SHELL PETROLEUM DEVELOPMENT COMPANY OF NIGERIA LIMITED

DIEBU CREEK 009T
WATER SHUT-OFF, PERFORATION EXTENSION AND SCON PROPOSAL
(CO LOG, WHM & FLOWLINE REPAIR REQUIRED)

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1. OBJECTIVE

WELL:	DIEBU CREEK 009T
TYPE:	Water Shut-off, Perforation Extension, SCON, WHM and FLRR Proposal
OBJECTIVE:	To restore production on Diebu Creek 009T on the E1000X sand by carrying out Water shut-off, perforation extension, chemical sand consolidation, well head maintenance and flowline repair and/or replacement. This activity is expected to unlock a potential of 700 bopd and safeguard resource volume of 1.42 MMstb.

2. WELL HISTORY/ PRESENT STATUS

DIEBU CREEK 009T: E1000X: 10,300 – 10,304; 10,330 – 10,336 ftah: (10,247 – 10,251; 10,277 – 10,283 ftss) SCON

Diebu Creek 009T was drilled in June 1973. It was later completed as a single string dual completion in November 1973 and came on stream in November 1973 with a net oil rate of 684 bopd on bean 16/64". The well attained peak production of 4,663 bopd in 1977. The increase in rate was followed by an increase in GOR to 5,000 scf/bbl in 1980, hence the well was beaned down to a rate of 2,000 bopd.

Water production started in March 1992 at 20% BSW and gradually increased to 30% by October 1992. The well continued to produce at an average rate of 1,100 bopd and water cut of 30% until 1997 when a wireline repair was carried out to isolate the lower sets of perforations. After the repair, the water production reduced to 0% and the well, produced at an average rate of 1,300 bopd on bean 24/64".

In 2003, water production started again and increased steadily to BS&W of 64% in 2012 when the well quit. The last recorded production from the well in May 2012 was 1498 bopd at GOR of 3196 scf/day, water cut of 64%, sand cut of 1.1 pptb and THP of 1228 psi.

Well was proposed for Nitrogen lift restoration activity as history showed that it was water loaded and would flow if lifted into production. In August 2013 during an STOG campaign the well was Nitrogen lifted. Unfortunately, the well could not flow after a prolonged period of lift due to station outage/trunk line sabotage. Well was concluded to be flushed as it was lifted to about 98% BS&W. Well is currently closed in due to High BS&W.

3. JUSTIFICATION AND PROPOSED ACTION

Diebu Creek 009T is one of the completed conduits on the E1000X reservoir and has historically produced satisfactorily with a cumulative production of ca. 20.64 MMstb. The well quit on vertical lift challenges as a result of HBSW in May 2012.

A review of historical well performance shows perforations is currently flushed but has scope for water shut-off and perforation extension. Based on the MBAL estimated present contacts (PGOC & POWC), there is ca. 50ft. of oil column below the PGOC that can be targeted by this well on the E1000X reservoir. Hence, it is proposed to carry out a Water shut-off activity on the existing perforations (10,300 – 10,304; 10,330 – 10,336 ftah (10,247 – 10,251; 10,277 – 10,283 ftss) and shoot new perforations between 10,275 – 10,285 ftah (10,222 – 10,232 ftss). The proposed perforations must be validated/further optimized based on results of Pulsed Neutron (CO/Sigma) log data from Diebu Creek 009T. If Pulsed Neutron (CO/Sigma) log data is not acquired during/prior to activity, the entire activity will be regretted.

It is therefore necessary to acquire Pulsed Neutron (CO/Sigma) logs to optimize the proposed perforation interval due to inherent reservoir heterogeneity, fault pattern, uncertainty in the MBAL predicted present contacts and uneven reservoir sweep observed from the producing conduits on the E1000X reservoir. Furthermore, the available CO log data in the E1000X reservoir was acquired on the North block of the reservoir (Diebu Creek 009T) in 1994 and there has been significant production after then.

Diebu Creek 009T was initially completed with SCON. However, historical performance show sand cut from the well occasionally exceeded the Shell cut-off of 10 pptb during production from lower perforation. Post isolation of lower perforations and open up of the existing perforation, there has been a decline in the sand cut (below 10pptb threshold). To forestall future sand production from the new perforations, the interval will be treated with SCON as remedial sand control. Flow line repair and/or replacement (FLRR) will also be carried out as the flowlines have been inactive since 2012. Consequently, the well head valves will be serviced and maintained.

It is therefore proposed to carryout water shut-off, perforation extension, SCON treatment, WHM and FLRR activity to restore potential of 700 bopd and develop contingent oil resource of 1.42 MMstb.

4. PROPOSAL SUMMARY

1. Acquire Pulsed Neutron Log data (CO & Sigma mode).
2. Carry out Chemical WSO & add perforations to the E1000X sand.
3. Deploy SCON across new perforations and allow to cure. If injectivity is poor (<1bbl/min), carry out acid soak to improve injectivity. (See Appendix 14 for Decision Tree)
4. Carry out wellhead repairs
5. Open well to flow.
6. Hand back well to Production.

5. SCON RECIPE

Analysis of Diebu Creek 009T historical performance suggests that sand control is required to maintain the sand below the acceptable limit of 10pptb to safeguard the well equipment and facilities. Although the depth of the target sand is >10,000 ft-tvd, Chemical Sand Consolidation (SCON) will still be deployed as a sand exclusion mechanism to sufficiently retain the formation sand post perforation extension

Chemical Sand Consolidation Fluid Schedule and Perforation Details:

NB: Preliminary Sand Trap 225 Schedule – E1000X Interval

Fluid Schedule –	Rate	E1000X – 10 ft perforation
Preflush 1 – 100 gal/ft.: 7% KCl + 0.5% ES 5	1.0 bpm	23.81 bbl.
Preflush 2 – 100 gal/ft.: Musol	1.0 bpm	23.81 bbl.
Main Treatment – 150 gal/ft.: Sand Trap 225 resin	1.0 bpm	35.71 bbl.
Spacer – 100 gal: Diesel	1.0 bpm	2.4 bbl.
After flush – 150 gal/ft.: 7% KCl + 0.5% ES 5	1.0 bpm	35.71 bbl.
Displacement	1.0 bpm	CT Volume

Perforation:

Production data from Diebu Creek 009T suggests that the existing perforation has been flushed, hence the need to perforate shallower and target the oil above the existing perforations. The proposed perforation depths were selected based on the estimated PGOC and POWC from MBAL model (PGOC / POWC at 10202/ 10,252 ftss respectively), while integrating the open hole data and production performance from the producing conduits.

	Existing Perforation		Proposed Perforation	
Reservoir	ftah	ftvdss	ftah	ftvdss
E1000X	10,300 – 10,304 10,330 – 10,336	10,247 – 10,251 10,277 – 10,283	10275 – 10285	10222 –10232

Note:

- The existing interval perforations will be squeezed-off and 10ft of new perforations will be added across the E1000X during the STOG activity.

- Perforation is a safety critical operation and must be conducted in line with all required safety precautions during gun arming, running in hole and pulling out of hole.

- The proposed perforations must be validated/further optimized based on results of Pulsed Neutron (CO/Sigma) log data from Diebu Creek 009T.

The proposed intervals will be perforated overbalance using a deep penetrating gun, 60 deg. phasing, 6 shots per foot.

6. POTENTIAL ESTIMATION

The well performance evaluation software, PROSPER, was used to determine the potential for Diebu Creek 009T on the E1000X reservoir. The SPOT IPR model was used to define the IPR for the proposed 10 ft perforations. Water cut of ca. 20% was assumed considering the expected breakthrough of water post intervention. Sensitivity on different choke sizes was made (16/64" to 32/64") while noting the impact on the drawdown applied to the reservoir. Bean 24/64" potential was used for the economic and technical evaluation of this activity resulting to a net oil potential of ca. 1022 bopd.

A risk factor of 70% was applied to the net potential based on OP18 premise for NFA (WO) technical risks assumptions on historical success rate for Perforation Extension and Chemical Sand Consolidation (SCON) and the risk of high gas production was also considered resulting to a risked potential of 700 bopd. Further sensitivity on starting water cut was done to provide a range of potentials expected from the proposed activity on the conduit.

DBUC 009T: E1000X Assuming 20% BSW and Current Av. Reservoir Producing GOR							
Bean (/64-in)	Gross Rate (bpd)	Net Rate (bopd)	FBHP (psig)	Drawdown (psi)	Water cut (%)	GOR (scf/bbl)	FTHP (psig)
16	623	498	3871	244	20	2000	1501
20	942	754	3740	375	20	2000	1468
24	1278	1022	3599	516	20	2000	1403
28	1629	1303	3442	673	20	2000	1333
32	1963	1570	3287	828	20	2000	1247

Conduit	Well Potential (bopd)		
	Low	Base	High
Diebu Creek 009T	500	700	850

7. RESOURCE ESTIMATION

The resource associated with this opportunity was estimated using Material balance model that was history matched with the performance and reservoir pressure data for the E1000X. The MBAL model indicates that the reservoir aquifer is responding strongly to production and leading to re-saturation of the gas cap. This is further supported by stable historical pressure in the reservoir despite the huge off-take from the reservoir. Potential of 700bopd used in the MBAL model was generated using the performance curves of the calibrated prosper model as the initial rate and applied the abandonment conditions to determine the recoverable volumes. The MBAL model gave a base case resource estimate of 1.42MMstb to be developed from the E1000X. The MBAL plot is shown in Appendix 8. The table below shows the range of resource volumes expected from the proposed activity on the conduit.

Interval	Reservoir	Planned DUR (for the interval)- MMstb	Np (for the interval) MMstb	Contingent Resources to be Developed by activity- MMstb		
				Low	Base	High
Diebu Creek 009T	E1000X	22.06	20.64	1.06	1.42	3.50

8. DATA ACQUISITION PLAN

Pulsed Neutron (Carbon Oxygen & Sigma) logs will be acquired during the rig less intervention activity to delineate present fluid contact (PGOC and POWC) on the northern part of the E1000X reservoir to further optimize the proposed perforation interval on Diebu Creek 009T. (Ref: DBUC009T Pulsed Neutron Logging Proposal)

Gamma Ray/ Casing Collar Locator (GR/ CCL) log will be acquired on wireline to depth match wireline perforation tool with the open hole logs to ensure perforation gun is on depth.

The logging details are captured in Table 1 below. Logging risk and mitigation plan are covered in Table 2.

Table 1: Detailed Logging Plan

Survey	Formation	Interval (ftah bdf)	No. of Pass	Original Fluid Type
Drift Run	All	0 – 10390	1	Gas/ Oil / Water
Sigma Pass	E1000X	10390 – 10175	1	Gas/ Oil / Water
Sigma Repeat Pass	E1000X	10390 - 10175	1	Gas/ Oil / Water
C – O Pass	E1000X	10390 – 10175	4	Gas/ Oil / Water
C-O Pass (Calibration)	Water Leg	9515 - 9415	4	Water

Note:

1. *All depths with respect to PDL and status diagram.*
2. *Correlate and log one pass of the gas view/ sigma mode. For the inelastic mode, a minimum of 4 passes is required.*
3. *Additional pass may be required if Signal to Noise ratio is poor.*
4. *If HUD is encountered, contact operations Petrophysicist to advise forward plan.*

Log Required	Logging Interval (ftah)	Remark
GR/ CCL	10000 – 10350	For correlation to put perforating gun on depth

Table 2: Logging Risk and Mitigation Plan

RISKS	POTENTIAL RISK ASSEMENT FOR DATA ACQUISITION (RAM MATRIX)		MITIGATION/MANAGEMENT
	LIKELIHOOD	IMPACT	
Well Control situation during wireline perforation run.	B	4P, 4A, 1E, 2C	▪ Ensure proper well conditioning before commencement of logging. ▪ Recommended tool speed for each logging run should be maintained. ▪ Appropriate Wire line BOP/ lubricator should be provided as contingency.
Surface gun discharge, gun misfiring and depth correlation mismatch	B	4P, 2A, 1E, 2C	▪ Use radio frequency safe detonators during wireline perforation operations. ▪ "Perforate Well on Paper" will be carried out in line with DEP ahead of operations. ▪ Run GR/ CCL correlation and interpretation to be carried out to put gun on depth for perforation. ▪ Gun firing must have redundancy mechanism. ▪ Inspect all charges to ensure full gun firing downhole.
Personnel exposure to radiation	B	3P, 1A, 4C, 4E	▪ Key logging personnel should wear dosimeters to check exposure to radiation and follow the required guidelines on RA logging tool handling as applicable. ▪ The logging tool should be kept and secured with perimeter protection and CAUTION sign before and after operation. ▪ The logging tools should be handled by trained and certified personnel ONLY. The lead engineer is responsible for handling the tool during transfer from/ to rack to/ from the logging tool. ▪ The logging tool must be 400ft below the surface while RIH and POOH before the neutron generator is switched on and before the continuation of normal operations on the well.
Getting stuck with radioactive tool in hole	C	0P, 3A, 0C, 0E	▪ Ensure the neutron generator is deactivated/ turned off. ▪ Ensure availability of appropriate fishing tools at the well site during WL logging. ▪ Pre-job safety meeting to hold before operation to intimate everyone of risk involved in deploying radioactive tool.
Inability of the tool to go downhole due to well inclination or borehole conditions (HUD	C	0P, 1A, 0C, 0E	▪ Ensure that drift and dummy runs are carried out in all the wells before the execution of the logging program. ▪ Maximum deviation is about 5deg, hence minimal restriction is expected

RISKS	POTENTIAL RISK ASSEMENT FOR DATA ACQUISITION (RAM MATRIX)		MITIGATION/MANAGEMENT
	LIKELIHOOD	IMPACT	
Shallower than Target Zone)			
Logging tool unable to go beyond XN Nipple	C	0P, 1A, 0C, 0E	▪ Contractor is required to provide a 1-11/16" tool as well as carry out drift run. Acquire data over revised depths. ▪ Risk to be adequately discussed during SWOP/ LWOP to identify mitigation plans for the activity.

9. WELL & RESERVOIR DATA SHEET

S/N	WELL/ SAND:	UNIT	Disc.	DIEBU CREEK 009T (E1000X)
1	a) Perforated interval b) Perforated interval c) Proposed Perforation interval d) Proposed perforation interval	ftah ftss ftah ftss	PP	10,300 – 10,304; 10,330 – 10,336 10,247 – 10,251; 10,277 – 10,283 10,275 – 10,285 10,222 – 10,232
2	a) Maximum Deviation Angle and Depth b) Derrick Floor Elevation c) Vertical Correction to mid- Perforation + DFE	° @ ftah ft ft	PG	5.77° @ 9842 44 N/A
3	a) Last Production Rate	bopd	PT	1498 bopd @ May. 2012
4	a) Reference Depth for Reservoir Pressures b) Original Reservoir Pressure * c) Present Reservoir Pressure d) Present Gradient e) Bubble Point Pressure f) Specific Gravity of Oil 60/60 g) Oil Viscosity at Reservoir Condition h) Solution Gas-Rsi (initial condition) i) Formation Volume Factor (initial condition) j) Static Reservoir Temperature	ftss psig psig psi/ft psig SG cP scf/stb - ° F	RE	10250 4480 4122 0.402 4480 0.82 0.23 1723 1.751 189
5	a) Other Wells Producing from the same Block b) Last production from Block (@ Aug. 2019) c) Ultimate Recovery (@ Aug. 2019) d) Cumulative Production from Block (@ Aug. 2019) e) Cumulative Production from Well (@ Aug. 2019) f) Remaining/Dev Reserve from Well	- bopd MMstb MMstb MMstb MMstb	RE/PT	0 2543 22.06 139.5 20.64 1.42
6	a) Porosity b) Shale Percent c) HC Saturation d) Permeability e) Sand Thickness as per PDL f) Net Oil Sand g) Net/Gross Ratio h) Original estimated GOC in Well (or Reservoir) i) Present estimated GOC in Well (or Reservoir) j) Change in GOC from original GOC k) Distance Between Highest Perforation and PGOC	% % % mD ftvd ftvd frac ftss ftss ft ft	PP	23 6 86 1233 288 111 0.97 10192 10202 (MBAL 2019) 10 20
7	a) Original Estimated OWC in Well (or Reservoir) b) Present Estimated OWC in Well (or Reservoir) c) Change in OWC From Original OWC d) Distance Between Lowest Perforation and POWC	Ftss Ftss ft ft tvd	PP	10316 10252 (MBAL 2019) 64 20
8	a) Tubing Size/Weight b) Casing Size/Weight c) Liner Size/Weight	in/ibs/ft in/ibs/ft in/ibs/ft	PT	3-1/2"/ 9.2 7"/ 23 N/A
9	a) Average Hole Size across Completion Interval	in	PP	8.5
10	a) Is there a barrier between top of completion Interval and the present estimated GOC. b) Is there a barrier between lowest completion Interval and the present estimated OWC		PG	No No

NA – Not Available, N/A - Not Applicable

10. RECENT WELL TEST DATA

Well	Date	Choke	BS&W	Gross	Net	GOR	Sand	FTHP	CHP
DBUC009T	June 2011	32	47	5408	2842	1956	0.8	1243	0
DBUC009T	July 2011	32	67	3699	1235	2902	0.2	1243	0
DBUC009T	August 2011	32	66	4057	1387	2257	0.2	1243	0
DBUC009T	September 2011	32	68	4112	1327	1997	0.1	1228	0
DBUC009T	October 2011	32	66	3865	1310	2180	0.5	1228	0
DBUC009T	November 2011	32	62	3292	1256	1936	0.5	1228	0
DBUC009T	December 2011	32	62	4379	1678	2030	1.1	1228	0
DBUC009T	May 2012	32	64	4091	1498	3196	1.1	1228	0

11. COST ESTIMATE

The total cost of the 4.07 KM flowline replacement **is $1,188,072.30,** while the total cost of the CO Log, Water shut-off, Perforation Extension and SCON is **$2,286,833.40**

S/N	DBUC 9T & 12T - WSO, PERF EXT, SCON, N2 LIFT	$
1	Mobilization	63,860.62
2	WHM package	39,000.00
3	Slickline package	28,950.00
4	Coiled Tubing Package	254,921.78
5	Swamp Logistics	675,610.00
6	Sand Trap (10ft interval)	132,000.00
7	Back Stop Treatment	116,715.30
8	QA/QC Engineer	11,964.00
9	Perforation	105,000.00
10	Liquid Nitrogen (3 tanks)	48,000.00
11	Chemicals (salts)	83,087.00
12	Demobilization	63,860.62
13	FTO/Security	108,153.00
14	AGO	20,800.00
15	Crew Flight	144,000.00
16	OH personnel	15,000.00
17	Wellhead Refurbishment	58,000.00
18	CCU Actuator / Control Panel	45,000.00
19	CO Logging	272,911.08
	Total	**2,286,833.40**

12. HSSE/ SPECIAL WELL/LOCATION CONDITION

CONDITION OF WELLHEAD	Not Ok
ANNULUS PRESSURE MEASUREMENT/DATE	CHP A = 0psi.; CHP B = 0psi. (15/08/2019)
MAASP / MAWOP	88 bar / 66 bar (A-annulus), 14 bar / 10 bar (B-annulus)
WELL INTEGRITY SUMMARY	Well has integrity issue (Multiple valve failures/Missing) – Well is currently closed in with ScSSSV. Valves will be fixed during Well Intervention
CONDITION OF PRODUCTION STRINGS	Tubing is ok.
ANY PROBLEM DURING PRIMARY CEMENTATION OR LAST RE-ENTRY	No
SPECIAL FISHING TOOL REQUIRED	No
LOCATION CONDITION	Ok. Slot has been dredged.
COMMON CELLAR	No
SEASONALLY FLOODED	Yes
SIZE LIMITATION	No

13. RISKS AND MITIGATION

RISKS	TECOP	LIKELIHOOD/ IMPACT	IMPACT	MITIGATION/ MANAGEMENT
Loss of well control during intervention.	Operational	M/H	▪ Well kick ▪ Spills into the environment ▪ Fire/blowout ▪ Company reputation	▪ Use of appropriately rated PCE (Wireline BOP/ lubricator) ▪ Robust pore pressure and fracture gradient predictions has been made to indicate expected reservoir pressure.
Well unable to flow due to insufficient lift post intervention activity.	Technical/ Operational	L/H	▪ Delay in OSD & cash flow deficit post intervention activity. ▪ Rig-less intervention cost escalation.	▪ Ensure adequate planning with robust contingency for N2 lift post intervention. ▪ Lift entire tubing capacity plus volume of fluid pumped into the wellbore.
Poor injectivity of the formation prior to SCON pumping	Technical	M/H	▪ Inability to deploy SCON for the interval ▪ No sand control for the interval ▪ Reduced production from the well	▪ Produce well at low bean to minimize sand production.
Well unable to sustain flow for an extended period because of reservoir pressure depletion.	Technical	L/M	▪ Potential impact on recovering of resources.	▪ Ensure that the withdrawal is managed to allow the aquifer to kick in.
High associated gas production after Perforation activity	Technical	H/H	▪ Potential impact on well rates if GOR creaming is required. ▪ Cost implication resulting from increase in Gas flaring penalty.	▪ Optimal bean control/ GOR creaming will be used to mitigate excessive AG production. ▪ Well offtakes will be managed to produce well at acceptable Rsi limit (3*Rsi).
Potential for drop objects during Well Intervention operations	Technical/ Operational	H/H	▪ Potential for Near misses and/or injury to personnel. ▪ Inability to continue the workover operation based on the severity of the above impact.	▪ Ensure DROP zones are identified prior to operations and proper barriers are in place. ▪ Ensure strict adherence to JHA and PTW processes during operation.
Possible HUD inside Tubing	Technical/ Operational	M/H	▪ Inability to access sand face to stimulate interval. ▪ Impact on intervention cost from excessive time spent on removing restriction.	▪ Drift tubing and tag XN profile prior to job execution. ▪ Run LIB if HUD is encountered to confirm nature of HUD. Contact PTW/O/NG or UPO/G/UVC ▪ Mobilize necessary fishing/ jetting tool to manage hole restriction/ HUD during operation.
Contamination risk from SCON chemicals.	Technical	L/H	▪ Tubing restriction if SCON chemical congeals during deployment impacting well promise and cost. ▪ HSSE impact from exposure to SCON chemicals.	▪ Proper chemical compatibility test and appropriate field supervision during SCON deployment. ▪ SCON chemicals should be properly bulked in the contractor's base and transported to the field locations

RISKS	TECOP	LIKELIHOOD/ IMPACT	IMPACT	MITIGATION/ MANAGEMENT
				▪ Ensure all connections are pressure tested and leak tight before pumping SCON chemicals ▪ STOP work authority to be in place to avoid any HSE exposure during SCON treatment. ▪ Unused chemicals should be returned to contractor base for proper disposal.
Tubing burst during pressure test.	Technical/ Operation	L/M	▪ Prolonged well operation and increased cost.	▪ Clearly define maximum allowable burst load and maximum allowable surface test pressure for the tubing.
Exposure to NORM	Technical/Organizational	L/H	▪ Health hazard to staff. ▪ Environmental and reputational impact and additional cost for clean-up.	▪ Safety measures as stipulated in the HSSE and SP Control Framework (Ionizing Radiation Manual) should be followed. ▪ A radiation protection officer should be appointed for the operation. ▪ Ensure exposure control and adequate dosimetry. ▪ Appropriate PPE should be worn by staff handling tubulars and other well accessories.
Community preventing access to location	Political	M/H	▪ Delays in well execution/ increased cost.	▪ Early engagement as per SCD / MoU. ▪ Ensure FTO is secured prior to commencement of operations.
Security	Political	M/H	▪ Delays in well execution/ increased cost.	▪ Security surveillance and intelligence evaluation should be conducted prior to equipment mobilization to site. ▪ Follow Journey Management Plan for all inter/ intra state commuting – crew change, supplies delivery, mobilization/de-mobilization. ▪ Maintain visible JTF presence within and around location as a deterrent to invasion or kidnapping.

14. LIST OF APPENDICES

Appendix 1: HSE Critical Activities

Appendix 2: Diebu Creek 009T Well Status Diagram (Current Status)

Appendix 3: Diebu Creek 009T Well Status Diagram (Proposed Status)

Appendix 4: Diebu Creek 009T Well Performance Plot

Appendix 5: Diebu Creek 009 Petrophysical Data layout

Appendix 6: Diebu Creek E1000X Hydrocarbon Distribution Plot

Appendix 7: Diebu Creek 009T Inflow/outflow Plot

Appendix 8: Diebu Creek 009T Well forecast plots.

Appendix 9: Diebu Creek E1000X Top Structure Map

Appendix 10: Geological Cross Section through E1000X Reservoir

Appendix 11: Correlation Panel with existing completions

Appendix 12: Pore Pressure Prediction for Diebu Creek 009T on E1000X Reservoir

Appendix 13: H2S Prediction for Diebu Creek 009T on E1000X Reservoir

Appendix 14: Diebu Creek 009T Intervention Decision Tree

Appendix 15: Diebu Creek 009T Well Head Picture

Appendix 1: HSE Critical Activities

HSSE Critical Activities (Rig-less Activities -Wells)

HSE Critical Task			Discipline	Close Out of HSSE Critical Task
Activity		Potential HSE Impact		
4a	Predict H2S presence. **DEP 25.80.10.18**	Loss of life and material integrity.	PT/PG*	The consequence of presence of H_2S is loss of life and material integrity. However, available PVT data in Diebu Creek & nearby fields do not indicate H2S presence. The H2S prediction chart in Appendix 13, shows negligible H2S risk in the target Reservoir (E1000X). Also, focused evaluation of the reservoir using the SPDC souring potential chart highlighted that the souring tendency of the reservoir is minimal.
5b	Predict pore and fracture pressure in an undeveloped reservoir **DEP 25.80.10.10**	Loss of Well Control and Integrity	PP	Not Applicable. Target reservoir is developed.
5c	Predict pore and fracture pressure in an already developed reservoir **DEP 25.80.10.10**	Loss Well Control and Integrity.	RE	Pore pressure/fracture gradient prediction for developed reservoir has been done and endorsed by technical authority (ref. appendix 12).
7a	Plan logging – Wireline and LWD operations **DEP 25.80.10.15**	Well control, human exposure	PP	A risk assessment has been carried out for the logging program and is included in this proposal. A LWOP session will be planned and will cover job planning and job hazard analysis. Every logging run will be preceded with a Pre-Job Safety Meeting and comprehensive Job Hazard Analysis (JHA); the perforating run(s) will be subjected to the Permit-to-work process. The Logging Program and Risk Assessment are presented in Table 1 & Table 2
7b	Plan logging – radioactive sources **DEP 25.80.10.15**	Environmental impact, surface handling risks to people, loss of sources in the hole	PP	Radioactive sources will be deployed in execution of the logging program. Radioactive handling permit (from NNRA) will be obtained prior to logging activity, and availability of contractor's valid permits will be ensured. LWOP session will be held prior to logging operation to discuss HSE risks and mitigation to ensure safe operational procedures in achieving a successful logging operation.
7c	Plan logging – explosives **DEP 25.80.10.15**	Potential for loss of life. HSSE management of surface and downhole operations	PP	• Personnel should follow the required guidelines on explosive tool handling as applicable. • The explosives should be kept secure in a dedicated location with perimeter protection and CAUTION sign, before and after operation.

				• Explosives should be handled by trained and certified personnel ONLY; Lead engineer is responsible for handling the tool during operations transfer.
7d	Plan logging - Pressurised formation fluid samples. **DEP 25.80.10.15**	surface handling: potential for loss of life.	PP	Not applicable.
7e	Plan logging - TZ and VSP survey operations **DEP 25.80.10.15**	Explosives, Airguns – Potential loss of life.	PP*/GP/WE	Not applicable.
10	Interpret cement bond integrity and casing wear log.	Zonal isolation and potential casing integrity.	PT*/PP	No cement bond log sighted. However, based on production history of this conduit, zonal isolation is not an issue and casing integrity is intact since no casing head pressures till date
11	Plan perforation and guns retrieval. **(Integrated as part of DEP 25.80.10.21)**	Hazards to life and facilities (misfired or unfired charges to surface).	PT*/WE	Radio silence will be observed while running in and running out of hole with the gun.
12	Predict sand production. **DEP 25.80.10.19**	Facility / flow-line integrity and loss of containment (LOC)	PT	Sand production is anticipated during well life and it is proposed to carry out Chemical sand consolidation to mitigate sand influx into wellbore.
13a	Predict produced fluid composition, especially contaminants like CO2, H2S, and mercury and potential formation water composition.	Corrosion and material integrity.	PT	PVT data from Diebu Creek E1000X reservoir indicates the absence of H2S. The souring tendency of the reservoir is also analysed to be minimal. Fluid sample analysis also show insignificant amount of CO2 in the reservoir as observed from applicable Diebu Creek E1000X PVT report. Hence CO2 and H2S corrosion is highly unlikely.
13b	Predict and manage scaling + reservoir souring impact from water flooding /water injection	Corrosion and material integrity including hazard to life	PT	Not Applicable. Water flooding / water injection is not planned for the target reservoir.
14	Predict well-head and produced fluid temperature.	Well head growth, surface flowlines limitation and stress integrity.	PT	The predicted / expected wellhead fluid temperature of between 80 - 95degF falls within the range seen in Wells in the nearby fields and are not expected to pose a threat during this operation and indeed in the life of the well. Also, the surface casing is cemented in place and no wellhead movement have been seen when this well was producing.
15	Plan (and execute) stimulation. **DEP 25.80.10.21**	Unsafe handling of chemicals (SHOC), equipment failure due to acid corrosion.	PT*/WE	Chemical treatment is planned in the scope of this intervention. Hence, SHOC card procedures are available for these chemicals. Appropriate PPE will be used by personnel on this job. Tool box talk and job hazard analysis will be conduction. Also, CWI have local experience handling these chemicals as these

				chemicals are deployed regularly in SPDC operation.
16	Establish safe operating boundaries (MAASP, closed in pressure, erosion and corrosion limits, etc.) for well integrity management.	Loss of well integrity.	PT	MAASP for the well and indeed well integrity boundary parameters are actively managed in e-WIMS. Presently, Diebu Creek 9T has action code 9 (November 2019) and no record of annulus pressure. Preventive maintenance/well integrity assurance activities are routinely carried out.
17a	Top-seal integrity assessment for primary recovery, waterflood, EOR and CO2 storage DEP 25.80.10.22	Human exposure, environmental and asset damage	PP	The risk of top-seal leakage due to primary recovery is considered low based on observations in the field and regional experience (Fields within the NUNR/ DBUC axis have produced for above 30 years with no recorded incidents). Geomechanical screening risk assessment carried out in Diebu Creek does not indicate risk of Top seal integrity issues.
17b	Prepare Abandonment Design option and program	Human exposure, environmental and asset damage.	PT	Not applicable.
18	Predict and monitor reservoir compaction and subsidence. DEP 25.80.10.16	Loss of wells, facility/platform integrity.	PP	The risk of compaction and subsidence is considered low based on the field and regional experience (Fields within the NUNR/ DBUC axis have produced for above 30 years with no recorded incidents). Geomechanical screening risk assessment carried out in Diebu Creek field does not indicate any risk of reservoir subsidence and compaction.
24	Prepare and maintain data to support emergency response. **DEP 25.80.10.12**	Lack of data or wrong data during emergency response may aggravate the emergency.	PT/PG*	All relevant well data and latest well information required for emergency response have been loaded in the SIRUS CATALOG and Sharepoint (see links below): SIRUS CATALOG Share point
26	Identify Hazards (HAZID) and prepare Hazard Register	Integral part of HSSE Case development. To confirm selected concept/process can be developed into a safe and operable plant.	WE	This intervention is planned on existing well. Hence, well design is not applicable. HSSE risks and mitigation for this Intervention will be built into the execution program

*Accountable Discipline, as per Published DEP

Appendix 2: Diebu Creek 009T Well Status Diagram (Current Status)

INITIAL COMPLETION STATUS AS AT NOVEMBER 1998 — **WELL : DIEBU CREEK-9**

CASING

SIZE	GRADE	WT.	DEPTH	CEMENT	SG
7 "	N80	23.0	968		
"	J55	23.0	5478		
"	N80	23.0	7482		
"	N80	26.0	9991		
"	N80	29.0	10491		

WELLHEAD

ITEM	TYPE	SIZE(INS)	WP (PSI)
GATE VALVE			
XMAS TREE	SSB	6 x 3-1/8 F x N	5000
ADAPTOR FL.	SPECIAL	6 x 6	5000
TUBING HANGER	DC-FBB	6 x 3-1/2 HCS	
TUBING HEAD SPOOL	DCB	10 x 6	3000 x 5000
CSG. H. HOUSING	WF	10-3/4 x 10	3000
SEAL BUSHING	'X'	10 x 7	ENERGISED

TUBING

STRING	SIZE	WT	GRADE	TYPE
"	3-1/2	9.2	N80	HCS
"	3-1/2	9.2	N80	ASL

DEVIATION

MAX 0 AT FT

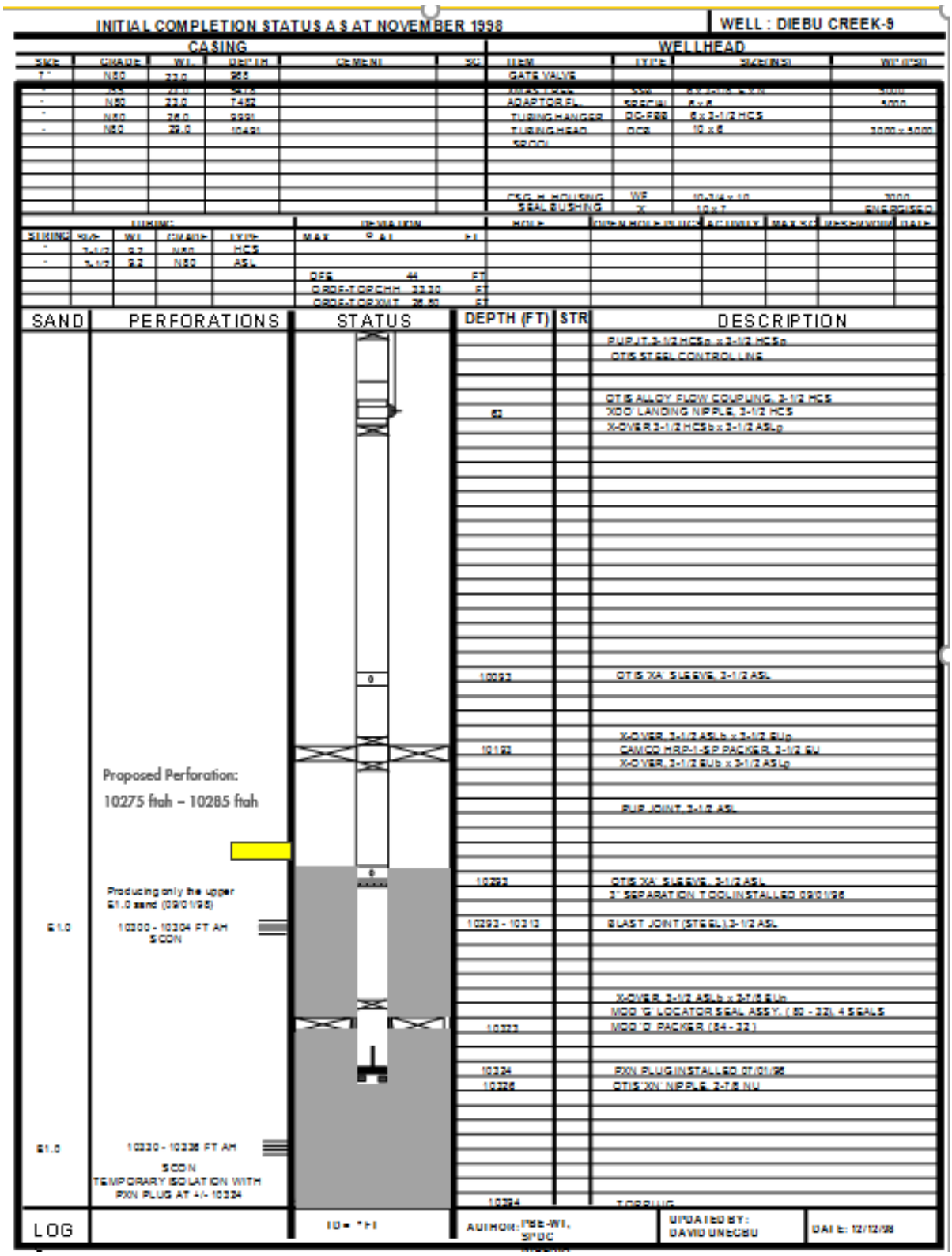
DFE 44 FT
ORDE-TOP CHH 33.30 FT
ORDE-TOP XMT 26.80 FT

HOLE | **OPEN HOLE PLUGS** | **ACTIVITY** | **MAX SG** | **RESERVOIR** | **DATE**

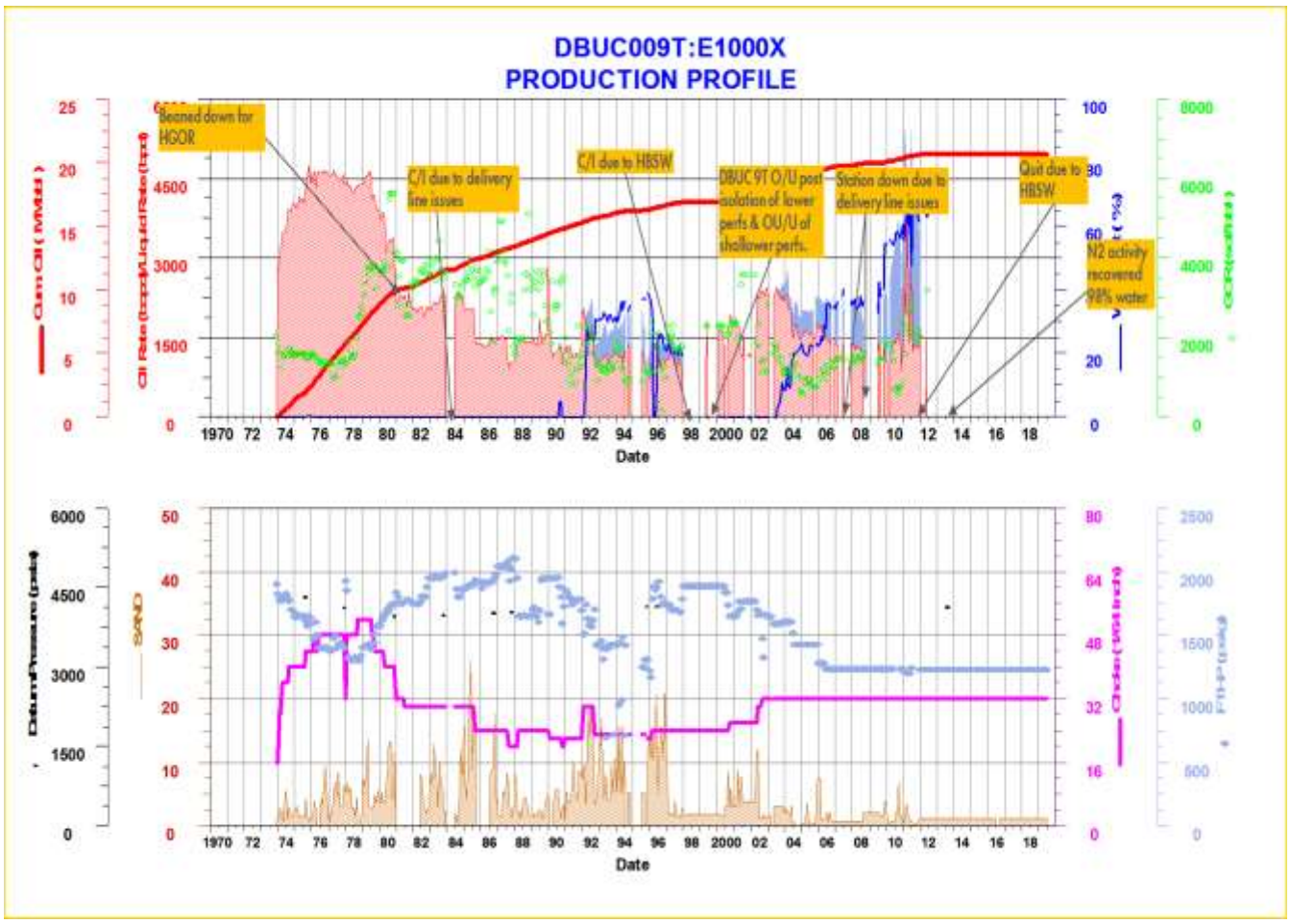
SAND	PERFORATIONS	STATUS	DEPTH (FT)	STR	DESCRIPTION
					PUP JT.3-1/2 HCSp x 3-1/2 HCSp
					OTIS STEEL CONTROL LINE
					OTIS ALLOY FLOW COUPLING, 3-1/2 HCS
			63		'XDO' LANDING NIPPLE, 3-1/2 HCS
					X-OVER 3-1/2 HCSb x 3-1/2 ASLp
			10093		OTIS 'XA' SLEEVE, 3-1/2 ASL
					X-OVER, 3-1/2 ASLb x 3-1/2 EUp
			10193		CAMCO HRP-1-SP PACKER, 3-1/2 EU
					X-OVER, 3-1/2 EUb x 3-1/2 ASLp
					PUP JOINT, 3-1/2 ASL
	Producing only the upper E1.0 sand (09/01/98)		10293		OTIS 'XA' SLEEVE, 3-1/2 ASL
					3" SEPARATION TOOL INSTALLED 09/01/96
E1.0	10300 - 10304 FT AH SCON		10293 - 10313		BLAST JOINT(STEEL),3-1/2 ASL
					X-OVER, 3-1/2 ASLb x 2-7/8 EUp
					MOD 'G' LOCATOR SEAL ASSY. (80 - 32), 4 SEALS
			10323		MOD 'D' PACKER (84 - 32)
			10324		PXN PLUG INSTALLED 07/01/96
			10326		OTIS 'XN' NIPPLE, 2-7/8 NU
E1.0	10330 - 10336 FT AH SCON TEMPORARY ISOLATION WITH PXN PLUG AT +/- 10324				
			10394		TOP PLUG

LOGS | TD = * FT | AUTHOR: PBE-WT, SPDC NIGERIA | UPDATED BY: DAVID UNEGBU | DATE: 12/12/98

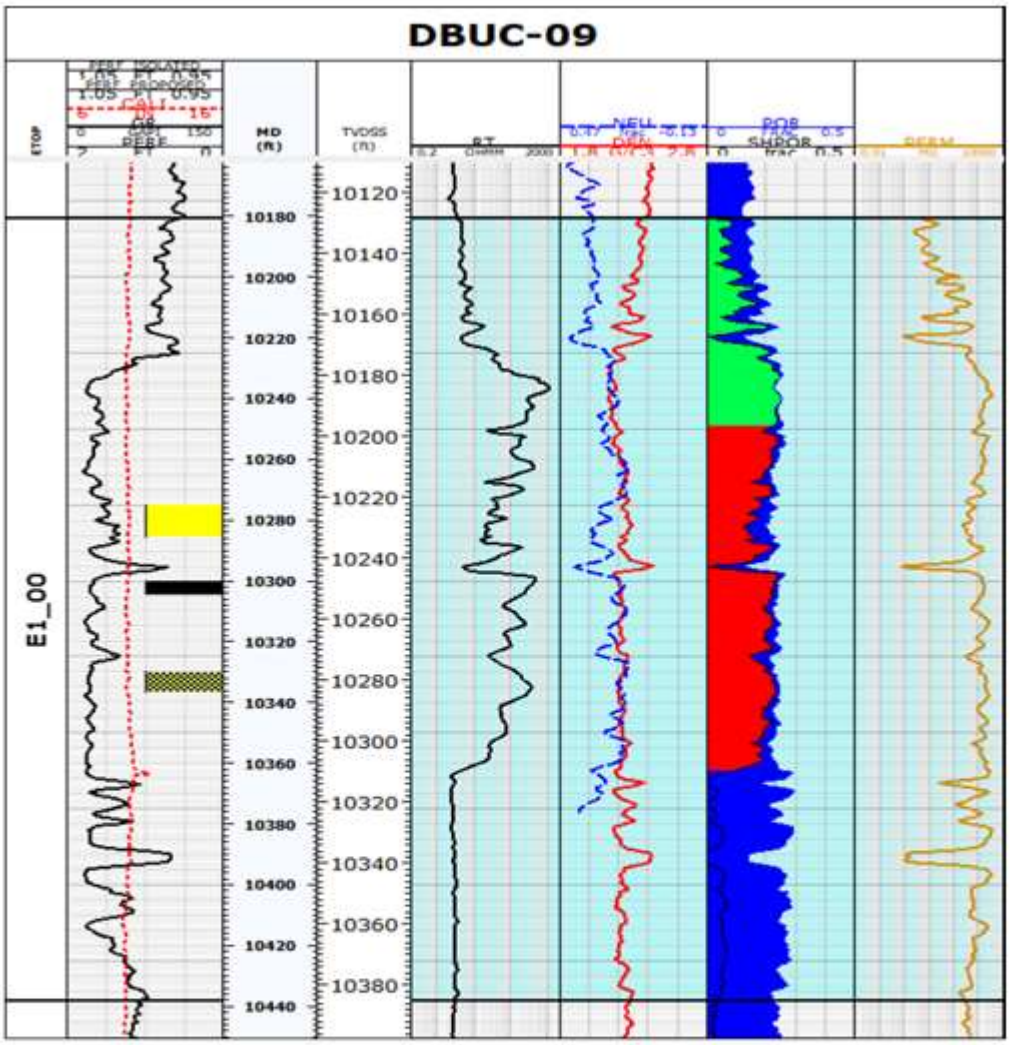
Appendix 3: Diebu Creek 009T Well Status Diagram (Proposed Status)



Appendix 4: Diebu Creek 009T Well Performance Plot



Appendix 5: Diebu Creek 009 Petrophysical Data Layout

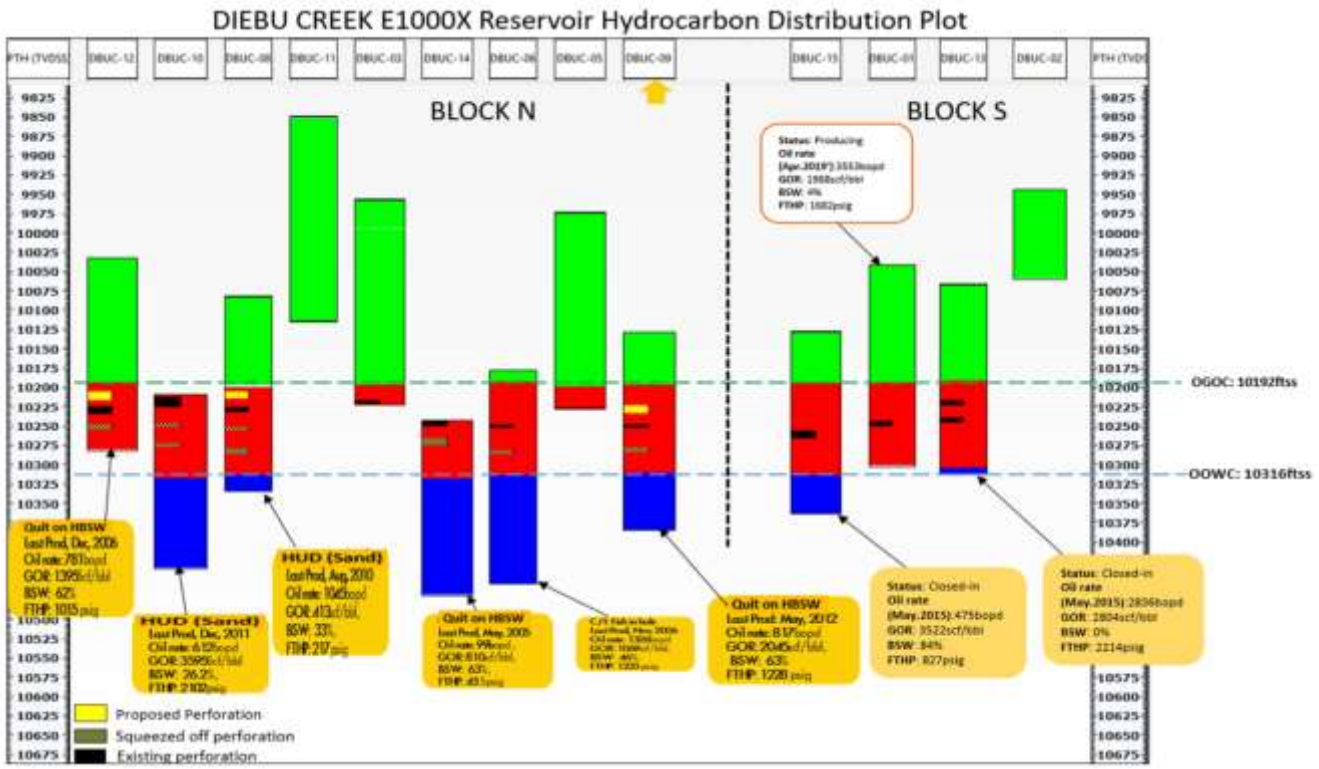


Proposed Perforation: 10275ftah – 10285ftah

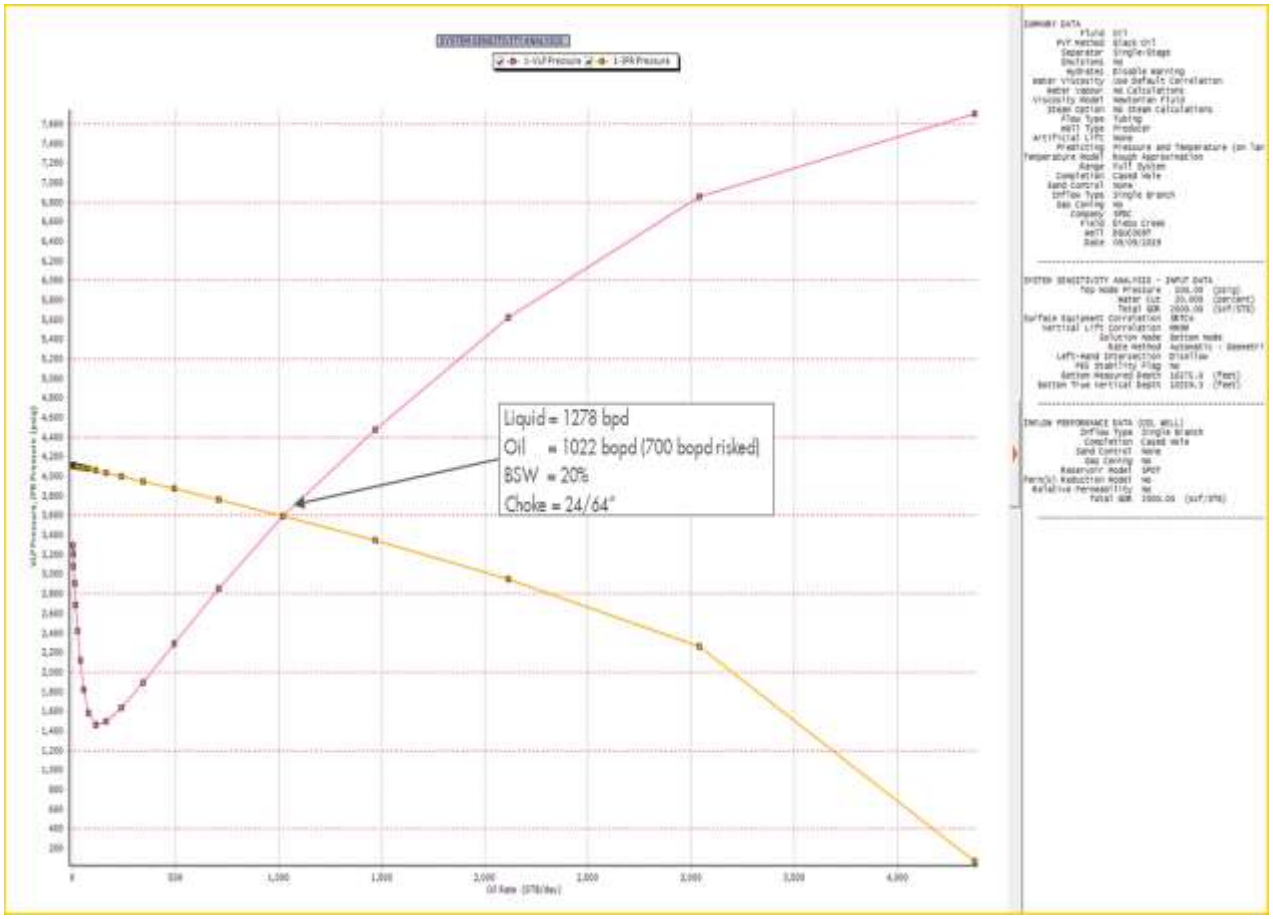
Isolated perforation

Existing perforation

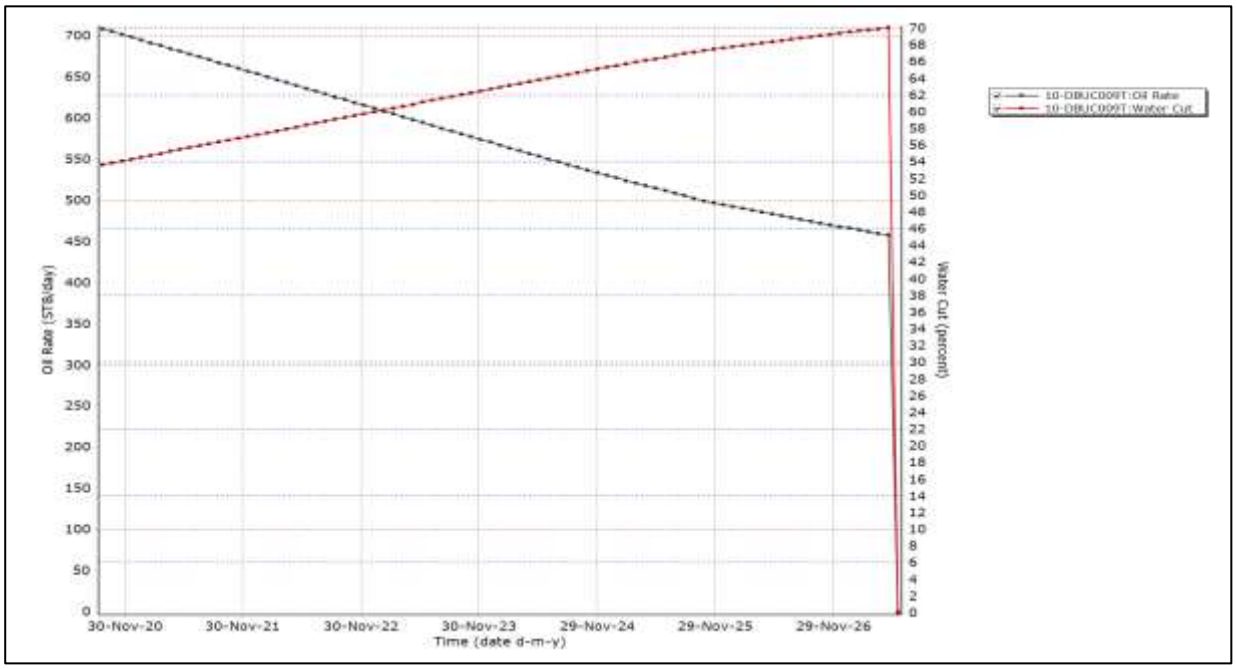
Appendix 6: Diebu Creek E1000X Hydrocarbon Distribution Plot

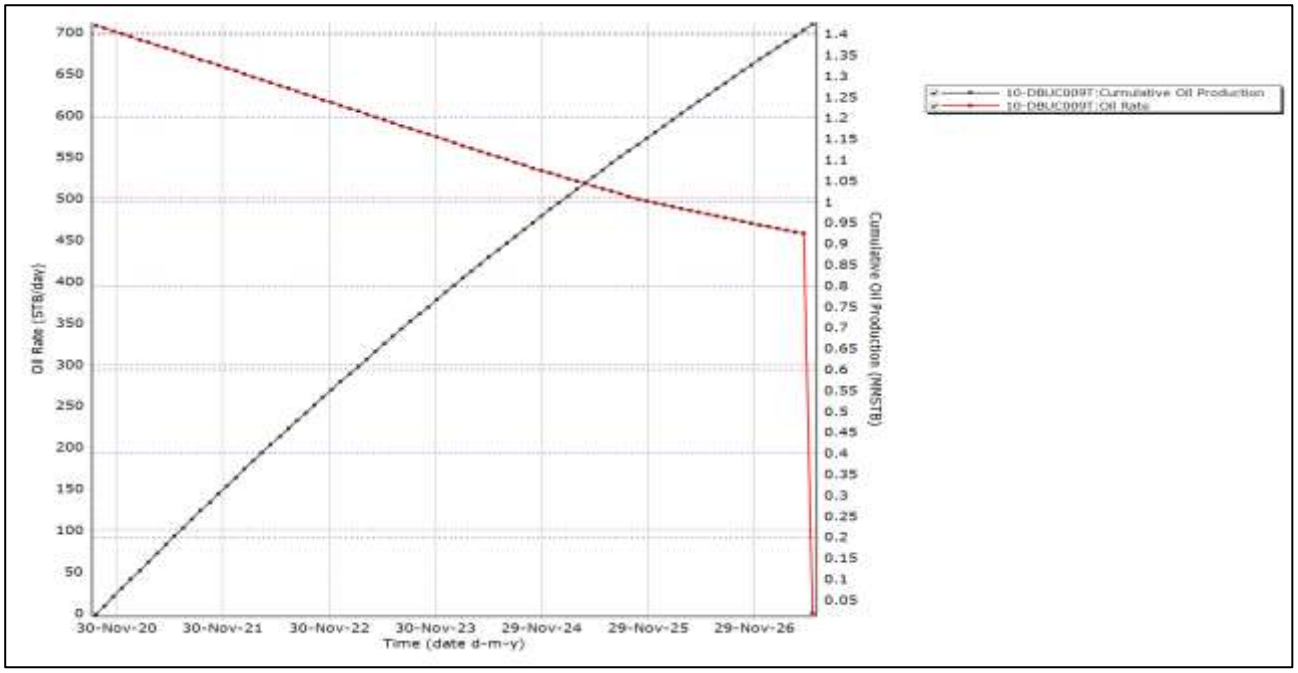


Appendix 7: Diebu Creek 009T Inflow/outflow Plot

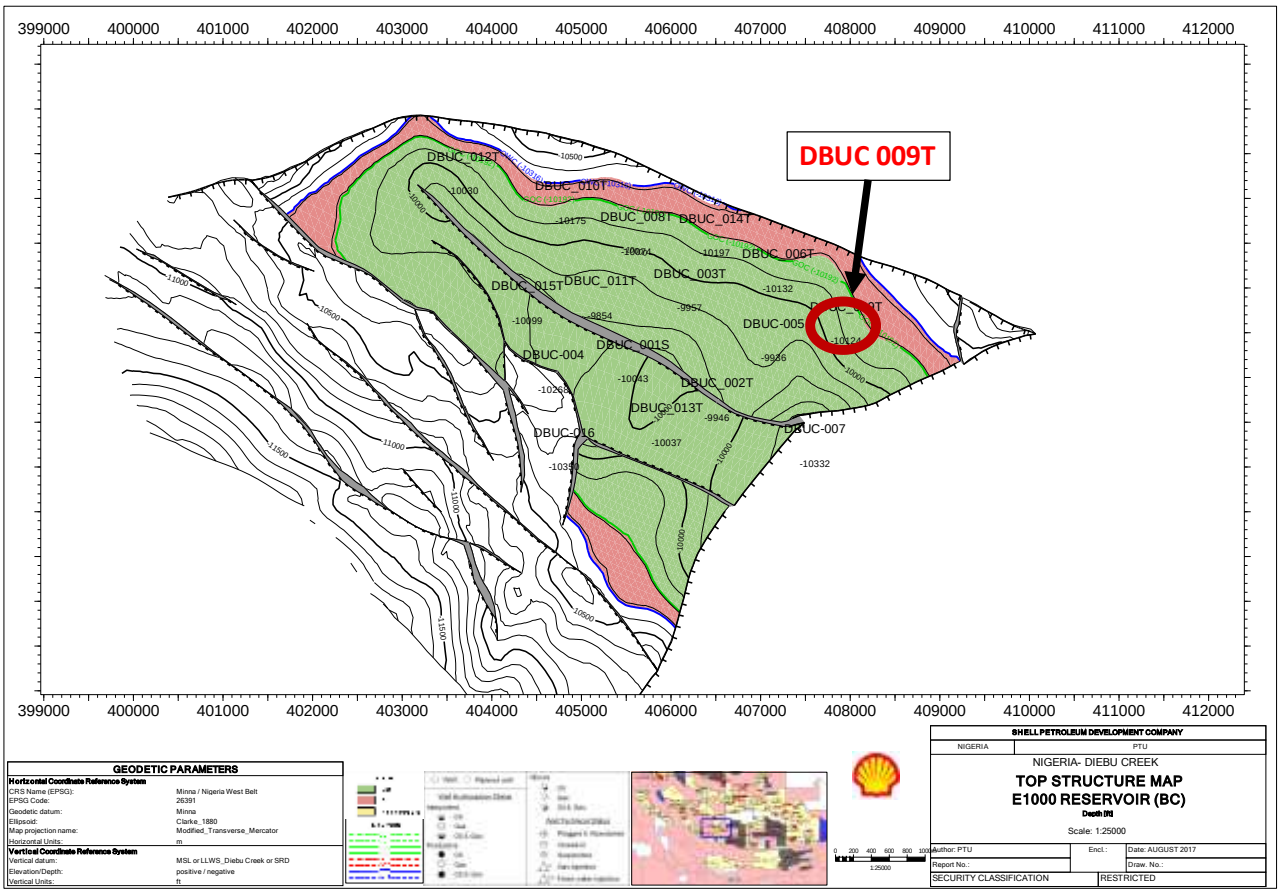


Appendix 8: Diebu Creek 009T MBAL forecast plots

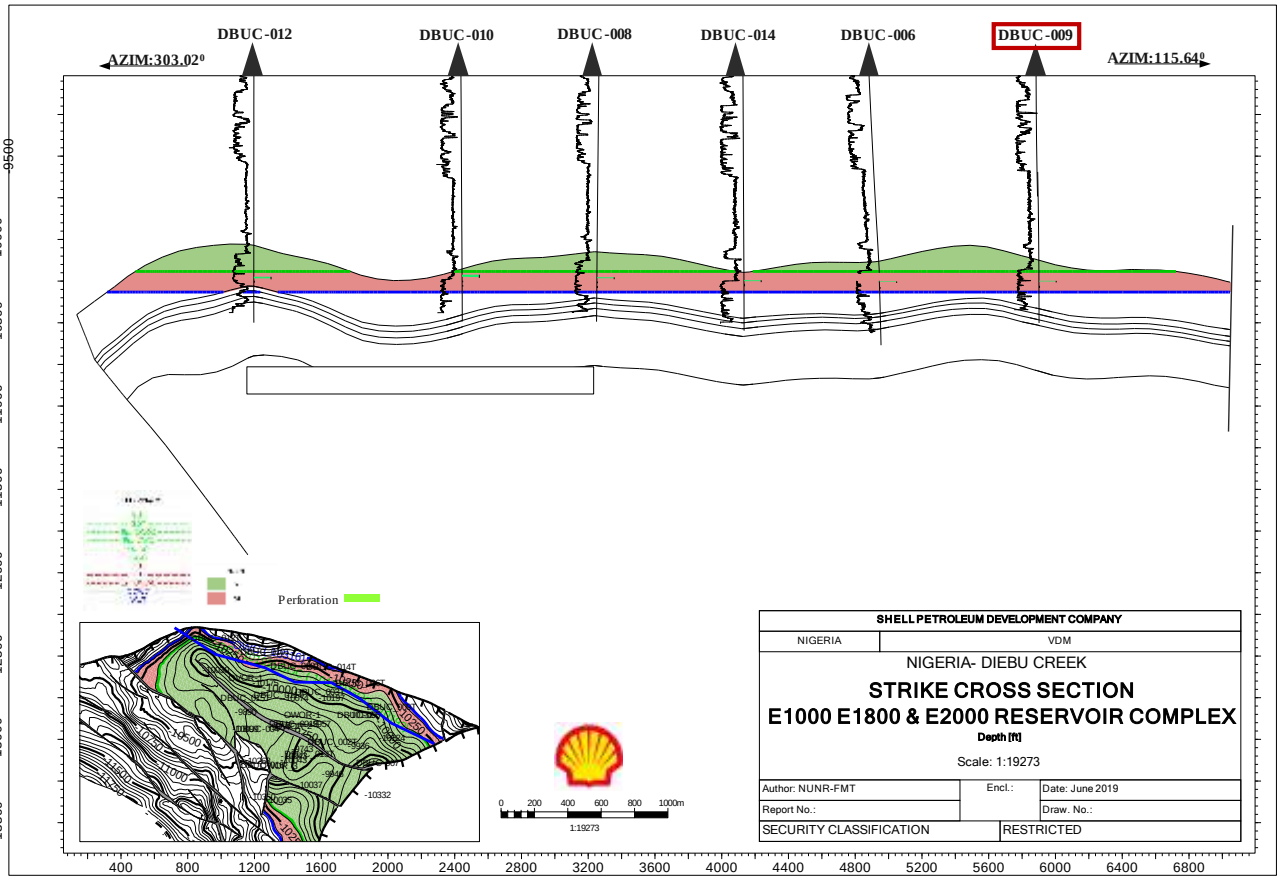




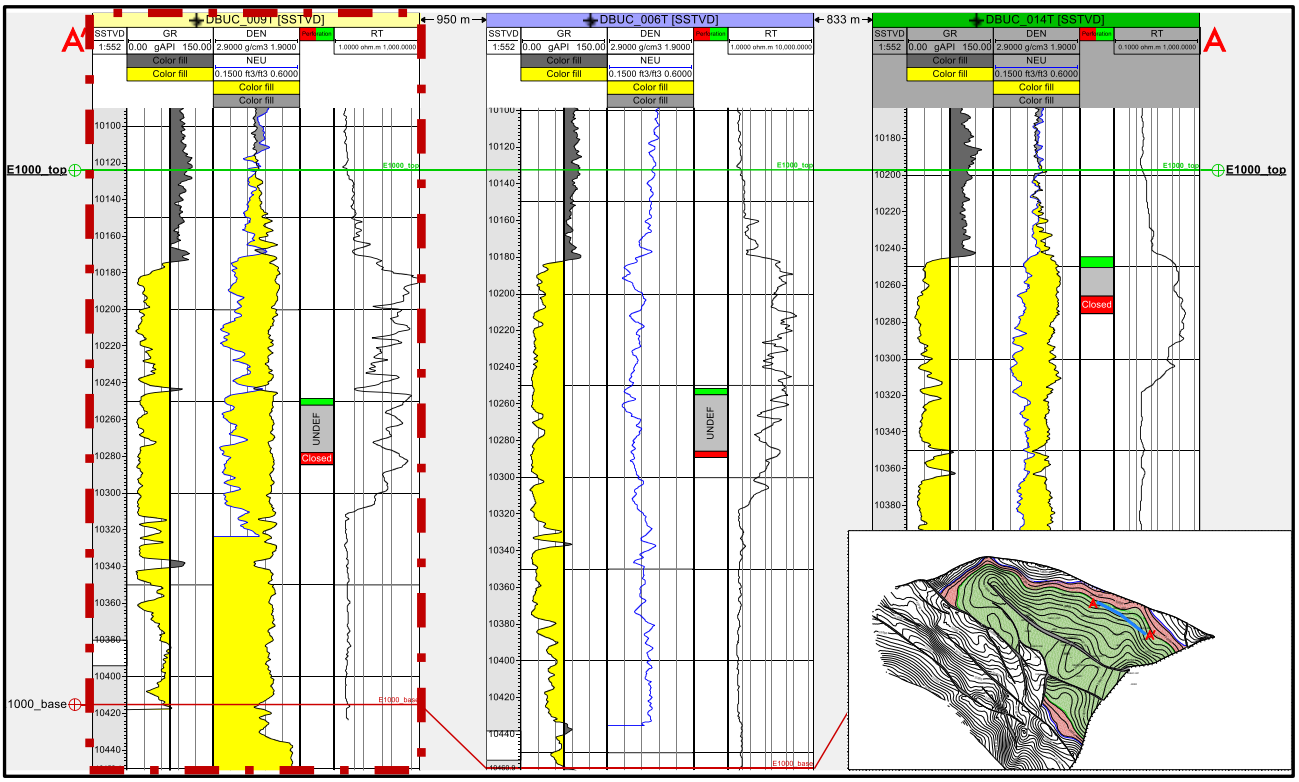
Appendix 9: Diebu Creek E1000X Top Structure Map



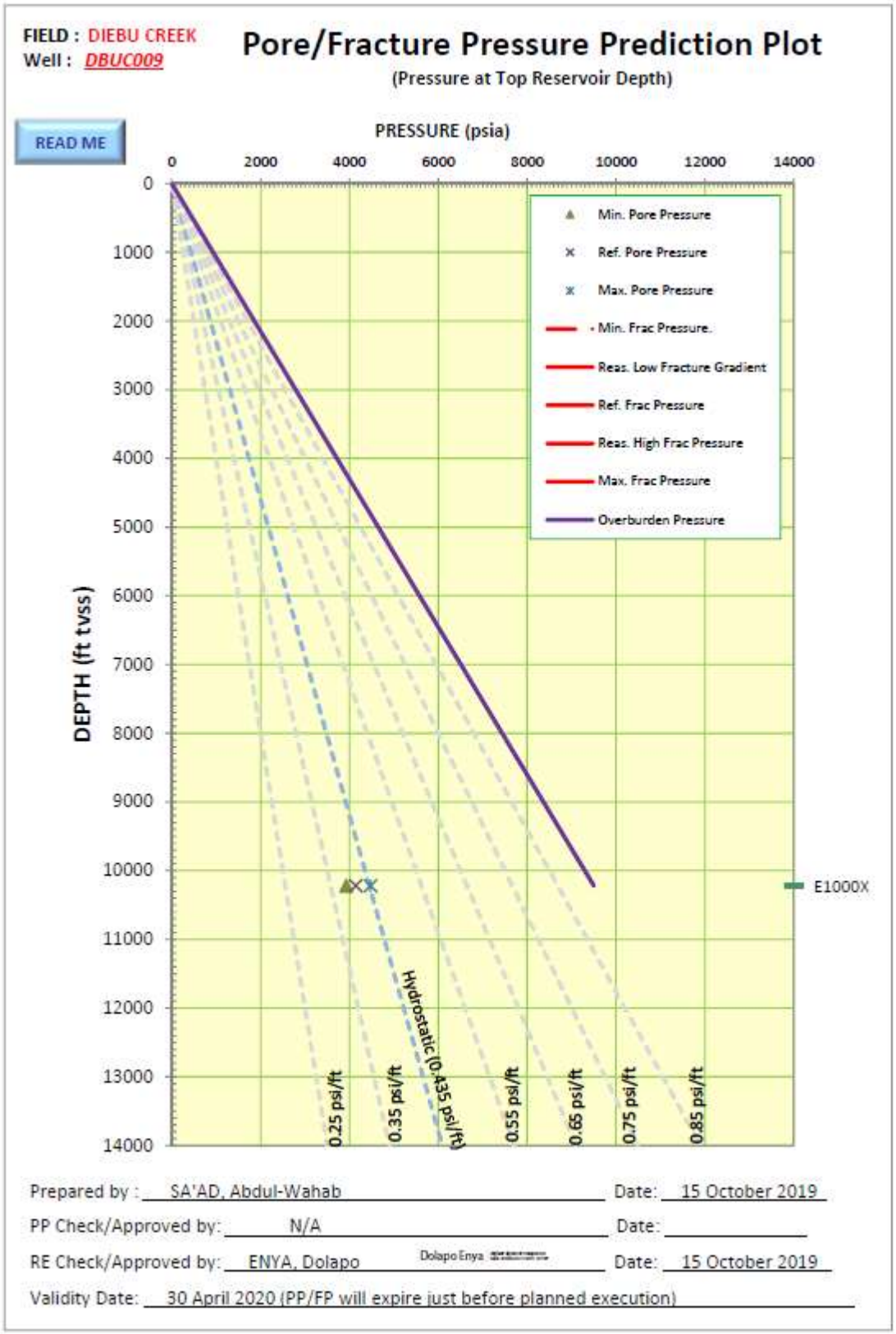
Appendix 10: Geological Cross Section through E1000X Reservoir

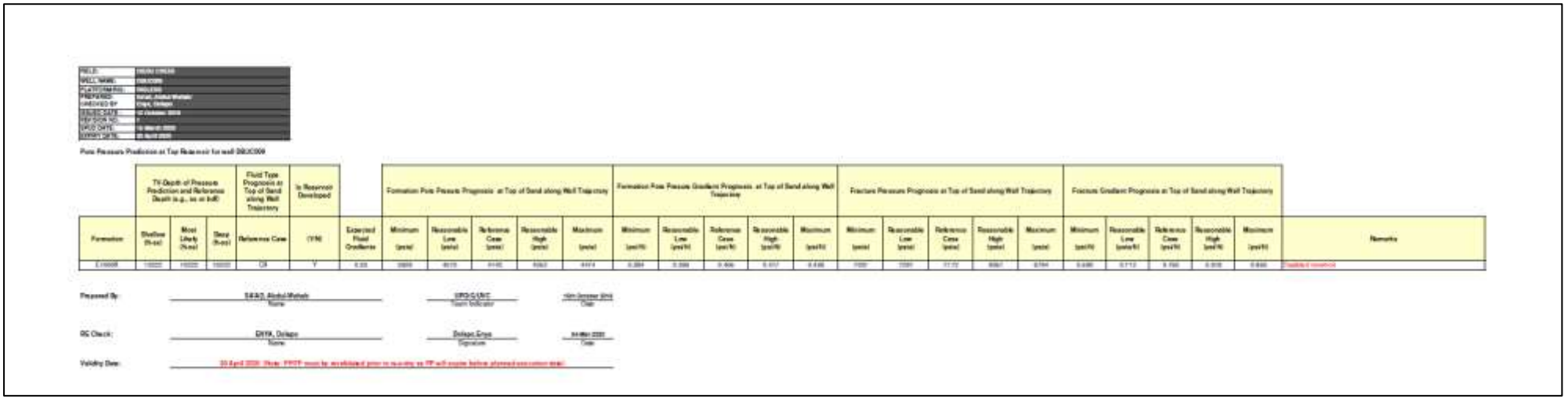


Appendix 11: Correlation Panel through E1000X Reservoir



Appendix 12: Pore Pressure Prediction for Diebu Creek 009T on E1000X





FIELD:	DIEBU CREEK
WELL NAME:	DBUC009
PLATFORM/FAC:	DBUC009
PREPARED:	Ismail_Abdul Wahab
REVIEWED BY:	Engr. Delapo
ISSUED DATE:	22 [illegible] 2020
REVISION NO:	2
SPUD DATE:	15 March 2020
EXPIRY DATE:	22 April 2020

Pore Pressure Prediction at Top Reservoir for well DBUC009

	TV Depth of Pressure Prediction and Reference Depth (e.g., ss or tvdf)			Fluid Type Prognosis at Top of Sand along Well Trajectory	Is Reservoir Developed		Formation Pore Pressure Prognosis at Top of Sand along Well Trajectory					Formation Pore Pressure Gradient Prognosis at Top of Sand along Well Trajectory					Fracture Pressure Prognosis at Top of Sand along Well Trajectory					Fracture Gradient Prognosis at Top of Sand along Well Trajectory					
Formation	Shallow (ft-ss)	Most Likely (ft-ss)	Deep (ft-ss)	Reference Case	(Y/N)	Expected Fluid Gradients	Minimum (psia)	Reasonable Low (psia)	Reference Case (psia)	Reasonable High (psia)	Maximum (psia)	Minimum (psi/ft)	Reasonable Low (psi/ft)	Reference Case (psi/ft)	Reasonable High (psi/ft)	Maximum (psi/ft)	Minimum (psia)	Reasonable Low (psia)	Reference Case (psia)	Reasonable High (psia)	Maximum (psia)	Minimum (psi/ft)	Reasonable Low (psi/ft)	Reference Case (psi/ft)	Reasonable High (psi/ft)	Maximum (psi/ft)	Remarks
E10000	10000	10000	10000	Oil	Y	0.33	3909	4015	4145	4263	4414	0.384	0.388	0.400	0.411	0.438	7000	7091	7172	8067	8794	0.680	0.713	0.760	0.816	0.840	Depleted reservoir

Prepared By: [illegible] Abdul Wahab (Name) — UPD/S/INT (Team Indicator) — [illegible] 2020 (Date)

QC Check: DIYA, Delapo (Name) — Delapo Engr (Signature) — 14 Mar 2020 (Date)

Validity Date: 22 April 2020 (Note: FPPP must be established prior to re-entry as FP will expire before planned execution date)

Appendix 13: H2S Prediction for Diebu Creek 009T on E1000X Reservoir

DIEBU CREEK 009T H_2S PREDICTION FOR E1000X RESERVOIR

- Diebu Creek 009 is completed as a SSS oil producer on the E1000X sand. It is proposed for Thru-Tubing perforation extension on the E1000X reservoir.

PVT Report and Production History

- There is PVT Report for the E1000X reservoir from DBUC-006 and the report indicates zero H2S composition in the reservoir. Also, gas samples from the HP separator taken in 2002 shows no H2S in the reservoir. See snapshot of PVT report on the next slide.
- No H_2S has been produced from the E1000X reservoir to date.

Souring Potential

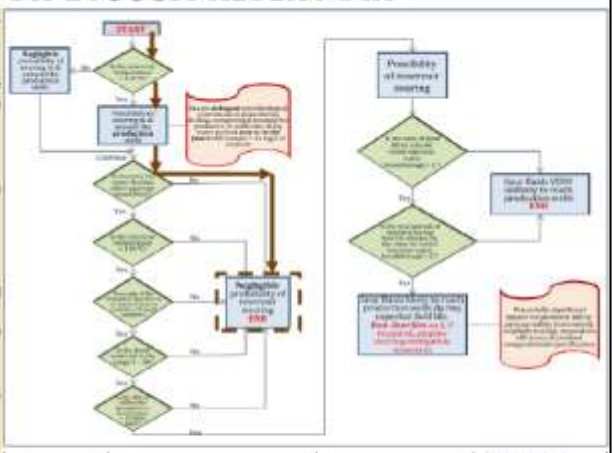
- The consequence of H_2S is loss of life and material integrity. However, available PVT data in Diebu Creek & nearby fields do not indicate H_2S presence.
  - The maximum reservoir temperature for the target sand (E1000X) is 87.22 °C (below 110 °C).
  - No water injection in Diebu Creek & nearby fields that can lead to reservoir souring.
  - No secondary or Tertiary recovery processes are being practiced in the field.
- Also, due to these reasons the souring tendency of the reservoirs is minimal (refer to the souring potential chart in attachment1);
- The fresh-saline water interface in DBUC-009 is 5096 ftss, which is about 5028 ftss away from the E1000X reservoir. The possibility of fresh water migration into this reservoir (E1000X) is low.

External Risks

- There is a risk of the Equipment (e.g. CT, Tanks) to be used in this operation, introducing some H_2S based on residue from their previous operations reacting with the acid to be used now.

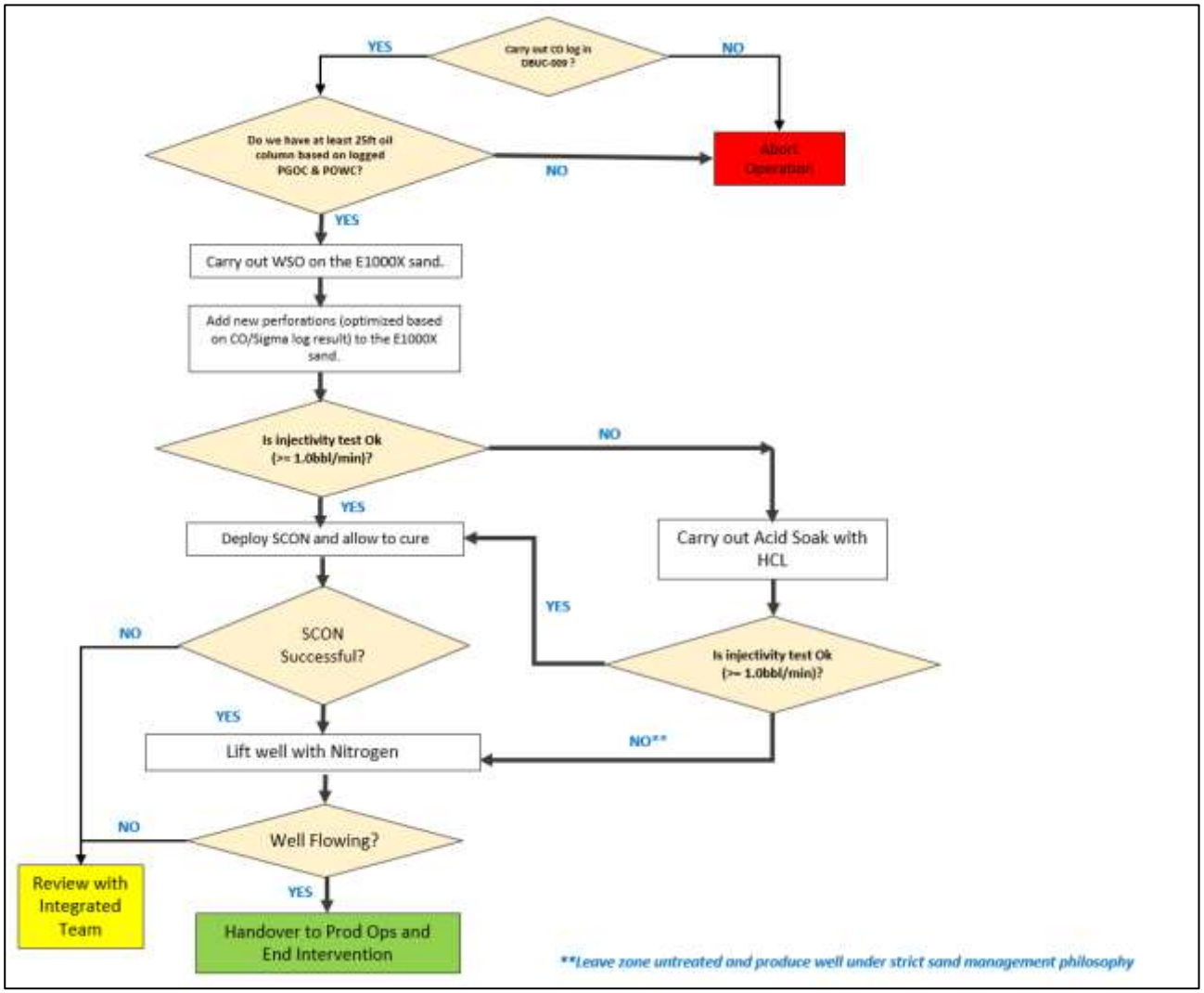
Mitigations

- Check and Confirm that previous use of the equipment would not intentionally give rise to H_2S after contacting HCL.
- H_2S Gas monitors will be utilized during Well Intervention execution to alert the crew of any latent threats.
- Appropriate PPE's to be worn as mitigation.



Prepared by	Unukogbon Obaro	Nwosu Obiora (FT)	05/ February / 2019
Checked by	Ahmed Suleiman (PG TA2)	Suleiman Ahmed	
Approved by	Komolafe Gbenga (PT TA2)	Gbenga Komolafe	
Approved by	Arochukwu Elias (PG TA2)	Elias Arochukwu	

Appendix 14: Diebu Creek 009T Intervention Decision Tree



Appendix 15: Diebu Creek 009T Well Head Picture