill cuttings or drilling fluids from the MODU if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water. 2 The MODU cuttings chute may be fitted with a hose, extending to the seabed, used to avoid cuttings and cement being deposited in locations where it is planned to install SD2 subsea equipment.			

Figure 5.4 Summary of Drilling Activities and Discharges



1. Drill 42" hole section using seawater and Pre-hydrated Bentonite (PHB) sweeps. PHB and cuttings discharged directly to the seabed.

2. Install 36" casing and cement in place. Drill 32" hole section using seawater and PHB sweeps.

3a. 28" hole section is drilled using water based mud. Used water based mud and cuttings returned to the MODU. Cuttings separated from the water based mud and the mud reused. Cuttings discharged to sea via the cuttings chute.
3b. Residual WBM at end of section drilling discharged to sea.

4. Install 22" casing and cement in place. Install the riser and blow out preventer (BOP) and drill 22" section using LTMOBM. Used mud and cuttings returned to MODU, containerised and shipped to shore.

5a. Install successively smaller casing and liner strings and cement in place isolating discrete permeable zones. Drill 8 ½" reservoir hole section. Install 5 ½" production liner and cement to provide a barrier against reservoir fluids and isolate discrete permeable zones.

5b. Remove LTMOBM by pumping clean up fluids to displace residual mud prior to placing clean completion brine. Recover clean up fluids to the drilling rig. The well is either for well testing activities or suspension (depending upon the drilling program and data acquisition requirements)

6. Prior to removing the BOP and riser the well will be suspended using mechanical plugs, kill string and suspension brine. The BOP and riser will be recovered and a corrosion cap installed on the wellhead. The well will remain suspended until completion activities commence.

5.4.2.1 Well Design and Drilling Fluid Types

All well-bore sections will be drilled using drilling fluids/drilling muds, the primary role of which is to:

- Maintain down-hole pressure to prevent formation fluids entering the well bore;
- Remove drill cuttings generated by the drill bit as it bores through the rock strata and transport these to the surface;
- Lubricate and provide cooling to the drill bit and the drill string; and
- Seal the wall of the well-bore in order to provide stabilisation.

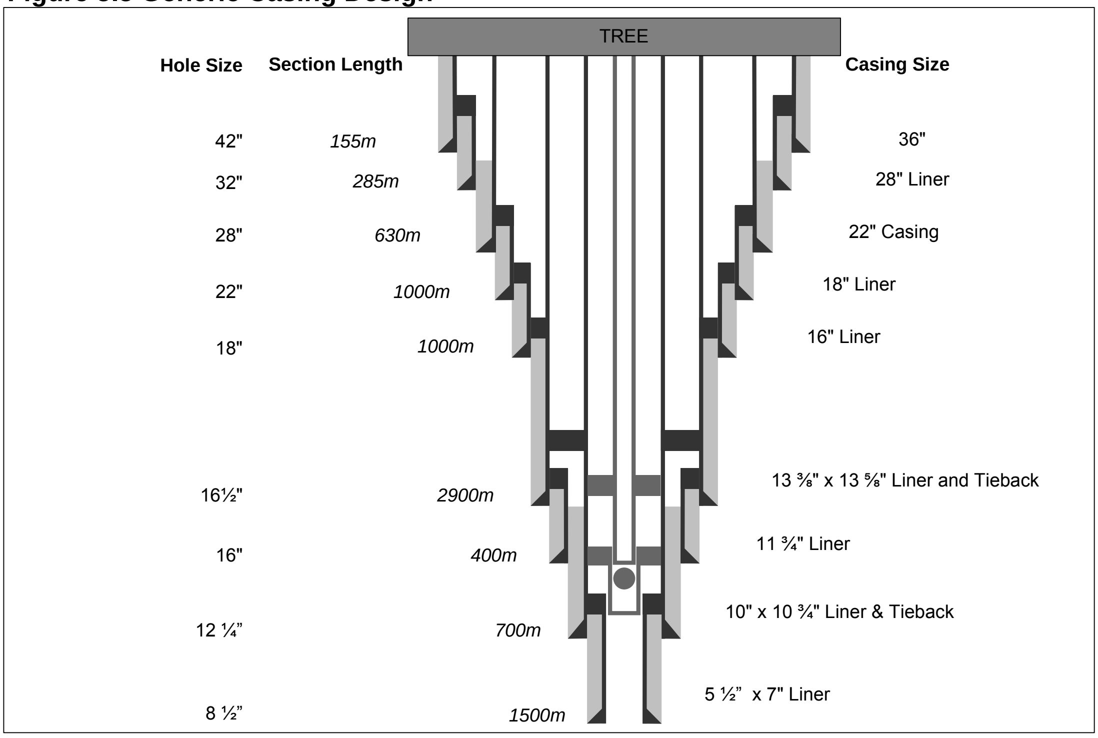
If required each geotechnical hole will be drilled to a depth of approximately 585m below seabed. Up to 4 holes may be drilled.

The generic design for the wells is presented in Table 5.3 and illustrated in Figure 5.5**.** The casing design for the wells will be similar to the existing SD well designs. It should be noted that the section lengths shown in Figure 5.5 are generic and will be relevant to all wells although there will be small fluctuations in length between well locations. Section lengths may vary depending upon where they are drilled in the field and will be optimised based upon the most current geological and reservoir data.

Table 5.3 SD2 Project Generic Well Design

Casing Size (in)	Hole Size (in)	Section Length (m)	Mud System	Disposal Route of Drilling Muds/Cuttings
36"	42"	155	Seawater PHB Sweeps	Discharge to sea at seabed.
28"	32"	285		
22"	28"	630	WBM	Discharge to sea via rig cuttings discharge chute or to seabed via hose.
18"	22"	1000	LTMOBM	Ship to shore.
16"	18"	1000		
$13^{3}/_{8}$/ $13^{5}/_{8}$"	$16^{1}/_{2}$"	2900		
$11^{3}/_{4}$"	16"	400		
10" X 10 $^{3}/_{4}$"	$12^{1}/_{4}$"	700		
$5^{1}/_{2}$" X 7"	$8^{1}/_{2}$"	1500		

Figure 5.5 Generic Casing Design



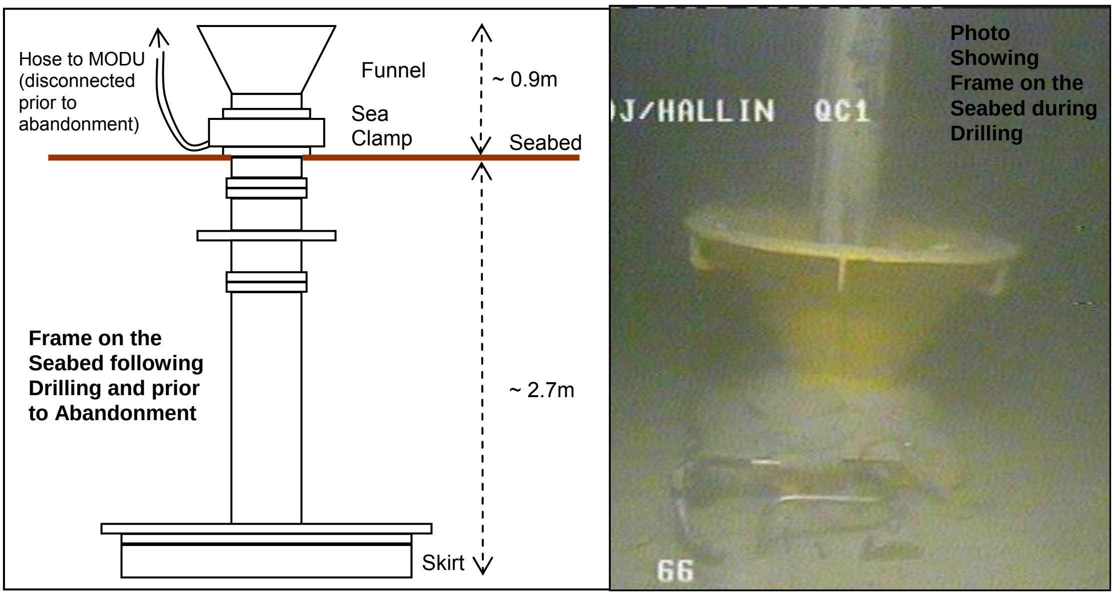
5.4.2.2 Drilling String Lubrication

Prior to the start of any drilling activities, the rig crew will apply pipe dope to the internal surfaces of the drilling string joints to prevent thread damage. Pipe dope is a lubricating grease which prevents the joints from becoming stuck together under high torque conditions. It is anticipated that BESTOLIFE 3010 Ultra (OCNS Category E) or a similar heavy metal free dope will be primarily used for this purpose with a small volume of heavy metal dope (e.g. Weatherford Lube Seal (UK)) used for certain operations, including tubing connections and associated completions for reliability and safety reasons. It is expected that trace amounts of pipe dope will be discharged to sea when drilling surface and top holes with seawater and PHB sweeps (42” and 32” hole sections) and with WBM cuttings (geotechnical holes and 28” hole section).

5.4.2.3 Geotechnical Seabed Frame

Prior to drilling the geotechnical holes in each flank, it is planned to install a frame, made of steel, on the seabed to guide the drill string during drilling as illustrated in Figure 5.6. Once in place, the frame will be static with the exception of the sea clamp, which will be operated from the rig via a hose filled with seawater. A small discharge of seawater to sea is anticipated when drilling is completed and the hose is disconnected**.**

Figure 5.6 Geotechnical Seabed Frame



Following completion of geotechnical drilling, the frame will extend approximately 0.9m above the seabed. It is planned to leave the frame in-situ upon completion of the geotechnical drilling work. The frame is made of steel and therefore inert. It contains no components that will result in discharges of chemicals. Due to the frame penetrating into the seabed and the associated suction forces of the seabed sediments, removal of the frame would require jetting of the seabed sediments using high pressure water hoses, resulting in further seabed disturbance. Leaving the frame in-situ is therefore considered the preferred option from an environmental perspective.

5.4.2.4 Drilling Fluids and Cutting Generation

Pilot and Geotechnical Holes and Upper 42”, 32” and 28” Hole Sections

If required the pilot and geotechnical holes will be drilled using a WBM system which will be pumped down the drill string, forcing the cuttings back up the borehole to the seabed. Drill cuttings will be discharged directly to the seabed. The holes will then be displaced using a weighted WBM. If necessary water based kill mud will also be used to control the fluids within the holes.

The 42” and 32” hole sections of each well will be drilled using a seawater system with drill cuttings discharged directly to the seabed. While drilling, the borehole will be cleaned out using high viscosity sweeps of PHB. The 36” and 28” diameter casings will be installed following drilling of the 42” and 32” hole sections respectively. Following drilling of the 32” hole section it is planned to pump a weighted WBM to the well to control the well during the installation of the 28” casing. The 36” and 28” casings are designed to support the load from the subsequent casing strings.

Following installation of the 36” and 28” casings, the 28” hole section will be drilled using a different weighted, WBM system, designed to stabilise the borehole and allow an increase in the pressure on the borehole wall.

For the pilot and geotechnical holes and the upper sections of the wells, it is proposed to use PHB sweeps and a WBM of the same specification and environmental performance as used for previous SD wells (refer to Chapter 9 for environmental performance/toxicity details). If there is a requirement to change the sweeps/drilling mud composition or to select different drilling fluids for commercial or technical reasons, the Management of Change Process (see Section 5.16) will be followed.

Table 5.4 presents a summary of the total expected chemical composition of the pilot hole, geotechnical hole and 42”, 32” and 28” hole section drilling fluids to be used per hole section.

Table 5.4 Estimated Use of WBM Drilling Chemicals Per Hole – Pilot Hole, Geotechnical Hole and 42”, 32” and 28” Sections [1,2]

Chemical	Trade Name	Function	Estimated Use per Hole (tonnes)[1]					Hazard Category[3]
			Pilot	Geo	42”	32”	28”	
Chemicals common to seawater/PHB sweeps and WBM								
Barite	Barite	Weighting Agent	648	1200	116	289	1826	E
Bentonite	Bentonite	Viscosifier	30	90	35	54		E
Soda Ash	Soda Ash	Alkalinity Control	3	7	1	0.7	2	E
Chemicals associated with WBM only								
Poly Anionic Cellulose	Polypac UL	Water soluble polymer designed to control fluid loss	6	12	2.1	3.5	19	E
Xanthan Gum	Duovis	Viscosfier	4	6	0.35	0.85	5	E
Nut Shells	Nut Plug	LCM/Pipe scouring	3	3	0.7	1.4		E
Salts (KCl)	Potassium chloride	Borehole stabiliser / shale inhibitor					325	E
Poly Ether Amine/Poly Ether Amine Acetate Blend	Ultrahib	Shale Inhibitor					96	GOLD
Aliphatic Terpolymer	Ultracap	Anti-acretion additive					7	GOLD
Ester/Alkenes C15-C18 Blend	Ultrafree	Shale Encapsulator					92	GOLD
Polyproplene Fibres	Super Sweep	Hole cleaning agent					2	GOLD
Magnesium oxide	Magnesium oxide	pH control			6			E

Notes:
1. A full list of chemicals potentially discharged can be found in Appendix 5B
2. Volumes will depend on the actual subsurface conditions encountered as such these volumes are best estimates based on previous experience.
3. Two methods of hazard assessment are used in accordance with internationally recognised practice - CHARM and Non CHARM. The CHARM Model is used to calculate the ratio of predicted exposure concentration against no effect concentration (PEC:NEC) and is expressed as a Hazard Quotient. Hazard Quotients are assigned to 1 of 6 categories and "GOLD" is the least hazardous category. Those chemicals that cannot be modelled by CHARM are assigned to a category (A to E) based on toxicity assessment, biodegradation and bioaccumulation potential. Category E is the least harmful category. Source: CEFAS, Offshore Chemical Notification Scheme - Ranked Lists of Notified Chemicals, Updated August 2010. Full details of the determination of hazard categories can be found in Appendix 5C.

Used WBM and cuttings from the 28” hole section will be returned to the MODU via a riserless Mud Recovery System (MRS). The riserless MRS consists of a subsea pump located on the seabed with a wellhead adapter which allows the attachment of hoses to the wellhead outlet valves. The seabed pump sucks WBM from the wellhead and returns it, along with cuttings to the MODU via a series of hoses. The mud and cuttings will then be treated in a solids control unit, separating mud from the cuttings onboard the MODU. However, mud / cuttings from the 28” hole section may be discharged directly to the seabed if required due to technical practicalities or safety issues.

The MRS does not seal the wellhead; it is open to allow the drill bit and drillstring access to the wellbore. To prevent excess mud being pumped out of the top of the wellhead, the pump rate of the subsea pump and rig mud pumps must be consistent. This is managed using a camera system which is installed on top of the MRS to monitor the mud level in the wellhead; the operator of the subsea pump and the driller will communicate to maintain consistent pump rates.

However, if, as a result of shale hydration, the MRS hoses become blocked then excess mud will be pumped out of the top of the wellhead and discharged at the seabed, similar to the 42” and 32” hole sections. Discharge at the seabed may also occur if there is a sudden flow of sands or fluids from the well onto the seafloor, known as shallow flow. This would be controlled by pumping mud at a high rate down the well causing the discharge of excess mud at the seabed. This would be undertaken for safety reasons as the MRS system does not have a well control capability[3].

The intention is not to routinely discharge WBM at the seabed, but if a blockage of the MRS hoses occurs, then WBM will be discharged while the hoses are cleared. It is not possible to shut down the MRS while the blockage is cleared as it is necessary for any rock cuttings in the hole to be removed to avoid the drillstring becoming stuck.

It is anticipated that it will take 10-15 minutes to restore the MRS and depending on the stage of drilling, the discharge volume would vary between 13-62m^3.

WBM cuttings will be discharged below the sea surface from the Istiglal and Heydar Aliyev in accordance with applicable PSA requirements[4]. WBM cuttings from the MODU can alternatively, be discharged directly to the sea bed using a hose fitted to the MODU cuttings chute.

It is not possible to preserve the separated WBM to allow for shipping to shore or other drilling rigs/platforms upon completion of drilling the geotechnical holes and the 28” hole sections. When drilling of the geotechnical holes and the 28” hole sections is completed excess mud will be discharged to sea in accordance with PSA requirements[4]; the total quantities for the SD2 Project are summarised in Table 5.6 below.

Depending on the drilling schedule, it is possible that batch setting may be undertaken. This involves drilling and casing the top hole sections (42” and 32”) of a number of adjacent wells, then temporarily suspending them with WBM treated with magnesium oxide before returning to drill the 28” and lower hole sections of the wells. The treated WBM would be discharged to sea from the top hole sections. During suspension the well would be isolated from the environment using a corrosion cap.

Lower 22”, 18” 16$^1/_2$” 16” 12$^1/_4$” & 8$^1/_2$ Hole Sections

To improve well bore stability, ensure appropriate lubrication, inhibit potential reactions with the shale sequence present in the Contract Area and minimise the risk of stuck pipe, it will be necessary to change to a Low Toxic Mineral Oil Based Mud (LTMOBM) for the 22”, 18” 16$^1/_2$” 16” 12$^1/_4$” & 8$^1/_2$ lower hole sections. The density of the drilling mud system will be monitored and adjusted by the addition of chemicals according to the down-hole conditions.

[3] Well control equipment is not installed at this stage to mitigate against weak formation.
[4] There shall be no discharge of drill cuttings or drilling fluids from the MODU if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water.

The density and chemical composition of the LTMOBM will be dependent on the actual well conditions encountered during drilling operations.

Table 5.5 presents the typical composition and estimated volumes of LTMOBM expected to be used per hole.

Table 5.5 Estimated Use of LTMOBM Drilling Chemicals Per Hole –22", 18" $16^1/_2$" 16" $12^1/_4$" & $8^1/_2$ Lower Hole Sections

Chemical	Trade Name	Function	Estimated Use per Well (tonnes)[1] All lower hole sections	Hazard Category[2]
Barite	M-I-Barite	Weighting Agent	4150	E
Base Oil	Escaid 110	Mineral Oil base fluid	2522	C
Organophyllic Clay	VG Plus	Viscosfier	79	E
Graphite & Lignite	Versatrol M	Fluid Loss Control	72	E
Calcium hydroxide	Lime	Alkalinity control	36	E
Emulsifier	SUREMUL PLUS	Mud Stability	131	D
SBM Polymer	Ecotrol RD	Fluid Loss Control	9	E
Calcium Chloride	Calcium Chloride	Borehole Stabiliser	339	E
Polyamide/Ethanol	EMI-1005	Viscosfier	10	*
Acrylic Graft Polymer	EMI-2223	Anti-accretion	10	*
Calcium Carbonate	Safecarb Z4	Lost Circulation and seepage control	100	E
Calcium Carbonate	Durcal 130	Lost Circulation and seepage control	85	E
Graphite	G Seal Plus	Lost Circulation and seepage control	85	E

* Not currently listed into UK OCNS Ranked Lists of Notified Products
Notes as per Table 5.4

Used LTMOBM and associated cuttings will be returned to the MODU via the marine riser, installed after the 22" diameter casing has been cemented in place. Onboard the MODU, mud and cuttings will pass through the MODU Solids Circulation System (SCS) that separates LTMOBM from cuttings via a series of shale shakers, a vacuum degasser and centrifuges, which in turn, separate increasingly smaller cutting particles from the mud. Separated LTMOBM will be reused where practicable, and the remainder returned to shore for disposal. LTMOBM associated drill cuttings will be contained in dedicated cuttings skips on the rig deck for subsequent transfer to shore for treatment and final disposal. It is not planned to release any LTMOBM or associated cuttings into the marine environment.

5.4.2.5 Summary of Mud and Cuttings

Table 5.6 presents the estimated quantities of waste drilling fluids and cuttings for each geotechnical hole (if required) and each well hole section (based on the experience of the project engineers and the diameter and length of each well section) and the planned disposal route.

Table 5.6 Estimated Well Cuttings and Mud Volumes Per Hole

Hole Size (Drill Bit Diameter)	Description	Estimated Fluids Discharged (Tonnes)[1,2]	Estimated Cuttings Discharged (Tonnes)	Estimated Cuttings Shipped to Shore (Tonnes)	Estimated Fluids Shipped to Shore (Tonnes)	Drilling Fluid/ Mud System	Cuttings and Mud Disposal	Duration of Discharge (hours)
12 1/4"	Pilot hole	1,015	50	0	0	WBM	At seabed	60
9”	Geotechnical hole	1,930	75	0	0			576
	Residual Mud (following geotechnical hole drilling)	495	n/a	0	0	WBM	To sea via rig cuttings caisson	6
42”	Conductor and Surface Holes	1,339	443	0	0	Seawater & PHB sweeps	At seabed	60
32”		1,339	442	0	0			60
28”	Surface Hole	522	729	0	0	WBM	To sea via rig cuttings caisson or hose. Plan to use MRS to recover mud.	50
	Residual Mud at end of WBM drilling	943	n/a	0	0		To sea via rig cuttings caisson	48
18" 16.5" 16" 12 1/4" 8.5"	Lower Holes	No planned discharge		2,823	Up to 5,062[3]	LTMOBM	Ship to shore.	

Notes:
[1]The WBM chemical usage includes water. Currently WBM is not stored for reuse. Untreated WBM is not stable over extended periods without additions of viscosifier and biocide.
[2] Note that estimates of WBM discharged is not equivalent to the estimated volumes of chemical used as per Table 5.4. This is because allowance is made for mud volumes left behind in casings.
3 Estimated volume of LTMOBM shipped to shore is conservative as it excludes mud volumes left behind in the well following casing, attached to the cuttings shipped to shore and the LTOBM returned to shore for reuse on subsequent wells.

5.4.2.6 Casing and Cementing

Once each hole section is drilled, a steel casing string will be installed and cemented into place. The casing provides structural strength for the well, protecting it from weak or unstable formations and is cemented into place by pumping cement slurry into the well bore. The cement passes around the open lower end of the casing and into the annulus between the casing outer wall and the host rock formation in the case of the top-hole conductor. For subsequent casings, the cement passes between the casing outer wall and inner wall of the previous casing. For each surface casing string (42” and 32” hole sections), some loss of cement to the seafloor usually occurs due to the need to slightly overfill the annulus to complete the casing cementing, required to ensure the casing is fully cemented to the seabed to prevent the well and specifically the conductor section from becoming unstable and potentially failing. Cement losses per well are estimated to occur over approximately 1 hour per hole.

The volume of cement used to cement each casing is calculated prior to the start of the activity. Sufficient cement is used to ensure that the casing is cemented securely and necessary formations isolated so that this safety and production critical activity is completed effectively while minimising excess cement discharges to the sea. However, at the end of cementing each casing string excess cement will remain in the MODU cement system. It is not technically practicable or safe to recover this.

Excess cement remaining in the cement system will be mixed with seawater and discharged to the marine environment following the cementing of each casings. The discharge will take approximately an hour at a rate of 8 barrels per minute. Excess cement from well cementing will be discharged using a hose located below the sea surface, for both the Istiglal and Heydar Aliyev. Dry cement will not be discharged to the marine environment under routine conditions.

Table 5.7 below presents the estimates of the worst-case volume discharged to the seafloor during casing cementing and from the drilling rig to sea during wash out of the cement unit. The estimated discharges of each cement chemical and the associated hazard categories are presented in Appendix 5B.

Table 5.7 Estimated Discharge of Well Cement Chemicals per Hole During Cementing and Cement Unit Wash Out

Activity	Discharge Route	36" Casing	28" Liner	22" Casing	18" Liner	16" Liner	13 3/8" X 13 5/8" Casing	11 1/4" Liner	10" X 10 3/4" Liner & Tieback
		Estimated Discharge per Casing/Liner (tonnes) [1]							
During casing/ liner cementing	To seafloor	60.0	57.2	48.7	6.5	6.38	9.0	4.4	8.6
During cement unit wash out[1]	To sea (via hose)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Note 1. Discharge comprises cement and water.

Following drilling and cementing, seabed levelling work may be required at the well locations to remove any accumulation of drill cuttings and cement, involving either mechanical excavation or jetting with seawater, prior to subsea installation works.

5.4.2.7 Drilling Hazards and Contingency Chemicals

A number of contingency chemicals will be retained for use in the event that hazards are encountered during drilling, predominantly associated with downhole mud losses. These are a risk due to the relationship between the pore pressure and the rock strength. Well paths are deliberately chosen to avoid zones of excessive pore pressure, where the pore pressure approaches the fracture pressure of the rock. The mud weight required to stabilise the borehole effectively fractures the rock and results in downhole losses. To prevent this, Loss Control Materials (LCM) can be added to the mud system. In addition magnesium oxide is also retained on the rig should batch setting be undertaken as described in Section 5.4.2.4 above.

Table 5.8 lists the anticipated chemicals intended to be stored on the rigs, used in the event of contingencies when drilling with WBM and subsequently discharged with the WBM either to the seafloor or from the MODU. By definition the use of contingency chemicals cannot be predicted with accuracy, although their use will be minimised to the extent practicable in accordance with operational needs.

Table 5.8 Estimated Usage of WBM Drilling Contingency Chemicals per Hole

Chemical Trade Name	Function	Estimated use per Hole (tonnes)[1]	Hazard Category[2]
STARCARB	Sealing/Bridging Agent	15	E
STEELSEAL	Sealing/Bridging Agent	15	E
EZ SPOT	Spotting Fluid	2.3	*
STARCIDE	Biocide	1.3	GOLD
OXYGON	Oxygen Scavenger	0.3	E
SOURSCAV	H_2S Scavenger	1.9	GOLD
Bentonite	Viscosifier	5	E
Sodium Bicarbonate	Alkalinity Control	1	E
Magnesium Oxide	pH Control	6	E

* Not currently listed into UK OCNS Ranked Lists of Notified Products
[1]Notes as per Table 5.4

The majority of contingency chemicals are planned to be used during lower hole drilling and will be recovered with the LTMOBM and shipped to shore for disposal. Contingency chemicals required during drilling of the 42”, 32” and 28” hole sections will be discharged with the seawater/PHB sweeps to the seabed or with the WBM cuttings via the rig cuttings chute.

5.4.3 Well Displacement

Displacement of the SD2 Project wells will be achieved by circulating a number of fluid slugs or “pills”. The function of the displacement pills (lighter synthetic mud sweeps) is to displace any LTMOBM from the well. During well displacement, displacement pills will be circulated back to the MODU with the LTMOBM and either be reused/recycled or will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures. Displacement chemicals or fluids will not be discharged to the marine environment under routine conditions. Solids collected within the MODU separator during well displacement will be collected and shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

5.4.4 Blow Out Preventer (BOP) and Wellhead Brace

5.4.4.1 BOP Operation

A blow out preventer (BOP) will be installed on all wells to control pressure in the well prior to installation of the well production facilities. The BOP control system uses hydraulic fluids to actuate the BOP valves. The response time between activation and complete function is based on the BOP valve closure and seal off time. For subsea installations, the BOP control system should be capable of closing each ram BOP in 45 seconds or less. Closing times should not exceed 60 seconds for annular BOPs. In order to comply with these response times, it is necessary to discharge small volumes of hydraulic fluid to sea; this design and practice is used in all BOP installations worldwide.

The BOP fluid comprises a proprietary control fluid (Stack Magic ECO Fv2), propylene glycol and water. The active components of Stack Magic ECO Fv2 and the typical proportions of this product, propylene glycol and water in the BOP fluid as a whole are summarised in Table 5.9.

Table 5.9 Percentage Composition of Stack Magic and BOP Fluid

Control Fluid	Percentage	BOP Fluid	Percentage (%)
Ethylene glycol	10-**30**	Control Fluid	3-**5**
Monoethanolamine	1-**10**	Propylene glycol	5-**25**
Triazine	1-**5**	Water	**70**-90
Triethanolamine	1-**10**		
Water	**45**-87		

It is anticipated that BOP testing will take place weekly for each well from when the BOP is installed to the end of completion activities (approximately 210 days for each well). On alternate weeks, either function testing (one pod) or full function/pressure testing (two pods) will be carried out. Table 5.10 summarises individual discharge events and the estimated volume discharged per event for two pod full function/pressure testing. Discharges from single-pod flushing will be 50% of the volumes and durations indicated in Table 5.10.

Table 5.10 Summary of BOP Fluid Discharge Events Per Well – Two Pods

BOP Function	Volume (litres)	Duration (min)	Depth	Frequency
Upper Annular	654	3.00	Depends on well location: WS: 410m ES: 530m WF: 165m EN: 470m NF: 70m	Fortnightly – 2 pod test
Lower Annular	644	3.00		
Upper Pipe Ram	260	1.16		
Middle Pipe Ram	264	1.16		
Lower Pipe Ram	70	1.16		
Upper Outer Choke (U.O.C) line	20	0.57		
Upper Inner Choke (U.I.C) line	20	0.57		
Lower Outer Choke (L.O.C) line	20	0.57		
Lower Inner Choke (L.I.C) line	20	0.57		
Upper Outer Choke (U.O.K) line	20	0.57		
Upper Inner Kill (U.I.K) line	20	0.5		
Lower Outer Kill (L.O.K) line	20	0.5		
Lower Inner Kill (L.I.K) line	20	0.5		
Total	**2,052**	**13.8**		

5.4.4.2 Wellhead Brace Installation

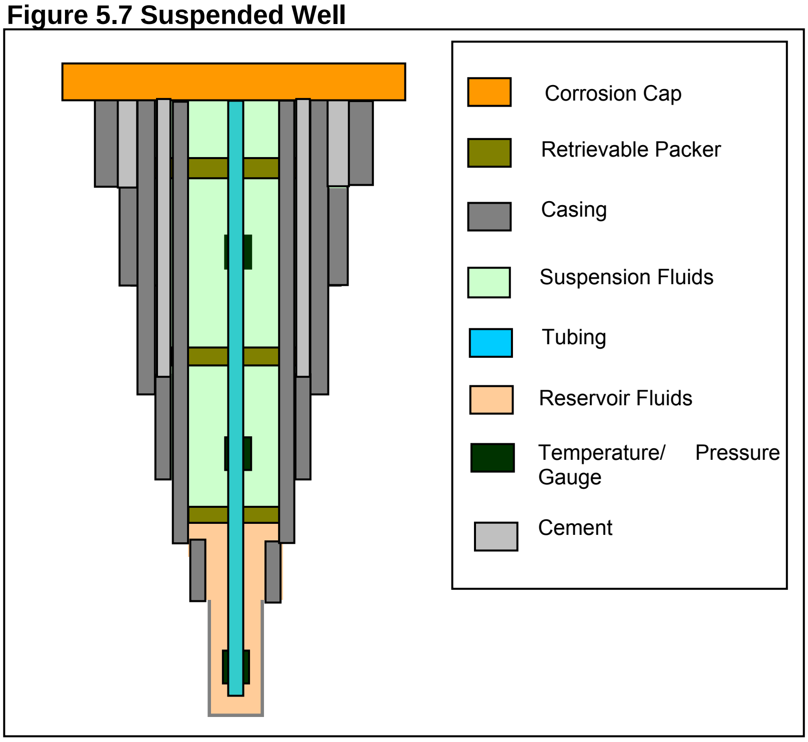
To support the wellhead during installation of the BOP and production tree it is planned to install a wellhead brace at each well location. The purpose of the brace is to minimise wellhead fatigue caused by the weight of the combined BOP and production tree. It is planned to install the bracing frame over the wellhead on the sea floor, temporarily supported by mudmats and subsequently secured using three piles. The frame and wellhead will then be connected, potentially using a grouted connection, which may result in a small discharge of cement to the seabed in the immediate vicinity of the wellhead.

5.4.5 Well Suspension

Following drilling, casing, cementing and displacement, the well is temporarily suspended by filling it with treated brine, which will protect it from any pressurised formations. It is anticipated that either calcium bromide, calcium chloride or sodium chloride brine will be used, depending on the downhole conditions of each well. Well suspension fluids will not be discharged to the marine environment under routine conditions.

The well will be isolated using mechanical packers, which isolate the zones within the well and a corrosion cap is installed on the subsea wellhead. The purpose of the cap is to cover the well until the production tree is installed. Figure 5.7 shows the suspended well.

Figure 5.7 Suspended Well



5.4.6 Well Re-entry and Completion

Well re-entry and completion activities will be undertaken for all 26 SD2 wells from either the Istiglal or Heydar Aliyev MODU. Following removal of the corrosion cap, the production tree will be installed and brines (as described within Section 5.4.5) will be circulated in the well to remove any remaining solids. Completion activities required to make the well ready for production will then commence. The intermediate completion will involve installation of a lubricator valve and packers into the wells to allow the well to be perforated in the presence of the brine such that perforated section remains isolated below the valve. The perforation gun assembly will be withdrawn through the valve and the well cleaned up using surfactant sweeps and clean brine.

Production tubing and associated down-hole tools (e.g. pressure gauges and down-hole safety valves) will then be installed and freshwater and MEG circulated within the well. The well will then undergo final clean up. It is planned to circulate all completion and clean up fluids back to the MODU, where they will be contained and shipped to shore for disposal. It is not planned to discharge any completion fluids.

During clean up as fluids flow to the MODU, it is anticipated that up to 500mmscfd (250mmscfd on average) will be flared on the MODU per well for up to 2 days.

5.4.7 Well Testing

The current base case assumes that well testing of one well in the WS flank and one well in EN flank will be undertaken. Well tests comprise flowing of formation fluids to the surface where pressure, temperature and flow rate measurements are made to evaluate well performance characteristics. The flow test, expected to last for up to 150 hours in total, will result in flaring of up to approximately 250mmscf of gas per well.

During the tests, gas and condensate will flow up the drilling string to the MODU where they will be separated, analysed and then flared at the rig flare boom. Solids collected within the MODU separator during flaring will be collected and shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures. It is estimated approximately 400kg of solids (comprising mostly sand and rock) will be collected per well.

Estimated volumes of atmospheric emissions associated with potential well testing are provided in Table 5.11 below. Further details associated with flare testing including an overview of the BP Well Test Assurance Process, designed to minimise flaring through effective well planning, are provided in Chapter 4 Section 4.10 of this ESIA

5.4.8 Well Workover and Intervention Activities

In order to maintain production it will be necessary to re-enter the SD2 wells from a MODU to undertake workover and intervention activities. These will include logging activities, circulating chemicals to remove build up of solids, re-perforations and replacement of tubing as well as drilling of sidetracks to improve flow from the SD2 wells. It is anticipated that there could be up to a total of 160 separate intervention events following well start up with each event requiring up to 9 days of MODU support per year. It is estimated that approximately half of the anticipated intervention events will result in flaring of up to 80MMscfd for one day. Solids collected within the MODU separator during flaring will be collected and shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures. During intervention events all workover and intervention fluids will be circulated back to the MODU, where they will be contained and shipped to shore for disposal. It is not planned to discharge any workover and intervention fluids.

5.4.9 MODU Drilling and Completion Emissions, Discharges and Waste

5.4.9.1 Summary of Emissions to Atmosphere

Table 5.11 summarises the GHG (i.e. CO_2 and CH_4[5]) and non GHG emissions predicted for the SD2 Project MODU drilling and completion activities. Key sources include:

- MODU engines and generators;
- MODU support/supply vessel engines; and
- Non routine flaring associated with well testing, clean up and intervention/workover activities.

Table 5.11 Estimated GHG and Non GHG Emissions Associated with Routine and Non Routine Drilling, Completion and Intervention Activities

	MODU	Support Vessels	Flaring	TOTAL
CO_2 (ktonnes)	229.6	546.5	619.8	**1,395.9**
CO (tonnes)	1,123.8	1,284.4	1,483.2	**3,891.4**
NO_x (tonnes)	3,577.1	9,392.5	265.6	**13,235.2**
SO_x (tonnes)	287.0	1,276.6	2.8	**1,566.3**
CH_4 (tonnes)	10.8	42.9	9,961.8	**10,015.5**
NMVOC (tonnes)	41.4	385.3	1,106.9	**1,533.6**
GHG (ktonnes)	229.8	547.4	829.0	**1,606.2**

Refer to Appendix 5A for emissions estimate assumptions.

5.4.9.2 Summary of Discharges to Sea

Table 5.12 provides a summary of the total estimated routine and non routine drilling fluid, cuttings and cement discharges to sea across the SD2 Project programme associated with planned activities.

Table 5.12 Total Estimated Drilling Fluids and Cement Discharges to Sea

Discharge	Frequency	Location	Estimated Volume (tonnes)	Discharge Composition
Seawater, PHB sweeps and cuttings	During 42” and 32” hole section drilling	Seabed	14,160 cuttings and 42,848 drilling fluids	Refer to Table 5.4
WBM and cuttings	During pilot hole drilling	Seabed	200 cuttings and 4060 WBM on cuttings	Refer to Table 5.4
	During geotechnical hole drilling	Seabed	300 cuttings and 7,720WBM on cuttings	Refer to Table 5.4
	During 28” hole section drilling	To sea (via cuttings chute)	11,664 cuttings and 8,352 WBM on cuttings	Refer to Table 5.4
Cement and cement chemicals	During each casing cementing	Seabed	3,206	Refer to Appendix 5B
Residual WBM	At end of geotechnical hole and 28” hole drilling	To sea (via cuttings chute)	17,068	Refer to Table 5.4
Residual cement	At the end of each casing section	To sea (via cuttings chute)	256	Refer to Appendix 5B

Note 1. Should the MRS fail or it becomes technically impractical or unsafe to use it, WBM and cuttings from the 28” hole section will be discharged directly to the seabed.

Discharges of hydraulic fluids to sea due to testing of the BOP are detailed in Section 5.4.4.1 above.

[5] To convert to CO_2 equivalent the predicted volume of CH_4 is multiplied by a global warming potential of 21.

5.4.9.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste generated during the SD2 Project drilling programme are provided in Table 5.13. Waste quantities have been estimated based on operational data from the drilling programmes of the previous SD wells using the Istiglal rig.
All waste generated during MODU drilling and completion activities will be managed in accordance with the existing AGT waste management plans and procedures. The planned destination of each waste stream is provided within Section 5.14.2 below.

Table 5.13 Drilling and Completion Activities Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Cement	2,521
		Domestic/Office waste	2,155
		Metals - swarf	802
		Paper and cardboard	12
		Wood	547
		Total (Non-hazardous)	**6,037**
Hazardous	Solid wastes	Batteries - dry cell	3
		Batteries - wet cell	5
		Clinical waste	4
		Contaminated materials	642
		Drilling muds and cuttings SOBM	84,171
		Explosives	1
		Filter bodies	15
		Lamps	1
		Oily rags	318
		Toner or printer cartridges	2
	Liquid wastes	Bentonite	381
		Completion fluids	21
		Drilling additives	1,393
		Drilling muds and cuttings WBM - contaminated	7,598
		Drilling muds and cuttings SOBM	9,808
		Oils - fuel	1,418
		Paints and coatings	12
		Sewage - untreated	124
		Solvents, degreasers and thinners	61
		Water - oily	19,181
		Well suspension fluids	114
		Total (Hazardous)	**125,270**

5.5 Onshore Construction and Commissioning of Terminal Facilities

5.5.1 Introduction

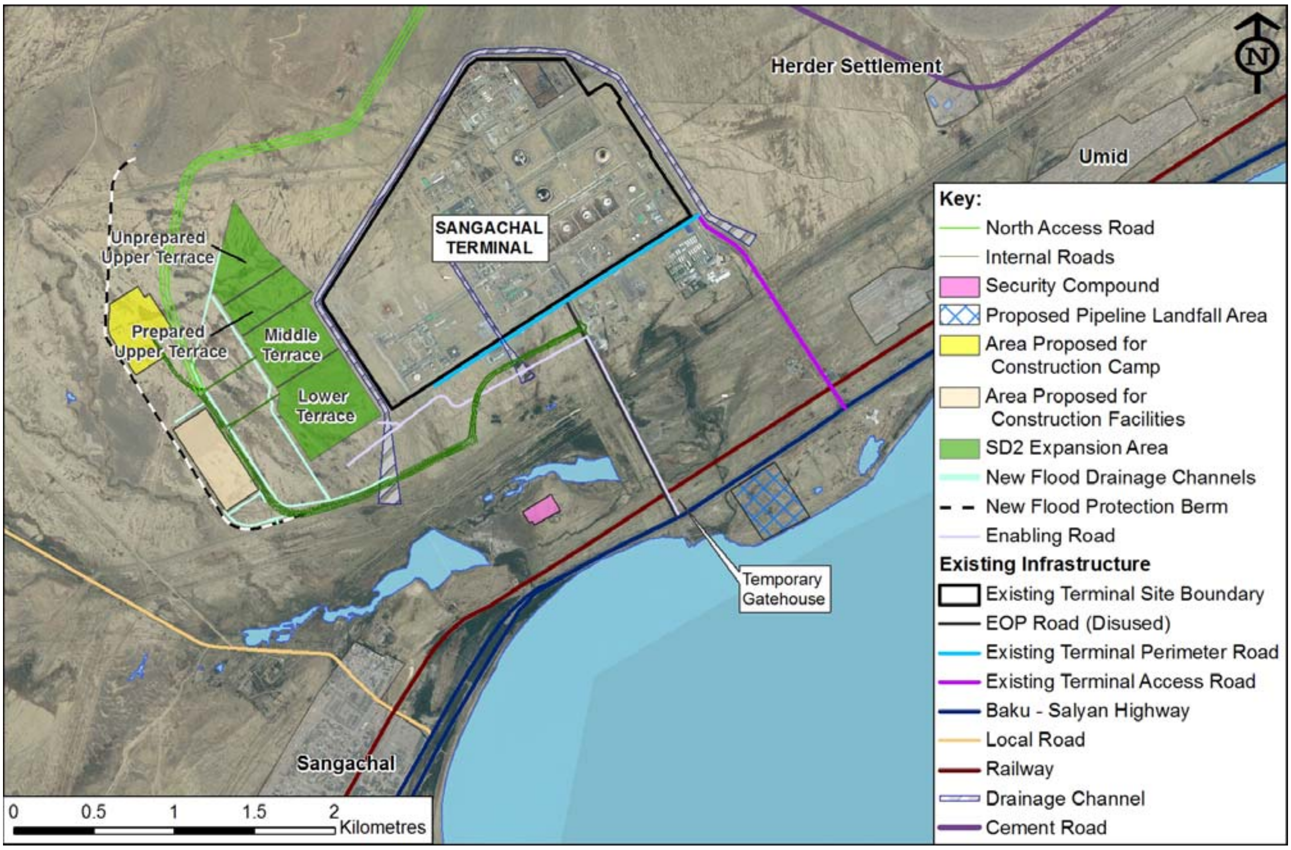
The onshore SD2 processing facilities and associated utilities will be located within the SD2 Expansion Area at the ST, immediately to the west of the existing SD1 facilities and within the current Terminal land ownership boundary.

As outlined in Section 5.1 above the SD2 EIW at the ST are ongoing. It is anticipated the following works will be undertaken as part of the SD2 EIW contractor's scope prior to handover to the SD2 Project contractor during 2Q 2014 (refer to Figure 5.8):

- Construction of access roads (temporary and permanent) to the SD2 Expansion Area and the associated construction areas;
- Construction of a flood protection berm, storm drainage channels and improvement works to the existing drainage in the Terminal vicinity; and
- Profiling of the ground levels across the SD2 Expansion Area.

These activities are assessed within the SD2 Infrastructure ESIA[6]. In addition, a new access road will be constructed between the Baku-Salyan Highway and the SD2 Expansion Area to the north of the Terminal.

Figure 5.8 Scope of SD2 Early Infrastructure Works

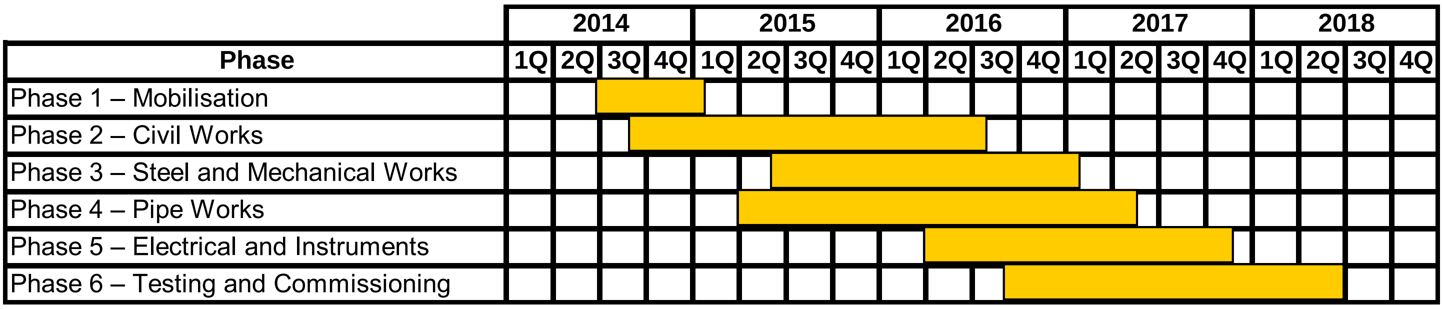


Any residual elements of the SD2 EIW which are not completed by the SD2 EIW contractor will be passed to and become the responsibility of the SD2 Project contractor.

The anticipated schedule for the SD2 Terminal construction and commissioning activities is shown in Figure 5.9.

[6] SD2 Infrastructure ESIA (2012)

Figure 5.9 Expected SD2 Terminal Construction Works Schedule



The key activities associated with each phase are described in Section 5.5.2 below. The facilities and utilities planned to be used to support the SD2 Terminal construction works are described in Section 5.5.3.

5.5.2 Terminal Construction and Commissioning Activities

5.5.2.1 Phase 1 – Mobilisation

Phase 1 of the works (mobilisation) is planned to include the completion of the preparation works at the Terminal not completed by the SD2 EIW contractor. In addition to completing any site clearance, access road and profiling work, these are expected to include:

- Construction and fit out of construction camp comprising:
  - Accommodation;
  - Laundry;
  - Communications and information technology facilities;
  - Washrooms;
  - Security facilities;
  - Lockers; and
  - Welfare and dining facilities.

- Construction and fit out of construction support facilities including:
  - Offices;
  - Warehouses;
  - Workshops;
  - Laydown areas;
  - Fabrication areas;
  - Laboratory;
  - Cylinder and fuel store;
  - Vehicle maintenance;
  - Dining facilities;
  - Maintenance and radiographics facilities;
  - Medical, welfare and changing facilities.
  - Brownfield site offices within the terminal property boundary to the north east of the current open drains tank and produced water plant; and
  - Car parking facilities.

  Security facilities, site entry and egress systems and site boundary fencing will also be provided. It is planned to locate the construction camp and facilities areas between the new flood berm and the new internal access roads shown in Figure 5.8. All structures are expected to be no more than 10m high once assembled.

- Utility works to connect the construction camp and construction facilities to mains power and water[7]. There are no planned connections to the municipal sewage

[7] It is anticipated that works associated with diversion of overhead and underground power cables required in the vicinity of the SD2 Expansion Area will be completed during the EIW. It is intended that the works will be designed and completed by the power line owner, who will be responsible for managing the works including possible interruptions to power supply.

network. Some of the site telecommunication systems will be tied to public systems. Telephones will be connected to Public Main Fibre Optic Cable. Connections with the mains water supply will be managed in liaison with the utility owner. It is anticipated that pipework associated with the construction camp drainage system will also be installed, leak tested and may be superchlorinated. Effluent from the pipework testing and chlorination that meets the applicable sewage and oil water performance and monitoring standards presented in Table 5.14 will either be used for irrigation and/or dust control or discharged. Out of spec effluent will be collected by road tanker, handled as liquid waste and removed from site.

Table 5.14 Oil Water and STP Discharge Standards

Parameter	Units	Limit Value
Oil Water Standards		
Oil in water (monthly average)	mg/l	10
Oil in water (daily maximum)	mg/l	19
STP Design Standards		
pH	-	6-9
Residual Chlorine	mg/l	<1[1]
		<0.2[2]
BOD	mg/l	20
COD	mg/l	100
Total Suspended Solids (TSS)	mg/l	30
Total Coliforms	MPN/100ml	<400

Notes: 1. Applicable to treated sewage used for irrigation or dust control. 2. Applicable to treated sewage discharged to the environment.

- Construction and commissioning of a modular type Sewage Treatment Plant (STP) sized to accommodate sewage generated from:

  - North construction camp and south construction facilities; and
  - SD2 Terminal Expansion Area;

  The STP will be designed to treat domestic water (including grey and black water) to applicable performance and monitoring standards in Table 5.14. During construction of the SD2 onshore facilities, sewage will be routed to the new STP when operational or collected by road tanker, handled as liquid waste and removed from site.

  Under routine conditions it is planned that treated sewage from the new STP will be either:

  - Discharged to the Shachkaiya Wadi; or
  - Used for irrigation purposes or for dust control where practicable and required.

  Sewage sludge will be transported off site for disposal to an appropriately licensed facility. Sumps will be used to provide contingency storage when the STP requires maintenance or is not available. Waste water from the sumps will be collected by road tanker, handled as liquid waste and removed from site.
- Construction of a central waste accumulation area (CWAA) for use during SD2 onshore facilities construction where waste will be segregated and stored prior to transport offsite.
- Construction of a dedicated vehicle refuelling facility (approximately 300m^2) for vehicle refuelling. The area will include lined concrete bunds, sized to contain 110% of the stored fuel capacity. Drainage within the refuelling facility will be routed to an oil water separator system. The refuelling facility oil water separators will be tested on a daily basis to confirm the total oil content is less than 19mg/l daily average and 10mg/l monthly average. Wastewater from the refuelling facility that does not meet the applicable discharge standards and separated oil will be collected by road tanker,

handled as liquid waste and removed from site. Once the refuelling facility is operational it is intended that plant and vehicles associated with the SD2 Infrastructure Project will either be refuelled at the facility or in the location where they are operating via mobile fuel bowsers.

- Construction of a vehicle wash facility. Wastewater from the vehicle wash facility will either be reused or discharged following treatment via an oil water separator. The vehicle wash facility oil water separators will be tested on a daily basis to confirm the total oil content is less than 10mg/l. Wastewater from the vehicle wash facility that does not meet the applicable discharge standards and separated oil will be collected by road tanker, handled as liquid waste and removed from site.
- Construction of a potable water plant designed to treat mains water to potable water standards.

While not included within the Base Case Design, space has been allocated for a concrete batching plant and an associated area for materials and precast storage.

The drainage system within the construction camp and construction facilities area will be designed to:

- Route wastewater from the vehicle wash and refuelling facilities for reuse or discharged after treatment using oil water separators. The oil water separators will be designed to treat wastewater from the vehicle wash facility to applicable oil water standards of 19 mg/l daily average and 10 mg/l monthly average. The separators will be tested on a daily basis to confirm the total oil content daily and average standards are met. Wastewater from the vehicle wash and refuelling facilities that does not meet the applicable discharge standards will be collected by road tanker, handled as liquid waste and removed from site.
- Route canteen waste water to the STP via a dedicated system to separate fats, oil and grease to minimise potential fouling of the STP. The contents of the traps will be collected by road tanker, handled as liquid waste and removed from site.

It is expected that high level lighting, designed in accordance with international standards e.g. ILE requirements, will be erected at the construction camp and construction facilities areas.

5.5.2.2 Phase 2 – Civil Works

Following mobilisation, construction works are planned to commence with civil works comprising:

- Piling – Piling will be undertaken across the lower, middle and upper terraces to support the majority of the foundations across the SD2 Expansion Area. A total of approximately 10,000 piles are planned, varying between 450-900mm in diameter and 10-15m in length. Piling is anticipated to last approximately 390 days with 25 piles installed per day;

  Underground pipework - This will comprise pipework associated with clean storm water drainage, open (contaminated) drainage, closed drainage and firewater networks within the SD2 Expansion Area;

- Pile Caps and Foundations – Following piling it is planned to install pile caps and ground beams and lay the foundations for all main structures including :
  - Off Specification Condensate Tank;
  - Condensate Storage Tank (located within the existing Terminal boundary);
  - Rich MEG Storage Tank;
  - Lean MEG Storage Tank;
  - Produced Water Storage Tank;
  - Open Drains Holding Tank; and
  - Fire Water Holding Tank.

The current base case design for the bund floors and berms for these tanks (with the exception of the Fire Water Holding Tank) assumes that the clay available on site can be re-compacted to provide a liner of sufficiently low permeability, in conjunction with a continuous High Density Polyethylene liner. Compaction trials are planned to confirm the suitability of the compacted clay for this purpose, in the event the clay is found to be unsuitable an alternative lining system will be selected; and

- Road and Site Civils – It is planned to construct a network of permanent internal roads within the SD2 Expansion Area. These will connect with the internal roads and the access road constructed as part of the EIW.

5.5.2.3 Phase 3 - Steel and Mechanical Works and Phase 4 - Pipe Works

Phase 3 will involve the fabrication and erection of pipe racks and structural steel work in addition to the installation of mechanical equipment (i.e. pre fabricated process and utility equipment and associated components) and Non Destructive Testing (NDT). All steelwork will have been grit blasted and painted prior to arrival on site. Assembly of the steel structures will be undertaken on site with minor repairs to paintwork damaged during erection undertaken in the field. It is anticipated that control rooms and administration buildings will be erected at the same time as the mechanical equipment.

Pipe will be welded together in situ. Pipework associated with spool fabrication will be painted offsite whereas the majority of straight pipe sections are expected to be painted on site. Pipework will also be installed to tie in the existing Terminal facilities and the new SD2 facilities where required.

5.5.2.4 Phase 5 – Electrical and Instruments and Phase 6 - Testing and Commissioning

Installation of electrical systems and control systems (Phase 5) will take place after completion of the mechanical systems as most control equipment needs to be fully integrated with mechanical or process equipment.

Following mechanical completion and testing of the electrical and control systems, all equipment will be first pre-commissioned (tested in isolation from other equipment) and then commissioned together with directly associated equipment. It is intended that the following equipment will be hydrotested:

- All process and utility lines;
- Storage tanks; and
- Civil basins / structures (including sumps, manholes and drainage systems).

For each test the system will be filled with freshwater and then emptied. An estimated 212,000m^3 of freshwater will be used. If possible and where practical, the hydrotest water will be temporarily stored and reused. Following the completion of testing the hydrotest water will either be discharged to the site drainage system if it conforms with oil content of less than 19mg/l daily average and applicable project sewage wastewater discharge standards (refer to Table 5.14) or collected by road tanker, handled as liquid waste and removed from site.

Final commissioning and testing activities are planned to comprise:

- Testing of the turbine for SD2 power generation – it is planned to test the power generation turbine over a 21 day period over a range of power loads from idle to full load. Gas will be supplied from the existing SD1 facilities during these tests with power generated exported to the Azeri grid.

- Testing of export gas compression turbines – each gas compression turbine is expected to be run for up to 24 hours. Gas will be supplied from the existing SD1 facilities
- Diesel user testing – it is planned to test the following diesel users for a maximum of 24 hours:
    - o Air compressor package; and
    - o Firewater pumps.
- Leak testing of vessels and major plant– final leak testing will be completed using inert gas (i.e. nitrogen or nitrogen/helium);
- Open drains treatment system flushing – The open drains treatment system will be flushed using freshwater to remove any debris within the system prior to start up. Prior to flushing of the complete drainage system, water samples from all drainage sumps will be tested to confirm the oil content. If the oil content of the water in the sumps exceeds 19mg/l daily average[8] the contents of the sump will be collected by road tanker, handled as liquid waste and removed from site. If the total oil content of the water in the sumps is lower than 19mg/l, the sump content will be discharged to the storm drainage channels.
- Produced water system – It is planned to send produced water from the SD2 produced water treatment system which meets the relevant inlet specifications to the ACG produced water treatment facilities. Off spec produced water during commissioning will be sent to the SD2 produced water holding tank and either recycled to the SD2 produced water treatment system and then sent to the ACG produced water treatment facilities (if inlet specifications are met) or tankered off site.

5.5.3 SD2 Terminal Facilities Construction Utilities and Support

5.5.3.1 Utilities

Utilities will include:

- Power – the majority of power at the north construction camp and south construction facilities will be provided from the Azeri grid. Emergency back-up by diesel generators will be provided at the construction camp and the construction camp facilities. Diesel generators will also be used across the SD2 Expansion Area during construction and commissioning for temporary power supply prior to completion of electrical system tie in works. When required, the generators will be refuelled from the dedicated refuelling facility by mobile bowsers (see below); and
- Water – potable and non potable water will be available at the north construction camp and south construction facilities. Water for general use within the SD2 Expansion Area (including dust suppression when needed) will be supplied by bowsers as required.

5.5.3.2 Waste

It is planned to route the waste generated during Terminal construction works to a new CWAA (refer to Section 5.5.2.1 above), where it will be segregated and stored prior to transportation offsite. Section 5.5.4 below details the types of waste expected and how waste will be managed across the Terminal construction phases.

5.5.3.3 Fuel Storage and Refuelling

It is intended that plant and vehicles associated with the SD2 Project will either be refuelled at the new SD2 dedicated vehicle refuelling facility or in the location where they are operating via mobile fuel bowsers. Hazardous fuels, oils and chemicals will be securely stored in clearly marked containers in a contained area to prevent pollution.

[8] Note monthly average oil water criteria is not applicable as discharges will be intermittent and of short (~hours) duration.

5.5.4 Terminal Construction Works Emissions, Discharges and Waste

5.5.4.1 Summary of Emissions to Atmosphere

Table 5.15 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during the SD2 Terminal construction and commissioning activities from key sources which include:

- Onsite construction plant, vehicles and generators (refer to Appendix 5F); and
- SD2 plant and utilities during commissioning.

Table 5.15 Estimated GHG and Non GHG Emissions Associated with SD2 Terminal Construction and Commissioning Activities

	SD2 Terminal Construction	SD2 Terminal Commissioning	TOTAL
CO_2 (ktonnes)	383.6	6.8	**390.4**
CO (tonnes)	2,081.6	7.4	**2,089.0**
NO_x (tonnes)	5,827.2	33.9	**5,861.0**
SO_x (tonnes)	239.8	0.03	**239.8**
CH_4 (tonnes)	20.2	2.3	**22.5**
NMVOC (tonnes)	936.7	0.1	**936.8**
GHG (ktonnes)	384.0	6.8	**390.8**

See Appendix 5A for detailed emission estimate assumptions.

5.5.4.2 Summary of Discharges to Sea

Routine and non routine discharges to the sea during SD2 Terminal construction and commissioning activities comprise:

- Discharge from pipework and chlorination testing (refer to Section 5.5.2.1);
- Discharge from the new STP (refer to Section 5.5.2.1);
- Drainage from the vehicle refuelling area, vehicle wash facility, parking areas and fuel storage areas (refer to Section 5.5.2.1);
- Hydrotest water ((refer to Section 5.5.2.4); and
- Open drains system flushing (refer to Section 5.5.2.4).

5.5.4.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non-hazardous and hazardous waste generated during the SD2 Terminal construction and commissioning activities are provided in Table 5.16.

Table 5.16 Onshore Terminal Construction and Commissioning Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Domestic/office waste	8,555
		Waste electrical and electronic cables	121
		Waste electrical and electronic equipment	0.1
		Paper and cardboard	114
		Plastics – recyclable (HDPE)	11
		Metals - swarf	2,796
		Tyres	97
		Wood	3,212
	Liquid wastes	Oils - cooking oil	17
		Total (Non-hazardous)	**14,923**
Hazardous	Solid waste	Adhesives, resins and sealants	2
		Contaminated materials	55
		Contaminated soils	4
		Oily rags	2
		Toner or printer cartridges	1
	Liquid waste	Oils - lubricating oil / Oils - fuel	11
		Paints and coatings	213
		Solvents, degreasers and thinners	13
		Water - oily	66
		Water treatment chemicals	1,417
		Total (Hazardous)	**1,783**

Waste produced during each phase of the SD2 Terminal Construction and Commissioning works will be segregated and temporarily stored onsite prior to transportation to the existing Sangachal Terminal CWAA or the new SD2 CWAA once complete. All waste generated during each phase of the SD2 Terminal construction and commissioning works will be managed in accordance with the existing AGT waste management plans and procedures. The planned destination of each waste stream is presented in Section 5.14.2 below.

5.6 Onshore Construction and Commissioning of Offshore and Subsea Facilities

5.6.1 Introduction

It is planned to undertake fabrication of the SDB jackets and topsides in Azerbaijan. It has been assumed for the purposes of this ESIA, that a combination of the following construction yards may be used:

- Baku Deep Water Jacket Factory (BDJF) yard[9]: Used extensively during the ACG Projects. It is planned that the jackets and elements of the subsea equipment will be constructed at the BDJF yard;
- Construction yards located on the western fringe of the Bibi Heybet oil field: Either in the South Dock[10] or the yard previously used to construct the ACG DWG-PCWU and Central Azeri Compression and Water Injection (CA-CWP) offshore facilities[11] ; and
- Pipe coating and storage yard.

5.6.2 Yard and Vessel Upgrade Works

The SD2 Project construction activities will require a number of minor upgrade works to be undertaken at the selected construction yards. The scope of the upgrades is dependant on which elements of the offshore facilities and subsea equipment are undertaken at each yard. The scope of potential upgrades includes:

- Extensions of the yard real estate to allow for equipment storage and fabrication;
- Ground improvement work to increase the weight bearing capacity – e.g. piling work, backfilling and ground compaction;
- Electrical system upgrades;
- New piping fabrication shop;
- New or refurbishments of the existing site support facilities, electrical systems, material storage areas, sewage treatment plant and waste handling facilities;
- New painting and blasting facility areas and waste handling facilities; and
- Upgrading on of the onshore skidway and quayside within the jackets yard.

In addition to yard upgrades, upgrades to the following vessels will be required:

- “Israfil Guseinov” pipelay barge;
- STB-1 transportation barge;
- Derrick Barge Azerbaijan (DBA) crane vessel; and
- Diving Support Vessel (DSV).

During reactivation, the vessels’ fire fighting foam systems will be tested. If vessels use biodegradable alcohol resistant aqueous film foaming foam (AR-AFFF) or aqueous film foaming foam (AFFF) products they will be discharged to sea. Non biodegradable foams will not be discharged but will be collected by road tanker, handled as liquid waste and removed from site.

9 Referred to in previous ACG Project ESIAs as Shelfprojectsroi (SPS).
10 Operated by the Caspian Shipyard Company (CSC).
11 Formally known as the Amec-Tekfen-Azfen (ATA) yard.

5.6.3 Subsea Facilities and Pipelines

Materials to fabricate the elements of the subsea facilities to be constructed in country will be received at the selected onshore subsea component fabrication facility. Planned fabrication activities include flame/plasma cutting, welding, grit blasting, painting and insulating, Once complete each element will undergo non destructive testing (NDT) and hydrotesting. Each element will then be appropriately stored until required for offshore installation. A number of subsea elements will be imported and may undergo non destructive testing (NDT) and hydrotesting at a selected yard. All hydrotest fluids from the subsea equipment fabrication and testing yards will be contained, collected by road tanker, handled as liquid waste and removed from site.

5.6.4 Jackets and Piles

The SD2 jackets, comprising two 8 legged, braced, steel structures, will support the topsides. The jacket structures will be approximately 110m tall, extending approximately 15m above the sea surface. The top of the jackets will be a “twin tower” configuration to enable “float over” installation of the topside deck. The design of the base will incorporate 3 pile sleeves at each of the 4 corners into which the 12 foundation piles will be driven.[12]

To construct the jackets, steel plate received at the fabrication yard, will be cut and shaped as required and then welded together with any prefabricated elements that are not constructed in country, to form the various sectional pieces. Section and weld joints will be integrity tested using NDT prior to grit blasting in preparation for painting.

The majority of grit blasting and anti corrosion painting of jacket and pile components will be undertaken in a paint shop with a fume extraction and grit recovery system in place. Grit blasting and anti corrosion painting of sections which are too large are to be accommodated within a paint shop will be undertaken within a temporary enclosure. Waste grit and paint will be collected and disposed of in accordance with the Waste Management Process (see Chapter 14). Cathodic protection will be provided by zinc-aluminium sacrificial anodes. The jacket sections will then be transferred to the assembly skidway, where they will be crane lifted into position and welded to other jacket sections to form the complete structure.

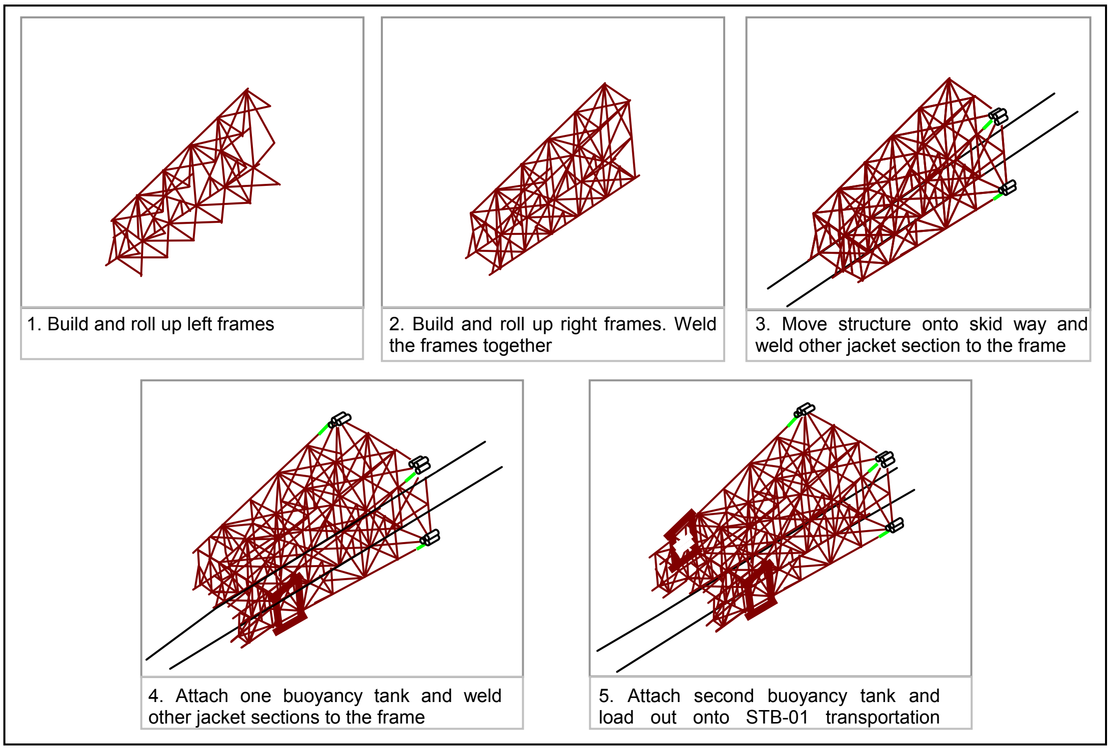
Two buoyancy tanks will be placed on either side of the jacket. The current plan is to reuse the ACG Phase 2 tanks for the SDB-QU jacket (slightly modified) and construct new buoyancy tanks for the SDB-PR jacket. Both sets of tanks will be cleaned and integrity checked using ultrasonic inspection at lift points on the tank walls. Figure 5.10 shows the various stages of jacket fabrication.

For the SDB-PR jacket, it will be necessary to pre-ballast a number of compartments on the buoyancy tanks prior to jacket load-out, to ensure stability of the jacket during installation using approximately $750m^3$ of seawater dosed with the same hydrotest chemicals as used on the subsea pipelines and flowlines to protect the tanks from corrosion (refer to Sections 5.8.4 and 5.9.4 for chemicals and proposed concentrations). Upon installation of the jacket the buoyancy tanks will be towed back to the shore for re-use or disposal. The treated water within the tanks will be discharged at the jacket location to ensure stability of the tanks during transportation to shore.

The 12 foundation piles (each 96” diameter and approximately 137m in length) and the four pin piles will be assembled, inspected and tested at the construction yard in a similar manner to the jacket.

[12] Refer to Appendix 5D for the SDB platform seismic design details.

Figure 5.10 Jacket Fabrication Process



5.6.5 Topsides

The SDB topsides will be steel structures erected from steel girders, steel stanchions, trusses and cross beams, which form and enclose decks and modules. Equipment, both electrical and mechanical will be installed into the topside modules. The topsides will comprise a number of decks including an upper deck, weather deck, mezzanine deck, cellar deck and under deck. The main components of the two topsides will be:

SDB-QU:

- Living Quarters
- Power generation and distribution system
- Direct Electrical Heating system
- MEG bulk storage (560m^3) and distribution system
- Subsea hydraulic power system
- Subsea controls interface
- Chemical injection system including methanol
- Utilities, platform support systems and infrastructure

SDB-PR:

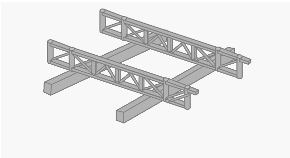
- Flow line reception facilities including pig launchers and receivers
- Production and test manifolds
- HP, Test and LP Separation system
- Offline Seawater Wash Facility
- Flash Gas Compressors
- Condensate Export Pumps
- Flare system and boom
- Fuel gas and marine pipeline gas buy-back systems
- Condensate and gas export systems
- MEG import system

The two topsides will be linked together offshore by a bridge, also constructed from steel trusses and cross beams. It is planned to construct the bridge at the same yard as the SDB-PR topside.

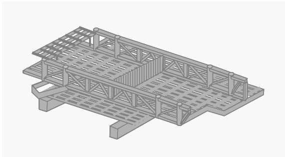
The main topside structures (including the bridge) and decks will be fabricated at the selected topside construction yard. Prefabricated and imported components and modules will either be transported from international fabrication yards or fabricated in other Baku construction yards (refer to Section 5.6.1 above). It is anticipated that the topsides will be constructed simultaneously.

Steel plate will be cut, shaped and welded to form the topside structural elements. The sections will then be grit blasted and painted with anti-corrosion paint. Prefabricated utility and process equipment will be lifted into place using cranes, installed into the structural frame, secured and then fitted with power and piping connections as required. A single flare boom structure, comprising a steel lattice frame structure, will be attached to the SDB-PR deck in the construction yard. All deck frame and component weld joints will be tested using NDT methods. Figure 5.11 shows the general topside construction approach.

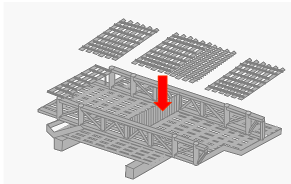
Figure 5.11 Topside Construction Process (SDB-QU Topside)



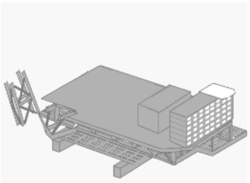
1. Fabricate truss lines and position on skidway.



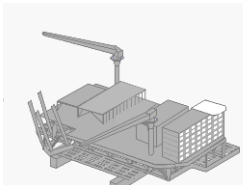
2. Infill cellar deck and commence equipment installation.



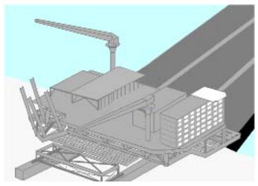
3. Install mezzanine and weather decks and start pipe erection.



4. Install living quarters and power generation.



5. Complete equipment, piping and cable installation.



6. Jack up and install loadout and installation frame ready for loadout onto barge.

5.6.6 Testing and Pre-Commissioning

The topside module elements including processing equipment and utilities will be tested onshore and where practicable, pre-commissioned. Testing will include hydrotesting of pipework and/or pressurised gas tests (using nitrogen with a 1% helium trace for detection). Onshore hydrotesting of the topside will be performed using potable water. On completion of the pressure test, the water will be reused where possible or used for dust suppression on site. If the water cannot be reused on site it will be collected by road tanker, handled as liquid waste and removed from site.

5.6.7 Topside Commissioning

Commissioning activities in the yards associated with the SDB topsides are planned to take place over a 10 month period including full commissioning of the SDB-QU topside utilities and partial commissioning (comprising system testing) of the platform process systems where possible, including:

- Fuel gas system;
- Condensate export system;
- Flare system;
- Flash gas compression system;
- Chemical systems;
- Methanol system; and
- MEG System.

These systems will be fully commissioned once in place offshore.

5.6.7.1 Seawater System

During onshore commissioning, seawater will be supplied to the topsides via a temporary seawater lift system from the quayside. The seawater system will be designed to operate at a flow rate of approximately $600m^3/hr$ for a period of up to 6 months and will be of a similar design to that approved for previous ACG projects. Seawater will be abstracted from the construction yard quayside and discharged back to the sea after use. The temperature difference between the seawater intake and discharge will be constant and independent of season as the energy demand on the seawater cooling system when in use will be constant.

Two treatment packages will be used for the temporary cooling water system to inhibit biological growth and corrosion within the seawater system:

- A chlorine/copper anti fouling system, which involves pulse dosing of abstracted seawater at concentrations of 50 ppb chlorine and 5ppb copper; and
- A continuous dosing system, which involves injection of sodium hypochlorite into the abstracted seawater at a concentration of 2mg/l. Prior to discharging the cooling water, a neutralising agent (sodium thiosulphate) will be added. Neutralisation agent dosing will be controlled and checked to ensure neutralisation is effective and residual chlorine content is maintained at less than 1mg/l.

5.6.7.2 Freshwater System

The freshwater supply system, with a total volume of approximately $160m^3$, is planned to be filled with freshwater dosed with sodium hypochlorite. To ensure that the entire system is adequately sterilised, approximately 2 - $3m^3$ will be expelled via taps and drains, collected and analysed. The system will be sealed once it is confirmed that the target concentration of hypochlorite has been achieved throughout the system.

After sterilisation, the contents of the freshwater supply system will be neutralised to reduce the chlorine content to less than 1mg/l and either used for dust suppression; discharged to the Caspian Sea; or collected by road tanker and handled as liquid waste and removed from site.

5.6.7.3 Diesel Users

The main platform power generation system comprises four 15 MW generators. Onshore commissioning of the generators using diesel is planned to include:

- Each generator run separately and intermittently for a week, for up to 8 hours a day at a maximum load of approximately 26%; and
- Synchronisation tests of 8 hour duration, running 3 of the 4 generators together at a maximum load of approximately 26%.

During commissioning of the compression system and topside utilities, the intention is to run the platform generators separately and intermittently for approximately 6 months. The diesel powered emergency generator, firewater pumps and platform pedestal cranes are also planned to be commissioned onshore.

It is expected that up to two air compressors with air drier packages and two 400V15Kva temporary generators will be used at the selected topside construction yard(s) for the duration of the commissioning activities.

5.6.8 Load Out and Sail-away

When completed, the jackets and topsides will be loaded onto the upgraded STB-01 barge for transportation to the SDB platform complex location.

The jackets will each be manoeuvred onto the STB-01 barge and sea fastened by welding members from the jacket to the barge deck. The barge will be ballasted and trimmed to sea-tow condition. The transportation barge will be assisted by 3 attendant support vessels during sail-away. Figure 5.12 shows the DWG-DUQ jacket on the transportation barge ready for sail-away.

Figure 5.12 DWG-DUQ Jacket During Loadout

Each topside will be installed with a loadout and installation frame, which can then be moved onto the STB-01 barge. As for the jackets, the barge will be assisted by 3 support vessels during sail-away. Figure 5.13 shows the East Azeri (EA) platform topside on the transportation barge.

Figure 5.13 EA Platform Topside Onboard STB-01 Barge

It is planned to load the bridge onto the STB-01 barge using a self-propelled modular transporter, seafasten it to the deck and transport it offshore to the SDB platform location. The jacket piles will be transported to site by “wet float”, that is, towed in the water behind a support or supply vessel.

5.6.9 Onshore Construction and Commissioning Emissions, Discharges and Waste

5.6.9.1 Summary of Emissions to Atmosphere

Table 5.17 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during onshore construction and commissioning from key sources which include:

- Construction yard engines and generators (including plant, cranes and on site vehicles);
- Volatile materials used during construction (e.g. paint and solvents);
- Temporary generators (during commissioning);
- Platform crane and emergency generator (during commissioning); and
- Platform main generators (during commissioning).

Table 5.17 Estimated GHG and Non GHG Emissions Associated with Routine and Non Routine SD2 Onshore Construction and Commissioning Activities

	Jacket and Bridge Construction	Topsides Construction	Topside Commissioning	TOTAL
CO_2 (ktonnes)	24.5	22.8	11.6	**58.9**
CO (tonnes)	88.2	83.9	5.5	**177.6**
NO_x (tonnes)	355.2	336.4	55.7	**747.3**
SO_2 (tonnes)	30.6	28.6	14.5	**73.6**
CH_4 (tonnes)	1.1	1.0	0.1	**2.2**
NMVOC (tonnes)	11.6	11.0	1.3	**24.0**
GHG (ktonnes)	24.5	22.9	11.6	**58.9**

See Appendix 5A for detailed emission estimate assumptions.

5.6.9.2 Summary of Discharges to Sea

Planned routine discharges to the sea during SD2 onshore construction and commissioning will be associated with the cooling water system. In total, approximately 600m^3/hr of neutralised seawater is estimated to be discharged to sea during the 6 month commissioning period (See Section 5.6.7.1). In addition discharges of AR-AFFF or AFFF products from fire fighting system testing during during vessel reactivation are also anticipated (see Section 5.6.2).

At the construction yards there will be 3 categories of drainage water:

- Black and grey water – black and grey water generated at the construction yard(s) will be collected in on site sewer pipes and sumps and then either transferred by road tanker or by sewer pipes to a municipal sewage treatment plant for treatment and disposal. If the construction yard has an operational sewage treatment plant that discharges treated effluent to the environment, the yard operator will be responsible for agreeing the discharge standard with the MENR and maintaining the discharge permit conditions stipulated by the MENR;
- Hazardous area drainage – Drainage water from areas in the construction yard(s) in which hazardous materials are stored and routinely used will be contained and will be collected by road tanker, handled as liquid waste and removed from site. If the yard operator has an agreement with the MENR for discharge of drainage from areas where hazardous materials are storage or used, they will be responsible for maintaining the discharge permit conditions stipulated by the MENR;[13;] and
- Storm/rain water drainage - uncontaminated rainwater will be discharged directly to the onshore or marine environment to prevent flooding and ponding of water on site.

[13] For discussion regarding spills refer to Chapter 14.

5.6.9.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated during onshore construction and commissioning are provided in Table 5.18. These have been estimated based on the waste records for construction of the previous ACG platforms, taking into account the scope of onshore construction associated with the SD2 Project.

All waste generated during onshore platform and subsea infrastructure construction and commissioning activities will be managed in accordance with the existing AGT management plans and procedures.

Table 5.18 Offshore Facilities Construction and Commissioning Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Domestic/office wastes	10,234
		Grit blast	1,989
		Metals - swarf	7,813
		Paper and cardboard	81
		Plastic	30
		Wood	890
	Liquid wastes	Oils - cooking oil	49
		Total (Non-hazardous)	**21,085**
Hazardous	Solid wastes	Batteries - wet cell	7
		Clinical waste	5
		Contaminated materials	82
		Contaminated soil	3
		Filter bodies	0.2
		Lamps	16.8
		Oily rags	2
		Pressurised containers	6
		Toner or printer cartridges	5
	Liquid wastes	Oils - fuel	23
		Oils - lubricating oil	64
		Paints and coatings	420
		Sewage - untreated	1,484
		Sewage sludges	4,523
		Solvents, degreasers and thinners	169
		Water - hydrotest water	22
		Water - oily	1,140
		Total (Hazardous)	**7,972**

5.7 Platform Installation, Hook Up and Commissioning

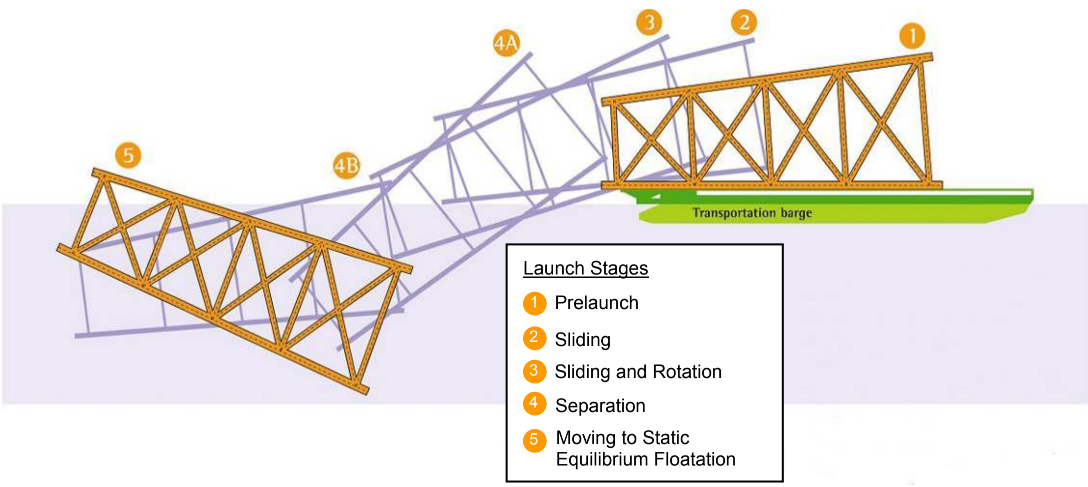
5.7.1 Pre Installation Survey and Seabed Works

Prior to any installation works, a seabed survey will be undertaken using a remotely operated vehicle (ROV), controlled from a support vessel. The survey will utilise multibeam sonar and video imaging. This will confirm that there are no obstacles present in the platform location. While not expected, if any obstacles are present they will be removed using a DSV. It also anticipated that localised excavation works will be required to prepare the area where the jacket gripper jacks and pin piles will be located.

5.7.2 Jacket

Installation of the SDB jackets, scheduled to take approximately 49 days, will follow similar methods as employed for the previous ACG projects. The two jackets will be installed concurrently using the same method. The process followed to unload and position the jacket is shown in Figure 5.14. Ballasting and use of the jacket buoyancy tanks will allow the jacket to be accurately positioned.

Figure 5.14 Jacket Installation



Once in position, the jacket will be attached to the anchored DBA crane[14] and set down onto four pre-installed pin piles. Hydraulic gripper jacks will secure the jacket until permanent piling is completed.

The pin piles are installed as temporary foundations for each jacket, until such time that the main piles are installed and grouted. Each pile is 140m long and will be towed to site and installed using the DBA. If the piles gain insufficient self weight penetration it will be necessary for the DBA to laterally support the top of each pile temporarily within a frame on the side of the vessel, whilst a vibratory driver is used to advance the pile in a controlled manner through the hard sand layers. Once sufficient penetration is achieved, the DBA will detach itself from the pile and a hydraulic hammer will then be used to drive it to its target penetration of approximately 100m. The residual ~37m length of each pile will then be cut subsea and removed.

An alternative method under consideration is to adopt a larger hammer and drive to ~138m penetration which will avoid the need for subsea cutting. Once all pin piles are installed, a full dimensional survey will be performed to allow the pin pile receptacles to be correctly positioned within each jacket, whilst under construction

The buoyancy tanks will be removed by a combination of seawater ballasting and lifting with the DBA crane, then drained and towed back to the onshore fabrication site for reuse.

[14] The DBA anchoring system comprises 8 anchors each attached to electrically driven hydraulic mooring winches. Up to 3 vessels are planned to assist with DBA anchor handling during jacket and topside installation.

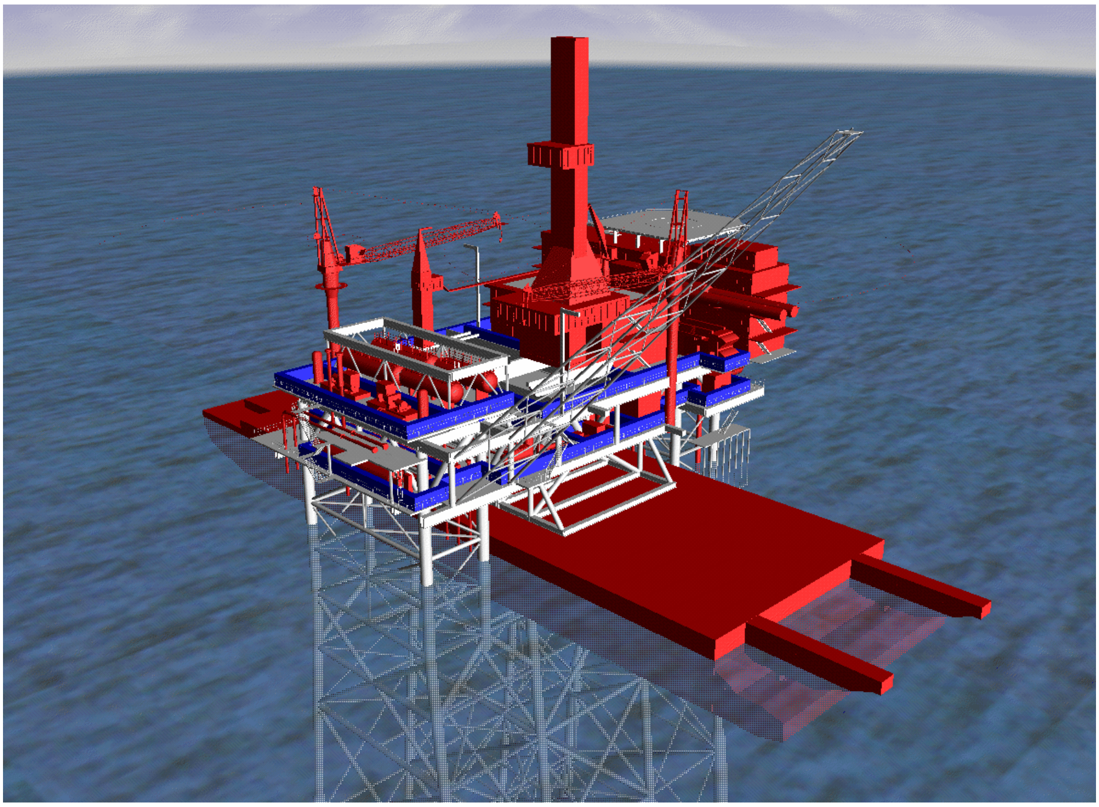
The treated pre-ballast water within the SDB-PR buoyancy tanks will also be discharged to sea over a period of approximately 8 hours.

12 main foundation piles will secure each of the jackets. The piles will be driven using an underwater hydraulic hammer and grouted to the jacket pile sleeves. Grout will be supplied via flexible hoses from the DBA to the grout manifold panel located on the side of the jacket; and pumped down into the annulus between the pile and pile sleeve. A passive mechanical seal will ensure that the grout material is retained inside the pile sleeve annulus. A high strength cement will be used for the grout operation. Discharge of excess cement will be minimised as far as possible. However, approximately 50m^3 of excess cement may be discharged as the grouting operation is completed for each jacket.

5.7.3 Topsides

The topsides are designed for the "float-over" method of installation, as employed for the previous ACG Phases. For each topside the STB-01 transportation barge is manoeuvred between the two jacket towers such that the topside is positioned above the intended installation position on the jacket as illustrated in Figure 5.15. The mating operation (i.e. the process of connecting the topside to the jacket) is executed by ballasting the barge such that the topside engages with shock absorbers in the jacket legs and the load is transferred. Sand jacks are then used to lower the topside until steel faces mate and are ready for welding. It is estimated that approximately 35m^3 of sand will be released from the 8 sand jacks during this process and discharged to the sea. Topside installation is scheduled to take approximately 15 days for the SDB-QU platform and approximately 20 days for the SDB-PR platform (including bridge installation).

Figure 5.15 Topsides "Float-Over" Installation Method



5.7.4 Bridge

The bridge will also be loaded onto the STB-01 transportation barge and towed to the SDB complex location offshore. The barge will be moored alongside the DBA, which will lift the bridge and position it between the SDB-PR & SDB-QU platforms using rigging and guides. Once in position the rigging will be removed and the temporary installation guides will be removed. The bridge will be welded in place to the platform at one end, with the other end fitted to allow natural movement during operation.

5.7.5 Topside Hook Up and Commissioning

Once the topsides and bridge are installed, a number of offshore hook up activities will need to be completed on the topside prior to start up. These will include:

- Installation of the SDB-QU firewater and seawater lift pumps and caissons;
- Installation of the hazardous open drains caisson pump;
- Tie-ins to all risers; and
- Connection of all umbilicals (including subsea cabling).

Commissioning will commence with living quarters and utility systems including the main power generators. The systems will then be started up over a 5 month period, allowing workers to inhabit the platform during commissioning and start up of the process facilities.

The current Base Case assumes that power during commissioning will be provided by the main platform generators, using diesel until fuel gas is available from onshore SCP facilities via the two SD2 32” marine export gas pipelines. To establish initial life support before the main platform generators are available it is planned to use one 1MW temporary diesel generator. It is anticipated that the temporary generator will be used for 6 months and the main platform generators will be run on intermittently diesel for 6-8 months during the commissioning period.

Commissioning of the deluge and foam systems is predicted to result in approximately 200 litres of seawater and approximately 20 litres of aqueous film forming foam (AFFF) (mixed with 140m^3 of seawater) discharged via the SDB-PR open drains caisson to the sea at 52m below sea level.

5.7.6 Installation, Hook Up and Commissioning Vessels

A number of vessels will be used to support the SDB platform installation, hook up and commissioning (HUC) activities, including the DBA, two anchoring handling vessels, the STB1 installation barge and support vessels. Table 5.19 summarises the vessel utilities.

Table 5.19 Installation, Hook Up and Commissioning Vessel Utilities

Utility	Description
Power Generation (DBA)	• Main Power provided by 6 diesel engines rated at 4080 kW
Sanitary Waste	• Grey water will be discharged to sea (without treatment) as long as no floating matter or visible sheen is observable. • Depending on the availability of the system, black water will either be: - Contained onboard for transfer to shore; - Once onshore, black water will be managed in accordance with the existing AGT management plans and procedures; Or - Black water will be treated to applicable MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards: Five day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable. • Sewage sludge will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.
Galley Waste	Depending on the availability of the system, galley food waste will either be • Contained and shipped to shore for disposal; or • Sent to vessel maceration units designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards prior to discharge.
Drainage/Water	• Deck drainage and wash water discharged to sea as long as no visible sheen is observable. • Oily bilge water, tank sludges, untreated oily water and waste oil will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

It is planned that crew changes will be by vessel through the SD2 platform installation, hook up and commissioning phase. Helicopters will be used for emergencies only.

5.7.7 Platform Installation, Hook Up and Commissioning – Emissions, Discharges and Waste

5.7.7.1 Summary of Emissions to Atmosphere

Table 5.20 summarises the GHG (i.e. CO_2 and CH_4) and non GHG routine emissions predicted to be generated during platform installation, hook up and commissioning from key sources which include:

- Jacket installation vessel engines and generators;
- Topside installation vessel engines and generators;
- Support vessels engines during HUC; and
- Power during commissioning.

Table 5.20 Estimated GHG and Non GHG Emissions Associated with SD2 Project Platform Installation, Hook Up and Commissioning

	Jackets Installation	Topsides & Bridge Installation	HUC Support Vessels	Commissioning	TOTAL
CO_2 (ktonnes)	11.0	5.3	2.1	40.3	**58.7**
CO (tonnes)	27.5	13.3	5.3	11.6	**57.7**
NO_x (tonnes)	202.5	98.2	38.9	170.1	**509.8**
SO_x (tonnes)	27.5	13.3	5.3	50.4	**96.5**
CH_4 (tonnes)	0.9	0.4	0.2	0.4	**2.0**
NMVOC (tonnes)	8.2	4.0	1.6	3.7	**17.5**
GHG (ktonnes)	11.0	5.3	2.1	40.3	**58.8**

See Appendix 5A for detailed emission estimate assumptions and Appendix 5F for vessel numbers and duration of use.

5.7.7.2 Summary of Discharges to Sea

Routine discharges to the sea during platform installation, hook up and commissioning comprise:

- Ballast water during jacket installation (refer to Section 5.7.2);
- Minor cement losses during jacket grouting (refer to Section 5.7.2);
- Sand from topside jacking activities (refer to Section 5.7.3);
- Seawater and AFFF from deluge and foam system testing (refer to Section 5.7.4); and
- Installation and support vessel discharges as described within Table 5.19.

5.7.7.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated during SD2 platform installation, hook up and commissioning are provided in Table 5.21. These have been calculated using data gained during the previous ACG Phases.

All waste generated during platform installation & HUC will be managed in accordance with the existing AGT management plans and procedures.

Table 5.21 Offshore Facilities Installation, Hook-up and Commissioning Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Domestic/Office waste	1,839
		Grit blast	133
		Metals - swarf	1,290
		Waste electrical and electronic cable	5
		Paper and cardboard	69
		Plastics - recyclable (HDPE)	31
		Wood	169
	Liquid wastes	Oils - cooking oil	0
		Total (Non-hazardous)	**3,535**
Hazardous	Solid waste	Batteries - dry cell/Batteries - wet cell	1
		Clinical waste	1
		Contaminated materials	104
		Lamps	1
		Oily rags	12
		Toner or printer cartridges	1
	Liquid wastes	Oils – lubricating oil	5
		Paints and coatings	27
		Solvents, degreasers and thinners	4
		Tank bottom sludges	30
		Water - hydrotest water	3,841
		Water - oily	2,365
		Water treatment chemicals	1
		Total (Hazardous)	**6,392**

5.8 Installation, Hook Up and Commissioning of Subsea Export and MEG Pipelines

5.8.1 Introduction

To enable gas and condensate to be exported from the SDB platform complex to the Sangachal Terminal, the following subsea export pipelines will be installed:

- Two 32” diameter Gas Export Pipelines; and
- One 16” diameter Condensate Export Pipeline.

In addition a 6” diameter MEG Pipeline will be installed to import MEG from onshore to the SDB platform complex. All four pipelines will be approximately 90.3km in length and laid within the same pipeline corridor. To ensure adequate support, the MEG pipeline will be clamped to the offshore section of the condensate pipeline (known as “piggybacking”). Figure 5.16 illustrates the routing of the SD2 subsea pipeline corridor from the offshore SDB platform complex to the onshore Sangachal Terminal.

5.8.2 SD2 Subsea Pipeline Integrity and Design

The SD2 subsea pipelines will be constructed of carbon steel and will be designed to ensure that they are suitable for the environmental conditions including seawater properties and geo-hazards.

All the pipelines will be protected by a coating together with a sacrificial anode cathodic protection system. In addition, corrosion-inhibiting chemicals will be added to the hydrocarbon product before it passes through the pipeline to minimise internal corrosion.

The pipelines will be designed for a 30 year design life. The gas and condensate pipelines will be provided with a reinforced concrete weight coating with a thickness of between 40 and 100mm along the majority of the length to provide the required level of negative buoyancy. The concrete weight coating where applied also affords protection from the mechanical impact of a dropped object.

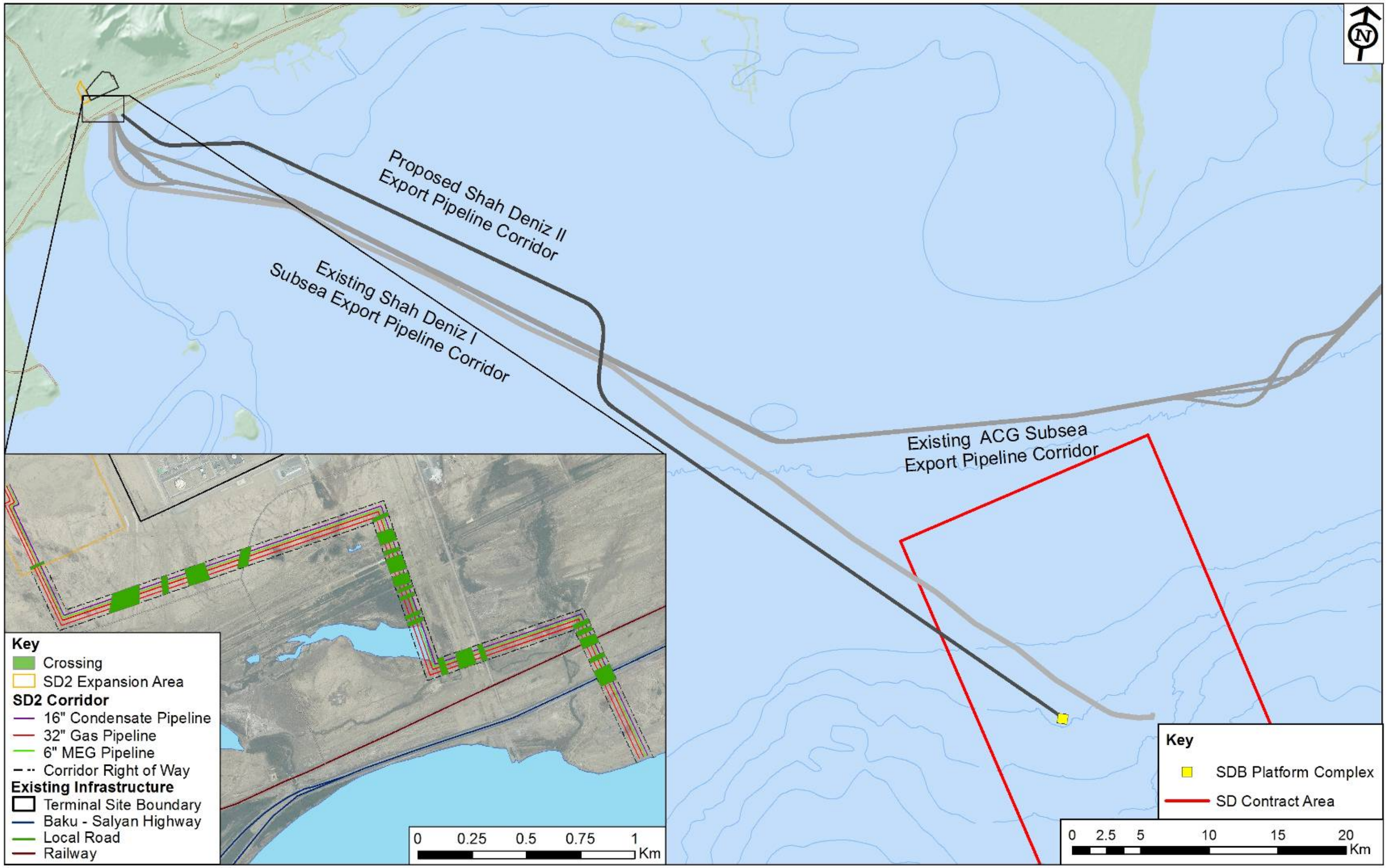
The subsea gas, condensate and MEG pipelines are planned to be routed along a common offshore corridor, which minimises possible interference from anchoring vessels and the risk of damage due to dropped objects. Where a pipeline is planned to cross an existing offshore pipeline(s), the intention is to construct crossing structures to ensure permanent separation between the pipelines.

In addition to the passive protection measures integrated into the SD2 subsea pipelines design described above, pipeline integrity systems will also include the following measures:

- Monitoring (pressure, flow and fluid contaminant concentrations);
- Corrosion protection;
- Inspection;
- Emergency response;
- Management of change (e.g. pipeline system modifications); and
- Assurance.

These form part of the existing Offshore Operations Pipeline Integrity Management System (PIMS) (refer to Chapter 14).

Figure 5.16 Routing of Proposed SD2 Export Pipelines and MEG Import Pipeline



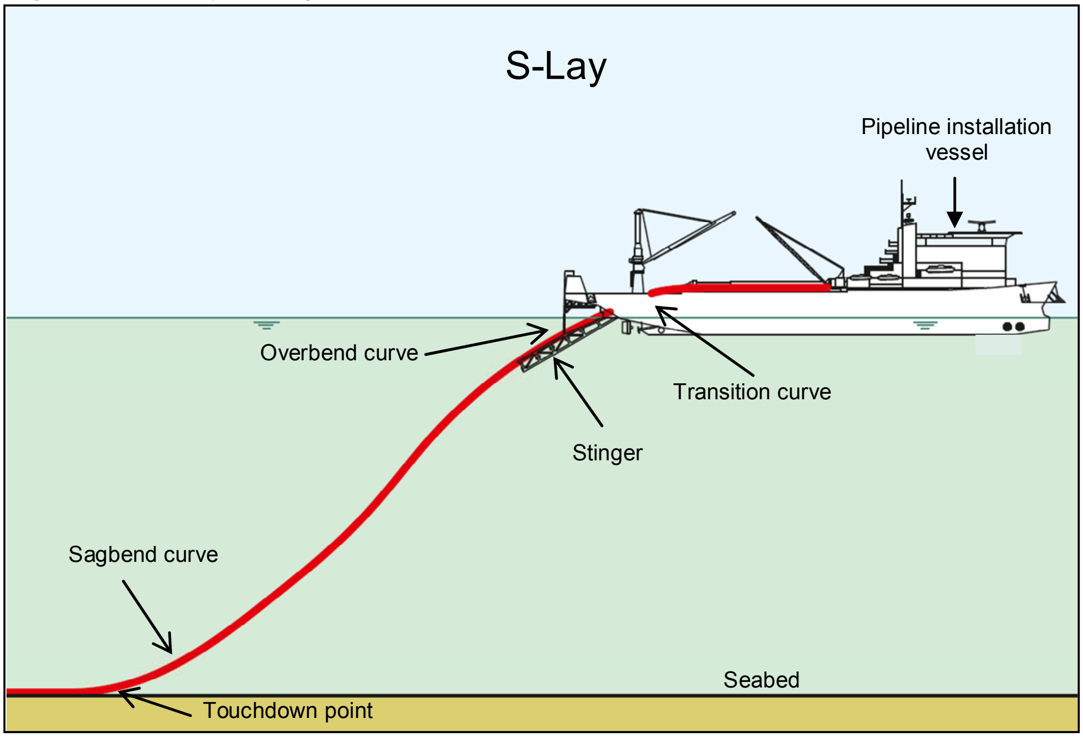
5.8.3 Pipeline Installation

5.8.3.1 Offshore

It is planned to use the pipelay barge "Israfil Guseinov" for the offshore subsea pipeline installation works. The installation methodology will be consistent with the previous ACG Projects. The pipe sections will be delivered to the lay-barge from the onshore coating yards by pipe supply vessels. The lay-barge will be used to install the subsea pipelines from the edge of the nearshore section within Sangachal Bay (from 8m water depth) towards the SDB platform complex.

On the lay-barge, each pipe section will be welded to the preceding one and the welded joints will be visually inspected and integrity tested using NDT techniques. The weld area will then be field-coated for protection with anti-corrosion material. The pipeline will be progressively deployed from the stern of the lay-barge via the "stinger", a support boom that extends outwards from the stern of the barge. The lay-barge lays pipe in an S-Lay configuration meaning that the pipeline lies on the seabed in the horizontal position, rises up through the water column and curves back to the vessel to assume a horizontal position such that pipe joints are added to the pipeline in a horizontal orientation. The tensioning system on the lay-barge maintains a controlled and constant deployment rate, while reducing bending stresses that could threaten the pipeline structure (refer to Figure 5.17)

Figure 5.17 S Lay Configuration



The 16" condensate line and 6" MEG line will be installed simultaneously. The 6" pipeline will be welded separately and the completed sections mechanically attached to the 16" pipeline using straps as it moves off the stern of the vessel.

The pipe-laying operation will be continuous with the barge moving progressively forward as sections of the pipe are welded, inspected, coated on board and then deployed to the seabed. The barge will be held in position by 10 anchors, each creating a depression in the seabed of approximately 20m^2 and 2m depth, which will naturally back fill over time. As pipe-laying proceeds, the anchors will be periodically moved by 2 anchor handling support vessels to pull the barge forward (with 1 more on standby). The distance of this will vary, but will typically be every 500m to 600m of pipeline length. The lateral anchor spread of the pipe-lay barge will typically be between 600m to 700m either side of the pipeline. Marine installation operations will occur within an exclusion zone that will extend for 500m each side of the pipeline corridor. During installation, exclusion buoys will be placed around the lay-barge installation area to indicate that the area is an exclusion zone and to ensure that other vessels do not encroach upon the area of activity. As pipe-laying progresses, the exclusion buoys will be moved along the route.

The offshore sections of the pipelines will generally be laid directly on the seabed and will not be trenched except in the shore approach area. Stability of the sections that are laid directly on the seabed will be provided by the concrete coating along the majority of the lengths[15]. Grout bags will be used for any required freespan corrections and rock dumping may be used to provide additional support or additional cover if required.

As Figure 5.16 shows, at approximately 38km from Sangachal the SD2 pipelines are planned to cross the existing ACG and SD1 export pipelines and associated services (e.g. cabling). These include:

- SD1 12" Condensate Export Pipeline (SDA to Sangachal) including 4" MEG pipeline;
- SD-1 26" Gas Export Pipeline (SDA to Sangachal);
- SD1 Fibre Optic Cable (Sangachal to SDA);
- AIOC 14" Produced Water Pipeline (ACG to Sangachal);
- AIOC 24" Oil Export Pipeline (ACG to Sangachal);
- AIOC Fibre Optic Cable (Sangachal to ACG);
- AIOC 28" Phase 1 Gas Export Pipeline (ACG to Sangachal);
- AIOC 30" Phase 1 Oil Export Pipeline (ACG to Sangachal); and
- AIOC 30" Phase 2 Oil Export Pipeline (ACG to Sangachal).

At these locations the existing pipelines and services will be flanked on either side by concrete pipe supports (installed either from the DSV or pipelay barge) to ensure minimum separation distances are maintained between the SD2 pipelines and existing pipelines and cables. Crossing angles will be optimised to achieve as close to 90° (where practical) in order to minimise the crossing distance and support dimensions. It is intended that the existing service is protected from impact by mattresses or similar unless there is potential for damage to the existing service through doing this.

5.8.3.2 Nearshore

Prior to commencement of works within the nearshore zone it will be necessary to establish a secure compound within the onshore landfall area and it may be necessary complete marine geotechnical surveys to confirm the seabed conditions along the proposed nearshore route. Marine geotechnical surveys will involve the collection of seabed samples using a corer or a vessel mounted drilling rig that will use and discharge a bentonite mud if required to facilitate sample retrieval. Works associated with the clearance and levelling of the compound are included within the EIW scope. It is anticipated that the following temporary facilities will be established within the compound and used throughout the nearshore pipeline installation activities:

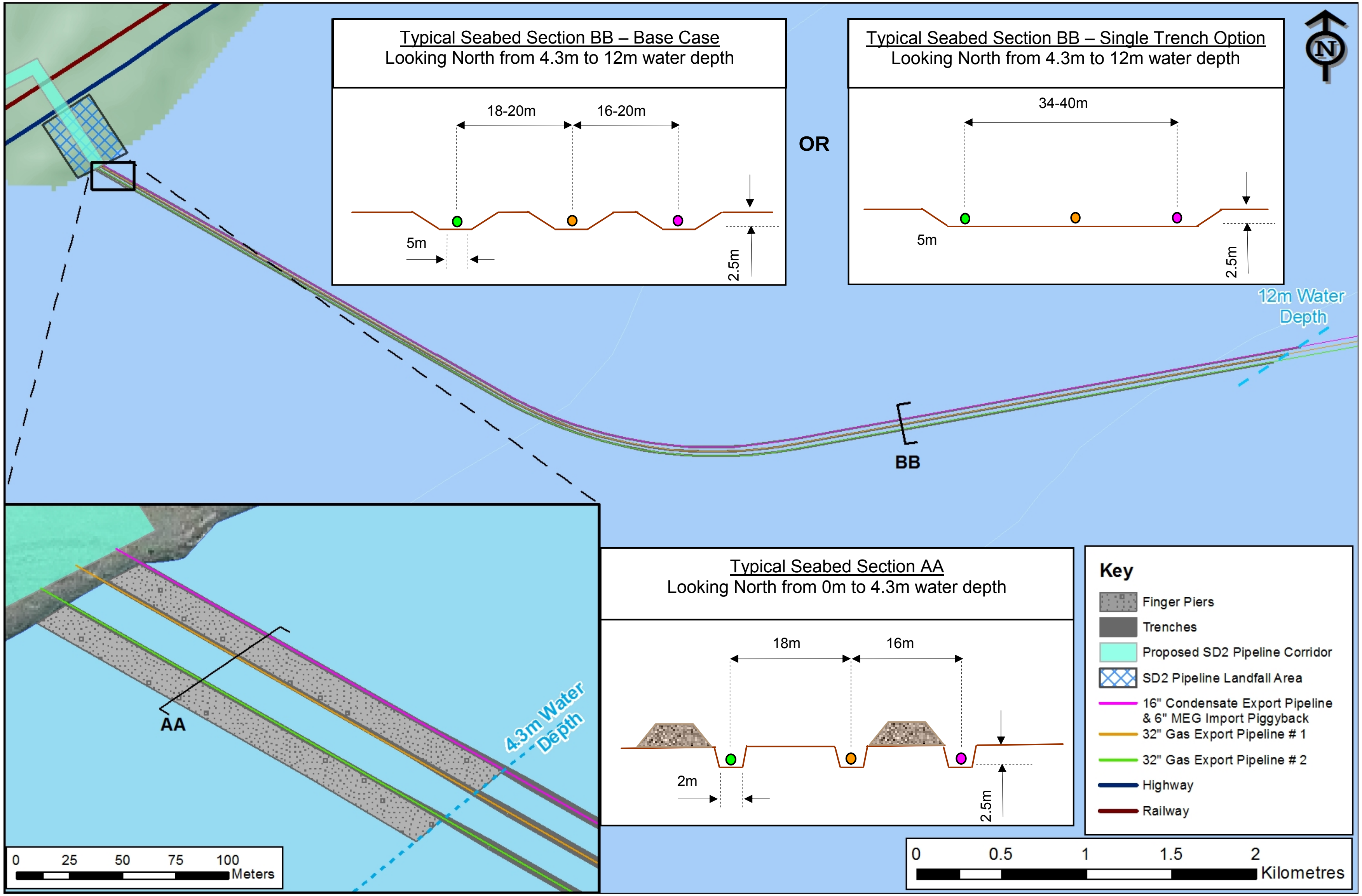
- Temporary offices and welfare facilities;
- Secure area for plant and equipment and fuel bunkering; and
- Area for temporary storage of trenched soils from the finger pier areas (prior reinstatement following the completion of beach pull and hydrotest activities).

In addition a temporary gravel road will be constructed from the Highway to the compound, designed to a standard suitable for lorries and excavators to use.

It is proposed to follow the same nearshore pipeline installation methodology adopted for previous ACG and SD Projects within the nearshore zone. The trenching proposed within the nearshore area is summarised within Figure 5.18.

[15] MEG pipeline will be provided with anti corrosion coating but will not require concrete coating for anti buoyancy as it will be attached to the condensate pipeline.

Figure 5.18 Proposed Nearshore Pipeline Trenching



The works will commence with the construction of two temporary finger piers to allow construction plant access to the nearshore for trenching. The piers will be constructed by dumping aggregate in the shallow marine zone to achieve the required clearance above sea level[16].

The piers will be designed to support vehicle access with an average planned width of approximately 4-5 m (approximately 10m at the base) and will extend out to approximately the 4.3m water depth contour.

It is currently anticipated that excavators using the finger berms will dig temporary channels into the shoreline for both the two 32” and 16” pipelines, which will be allowed to flood. An option to combine the three trenches into one wide trench after finger pier limits is also being considered. The pipelines will be pulled from the pipe-lay barge[17] moored in Sangachal Bay using a shore based winch through the trenches. The trenches will then be backfilled leaving the shoreward end of the pipelines uncovered and creating an earth “cofferdam”. The “cofferdams” will be pumped dry and the shore section of the pipelines will be trenched from the onshore landfall area to meet the end of the pipelines in the cofferdam.

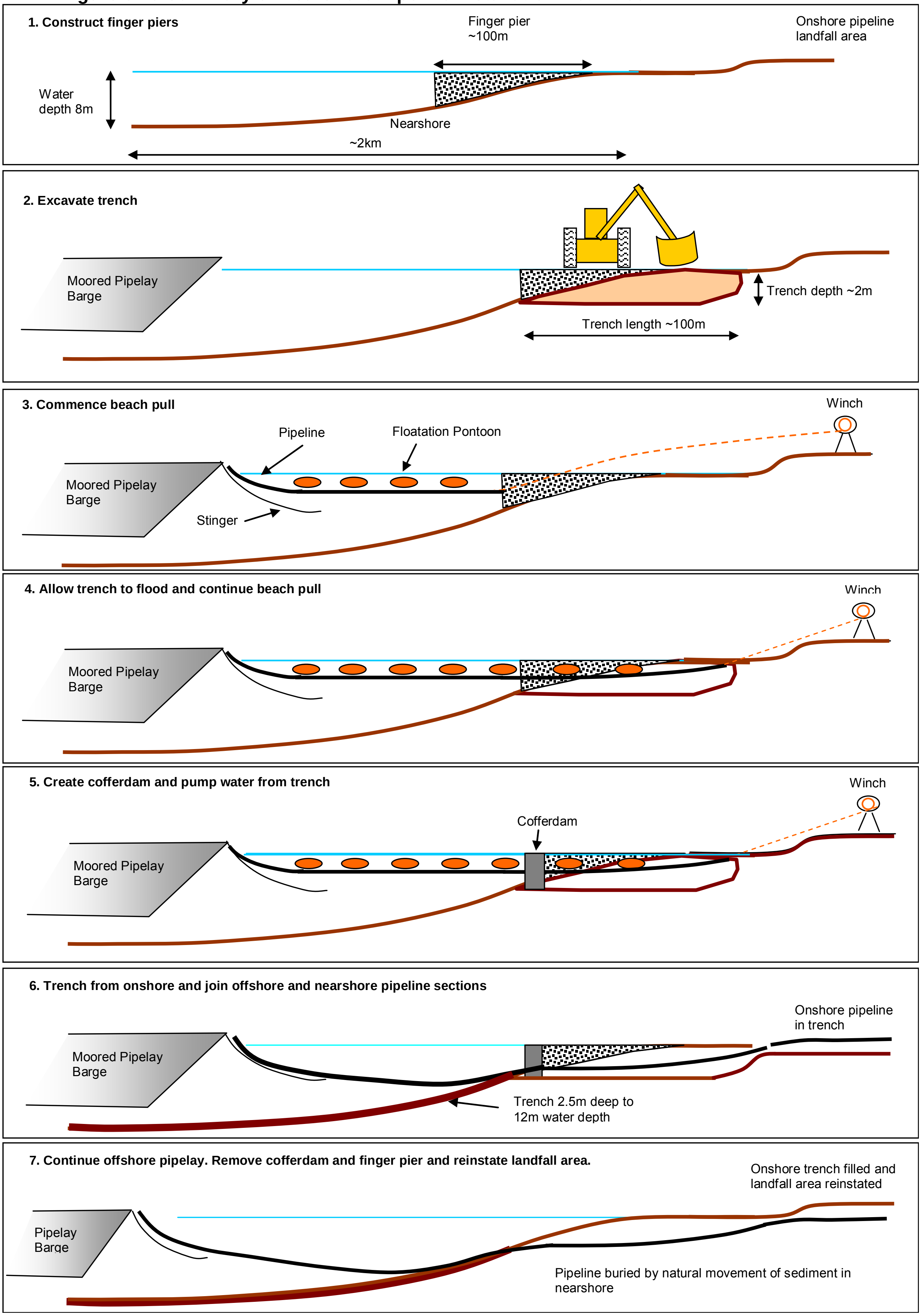
To allow the pull direction to be deflected as the pipeline is pulled onshore a pulley rigging arrangement will be set-up to angle to the pull. The pulley system will most likely be constructed using sheet piles as anchors.

In total it will be necessary to pull the pipelines a distance of approximately 3km from the edge of the nearshore zone (at a depth of 8m) to the onshore landfall area. The pipelines will be kept afloat during the shore-pull exercise by means of floatation pontoons attached to the pipelines. From the end of the piers to a water depth of approximately 12m it is intended to dig three trenches approximately 2.5m deep and 5m wide as shown in Figure 5.18

Figure 5.19 provides a summary of the proposed nearshore pipeline installation activities.

[16] It is planned to source aggregate for finger piers from within Azerbaijan
[17] The draft of the pipe-lay barge restricts the operation of the vessel in shallow water and the lay-barge can only operate in water depths of greater than 8m

Figure 5.19 Summary of Nearshore Pipeline Installation Activities



Based on current information, it is intended to dig the trenches to the 12m water depth contour by dredging the seabed using a cutter suction dredger (CSD). However, if further information obtained through ground truthing surveys to be performed in 2Q 2013 show the seabed and underlying material is not suited to the use of the CSD, alternative approaches may be considered.

The CSD is a stationary dredger consisting of a pontoon, positioned with a spud-pole at the stern, and two anchors at the front. A CSD uses a rotating cutter head to loosen the soil material over the area to be dredged, while a suction intake located within the cutter head sucks up the loosened material through the use of powerful centrifugal pumps.

The cutter head is mounted at the end of a steel structure called a ‘ladder’ positioned at the front of the vessel. The ladder can be lowered and raised through the use of winches, while the dredger can be moved from side to side via winches connected to the anchors. An anchor handling vessel will be used to move the anchors into their correct locations. As such, during the dredging works the following vessels will be utilised throughout: a CSD, a multicat, a spreader pontoon, a survey vessel and a crew boat.

Subject to a detailed survey, it is estimated that in performing the nearshore pipeline installation, an approximate volume of 1,000,000 m^3 of material will need to be dredged. The material removed by the CSD is typically pumped through a floating pipeline of approximately 500m, resulting in a proposed disposal area 500m away from the trench. The spreader pontoon will be connected to the end of this pipeline in order to dispose the dredged material evenly over this area. With this form of disposal, ridges will be created on the seabed. However, if natural backfilling does not remove this ridge, the material will later be removed by the CSD and used to backfill and cover the pipelines in the trenches. In this way the original seabed will be restored as far as practicable.

Once installation and testing of the pipelines in the nearshore zone is complete, all materials deposited at the area (aggregate, sheets piles and other material) will be managed in accordance with the Waste Management principles detailed in Chapter 14: Environmental and Social Management.

The works are expected to take approximately 16 months in total over a period of 2 year period as shown in Figure 5.3.Beach pull activities are expected to take 10 days for each pipeline and CSD trenching is expected to take 4 months.

5.8.3.3 Onshore

The onshore section of the SD2 pipelines between the onshore landfall area to the tie in within the new SD2 facilities at the Terminal will be approximately 4.1km in length and constructed using open cut and augur bore techniques. It is anticipated that a Right of Way (RoW) (approximately 80m in width) will be established. Temporary laydown areas and pipeline construction offices will be established within the pipeline RoW from the Terminal to the onshore landfall area. For the majority of the route to the Terminal each pipeline will be installed in a trench with sufficient depth to ensure a minimum of cover to top of pipeline of 1m. All soil removed from the trench being excavated will be placed aside and stored so that it may be used for later reinstatement of the route, in order to maintain the environmental characteristics of the area.

As required the pipe, which will be stored at temporary laydown areas along the route, will be laid out along the RoW. Pipe joints will be welded to form a continuous length. Once a trench is excavated, pipe lengths will be lifted by side-booms (or other appropriate machines) and lowered into the bottom of the trench. The trench will then be backfilled.

As shown in Figure 5.16, the onshore pipelines will need to cross the Baku Salyan Highway, the railway and various third party pipelines/service lines. Over 60 crossings of existing utilities and pipelines have been identified. For trenchless crossings, it is currently planned to maintain a minimum separation of approximately 1m from the bottom of the existing service. At each trenchless crossing location it will be necessary to excavate launch and reception pits to enable crossing installation. All soils excavated from the pits will be placed aside and stored so that it may be used for later reinstatement of the route, in order to maintain the environmental characteristics of the area.

Prior to installation, a survey of the route will be conducted to establish where preparatory works may be required. Preparatory works may be required to upgrade access routes to allow transportation of construction loads (materials, equipment and vehicles) to the RoW. Provision of temporary drainage measures may be required within the construction area to control storm water runoff in the vicinity of the construction area. All working areas along the RoW will be clearly marked to ensure the safety of operations and the public.

Once installed the onshore pipelines will connect to the SD2 facilities at the Terminal via a weld downstream (upstream for MEG Pipeline) of the pig traps.

5.8.4 Pipeline Pre Commissioning

Installation of the pipelines will be completed before the offshore facilities are in place. Pre commissioning activities (i.e. cleaning, hydrotesting, inspecting and dewatering) will be completed prior to the introduction of hydrocarbons as described below.

To prevent corrosion and inhibit bacteria growth, seawater used for pre commissioning activities will be chemically treated. A dye will also be added to the water to provide a method of identifying leakage during hydrotesting. The following Base Case chemicals, at the indicated dosage rates, are currently planned to be used:

- 1000ppm Hydrosure HD5000 (combined biocide, corrosion inhibitor and oxygen scavenger); and
- 100ppm Tros Seadye (dye).

In the event that different chemicals are required, the SD2 Project Management of Change Process (see Section 5.16) will be followed. The intent is to use chemicals no more toxic or persistent than the Base Case chemicals.

The pipelines will remain filled within treated seawater until dewatering occurs. During this period each pipeline shall be monitored to ensure systems are being continually protected against corrosion. If preservation chemicals are deemed to be depleting the treated seawater will be displaced to sea and refilled with treated seawater at the dosage rates stated above.

The pre commissioning activities comprise the following:

- Flooding, cleaning and gauging (FCG): The flooding operation will introduce chemically treated filtered seawater into the offshore pipeline sections. The cleaning operation will remove construction debris from the internal pipeline surface. The gauging operation will confirm that there are no pipeline deformations or intrusions. The treated water used to drive the cleaning and gauging pigs will be discharged to the environment at temporary subsea pig trap in the vicinity of the SDB platform complex;
- Hydrotest: The offshore pipeline sections will be pressurised to 1.25 times the design pressure. Upon completion of the hydrotest the volume of treated water that was used to pressurise the pipeline will be discharged to the environment at the temporary subsea pig trap;
- Leak test: The complete pipeline systems (onshore and offshore sections) will be topped up with treated water and hydrostatically leak tested up to 1.1 times the design pressure. Upon completion of the leak test the volume of treated water that was used to pressurise the pipeline will be discharged to the environment via the SDB-PR open drains caisson;
- Pre In Line Inspection (ILI) gauging: The complete pipeline systems from the Pig Launcher and Receiver facilities at the Terminal to the SDB-PR platform will be gauged to ensure that an ILI pig can travel along the pipeline. This will result in the

discharge of the treated water volume from each pipeline to the SDB-PR open drains caisson. For the 16” condensate export pipeline this activity will be performed using dry air as the propelling medium, thus simultaneously dewatering the line;

- ILI operation: Each pipeline will be pigged using an ILI pig, resulting in the discharge of the treated water volume from each pipeline via the SDB-PR open drains caisson. For the 16” condensate export pipeline this operation will be performed using dry air as the propelling medium.
- Dewatering: The entire pipeline system will be dewatered by propelling pigs with dry air. The pig train will contain a fresh water desalination slug. One complete, treated water volume from each pipeline and a fresh water desalination slug will be discharged to sea via the SDB-PR open drains caisson. At this point the dry air in the pipelines will be replaced with nitrogen.

FCG and hydrotesting of the onshore sections will follow the same methodology as described above. It is intended that the treated water used from these activities for the onshore sections will be sent to the offshore pipeline sections and then offshore to be discharged at the temporary subsea pig trap. During final commissioning of the completed pipelines, prior to 1st gas, the nitrogen present in the pipeline systems will be displaced by the hydrocarbons that the pipelines will carry during operations. The only discharge to the atmosphere will be nitrogen gas.

5.8.5 Summary of Pipeline Installation Discharges

Table 5.22 presents the expected volume and location of discharges associated with gauging, hydrotesting, tie-in, testing and dewatering of the SD2 subsea export and MEG import pipelines.

Table 5.22 Estimated Pipeline Gauging, Hydrotesting, Tie-in, Leak Tests and Dewatering Discharges

		Discharge Location	Anticipated Date	Estimated Discharge Volume (m^3)	Discharge duration (hr)	Total Estimated Discharge Volume (m^3)[3]
Gas Pipeline 1	Flood, clean and gauge[4]	-95m below sea level	Q1 2015	9,646	12	201,440 treated seawater 2,181 desalinated freshwater
	Hydrotest[1,4]		Q2 2015	416	12	
	Leak test[1]	-52m below sea level	Q3 2016	365		
	Pre ILI gauging[2]		Q3 2016	49,858	60	
	ILI pigging[2]		Q3 2016	49,858	60	
	Dewater pipeline following full length test (includes 100% contingency)[2]		Q3 2016	93,477	53	
Gas Pipeline 2	Flood, clean and gauge[4]	-95m below sea level	Q2 2015	9,646	12	203,924 (treated seawater) 2,181 desalinated freshwater
	Hydrotest[1,4]		Q2 2015	416	12	
	Leak test[1]	-52m below sea level	Q3 2016	365		
	Pre ILI gauging[2]		Q3 2016	49,858	60	
	ILI pigging[2]		Q3 2016	49,858	60	
	Dewater pipeline following full length test (includes 100% contingency)[2]		Q3 2016	95,962	53	
Condensate Pipeline	Flood, clean and gauge[4]	-95m below sea level	Q2 2015	2,719	6	43,551 treated seawater 615 desalinated freshwater
	Hydrotest[1,4]		Q2 2015	179	12	
	Leak test[1]	-52m below sea level	Q3 2016	157		
	Pre ILI gauging[2]		Q3 2016	14,056	30	
	ILI pigging[2]		Q3 2016	14,056	30	
	Dewater pipeline following full length test (includes 100% contingency)[2]		Q3 2016	12,998	26	
MEG Pipeline	Flood, clean and gauge[4]	-95m below sea level	Q2 2015	367	6	5,876 treated seawater 83 desalinated freshwater
	Hydrotest[1,4]		Q2 2015	23	12	
	Leak test[1]	-52m below sea level	Q3 2016	20		
	Pre ILI gauging[2]		Q3 2016	1,897	30	
	ILI pigging[2]		Q3 2016	1,897	30	
	Dewater pipeline following full length test (includes 100% contingency)[2]		Q3 2016	1,754	26	

Notes: 1. Discharge during hydrotest and leak testing comprises volume of water used to increase pressure to test pressure
2. Estimated discharge volume includes 20% overfill contingency 3. Volumes include spool volumes
4. Includes volume from onshore section testing

The project team is undertaking an evaluation of the options to manage disposal of treated seawater used during pipeline and flowline pre-commissioning to assess the best practical environmental option (BPEO). Upon completion of the BPEO the Project team will update MENR about the selected hydrotest water disposal option and obtain MENR approval.

5.8.6 Installation Vessels and Plant

A number of vessels will be used to undertake the pipelay activities including the Israfil Guseinov pipelay barge, three anchoring handling vessels, four pipe supply vessels, the DSV and various supply and support vessels. Table 5.23 summarises the pipelay barge and support vessel utilities.

Table 5.23 Pipelay Barge and Support Vessel Utilities

Utility	Description
Power Generation (Israfil Guseinov)	• The main power provided by 5 diesel generators rated at 1,600kW each.
Sanitary Waste	• Grey water will be discharged to sea (without treatment) as long as no floating matter or visible sheen is observable. • Depending on the availability of the system, black water will either be: - Contained onboard for transfer to shore; - Once onshore, black water will be managed in accordance with the existing AGT management plans and procedures; Or - Black water will be treated to applicable MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards: Five day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable. • Sewage sludge will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.
Galley Waste	Depending on the availability of the system, galley food waste will either be • Contained and shipped to shore for disposal; or • Sent to vessel maceration units designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards prior to discharge.
Drainage/Water	• Deck drainage and wash water discharged to sea as long as no visible sheen is observable. • Oily bilge water, tank sludges, untreated oily water and waste oil will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

The type and number of onshore construction plant anticipated for the onshore pipeline installation activities are included within Appendix 5F.

5.8.7 Installation of Subsea Export and MEG Pipelines Emissions, Discharges and Waste

5.8.7.1 Summary of Emissions to Atmosphere

Table 5.24 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during subsea export and MEG import pipeline installation, tie-in and commissioning from key sources which include:

- Pipelay barge and support vessel engines and generators;
- Onshore construction plant; and
- Commissioning plant.

Table 5.24 Estimated GHG and Non GHG Emissions Associated with SD2 Project Installation of Subsea Export and MEG Pipelines

	Offshore and Nearshore Installation	Onshore and Nearshore Installation	Pre-Commissioning	Total
CO_2 (ktonne)	296.2	21.9	47.5	**365.5**
CO (tonnes)	740.4	113.3	150.3	**1,004.0**
NO_x (tonnes)	5,460.5	332.6	721.4	**6,514.5**
SO_x (tonnes)	740.4	43.8	29.7	**813.9**
CH_4 (tonnes)	25.0	1.2	2.5	**28.6**
NMVOC (tonnes)	222.1	50.3	65.1	**337.5**
GHG (ktonnes)	296.7	1.9	47.5	**366.2**

See Appendix 5A for detailed emission estimate assumptions.

5.8.7.2 Summary of Discharges to Sea

Routine and non routine discharges to the sea during pipeline installation, tie-in and commissioning comprise:

- Pipeline cleaning and hydrotest fluids (refer to Section 5.8.4 above); and
- Pipelay and support vessel discharges as described within Table 5.23.

5.8.7.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated during the export pipeline and subsea infrastructure installation, tie-in and commissioning programme are provided in Section 5.9.5.3.

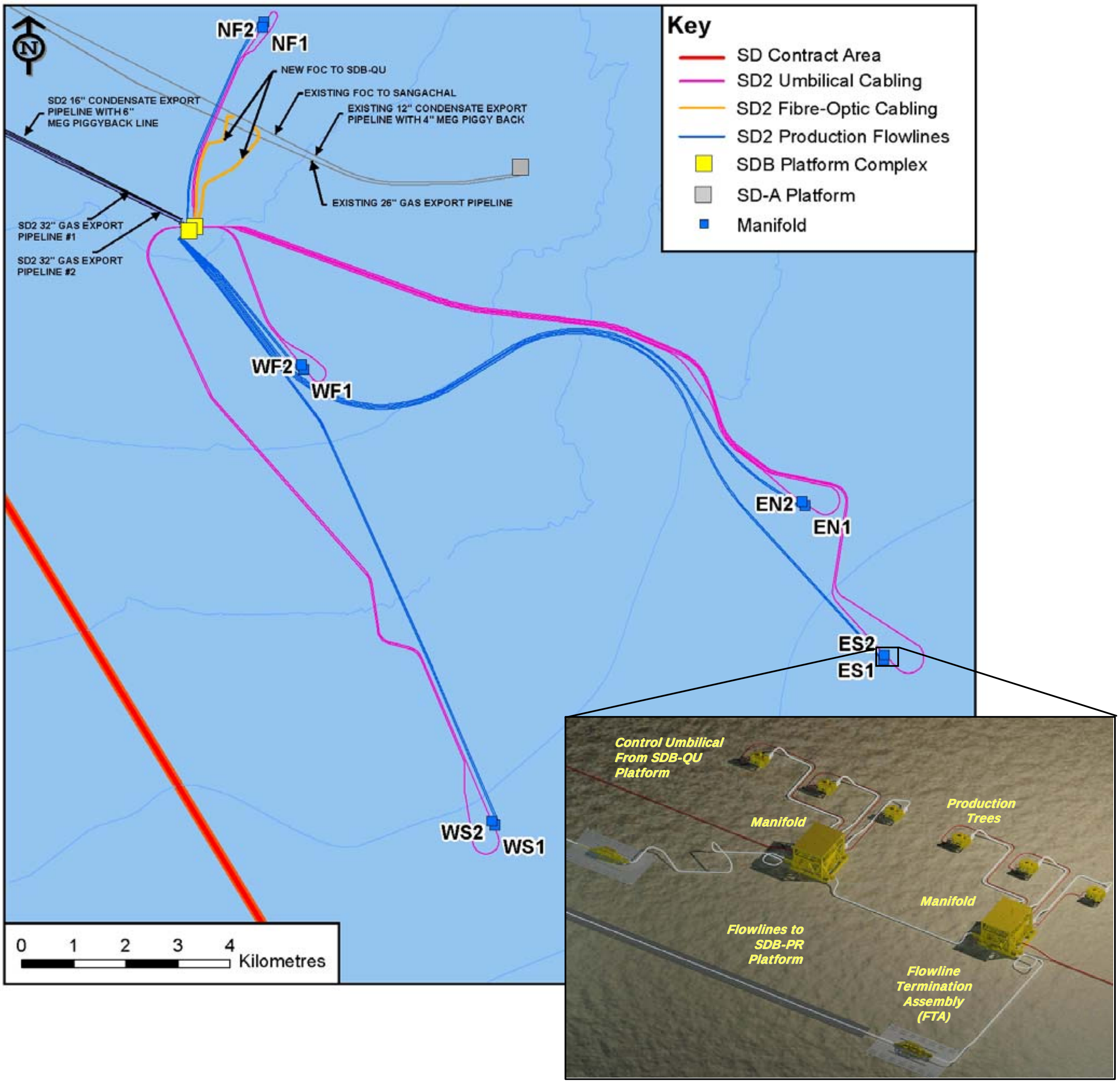
5.9 Subsea Infrastructure Installation, Hook Up and Commissioning

5.9.1 Introduction

The infield subsea infrastructure will be designed to transport the production fluids from the SD2 Project wells to the new offshore SDB platform complex. The elements of the subsea infrastructure to be installed within the SD Contract Area, as shown within Figure 5.20, include:

- 26 subsea production trees;
- 10 subsea production manifolds including a High Integrity Pressure Protection System (HIPPS). Each manifold will be tied to either 2 or 3 wells, located in 5 locations across the Contract Area, forming 5 well clusters;
- 10 production flowlines (two per well cluster) including in-line Direct Electrical Heating (DEH) cables and Subsea Safety Isolation Valves (SSIVs); and
- Subsea controls, chemical distribution (including MEG) and umbilicals.

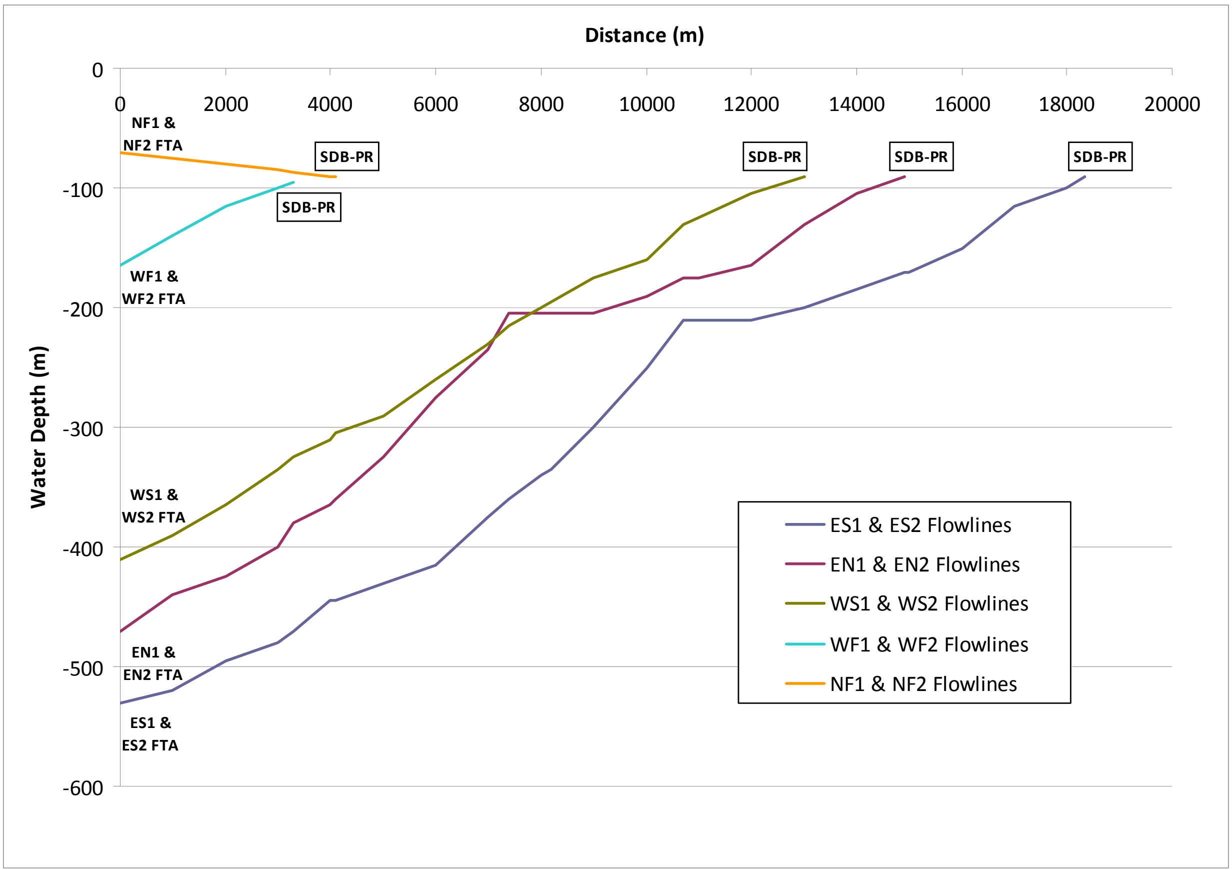
Figure 5.20 Layout of SD2 Infield Subsea Infrastructure



5.9.2 SD2 Subsea Infrastructure Design

The flowlines will be constructed from carbon steel and will incorporate a coating with thermal insulation in addition to a cathodic protection system which is compatible with the DEH system. The approximate flowline lengths and associated indicative seabed profiles are shown in Figure 5.21.

Figure 5.21 Approximate Flowline Lengths and Associated Seabed Profiles



5.9.3 Subsea Infrastructure Installation

The pipelay barge "Israfil Guseinov" will be used to install the flowlines using the same technique as for the export pipelines (refer to Section 5.8.3.1 above). The DEH system cabling will be strapped to the flowlines as they pass through the firing line and are deployed from the back of the pipelay vessel.

The pipelay barge will also be used to install the flowline termination assemblies (FTAs) associated with each cluster and will be used to store the tie-in spools between the platform risers and SSIVs and between the SSIVs and the flowlines prior to final installation by divers. Installation of the other subsea production infrastructure will be completed using the DBA, DSV, pipelay barge and various support and supply vessels. Each of the 9 SSIVs will be secured using 4 piles. The base case assumes the manifolds will be installed onto a foundation structure using suction piles. The utilities associated with the installation vessels are described in Table 5.23 above.

It is anticipated that the production trees, manifolds, associated jumpers and manifold headers are installed pre-filled with MEG. The equipment will be fitted with pressure caps to minimise losses of fluids to sea however it is anticipated that small volumes of MEG (between 10.74 and 13.84m^3 per flank) will be discharged to sea at the seabed during installation in the vicinity of each manifold and the associated production trees.

5.9.4 Flowline Pre Commissioning

Following installation the infield flowlines will be pre commissioned (i.e. cleaned, hydrotested, tied-in, tested and dewatered) using the same methodology adopted for the export pipelines (refer to Sections 5.8.4 above). The flowlines will be filled with treated seawater from a support vessel. It is anticipated that seawater will be dosed with:

- 1000 ppm Hydrosure HD5000 (combined biocide, corrosion inhibitor and oxygen scavenger); and
- 100ppm Tros Seadye (dye).

In the event that different chemicals are required, the SD2 Project Management of Change Process (see Section 5.16) will be followed. The intent is to use chemicals no more toxic or persistent than the Base Case chemicals.

The flowlines will remain filled within treated seawater until they are tied in. During this period each flowline shall be monitored to ensure systems are being continually protected against corrosion. If preservation chemicals are deemed to be depleting the treated seawater will be displaced to sea and refilled with treated seawater at the dosage rates stated above.

Table 5.25 presents the expected volume and location of discharges associated with gauging, hydrotesting, tie-in, testing and dewatering of the SD2 infield flowlines.

Table 5.25 Estimated Flowline Gauging, Hydrotesting, Tie-in, Leak Tests and Dewatering Discharges

		Discharge Location	Anticipated Date	Estimated Discharge Volume (m^3)	Discharge duration (hr)	Total Estimated Discharge Volume (m^3)[3]
NF Flowlines	Flood, clean and gauge	Seabed - 95m below sea level	Q1 2015	484	1	2,512 treated seawater 30 desalinated freshwater
	Hydrotest[1]		Q1 2015	12	12	
	Leak test[1]	SDB Open Drains Caisson -52m below sea level	Q3 2016	11		
	Pre intelligent pigging gauging[2]		Q3 2016	718	3	
	Intelligent pigging[2]		Q3 2016	718	3	
	Dewater flowlines following full length test[4]		Q3 2016	598	2	
WF Flowlines	Flood, clean and gauge	Seabed at SDB location) -95m below sea level	Q2 2015	458	1	2,041 treated seawater 23 desalinated freshwater
	Hydrotest[1]		Q2 2015	9	12	
	Leak test[1]	SDB Open Drains Caisson -52m below sea level	Q4 2016	10		
	Pre intelligent pigging gauging[2]		Q4 2016	560	2	
	Intelligent pigging[2]		Q4 2016	560	2	
	Dewater flowlines following full length test[4]		Q1 2017	467	2	
ES Flowlines	Flood, clean and gauge	Seabed at SDB location) -95m below sea level	Q2 2017	900	1	13,147 treated seawater 134 desalinated freshwater
	Hydrotest[1]		Q2 2017	50	12	
	Leak test[1]	SDB Open Drains Caisson -52m below sea	Q2 2018	46		
	Pre intelligent pigging gauging[2]		Q3 2018	3205	12	
	Intelligent pigging[2]		Q3 2018	3205	12	

		Discharge Location	Anticipated Date	Estimated Discharge Volume (m^3)	Discharge duration (hr)	Total Estimated Discharge Volume (m^3)[3]
	Dewater pipeline following full length test (includes 100% contingency)[2,4]	level	Q3 2018	2670	10	
WS Flowlines	Flood, clean and gauge	Seabed at SDB location) -95m below sea level	Q3 2017	734	1.4	7,011treated seawater 93 desalinated freshwater
	Hydrotest[1]		Q3 2017	35	12	
	Leak test[1]	SDB Open Drains Caisson -52m below sea level	Q4 2019	32		
	Pre intelligent pigging gauging[2]		Q4 2019	2,224	9	
	Intelligent pigging[2]		Q4 2019	2,224	9	
	Dewater flowlines following full length test[4]		Q4 2019	1,853	7	
EN Flowlines	Flood, clean and gauge	Seabed at SDB location) -95m below sea level	Q3 2019	798	2	7,917treated seawater 105 desalinated freshwater
	Hydrotest[1]		Q3 2019	42	12	
	Leak test[1]	SDB Open Drains Caisson -52m below sea level	Q2 2023	36		
	Pre intelligent pigging gauging[2]		Q2 2023	2,522	10	
	Intelligent pigging[2]		Q2 2023	2,522	10	
	Dewater flowlines following full length test[4]		Q2 2023	2,101	8	

Notes:
1. Discharge during hydrotest and leak testing comprises volume of water used to increase pressure to test pressure
2. Estimated discharge volume includes 20% overfill contingency
3. Each event includes volume of the two flowlines, FTAs, SSIVs, spools and risers for each flank.
4. Discharge includes slug of desalinated freshwater

The project team is undertaking an evaluation of the options to manage disposal of treated seawater used during pipeline and flowline pre-commissioning to assess the best practical environmental option (BPEO). Upon completion of the BPEO the Project team will update MENR about the selected hydrotest water disposal option and obtain MENR approval.

5.9.5 Subsea Infrastructure Installation, Hook Up and Commissioning Emissions, Discharges and Waste

5.9.5.1 Summary of Emissions to Atmosphere

Table 5.26 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during subsea installation, hook up and commissioning from the pipelay barge and support vessel engines and generators.

Table 5.26 Estimated GHG and Non GHG Emissions Associated with SD2 Project Installation of Subsea Infrastructure

	Subsea Infrastructure Installation	Subsea Infrastructure Pre-Commissioning	Total
CO_2 (ktonne)	38.9	20.2	**59.0**
CO (tonnes)	97.2	50.4	**147.6**
NO_x (tonnes)	716.9	371.7	**1,088.6**
SO_x (tonnes)	97.2	50.4	**147.6**
CH_4 (tonnes)	3.3	1.7	**5.0**
NMVOC (tonnes)	29.2	15.1	**44.3**
GHG (ktonnes)	38.9	20.2	**59.1**

See Appendix 5A for detailed emission estimate assumptions.

5.9.5.2 Summary of Discharges to Sea

Routine and non routine discharges to the sea during subsea infrastructure installation, tie-in and commissioning comprise:

- Subsea infrastructure discharges during installation (refer to Table 5.25 above);
- Flowline cleaning and hydrotest fluids (refer to Table 5.26 above); and
- Pipelay and support vessel discharges as described within Table 5.23.

5.9.5.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non-hazardous and hazardous waste generated during the SD2 export pipeline, MEG import pipeline and subsea infrastructure installation, hook up and commissioning activities are provided in Table 5.27. This data are based on waste volumes recorded for similar activities undertaken during the previous ACG Projects.

Table 5.27 Subsea Export Pipelines, MEG Import Pipeline and Subsea Infrastructure Fabrication and Installation Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Domestic/office waste	5,223
		Grit blast	31
		Metals - swarf	4,139
		Paper and cardboard	62
		Plastics - recyclable (HDPE)	3
		Tyres	42
		Waste electrical and electronic cable	9
		Wood	287
	Liquid wastes	Oils – cooking oil	0
		Total (Non-hazardous)	**9,797**
Hazardous	Solid wastes	Clinical waste	0.1
		Contaminated materials	1,057
		Contaminated soil	6
		Oily rags	36
	Liquid wastes	Oils – lubricating oil / Oils - fuel	102
		Paints and coatings	92
		Solvents, degreasers and thinners	8
		Water - oily	5,618
		Water - hydrotest water	95
		Water treatment chemicals	31
		Total (Hazardous)	**7,046**

5.10 Offshore Operations and Production

5.10.1 Overview

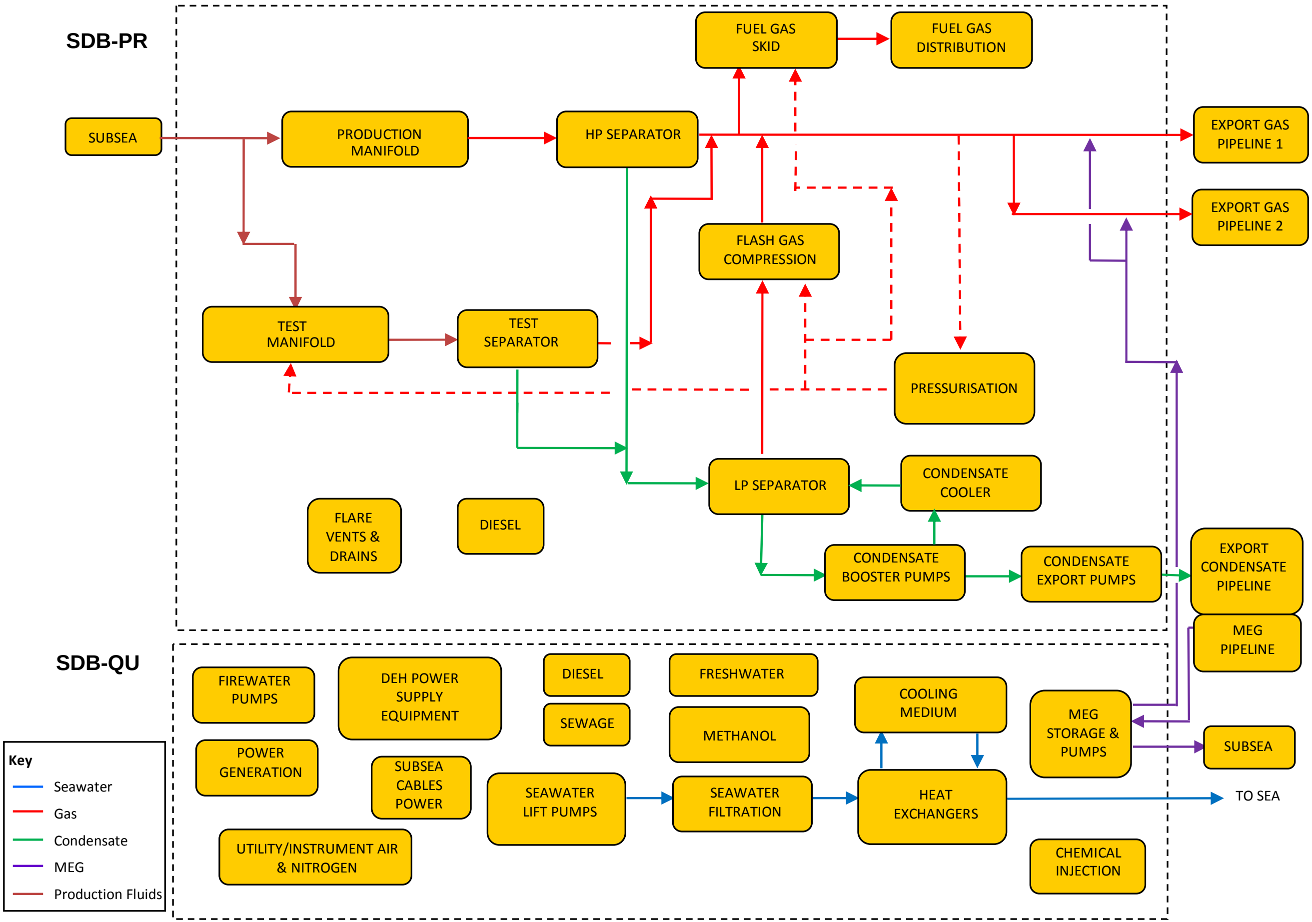
The SDB platform complex comprises the bridge linked SDB-PR and SDB-QU platforms.

Key production activities that will be undertaken on the SDB platforms will include:

- Gas and condensate separation and production;
- Gas export; and
- Condensate export.

Process systems will be located on the SDB-PR platform. Utilities and worker accommodation facilities will be located on the SDB-QU platform. The systems on each platform and relevant interconnections are shown schematically within Figure 5.22.

Figure 5.22 SDB-PR and SDB-QU Process and Utilities Systems



The sections below provide an overview of the key systems shown in Figure 5.22.

5.10.2 Production and Separation

The production fluids from each of the subsea production system flowlines will be routed to one of two production manifolds, or to the test manifold during well testing.

There will be two trains of separation in a 2 x 50% configuration (i.e. two trains designed to operate simultaneously under routine conditions at 50% throughput each). The fluids from the production manifold will be sent to a dedicated 2-phase HP separator. From the HP separator the fluids will be routed to a 2-phase LP separator. The gas from the HP separator will be routed to gas export via a pressure control system.

The test manifold fluids will be routed to a 1 x 100% 3-phase test separator, sized to accommodate the maximum expected operational flows from any one flowline. The test separator will be designed to operate as a production separator in the event that the HP separator is unavailable (e.g. due to maintenance). The LP separators will be sized to handle flow from both HP and test separators.

The HP and test separators will be equipped with a spill offs to flare (via the SDB-PR platform header) for safe disposal of gas during the establishment of gas buy back or during flowline pigging operations.

A pressurisation/depressurisation manifold will be provided to receive fluids from a controlled subsea flowline depressurisation, which will occur prior to planned flowline pigging or if a non routine event occurs which has the potential to reduce flowline temperatures to below 26°C and the primary method of hydrate control is not available (refer to Section 5.11.2.2 below).

It is intended that well clean up, completion, workover and intervention activities will be undertaken by the MODU (refer to Section 5.4 above), minimising the carry over of solids and completion, workover and intervention chemicals to the SD2 offshore facilities. However the platform separation system will be designed to accommodate the small amount of remaining solids and chemicals expected from the production wells during start up, workover and intervention.

5.10.3 Gas Export

The gas from HP production separators, test separator and flash gas compression system will be exported to Sangachal Terminal via the two new 32” dedicated gas export pipelines. A 16” cross over/balance line will be provided between the two export lines, which also provides the primary source of the platform fuel gas. MEG is injected into the gas prior to export to the Terminal.

A three stage flash gas compression system will be provided to continuously recover low pressure gas from the LP production separators for routing to the gas export system. When the flash gas compression system is unavailable (due to trips or testing of pressure safety valves (PSVs)), gas will be routed to flare. These compressors are also used during flowline repressurisation activities (see Section 5.10.6).

5.10.4 Condensate Export

Condensate will be exported to Sangachal Terminal via the new 16” condensate export pipeline. Condensate from the LP Production Separators will be routed to the Condensate Booster Pumps and then to Condensate Export Pumps and 16” Condensate Pipeline.

During start up, the condensate booster and export pumps will be run in recycle mode with the condensate returned to the LP separator. A portion of the recycled condensate stream will be routed through a cooler to prevent the temperature of the combined stream from exceeding 50°C.

5.10.5 Fuel Gas System

The main consumer of the fuel gas will be the power generation system on the SDB-QU platform. In addition, the gas will also be used for purge and pilot in HP and LP flare systems and for storage vessel blanketing.

The normal source of fuel gas will be production gas from the gas export manifolds. An alternative source is buy back gas, which will be supplied from the 32” gas export pipelines. When the normal source of fuel gas is not available, e.g. during platform shutdown and restart, the preferred option is to use buy back gas. This gas is expected to contain some liquid surge volumes, which will be collected within the HP and test separators. To avoid choking the continuous supply of fuel gas to the users, the gas stream from the separators during the initial period of liquid removal will be sent to flare at an estimated rate of 75mmscfd.

5.10.6 Pressurisation System

The pressurisation system will be located on the SDB-PR platform and will be designed to supply heated gas in order to prevent hydrate and ice formation during subsea flowline pressurisation during a platform shutdown or restart. The primary source of pressurisation gas will be buy back gas from the new 32” gas export pipelines.

5.10.7 Flare System

The SDB platforms will be fitted with a flare system, designed to safely dispose of hydrocarbon gases released from the processing facilities during non routine and emergency conditions. Under routine operational conditions, the platform flare system is designed for purge and pilot flaring only.

The HP flare system will be designed to collect hydrocarbon discharges from pressure relief, control and depressurisation valves from equipment with a design pressure at or above 18 barg (with the exception of the flash gas compressor discharge cooler bursting discs which are routed directly to the LP flare drum via a segregated header. In addition, spill-offs to flare will be provided on each of the separators (LP/HP/Test) for use during round trip pigging and gas buy back.

The process equipment items that comprise the HP flare system (including the HP flare drum and heater) will be located on the SDB-PR platform. The SDB-QU platform header will be routed to the HP flare drum on the SDB-PR platform via the bridge. The SDB-PR liquid header will also be routed to the HP flare drum.

The LP flare system, located on the SDB-PR platform, will be designed to collect hydrocarbon discharges from pressure relief, control valves and tank/drum vents from equipment with a design pressure below 18 barg, with the exception of the:

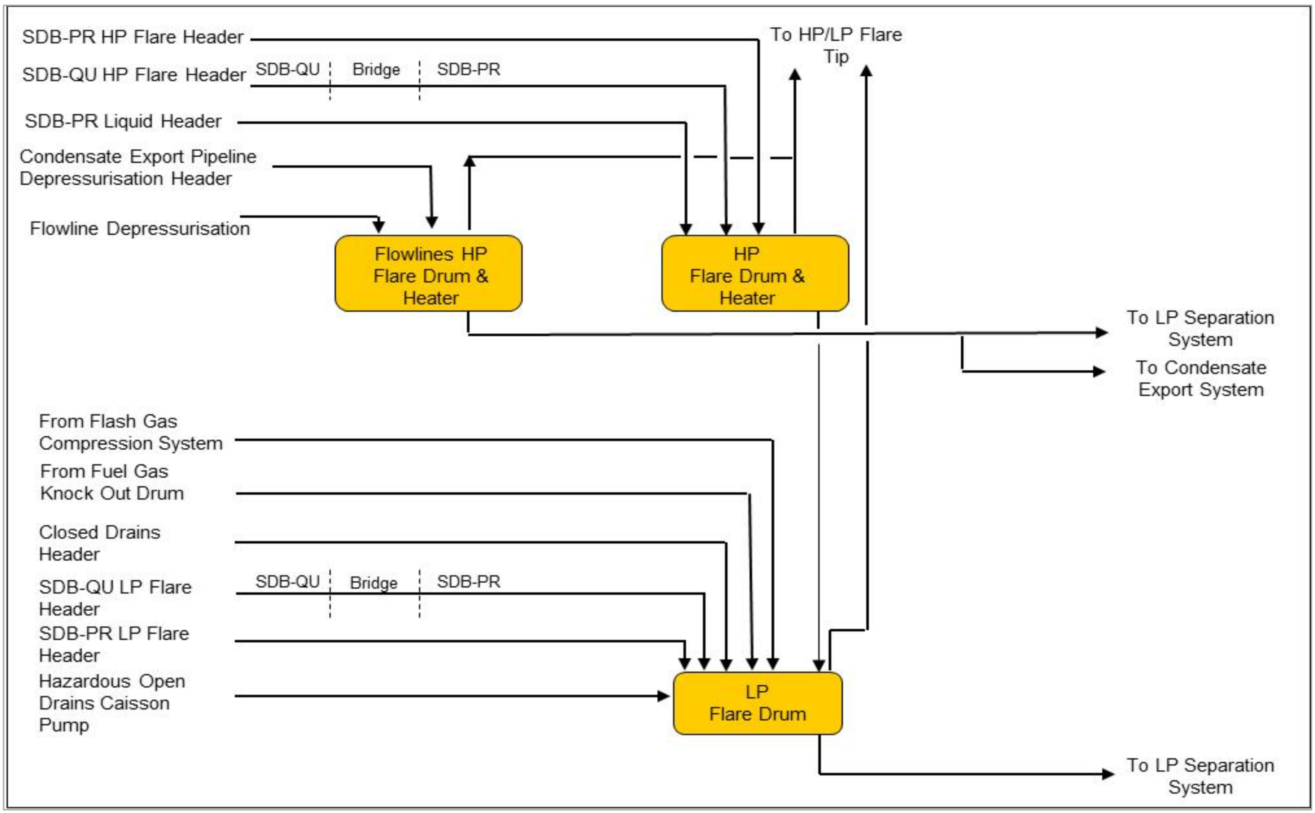
- Flash gas compressor discharge cooler bursting discs which are routed directly to the LP flare/closed drains drum, and
- Cooling medium expansion drum which is routed to the LP flare/closed drum via the SDB-QU and SDB-PR LP flare collection headers.

The LP flare will share the 1x100% HP/LP flare tip package. The flare boom will be located on the south east corner of the SDB-PR platform at 180° to platform north and orientated at 60° to the horizontal. The flare, up to approximately 135m in length, will be designed to achieve a combustion efficiency of 98% and will be of a ‘smokeless design’. Fuel gas will be normally used to continuously purge the flare collection headers/sub-headers to ensure no air ingress while minimising the purge flow.

The SD2 Base Case assumes between 0.2% and 0.8% of the total gas produced will be flared per annum; between 0.1% and 0.3% will be flared offshore and the remainder at the Terminal.

Figure 5.23 shows a simplified flow diagram of the HP and LP flare systems.

Figure 5.23 HP and LP Flare Systems



5.10.8 Power Generation

Main electrical power for the offshore users will be provided by four gas turbine driven generators, each rated at 11.9MW (at 35°C). The generators will be dual fuel type, normally operating on fuel gas, switching to diesel when fuel gas is not available. Under routine conditions it is anticipated the offshore power demand will be 13MW (pre plateau production) rising to 19.1MW (plateau to end of PSA) and this demand will be met by 2 of the generators. Routine conditions are anticipated to occur typically for 91% of the year during operations.

When fluid flow is low or during upset conditions, it will be necessary to maintain the temperature of the subsea flowlines above a minimum of 26°C to prevent the formation of hydrates. This will be achieved by use of the DEH System (refer to Section 5.11 for further details of the DEH system operation). The electrical power demand has been determined based on two expected DEH modes:

- Keep warm up – where the flowlines are keep warm (at a minimum 26°C) following a production shutdown; and
- Cold start up – where the flowlines are heated from a minimum ambient seabed temperature to 26°C.

The currently anticipated electrical loads for the offshore platforms across the PSA are presented in Table 5.28.

Table 5.28 Anticipated Offshore Electrical Loads Across the PSA

Activity	2018 - 2019 MW (1-3 flowlines)	2020 - -2038 MW (6-10 flowlines)	Duration % Time
Normal Steady State	13	19.1	91
Keep Warm	14.8 - 15.8	27.2 - 33.4	7.5
Cold Start Up (Peak)	21.4 - 22.4	28 - 34.2	1
Planned Shut Down (base load only)	6	6	0.5*

*Estimated to occur once every 2 years.

Emergency power will provided by a diesel generator located on the SDB-QU platform.

5.10.9 Sand Separation System

The processing facilities will be designed to handle the anticipated sand volumes during the initial years of operation. As the rate of produced water from the reservoir increases it is anticipated that online sand removal within the HP and Test separators may be required.

Provision is made within the design for the sand separation package to be located on the SDB-PR platform, and for the ancillary systems to be located on SDB-QU platform.

An offline seawater wash system will be installed for operation from first gas on the HP and Test separators to remove any accumulated sand so the separator vessels can be opened for maintenance/inspection. Liquid and solid waste from the offline seawater wash system will be contained and shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

5.10.10 Platform Utilities

5.10.10.1 Diesel System

The main platform diesel users comprise:

- Cranes;
- Emergency power generator;
- Main power generators (only when both the fuel gas and buy back system is unavailable);
- Firewater pumps; and
- Lifeboats.

Diesel will be transferred from supply boats and offloaded onto each platform by hose, where it will be filtered and stored in the SDB-PR and SDB-QU crane pedestals; one on the SDB-PR and two on the SDB-QU platform, each with a working volume of 123m^3. The diesel storage tank and transfer pump on SDB-PR will be utilised to top up the SDB-QU diesel storage tanks as and when needed via manual operation.

When required, diesel will be pumped to the diesel users, via the diesel treatment package on the SDB-QU platform, which will remove small amounts of water and particulates that have contaminated the diesel during vessel transfer from the onshore diesel treatment facilities. Water and particulates collected in the diesel treatment system will be sent to the non-hazardous open drains system for disposal.

5.10.10.2 Seawater System

Seawater will be required onboard the SDB platform complex for a number of purposes including:

- Heating, Ventilation and Air Conditioning (HVAC);
- Living quarters ablutions;
- Freshwater maker;

- Fire water ring main pressurisation facility;
- Offline Seawater wash system;
- Cooling for the cooling medium system; and
- Washdown facilities.

The seawater system will be located on the SDB-QU platform with a cross-over line across the bridge to the SDB-PR platform. Seawater will be extracted from 1 of the 2 vertical seawater lift pump caissons at a depth of -75m below sea level. The maximum seawater extraction design flow rate per pump will be approximately 2,173m^3/hr. The design of the seawater intake caissons on the platform will incorporate a mesh of 200mm diameter.

Lifted seawater will be electrochlorinated in an antifouling package and dosed with 50 ppbv of chlorine and 5 ppbv copper; and then filtered to remove any particles that are above 50 microns in diameter. After use, part of the seawater (up to 2,124m^3/hr) will be returned to the Caspian, via the seawater discharge caisson (at a depth of -54.5m below sea level).

The design and operation of the seawater/cooling water system has been reviewed and confirmed that the temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees more than the ambient water temperature**.**

5.10.10.3 Cooling Medium System

The SDB-QU platform will be equipped with an indirect cooling medium system. The cooling medium (20% by weight MEG) will be cooled against seawater and will be circulated within a closed loop to users on both the SDB-QU platform and the SDB-PR platform (via the bridge).

In the event that the cooling medium becomes degraded and requires replacement, the used cooling medium will be drained from the system, containerised and will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures. The system will then be recharged with fresh cooling medium.

5.10.10.4 Chemical Injection Systems

The production process requires the addition of certain chemicals to facilitate production, aid the separation process, protect process equipment from corrosion and protect equipment, pipelines and the subsea production system from hydrate formation. There will be three separate chemical systems located on the SDB-QU platform which will supply both the SDB-QU and SDB-PR (via a bridge crosslink):

- Main chemical injection system;
- MEG injection system; and
- Methanol injection system.

Main Chemical Injection System

The Main Chemical Injection Package will provide chemicals primarily for the production and export systems. Chemicals will be supplied to the platform in transportable tote tanks located on a dedicated chemical lay down area above the storage tanks. These tote tanks will be decanted into the 1 x 100% storage tanks for each of the injection systems. For large inventories (exceeding the maximum tote tank size of 30 m^3) the chemicals will be delivered by supply boats and offloaded directly into the respective storage tanks. Transfer lines for chemicals from supply boats shall be fitted with slam shut valves. Storage tanks shall be sized to provide 14 days of chemicals at the maximum dosage rate.

The anticipated chemicals will be injected into the process streams as required and will be transported to the SD2 onshore facilities, co-mingled with the gas and condensate, via the SD2 gas and condensate subsea export pipelines.

The pumps associated with the main chemical injection package will be provided with integral drip trays or pans. Minor spills contained with the drip pans or trays will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

MEG

The MEG injection system will be used to suppress hydrate formation during low temperature conditions in the following cases:

- Continuous injection into the gas export pipelines during routine operations;
- Intermittent injection into the production flowlines/subsea production system, riser and SSIV area, for fluid displacement during a production shutdown;
- Intermittent injection into the production flowlines/subsea production system during start-up/restart of high pressure wells.

MEG will be supplied to the SDB platform complex via the dedicated 6” import pipeline from Sangachal Terminal. Lean MEG storage will be provided on SDB-QU platform, sized for a total working volume of 560m^3. This is based on the volume of MEG required to displace the risers and SPS for the five flanks of the subsea production system during a shutdown plus 60 m^3 for normal injection to gas export pipelines.

Minor spills from the MEG system will be contained in drip trays. The contents of the drip trays will be manually removed by hose, contained and will be shipped to shore for disposal in accordance with the existing AGT waste management plans and procedures.

Methanol

The purpose of the methanol system is to prevent ice/hydrate formation during flowline re-start, flowline depressurisation, gas buy back operations, HP and test separation and fuel gas system start-ups, as well as gas export pipeline manual depressurisation. The system will also be used for ice/hydrate remediation of flowline production risers and pipework, topsides production systems and subsea production system.

Methanol will be delivered by supply boats and offloaded directly to the 250m^3 methanol storage tank. During early years of production methanol will be supplied to the offshore facilities by tote tank only.

The methanol system will be located within a dedicated kerbed area and methanol pumps trays equipped with drip trays. For safety reasons, methanol spillage from the kerbed area will be routed overboard, while methanol pump drip trays (which may contain lube oil) will be routed to the SDB-QU hazardous area open drains system.

5.10.10.5 Drainage System

Open Drains

The SDB-PR and SDB-QU platforms will be provided with separate self-contained open drains systems (see Figure 5.24).

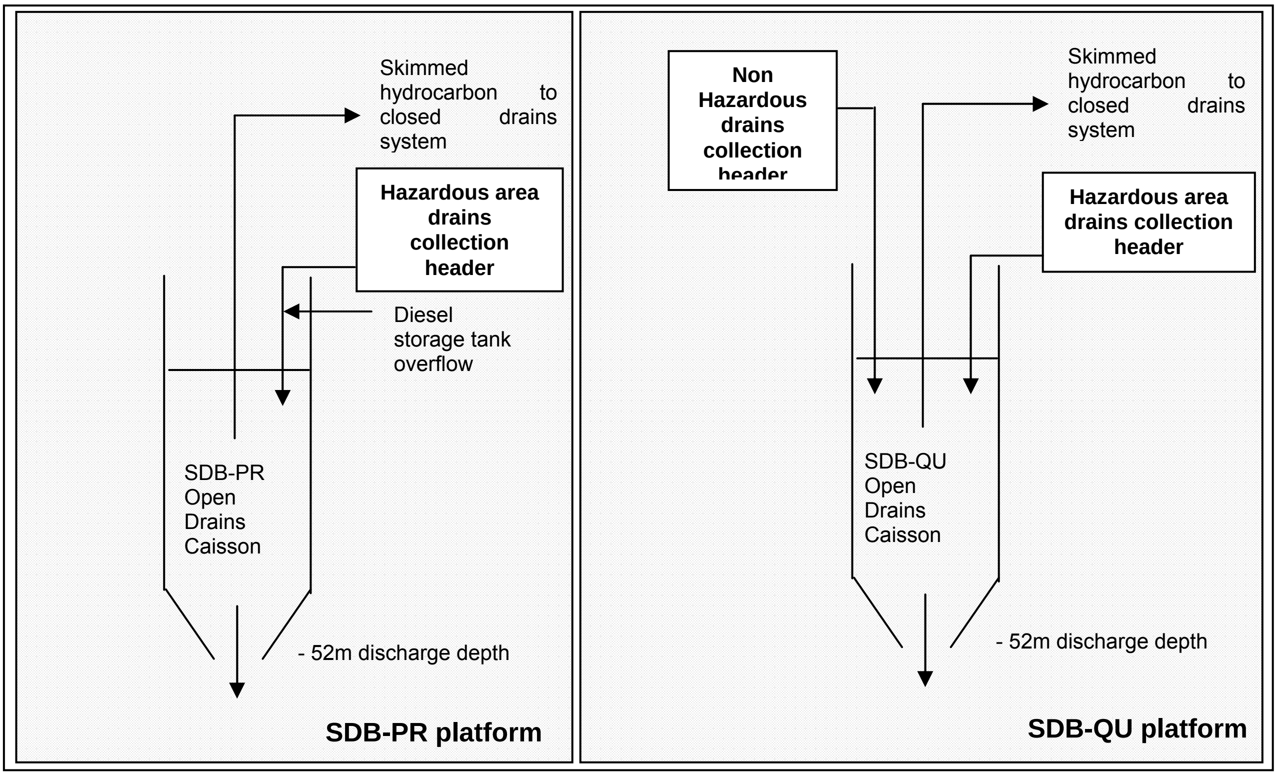
The SDB-PR platform will be provided with a hazardous area open drains system. The purpose of the hazardous area open drains system is to route drainage from rainwater, wash down water, firewater deluge, spillages and equipment drains/leakages from all the deck levels in the hazardous area of the platform to the SDB-PR open drains caisson.

The SDB-QU platform will be provided with two separate systems; a hazardous area drains system and a non-hazardous area drains system. The two systems will be segregated to prevent migration of gas or vapour from the hazardous to non-hazardous areas of the platform. Effluent from both hazardous and non-hazardous area open drains will be routed to the SDB-QU open drains caisson.

Under routine conditions it is not planned to route minor spills of production chemicals or MEG to the SDB-QU open drains caisson. However in the event of a production chemical tank overfilling or a significant spill or leakage, production chemicals and/or MEG spills/leaks will be sent to the SDB-QU non hazardous drains for safety reasons.

Both the SDB-QU and SDB-PR open drains caissons are designed to ensure that there is no visible sheen on the sea surface and to discharge at a depth of 52m below sea level. Any oil in the open drains caissons will be routed to the LP flare/closed drains drum on the SDB-PR platform. Deluge from deck drain boxes shall be routed directly overboard for safety reasons.

Figure 5.24 SDB-QU and SDB-PR Platform Open Drains Systems



Closed Drains

The function of the closed drains system is to collect hydrocarbon liquids/hazardous fluids from process equipment and instruments during maintenance operations. The contents of closed drain systems on the both the SDB-QU and SDB-PR platforms will be routed to the LP flare/closed drains drum on the SDB-PR platform. The gaseous hydrocarbons collected in the drum will be routed to flare and the liquid phase routed to the LP separators.

5.10.10.6 Instrument Air and Inert Gas System

Both the instrument and plant air systems and the inert gas system will be located on the SDB-QU platform, with lines across the bridge to the SDB-PR platform for the supply of air and inert gas to users.

5.10.10.7 Freshwater

Freshwater will be produced on the SDB-QU platform from seawater (taken from the seawater system) in the freshwater maker. The freshwater maker system will utilise a reverse osmosis (RO) process to desalinate seawater. Freshwater for potable use will be produced from an ultra violet (UV) sterilisation unit. Saline effluent from the freshwater maker will be returned to the Caspian via the SDB-QU sewage discharge caisson (at -16.2m below sea level).

5.10.10.8 Fire Systems

The platforms will be equipped with a firewater distribution system, which will be supplied by two diesel powered firewater pumps located on the SDB-QU platform. The firewater pumps will be tested on a weekly basis for an hour with seawater circulated through the firewater system and discharged via the SDB-QU seawater discharge caisson.

A foam concentrate system will be provided to enhance the effectiveness of water spray protecting the separator module and the flowlines HP flare drum area, where there is potential for hydrocarbon pool fires. Following commissioning (see Section 5.7.5), foam will be discharged during annual testing. Foam system chemicals of the same specification and environmental performance as those used in existing SD and ACG platform foam systems will be stored on the platform for emergency use[18].

5.10.10.9 Black and Grey Water

Black water and grey water from living quarters will be collected via the sewer system and treated in a sewage treatment package on the SDB-QU platform, sized to accommodate up to 240 Persons On Board (POB) (anticipated during commissioning).

It is intended that the sewage treatment package will be a membrane bioreactor fitted with jet aeration. Treated effluent will be discharged to sea via the SDB-QU platform sewage caisson (16.2m below sea level).

The sewage treatment package will be designed:

- In accordance with PSA requirements i.e. sanitary waste may be discharged from a U.S. Coast Guard certified or equivalent Marine Sanitation Device (MSD) to meet USCG Type II standards of total suspended solids of 150mg/l and faecal coliforms of 200MPN (most probable number) per 100ml;
- To ensure that a high proportion of the biodegradable surfactants present (greater than 90%) degrade prior to discharge of the treated effluent; and
- To allow mechanical removal of sludge, which will be contained in dedicated tote tanks and shipped to storage for disposal.

[18] The SD2 Project Management of Change Process (Section 5.16) will be followed should alternative chemicals be required.

Laundry grey water will be discharged to sea (without treatment) in accordance with applicable PSA requirements via the SDB-QU sewage caisson (16.2m below sea level) i.e. domestic wastes and grey water may be discharged as long as no floating solids are observable.

The sewage treatment package buffer tank will be sized to accommodate an additional day's black water above the normal operating capacity. In the event that the sewage treatment package is unavailable, all grey water (from living quarters and laundry) will be routed directly to the sewage caisson to maximise the storage volume available for black water.

5.10.10.10 Galley Waste

Organic food waste originating from the platform galley will be macerated to less than 25mm in accordance with MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships requirements and discharged to the SDB-QU sewage caisson.

5.10.11 Pipeline and Flowline Maintenance

Maintenance of the gas and condensate export pipelines, the MEG import pipeline and the infield flowlines will include periodic pigging. The condensate pipeline will be routinely pigged primarily to manage wax accumulation. All export/import pipelines and flowlines will undergo periodic inspection pigging to confirm integrity.

5.10.11.1 Export and MEG Import Subsea Pipelines

It is anticipated that the condensate export pipeline will be pigged approximately every three days. Pigging of the gas export pipelines will be infrequent and is expected to occur when flowrates drop below 350MMScfd.

Throughout the PSA, pigging will be undertaken in the direction of flow i.e. from the pig launchers located on the SDB-PR platform to the Terminal.

Each pigging event will require the associated condensate or gas export pipeline pig launcher on the SDB-PR platform to be depressurised with the resulting gas sent to flare.

For the MEG pipeline, pigging (expected to be undertaken infrequently) will be undertaken in the direction of flow i.e. from the pig launchers located on the Terminal to the SDB-PR platform. Contaminated MEG from pigging will be contained and shipped to shore, where it will either be regenerated or sent offsite for disposal in accordance with the existing AGT waste management plans and procedures.

5.10.11.2 Flowline Pigging

A pig launcher/receiver will be provided on the SDB-PR platform for each of the ten flowlines, which will be tied back to the platform in pairs to enable round trip pigging. It is anticipated that each flowline will be pigged every 3 years. Each pigging event will comprise 4 pig runs, propelled by gas at a rate of up to 50mmscfd. The hydrocarbon stream from the flowlines during pigging will be sent to the HP or Test separators via the dedicated pig receivers and the gas stream subsequently sent to flare. The pig receivers will be equipped with drip tray to collect solids/drips which will be contained and shipped to shore for appropriate disposal.

5.10.12 Supply and Logistics

Consumables such as diesel, chemicals and supplies will be transported to the platform by vessels, normally every 7-14 days, depending on requirements. Personnel will be transferred to the platform by vessel (up to two vessels per week during normal operations). Helicopter transfer may be used for contingency (i.e. for emergencies). There will be no helicopter or vessel refuelling facilities on the platform complex.

5.10.13 Offshore Operations Emissions, Discharges and Waste

5.10.13.1 Summary of Emissions to Atmosphere

Table 5.29 shows the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during SD2 start up and offshore production from key sources across the PSA period. These sources include:

- Main power generators;
- Emergency diesel generator;
- Firewater pump;
- Platform cranes;
- Flare; and
- Crew change helicopters/vessels and supply vessels.

Table 5.29 Predicted GHG and non GHG Emissions Associated with Routine and Non Routine SD2 Offshore Operations and Production Activities

	CO_2 (ktonne)	CO (tonne)	NOx (tonne)	SO_2 (tonne)	CH_4 (tonne)	NMVOC (tonne)	GHG (ktonne)
TOTAL	**3,642.5**	**4,875.4**	**13,262.1**	**511.2**	**3,920.9**	**786.9**	**3,724.8**

See Appendix 5A for detailed emission estimate assumptions.

5.10.13.2 Summary of Discharges to Sea

Planned discharges to sea from SD2 offshore operations comprise:

- Platform cooling water (refer to Section 5.10.10.2);
- Platform drainage (refer to Section 5.10.10.5);
- Platform freshwater maker returns (refer to Section 5.10.10.7);
- Platform black and grey water (refer to Section 5.10.10.9); and
- Platform galley waste (refer to Section 5.10.10.10).

5.10.13.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated by the SD2 offshore operations during the PSA period are provided in Table 5.30. These have been estimated based on the waste records for the Shah Deniz Alpha platform.

All waste generated during SD2 offshore operations and production activities will be managed in accordance with the existing AGT management plans and procedures.

Table 5.30 Offshore Operations Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Domestic/office wastes	2,759
		Metals - swarf	1,249
		Paper and cardboard	125
		Plastic – recyclable (HDPE)	55
		Waste electrical and electronic cables	28
		Waste electrical and electronic equipment	12
		Wood	770
	Liquid wastes	Oils - cooking oil	31
		Total (Non-hazardous)	**5,029**
Hazardous	Solid wastes	Batteries - wet cell	38
		Clinical waste	1
		Contaminated materials	502
		Contaminated soils	114
		Explosives	0.2
		Filter bodies	36
		Greases	0
		Lamps	6
		Oily rags	477
		Pressurised containers	1
		Tank bottom sludges	115
		Toner or printer cartridges	4
	Liquid wastes	Acids	0.2
		Antifreezes	10
		Oils - fuel	3,292
		Paints and coatings	10
		Sewage sludges	1,029
		Water treatment chemicals	382
		Total (Hazardous)	**6,018**

5.11 Subsea Operations

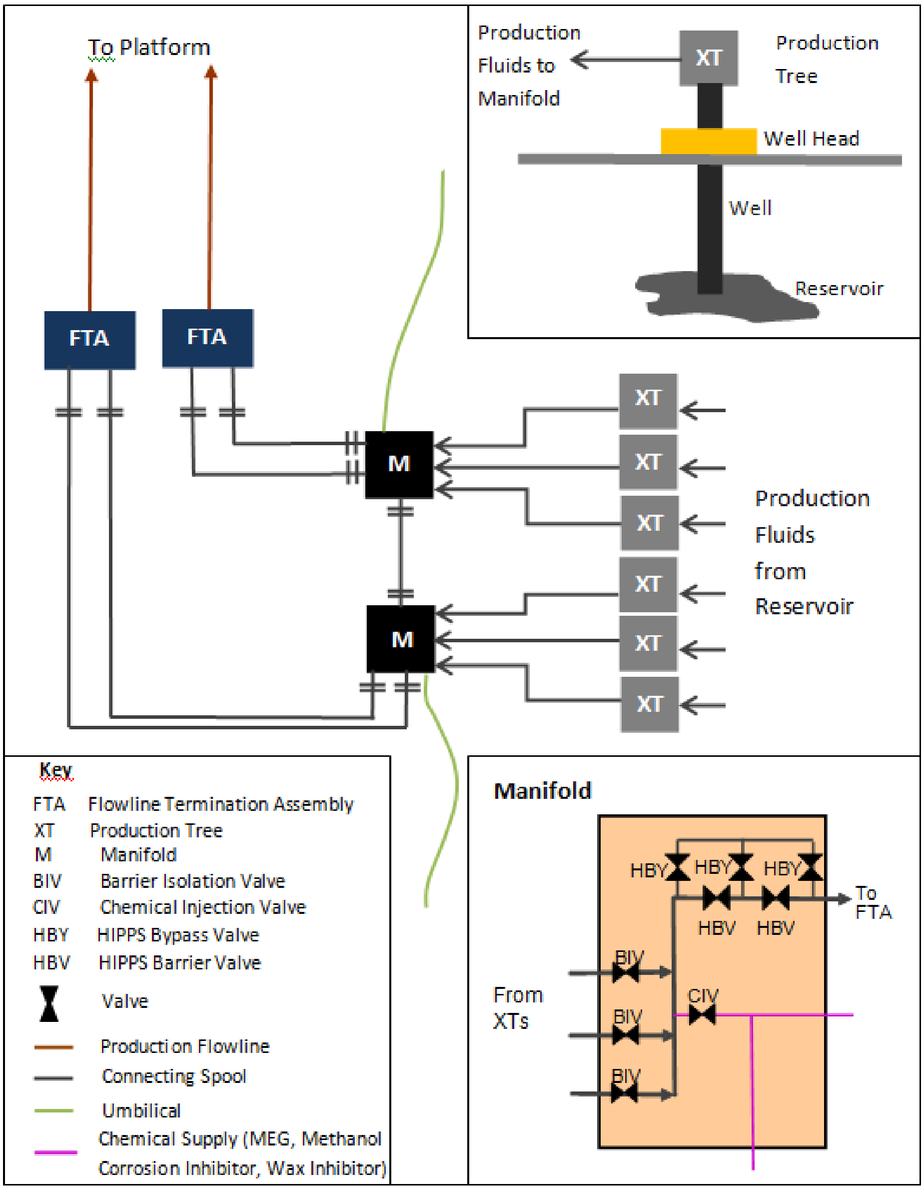
5.11.1 Introduction

Subsea production is planned to commence following the installation and tie-in of the infield subsea infrastructure in the north flank (NF). The infield subsea infrastructure will then be installed in the remaining 4 flanks (WF, ES, EN and WS) and tied in sequentially. The layout of the infield subsea production system, which is grouped into five well clusters, is shown in Figure 5.20. Each cluster comprises:

- Up to six wells, each fitted with a production tree;
- Two production manifolds, each tied to two or three wells, incorporating HIPPS;
- Two looped production flowlines, tied back to the SDB-PR platform, incorporating DEH cabling;
- One SSIV and associated umbilical and controls system per flowline adjacent to the SDB-PR platform;
- Two FTAs; and
- Umbilicals (including fibre optic cables).

Figure 5.25 illustrates the typical layout of the cluster and the valves associated with the manifolds and wellheads (within the production tree).

Figure 5.25 Typical Subsea Production System Layout of Each Cluster



The subsea production system valves will be controlled from the SDB-QU platform using an open loop subsea control system. Chemicals and power required for flow assurance (i.e. wax, scale, corrosion and hydrate management) will be provided from the SDB-QU platform via umbilicals.

5.11.2 Flow Assurance

During routine operations a number of chemicals will be required within the subsea production system to minimise the formation of wax and scale and control corrosion, During non routine conditions including well start up, testing, maintenance and shutdown it will be necessary to minimise the potential formation of hydrates within the subsea production system. This will be achieved using a combination of DEH and MEG. Methanol will also be used, if required, to dissolve hydrates which may form in the subsea equipment.

5.11.2.1 Subsea Flow Assurance Chemicals

A summary of the subsea flow assurance chemicals is provided within Table 5.31. All chemicals will be provided from the SDB-QU platform via umbilicals. It is not planned to discharge flow assurance chemicals to sea during subsea operations during either routine or non routine conditions.

Table 5.31 Subsea Flow Assurance Chemical Requirements

Chemicals	Required For
Corrosion Inhibitor	Corrosion management
Wax Inhibitor	Wax management
Scale Inhibitor	Scale management
MEG	Hydrate management
Methanol	Hydrate remediation

5.11.2.2 DEH Operation

The DEH system is designed to maintain the temperature of the production fluids within the subsea flowlines above 26°C during shutdown (when flow is low or static) to prevent the formation of hydrates and to heat the flowline contents from ambient seabed temperature to 26°C. All DEH cabling is insulated.

The system comprises cabling running from the SDB-QU platform to each flowline via dedicated subsea junction boxes. These are connected to the Piggyback Cable (PBC) and flowline at the near-end Current Transfer Zones (CTZ). The single core PBC runs along the flowline, and has an integrated dropped object protection system which is connected to the flowline, completing the circuit, at the far-end CTZ. The CTZ's are made up of banks of bracelet anodes attached to the flowline which ground the system and allow current to transfer through the water.

It is anticipated that the cable surface temperature of the PBC will not exceed 10°C during DEH system operation. The outer surface of the production flowlines are not expected to be greater than 0.2°C above ambient seawater temperature under both routine conditions and when the DEH is operational.

When activated, an alternating current passes along the cable, heating the flowline due to electrical resistance.

The power required for the DEH system will be provided from the SDB power generation system. The DEH power requirements will be determined by the relevant DEH scenario and number of flowlines to be heated (refer to Section 5.10.8). The two main DEH scenarios can be described as follows:

- **Cold start up** - where the production fluids within the flowlines are heated from ambient temperature to 26°C prior to restart. It is anticipated that this type of scenario will occur 1% of the time during the PSA period;

- **Keep warm** – where the system is used to maintain the production fluids within the flowlines temperature at 26°C after a planned production shutdown. It is anticipated that this type of conditions will occur 7.5% of the time during the PSA.

An electrical field will be generated around the flowlines during DEH operation, reaching approximately 0.18V/m around the 10 flowlines as they approach the platform in parallel and approximately 5V/m immediately adjacent to the CTZ. In both cases the field strength drops very rapidly away from the flowlines. Within 10m of the flowlines approaching the platform field strength is anticipated to halve and within 2m of the CTZ.

5.11.3 Subsea Control System

To control and monitor the flow of production fluids from the reservoir at the wellheads and the manifolds a subsea hydraulic control system will be used. As hydraulic valves are actuated control fluid will be discharged to sea as described below. The system will be constantly supplied with control fluid via the subsea umbilicals.

5.11.3.1 Manifold

The purpose of the manifold is to comingle and then route the production fluids to the SDB platform complex via the production flowlines**.** Each manifold will be equipped with HIPPS. The function of the HIPPS is to provide rapid isolation of the manifold from the flowlines, protecting the flowlines and platform facilities in the event of overpressure in one of the associated wells or caused by the closure of a SSIV at the platform complex.

The function of the hydraulic valves associated with the manifold include:

- **Chemical injection valves (CIV)** – to enable the introduction of wax inhibitor, corrosion inhibitor, MEG and methanol into the production fluids when required;
- **Barrier Isolation Valves (BIV)** – to allow the well slots within the manifold to be isolated;
- **HIPPS Barrier Valves (HBV)** – to stop the flow of production fluids from the manifold; and
- **HIPPS Bypass Valves (HBY)** – to allow differential pressure across the HIPPS barrier valves to be equalised and to enable testing of the HIPPS barrier valves.

The current design provides for up to 25 hydraulically actuated valves and associated DCVs at each manifold**.**

5.11.3.2 Wellhead

The functions of the hydraulic valves associated with each wellhead are:

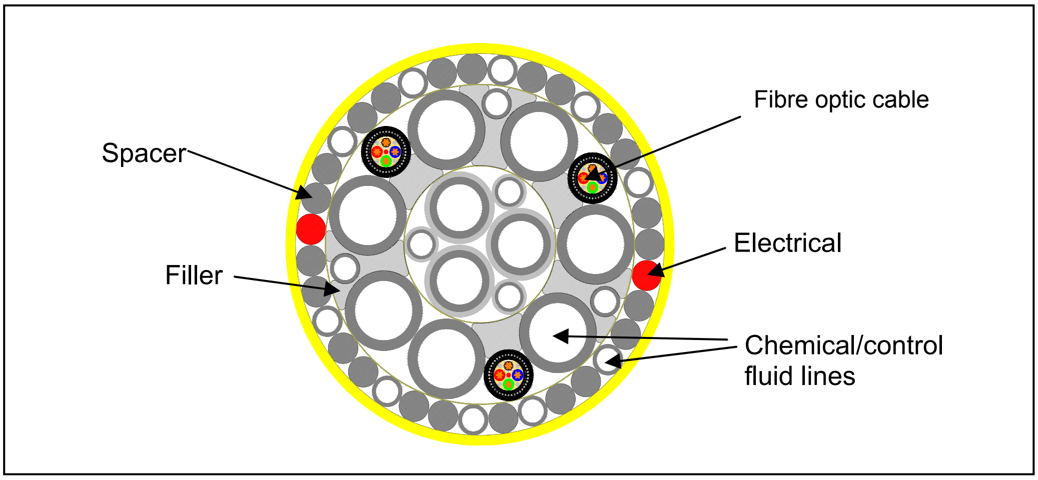
- Provide isolation from the reservoir;
- Manage the flow of production fluids from the well; and
- Enable chemicals (MEG, methanol and scale inhibitor) to be injected into the well where required;

The well control system also incorporates a hydraulically actuated choke, which can be moved in incremental steps to regulate the flow of production fluids. The current design provides for up to 24 actuator valves (including the production choke valve) and associated DCVs at each well.

5.11.3.3 Umbilicals

Chemicals, control fluids and electrical signals will be supplied to each well cluster via umbilicals, constructed of stainless steel**.** Figure 5.26 shows a cross section through a typical umbilical.

Figure 5.26 Typical Umbilical Cross Section



5.11.3.4 Control Fluid

It is planned to use Castrol Transqua HC10 water based control fluid within the SD2 subsea control system. This product has been selected using a thorough assessment process (as detailed within Chapter 4) based on its suitability, environmental performance and low toxicity.

5.11.3.5 Valve Operations During Routine Operations

Operation of the subsea valves across the lifetime of the SD2 Project are expected to occur during the following:

- **Well testing** – involves partial shutdown of each well on 3 occasions per year and a full shutdown once a year to enable the flow characteristics of the well to be tested;
- **Pigging** – integrity pigging of the flowlines as described in Section 5.10.11.2 above is expected to be required on a 3 yearly basis**,** requiring production to be shutdown on the flowline being pigged. This requires the relevant well to be closed in addition to the BIV and CIV manifold valves. The HIPPS valves are designed to remain open during pigging;
- **Field shut down** - full field shutdown is expected to occur once every 4 years; partial field shutdowns involving shutting down of a well cluster or part of cluster is also expected to occur on a 4 yearly basis; and
- **HIPPS testing** – it is anticipated that the HIPPS associated with each manifold will be tested annually. This would require the valves associated with relevant wells to be closed. In addition the HBY and MEG valves would need to be opened and closed approximately 3 times during the test.

The valves associated with the well and manifold are designed to return to the open position within the following times:

- **Well –** 45 seconds; and
- **Manifold –** 20 seconds.

.
Discharge of control fluids occurs as the valves open. The volumes discharged are proportional to the swept volume of the valve, which range from 0.1 to 25 litres.

The design of the hydraulic control system makes allowance for a small continuous DCV discharge. It is anticipated, based on typical rates provided by vendors, that this discharge will approximately 0.03cm^3 per minute per valve on average. The system is designed to route these discharges to a small reservoir. The vent line from the reservoir to sea incorporates check valves set to open at a pressure of 5-10 psi above ambient.

5.11.3.6 Summary of Control Fluid Discharges During Routine Operations

A summary of the anticipated volume of control fluids discharged per year is provided in Table 5.32. These volumes have been based on when each well and manifold is planned to commence operation (refer to Figure 5.3) and the anticipated valve operations and DCV discharge rates presented in Section 5.11.3.5 above.

Table 5.32 Estimated Discharges of Control Fluid due to Valve Operations and DCV Discharges Per Day

Year	Volume In Litres/Day		
	Valve Operations	DCV Discharge	Total
2018	1.3	6.3	7.6
2019	2.7	12.6	15.3
2020	4.5	18.9	23.4
2021	7.0	22.1	29.1
2022	4.7	22.1	26.8
2023	9.2	32.7	41.9
2024	7.3	34.7	42.0
2025	11.7	36.7	48.4
2026	9.5	39.8	49.3
2027	10.6	39.8	50.4
2028	8.5	39.8	48.3
2029	13.7	39.8	53.5
2030	8.5	39.8	48.3
2031	10.6	39.8	50.4
2032	9.5	39.8	49.3
2033	12.7	39.8	52.5
2034	8.5	39.8	48.3
2035	11.6	39.8	51.4
2036	8.5	39.8	48.3

5.11.4 Discharges During Subsea Production System Interventions

During operations it will be necessary to replace a number of subsea production system components. The most frequent replacements (known as interventions) are expected to be the control modules associated with the production trees and manifolds. During replacement activities, the relevant valves will be actuated to isolate the module being replaced, resulting in discharges of control fluids. These are expected to small and included within the control fluid volumes within Table 5.32. Discharges are also anticipated to result from replacement of each production tree choke as detailed in Table 5.33 below.

Table 5.33 Estimated Discharges During Production Tree Choke Interventions

Component	Number	Anticipated Intervention	Fluid Discharged per intervention	Volume Discharged per Intervention (m^3)	Discharge Duration (hrs)
Production tree choke	4 – 471 per tree	Once per tree	MEG	1.3	6

Prior to subsea interventions (not including control modules and production tree chokes) which may result in discharges to sea a risk assessment will be completed and the MENR informed as required.

5.11.5 Subsea Operations Emissions, Discharges and Waste

Emissions and waste associated with all offshore operations including subsea operations are provided in Section 5.10.13.

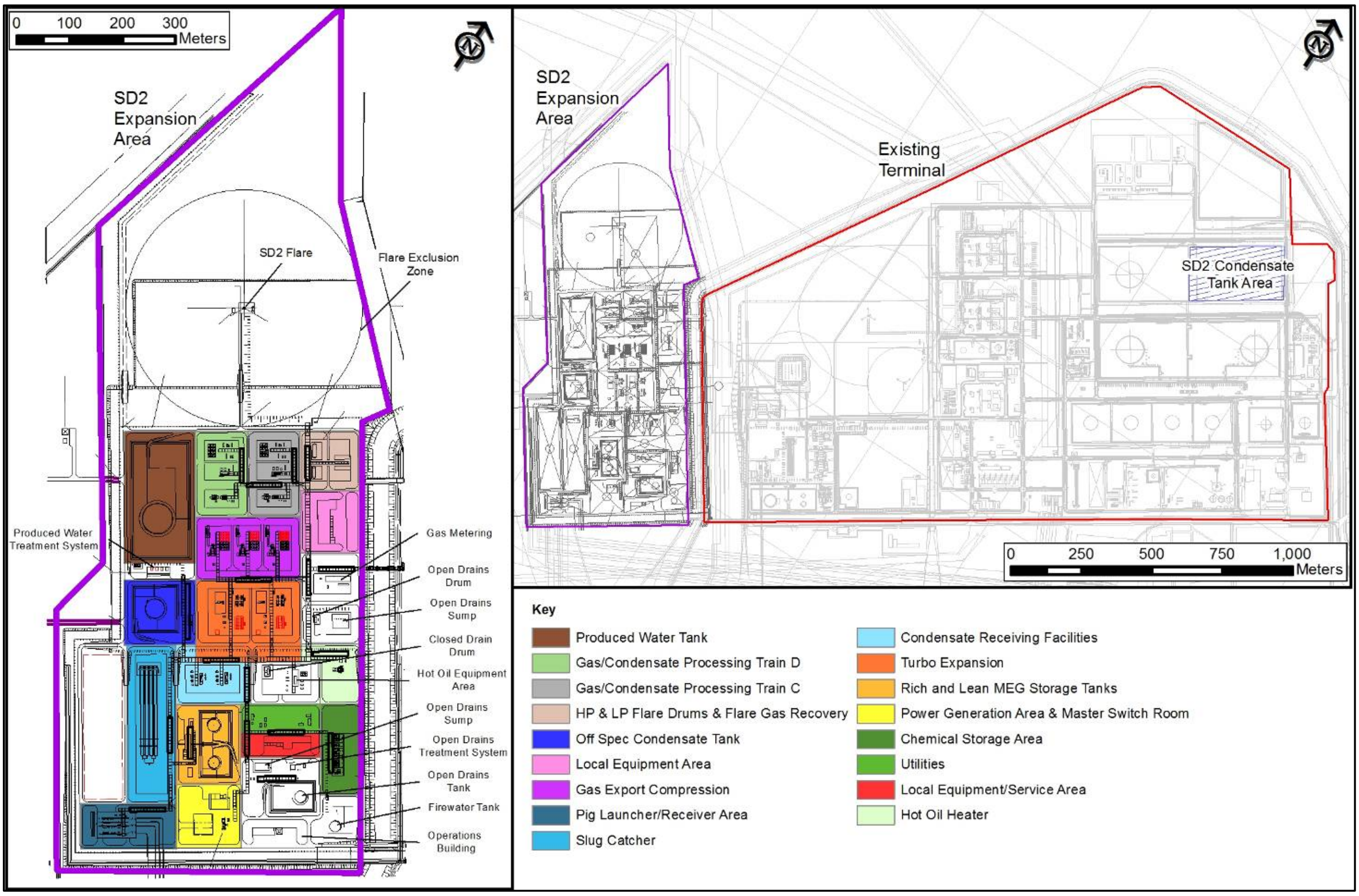
Anticipated discharges associated with subsea operations are summarised within Tables 5.32 and 5.33 above.

5.12 Onshore Operations and Production

5.12.1 Overview

The SD2 onshore process facilities and associated utilities will be located within the SD2 Expansion Area, adjacent to the existing Sangachal Terminal and will be partially integrated with the existing ACG and SD facilities. Figure 5.27 shows the proposed layout of the SD2 onshore facilities.

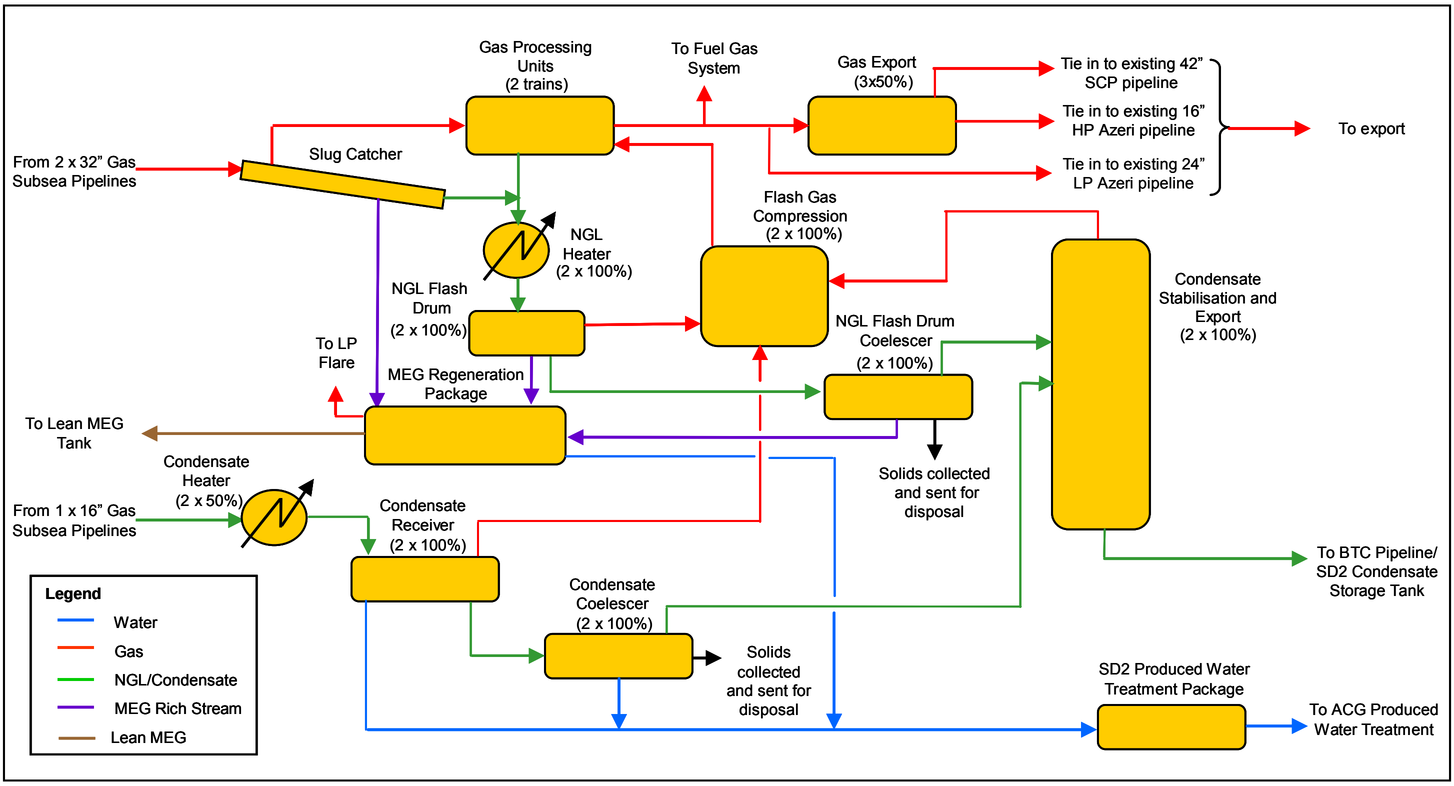
Figure 5.27 Layout of SD2 Onshore Facilities and Utilities



The primary purpose of the onshore SD2 facilities is to receive the hydrocarbon streams via the SD2 gas and condensate subsea export pipelines and process the fluids to obtain gas and condensate at a quality suitable for export (via the SCP and BTC facilities respectively)[19]. Figure 5.28 shows a simplified flow diagram of the SD2 onshore processes.

[19] The condensate will be comingled with the oil exported via the BTC facilities.

Figure 5.28 SD2 Onshore Process Schematic



The SD2 onshore facilities are designed to incorporate two gas and condensate processing trains.

The sections below provide an overview of the SD2 onshore process and utility systems.

5.12.2 Gas Processing and Export Facilities

The SD2 onshore facilities will be designed to receive gas from the SD2 offshore facilities via the two 32" gas pipelines at a pressure of 75 barg and at a temperature of between 2 and 25°C.

The gas will be delivered to the SD2 gas processing facilities via a slugcatcher.

Gas recovered from the slug catcher will be routed to 2 x 50% gas conditioning trains comprising heat exchangers, scrubbers, turbo expanders, separators and ancillary equipment. These facilities are designed to remove liquid vapour from the gas received from the slugcatcher and from the flash gas compression system such that the dewpoint specification for export is achieved.

The liquid stream from the gas processing trains will be routed to the natural gas liquids (NGL) Heaters. A portion of the gas will be routed to the SD2 fuel gas system.

The NGL heaters will also receive hydrocarbon liquid stream from the slugcatcher. From the heaters, the NGL stream will be sent to the NGL flash drums (1 x 100% per train) and NGL coalescers, designed to separate the streams into:

- A gas stream, which will be sent to the gas processing trains for further treatment and conditioning;
- A MEG rich aqueous stream, which will be routed to the MEG Regeneration Package for further treatment or to the Rich MEG Tank when the regeneration package is not available; and

- A hydrocarbon liquid stream which will be routed to the condensate stabilisation and export facilities via the NGL flash drum coalescers (1 per processing train). Coalesces will be used to remove solids and water from the hydrocarbon liquid stream. Solids will be managed in accordance with existing AGT waste management plans and procedures.

Conditioned gas will be compressed and cooled in 3x50% trains. The gas will be analysed and metered before delivery to the existing SCP, LP Azeri and HP Azeri pipelines.

The gas export compression facilities will comprise 3 x 50% gas export compressors driven by gas turbines with a total capacity of 1,777 MMscfd. Waste Heat Recovery Units (WHRU) will be installed on these gas turbines to recover the heat from the turbine flue gas for the heating medium system.

During start up it is planned to use gas from the existing SD1 and SCP facilities to pressurise the SD2 onshore facilities and to provide gas to the SDB offshore facilities via the two 32” subsea gas pipelines.

5.12.3 Condensate Processing, Storage and Export

The SD2 onshore condensate facilities, comprising 2 processing trains, will be designed to receive condensate via the 16” condensate pipeline at a pressure of 15barg and a temperature between 5 and 25°C.

The condensate from the offshore pipeline will be routed to condensate receivers, via heaters designed to raise the condensate temperature to 65°C. Flash gas will be routed to the 1st stage flash gas compressor suction scrubber. Condensate will be sent to the condensate stabilisation system via the condensate coalescers (1x100% per processing train) for water removal. The treated condensate will then be sent to the condensate stabilisation system. The recovered water will be routed to the SD2 produced water treatment package.

The purpose of the condensate stabilisation facilities is to heat the condensate and remove the “light end” components that have the potential to vaporise under ambient conditions during storage. The gas from the stabilisation facilities will be sent to the flash gas compression system. The stabilised condensate will be sent to the BTC export facilities. Should there be any restriction to the BTC pipeline, the condensate will be sent to the SD2 condensate storage tank and re-routed back to the BTC pipeline via the condensate storage tank pump. The tank, to be located within an existing bund adjacent to the exiting ACG crude oil tanks, will have a capacity of 500,000bbls and will be of a floating roof design.

If the condensate from the stabilisation facilities does not meet the BTC export facility inlet specifications, the condensate will be sent to the off spec condensate storage tank and then recycled back to the condensate processing facilities. The tank will be of domed roof design and will be provided with a fuel gas blanketing system and will have a capacity to maintain the peak condensate production rates for 12 hours for 2 trains and to manage transient flows from the condensate pipeline, particularly during pigging.

During offshore start up and re start of wells completion fluids, salty MEG and methanol will be routed onshore. These will either be routed to the off-spec condensate tank then transferred to a road tanker for appropriate offsite treatment and disposal or, if demonstrated to be of acceptable composition for treatment by the onshore SD2 facilities will be sent to one of the following locations:

- Produced water storage tank / treatment package;
- SD1 rich MEG tank (for MEG recovery); or
- SD2 rich MEG tank (for MEG recovery).

During start up of the SD2 onshore facilities, it is planned to route stabilised condensate from the SD1 facilities to the SD2 condensate receivers via the SD2 off spec condensate tank.

5.12.4 SD2 Onshore Utilities

5.12.4.1 MEG Regeneration and Storage

MEG will be used at the onshore and offshore SD2 facilities to prevent hydrate formation in equipment and flowlines under low flow/low temperature conditions.

The purpose of the MEG regeneration system is to separate the water and other impurities from the rich MEG stream to produce a supply of lean MEG for re-use. The system comprises a rich MEG storage tank (equipped with hydrocarbon skimming facilities), a flash drum, a regenerator, charcoal filters, a pump and heat exchangers. The separated water stream will be sent to the SD2 Produced Water Treatment Package. The lean MEG stream will be sent to the lean MEG Storage tank. From here, it will be pumped to onshore users, when required, and will supply the offshore MEG storage tank via the 6” MEG pipeline.

The onshore lean and rich MEG storage tanks will be of dome roof design and supplied with hydrocarbon gas blankets, routed to the LP Flare. To top up the MEG system, fresh MEG will be supplied as required from ISO tanks delivered to the Terminal by truck.

5.12.4.2 Produced Water

The SD2 Project has adopted the following produced water handling hierarchy:

1. First Option: Utilise ACG produced water treatment and disposal options when available. The SD2 onshore Base case design includes the following facilities to support this option:
   a. A produced water treatment package, designed to treat SD2 water to achieve inlet water specification for the ACG produced water treatment facility
   b. A produced water storage tank of domed roof design, equipped with hydrocarbon skimming facilities

   Hydrocarbons recovered from the treatment package and the produced water storage tank will be re-routed to SD2 processing facilities via the SD2 closed drains system. The treated produced water that meets the required specifications will be sent to the ACG produced water treatment facilities where it will be comingled with the ACG produced water, treated to the relevant specifications and sent offshore to the reinjection facilities on the Compression and Water-injection Platform (CWP) at Central Azeri (CA).

   Waste from the SD2 produced water treatment package will be managed in accordance with the existing AGT waste management plans and procedures.

2. Second Option: SD produced water will be sent off site for treatment and disposal at a third party treatment contractor site. Treatment trials will be completed with potential 3rd party treatment contractors at their facilities. Either the existing tanker loading facility will be used or a new facility loading will be used will be used to transfer the PW to tankers for offsite treatment.

3. Third Option: During emergency situations, when option 1 and 2 are not available and there is no produced water tank storage capacity at Sangachal, SD produced water will be sent to a new storage pond.

The pond design will include a sloped floor for drainage, composite liner of a type particularly suited to produced water, a gas-venting system to prevent gas build-up and ballooning of the liner, and an automatic leak detection system with a manual back-up. A risk assessment will be completed to confirm the need and specification of a produced water pre-treatment package to treat the water prior to storage in the pond to ensure risks associated with health and nuisance issues (e.g. odour) are managed and appropriate mitigation is incorporated into the design. BP will submit to the MENR for review and approval prior to construction of the pond:

a. The design of the emergency produced water storage pond;
b. A comprehensive monitoring system to detect potential leakage from the produced water storage pond; and
c. A waste management plan that will detail the waste characterisation methodologies and treatment and disposal techniques for any waste products associated with the pre-treatment and storage of produced water in a pond.

5.12.4.3 Fuel Gas System

The fuel gas system will be designed to provide LP and HP fuel gas to the following;

- Gas turbine driven power generator;
- Export compressor drivers;
- Blanketing gas for condensate pipeline fluids, rich MEG, lean MEG, produced water storage and off spec condensate storage tanks;
- Seal gas for flash gas compressors; and
- Pilot gas within the HP and LP flare systems.

The supply to the system, which will comprise scrubbers, superheaters, and filters, will be taken from the gas processing trains. Under routine conditions the average daily fuel gas demand is estimated as 13.6MMscfd. During start-up it is planned to supply fuel gas to the system from the existing SCP facilities.

5.12.4.4 Power Generation

The power supply for the SD2 onshore facilities will be provided from a new 110kV system, located within the SD2 Expansion Area. Power will be routinely supplied from the existing generation system at the Terminal with back up provided by a single open cycle gas turbine driven power generator, rated at 23MW, located within the SD2 Expansion Area and connected to the new 110kV system via an 11/110kV unit transformer. Back up power will also be available from the Azeri national grid. During start up, fuel gas for power generation will be sourced from the existing SCP gas pipeline

5.12.4.5 Heating System

Under routine conditions the SD2 onshore heating requirement will be provided by three WHRUs installed on the 3 x 50% export compressor turbines. The heating system will be designed to provide 24MW of heat from each WHRU.

During start up or when one of the WHRUs is not available, e.g. during maintenance, heat will be supplied by a 50MW direct fired oil heater.

It is anticipated that the oil heater will be used for up to 6 weeks during start up. Following start up, the WHRU system is designed to be available for 98-99% of the time based on the anticipated turbine availability.

5.12.4.6 Flare System

The SD2 onshore facilities include a flare system, which is required for operational and safety reasons. Under routine operating conditions, the onshore SD2 flare system is designed to undertake pilot flaring only.

However, non routine flaring will occur due to equipment trips e.g. loss of a compressor train or during emergency depressurisation. These events will occur for periods of between 5 days (at a low rate of 1.1mmscfd) to 1 hour (at a rate of 890mmscfd) periodically across each year. Emergency depressurisation (planned to occur no more than once or twice over the PSA) at the design rate of the flare is expected to occur over an hour.

The SD2 onshore flare system is currently under design.

The current design criteria that have been adopted by the project are as follows:

- Elevated HP and LP flare systems;
- HP flare gas recovery on both HP and LP flare systems to minimise hydrocarbon inventory to the flare stacks during normal operations;
- Flare gas ignition based on continuously lit pilot burners supplied with LP fuel gas;
- Continuous purge using either nitrogen or LP fuel gas (depending on safety considerations);
- Sequential or controlled blowdown system design to minimise the HP flare design flow-rate and reduce stack height.

For the purposes of the ESIA it is assumed that the HP and LP flare tips will be located on a single elevated stack of height 107m and the maximum design flowrate for the HP flare will be 1810MMscfd.

5.12.4.7 Diesel Supply

Diesel will be supplied from the EOP diesel system and stored in day tanks to be used for the firewater pumps and diesel air compressor package when required.

5.12.4.8 Chemical Injection System

The production process requires the addition of certain chemicals to facilitate production, aid the separation process and protect process equipment from corrosion and hydrate formation. Two separate chemical systems will be provided:

- Main Chemical Injection Package; and
- Methanol injection system

The Main Chemical Injection Package will provide production chemicals from storage tanks, sized to provide 14 days of chemicals at the maximum dosage rate or 1.5 times the normal tote tank volume (whichever is greater).

The Methanol injection system will comprise a storage vessel (1 x 100%) and pumps (2 x 100%). The vessel will be inert gas blanketed and its storage volume will be determined by continuous injection for 24 hours at the largest individual continuous injection rate or 50m^3 (whichever is greater).

Spill containment measures within the chemical injection area will include paving, kerbing and bunding. Drainage from this area will be routed to the open drains treatment system.

5.12.4.9 Drainage Systems

Open Drains System

Routing of open drains effluent can be classified into the following:

- Clean storm water is water run off from roads, roofs, unpaved areas and certain areas of concrete paving outside of process areas where no contamination from hydrocarbons or other sources can occur. Storm water is collected in concrete channels and independently discharged from each of the three proposed terraces to the existing Flood Protection channel.
- Contaminated water is collected from concrete paved areas, generally located within process and utility areas, where possible contamination by hydrocarbons and chemicals may occur. This run off is unsuitable for disposal into clean watercourses without treatment and is thus routed via the open drains system for treatment, as described below.

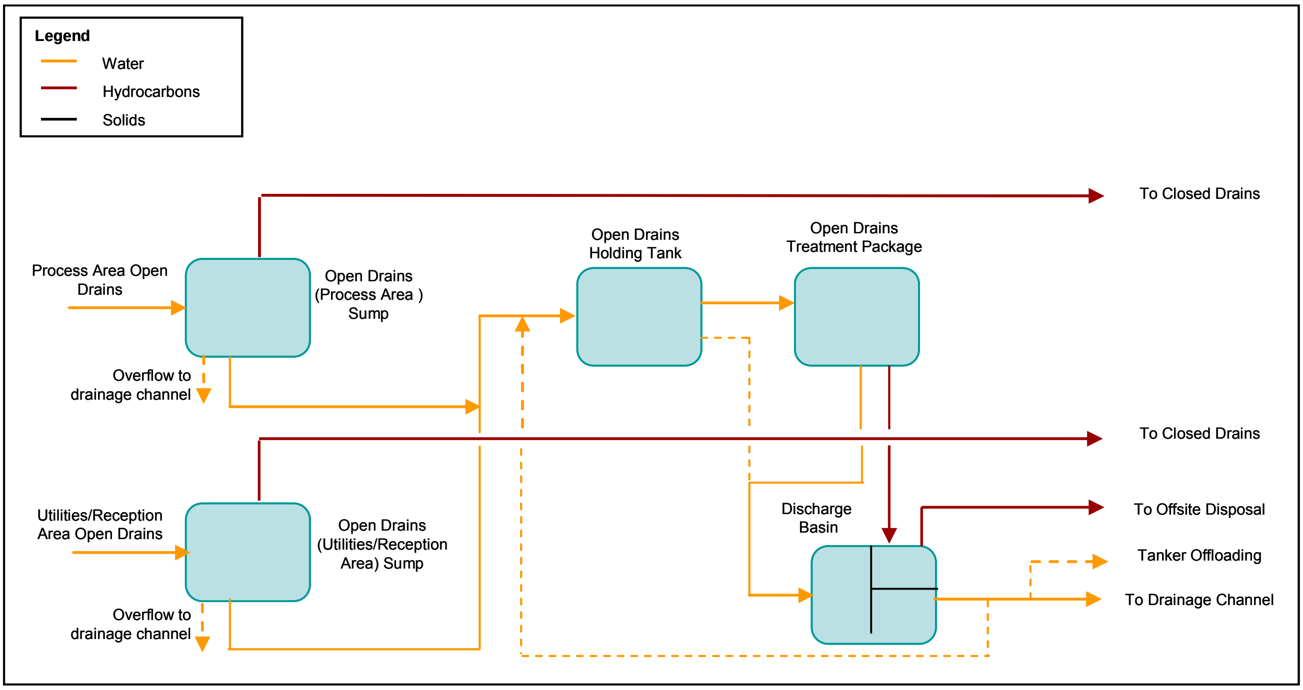
Drainage will be routed from paved process and utility areas to the open drains holding tank via two sumps (refer to Figure 5.29). The holding tank is sized to accommodate the maximum anticipated daily rainfall accumulation in addition to re-processing of off-spec open drains water from the open drains treatment package.

The sumps each sized to provide a residence time of 40 minutes at peak rainfall intensity of 25mm/hour, will include two chambers divided by an underflow weir. Separated hydrocarbons collected within the first chamber will be removed from the surface of the water and routed to the closed drains system.

From the open drains holding tank, the effluent will be routed to the open drains treatment package, designed to treat water to the applicable oil in water standards (i.e. less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis). Treated water will then be discharged to the drainage channel via the discharge basin. Hydrocarbons from the open drains treatment package will be routed to the oil containment chamber within the discharge basin, from where they will be pumped out and subsequently sent offsite for disposal in accordance with the existing AGT waste management plans and procedures.

Off spec treated drainage will be returned to the open drains holding tank for retreatment or, removed via tanker if the treatment facilities are not available.

Figure 5.29 SD2 Open Drains System



Note: Dotted lines represent routing under non routine conditions e.g. maintenance, start up

Closed Drains

The closed drains system will be provided primarily to collect process liquids when draining equipment and piping for maintenance. The system will comprise two closed drains drums and associated pumps. One drum will serve the lower terrace users and one will serve the middle and upper terrace users. The drums will be vented to the flare gas recovery system and the collected liquids will be returned to the SD2 processing facilities.

The closed drains drums will be located in dedicated concrete pits, equipped with pit pumps to intermittently to remove any groundwater or rain that may have accumulated in the pit and sent it to the open drains system.

5.12.4.10 Instrument and Plant Air and Inert Gas System

An instrument air system will be designed to provide plant and instrument air for use in process and maintenance. The system will be equipped with a diesel driven air compressor to maintain air pressure in the instrument air system during power outages. It is anticipated that the air compressor will be tested weekly for 1 hour during operations.

Inert gas (nitrogen) will be generated on demand by a membrane package using dry compressed air.

5.12.4.11 Freshwater

Freshwater will be supplied to the SD2 onshore facilities via a connection with the existing ST freshwater distribution system.

5.12.4.12 Fire Systems

The SD2 firewater system will comprise two dedicated diesel driven pumps, a firewater holding tank (5,000m^3 capacity) and tie ins to the existing Terminal firewater system to provide back up supply and pressurise the system prior to use.

It is anticipated that the firewater pumps will be tested weekly for 1 hour using freshwater which will be subsequently sent to the open drains system.

A foam system will be used to protect the SD2 condensate storage tank and any other areas where there is significant liquid hydrocarbon risk. SD2 will use foam system chemicals of the same specification and environmental performance as those currently used at the Terminal. No routine testing of the foam system is planned.

5.12.4.13 Export and MEG Pipeline Maintenance

Maintenance of the gas, condensate and MEG pipelines between the SDB platforms and the Terminal will include periodic pigging.

The gas and condensate pipelines will be pigged from the offshore platform complex to the dedicated pig receivers at the Terminal whereas the MEG pipeline will be pigged in the opposite direction. Gas within the condensate and gas pipeline pig receivers will be sent to the flare gas recovery system. Liquids collected within the pig receivers will be sent to the condensate processing facilities. The condensate pig receiver will be equipped with a heater to melt the wax collected in the receiver. Solids collected in the receivers will be collected and disposed of in accordance with the Waste Management Process (see Chapter 14). It is anticipated that the condensate export pipeline will be pigged approximately every three days. Pigging of the gas export pipelines is expected to occur approximately once every five days when flowrates are less than 400MMscfd. No pigging is anticipated at flowrates greater than 400MMscfd other than for infrequent integrity checks.

The MEG import line between the SD2 onshore and offshore facilities will also be pigged with resulting liquids routed to the contaminated MEG drains drum.

5.12.5 Onshore Operations Emissions, Discharges and Waste

5.12.5.1 Summary of Emissions to Atmosphere

Table 5.34 shows the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during SD2 onshore production from key sources across the PSA period. These sources include:

- Main power generator and compressor drivers;
- Diesel users (i.e firewater pumps and the diesel air compressor package during tests); and
- Non routine flaring.

Table 5.34 Predicted GHG and non GHG Emissions Associated with Routine and Non Routine SD2 Onshore Operations and Production Activities

	CO_2 (ktonne)	CO (tonne)	NOx (tonne)	SO_2 (tonne)	CH_4 (tonne)	NMVOC (tonne)	GHG (ktonne)
TOTAL	**6062.5**	**7391.6**	**25631.0**	**29.2**	**4190.1**	**297.9**	**6150.5**

See Appendix 5A for detailed emission estimate assumptions.

5.12.5.2 Summary of Discharges

Planned discharges from SD2 onshore operations comprise:

- Rainwater runoff from normally uncontaminated areas (refer to Section 5.12.4.9); and
- Treated open drains effluent (refer to Section 5.12.4.9).

5.12.5.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated by the SD2 onshore operations during the PSA period are provided in Table 5.35. These have been estimated based on the waste records for the operational SD1 facilities.

Solid waste collected in the pig receiver will be managed in accordance with existing AGT waste management plans and procedures.

Table 5.35 Onshore Operations Waste Forecast

Classification	Physical form	Waste stream name	Estimated quantity (tonnes)
Non-hazardous	Solid wastes	Domestic/office wastes	1,100
		Metals - swarf	238
		Paper and cardboard	4
		Plastic - recyclable (HDPE)	8
		Waste electrical and electronic cables	7
		Wood	143
	Liquid wastes	Oils - cooking oil	0
		Total (Non-hazardous)	**1,500**
Hazardous	Solid wastes	Contaminated materials	11
		Contaminated soils	371
		Filter bodies	17
		Lamps	0.1
		Oily rags	37
		Pigging wax	4
		Toner or printer cartridges	0.3
	Liquid wastes	Completion fluids	1,743
		Water - oily	181
		Total (Hazardous)	**2,364**

5.13 Decommissioning

In view of the operational lifetime of the SD2 development, it is not possible to provide a detailed methodology for the potential decommissioning of the onshore, subsea and offshore facilities. In accordance with the PSA, BP will produce a field abandonment plan one year before 70% of the identified reserves have been produced.

5.14 Summary of Emissions and Waste

5.14.1 SD2 Project Emissions

Table 5.36 presents an estimate of the total GHG and non GHG emissions associated with the SD2 Project, assuming operations continue until the end of PSA in 2036.

Table 5.36 Estimated GHG and non GHG Emissions Associated with the SD2 Project

	Emissions to Atmosphere						
	CO_2	CO	NO_x	SO_x	CH_4	NMVOC	GHG
	ktonnes	tonnes	tonnes	tonnes	tonnes	tonnes	ktonnes
Drilling & Completion	1,396	3,891	13,235	1,566	10,016	1,534	1,606
Onshore construction and commissioning of Terminal facilities	390	2,089	5,861	240	23	937	391
Onshore construction and commissioning of offshore and subsea facilities	59	178	747	74	2	24	59
Platform Installation and Commissioning	59	58	510	96	2	18	59
Installation, hook up and commissioning of subsea export and MEG pipelines	366	1,004	6,514.5	813.9	28.6	337.5	366.2
Installation, hook up and commissioning of subsea infrastructure	59	148	1,089	148	5	44	59
Offshore Operations	3,642	4,875	13,262	511	3,921	787	3,725
Onshore Operations	6,062	7,392	25,631	29	4,190	298	6,150
Total	**12,033**	**19,634**	**66,849**	**3,478**	**18,184**	**3,979**	**12,415**

See Appendix 5A for detailed emission estimate assumptions.

5.14.2 SD2 Project Hazardous and Non Hazardous Waste

Table 5.37 presents a summary of the forecast hazardous and non hazardous waste generated by the SD2 Project.

Table 5.37.Hazardous and Non Hazardous SD2 Waste Forecast

Classification	Physical form	Typical examples of waste stream	Estimated quantity (tonnes)							
			Drilling and completion activities	Onshore terminal construction and commissioning	Offshore facilities construction and commissioning	Offshore facilities installation, hook-up and commissioning	Subsea export pipelines, MEG import pipeline and subsea infrastructure fabrication and installation	Offshore operations phase	Onshore operations phase	Totals
Non-hazardous	Solid wastes	Domestic/office waste Metals - swarf Paper and cardboard Plastics Wood	6,037	14,906	21,036	3,535	9,797	4,998	1,500	**61,809**
	Liquid wastes	Oils - cooking oil	0	17	49	0	0	31	0	**97**
		Total (Non-hazardous)	**6,037**	**14,923**	**21,085**	**3,535**	**9,797**	**5,029**	**1,500**	**61,906**
Hazardous	Solid wastes	Adhesives, resins and sealants Batteries – wet/dry cell Clinical waste Contaminated materials Contaminated soil Drilling additives Drilling muds and cuttings SOBM Filter bodies Greases Oily rags	86,441	63	127	119	1,099	1,295	440	**89,584**
	Liquid wastes	Acids Antifreezes Bentonite Drilling muds and cuttings WBM - contaminated Drilling muds and cuttings SOBM Oils - fuels Oils – lubricating oil Paints and coatings Solvents, degreasers and thinners Water - oily Water treatment chemicals	38,851	1,720	7,845	6,273	5,947	4,723	1,924	**67,283**
		Total (Hazardous)	**125,270**	**1,783**	**7,972**	**6,392**	**7,046**	**6,018**	**2,364**	**156,867**

The current destinations of waste streams that are predicated to be generated during SD2 project and the currently used destinations by BP are provided within Table 5.38. BP may change the waste destination and disposal technique if more efficient alternatives become available that conform with applicable BP and national legislation requirements.

Currently there is one waste stream that SD2 will produce that do not currently have BP AGT approved destination: waste lamps. BP will continue to assess options in order to find an acceptable disposal solution for this waste stream.

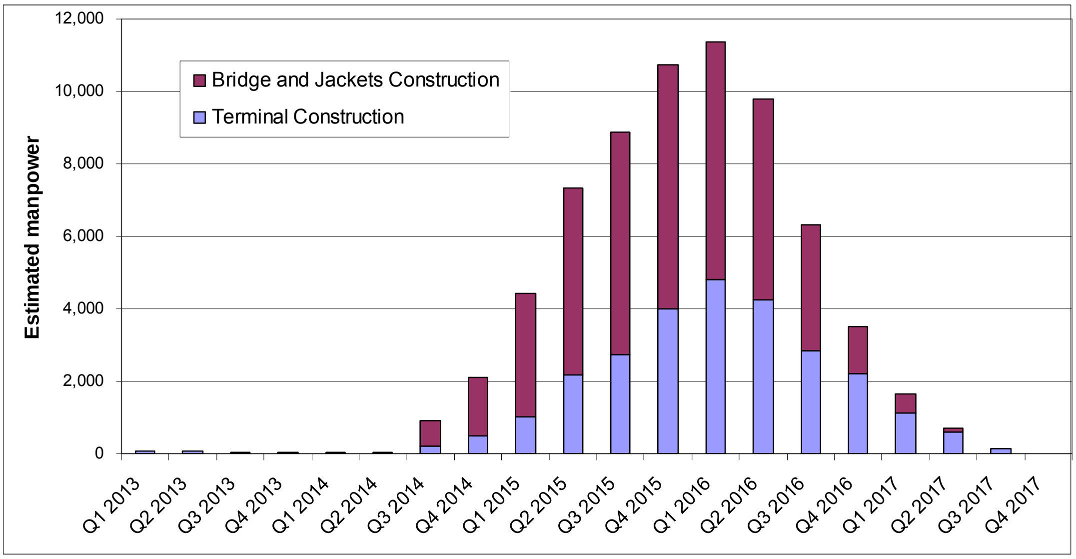
Table 5.38 Current Planned Destination of SD2 Principal Project Waste Streams

Category	Sub Category	Destination/Technique
Non hazardous non recyclable waste	Domestic/office wastes	Non-hazardous landfill – current facility has been designed and constructed to EU standards
Recyclable wastes	Oils - cooking oil	Recycling contractors[1]
	Waste electrical and electronic cables	
	Cement	
	Grit blast (uncontaminated)	
	Paper and cardboard	
	Plastics – recyclable (HDPE)	
	Tyres	
	Waste electrical and electronic equipment	
	Wood	
	Metals - swarf	Sent to SOCAR
Solid hazardous wastes	Adhesives, resins and sealants	Treatment/disposal by licensed AGT Region approved contractor or storage pending availability of appropriate techniques/contractor
	Clinical waste	
	Contaminated materials	
	Contaminated soils	
	Paints and coatings (cured)	
	Explosives	
	Grit blast (contaminated)	
	Filter bodies	
	Oily rags	
	Pressurised containers	
	Toner or printer cartridges	
	Batteries - dry cell	Sent to SOCAR
	Batteries - wet cell	
Non-water based drill cuttings	Drilling muds and cuttings LTMOBM	Cuttings will be treated by the indirect thermal desorption unit at Serenja or by alternative disposal options. Recovered base oil from thermal desorption unit may be reused if it meets the reuse specification or it will be either disposed as a liquid waste. Solid process residuals from the thermal desorption unit will either be disposed or used as cover material at a hazardous or non-hazardous landfill depending on its characterisation. One of current alternative disposal options for non-water based cuttings is bioremediation, however the BP will continue working on alternative long term reuse options, that may add additional disposal routes non-water based drill cuttings and associated treatment process residuals.
	Drilling muds and cuttings SOBM	
	Drilling muds and cuttings WBM - contaminated	
Hazardous liquid wastes	Acids	Treatment and disposal/recovery by licensed AGT Region approved contractor or storage pending availability of appropriate techniques/contractor
	Alkalis and bases	
	Antifreezes	
	Bentonite	
	Completion fluids	
	Drilling additives	
	Oils - fuel	
	Greases	
	Laboratory chemicals and testing reagents	
	Oils - lubricating oils	
	Solvents, degreaser and thinners	
	Surfactants	
	Tank bottom sludges	
	Paints and coatings (uncured)	
	Water - oily	
	Water treatment chemicals	
	Well suspension fluids	
Notes: 1. Currently recyclable waste is received by SOCAR or, if SOCAR reject the waste for any reason, alternative recycling/reuse contractors.		

5.15 Employment

Figure 5.30 shows the estimated employment associated with terminal construction and the construction of the jackets at the onshore construction yards. The figure shows that it is estimated that employment associated with the SD2 construction works at the Terminal will peak at approximately 4,800 during 2016, while the employment at the onshore jacket construction yards is expected to peak at 6,700 during 2015.

Figure 5.30 Estimated Manpower Associated with SD2 Onshore Terminal Construction Works and Onshore Jacket Construction



In addition it is estimated that a peak workforce of approximately 1,500 will be employed at the topside onshore construction yard and approximately 2,000 will be employed for marine subsea works. It is expected that onshore and offshore operations will require a workforce of more than 100.

5.16 Management of Change Process

During the 'Define', 'Execute' and 'Operate' stages of the SD2 Project, there may occasionally be a need to change a design element or a process. The SD2 Project intends to implement a formal process to manage and track any such changes, and to:

- Assess their potential consequences with respect to environmental and social impact; and
- In cases where a new or significantly increased impact is anticipated, to inform and consult with the MENR to ensure that any essential changes are implemented with the minimum practicable impact.

All proposed changes, whether to design or process, will be notified to the Project HSE team, who will review the proposals and assess their potential for creating environmental or social interactions.

Changes which do not alter existing interactions or impacts, or which give rise to no interactions or impacts, will be summarised and periodically notified to the MENR, but will not be considered to require additional approval. This category will include items such as minor modification of chemical and drilling fluid systems, where the modification involves substitution of a chemical with equal or less environmental impact than the original.

If internal review and assessment indicates that a new or significantly increased impact may occur, the following process will be applied:

- Categorisation of the impact using ESIA methodology;
- Assessment of the practicable mitigation measures;
- Selection and incorporation of mitigation measures; and
- Re-assessment of the impact with mitigation measures in place.

In practical terms, the changes that will require prior engagement and approval by the MENR are those that:

- Result in a discharge to the Caspian that is not described in the SD2 Project ESIA;
- Increase the quantity discharged as detailed in the SD2 Project ESIA by more than 20%[20,21;]
- Result in the discharge of a chemical not referenced in the ESIA and not currently approved by the MENR for use in the same application by existing AGT Region operations; or
- Create or increase noise, light or other disturbance above applicable thresholds to human populations living in the vicinity of the SD2 Project activities.

Once the changes (and any appropriate mitigation) have been assessed as described above, a technical note will be submitted to the MENR describing the proposal and reporting the results of the revised impact evaluation. Where appropriate, this may include the results of environmental testing and modelling (e.g. chemical toxicity testing and dispersion modelling). Following submission of the technical note, the Project team will engage in meetings and communication with the MENR in order to secure formal approval. Once approved, each item will be added to a register of change. The register will include all changes, including those non-significant changes notified in periodic summaries, and will note any specific commitments or regulatory requirements associated with those changes.

[20] For the discharges detailed in the ESIA, an increase of 20% in volume would result in a 3-4% increase in the linear dimension of the mixing zone. For instance, a mixing plume 100m by 20m by 20m would increase by less than 2m in each dimension. Taking into account the actual size of the predicted mixing zones, this magnitude of increase is considered to make no material difference to the physical extent of the impacts. In practical terms, this would apply to increases of more than 20% (the value was selected to be conservative).
[21] Unless increase is deemed to have no material effect on the associated impact(s).