Markham ST-1 Decommissioning Close Out Report

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TABLE OF ACRONYMS AND GLOSSARY OF TERMS

Term	Description
DOB	Depth of burial. The depth between the blue line (DOC) and maroon line (DOL) on the burial profiles
DOC	Depth of Cover: The blue line on the burial profiles shows the profile of cover. The area between the blue line (DOB) and maroon line (DOL) shows the backfill
DP	Decommissioning Programme(s)
Drift tool	Used to verify hole diameter
DSV	Dive Support Vessel
GE	General Electric (proprietary equipment)
Gumbo box	Used for well solids control; removes hydrated clays
HLV	Heavy Lift Vessel
hrs	hours
ID	Identifier
INEOS	INEOS UK SNS Limited
“	Inch; 25.4 millimetres
J6A	Markham J6A Platform located on Netherlands Continental Shelf
kg	kilogramme
Km	kilometre
MAOP	Maximum Allowable Operating Pressure
MDBRT	Measured Depth Below Rotary Table
NFFO	National Federation of Fisherman’s Organisation
NL	Netherlands
NORM	Naturally Occurring Radioactive Material
NPT	Non-Productive (Operational) Time
NUI	Normally Unattended Installation
M	Metres
OGA	Oil & Gas Authority
OPRED	The Offshore Petroleum Regulator for Environment and Decommissioning
OPEP	Oil Pollution Emergency Plan
OSS	Offshore Supply Ship
OSV	Offshore Support Vessel
Pig	In pipeline transportation, pigging is the practice of using devices known as pigs or scrapers to perform various maintenance operations inside a pipeline. This is done without stopping the flow of the product in the pipeline.
Pig receiver	A pig receiver is a device to get a pig out of a pipeline without interrupting flow
PL, PLU	Pipeline Identification numbers (UK)
ROVSV	Remotely Operated Vessel Support Vessel
SNS	Southern North Sea
SR20	Type of mechanical connector used for connecting lengths of casing
SSSV	Subsea Safety Valve
Spirit Energy	Sprit Energy Nederland B.V.
Seaway 7	Subsea 7 and Seaway Heavy Lifting
ST-1	Markham ST-1 Platform
TDS	Top Drive System (improve drilling efficiency by replacing the rotary table and travelling equipment with travelling rotary mechanism with a swivel provided with a mechanical handling system, or a power swivel)
Te	Metric Tonne (1,000kg)
UKCS	United Kingdom Continental shelf
USIT	Ultrasonic Imager Tool
UTM	Universal Transverse Mercator
Warm suspension	An installation is in ‘warm suspension’ when hydrocarbons are known to remain onboard and the wells have not yet been decommissioned, only isolated

EXECUTIVE SUMMARY

This document contains the close-out report for the two Markham ST-1 Decommissioning Programmes approved by the Secretary of State on the 22 February 2018, one for each set of notices under section 29 of the Petroleum Act 1998. The Decommissioning Programmes are:

- The Markham ST-1 installation (a steel jacket and topsides structure); and,
- The associated two pipelines, UK designated ID numbers PL992 and PL993.

The pipeline and umbilical cross the UK-NL Median Line, so the State Supervision of Mines (NL) was also consulted as part of the Statutory Consultation process.

Key elements of the approved Decommissioning Programmes are summarised below:

- The Markham ST-1 wells will be decommissioned;
- The Markham ST-1 installation will be fully removed to 2m below the seabed;
- Pipelines will be flushed, and most will be left *in situ* with the short end sections cut and removed to minimise snag hazards arising in future;
- In the UK sector the mattresses and sand or grout bags will be removed from near the ST-1 installation as part of the pipeline partial removal activities;
- In the NL sector, while the tie-in pipe spools along with the associated concrete mattresses and sand or grout bags will be fully recovered, the pipeline itself and the local concrete mattresses will remain with J6A until the installation is decommissioned.

The well decommissioning operations were completed 25 July 2018 taking a total of ~126 days.

The ST-1 installation was removed.

The 12” gas pipeline successfully pigged and flushed using a gel pig and chemical train with the associated fluids being transported along the pipeline using the mud pumps on the drill rig. The 2”/3” methanol line was successfully flushed.

Both pipelines were disconnected from the ST-1 and J6A platforms, with the pipelines being cut back to a burial depth equal to or greater than 0.6m below mudline. The concrete mattresses and grout bags were removed.

As a result of monitoring and a review of recorded data, the company believes that all residual risks to other users of the sea have sufficiently been removed and that a programme of future field infrastructure surveys would not provide any useful information in this regard. That is, the stability of the seabed and pipelines in this area is such that it would be unnecessary to conduct further inspection and verification work in future.

Analysis of environmental survey data also suggests that the local environment is in a state typical of the wider southern North Sea region. With no further site-specific anthropogenic inputs, it is felt that that natural degradation of contaminants should help restore the area to pre-developed conditions in a relatively short timescale. Accordingly, Spirit Energy proposes that no additional site and environmental surveys or inspection of remaining features in the Markham ST-1 area are necessary.

A trawl sweep of the ST-1 area was conducted by the NFFO. The overtrawl demonstrated that the area occupied by the ST-1 installation and infrastructure was clear of snagging hazards. However, the trawl sweep encountered an obstruction at 53°50.30 N 02°52.03 E. The snag had occurred on the Windermere infrastructure that had been disconnected from ST-1 but not yet formally decommissioned. As a result, the NFFO was unable to issue a clean seabed certificate. The snagging hazard has meantime been covered with a concrete mattress that will be recovered when Windermere is decommissioned. Current indications that Windermere will be decommissioned by end 2022 [3].

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1. INTRODUCTION

1.1 Purpose

This document contains the close out report for the two Markham ST-1 Decommissioning Programmes, one for each set of notices under Section 29 of the Petroleum Act 1998. The Decommissioning Programmes are:

- The Markham ST-1 installation (a steel jacket and topsides structure); and,
- The associated two pipelines.

The pipelines cross the median line into the Netherlands sector and covered by the Markham Treaty. Therefore, Spirit Energy and OPRED liaised with the State Supervision of Mines and the Ministry of Economic Affairs in Netherlands.

The Decommissioning Programmes [1] explain what was to have been achieved after completion of the decommissioning activities. The pipeline Decommissioning Programme is supported by a Comparative Assessment [6] and an Environmental Impact Assessment [7]. This decommissioning report provides the outcome of the ST-1 Decommissioning activities and marks the formal close out submission to the Offshore Petroleum Regulator for Environment and Decommissioning as described within their Guidance Notes [2].

1.2 Field Overview

The Markham field was discovered in 1984 and extends over license blocks 49/5a and 49/10b on the UK Continental Shelf and license blocks J3b and J6 on the Netherlands Continental Shelf.

ST-1 comprises six wells and a single installation connected via two pipelines (12” and piggybacked 2” nominal bore) to the Markham J6A installation on the Dutch sector 5.6km (measured via pipeline length, 5km as the crow flies) from the ST-1 installation. The pipelines cross the median line into the Dutch sector and are covered by the Markham Treaty. A cessation of production justification report was submitted to OGA on 22 April 2016 and approved 11 August 2016. Formal cessation of production from ST-1 occurred 11 April 2016.

The ST-1 installation and pipelines as well as the J6A installation are owned by the Markham partners. ST-1 was installed in 1994 and was a normally unattended installation (NUI) supported by a four-leg steel jacket in a water depth of 31m. Primary control was exercised from J6A. The decommissioned Stamford and live Grove pipelines cross the ST-1 to J6A pipelines in the J6A 500m zone in the NL sector.

Historically the ST-1 installation also exported gas to J6A from the Windermere installation which is operated by INEOS UK SNS Limited. The Windermere installation, pipeline and umbilical are addressed by separate Decommissioning Programmes submitted independently by INEOS [3].

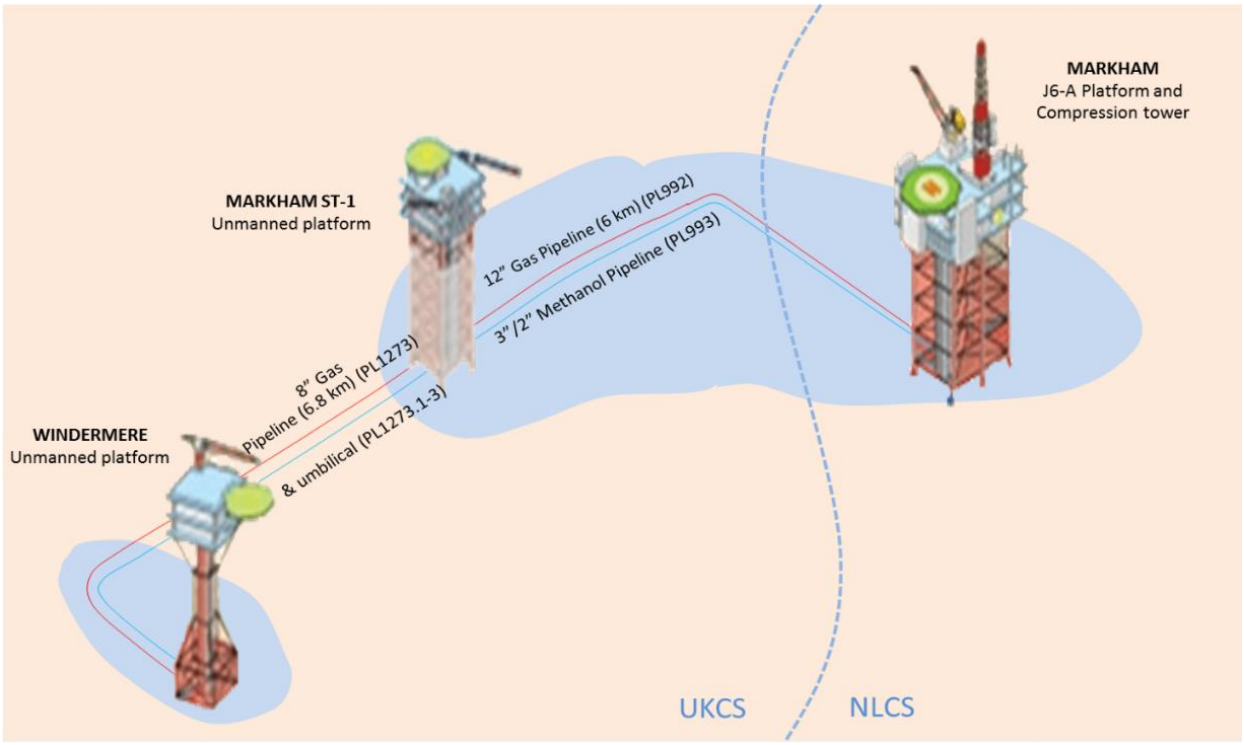


Figure 1.2.1: Markham & Windermere Field Layout

2. DECOMMISSIONING PROGRAMMES

The ST-1 Decommissioning Programmes underwent the Statutory Consultation between 13 July and 10 August 2016. The final version of the document was submitted to OPRED 31 January 2018 and approved by OPRED on behalf of the Secretary of State on 22 February 2018.

Key elements of the approved Decommissioning Programmes are summarised below:

- The Markham ST-1 wells will be decommissioned;
- The Markham ST-1 installation will be fully removed to 2m below the seabed;
- Pipelines will be flushed, and most will be left *in situ* with the short end sections cut and removed to minimise snag hazards arising in future;
- In the UK sector the mattresses and sand or grout bags will be removed from near the ST-1 installation as part of the partial pipeline removal activities;
- In the NL sector, while the tie-in pipe spools along with the associated concrete mattresses and sand or grout bags will be fully recovered, the pipeline itself and the local concrete mattresses will remain with J6A until the installation is decommissioned.

2.1 Overview of Assets being Decommissioned

Field Data			
Field(s):	Markham (ST-1)	**Production Type**	Gas
Water Depth (m)	Approx. 31m	**UKCS Block**	49/5a, 49/10b
Surface Installations			
Number	**Type**	**Topsides Weight (Te)**	**Jacket Weight (Te)**
1	Steel jacket	1,300	888(1)
Subsea Installation(s)		**Number of Wells**	
Number	**Type**	**Platform**	**Subsea**
n/a	n/a	6	0
Drill Cuttings pile(s)	**Water Depth (m)**	**Distance to median**	**Distance from nearest UK coastline**
Number of Piles	**Total Estimated volume (m^3)**	**km**	**km**
0	n/a	2.34	160

Table 2.1.1: Installation Being Decommissioned

Pipeline ID	Nominal Size (in)	Length (m)	Status, Other
PL992 Riser (ST-1)	12	58	On jacket
PL992 Pipespools (ST-1)	12	88	Underneath concrete mattresses
PL992 Flowline (UK/NL)	12	2,350/3,130	Trenched & buried
PL992 Pipespools (J6A)	12	49	Underneath concrete mattresses
PL993 Riser (ST-1)	12	58	On jacket
PL993 Pipespools (ST-1)	2	93	Underneath concrete mattresses
PL993 Pipeline (UK/NL)	2	2,347/3,127	Trenched & buried; piggybacked to PL992
PL993 Pipespools (J6A)	2	52	Underneath concrete mattresses

NOTES
1. The 3" Methanol and 12" gas pipelines risers at J6A (NL sector) are not listed here on the basis that they were originally installed with the J6A jacket;
2. UK/NL indicates the pipeline is cross-border, with the quoted lengths in UK/NL waters, respectively.

Table 2.1.2: Pipelines Being Decommissioned

[1] The jacket weight excludes the weight of conductors. Including conductors this weight increases to 1,219 Te

3. AMENDMENTS TO & DEVIATIONS FROM THE DP

3.1 Amendments

No formal amendments were made to the approved Decommissioning Programmes, but three deviations were discussed and agreed with OPRED. The deviations are described in Table 3.1.1:

Description of Deviation	Reference in DP	Reason for Deviation Request
Width of pipeline survey corridor reduced from 200m to 100m	Section 6.5 & 6.6	Annex C Article 15 in the DECC Guidance Notes v4 March 2011 refers to a pipeline corridor 200m wide. The more recent Guidance Notes November 2018 have modified this requirement to a 50m wide corridor either side of the pipeline(s) in article 12.39.
Overtrawl of Markham ST-1 500m zone only, not the pipeline	Section 6.5 & 6.6	The most recent Guidance Notes (November 2018) explain that this is an exceptional requirement; no decommissioning work was conducted along the pipeline(s) outside of the 500m zone; disturbance to the seabed is minimised.
No post-decommissioning environmental survey.	Section 6.5 & 6.6	The most recent Guidance Notes (November 2018) explain that there may be instances where a post-decommissioning environmental survey would be required, where for example, there is significant contamination in the vicinity of an installation. In the instance of Markham ST-1 there is no significant contamination in the vicinity of the installation. On reviewing the environmental data and due to low contamination levels demonstrated in previous correspondence OPRED are content that no post-decommissioning survey would be required.

Table 3.1.1: Deviations to the Decommissioning Programmes

4. DECOMMISSIONING ACTIVITIES

The following section describes the completed decommissioning activities, how they were executed and confirms that the completed activities were carried out in accordance with the approved DPs. Decommissioning activities carried out on pipelines PL992 & PL993 are provided in more detail within section 5 of this report.

The execution phase was split into four distinct phases:

- Well decommissioning;
- Pipeline decommissioning;
- Removal of the installation; and,
- Post-decommissioning surveys.

This was deemed to be the best execution strategy from a cost and scheduling perspective.

4.1 Well Decommissioning

4.1.1 Overview

The B391 rig move commenced from Harwich and reached the Markham ST-1 500 m zone at 12:00 on 6th March 2018. The rig was located alongside the ST-1 platform, the jack-up rig legs preloaded, and the rig jacked up to the required elevation. Platform interface work was performed by Tyco. B391 / ST-1 platform interface was completed, and the wells officially handed over from production in readiness for decommissioning at 15:00 16/03/18.

Well decommissioning activities included the decommissioning of six wells and the removal of an unused conductor. All ST-1 wells were decommissioned using batch operations. This was for two reasons: 1) to promote efficiency during similar operations and 2) to minimise non-productive time should any difficulties be encountered during decommissioning operations.

Initial set-up and demobilisation took ~16 days. Ignoring initial set-up and demobilisation the well decommissioning operations were completed 25 July 2018 taking a total of ~126 days. Removal of the seventh conductor string took ~2 days. Each well took an average of 18 days, although it took an overall 38 days to decommission 49/5a-B6, which was particularly problematic, and so if as an outlier this well was to be ignored each well took an average ~16 days to decommission, ignoring set-up time.

Total batch times for each phase were as follows:

- Phase 1 - Well kill operations: 37.4 days;
- Phase 2 - Tree recovery 2.3 days;
- Phase 3 - Recover completion tubing & install permanent plugs 74.2 days;
- Phase 4 -- Multi-string conductor recovery 13.8 days (seven well slots).

4.1.2 Well 49/5a-B1

The original exploration well 49/5a-6z was drilled using a mud line hanger system in January 1991 and after flow testing it was suspended while the ST-1 platform was installed. After the ST-1 platform was installed and tied back to Markham J6-A, the well was completed and put into production in 1994. It was renamed 49/5a-B1.

Well 49/5a-B1 penetrates the Rotliegend Lower Leman Sandstone Formation. It is S-shaped and deviated 49° at 3,258m, before dropping to 32° through the reservoir. The original 49/5a-6 well bore did not have a satisfactory permanent barrier in place to isolate the surface from any pressure from the Plattendolomite layer.

Well decommissioning operations took a total of ~21 days to complete with NPT being recorded as indicated in Table 4.1.1. During phase 1 a slickline failure caused a delay in progress otherwise

there were no issues arising in either phase 1 or phase 2 of the decommissioning operations. During phase 3 the short section of 4-1/2" velocity string above the SSSV couldn't be recovered separately using a spear so it was recovered along with the completion. Placement of the combination abandonment plug set as 3x stacked cement plugs isolating both the Leman sandstone and the Plattendolomite also went as per programme.

Just prior to recovery of the upper portion of 7" liner and 9-5/8" casing string was determined that the 9-5/8" mudline hanger has been badly damaged with the 9-5/8" casing had severed and previous attempts to recover the mudline hanger had been unsuccessful The upper portion of 7" liner was cemented to the 9-5/8" casing from the top of the liner at 174m to the depth of severed 9-5/8" casing at 456m MMDBRT. This necessitated a change in the well decommissioning programme to include a cement bond log using USIT via wireline to verify the quality of the cement in the 7" x 9-5/8" annulus, and placement of cement in the both the 7" liner and 9-5/8" x 13-3/8" annulus across the critical depth of 390 – 460 MDBRT. These operations were carried out successfully and a verification pressure test successfully performed on the cement inside the 7" liner. However, it was not possible to obtain a test on the 9-5/8" x 133/8" annular cement and an additional section of 9-5/8" casing was recovered, and a plug successfully placed and tested inside the 13-3/8" casing, bring the phase 3 operations to a satisfactory conclusion.

Phase 4 recovery operations went well, although the original plan was to back out both the 13-3/8" and 20" casings strings at the mudline hanger. The earlier issues experienced with removing the 9-5/8" casing at the mudline hanger as well as reliability issues with the cutting tools led to the 13-3/8" and 20" casings being cut 10ft below mudline rather than removed down to the mudline hanger. The 30" conductor stump was cut and recovered as per programme.

Non-Productive Time for each of the phases was recorded as follows:

PHASE	NPT (DAYS/HRS)	EXPLANATION
Phase 1	12 hrs	Failure of slickline tool
Phase 2	0	None to report
Phase 3	33.6 hrs	Suspend B1, skid to another well while preparing a revised work programme, re-enter B1 well
	76.8 hrs	Remedial decommissioning operations to place and verify a 13-3/8" abandonment plug - 3.2 days
Phase 4	0	None to report
SUB-TOTAL:	**122.4 hrs**	

Table 4.1.1: Well 49/5a-B1 NPT

All activities were consented under the appropriate permits and monitored throughout operations by an independent well examiner. The decommissioned well schematic is included in Appendix A.1.

4.1.3 Well 49/5a-B2

The 49/5a-B2 well used as a disposal well for four of the other ST-1 well annulus fluids. Wellhead and Tree integrity checks were performed, and the well was constantly monitored by the rig's Tally Book system. The well was used to dispose of A-Annulus fluids from the B1, B3, B4, and B6 wells.

During phase 1 problems with the explosive cutter meant that alternative cutting tools needed to be sourced and a pause in operations; the rig was meantime skidded to well B5. The decommissioning operations were successfully resumed a couple of days later. Phase 2 operations were carried out without incident.

Overall, phase 3 operations were eventually implemented in line with the decommissioning programme. The completion tubing was recovered, the zones of flow potential, Leman and Plattendolomite were successfully isolated and any remaining OBM behind the 9-5/8" casing was isolated with an abandonment cap, but some issues did arise as operations progressed resulting in NPT being recorded.

Phase 4 recovery operations generally went well, the original plan had been to recover the 13-3/8", 20" and 30" casing string together. However, the drill rig had become so proficient at skidding that the B2, B3, B4, B5 & B6 13-3/8" casing strings were recovered as a batch operation. This proved very efficient and should be considered as the base plan for similar operations in future.

The 20" and 30" casings were recovered together. Construction records showed that the 20" casing was cemented to surface and should be cemented together but during operations for this well the 20" was not cemented to the 30" from 3m below mudline; therefore the 20" and 30" strings were recovered separately. This approach did have slight benefits in that the recovering the 20" and 30" string separately meant that the 30" could be cut using a radial band torch which was significantly faster than using the Bandsaw. The drill and pin approach were still used to lift out the 30" casing with the SR20 connections.

It is worth mentioning that while the 20" spear furnished with a grapple had successfully been deployed through the GE starter head in 5 other wells it couldn't pass through the starter head on this well. This was remedied by increasing internal diameter of the starter head by local grinding. Thereafter it was possible to redeploy the spear and grapple. This could not have been foreseen prior to the offshore work and serves to indicate operational issues that can arise.

This well took a total of ~17 days to decommission, and NPT for each of the phases was recorded as follows:

PHASE	NPT (DAYS/HRS)	EXPLANATION
Phase 1	21.25 hrs	Explosive Cutter miss-run x2
	15 hrs	Rig up and run alternative E-Line Cutter
Phase 2	0	None to report
Phase 3	33.6 hrs	Suspend B1, skid to another well while preparing a revised work programme, re-enter B1 well
	76.8 hrs	Remedial decommissioning operations to place and verify a 13-3/8" abandonment plug - 3.2 days
	1.25 hrs	Unable to release the tubing hanger retrieval tool from the completion hanger.
	11.5 hrs	Delays in arrival of NORM inspector due to adverse weather
	8.25 hrs	Casing cutting tool failure
Phase 4	2 hrs	incorrect cross-over available to run plug on 2-7/8" pipe
	1.5 hrs	Investigation of leak observed on swivel packings
	3 hrs	Unable to insert grapple inside wellhead housing
Phase 4	0	None to report
SUB-TOTAL:	**~174.15 hrs**	

Table 4.1.2: Well 49/5a-B2 NPT

All activities were consented under the appropriate permits and monitored throughout operations by an independent well examiner. The decommissioned well schematic is included in Appendix A.2.

4.1.4 Well 49/5a-B3

As with the other wells this well was decommissioned as part of the overall batching operations taking a total of ~15 days to complete. Phase 1, phase 2 were successfully completed without loss but NPT occurred during phases 3 and 4.

PHASE	NPT (DAYS/HRS)	EXPLANATION
Phase 1	0	None to report
Phase 2	2 hrs	NT-2 actuator bolt sheared as a result of using incorrect torque settings that were incorrectly documented
Phase 3	27 hrs	GE keeper ring not installed
	8 hrs	GE unable to satisfy pressure test
Phase 4	3.75 hrs	Cut not successfully completed on first run on conductor, albeit successful subsequently
	26 hrs	Re-cut of 20" casing and 30" conductor near mud line
Phase 4	0	
SUB-TOTAL:	**~66.75 hrs**	

Table 4.1.3: Well 49/5a-B3 NPT

All activities were consented under the appropriate permits and monitored throughout operations by an independent well examiner. The decommissioned well schematic is included in Appendix A.3.

4.1.5 Well 49/5a-B4

As with the other wells this well was decommissioned as part of the overall batching operations. All phases of decommissioning this well took a total of ~14 days, and the work was completed without incident and without NPT. The decommissioning activities involved the following:

Pre-operations: This work included operations that could be done prior to operations that required the rig to be over the well slot and included in-flow tests and pressure testing of various valves including swab valves, annulus valves, wing valves and cross-over valves.

- Phase 1 - Kill well and install temporary barriers;
- Phase 2 - Remove Xmas tree;
- Phase 3 - Recover completion tubing and install permanent barriers;
- Phase 4 - Cut and recover 13-3/8” and 20” casing strings and 30” conductor string.

All activities were consented under the appropriate permits and monitored throughout operations by an independent well examiner. The decommissioned well schematic is included in Appendix A.4.

4.1.6 Well 49/5a-B5

As with the other wells this well was decommissioned as part of the overall batching operations. All phases of decommissioning this well took a total of ~21 days, and NPT for each of the phases was recorded as presented in Table 4.1.4. Further NPT was offset by suspending the well and skidding to another well to carry on with batch operations there. The decommissioning activities involved were the same as described earlier.

PHASE	NPT (DAYS/HRS)	EXPLANATION
Phase 1	14.5 hrs	Failure of deep-set plug
	22.75 hrs	Loss of circulation after tubing cut
Phase 2	0	None to report
Phase 3	18 hrs	B annulus pressure well control issues
	9 hrs	Wellhead issues
	36.75 hrs	Further wellhead issues
	61.75 hrs	Problems setting bridge plugs
Phase 4	0 hrs	None to report
SUB-TOTAL:	**~162.75 hrs**	

Table 4.1.4: Well 49/5a-B5 NPT

All activities were consented under the appropriate permits and monitored throughout operations by an independent well examiner. The decommissioned well schematic is included in Appendix

A.5.

4.1.7 Well 49/5a-B6

Well 49/5a-B6 was drilled & completed by the Noble Lynda Bossler jack-up MODU for CH4. It was spudded on the 5th of Oct 2004 and handed over to production operations on the 28th of Feb 2005.

The well design differed from the earlier B1 through B5 wells. Casing setting depths are different, and the well is significantly deeper. The tubing is 4½" monobore from surface to the reservoir.

B6 penetrates the Leman Sandstone Formation at 5,508m. The well is S-shaped. It builds to 68° at 4,115m and drops back to 26° before penetrating the Leman reservoir at 5,508m MDBRT. Well TD was 5655 m MDBRT.

As with the other wells this well was decommissioned as part of the overall batching operations but was the most problematic, taking an overall 38 days to complete. Outside of normal operations, contributors to the time taken to decommission the well include operations and troubleshooting associated with the following:

Phase 1

- 2" choke valve on B2 annuls had a seal that had disintegrated;
- The drift tools could not be recovered into the catcher and continued to jam when the drift tool string was being recovered to surface; this was thought to be due to the presence of small amounts of grease across one of the drift keys and the re-zero button was not fully reset; on inspection the tool string was found to have small dent;
- There were issues with the tubing cutter; a faulty detonator was considered to be the cause.

Phase 3

- H_2S alarms causing interruptions to operations for a few hours while the cause was investigated, and safety protocols followed;
- Unplanned increase in well pressure that needed investigating;
- Split insert packer badly deformed and the diverter outer package seals inside the packer housing were damaged. This required the diverter to be stripped down with the outer packer being replaced;
- Leaking flowline to Gumbo box that needed rectification;
- Pressure spikes and stalling incidents due to worn knives;
- High torque readings in TDS during milling operations due to calibration issues;
- Contamination of Gumbo box and trip tank due method used for cleaning casing joints coated in heavy OBM residues, leading to additional decontamination work.

Phase 4

- Problems with recovering 8m long section of 20" casing before establishing it was cemented inside the 30" conductor.

All phases of decommissioning this well took a total of ~38 days, and the work was completed without incident. The decommissioning activities involved the following:

Total batch times for each phase were as follows:

- Phase 1 - Well kill operations ~12 days
- Phase 2 - Tree recovery 7 hours (i.e. <1 day);
- Phase 3 - Recover completion tubing & install permanent plugs ~24 days
- Phase 4 -- Multi-string conductor recovery ~2 days

PHASE	NPT (DAYS/HRS)	EXPLANATION
Phase 1	0 hrs	None to report
Phase 2	0 hrs	None to report
Phase 3	20.5 hrs	Losses / well control
	21.25 hrs	Paragon diverter element failure
	32.75 hrs	Knife wear
	38.75 hrs	Knife wear
	31.5 hrs	Knife wear
Phase 4	29.25 hrs	Weatherford fishing
SUB-TOTAL:	**~174 hrs**	

Table 4.1.5: Well 49/5a-B6 NPT

All activities were consented under the appropriate permits and monitored throughout operations by an independent well examiner. The decommissioned well schematic is included in Appendix A.6.

4.2 Pipeline Decommissioning

4.2.1 Pipeline flushing

Decommissioning of the two ST-1 pipelines was carried out during two separate campaigns. The intention was that this work would be carried out in advance of the removal of the platform with contingency should there be delays. The first of which was the pipeline flushing and cleaning campaign using the ROVSV, the Skandi Acergy. The vessel mobilised from Peterhead on the 22nd of April 2018 and de-mobbed back in the same Port on the 1st of May 2018. As the Paragon B391 jack-up drilling rig was stationed alongside ST-1 for the well decommissioning campaign, it was used for accommodation and to support the pipeline flushing campaign.

The Skandi Acergy vessel was set up alongside the J6A platform with a filtration spread onboard to receive fluids via temporary pipework connected to the pig receiver on the platform. Originally the intention had been to discharge oil in water within acceptable limits overboard directly from the ROVSV under the appropriate permit, although the NL regulations were such that any fluids could not be discharged from a non-fixed asset and so had to be sent back to J6A and discharged from there. Refer Figure 4.2.1.

The filtration spread on the ROVSV was provided by Cetco Energy Services working with Altus Intervention and used several vessels and equipment, including 12x 20m^3 tote tanks[2], filtration units, hydrocarbon coalesce and absorption media, pumps, laboratory, air dryer, and nitrogen gas quads.

[2] This quantity of tanks was mobilised as a contingency measure to accommodate potentially untreatable fluids.

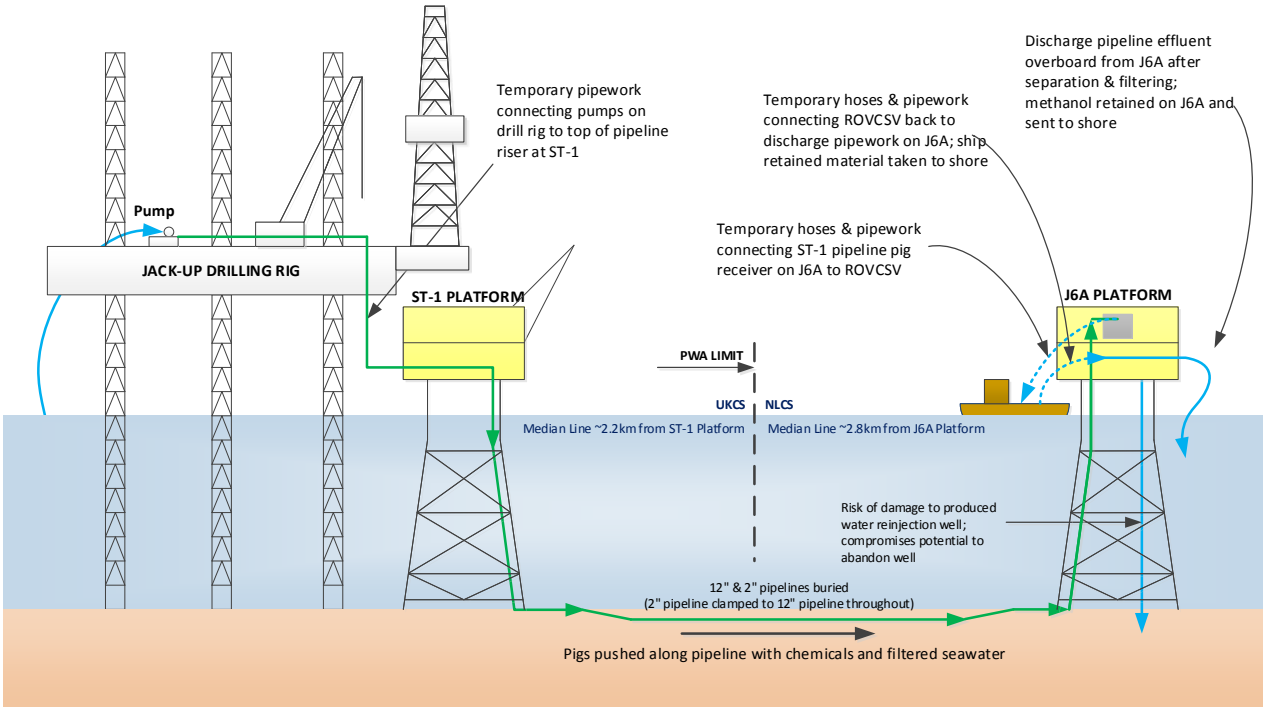


Figure 4.2.1: ST-1 to J6A pipeline flushing arrangement

The gel pigs and chemical train (Figure 4.2.2) were loaded into the pipeline from the ST-1 topsides prior to the vessel arriving in field. Access to ST-1 was via the Paragon jack up drill rig the B391, and pipeline flushing was conducted via drill rig pumps.

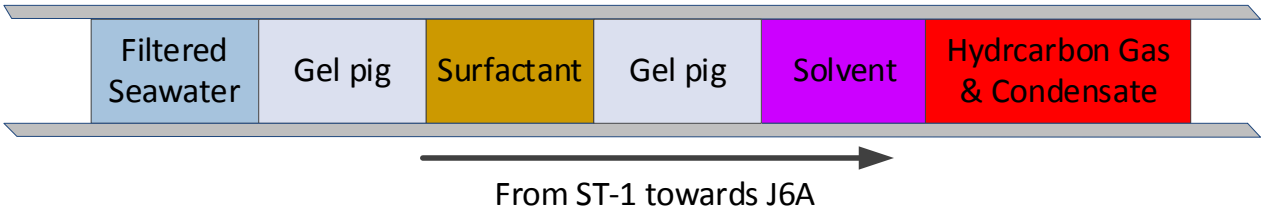


Figure 4.2.2: Pig train used for 12” Gas Pipeline

The flow rate was originally intended to be 800 litres per minute but due to restrictions after the pig receiver the flow rate had to be reduced to prevent pressure building up in excess of the MAOP of the filtration spread, 16barg. Flow rate averaged around 180 litres per minute.

The method initially used for analysis of the fluids discharged from the 12” gas pipeline before potentially being discharged overboard initially returned inconsistent results. Therefore, the oil in water analyser on J6A was used to demonstrate that the pipeline was left in a clean condition prior to being decommissioned. J6A uses a recognised reference method.

The 2” methanol pipeline was flushed from ST-1 to J6A with the contents captured in two steel iso tanks connected to a discharge point taken from the methanol pipeline on J6A.

It took ~10 days to carry out the flushing activities, including mobilisation (<48 hours) and demobilisation activities at from and to Peterhead harbour.

4.2.2 Removal of stability and protection features

The second campaign to complete the decommissioning activities associated with both pipelines was to remove the stability and protection features and to disconnect both from the ST-1 and J6A platforms, cut sections back to the required burial depth.

The recovery of mattresses and grout bags took place as part of the S7 ROVSV subsea

decommissioning campaign carried using the EDT Jane. The vessel mobilised on the 9th of September 2018 and demobilised on the 3rd of October 2018.

The primary method for removing the mattresses was to be the 'curtain lift' method using a lifting frame connected to the mattress lifting loops by ROV friendly snap hooks.

Prior to the removal of the mattresses a survey was carried out using an ROV to confirm the condition and number of mattresses to be removed and their burial status. From this, the mattresses were thought to be in good condition.

Although they were thought to be in good condition, their design was such that the 3.5m long polypropylene lifting loops that had originally been used to install the mattresses disintegrated when being lifted. The polypropylene rope used to bind the concrete blocks in the mattress also disintegrated. Therefore, a contingency measure was used. This involved using a hydraulic grab to recover the mattresses into a basket while any smaller pieces left behind were recovered by ROV to baskets temporarily placed on the seabed. The baskets were recovered to the deck of the ROVSV. Some whole mattresses were successfully placed into the basket, but this was by exception rather than the rule.



Figure 4.2.3: Concrete mattresses & rigging, failed polypropylene rope

All the grout and sandbags were removed from the seabed using a hydraulic grab with half-shell bucket attachments, once lifted from the seabed they were decanted into a subsea basket and recovered to deck.

4.2.3 Pipeline disconnection

The second campaign to complete the decommissioning activities associated with both pipelines was to disconnect both from the ST-1 and J6A platforms, cut sections back to a burial depth equal to or greater than 0.6m below mudline.

Product	Cut Location (UTM)	Cut Location WGS84 Decimal	WGS84 Decimal Minute
PL992 12" pipeline	491490.28 E 5966142.63 N	53.84372695° E 2.870662697° N	53°50.6236' E 2°52.2398' N
PL993 2" Pipeline	491490.28 E 5966142.63 N	53.84372695°E 2.870662697°N	53°50.6236' E 2°52.2398' N

Table 4.2.1: Summary of Cut Locations @ST-1 (UK)

Figure 4.2.4: PL992 & PL993 both severed

For the ST-1 jacket to be removed the Windermere pipelines also had to be severed.

Product	Cut Location (UTM)	Cut Location WGS84 Decimal	WGS84 Decimal Minute
PL1273.1-3 Windermere Umbilical	491369.00 E 5966168.80 N	53.84396017° E 2.86881866° N	53°50.63761022' E 2°52.12911958' N
PL1273 Windermere 8" Pipeline (near 1st mat)	491398.80 E 5966154.80 N	53.84383483° E 2.869271976° N	53°50.63008984' E 2°52.15631858' N

Table 4.2.2: Summary of PL1273 & PL1273.1-3 Cut Locations @ST-1 (UK)

Figure 4.2.5: Windermere pipeline PL1273 severed (mattress in foreground)

Product	Cut Location (UTM)	Cut Location WGS84 Decimal	WGS84 Decimal Minute
PL992 12” pipeline at riser	496371.2 E 5964072.4 N	53.82517642° E 2.94487107° N	53°49.51058499’ E 2°56.69226423’ N
PL992 12” near pipeline flange	496355.9 E 5964065.0 N	53.8251098° E 2.94463872° N	53°49.50658782’ E 2°56.67832319’ N
PL993 2” pipeline at riser	496371.4 E 5964072.1 N	53.82517372° E 2.944874112° N	53°49.51042329’ E 2°56.69244674’ N
PL993 2” near pipeline flange	496336.3 E 5964065.4 N	53.82511325° E 2.944340951° N	53°49.50679527’ E 2°56.66045708’ N

Table 4.2.3: Summary of Cut Locations @J6A (NL)

Figure 4.2.6: PL992 & PL993 severed at J6A @mattresses and riser)

4.3 Removal of the ST-1 Installation

Removal of the ST-1 installation was planned to be flexible allowing time for the well decommissioning and pipeline decommissioning activities to be completed, allowing for potential delays. It was removed using the monohull crane vessel Seaway Strasnov during an offshore campaign that took place in the summer of 2019. The vessel mobilised from Rotterdam on 13th June 2019 and demobilised back to Rotterdam on 21st July 2019.

Worksite preparations for the topsides lift included initial 'make safe' activities carried out by the Spirit Energy operations crew and delegated crew members from the lift vessel. Once the 'make safe' was completed and signed off the gangway bridge link was landed to allow pre-removal activities to take place.

Preparatory activities that were carried out prior to the removal of the topsides included the following;

- Installation of a gangway between the ST-1 platform and the crane vessel;
- Installation of lifting points;
- Lowering and pinning of caissons;
- Removal of solar panels from helideck to remove clash with the rigging used for removing topsides;
- Disconnection of all components between the topsides and jacket;
- Removal of risers and J-tube.

Once the preparatory works had been completed the following activities were carried out:

- Installation of rigging to the lifting points;
- Sever topsides from the jacket legs above the spider deck;
- Remove the gangway connecting the crane vessel to the topsides;
- Lift and remove topsides;
- Sea-fasten topsides to the back deck of the crane vessel.

Once the topsides were landed on the deck of the crane vessel and secured in place for sea-fastening the jacket removal preparation works were completed. These activities included:

- Cut and remove jacket stubs;
- Installation of work platform;
- Installation of gangway;
- Installation of rigging platform;
- Installation of lifting points;

- Dredge soil plugs from piles to required depth;
- Installation of rigging – connection of rigging between lifting points and the lift vessel crane;
- Cut jacket piles at 2m below mud line;
- Removal of gangway just before lifting of jacket;
- Lift jacket and cut pile stubs once inboard;
- Lower jacket to deck of crane vessel and sea-fasten onto supporting grillage;
- Installation of a single mattress to cover the end of the Windermere pipeline (the snag hazard);
- Perform post removal seabed survey using ROV.

Once the jacket was removed the lift vessel transported the Topsides & Jacket to the Veolia/Peterson decommissioning facility in Dales Voe in Shetland for dismantling.

4.4 Post-Decommissioning Surveys

An overtrawl survey was conducted by NFFO between 25 and 27 July 2019 using a standard ground rig with tickler chains with no net attached over several overlapping trawl sweeps to give good ground contact covering the whole 500m zone. The trawl sweeps were recorded on an electronic navigational plotting system to demonstrate that the full 500m zone had been covered.

On two of the days the trawl sweep encountered an obstruction at 53°50.30 N 02°52.03 E. On further inspection it was identified that the snag had occurred on the Windermere infrastructure that had been disconnected from ST-1 but not yet formally decommissioned (Refer Figure 4.2.5 presented earlier). As a result, it was inappropriate for NFFO to issue a clean seabed certificate, but an end of campaign report identified the locations of the snag. INEOS confirms that their intention is to remove the mattress installed to cover the end of the Windermere pipeline at the time it is formally decommissioned.

5. BURIAL STATUS OF PIPELINES

5.1 Survey 2017

Since they were originally installed in 1994, as is shown in Figure B.1.1 (the original as-laid profile inside the trench), Figure B.2.1, and Figure B.3.1 Appendix B, both pipelines have continued to exhibit excellent burial and depth of cover with no migration of seabed sediment over the survey periods. The pipeline severance locations are shown in Figure 5.1.1

On this basis, Spirit Energy would propose not to carry out any additional pipeline status surveys for PL992 or the piggybacked PL993 in future.

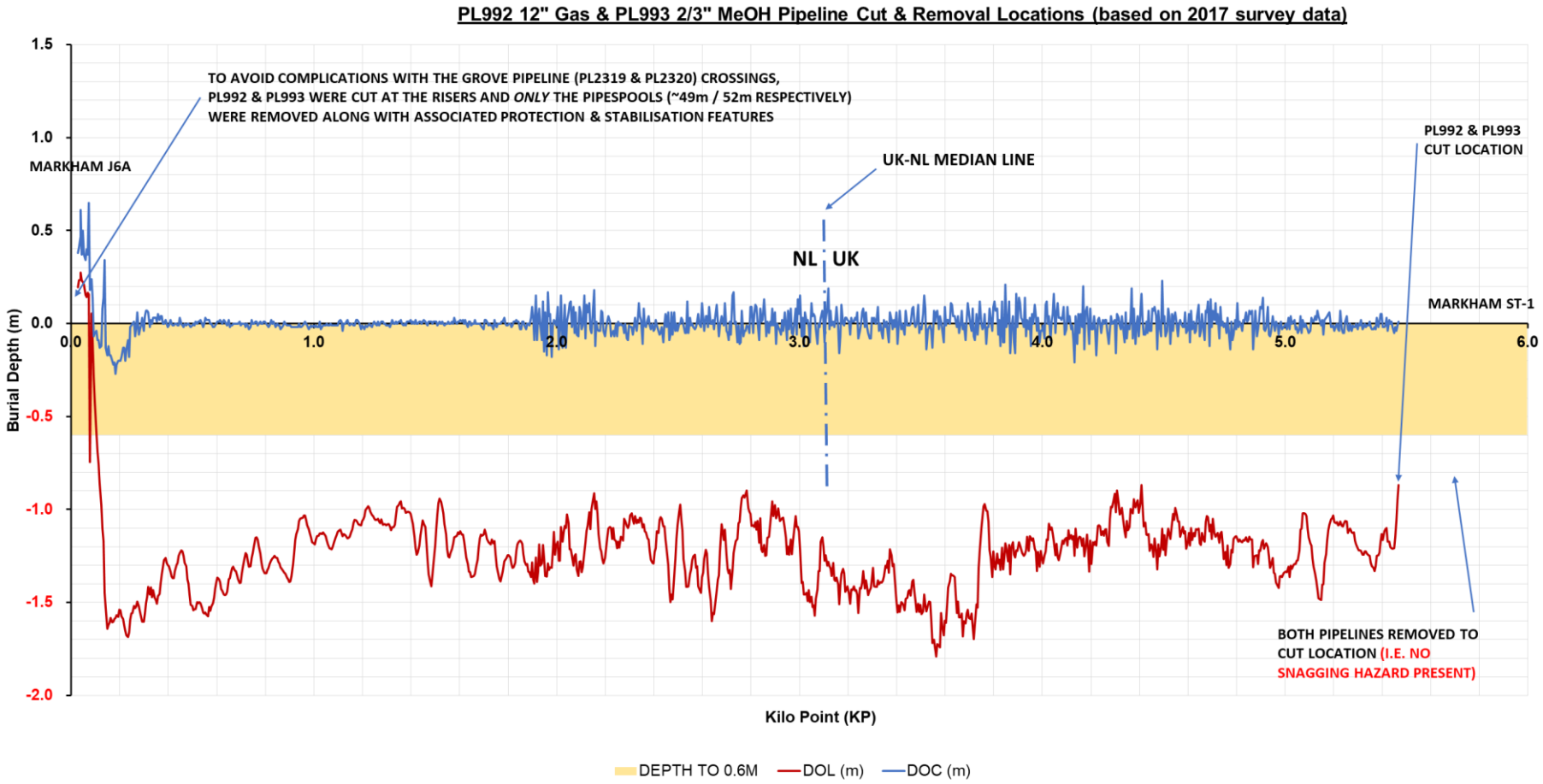


Figure 5.1.1: PL992 & PL993 Cut & Removal Locations

6. ENVIRONMENTAL IMPACT AND PERFORMANCE

6.1 Permits and Licenses

The decommissioning work was undertaken under the existing OPEP for the facilities (OPEP Reference number 2053). The scope of the OPEP includes well.

The Environmental Impact Assessment was submitted to OPRED as a supporting document to the decommissioning programme for the Markham ST-1 field. The decommissioning programmes and supporting documents were submitted to OPRED for public consultation on the 13th of July 2016.

Following consultation, notification for approval of the decommissioning programmes was given by OPRED[3] on 22nd February 2018. The works undertaken were aligned with the proposals submitted in the Decommissioning Programmes and the supporting documents, including the Environmental Impact Assessment.

The permits and licences obtained for the decommissioning of the ST-1 facilities are shown in Table 6.1.1 including their current status.

Permit	Reference Number Approval Date	Status
Consent to Locate	CL/161/5 Version 5 21 Dec 2017	Life permit
Marine License	ML/296/4 05 July 2019	License expired 30 Sept 2019
Marine License	PLA 501 ML/297/1 07 August 2018	License expired 31 Dec 2018
Chemical Permit	PLA501 CP/1557/0 15 March 2018	Permit expired 31 Dec 2018
Oil Discharge Permit	PLA 501 OTP/672/0 18 May 2018	Permit expired 01 Dec 2018
Oil Pollution Prevention & Control (OPPC)	L00084.21	Life Permit surrendered via OLP/274
Environmental Permit Radioactive Substances	EPR/NB3792DD/V002 28 Feb 2018	This is in the process of being relinquished
Pipeline Works Authorisation	PA2350 179/V/17 26 July 2017	Variation consented 26 July 2017
Pipeline Works Authorisation	PA2512 29/V/18 26 March 2018	Variation consented 26 Mar 2018

Table 6.1.1: ST-1 Permits & Licenses (UK)

6.2 Environmental Surveys

An environmental baseline survey including habitat investigation was undertaken by Fugro Surveys Ltd. in September 2013 [10] [11]. The survey area included the ST-1 installation and the pipeline route to the J6A platform.

The maximum tidal current speed in the Markham area during mean spring tides is between

[3] As a formal consultee, there was no objection to the decommissioning proposals from State Supervision of Mines.

0.51m/s and 1.02m/s (1 - 2 knots). Surge and wind–driven currents, caused by changes in atmospheric conditions, can be much stronger and are generally more severe during winter. Wave heights are variable with 15% of winter waves and 2% of summer waves exceeding 4m.

Survey data was interpreted as showing a sandy seabed along the pipeline route with some areas of overlying gravel and pebbles.

Like the surrounding area, the phytoplankton community around ST-1 is dominated by the dinoflagellate genus *Ceratia* while, in terms of abundance, the zooplankton communities are dominated by copepods and, Calanus *spp*.

The area has a sparse assemblage of epifauna typified by low species abundance and diversity at all stations. Visible epifauna comprised sea stars (Asteroidea including *Asterias rubens*, *Astropecten irregularis* and *Luidia sarsii*), and crabs (*Brachyura*). Grab samples from the area suggest a relatively homogenous community present throughout the area.

Several commercially important fish species are known to spawn in the area. These include cod, herring, mackerel, plaice, sprat and *Nephrops*. In addition, the area is also recognised as a nursery ground for several species including *Nephrops*, anglerfish, cod herring, sandeel, sprat and whiting.

Harbour porpoise, minke whale, pilot whale and white-beaked dolphin have been sighted in the area around ST-1.

Seabird vulnerability to surface pollution in the area varies throughout the year ranging from very high in November and December, to medium to high throughout the rest of the year.

The nearest protected area to the ST-1 installation and subsea infrastructure is the Klaverbank Site of Community Importance (SCI) located within the Dutch waters through which the gas and methanol pipelines between ST-1 and J6A pass. Klaverbank is the only site in the Dutch North Sea where considerable quantities of gravel lie on the surface and larger cobbles with a specific covering of calcareous red algae also occur. The nearest protected area in UK waters is the North Norfolk Sandbanks and Saturn Reef SCI *c.*35km from the development. This area is protected due to a series of ten main sandbanks and associated fragmented smaller banks formed as a result of tidal processes and areas of *Sabellaria spinulosa* biogenic reef. The nearest recommended Marine Conservation Zone (MCZ) is Markham's Triangle, *c.*3km north of ST-1.

The nearest protected areas to the Markham ST-1 installation are the Klaverbank SCI, the North Norfolk Sandbanks and Saturn Reef SCI and the Dogger Bank SAC located c.2km east, 35km south and 50km north, respectively as shown in Figure 6.2.1.

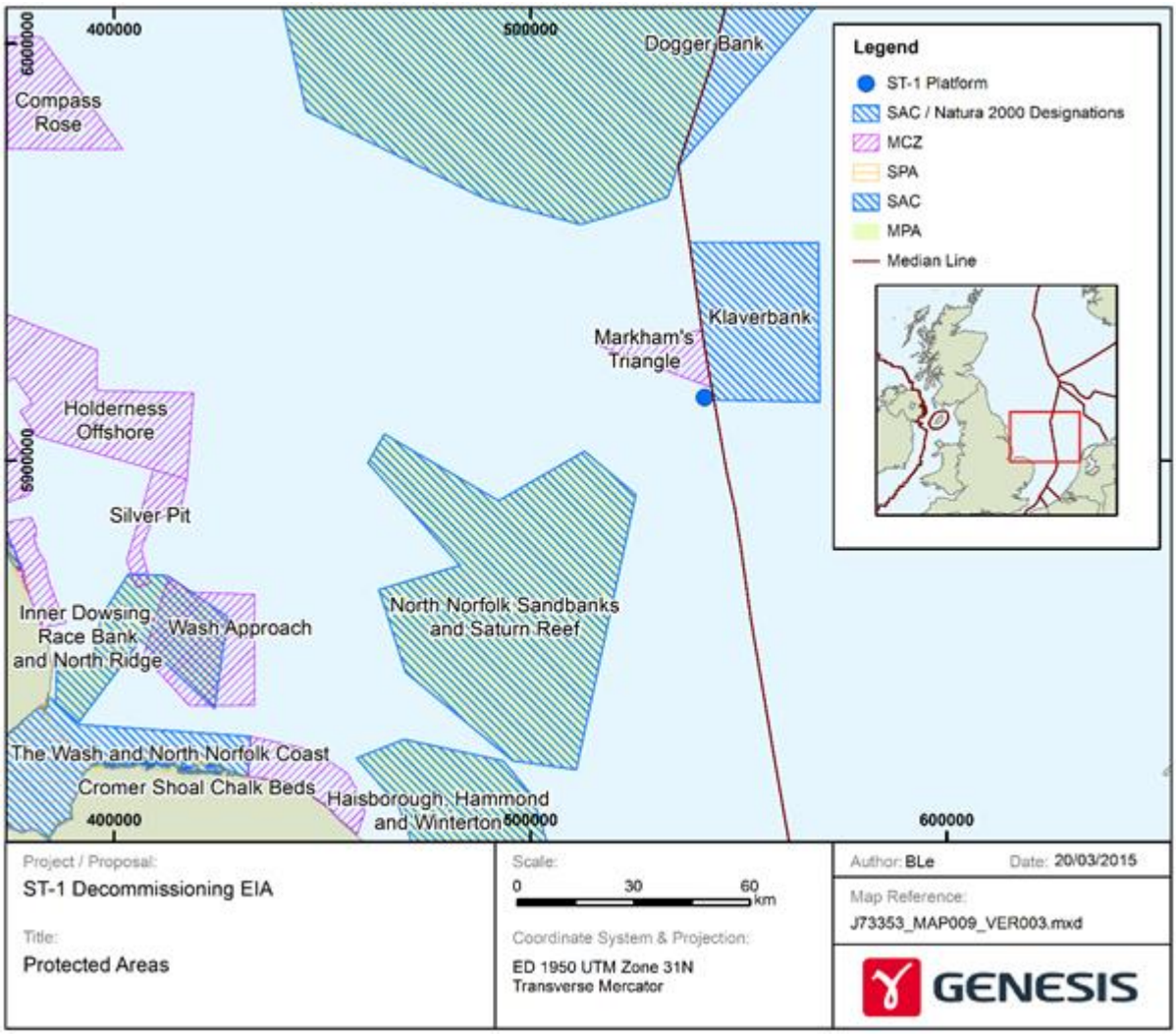


Figure 6.2.1: SACs/SCIs, SPAs, and Natura 2000 sites in the region of ST-1

The results of the survey are discussed in the environmental impact assessment that supported the decommissioning programmes and shall not be repeated here. The conclusion of the assessment was that the potential for significant impacts because of decommissioning ST-1 is low. Generally, the impacts identified were assessed as short-term and localised with low potential for long term or wider field impacts. No significant environmental incidents occurred during the decommissioning activities and this combined with the results of the baseline survey conducted prior to decommissioning were such it was not considered necessary to carry out a post-decommissioning environmental survey.

6.3 Waste Management Performance

6.3.1 Commitments

Waste was to be dealt with in accordance with the Waste Framework Directive. The reuse of an installation or pipelines - or parts thereof, is first in the order of preferred decommissioning options. Steel and other recyclable metal are estimated to account for the greatest proportion of the materials inventory. The estimated mass of material to be returned to shore and aspirations for the disposal of waste were described in the decommissioning programmes (Table 6.3.1 and Table 6.3.2).

Inventory	Region	Total Inventory Tonnage	Planned tonnage to shore	Planned tonnage decommissioned *in situ*	Planned tonnage left *in situ* (deferred)
Installations	UK	3,180	2,482	698	0
	Netherlands	n/a	n/a	n/a	n/a
Pipelines	UK	514	120	394	0
	Netherlands	642	51	525	66

Table 6.3.1: Inventory Disposition

In the decommissioning programmes a distinction was made between the planned quantity decommissioned *in situ* and that in the Dutch sector for which decommissioning was to be deferred. The quantity decommissioned *in situ* comprises most of the flowlines inclusive of protective coating and piggyback clamps. The section of flowline protected by concrete mattresses and the transition section will be removed when the Markham J6A installation is decommissioned at some point in the future. In order to minimise complications associated with the Grove pipeline crossing only the tie-in pipe spools and concrete mattresses covering them (estimated at ~8 no.) were to be recovered at this time. The pipe spools were to be disconnected from the bottom of the riser at J6A and from the flowline at the pipeline flanges and removed. The two 12” and 3” risers will be removed along with the J6A installation when it is decommissioned. As they were installed with the J6A installation their weight is not accounted for here.

All recovered material will be transported onshore for reuse, recycling, or disposal. It was not possible to predict the market for reusable materials with any confidence; the figures in Table 6.3.2 were aspirational.

Inventory	Region	Re-use	Recycle	Disposal
Installations	UK (2,482 Tonnes)	<5%	>95%	<5%
	NL (0 Tonnes)	n/a	n/a	n/a
Pipelines	UK (120 Tonnes)	<5%	>95%	<5%
	NL (51 Tonnes)	<5%	>95%	<5%

Table 6.3.2: Reuse, Recycle & Disposal Aspirations for Recovered Material

6.3.2 Performance

Subsea materials originating in the NL arrived at the Port of Den Helder 01 October 2018, while subsea materials originating in the UK arrived at Great Yarmouth 19, 24 and 27 September 2018.

The ST-1 Topside & Jacket arrived at the Veolia-Peterson Dales Voe Decommissioning Facility in Lerwick on 14 July 2019. The Jacket was dismantled on 23 August 2019, the Topside was dismantled on 01 November 2019, hazardous waste left the site on 13 December 2019 and NORM cleaning was completed at Veolia-Peterson Greenhead Base Decommissioning Facility in Lerwick prior to Christmas 2019.

All waste materials were disposed of as part of the onshore works.

Preparation and Disposal – NL

Following initial assessments all subsea related materials were subject to decontamination procedures using high pressure water jetting. Non-contaminated and NORM contaminated pipework were dealt with at separately at different disposal sites.

Concrete mattresses were destructed using mechanical equipment with the resulting materials being segregated and recycled separately.

Preparation and Disposal - UK

At Great Yarmouth, all subsea related materials were subjected to an initial assessment prior to being logged and quarantined in preparation for Naturally Occurring Radioactive Materials (NORM) surveillance checks. Following the NORM checks, non-contaminated pipework was recycled while NORM contaminated pipework was subject to decontamination followed by incineration.

Concrete mattresses were destructed using mechanical techniques, including use of an excavator with integrated pulverizing equipment. The resulting aggregate was then recycled. All work was conducted in accordance with a waste management plan.

At Dales Voe yard in Shetland the ST-1 topside was dismantled in three stages:

- Soft strip – removed all loose equipment;
- Decontamination – all tanks and pipework were monitored systematically drained down removing any residual oils or fluids encountered;
- All tanks and pipework were checked for the presence of NORM and identified so that they could be dealt with safely and appropriately.

All waste streams were segregated as the dismantling work progressed. The topsides took around 4 months to be dismantled and processed.

Following some design activity, the dismantling of the jacket involved weakening or removing some of the jacket bracing before being toppled. The jacket took two weeks to be processed and disposed of after the initial toppling operation.

Overall, 2,177.6 Te of material was recovered to shore, 99.08% of the material was either reused, recycled as base material, or recycled as energy, <1% of material was disposed to landfill (Table 6.3.3, Table 6.3.4, and Table 6.3.5).

Description	Mass (Te)	Location, Date	Reused (Te)	Recycled (Te)	Recovery as Energy (Te)	Landfill (Te)
Pipe spools (12", 2"), Concrete mattresses	132.870	Great Yarmouth, 19-27 Sept 2018 Lerwick, 24 Sept 2018	22.20	107.90	0.15	2.6140
		Equivalent %:	16.71%	81.21%	0.11%	1.97%

NOTES
1. Concrete mattresses used for hard standing at quayside;
2. General waste includes plastics obtained from crushed concrete mattresses.

Table 6.3.3: Material Returned to UK Shore & Ultimate Disposal Route

Description	Mass (Te)	Location, Date	Recycled (Te)	Reused (Te)	Recovery as Energy (Te)	Landfill (Te)
ST-1 Topsides & Jacket[1]	2,177.58	Dales Voe, Lerwick, 15 July 2019	2,090.94	1.35	11.05	74.24
		Equivalent %:	96.02%	0.06%	0.51%	3.41%

NOTE:
1. ST-1 Topsides' lockers, small table and liquid storage bund re-used on site by Veolia.

Table 6.3.4: Material Returned to UK Shore & Ultimate Disposal Route

Description	Mass (Te)	Location, Date	Reused (Te)	Recycled (Te)	Recovery as Energy (Te)	Landfill (Te)
Pipe spools (12", 3"), Concrete mattresses	43.41	Den Helder, 01 Oct 2018	7.14	24.49	10.53	1.25
		Equivalent %:	16.45%	56.42%	24.25%	2.88%

Table 6.3.5: Material Returned to NL Shore & Ultimate Disposal Route

7. IMPACT ON HSE

7.1 Event Tables

Type	Asset	Event Description	Date	Comment
FAI	Drill Rig	Personnel struck by object ejected from test port	23 June 2018	Small plastic object
NM	Drill Rig	Drill string lifted while annular closed resulting in overpull	22 June 2018	
NM	Drill Rig	Incorrect NORM readings obtained due to incorrect probes being used	18 June 2018	
ML	Drill Rig	Equipment damaged due to snagging of rigging	05 June 2018	
NM	Drill Rig	Loose nut found in a recess pocket of the TDS	22 May 2018	
ML	OSS	Fire in thruster control box	20 May 2018	
ENV	Drill Rig	Diesel fuel spill due to misalignment of valves and refuelling nozzle	06 April 2018	Approximately 3 litres of diesel was spilt but contained within a bunded area
NM	Drill Rig	V door blown shut due to high winds, connecting against the slick line and samson post as it closed	06 April 2018	
NM	Onshore Yard	Problem with jammed rigging that could have led to a more severe incident	15 July 2019	Lifting and safety procedures were such that no personnel were exposed at any time
REG	HLV	Light sheen observed as the jacket was being lifted out of the sea to the deck of the lifting vessel	11 July 2019	Possibly due to residual contaminants being present in one of the caissons, managed to ALARP
REG	OSV	Inconsistency with approved marine license compared to what was recovered	15 Jan 2019	24 concrete mattresses recovered instead of 23. Lesson learned – err on the side of caution

Table 7.1.1: HSE Event Summary Table

7.2 Safety Case

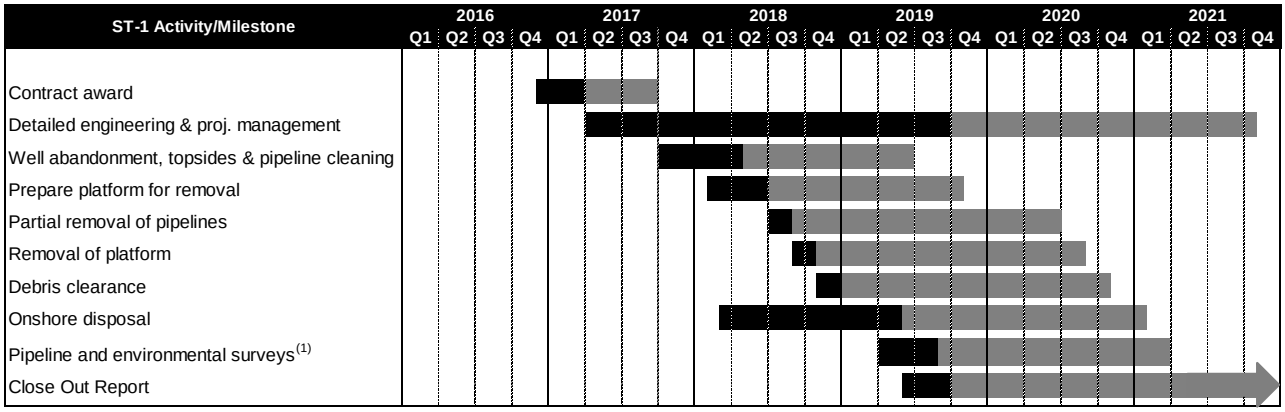
As duty holder of Markham ST-1 platform, Spirit Energy Nederland B.V. submitted all the appropriate Safety Case revisions under Regulation 14 of the Offshore Installations (Safety Case) Regulations 2005. It is worth noting that at the time of the execution activities project, Markham J6A platform in the NL – the former export route for ST-1, was still producing.

8. SCHEDULE COMMITMENTS

8.1 Original Schedule

Figure 8.1.1 presents the original outline schedule for key decommissioning activities relating to the proposals in the Decommissioning Programmes. The activities remain subject to any unavoidable constraints - for example vessel availability, that may be encountered while executing the decommissioning activities. Therefore, activity schedule windows have been included to account for this uncertainty.

The commencement of offshore decommissioning activities depended on commercial agreements and commitments.



Notes / Key

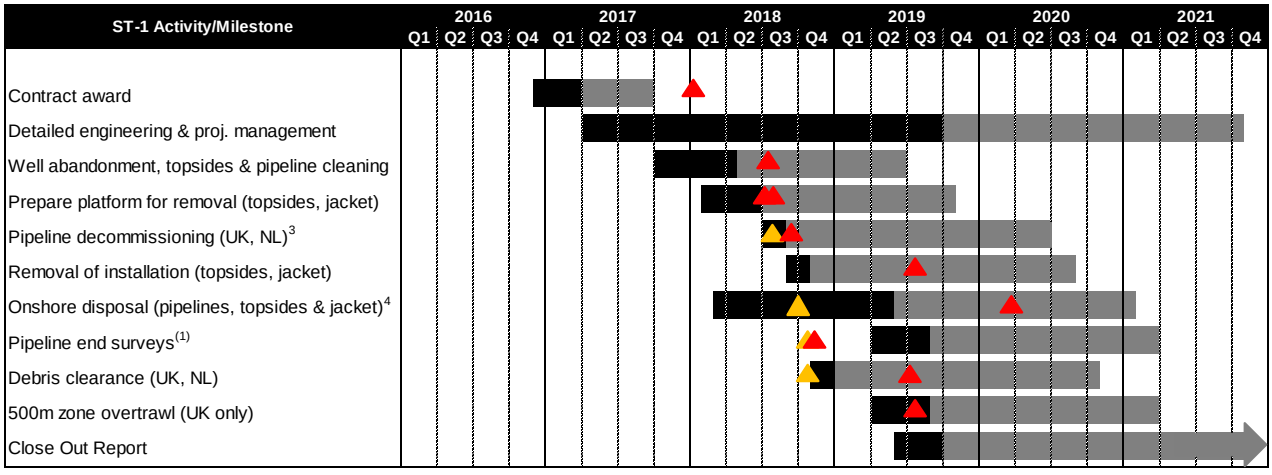
Earliest potential activity

Activity window to allow commercial flexibility associated with well abandonment, installation and pipeline decommissioning activities

1. First Decommissioning survey and environmental survey; timing of future surveys to be agreed with BEIS and SSM

Figure 8.1.1: Original Gantt Chart of Markham ST-1 Project Plan

8.2 As-Built Schedule



Notes / Key

1. Earliest potential activity
2. Activity window to allow commercial flexibility associated with well abandonment, installation and pipeline decommissioning activities
3. J6A platform was still operating
4. Decommissioned waste pipeline material from UK returned to UK, pipeline material removed from NL returned to NL
5. Activity finish UK
6. Activity Finish NL

Figure 8.2.1: As-Built Markham ST-1 Project Plan

Activity / Milestone	Actual or Forecast Completion Date
Contract Award	08 January 2018
Pipeline cleaning & flushing	09 May 2018
Well decommissioning (6xwells)	25 July 2018
Removal of installation (topsides, jacket)	01 July 2019, 11 July 2019
Decommissioning of pipelines (ST-1, J6A)	26 Sept 2018, 30 Sept 2018
Pipeline end surveys (ST-1, J6A)	26 Sept 2018, 30 Sept 2018
Onshore disposal (pipelines (UK & NL), topsides & jacket)	30 Aug 2019, 11 Nov 2019
Debris clearance (500m ST-1 & pipeline to J6A, J6A)	22 July 2019, 30 Sept 2018 (J6A)
NFFO Overtrawl	28 July 2019
Close Out Report	June 2020 (TBA)

Table 8.2.1: Actual or Forecast Activities for ST-1 (UK & NL)

9. COMPLETION OF ACTIVITIES

A photographic record was maintained for some of the decommissioning activities as included below.

9.1 B931 Jack Up Drilling Rig

Figure 9.1.1: B391 Jack Up Drill Rig

9.2 Concrete mattresses

Figure 9.2.1: Concrete mattresses recovered in baskets

Figure 9.2.2: Loose concrete mattress

9.3 Markham ST-1 Platform

Figure 9.3.1: ST-1 Platform on a calm February day (2018)

Figure 9.3.2: Solar Panels mounted on Helideck

9.4 Preparing to remove Markham ST-1

Figure 9.4.1: Reinstating the Topsides Lifting Padeyes (Leg A1 & A2)

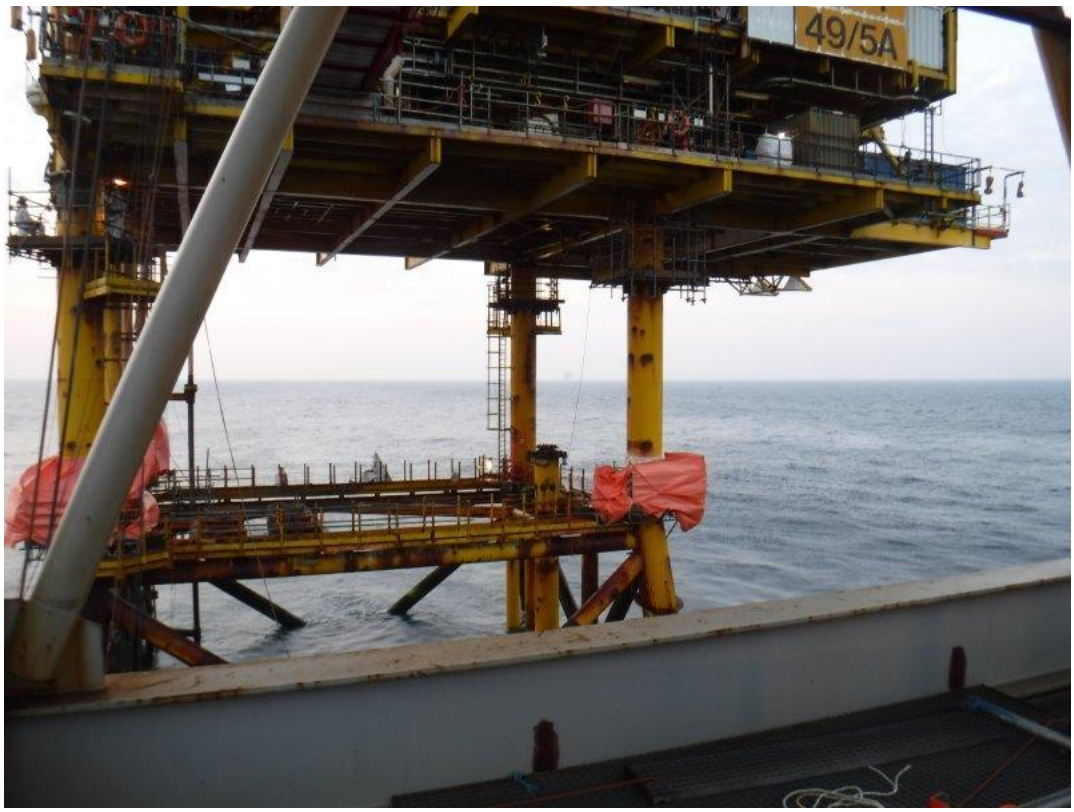


Figure 9.4.2: Legs & Cutting

9.5 Markham ST-1 Removal Operations

Figure 9.5.1: Markham ST-1 Topsides about to be lifted

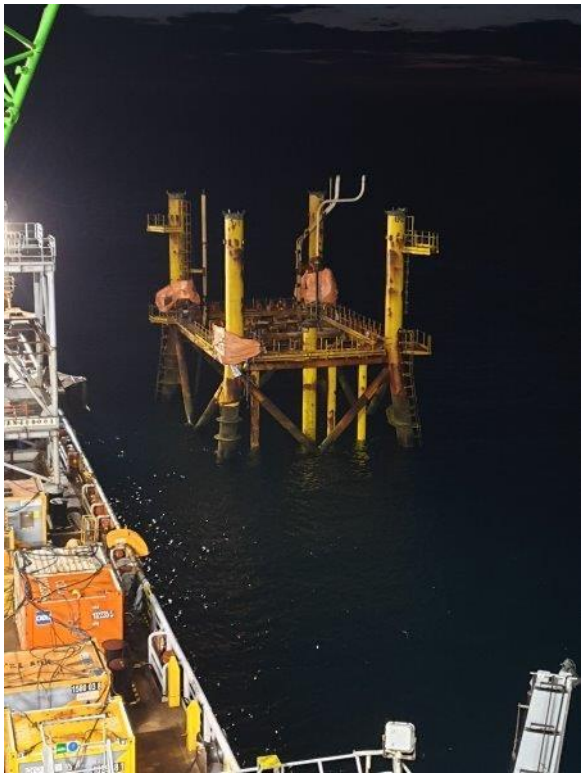


Figure 9.5.2: Markham ST-1 Jacket without topsides

Figure 9.5.3: Markham ST-1 Jacket being recovered

9.6 Markham ST-1 Arrival at Dales Voe, Shetland

Figure 9.6.1: Markham ST-1 Topsides & Jacket arriving at Dale's Voe, Shetland

9.7 Markham ST-1 being lifted onto Quayside

Figure 9.7.1: Markham ST-1 Topsides being lifted to shore

Figure 9.7.2: Markham ST-1 Jacket being lifted to shore

9.8 Markham ST-1 on the Quayside at Dales Voe, Shetland

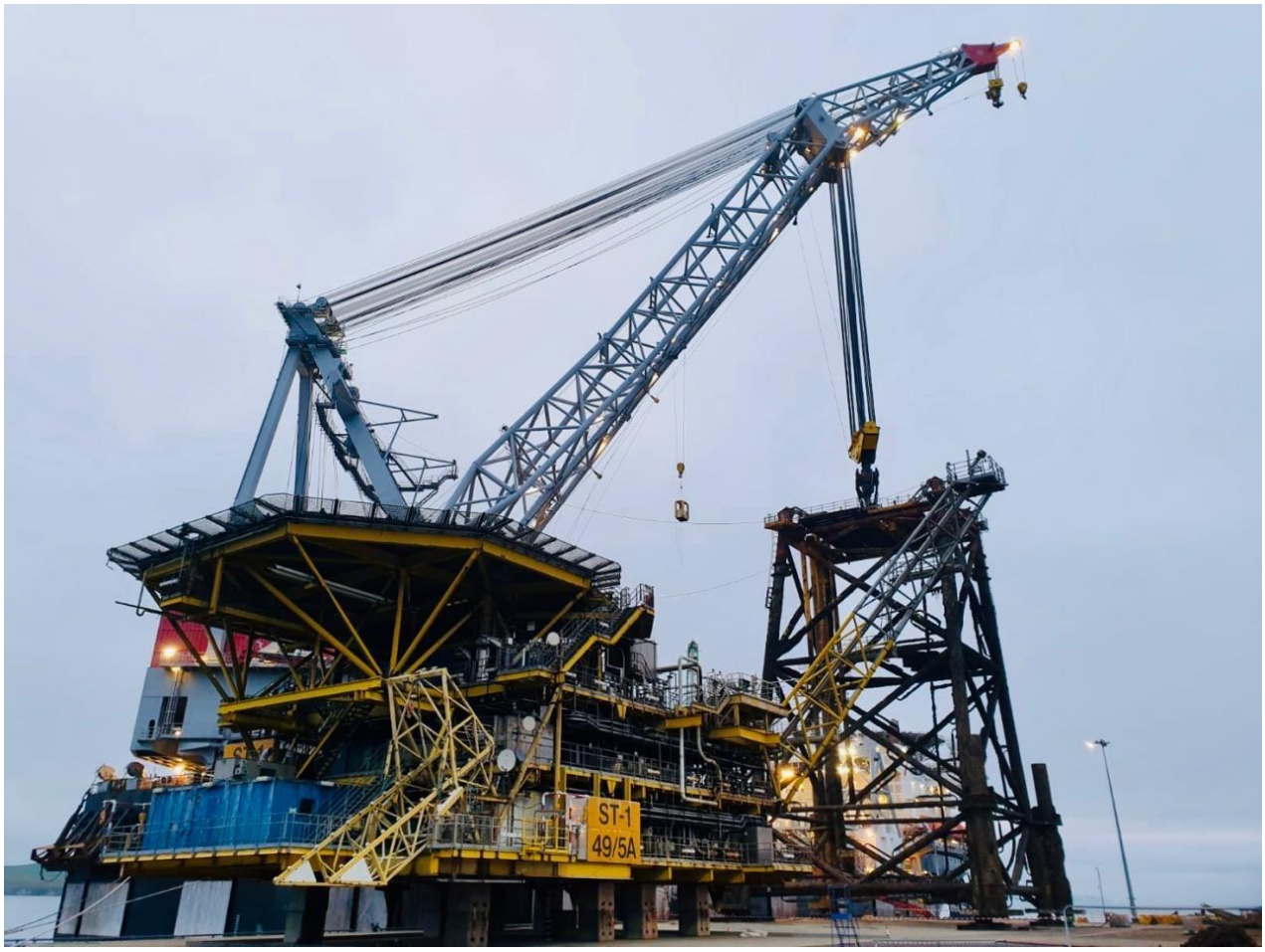


Figure 9.8.1: Markham ST-1 Topsides & Jacket on quayside

Figure 9.8.2: Markham ST-1 Topsides fully landed

Figure 9.8.3: Markham ST-1 Jacket fully landed

10. COST

10.1 Markham ST-1 Cost Performance

A comparison of gross estimated and outturn costs for the completion of the ST-1 decommissioning is provided in Table 10.1. As we do not propose to carry out legacy surveys for the ST-1 pipelines in the UK, we have not included an estimate for future survey costs.

Scope	Estimated Cost £m	Outturn Cost £m
Well decommissioning	22.9	23.6
Pipeline decommissioning	3.1	2.6
ST-1 Installation removal	9.6	6.9
Future pipeline and environmental survey requirements	0.5	0.0
TOTAL:	**36.1**	**33.1**

NOTES:

1. Figure all include a total contingency £3.9m;
2. Notional estimate. Future pipeline survey requirements not included as part of decommissioning cost estimate.

Table 10.1.1: Cost performance summary

Overall outturn costs came in under budget. Well decommissioning costs were higher than originally estimated due to contingencies identified during detailed design not being included in the original estimate. The platform removal and pipeline decommissioning scope was bid as fixed price. The final cost for the pipeline and platform removal scope includes £1.34m of variations to contract.

11. LESSONS LEARNED

11.1 Well decommissioning

- Front end work is relatively cheap and worth pursuing that extra mile. An accurate review of well construction records is essential for planning well decommissioning operations;
- Well production records are not always accurate or reliable and despite obtaining well construction records surprises did still occur, so early well access essential for effective planning;
- Contingency planning is essential for efficient abandonment operations and ongoing dialogue with the Functional Wells Group, Regulator and Well Examiner allowed the exploration of multiple “what if?” scenarios;
- Issues with obsolete wellheads and aging tooling are likely and should be planned for, because they will occur;
- Batching operations were an efficient way to perform the well decommissioning operations with good support from the drill rig personnel with respect to multi-well centre. Continuous operational reviews led to a relatively late decision to batch 13-3/8” recovery, but this proved an efficient option.
- Flexibility to suspend well operations and skid to another well centre was essential for efficient operations;
- Previously normally pressurised Chalk became recharged over time, possibly by Zechstein bleed off.

11.2 Facilities element

- ST-1 was the first of Spirit Energy’s platforms to be decommissioned and at handover from operations to the decommissioning the current status of the platform could have been better. Spirit Energy has now developed a Hazardous Area Declassification process recognised that there are advantages in handing over the facility from operations to the decommissioning project during late life operations rather than waiting until production has ceased;
- During pipeline cleaning several issues arose concerning the filtration system, oil in water sampling, including mistakes when dealing with the cleaning pigs and the initial wave of pipeline effluent during the cleaning process. This meant that the pipeline cleaning effluent being taken to shore in tote tanks rather than dealt with using the filtration system. As a result, we would recommend:
    - Dispose of pigging fluids to a donor well where possible, but otherwise ensure that the first wave of pipeline effluent bypasses the filtration system and directed towards tanks to remove potential contamination issues;
    - When performing the oil-in-water analyses using the temporary analysers the results were found to be inconsistent. Therefore, use the platform oil-in-water analysers as these will have been calibrated more consistently.
- Ensure that valves that will be required to maintain isolation of pipelines and plant while the installation has been put into ‘warm suspension’ have been operationally tested and maintained, and use a HAZID process to determine the need for pressure monitoring with a bleed-off facility;
- In previous decommissioning projects concrete mattresses had been successfully recovered using what is called the ‘curtain lift’ method which involves recovering the mattresses using the hoops on just one side of the mattress. It was expected that this method would be used again. However, in this case the mattresses were ‘link-lok’ type mattresses held together with smaller diameter (8mm) polypropylene rope. None of the mattresses could be lifted using the ‘curtain lift’ method and they were recovered to subsea baskets being handled multiple times. The lessons to be learned from this are:
    - Carry out a trial lift using the method planned for the activity;

  - Consider ‘what if’ scenarios, put contingency measures in place, and assume that they will be used.
- As is often the approach in executing decommissioning activities offshore there was flexibility built into the platform removal schedule, noting that well decommissioning and pipeline subsea disconnection activities needed to be completed before the platform could be removed. The idea is that the work could fit into a window of opportunity given by the removal contractor;
- In this instance a two-year window was agreed and as a result the project went into hibernation to reduce management costs. However, this proved to be challenging and probably was not helped by a change in the crane vessel being used, contractor’s resources being stretched and giving insufficient time to prepare for the offshore works. The lessons to be learned from this are primarily to ensure that the contractor has enough resources, and gives enough time to plan the work effectively and to carry it out;
- The preparatory works required the removal of paint, and some of the paint had been manufactured using the compound Cr(VI) that is a known carcinogen. In this instance, the company considered that preparatory work was poor. Lessons to be learned from this would include ensuring that the requirement for health monitoring are fully understood and prepared for prior to mobilisation, possibly involving a third party to verify preparedness of the contractor;
- Removal of the jacket involved excavating sediment from the pile guides. The removal contractor had installed the jacket several years ago, so should have been familiar with the requirements and should have been fully prepared, having analysed the geotechnical aspects, sourced the necessary excavation equipment, and have conducted field trials. Lessons learned from this are that the removal contractor should spend the time to be fully prepared for the work, if necessary, using a specialist contractor with a proven track record;
- Third party pipelines were connected to the Markham ST-1 platform and both a pipeline and umbilical needed to be severed before the platform could be removed. As the decommissioning programme had not been approved the work was limited to just cutting the pipeline and umbilical without remedial work. However, it was necessary to demonstrate that the 500m zone was clear of snagging hazards. Despite best endeavours the overtrawl demonstrated that a snagging hazard remained due to the third-party pipeline and understandably the NFFO could not issue a clean seabed certificate. The lesson learned from this would be to try and ensure that any third-party infrastructure can be dealt with as part of the same campaign so that the demonstration of a clear seabed can continue unhindered.

12. SEABED CLEARANCE CERTIFICATE

A trawl sweep of the ST-1 area was conducted by the NFFO. The overtrawl demonstrated that the area occupied by the ST-1 installation and infrastructure was clear of snagging hazards. However, the trawl sweep encountered an obstruction at 53°50.30 N 02°52.03 E. On further inspection it was identified that the snag had occurred on the Windermere infrastructure that had been disconnected from ST-1 but not yet formally decommissioned. As a result, the NFFO was unable to issue a clean seabed certificate. The snagging hazard has meantime been covered with a concrete mattress that will be recovered when Windermere is decommissioned. Spirit Energy will continue to engage with INEOS regarding the removal of the mattress and will update OPRED once the mattress has been removed.

The expectation is that a Clean Seabed Certificate or equivalent form of verification will be available once the Windermere decommissioning activities have been completed. Current indications are that Windermere related decommissioning activities would be completed by end 2022 [3].

13. CONCLUSIONS

13.1 Overview

Following completion of the Markham ST-1 decommissioning operations, Spirit Energy can confirm the scope has been executed in accordance with the approved Decommissioning Programmes; that risks to other users of the sea have been removed or reduced as far as possible, and the regulatory requirements have been met. Three deviations to the Decommissioning programmes were sought and approved. These were:

- Width of pipeline survey corridor reduced from 200m to 100m;
- Overtrawl of Markham ST-1 500m zone only, not the pipeline;
- No post-decommissioning environmental survey.

13.2 Well Decommissioning

Initial set-up and demobilisation took ~16 days. Ignoring initial set-up and demobilisation the well decommissioning operations were completed 25 July 2018 taking a total of ~126 days. Removal of the seventh conductor string took ~2 days. Each well took an average of 18 days, although it took an overall 38 days to decommission 49/5a-B6, which was particularly problematic, and so should this well be ignored as an outlier, each well took an average ~16 days to decommission, ignoring set-up time.

The accumulated batch times for all six wells for each phase were as follows:

- Phase 1 - Well kill operations: 37.4 days;
- Phase 2 - Tree recovery 2.3 days;
- Phase 3 - Recover completion tubing & install permanent plugs 74.2 days;
- Phase 4 -- Multi-string conductor recovery 13.8 days (seven well slots).

13.3 Pipelines & Stabilisation Materials

The 12” gas pipeline successfully pigged and flushed using a gel pig and chemical train with the associated fluids being transported along the pipeline using the mud pumps on the drill rig. The 2”/3” methanol line was successfully flushed.

Both pipelines were disconnected from the ST-1 and J6A platforms, with the pipelines being cut back to a burial depth equal to or greater than 0.6m below mudline.

The concrete mattresses and grout bags were removed although contingency measures involving use of a grab were used to recover the concrete mattresses into a basket while any smaller pieces left behind were recovered by ROV to baskets that were temporarily placed on the seabed. The baskets were recovered to the deck of the ROV support vessel.

All the grout and sandbags were removed from the seabed using a hydraulic grab with half-shell bucket attachments, once lifted from the seabed they were decanted into a subsea basket and recovered to deck.

There was a complication with completion of the decommissioning of the pipelines at ST-1, however, as due to a snagging hazard that remains from the presence of the Windermere pipelines. This will be rectified by INEOS at some future date [3].

13.4 HSE & Waste Management Performance

In terms of waste management performance, 2,177.6 Te of material was recovered to shore: 99.08% of the material was either reused, recycled as base material, or recycled as energy, while <1% of material was disposed to landfill.

A total of eleven HSE events were classed as recordable. Fortunately, there were none that resulted in serious injury to project personnel or in a major environmental impact. Most could be categorised as near miss events.

13.5 Lessons Learned

Key lessons learned include:

- Front end loading a project pays dividends;
- Batch operations and built-in flexibility can improve the efficiency of well decommissioning activities;
- Use a managed process to enable handover over of a facility from operations to the decommissioning project *during* late life operations rather than waiting until production has ceased. This will reduce potential problems associated with revisiting a platform where the wells have not yet been decommissioned;
- Ensure that the removal contractor has enough resources, and gives enough time to plan the work effectively and to carry it out;
- Ensure that the requirement for health monitoring are fully understood and prepared for prior to mobilisation;
- Develop contingency measures for the recovery of concrete mattresses;
- Try to ensure that ensure that any third-party infrastructure can be dealt with as part of the same campaign so that the demonstration of a clear seabed can be achieved unhindered.

13.6 Legacy Aspects

As a result of monitoring and a review of recorded data, Spirit Energy believes that all residual risks to other users of the sea have effectively been removed on a long-term basis and that a programme of future field infrastructure surveys would not provide any useful information in this regard. That is, the stability of the seabed and pipelines in this area is such that it would be unnecessary to conduct further inspection and verification work in future.

Analysis of environmental survey data also suggests that the local environment is in a state typical of the wider southern North Sea region. With no further site-specific anthropogenic inputs, it is felt that that natural degradation of contaminants should help restore the area to pre-developed conditions in a relatively short timescale. Accordingly, the company proposes that no additional site and environmental surveys or inspection of remaining features in the Markham ST-1 area are necessary.

A trawl sweep of the ST-1 area was conducted by the NFFO. The overtrawl demonstrated that the area occupied by the ST-1 installation and infrastructure was clear of snagging hazards. However, the trawl sweep encountered an obstruction at 53°50.30 N 02°52.03 E. On further inspection it was identified that the snag had occurred on the Windermere infrastructure that had been disconnected from ST-1 but not yet formally decommissioned. As a result, the NFFO was unable to issue a clean seabed certificate. The snagging hazard has meantime been covered with a concrete mattress that will be recovered when Windermere is decommissioned. Current indications that Windermere will be decommissioned by end 2022 [3].

13.7 Cost

The outturn costs (£33.1m) were slightly lower than estimated (£36.1m). Well decommissioning costs were higher than originally estimated due to contingencies identified during detailed design not being included in the original estimate. The platform removal and pipeline decommissioning scope was bid as fixed price.

14. REFERENCES

[1] Fugro (2014) ST-1 Decommissioning Survey UKCS Block 49/5a. Volume 1 of 2: Environmental Habitat Assessment with Herring Spawning Ground Assessment. FSLTD Report No. 130019.1v1.2;

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[3] INEOS (2018) Windermere Decommissioning Programmes, RD-WIN-ZPL001. Weblink last accessed 07 Feb 2020: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/701076/WindermereDecommissioning_Programme.pdf

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[5] SE (2018) Markham ST-1 Decommissioning Programmes, CEU-DCM-GMA0025-REP-0010; Weblink: last accessed 07 Feb 2020: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693560/Markham_ST-1.pdf

[6] SE (2018) Markham ST-1 Decommissioning Comparative Assessment, CEU-DCM-GMA0025-REP-0009;

[7] SE (2018) Markham ST-1 Decommissioning Environmental Impact Assessment, CEU-HSEQ-GMA0025-REP-0002.

APPENDIX A DECOMMISSIONED WELL SCHEMATICS

Appendix A.1 Decommissioned Well 49/5a-B1

PRE-ABANDONMENT WELL STATUS SCHEMATIC 49 / 5a - B1 (Slot 8)

CASING/TUBING SCHEME

Size (inches)	Weight (lb/ft)	Grade	Coupling	Casing Shoe Depth mMD	Casing Shoe Depth mTVD	TTOC mMD	Annulus Fluid Type	Well Construction Casing P/test
30	310	X52	RL4	123	123	Seabed	Cement	N/A
20	133	X56	RL4S / SR-20	456	456	Seabed	Cement	1500 psi with 8.6 ppg
13⅜	68	N80	Buttress / New VAM	2202	1794	Seabed	Cement / KCl Polymer (10.4 ppg)	3000 psi with 10.4 ppg
9⅝	47 53.5	N80 P110	VAM	3424	2659	2626	Sat Salt WBM (13.0 ppg)	4800 psi with 12.3 ppg
7 x 7⅝	32 / 56	L80 / MW 125	VAM / MUST	4223	3238	Liner Top @ 3256	Cement	4500 psi with 10.0 ppg
7	29	N80	New Vam	3255	2563	2500 estimated	10.0 ppg brine (Scab Liner)	4500 psi with 10.0 ppg
4½ Lnr	13.5	L80	New Vam	4691	3654	Liner Top @ 4105	Cement	5000 psi (10.0 ppg)
5½ Tbg	15.5	L80	Vam Ace	168	168		10.0 ppg brine	Tubing 5000 psi (10.0ppg)
4½ Tbg	12.6	L80	Vam Ace	4060	3110		10.0 ppg brine	Annulus 3500 psi (10.0 ppg)

Depths corrected for the B391 RT elevation of 45.6 m above LAT. Water Depth = 31.6m (LAT).

ABANDONMENT DIAGRAM 49 / 5a - B1 Slot 8

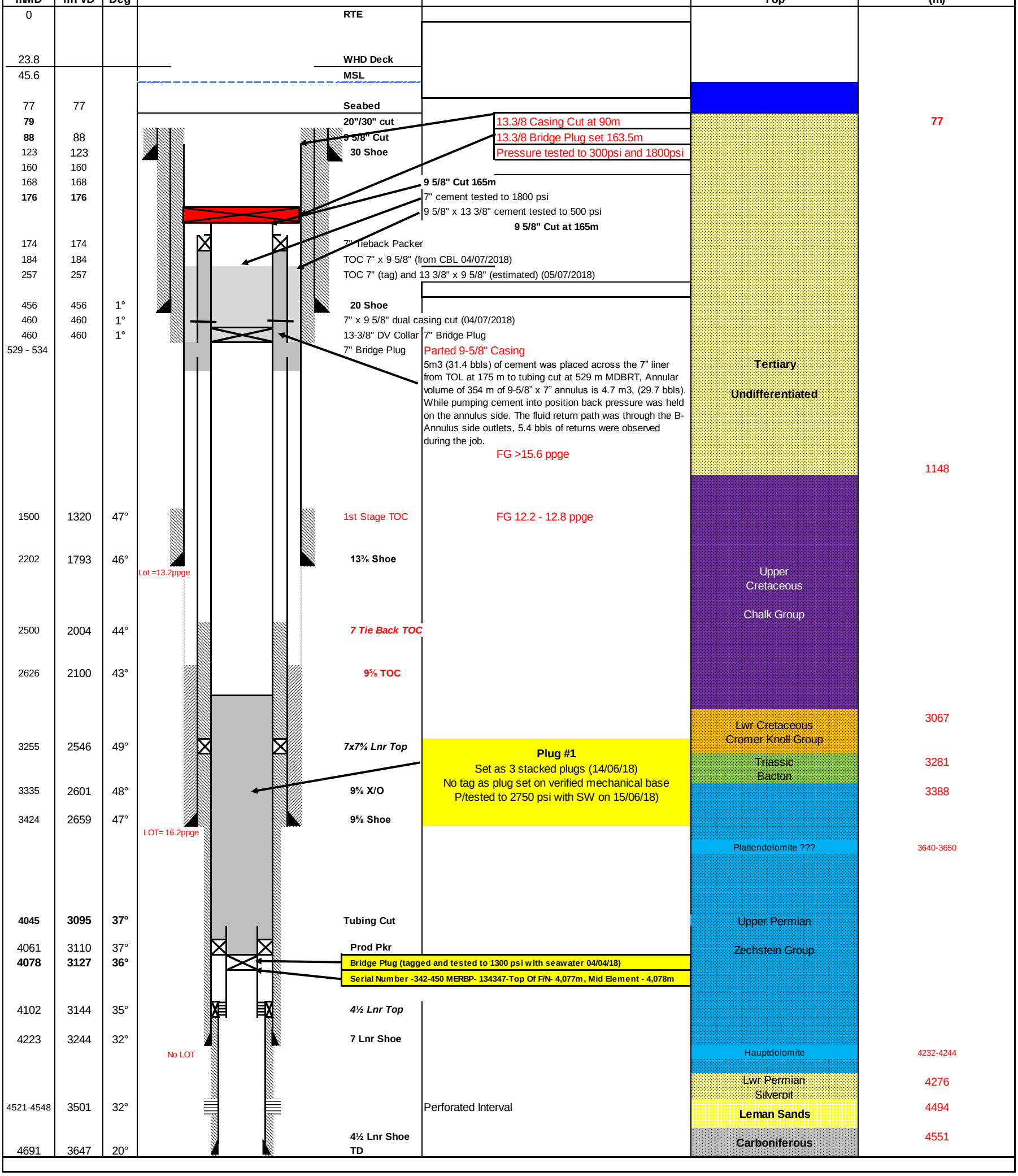


Figure A.1.1: Decommissioned Well 49/5a-B1 Schematic

Appendix A.2 Decommissioned Well 49/5a-B2

PRE-ABANDONMENT WELL STATUS SCHEMATIC 49 / 5a - B2 (Slot 6)

CASING/TUBING SCHEME

Size (inches)	Weight (lb/ft)	Grade	Coupling	Casing Shoe Depth mMD	Casing Shoe Depth mTVD	TTOC mMD	Annulus Fluid Type	Well Construction Pressure Test
30	310	X52	SR20	131	131	Driven	N/A	N/A
20	94	X56	RL4S	540	540	Seabed	Cement	N/A
13⅜	68	L80	Buttress	2130	2032	1700	KCl Polymer (10ppg)	3000 psi with 9.9 ppg
9⅝ x 10¾	47 / 111	L80 / Q125	New Vam	2320	2210	2065	OBM (12.5 ppg)	4800 psi with 12.5 ppg
7 x 7⅝	32 / 56	L80 / MW125	New Vam / MUST	3413	3216	2172	Cement	4800 psi with 11.9 ppg
4½ Lnr	13.5	L80	New Vam	4067	3514	3255	Cement	5000 psi (10.0 ppg)
5½ Tbg	15.5	L80	VAM Ace	2137	2037	N/A	10.0 Nacl Brine	Tubing 5000 psi (10.0ppg)
4½ Tbg	12.6	L80	Vam Ace	3257	3073	N/A		Annulus 3300 psi (10.0 ppg)

Depths corrected for the B391 RT elevation of 45.6 m above LAT. Water Depth = 31.6m (LAT).

WELL ABANDONMENT DIAGRAM 49 / 5a - B2 Slot 6

Depth mMD	Depth mTVD	INC Deg	SCHEMATIC	DESCRIPTION	Formation Top	MD (m)
0			RTE			
23.8			WHD Deck			
45.6			MSL			
77	77		Seabed			77
80			30" and 20" Cut			
220			Cement plug 220m to 140m; 20" BP			
220			13-3/8" Cut 220m			
232			13-3/8" CTX 370 BP P-tested 500psi over SW at 232m			
258			9-5/8" Casing cut & pulled			
309	131		30 Shoe			
			SW		Tertiary	
312	312				Undifferentiated	
540	540		20 Shoe; 13ppg FIT			
			SW			
1319						
1385						
1448						
1514						1095
1578						
1644			9-5/8" casing cuts			
1700	1629	21°	13⅜ TOC		Upper Cretaceous Chalk Group	
2065	1972	22°	Plug#3 tagged at 1991m. P-tested 2400psi over SW; 9⅝ TOC			2079
2131	2033	21°	13⅜ Shoe		Lwr Cretaceous Cromer Knoll Group	
2135	2037	21°	15.3ppg FIT; 5-1/2" x 4-1/2" Tubing X/O			
2169	2068	21°	7x7⅝ Lnr Top	***NB: Cement surface samples from plug #1/2 were set and stinger came out clean. A Cement Plug Tag Requirement Risk Assessment was used. As all the criteria on this risk assessment had been met it was decided that there was no requirement to tag the plug***	Triassic Bacton	2212
			3 off stacked cement plugs set from 2814m			2265
2217	2086	21°	9⅝ x 10¾ XO			
2320	2209	21°	9⅝ Shoe; 19ppg FIT		Plattendolomit	2501-2509
			Tubing Cut 2824m 3.475 SLB Power Cutter 20-04-2018			
3217	3037	24°	3.78 QN nipple		Upper Permian Zechstein Group	
3221	3041	24°	Prod Pkr			
3234	3053	24°	Bridge Plug (tested to 1500 psi with seawater 16/04/18); Serial Number -342-450 MERBP- 166274-Top of F/N- 3,233m, Mid Element - 3,234m			
3240	3058	25°	3.70 QN nipple			
3255	3076	25°	4½ Lnr Top			
3257	3073	25°	Seal Assy			
3413	3215	24°	7" Lnr Shoe; 20ppg FIT		Hauptdolomite	3441-3452
					Lwr Permian Silverpit	3480
3788-4048	3478	71-88	Perf Interval		Leman Sands	3792
4071	3514	89°	4½" Lnr Shoe		Carboniferous	

Figure A.2.1: Decommissioned Well 49/5a-B2 Schematic

Appendix A.3 Decommissioned Well 49/5a-B3

PRE-ABANDONMENT WELL STATUS SCHEMATIC 49 / 5a - B3 (Slot 3)

CASING/TUBING SCHEME

Size (inches)	Weight (lb/ft)	Grade	Coupling	Casing Shoe Depth mMD	Casing Shoe Depth mTVD	TTOC mMD	Annulus Fluid Type	Well Construction Pressure Test
30	310	X52	SR20	131	131			N/A
20	94	X56	RL4S	540	537	Seabed	Cement	1000 psi with 8.6 ppg SW
13⅜	68	L80	Buttress	2432	2015	1099	Ancoquat WBM (10 ppg)	3000 psi with 10.0 ppg
9⅝ x 10¾	53.5 / 111	L80 / Q125	New Vam / Vam HW	2825	2291	2286	AquaMUL OBM (13.0 ppg)	4800 psi with 11.9 ppg
7 x 7⅝	32 / 56	N80 / P110	Hydril MACII	4153	3218	3750	AquaMUL OBM (14.5 ppg)	3300 psi with 14.1 ppg
4½ Lnr	12.6	L80 13% Cr	Hydril 503	5050	3536	4008	Cement	5000 psi with 8.4 ppg
5½ Tbg	15.5	L80	Vam Ace	2658	2174	N/A	Inhibited Water (8.4 ppg)	Tubing 5000 psi (8.4 ppg)
4½ Tbg	12.6	L80	Vam Ace	3976	3082	N/A	Inhibited Water (8.4 ppg)	Annulus 4000 psi (8.4 ppg)

Depths corrected for the B391 RT elevation of 45.6 m above LAT. Water Depth = 31.6m (LAT).

WELL ABANDONMENT Diagram 49 / 5a - B3 Slot 3

Depth mMD	Depth mTVD	INC Deg	SCHEMATIC	DESCRIPTION	Formation Top	MD (m)
0			RTE			
23.8			WHD Deck			
45.6			MSL			
76.6			Seabed			
78.7			30" Cut			
84.0			20" Cut			
131			30 Shoe			
238			20" CX BP CXD127 set at 238m			
238			13-3/8" casing cut 238m			
250			13.3/8"CX BP Set 16/05/2018, P-tested 500psi SW			
260			9.5/8 Casing Cut at 260m MD BRT			
540	537	9°	20 Shoe			
1099	1054	34°	13⅜ TOC			
2286	1910	42°	9⅝ TOC			
2443	2026	44°	13⅜ Shoe			
2658	2174	46°				
2678	2191	46°	7x7⅝ Lnr Top			
2825	2291	48°	9⅝ Shoe			
3750	2925	47°	7" Lnr TOC			
3964	3072	43°				
3971	3082	43°	3.78 QN nipple			
3976	3085	43°	Prod Pkr			
3985	3096	43°				
4005	3106	43°	3.70 QN nipple			
4153	3215	42°	4½ Lnr Top Seal Assy 7" Liner Shoe			
4716-4960	3513	81°	Perf Interval			
4800	3525	83°	Bridge Plug			
5029	3533	85°	4½" Shoe			

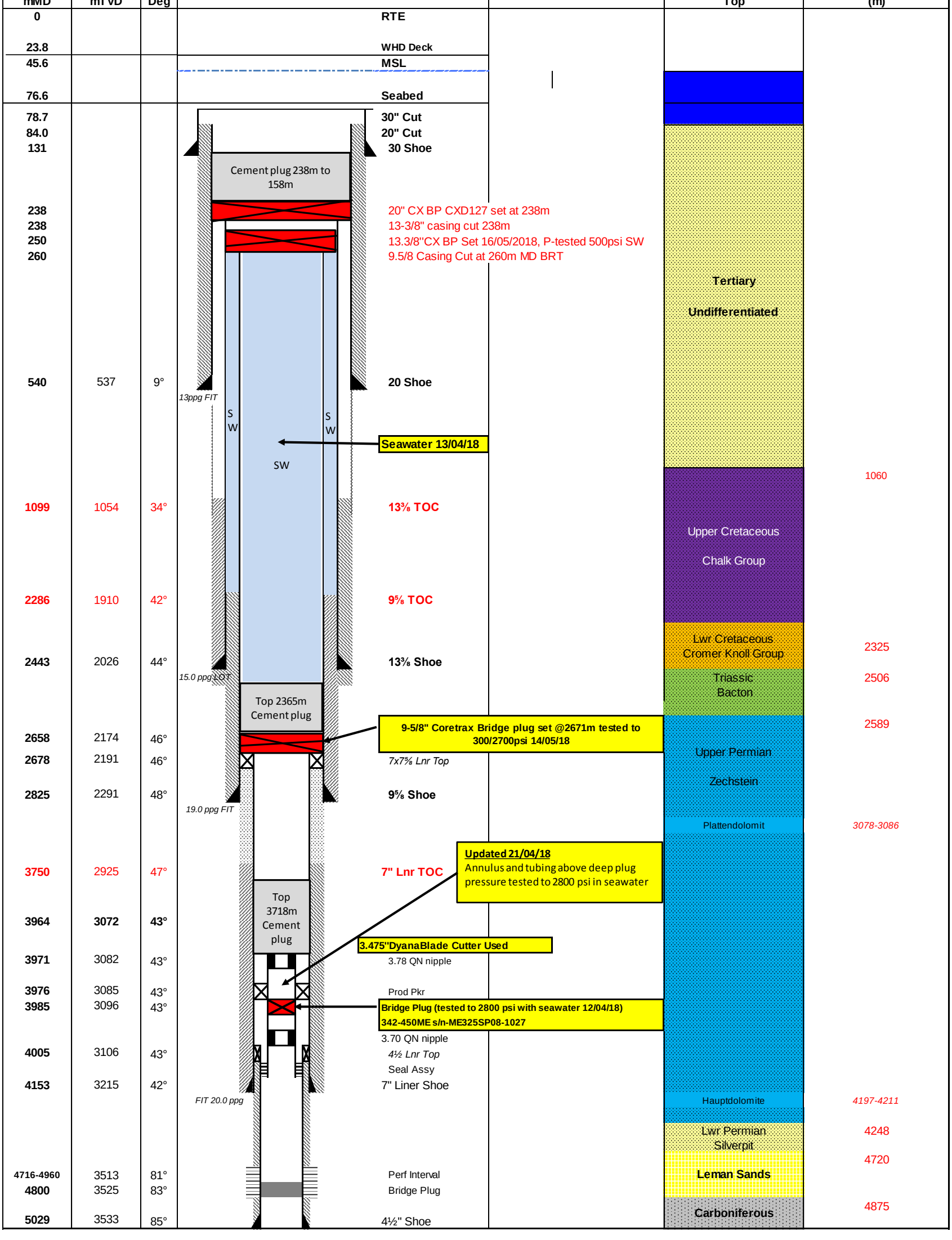


Figure A.3.2: Decommissioned Well 49/5a-B3 Schematic

Appendix A.4 Decommissioned Well 49/5a-B4

PRE-ABANDONMENT WELL STATUS SCHEMATIC 49 / 5a - B4 (Slot 2)

CASING/TUBING SCHEME

Size (inches)	Weight (lb/ft)	Grade	Coupling	Casing Shoe Depth mMD	Casing Shoe Depth mTVD	TTOC mMD	Annulus Fluid Type	Well Construction Pressure Test
CASING								
30	310	X52	SR20	131	131	Driven		
20	94	X56	RL4S	539	539	Seabed	Cement	1000 psi with 8.6 ppg SW
13 3/8	68	L80	Buttress	1223	1149	463	KCl / PHPA (10.0 ppg)	3000 psi with 10.0 ppg WBM
9 5/8 x 10 3/4	47 / 111	L80 / Q125	New Vam / VAM HW	2564	2234	1875	KCl / PHPA (10.5 ppg)	4400 psi with 10.5 ppg WBM
7 x 7 5/8	32 / 56	L80 / P110	Hydril 513 / MACII	3751	3228	2888	OBM (14.8 ppg)	2700 psi with 14.8 ppg OBM
4 1/2	12.6	L80 13%Cr	Hydril	4317	3503	3604	Cement to TOL	5000 psi with 8.4 ppg
COMPLETION TUBING								
5 1/2	15.5	L80 13Cr	Vam Ace	2378	2078	N/A	8.34 ppg Inhibited Drill Water	Tubing 5000 psi (8.4 ppg)
4 1/2	12.6	L80 13Cr	Vam Ace	3608	3111	N/A		Annulus 4000 psi (8.4 ppg)

Depths corrected for the B391 RT elevation of 45.6 m above LAT. Water Depth = 31.6m (LAT).

WELL ABANDONMENT DIAGRAM 49 / 5a - B4 Slot 2

Depth mMD	Depth mTVD	INC Deg	SCHEMATIC	DESCRIPTION	Formation Top	MD (m)
0			RTE			
23.8			WHD Deck			
45.6			MSL			
77	77		Seabed	30" and 20"Casing/Conductor Cut 3m Below ML (80m)		
110	**110**		13-3/8" Cut		Tertiary Undifferentiated	77
117	117					
131	131		30 Shoe			
193	**193**		SW			
202	202					
463	460	7	13⅜ TOC			
539	539	10	20 Shoe			
			No FIT; Cement plug (183m) 1086m- 903m			1099
			13-3/8" CTX376 set @ 1087m p-tested 1000psi over 10ppg			
			Cut 9-5/8" Casing 1105m			
1223	1149	39°	13⅜ Shoe		Upper Cretaceous Chalk Group	
			No FIT; Wel displaced to 10ppg brine at 2088m			
1875	1682	36°	9⅝ TOC	Wireline Sonic TOC		
			SW			2315
2378	2078	35°	Cement plug 2395m to; 5½ x 4½ XO		Lwr Cretaceous Cromer Knoll Group	
			9-5/8" CTX 327 BP set @ 2395m p-tested 2200psi over SW			
2407	2101	35°	*7 x 7⅝ Lnr Top*		Triassic Bacton	2453
2564	2234	28°	9⅝ Shoe; 19ppg FIT; SW			2509
					Plattendolomit	*2658-2661*
2888	2516	32°	7-5/8" TOC			
			Cement plug 3548m to 3243m			
3549	**3060**	**35°**	Tubing Cut at 3549m 08/04/18; 3.475"DyanaBlade Cutter Used		Upper Permian	
3559	3070	35°	3.78 QN nipple			
3564	3074	35°	Prod Pkr			
3574	**3080**	**35°**	**Bridge Plug (tested to 1500 psi with seawater 08/04/18)**			
			342-450ME			
3584	3090	34°	3.70 QN nipple			
3601	3104	34°	*4½ Lnr Top*			
3605	3108	34°	Seal Assy			
3751	3228	34°	**7" Lnr Shoe**; 16ppg FIT		Hauptdolomite	*3793-3806*
					Lwr Permian Silverpit	3833
4059-4135	3468	57°	Perf Interval		**Leman Sands**	4062
						4130
4237	3502	90°	Bridge Plug	Leaking shoe track	**Carboniferous**	
4317	3503	89°	4½" Shoe			

Figure A.4.3: Decommissioned Well 49/5a-B4 Schematic

Appendix A.5 Decommissioned Well 49/5a-B5

ABANDONMENT WELL STATUS SCHEMATIC 49 / 5a - B5 (Slot 4)

CASING/TUBING SCHEME

Size (inches)	Weight (lb/ft)	Grade	Coupling	Casing Shoe Depth mMD	Casing Shoe Depth mTVD	TTOC mMD	Annulus Fluid Type	Well Construction Pressure Test
CASING								
30	310	X52	SR20	127	127			
20	94	X56	RL4S	537	535	Seabed	Cement	1000 psi with 8.6 ppg SW
13 3/8	68	L80	Buttress	1406	1232	566	PolySeal WBM (11.7 ppg)	2600 psi with 11.0 ppg WBM
9.625 x 10 3/4	53.5 / 85.3	L80 / T95	New Vam	3110	2378	2440	Ecomul OBM (10.6 ppg)	4800 psi with 10.6 ppg OBM
7 x 7 5/8	32 / 56	L80 / MW 125	New Vam / MUST	4346	3219	3550	Cement	2600 psi with 16.3 ppg OBM
4 1/2	12.6	L80 13%Cr	New Vam	4773	3628	4184	Cement	4000 psi with 8.6 ppg SW
4 1/2 Scab	13.5	C95 13%Cr	VAM Ace	4151	3068	2705	Cement	3000 psi with 12.5 ppg WBM
COMPLETION TUBING								
5 1/2	15.5	L80	Vam Ace	275	275		8.34 ppg Inhibited Drill Water	Tubing 5000 psi (8.4 ppg)
4 1/2	12.6	L80	Vam Ace	2670	2171			Annulus 3000 psi (8.4 ppg)

Depths corrected for the B391 RT elevation of 45.6 m above LAT. Water Depth = 31.6m (LAT).

Abandonment Diagram 49 / 5a - B5 Slot 4

Depth mMD	Depth mTVD	INC Deg	SCHEMATIC	DESCRIPTION	Formation Top	MD (m)
0				RTE		
23.8				WHD Deck		
45.6				MSL		
77	77			Seabed		77
107	107			13-3/8" Cut at 107m		
127	127	1°		30 Shoe		
226	**226**	**1°**				
252	252	1°				
275	275	1°				
537	535	10°		20 Shoe		
566	563	10°		13⅜ TOC		
918						
1189						
1190				13-3/8" CX-2 BP set - failed p-test		
1212				13-3/8" CX-2 BP not set failed p-test		
1212				9-5/8" Casing Cut		
1223				9-5/8" Coretrax BP	FG >15.6 ppge	
1233				4-1/2" Tubing Cut	Upper Cretaceous	1213
1406	1232	43°		13⅜ Shoe	FG 12.2 - 12.8 ppge	
2440	1946	46°		9⅝ TOC		
2490	1981			9⅝ x 10¾" XO		
2655	**2099**	**47°**		**Tubing Cut (01/04/18)**		
2668	2102	47°		*Prod Pkr*		
2684	2113	47°		**Pump Open Plug - failed**		
2689	2116	47°		*3.775" QN Nipple*		
2702	2125	47°		*9⅝x 7x4½ Scab Lnr Top*		
2702	2125	47°		Est. TTOC (96 bbls 16 ppg) P-tested to 2750psi w/ SW (19/04/18)		
2854	2223	51°		Tie-back packer, (leaking)		
2860	2227	51°		*Scab 7⅝ Lnr Hanger, (leaking)*		
2956	3286	52°		Lnr tie-back packer, (leaking)		
2959	2288	52°		*7x7⅝ Lnr Hanger, (leaking)*		
3110	2378	53°		**9⅝ Shoe**		
3530	2660	46°		**7" Lnr TOC**		
4151	3068	42°		*Prod Pkr*		
4169	3081	42°		*3.73 QN nipple*		
4181	3086	41°		*4½ Lnr Top*		
4346	3219	32°		*7 Shoe*		
4472	3329	26°		Partly milled BP w/mill fish		
4632 - 4660	3475	23°		Perf Interval		
4773	3628	23°		4½" Shoe		

SCHEMATIC labels: SW; 11ppg FIT; 270m Cement plug 1189m - 918m. Tagged & p-tested 1800psi over SW; 12.8ppg FIT; 16.3ppg LOT; No FIT

Formation Top: Tertiary Undifferentiated; Upper Cretaceous; Lwr Cretaceous Cromer Knoll Group (3000); Triassic Bacton (3193); Plattendolomit (3266, 3530-3568); Upper Permian Zechstein Group; Hauptdolomite (4371-4382); Lwr Permian Silverpit (4412); Leman Sands (4607); Carboniferous (4662)

Figure A.5.4: Decommissioned Well 49/5a-B5 Schematic

Appendix A.6 Decommissioned Well 49/5a-B6

WELL STATUS SCHEMATIC 49 / 5a - B6 (Slot 7)

CASING/TUBING SCHEME

Size (inches)	Weight (lb/ft)	Grade	Coupling	Casing Shoe Depth mMD	Casing Shoe Depth mTVD	TTOC mMD	Annulus Fluid Type	Well Construction Pressure Test
CASING								
30	310	X52	DS 60/MT	152	152	Driven		
20	133	X56	RL4S	1124	1092	220	Cement	2000 psi with 9.2 ppg WBM
13 3/8	72	L80	Buttress	3761	2463	2456	KCl Polymer (11.3 ppg)	3250 psi with 11.3 ppg WBM
9.625 x 10 3/4	53.5 / 109	P110	Tenaris AMS & ST-L	5253	3236	3033	OBM (14.8 ppg)	5000 psi with 10.2 ppg OBM
7 x 4 1/2	29 /13.5	C95	Vam Ace	5649	3586	5115	Cement	5000 psi with 8.4 ppg
COMPLETION TUBING								
4 1/2	12.6 / 13.5	13Cr95	Vam Ace	5168			8.4 ppg (Drill Water + 5% KCL brine)	Tubing 5000 psi with 8.4 ppg Annulus 3500 with 8.4 ppg

Depths corrected for the B391 RT elevation of 45.6 m above LAT. Water Depth = 31.6m (LAT).

ABANDONMENT DIAGRAM 49 / 5a - B6 Slot 7

Depth mMD	Depth mTVD	INC Deg	SCHEMATIC	DESCRIPTION	Formation Top	MD (m)
0			RTE	Updated 11/06/18 - CC		
23.8			WHD Deck			
45.6			MSL			
77	77		Seabed	30'' and 20''Casing/Conductor Cut 3m Below ML (80m)		
110	110		13-3/8" Cut			77
152	152	1°	30 Shoe 20" Top up Cmt Jobs			20" TOC below seabed. Several 20" top-up jobs required due to thief zone
220	220	2°	20" TOC			
992		25°	Cement Plug #3 992.4 - 1070 m	Plug #3 (77.6 m) - Chalk isolation plug 992.4 - 1070 m MDBRT Tag and P/test to 550 psi with 10.1 ppg WBM on both casing and annulus side (500 psi over injection presure)	Tertiary Undifferentiated	
1070	1042	25°	TOC, tag 10 klbs 09/06/18 13-3/8" Casing Cut			
1080	1052	25°	13-3/8" Bridge Plug			
1090	1062	26°	9-5/8" Casing Cut			1,098
1124	1092	26°	20 Shoe FIT = 12ppg			
2456	1867	63°	13⅜ TOC		Upper Cretaceous Chalk Group	
3033	2131	63°	9⅝ TOC (compromised with Micro-annulus)	Plug #2 (189 m) Platten isolation plug 3558 - 3587 m MDBRT Tag and P/test to 1150 psi with 13.5 ppg mud		
3558		62°	Top Section Mill window	Updated 04/06/18 (CC) Milling Runs 1) 3558 - 3562.7m (4.7 m) 2) 3562.7 - 3571.6m (8.9 m) 3) 3571.6 - 3579m (7.4 m) 4) Tool Failure 5) 3579 - 3587m (8 m)	Lwr Cretaceous Cromer Knoll Group	3304
3587		62°	Base Section Mill window		Triassic Bacton	3518
3623	2394	60°	Bridge Plug set 23/05/18, tag and test (3200 psi in SW)			
3662	2414	60°	9-5/8" x 10-3/4" X/O			3717
3761	2463	58°	13⅜ Shoe FIT = 19ppg			
					Plattendolomit	3907-3996
3996	2575	65°	9-5/8" x 10-3/4" TOC (no micro-annulus)			
4835				Plug #1 (305 m) Reservoir isolation plug 4835 - 5140 m MDBRT		
5112	3123	41°	7 x 4½ Lnr Top			
5140	**3175**	**37°**	Tubing Cut (27/03/18)			
5146	3181	37°	3.75 Nipple			
5165	3164	38°	Packer			
5179	**3178**	**38°**	Bridge Plug (tested to 1500 psi with seawater 25/03/18)			
			342-450ME			
5186	3187	37°	3.668 Nipple			
5194	3187	37°	Seal bore receptical			
5253	3236	33°	9⅝ Shoe FIT = 16ppg		Hauptdolomite	5232-5244
					Lwr Permian Silverpit	5279
5510 - 5517	3475	25°	Perf Interval			5508
5562 & 5542	3475	25°	2 x Maga Plugs		Leman Sands	
5528 - 5570	3475	25°	Perf Interval			5575
5649	3586	22°	4½" Lnr Shoe		Carboniferous	

Figure A.6.5: Decommissioned Well 49/5a-B6 Schematic

APPENDIX B PL992 & PL993 BURIAL PROFILES

Appendix B.1 PL992 & PL993 As-Laid (~1994)

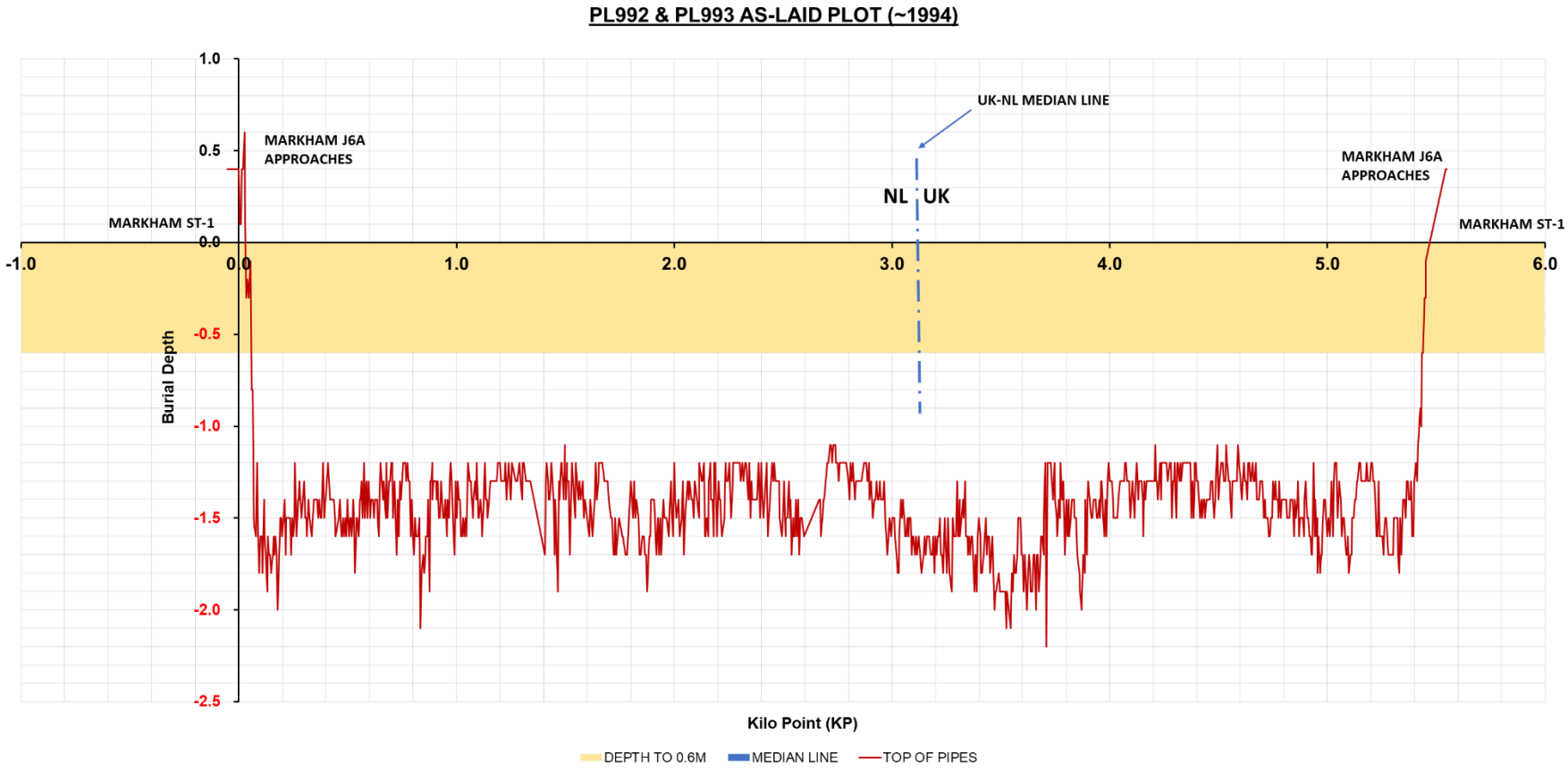


Figure B.1.1: PL992 & PL993 As-Laid Profile (Prior to natural backfill)

Appendix B.2 PL992 & PL993 As-Surveyed (2014)

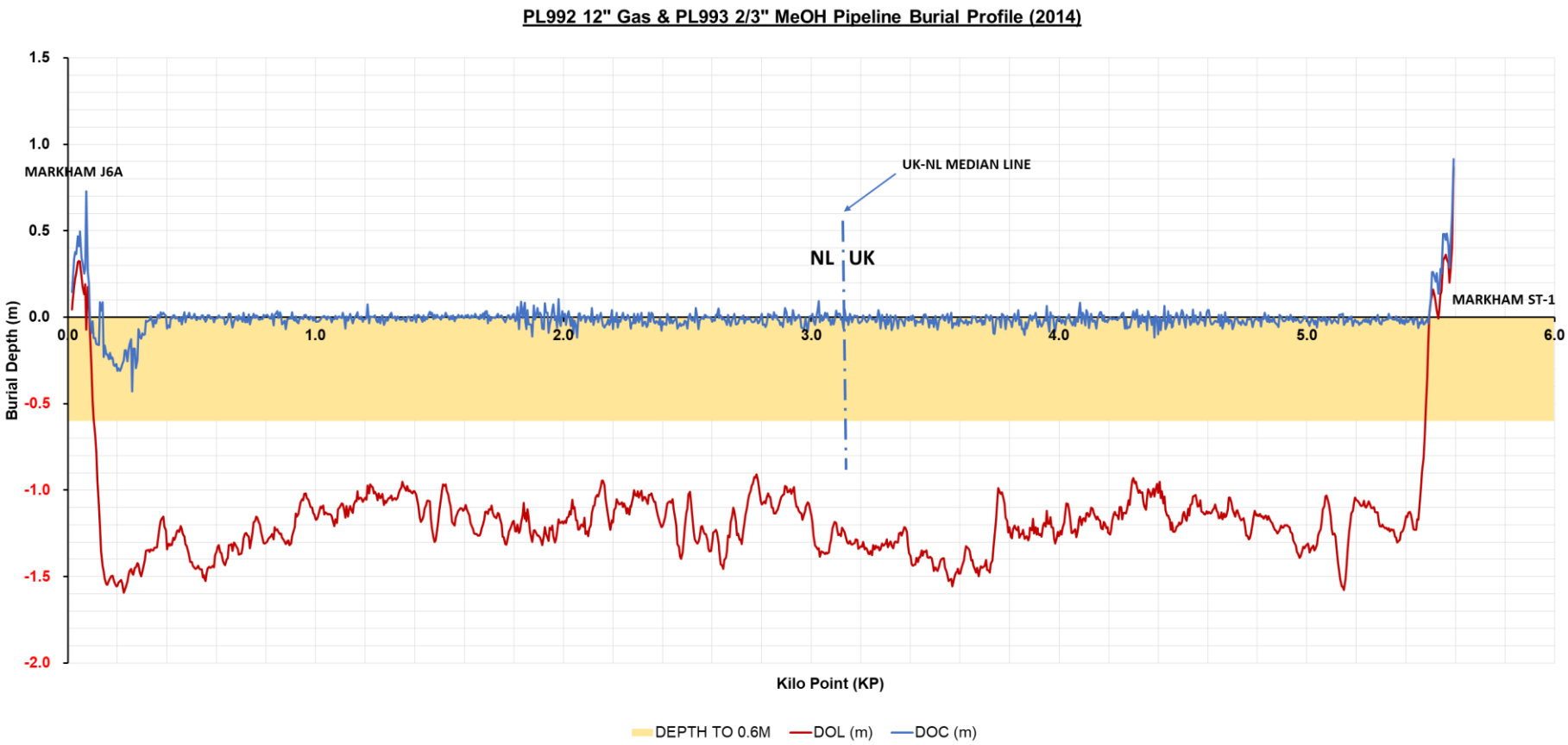


Figure B.2.1: PL992 & PL993 As-Surveyed Profile (2014)

Appendix B.3 PL992 & PL993 As-Surveyed (2017)

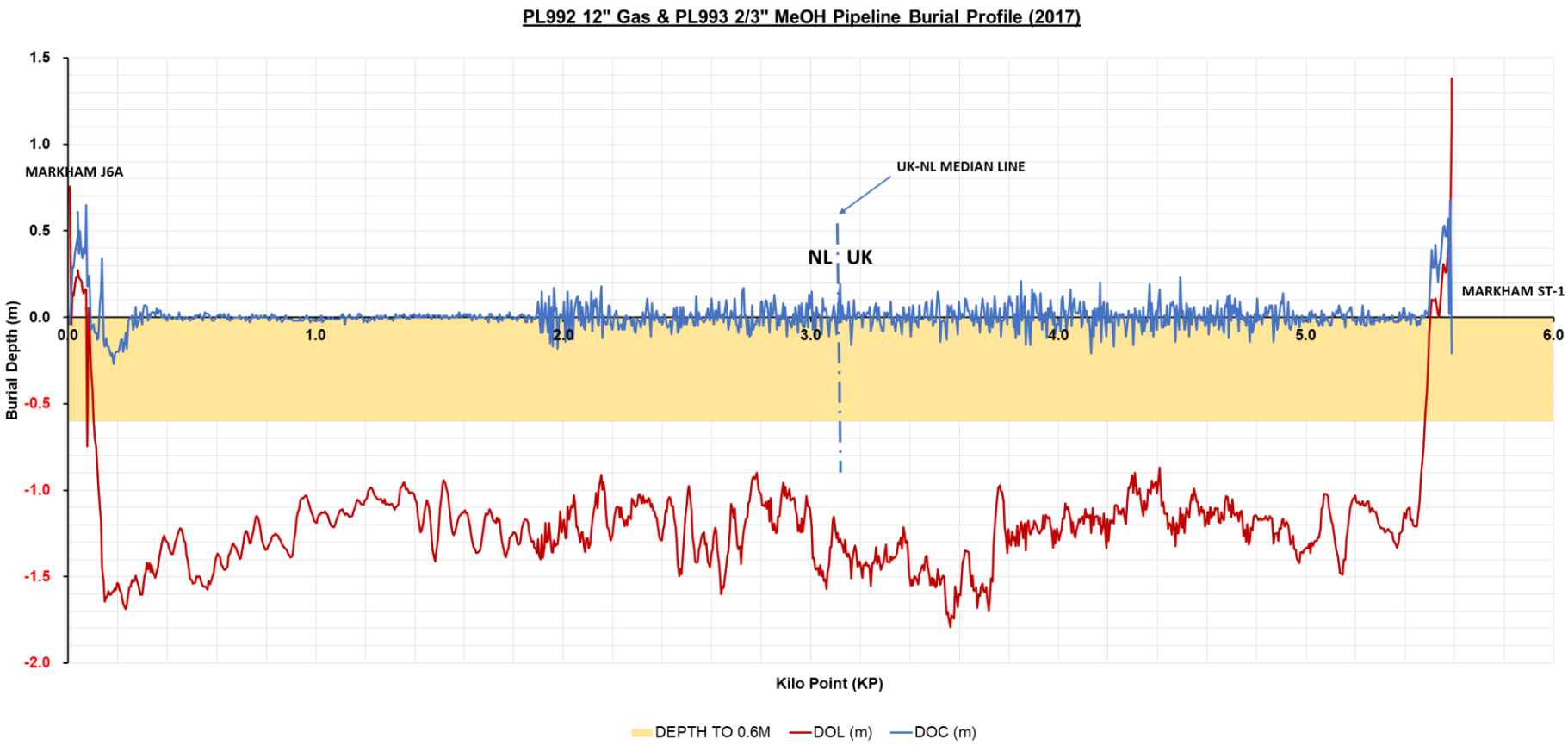


Figure B.3.1: PL992 & PL993 As-Surveyed Profile (2017)

APPENDIX C AS-LEFT LAYOUT DRAWINGS

Appendix C.1 Markham ST-1

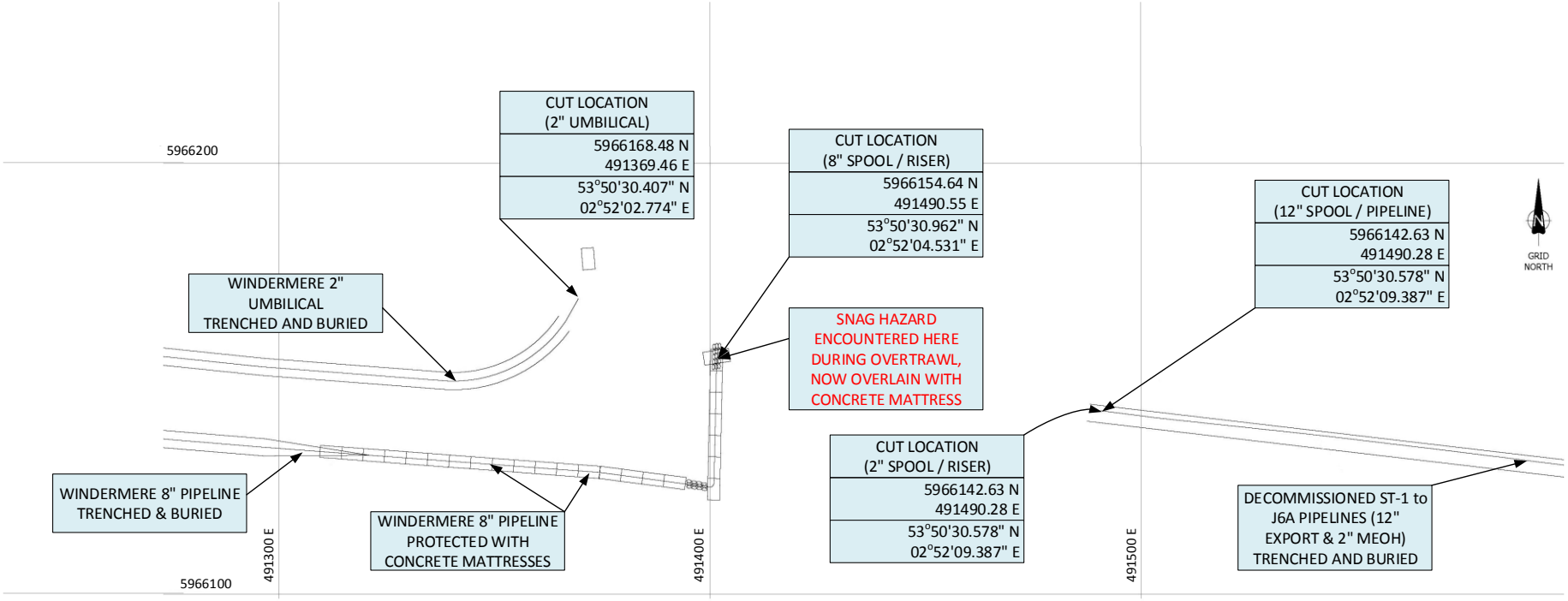


Figure C.1.1: Markham ST-1 As-Left Status

Appendix C.2 Markham J6A

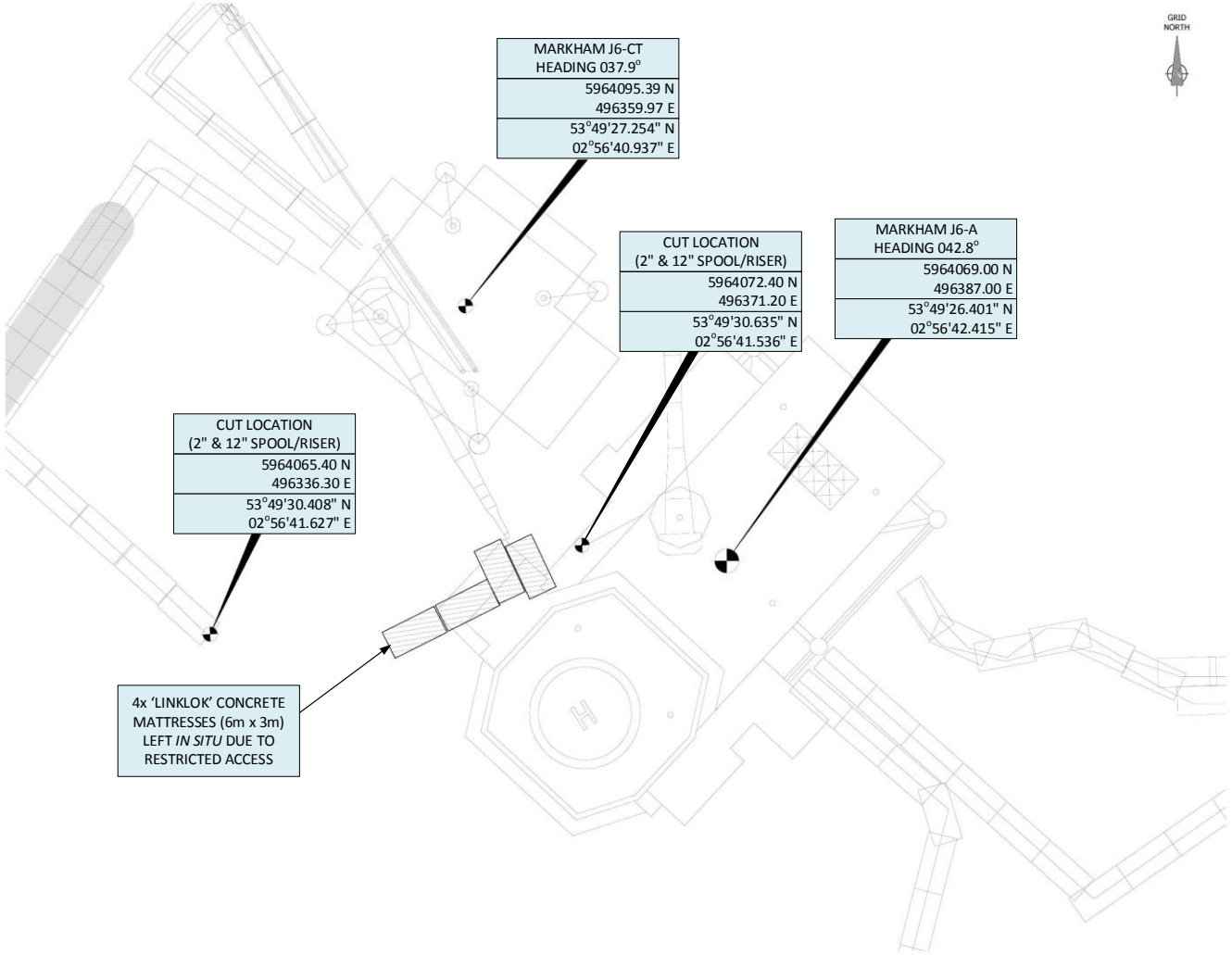


Figure C.2.1: Markham J6A As-Left Status

APPENDIX D NFFO OVERTRAWL REPORT

NFFO Services Ltd

30 Monkgate
York
YO31 7PF
Tel; 01904 635 432.

Markham ST1 decommissioning Program.

The Fv Resolution PD797 ex WY78

The Whitby based trawler Resolution WY78 was put forward by the federation to carry out the over trawl study. Being of a standard trawler design, the vessel was the safest type of vessel to conduct this operation based on a variety of factors which included;

1. Vessel design
2. Maximum open deck work area
3. Documented vessel safety management system in place
4. Compliance with marine standards at the highest level in the fishing industry
5. Suitable engine power
6. Range of deck equipment and machinery
7. Suitable gear handling system
8. Experienced personnel / crew

NFFO Services Ltd

VESSEL DETAILS

MAIN DETAILS:
Name: Resolution
Call Sign: MBCZ5
Hull Type: Steel
Year of Build: 1983
Refurbished: 2017
Flag:UK
Service: Guard & Chase

MAIN ENGINE:
Make: Baudouin
Model: 6M26.2
HP:
KW:328

VESSEL DIMENSIONS & WEIGHT:
Length: 18.26m
Beam: 6.58m
Depth: 3.75m
GRT: 106

BUNKER CAPACITY:
Fuel Oil: 11000Lts
Lube Oil: 750Lts
Duration at Sea: 30 Days

SPEED & APPROX. FUEL CONSUMPTION:
Cruising Speed:8.8knots
Maximum Speed: 10knots
Ltrs per Day during Guard Activities
312

ACCOMMODATION:
Berths:7

NAV & COMMUNICATION EQUIPMENT:

Radars: 2x Furuno 48nm
Plotters: 1x Trax 1x Sodena
VHF: 3
Echo Sounder: Furuno
MF/HF GMDS: Sailor
AIS Facility: Class A
Telephone Facility: Yes
Satellite Phone Facility: Yes
Email Facility: Yes

CERTIFICATES:

Full MCA Certification
Load Line Exemption
IMCA

Please Note: All information is provided for guidance only; specifications may change without notice when equipment is replaced or

Operations.

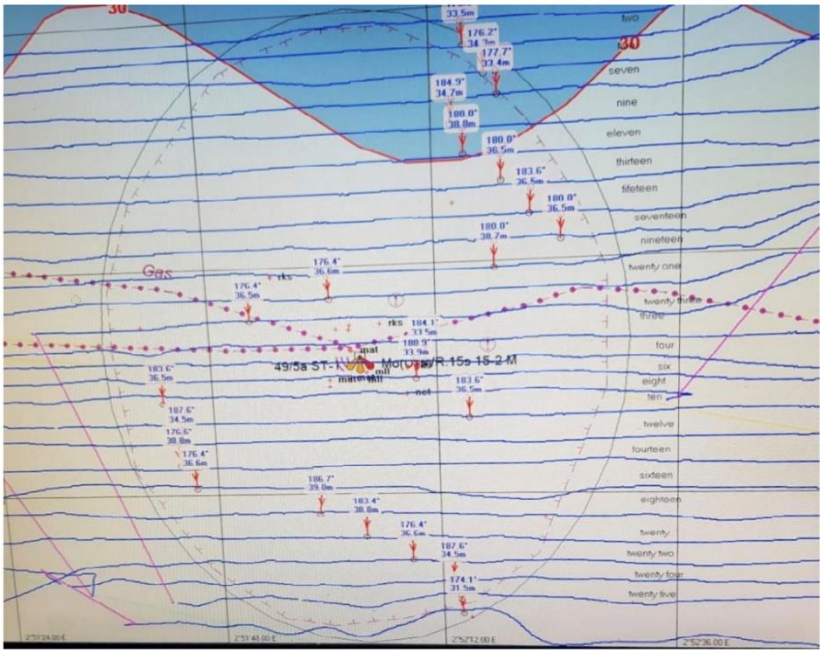
After arriving on location at the Windemere ST1 500M zone 25th July 2019 at 06.00hrs, the sweep program commenced by trawling through the decommissioned ST1 platform 500m safety zone using a standard ground rig with tickler chains with no net attached to give good ground contact covering the whole 500m zone.

Day one the vessel concentrated on covering the whole 500M zone completing a total of 26 passes on an East West course, each pass through the zone concluded with a turning circle outside the area of operations before proceeding to the next parallel line Each line on the plotter tracks shown below indicates the vessel carried out these sweeps approximately 36 to 40 metres apart giving good seabed coverage with a distance of approximately 70 metres between the trawl doors giving a good coverage and overlap between each line of the sea bed.

The objective of this practice was to overlap the sweeps to give blanket coverage of each area and all tracks undertaken by the vessel were recorded on the electronic navigational plotting system to demonstrate that the total 500-metre zone was covered with the Ground rig.

Day one the vessels master confirmed they experienced no snagging hazards throughout the day's operations.

Plotter screen shot of day one's operations.



On the second day of Operations the vessel commenced operations at 06.30hrs and concentrated on sweeping the whole 500M Zone carrying out operations with North -South transits through the 500-metres zone.

07.20am the vessels trawl wires closed together, and the vessel stopped moving ahead due to snagging on an obstruction on the seabed in approximate position 53°50.30 N - 02°52.03 E the vessel hauled back and successfully retrieved the sweep gear.

The vessel then tried a parallel trawl sweep with the vessel positioned 30 metres to the east of the previous line but again the vessel slowed down and stopped due to his trawl sweep gear encountering a obstruction at the centre of the 500 metre zone in the same approximate position as above, the sweep gear was again successfully retrieved with no damage and a decision was made to carry on the trawl sweeps throughout the rest of the 500 metre zone avoiding the area where the vessel had now experienced a sea bed hazard on 2 occasions.
No further seabed obstructions were encountered throughout the day's operations.

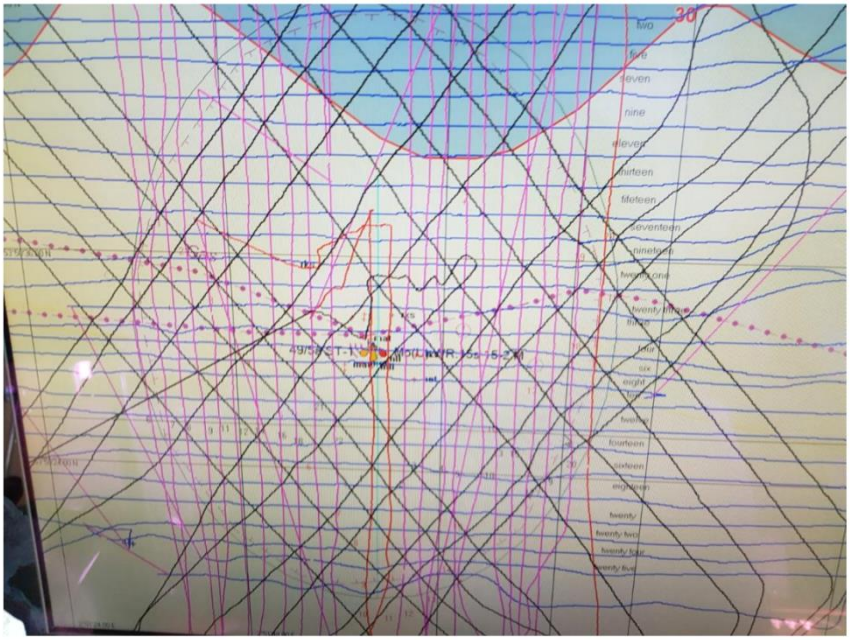
Plotter screen shot of day 2 operations.

On the third day of operations the vessel commenced operations at 06.00hrs with a planned sweep pattern of North East – South West & North West – South East to be completed throughout the day.

At 11.30 hrs while sweeping through the centre of the 500-metre zone the vessel again encountered a seabed obstruction in approximate position 53°50.31N - 02°52.03E causing the trawl sweep gear to close up and the vessel to stop.
The gear was successfully hauled back with no damage and redeployed to carry on with trawl sweep operations, no further seabed obstructions were encountered throughout the day.

Plotter screen shot of all three days trawl sweeps operations combined.

NFFO Services Ltd



Markham ST1 500m Zone - summary

Number of individual 35-40-metre-wide passes through the Safety Zone was N to S = 24
Number of individual 35-40-metre-wide passes through the Safety Zone was E to W = 26
Number of individual 35-40-metre wide passes through the Safety Zone was NE to SW = 11
Number of individual 35-40-metre-wide passes through the Safety Zone was SE to NW = 10

On the basis of the above the National Federation of Fishermen's Organisation feel it would be inappropriate to issue a Clean Sea Bed certificate for the Markham's ST1 500 metre zone until further investigation of the Seabed hazard encountered is carried out and remedial work to remove this obstruction has being carried out satisfactorily to enable successful over trawl operations.

Ian Rowe
NFFO Services Ltd
29th July 2019.