End of Well Report NLW-GT-02-S1

SodM Version

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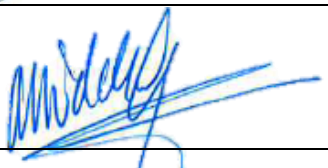
Checked by	Maarten Middelburg	Drilling Manager		20-7-2018
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GLOSSARY

AH	Along hole
AKO	Adjustable Kick-Off
BGL	Below ground level
BHA	Bottom hole assembly
BOP	Blowout preventer
NLW-GT-01	Naaldwijk Geothermal 01
NLW-GT-02	Naaldwijk Geothermal 02
CBL	Cement bond log
CHH	Casing head housing
C/O	Change Out
CP	Conductor Pipe
CRT	Casing running Tool
DC	Drill Collar
DP	Drill pipe
DSV	Drilling supervisor
EMW	Equivalent mud weight
ESP	Electric submersible pump
FMS	Flush Mounted Spider
FIT	Formation integrity test
FOSV	Full opening safety valve
GL	Ground level
GOT	German Oil Tools
GR	Gamma-Ray
HSE	Health, Safety & Environment
HWDP	Heavyweight drillpipe
IR	Iron Roughneck
LCM	Lost circulation material
LOT	Leak Of Test
LTI	Lost Time Incident
MD	Measured Depth
MW	Mud Weight
MWD	Measurement while drilling
NAP	Normaal Amsterdams Peil
NDSV	Night Drilling Supervisor
NPT	Non-productive time
OH	Open hole
PBL	Circulation sub
PBR	Polished Bore Receptacle
PDC	Polycrystalline diamond compact
PDM	Positive displacement (mud) motor
PJSM	Pre-job safety meeting
POA	Plan of action
POOH	Pull out of hole
ppf	pounds per foot
P/U	Pick Up
PUW	Pick up weight
PV	Plastic viscosity
R/D	Rig Down
RF	Rig Floor
RIH	Run in hole
ROP	Rate of penetration
RSS	Rotary steerable system
RT	Rotary table
RTTS	Retrievable Test-Treat-Squeeze (packer)
R/U	Rig Up
s.g.	Specific gravity
SodM	Staatstoezicht op de Mijnen
SOW	Slack off weight
Spm	Strokes per minute
SPP	Stand pipe pressure
TD	Total depth
TDS	Top Drive Swivel
TOC	Top of cement
TOL	Top of liner
TRS	Tubular Running Services
TP	Toolpusher
TSP	Top Set Packer
TVD	True vertical depth
TWCV	Two Way Check Valve
USIT	Ultrasonic Imager Tool
VFD	Variable Frequency Drive
WBM	Water Based Mud
WEP	Well Engineering Partners
WOB	Weight on bit
WOC	Wait on cement
WSG	Well Services Group
WTF	Weatherford
WWS	Wire-wrapped screen
YP	Yield point

1. General Project data

Field	Naaldwijk
Well Number:	NLW-GT-02-S1
Well Name	Naaldwijk-GT-02-Sidetrack-1
Well Type	Geothermal Production
Start operations	09-03-2018; 00:00 hr
Spud date	10-03-2018; 04:45 hr
Start rig down (end of well)	02-05-2018; 09:00 hr
Days Operational	53,6 days
Operator	Trias Westland

Surface Location	Latitude & Longitude	Geographical
	51° 59' 26,96"N 4° 14' 22,36"E	X: 76154m (RD) Y: 445230m (RD)

Grid Coordinate System	Rijksdriehoeksmeting / Netherlands New
Drilling Contractor	KCA Deutag
Drilling Rig	T-207
Depth reference	Rotary Table (RT), unless otherwise stated

Project Management:

Project Director	Marco van Soerland
Project Manager	Floris Veeger
Drilling Manager	Maarten Middelburg
Sr. Drilling Engineer	Bert Jan Koers
Drilling Engineer	Andrea Di Cicco
Sr. Well Site Geologist	Dick Stegers
HSE Manager	Peter v.d. Burg
HSE Coordinator	Arno Otten

Drilling Supervisors on 2 week rotational scheme:

Drilling Supervisor	Karl Gollob	09-03-2018 / 13-3-2018 27-03-2018 / 10-04-2018 24-03-2018 / 30-04-2018
Drilling Supervisor	Per Gwalter	13-03-2018 / 27-03-2018 10-04-2018 / 24-03-2018
Night Drilling Supervisor	Joost van Tilborg	09-03-2018 / 19-03-2018 02-04-2018 / 16-04-2018 30-04-2018 / 02-05-2018 (DSV)
Night Drilling Supervisor	Barry Ross	19-03-2018 / 02-04-2018 16-04-2018 / 30-04-2018

2. Well summary

Primary Objective		Lower Cretaceous reservoir (Delft Sandstone)	
Primary Objective Depth		2463 m MD	2367 m TVD
Total Depth		2680 m MD	2525 m TVD
Elevation	RT – GL	9.32 m	
	GL – NAP	-0.90 m (NAP is 0.9m below ground level)	
	NAP – RT	8.42 m	

Table 1: Well summary

Item	MD (m)	TVD (m)	Comments
30" Conductor	134	134	The 30" Conductor was pre-installed to 134m MD RT using a truck mounted unit as part of the drill site construction.
24" Hole TD	1105	1088	This vertical section was drilled with a TCI (IADC 415) bit type GO4BCPS below a PDM directional BHA. Shaker system of the rig, (x3 single deck shakers) and additional MD3 triple deck shaker were sufficient to allow proper flow rates. At 1188 m drilled trough a fault, causing total losses. No success in curing losses and pipe stuck. Decided to severe pipe at 298 m. LCM pills not effective, pumped Zonelock S pill, losses stopped. POOH to run clean out BHA. Washed/reamed to 210 m, still losses. Decided to set cement plug for side track. Cleaned out cement plug to 141 m. Started sidetrack with Bentonite mud. Another LCM pill was needed to cure losses. At 442 m displaced well back to KCl Glydril mud and continued drilling to section TD at 1105 m.
20" Casing	1102	1085	RIH 20" casing and stood up at 142 m, POOH and ran 2 x clean out BHA. RIH casing without centralizers, stood up at 156 m but managed to work casing down to planned setting depth. Ran cement stinger and cemented casing as per program. Installed 21-1/4" wellhead and BOP's
17 ½" Hole	2385	2304	The fault experienced in the first 24" hole section was now expected in this section in the Upper Holland Marl. A dumb-iron BHA was used to drill float equipment and performed a limit test to 1.45 s.g. at 1108 m MD. Continued drilling with same hold BHA to 1264 m. BHA was changed out for RSS to perform directional work. The BHA was showing a strong building tendency. High stick-slip was experienced from 1944m onwards. At 2185 m it was decied to POOH for steering issues, low ROP and high stick-slip. Drill collars were removed from the string and a stabilizer added. Bit was in good condition and although perhaps too aggressive (519) for the sandstones it was re-run. Drilled to section TD at 2385 m. BHA had to be pumped OOH due to overpulls when pulling only on elevators.
13 ⅝" Liner	(TOL) 993 (SHOE) 2376		The 13 ⅝" liner was run to setting depth 9m off proposed depth. Setting the liner hanger went as per plan. The cement job was carried out as per plan and the plugs bumped and liner tested. Reverse circulating showed 3m³ of pure cement. Set packer and circulated clean above TOL.

13-5/8" Tie-back	surface	1005	Run 12-1/4" Dress/Mill BHA into liner top and landed NO-GO 1m deeper than expected. Displaced well to inhibited water. Run tie-back string and pressure test casing and tie-back to 100 bar.
12 ¼" Hole TD	2680	2525	RIH 12 ¼" RSS with PDC bit. Drilled out shoe track and rat hole without any issues. Performed limit test to 1.50 s.g. below 13 5/8" shoe. Displace to drill-in fluid and commenced drilling. Overall performance was good with ROP's varying between 10 – 15 m/hr. Inclination was built to 45 deg. TD was called at 2680m. POOH on elevator to 2541m where 10ton overpull was observed. The tight spot was reamed and BHA pumped OOH to 13 5/8" casing shoe.
9 ⅝"Liner	2642	2499	The 9-5/8", 53,5#, L80, VAM21 liner with Wire Wrapped screens was run with a 5 ½" DP as inner string to 13 5/8" casing shoe. Upon entering the open significant drag was observed and the liner had to be worked all the down to setting depth at 2642 m. The liner hanger set successfully. While displacing the well to brine the annulus packed off. Decided to set packer and complete displacement via inside of 9 5/8" liner.
Suspend well			Installed tubing hanger + one 8 5/8" casing joint. X-mas tree installed and tested against TWCV. Removed TWCV after pressure test.
Welltest			The welltest is performed with the rigless intervention unit (RIU) of Franks. Before installation of the ESP wireline logs (USIT- CBL- VDL) of the 13 5/8" liner and tie-back string were taken by Schlumberger. ESP run on 8 5/8" 32# L80 Polseal tubing to 749 m BGL with Expro memory P&T gauges on slickline suspended below the ESP centraliser. Depth of memory gauges is 2259 m MD BGL. Welltest is performed successfully, total volume produced 2991m³ water and 4591 Nm³ gas. After 24 hrs build up the ESP is POOH and memory gauges retrieved on slickline. A downhole fluid sample was taken at 2319 m MD. The well is suspended with tubing hanger + one 8 5/8" casing joint and X-mas tree installed. TWCV is removed after pressure test.

2.1 Directional plots

SURVEY MANAGEMENT **DEFINITIVE SURVEY SIGN-OFF**

Client:		Job No.:	17hol0035	Report Date:	18-May-18
Field:	Naaldwijk (Trias Westland)	Well Name:	NLW-GT-02	Borehole:	NLW-GT-02-S1
Stru/Slot:	NLW-GT-02/NLW-GT-02	Survey:	NLW-GT-02-S1 Def Survey		

Structure Reference:	445230.00	76154.00
	N 51° 59' 26.96188"	E 4° 14' 22.35732"
Slot Coordinates:	445230.00	76154.00
	N 51° 59' 26.96188"	E 4° 14' 22.35732"
Structure/Slot Uncertainty:	0.00 m(3.00 sigma)	0.00 m(3.00 sigma)
Grid Coordinate System:	Amersfoort * OGP-Nld / RD Dutch Onshore	
TVD Reference Datum:	Borehole: Unknown	
TVD Reference Elevation:	8.420 m above NAP	
Seabed/GroundLevel:	0.900 m below NAP	

Depth Units:	(m)	
Survey Date:	3-Apr-18	
Azimuth Reference:	Grid North	
Mag. Model / Mag. Decl. Date:	HDGM 2017	4-Feb-18
Magnetic Declination:	1.102 °	
Grid Convergence:	-0.90562969 °	
Total Correction:	2.0078 °	
Vertical Section Origin:	0.000 m, 0.000 m	
Vertical Section Plane:	107.442 ° (Grid North)	

DEFINITIVE SURVEY CONSTRUCTION - ORIGINAL WELL

Instrument Type	Survey From	Survey To	Hole Size	Casing Size
SLB_MWD+SAG-Depth Only	0.00	9.32		
SLB_MWD+SAG	9.32	137.00	30.00	30.00
SLB_MWD+SAG	137.00	137.00	30.00	30.00
SLB_MWD+SAG	137.00	1102.00	24.00	20.00
SLB_MWD+SAG	1102.00	2376.00	17.50	13.63
SLB_MWD+SAG	2376.00	2680.00	12.25	12.25
	Projection to TD:		Type:	

WELL REFERENCE POINT LOCATION

MD	INC	AZ	TVD	VS	NS	EW	Northing	Easting	Latitude	Longitude
9.32	0.00	0.00	9.32	0.00	0.00	0.00	445230.00	76154.00	N 51° 59' 26.96188"	E 4° 14' 22.35732"

BOTTOM HOLE LOCATION

MD	INC	AZ	TVD	VS	NS	EW	Northing	Easting	Latitude	Longitude
2680.00	45.00	108.05	2525.60	724.20	-213.54	692.02	445016.47	76845.98	N 51° 59' 20.40543"	E 4° 14' 58.79969"

BOTTOM HOLE LOCATION COMPARISON SOURCE :

MD	INC	AZ	TVD	VS	NS	EW	Northing	Easting	Latitude	Longitude

COMMENTS

Surveys in 24" section and partially in 17.5" section corrected for drillstring magnetism (DMAG).

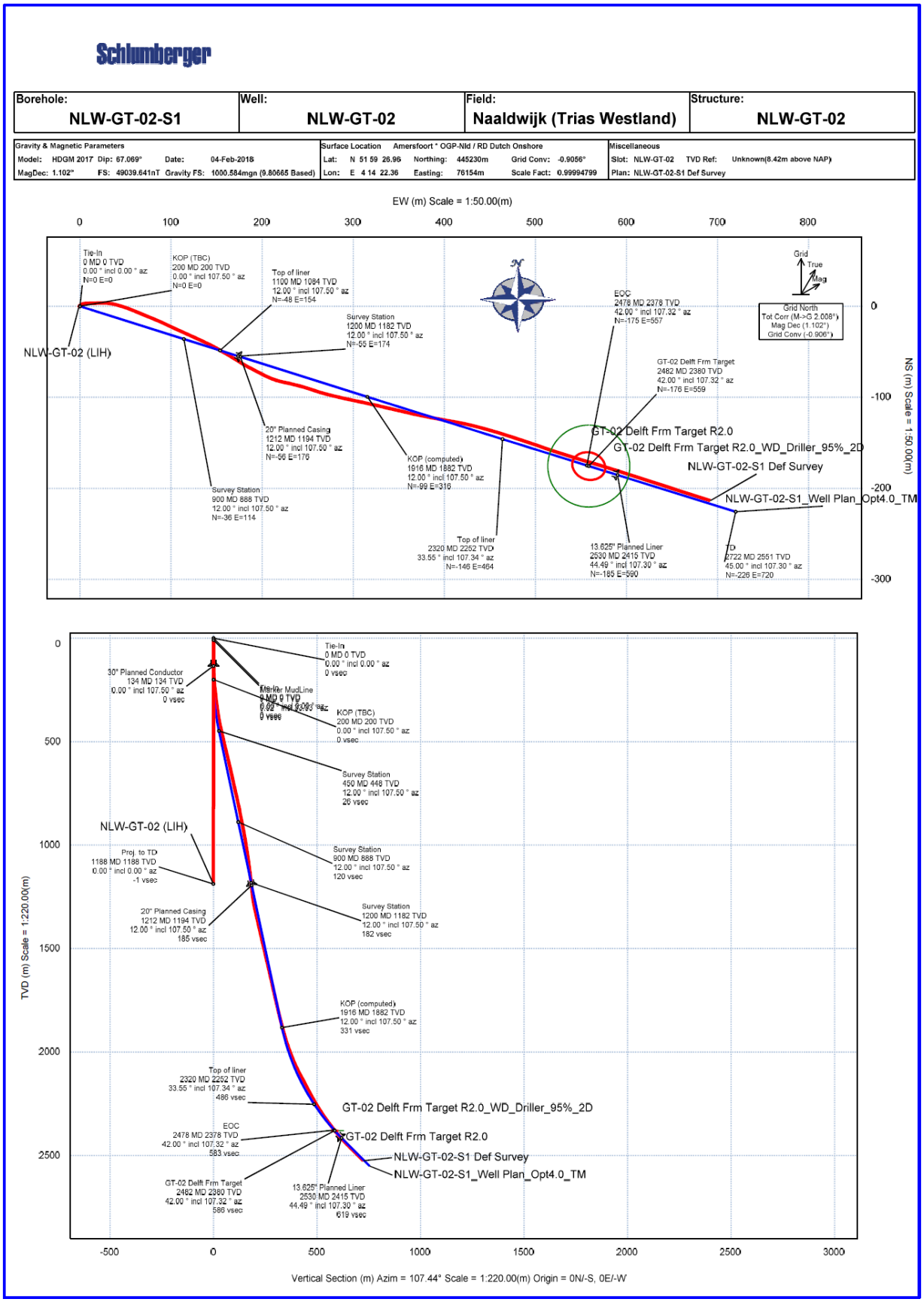


Figure 1: NLW-GT-02-S1 Vertical Section plot and plan view plot- drilled vs. planned

2.2 Technical summary

2.2.1 Casing

Table 2: NLW-GT-02-S1 tubular summary

Item	Top (m MD)	Bottom (m MD)	Weight	Grade	Connection
30" Conductor	0	134	0.5" WT	S355	Welded
20" Conductor	0	1102	133 ppf	NT95	BTC
13 ⅝" Tie-back	0	1005	88.2 ppf	L80	VAM21
13 ⅝" Liner	993	2376.5	88.2 ppf	L80	VAM 21
9 ⅝" WWS Liner	2325	2642	53.5 ppf	L80	VAM 21

2.2.2 Cement

Table 3: NLW-GT-02-S1 cement summary

Item	TOC (m MD)	Lead Slurry Volume (m^3)	Lead Slurry Weight (s.g.)	Tail Slurry Volume (m^3)	Tail Slurry Weight (s.g.)	Type
20" Casing	Surface	153	1,57	38	1,67	PozzoCemoil w/Cemnet fibres
13 ⅜" Liner	Liner Top	107	1.67	21	1.88	PozzoCemoil lead G class Tail

3. Drilling fluid summary

Per section the following drilling fluid types have been used:

Table 4: NLW-GT-02-S1 drilling fluid summary

Section	Type	Density (s.g.) Min – Max	PV (cP) Min – Max	YP (lbf/100ft2) Min – Max
24"	Bentonite spud mud & KCl Glycol WBM	1,05– 1,26	13 – 20	14 – 18
17 ½"	KCl Glycol WBM	1,24 – 1,28	15-29	17 - 25
12 ¼"	Drill-in Fluid (Flo Pro)	1,13 – 1,15	14 - 16	15 - 26

The figure below shows the mud weight, PV and YP versus depth during drilling operations.

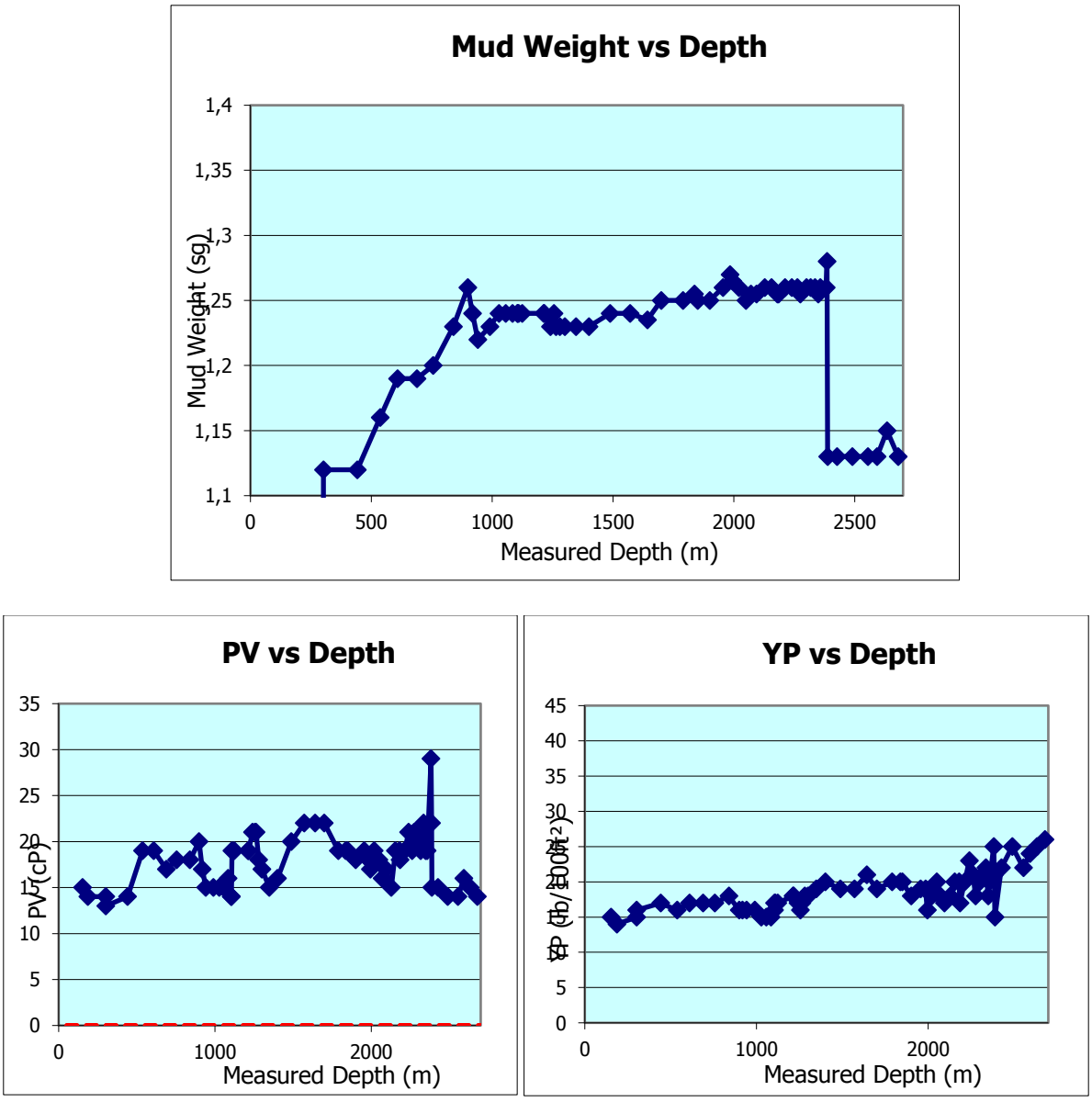


Figure 2: NLW-GT-02-S1 mud weight vs. depth

4. Geology

Below the geological column with vertical and along hole depths below RT.

Table 5: NLW-GT-02-S1 geological lithostratigraphic column

5. Well schematic

A detailed well schematic summarizing all casing sizes is shown below.

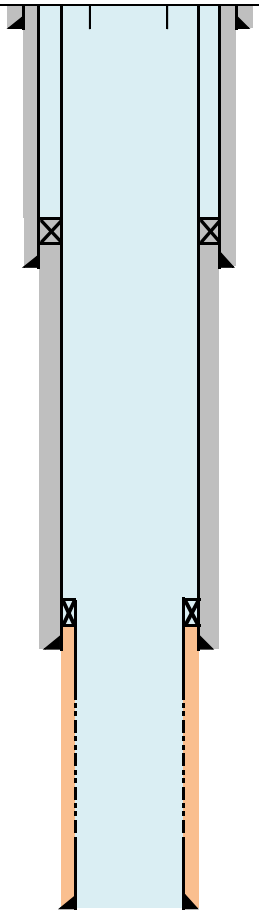
Nr.	Item Description Production well All depths from RT *RT = 9,32 m above GL* *RT =8,42 m above NAP*	Wellhead and Xmastree **NLW-GT-02-S1** 1x joint 8 5/8" 32# L80 installed below tubing hanger.	Depth m tvd	Depth m ah	Hole ID in	Pipe OD in	Collar OD in (nom)	Pipe ID in	Pipe ID in (drift)
1	30" 0,5" WT S355 Conductor		134	134	35,433	30,000	welded	29,000	29,000
	20" x 16" liner hanger & packer X/O to 13 5/8"		976	992	Top of liner				
2	20" 133# NT95DE ERW BTC Casing		1085 1089	1102 1106	24,00 section TD	20,000	21,000	18,730	18,542
	13 5/8" x 9 5/8" Liner Hanger + Packer		2254	2325	Top of liner (50 m liner lap)				
3	13 5/8" 88.2# L80 VAM21 Liner + Tie back		2297 2304	2376 2385	17,5" section TD	13,625	14,699	12,375	12,250
			2365	2460	Top Screens				
			2368	2464	Top Delft Sandstone				
			2453	2578	Bottom Screens				
4	9 5/8" 53,5# L80 VAM21 WWS		2499 2525	2642 2680	12,25" TD	9,625	10,542	8,535	8,500
*Not in scale.									

Figure 3: NLW-GT-02-S1 well schematic

Figure 4 shows the well schematic during the welltest. The installation of the ESP was done with a crane based operations in May 2018. (note all depths referred to Ground level).

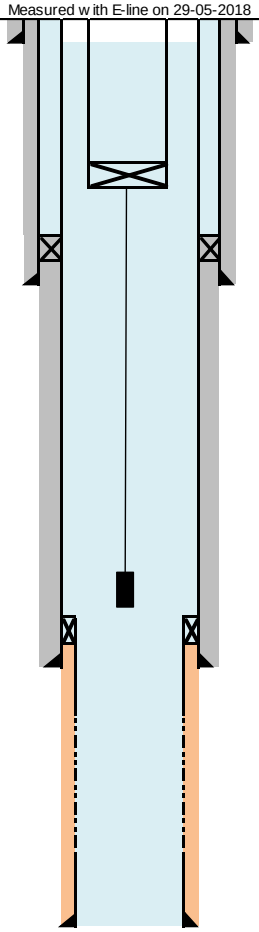
Nr.	Item Description Production well All depths from GL *GL - NAP: -0,9 (NAP is 0,9 m above GL)*	Wellhead and Xmastree **NLW-GT-02-S1** Static fluid level: 95m BGL Measured with E-line on 29-05-2018	Depth m tvd	Depth m ah	Hole ID in	Pipe OD in	Collar OD in (nom)	Pipe ID in	Pipe ID in (drift)
1	30" 0,5" WT S355 Conductor		125	125	35,433	30,000	welded	29,000	29,000
	8 5/8" 32# L80 Polseal tubing					8,625	9,650	7,921	7,796
	ESP on 8 5/8" tubing			ESP intake at: 721,7 m MD / 711,6 m TVD ESP P/T gauge at: 747,8 m MD / 737,1 m TVD					
	20" x 16" liner hanger & packer X/O to 13 5/8"		967	983	Top of liner				
2	20" 133# NT95DE ERW BTC Casing		1076 1080	1093 1097	24,00 section TD	20,000	21,000	18,730	18,542
				P&T gauges at: 2259,8 m MD / 2197,1 m TVD					
	13 5/8" x 9 5/8" Liner Hanger + Packer		2245	2316	Top of liner				
3	13 5/8" 88.2# L80 VAM21 Liner + Tie back		2287 2295	2366 2376	17,5" section TD	13,625	14,699	12,375	12,250
			2356 2359	2451 2455	Top Screens Top Delft Sandstone				
			2444	2569	Bottom Screens				
4	9 5/8" 53,5# L80 VAM21 WWS		2490 2516	2633 2671	12,25" TD	9,625	10,542	8,535	8,500
*Not in scale.									

Figure 4. Well schematic during welltest

6. HSE performance

6.1 General

To ensure that the operation was carried out in a safe manner, several HSE tools were implemented both by Trias Westland and KCA Deutag.

KCA Deutag's Permit to Work system was a tool used in order to perform additional activities outside regular drilling activities that carry a potential risk. Both the Toolpusher's and DSV's approval were required for a Permit to Work to come into effect.

Other HSE tools utilized on location were:

- Toolbox meeting during every shift change of rig contractor (06:45 & 18:45)
- Pre-job safety meetings (PJSM) before every non-drilling operation (casing running, cementing, well-test etc.)
- General safety meetings with rig crews
- Local Fire brigade location visit and acquaintance to operations
- SET card system of KCA Deutag
- Regular HSE inspections carried out by HSE coordinator
- Weekly HSE meeting

6.2 Incidents

- 1x collision outside the site with scooter – Injured person was brought to hospital for medical treatment.

6.3 Drills / Emergency exercises, inspections & audits

Drill / emergency exercises:

- Fire drills 28/02/2018, 24/03/2018,
- Muster drills 28/02/2018, 24/03/2018
- Kick drills 06/04/2018, 28/4/2018
- BOP tests 04/04/2018, 23/04/2018