Projects & Technology
Pipelines Discipline Support

Goldeneye Pipelines Emerging Recommendations Report

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Goldeneye
Comparative Assessment

Emerging Recommendations Report

Submitted to the U.K. Department for Business, Energy and Industrial Strategy

Shell Report Number GDP-PT-S-AA-7180-00002

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Revision History

Rev #	Reason for Issue / Change
R01	Issued for review.
A01	Updated with comments from R01
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List of Holds

Hold #	Reason for Hold
1	Document Number for EA Report
2	PLU number for the SSIV Umbilical will be assigned when the PWA is updated

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External stakeholders consulted during the Goldeneye Decommissioning Comparative Assessment process:

- Scottish Fishermen's Federation (SFF);
- Department of Business, Energy and Industrial Strategy (BEIS);
- Joint Nature Conservation Committee (JNCC);
- Marine Scotland;
- Scottish Natural Heritage;
- Aberdeenshire Council.

"Collectively" referred to in this document as "**stakeholder consultees**".

1. Executive Summary

This document provides a record of the Comparative Assessment (CA) of credible decommissioning options, carried out for the Goldeneye pipelines between the Goldeneye Platform and the Shell St Fergus Gas Terminal. It presents the emerging recommendations for statutory and public consultation in support of the Goldeneye Draft Decommissioning Programme [1].

The Goldeneye field is located 100km north-east of Peterhead in the Central North Sea (CNS) area of the U.K. Continental Shelf (UKCS). The platform comprises a steel jacket, topsides and fixed risers that connect to the Mono-Ethylene Glycol (MEG) import pipeline and gas export pipeline at the seabed.

The subsea infrastructure associated with Goldeneye has been subjected to Comparative Assessment (CA) in order to determine the optimal solution for decommissioning. This infrastructure includes the onshore and offshore sections of the MEG pipeline PL1979 and gas export pipeline PL1978, as well as associated tie-in spools, jumpers and mattresses.

The CA has been conducted in accordance with the Department of Business, Energy and Industrial Strategy (BEIS, formerly DECC – Department of Energy and Climate Change) Guidance Notes on Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 [2].

This CA is submitted by Shell U.K. Limited, registered company number 00140141 (Shell) as operator, on behalf of itself and its co-venturers Esso Exploration and Production UK Limited, registered company number 00207426 (Esso), Endeavour energy UK Ltd, registered company number 05030838 (Endeavour) and Spirit Energy resources Limited (formerly Centrica Resources Ltd), registered company number 10854461 (Spirit Energy) all being the recipients of the Section 29 Notices, and throughout this document the terms 'owners', 'we' and 'our' refer to all the co-venturers.

A summary of the recommendations for each scope is presented in Table 1-1 below.

Scope description	Decision type	Emerging Recommendation
Onshore pipelines	Narrative	Decommission in situ
Piggybacked trenched-and-buried pipelines from KP 0 – 6	Narrative	Decommission in situ
Piggybacked trenched-and-buried pipelines from KP 6 - 20	Qualitative	Decommission in situ, Shell to perform a post-decommissioning survey to confirm burial depth and remediate any areas of concern with additional rock-cover
Trenched and buried 4" MEG line, KP 20 - 102	Narrative	Decommission in situ, pipeline end will be lowered into the seabed, most likely by fluidising the surrounding soil. Failure to achieve sufficient burial depth of the end will be mitigated by use of additional rock cover
Surface-laid 20" gas export pipeline, KP 20 - 102	Qualitative	Trench and bury with end flanged and buried; target depth of 0.6m with any inability to achieve this depth to be discussed with regulator and SFF to agree if remediation required
Surface laid tie-in spools and mattresses	Narrative	Recover to shore
Spud can depressions	Narrative	Over-trawl trial and remediate if required

Table 1-1 – Emerging Recommendations Summary

All other infrastructure (out with the scope of the comparative assessment) will be removed during the decommissioning works:

- The production wells will be plugged and abandoned;
- All risers will be removed and returned to shore for recycling;
- The SSIV structure will be removed and returned to shore for recycling.

2. Introduction

2.1. Purpose

The purpose of this report is to present the emerging recommendations from the comparative assessment for the Goldeneye pipelines in support of the Goldeneye Draft Decommissioning Programme [1].

The following is included within this document:

- Description of the infrastructure to be decommissioned;
- Description of decommissioning options considered;
- Comparative assessment methodology;
- Emerging recommendations from the comparative assessment.

The decommissioning options for the pipelines have been subjected to a process of comparative assessment in order to determine the optimum method of decommissioning in compliance with the BEIS Guidance Notes [2].

The following pipelines are included in the comparative assessment:

PL Number	Name	Diameter (inch)	Approx. Length (km)
PL1978	Gas export pipeline	20	105
PL1979	Service pipeline (MEG)	4	105
PLU-HOLD	SSIV Umbilical	4	0.2

Table 2-1 – Pipelines subject to comparative assessment

2.2. Assumptions

Assumptions for the comparative assessment:

- Risers and associated infrastructure will be recovered as part of the overall decommissioning programme.
- All structures will be recovered as part of the overall decommissioning programme.
- Pipelines have already been flushed as the asset is no longer producing; the pipelines are currently filled with inhibited fresh water.

2.3. Regulatory Context

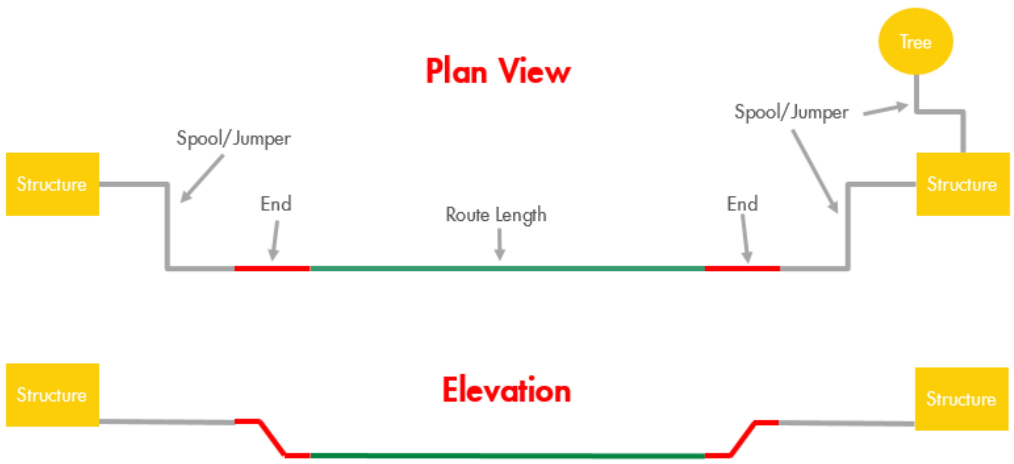
The decommissioning of offshore oil and gas installations and pipelines on the United Kingdom Continental Shelf (UKCS) is regulated through the Petroleum Act 1998, as amended by the Energy Act 2008. The U.K.'s international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention). Agreement on the regime to be applied to the decommissioning of offshore installations in the Convention area was reached at a meeting of the OSPAR Commission in July 1998 (OSPAR Decision 98/3). The BEIS (Formerly DECC) Guidance Notes [2] align with OSPAR Decision 98/3.

Pipelines currently do not fall within the remit of OSPAR Decision 98/3 but it is a requirement of BEIS Guidance Notes [2] that operators apply the OSPAR framework when assessing pipeline decommissioning options.

Because of the widely different circumstances of each case, BEIS do not predict with any certainty what decommissioning strategy may be approved in respect of any class of pipeline. Each pipeline must therefore be considered in the light of a comparative assessment (CA) of the credible options, taking into account the safety, environmental, technical, societal and cost impacts of the options. Cost may only be a determining factor when all other criteria emerge as equal.

2.4. General Definitions

The following table specifies the meaning of wording in this report when it is used in a general context to avoid any confusion or doubt.

Wording	Definition for the purposes of this assessment
Riser	Pipeline section from the seabed to the platform topsides.
Pipeline	When pipeline is used in the general text, this should be assumed to mean pipeline in general and may also reference the pipeline system (including spools, cathodic protection etc.), e.g. this can refer to a rigid or flexible pipeline. If a specific pipeline is referenced, then this may also include "rigid" or "flexible" pipeline.
Protection	If protection is referenced this will refer to either concrete mattresses or grout bags, any other protection will be specifically referenced.
Structure	Gas Export Sub-sea Isolation Valve structure
Route Length / End / Spool / Jumper	A single pipeline is split into 3 different sections for the purpose of this comparative assessment. The route length, which can generally be described as the section of pipe on the bottom of the trench. The end of a pipeline in general is the section between the trench transition (as the line comes out of a trench) and the tie-in to the structure (including spools). Finally, the spool or jumper which is the section of pipe lain on the seabed and facilitates the tie-in to any structures. The diagram below illustrates the differences between the different sections: 

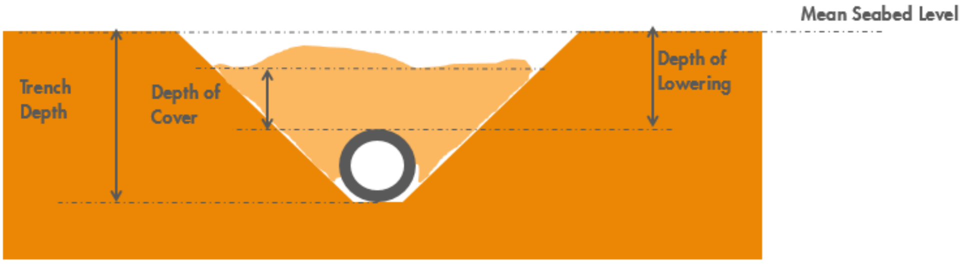
<table>
<tr><th>Wording</th><th>Definition for the purposes of this assessment</th></tr>
<tr><td>Burial Depth Definitions</td><td>Different definitions will be used for different burial depths. The following diagram illustrates the different burial depth definitions:

</td></tr>
<tr><td>Exposure</td><td>When an exposure is described this is essentially when the crown of the pipe or umbilical can be seen. This does not generally mean a hazard.</td></tr>
<tr><td>Reportable Span</td><td>A reportable span is a significant span which meets set criteria (fish safe criteria) of height above the seabed and span length.</td></tr>
<tr><td>Liquefaction</td><td>Liquefaction is the process of fluidising the seabed to the point where the soil has no inherent strength and hence the pipe or similar will simply fall to the bottom of the trench.</td></tr>
</table>

Table 2-2 – General Definitions

2.5. Carbon Capture and Storage

The Goldeneye field, pipelines and associated reservoir were identified as having potential re-use for Carbon Capture and Storage (CCS) by the Peterhead CCS Project. When the U.K. Government withdrew funding for the Peterhead CCS Project, Shell's view was that CCS utilising the Goldeneye infrastructure was not commercially viable. However, CCS stakeholders have indicated an interest in maintaining the integrity of the pipeline such that future re-use is not prohibited. Although not aware of any current commercially viable proposals for re-use of the Goldeneye infrastructure, Shell U.K. is nevertheless open to discussions on future re-use and believes that, in a world requiring more energy but less CO_2, there is a critical role for CCS deployment at scale.

Therefore, this Comparative Assessment has been conducted taking into account the impact each proposed solution would have on any potential future re-use.

2.6. Abbreviations

BEIS	Department of Business, Energy and Industrial Strategy (formerly DECC)	NUI	Normally Unattended Installation
CA	Comparative Assessment	OBM	Oil Based Mud
CCS	Carbon Capture and Storage	OGUK	Oil and Gas UK
		OOM	Order of Magnitude
CNS	Central North Sea	OSPAR	Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
DECC	Department of Energy and Climate Change (Now BEIS)	PMF	Priority Marine Feature
EAR	Environmental Appraisal Report	POB	Persons on Board
EUNIS	European Nature Information Service	QRA	Quantitative Risk Assessment
FAR	Fatal Accident Rate	ROV	Remotely Operated Vehicle
FEED	Front End Engineering Design	SFF	Scottish Fishermen's Federation
ICES	International Council for the Exploration of the Sea	SIMOPS	Simultaneous Operations
JNCC	Joint Nature Conservation Committee	SNH	Scottish Natural Heritage
KP	Kilometre Point	SPA	Special Protection Area
MDAC	Methane Derived Authigenic Carbonate	SSIV	Sub-sea Isolation Valve
MEG	Mono-Ethylene Glycol		
MLWS	Mean Low Water Springs	UKCS	United Kingdom Continental Shelf
(p)MPA	(proposed) Marine Protected Area	VMS	Vessel Monitoring System
		WBM	Water Based Mud
NOSWA	North of Scotland Water Authority		

Table 2-3 – Table of Abbreviations

2.7. Field Overview

2.7.1. General

The Goldeneye field was a normal temperature, normal pressure gas condensate field located in blocks 14/28b, 14/29a, 20/3b and 20/4b of the United Kingdom Continental Shelf (UKCS) in the central North Sea, approximately 100km North-East of St. Fergus.

Goldeneye has been operational as a gas producing field since 2004, and the last well in the Goldeneye field watered out on the 8th December 2010. The field was finally shut-in on the 16th February 2011. In March 2011, the Joint Venture Partners and DECC (now BEIS) agreed with the Cessation of Production assessment made by Shell U.K. Ltd and approval was received from DECC. In 2012, the pipelines were flushed, made hydrocarbon-free and filled with fresh water.

The platform and associated infrastructure have been preserved and maintained as a Normally Unattended Installation (NUI), managed under a revised Safety Case which ensured safety and integrity have been maintained, for potential future use in association with the Peterhead CCS (Carbon Capture and Storage) project that is no longer progressing.

The NUI is a 4-leg steel jacket substructure supporting an integrated topsides deck structure. The topside includes process facilities for separation, export metering with chemical injection (MEG, Mono-ethylene Glycol) and basic supporting utilities (e.g. power, venting etc). The full well stream was transferred to the dedicated Goldeneye reception facility co-located at the Shell St. Fergus gas terminal. The MEG was supplied from St. Fergus. Goldeneye is fully controlled from Shell St. Fergus control room.

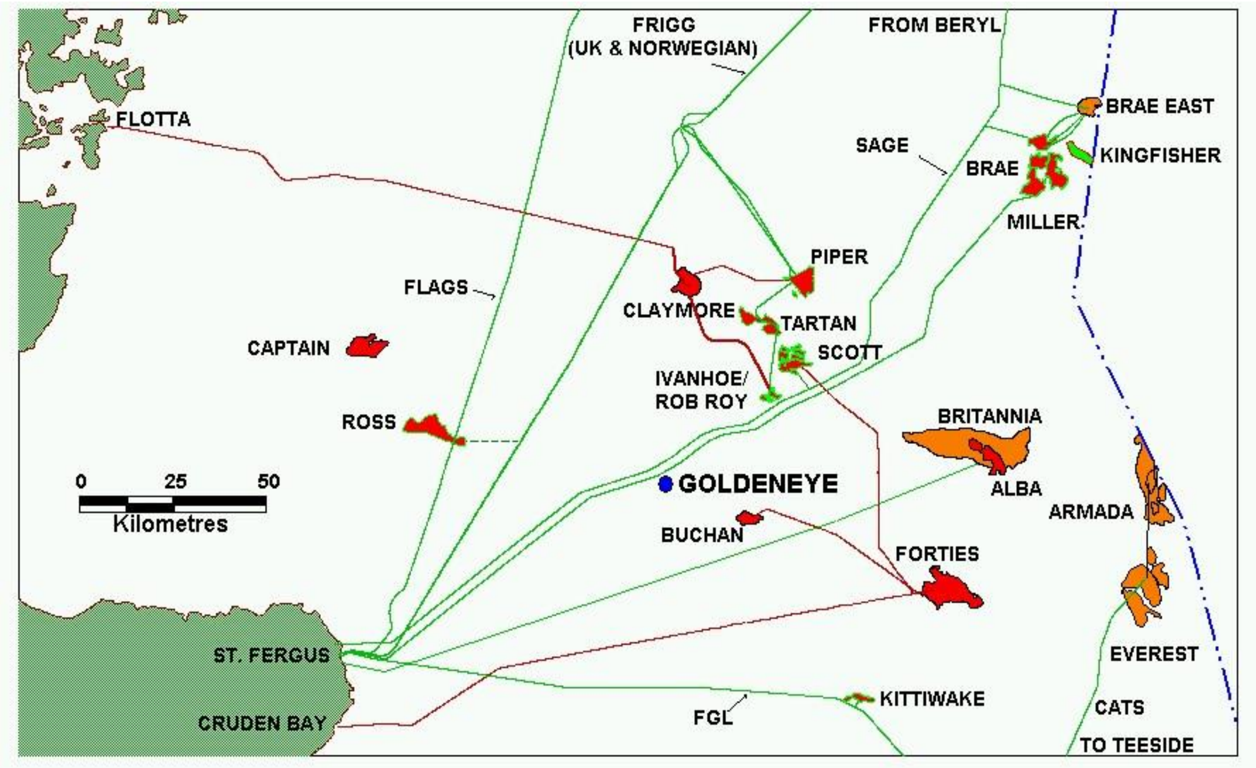


Figure 2-1 – Goldeneye Field Location

2.7.2. Environmental Summary of Goldeneye Field

The Goldeneye field is located in the Central North Sea (CNS), approximately 100 km north-east of the St Fergus Gas Terminal in the north-east of Scotland (Figure 2-1).

Protected/Sensitive Habitats

The field is located on the edge of an offshore area of research and potential Annex I habitat for fluid seeps under the Habitats Directive, however, no active bubble streams or Methane Derived Authigenic Carbonate (MDAC) has been observed in any of the field or pipeline surveys. The nearshore section of pipeline (out to 12 nm) passes through the proposed Southern Trench Marine Protected Area (pMPA), proposed for the following features: minke whale, ocean fronts, shelf deeps and burrowed mud habitat; and Submarine mass movement – slide scars; Quaternary of Scotland sub-glacial tunnel valleys and moraine. The pipelines come ashore north of the Buchan Ness to Collieston Coast Special Protection Area (SPA) and 4.5 km south of the Loch of Strathbeg SPA. These sites in relation to the Goldeneye infrastructure are shown in Figure 2-2.

Benthic Environment

The seabed sediment around the Goldeneye platform area is largely homogeneous comprising poorly sorted silty fines, with the underlying layers of sediment expected to comprise very soft sandy clay and soft to firm clay. The platform area habitat is assigned to the EUNIS biotope 'polychaete-rich deep community in offshore mixed sediments'.

The platform area is classified as an OSPAR-threatened and / or declining habitat 'Seapen and burrowing megafauna communities', based on megafaunal burrows and/or seapens, particularly Phosphorescent sea pen (*Pennatula phosphorea)*, observed throughout the area. Juveniles of Ocean Quahog (*Arctica islandica*) are also present at the platform location.

There were no operational discharges from the platform and all five production wells only discharged Water Based Muds (WBM) to sea. An environmental survey of the platform vicinity, in 2009, found no evidence of any oil and gas contamination and no evidence of drill cuttings piles.

Analysis of the seabed along the pipeline route is based on survey results for the nearby Atlantic to Cromarty pipeline. The seabed comprises mainly 'circalittoral mixed sediment' out to approximately 45 km from shore. The sandy areas exhibited low biodiversity, while areas which featured fragmented shells, gravel, pebbles and cobble exhibited relatively high biodiversity.

Patches of Ross worm (*Sabellaria spinulosa)* was identified between 3 km and 16 km from the shore while potential stony reefs were also observed between 6 km and 9 km. Several depressions were observed, most of which contained boulders of up to 1.2 m height.

Fish

The Goldeneye platform lies within spawning grounds for cod (*Gadus morhua*; January to April), lemon sole (*Microstomus kitt*; April to September), Norway lobsters (*nephrops spp,* year-round), sand eels (*Ammodytidae spp.*; November to January), Norway pout (*Trisopterus esmarkii*; January to April), sprat (*Sprattus sprattus*) and Whiting (*Merlangius merlangus*; February to June) (Coull *et al.*, 1998; Ellis *et al.*, 2010). The area is also used as nursery grounds for anglerfish (*Lophius piscatorius*), blue whiting (*Micromesistius poutassou*), cod, European hake (*Merluccius merluccius*), herring (*Clupea harengus*), ling (*Molva molva*), mackerel, sandeels, Spotted ray (*Raja montagui*), sprats, spurdog (*Squalus acanthias*) and whiting (Aires *et al.*, 2014; Coull *et al.*, 1998; Ellis *et al.*, 2010).

Cetaceans and pinnipeds

The JNCC Cetacean Atlas suggests that moderate densities of harbour porpoise (Phocena phocena), white-beaked dolphin (Lagenorhychus albirostris), Atlantic white-sided dolphin (Lagenorhynchus acutus) and minke whale (Balaenoptera acutorostrata) may occur in the vicinity of the Goldeneye platform. Harbour porpoises are protected under Annex II of the Habitats Directive and all four species are listed as Priority Marine Features (PMFs).

Both grey (Halichoerus grypus) and harbour seals (Phoca vitulina) are Annex II species and also listed on the U.K.'s PMF list. Telemetry data collected between 1991 – 2012 and count data 1988 – 2012 indicate that grey seals are likely to occur within the Goldeneye area and along the pipeline route. Harbour seals are unlikely to occur in these areas.

Birds

Fulmar, gannets, guillemots, kittiwake, puffin, great skua and great black-backed gulls may be present all year round in the vicinity of Goldeneye. In addition, species protected by the EC Birds Directive are expected in low densities during summer (arctic tern) and late summer (storm petrel).

Seabird vulnerability to surface pollution in Block 14/29 is classified as moderate or low on the Seabird Oil Sensitivity Index, although adjacent blocks are classified as extremely high sensitivity in January.

Fishing intensity

The Goldeneye platform is situated in ICES rectangle 45E9 and the pipeline route transects 44E8 and 44E9. Based on available data for 2012-2016, the average effort in ICES rectangle 45E9 is 792 days per year (0.5% of U.K. total), while fish landing is estimated at an annual average of £4.76m and 4,258 tonnes. Rectangles 44E8 and 44E9 are subject to higher fishing effort (days), though yield slightly lower average landings than 45E9. VMS data between 2009 and 2013 indicate high activity of larger (>15m) vessels with Nephrops mobile gear in the vicinity of Goldeneye.

Full details of the environmental aspects and impacts of the Goldeneye Decommissioning Project can be found in the Environmental Appraisal Report [3], also issued for public consultation in support of the Goldeneye Draft Decommissioning Programme [1].

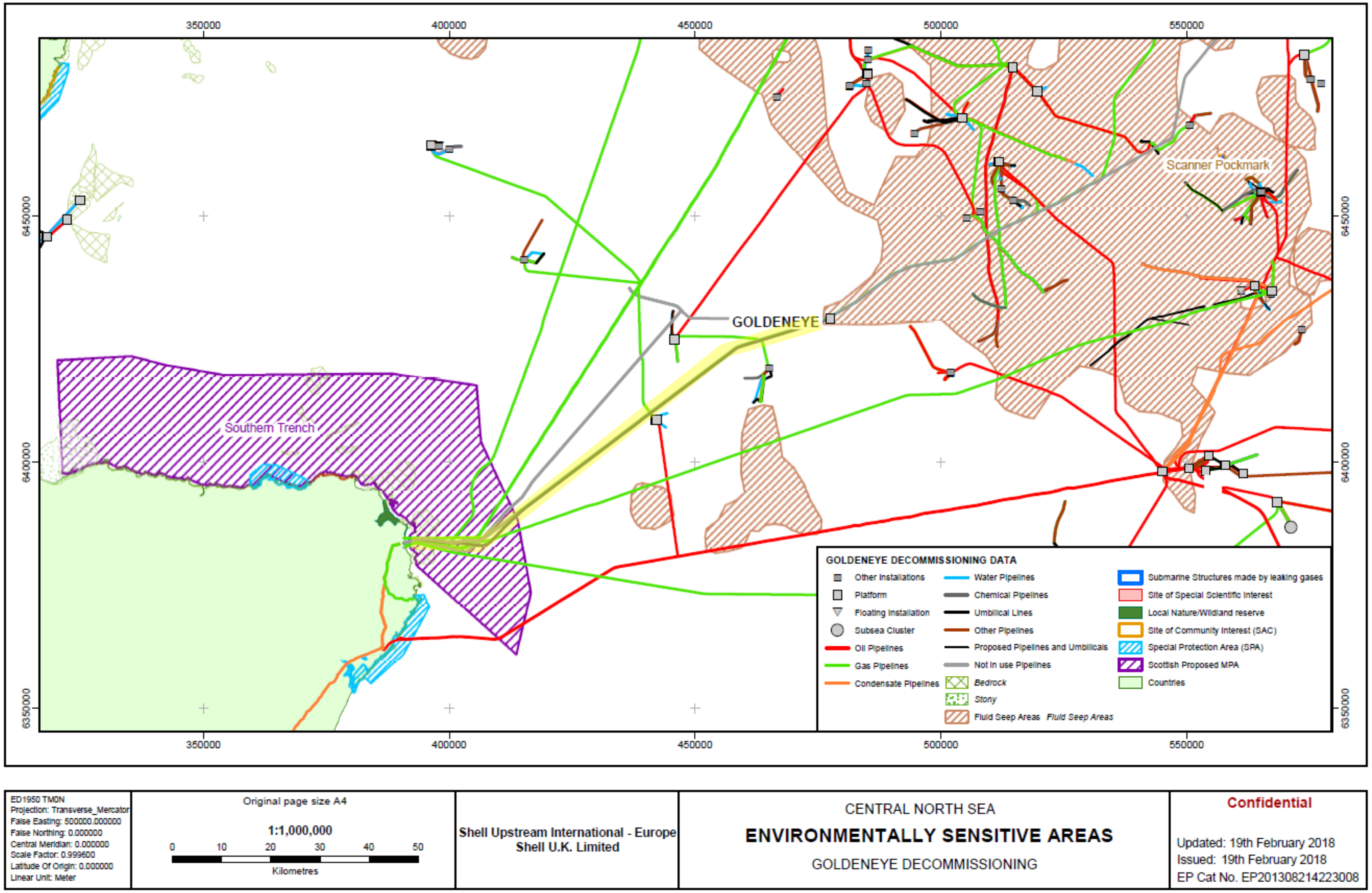


Figure 2-2 – Goldeneye Environmental Overview

2.7.3. Goldeneye Field Infrastructure

The Goldeneye platform consists of a 4-leg steel jacket substructure weighing approximately 2500 tonnes in 120m of water 100km north-east of the St Fergus Gas Terminal in north-east Scotland. A 1300 tonnes integrated topside contains separation, export metering, chemical injection and basic support utilities. There are no drilling facilities onboard and the platform is a NUI. Shell plan to plug and abandon the platform wells and put the facility into a Permanently Unattended state in summer 2018.

The full well-stream was exported via the 20" Goldeneye Gas Export Pipeline PL1978 to dedicated reception facilities at the St Fergus Gas Terminal, with MEG exported in the opposite direction via the 4" MEG Pipeline PL1979. Details of each pipeline are provided in Table 2-4.

PARAMETER	20" GAS PIPELINE	4" MEG PIPELINE
N# / PL#	N0209/PL1978	N2805/PL1979
Diameter	508 mm	114.3 mm
Wall Thickness	15.9mm – 14.3mm	11.1 mm
Material	Carbon Steel	Carbon Steel
Length	102 km	102 km
Service	Gas Production	MEG Service Line
Current Contents	Inhibited Water	Water
Weight Coatings	Concrete Coated	N/A
Offshore Crossings	5 under, 3 over	5 under, 3 over

Table 2-4 – Pipeline Summary

From the onshore facilities at St Fergus, the pipelines are piggybacked and laid in a common trench for approximately 610m from the valve pit to the Mean Low Water Springs (MLWS) at the beach. This onshore section is not part of the section 29 notice for which the Decommissioning Programme is produced but decommissioning proposals are included within Shell's proposals for completeness.

From the MLWS, the pipelines share a common trench for the first 20 kilometres, where they separate and the 4" MEG pipeline continues in its own trench until adjacent to the Goldeneye platform. A surface-laid tie-in spool connects the 4" MEG pipeline to a riser from the seabed to the Goldeneye topsides.

The 20" Gas Export pipeline is surface-laid from the point of separation at KP20 before, via surface-laid tie-in spools, tying into the Subsea Isolation Valve (SSIV) structure adjacent to the Goldeneye platform.

Surface-laid tie-in spools connect the flanged end of the gas export pipeline to the SSIV; and the SSIV to the production riser from the seabed to the Goldeneye topsides. A SSIV umbilical runs from the Goldeneye topsides via a riser to the SSIV structure and is essentially two hydraulic control lines to control the SSIV. Hereafter these are referred to as surface-laid control jumpers.

All surface-laid spools and jumpers at the approach to Goldeneye and the transition area at KP20 are protected by mattresses, with the transition area also protected by rock cover.

Between KP 6 and 20 five pipelines cross under the Goldeneye pipelines, with three lines crossing over both pipelines between KP 20 and the Goldeneye platform. All crossings are protected by mattresses and rock cover.

Figure 2-3 shows the approach to Goldeneye; while Figure 2-4 provides an overview of the whole field Additional details are provided for each section of pipeline in Section 5.

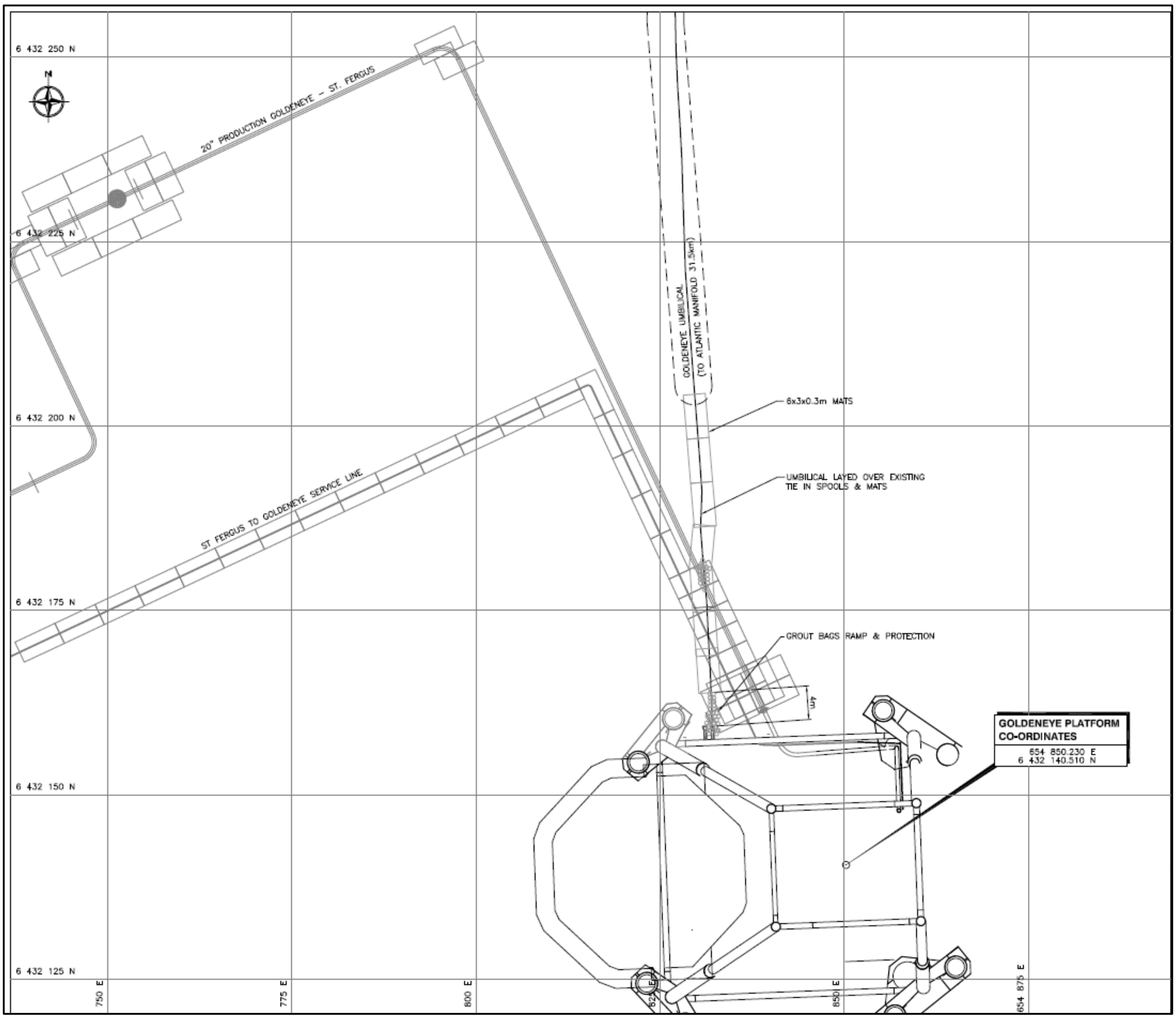


Figure 2-3 – Subsea Layout at Goldeneye

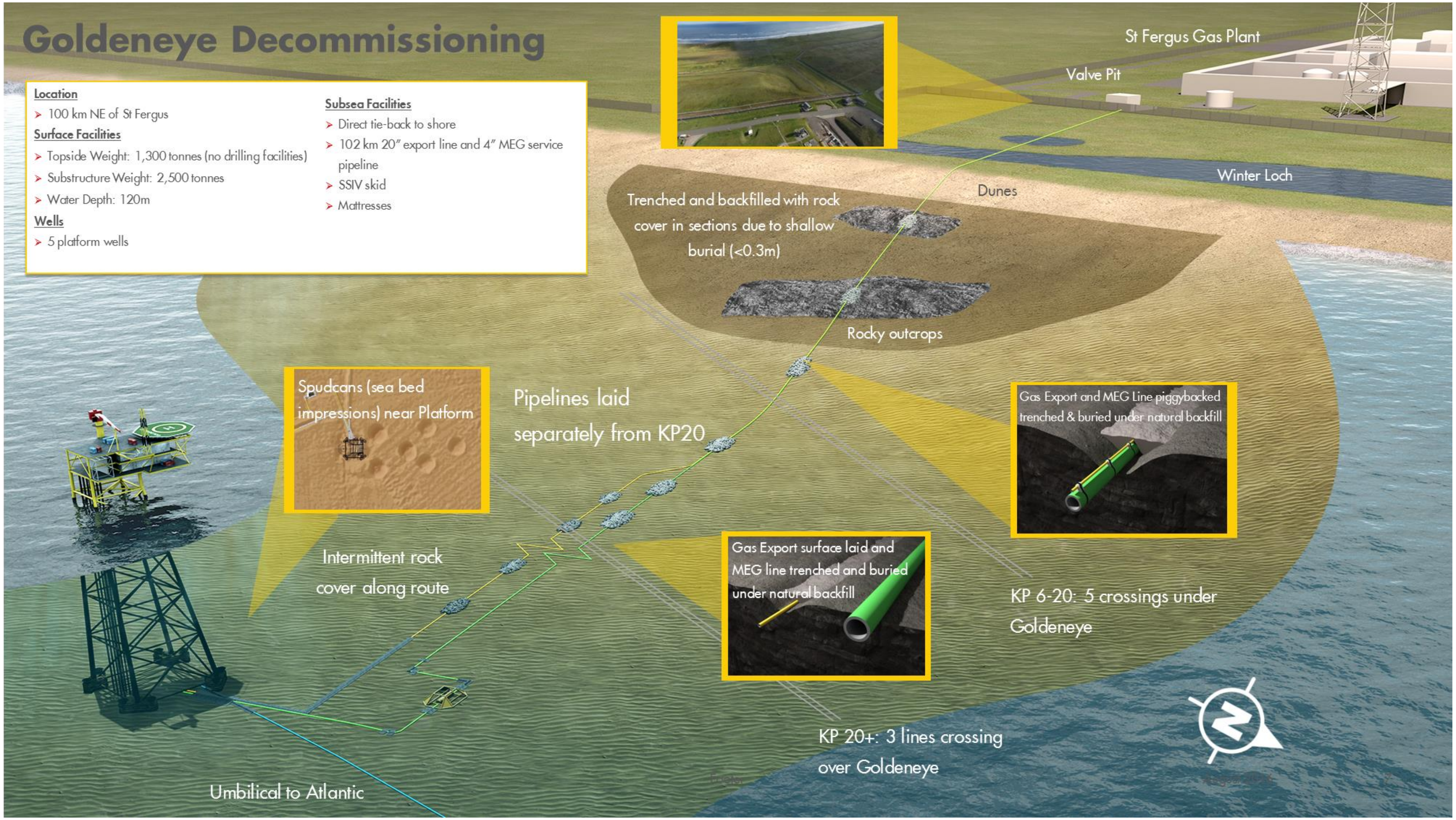


Figure 2-4 – Goldeneye Field Schematic

3. Comparative Assessment Process

3.1. General Process Description

The comparative assessment process was performed in accordance with the BEIS (formerly DECC) decommissioning guidance notes [2] and guidance was used from the OGUK pipeline comparative assessment guidance notes [4].

The following sections present the comparative assessment methodology used for each of the Goldeneye pipelines, however a summary of the process is used as follows:

- Scoping of subsea infrastructure to be decommissioned and inventory mapping;
- Decommissioning assessment criteria and sub-criteria;
- Decommissioning options to be considered;
- Screening workshop to initially agree the decommissioning options to take further and any grouping to be considered.
- Selection of groups for narrative conclusion;
- Traffic light assessment, as required;
- Scoring assessment, as required.

Stakeholder engagement and multi-disciplinary reviews have formed an important part of the comparative assessment process and stakeholder.

3.2. Scoping and Inventory Mapping

The initial phase of the comparative assessment process was to identify the scope to be decommissioned and map the inventory which requires decommissioning. This is summarised in section 2.7.

3.3. Criteria and Sub-Criteria

The next step in the comparative assessment process is to agree the criteria and sub-criteria to be used. The following table presents the selected criteria and sub-criteria, which was used to assess each option for decommissioning during the comparative assessment process. The criteria are in line with the criteria recommended in the OGUK comparative assessment guidelines [4], except for the impact of operations and legacy impact of operations and legacy impact sub-criteria which have been adapted as shown in the table below.

Criteria	Sub-Criteria	Applicable to	Applicable When	Factors	Potential Sources of data
Safety	**Project risk to personnel – Offshore**	Project team offshore, project vessels crew, diving teams, supply boat crew, heli-ops, survey vessels crew	During execution phase of the project including any subsequent monitoring surveys	Type of activity Number of personnel involved & project duration. Number of crew changes (helicopter transfers) Number of vessels involved & SIMOP activity Numbers, durations and depth that divers are anticipated to work. Any unique or unusual handling or access activities required of personnel.	Decommissioning methodology for each option; vessel study; diving study; etc Coarse QRA data based on POB / exposure, durations and activity Fatal Accident Rate (FAR). Industry data will be used to derive the probability of loss of life.
	Project risk to other users of the sea	Navigational safety of all other users of the sea, fishing vessels, commercial transport vessels, military vessels	During execution phase of the project including any subsequent monitoring surveys	Likelihood of incursion into project exclusion zone by other users of the sea Number and type of transits by project vessels to and from the project work site	Fishing study on anticipated activity in area of activity Other vessels movements review, stakeholder engagement
	Operational risk to personnel – Onshore	Onshore dismantling and disposal sites personnel; extent of materials transfers/ handling on land	During execution phase of the project, through to final disposal of recovered materials	Extent of dismantling required & hazardous material handling anticipated. Numbers of road transfers from dismantling yard to final disposal site.	Decommissioning methodology for each option, considering volume and type of material to be returned to shore Coarse QRA data based on POB / exposure, durations and activity Fatal Accident Rate (FAR)
	Potential for a high consequence event	Project team offshore and onshore; project vessels; diving teams; supply boat crew; heli-ops; survey vessels; onshore dismantling and disposal sites personnel	During execution phase of the project including any subsequent monitoring surveys	Decommissioning philosophy; potential for dropped object over a live pipeline; degree of difficulty anticipated in onshore dismantling	Decommissioning methodology for each option; vessel study; diving study; etc
	Residual risk to other users of the sea	Fishing vessels, fishermen, supply boat crews, military vessel crews, commercial vessel crew and passengers, other users of the sea	Following completion of the Decommissioning project and residual / ongoing impact in perpetuity	Extent of facility / equipment / pipeline left in situ on completion of the project and its likelihood to form a future hazard; likelihood for further deterioration; predicted future fishing activity; proximity of retained facilities to main transport routes	Decommissioning methodology for each option, focussing on volume and type of infrastructure to be left in situ; fishing navigational safety study on anticipated activity in area(s) where infrastructure is decommissioned in situ; assessment(s) of degradation for infrastructure left in situ; stakeholder engagement
Environmental	**Impact of operations**	Environmental impact to the marine environment, nearshore areas and onshore caused by project activities	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not	Associated planned discharges; marine noise; seabed disturbance, including seabed footprint (area), sediment suspension and contaminated sediment including drill cuttings; protected	Asset knowledge, decommissioning methodologies, Environmental Baseline Survey, Habitat Survey, Waste Inventory, Environmental Appraisal Report,

Criteria	Sub-Criteria	Applicable to	Applicable When	Factors	Potential Sources of data
			include landfill and long-term storage impacts) For rock placement, trenching and dredging any seabed disturbance is included here, depending on area of impact – changes to habitat and species are covered in Legacy Impact.	habitat and species in nearshore, marine and onshore areas – conservation objectives, their presence, impacts, distance from activities; waste processing	project schedule, collision assessment, predicted discharges to sea, historic events
	Energy and emissions and resource consumption	Project activities from vessel mobilisation to the final destination of waste, including the energy and emissions penalty for leaving recyclable material in field. Includes vessel mobilisation, demobilisation, waiting on weather, post-decommissioning monitoring surveys.	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) Not recovering and recycling the installations material will require that raw material and energy will be consumed to replace the materials which would have been recycled if the structure had been brought onshore	Number and type of vessels; duration of vessel activities; tasks vessels are fulfilling; vessel station keeping approach Energy and emissions required to replace recyclable materials not recovered for recycle of re-use Helicopter trips are not to be included as impact is marginal.	Energy and emissions assessment, undertaken per Institute of Petroleum: Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures
	Legacy Impact	Ongoing long term environmental impact and benefit caused by materials left in place or long-term waste storage / landfill	Following completion of the Decommissioning project and residual / ongoing impact For rock placement, trenching and dredging any changes to habitat and species are included here - seabed disturbance is included in Impact of Operations, depending on area of impact.	Waste disposal including onshore landfill and long-term waste storage; habitat alteration and long-term changes in species composition; physical and chemical degradation of products left on the seabed (make and content of material like wax, chemicals, plastic and concrete, steel, debris). CA will be conducted with assumption that reasonable endeavours are used to clean the infrastructure.	Decommissioning methodology for each option, focussing on volume and type of infrastructure to be left in situ; Environmental Baseline Survey; Habitat Survey; Waste Inventory
Technical	**Risk of major project failure** Cost and Schedule overruns. Ease of recovery from excursion.	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	Maturity of scope definition, confidence level that project will proceed as foreseen; ability to recover from unplanned events which could impact completion of the project as planned; extent of potential re-engineering that may be required and its impact if strategy goes wrong	Decommissioning methodology for each option, concept / pre-FEED study, lessons learned from industry
	Technology demands, Availability / Track Record	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	Extent of new or emerging technology proposed by the option; extent of application of existing technology to different uses; extent that the approach has been completed before	Decommissioning methodology for each option, concept / pre-FEED study, lessons learned from industry

Criteria	Sub-Criteria	Applicable to	Applicable When	Factors	Potential Sources of data
Societal	**Commercial impact to fisheries**	Impacts from both the decommissioning operations and the end-points on the present commercial fisheries in and around the field	During and following completion of the Decommissioning project and residual / ongoing impact	Residual impact on fishing areas: • If exclusion zones are to be retained where equipment or materials are left in-situ • If fishing habitats are inhibited as a result of the decommissioning methods adopted	Fishing study on anticipated activity in area of activity; decommissioning methodology for each option focussing on volume and type of infrastructure to be left in situ; vessel study; publicly available data; stakeholder engagement
	Socio-economic impact on communities and amenities	The impact from any near shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on the health, well-being, standard of living, structure or coherence of communities or amenities. E.g. business or jobs creation, job loss, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads.	During and following completion of the Decommissioning project and residual / on-going impact	May be positive or negative; jobs created; establishment of track record; improvements to roads and quaysides; use of limited landfill resource	Decommissioning methodology for each option; publicly available data; stakeholder engagement
Economic	**Cost**	Overall Project	Full decommissioning project cost including future monitoring surveys and proposed remediation, if required	Actual cost estimates are not to be included in the CA report but a normalised scale can be produced to indicate the comparison between each option	Cost and schedule estimates
	Cost Risk / Uncertainty	Overall Project	Project execution phase and ongoing cost liability (surveys and potential remedial action)	Uncertainty in estimates prepared, potential for / risk of growth through the project, risk will be greater with a larger number of unknowns and where activities are weather sensitive	Risk and opportunity register

Table 3-1 – Comparative Assessment Criteria and Sub-Criteria

Note that, per Section 2.5, Carbon Capture and Storage (CCS) is a field-specific consideration for Goldeneye. Therefore, in addition to Shell's standard criteria and sub-criteria provided in Table 3-1 above, CCS was included in the CA as part of the *Socio-economic Impact on Communities and Amenities* sub-criterion. This included both the societal climate change benefits and local employment from potential future CCS.

3.4. Decommissioning Options and Initial Screening Workshop

3.4.1. Decommissioning Options

The options available for decommissioning have been considered and were assessed as part of the initial screening process to assess each options feasibility. The options for decommissioning being assessed are shown in section 4.

3.4.2. Initial Screening Workshop

An initial screening workshop was held where experts were consulted to assess the technical feasibility and practicality of each of the decommissioning options relating to each scope. The initial screening workshop also identified which scopes displayed similar characteristics and could therefore be grouped and assessed together.

Where a particular piece of scope was in-line with the BEIS guidance notes [2], such as a blanket rock covered pipeline, the decommissioning option was preliminarily selected at the initial screening workshop. During the CA workshop, the proposed methods were presented to and discussed with the key stakeholders to confirm their acceptance of the proposed decommissioning method. The scopes that could not be selected during the initial screening workshop were taken into the comparative assessment workshop for traffic light screening.

3.5. Traffic-light assessment

A comparative assessment workshop was organised with the relevant stakeholders to assess each decommissioning option that was not selected during the initial screening workshop. Table 5-1 shows a summary of the groups assessed during the traffic light screening stage.

During the workshop each scope or group was assessed individually, whereby each option was qualitatively assessed against each of the sub-criteria detailed in Section 3.3, using a simple traffic light system. An example of the traffic lighting is shown in the table below.

		Option Category	Leave In-Situ	Remediate	Remove
		Include Option for Screening?	☑ Option 1	☑ Option 2	☑ Option 5
Criteria	Ref	Sub Criteria	Option 1: Leave In-Situ (Do Nothing)	Option 2: Leave In-situ (Remediate with Rock Cover Above Seabed)	Option 5: Full Removal
Safety	1	Project risk to personnel - Offshore			
	2	Project risk to other users of the sea			
	3	Project risk to personnel - Onshore			
	4	Potential of a high consequence even			
	5	Residual risk to other users of the sea			

Table 3-2 – Example Traffic Lighting

The traffic lighting assessment was conducted using the qualitative scoring guidance provided in section Appendix C of this document, developed from Appendix A of the Oil and Gas UK Guidelines for Comparative Assessment in Decommissioning Programmes [4] with two adaptations for the sub-criteria "impact of operations" and "legacy impact".

Attendees at the workshop identified the preferred option as one which scored better in the traffic light scoring than all other available options. The assessment of what quantified "better" was made on a case-by-case basis by the workshop attendees, however the following guidance was provided:

- It was not necessary for the preferred option to score all, or even a majority, of "green" results;
- A "red" result did not necessarily mean that an option was unacceptable or had been ruled out, it merely indicated that it was not favourable for the associated sub-criterion;

- The relative importance of each sub-criteria was considered, e.g. safety risk to project personnel is a more important factor than cost risk;
- Cost was only a deciding factor where all other criteria were equal.

3.6. Scoring Assessment

As detailed in Section 5, none of the Goldeneye decommissioning scopes required a scoring assessment so no details are included of the methodology.

4. Decommissioning Options

A brief discussion of the decommissioning options is presented below, which will cover the high-level options of pipeline removal, re-use, remediation or leave in-situ.

4.1. Re-use

There are no immediate re-use opportunities for oil and gas production, however the Goldeneye pipelines have been identified as potential candidates for future carbon capture and storage (CCS) projects. See Section 2.5 of this document for discussion of CCS re-use.

4.2. Removal

4.2.1. Cut and lift

The cut and lift method to date has been the most commonly used method to remove pipelines. The method requires the pipeline to be un-trenched and water flooded, noting the Goldeneye pipelines are already hydrocarbon free and flushed. The pipeline will then be cut into sections by an ROV using hydraulic shears and then recovered by a vessel using a hydraulic lifting beam ready for transport to shore and disposal. A simplified schematic of the cut and lift process is shown in Figure 4-1. The preferred method of cutting will generally be decided by the contractor performing the work, subject to risk assessment and endorsement by Shell, however will most likely be hydraulic shears.

The cut and lift method can be used for the entire pipeline removal or localised sections, such as spools or spans.

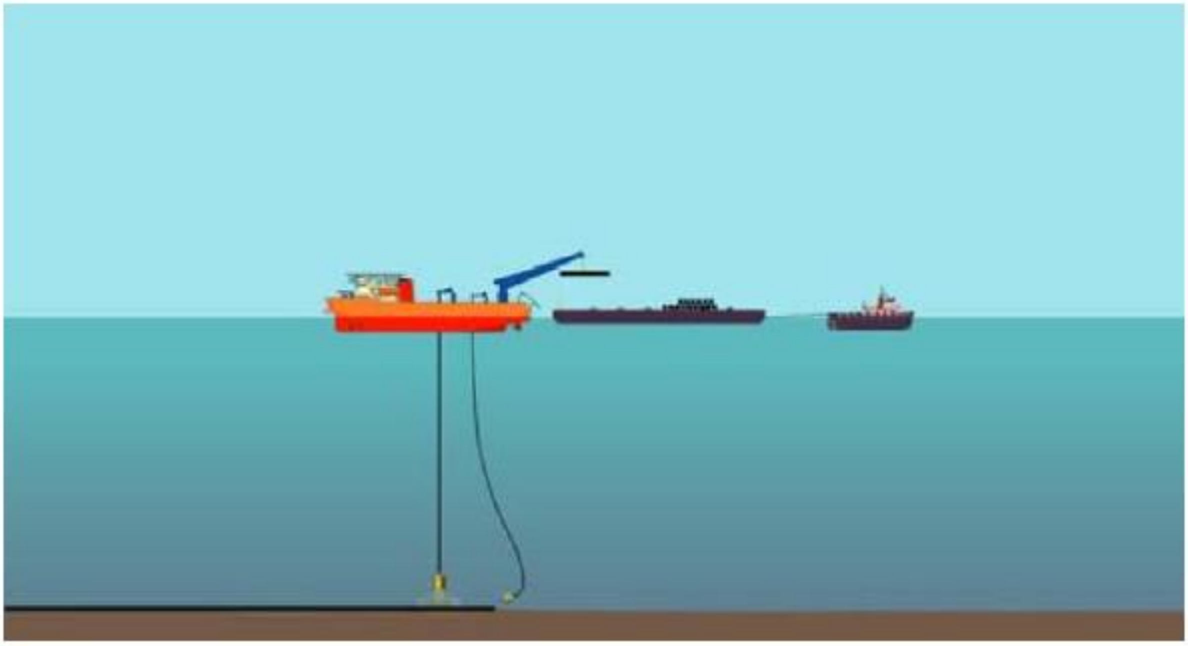


Figure 4-1 – Cut and Lift Pipeline Removal Illustration

4.2.2. Reverse Reel

Reverse reeling of the pipelines would potentially require them to first be un-trenched and de-watered to reduce the submerged unit weight. The pipeline ends would then need to be cut or disconnected and then the reeling vessel would connect to the pipeline end and then recover the end using the A&R (abandonment and recovery) winch until the tensioner could grip the pipeline and proceed to pull the pipeline on to the vessel. The pipeline would then need to be connected to the main reel, so that the vessel could proceed to reel on. The pipeline would then be transported to shore for disposal or recycling.

Reverse reeling has previously been performed on flexible pipelines and umbilicals, however there is very little, if any, experience of the reverse reeling of a complete rigid pipeline. Due to this a significant level of engineering would need to be completed, prior to selecting this option. Further, there is considered to be no practical means of reeling a pipeline of the diameter and length of the Goldeneye Gas Export Pipeline, therefore this option was not considered for any of the scopes.

4.2.3. Reverse S-lay

Reverse S-lay is a potentially feasible option to recover pipelines, however there is very limited experience using this technique and a detailed study and trials would need to be performed prior to committing to this method. Reverse S-lay is the reversal of the common S-lay installation technique, which generally consists of a pipeline lay vessel or barge equipped with a stinger and tensioner and then the line pipe is welded together on the vessel, prior to being laid onto the seabed, which is controlled by the applied tension to the pipeline.

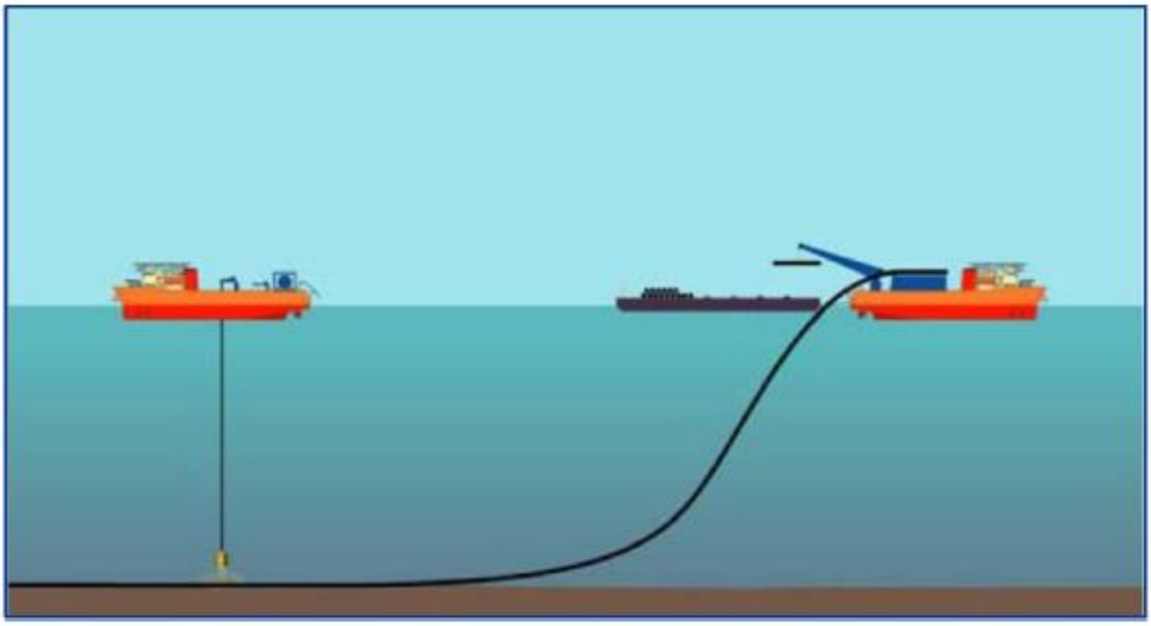


Figure 4-2 – Reverse S-lay Illustration

For the removal process the tensioner would be used to recover the pipeline from the seabed and then it would be cut to manageable lengths on the vessel and transported back to shore.

The pipeline would need to be un-trenched to perform this method of recovery. In addition, it would be prudent to dewater the pipeline (air filled or nitrogen purged) to reduce the equivalent weight of the pipeline and hence reduce the required tension. A summary of the reverse S-lay methodology is summarised in Figure 4-2.

4.3. Leave In-situ

4.3.1. Pipelines (No remediation)

This option consists of leaving the pipeline or umbilical in-situ with no further remediation, however the pipeline ends maybe cut and buried or cut and rock covered.

4.3.2. Pipelines (Re-trench)

Re-trenching the pipelines is an option for pipelines subject to increased risk from snagging or becoming unstable (e.g. buoyant pipelines or free spanning pipelines) due to a reduction in the burial depth or cover. The retrenching of a pipeline can be performed by a jet trencher, plough or mass flow excavator. Re-trenching on areas with remedial rock may need the rock removed prior to trenching, depending on the rock grade.

4.3.3. Localised Cut and Lift

For localised exposures or areas of low cover, localised cut and lift operations can be used, which would be executed in a similar manner to that shown in section 4.2.1.

4.3.4. Pipelines (Remedial Rock Cover)

Remedial rock cover involves either blanket or locally placing rock at specific locations to increase the cover on the pipeline to reduce the risk of snagging or it affecting other users of the sea. Due to the water depth at Goldeneye (approx. 90m) a fall pipe vessel, shown in Figure 4-3, would be the most likely method for additional rock cover.

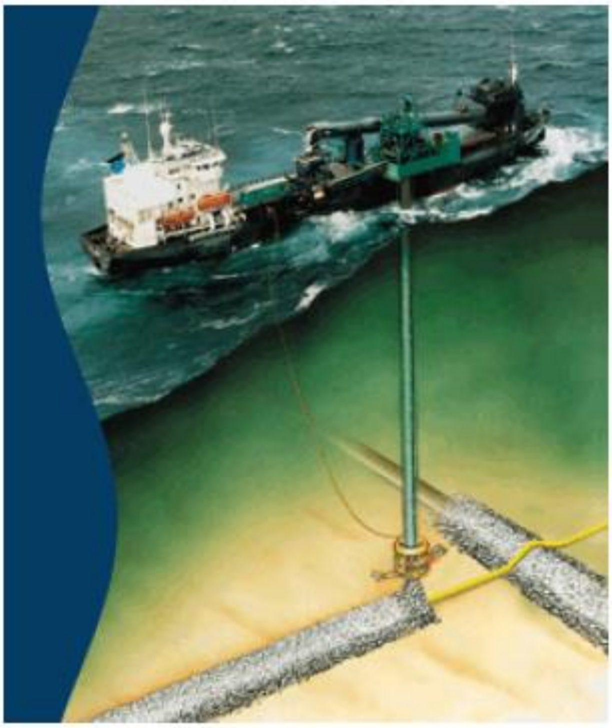


Figure 4-3 – Remedial Rock Cover Installation Illustration

5. Comparative Assessment Results

5.1. Initial Decommissioning Options Screening and Grouping

A number of stakeholder engagements took place during the initial screening phase to further understand and clarify each stakeholder's concerns and views regarding the decommissioning of the Goldeneye Field.

Internal workshops to screen the options were held by Shell in Q4 2017 utilising information from both internal and external survey data gathered over the life of the field. The workshops enabled the project team to identify and define credible options for each scope, assessing what data gaps existed for each option and defining whether any studies were required to inform the comparative assessment workshop.

During the initial screening workshop, the scopes for a narrative conclusion were identified, if they were generally within regulator guidelines for decommissioning, e.g. blanket rock covered. In addition to identifying the narrative conclusions the pipelines were grouped, where applicable, for the purposes of the comparative assessment workshop. A summary of the grouping and options assessed for each scope is shown in Table 5-1.

Details of the conclusions for each scope and group are contained within the following sections.

Pipeline / Asset	Sub Category	Decommissioning Options	Comparative Assessment Method	Applicable Grouping
Goldeneye 20" Gas Export Pipeline PL1978	Land Section St Fergus Plant to Low Water Level (KP 0.0)	Decommission in situ ~~Excavate, cut-and-remove~~	Narrative	N/A
	Inshore Section KP 0.0 – 6.0	Decommission in situ ~~Trench and bury~~ ~~Blanket rock cover~~ ~~Total removal by reverse s-lay~~ ~~Total removal by cut-and-lift~~	Narrative	N/A
	Trenched and Buried Piggyback Section KP 6.0 – 20.0	Decommission in situ Remedial rock cover ~~Blanket rock cover~~ ~~Total removal by reverse s-lay~~ Total removal by cut-and-lift	Traffic Light Assessment	Group 1
	Surface Laid Section KP 20.0 – 102.0	Decommission in situ Trench and bury Blanket rock cover Fishing gateways Total removal by reverse s-lay ~~Total removal by cut-and-lift~~	Traffic Light Assessment	Group 2
	Pipeline Subsea End	Decommission in situ Trenched Lowered and rock-covered Removed with pipeline	Traffic Light Assessment	Group 2
	Tie-in spools	Disconnect and recover spools including associated mattresses	Narrative	N/A
Goldeneye 4" MEG Pipeline PL1979	Land Section St Fergus Plant to Low Water Level (KP 0.0)	Decommission in situ ~~Excavate, cut-and-remove~~	Narrative	N/A
	Inshore Section KP 0.0 – 6.0	Decommission in situ ~~Trench and bury~~ ~~Blanket rock cover~~ ~~Total removal by reverse s-lay~~ ~~Total removal by cut-and-lift~~	Narrative	N/A
	Trenched and Buried Piggyback Section KP 6.0 – 20.0	Decommission in situ Remedial rock cover ~~Blanket rock cover~~ ~~Total removal by reverse s-lay~~ Total removal by cut-and-lift	Traffic Light Assessment	Group 1

	Trenched and Buried Section KP 20.0 – 102.0	Decommission in situ ~~Trench and bury~~ ~~Blanket rock cover~~ ~~Total removal by reverse s-lay~~ ~~Total removal by cut-and-lift~~	Narrative	N/A
	Pipeline Subsea End	Install blind flange on end, lower and cover at least 0.6m below mean seabed	Narrative	N/A
	Tie-in spools	Disconnect and recover spools including associated mattresses	Narrative	N/A
Spud Can Depressions	Both existing and from plug and abandonment jack-up rig	Perform over-trawl trials to verify seabed is safe for future users of the sea, any remediation required will consist of rock fill to 0.5 – 1.0m below mean seabed level	Narrative	N/A

Table 5-1 – Summary of Decommissioning Options and Grouping

Notes:

1. Options with a strikethrough (e.g. ~~Leave in-situ~~) were deselected during initial screening.
2. Pipeline / umbilical ends and spools / jumper decommissioning options also include the treatment of mats.

5.2. Onshore Sections

From landfall at the Mean Low Water Springs on the beach to the valve pit within the St Fergus Terminal, approximately 610m of each pipeline is trenched and buried to above 0.6m burial depth. Both pipelines cross underneath the North of Scotland Water Authority (NOSWA) 16” water pipeline as shown in Figure 5-1.

Note that these sections of pipeline are not included within the Section 29 notice issued to Shell U.K. by BEIS, however details of the decommissioning proposals are included for information to ensure public awareness and allow scrutiny of decision making.

Figure 5-1 – Annotated satellite picture of pipelines approach to St Fergus Terminal

The decommissioning option for the onshore sections of both pipelines was provisionally selected during the screening workshop. As the 4” MEG pipeline is piggybacked to the 20” gas export pipeline in this area, both pipelines were assessed together.

In line with Table 5-1, two options were assessed for the onshore sections:

- Decommission in situ
- Excavate, cut-and-remove

As both pipelines are buried to greater than one metre depth for the entire onshore section, a **decommission in situ** recommendation was presented at the CA Workshop. This recommendation is further supported by the disturbance that would be caused to the sand dunes and Winter Loch by excavation activities required to remove the pipelines, as well as disruption to the NOSWA pipeline. Although the pipeline will degrade over time, it was agreed that this is unlikely to cause significant subsidence.

The **stakeholder consultees** agreed with the **decommission in situ** recommendation, including those who were unable to attend the workshop.

5.3. Inshore Sections

Sections of both the 20" Gas Export Pipeline and 4" MEG Pipeline from KP 0 (MLWS on the beach) to KP 6. In this area, the pipelines are piggy-backed and buried to greater than 0.5m burial depth along the whole length. Most of this section is also trenched, with the exception of KP 5 to 6 where trenching was not possible due to the presence of a rocky outcrop on the seabed. Rock cover on top of the pipeline has maintained the minimum 0.5m coverage where trenching has not been possible.

A graphical summary of the pipelines' trenching and burial status can be found in Appendix A of this document.

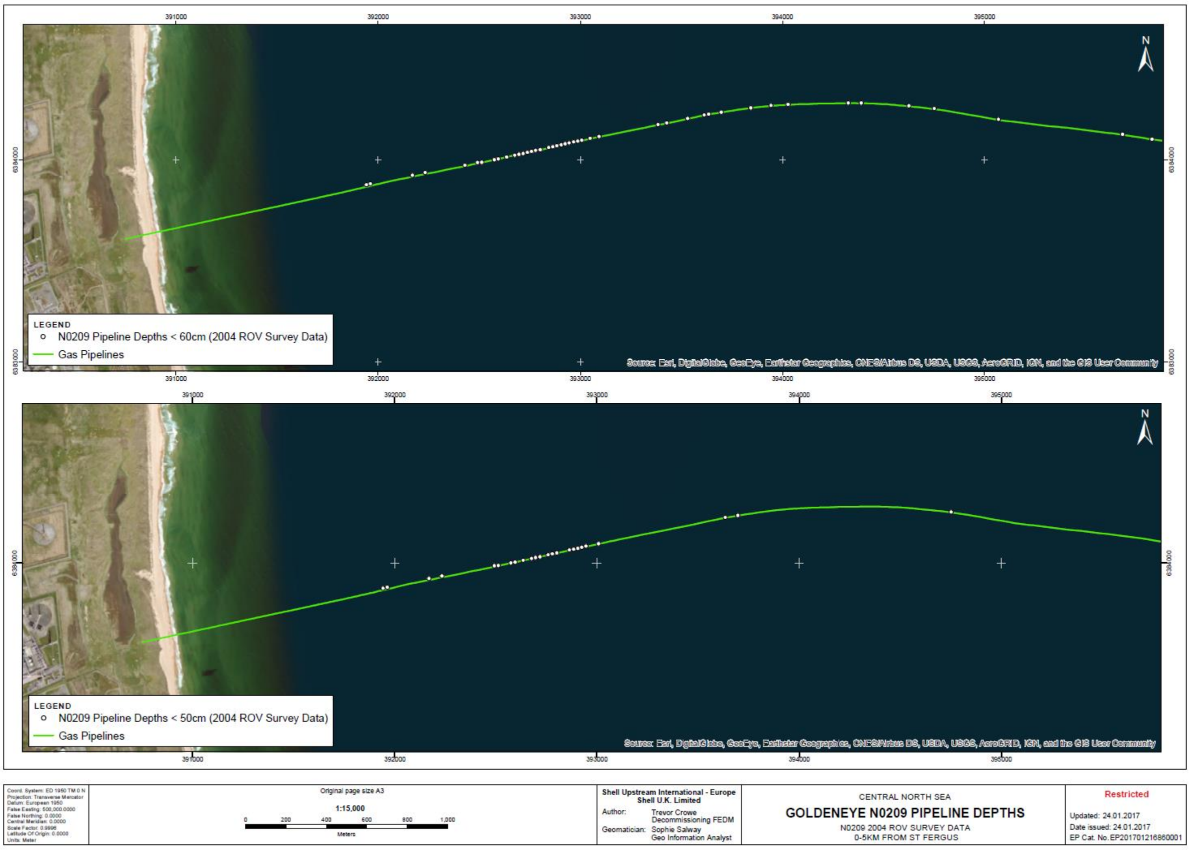


Figure 5-2 – 2004 survey results showing areas of less than 0.5 (bottom) and 0.6m depth of cover

Since installation the pipelines have exhibited evidence of increasing backfill and burial depth, as evidenced by the survey results shown in Figures 5-2 and 5-3. Figure 5-2 shows the 2004 survey results, Figure 5-3 shows the 2009 results. The green line indicates the path of the piggy-backed pipelines and the white dots indicate areas of less than 0.5m depth-of-cover in the bottom picture; areas of less than 0.6m depth-of-cover in the top picture. The decreasing frequency of the dots indicate an increasing depth-of-cover in the five years between the surveys, a trend that is expected to have continued in the 8 years since the second survey. In addition, seabed surveys in the area show sand mega ripples, indicating a mobile seabed which further supports the expectation of increasing depth-of-cover.

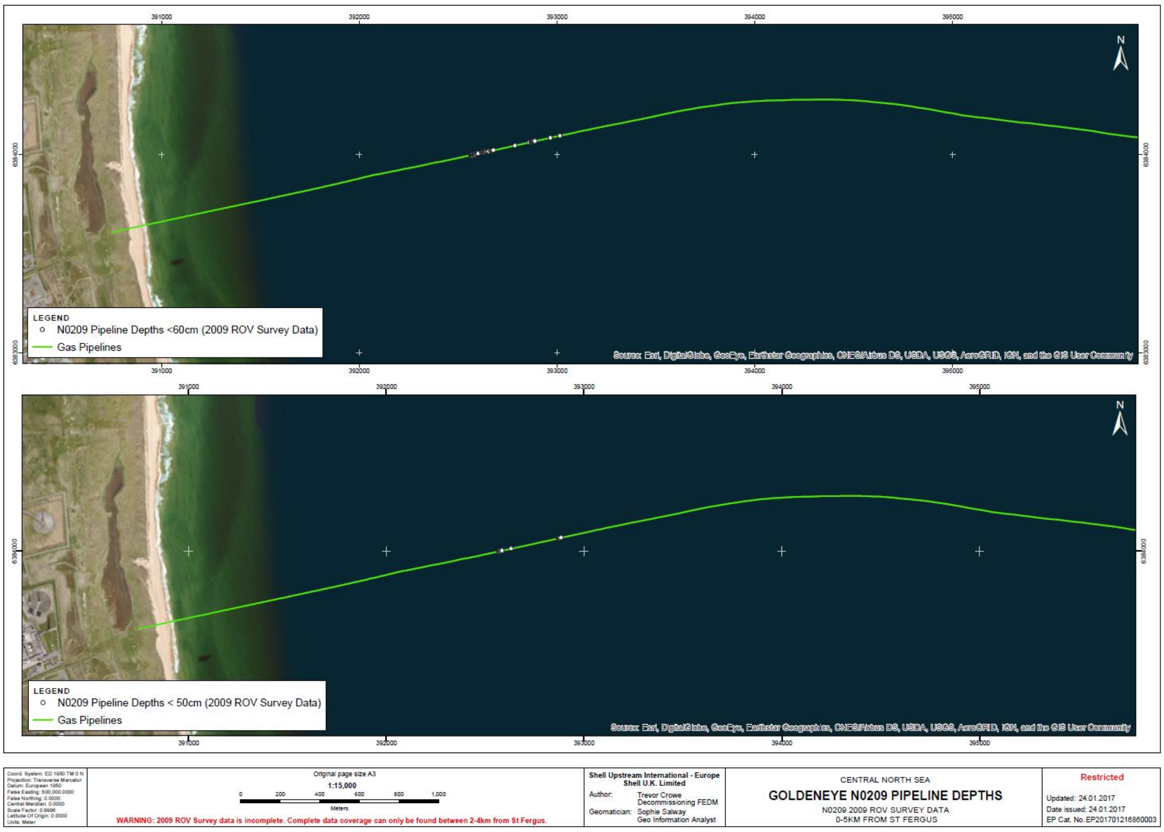


Figure 5-3 – 2009 survey results showing areas of less than 0.5 (top) and 0.6m depth of cover

In line with Table 5-1, five options were assessed for the inshore sections:

- Decommission in situ
- Trench and bury
- Blanket rock cover
- Total removal by reverse s-lay
- Total removal by cut-and-lift

The decommissioning option for the onshore sections of both pipelines was provisionally selected during the screening workshop.

In line with Section 10.6 of the BEIS Guidance Notes [2], pipelines which "are adequately buried or trenched and which are not subject to development of spans and expected to remain so" may be candidates for decommissioning in situ.

'Trench and bury' was discounted as the pipelines are already sufficiently trenched where it is possible to achieve trench depth. Due to the evidence available that burial depth was naturally increasing over time, the negative environmental impact from additional blanket rock cover was assessed to be disproportionate to the negligible benefit of additional burial depth. Similarly, short-term environmental impact from deburial activities and the safety risk of additional vessel work lead to the total removal options being discounted.

Supported by evidence of increasing burial depth over time, a **decommission in situ** recommendation was presented at the CA Workshop. Shell will perform a post-decommissioning survey to confirm the burial depth and inform a risk-based assessment of future monitoring.

The **stakeholder consultees** agreed with the **decommission in situ** recommendation, including those who were unable to attend the workshop.

5.4. Trenched and Buried Piggy-Backed Sections KP 6 – 20

Sections of both the 20" Gas Export Pipeline and 4" MEG Pipeline from KP6 to KP20. In this area, the pipelines are piggy-backed, trenched and buried. Both pipelines cross over five third-party pipelines in this area: FLAGS (PL002), Frigg (PL6), Vesterled (PL7) Miller (PL720) and Britannia (PL1270). This section also includes the "transition area" at approximately KP20, where the pipelines leave their shared trench and separate. The surface laid section of the piggybacked lines and, as it separates, the surface-laid section of the 4" MEG pipeline as it transitions into its trench are protected by concrete mattresses which are covered by rock.

Generally, there is evidence of trenching of the pipelines that achieved more than 0.6m depth-of-lowering. Although the 2004 post-installation as-backfilled survey indicated some areas of shallow depth-of-cover, subsequent sonar surveys have indicated that natural backfill has covered both pipes. Further, it is not possible to identify the trench on the sonar images – implying that natural backfill has completely filled the trench. With the exception of the crossings, the depth of lowering is well above 0.6m, thereby providing strong indications of depth-of-cover greater than 0.6m.

A graphical summary of the pipelines' trenching and burial status can be found in Appendix A of this document.

In line with Table 5-1, five options were assessed for this section:

- Decommission in situ
- Remedial rock cover
- Blanket rock cover
- Total removal by reverse s-lay
- Total removal by cut-and-lift

Blanket rock cover was excluded during the initial screening as there is clear evidence of sufficient depth-of-cover across the majority of the pipelines. It was assessed that any requirement for rock would be limited to any areas of insufficient cover.

Total removal by reverse s-lay was also discounted as it was assessed that cut-and-lift would be the more likely total removal option due to the lack of previous experience and safety risk in reverse s-lay of piggy-backed lines.

The other three options (decommission in situ, remedial rock cover and total removal by cut-and-lift) were subjected to traffic light assessment at the CA Workshop in line with the process detailed in Section 3. The pipelines were assessed together and designated as Group 1 for the purposes of the CA.

The summarised findings of that assessment are shown in Figure 5-4 below.

Table 8-1 in Appendix B contains expanded details of the scoring reached by the attendees at the CA Workshop, recording where project specific information or specific stakeholder concern influenced the scoring.

Criteria	Ref	Sub Criteria	Leave In-Situ	Remediate	Remove
		Include Option for Screening?	☑ Option 1	☑ Option 3	☑ Option 6
			Option 1: Leave In-Situ (Do Nothing)	Option 3: Remedial rock cover on sections with less than 0.6m coverage	Option 6: Remove: Cut and lift
Safety	1	Project risk to personnel - Offshore	g	g	r
	2	Project risk to other users of the sea	g	g	g
	3	Project risk to personnel - Onshore	g	g	a
	4	Potential of a high consequence event	g	g	a
	5	Residual risk to other users of the sea	a	a	a
Environment	6	Marine impact of operations	g	a	a
	7	Energy, emissions, resource consumption			
	8	Impact of marine end points (legacy impact)	a	a	a
Technical	9	Risk of major project failure	g	g	a
	10	Technology demands / track record	g	g	g
Societal	11	Commercial impact on fisheries	a	a	a
	12	Socio-economic impact on communities and amenities	g	g	r
Economic	13	Cost	g	g	r
	14	Cost risk and uncertainty			
		Option Screened for Comparative Assessment Inclusion?	☑ Option 1	☑ Option 3	☑ Option 6

Figure 5-4 – Traffic Light Summary for Group 1

Key for colour-blind readers: g – Green, a – Amber, r - Red

Scoring "red" for safety risk to project personnel, socio-economic impact and cost, total removal by cut-and-lift was clearly assessed to be the least optimal option. The options to decommission in situ or use additional remedial rock cover were scored very similarly, with the latter assessed to have a greater environmental impact from the marine operations associated with placing additional rock.

Sub-criteria 7 and 14 (for *Energy, Emissions, Resource Consumption* and *Cost Risk and Uncertainty*) are 'greyed out', indicating that there was assessed to be no significant difference between the three options for these sub-criteria.

Therefore, the emerging recommendation from the CA Workshop is to **decommission in situ**, however Shell will perform a post-decommissioning survey to confirm burial depth and remediate any areas of concern with additional rock-cover. Shell will discuss volume and grade of rock to be used with the Scottish Fishermen's Federation (SFF), should any areas of concern be identified.

The decommission in situ proposal includes the five pipeline crossings. The crossings are well protected by concrete mattresses covered with rock. A decommission in situ solution does not preclude the future re-use of the pipeline for CCS and presents low risk of snagging to fishermen.

The **stakeholder consultees** were in agreement with the **decommission in situ** recommendation.

5.5. 4" MEG line, Trenched and Buried KP 20 – 102

Trenched and buried section of the 4" MEG pipeline from the transition section at approximately KP20 (where the MEG line separates from its piggyback of the gas export pipeline) to the Goldeneye platform at KP 102. On approach to the Goldeneye platform, the pipeline exits the trench to a flanged connection with a surface laid tie-in spool which itself is flange-connected to the riser at the foot of the platform. This scope includes the pipeline end where it will be disconnected from the tie-in spool at the flange.

Generally, there is evidence of trenching of the pipeline that has achieved more than 0.6m depth-of-lowering. Although the 2004 post-installation as-backfilled survey indicated some areas of shallow depth-of-cover, subsequent sonar surveys have indicated that natural backfill has covered the pipe. Further, it is generally not possible to identify the trench on the sonar images – implying that natural backfill has completely filled the trench. With the exception of the crossings, the depth of lowering is well above 0.6m, thereby providing strong indications of depth-of-cover greater than 0.6m.

A graphical summary of the pipeline's trenching and burial status can be found in Appendix A of this document.

In line with Table 5-1, five options were assessed for this section:

- Decommission in situ
- Trench and bury
- Blanket rock cover
- Total removal by reverse s-lay
- Total removal by cut-and-lift

The decommissioning option for this section of pipeline was provisionally selected during the screening workshop.

In line with Section 10.6 of the BEIS Guidance Notes [2], pipelines which "are adequately buried or trenched and which are not subject to development of spans and expected to remain so" may be candidates for decommissioning in situ.

'Trench and bury' was discounted as the pipeline is already sufficiently trenched where it is possible to achieve trench depth. Due to the evidence available that burial depth was naturally increasing over time, the negative environmental impact from additional blanket rock cover was assessed to be disproportionate to the negligible benefit of additional burial depth. Similarly, short-term environmental impact from deburial activities and the safety risk of additional vessel work lead to the total removal options being discounted.

Supported by evidence of increasing burial depth over time, a **decommission in situ** recommendation was presented at the CA Workshop. Shell will perform a post-decommissioning survey to confirm the burial depth and inform a risk-based assessment of future monitoring. The pipeline end will be fitted with a blank flange and lowered into the seabed, most likely by fluidising the surrounding soil. Any failure to achieve sufficient burial depth of the end will be mitigated by use of additional rock cover.

The **stakeholder consultees** were in agreement with the **decommission in situ** recommendation.

5.6. Surface Laid 20" Gas Export Pipeline, KP 20 – 102

20" Gas Export Pipeline from the transition area where the piggybacked pipelines separate at approximately KP 20 to the flange upstream of the tie-in spools to the SSIV structure at approximately KP 102, including the pipeline end. This entire section of pipeline is surface-laid.

As with the other scopes, the seabed in this area is mobile and spans have regularly developed along the length of the pipeline. Although these spans are not recordable (i.e. the height and length are below the recordable thresholds), they are significant in number as shown in Figure 5-5 below.

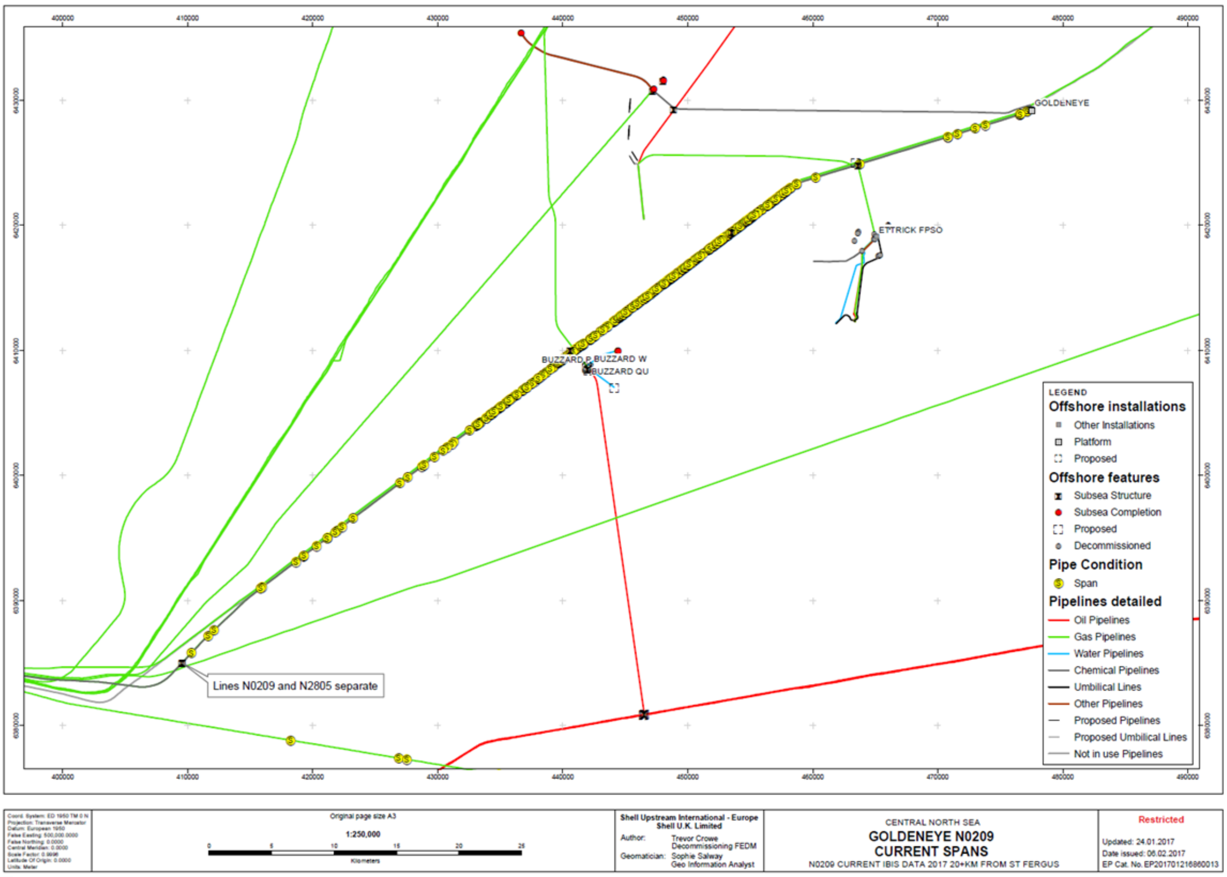


Figure 5-5 – 2017 survey data of Gas Export Pipeline (yellow dots indicate a span)

Evidence from sonar surveys to date indicates that these spans are not static, with the mobile seabed resulting in the spans themselves moving over time. A graphical summary of the sonar survey findings and locations of spans can be found in Appendix A.

In line with Table 5-1, six options were assessed for this section:

- Decommission in situ
- Trench and bury
- Blanket rock cover
- Fishing gateways
- Total removal by reverse s-lay
- Total removal by cut-and-lift

Prior to the initial screening exercise, Shell consulted the SFF on the potential use of "fishing gateways", where fishing traffic crossing a pipeline would be directed to do so at particular points on the line, approximately 1km wide. These crossing points, or gateways, would have a specific mitigation applied, e.g. rock cover of the surface laid section, to minimise snagging risk to the fishermen. Applying this mitigation to specified areas rather than a blanket solution for the entire pipeline would reduce environmental impact and cost.

However, on consultation with the SFF, the gateways solution was not assessed as feasible over the long term for the Goldeneye pipelines. The SFF's stated preference is for "clear seabed" on conclusion of decommissioning activities. Gateways have been suggested as a solution for pipelines in a pre-existing trench but which have not achieved sufficient depth-of-cover. This does not apply to the surface-laid gas export pipeline for Goldeneye. Creating gateways by rock-covering specific sections would not achieve a "clear seabed".

Further, as opposed to sections of rock-cover within an existing trench that would become progressively covered by the surrounding seabed, gateways of rock proud of the mean seabed level would gradually become dislodged by the volume of fishing traffic repeatedly crossing the berm at the same point. This could eventually result in reducing cover, expose the pipeline and require additional and on-going monitoring and remediation to prevent a snagging hazard.

As such, the option for fishing gateways was not taken forward to the comparative assessment workshop for further evaluation.

Total removal by cut-and-lift was discounted as it was assessed that reverse s-lay would be the more likely total removal option due to the comparatively lower safety exposure, vessel time in field and cost.

The other four options (decommission in situ, trench and bury, blanket rock cover and total removal reverse s-lay) were subjected to traffic light assessment at the CA Workshop in line with the process detailed in Section 3. This scope was designated as Group 2 for the purposes of the CA.

The summarised findings of that assessment are shown in Figure 5-6 below.

Table 8-2 in Appendix B contains expanded details of the scoring reached by the attendees at the CA Workshop, recording where project specific information or specific stakeholder concern influenced the scoring.

		Option Category	Leave In-Situ	Remediate		Remove
		Include Option for Screening?	☑ Option 1	☑ Option 2	☑ Option 3	☑ Option 5
Criteria	**Ref**	**Sub Criteria**	**Option 1: Leave In-Situ (Do Nothing)**	**Option 2: Trench and bury the pipeline length**	**Option 3: Blanket rock cover the pipeline length**	**Option 5: Remove: Reverse S-lay**
Safety	1	Project risk to personnel - Offshore	g	g	g	r
	2	Project risk to other users of the sea	g	g	g	g
	3	Project risk to personnel - Onshore	g	g	g	a
	4	Potential of a high consequence event	g	g	g	a
	5	Residual risk to other users of the sea	r	a	a	a
Environment	6	Marine impact of operations	g	r	r	g
	7	Energy, emissions, resource consumption				
	8	Impact of marine end points (legacy impact)	a	g	r	g
Technical	9	Risk of major project failure	g	a	g	a
	10	Technology demands / track record	g	g	g	a
Societal	11	Commercial impact on fisheries	r	a	a	a
	12	Socio-economic impact on communities and amenities	g	g	g	r
Economic	13	Cost	g	a	r	r
	14	Cost risk and uncertainty	g	g	g	a
		Option Screened for Comparative Assessment Inclusion?	☑ Option 1	☑ Option 2	☑ Option 3	☑ Option 5

Figure 5-6 – Traffic Light Summary for Group 2

Key for colour-blind readers: g – Green, a – Amber, r - Red

The option for total removal by reverse s-lay was clearly assessed to be the least optimal, scoring "green" for environmental sub-criteria but "red" for safety risk to project personnel, cost and – by virtue of its impact on potential future CCS options – socio-economic impact.

Blanket rock cover was assessed to have a detrimental environmental impact from introducing new and habitat-altering substrate, as well as significant cost in comparison to other options.

Decommissioning in situ scored "red" for residual risk to other users of the sea and commercial impact on fisheries by virtue of the potential future snagging risk from the surface laid pipeline, both in terms of spans developing over time and future degradation of the pipeline.

Trench and bury scored "red" for marine impact of operations due to the seabed disturbance that is created, however attendees at the CA Workshop deemed this to be a less important consideration in this area due to the highly mobile seabed and natural disturbance that indigenous species were therefore already acclimatised to.

Sub-criterion 7 (for *Energy, Emissions, Resource Consumption*) is 'greyed out', indicating that there was assessed to be no significant difference between the four options for this sub-criterion.

Therefore, the emerging recommendation from the CA Workshop is to **trench and bury** the surface laid sections of the gas export pipeline. The pipeline end, currently flanged to the tie-in spools upstream of the SSIV, will also be buried, with any failure to achieve the appropriate depth-of-cover mitigated by additional rock cover up to mean seabed level, as shown in Figure 5-7. A blank flange will be installed on the end of the pipeline prior to burial.

The **stakeholder consultees** were in agreement with this proposal.

The trench and bury proposal for this area does not include the three pipelines crossings which will be decommissioned in situ. The Goldeneye gas export pipeline is crossed by three pipelines: the 6" Golden Eagle to Ettrick Gas Import / Export PL3037, the 6" Ettrick Gas Import / Export PL2488 and the 10" Buzzard (P) to Captain Tee PL2072. The crossings are well protected by concrete mattresses covered with rock. A decommission in situ solution does not preclude the future re-use of the pipeline for CCS and presents low risk of snagging to fishermen.

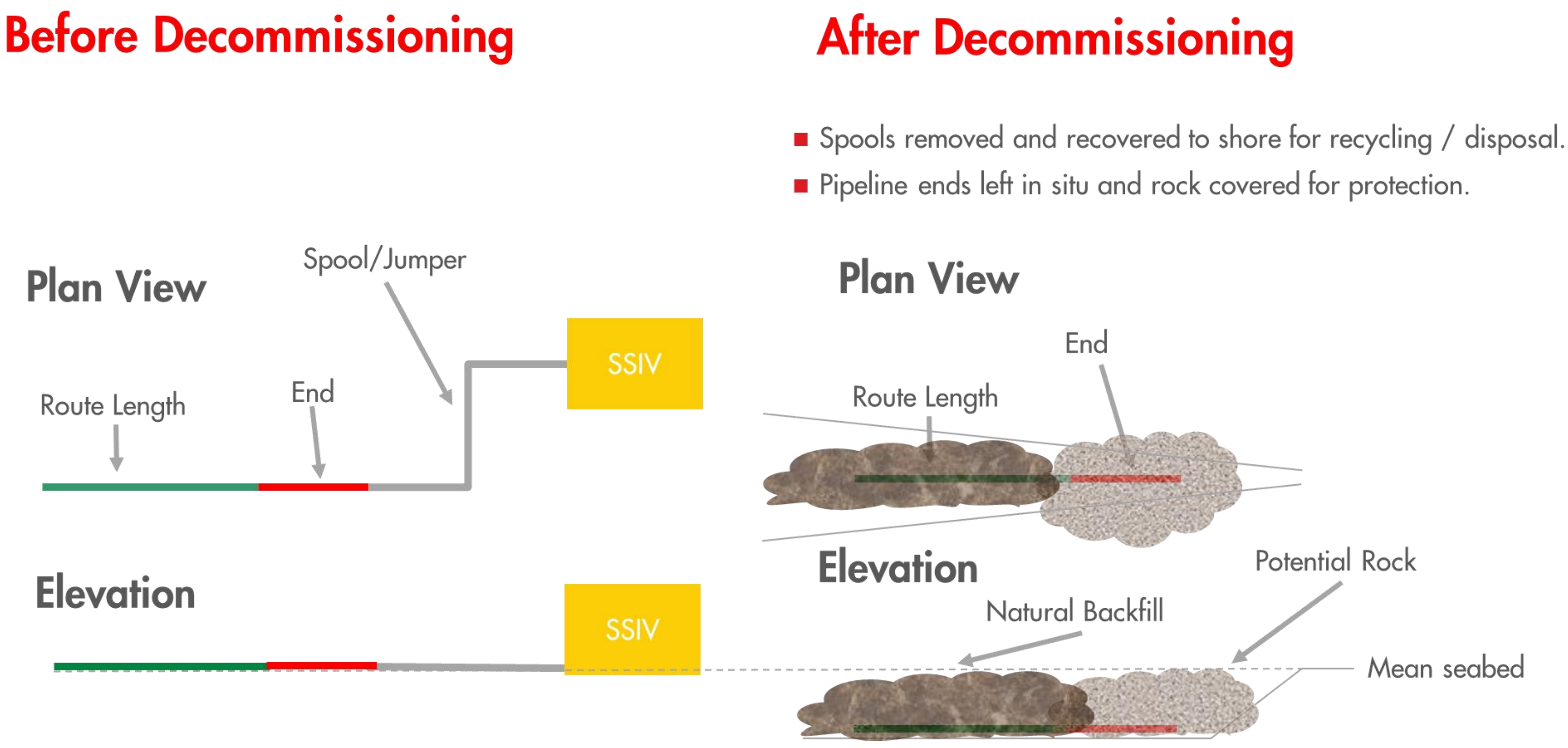


Figure 5-7 – Gas Export Pipeline End Decommissioning Illustration

5.7. Pipeline Tie-in Spools and Mattresses

Surface-laid spools for both the 20" Gas Export Pipeline and 4" MEG Pipeline, surface-laid control jumpers and protection mattresses. This infrastructure is located at the approach to the Goldeneye Platform to connect the pipelines to the topsides via riser sections, as shown in Figure 5-8.

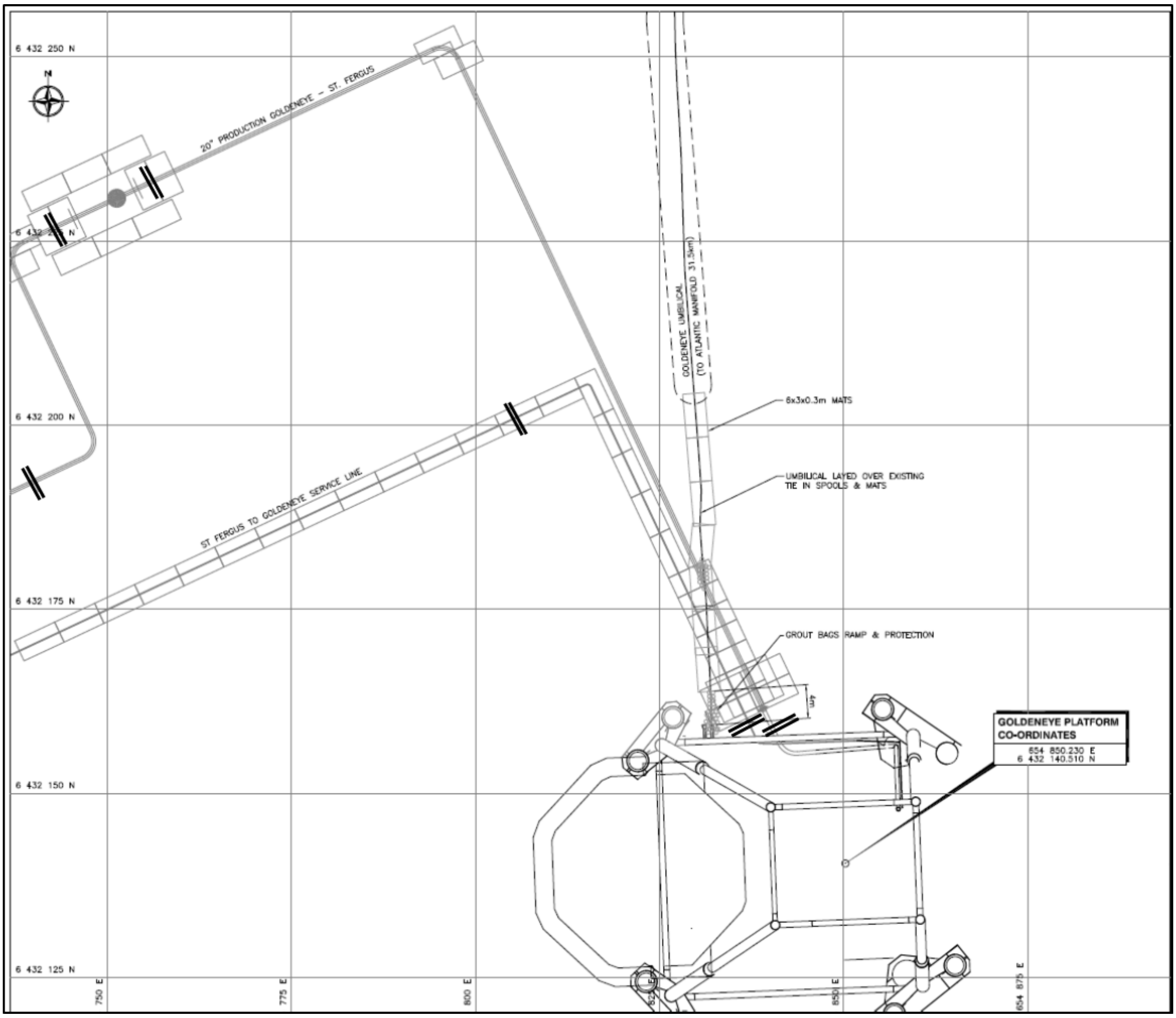


Figure 5-8 – Tie-in Spools and Mattresses at Goldeneye

The Atlantic Umbilical PLU2033, shown in Figure 5-8 approaching the Goldeneye platform from the north, is not part of this CA or the Decommissioning Programme. The Atlantic & Cromarty Decommissioning Programme, available publicly on the BEIS website, proposes the following decommissioning solution for the Atlantic Umbilical: "trenched and rock-covered sections (including crossings) to remain in situ, exposed ends to be buried after cutting and cut sections removed". It is therefore anticipated that the surface-laid section of the Atlantic Umbilical, including where it crosses the Goldeneye pipelines, will be removed; and the riser section of the Atlantic Umbilical within the J-tube at Goldeneye will be removed with the Goldeneye jacket.

All mattresses are accessible, are not buried and are relatively new and therefore expected to be in good condition. The tie-in spools are all surface-laid with mattress cover only and no rock-cover. Therefore, the circumstances were assessed to be similar to Shell's Curlew Comparative Assessment and the same outcome was assumed.

The proposal for the tie-in spools and mattresses is therefore to **recover all material to shore for recycling and disposal.**

The **stakeholder consultees** were in agreement with this proposal.

5.8. Spud Can Depressions

Jack-up drill rigs have left impressions in the seabed to the east of the Goldeneye Platform of up to 2m depth and approximately 40m in diameter, as shown in Figure 5-9 overleaf. Additional depressions are expected to be created by the jack-up rig used during the wells' plug and make-safe activities. The Comparative Assessment Workshop was asked to assess whether these depressions could present a future snagging to risk to fishermen.

Shell proposed to **carry out over-trawling trials of the depressions at the conclusion of decommissioning activities and remediate any problematic areas of disturbance.**

The **stakeholder consultees** agreed with this proposal.

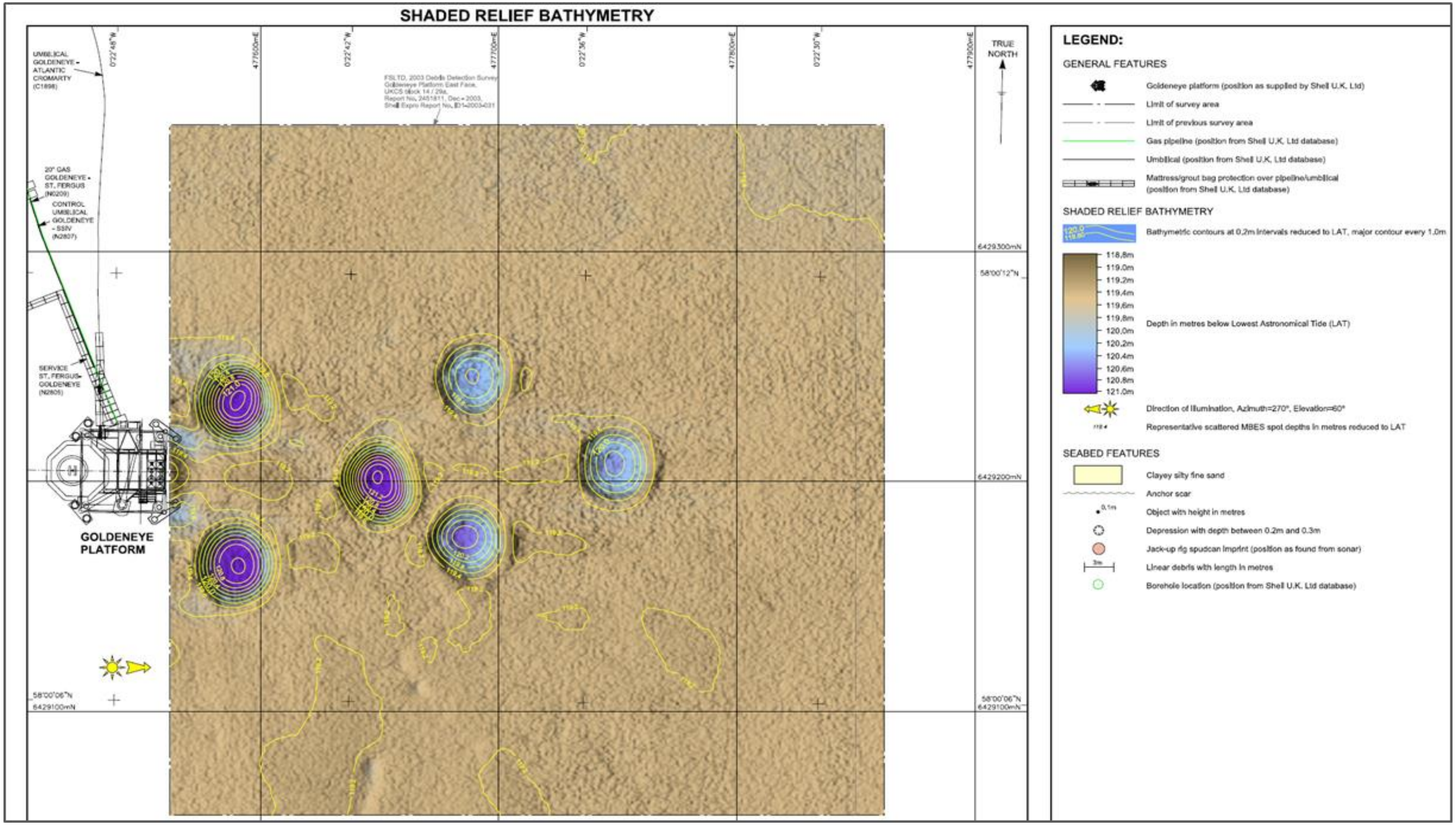


Figure 5-9 – Spud Can Depressions at Goldeneye

6. References

[1] Goldeneye Draft Decommissioning Programme, GDP-PT-S-AA-8203-00001

[2] BEIS (Formerly DECC) Guidance Notes on Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998, version 6 March 2011

[3] Goldeneye Environmental Appraisal Report, HOLD

[4] Oil and Gas UK, "Guidelines for Comparative Assessment in Decommissioning Programmes," 2015

7. Appendix A: Pipeline Burial Depth Summary

7.1. General

The burial depth of the pipelines and umbilicals is important information when considering leaving pipelines or umbilicals in-situ or removal. The as-built data and alignment sheets for the Goldeneye pipelines have been assessed and the operational survey data has been assessed to determine the pipelines' burial depth. The following sections present graphical summaries of the Goldeneye pipeline data.

7.2. Pipeline Burial Depth Definition

The definitions of burial depth that are being reported, generally there are two definitions for burial depth; depth of lowering and depth of cover, which are both illustrated in the figure below. The depth of cover is the conventional definition of burial depth, which is the depth of backfill or rock on top of the pipeline or umbilical. The depth of lowering is the depth of the top of the pipeline or umbilical below the natural mean seabed level. The natural mean seabed level is ignoring any berms to the sides of the trench.

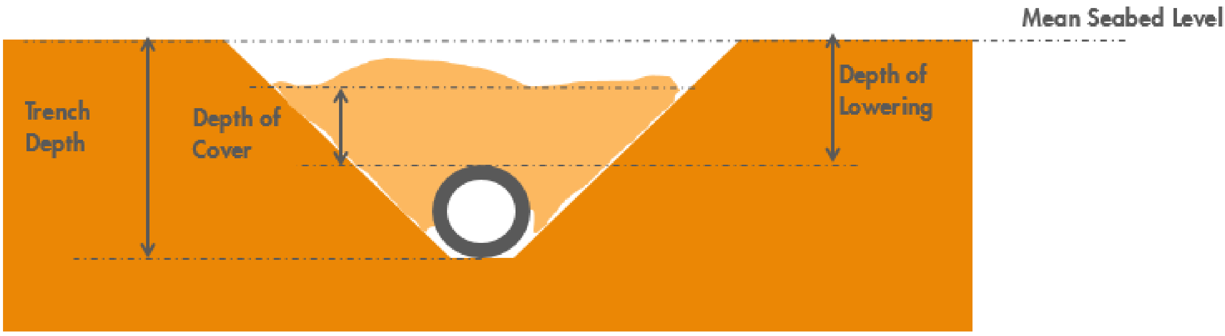


Figure 7-1 – Burial depth definition

7.3. Inshore Pipelines

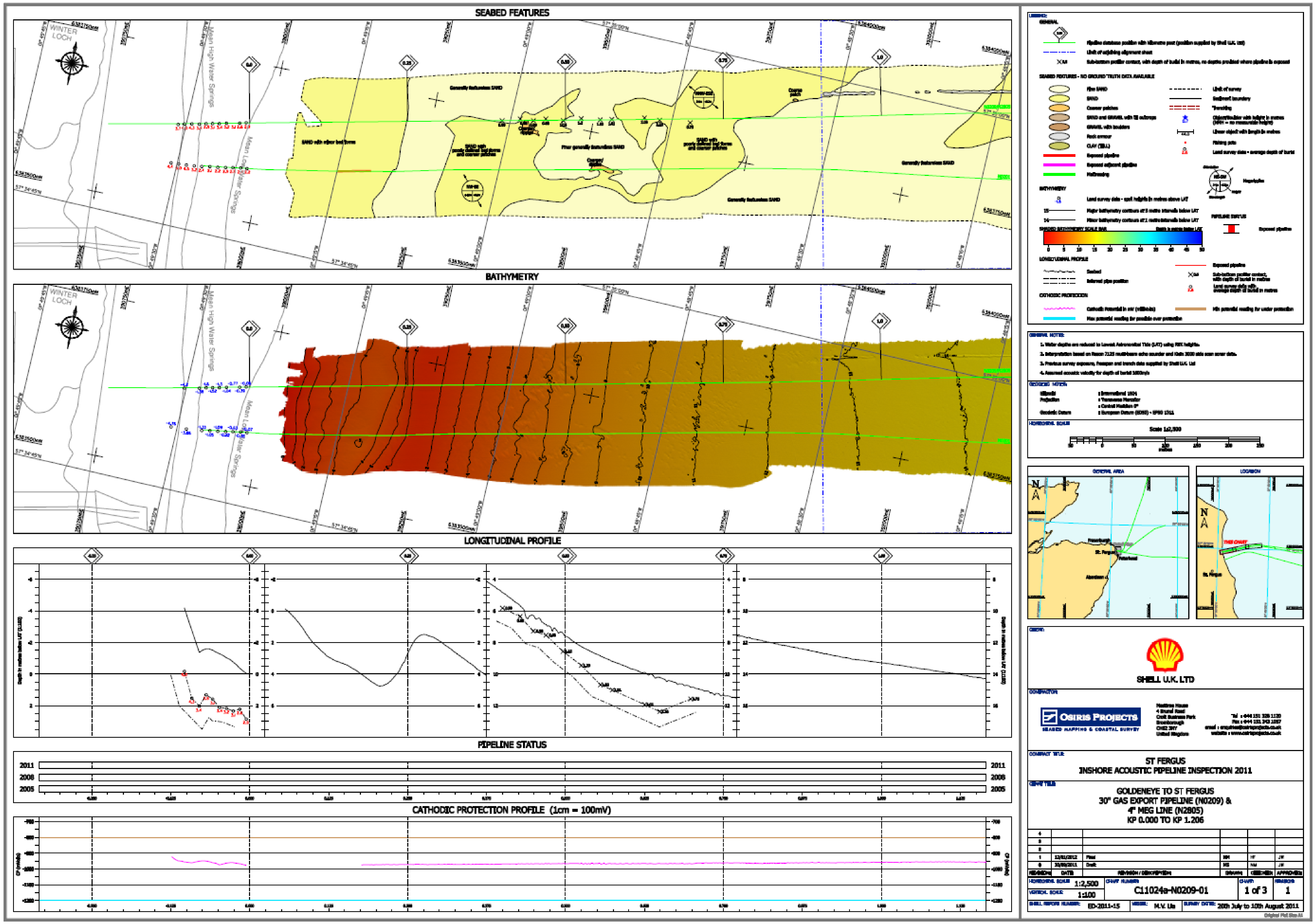


Figure 7-2 – Goldeneye Gas Export Pipeline Survey Results Summary

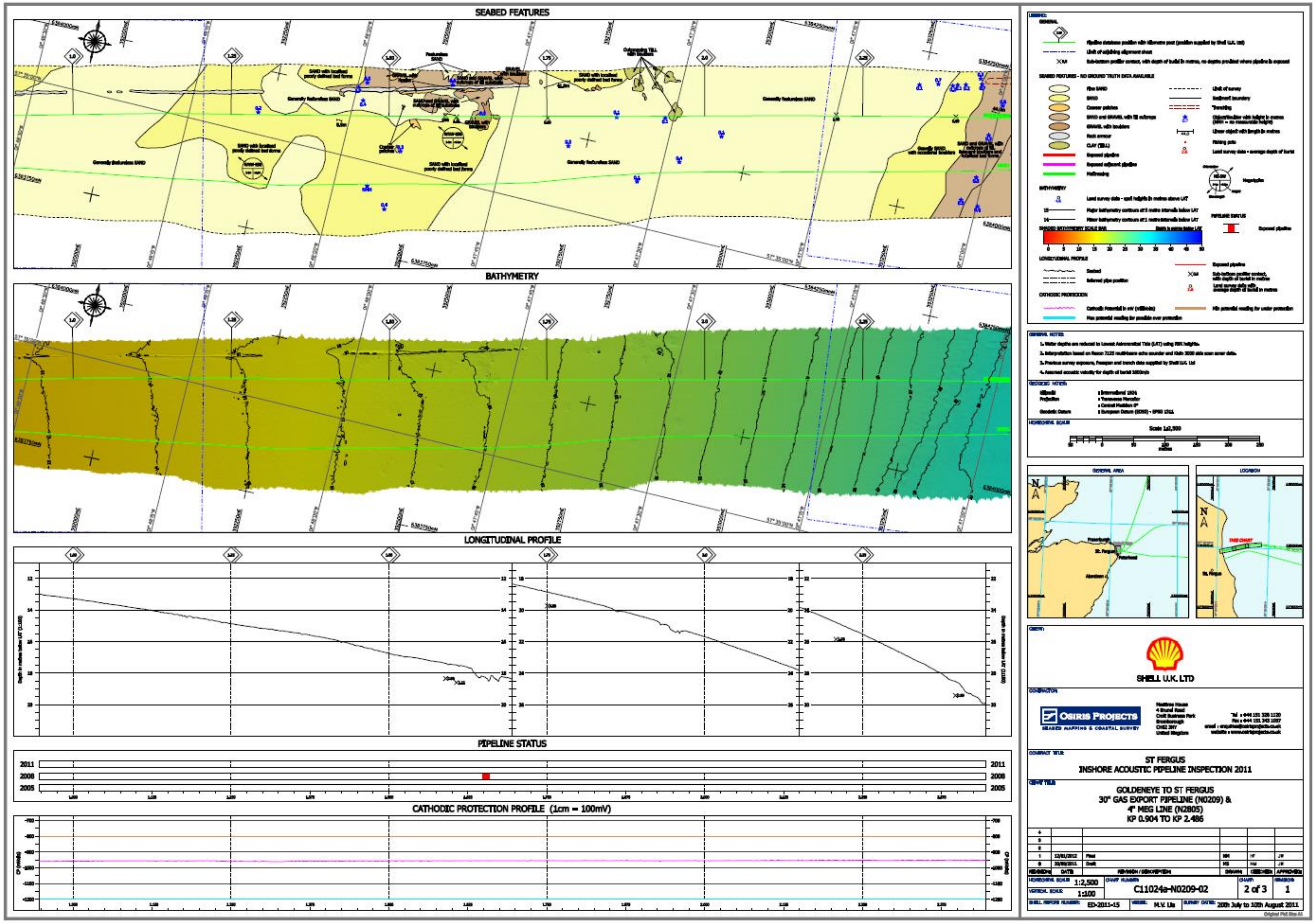


Figure 7-3 – Goldeneye Gas Export Pipeline Survey Results Summary

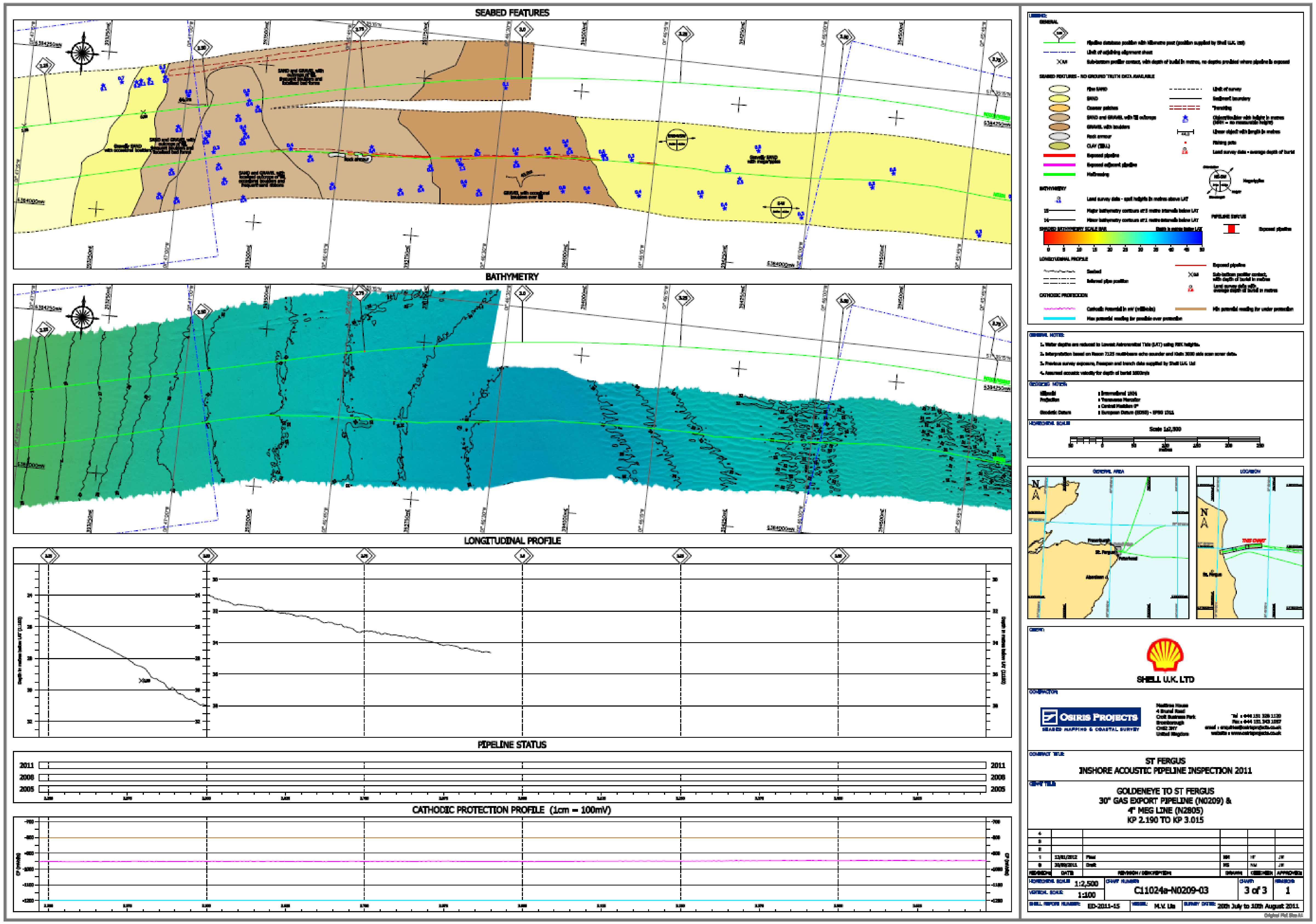


Figure 7-4 – Goldeneye Gas Export Pipeline Survey Results Summary

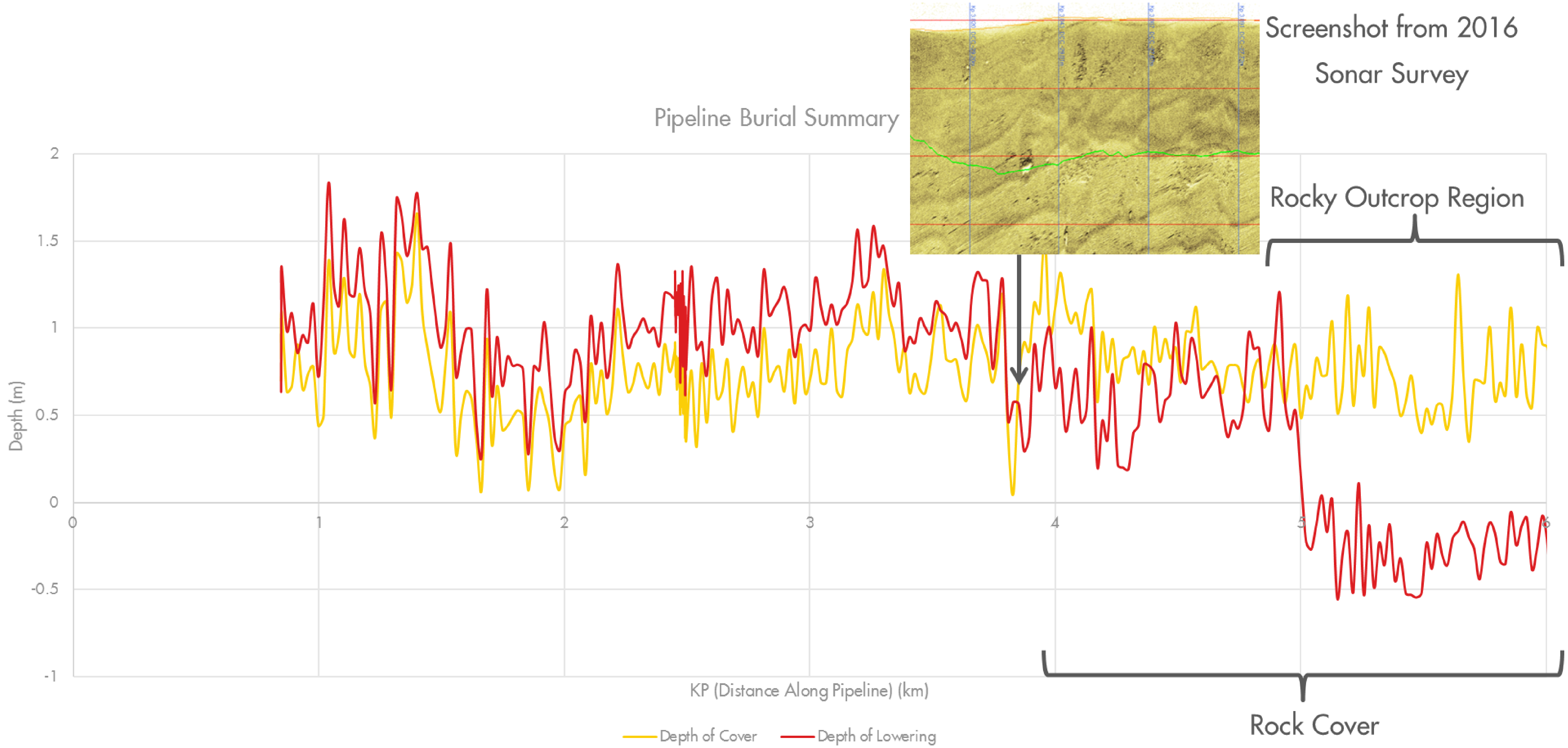


Figure 7-5 – Goldeneye Inshore Pipelines 2004 As-Backfilled Survey Summary

7.4. KP 6 – 20 Piggybacked, Trenched and Buried Pipelines

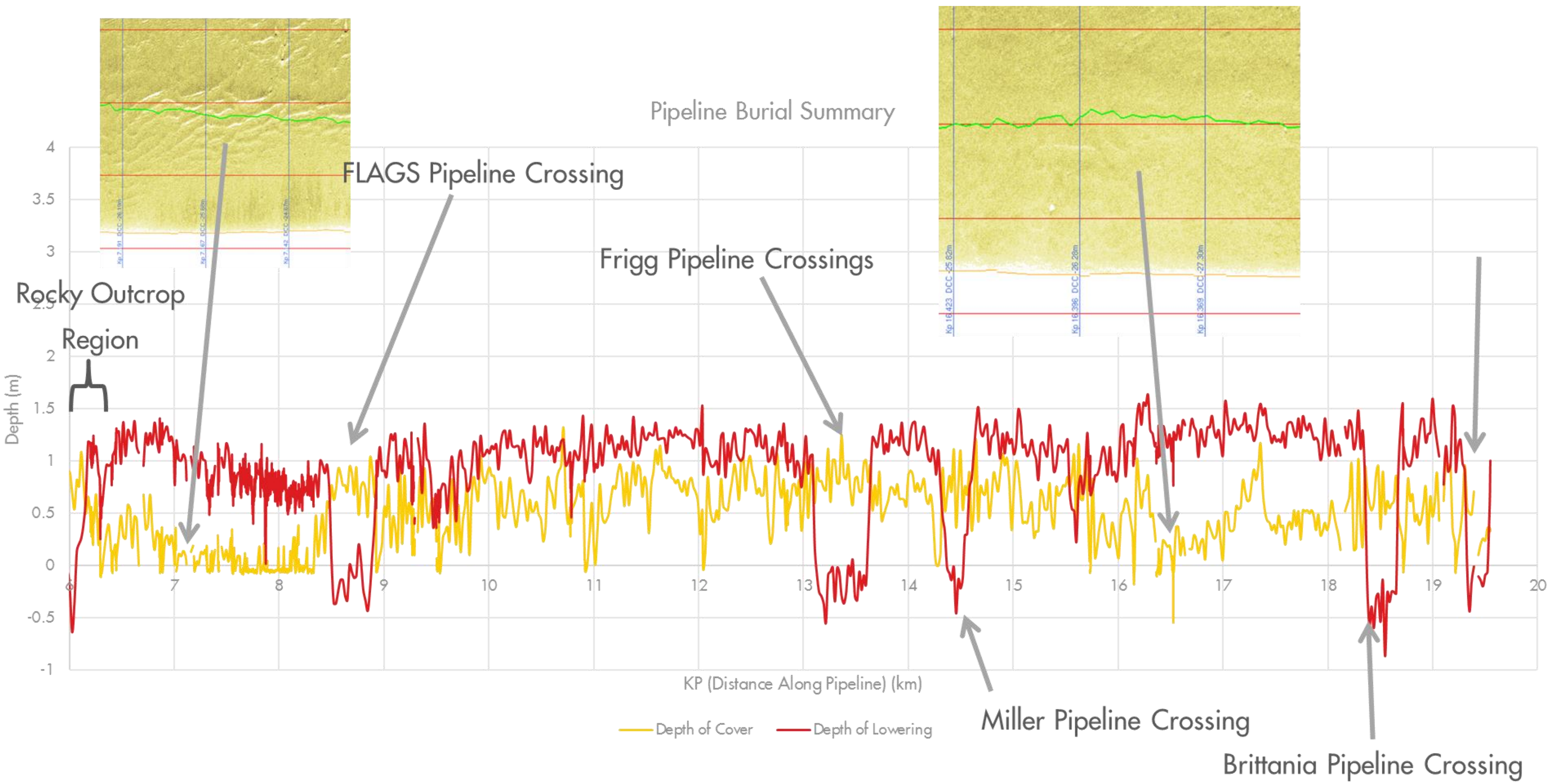


Figure 7-6 – Goldeneye Pipelines (KP 6 - 20) 2004 As-Backfilled Survey Summary and Corresponding 2016 Sonar Results

7.5. Gas Export Pipeline Burial Summary

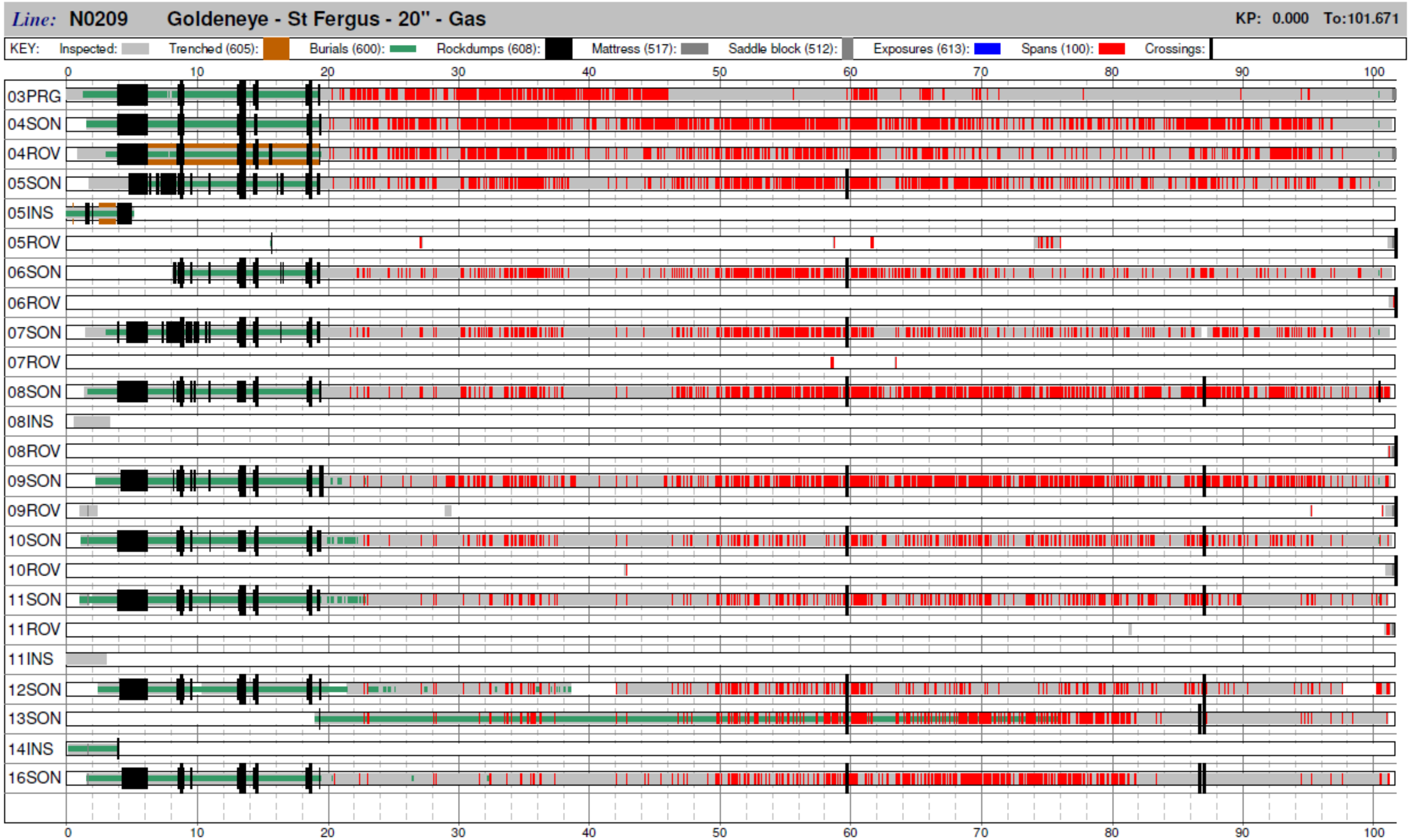


Figure 7-7 – Goldeneye Gas Export Pipeline Survey Results Summary

7.6. MEG Pipeline Burial Summary

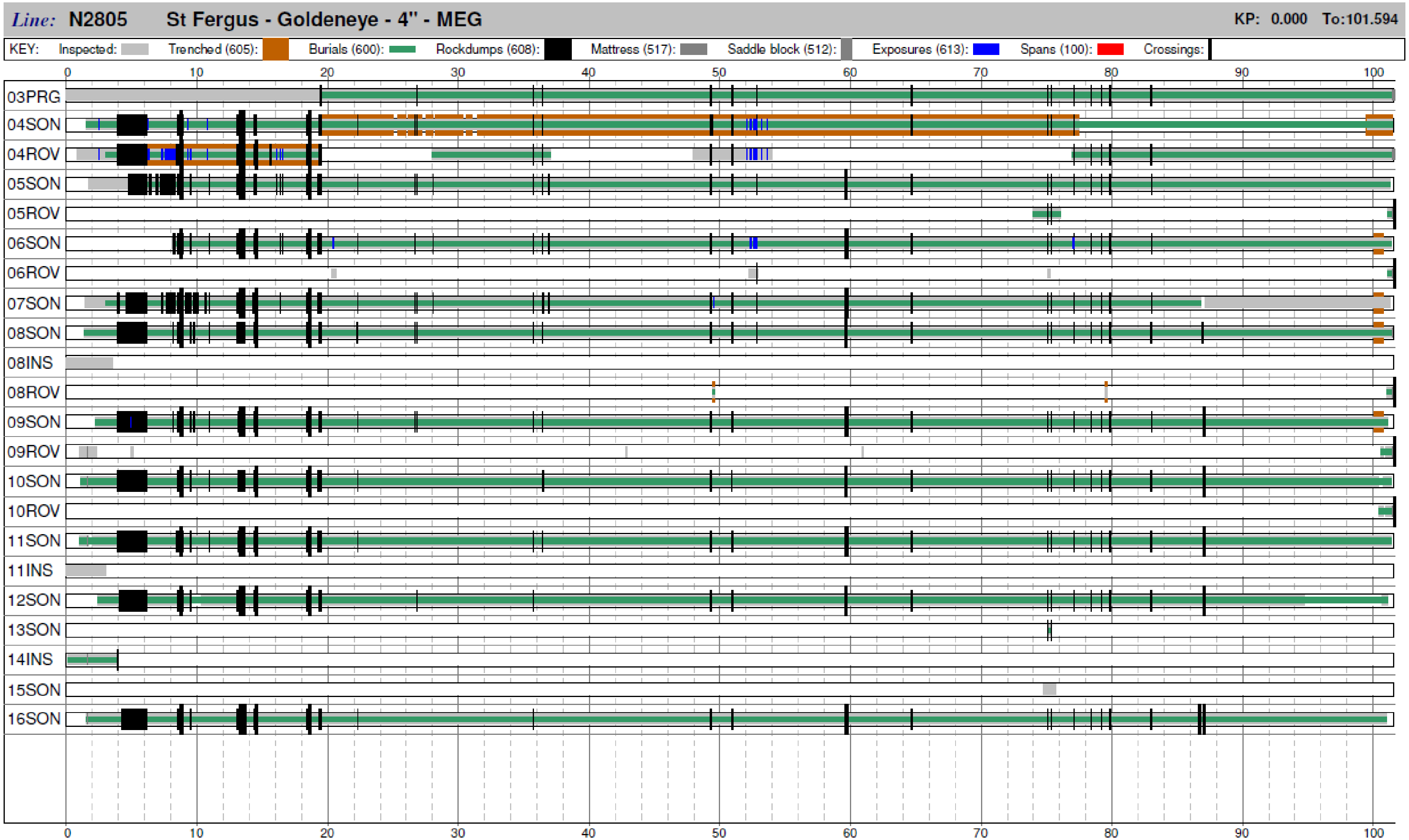


Figure 7-8 – Goldeneye MEG Pipeline Survey Results Summary

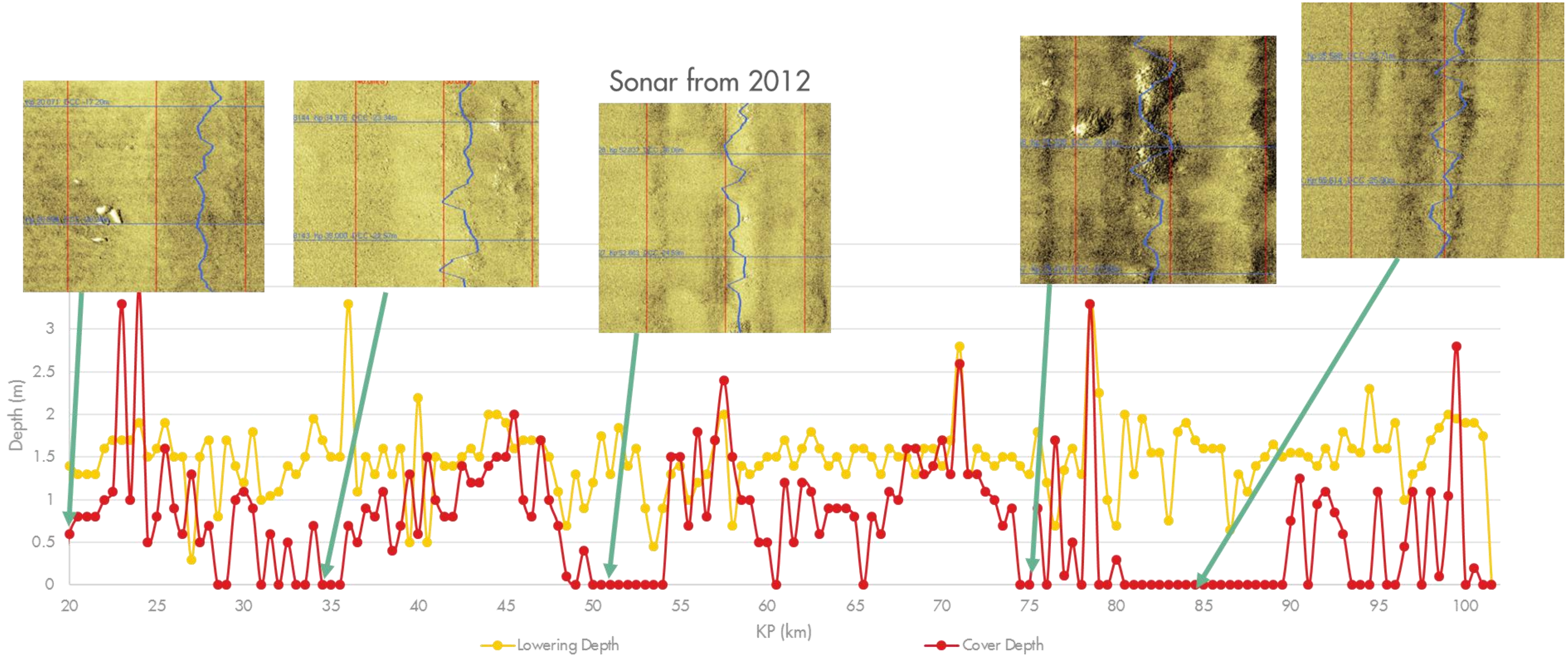


Figure 7-9 – Goldeneye MEG Pipeline (KP 20 – 102) 2004 As-Backfilled Survey Summary and Corresponding 2012 Sonar Results

8. Appendix B: Expanded Assessment Tables

8.1. Group 1: Trenched and Buried Piggy-Backed Sections KP 6 – 20

Criteria	Sub Criteria	Notes
Safety	Project risk to other users of the sea	Although vessels would be operating in the area for a reasonable duration for the Total Removal option, this was deemed to be similar to day-to-day activities and pose little additional risk to fishermen in the area.
	Potential of a high consequence event	Total removal was scored amber due to the risk of dropping cut pipe onto other pipelines approaching congested pipeline routes at St Fergus Terminal
	Residual risk to other users of the sea	No exposures on pipeline but rock cover and sea bed have flattened as per ripples seen on survey. Crossings are the only areas that are not in a deep trench but they are adequately protected by mattresses and rock cover. The SFF enquired as to why this was not presented as a narrative conclusion. Shell advised that specific environmental considerations regarding the pMPA meant qualitative assessment was preferred, also some of the data being presented which may support a narrative conclusion was only produced after the initial screening workshop. It was noted that the scores for Options 1 and 3 would be 'green' but the presence of the crossings and transition section, with surface laid material and rock cover proud of the seabed, drove the amber result. Option 6 was considered to have slightly higher risk, although within the 'amber' band due to the presence of cut ends at the crossings and short-term risk of the trench berms created by pipeline deburial.

Criteria	Sub Criteria	Notes
Environmental	Marine impact of operations	There are *Sabellaria* present, although they are juvenile and there is no evidence of reefs as classified by the reefiness index. Although in the Southern Trench pMPA there are no designating species or habitats identified in the surveys, hence why the result has not been deemed 'red'. The scoring is driven by the volume of rock required, although seabed disturbance was considered, it was not deemed to be an important factor in this area due to the naturally high level of seabed mobility. In a pre-workshop meeting, the SNH queried how much volume would be required and where it would need to be placed. It was advised that rock placement would depend on areas of low coverage being identified during a post-decommissioning survey.
	Energy, emissions, resource consumption	Emissions are not a differentiator – emissions from decommissioning activity will be low in relation to general North Sea activity and the lost energy from non-recycled material decommissioned in situ helps neutralise any environmental benefit from reduced offshore activity during decommissioning execution.
	Impact of marine end points (legacy impact)	Driven partially by crossings being decommissioned in situ but also from removed material going to landfill. Material proud of seabed at crossings
Societal	Commercial impact on fisheries	Although each option was scored 'amber' here it was noted that this reflected the condition against pre-oil circumstances and focused on the remaining presence of the crossings and transition section. It was noted that fishing continues in this area based on available VMS data, although only vessels >12m in length are required to carry VMS recording equipment and smaller vessels and static gear (e.g. lobster pots) would suffer a short-term impact from decommissioning activities.
	Socio-economic impact on communities and amenities	The scores here reflect the impact each option would have on the retaining the pipeline for potential future CCS projects.

Criteria	Sub Criteria	Notes
Economic	Cost	Although rock cover is deemed to be more expensive that decommissioning in situ, the cost was deemed to be relatively closer to Option 1 than total removal and so a 'green' score was assigned.
	Cost risk and uncertainty	We are as certain of all the costs and therefore this sub-criterion has been removed as a consideration.

Table 8-1 – Group 1 Scoring Explanations

8.2. Group 2: Surface-Laid Gas Export Pipeline, KP 20 - 102

Criteria	Sub Criteria	Notes
Safety	Project risk to personnel - Offshore	Option 2 assumes the use of a jet trenching machine, therefore scoring green. Option 5 was scored 'red' due to the risk to divers from degrading concrete coating and uncertain joint integrity during reverse s-lay.
	Project risk to personnel - Onshore	Option 5 was scored 'amber' due to the degrading material that will be returned to shore and the number of lifts required at the quayside and recycling yards.
	Potential of a high consequence even	Increased SIMOPS and helicopter crew changes drove the 'amber' result for option 5.
	Residual risk to other users of the sea	Option 1 was 'red' due to the presence of material proud of the seabed which may pose a snagging risk in future. The SFF noted that Option 2 was preferable to Option 3 due to the elevated snagging risk of the proposed rock berm. Option 5 was scored 'amber' due to the presence of a cut end at KP 20.
Environment	Marine impact of operations	Although trench and bury is scored 'red' due to the seabed disturbance that is created, this was deemed to be a less important consideration for this area due to the highly mobile status of the seabed and natural disturbance that indigenous species were acclimatised to.
	Energy, emissions, resource consumption	Grey out as per group one
	Impact of marine end points (legacy impact)	For Option 1, although material is left proud of the seabed, it is inert and therefore scored 'amber'.

Criteria	Sub Criteria	Notes
Technical	Risk of major project failure	Regarding option 2, the technology exists but achieving a consistent 0.6m burial depth could prove difficult and is therefore a risk. Shell has liaised with the contractors in the market who reported high confidence in achieving 0.3m burial depth. Option 5 was scored 'amber' due to risk activities could take significantly longer.
	Technology demands / track record	Option 2 - base case is for trenching but would consider new technologies Option 5 has been considered but not used for previous comparable jobs, therefore scored 'amber'.
Societal	Commercial impact on fisheries	Although each option was scored 'amber' here it was noted that this reflected the condition against pre-oil circumstances and focused on the remaining presence of the crossings and transition section. Option 1 leaves significant concerns of pipeline spans developing over time, particularly due to the highly mobile seabed in the area.
	Socio-economic impact on communities and amenities	The scores here reflect the impact each option would have on the retaining the pipeline for potential future CCS projects.
Economic	Cost risk and uncertainty	Option 5 has been scored 'amber' due to lack of prior experience with which to benchmark the estimate.

Table 8-2 – Group 2 Scoring Explanations

9. Appendix C: Comparative Assessment Criteria Parameters

Criteria	Sub-Criteria	Applicable to	Applicable When	Green / Most Preferred	Amber / Moderate	Red / Least Preferred
Safety	Project risk to personnel – Offshore	Project team offshore, project vessels crew, diving teams, supply boat crew, heli-ops, survey vessels crew	During execution phase of the project including any subsequent monitoring surveys	Minimal preparatory activity to be completed prior to start of removal activity. No underdeck / overside working. Minimal materials handling on deck or barge during removal. Minimal diver activity.	Some preparatory activity to be completed prior to start of removal activity – but straight forward. Limited underdeck / overside working. Some materials handling activity on deck or barge during removal – but straight forward. Increased diver activity for short intervals and for less than 25% project duration.	High level of preparatory activity to be completed prior to start of removal activity. Significant underdeck / overside working. Multiple materials handling activity on deck or barge during removal. Extended diver activity throughout entire project phase.
	Project risk to other users of the sea	All other users of the sea, fishing vessels, commercial transport vessels, military vessels	During execution phase of the project including any subsequent monitoring surveys	Minimal project activity outside existing exclusion zone. Minimal additional vessels transits to and from shore.	Moderate project activity outside existing exclusion zones but for short durations. Some additional vessel transits to and from shore of significant sized vessels. No complex transits.	Significant project activity outside existing exclusions zones but for most of project duration. Some complex transits to shore.
	Operational risk to personnel – Onshore	Onshore dismantling and disposal sites personnel; extent of materials transfers/ handling on land	During execution phase of the project, through to final disposal of recovered materials	Medium sized / volume of structures returned as waste - moderate dismantling required onshore, minimal work at height. Minimal contaminated materials to be returned, capable of being processed in existing facilities without additional specialist equipment or treatment.	Large size / volume of structures returned as waste – more dismantling required onshore, some working at height possible. Some contaminated materials may be returned, may require some additional specialist equipment or treatment.	Significant sized or awkward shaped structures returned as waste – significant working at height required, significant and complex dismantling and materials handling activities required. Significant volumes of contaminated materials handling and clean up anticipated; or requires onerous levels of additional specialist equipment / treatment.
	Potential for a high consequence event	Project team offshore and onshore; project vessels; diving teams; supply boat crew; heli-ops; survey vessels; onshore dismantling and disposal sites personnel	During execution phase of the project including any subsequent monitoring surveys	Short vessel campaign (summer campaign); low level vessel SIMOPS; minimal helicopter crew changes anticipated; few lifting operations; all straightforward and not over live plant.	Prolonged vessel campaigns; some vessel SIMOPS; helicopter crew changes possible; some lifting operations; recovered structures lifted onto vessels for backload but not over live plant.	Extensive vessel campaigns; multiple mob / demob; multiple vessel SIMOPS; helicopter crew changes likely; major lifting operations, some very large lifts; possible lifts of structures over live trunk lines.
	Residual risk to other users of the sea	Fishing vessels, fishermen, supply boat crews, military vessel crews, commercial vessel crew and passengers, other users of the sea	Following completion of the Decommissioning project and residual / ongoing impact in perpetuity	None anticipated as clear seabed on completion of project, all material left in situ is adequately trenched or buried below mean seabed level.	Some materials which are proud of mean seabed level / not trenched or buried but are otherwise protected, i.e. rock-covered or present minimal risk of snagging due to their inherent structure (e.g. large diameter trunk lines). Other mitigations in place (retention of exclusion zones).	Material left in situ is proud of the seabed and not protected by rock-cover and could represent a future snagging risk; mitigation available is limited to marking on admiralty charts. Material left in situ would require significant future monitoring and / or future mitigation measures.
Environmental	Impact of operations	Environmental impact to the marine environment, nearshore areas and onshore caused by project activities	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) For rock placement, trenching and dredging any seabed disturbance is included here, depending on area of	No associated discharges*1; No behavioural disturbance to any marine mammals; Area of disturbance equal or less than area disturbed during installation and/or operations; No disturbance to drill cuttings accumulation*2; Extend of the sediment resuspension equal or less than the extent caused during operations and/or installation;	Non-SUB, GOLD or E/PLONOR chemicals discharges*1; Temporary changes to behaviour of any marine mammals i.e. temporary move away from the area; Area of disturbance is up to two times bigger than the area disturbed during installation and / or operation; Less than half the volume of the drill cuttings deposits*2 will be disturbed;	Any other chemical discharges*1 (other than in Amber) e.g. SILVER, OCNS A-C or no longer CEFAS registered; Permanent damage / change to behaviour of any mammals (i.e. move away permanently and / or permanent damage to hearing); Area of disturbance more than two times bigger than the area disturbed during installation and / or operations; AND Greater than half the volume of the drill cuttings will be disturbed; AND

Criteria	Sub-Criteria	Applicable to	Applicable When	Green / Most Preferred	Amber / Moderate	Red / Least Preferred
			impact – changes to habitat and species are covered in Legacy Impact.	No protected / sensitive species and or habitats affected; Onshore processing can be completed by existing facilities without additional specialist equipment / treatment*4	Extent of the sediment resuspension is up to two times bigger than during operation and/or installation; Presence of protected / sensitive species and/or habitats identified and confirmed by a survey*3; Onshore processing requires moderate levels of specialist equipment / treatment, additional qualified personnel, etc	Sediment resuspension is more than twice than during operation and/or installation; Presence of designated protected species and/or habitats*3; Onshore processing requires onerous or offsite levels of specialist equipment / treatment
	Energy, emissions and resource consumption	Project activities from vessel mobilisation to the final destination of waste, including the energy and emissions penalty for leaving recyclable material in field. Includes vessel mobilisation, demobilisation, waiting on weather, post-decommissioning monitoring surveys.	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) Not recovering and recycling the installations material will require that raw material and energy will be consumed to replace the materials which would have been recycled if the structure had been brought onshore	Short duration and/or small number of vessels during decommissioning operation and future monitoring; Small volume of material left in situ	Moderate duration and number of vessels during decommissioning operation and future monitoring; Moderate volume of material left in situ	Significant duration and number of vessels required for operations and future monitoring; Significant volume of material left in situ
	Legacy impact	Ongoing long term environmental impact caused by materials left in place or long-term waste storage / landfill	Following completion of the Decommissioning project and residual / ongoing impact For rock placement, trenching and dredging any changes to habitat and species are included here - seabed disturbance is included in Impact of Operations, depending on area of impact.	Minor volumes of material to landfill; No hazardous waste requiring long-term storage; No change to habitat or species composition (introduction of no new materials); No material left ON the seabed; and / or inert material left IN the seabed (trenched or buried)	Moderate volumes of material to landfill; Non-hazardous waste requires disposal (landfill) OR Small amount of hazardous waste requiring treatment and / or long term-storage; Possible / temporary alteration of species composition due to habitat alteration with recovery and recolonization of the area by original species; Inert material left ON the seabed; or contaminated material left IN the seabed posing no significant threat to the environment *5	Majority of recovered material destined for landfill; Majority of hazardous waste long-term storage; Permanent habitat alteration with permanent changes in species composition; Material left ON or IN the seabed containing contaminated material that poses a significant long-term threat to the environment*6
Technical	Risk of major project failure	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	High level of confidence that schedule slippage can be accommodated within the contingency and float in the plan; high level of confidence that cost increases can be accommodated by contingency UAP budget allocation; slippage to schedule and growth in cost anticipated is small; assets and equipment are immediately available to facilitate recovery and stabilise the situation after an incident; speed of recovery is anticipated to be swift; limited impact on planned campaign schedule is anticipated as remaining planned activities can continue in the interim.	Less confidence in cost and schedule, however moderate level of delay and cost overrun is anticipated as worst case; assets and equipment are available in a reasonable timeframe from onshore to stabilise the situation after an incident; speed of recovery is anticipated to be longer due to some re-engineering of activities being required; considerable impact on the planned campaign schedule is anticipated, as remaining planned activities cannot continue in the interim.	Significant delays are possible if upsets occur pushing removals phase into a separate season and increased cost overrun possible; re-engineering required to develop procedures and identify assets and equipment to stabilise the situation after an incident; speed of recovery is anticipated to be slow due to re-engineering and procurement of new equipment; significant impact on the entire project schedule and company reputation.

Criteria	Sub-Criteria	Applicable to	Applicable When	Green / Most Preferred	Amber / Moderate	Red / Least Preferred
	Technology demands, Availability / Track Record	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	The proposed concept has been successfully implemented in the past; technological feasibility of the concept is beyond doubt; industry and expert opinion consistently concludes that the proposed solution is technically robust and complies with existing legislation; vessels and most supporting equipment are industry-standard with good track record of successful operation with no new marine asset construction required; some minor supporting equipment may require investment to aid development or proof of use as planned, however it is anticipated that this can be completed successfully ahead of the project schedule; the supply chain is generally readily available in the present market; project schedule is reasonable and equipment availability is within project timetable.	The proposed concept has been seriously considered for several directly comparable assets in the past but has not yet been used; technological feasibility of the concept requires some additional engineering development; expert opinion is united in confidence that the proposed solution is generally technically sound and complies with existing legislation; some vessels require some investment to aid minor development, however there is widespread confidence within the industry that this shall be completed successfully; more supporting equipment requires early investment to aid development, however it is anticipated that this will be completed successfully ahead of the project schedule; the supply chain requires some engagement to meet project requirements; project schedule can be managed to suit equipment availability within the overall project timetable.	The proposed concept is not mature; technological feasibility of the concept requires considerable engineering to prove; there is some doubt within the industry and expert opinion is divided on whether the proposed solution is technically sound and can comply with existing legislation; vessel require investment to aid their development and construction; other supporting equipment requires investment to aid development; there is uncertainty within the industry that this will be completed successfully ahead of the project schedule; the supply chain requires development; project schedule is tight but may be managed to suit equipment availability.
Societal	Commercial impact to fisheries	Impacts from both the decommissioning operations and the end-points on the present commercial fisheries in and around the field	During and following completion of the Decommissioning project and residual / ongoing impact	The status of the area / site post-decommissioning will have no effect on commercial fisheries.	The status of the area / site post-decommissioning results in small areas of fishing ground or water column becoming inaccessible to fishing and is lost to fishing over prolonged period.	The status of the area / site post-decommissioning results in larger areas of fishing ground or water column becoming inaccessible to fishing and is lost to fishing over a prolonged period.
	Socio-economic impact on communities and amenities	The impact from any near shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on the health, well-being, standard of living, structure or coherence of communities or amenities. E.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads.	During and following completion of the Decommissioning project and residual / on-going impact	No or minor negative impact: short-term (<6 months) impact on local communities causing potential minor nuisance from some aspects of the operations, but would cease and revert to previous condition on completion of specific short-term operations. Short-term (<6 months) impact on local amenities for some or all of the operations, but would cease and revert to previous condition on completion of operations, without the need for mitigation. Positive impact: new business or long-term employment created, extends beyond duration of the operation by more than 1 year. Permanent road and other infrastructure improvements created.	Some negative impact on local communities, leading some actual deterioration in quality of life, deterioration would exist while actual operations were being carried out but would essentially cease as soon as operations were completed and quickly revert to pre-operation condition; some impact on local amenities, leading to some actual deterioration in amenities; deterioration would exist whilst actual operations were being carried out. Some mitigation / remedial work would be required when operations were completed to restore amenities to pre-operational condition. Short term and local positive impact on communities as localised increased job prospects created for duration of the operation. No permanent positive impact on amenities anticipated.	Significant and long-term (>1 year) negative impact on local communities leading to noticeable deterioration in quality of life during the operations. Anticipated this would persist for a period of 6 months to 1 year after actual operations had ceased. Significant and long-term (>1 year) impact on local amenities, leading to noticeable deterioration during the operations. Mitigation / remedial work would be required when operations were completed to restore amenities to pre-operational condition. No positive impact on communities or amenities. Existing businesses and infrastructure can accommodate operations.

Criteria	Sub-Criteria	Applicable to	Applicable When	Green / Most Preferred	Amber / Moderate	Red / Least Preferred
Economic	Cost	Overall Project	Full decommissioning project cost including future monitoring surveys and proposed remediation, if required	Lowest cost option	-	Highest cost option
	Cost Risk / Uncertainty	Overall Project	Project execution phase and ongoing cost liability (surveys and potential remedial action)	Scope reasonably defined and understood; estimate developed using recognised and validated estimating tools; validated cost basis industry norms from similar work already carried out.	Some uncertainty / information gaps in parts of the scope and / or equipment used; estimate developed using recognised and validated estimating tools; validated cost basis using industry norms, some information gaps in norms due to costs of new or emerging equipment rates not being available.	Uncertainty in many areas of the scope and in equipment used; OOM estimate only developed; significant information gaps in norms due to costs of new / emerging equipment rates not being available.

Table 9-1 – Comparative Assessment Criteria Parameters

<u>Notes relating to the Environmental sub-criteria (Table 9-1):</u>

Impact of Operations:

*[1] Discharges of pipeline and umbilical contents which have been cleaned to a cleanliness level as agreed with regulator;

*[2] Any drill cuttings deposits regardless of OSPAR 2006/05 definition;

*[3] must be supported by any survey (ignoring reference station);

*[4] this only applies if material is returned onshore for disposal

Associated discharges do not include accidental releases; these are not considered in the environmental evaluation of the options as they are probabilistic events and their inclusion would skew the data as the order of their impact is significantly higher than of the planned activities with build-in mitigations and controls

Legacy Impact:

Waste Disposal to include end-products of any cleaning operations; does not apply if all material is left in situ, i.e. nothing is brought onshore for disposal.

*[5] Example: steel pipeline which was cleaned to BAT, but the pipeline is still left in situ

*[6] Science immature on plastic content but it is an increasing problem with higher focus from society and environmental science community

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