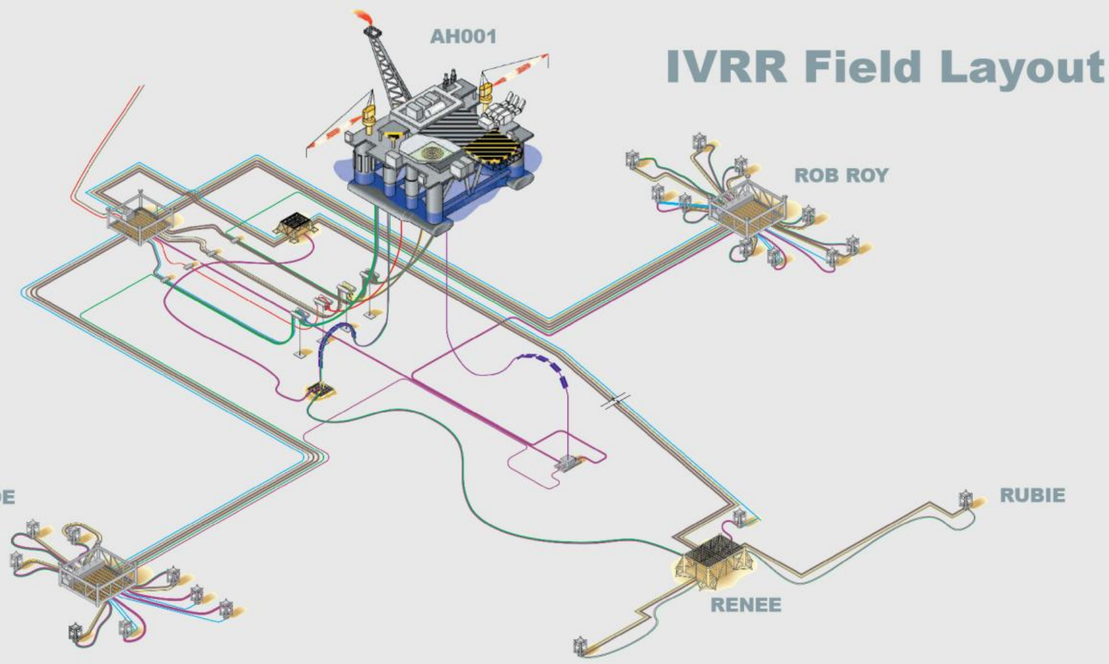
Ivanhoe and Rob Roy Fields Decommissioning Programmes



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ABBREVIATIONS :

BT	British Telecom
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CI	Chemical Injection
CUBS	Control Umbilical Base Structure
dB re 1 µPa	Decibel [to reference pressure of 1 micro Pascal in water]
DECC	Department of Energy and Climate Change
DP	Dynamic Positioning
DPR	Decommissioning Programme Reference
DSV	Diving Support Vessel
DUBS	Dynamic Umbilical Base Structure
DWT	Deadweight Tonnage
EHDB	Electro-Hydraulic Distribution Box
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ENVID	Environmental Issues Identification
ES	Environmental Statement
ESDV	Emergency Shut-Down Valve
FPF	Floating Production Facility (vessel)
ft	Foot
GJ	Gigajoule
GWP	Global Warming Potential
HSE	Health and Safety Executive
HS&E	Health, Safety and Environment
ICES	International Council for the Exploration of the Sea
ID	Internal Diameter
In	Inch
IVPM	Ivanhoe Production Manifold
IVRR	Ivanhoe Rob Roy [Development]
JNCC	Joint Nature Conservation Committee

ABBREVIATIONS :

km^2	Square Kilometres
km^2years	Square Kilometres Years
KPI	Key Performance Indicator
LWIV	Light Well Intervention Vessel
m	Metre
m^2	Square Metres
m^3	Cubic Metres
MDAC	Methane Derived Authigenic Carbonate
MDSS	Measured Depth Subsea
mmbbl	Million Barrels
MODU	Mobile Offshore Drilling Unit
MWA	Mid Water Arch
Nm	Nautical Mile
NORM	Naturally Occurring Radioactive Material
OBM	Oil-based Mud
OCR	Offshore Chemical Regulations
OPEP	Oil Pollution Emergency Plan
OPPC	Oil Pollution Prevention Control
OSPAR	Oslo and Paris [Convention for the Protection of the Marine Environment of the North-East Atlantic]
PAH	Polycyclic Aromatic Hydrocarbons
PEXA	Practise and Exercise Areas
PON	Petroleum Operations Notice
RBM	Riser Base Manifold
ROV	Remotely Operated Vehicle
RRC	Riser Release Connector
RRPM	Rob Roy Production Manifold
RSD	Riser Stabilising Devices

ABBREVIATIONS :

SAC	Special Area of Conservation
SCM	Subsea Control Module
SSIV	Subsea Isolation Valve
SUT	Static Umbilical Termination
SUTB	Subsea Umbilical Termination Box
t	Tonne
THC	Total Hydrocarbon Concentration
UKCS	United Kingdom Continental Shelf
WBM	Water Based Mud
WI	Water Injection

SECTION 29 NOTICE HOLDERS :

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In October 2008 and in accordance with the requirements of the Petroleum Act 1998, the Department of Energy and Climate Change (DECC) issued Section 29 Notices for the submarine pipeline and offshore installations associated with the Ivanhoe and Rob Roy (IVRR) development.

The Notices were issued to:

- Endeavour Energy UK Limited
- Endeavour North Sea Limited
- Hess Limited
- Talisman Oil Trading Limited

The Section 29 Notice Holders for the IVRR development each confirm that they authorise Hess Limited (Hess), as operator of these fields, to submit a Decommissioning Programme for each Section 29 Notice, as directed by the UK Secretary of State. Each Notice Holder confirms that they support the proposals detailed in the Decommissioning Programmes presented in this document (Appendix A).

1 INTRODUCTION

1.1 The IVRR Development

The Ivanhoe – Rob Roy (IVRR) development consists of the Ivanhoe and Rob Roy fields. The IVRR development is located in Block 15/21 of the United Kingdom Continental Shelf (UKCS), approximately 193 km north-east of Aberdeen in an average water depth of 140 m. The Ivanhoe and Rob Roy fields lie approximately two miles apart. The Rob Roy field includes the Hamish facilities. These are located in Block 15/21b, but the single Hamish production well is located in Block 15/21a and is a tieback well routed through the Rob Roy production manifold. The co-venturers in the IVRR development are Hess Limited (Hess), Endeavour Energy UK Limited and Endeavour North Sea Limited (collectively referred to as Endeavour) (Table 1.1). Hess operated the development on behalf of the co-venturers. Talisman Oil Trading Limited (Talisman), though not co-venturers in IVRR, received Section 29 Notices as the oil and gas export pipelines connect to the Talisman-owned Claymore and Tartan platforms.

Table 1.1: IVRR Co-venturers

Field	Hess	Endeavour
Ivanhoe	76.55%	23.45%
Rob Roy	76.55%	23.45%
Hamish	76.55%	23.45%

Production from IVRR was achieved through the floating production facility (FPF) *AH001*, which was anchored centrally between the Ivanhoe and Rob Roy fields. *AH001* was owned by Hess and operated by Aker Solutions as Duty Holder. *AH001* operated at the development for 20 years. *AH001* also processed produced fluids from the Renee and Rubie fields (collectively referred to as R-Block). The R-Block facilities are the subject of separate Section 29 Notices and a separate decommissioning programmes document.

The wellheads for each field are grouped around field-specific production manifolds, namely the Ivanhoe production manifold (IVPM) and the Rob Roy production manifold (RRPM). Both field manifolds are connected to a central riser base manifold (RBM) which routed production to *AH001*. Produced oil was exported through a 14” steel pipeline from *AH001* via the RBM to the Claymore A platform; processed gas was exported through an 8” steel pipeline from *AH001*, via the RBM to the Tartan A platform. The IVRR development has collectively produced 100 mmbbl of oil during its life.

1.2 Potential Redevelopment Options

Hess and Endeavour have explored all options for continuing production from the fields using the FPF *AH001* but concluded that no option was economically viable. The co-venturers also considered the potential for redeveloping oil and gas reserves in the vicinity of the Ivanhoe, Rob Roy and Hamish fields. Hess decided not to pursue the redevelopment of these fields, but Endeavour wished to maintain the option of redevelopment, subject to further studies.

In December 2008, Hess and Endeavour agreed to suspend the development and Hess proposed their plans for the removal of *AH001* and safe suspension of the development to DECC. DECC agreed these plans in March 2009, advising that Endeavour had been given two years with a possible extension of two further years, to investigate redevelopment opportunities. In April 2012, Endeavour confirmed that they did not wish to pursue redevelopment of the IVRR fields.

1.3 Work Completed to Date

The work to decommission the IVRR development has been conducted in phases. Phase 1, suspension of the development and removal of the FPF *AH001* from the field, was completed in 2009. In 2011, decommissioning preparatory work, including the removal of some items, was completed and is referred to as Phase 2. Both phases of work were agreed with DECC before work began. A full description of the activities completed during each phase is presented within the supporting document ADP-009 and a summary is presented here for information purposes only.

1.3.1 Phase 1: Suspension and FPF Removal

A programme of work was completed in 2009 to flush and clean the production equipment and to release the FPF *AH001* from the IVRR infrastructure. All flexible risers and the FPF mooring system were disconnected from the FPF and laid on the seabed. The 14" oil and 8" gas export lines were disconnected at Claymore and Tartan respectively and the spool sections were removed and recovered. The *AH001* was then sailed away, leaving the remaining IVRR infrastructure on the seabed. A guard vessel was deployed to warn vessels of the presence of the subsea infrastructure and associated subsea equipment safety zones.

1.3.2 Phase 2: Decommissioning Preparatory Work

In preparation for the full decommissioning of the IVRR development, work was completed in 2011 and early 2012 to remove certain items from the seabed. This work was planned and executed in agreement with DECC. The items removed during this phase of work were:

- Mid-water arches, including bend restrictors and gravity bases
- Riser stabilising devices
- Eight flexible risers, including the riser release connector (RRC) sections (PL547, PL513-9)
- Chemical injection umbilicals (PL551 and PL520, dynamic sections)
- Control umbilical to the control umbilical base structure (CUBS) and dynamic umbilical base structure (DUBS) (dynamic sections) and DUBS to R-Block cross-over structure (static section - see R-Block Decommissioning Programmes)
- FPF mooring system
- Drilling rig anchoring system

As these items have already been removed from the field they do not form part of this submission; however, as the items were part of the IVRR development they are part of the total inventory of the field and have been included in the overall inventory of material (Section 5).

The Ivanhoe Xmas tree and IVPM flowline jumpers and umbilicals, the Rob Roy Xmas tree and RRPM flowline jumpers and umbilicals plus all interfield flowlines to the RBM were all disconnected and blanks installed on open ends in Q1, 2012. The 14" oil and 8" gas export lines to Claymore and Tartan respectively were also disconnected at the RBM.

The Renee/Rubie (R-block) pipeline infrastructure (refer to the separate Renee/Rubie Decommissioning Programme) was also disconnected between the IVRR RBM and the R-block crossover structure, with the intervening spools being removed and laid aside on the seabed for future recovery.

1.4 Scope of Document

Hess, on behalf of the co-venturers, has prepared Decommissioning Programmes for the two IVRR fields (Ivanhoe and Rob Roy), as required by the Petroleum Act 1998. The decommissioning of the development will be managed as one project and the possible decommissioning options and associated impacts have been assessed collectively.

The sections presented in this document therefore reflect a combined assessment and management approach. However, as each field is subject to separate Section 29 Notices under the Petroleum Act, four decommissioning programmes are presented in this document. The R-Block facilities will be the subject of a separate document.

1.5 Structure of Document

For both the Ivanhoe and Rob Roy fields, there are two Section 29 Notices, one for the subsea installations / facilities and one for the pipelines. Four Decommissioning Programmes are therefore presented in this document and have been assigned Decommissioning Programme Reference numbers as shown in Table 1.2. The structure of the document is illustrated in Table 1.3.

Table 1.2: Decommissioning Programme Reference (DPR) Numbers for the IVRR Development

Field	DPR	Section 29 Notice Reference	Items
Ivanhoe	1	01.08.07.06/00029C	FPF *AH001* and subsea equipment, including the production manifold.
	2	01.08.07.05/203C	Pipelines and any associated apparatus.
Rob Roy (including Hamish)	3	01.08.07.06/00026C	All subsea equipment, including the production manifold.
	4	01.08.07.05/37C	Pipelines and any associated apparatus.

Table 1.3: Decommissioning Programmes Presented in this Document

Section Number	Title	DPR			
		1	**2**	**3**	**4**
1	Introduction	Combined			
2	Executive Summary	Combined			
3	Background Information	Combined			
4	Facilities to be Decommissioned	Sect 4.2	Sect 4.3	Sect 4.5	Sect 4.6
5	Inventory of Materials	Sect 5.1	Sect 5.2	Sect 5.4	Sect 5.5
6	Removal and disposal options for the pipelines and umbilical	NA	Sect 6	NA	Sect 6
7	Selected removal and disposal options	Combined			
8	Well decommissioning	Combined			
9	Drill cuttings	Combined			
10	Environmental impact assessment	Combined			
11	Interested party consultations	Combined			
12	Costs	Combined			
13	Schedule	Combined			
14	Project management and verification	Combined			
15	Debris clearance	Combined			
16	Pre- and Post- decommissioning monitoring and maintenance	Combined			
17	Supporting Studies	Combined			
Appendix A - Section 29 Notice Holders' confirmation of support		Combined			

1.6 Facilities to be Decommissioned

As described in Section 1.3, some items have already been removed from the Ivanhoe and Rob Roy fields. The infrastructure which remains on the seabed and requires decommissioning is shown in Figure 1.1 and comprises:

- Three manifold structures, including the Riser Base Manifold (RBM) and the Ivanhoe and Rob Roy production manifolds (IVPM and RRPM respectively)
- Surface laid pipelines and umbilicals
- The buried oil and gas export pipelines
- Currently suspended IVRR wells and associated structures

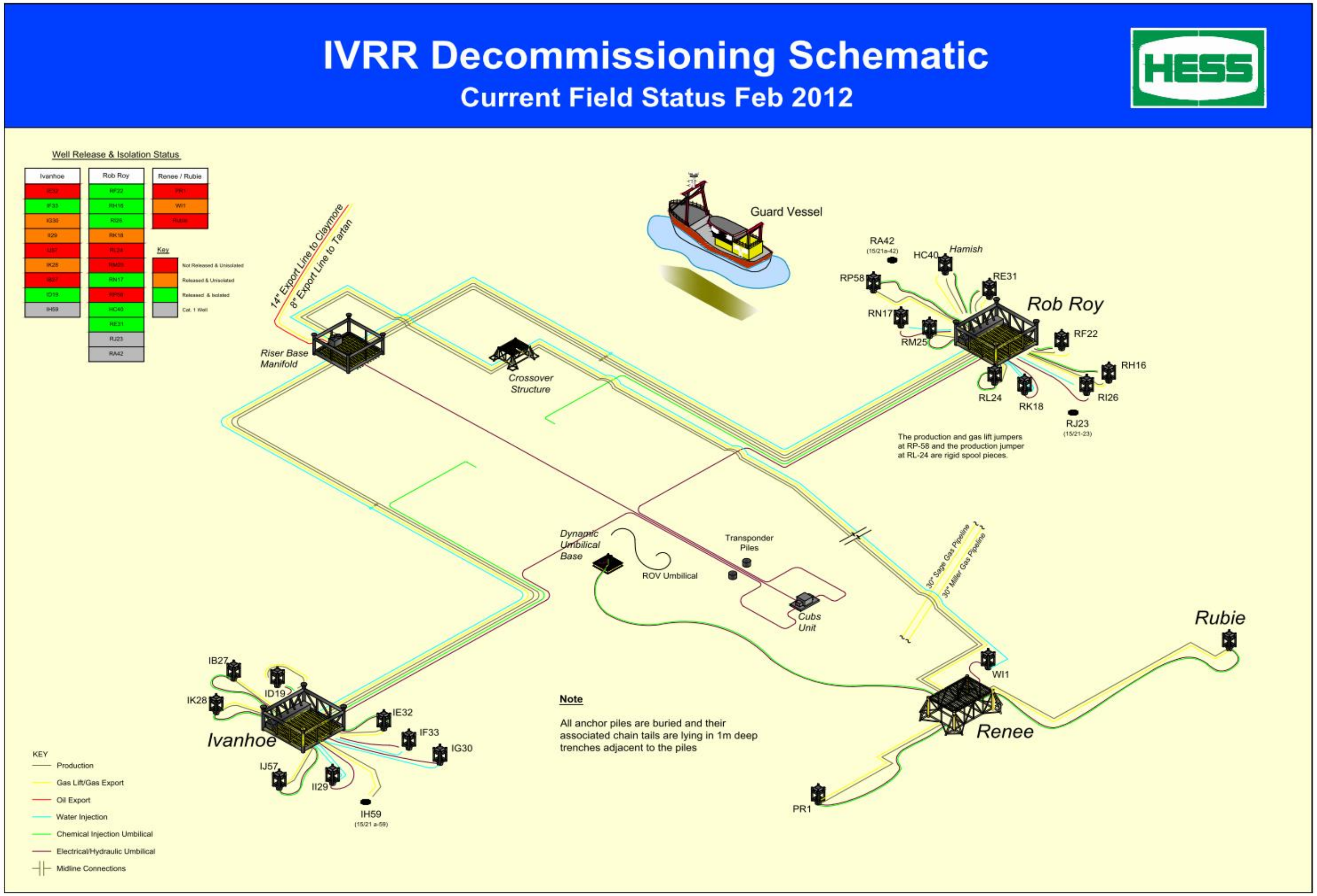

Figure 1.1: Remaining IVRR Infrastructure Which Requires Decommissioning (including R-Block Facilities, subject of a separate document)

2 EXECUTIVE SUMMARY

2.1 Status of the Development and the need for Decommissioning

The Ivanhoe and Rob Roy (including Hamish) development is located in Block 15/21 of the Central North Sea, approximately 193 km from the UK coast. Hess and co-venturers Endeavour have determined that there are no viable alternative uses for the IVRR facilities and have concluded that the fields should be decommissioned. These Decommissioning Programmes have therefore been prepared in accordance with the requirements of the Petroleum Act 1998 and the DECC Guidance Notes (version 6). The assessments and recommendations in this document are supported by an Environmental Statement and other technical studies.

2.2 Proposed Decommissioning Programmes

Full decommissioning of the IVRR facilities will involve the removal or making safe of the remaining subsea infrastructure which comprises pipelines, umbilicals, wells, the production manifolds and other subsea structures. The options for the decommissioning of the pipelines and umbilicals were the subject of a Comparative Assessment study, as required under the Petroleum Act 1998. This study evaluated the performance of the options under criteria such as technical feasibility, risk to personnel and the others users of the area, economics and environmental impact. The performance of the options were scored and ranked to identify the recommended decommissioning solution for the pipelines and umbilicals.

All pipelines and umbilicals lying on the seabed will be removed and taken to shore for recycling or disposal, as appropriate. The only buried pipelines in the development are the oil and gas export pipelines which exported the production to the Talisman operated Claymore A and Tartan A platforms respectively. The end sections of these pipelines, which are not buried, will be cut at the trench transitions and removed. The cut ends will be buried to a minimum depth of 0.6 m below the seabed surface using a water-jet.

The production manifolds and other structures will be removed and returned to shore for recycling or disposal. Where structures have been piled, the piles will be cut at least 0.6 m below the seabed to allow removal of the structures. The piles of the FPF mooring system were driven into the seabed so that the tops of piles were 10 m below the seabed surface. These piles will remain *in-situ*.

The IVRR wells will be plugged and abandoned in accordance with the Oil and Gas UK Guidelines for the Suspension and Decommissioning of Wells. The casing strings will be cut at least 10 ft (3 m) below the seabed and the casings and xmas trees will be removed to shore for reuse and recycling. Well decommissioning will be completed under the appropriate permits.

As the drill cuttings from the IVRR drilling activities do not exceed the OSPAR 2006/5 thresholds for oil loss or persistence, they will be left on the seabed to degrade naturally.

2.3 Environmental Sensitivities

The IVRR development is located in an area in which pockmarks may occur. The area has not been the subject of a habitats assessment survey but pockmarks have been identified in the IVRR area and pipelines have been installed so as to avoid these features. The seabed consists of coarse to medium silts which support benthic communities dominated by polychaete worms and molluscs.

There are no designated offshore conservation sites near the IVRR development. The closest offshore Special Area of Conservation (SAC) is the Scanner pockmark (candidate SAC), approximately 50 km to the north-east of the development. The nearest UK statutory and non-statutory coastal conservation sites are some 130 km from the development.

Seabirds recorded in the area include fulmar, gannet, kittiwake, guillemot, razorbill and puffin. Other species which may occur in the area include the herring gull, common gull and greater black-backed gull. Seabird densities are generally low and the vulnerability of seabirds to oil pollution is low to moderate in spring, high from July to October and very high in November.

Mammals recorded in and around the IVRR area include minke and killer whales, white-beaked and Atlantic white-sided dolphins and harbour porpoise. These species are present in the North Sea throughout the year, but sightings generally peak in the summer months.

The IVRR fields lie within spawning grounds for a number of commercial and non-commercial species, including Norway pout, cod and, in particular, *Nephrops*. The fields also lie within or near nursery areas for monkfish, blue whiting, cod, European hake, ling, mackerel, sandeel, spurdog, whiting, Norway pout, sprat and *Nephrops*. Fishing effort in the area is classed as relatively low when compared with other areas of the North Sea. Catches are dominated by *Nephrops*, followed by other demersal species such as haddock and finally the pelagic species - herring with a small proportion of mackerel.

The closest operating platform is approximately 6 km away. The closest subsea pipeline is the pipeline connecting the IVRR fields with the Renee and Rubie fields (R-Block) which is also due to be decommissioned. The nearest operational subsea cable is more than 40 km to the south.

2.4 Environmental Impact of Decommissioning

A number of potentially significant impacts were identified in the environmental impact assessment. On further assessment, with the assumption that established and proven industry controls would be applied to manage these impacts, the majority were assessed as being of low potential impact. In most cases, the effects will be localised and there is a good prospect of full recovery over time.

The most likely environmental impact will be disturbance to the seabed caused by such activities as the removal of pipelines and structures, the placement of rig anchors during well decommissioning, and water jetting operations to bury cut pipeline ends. These impacts will be highly localised and temporary in nature with strong potential for recovery. The removal of the surface subsea infrastructure by these operations will allow the seabed habitat to recover fully from oil and gas production activities and allow fishing to resume in the area.

In terms of unplanned events, the only potentially significant impact identified was a large oil spill caused by a loss of well control during the well abandonment operations. However, the probability of such a spill is very low, and Hess will have mitigation and management procedures in place to prevent this from happening, as well as adequate resources to deal with any such spill should it occur.

Overall, it is concluded that the proposed IVRR development decommissioning operations will not cause any significant environmental effects.

2.5 Long-term Environmental Impacts

The proposed decommissioning of the IVRR development will result in the removal of all structures lying on the seabed. The sections of pipelines that are to be left *in-situ* are already buried and the surface sections will be removed and the cut ends will be buried to a minimum depth of 0.6 m. Any piles that will remain *in-situ* will either be cut at least 0.6 m below the seabed or have already been driven to a depth of 10 m. All of the techniques and procedures that would be employed are routinely used in oil and gas development or decommissioning projects.

The long-term presence of buried items is unlikely to cause any impact to other users of the sea (eg fishermen) due to the depth of burial and the low level of trawling activity in the area. The post-decommissioning monitoring programme that will be agreed with DECC will allow any required remedial action to be identified and implemented in a timely manner.

2.6 Estimated Schedule and Cost

It is intended that the main decommissioning activities will be performed during 2013 - 2016. The cost of the decommissioning project will be influenced by a number of factors, eg market rates of vessels and equipment, and the engineering studies required prior to the work commencing.

The entire decommissioning programme will be managed by Hess. All measures to minimise and mitigate environmental impact, as described in the environmental impact section, will be delivered by the project through the Decommissioning Project Environmental, Health and Safety (EHS) Plan which will implement the requirements of the Hess Environmental Management System (EMS) for this specific project.

2.7 Monitoring and Maintenance of Remains

Discussions have yet to take place on the post-decommissioning survey requirements for the IVRR development. It is likely that as-left surveys will be completed at each stage of work and reported to DECC. Monitoring of the buried items will then take place following decommissioning of the development, taking into account the local oceanographic conditions and potential for buried items to become exposed.

3 BACKGROUND INFORMATION

3.1 Current IVRR Facilities

The IVRR fields are located in Block 15/21a of the Central North Sea. The Hamish field, which is a single well and is part of the Rob Roy wellhead cluster, is located in Block 15/21b. The Ivanhoe and Rob Roy fields are approximately two miles apart and production was achieved through the Floating Production Facility *AH001* which was anchored centrally between the two fields.

Following suspension of the fields in 2008 (Phase 1) and subsequent decommissioning preparatory work in 2011 (Phase 2), the items which remain in-field and require decommissioning include the three manifold structures (RBM, IVPM and RRPM), the IVRR wells, the in-field pipelines and umbilicals and the buried oil and gas export pipelines (Section 1.6). Detailed descriptions of the facilities in the Ivanhoe and Rob Roy fields are presented in Section 4.

A detailed description of the environmental conditions at the IVRR development is given in the environmental statement for the decommissioning of the IVRR fields (ADP-005).

3.2 Metocean Data

Winds in the IVRR area are most frequently from the northwest in the summer and can reach up to 21 knots. In the autumn and winter, stronger westerly and south-westerly winds, reaching over 34 knots, dominate (Fugro ERT, 2012).

Average sea surface temperatures range from 14.5°C in the summer, dropping to 7°C in winter. At the seabed, temperatures are steadier and remain at around 7°C throughout the year. As a result, a thermocline may develop in the summer months, usually at a depth of between 50 m and 60 m, stratifying the water column (Fugro ERT, 2012).

Water movement in the IVRR area is generally in an easterly direction; currents in the area are relatively weak and are largely wind-driven (Fugro ERT, 2012).

3.3 Seabed

The surface seabed sediments of the IVRR area have been characterised from the pre-decommissioning survey conducted in 2010 and consist of coarse to medium silts (Fugro ERT, 2011). The seabed across the development is essentially flat and water depths range from 113 m to 149 m. The IVRR development lies within a wider area of seabed - the Witch Ground Basin - known to contain pockmarks (Johnson *et al*,1993), and several pockmarks have been found within Block 15/21 and nearby blocks. Some pockmarks may contain methane derived authigenic carbonate (MDAC). MDAC can provide a habitat for a range of marine organisms and may qualify as a Special Area of Conservation (SAC) under the Habitats Directive. No site-specific habitat surveys have been conducted at the IVRR fields to confirm the location of pockmarks of conservation importance but subsea pipelines have been routed to avoid possible pockmarks.

During the drilling of the twelve wells at Ivanhoe and the thirteen wells at Rob Roy (including Hamish), drill cuttings were discharged to the seabed under permit. Of the twelve Ivanhoe wells, eight were drilled with oil based mud (OBM) drilling fluids. Of the thirteen Rob Roy wells, six were drilled with OBM (ERT, 2009a). Consequently, the Ivanhoe and Rob Roy fields required the Stage 1 screening assessment under OSPAR Recommendation 2006/5. For the purposes of this screening, values for the total volumes and physical sizes of the cuttings accumulations were derived using data on the original volumes discharged, and the levels of THC and metals in the sediments surrounding the wells. The Stage 1 assessment determined that nine wells at Ivanhoe and nine wells at Rob Roy were drilled in close proximity and would therefore represent the largest accumulations of discharged drill cuttings. Though not all these wells used OBM, the volumes of cuttings from these wells were included to estimate the total volume of drill cuttings that could be classified as an “Organic Phase Mud pile”. It was calculated that approximately 6,444 m^3 of OBM cuttings were discharged at both Ivanhoe and Rob Roy (a total of 12,888 m^3) with an estimated cuttings area of 2,194 m^2 at each of the sites. The assessment of the IVRR drill cuttings concluded that they are unlikely to exceed the thresholds for oil loss rate and persistence established by OSPAR Recommendation 2006/5 (ERT, 2009a).

Bathymetric surveys conducted in 2009 using multi-beam equipment identified drill cuttings accumulations approximately 1 m high near the wells. These accumulations were restricted to within an approximate radius of 5 m from the wellheads. No further surveys or mapping of the drill cuttings has been undertaken at either Ivanhoe or Rob Roy.

The pre-decommissioning survey of the IVRR development found total hydrocarbon (THC) and polycyclic aromatic hydrocarbon (PAH) concentrations above the background levels in the vicinity of the Ivanhoe and Rob Roy drilling sites, with a maximum THC level of 262 µg/g (dry weight) found within 250 m of the Rob Roy wellheads. These elevated levels are present up to 500 m from the IVRR wellheads. The THCs in the area have decreased since earlier surveys were conducted, which may be the result of natural weathering or dissipation of the hydrocarbons, particularly as no new wells have been drilled at Ivanhoe since 2003 and at Rob Roy since 2001. Metal concentrations decrease with increasing distance from the IVRR drill sites. There has also been a general decrease in these levels since earlier seabed sampling surveys (Fugro ERT, 2012).

3.4 Biological Environment

3.4.1 Plankton

The plankton community in the waters around the IVRR fields is characteristic of that found over a wide area of the Central North Sea (Fugro ERT, 2012).

3.4.2 Benthos

The benthic communities of the IVRR development are categorised as belonging to the biotope SS.SMu.OMu.LevHet of deep offshore mud and sandy mud. The pre-decommissioning survey found that the polychaete *Paramohinome jeffreysii* and mollusc *Parvicardium minimum* were abundant at both Ivanhoe and Rob Roy, with *P. minimum* dominating at stations closest to the wells, most notably at Rob Roy.

The pre-decommissioning survey also showed that the number of the taxa in the IVRR area was relatively low with a moderate to high degree of similarity across both survey areas. In general, the communities of stations at and within 500 m from the wells were distinct from the other stations. The presence of scavenger and carnivore species, some of which are known to be associated with areas of high PAH levels, was established at both survey areas and may indicate that the difference in the communities may be a result of the discharge of hydrocarbon-based drilling fluids (Fugro ERT, 2012).

3.4.3 Fish and Shellfish

The IVRR area contains fish stocks of both commercial and non-commercial importance. Demersal fish species include haddock, whiting and monkfish, with smaller numbers of cod, saithe and flatfish, lemon sole and plaice. The main pelagic species present is herring with small numbers of mackerel. The IVRR area lies within the Fladen ground which is dominated by muddy sediments which support high densities of commercially important crustaceans, eg *Nephrops* (Fugro ERT, 2012).

3.4.4 Seabirds

Seabird densities in the IVRR area are generally low, though numbers may increase in the post-breeding periods. The abundant bird species in and around the IVRR area are fulmar, gannet, kittiwake, guillemot, razorbill and puffin. In the IVRR area, the vulnerability of seabirds to oil pollution is regarded as low to moderate during spring, high from July onwards and very high in November (Fugro ERT, 2012).

3.4.5 Marine Mammals

Several species of whale, dolphin and porpoise have been recorded in the Central North Sea including minke whales, killer whales, white-beaked dolphins, Atlantic white-sided dolphins and harbour porpoises, all of which have been sighted in or around the IVRR area. These species have been observed in the IVRR area in low numbers, with the exception of white-beaked dolphins (moderate numbers in September and November) and harbour porpoise (moderate numbers in February and high numbers in July), (Fugro ERT, 2012).

3.5 Conservation Interests

The IVRR development is within an area where pockmarks may occur, but no formal habitats survey has been carried out in the area to determine if pockmarks of conservation importance are present. No SACs for pockmarks, sea caves, reefs or sandbanks have been identified; the Scanner and Braemar pockmarks which are candidate SACs are located approximately 50 km and 115 km respectively from the IVRR fields. No evidence of the cold water reef-forming coral *Lophelia pertusa* or the reef-forming Ross worm *Sabellaria spinulosa* has been found. The nearest UK coast and areas of conservation importance for seabirds and coastal environments are over 130 km from the IVRR development.

3.6 Fishing, Shipping and other Commercial Activities

After the FPF *AH001* left the field, Hess applied for and was granted a subsea safety zone named ‘IVRR Centre’, centred on the former location of the FPF. The subsea safety zones around the Ivanhoe, Rob Roy and Hamish wells will remain in place until the fields are fully decommissioned.

3.6.1 Fishing Activities

The IVRR fields lie in ICES statistical rectangle 45F0 and adjacent to 45E9. Data for catches landed from the area between 2008 and 2010 show that landings were dominated by shellfish, specifically *Nephrops*. The demersal fishery is dominated by haddock. Pelagic fishery activity in the area is low and is dominated by herring catches, with only a small amount of mackerel.

Fishing effort around the IVRR fields is classed as relatively low compared with other areas in the North Sea. Coull *et al*., (1998) rated fishing effort in this rectangle as low for demersal and pelagic gears and very high for *Nephrops* gears.

3.6.2 Shipping

There are 24 routes within ten nautical miles of the location of the IVRR fields, with an estimated 1,573 vessels per annum (approximately four vessels per day). The majority of these are offshore support vessels (74%) and cargo ships (18%) in the 1,500 to 5,000 Deadweight Tonnage (DWT) range. 13 of the 24 routes identified are used by oil and gas supply vessels travelling between the Scottish coast and offshore installations close to the IVRR development. The closest route to the Ivanhoe field is 2 nm to the south-west and is used by an estimated 18 vessels per year. The closest route to Rob Roy is 2.5 nm to the north-east of the field and is used by an estimated 20 vessels per year. Overall, shipping activity within the IVRR area is classed as 'low' (Fugro ERT, 2012).

3.6.3 Oil and Gas Developments

The closest operating field is the Telford field, approximately 6 km to the north-east in Block 15/22. The Scott JU and JD platforms are also to the north-east of the development, approximately 12 km away.

3.6.4 Cables, Pipelines and Seabed Obstructions

The nearest operational cable in the vicinity of IVRR, the BT-owned CNS Fibre Optic, is more than 40 km to the south. The main subsea pipeline in the area is that which runs between IVRR and the Renee and Rubie fields, which is also operated by Hess and is also due to be decommissioned. The SAGE to St. Fergus and Miller to St. Fergus gas pipelines, Tweedsmuir to Piper pipeline and the Scott to Forties pipeline are all situated near the IVRR development.

Two marked wreck sites have been identified to the north-west and south-east of the IVRR fields, both approximately 5 km away.

3.6.5 Military Activity

Aircraft, ships and submarines from several countries use the North Sea as a training ground and for routine operations; the distribution and frequency of these operations is unknown. There are no practise and exercise areas (PEXA) within the vicinity of the IVRR fields: the closest such area is approximately 120 km from the IVRR development.

4 FACILITIES TO BE DECOMMISSIONED

4.1 The Ivanhoe Field

Five wells produced fluids from the Ivanhoe reservoir. Fluids were transported through five flexible production jumpers which connect at the Ivanhoe Production manifold (IVPM) to an 8" flexible pipeline, PL547. Fluids were transported through this pipeline to the riser base manifold (RBM) and on to the *AH001* through an 8" flexible riser. Ivanhoe well IH59 was never completed, but a flexible production jumper for it is connected to the IVPM.

Figure 4.1 shows the layout of the Ivanhoe infrastructure during the production life of the field.

The following items require decommissioning:

- Ivanhoe Decommissioning Programme, DP1:
  - Subsea Structures (Section 4.2.1)
  - Mattresses and Grout Bags (Section 4.2.2)
  - Wells (Section 4.2.3)
  - Pipeline Structures (Section 4.2.4)
- Ivanhoe Decommissioning Programme, DP2
  - Production Flowlines and Jumpers (Section 4.3.1)
  - Gas Lift Flowlines (Section 4.3.2)
  - Water Injection Flowlines (Section 4.3.3)
  - Umbilicals (Section 4.3.4)
  - Export Pipelines (Section 4.3.5)

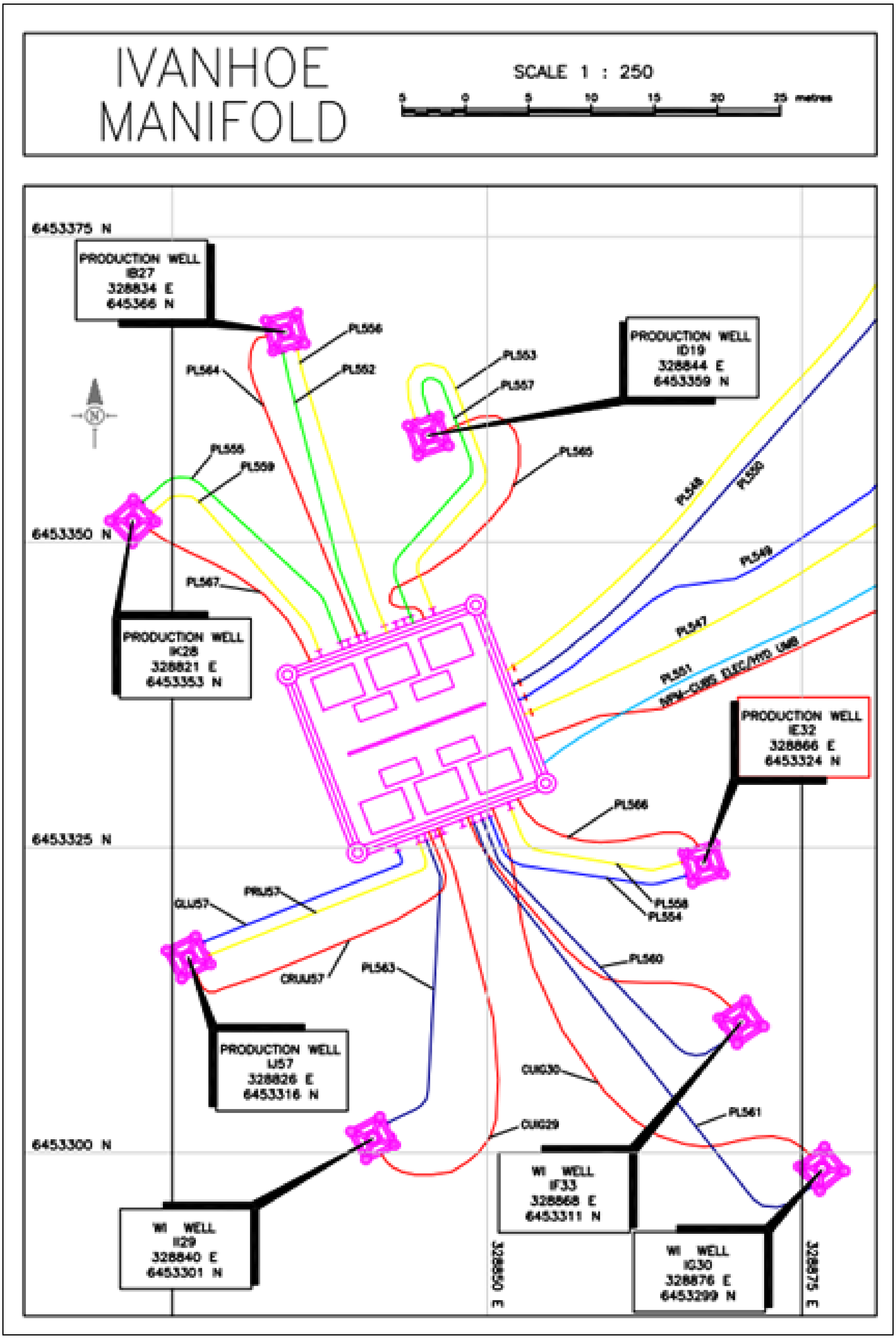

Figure 4.1: The Infrastructure Around the Ivanhoe Well Centre

4.2 Items to be Decommissioned under Ivanhoe Decommissioning Programme, DP1

4.2.1 Subsea Structures

4.2.1.1 Ivanhoe Production Manifold (IVPM)

The Ivanhoe production manifold (IVPM) collected the produced fluids from the Ivanhoe wells and distributed the injection water and lift gas provided by *AH001* to the wells. The IVPM is a rectangular structure made of tubular steel, 16 m long, 15.6 m wide and 8 m high, weighing 359 tonnes. The structure is secured to the seabed by four steel piles each 0.76 m in diameter and 38 m long. The IVPM ties back to the RBM structure through two production pipelines (PL547, PL548) and is further connected by PL550 (injection water) and PL549 (lift gas) flowlines.

The manifold was remotely controlled via retrievable electro-hydraulic control modules mounted on the structure and was connected to the wells via flexible flowlines and control umbilicals. Flexible jumpers connect the headers, through individual production valve modules on the IVPM to the production trees. Jumpers for a well that was never completed (IH59) are also present. Chemical injection cores run from the umbilical termination bulkhead plate on the manifold to the production wellheads and production and test headers. Water injection jumpers, 4” in diameter, connect the water injection wellheads to the water injection header via water injection valve modules on the manifold. Wells IF33 and IG30 are supplied by single jumpers (PL560 and PL561 respectively) and II29 by dual jumpers PL562 and PL563. A 500 m radius safety zone is established around the IVPM.

4.2.1.2 Riser Base Manifold (RBM)

The riser base manifold (RBM) (Figure 4.2) is located 253 m to the north-west of the previous *AH001* location. It is a rectangular, tubular steel structure 14 m long, 13.3 m wide and 6.6 m high, secured to the seabed by four steel piles 36.9 m long and 0.76 m in diameter. A 500 m safety zone is established around the structure.

The RBM served as a distribution point for the infield flowlines, export pipelines and flexible risers (Figure 4.3). A total of 8 risers, 15 pipelines and 1 control umbilical connected to the RBM. All injection water and lift gas was routed through the RBM, along with production from IVRR and R-Block as well as the gas and oil export lines. Control was provided through an electro-hydraulic SCM within the RBM. Piping on the RBM was designed so that Rob Roy fluids could be transported to *AH001* through a dedicated 8” riser, or commingled with Ivanhoe production fluids and transported through the Ivanhoe 8” flowline and flexible riser (PL547).

To minimise the number of dynamic riser connections to *AH001*, the thirteen infield flowlines from IVRR and R-Block were reduced to six lines in the RBM. This was achieved by manifolding the service lines (water injection, gas lift and test). The four additional tie-ins are linked to each riser, and the associated pipework and valves provide a means of crossing between the production flowlines and production risers. Each line includes hydraulically operated valves to control the distribution of the fluids. The 14" oil export pipeline is routed through the RBM. In addition to the emergency shut-down valve (ESDV) on the *AH001* topsides, the 14" oil export line to Tartan includes an actuated ESDV and a downstream manually operated valve.

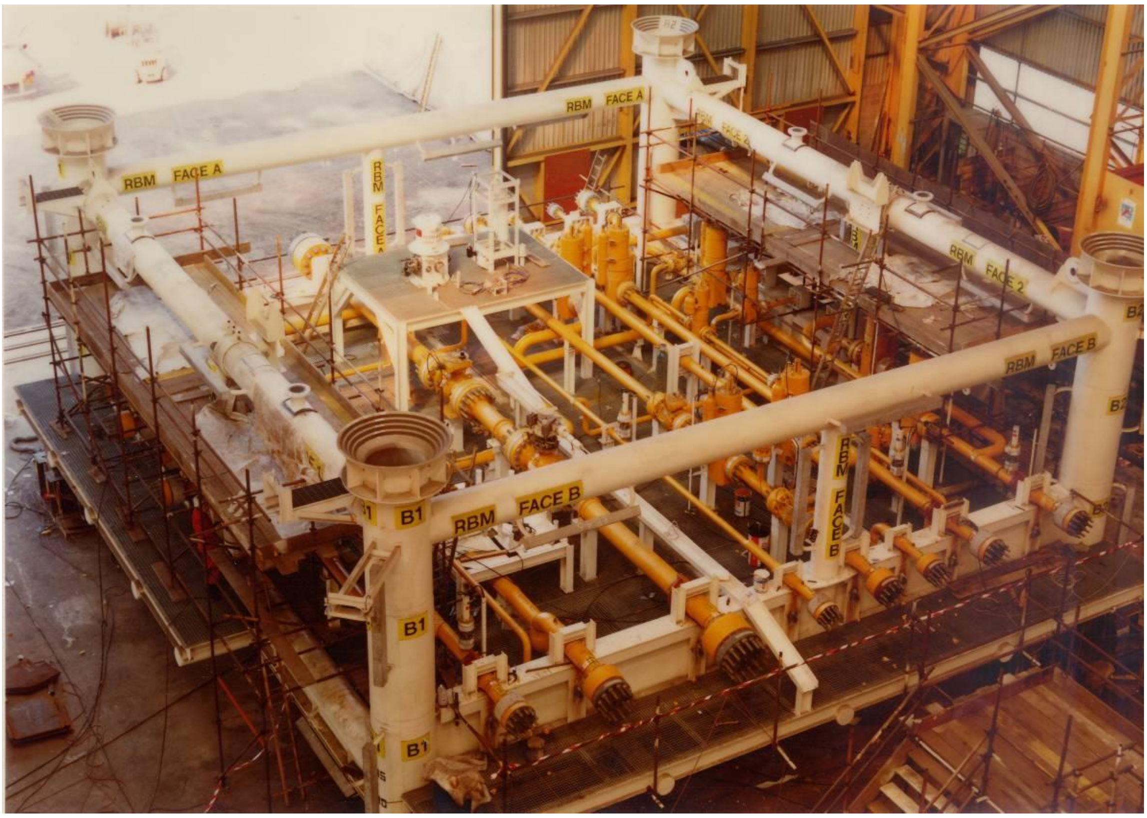

Figure 4.2: Riser Base Manifold (RBM)

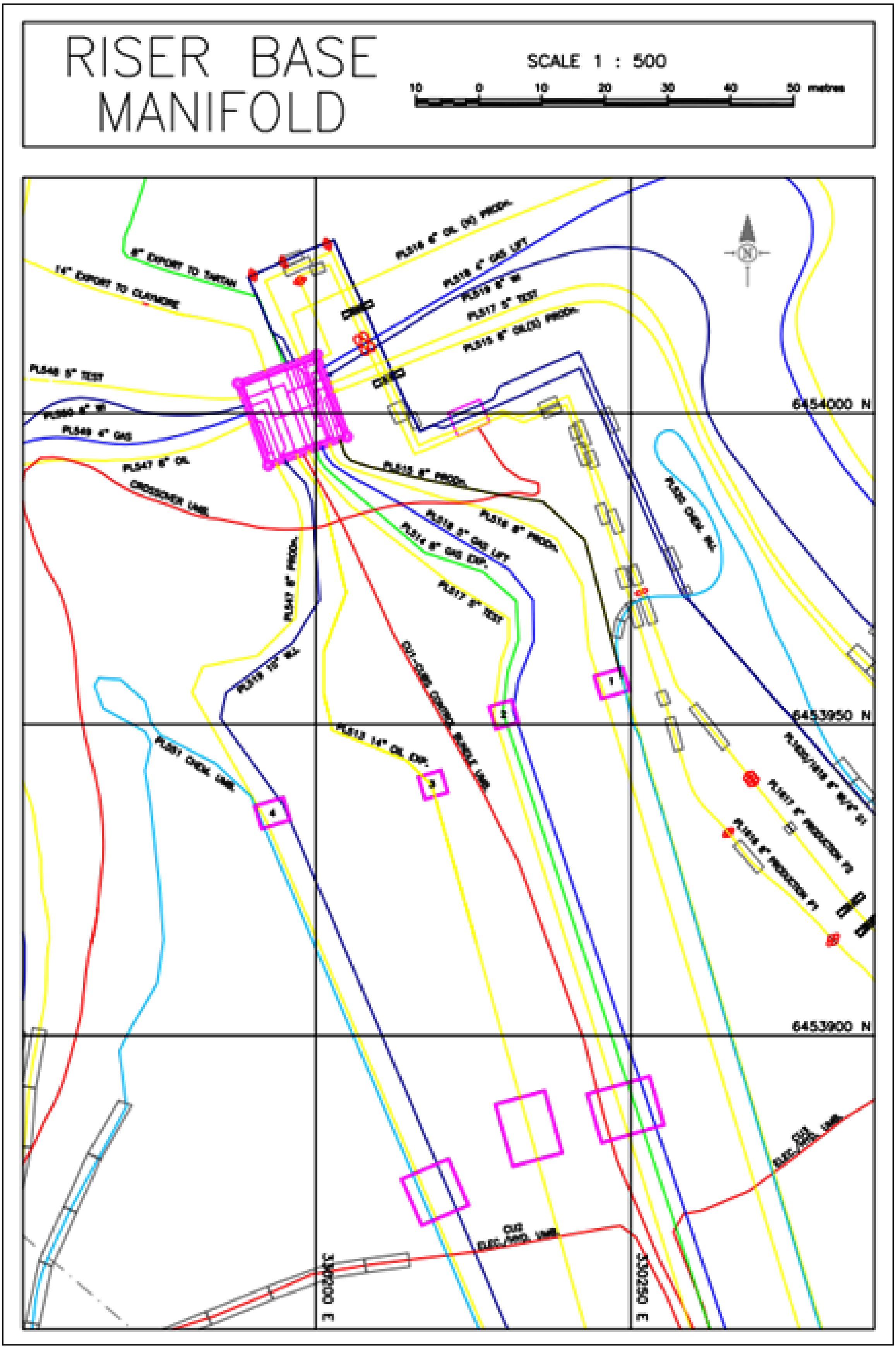

Figure 4.3: RBM Layout

4.2.1.3 Control Umbilical Base Structure (CUBS)

The dynamic section of the control umbilical was shared by Ivanhoe and Rob Roy (PL551). This section was deployed in a steep wave configuration, terminating at the seabed at the control umbilical base structure (CUBS). Three static umbilicals then connect to the RBM, IVPM and RRPM. The CUBS is a steel frame, 7 m by 4 m and 1.2 m high. The frame incorporates the subsea umbilical termination box (SUTB) and the static umbilical termination (SUT) for the IVPM and RRPM. The umbilical for the RBM also terminates at this structure.

4.2.2 Mattresses and Grout Bags

There are 84 Armorflex mattresses associated with the Ivanhoe and *AH001* infrastructure: nine mattresses protect each of the surface flowlines PL547 (production), PL548 (test), PL549 (gas lift) and ten cover PL550 (water injection) between the RBM and IVPM. 18 mattresses protect the static section of the control umbilical between CUBS and IVPM and nine are associated with the static section of PL551, the chemical injection umbilical between the RSD and IVPM. Finally, 20 mattresses protect the CUBS to RBM control umbilical section that passes under the previous location of the *AH001*. The location and number of grout bags which may have been used to stabilise subsea infrastructure is currently unknown. If any grout bags are identified during recovery of the structures, they will also be collected and returned to shore.

4.2.3 Wells

The subsea wells are arranged around the IVPM structure. Five production wells and three water injection wells connect to the IVPM.

4.2.4 Pipeline Structures

The oil (PL513) and gas (PL514) export pipelines include midline T and emergency shut-down valves (ESDVs). The PL513 ESDV is located on a skid and protected by a steel structure; the PL514 ESDV is housed in a combined skid and protection structure. These structures have been listed separately from the pipelines in the inventory.

Figure 4.4: Example of Ivanhoe, Rob Roy and Hamish Xmas Tree

4.3 Items to be Decommissioned under Ivanhoe Decommissioning Programme, DP2

Table 4.1 (overleaf) gives details of the pipelines associated with the Ivanhoe Field as listed in the Section 29 Notice. All static sections of the Ivanhoe pipelines were laid on the surface of the seabed; one umbilical was also protected with rock-dump.

Table 4.1: Ivanhoe Pipelines and Descriptions

Pipeline Number	Pipeline Type	Location	Surface/Buried
PL513	Oil production	RBM to Claymore	Buried
PL514	Gas production	RBM to Tartan	Buried
PL547	Produced fluids	IVPM to RBM	Surface
PL547(J)IH59	Produced fluids	Well IH59 (not completed) to IVPM	Surface
PL548	Test fluids	IVPM to RBM	Surface
PL549	Lift gas	RBM to IVPM	Surface
PL549(J)IH59	Lift gas	IVPM to IH59 (not completed)	Surface
PL550	Injection water	RBM to IVPM	Surface
PL551	CI Umbilical	*AH001* to RSD	Dynamic
PL551	CI Umbilical	RSD to IVPM	Surface
PL552	Produced fluids	Production well IB27 to IVPM	Surface
PL553	Produced fluids	Production well ID19 to IVPM	Surface
PL554	Produced fluids	Production well IE32 to IVPM	Surface
PL555	Produced fluids	Production well IK28 to IVPM	Surface
PL556	Lift gas	IVPM to production well IB27	Surface
PL557	Lift gas	IVPM to production well ID19	Surface
PL558	Lift gas	IVPM to production well IE32	Surface
PL559	Lift gas	IVPM to production well IK28	Surface
PL560	Injection water	IVPM to injection well IF33	Surface
PL561	Injection water	IVPM to injection well IG30	Surface
PL562	Injection water	IVPM to injection well II29	Surface
PL563	Injection water	IVPM to injection well II29	Surface
-	Control umbilical	*AH001* to CUBS	Dynamic
-	Control umbilical	CUBS to RBM	Surface*
-	Control umbilical	CUBS to IVPM	Surface
PL564	Control umbilical	IVPM to production well IB27	Surface
PL565	Control umbilical	IVPM to production well ID19	Surface
PL566	Control umbilical	IVPM to production well IE32	Surface
PL567	Control umbilical	IVPM to production well IK28	Surface
-	Control umbilical	IVPM to IJ57, II29, IG30, IF33	Surface
PL1769	Produced fluids	Production well IJ57 to IVPM	Surface
PL1770	Lift gas	IVPM to production well IJ57	Surface

* Protected by rock dump

Shaded: removed in 2011 (ADP-009).

4.3.1 Production Flowlines and Jumpers

Produced fluids from the five Ivanhoe production wells were transported through flexible production jumpers from the wells to the IVPM (Figure 4.1). Fluids from all five wells were then transported from the IVPM to the RBM through a single 8” flexible production pipeline (PL547, Figure 4.3) and from the RBM to *AH001* through an 8” flexible riser (PL547), supported by a mid-water-arch (MWA).

The IVPM also has a test header which is connected by flexible jumper lines to the wellheads and by a 5” flexible pipeline (PL548) to the RBM. Test fluids were then transported to the *AH001* test manifold via a 5” flexible riser (PL517).

4.3.2 Gas Lift Flowlines

In order to provide gas lift support to production wells, treated gas was taken from a tee-section of the *AH001* gas import/export pipeline and transported to the RBM through a 5” flexible riser (PL518). From the RBM, a 4” flexible flowline (PL549) transported the gas to the IVPM where 2” flexible jumpers then distributed the gas to the production wellheads.

4.3.3 Water Injection Flowlines

Treated, de-aerated water was provided for injection from *AH001* to the RBM via a 10” flexible riser (PL519). From the RBM, an 8” flexible flowline (PL550) transported the water to the IVPM, where separate 4” jumpers then supplied the water injection wellheads.

4.3.4 Umbilicals

Two types of umbilical - chemical injection and control (electrical/hydraulic) - were used at IVRR. Each umbilical consisted of a static and dynamic section.

4.3.4.1 Chemical Injection (CI) Umbilical

The chemical injection umbilicals supplied various chemicals to the wells, as needed. The chemicals used included methanol, scale inhibitor, biocide and oxygen scavenger. Chemicals were routed from the chemical package on *AH001* through the dynamic and static sections of the CI umbilical (PL551) to the IVPM and through dynamic and statics sections of PL520 to the RRPM.

PL551 (Ivanhoe)

The umbilical consists of ten cores. The dynamic section of the umbilical was clamped to the 8" flexible production riser PL547, passing over a MWA and terminating at one of the RSDs, where the ten hoses split out and connect to the static section of the umbilical through a bulkhead plate. The dynamic section of PL551 was removed in 2011. The static section of PL551 then runs to a similar bulkhead plate at IVPM. At the IVPM bulkhead plate, the individual cores are again split out and connect to single core bulkhead connectors at the base of each production control module and on to the chemical injection points on the manifold. From here, the cores run to the production trees fastened to the control umbilical bundles, terminating at a stab plate mounted on the individual trees. No chemical injection was required for the water injection trees.

4.3.4.2 Control Umbilical

The control umbilical for both Ivanhoe and Rob Roy had both dynamic and static sections: The umbilical ran from near the hydraulic power unit onboard the *AH001* through a vertical caisson and was deployed in a steep wave configuration terminating at the seabed Control Umbilical Base Structure (CUBS). The Ivanhoe and Rob Roy fields shared this 225 m dynamic section of the umbilical which was removed in 2011. From the CUBS, three static umbilicals run on the seabed to the RBM, IVPM and RRPM. Note that control umbilicals and jumpers do not have PL numbers associated with them in the IVRR field. Sections of the umbilicals, particularly in the vicinity of the previous *AH001* location, are protected from dropped objects by rock dump.

Ivanhoe Control Umbilical

At the IVPM, the static umbilical terminated at an Electro-Hydraulic Distribution Box (EHDB), which configured the electrical supply, communications and hydraulic supply through utility jumpers to the SCMs.

4.3.5 Export Pipelines

Both the oil and gas export pipelines were installed in a trench approximately 1 m deep and left to naturally back-fill. During suspension operations they were cleaned to ensure the residual hydrocarbon levels were <30 mg/L before they were disconnected from the Tartan and Claymore infrastructure.

4.3.5.1 14" Oil Export Pipeline

Crude oil, containing natural gas liquid, was exported from *AH001* to the Claymore A platform through a 14", 40 km long pipeline, PL513. At Claymore A, the oil was commingled with Claymore A and Tartan A fluids and transported through a 30", 180 km pipeline to the Flotta terminal, Orkney (Figure 4.5).

The rigid riser PL513 connected the *AH001* to the subsea riser release connector (RRC) at the top of a 12" flexible riser and included the ESDV. The flexible riser ran from the RRC and attached to the RBM through flanges. From here, the 14" steel pipeline continues to the Claymore A platform and includes a 10" midline tee connection and a subsea hydraulically operated, fail-close ESD valve situated 150 m from the platform with manually operated ball valves either side of the ESD. The pipeline connected to the Claymore A topsides through a 14" rigid steel riser.

As part of field suspension operations, this line was pigged clean, flushed with inhibited seawater, depressurised, disconnected from the Claymore infrastructure and fitted with blind flanges in May 2009.

4.3.5.2 8" Gas Export Pipeline

Gas was exported to the Tartan A platform through an 8", 22 km long pipeline, PL514. From Tartan A, the gas was commingled with Tartan A export gas and transported through an 18", 71 km long pipeline to the Frigg pipeline system and onward to the St. Fergus terminal (Figure 4.6).

As with the oil export pipeline, gas was exported from *AH001* through a rigid riser (8") to the RRC at the top of the 8" flexible riser. This section contained the ESDV. The flexible riser then connected to the RBM and from here, the 8" steel pipeline, which includes an 8" midline tee connection, approaches the Tartan A platform from the east (Figure 4.6). 170 m from the platform, a gas skid structure houses the subsea hydraulic fail-safe close ESD valve and the two manually operated valves either side of the ESD. The gas was then transported through an 8" seabed flexible spoolpiece and riser and 8" rigid riser to the topside pipework.

During the field suspension activities, the gas export line was depressurised and purged with nitrogen in May 2009. The line was then flooded with inhibited seawater, disconnected at the gas skid and fitted with blind flanges.

Depth-of-burial surveys have been completed for the two export lines which indicate a level of cover of approximately 1 m, varying slightly along the length of the buried sections. A survey is currently underway to confirm the current depth of burial of the buried sections of the gas and oil export pipelines which are to remain *in-situ*.

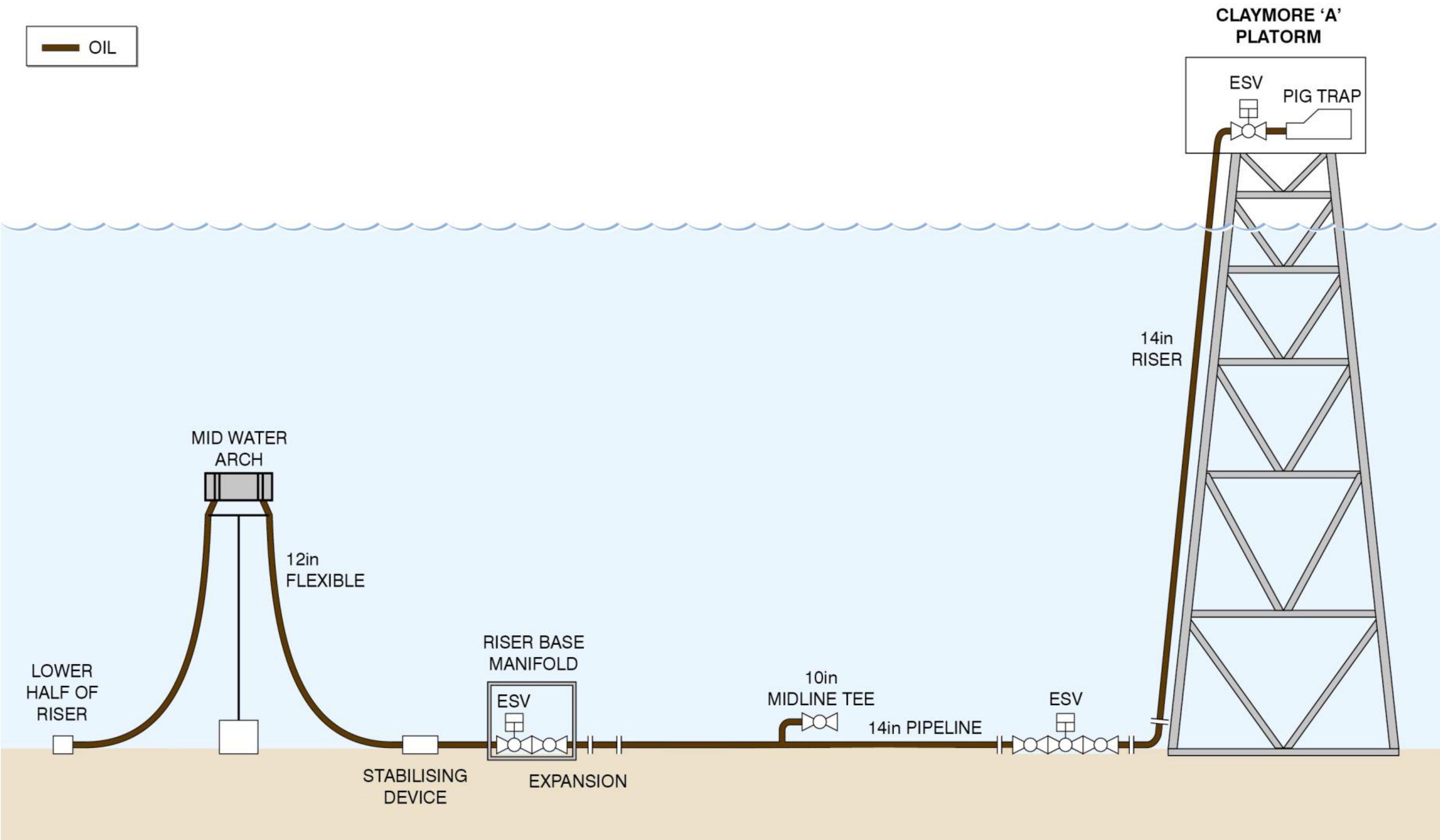

Figure 4.5: Oil Export System During Field Operation (MWA and Flexible Risers have now been removed)

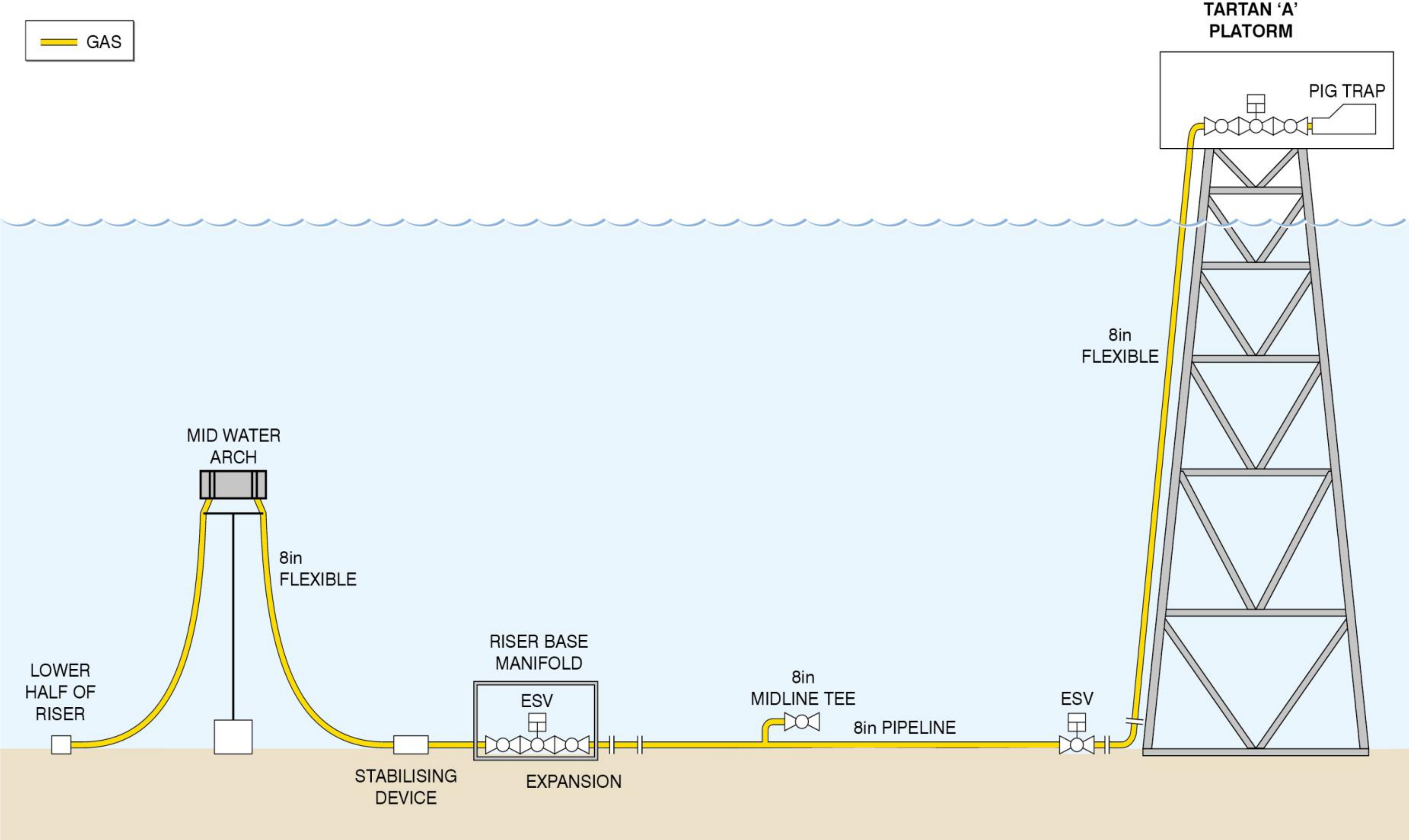

Figure 4.6: Gas Import/Export System During Field Operation (MWA and Flexible Risers have now been removed)

4.4 The Rob Roy and Hamish Fields

Seven production wells were used to recover the hydrocarbon reserves from the Rob Roy and Hamish fields. The hydrocarbons were transported through flexible jumpers to the Rob Roy production manifold, where two 8” flexible pipelines, PL515 and PL516, transported the fluids to the RBM. From the RBM, flexible risers then transported the fluids to *AH001*. Flexible riser PL516 also transported fluids from R-Block.

Figure 4.7 shows the layout of the infrastructure around the Rob Roy production manifold during the production life of the field.

The following items remain on the seabed and will be decommissioned:

- Rob Roy and Hamish Decommissioning Programme, DP3:
    - Subsea Structures (Section 4.5.1)
    - Mattresses and Grout Bags (Section 4.5.2)
    - Wells (Section 4.5.2)
- Rob Roy and Hamish Decommissioning Programme, DP4
    - Production Flowlines and Jumpers, including Flexible Risers (Section 4.6.1)
    - Gas Lift Flowlines (Section 4.6.2)
    - Water Injection Flowlines (Section 4.6.3)
    - Umbilicals (Section 4.6.4)

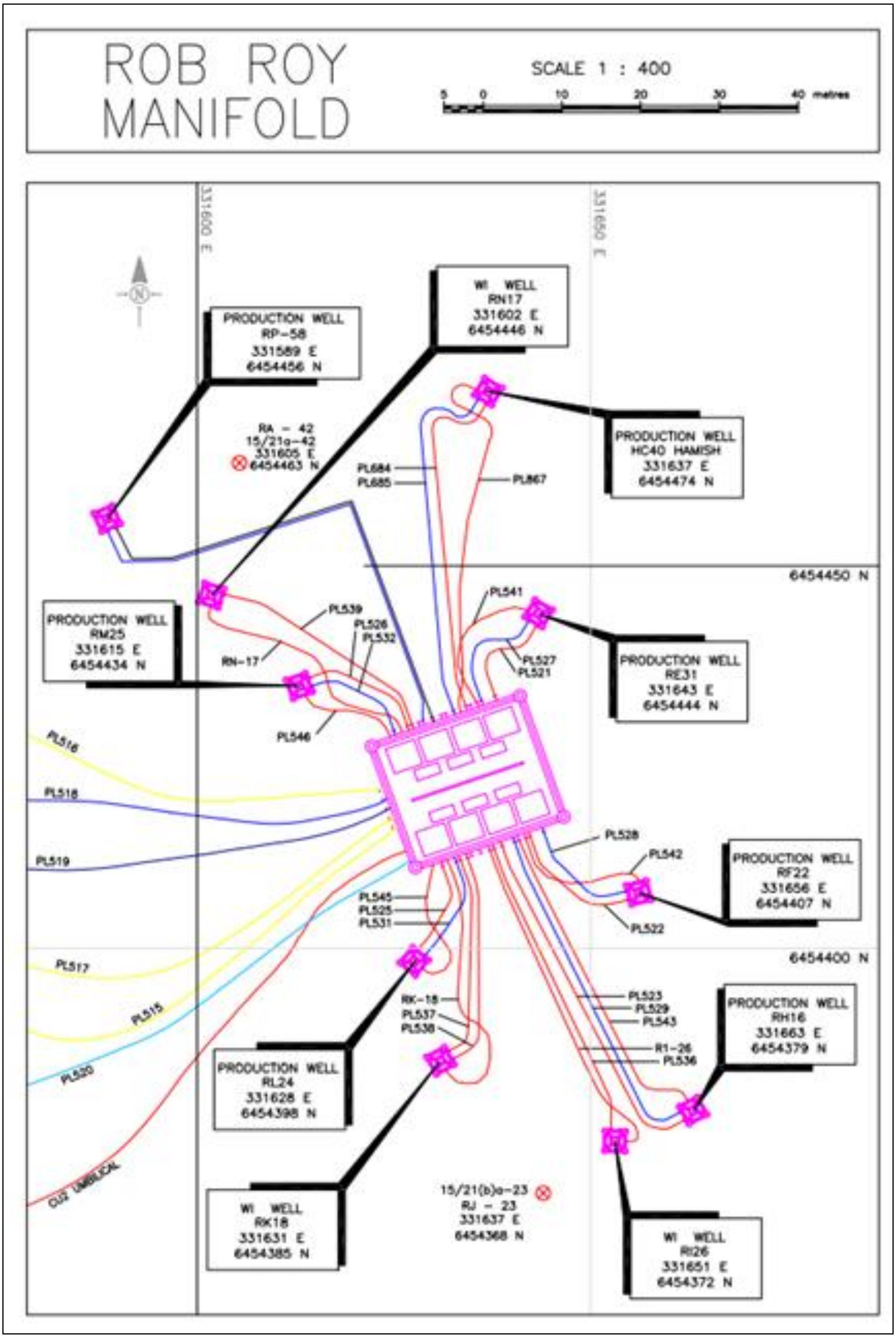

Figure 4.7: The Rob Roy Well Centre Infrastructure

4.5 Items to be Decommissioned under Rob Roy and Hamish Decommissioning Programme, DP3

4.5.1 Subsea Structures

4.5.1.1 Rob Roy Production Manifold (RRPM)

The Rob Roy production manifold (RRPM) received the production fluids from the Rob Roy and Hamish wells. It was also the distribution point for the injection water and lift gas required to maintain production. This rectangular structure is made from tubular steel and weighs 452 tonnes. It is 20 m long, 16.8 m wide and 8 m high and is secured by four 0.76 m diameter piles, 43 m in length. Five flowlines connect the RRPM to the RBM: three production flowlines (PL515, PL516 and PL517), the lift gas flowline (PL518) and the injection water flowline (PL519).

The six Rob Roy production wells, single Hamish production well and three water injection wells are arranged around the RRPM and are connected to the RRPM by flexible production and umbilical jumpers. As with the IVPM, all fluids to or from the production and water injection wells were routed via valve modules on the manifold.

The RRPM piping is anchored at two points: the headers are anchored at the infield flowline connections to protect them from snagging, and studded blocks bolted to a base frame and welded to the manifold structure protect the production valve manifolds. A 500 m safety zone exists around the RRPM.

4.5.2 Mattresses and Grout Bags

Of the 80 mattresses associated with the Rob Roy and Hamish infrastructure, 69 are Armorflex mattresses. Nine each protect PL518 (gas lift), PL517 (test), PL515 (production), PL516 (production), PL519 (water injection) and the static section of the chemical injection umbilical PL520 from the RSD to the RRPM; 15 mattresses cover the static section of the control umbilical from the CUBS to the RRPM. 11 smaller mattresses protect the spoolpieces associated with well RP58.

Grout bags may have been used to stabilise the subsea structures such as the RRPM but it is currently unknown how many may have been used or their location. Should any grout bags be identified during the decommissioning operations, they will also be removed from the seabed.

4.5.3 Wells

Eight production wells recovered the Rob Roy and Hamish reserves and they are arranged around the RRPM structure. One exploration well has been abandoned and another exploration was sidetracked to the Hamish producer well. The well RJ23 was not completed.

4.6 Items to be Decommissioned under Rob Roy and Hamish Decommissioning Programme, DP4

Table 4.2 (overleaf) presents details of the pipelines associated with the Rob Roy Field as listed in the Section 29 Notice. All static sections lie on the seabed surface.

4.6.1 Production Flowlines and Jumpers

Rob Roy and Hamish production fluids were transported via seven production jumpers which connect at the Rob Roy Production Manifold (RRPM) to two 8" flexible pipelines, PL515 and PL516 (Figure 4.7). The fluids were transported through these pipelines to the RBM and on through the 8" flexible riser PL515, supported by the MWA, to *AH001*.

The RRPM includes a test header, which is connected by flexible jumper lines to the wellheads and by a 5" flexible pipeline (PL517) to the RBM. The 5" flexible riser, (PL517) transports the test fluids from Rob Roy and Ivanhoe from the RBM to *AH001*.

4.6.2 Gas Lift Flowlines

As with the treated gas used for gas lift of the Ivanhoe wells, Rob Roy wells received the treated gas from a tee connection off the main gas import/export pipeline, via *AH001* and through the 5" flexible riser, PL518 which connects to the RBM. A 4" flexible pipeline, also designated PL518, then transported the gas from the RBM to the RRPM. 2" flexible jumpers then transported the gas from the RRPM to the individual wellheads.

4.6.3 Water Injection Flowlines

The treated, deaerated water used for injection in the Rob Roy wells was supplied from *AH001* via a 10" flexible riser (PL519) to the RBM. Flexible pipeline PL519 carried the water to the RRPM and on to the water injection wellheads through 4" jumpers.

Table 4.2: Rob Roy and Hamish Pipelines and Descriptions

Pipeline Number	Pipeline Type	Location	Surface/Buried
PL515	Production fluids	RRPM to RBM	Surface
PL516	Production fluids	RRPM to RBM	Surface
PL517	Test fluids	RRPM to RBM	Surface
PL518	Lift gas	RBM to RRPM	Surface
PL519	Injection water	RBM to RRPM	Surface
PL520	CI umbilical	*AH001* to RSD	Dynamic
PL520	CI umbilical	RSD to RRPM	Surface
PL521	Production fluids	Production well RE31 to RRPM	Surface
PL522	Production fluids	Production well RF22 to RRPM	Surface
PL523	Production fluids	Production well RH16 to RRPM	Surface
PL525	Production fluids	Production well RL24 to RRPM	Surface
PL526	Production fluids	Production well RM25 to RRPM	Surface
PL527	Lift gas	RRPM to production well RE31	Surface
PL528	Lift gas	RRPM to production well RF22	Surface
PL529	Lift gas	RRPM to production well RH16	Surface
PL531	Lift gas	RRPM to production well RL24	Surface
PL532	Lift gas	RRPM to production well RM25	Surface
PL536	Injection water	RRPM to injection well RI26	Surface
PL537	Injection water	RRPM to injection well RK18	Surface
PL538	Injection water	RRPM to injection well RK18	Surface
PL539	Injection water	RRPM to injection well RN17	Surface
-	Control umbilical	CUBS to RRPM	Surface
PL541	Control umbilical	RRPM to production well RE31	Surface
PL542	Control umbilical	RRPM to production well RF22	Surface
PL543	Control umbilical	RRPM to production well RH16	Surface
PL545	Control umbilical	RRPM to production well RL24	Surface
PL546	Control umbilical	RRPM to production well RM25	Surface
PL684	Production fluids	Production well HC40 to RRPM	Surface
PL685	Lift gas	RRPM to production well HC40	Surface
PL687	Control umbilical	RRPM to production well HC40	Surface
PL1881	Production fluids	Production well RP58 to RRPM	Surface
PL1882	Lift gas	RRPM to production well RP58	Surface
PLU1883	Control umbilical	Production well RP58 to RRPM	Surface
-	Control umbilical	RRPM to RN17, RK18, RI-26	Surface

Shaded: removed in 2011 (ADP-009)

4.6.4 Umbilicals

Two types of umbilical - chemical injection and control (electrical/hydraulic) - were used at IVRR. Each umbilical consists of a static and dynamic section.

4.6.4.1 Chemical Injection (CI) Umbilical

The chemical injection umbilicals supplied various chemicals to the wells, as needed. The chemicals included methanol, scale inhibitor, biocide and oxygen scavenger. Chemicals were routed from the chemical package on *AH001* through the dynamic and statics sections of PL520 to the RRPM.

PL520 (Rob Roy)

Chemical injection umbilical PL520 contained fifteen cores. The dynamic section of the umbilical was piggy-backed to the outermost starboard production riser (PL515) and terminated at a RSD, where the cores split out via a bulkhead plate and connected with the static section of the umbilical which then ran the RRPM. The dynamic section of PL520 was removed in 2011. At the RRPM, the umbilical terminated at a 15-way bulkhead plate adjacent to the electro-hydraulic distribution box (EHDB). From here, the individual cores ran via the manifold cable trays to single core bulkhead connectors mounted at the base of each production control module and on to chemical injection points on the manifold pipework. From here, the cores run to the production trees fastened to the control umbilical bundles, terminating at a stab plate mounted on the individual trees.

4.6.4.2 Control Umbilical

The control umbilical for both Ivanhoe and Rob Roy had both dynamic and static sections: The umbilical ran from near the hydraulic power unit onboard the *AH001* through a vertical caisson and was deployed in a steep wave configuration terminating at the seabed Control Umbilical Base Structure (CUBS). The Ivanhoe and Rob Roy fields shared this 225 m dynamic section of the umbilical which was removed in 2011. From the CUBS, three static umbilicals run on the seabed to the RBM, IVPM and RRPM. Note that control umbilicals and jumpers do not have PL numbers associated with them in the IVRR field. Sections of the umbilicals, particularly in the vicinity of the previous *AH001* location are protected from dropped objects by rock dump.

Rob Roy Control Umbilical

At the RRPM, the static umbilical section terminated at an EHDB, which configured the electrical supply, communications and hydraulic supply through utility jumpers to the SCMs.

5 INVENTORY OF MATERIALS

5.1 Ivanhoe Decommissioning Programme, DP1

5.1.1 Subsea Structures, including Wellhead Structures

Table 5.1: Dimensions, Material and Weight of Structures Associated with Ivanhoe and *AH001*

Item	Dimensions (m)	Material	Weight (t)
IVPM	16 x 15.6 x 8	Steel	359
RBM	14 x 13.3 x 6.6	Steel	324
CUB	7 x 4 x 1.2	Steel	15
Well materials	-	Steel	231
Rig anchoring piles (4)	30 x 1.52 (diameter)	Steel	152
FPF mooring piles (12)	1.5 x 30	Steel	480
Transponder piles (2)	4 x 0.46 (diameter)	Steel	2.8
Gas export midline T	4.7 x 1.3 x 1.5	Steel	3
Gas export ESDV structure	3.5 x 2.9 x <2	Steel	7.5
Oil export midline T	4.9 x 1.3 x 1.5	Steel	5
Oil export ESV skid and structure	27 x 4.2 x 3.7	Steel	80

5.1.2 Mattresses and Grout Bags

Table 5.2: Number and Weight of Mattresses Associated with Ivanhoe and *AH001*

Item	Number	Material	Dimensions (m)	Weight (t)
Armorflex mattress	84	Concrete	9.4 x 2.4 x 0.225	10

5.1.3 Wells

5.1.3.1 Production Wells

Production from Ivanhoe was achieved through five production wells and three injection wells (Tables 5.3 and 5.4), all of which are currently suspended.

Table 5.3: Ivanhoe Production Wells

Hess Well ID	DECC Well No.	Completion Date	Well Type	Depth (ft MDSS)
ID19	15/21a-19	July 1988	Oil producer	8,366
IB27	15/21a-27	November 1989	Oil producer	8,730
IK28	15/21a-28	November 1995	Oil producer	8,534
IE32	15/21a-32	October 1989	Oil producer	8,600
IJ57	15/21a-57	June 2000	Oil producer	8,870

5.1.3.2 Injection Wells

Table 5.4: Ivanhoe Injection Wells

Hess Well ID	DECC Well No.	Completion Date	Well Type	Depth (ft MDSS)
II29	15/21A-29	January 1990	Single selective water injector	9,232
IG30	15/21a-30	April 1990	Water injector	9,696
IF33	15/21a-33	December 1990	Water injector	9,477

5.2 Ivanhoe Decommissioning Programme, DP2

Tables 5.5 to 5.9 present information on the construction of the flowlines and jumpers used throughout the Ivanhoe Field.

5.2.1 Production Risers, Flowlines and Jumpers

Table 5.5: Description of Flowlines and Jumpers Currently in the Ivanhoe Field

Pipeline Number	Internal Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL547	8	Rislan	1,612	190.5	IVPM	RBM
PL547(J)IH59	4	Rislan	54	3.1	IH59	IVPM
PL548	5	Rislan	1,612	78.4	IVPM	RBM
PL552	4	Rislan	54	2.6	IB27	IVPM
PL553	5	Rislan	29	1.9	ID19	IVPM
PL554	4	Rislan	29	1.6	IE32	IVPM
PL555	4	Rislan	29	1.6	IK28	IVPM
PL1769	5	Rislan	45	2.7	IJ57	IVPM
PL513 (rigid spool)	14	Rislan	56	12.2	RBM	Oil export line
PL514 (rigid spool)	8	Rislan	37	2.8	RBM	Gas export line

5.2.2 Gas Lift Flowlines

Table 5.6: Description of Gas Lift Flowlines in the Ivanhoe Field

Pipeline Number	Internal Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL549	4	Rislan	1,607	54.4	RBM	IVPM
PL549(J)IH59	2	Rislan	54	1.2	IVPM	IH59
PL556	2	Rislan	54	1.2	IVPM	IB27
PL557	2	Rislan	29	0.7	IVPM	ID19
PL558	2	Rislan	29	0.7	IVPM	IE32
PL559	2	Rislan	29	0.7	IVPM	IK28
PL1770	2	Rislan	50	1.1	IVPM	IJ57

5.2.3 Water Injection Flowlines

Table 5.7: Description of Water Injection Flowlines in the Ivanhoe Field

Pipeline Number	Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL550	8	Rislan	1,600	136.9	RBM	IVPM
PL560	4	Rislan	43	2.1	IVPM	IF33
PL561	4	Rislan	43	2.1	IVPM	IG30
PL562	4	Rislan	43	2.1	IVPM	II29
PL563	4	Rislan	43	2.1	IVPM	II29

5.2.4 Umbilicals

Table 5.8: Description of Umbilicals Currently in the Ivanhoe Field

Pipeline Number	Length (m)	Weight (t)	From	To
Chemical injection				
PL551 (static)	1590	13.7	RSD	IVPM
Control				
-	417	1.5	CUBS	RBM
-	1894	19.5	CUBS	IVPM
PL564	80	0.4	IVPM	IB27
PL565	80	0.4	IVPM	ID19
PL566	80	0.4	IVPM	IE32
PL567	80	0.4	IVPM	IK28
-	(each) 80	1.7	IVPM	IJ-57, II-29, IG-30, IF-33

5.2.5 Export Pipelines

Table 5.9: Description of IVRR Export Pipelines

Pipeline Number	Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL513	14	Concrete	40,000	10,432	RBM	Claymore
PL514	8	Concrete	22,000	2,955	RBM	Tartan

5.3 Summary of Subsea Infrastructure Material Weights: Ivanhoe

Table 5.10: Summary of Types of Material and Weights in the Ivanhoe Field, including Items Removed in 2011 Campaign

Item	Material	Total Weight (t)	Weight to be Recovered (t)
Items Removed in 2011 Campaign (ADP-009)			
Risers	Steel	295	295
	Plastics	46	46
	Aluminium	0.15	0.15
	Copper	0.008	0.008
	NORM scale	1.4	1.4
Umbilicals	Steel	0.36	0.36
	Plastics	5	5
	Copper	0.29	0.29
Structures	Steel	2,199	2,199
Infrastructure Currently in the Ivanhoe Field			
Pipelines	Steel	7,539	508
	Plastics	61.3	61.3
	Aluminium	2	2
	Copper	0.06	0.06
	Concrete	6,273	66.7
	NORM scale	3.6	3.6
Umbilicals (CI and control combined)	Steel	19.4	19.4
	Plastics	17.6	17.6
	Copper	1.1	1.1
Structures	Steel	1,660	1,028
Mattresses	Concrete	840	840

Table 5.11: Overall Weight and Proposed Fate of Material from the Ivanhoe Field

Material	Total Weight (t)	Weight to be Recovered (t)	Proposed Fate (t)			
			Recycle	Reuse	Disposal	In-situ
Items Removed in 2011 Campaign (ADP-009)						
Steel	2,495	2,495	2,495	0	0	0
Plastic	50	50	50	0	0	0
Aluminium	0.2	0.2	0.2	0	0	0
Scale	1.4	1.4	0	0	1.4	0
Items Currently in the Ivanhoe Field						
Steel	9,218	1,552	1,552	0	0	7,665
Plastic	78.8	78.8	78.8	0	0	0
Aluminium	1.9	1.9	1.9	0	0	0
Copper	1.1	1.1	0	0	0	0
Concrete	7,113	907	0	0	907	6,206
Scale	3.6	3.6	0	0	3.6	0

5.4 Rob Roy and Hamish Decommissioning Programme, DP3

5.4.1 Subsea Structures, including Wellhead Structures

Table 5.12: Dimensions, Material, Weight of Structures Associated with Ivanhoe/A*H001*

Item	Dimensions (m)	Material	Weight (t)
RRPM	20 x 16.8 x 8	Steel	452
Well materials	-	Steel	318

5.4.2 Mattresses and Grout Bags

Table 5.13: Number and Weight of Mattresses Associated with Rob Roy and Hamish

Item	Number	Material	Dimensions (m)	Weight (t)
Armorflex mattress	69	Concrete	9.4 x 2.4 x 0.225	10
Other mattress	11	Concrete	6 x 3 x 0.15	4.8

5.4.3 Wells

Ten completed wells are associated with Rob Roy and Hamish: seven production and three water injection. These were suspended during Phase 1 activities (Table 5.14 and Table 5.15). There are also two 'Category 1' abandoned Rob Roy wells (Table 5.16).

5.4.3.1 Production Wells

Table 5.14: Rob Roy and Hamish Production Wells

Hess Well ID	DECC Well No.	Completion Date	Well Type	Depth (ft MDSS)
RH16	15/21a-16	June 1988	Oil producer	8,331
RF22	15/21a-22	May 1990	Oil producer	8,925
RL24	15/21a-24	April 1989	Oil producer	8,685
RM25	15/21a-25	July 1988	Oil producer	8,821
RE31	15/21a-31	August 1989	Oil producer	9,020
RP58	15/21a-58	August 2001	Oil producer	9,965
HRCZ40z*	15/21a-40z	February 1990	Oil producer	10,520

*Hamish

5.4.3.2 Injection Wells

Table 5.15: Rob Roy Injection Wells

Hess Well ID	DECC Well No.	Completion Date	Well Type	Depth (ft MDSS)
RN17	15/21a-17	May 1990	Water injector	10,805
RK18	15/21a-18	June 1989	Dual completion injector	10,320
RI26	15/21a-26	August 1988	Water injection	10,451

5.4.3.3 'Category 1' Abandonments

Table 5.16: Rob Roy 'Category 1' Abandonments Wells

Hess Well ID	DECC Well No.	Completion Date	Well Type	Depth (ft MDSS)
-	15/21a-42	-	Exploration	10,527
RJ23	15/21a-23	-	-	1,557

5.5 Rob Roy and Hamish Decommissioning Programme, DP4

Tables 5.17 to 5.20 present information on the construction of the flowlines and jumpers used in the Rob Roy Field.

5.5.1 Production Flowlines and Jumpers

Table 5.17: Description of Flowlines and Jumpers in the Rob Roy Field

Pipeline Number	Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL515	8	Rislan	1,612	188.9	RRPM	RBM
PL516	8	Rislan	1,612	188.9	RRPM	RBM
PL517	5	Rislan	1,612	78.1	RRPM	RBM
PL521	4	Rislan	29	1.6	RE31	RRPM
PL522	4	Rislan	29	1.6	RF22	RRPM
PL523	5	Rislan	54	3.1	RH16	RRPM
PL525	4	Duplex	13	0.5	RL24	RRPM
PL526	4	Rislan	43	2.2	RM25	RRPM
PL684	5	Rislan	54	3.1	HC40	RRPM
PL1881	4	EPDM 10mm	57	1.8	RP58	RRPM

5.5.2 Gas Lift Flowlines

Table 5.18: Description of Gas Lift Flowlines in the Rob Roy Field

Pipeline Number	Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL518	4	Rislan	1,607	54.4	RBM	RRPM
PL527	2	Rislan	29	0.74	RRPM	RE31
PL528	2	Rislan	29	0.74	RRPM	RF22
PL529	2	Rislan	54	1.21	RRPM	RH16
PL531	2	Rislan	29	0.74	RRPM	RL24
PL532	2	Rislan	29	0.74	RRPM	RM25
PL685	2	Rislan	54	1.21	RRPM	HC40
PL1882	2	FBE 0.5mm	65	0.63	RRPM	RP58

5.5.3 Water Injection Flowlines

Table 5.19: Description of Water Injection Flowlines in the Rob Roy Field

Pipeline Number	Diameter (in)	Coating	Length (m)	Weight (t)	From	To
PL519	8	Rislan	1,600	136.9	RBM	RRPM
PL536	4	Rislan	43	2.1	RRPM	RI26
PL537	4	Rislan	43	2.1	RRPM	RK18
PL538	4	Rislan	43	2.1	RRPM	RK18
PL539	4	Rislan	43	2.1	RRPM	RN17

5.5.4 Umbilicals

Table 5.20: Description of Umbilicals Currently in the Rob Roy Field

Pipeline Number	Length (m)	Weight (t)	From	To
Chemical Injection				
PL520 (static)	1,590	15	RSD	RRPM
-	1,894	19.48	CUBS	RRPM
PL541	80	0.42	RRPM	RE31
PL542	80	0.42	RRPM	RF22
PL543	80	0.42	RRPM	RH16
PL545	80	0.42	RRPM	RL24
PL546	80	0.42	RRPM	RM25
PL687	80	0.42	RRPM	HC40
PL1883	80	0.42	RRPM	RP58
-	(each) 80	1.08	IVPM	RN17, RK18, RI26

5.6 Summary of Subsea Infrastructure Material Weights: Rob Roy and Hamish

Table 5.21: Summary of Types of Material and Weights in the Rob Roy and Hamish Fields, including Items Removed in 2011 Campaign

Item	Material	Total Weight (t)	Weight to be Recovered (t)
Items Removed in 2011 Campaign (ADP-009)			
Umbilicals	Plastics	1.11	1.11
Infrastructure Currently in the Rob Roy and Hamish Fields			
Pipelines	Steel	592	592
	Plastics	80	80
	Aluminium	2.6	2.6
	Copper	0.06	0.06
	NORM scale	3.7	3.7
Umbilicals (CI and control combined)	Steel	19.5	19.5
	Plastics	18.1	18.1
	Copper	1.06	1.06
Structures	Steel	770	770
Mattresses	Concrete	743	743

Table 5.22: Overall Weight and Proposed Fate of Material from the Rob Roy and Hamish Fields

Material	Total Weight (t)	Weight to be Recovered (t)	Proposed Fate (t)			
			Recycle	Reuse	Disposal	In-situ
Items Removed in 2011 Campaign (ADP-009)						
Plastic	1.11	1.11	1.11	0	0	0
Items Currently in the Rob Roy and Hamish Fields						
Steel	1381	1381	1381	0	0	0
Plastic	98	98	98	0	0	0
Aluminium	2.6	2.6	2.6	0	0	0
Concrete	743	743	0	0	743	0

5.7 Summary of IVRR Material and Proposed Fates

Table 5.23: Total Materials within the IVRR Development, including Material Already Removed from the Fields

Material	Ivanhoe (tonnes)	Rob Roy (tonnes)	Total in IVRR (tonnes)	Tonnage to be Recovered
Steel	11,713	1,381	13,094	5,428
Plastic	129	99	228	228
Aluminium	2	3	5	5
Copper	3	0	0	0
Concrete	7,113	743	7,856	1,650
Scale	4	0	4	4

Table 5.24: Proposed Fate of Material from IVRR Development, including Material Already Removed from the Fields (ADP-009)

Material	Tonnage			
	Recycle	Reuse	Disposal	In-situ
Steel	5,428	0	0	7,665
Plastic	228	0	0	0
Aluminium	5	0	0	0
Copper	0	0	1	0
Concrete	0	0	1,650	6,206
Scale	0	0	4	0

SECTION 6 : REMOVAL AND DISPOSAL OPTIONS FOR THE PIPELINES AND UMBILICALS

6 REMOVAL AND DISPOSAL OPTIONS FOR THE PIPELINES AND UMBILICALS

6.1 Introduction

All subsea structures currently within the IVRR fields, including the RBM, IVPM, RRPM and well structures will be completely removed from the seabed and returned to shore. The pipelines and umbilicals were however subject to a Comparative Assessment, as required by the Petroleum Act 1998.

The options available for the decommissioning of the IVRR flowlines and umbilicals have been assessed to determine the most appropriate course of action. This assessment considered, for each option, the complexity and technical risk, the risk to personnel, environmental impact, effects on the safety of navigation or other users of the sea and economic factors.

This section presents the options that were considered and the results of the Comparative Assessment of the options. The full description of the Comparative Assessment methodology is presented in the report IVRR Decomm-HSE-RP-410 Rev 0.

6.2 Comparative Assessment Method

The DECC Guidance Notes require that each feasible option for the decommissioning of a flowline or umbilical should be evaluated through a formal Comparative Assessment process. For the IVRR lines, Hess evaluated each option against the five main criteria recommended by DECC. These were further divided into 12 sub-criteria, some of which could be evaluated quantitatively and some qualitatively. Hess also took the opportunity to weight the assessment criteria according to their importance, priority to the project and Hess corporate requirements. The assessment criteria and the associated weightings are as follows:

- Risk to personnel (25% weighting)
- Economics (20% weighting)
- Effect on safety of navigation and other users of the sea (20% weighting)
- Environmental impact (20% weighting)
- Complexity and associated technical risk (15% weighting)

The qualitative and quantitative data required to inform the Comparative Assessment were gathered in two separate phases of work: Desk-top studies were undertaken to generate data for those criteria that could be assessed quantitatively; these were atmospheric emissions and energy use, safety and cost.

A workshop was then held at the Hess office in Aberdeen, where technical and environmental experts from Hess and ERT (Scotland) Limited undertook the qualitative assessment. The attendees discussed all the criteria, and scored the performance of each option on a scale of 1 to 5 where a score of 5 represents the most desirable outcome for the assessment criterion in question.

6.3 Comparative Assessment Pipeline Options

Each pipeline and umbilical in the IVRR development was considered and it was found that the flowlines could be grouped according to their current status (eg buried or unburied or NORM contaminated) and physical characteristics. Similarities in the size, construction and status of the flowlines would result in the flowlines having similar decommissioning options. The decision was therefore taken to group the flowlines into three categories (A, B and C, see Table 6.1) and to conduct a comparative assessment for each category identified within the IVRR development.

Category A included all surface-laid pipelines and umbilicals with an internal diameter less than 12"; Category B included buried flowlines with an internal diameter greater than 12" (ie the export pipelines) and Category C included any flowlines, regardless of diameter or whether they were buried, that could be contaminated with NORM. Full descriptions of the IVRR pipelines, their physical characteristics and whether they are buried or surface-laid are presented in the tables in Sections 4 and 5. The decommissioning options for each category were determined and the comparative assessment then considered the performance of the options for each category of flowline.

For all flowlines, the possible decommissioning options were essentially the same, namely: leave the flowlines *in-situ* and protect any unburied sections with a combination of rock-dump and mattresses already in the field; remove some or all of the flowlines for onshore processing or completely trench and bury the flowlines. At the time of the comparative assessment workshop, any flowlines considered to be at risk of NORM contamination were considered as a separate category of flowline because of the slightly different processing and handling requirements.

Each option and the programme of work to complete decommissioning for each category of flowline is fully described in the Comparative Assessment report (ERT, 2009b). The feasible decommissioning options that were considered for the various categories of IVRR flowlines during the comparative assessment process are presented in Table 6.1.

Table 6.1: Options Available to the IVRR Decommissioning Project

Category of Items to be Decommissioned	Options			
	1	2	3	4
A - Flexible and Rigid Flowlines and Umbilicals on the Seabed	Leave all lines in place - use existing mattresses and additional rock dumping to cover surface lines.	Remove (reel) all surface lines (onshore disposal or recycling)	Jet-in or trench surface lines[2].	-
B - Buried Flexible and Rigid Flowlines and Umbilicals[1]	Leave all lines in place - use existing mattresses and additional rock dumping to cover surface lines.	Remove (reel) all surface lines at trench transition and bury cut ends with rock dump (onshore disposal or recycling).	Remove (reel) all surface lines at trench transition and bury cut ends by jetting-in (onshore disposal or recycling).	Remove all surface and buried sections of lines (onshore disposal or recycling).
C - NORM Lines on the Seabed	Removal and offshore treatment and disposal of NORM	Removal and onshore treatment and disposal of NORM.	Rock dump NORM contaminated surface lines, remove non-contaminated lines.	Jet-in NORM contaminated surface lines, remove non-contaminated lines.

[1] Includes sections of flowlines and umbilicals lying on the seabed.

[2] This method is impractical for the infield flowlines which are generally between 20 – 50 m in length and would be removed from the seabed.

Edited from IVRR-Decomm-HSE-RP-433 Rev C, (Hess, 2009).

6.4 Comparative Assessment Results

The comparative assessment method used to evaluate the decommissioning options resulted in a total weighted score being generated for each option, with the highest score representing the best performing decommissioning option for each category of flowline (Table 6.2).

Table 6.2: Overall Comparative Assessment Scores of the IVRR Decommissioning Options

Items to be Decommissioned	Options			
	1	2	3	4
A- Flexible and Rigid Flowlines and Umbilicals on the Seabed	3.18	3.98	3.68	-
B – Buried Flexible and Rigid Flowlines and Umbilicals	3.33	3.36	3.80	3.48
C – NORM Lines on the Seabed	2.88	3.61	3.61	3.71

Note: each preferred option for the items as indicated by the highest score is highlighted in a green box.

The overall comparative assessment scores for the options to decommission the IVRR flowlines indicate that the following are the preferred options:

- For flexible and rigid flowlines and umbilicals on the seabed: Complete removal by reverse reeling for onshore disposal or recycling.
- For buried flexible and rigid flowlines and umbilicals: Remove the surface components and in-field flowlines, bury the cut ends and leave in-situ.
- For NORM contaminated lines: Bury NORM contaminated surface lines and leave in-situ.

6.5 Comparative Assessment Selection and Conclusion

The Comparative Assessment results were based on the information available at the time of the workshop. Since then, several new onshore sites have become available for the disposal of NORM-contaminated materials. Furthermore, ongoing work within the project has established that the level of NORM contamination is not as extensive as previously thought. As a result of these developments, Hess have reviewed the outcome of the Comparative Assessment process for the NORM-contaminated lines and have decided that these lines will now be removed from the seabed surface and returned to shore for treatment and recycling or disposal as appropriate. This is reflected in the inventory of materials and the proposed fates of these materials in the Ivanhoe and Rob Roy fields (Section 5).

7 SELECTED REMOVAL AND DISPOSAL OPTIONS

7.1 Introduction

This section presents the proposed programme of work that will be conducted offshore to decommission the subsea infrastructure and flowlines remaining in the IVRR fields following the Phase 1 suspension and Phase 2 pre-decommissioning activities.

With the exception of the well decommissioning operations, the work to decommission the IVRR infrastructure will be completed using a diving support vessel (DSV), supported by other vessels, such as a heavy lift barge, as necessary. The programmes of work for the plugging and full abandonment of the wells, decommissioning the drill cuttings and for the removal of subsea debris are presented in Sections 8, 9 and 15 respectively.

It is Hess's intention to invite competitive tenders for the removal and disposal of the facilities, pipelines and umbilicals. Therefore, the final solution adopted in each case will depend upon the contractor(s) chosen and their available vessels and equipment, although the general proposals outlined in this section will be the guiding principles and philosophy.

7.2 Subsea Structures

The remaining subsea structures, such as the RBM, manifolds and CUBS will be recovered in single lifts (ie reverse installation) or cut into sections using grit-cutting or another suitable cutting method on the seabed for small piece recovery, depending on the size and weight of the structure and the vessel finally selected for the work. For those structures which are secured to the seabed with piles, the piles will be cut at least 0.6 m below the seabed using a grit-cutter or other suitable method. The structure will be removed and the remainder of the piles will be left *in-situ*.

7.2.1 Mattresses and Grout Bags

It is anticipated that a subsea basket will be used to lift the mattresses from the seabed as this is likely to be the safest and most practicable option. It is intended that all mattresses will be recovered. If it is found, however, that the mattresses or grout bags have deteriorated to such an extent that it is impracticable or unsafe to remove the remaining 'rubble', discussions will be held with DECC to decide on a course of action.

Once the schedule for removal has been finalised, alternative methods of recycling mattresses will be investigated (eg for use by local authorities in construction/civil engineering projects, coastal defence work, or the construction/reinforcement of breakwaters around harbours and marinas). Parts of the mattresses could also have a potential use as moorings. Ultimately, the concrete could be broken up to supplement aggregate used in roads or other construction projects.

7.3 Subsea Flowlines and Umbilicals

As described in Section 6.5, those pipelines and umbilicals which lie on the seabed, including any NORM-contaminated lines, will be completely removed and returned to shore for recycling/reuse/disposal. The pipelines and umbilicals will be recovered by reverse-reel or will be cut into sections and lifted, depending on the vessel ultimately selected for the work.

The buried oil and gas export lines will be left in place, with any unburied sections severed at the trench transition. It is currently estimated that 350 m of each of the export surface lines will be removed. The cut ends will be buried with a jetting tool to at least 0.6 m depth. The subsea isolation valve (SSIV) structures within the Talisman 500 m exclusion zones around the Claymore and Tartan platforms will be removed from the seabed in single or multiple sections.

7.4 NORM (Naturally Occurring Radioactive Material)

As described in the preceding sections, Hess intend to remove any NORM-contaminated flowlines and return them to shore for treatment and recycling or disposal of the materials as appropriate. The contractor for this work has yet to be selected, but Hess will ensure that the selected contractor has the experience and management procedures in place to handle and dispose of the NORM in a responsible way and in accordance with the relevant legislation.

7.5 Use of Explosives

There is no intention to use explosives during the decommissioning activities. In the unlikely event that explosives were required, and as part of the programme to manage the potential environmental impacts of decommissioning, the JNCC guidelines on minimising the risk of disturbance and injury to marine mammals would be followed (http://og.decc.gov.uk/assets/og/environment/jncc-ex-guide.pdf).

7.6 Remains on the Seabed After Decommissioning

With the exception of the buried sections of the export pipelines, piles that have been driven below the seabed and any areas of rock-dump, all of which will remain *in-situ*, all other items on the seabed will be removed for onshore disposal or recycling.

8 WELL DECOMMISSIONING

8.1 Description of Wells

Twenty wells are currently suspended in the IVRR development, including two 'Category 1' wells which have been plugged and require the wellheads to be cut and removed (Table 8.1).

Table 8.1: Summary of Wells in IVRR

Field	Suspended Oil Producing Wells	Suspended Water Injection Wells	'Category 1' Wells
Ivanhoe	5	3	0
Rob Roy (including Hamish)	7	3	2

The majority of the wells share a number of common features:

- All are subsea wells fitted with National dual bore Xmas trees, tied back by surface pipelines to field-specific production manifolds and then a riser base manifold (RBM). Fluids were transported from the RBM to the AH001 FPF, anchored mid-way between the fields, via a flexible riser system, supported by mid-water arch (MWA) structures
- The completion strings in the producers are 13Cr tubulars
- The completion strings in the injectors L80 tubulars
- All producers have permanent downhole gauges and cables installed

Two of the wells, however, were completed differently: Ivanhoe 15/21a-29 was completed as a single-selective injector, and Rob Roy 15/21a-18 is a dual completion.

Between April and June 2009, the wells were suspended by closing all of the Xmas tree production and annulus hydraulic valves and performing pressure tests to verify two competent barriers to flow from the wells. Where any difficulties were encountered in obtaining a test on the tree valves, the barrier was extended out to the subsea manifold valves, located approximately 50 m from the wells. The flowline jumpers between the Xmas trees and production manifolds were all disconnected at both ends and laid on the seabed in Q1, 2012 for future recovery. Blind flanges with double block and bleeds were fitted to all Xmas trees with environmental blinds installed on the production manifolds.

Similarly, the control umbilicals have also been disconnected from the Xmas trees and production manifolds.

In addition, the interfield flowlines from the IVPM and RRPM to the RBM and the oil and gas export lines have all been disconnected at both ends with environmental blinds fitted.

8.2 Well Decommissioning

At Rob Roy, two wells have been 'Category 1' suspended (only requiring wellhead removal for full abandonment), six wells have been suspended by means of both deep and shallow plugs and four wells are currently suspended by means of being shut in at the Xmas tree. All wells are awaiting further intervention and full abandonment.

At Ivanhoe, one well has been suspended by means of both deep and shallow plugs and is awaiting full abandonment, while seven are currently suspended by means of being shut in at the Xmas tree and are awaiting intervention and full abandonment.

As part of the decommissioning programme, Hess will re-enter the suspended wells (with the exception of the two 'Category 1' wells) and complete full abandonment in compliance with current legislation and Hess Wells Policies and Procedures. The wellheads will be removed from the 'Category 1' wells.

Full well decommissioning will be achieved through the use of a light well intervention vessel (LWIV) followed by a mobile offshore drilling unit (MODU). Well decommissioning will involve flushing and cleaning the wells, pulling completions to access the wellbores and placing permanent cement barriers at the appropriate depths according to the specific features of each well/reservoir. The fluids generated from the flushing will be contained and disposed of in compliance with applicable legislation.

The number and type of barriers will be designed in accordance with the Oil & Gas UK Guidelines for the Suspension and Abandonment of Wells, Issue 3, published in January 2009. Once all the deep-set reservoir barriers have been established, a shallow cement plug will be placed and the casing strings cut a minimum of 10 ft. below the seabed and recovered to surface, such that no well component is left sitting proud of the seabed. A seabed survey will then be undertaken using an ROV to check for debris.

All well abandonment activities will be consented, completed and reported under current UK permitting legislation, ie Petroleum Operations Notices for the use and discharge of chemicals during abandonment, and OPPC permit for the discharge of reservoir hydrocarbons during abandonment operations. Individual close-out reports will be prepared for each well and these will be submitted to and stored in the UK National Hydrocarbon Data Archive.

9 DRILL CUTTINGS

9.1 Introduction

In response to the implementation by DECC of OSPAR Recommendation 2006/5 on a 'Management Regime for Offshore Cuttings Piles', the cuttings piles in the IVRR fields were screened in 2009 to determine their environmental characteristics. The information summarised in this section is based on the Technical Review of Cuttings Data from Ivanhoe, Rob Roy and Hamish Fields with regards to Decommissioning and OSPAR Recommendation 2006/5 (ERT 1900, July 2009).

9.2 Methodology and Results

OSPAR Recommendation 2006/5 requires that any accumulation of cuttings derived from drilling more than one well, where oil based drilling muds (OBM) have been used and discharged, must be subjected to the Stage 1 screening assessment. If only water based muds (WBM) have been used to drill wells in a field then no assessment is required.

Following discussion with DECC, it was agreed that sidetrack wells should not be included when determining the total number of wells to be considered in the assessment. The review of historical data for the IVRR development determined that only two fields, Ivanhoe and Rob Roy, required the full Stage 1 screening assessment because OBM had been used and discharged at eight of the 12 wells at Ivanhoe and six of the 13 wells at Rob Roy; Hamish was exempt from the screening assessment as it is a single well site and OBM was not used in drilling operations. .

The Stage 1 screening process was a desk-based exercise and used end of well reports and environmental survey data collected in 1987 and 1990 to predict values for comparison with the OSPAR thresholds for oil loss and area persistence. These thresholds are defined as a rate of oil loss to the water column of less than 10 tonnes per year and a total area of seabed contamination, where the concentration of oil exceeds 50 mg/kg and the duration that this contamination level remains, of less than 500 km^2years (OSPAR 2006/5).

9.3 Conclusions

The desk-top cuttings pile review indicated that it was highly unlikely that the OSPAR 2006/5 oil loss or area persistence thresholds would be breached at either the Ivanhoe or Rob Roy fields. The data for the individual fields are presented in Table 9.1.

Table 9.1: Stage 1 Screening Process Results for the Ivanhoe and Rob Roy Fields

Field	Estimated Cuttings Volume (m^3)	Estimated Cuttings Area (m^2)	Maximum Estimated 50mg/kg Effect Area (km^2)	Rate of Oil Leaching (tonnes/year)	Persistence (km^2years)
Ivanhoe	6,444	2,194	0.785	0.42	55
Rob Roy	6,444	2,194	2.01	0.42	142
OSPAR threshold value				10	500

As the IVRR cuttings piles are below both the oil loss to the water column and the area persistence thresholds and no other discharges have contaminated the cuttings pile, the preferred option for management of these piles is to leave them *in-situ*, to degrade naturally, as described in OSPAR Recommendation 2006/5.

Further data was gathered during the pre-decommissioning baseline survey in 2010. The sampling grid was centred on the drill centres, with stations selected to show any gradient of effect from the discharge of OBM drilling fluids. This survey showed that THC levels in the vicinity of the wells had decreased from the levels reported in the 1987 and 1990 surveys. Since the OSPAR Recommendation Phase 1 screening assessment of the cuttings piles at Ivanhoe and Rob Roy had been based on the trends in THC exhibited in the data from the previous surveys, and the THC levels reported in the 2010 survey were substantially lower than those previously reported, it is very likely that the present areas of contamination fall well below both OSPAR thresholds.

10 ENVIRONMENTAL IMPACT ASSESSMENT

10.1 Introduction

This section summarises the outcomes of the Environmental Impact Assessment (EIA) conducted for the proposed decommissioning of the IVRR fields and facilities. The information is based on the full Environmental Statement (ES) (ADP-005) and the Comparative Assessment report (IVRR-Decomm-HSE-RP-410 Rev 0). The environmental setting and sensitivities of the IVRR area are summarised in Section 3.

10.2 The Environmental Impact Assessment Process

The objective of the EIA process is to incorporate environmental considerations into the project planning and design activities, to ensure that best environmental practice is followed and ultimately to achieve a high standard of environmental performance. The process also provides an opportunity for consultation with stakeholders at an early stage to ensure that all concerns are identified and can be addressed. The EIA was carried out in accordance with the Petroleum Act and other applicable environmental legislation such as The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended) and the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended by the Offshore Petroleum Production and Pipelines (Assessment of Environmental Impacts) (Amendment) Regulations 2007, and the Hess Environmental Management System (EMS).

In addition to the pre-decommissioning environmental survey in 2010, specialist studies were commissioned on commercial shipping traffic and the extent of hydrocarbon contamination of the seabed in the vicinity of the IVRR fields, to provide the necessary information to inform the EIA and assess potential impacts.

A scoping exercise was conducted to identify potential environmental impacts and an environmental issues identification (ENVID) workshop was held. During the ENVID, key activities associated with each phase of the project were described with technical input from members of the project team and recorded on a scoring matrix. The environmental aspects associated with these activities were then identified and the physical, biological, and socio-economic impacts on the environment were determined with reference to the local environmental sensitivities.

All aspects that were scored as “significant” were fully assessed as part of the EIA. Any aspect that was scored “insignificant” was deemed not to require further assessment. While it is recognised that this approach is subjective to some extent and open to a level of interpretation, it aims to provide consistency and transparency to the overall scoping process. The following were identified as having the potential to significantly impact the environment:

- The physical presence of the vessels
- Disturbance to the seabed
- Disturbance of the drill cuttings piles
- The planned use and discharge of chemicals to sea
- Waste handling
- Energy use and the production of atmospheric emissions
- Noise and vibration arising from the decommissioning operations
- A large hydrocarbon spill

A detailed assessment of these impacts is contained within the supporting Environmental Statement (ES) and is summarised in the following sections.

10.3 Physical Presence of the Vessels

The physical presence of the vessels and the MODU during the decommissioning operations has the potential to interfere with other users of the sea, for example shipping and fishing vessels, due to the exclusion zones that will be required around the vessels.

A 500 m exclusion zone continues to exist around the former site of the FPF *AH001* and the subsea infrastructure which currently remains on the seabed. A guard vessel has patrolled the IVRR development since the field was suspended and will remain in place until decommissioning operations end. Vessels involved in the decommissioning operations will primarily work within these 500 m zones, but the safety zone associated with the rig to be used as part of well decommissioning operations may encompass an area beyond the existing safety zones, though this area is expected to be relatively small. In addition, available fishing areas may be further reduced by the anchor spread and anchor chains of the drilling rig. Compared with the available area for fishing and shipping during the active and suspended phases of the development’s life, however, there will only be small incremental changes as a result of the decommissioning operations.

The IVRR fields lie in an area of low shipping density but in an area of high shellfish fishery effort. Any disturbance to these industries from the decommissioning vessels is expected to be minor and of a relatively short duration, after which, when all the subsea infrastructure is removed, the entire IVRR area will be accessible again. To minimise interference with shipping and the fishing industry, Hess will follow the same well-established systems for consultation, notification and permitting that have been developed for offshore exploration and production operations. Hess is consulting with the relevant authorities and fishing organisations with respect to the proposed activities, and will notify mariners and fishermen regarding these operations. The potential for interruption to shipping and fishing activities during the proposed decommissioning operations is therefore considered to be small.

10.4 Seabed Disturbance

The main sources of seabed disturbance will be the physical removal of infrastructure from the seabed, any water-jet burial operations, and the placement of the MODU's anchors prior to well decommissioning. There may also be some disturbance to the seabed from displaced rock cover when the CUBS-RBM umbilical is recovered through the rock. Some disturbance may also occur as a result of the post-decommissioning over-trawl survey which is required to establish a clear seabed and that no obstructions to other users of the sea remain. However, this level of disturbance is expected to be very small in comparison to the decommissioning activities.

Most of the pipelines and umbilicals to be recovered are lying on the seabed such that only the upper layers of the seabed will be disturbed as these items and the subsea structures are lifted. Only one umbilical is currently protected by rock – the CUBS to RBM umbilical – where it passes underneath the previous FPF location. This umbilical will be pulled through the existing rock cover; there are no plans to use water-jetting to clear the rock cover prior to removal. The use of water-jetting to bury the cut ends of the buried oil and gas pipelines will cause greater disturbance as the cut ends will be buried to a depth of 0.6 m. In total, approximately 26 km of flowlines will be removed, and if it is assumed that any disturbance to the seabed will be restricted to 10 m either side of the pipeline, this equates to an area of 0.52 km^2 of seabed being disturbed. During well decommissioning, the anchors of the MODU will disturb the seabed and will result in an estimated maximum area of 0.12 km^2 of seabed disturbance. There will also be a small amount of seabed disturbance as the well components are recovered, eg the conductors. The current total footprint of the subsea infrastructure in the field, including the RBM and the production manifolds, is estimated to be 741 m^2 (0.0007 km^2). During recovery of the structures, an area slightly larger than this may be disturbed.

Seabed disturbance is likely to result in the suspension of sediment in the water column and disturbance to or loss of a small proportion of the local benthic community. It may also result in the temporary disturbance of demersal fish species present in the area during the operations. The re-suspended material would be expected to settle in a restricted area due to the weak currents of the area and re-colonisation of the seabed is expected to be rapid following cessation of the disturbance.

Overall, no specific environmental sensitivities, such as conservation interests or qualifying features under the Habitats Directive, have been identified that would require additional mitigation with respect to decommissioning operations. In addition, whilst it seems likely that scars may be evident on the seabed for up to a few months, any impacts to the seabed are considered to be minor, given the relatively small area of seabed involved and the potentially rapid recovery of the benthos.

10.5 Disturbance of the Drill Cuttings Pile

OBM cuttings were discharged at eight Ivanhoe and six Rob Roy wells. The assessment of the drill cuttings piles in response to OSPAR Recommendation 2006/5 concluded that the accumulations would be unlikely to exceed the OSPAR thresholds for rate of oil loss to the water column and persistence over the seabed contaminated (Section 9).

Physical activities on or near the seabed at the well sites may therefore cause oil-contaminated material to be suspended into the water column. However, it is expected that any re-suspended material will re-settle in the same area, and thus no significant export of oily contaminants to clean areas of seabed will occur. The IVRR infrastructure was installed in such a way as to avoid any drill cuttings accumulations (Fugro ERT, 2012). No such accumulations have been identified in recent surveys and it is assumed that cuttings have been dispersed by the local hydrodynamic regime, leaving only elevated levels of contamination of the seabed sediment. The pre-decommissioning survey has confirmed that the levels of hydrocarbons in the sediment, though elevated above background levels at the innermost stations, are now lower than those previously reported for the fields indicating that the hydrocarbons continue to degrade naturally or are being dispersed by seabed currents (Section 3.3). It is therefore concluded that the disturbance of contaminated seabed sediments during well or facility decommissioning is unlikely to have any significant adverse effect on the environment.

10.6 Planned Use and Discharge of Chemicals to Sea

Chemicals may be required for various applications during the well decommissioning process. There may also be some chemical discharges during the pipeline decommissioning.

The use and discharge of chemicals for offshore oil and gas activities on the UKCS is regulated under the Offshore Chemicals Regulations (OCR) 2002 (as amended). An application for a term permit for the use and discharge of chemicals during the well abandonment and the pipeline decommissioning operations will be submitted to DECC in the form of a Petroleum Operations Notice (PON). Each PON will contain a complete and fully quantified list of all chemicals to be used and discharged during the course of the proposed activity. Only chemicals which are approved for use and discharge in the UK by the Centre for the Environment, Fisheries and Aquaculture Science (CEFAS) can be used.

10.7 Waste Handling

Over the course of decommissioning operations, waste materials will be generated, mostly from the removal of various types of seabed infrastructure. Disposal of waste from offshore operations is primarily controlled by The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008 and The Environmental Protection Act 1990 with its associated regulations such as the Environmental Protection (Duty of Care) Regulations 1991 and Hazardous Waste (England and Wales) Regulations 2005.

As required under the Duty of Care, all waste produced offshore will be segregated and recorded. Wastes generated during decommissioning will be segregated by type and periodically transported to shore in an auditable manner through licensed waste contractors.

NORM contamination which may be present in the IVRR infrastructure will require specialised waste transport and handing processes and is regulated under the Radioactive Substances Act 1993. As the infrastructure is recovered to the vessels, it will be examined for the presence of NORM. If any contamination is found, the items will be sealed and delivered to specialist contractors for decontamination treatment and disposal.

The recovered subsea infrastructure, such as decommissioned flowlines, umbilicals and well infrastructure, will be returned to shore for processing. If possible, the materials will be reconditioned and reused, or component parts may be stripped out for recycling. Only where reclaiming or recycling is not technically possible will any material ultimately be sent to landfill for disposal. The impact of disposing of such material to landfill was assessed during the EIA as representing a maximum of approximately 0.2% of the waste sent to landfill by the construction and demolition industries and was therefore assessed as a minor impact.

10.8 Energy Use and Atmospheric Emissions

The proposed decommissioning operations will result in both energy use and subsequent atmospheric emissions. Energy use is described as a function of energy used during the actual decommissioning activities. This includes operations to dismantle facilities or components, transport them to shore, and recycle or treat any recovered material. Additionally, there will be theoretical quantities of energy and gaseous emissions associated with recyclable material that is left *in-situ* and not re-used or recycled. The total amounts presented in the following sections therefore refer to the sum of the actual energy use and theoretical energy cost. This approach to the estimation of energy use and gaseous emissions ensures that the "savings" that may be achieved by retrieving material from the sea and recycling it are fully and accurately quantified. The quantification of energy use in this assessment is based on the 'Guidelines for the calculation of estimates of energy use and gaseous emissions in the decommissioning of offshore structures' published by the Institute of Petroleum in 2000.

A general indicator of atmospheric emissions is the global warming potential (GWP), which is expressed in tonnes of CO_2 equivalents. GWP is a measure of the radiative effect of a given gas in relation to CO_2, integrated over a chosen time period, often 100 years. It is estimated that 86,500 tonnes of CO_2 equivalent would be produced by the IVRR decommissioning operations, including vessel operations, onshore transport, recycling and new manufacture of materials left *in-situ*. This figure is approximately equivalent to that of a MODU drilling 14 North Sea exploration wells. Of this figure, the largest contributions are from the vessels (including the MODU, LWIV and DSV) involved in the dismantling work offshore, and from the onshore facilities which would undertake the cleaning, breaking and recycling of the decommissioned items. Of this figure, 20,300 tonnes CO_2 equivalent arises from the fact that the buried sections of the export pipelines will be left *in-situ* and that the materials in these items will be unavailable for recycling and, theoretically, will have to be replaced by new manufacture.

The total energy use in the proposed decommissioning programme is estimated to be 991,228 GJ; this is equivalent to 0.0011% of the total UK inland energy use in 2010 (9.15×10^9 GJ). In this context, the atmospheric emissions and energy use associated with the IVRR decommissioning operations are considered to be small.

10.9 Noise and Vibrations

The main sources of underwater sound produced during the decommissioning operations at IVRR will be the machinery and engines on the MODU, LWIV and DSV, and the mechanical cutting tools that will be used to cut the pipelines and piles. In addition, the LWIV and the DSV will operate on their Dynamic Positioning (DP) system to remain in position, and the intermittent bursts of noise from the thrusters will add to their acoustic footprint.

The broadband sound levels for vessels operating on DP typically range from 174 to 191 dB re 1µPa @ 1m, with the strongest tones being emitted at frequencies of less than 1 kHz. Although no specific data is available for the sound intensity of mechanical cutting tools, these are expected to be below this level.

The potential impact on marine mammals from the noise and vibration of the proposed operations has been assessed in the Environmental Statement. Although it is unlikely that any of the proposed decommissioning operations will cause injury to marine mammal species, they may evoke short-term behavioural responses from any cetaceans present in the immediate vicinity of the operations.

The cetacean species likely to be in the vicinity of the IVRR fields during decommissioning includes species considered to be mid-frequency cetaceans (estimated auditory bandwidth of 150 Hz to 160 kHz) and high-frequency cetaceans (estimated auditory bandwidth of 200 Hz to 180 kHz) such as harbour porpoise. Within 0.1 km of the activities, sound levels have been calculated to be between 123 and 163 dB re 1µPa @ 1m, dropping to 103 to 143 dB re 1µPa @ 1m at 1 km from the noise source.

Cetacean densities in the IVRR area are generally low (Section 3.4.5), and the operations will be temporary and intermittent. The impacts of underwater noise on cetaceans from any of the decommissioning operations at IVRR are therefore considered to be insignificant (Fugro ERT, 2012).

There are no plans to use explosives during the decommissioning activities, and Hess would exhaust all other options before applying to use explosives in connection with their operations at IVRR. Should this unlikely event occur, Hess would apply for the relevant permits and follow the existing JNCC guidelines for minimising the risk of disturbance and injury to marine mammals (https://www.og.decc.gov.uk/environment/jncc_ex_guide.pdf).

10.10 Hydrocarbon Spills

During the proposed decommissioning operations, the main risks of a significant oil spill are associated with well abandonment operations, and the spillage of fuel oil from the vessels engaged in the programme. Any large spill is therefore likely to involve either crude oil or diesel oil.

The probability of a spill as a result of a loss of well control is extremely low; the wells are being abandoned as they no longer produce economically viable amounts of oil, and their present conditions are well known. The well abandonment operations have been risk-assessed in a loss of containment study and simulations have been conducted using the "Prosper" software to estimate maximum oil flow rates from the IVRR wells during a well blow-out event.

Each wellhead will have been isolated and fitted with blind flanges with double block and bleed valves for protection. In order to prevent a spill occurring, stringent safety and operational procedures will be followed throughout decommissioning activities. However, should a well blow-out occur, deterministic modelling indicates that crude oil may beach on the UK coastline within three days and could also cross the UK/Norway median line within three days, potentially beaching within five days in winter or eight days in summer (Fugro ERT, 2012).

It should be noted that the modelling assumes no action is taken to mitigate the spill, and in reality Hess would mobilise oil spill response measures immediately. In the very unlikely event that a large spill were to occur, it would be a priority for Hess to ensure that no spilled oil would impact the coastline and all oil spill response techniques would be employed to prevent this.

Diesel will be the main fuel used for power generation during the proposed decommissioning operations and will therefore be the most significant type of hydrocarbon stored on the drilling rig, LWIV and DSV. Once spilled into the sea, diesel oil evaporates and disperses relatively quickly. Deterministic modelling of a release of 2,215 m^3 of diesel at the IVRR development conducted for the LWIV Seawell/Well Enhancer oil pollution emergency plan (OPEP) (ADP-006) indicated that the volume of diesel on the sea surface would become insignificant after 9 hours and that no oil would cross the UK/Norway median line or threaten the nearest UK coastline.

The highest risk of a diesel spillage occurs during fuel bunkering operations between the mobile drilling rig and supply vessels. Hess and the rig operator will have operational procedures in place which will minimise the risk of a spill during bunkering operations. Hess currently has an approved oil pollution emergency plan (OPEP) in place for the suspended subsea infrastructure of the IVRR development (ADP-018) and a contract with Oil Spill Response is in place, allowing the rapid deployment of personnel and equipment in the event of a large spill. This OPEP conforms to the Merchant Shipping (Oil Pollution, Preparedness, Response and Co-operation Convention) Regulations 1998 and the Offshore Installations (Emergency Pollution Control) Regulations 2002, and has been approved by DECC. Once planning of the decommissioning operations is finalised, this document will be revised and submitted to DECC for approval.

10.11 Cumulative and Transboundary Impacts

Cumulative impacts occur as a result of a number of activities, discharges or emissions combining or overlapping, potentially creating a new impact or exacerbating an existing one.

The proposed decommissioning operations may impact upon the benthos through habitat disturbance related to the placement of spud cans or anchors, and by the disturbance and re-suspension of sediments (including previously deposited drill cuttings) by various activities. These impacts will be very localised and temporary in nature with strong potential for recovery. The total area affected would be a small proportion of the available benthic habitat, and no habitats of particular conservation concern are present in the area. Finally, the cessation of oil and gas operations in the IVRR fields will remove the intermittent seabed disturbance associated with the preceding field exploration, development and production activities, give seabed habitats the chance to recover, and therefore result in a beneficial impact in cumulative terms.

Transboundary impacts are those which could have an impact on the environment and resources beyond the boundary of UK waters. The only event associated with the decommissioning of the IVRR development which could have a transboundary effect is an accidental spill of hydrocarbons. The most likely type of hydrocarbon spill would be the loss of diesel as a result of a collision between vessels, though deterministic modelling has indicated that such a spill, even if left untreated, would be unlikely to cross the median line. Although very unlikely, crude oil spillage from a well blow-out during operations has also been modelled. The stochastic modelling, based on statistical Metocean data, indicated that there is only a 10% chance of the crude reaching the Norwegian coast and a 5% chance of crude beaching on the UK coast (without intervention). In reality, in the event of an oil spill, Hess would initiate oil spill responses appropriate to the magnitude of the spill.

10.12 Conclusions

All the measures to minimise and mitigate environmental impact, as described in this environmental impact section and fully described in the supporting Environmental Statement, will be delivered by the project through the IVRR Decommissioning Project EHS Plan. The EHS Plan implements the requirements of the Hess EMS for this specific project.

The only potentially significant impact is a large oil spill resulting from a loss of well control during the well abandonment operations. The probability of such a spill is very low, and Hess will have mitigation and management procedures in place to prevent this from happening, as well as adequate resources to deal with such a spill should it occur. All other impacts identified during the EIA are expected to have only localised impacts, with good potential for recovery over time.

Overall, it is therefore concluded that the proposed IVRR fields decommissioning operations will not result in any significant long-lasting environmental effects.

11 INTERESTED PARTY CONSULTATIONS

11.1 Consultation with Statutory Consultees and Public Notification

In parallel to the submission of the consultation draft Decommissioning Programmes to DECC for consideration, copies will be submitted to the following four statutory consultees:

- The National Federation of Fisherman's Organisations
- Scottish Fisherman's Federation
- Northern Ireland Fisherman's Federation
- Global Marine Systems Limited

A notice will be published in a local and national newspaper as well as the London Gazette, advising that a draft Decommissioning Programmes document has been submitted for consultation.

A copy of the consultation draft Decommissioning Programmes document will be placed on an open access internet site at http://www.hess.com/decommissioning and this site will be referenced within the press notice.

12 COSTS

Estimated costs for the decommissioning of the IVRR development have been prepared. The final cost of the project will depend on the actual cost of any further engineering studies, eg well engineering, and the personnel, equipment, vessels and contractors required to complete the work both offshore and onshore. Due to the sensitive nature of the information, detailed cost data will be provided to DECC separately during the Decommissioning Programme approval process.

13 SCHEDULE

The high level schedule for the overall IVRR decommissioning project is shown in Figure 13.1. In general, this schedule is based on performing the offshore operations during 2013 - 2016 and will be dependent upon the availability of vessels and equipment. Synergies with other Hess decommissioning projects which may be performed in the same time-frame will be explored and so the final timing of individual activities may be different from that shown.

The final seabed clearance survey will be conducted on cessation of offshore operations, and the close-out report will be submitted to DECC within four months of this survey. The requirement for further surveys, and the nature and frequency of future monitoring of the condition of the buried pipelines, will be discussed and agreed with DECC.

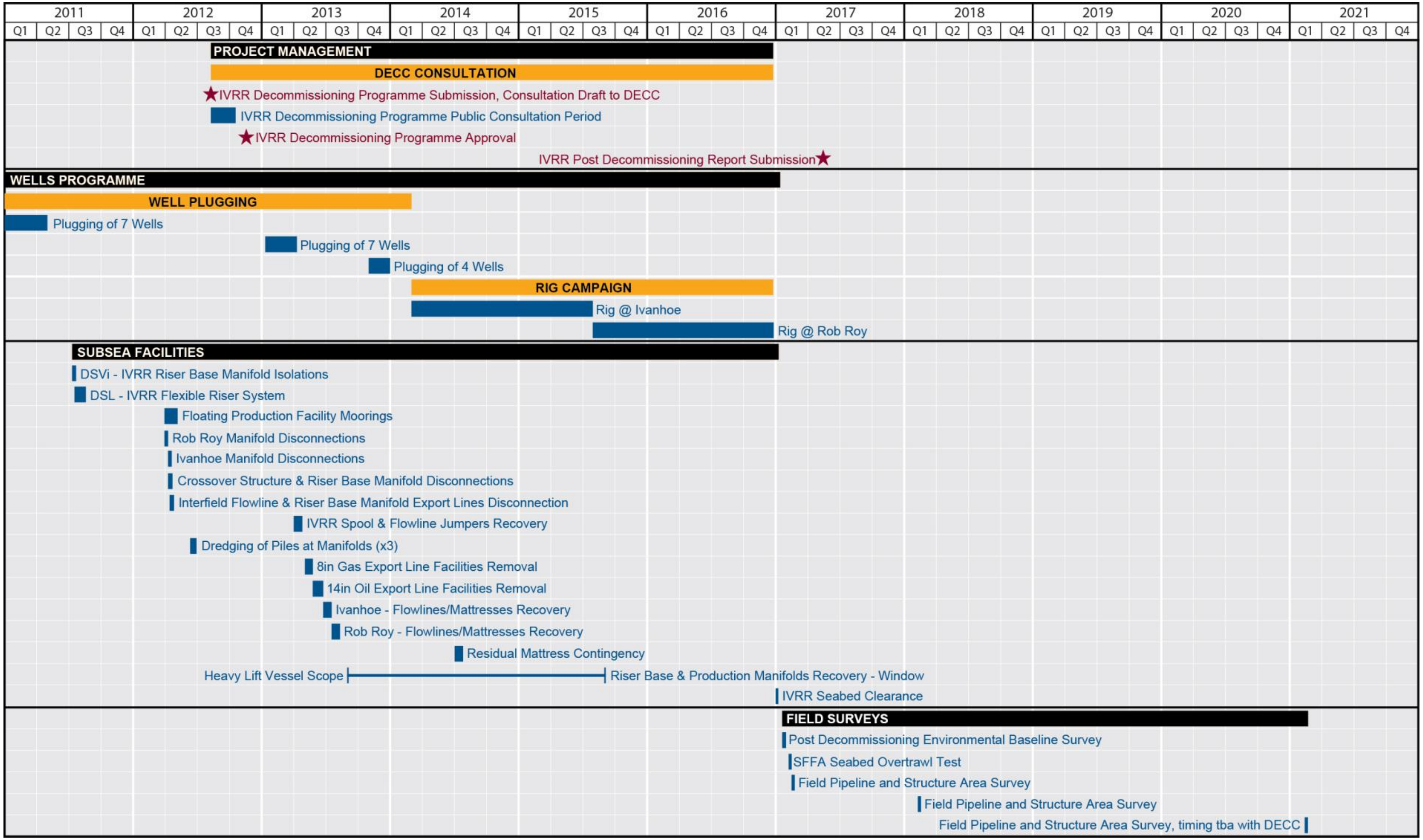

Figure 13.1: Outline Schedule for Phase 3 Full IVRR Decommissioning Project

14 PROJECT MANAGEMENT AND VERIFICATION

14.1 Project Management

A multi-disciplinary project team will be assembled by Hess to implement the Decommissioning Project. The team's responsibility will be to execute the decommissioning of the subsea wells and infrastructure in a safe manner, according to the Hess Project Management Guidelines.

Hess has an established Environmental Management System (EMS), certified to the international standard ISO 14001:2004 and OSPAR Recommendation 2003/5, which has been approved by DECC. The environmental management of the decommissioning operation itself will be covered by the Project Environment, Health and Safety (EHS) Plan.

Key decisions will be made and management control achieved by the Hess Value Navigator Process. The strategy for this project will be to maximise the use of Hess in-house resources and existing contracts for the preparatory work, and to award a series of lump sum contracts to pre-qualified prime contractors for the main decommissioning activities.

The overall contract strategy for the decommissioning operations is still being developed but it is anticipated that the main awards will cover the following scopes of work:

- Engineering, preparations and removal of subsea facilities and pipelines
- Engineering, preparations and setting of well deep barriers
- Engineering, preparations and setting of well shallow barriers
- Environmental support
- Onshore recycling and disposal

The contractors will be monitored at all stages of the work to ensure compliance with Key Performance Indicators (KPIs), procedures and principles. The Hess project team will be responsible for the execution of the project, including:

- Setting EHS standards and targets for the project
- Determining the scope and schedule of the decommissioning work
- Selecting and managing contractors
- Reviewing the progress of the project and reporting to DECC
- Ensuring compliance with appropriate regulatory requirements
- Ensuring that the IVRR fields are left in the condition as described in each programme and as approved by DECC

14.2 Legal Compliance

The execution of this project will follow Hess procedures and requirements, which will include the timely management of all applicable consents, licences and permits required for the work. This will include, but not be limited to, the relevant environmental permits, waste management and disposal consents, and notifying other users of the sea of the offshore activities, as well as any associated reporting requirements.

14.3 Duty of Care for Waste Materials

All wastes generated during decommissioning operations will be handled in accordance with the Hess Waste Management Strategy, and a project-specific Waste Management Plan will be developed. Hess will ensure that waste management and minimisation during the planned operations comply with the existing regulatory framework. Waste will be segregated and stored in suitable containers on the various vessels involved in operations, and its subsequent transportation, treatment and ultimate fate will be monitored.

Hess will ensure that all waste contractors are appropriately registered and all waste managers are appropriately authorised for the activities and types of waste being treated or disposed of. This will be achieved through following established Hess procedures and will include a requirement for the contractor to provide HS&E policy statements, ISO registration certificates, waste management licences and registered waste carriers certificates. No waste from the decommissioning project is expected to be shipped across frontiers. Hess will ensure compliance with their legal "Duty of Care" with regard to the management, treatment and disposal of all waste equipment and materials retrieved onshore during the programme (see also Section 10.7). Hess intends to recycle 95% of the recyclable material that is returned to shore. If it is possible to reuse or sell any recovered equipment, Hess will evaluate the opportunity on a case-by-case basis.

14.4 Verification

The project will be subject to internal peer reviews at key stages. This will involve Hess, Endeavour and other stakeholders. Key technical decisions are also subject to approval from the Hess internal 'technical authorities'.

The well abandonment programme will be examined under Regulation 18 of the Offshore Installation and Well Design and Construction Regulations (DCR, 1996) and will be verified by Hess's well examiner.

The verification of a clear seabed will be conducted by an independent vessel at the end of decommissioning operations. Within four months of completion of the work, Hess will provide the following information to DECC:

- Post-decommissioning survey report
- Debris clearance survey report
- Seabed clearance certificate
- Project close-out report

14.5 Reporting Progress to DECC

Upon approval of the Decommissioning Programmes, DECC will be given regular progress reports which will continue during the offshore removal operations.

15 DEBRIS CLEARANCE

15.1 Seabed Clearance

Very little debris has been identified within the IVRR fields during ROV inspection surveys. Where debris has been noted, it has been identified and logged and will be removed during the decommissioning operations. Should any large item be lost overboard during the programme of work, it will be located and retrieved.

An ROV debris survey will be carried out at each IVRR subsea structure on completion of the proposed offshore decommissioning operations. Any debris associated with the IVRR development that is found will be removed. The debris surveys will cover at least a 200 m wide corridor along the length of any pipelines and an area of 500 m radius around the subsea structures. All debris recovered will be processed in accordance with the Hess waste management strategy.

15.2 Final Condition of the Offshore Site

At the end of the decommissioning activities, all structures previously lying on the seabed will have been removed. All trenched, buried or piled items will be left *in-situ* at a minimum depth of 0.6m below the seabed. Upon completion of all subsea removal operations, an independent debris trawl will be organised and a seabed clearance certificate obtained and submitted to DECC.

16 PRE- AND POST- DECOMMISSIONING MONITORING AND MAINTENANCE

16.1 Introduction

In order to monitor the extent and significance of any impacts that may be caused by the offshore decommissioning operations, a programme of pre- and post-decommissioning surveys will be performed for the IVRR fields. This section outlines the scopes of the proposed surveys.

16.2 Pre-decommissioning

16.2.1 Annual ROV Surveys of Subsea Facilities

Following the suspension of the fields, and continuing until they are fully decommissioned, an annual ROV survey will be carried out to undertake general visual inspections of all Xmas trees, structures, pipelines and umbilicals to ensure there are no significant changes to their condition.

16.2.2 Environmental Baseline Survey

In order to fully characterise the physical, chemical and biological status of the IVRR fields prior to the decommissioning operations, a pre-decommissioning environmental baseline survey was conducted in 2011. The baseline survey followed a radial sampling strategy, as outlined in the OSPAR-JAMP guidelines for sediment sampling, to ensure sufficient coverage.

16.2.3 Drill Cuttings Monitoring

The pre-decommissioning survey included a sampling campaign to characterise the level of seabed contamination from the discharge of OBM drilling fluids and the extent of cuttings dispersion around each drill centre. This addressed the requirements of OSPAR Recommendation 2006/5 and ensured that the extent of cuttings dispersion around each drill centre was sufficiently characterised. As no physical drill cuttings piles are present, the sampling grid to investigate OBM contamination was arranged using the drill centres as the central point.

16.3 Post-decommissioning

16.3.1 ROV Surveys of Subsea Facilities

Once the fields have been decommissioned, a detailed survey will be performed to verify that all items have been cleared from the seabed surface and that no obstructions remain on the seabed. In addition, two post-decommissioning surveys will be performed, at intervals to be agreed with DECC, on the trenched areas of pipelines that remain buried in the seabed to confirm their depth of burial, status and condition. A full report of the post-decommissioning surveys will be submitted to the DECC Offshore Decommissioning Unit and the need for further monitoring surveys will then be discussed and agreed with DECC.

16.3.2 Post-decommissioning Environmental Survey

Following completion of the decommissioning work, a post-decommissioning environmental survey will be conducted, re-sampling the stations investigated during the pre-decommissioning study in order to monitor any change in the local seabed environment, eg redistribution of cuttings material or contaminated sediments. The need for further monitoring surveys will be discussed and agreed with DECC.

17 SUPPORTING STUDIES

Table 17.1: Supporting Studies for the IVRR Decommissioning Programmes

Document Number	Title
ADP-005	Environmental Statement Ivanhoe and Rob Roy (Fugro ERT, 2012)
ASE-170	Technical Review of Cuttings Data from Ivanhoe, Rob Roy and Hamish Fields with Regards to OSPAR Recommendation 2006/5 on a Management Regime for Cuttings Piles (ERT, 2009a)
IVRR-Decomm-HSE-RP-410 Rev 0	Comparative Assessment: Decommissioning of the Suspended Ivanhoe, Rob Roy, Hamish, Renee and Rubie Fields (ERT, 2009b)
ADP-013	AH001 Pre-decommissioning Environmental Baseline Survey: Ivanhoe and Rob Roy Survey Area (August/October 2010)
ADP-018	Oil Pollution Emergency Plan: IVRR (Suspended Fields)
ADP-006	Oil Pollution Emergency Plan: IVRR (Seawell/Enhancer)
ADP-019	Decommissioning Project EHS Plan
ADP-009	Summary of IVRR Phase 1 and Phase 2 Works.

APPENDIX A : SECTION 29 NOTICE HOLDERS' CORRESPONDENCE REGARDING SUBMISSION OF DECOMMISSIONING PROGRAMMES