REPORT
206

WAUKARLYCARLY 1 BASIC DATA WELL COMPLETION REPORT

by
LS Normore and M Rapaic

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EXPLORATION INCENTIVE SCHEME

Government of Western Australia
Department of Mines, Industry Regulation and Safety

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* inGauge Energy, Milton QLD 4064

PERTH 2020

Geological Survey of Western Australia

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About this publication
This Report is a basic data well completion report, written and compiled jointly between the Geological Survey of Western Australia (GSWA) and inGauge Well Engineering and Project Management. The majority of the appendices in the Report are the responsibility of industry contractors and no editing has been undertaken by GSWA.

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Cover photograph: Evening light surrounds DDH1 Drilling's ER01 rig during the drilling of Waukarlycarly 1

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Available with the PDF online as an accompanying digital resource

Waukarlycarly 1 basic data well completion report

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Abstract

Deep stratigraphic well Waukarlycarly 1 was spudded on 1 September 2019 in the Waukarlycarly Embayment on the southwestern margin of the Canning Basin. The well reached total depth of 2680.53 mRT on 30 November 2019, with rig release on 12 December 2019. This drilling project was funded by Geoscience Australia's Exploring for the Future initiative, with the Geological Survey of Western Australia of the Department of Mines, Industry Regulation and Safety participating as project operator. Drilling was conducted by Perth based DDH1 Drilling, with inGauge Project Engineering and Well Management providing the drilling management services. Access to the site was from Port Hedland via Marble Bar, or through the Metals X Nifty Copper mine site airstrip. Pason Australia provided live online data of drilling parameters and mudgas.

The main objectives of the stratigraphic drilling were to:

- obtain data to allow correlation of seismic reflectors on the Kidson seismic survey to their corresponding stratigraphic horizons in the well
- continuously core through the entire Canning Basin stratigraphy
- obtain approximately 100 m of core from the pre-Canning Basin basement
- acquire downhole geophysical surveys, including a standard suite of wireline logs and a vertical seismic profile.

All of the main objectives of the project were achieved. The well encountered no indications of hydrocarbons. Interpretation of data and samples currently being analysed will be released at a later date.

Keywords: Canning Basin, stratigraphic drilling, Waukarlycarly Embayment, well completion report

Well summary

Waukarlycarly 1 was drilled as a stratigraphic well at the southern end of the depocentre of the Waukarlycarly Embayment, a structural division in the southwest Canning Basin (Fig. 1). The drilling was a follow-up project to the recently acquired Kidson seismic survey (18GA-KB1) to provide stratigraphic data for a very poorly understood tectonic component of the southern Canning Basin. The wellsite was about 214 km east of Marble Bar and 51 km west-northwest of Telfer gold mine in the Pilbara region of Western Australia.

DDH1 Drilling's rig ER01 was mobilized from the Merriden yard between 15 and 27 August 2019, with rig setup completed on 31 August 2019. The well was spudded on 1 September 2019, rotary drilled from the surface to 580.00 mRT (metres rotary table) and then continuously cored to a total depth (TD) of 2680.53 mRT. TD was reached on 30 November 2019 with rig release on 12 December 2019. Relevant well information is found in the well card (Table 1).

The operations for the Waukarlycarly 1 well are summarized in bullet points below. Further details of the drilling operations can be found in the daily drilling reports (Appendix A). Detailed geological reports are found in Appendix B, with mud and composite logs located in Appendices C and D, respectively. A list of core runs is found in Appendix E and tray depths reported in Appendix F. Field core photographs taken under white light in dry and wet conditions and under ultraviolet light are found in Appendix G. Two detailed HyLogger summaries of cuttings (Appendix H) and core (Appendix I) are augmented with HyLogger core photographs (Appendix J). Detailed downhole geophysical reports are also included in the Appendices: cement bond log 177.8 mm (7") casing (Appendix K), cement bond log 139.7 mm (5.5") casing (Appendix L), wireline logs #1: 155.6 mm (6⅛") hole (Appendix M), wireline logs #2: 120.7 mm (4¾") PQ hole (Appendix N), wireline logs #3: 95.3 mm (3¾") HQ hole (Appendix O), and the vertical seismic profile (VSP; Appendix P). Rig details for ER01 are found in Appendix Q.

A time versus depth chart for the Waukarlycarly 1 well is provided in Figure 2. A well schematic is presented in Figure 3.

- The 244.5 mm (9⅝") conductor casing was set at 20 mRT inside a 311 mm (12¼") hole.

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- The 215.9 mm (8½”) hole was then drilled to 218 mRT using a conventional polycrystalline diamond compact (PDC) drill bit. The 177.8 mm (7”) casing shoe was set at 215 mRT.
- The 177.8 mm (7”) surface casing was drilled out with a 155.6 mm (6⅛”) PDC drill bit to 580 mRT. The section was then cored with a 146 mm (5¾”) core bit to 727.14 mRT. After coring, the section was cleaned out with a 155.6 mm (6⅛”) PDC bit before running temporary casing of 139.7 mm (5½”) SQ drill pipe to 726.13 mRT.
- The next section was cored with a 120.7 mm (4¾”) bit to 1602.6 mRT. The 114.3 mm (4½”) PQ drill pipe was then landed on the wellhead with PQ pipe shoe at 1602.6 mRT before continuing to drill. The final section was cored with a 95.3 mm (3¾”) HQ bit to TD of 2680.53 mRT.
- The PQ casing did not pull free and required cutting, resulting in 1031 m of PQ pipe retrieved from the well leaving 571.6 m of PQ pipe in hole between 1031 and 1602.6 mRT. The SQ casing did not pull free. The pipe was cut and 300 m was retrieved at the surface, leaving 426.13 m of pipe in hole between 300 and 726.13 mRT.
- The well was plugged and decommissioned.

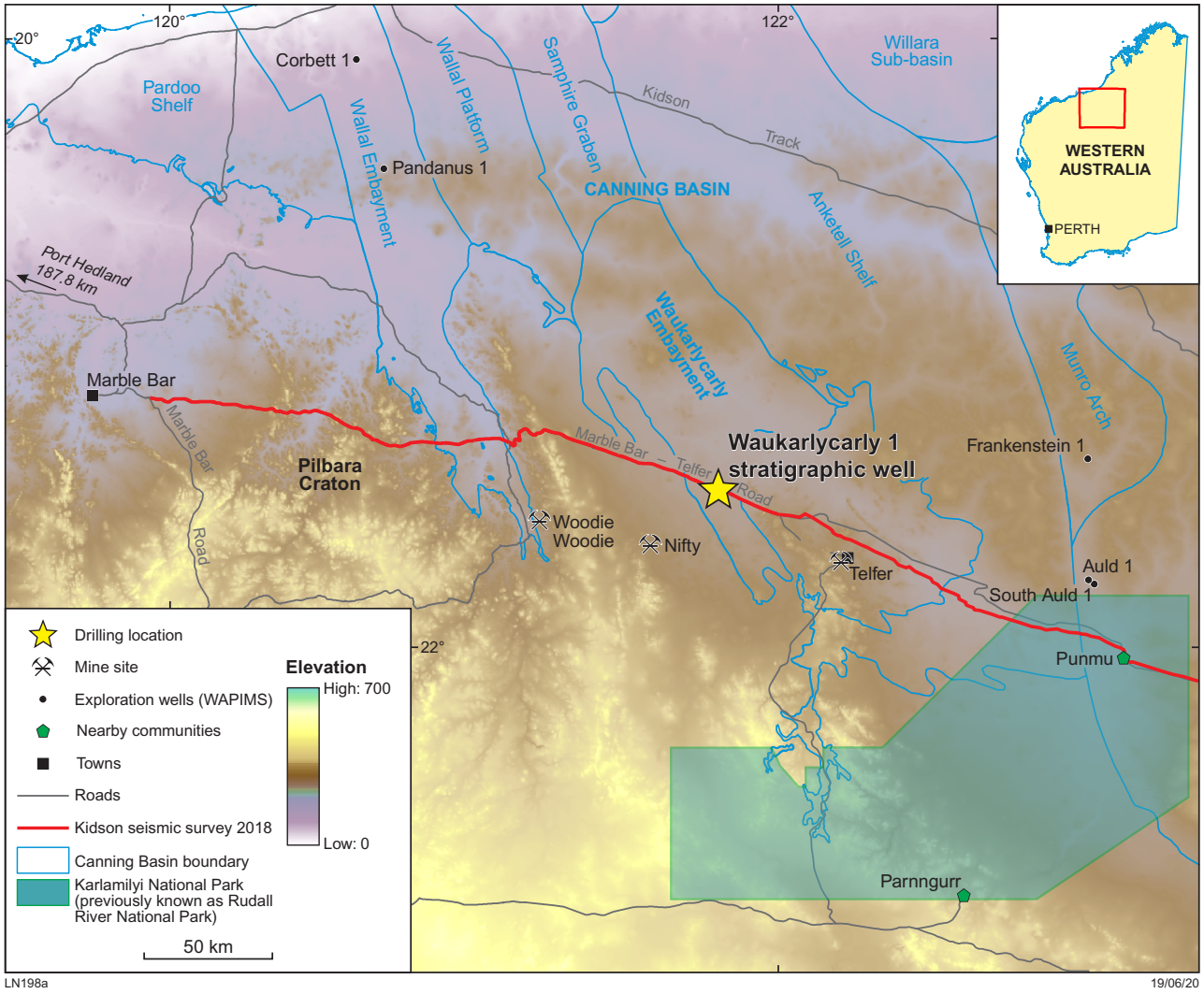

Figure 1. Location map of the Waukarlycarly 1 stratigraphic well. Abbreviation: WAPIMS, Western Australian petroleum and geothermal information management system

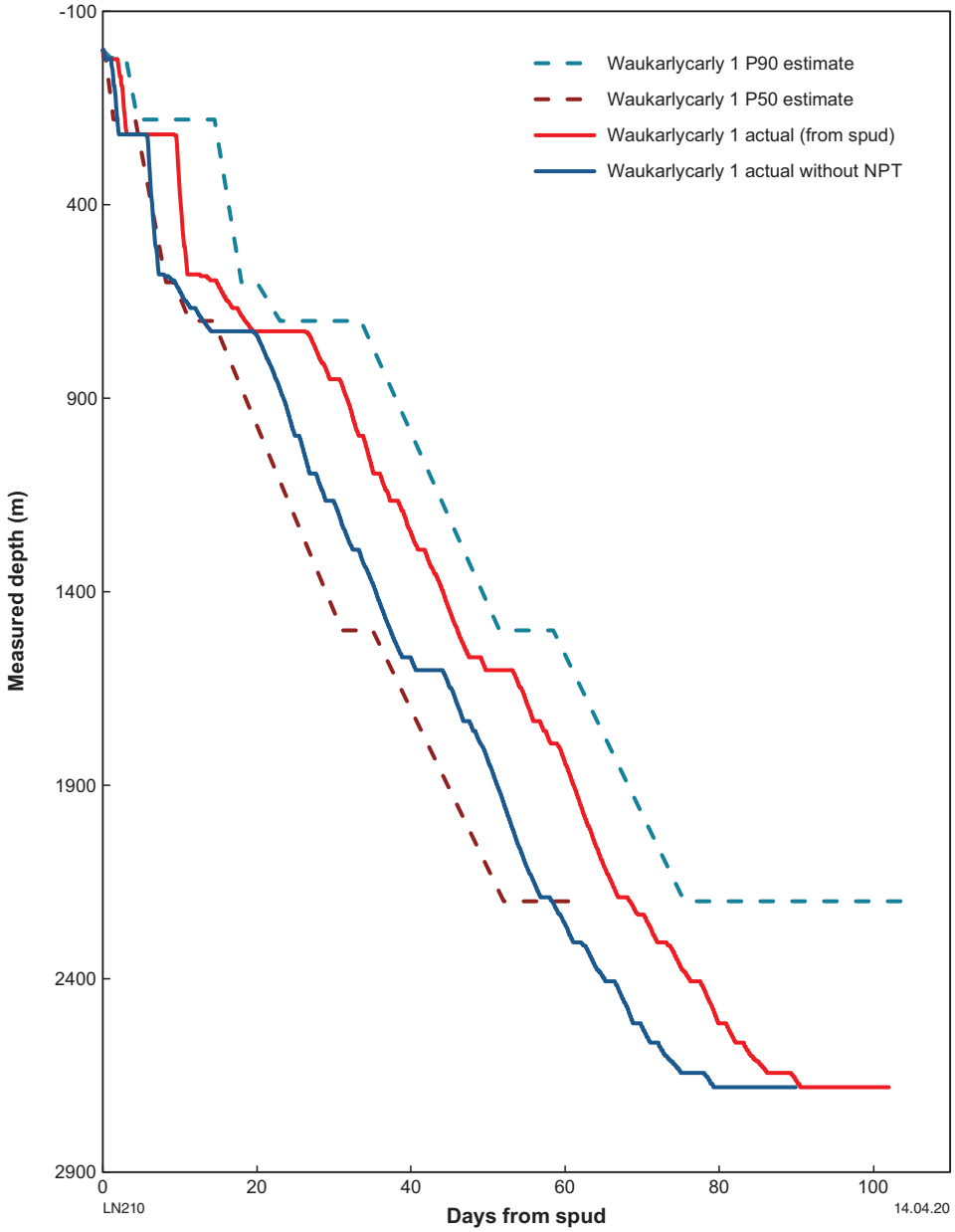

Figure 2. Time–depth curve: predicted vs actual; P50 and P90 are statistical confidence levels for estimates; P50 means 50% of estimates exceed the P50 estimate and it has a higher chance of occurring than P90 which has 90% of estimates exceeding the P90 estimate. Abbreviation: NPT, non-productive time

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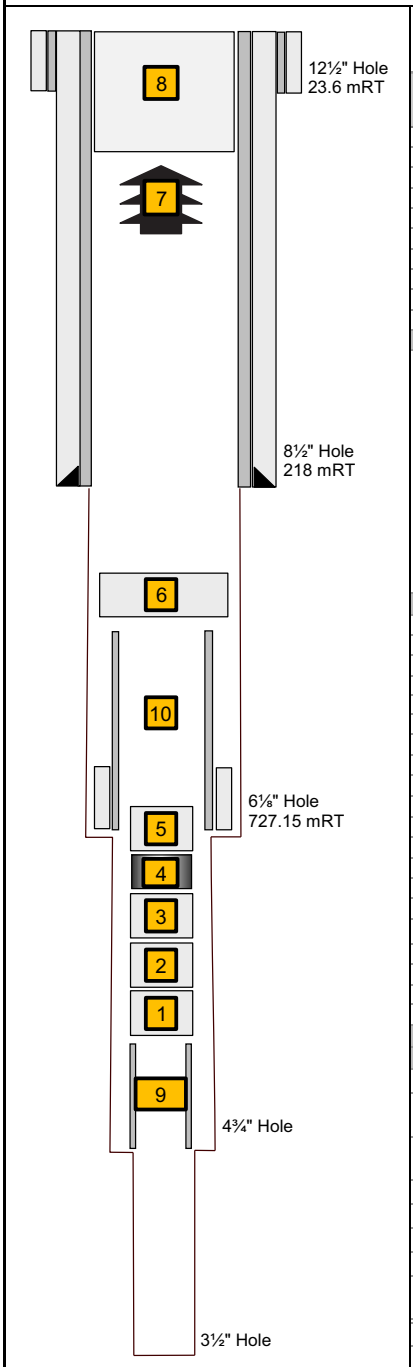
Waukarlycarly 1



Latitude:	21°28'41.4"S	**Well spudded:**	1/09/2019	**Ground level:**	258.00 mASL
Longitude:	121°46'56.8"E	**Last activity:**	11/12/2019	**RT:**	3.60

ITEM NO.	DESCRIPTION	Length (m)	Depth (mRT)
1	Cement plug, depths unknown		
2	Cement plug, depths unknown		
3	Cement plug, depths unknown		
4	Van Ruth mechanical plug set at 737 mRT		
5	Cement plug		
6	Cement plug, depths unknown		
7	7" cementing plug (upside down)		30.00
8	Surface cement plug	30.00	0.00
9	PQ core pipe	571.60	1031.00
10	SQ core pipe	426.13	300.00

BREIF HISTORY OF WELL

Drilling: Waukarlycarly 1 was a collaborative drilling project between GSWA and GA. The well is a stratigraphic investigation of the Waukarlycarly Embayment of the southwest Canning Basin. The work was undertaken by drilling company DDH1. It was drilled in five sections: 12½" hole, 8½" hole, 6⅛" hole, 4¾" hole and 3½" hole. The well was cored from 580 mRT to TD. A 7" surface casing string was used in the construction and cemented to the surface to isolate surface formations and allow for the installation of a BOP. Two intermediate strings were then used to achieve TD but were not cemented to the surface. At the end of the well, as much of the temporary casing was retrieved as possible but some remains in the hole.

Completions: The well was then decommissioned with a series of cement plugs, one mechanical plug and one cementing plug. The cement plug placed downhole did not hold pressure when tested. The surface cement plug was set from 30 mRT to the surface on top of the cementing plug.

CASING DETAILS

CEMENTING DETAILS		
Size:	9⅝" conductor	Cemented with 12.58 bbl of 15.4 ppg cement
Weight:	53 ppf	
Grade:		
Depth set:	20 mRT	
SURFACE		
Size:	7"	26.73 bbl of 13.5 ppg cement pumped with pressure cementing technique. Tagged cement at 203.2 mRT before drilling out
Weight:	26 ppf	
Grade:	VAM	
Depth set:	215 mRT	
SQ CORE PIPE		
Size:	5½"	Cemented from 726 to 700 mRT with 4 bbl of 14.4 ppg cement. Attempted to retrieve temporary casing but unable to recover total length due to stuck pipe. Pipe cut at 500 mRT but only 300 m of pipe retrieved resulting in 426.13 m of pipe between 300 and 726.13 mRT left in hole
Weight:	12 ppf	
Grade:	SQ	
Depth set:	726.13 mRT	
PQ CORE PIPE		
Size:	4½"	Attempted to retrieve temporary casing but unable to recover total length due to stuck pipe. Pipe cut at 1031 mRT and 1031 m of pipe retrieved resulting in 571.6 m of pipe between 1031 and 1602.6 mRT left in hole
Weight:	10 ppf	
Grade:	PQ	
Depth set:	1602.6 mRT	

ABANDONMENT PLUGS

Plug	Top (mRT)	Comment
1	unknown	4.7 bbl of 14 ppg cement mud spot at 756 mRT. Plug slumped after plug 3
2	unknown	2.5 bbl of 14 ppg cement spot on top of last plug. Plug slumped after plug 3
3	unknown	3.8 bbl of 14 ppg cement spot on top of last plug. Plug slumped, no tag down to 740 mRT
4	737	Van Ruth mechnical plug
5	714	5 bbl of 14 ppg cement spot at 737 mRT
6	unknown	5 bbl of 12.5 ppg cement pumped from surface
7	30	7" cementing plug pushed into hole and set at 30 mRT
8	0	Mixed and pumped from surface on top of cement plug set at 30 mRT. Weight not recorded

	WELLSITE SUPERVISORS: Bradley Beaman / Steve Muirhead		
PROPOSED:	LAST WORKOVER: N/A		
COMPLETION:	DRAFTED BY: Dylan Shaw	DATE:	11/12/2019
RECOMPLETION:	REVISED BY:	DATE:	
OTHER:	CHECKED BY:	DATE:	

LN212 04.06.20

Figure 3. Well schematic. Abbreviations: BOP, blow-out preventer; GA, Geoscience Australia; GSWA, Geological Survey of Western Australia

Table 1. Well card

Well name	Waukarlycarly 1
Well operator	GSWA
Well profile	Vertical
Well objective	Stratigraphic investigation
Primary geological target	Base of Canning Basin
Well location	Onshore Canning Basin (Waukarlycarly Embayment), Western Australia
Licence	N/A
Landowner	UCL, Western Australian Government
Native Title status	Martu (Area A) determined land
Regulatory authority	Department of Mines, Industry Regulation and Safety (DMIRS)
Location Data	
Geodetic datum	GDA94
Grid system	MGA 94 UTM Zone 51K
Latitude	21°28'42.77"S
Longitude	121°46'56.42"E
Easting	373850.70
Northing	7624398.00
Ground level elevation	258 mASL
RT to ground level / RT	3.6 m
Drilling contractor / rig number	DDH1/ER01: WEI Drilling Rig DA75 S
Spud date	01/09/2019
Date reached TD	30/11/2019
Rig release	12/12/2019
TD	2680.53 mRT
Maximum deviation angle	3.0°
311.2 mm (12¼") hole	311.2 mm (12¼") hole depth: 23.6 mRT
244.5 mm (9⅝") conductor casing	20 mRT, 53 ppf BTC
215.9 mm (8½") hole	215.9 mm (8½") hole depth: 218 mRT
177.8 mm (7") surface casing	177.8 mm (7") 26 ppf VAM BTC casing depth: 215 mRT
155.6 mm (6⅛") hole	155.6 mm (6⅝") hole depth: 727.14 mRT
139.7 mm (5½") intermediate casing	139.7 mm (5½") 12 ppf BTC casing depth: 726.13 mRT
120.7 mm (4¾") hole	120.7 mm (4¾") hole depth: 1602.6 mRT
114.3 mm (4½") temporary casing	114.3 mm (4½") 10 ppf PQ casing depth: 1031 – 1602.6 mRT (not cemented)
95.3 mm (3¾)"hole	95.3 mm (3¾)" hole depth 2680.53 mRT
Well status on rig release	Plugged and decommissioned

Abbreviations: BTC, buttress thread coupling; mASL, metres above sea level; ppf, pounds per foot; RT, rotary table; UCL, unallocated Crown land

Formation evaluation

This stratigraphic well collected ditch cuttings (surface to 580.00 m) and continuous core (580.00 – 2680.53 m), mud logging data and multiple geophysical surveys.

Formation sampling

A top-hole interval was mud rotary drilled from the surface to 580.00 m, followed by continuous coring to 2680.53 m TD (Table 2). Cuttings were collected and described at 3 m intervals throughout the rotary drilled section, which was broken into three stages, starting with a 311.2 mm (12¼")-diameter hole down to 23.63 m, followed by a 215.9 mm (8½")-diameter hole to 218.00 m and finally a 152.4 mm (6")-diameter hole to 580 m. Lithological descriptions of this interval can be found in the mud log in Appendix C.

There were three stages of continuous coring to TD: SQ core from 580.00 to 727.14 mRT (147.14 m in length), PQ core from 727.14 to 1602.64 mRT (875.50 m in length) and HQ core (e.g. Fig. 3) from 1602.64 to 2680.53 mRT (1077.89 m in length). Each core tray was photographed dry, wet and under ultraviolet light (Appendix F) as soon as possible after core reached the surface, utilizing the specifically designed facilities of the DDH1 Drilling 'GeoShack'. The full core and cuttings were analysed using the GSWA HyLogger-3 at the Perth Core Library (Appendices H–J).

Upon completion of drilling the 155.6 mm (6⅛") hole section to 580.00 mRT, the SQ 146 mm (5¾") core barrel was picked up and the hole was cored from 580.00 to 727.14 mRT in 30 runs. Problems experienced during drilling included issues with the wireline retrieval winch, repair and replacement of the hydraulic pump-out hose, and the changing out of five out of six mud shaker motors. Core recovery for the section was 98.5%.

The 120.7 mm (4¾") PQ section was cored from 727.14 to 1602.64 mRT in 117 core runs and 7 bit changes. Core recovery for the section was 99.74%.

The 95.3 mm (3¾") HQ hole section was cored from 1602.64 to 2680.53 mRT in 133 core runs using six bits. There were two significant occasions where repairs had to be conducted to the top-drive core head, which cracked twice and subsequently had to be welded prior to proceeding with coring operations. Total core recovery for the HQ core section was 99.93%.

Mud logging

The Pason Australia Pty Ltd logging system was used to monitor drilling parameters and gas analysis, including C1 to C4, total gas and CO_2. Pason also provided real-time data transmission for remote monitoring. Two significant events resulted in system downtime: 1) faulty depth encoder at 717.6 mRT in the SQ hole section; 2) malfunction of the doghouse monitor at 850 mRT in the PQ hole section.

The following parameters were recorded by the rig's Pason system (Appendix C):

- depth (m)
- rate of penetration (ROP) (m/hr)
- hook load (kilopounds [klb])
- weight on bit (klb)
- revolutions per minute (rpm)
- torque (ft-lbs)
- mud flow in (gal/min)
- mud flow out (%)
- stand-pipe pressure (pounds per square inch [psi]).

Table 2. Formation sampling

Sample type	*Sample size*	*Sample container*	*Hole size, mm (inches)*	*Top depth (m)*	*Base depth (m)*	*Interval thickness (m)*
Cuttings	200–400 g per 3 m	2 sets Mylar bags, 1 set calico bags	311 mm (12¼")	0*	23.63	23.63
Cuttings	200–400 g per 3 m	2 sets Mylar bags, 1 set calico bags	215.9 mm (8½")	23.63	218.00	194.37
Cuttings	200–400 g per 3 m	2 sets Mylar bags, 1 set calico bags	152.4 mm (6")	218.00	580.00	362.00
Cuttings	30 g per 3 m	20 sample chip trays	Rotary section	0*	580.00	580.00
Cuttings	50 g per 3 m	Individual plastic jars	Rotary section	0*	580.00	580.00
SQ core	Continuous core; 102 mm diameter	SQ core trays 2 m	146 mm	580.00	727.14	147.14
PQ core	Continuous core; 85 mm diameter	PQ core trays 3 m	122.6 mm	727.14	1602.64	875.50
HQ core	Continuous core; 63.5 mm diameter	HQ core trays 4 m	96 mm	1602.64	2680.53	1077.89

NOTE: * Rotary floor 3.6 m

Wellsite geologists were responsible for the collection of ditch cuttings and marking up the core in collaboration with GSWA geologists who were responsible for describing and photographing the core. The mud and composite logs were produced by the inGauge wellsite geologists and operations geologist using Golden Software's Strater 5 well log, borehole and cross-section visualization software.

Hydrocarbon shows

Oil shows

No oil shows were recorded.

Gas shows

No hydrocarbon gas shows were recorded. Background gas was negligible or below detectable limits. Bump test gas was routinely pumped through the lines to ensure the gas detection equipment was operational. CO_2 was detected in minor amounts (<1%) from 1380 mRT to TD.

Wireline logging summary

Wireline logging was conducted at three stages (Table 3, Appendices K–P); 215.9 mm (8½") hole to 726 m, PQ hole to 1602 m and HQ hole to 2630 m TD.

Drilling and completion data

Primary contractors and service providers

Multiple service providers were contracted to carry out the drilling and completion operations (Table 4).

Operations summary

Reports summarizing the operations of Waukarlycarly 1 are included as Appendices to this Report (Appendices A–Q), and are available as an accompanying digital resource.

Table 3. Wireline logging summary

Run	*Tool string*	*Open/cased hole*	*Interval (m MDRT)*	*Contractor*
1	GR-16N-64N-NEU-LATR-SP-Temp-Tilt-Azi	Open	0 – 726.92	Wireline Services Group
2	GR-CALI-3-Element Guard Res (ResSG)-Dens	Open	0 – 726.64	Wireline Services Group
3	FWS	Open	0 – 726.0	Wireline Services Group
4	ATV	Open	0 – 726.0	Wireline Services Group
5	CBL	Cased	0 – 218.0	Wireline Services Group
6	GR-16N-64N-NEU-LATR-SP-Temp-Tilt-Azi	Open	720.0 – 1602.8	Wireline Services Group
7	GR-CALI-3-Element Guard Res-Dens	Open	726.0 – 1603.12	Wireline Services Group
8	FWS	Open	500.0 – 1589.8	Wireline Services Group
9	ATV	Open	300.0 – 1598.0	Wireline Services Group
10	CBL	Cased	495.0 – 733.0	Wireline Services Group
11	Check-shot and VSP	Open	650.0 – 2610.0	Hi-Seis
12	MDL-MPD-MDN-CALI-MCG-CXD	Open	720.0 – 2679.29	Weatherford Logging

Abbreviations: ATV, acoustic televiewer; CBL cement bond log; FWS, full waveform sonic; MDRT, mean depth rotary table

Table 4. Contractors and service providers

Service	*Provider*
Drilling rig	DDH1
Rig camp	DDH1
Well design and site supervision	inGauge Energy
Wireline logging (open hole and cased hole)	Wireline Services Group, Hi-Seis and Weatherford
Onsite geology	inGauge Energy and GSWA
Drilling parameters and mudgas	Pason Australia

Rig setup

Rig setup began on 28 August 2019. During rig setup, a broken top-drive tilt ram was identified and required repair. While waiting on repair, the additional hazard hunt items were closed out. Rig installation was completed within four days and the well was spudded at 00:00 hours on 1 September 2019.

Conductor

The 311 mm (12¼") conductor hole was drilled to 23.6 mRT. The first 10 m was drilled with a pump rate of 50 gallons per minute (gpm) and ROP of 6.6 m/hr. The remainder of the section was drilled with 60 gpm and 4.5 m/hr ROP. While drilling, the shakers required troubleshooting.

The 244.5 mm (9⅝") conductor casing was run and set at 20 mRT and cemented in place. The bell nipple and flowline were installed after the cement job.

Surface hole

Before drilling of the surface section could continue, the shakers required electrical repairs with the shaker motors requiring change out. Drilling fluid for the section was mixed using drilling mud additives PAC-L and PAC-R (see glossary).

The 215.9 mm (8½") bottom hole assembly (BHA) was then run in hole and tagged cement at 6 mRT. The cement was drilled out and, once it was placed in a new formation, the wellsite geologist was advised to control the drilling rate. An average ROP of 10 m/hr and 110 gpm pump rate was used down to 175.8 mRT, at which point the pump rate was staged up to 205 gpm. Section TD was achieved at 218 mRT, then the hole was cleaned by circulating 2 x 5 barrel (bbl) high viscosity (hi-vis) sweeps. A wiper trip was performed on the section while waiting on cement-batch tank cleaning and maintenance.

Surface casing and cementing

The 177.8 mm (7") casing was then picked up and run in hole with a two-joint shoe track used on the bottom of the string. The casing was run to 218 mRT and rigged up for the cement job. The pressure cementing technique was used, and conducted by the drilling contractor. Cement was mixed but unable to be pumped due to a plugged suction line. The cement was dumped.

The casing was pulled off the bottom and a single joint laid out to allow for rotation and reciprocation of casing at regular intervals to verify the casing was not stuck, and to break circulation. Casing and well condition was monitored for 61 hours while resolving the ability to mix and pump cement. A slow circulation rate (30 strokes per minute [spm]) was maintained and regular casing reciprocation was used to ensure casing did not become stuck to the wellbore.

Once equipment was operational, the landing joint was picked up and the casing spaced out. The pressure cementing technique was used with 27.73 bbl of 13.5 pounds per gram (ppg) cement mixed and pumped. The cement was displaced with the rig pump and the plug bumped to 600 psi. The pressure was held for 15 minutes before bleeding back to 125 psi. The pressure was held for a further six hours before bleeding off.

Nipple up blow-out preventers

The blow-out preventer (BOP) stack was placed directly on the A section. Multiple modifications were required in order to fit the stack below the rig. The riser and bell nipple were modified along with the U-tube line to the mud tank. Once nippled up, the functioning of the BOP was tested and verified to be in working order. After function testing the BOP was then pressure tested.

155.6 mm (6⅛") hole section

The amount of core recovered from the 155.6 mm (6⅛") hole section was 142.85 m, with a recovery efficiency of 98.54%.

Before drilling could commence, the shaker motors were again replaced in an effort to alleviate problems.

A conventional 155.6 mm (6⅛") PDC BHA was run in hole and cement tagged at 203.2 mRT. The shoe track and 2 m of new formation was drilled out to 220 mRT. The drill-out fluid was displaced to mud to conduct the leak off test (LOT). For the 155.6 mm (6⅛") section, a KCl/polymer mud was used. The LOT indicated a maximum equivalent mud weight of 14.1 ppg.

Drilling continued with a conventional PDC bit at a controlled drilling rate to 580 mRT. Before pulling out of the hole, the well was circulated clean with 2 x 5 bbl hi-vis sweeps. A 146 mm (5¾") coring BHA was then picked up and run in hole.

From 580.00 – 727.14 mRT, the well was cored with a 146 mm (5¾") coring BHA. While drilling the cored section, several repair periods were required. These included repairs to the winch, troubleshooting the Pason equipment, repairs to the pipe handler and modifications to the bell nipple. Once TD for the section had been reached, the well was cleaned with 2 x 5 bbl hi-vis sweeps.

The coring BHA was then pulled out of the hole and laid out. The open hole was then logged with four runs:

1. neutron
2. duel density
3. full waveform sonic
4. acoustic televiewer.

A 155.6 mm (6⅛") clean-out assembly was then run in hole to ream out the section. The hole was reamed out to section TD.

A 139.7 mm (5½") SQ drillpipe was then run in hole as a temporary casing section. The temporary casing was landed into the A section with the shoe set at 726.13 mRT. The shoe was cemented by mixing and pumping 4 bbl of 14.4 ppg cement. The cement was displaced with 56 bbl of mud with the plug bumped to 500 psi. While waiting on cement, the BOP was nippled down and the B section installed.

120.7 mm (4¾") hole section

The amount of core recovered from the 120.7 mm (4¾") hole section was 873.23 m, with a recovery efficiency of 99.74%.

The BOP was pressure tested and new mud mixed for the section.

The 120.7 mm (4¾") coring BHA was picked up and run in hole. Cement was tagged at 714.74 mRT and coring commenced. The hole was cored to 729.63 mRT and circulated clean before conducting the formation integrity test (FIT). Maximum pressure applied was 1000 psi (17 ppg equivalent mud weight) and held without formation breakdown.

The interval was then cored to section TD of 1602.83 mRT. While drilling this section of the hole, the Pason system dropped out and required repair by a Pason technician. The hole was circulated clean at section TD with 2 x 5 bbl hi-vis sweeps before pulling out the BHA. The open-hole section was then logged with four runs using a cement bond log (CBL) tool included on one of the runs.

The logging runs were:

1. neutron
2. duel density
3. full waveform sonic – CBL
4. acoustic televiewer.

After logging, 114.3 mm (4½") PQ core pipe was run into the hole with a PQ reamer assembly BHA. The pipe was washed down to 1602.64 mRT. An 8 bbl hi-vis pill was pumped across the open-hole section. It was then landed on to the B section and set as a temporary casing. The pipe rams in the BOP were changed out to suit the next section and was pressure tested.

95.3 mm (3¾") hole section

The amount of core recovered from the 95.3 mm (3¾") hole section was 1077.21 m, with a recovery efficiency of 99.94%.

The HQ coring BHA was picked up and run in hole. The BOP was pressure tested for the new pipe size before drilling commenced. The section was cored with a 95.3 mm (3¾") coring BHA. During drilling, the main support from the top-drive head to the coring head was torn off the support brace on two separate occasions. The brace required welding on each occasion.

At 2515.53 mRT, the HQ pipe became stuck in the hole. The stuck pipe was initially treated by working the pipe with 60–125 klbs hook load and pumping 5 bbl hi-vis sweeps. The secondary treatment was to spot 5 bbl of citric acid pill mixed to 20 lb/bbl. The pill was pumped across the BHA by chasing with 22 bbl of water and 58 bbl of mud. It was allowed to soak for 40 minutes before working at 50 klbs over string weight but there was no movement. A 20 bbl Liquid Sperse pill as then mixed at 10 lb/bbl and pumped across the BHA. After soaking for one hour, the pipe came free at 35 klbs pull above string weight. The BHA was pulled back 100 m and the well circulated while reconditioning the mud system. The string was then run back to the bottom, working any tight spots. Once on the bottom, coring continued.

At 2643.33 mRT, the BHA was pulled out of the hole and the Hi-Seis wireline logging unit was rigged up. A test run with the VSP tool was conducted before completing the actual VSP logging. After completing the logging, the 3¾" coring BHA was run back in to the hole and coring continued.

The section was cored to a TD of 2680.53 mRT. The BHA was then pulled out of the hole and laid out to rig up for wireline logging. The wireline unit logged open hole from 2679 to 1605 mRT and logged cased hole from 1605 to 727 mRT.

Well decommissioning

Decommissioning of the well started by attempting to retrieve the temporary casings. The rig picked up the 114.3 mm (4½") PQ casing pipe and began pulling but the pipe was stuck in hole. To try and free the pipe, an 18 bbl pill of Liquid Sperse was mixed and pumped with 6 bbl displaced into the annulus at shoe. The pipe was then worked with 20 klbs pull over string weight. The rig continued to work the string and displace 2 bbl of Liquid Sperse pill every hour over a three-hour period. A second 18 bbl Liquid Sperse pill was pumped with 6 bbl spot on bottom across the annulus while waiting on the casing cutting tool.

The PQ casing cutter was run in hole to 1301 mRT and a cut was attempted but was unsuccessful. The cutter was then pulled to the surface for repairs and reset before running back in hole. The cutter was run in hole again to 1031 mRT. This time the cut was successful and 1031 m of PQ pipe was recovered at the surface. The remaining 571.6 m of 4½" PQ pipe was left in hole.

An HQ cement stinger was then run in hole to 756 mRT. At this depth, a 4.7 bbl cement plug weighted at 14 ppg (cement plug #1) was pumped and the string pulled back to 650 mRT. The string and well were circulated clean. After waiting on cement, the top of the plug was tagged at 729 mRT.

Cement plug #2 was spot above plug #1 at 729 mRT. The plug consisted of 2.5 bbl of 14 ppg cement. The stinger was then pulled back to 603 mRT and the well circulated clean. After waiting on cement, the stinger was run back to bottom and tagged cement at 726.5 mRT. A pressure test was conducted but the cement plug did not hold pressure.

Cement plug 3# was spot at 714.58 mRT with 3.8 bbl of 14 ppg cement pumped. The stinger was pulled back to 597 mRT and the well circulated clean. After waiting on cement, the stinger was run back to bottom but ran down to 740 mRT without tagging cement. This indicated that the cement plugs had dropped.

To improve cement plug placement, a mechanical Van Ruth plug was pumped down hole and set at 737 mRT. On top of the mechanical plug, cement plug #4 was pumped. It consisted of 5 bbl with a weight of 14 ppg. The string was then pulled back to 602 mRT and the well circulated clean. The stinger was then run back down hole and the top of the plug tagged at 714 mRT. The well was pressure tested but the well did not hold pressure. The cement stinger was then pulled out to the surface.

An attempt was made to recover the 5½" SQ casing with the initial attempt resulting in recovering 96 m of casing. An SQ casing cutter was then run into the hole to 500 mRT. The cutter was operated and then pulled to the surface. An SQ pipe spear was then run in hole and latched onto the casing, recovering a further 180 m. The SQ spear was run in hole a second time, retrieving an additional 24 m of SQ casing. A third attempt was made to retrieve the remaining SQ casing but showed no movement with 125 klbs of hook load. The remaining 426.13 m of SQ pipe was left in hole.

The well head was removed and cement plug #5 was mixed and pumped into the hole from the surface. It consisted of 5 bbl with a weight of 12.5 ppg. A 177.8 mm (7") casing cement plug was then pushed 30 mRT into the well (upside down) to provide a base for the surface plug. A quick-setting foam was poured into the well on top of the plug. 'Collar Set' was then poured on top of the quick set foam. The surface plug (cement plug #6) was set on top of the casing plug by mixing and pumping from surface. No details were recorded regarding volume or weight, but operational crew noted cement to surface.

Time analysis

Rig setup was completed in four days. The drilling scope was completed in 102 days from spud to rig release.

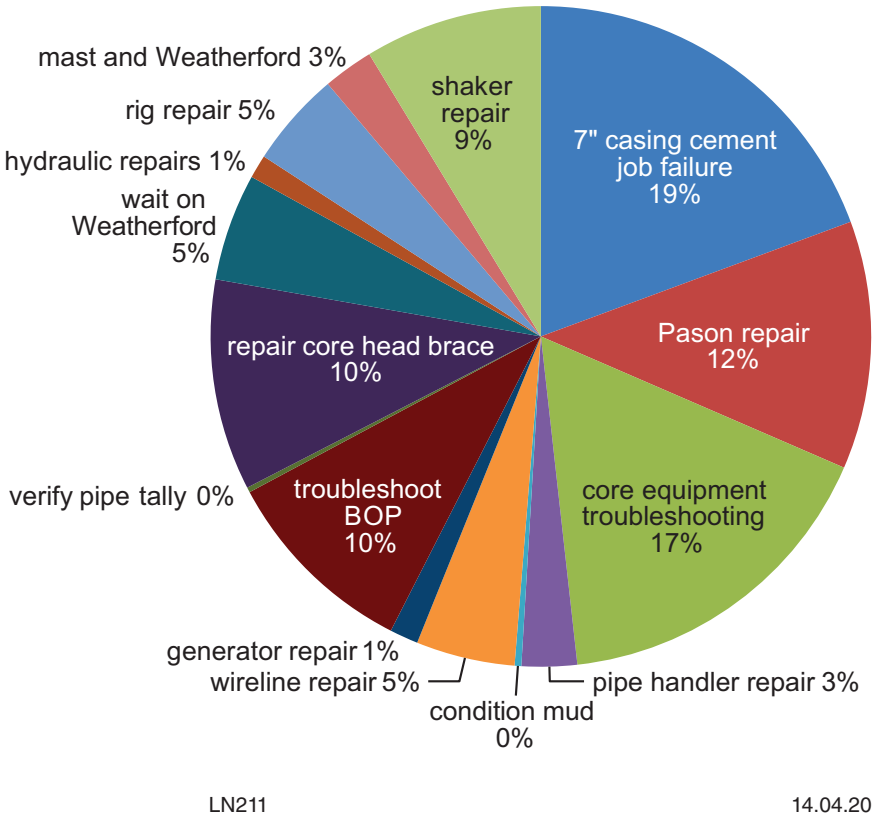


Figure 4. Breakdown of NPT according to task

Table 5. Breakdown of operational time

Spud	*Release*	*Actual days*
1/09/2019 00:00	12/12/2019 00:00	102
Activity	*Operational hours*	*Percentage*
Coring	590.45	24.12%
Core retrieval	577.30	23.58%
NPT	304.75	12.45%
Run in hole	158.00	6.45%
Pull out of hole	156.00	6.37%
Wireline logging	113.00	4.62%
Wellhead / BOP / surface connections	97.75	3.99%
Cement plug	91.00	3.72%
Retrieve PQ casing	70.50	2.88%
Drilling	68.50	2.80%
Rig down	34.00	1.39%
Circulate	30.25	1.24%
Wait on cement	24.50	1.00%
Retrieve SQ casing	21.50	0.88%
Cement job	20.50	0.84%
Run casing	19.25	0.79%
Stuck pipe	17.25	0.70%
Rig setup coring equipment	13.50	0.55%
Slip and cut	13.50	0.55%
Reaming	8.50	0.35%
Rig service	8.00	0.33%
FIT	4.50	0.18%
Site inspection	2.50	0.10%
Wait on weather	2.50	0.10%
Lost circulation	0.50	0.02%
Total	2448	100%

Drilling bit data

Table 6. Drilling bit data

Bit	Size (")	Make/type	Serial number	In (mRT)	Out (mRT)	Metres drilled	On bottom hours	Average ROP (m/hr)	TFA (in^2)	rpm	WOB (klbs)	Bit condition
1	12¼	Tri-cone	5197327	3.60	23.60	20.00	4.00	6.00	0.746	60	7	1-1-NO-1-E-IN-NO-TD
2	8½	PDC	00505HXX	6.00	218.00	212.00	20.75	8.60	0.650	40	3	1-1-NO-1-X-IN-NO-TD
3	6⅛	PDC	7990579	202.00	580.00	378.00	27.10	19.90	0.442	50	5	3-1-CT-N-X-N-N-TD
4	5¾	6DD Impreg Core	-	580.00	667.34	87.34	34.50	2.53	-	276	6–8	95% Worn
5	5¾	8DD Impreg Core	-	667.34	727.14	59.80	33.75	1.80	-	162	5–7	50% Worn
6	6¾	PDC	E209883	580.00	727.00	147.00	8.50	17.29	0.245	-	-	1-1-NO-A-X-1-NO-TD
7	4¾	9DD Impreg Core	-	715.00	850.00	139.73	50.00	3.00	-	355	6.5	25% Worn
8	4¾	9DD Impreg Core	HA62966/2	850.00	997.19	147.19	32.50	4.00	-	355	9	100% Worn
9	4¾	7DD Impreg Core	HA34880/1	997.19	1095.00	97.81	20.35	5.80	-	378	3–6	-
10	4¾	4DD Impreg Core	HA21981-87	1095.00	1164.00	69.00	17.50	3.90	-	295	7	100% Worn
11	4¾	4DD Impreg Core	11A24823-05	1164.00	1291.69	127.50	30.50	4.18	-	350	7	100% Worn
12	4¾	4DD Impreg Core	HA21981	1291.69	1569.64	277.95	68.95	4.50	-	336	4–8	50% Worn
13	4¾	5DD Impreg Core	HA65356/1	1569.64	1602.00	33.00	8.25	4.00	-	336	4–8	75% Worn
14	3¾	Hayden 4-6	HA35432-01	1602.00	1734.48	131.84	33.50	5.00	-	390	8–11	50% Worn
15	3¾	Hayden 4-6	HA28575/2	1734.48	2189.44	454.96	115.75	4.50	-	330	10	100% Worn
16	3¾	Hayden 4-6	HA28575/1	2189.44	2306.22	116.78	36.25	3.00	-	330	10	100% Worn
17	3¾	Hayden 7SA	HA65934/1	2306.22	2406.63	100.40	30.75	3.25	-	340	4–7	95% Worn
18	3¾	Hayden 8A4	HA65818/4	2406.63	2565.53	159.00	44.72	3.50	-	320	2–8	100% Worn
19	3¾	Hayden 8A4	HA63762/7	2565.53	2680.53	115.00	35.25	3.26	-	330	2–8	45% Worn

Table 7. Breakdown of NPT hours spent on various tasks

Spud	*Release*	*Actual days*
1/09/2019 00:00	12/12/2019 00:00	102

Task	*NPT hours*
177.8 mm (7”) casing cement job failure	59
Pason repair	37
Core equipment troubleshooting	51
Pipe handler repair	8.25
Condition mud	1
Wireline repair	14.75
Generator repair	4.25
Troubleshoot BOP	29.5
Verify pipe tally	0.75
Repair core head brace	31.5
Wait on Weatherford	16
Hydraulic repairs	3.5
Rig repair	14.25
Mast and washpipe	7.5
Shaker repair	26.5
Total	**304.75**

Health, safety and environment overview

Table 8. Health, safety and environment (HSE) summary

Incident type	*# of incidents*
LTI	0
MTI	0
First aid	0
Equipment incidents	2
Environmental	0
Vehicle incidents	0
Total incidents	2

Abbreviations: LTI, lost time incident; MTI, medical treatment incident

Table 9. HSE incidents

Date	*Type*	*Description*
18/10/2019	Equipment	Near miss as 9 m pipe dropped from mast
30/10/2019	Equipment	While laying out 8” collar 4.5 m @ approximately 1000 kg, the left-hand side tilt ram broke at the bulkhead end

Wellbore integrity

177.8 mm (7”) surface casing and cement

The CBL indicated that the casing was poorly cemented from the surface to 85 m. The remainder of the casing was well cemented from 85 to 215 m. The CBL can be reviewed in Appendix K.

139.7 mm (5½”) intermediate casing and cement

The CBL indicated good cement bond from 500.0 to 718.5 m, at which point the casing parted with 9 m of casing dropping 7 m. As a result, an open-hole section from 715.0 to 718.5 m was cemented, and a 9 m length of casing remains uncemented from 718.5 to 729.0 m. The CBL can be reviewed in Appendix L.

Conclusion

All of the main objectives of the project were achieved. Wireline, VSP and continuous core data from Waukarlycarly 1 will allow correlation of specific seismic reflectors on the Kidson seismic survey to their corresponding stratigraphic horizons. Continuous core from 580.00 to 2585 mRT through the entire Canning Basin stratigraphy will provide exceptional access to formation contacts and inform future work on the basin evolution of the Waukarlycarly Embayment. The cored interval from the pre-Canning Basin basement will assist in regional tectonics. The well encountered no indications of hydrocarbons. Interpretations of data currently being analysed will be released at a later date in the Waukarlycarly 1 interpretative well completion report. Post-well analyses will also be compiled into an interactive digital core atlas.

Glossary

ATV: acoustic televiewer

bbl: barrel

bit sizes:

- **SQ:** 146 mm diameter
- **PQ:** 122.6 mm diameter
- **HQ:** 96 mm diameter

BHA: bottom hole assembly

BOP: blow-out preventer

CBL: cement bond log

DMIRS: Department of Mines, Industry Regulation and Safety

FIT: formation integrity test

FWS: full waveform sonic

GA: Geoscience Australia

gpm: gallons per minute

GSWA: Geological Survey of Western Australia

HSE: health, safety and environment

klbs: kilopounds

LOT: leak off test

LTI: lost time injury

mASL: metres above sea level

MDRT: mean depth rotary table

MGA: Map Grid Australia

mRT: metres rotary table; datum from which drillers depth is measured from

MTI: medical treatment incident

NPT: non-productive time

PAC-L: drilling mud additive; filtration control polyanionic cellulose

PAC-R: drilling mud additive; modified natural cellulosic polymer, provides filtration control in most water-based drilling fluids

PDC drill bit: polycrystalline diamond compact drill bit

ppf: pounds per foot

ppg: pounds per gallon

psi: pounds per square inch

ROP: rate of penetration

rpm: revolutions per minute

RT: rotary table

spm: strokes per minute

TD: total depth

TFA: total flow area

UCL: unallocated Crown land

UTM: Universal Transverse Mercator

VSP: vertical seismic profile

WOB: weight on bit

Stratigraphic well Waukarlycarly 1 was drilled in the Waukarlycarly Embayment of the southwestern Canning Basin. Drilling began on 1 September 2019, reaching a total depth of 2680.53 m in pre-Canning Basin low-grade metasedimentary rocks. This stratigraphic drilling project followed the Kidson Sub-basin seismic survey acquired in 2018 and was funded by Geoscience Australia's Exploring for the Future initiative. The Geological Survey of Western Australia was the project operator. This 'basic data' well completion report presents all the primary technical information received during drilling and will be followed by an 'interpretative' well completion report, detailing the interpretation of this basic data as well as incorporating additional information obtained from post-well analysis.

Normore and Rapaic

WAUKARLYCARLY 1 BASIC DATA WELL COMPLETION REPORT

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Further details of geoscience products are available from:

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