Santos

Mittwell

# CASINO DEVELOPMENT

## CASINO-5
## DRILLING AND COMPLETION PROGRAMME

## Document Number CD-4000-P15-002

## VIC-P44

## APPROVAL

| DATE | REV | REASON FOR ISSUE | AUTHOR | CHECKED | APPROVED |
|---|---|---|---|---|---|
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# CASINO-5 DRILLING AND COMPLETION PROGRAMME

# 1 WELL INFORMATION

Summary Data Sheet

| | |
|---|---|
| Well Name : | Casino-5 |
| Well Designation : | Horizontal Gas Producer |
| Permit : | VIC P-44 |
| Interest Holders: | Santos Ltd 50%<br>AWE 25%<br>Mitsui 25% |
| Operator : | Santos Ltd |
| Anticipated spud date : | 5 May 2005 |
| Budget Duration : | 23 days<br>Drilling Operations 16 days, Completion Operations 7 days |
| Drilling Contractor / Rig : | Diamond Offshore General Company (DOGC) / Ocean Patriot |
| RT - SL / Water Depth: | 22 m / 70 m water depth PRELIMINARY |
| Geographic Surface Location : | Lat 38° 47' 43.746" S<br>Long 142° 44' 44.54" E<br>Easting: 651 603 mE<br>Northing: 5 704 471 mN |
| Surface Position Tolerance: | 10 metres |
| Target Location : (GDA94) | Depth: 1743mRT TVD (TOP Waarre C Fm)<br>Lat 38° 47' 43.746" S<br>Long 142° 44' 44.54" E<br>Easting: 651 603 mE<br>Northing: 5 704 471 mN |
| Primary Objective : | Waarre C Sandstone |
| Depth of Objective : | 1743 mRT TVD (± 4mRT MD) |
| Well Depth (TD): | 1788 mRT TVD (m) contingent on base reservoir |

**Note:** The Casino-5 well target is the Waarre-C well location referred to in the Casino Development VIC-P44 Field Development Plan (Document ref. 5738041-FDP-001-0) page 167 of the Casino Field Development Plan.

See Figure 1 and Figure 2 respectively for the Casino-5 well location map and time depth curve.

## 1.1 Programme Basis

This Drilling and Completion Programme describes the activities that have been programmed for the well.
This programme is to be used in conjunction with the documents referenced below.

- Detailed Drilling and Completions Instructions for Casino-5
- Santos Drilling Guidelines
- Casino Well Design Workbook

Any changes to this programme can only be made with the written approval of the Drilling and Completions Manager via a Change Control Form (as detailed in the Drilling and Completions Management System).

## 1.2 Reference Manuals

The Casino Drilling and Completions EHS Management System Manual defines how Santos will manage EHS for this programme.

## 1.3 Drilling Hazards

| | |
|---|---|
| Shallow Gas | No shallow gas is expected at this location (based on seismic interpretation). Additionally, no shallow gas was encountered in Casino-2 which was drilled 150 metres from Casino-5<br><br>Routine shallow gas procedures shall be in place for riserless top hole drilling (as per DOGC procedures). |
| Toxic Gas | No $H_2S$ has been observed in the offset wells and is not expected on Casino-5. |
| Lost Circulation | **17 ½" Hole**<br>This hole section will be drilled riser-less on Casino-5.<br>**12 ¼" Hole:**<br>Potential for high mud losses in Dilwyn Formation in the upper part of the hole section. This formation is planned for drilling with seawater and high vis sweeps. There are no recorded losses below the Pebble Point formation in offset wells.<br>**8 ½" Hole:**<br>No lost circulation has been observed in offset wells in the Waarre-C formation. Full returns are expected in Casino-5. |
| Differential Sticking | Differential sticking has not been observed on offset wells and is considered a low risk on Casino-5. |
| Abnormal Pressure | Formation pressure data from Casino-2 indicates maximum formation pressure of 1.12sg in Waarre sands. Formations above the Waarre sands are prognosed to be normally pressured. |
| Fracture Gradient | LOT data from offset wells are shown in section 2.3. Insufficient fracture gradient is not expected to be a limiting factor in Casino-5 based on recent offset drilling within the Casino field. |
| Borehole Stability | **17 ½" Hole:**<br>Tight hole has been experienced in offset wells. Connections shall be reamed through problem section.<br>**12 ¼" hole:**<br>A well-bore stability study has been conducted and reviewed. Sufficient mud weight is programmed to control borehole breakout based on this study.<br>**8½" Hole:**<br>No stability problems are expected in the Waarre C formation. |

| | |
|---|---|
| Hard Drilling | **17 ½" Hole:**<br>No hard drilling is expected in this hole section.<br>**12 ¼" hole:**<br>Pyrite stringers potentially destructive to PDC bits are expected in the Massacre Shale. The pyrite zone will be drilled with a TCI bit prior to running a PDC bit.<br>**8½" Hole:**<br>No hard drilling is expected in the Waarre-C sands. |
| Drillstring Vibration | No drillstring vibration problems were reported on offset wells. |
| Temperature | No abnormal temperatures are expected on Casino-5. The expected maximum static BHT is 79°C. |
| Weather | Casino-5 location is not subject to cyclonic activity. Heavy weather however may limit operations periodically. Heavy weather operating procedures ate detailed in the DOGC Emergency Response Manual |
| Seabed Conditions | No seabed related problems are expected during spudding operations based on recent offset well experience and location surveys. |

## 1.4 Operational Setting

CASINO-5 will be drilled by the semi-submersible mobile offshore drilling unit (MODU) Ocean Patriot, which is operated by Diamond Offshore (DOGC).

Marine logistical support for drilling operations will be from the Portland Supply Base. Two vessels will be utilised during Casino-5 operations for towing and supply. One vessel will remain in the vicinity of the MODU at all times during operations to provide support in the event of an emergency. Distance from Portland to the Casino-5 location is ~60 Nm. One way economy sailing time is ~4 hours.

One way helicopter flying duration (from Essendon airport) is ~80 minutes depending on the weather conditions.

# 2 GEOLOGICAL INFORMATION

## 2.1 Objectives

The objective of this well is to develop the gas reserves of the Waarre C reservoir via a vertical well located near the crest of the reservoir. Dynamic modelling conducted during the development planning phase has indicated that the entire Waarre C reserves can be developed with a single vertical production well.

## 2.2 Formation Tops

| Formation Tops | Predicted Depth (mRT TVD) Casino-5 | Uncertainty |
|---|---|---|
| Mepunga Formation | 680 | +/- 5m |
| Wangerrip Group | 776 | +/- 5m |
| Pebble Point Formation | 1077 | +/- 5m |
| Massacre Shale | 1146 | +/- 5m |
| Timboon Sst | 1157 | +/- 5m |
| Paaratte Formation | 1350 | +/- 5m |
| Skull Creek Mudstone | 1617 | +/- 5m |
| Top Waarre Formation | 1743 | +/- 5m |
| **Waarre Cb Main Pay** | 1752 | +/- 5m |
| **Waarre Ca Pay** | 1761 | +/- 5m |
| Base Waarre C Res | 1780 | +/- 5m |
| Total Depth | ~1788 | |

Note 1: The Ocean Patriot rotary table is 22 m above LAT.

## 2.3 Temperature, Pore Pressure and Fracture Gradient

The maximum expected bottom hole temperature at Casino-5 (at 1788m mRT TVD) is 79°C.

Formation pressure gradient for Casino-5 is expected to be ~1.12sg in the Waarre C sand. Mud weights of ~1.25sg are planned for the 311mm (12¼“) hole section to control potential well-bore instability in formations above the target. Mud weight of 1.24sg is planned for drilling the 216mm hole section (Waarre C sand).

The leak off tests (LOT) on offset wells are shown below.

| Well | LOT (sg) | Depth (m TVD) |
|---|---|---|
| Casino-1 | 2.07 | 758 |
| | | |
| Casino-2 | 1.22 | 691 |
| | | |
| Casino-3 | 1.8 | 648 |
| | | |
| Minerva-3 | 1.63 | 587 |
| | | |
| Minerva-4 | 1.77 | 624 |
| | | |

# 3 DRILLING INFORMATION

## 3.1 914mm (36") Hole for 762mm (30") Casing (90mRT – 134mRT)

The 914mm (36") hole will be drilled to approximately 134mRT MD to allow setting of a 4 joint, 762mm (30") conductor string with a swaged 508mm (20") shoe. The 914mm (36") hole section will be drilled vertically with seawater and gel sweeps and will be drilled with a 660mm (26") bit / 914mm (36") hole opener combination.

## 3.2 445mm (17½") Hole for 340mm (13⅜") Casing (134mRT – 650mRT)

After drilling out the 508mm (20") swaged conductor shoe with a 445mm (17½") bit, 445mm (17½") hole will be drilled riser-less to the 340mm (13⅜") casing point at approximately 650mRT MD, approximately 30m above the Mepunga formation. After running and cementing the 340mm (13⅜") casing, the 476mm (18¾") Drill Through Horizontal Subsea Tree will be installed prior to running BOPs. A detailed procedure for running the tree will be issued to the rig prior to spud.

## 3.3 311mm (12¼") Hole for 244mm (9⅝") Casing (650mRT - 1730mRT)

Casino-5

After drilling out the 340mm (13 3/8") casing shoe at ~640mRT MD and conducting a leak-off test, a vertical 311mm (12 ¼") hole will be drilled down to the 244mm (9⅝") casing point approximately 13m TVD above the Waarre 'C' sands. The 244mm (9⅝") casing string will be run to ~1720mRT MD.

## 3.4 216mm (8½") Hole for Expandable Sand Screens (1730mRT MD – 1788mRT MD)

After drilling out the 9⅝" casing shoe and conducting a leak-off test, 216mm hole will be drilled to a target total depth of 1788mRT MD.

Refer to section 5 for details on running the lower completion.

## 3.5 Summary Drilling Sequence.

The following is an outline of the planned drilling sequence on Casino-5:

- Mobilise rig to the Casino-5 Location;
- Run anchors;
- Drill 914mm (36") hole to ~134mRT MD with 660mm (26") bit and hole opener;
- Run and cement 762mm (30") conductor;
- Drill 444mm (17½") hole to 650mRT MD;
- Run and cement 340mm (13⅜") surface casing to 640mRT MD;
- Run 476mm (18 ¾") Drill Through Horizontal Subsea Tree
- Run BOPs;
- Drill 311mm (12¼") hole to the 244mm (9⅝") casing point at ~1730mRT MD.
- Run and cement 244mm (9⅝) intermediate casing to ~1720mRT MD;
- Drill 216mm (8½") hole to ~1788m;
- Run lower completion to ~1778m;
- Run upper completion;
- Clean-up well / test;
- Recover anchors;

Refer to the Casino-5 time in Figure 2.

## 3.6 Casing Design Summary

**CASING DESIGN** – Weight, Grade & Strength

Seabed Depth: 92m RT

| | Casing | | | | Strength | | |
|---|---|---|---|---|---|---|---|
| HOLE SIZE | CSG SIZE | SETTING DEPTH (mRT MD) | JOINT TYPE | WEIGHT/GRADE/CONNECTIONS | BURST MPa (psi) | COLLAPSE MPa (psi) | TENSION kdaN (kips) |
| 914mm (36”) | 762mm (30”) | 134 | Wellhead<br>Conductor<br>Shoe Joint (Swaged to 508mm (20”) | 762mm (30”) (30”) Cameron Wellhead Housing STM-10 c/w 1 x 38mm (1.5”) WT, 762mm (30”) Intermediate Extension (30” x 1.5” Lynx HT Box down)<br>1 x 25mm WT 762mm (30”) Intermediate Joint (Lynx HT Pin x Lynx SA-2 Box)<br>1 x 25mm WT 762mm (30”) (Intermediate Joint (Lynx SA-2 Pin x SA-2 box)<br>762mm (30”) x 25mm WT (X52) x 508mm x 25mm WT (X56) Crossover joint (Lynx SA-2 pin up) | 20.7 (3000) | 10.9 (1581) | 1486 (3320) |
| 445mm (17½”) | 340mm (13⅜”) | 640 | Wellhead<br>Surface Casing<br>Shoe joint | 476mm (18¾”) Cameron STM-10 ‘E’ Housing with w/ H4 profile, w/508mm (20”) 25mm WT (1”) x 340mm (13 ⅜”) 107kg/m (72ppf) crossover extension, BTC pin down.<br>340mm (13⅜”) 107kg/m (72ppf); L80; BTC<br>340mm (13⅜”) 107kg/m (72ppf); L80; BTC | 37.1 (5379) | 18.4 (2668) | 739 (1662) |
| 311mm (12¼”) | 273mm (10¾”) x 244mm (9⅝”) | 1720 | Casing Hanger<br>Intermediate Casing<br>Float, Shoe joints | 330mm x 273mm (10¾ ”) STM-10 Casing Hanger<br>7 jts 273mm (10¾ ”) 83kg/m (55½ppf); L80; Vam Top (down to 148 mRT MD)<br>1 jt x 273mm (10¾”) x 244mm (9⅝”) L80 Vam Top XO (at ~160 mRT MD)<br>119 jts 244mm (9⅝”) 70 kg/m (47ppf); L80; Vam Top (160 – 1588 mRT MD)<br>1 jt 244mm (9⅝”) 70 kg/m (47ppf) L80 Vam top box / KS Bear Pin XO<br>7 jts 244mm (9⅝”) 70 kg/m(47ppf); 13Cr80; KSBear (1600 – 1684 mRT MD)<br>1 jt 244mm (9⅝”) 70 kg/m (47ppf) 13Cr80; KS Bear box / BTC Top Pin XO<br>244mm (9⅝"), 70 kg/m (47ppf), L-80, BTC (1696 – 1720mRT MD) | 44.4 (6438)<br>47.3 (6870) | 27.7 (4020)<br>32.8 (4760) | 568 (1278)<br>483 (1086) |
| (8½”) | 168mm (6⅝”) | ~1778<br>ESS hanger at ~1700 | Lower Completion Tubing<br>Expandable Sand Screen | 194mm (7 5/8”) 44.3 kg/m (29.7 ppf); 13Cr80; Fox (1700 – ~1730 mRT MD)<br>216mm (expanded) ESS 150 micron 1730 - ~1778 mRT MD | 47.5 (6887)<br>N/A | 33 (4785)<br>N/A | 304 (684)<br>N/A |

## CASING DESIGN – Safety Factors & Design Assumptions

Seabed Depth: 92m RT

| | Casing | | Safety Factors | | | | Worst Case Design Assumptions | | |
|---|---|---|---|---|---|---|---|---|---|
| HOLE SIZE | CSG SIZE | SETTING DEPTH (mRT) | BURST | COLLAPSE | AXIAL | TRIAXIAL | BURST | COLLAPSE | AXIAL |
| 914mm (36") (36") | 762mm (30") (30") | 134 | - | - | - | - | - | - | - |
| 445mm (17½") | 340mm (13⅜") | 750 | 1.29 | 3.4 | 3.5 | 1.79 | Casing pressure test. | Cementing | Pressure test |
| 311mm (12¼") | 273mm (10¾") x 244mm (9⅝") | 148 XO 1720 | 1.34 1.39 | 13.84 1.58 | 2.12 2.11 | 1.61 1.67 | Casing pressure test. Casing pressure test. | Full evacuation – production case | Green cement pressure test Green cement pressure test |
| 216mm (8½") | 168mm (6⅝") | ~1778 ESS hanger at ~1700 | N/A** | N/A** | N/A** | N/A** | N/A | N/A | N/A |

Notes: ***Safety Factor = Pipe Rating ÷ Design Load**

**Casing design carried out using StressCheck 2000.1**

****The 168mm liner string is not a pressure integral string.**

## 3.7 Drilling Fluid Summary

| MI SWACO | DRILLING FLUID PROPOSAL<br>PRICED SUMMARY<br>Well: Casino 5 | Prepared date/by: 12-Nov-04 / Dave Bennett | SANTOS verification: | Date : 11-Jan-05 | Santos |
|---|---|---|---|---|---|
| | | Verified date/by: | | Rev. No: 0 | |
| | | Approved date/by: | SANTOS Approval: | Total cost US$: 123,549 | |

**36 Section: Seawater / Hi Vis Sweeps**

| Depth meters | MW sg | Funnel Visc, sec. | 6 rpm | pH | Gel 10s lb100sqft | Gel 10m lb100sqft |
|---|---|---|---|---|---|---|
| | alap | >100 | > 40 | 9 - 10 | >15 | >40 |

**COMMENTS:**
This section will be drilled with Seawater and high viscosity sweeps at a rate of 50 bbl every 5 m.
Prehydrated bentonite will be utilised for this.
Guar Gum will be held in contingency for Hi Vis Sweeping and used if required.
At TD sweep the hole clean with a 100 bbl Hi Vis Pill.
Displace the open hole to Hi - Vis prehydrated bentonite (not flocculated) prior to pulling out for wiper trip and prior to pulling out to run casing.

| PRODUCTS | Unit | Size | Concentrations Sweeps | Displ vol | Tot Unit | VOLUMES | bbl |
|---|---|---|---|---|---|---|---|
| Bentonite | lb | 100 | 35.0 | 35.0 | 291 | DISPL. VOL. X 2 | 330 |
| Caustic Soda | kg | 25 | 0.2 | 0.2 | 3 | | |
| Soda Ash | kg | 25 | 0.2 | 0.2 | 3 | | |
| Lime | kg | 25 | 0.8 | 0.0 | 7 | | |
| | | | | | | SWEEPS | 500 |
| | | | | | | **TOT. VOL.** | **830** |
| | | | | | | **NEW MUD** | **830** |
| | | | | | | Max Angle, deg. | 0 |
| Total section cost | | | | US$ | 3,189 | Dilut. fac | n/a |

**17 1/2 Section: Seawater / Hi Vis Sweeps**

| Depth meters | MW sg | Funnel Visc, sec. | 6 rpm | pH | Gel 10s lb100sqft | Gel 10m lb100sqft |
|---|---|---|---|---|---|---|
| | alap | >100 | > 40 | 9 - 10 | >15 | >30 |

**COMMENTS:** This section will be drilled with Seawater and high viscosity sweeps at a rate of 40-50 bbl every 10 m or as required. Alternate the sweeps between PHG and flocculated PHG. The PHG will help consolidate and seal any loose sand section by forming a wall cake. Guar Gum will be held in contingency for Hi Vis Sweeping and used if required. Losses are expected and no attempt will be made to cure these losses. Only if hole cleaning becomes difficult upon entering the loss zone then LCM may be temporarily incorporated into the Hi-Vis Sweeps to raise the annular fluid column & therefore the cuttings from above the BHA. At TD sweep the hole clean with a 150 bbl Hi Vis Pill. Displace the open hole to Hi - Vis prehydrated bentonite (not flocculated) prior to pulling out for wiper trip and prior to pulling out to run casing.

| PRODUCTS | Unit | Size | Concentrations Sweeps | Displ vol | Tot Unit | VOLUMES | bbl |
|---|---|---|---|---|---|---|---|
| Bentonite | lb | 100 | 28.0 | 35.0 | 896 | DISPL. VOL.X 1.5 | 900 |
| Caustic Soda | kg | 25 | 0.2 | 0.2 | 9 | | |
| Soda Ash | kg | 25 | 0.2 | 0.2 | 12 | | |
| Lime | kg | 25 | 0.5 | 0.0 | 29 | | |
| | | | | | | SWEEPS | 3200 |
| | | | | | | **TOT. VOL.** | **4100** |
| | | | | | | **NEW MUD** | **4100** |
| | | | | | | Max Angle, deg. | 0 |
| Total section cost | | | | US$ | 9,924 | Dilut. fac | n/a |

**12 1/4 Section: Seawater / Hi Vis Sweeps and 8% KCL/PHPA/Polymer**

| Depth meters | MW sg | YP lb/100sq.ft | PV cP | Gel 10s lb/100sq.ft | Gel 10m lb/100sq.ft | 6 rpm | pH | API FL ml | KCl % wt | PHPA ppb | LGS %vol | MBT ppb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 750 | 1.25 | 6 RPM | weight | > 14 | < 25 | 10-12 | 8.5 - 9.5 | < 6 | 8 | 1.0 -1.5 | < 5 | alap |
| 1720 | as req'd | dependent | dependent | non-progressive | | | | | | | | |

**COMMENTS:** Drill out the shoe track cement with seawater sweeping with mud left over from the previous hole section. The initial part of this interval down to 1100m will be drilled with Seawater and high viscosity sweeps at a rate of 40-50 bbl every 15 m or as required. Based on offsets, by drilling with seawater and pumping hivis sweeps, severe losses due to severe sand blinding of the shakers will be avoided. Alternate the sweeps between PHG and flocculated PHG. The PHG will help consolidate and seal any loose sand section by forming a wall cake. Guar Gum will be held in contingency for Hi Vis Sweeping and used if required. Mud properties of the PHG Hivis sweeps will be the same as those quoted for the 17 1/2" section.
Once through the sand the mud system can then be displaced to a 8% KCL/PHPA/Polymer mud system. Claystone inhibition will be achieved through the maintainance of 8% KCl and polyacrylamide cuttings encapsulation. Monitor well for signs of overpressure & control with appropriate mud weight. A mud weight of 1.23sg will probably be sufficient to drill this well but density should be increased immediately if hole instability is observed. Efficient hole cleaning will be based on maintaining the 6 rpm readings between 10 & 12 dial units with premixed Duovis. API Fluid Loss will be controlled to < 6 cc with . Treat down hole mud with Glute 25 prior to trips. Optimise use of solids control equipment to maintain LGS below 5% by vol. Ensure unimpeded cuttings movement off shaker screens.

Length: 970

| PRODUCTS | Unit | Size | Concentrations New | Maint | Tot Units | VOLUMES | bbl |
|---|---|---|---|---|---|---|---|
| Barite | lb | 100 | 100.0 | 10.0 | 2394 | SURFACE | 600 |
| Caustic Potash | kg | 25 | 0.2 | 0.2 | 16 | RISER | 109 |
| OS-1 | kg | 25 | 0.2 | 0.2 | 16 | CASING | 322 |
| Polypac UL | kg | 25 | 1.3 | 0.3 | 63 | OPEN HOLE | 464 |
| Polyplus | kg | 25 | 1.0 | 0.3 | 51 | DILUTION | 682 |
| KCl | mt | 1 | 30.0 | 2.0 | 32 | HOLE TOT | 895 |
| Sodium Bicarbonate | kg | 25 | 0.2 | 0.1 | 12 | **TOT. VOL.** | **2177** |
| Duovis | kg | 25 | 1.3 | 0.3 | 63 | RECEIVED | 0 |
| Glute 25 | lt | 25 | as required | | 8 | **NEW MUD** | **2177** |
| | | | | | | MUD LEFT | 1495 |
| | | | | | | Max Angle, deg. | 0 |
| **HiVis sweeps** | | | | | | | |
| Bentonite | lb | 100 | 28.0 | | 336 | **HiVis Sweeps** | |
| Caustic Soda | kg | 25 | 0.2 | | 4 | Sweeps | 1200 |
| Soda Ash | kg | 25 | 0.2 | | 4 | | |
| Lime | kg | 18.5 | 0.5 | | 15 | | |
| Total section cost | | | | US$ | 62,814 | Dilut. fac | 1.10 |

## 216mm (8 ½") Hole Section: Flo Pro Drill-in fluid

| Depth meters | MW sg | YP lb100sqft | PV cP | 6 rpm | pH | API FL ml | Sized CaCO3 | Gel Strengths | LSRV 0.3rpm | MBT ppb | LGS %vol | KCl % wt | NaCl % wt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.22 - 1.23 | 6 rpm dependent | alap | LSRV dependent | 9.5 | <5 | 50 ppb | non-progressive | 40-60K | <5 | < 5% alap | 6% | 20% |

**COMMENTS:** This section is to be drilled with a Flo-Pro NT Drill-In Fluid. This fluid has been selected due to its excellent non-formation damaging and hole cleaning characteristics. Drill out the shoe track cement with seawater and high vis sweeps to avoid cement contamination of the fluid. Pump a 100 bbl high vis sweep ahead of the new fluid when displacing. Excellent hole cleaning is essential through this horizontal hole and will be based on the 0.3rpm LSRV readings of 50 - 70K with premixed Flo-Vis Plus. Omyacarb 20 will be added at 50 ppb to help bridge theWarre C sands and minimise invasion potential and also provide mud weight. A mud weight of 1.22 sg will be maintained throughout. The API fluid loss will be controlled to <5 ml with pre-mixed Dualflo HT. Optimise shaker screen selection to minimise LGS content.

| PRODUCTS | | | Concentrations | | | VOLUMES | |
|---|---|---|---|---|---|---|---|
| TYPE | Unit | Size | New | Maint | Tot Unit | | bbl |
| Flo-Vis Plus | kg | 25 | 2.0 | 0.3 | 48 | SURFACE | 600 |
| Caustic Potash | kg | 25 | 0.3 | 0.1 | 8 | RISER | 109 |
| Dualflo HT | lb | 50 | 3.5 | 0.3 | 39 | CASING | 390 |
| KCL | mt | 1 | 24.0 | 2.0 | 13 | OPEN HOLE | 9 |
| Glute 25 | lt | 25 | 0.2 | 0.1 | 6 | DILUTION | 32 |
| Omyacarb 20 | kg | 25 | 50.0 | 2.0 | 1076 | HOLE TOT | 509 |
| Flossy Salt | mt | 1 | 80.0 | 2.0 | 42 | **TOT. VOL.** | **1141** |
| Sodium Bicarbonate | kg | 25 | 0.20 | 0.0 | 4 | RECEIVED | 0 |
| Defoam A | lt | 25 | as required | | | **NEW MUD** | **1141** |
| | | | | | | MUD LEFT | 1109 |
| | | | | | | Max Angle, deg. | 0 |
| Total section cost | | | | US$ | 47,623 | Dilut. fac | 0.8 |

## 3.8 Cementing Summary

| Hole | Casing | Cement Slurry | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **SIZE** | **SIZE/SETTING DEPTH (mAHRT)** | **TYPE** | **REQUIREMENTS** | **WATER** | **WEIGHT (ppg) YIELD (CuFt/Sk)** | **EXCESS** | **TOC (mRT)** | **ADDITIVES** | **PRE-FLUSH/ POST FLUSH** |
| 36″ | 30"x20" @ 134.5 mRTm<br>BHST / BHCT 23$^0$C / 26$^0$C | Tail 'G' | Job Pumping Time 1.0 hr<br>Thickening Time 3hr<br>Compressive strength 3000 psi | SW | 15.8<br>1.19 | 200% excess on gauge hole | TOC @ seabed. | D047: 0.01 gal/sk<br>S001: 1.00%BWOC | Pre: 6.4 m$^3$ seawater; 1.6 m$^3$ with Dye/Mica<br>Post: Displace w/ seawater 2.5 m$^3$ |
| 17 ½″ | 13 $^3/_8$″ @ 640m<br>BHST / BHCT 46°C / 27°C | Lead 'G' | Job Pumping Time 1.0 hr<br>Thickening Time 8.0 hr | SW | 12.5<br>2.23 | 50% excess on gauge open hole | TOC @ seabed | D047: 0.02 gal/sk<br>D075: 0.42 gal/sk | Pre: 19.1 m$^3$ Sea water |
| | | Tail 'G' | Job Pumping Time 1.0 hr<br>Thickening Time 3.5 hr<br>Comp. strength 3000 psi | SW | 15.8<br>1.18 | 20% excess on gauge open hole | TOC @ 490m | D047: 0.01 gal/sk<br>D145A: 0.03 gal/sk | |
| 12 $^1/_4$" | 9 $^5/_8$" @ 1720m<br>BHST / BHCT 81°C / 54°C | Lead 'G' | Job Pumping Time 1.5 hr<br>Thickening Time 3.5 hr | SW | 12.5<br>2.23 | 20% Excess on gauge hole | TOC @ 1320m | D047: 0.02 gal/sk<br>D075: 0.42 gal/sk | Pre: TBA |
| | | Tail 'G' | Fluid Loss <150mL/30min<br>Job Pumping Time 1.0 hr<br>Thickening Time 3.5 hr | DW | 15.8<br>1.16 | 20% Excess on gauge hole | TOC @ 1570m | D047: 0.01 gal/sk<br>D193: 0.25 gal/sk<br>D145A: 0.08 gal/sk | |

**Notes:** (1) Volume includes excess as stated
(2) Volumes to be confirmed with Dowell prior to the job
(3) Additive quantities and thickening times to be confirmed with lab testing using rig samples.

| | |
|---|---|
| D047 | Antifoam |
| S001 | Accelerator |
| D075 | Liquid Extender |
| D110 | Retarder |
| D145A | Dispersant |

## 3.9 Pressure Testing Schedule

| Test Performed | On Stump | | 340mm (13⅜") Casing | | 273mm (10¾") x 244mm (9⅝") Casing* | |
|---|---|---|---|---|---|---|
| | MPa | psi | MPa | psi | MPa | psi |
| **Pressure testing after bumping the cement top plug:** | | | | | | |
| 340mm (13⅜") Casing initial test – contingent upon bumping the plug ***(limited by Cameron running tool)*** | - | - | 20.7 | 3000 | - | - |
| 273mm (10¾") x 244mm (9⅝") Casing initial test – contingent upon bumping the plug | - | - | - | - | 27.6 | 4,000 |
| **BOP testing:** | | | | | | |
| 70% of casing burst 340mm (13⅜") (for information) | - | - | 24.2 | 3514 | - | - |
| 70% of casing burst 273mm (10¾") (for information) | - | - | - | - | 31.1 | 4,506 |
| 70% of casing burst 244mm (9⅝") (for information) | - | - | - | - | 33.2 | 4,809 |
| Blind/Shear Ram | 34.5 | 5,000 | 20.5 | 3000 | 27.6 | 4,000 |
| LMRP Connector | 27.6 | 4000 | 17.2 | 2,500 | 17.2 | 2,500 |
| Wellhead Connector | - | - | 27.6 | 4,000 | 27.6 | 4,000 |
| Annular Preventer | 27.6 | 4000 | 17.2 | 2,500 | 17.2 | 2,500 |
| Pipe Rams | 34.5 | 5,000 | 27.6 | 4,000 | 27.6 | 4,000 |
| Choke Manifold, Choke and kill lines, TDS Safety valves, Standpipe Manifold | - | - | 27.6 | 4,000 | 27.6 | 4,000 |

- A full BOP stump test shall be conducted prior to the running the stack (off critical path). A full BOP test shall be conducted prior to drilling out of the 340mm (13⅜") string.
- A full BOP test shall be conducted at least every 14 days.
- A test plug shall be utilised for all BOP pressure tests and connector pressure tests once the stack has been run except for the blind/shear ram test.
- The test shall include a 5 minute low pressure test to 1.4 MPa (200psi). High pressure testing shall be conducted for 10 minutes
- The worst case theoretical surface pressure has been calculated at 18.6 MPa (2700 psi) assuming total evacuation to gas and the maximum estimated formation pressure prognosed for the Waarre-C formation
- A blind/shear test is not required during routine tests once in open hole.
- The blind/shear rams shall be tested against casing/cement
- The 273mm (10-3/4") shall only be pressure tested during the initial BOP stump test and once the tubing hanger landing string has been run.

## 3.10 Formation Integrity Tests

### 340mm (13⅜") Casing Shoe

A full leak-off test (LOT) shall be performed at the 340mm (13 3/8") casing shoe on Casino-5

A leak off test in the range of 1.6 – 1.80sg is expected at the 340mm casing shoe at a depth of ~730mRT MD. A leak-off test of 1.5sg is sufficient for a 7.95 m3 (50bbl) swabbed gas kick tolerance with a mud weight of 1.2sg and maximum expected formation pressures.

### 244mm (9⅝") Casing Shoe

A full leak-off test shall be performed at the 244m (9⅝") casing shoe on Casino-5.

## 3.11 Target Tolerance

| Target | | Tolerance |
|---|---|---|
| Depth: | 1743mRT TVD | 70m radius |
| Lat | 38° 47' 43.746" S | |
| Long | 142° 44' 44.54" E | |
| Easting: | 651 603 mE | |
| Northing: | 5 704 471 mN Lat | |

The target corresponds with the top of the Waarre-C sand. Following intersection, the well will be drilled vertically to ~1788m

# 4 EVALUATION

## 4.1 Directional Surveying Programme

| Hole Section | Survey Type |
|---|---|
| 445mm (17½") | EMS dropped at section TD |
| 311mm (12¼") | MWD (Measurement While Drilling) |
| 216mm (8½") | MWD (Measurement While Drilling) |

## 4.2 Real-time Logging Requirements (FEWD)

| Hole Section | Survey Type |
|---|---|
| 445mm (17½") | Not required |
| 311mm (12¼") | GR-Res |
| 216mm (8½") | GR-Res-Density Neutron (contingent only) |

## 4.3 Sampling Programme

Cuttings samples will be collected at 6m intervals from beneath the 340mm (13 3/8") shoe to 100m above the Waarre-C Sand where the sampling interval will be shortened to 3m through to TD. A detailed sampling programme will be available at the well site.

## 4.4 Wireline Logging

| Hole Section | Logging Tools |
|---|---|
| 445mm (17½") | Not required |
| 311mm (12¼") Casino-5 | Not required |
| 216mm (8½") | GR-Res-Density-Neutron (contingent only) |

## 4.5 Coring

No coring is planned for Casino-5.

## 4.6 Testing

A well clean-up is planned for Casino-5 following installation of the upper completion and is detailed in Section 5.

# 5 COMPLETION

## 5.1 Introduction

Casino–5 will be completed as a vertical producer in the Waarre-C sands, tied back via sub-sea flow lines to a shore based gas processing plant. The completion has been designed to be as reliable as possible to remove the need for any re-entry over its producing life of around 12 years. The produced gas contains 0.8% Carbon Dioxide and no Hydrogen Sulphide. Chrome metallurgy (13% or greater) has been specified to ensure long life in the expected corrosive environment. Reservoir sand strength studies have concluded that the risk of sand production is low, but cannot be disregarded and therefore a sand exclusion system has been incorporated into the completion as the sub-sea system cannot tolerate sand production. An Expandable Sand Screen (ESS) sand exclusion system will be deployed. Early water break-through is not expected, and when it occurs, will signal the end of the producing wells life.

The horizontal subsea tree will be installed and BOPs run immediately prior to drilling the 12¼" hole section. Detailed procedures will be generated to cover the tree installation sequence.

The 12¼" hole section will reach TD above the reservoir and a 9⅝" x 10¾" production casing run and cemented. It is important that the 12¼" hole is not drilled into the reservoir as this could jeopardise ESS integrity and adversely affect well productivity. The lower portion of the 9⅝" section will be 13 Cr as this will be in contact with produced fluids.

The 216mm (8½") vertical production bore will then be drilled using a water based drill-in fluid containing sized bridging agents. Once TD has been reached, it will be necessary to condition the mud to ensure the drill-in fluid does not plug the screens.

TD will be towards the base of the Waarre-C sand. Blank 7⅝" pipe will be run between the packer and top reservoir – the ESS will cover the interface between reservoir and overlying seal as this is where some of the high quality reservoir is predicted to occur.

The lower completion comprises of ESS, 7-5/8" base pipe and the ESS hanger. The screens will be run and set in the drill-in fluid. Two trips will be needed. The first is to run the ESS and set the packer. The second trip is to expand the ESS, which will require two passes to fully expand the screens. A circulation sub will be installed in the ESS running string (above the ESS hanger) to allow displacement of the drill-in fluid from the casing with inhibited completion brine. The density of the brine will be slightly lower than the drill-in fluid to prevent inversion. The ESS running string will then be recovered.

The upper completion is a single 177.8mm (7") 13Cr tubing completion with a Tubing Retrievable Safety Valve (TRSV) installed approximately 50m below the mudline. A permanent hydraulic set packer will be set at approximately 1700mRT MD. During completion running, the hole will be monitored and kept full at all times, via the trip tank, as there is no mechanical barrier isolating the reservoir. A wireline entry guide will be positioned a minimum of one tubing length above the top of the lower completion with the permanent packer set within the 13Cr section of casing. Chrome metallurgy will be used for all flow wetted areas.

The upper completion will be landed with a 187.3mm (7⅜") subsea test tree run on a 244.5 mm (9⅝") landing string.

The tubing will be displaced with diesel prior to packer setting in order to provide under-balance for the well flowback. A standing valve will then be run on slickline and set in the standing valve profile in the tailpipe below the production packer. The tubing will be pressure

tested and packer set. The tubing will then be pressure tested to 27.6MPa (4000 psi). Note: maximum SITHP during production operations is ~ 18.6MPa (2700 psi).

Due to the absence of mechanical isolation from the reservoir, it will not be possible to pressure test the TRSV prior to setting the packer or pressure test the packer from below once the packer is set. Note the TRSV will be body tested prior to running in hole. The TRSV will be inflow tested after packer setting and the production packer will be pressure tested from above via an annular pressure test. A contingency chemical cutting tool will be available to cut the chemical cut sub to allow recovery of the upper completion if required.

The well will be cleaned up and then well tested in order to determine key reservoir parameters and well deliverability. Bean-up will be gradual to avoid hydraulic shocks to the formation & potential de-stabilisation (say, over a 1-2 hr period). Hydrate inhibitors will be injected at the subsea test tree.

After clean-up, the well will be shut-in and the TRSV inflow tested. The well will then be left in a condition to be connected to sub-sea flowlines and umbilicals.

Refer to Attachment C for further detail on the upper and lower completion of Casino 5.

## 5.2 Summary Completion Procedure

Detailed completion procedures will be issued prior to installation. An outline of the procedure is given below and assumes that the subsea tree and BOPs are installed, the 12¼" hole section drilled, 9⅝" casing string run and cemented and the 216mm (8½") hole has been drilled to TD and conditioned with clean kill weight mud.

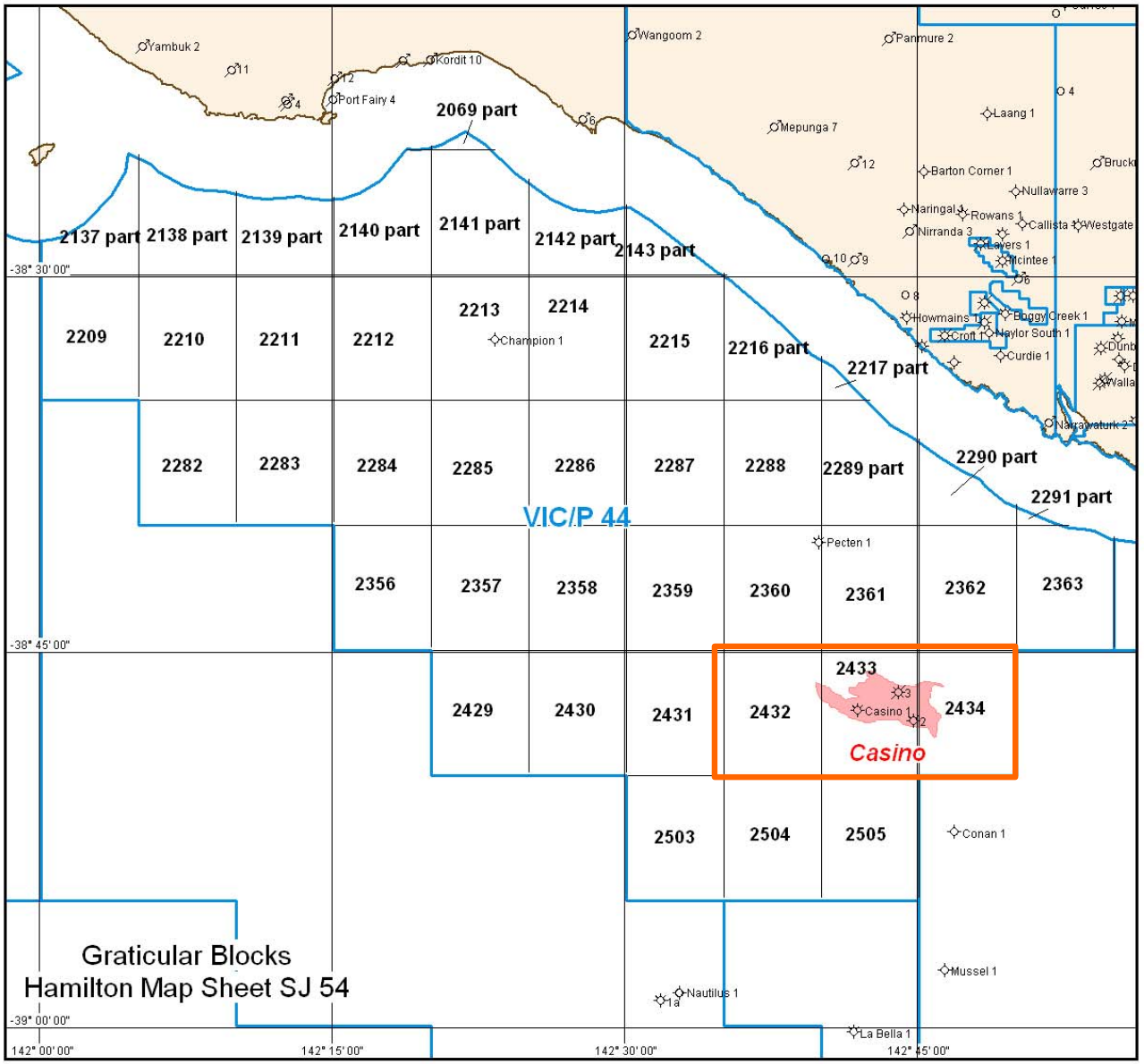
- Run 244.5mm (9⅝") casing scrapers and scrape casing at packer setting depths. Clean riser with riser brush. Function and jet BOP's and circulate clean. Jet wellhead and sub-sea tree.
- Run ESS in drill-in fluid. Run blank 7⅝" pipe and pup joints as required.
- Make up ESS hanger.
- RIH and space out to leave a ~3m rat hole, with ESS across reservoir with overlap onto overlying none-reservoir formation. Space out with blank 7⅝" pipe to place packer element clear of 9⅝" casing connections.
- X/O to drillpipe and RIH to required depth.
- Set packer. Disengage running tool. POOH.
- Run liner expansion tool with PBL sub. Make first pass to expand ESS. Make second pass to conform ESS with borehole wall.
- POOH until PBL sub is ~20m above top of packer. Function PBL sub.
- Displace upper part of well to kill weight brine. Note: Density of brine will be less than density of drill-in fluid to prevent fluid inversion.
- POOH and lay down running tool. Pull XT Drill Through Wear Bushing. Jet Production XT profiles with rubber coated bull-nose.
- Run upper completion. Sub-assemblies consists of:
  - Wireline Entry Guide (WEG);
  - 117.5mm (4⅝") RNQN nipple profile;
  - Permanent production packer & 140mm (5½") chemical cutting sub;

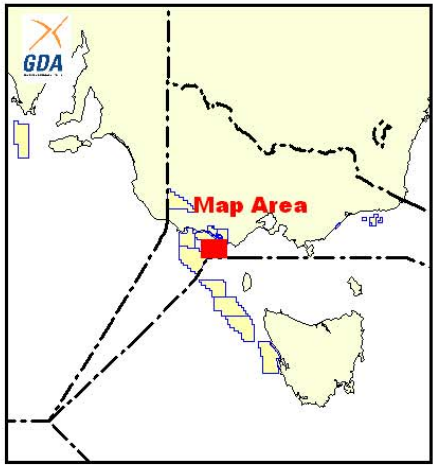
  - Tubing Retrievable Safety Valve (TRSV) & flow couplings (note: pressure to be held on TRSV control line whilst running TRSV in hole).
  - Tubing Hanger.
- Make up Tubing Hanger to running tool and 187.3 mm (7⅜") subsea test tree. Run in hole with 244.5 mm (9⅝") landing string.
- Rig up flowhead and slickline equipment. Land tubing hanger in Production XT. Pressure test the flowhead to the well-test choke manifold and production test equipment.
- Pump Diesel into tubing and displace tubing volume (minus a safety factor), taking returns from annulus via choke manifold.
- RIH with standing valve on slickline. Pressure test tubing to 15.5MPa (2250 psi)/10 mins – a higher pressure will set packer.
- Increase pressure and set packer Packer will start to set at ~ 19.0MPa (2750 psi). Test tubing to 27.6MPa (4000 psi). Bleed-off pressure in tubing (keeping TRSV open).
- Pull standing valve using slickline. Run downhole pressure gauges on slickline.
- Pressure test annulus above packer to 27.6 MPa (4000 psi).
- Bean-up well progressively over 1-2 hrs and avoid imposing hydraulic shocks on the sand face. Flow well to clean-up as per instruction from Reservoir Engineer. Hydrate inhibitors to be injected at the sub-sea tree.
- Close well in at Flowhead. Pull downhole pressure gauges with slickline. Close TRSV. Inflow test TRSV by bleeding off above.
- Run Lower Crown Plug and POOH Landing String Assembly.
- Jet ITC profile. Run Internal Tree Cap/Upper Crown Plug & pressure test same.
- Pull the Rig BOP's
- Run Debris Cap.
- Recover anchors.
- Move rig off location.

## 5.3 Completion Program Barrier Summary

| Programmed Step | Internal Barriers | Annular Barriers |
|---|---|---|
| **Run Lower Completion** | 1. Overbalance drilling fluid<br>2. IBOP / top drive<br>3. stabbing valve | 1. Overbalance drilling fluid<br>2. BOP – annular or pipe rams for drill pipe<br>3. BOP – shear rams whilst sand screens across stack |
| **Run Upper Completion (Pre landing of and pressure testing of tubing hanger and pre circulation of diesel)** | 1. Overbalance drilling fluid<br>2. IBOP / top drive<br>3. stabbing valve | 1. Overbalance packer fluid<br>2. BOP – annular or pipe rams for tubing<br>3. BOP – shear rams whilst completion above the BOP<br>4. BOP – shear rams when landing string umbilicals prior to landing the tubing hanger |
| **Run Upper Completion (Post Landing of tubing hanger and post circulation of diesel). Includes setting of downhole pressure gauges on slickline** | 1. Flowhead and co-flexip line (pressure tested)<br>2. Slickline Pressure Control Equipment (PCE) (pressure tested)<br>3. Welltest choke manifold (pressure tested)<br>4. Subsea Test Tree Valves and lubricator valves. | 1. Overbalance packer fluid<br>2. Tested Tubing Hanger seals<br>3. BOP - 9 5/8” rams (pressure tested) |
| **Run Upper Completion (Post packer setting) and Post Clean up flow** | 1. Flowhead and co-flexip line (pressure tested)<br>2. Slickline PCE (pressure tested)<br>3. Welltest choke manifold (pressure tested)<br>4. Subsea Test Tree Valves and lubricator valves. | 1. Overbalance packer fluid<br>2. Production packer<br>3. Tested Tubing Hanger seals<br>4. BOP - 9 5/8” rams (pressure tested) |
| **Suspension (During recovery of Landing string and running of ITC)** | 1. Lower crown plug (pressure tested)<br>2. BOP – shear rams | 1. Overbalance packer fluid<br>2. Production packer<br>3. Tested Tubing Hanger seals<br>4. BOP – shear rams |
| **Pulling BOP and running debris cap** | 1. Lower crown plug (pressure tested)<br>2. ITC & Upper crown plug (pressure tested) | 1. Lower crown plug (pressure tested)<br>2. ITC & Upper crown plug (pressure tested) |

# Figure 1 – Well Location Map




Santos

**VIC/P44**

**Declaration of Location Over**

**Casino Field**

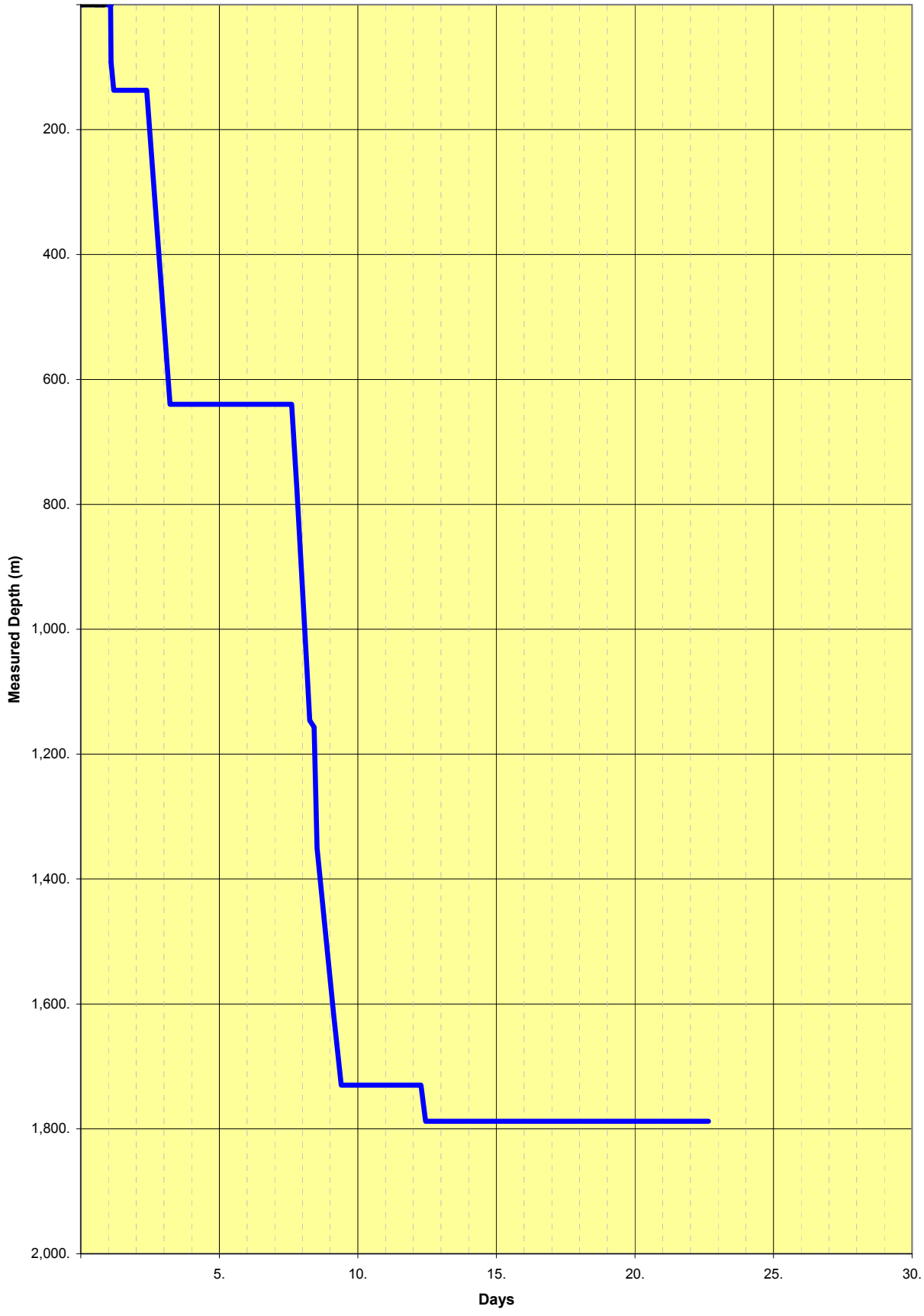
5 0 5 10 15

Kilometres

Santos Ltd ABN 80 007 550 923, Feb 2004 File No. OTWAY 603

Figure 2

# Figure 2 – Time Depth Curve



# Attachment A – Ocean Patriot Blow Out Prevention Equipment

Cameron 18-3/4" Type ULL BOP rated to 15,000 psi working pressure.

| Component | Type / Pressure Rating |
|---|---|
| Upper Annular | Cameron Type D 18-3/4" – 34.5mPa (10,000 psi) |
| LMRP Connector | 473mm (18 ¾") Cameron Collett<br>34.5 MPa (10,000 psi) |
| Lower Annular | Cameron Type D 18-3/4"<br>34.5mPa (10,000 psi) |
| #1 Blind/Shear Rams | Cameron ULL Blind/Shear<br>103 MPa (15,000 psi) |
| Upper Kill Entry | Below ram #1 – 103 MPa (15,000 psi) |
| #2 Upper Pipe Rams Variable | Cameron ULL Variable 89mmx127mm (3 ½" x 5")<br>103 MPa (15,000 psi) |
| #3 Middle Pipe Rams 273mm (10 ¾") | Cameron ULL - 273mm (10-3/4") pipe ram<br>103 MPa (15,000 psi) |
| Choke Entry | Below ram #3– 103 MPa (15,000 psi) |
| #4 Lower Pipe Rams 127mm (5") | Cameron ULL - 127mm (5") pipe ram<br>103 MPa (15,000 psi) |
| Lower Kill Entry | Below ram #4 – 103 MPa (15,000 psi) |

# Attachment B – List of Contractors

| | | |
|---|---|---|
| Baker Atlas<br>Level 2, 200 Adelaide Terrace<br>Perth, WA 6004<br>Contact: Scott Blair | Tel: (08) 9455 0915<br>Fax: (08) 9455 0961<br>Mob: 0417 357 071 | Wireline Logging |
| Bristow Helicopter<br>130 Fauntleroy Avenue<br>Redcliffe, WA 6104<br>Contact: Patrick Thirley | Tel: (08) 9478 3388<br>Fax: (08) 9478 3844<br><br>Mob: 0418 121795 | Helicopters |
| Cameron<br>1 Glencairn Ave<br>Deer Park VIC 3023<br>Contact: Bruce Hassett | Tel: (03) 9361 4444<br>Fax:<br><br>Mobile: 0411 704 914 | Wellheads & Trees |
| Diamond Offshore General Company<br>Unit 2, 5 Turner Avenue,<br>Bentley WA, 6012<br>Contact: Steve Ramsey | Tel: (08)6363 8945<br>Fax: (08) 6363 8999<br><br>Mobile: 0431 507 423 | Drilling Contractor |
| Dowell Schlumberger<br>Level 5, 256 St Georges Terrace<br>Perth WA 6000<br>Contact: Matt Cazalet | Tel: (08) 9420 4659<br>Fax: (08) 9420 4715<br><br>Mobile: 0411 654 526 | Cementing |
| ECL Australia<br>Level 1, 610 Murray St<br>West Perth, WA 6005<br>Contact: Ian Scorgie | Tel: (08) 9480-0105<br>Fax: (08) 9480-0105 | Rig Positioning - QA |
| Expro Group<br>42-44 Wittenberg Drive<br>Canning Vale WA 6155<br>Contact: Dave Linkston | Tel: (08) 9456 7619<br>Fax: (08)<br><br>Mobile: 0403 242 966 | Well Testing |
| Farstad Shipping<br>Level 9, 16 St Georges Tce<br>Perth, WA 6000<br>Contact: Captain Bruce Dann | Tel: (03) 9254 1546<br>Fax: (03) 9254 1659<br>Mobile: 0408 488 382 | Workboats |
| Fugro (Thales)<br>Hydrographic House, 4 Ledgar Road<br>Balcatta, 6021<br>Contact: Terry Blake | Tel: (08) 6241 1351<br>Fax: (08) 9344 8783<br>Mobile: 0427 779 190 | Rig Positioning |
| Halliburton Sperry Sun<br>Level 2,256 St Georges Terrace<br>Perth WA 6000<br>Contact: Steve Edwards | Tel: (08) 6424 4607<br>Fax: (08) 6424 4699<br><br>Mobile: 0417 931 764 | MWD |
| K&S Freighters<br>Canal Court, Portland Vic 3305<br>P.O. Box 649<br>Contact: David Whitehead | Tel: (03) 5523 4144<br>Fax: (03) 5523 5647<br><br>Mobile: 0419 829 792 | Shorebase |
| MI Australia Pty Ltd<br>Level 11, 251 Adelaide Terrace<br>Perth, WA 6000<br>Contact: Dave Bennett | Tel: (08) 9325 4822<br>Fax: (08) 9325 1897<br><br>Mobile: 0417 971 769 | Drilling Fluids |
| Security DBS<br>Level 2, 256 St Georges Terrace<br>Perth, 6000<br>Contact: Joe Thompson | Tel: (08) 6424 4642<br>Fax: (08) 6424 4699<br><br>Mobile: 0414 911 787 | Coring Services |
| Swire Pacific Offshore<br>2nd Floor, Queensgate Centre,<br>Cnr William & Newman Streets<br>Fremantle, WA 6160<br>Contact: Sam Pullen | Tel: (08) 9430 5434<br>Fax:<br><br>Mobile: 0411 430 669 | Workboats |
| Weatherford<br>Level 2, 225 St Georges Terrace<br>Perth, WA 6000<br>Contact: Aaron Sinnott | Tel: (08) 92124606<br>Fax: (08) 9226 4638<br><br>Mob: 0418 51 759 | Casing Running Services |

# Attachment C – Completion Schematic